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The Geodesist's Handbook 2012

International Association of Geodesy

A constituent Association of the

International Union of Geodesy and Geophysics (IUGG)

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GEODESIST'S HANDBOOK 2012

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Foreword

The International Association of Geodesy (IAG) publishes periodically after each IUGG/IAG General Assembly a new issue of the Geodesist's Handbook. The objective is to present the current IAG structures and specifications, and to introduce the terms of reference and officers of the Association's components to the broad geodetic community. The scientific program and the planned activities for the upcoming legislature period are described in detail.

The first part of the Handbook 2012 reviews the latest developments and presents the current status of IAG. The IAG Statutes, Bylaws and Rules are published in their latest versions.

The second part summarizes the official outcome of the 43rd IAG General Assembly held in conjunction with the 25th IUGG General Assembly in Melbourne, Australia, in June/July 2011. An overview of the most important IAG results from 2007 to 2011 is given in the presidential address. The citations of the scientists decorated in Melbourne with the highest IAG awards (Levallois Medal, Guy Bomford Prize, and Young Authors Award) are published. Reports of the Secretary General, the IAG Council and Executive Committee meetings, and the resolutions conclude this section.

The third part of the Handbook contains the detailed structures and programs for the period 2011-2015. All IAG components (Commissions, Services, the Global Geodetic Observing System, and the Communication and Outreach Branch) are presented along with their sub-components (Inter-commission Committee, Sub-commissions, Projects, Study Groups and Working Groups). This part describes the planed scientific work of IAG during the coming years.

The fourth part completes the Handbook with some general information useful for the geodetic community. Geodetic standards and conventions relevant for geodesy are summarized, the IAG Internet representation is highlighted, and the IAG national representatives and main IAG publication series are listed.

We'd like to thank all the contributors to the Geodesist's Handbook 2012. These are in particular all the IAG officers listed in the structures, but also the uncounted secretaries and technicians in the institutions affiliated with IAG or one of its components or sub-components. The engaged and authentic cooperation in geodesy is one of the most effective means for the great success of our science. We hope that this collaboration will be continued or even extended in the current period 2011 – 2015.

Hermann Drewes	Helmut Hornik	József Ádám	Szabolcs Rózsa
Secretary General	Assistant Secretary General	COB President	COB Secretary

List of Previous Geodesist's Handbooks

1980: Bulletin Géodésique, vol. 54, no. 3

1984: Bulletin Géodésique, vol. 58, no. 3

1988: Bulletin Géodésique, vol. 62, no. 3

1992: Bulletin Géodésique, vol. 66, no. 3

1996: Journal of Geodesy, vol. 70, no. 12

2000: Journal of Geodesy, vol. 74, no. 1

2004: Journal of Geodesy, vol. 77, no. 10-11

2008: Journal of Geodesy, vol. 82, no. 11

The International Association of Geodesy (IAG)

Historical Overview

J. Ádám[1], **H. Drewes**[2]

[1]President of the IAG Communication and Outreach Branch, [2]IAG Secretary General

This compilation is based on the paper of *Ádám (2008)* the tables of which are updated with the information of the IAG period 2007-2011. The purpose is the documentation of the history of IAG in a continuous way.

Reference

Ádám J. (2008): Update of the History of the International Association of Geodesy. In: The Geodesist's Handbook 2008. *Journal of Geodesy,* 82(2008), 11(662-674).

Table 1: General Assemblies of the International Association of Geodesy

No	*Meeting Location*	*Year*
I. General Conferences		
I.a. "Mitteleuropäische Gradmessung" (1862-1867)		
1	Berlin, Prussia	1864
2	Berlin, Prussia	1867
I.b. „Europäische Gradmessung" (1867-1886)		
3	Vienna, Austria	1871
4	Dresden, Saxony	1874
5	Stuttgart, Würtemberg	1877
6	Munich, Bavaria	1880
7	Rome, Italy	1883
8	Berlin, Prussia	1886
I.c. International Geodetic Association (Internationale Erdmessung) (1886-1919)		
9	Paris, France	1889
10	Brussels, Belgium	1892
11	Berlin, Germany	1895
12	Stuttgart, Germany	1898
13	Paris, France	1900
14	Copenhagen, Denmark	1903
15	Budapest, Austria-Hungary	1906
16	Cambridge, United Kingdom	1909
17	Hamburg, Germany	1912

II. General Assemblies of the Section and the Association of Geodesy as part of the General Assemblies of the IUGG		
II.a Section of Geodesy of the IUGG (1922-1933)		
18	Brussels, Belgium (Constitutive Assembly)	1919
19	Rome, Italy	1922
20	Madrid, Spain	1924
21	Prague, Czechoslovakia	1927
22	Stockholm, Sweden	1930
23	Lisbon, Portugal	1933
II.b. Association of Geodesy (1933-1946)		
24	Edinburgh, United Kingdom	1936
25	Washington, United States	1939
II.c. International Association of Geodesy (IAG; 1946-….)		
26	Oslo, Norway	1948
27	Brussels, Belgium	1951
28	Rome, Italy	1954
29	Toronto, Canada	1957
30	Helsinki, Finland	1960
31	Berkeley, United States	1963
32	Zurich-Lucerne, Switzerland	1967
33	Moscow, USSR	1971
34	Grenoble, France	1975
35	Canberra, Australia	1979
36	Hamburg, F.R. Germany	1983
37	Vancouver, Canada	1987
38	Vienna, Austria	1991
39	Boulder, USA	1995
40	Birmingham, United Kingdom	1999
41	Sapporo, Japan	2003
42	Perugia, Italy	2007
43	Melbourne, Australia	2011
44	Prague, Czech Republic	2015

Table 2: Scientific Assemblies of the IAG

No	*Meeting Location*	*Date*	*Number of participants*
1	Tokio, Japan	May 7-15,1982	200
2	Edinburgh, Scotland	August 3-12,1989	NA
3	Beijing, China	August 8-13,1993	350
4	Rio de Janeiro, Brasil	September 3-9,1997	350
5	Budapest, Hungary	September 2-7, 2001	461
6	Cairns, Australia (∗)	August 22-26, 2005	724 (IAG:145)
7	Buenos Aires, Argentina	August 31- Sept. 4, 2009	363
8	Potsdam, Germany	September 1-6, 2013	

(∗) with IAPSO and IABO

Table 3: IAG Presidents

No	*Period*	*Name*	*Residence*
I.a,b.	*"Mitteleuropäische Gradmessung" (1862-1867) and „Europäische Gradmessung" (1867-1886)*		
1	1864-1868	Peter Andreas Hansen	Gotha, Thuringia
2	1869-1874	August von Fligely	Vienna, Austria
3	1874-1886	Carlos Ibañez e Ibañez de Ibero	Madrid, Spain
I.c.	*International Geodetic Association (Internationale Erdmessung) (1886-1919)*		
3	1887-1891	Carlos Ibañez e Ibañez de Ibero	Madrid, Spain
4	1892-1902	Hervé E. A. A. Faye	Paris, France
5	1903-1917	Léon J. A. Bassot	Paris, France
II.a	*Section of Geodesy of the IUGG (1922-1933)*		
6	1922-1933	William Bowie	Washington, USA
II.b.	*(International) Association of Geodesy (1933- ....)*		
7	1933-1945	Felix A. Vening-Meinesz	Amersfoort, The Netherlands
8	1945-1951	Walter D. Lambert	Washington, USA
9	1951-1954	Carl F. Baeschlin	Zurich, Switzerland
10	1954-1957	James de Graaf Hunter	London, United Kingdom
11	1957-1960	Gino Cassinis	Milan, Italy
12	1960-1963	Charles A. Whitten	Washington, USA
13	1963-1967	Guy Bomford	London, United Kingdom
14	1967-1971	Antonio Marussi	Trieste, Italy
15	1971-1975	Youri D. Boulanger	Moscow, USSR
16	1975-1979	Tauno J. Kukkamäki	Helsinki, Finland
17	1979-1983	Helmut Moritz	Graz, Austria
18	1983-1987	Peter V. Angus-Leppan	Kensington, Australia
19	1987-1991	Ivan I. Mueller	Columbus, USA
20	1991-1995	Wolfgang Torge	Hannover, Germany
21	1995-1999	Klaus-Peter Schwarz	Calgary, Canada
22	1999-2003	Fernandó Sansó	Milan, Italy
23	2003-2007	Gerhard Beutler	Bern, Switzerland
24	2007-2011	Michael G. Sideris	Calgary, Canada
25	2011-2015	Chris Rizos	Sydney, Australia

Table 4: IAG Secretaries (Secretaries General)

No	*Period*	*Name*	*Residence*
1	1886-1900	Adolf Hirsch	Neuchatel, Switzerland
2	1900-1918	Hendricus G. van de Sande-Bakhuysen	Leiden, The Netherlands
3	1919-1945	Georges Perrier	Paris, France
4	1946-1960	Pierre Tardi	Paris, France
5	1960-1975	Jean-Jacques Levallois	Paris, France
6	1975-1991	Michel Louis	Paris, France
7	1991-1995	Claude Boucher	Paris, France
8	1995-2007	Carl Christian Tscherning	Copenhagen, Denmark
9	2007-	Hermann Drewes	Munich, Germany

Table 5: Hosts and Directors of the IAG Central Bureau / IAG Office (since 2007)

No	*Period*	*Host Institute*	*Directors*	*Place, Country*
1	1864 – 1885 1886 – 1917	Royal Prussian Geodetic Institute	Johann Jacob Baeyer Friedrich Robert Helmert	Potsdam, Prussia/Germany
2	1922 – 1946 1946 – 1960 1960 – 1975 1975 – 1991 1991 – 1995	Institut Géographique National (IGN)	Georges Perrier Pierre Tardi Jean-Jacques Levallois Michel Louis Claude Boucher	Paris, France
3	1995 – 2007	Niels Bohr Institute, Department of Geophysics, University of Copenhagen	Carl Christian Tscherning	Copenhagen, Denmark
4	2007 –	Deutsches Geodätisches Forschungsinstitut (DGFI)	Hermann Drewes	Munich, Germany

Table 6: Editors in Chief of Official Journals of the IAG (BG = Bulletin Géodésique, MG = Manuscripta Geodaetica, BG and MG merged to JoG = Journal of Geodesy)

No	*Journal*	*Period*	*Name of Editor-in-Chief*	*Residence*
1	BG	1922 – 1945	Georges Perrier	Paris, France
2	BG	1946 – 1951	Pierre Tardi	Paris, France
3	BG	1952 – 1964	Jean-Jacques Levallois	Paris, France
4	BG	1965 – 1975	Michel Louis	Paris, France
5	BG	1975 – 1986	Ivan I. Mueller	Columbus, USA
6	BG	1987 – 1995	Carl Christian Tscherning	Copenhagen, Denmark
1	MG	1976 – 1980	Ivan I. Mueller	Columbus, USA
2	MG	1980 – 1982	Peter Meissl	Graz, Austria
3	MG	1982 – 1988	Erwin Groten	Darmstadt, F.R. Germany
4	MG	1989 – 1991	Clyde C. Goad / Erik W. Grafarend	Columbus, USA / Stuttgart, Germany
5	MG	1991 – 1995	Petr Vaníček	New Brunswick, Canada
1	JoG	1995 – 2003	Peter J. G. Teunissen	Delft, The Netherlands
2	JoG	2003 – 2007	William E. Featherstone	Perth, Australia
3	JoG	2007 –	Roland Klees	Delft, The Netherlands

Table 7: Editors of The Geodesist's Handbook

No	*Year*	*Editor*	*Residence*
1	1980	Ivan I. Mueller	Columbus, USA
2	1984	Carl Christian Tscherning	Copenhagen, Denmark
3	1988	Carl Christian Tscherning	Copenhagen, Denmark
4	1992	Carl Christian Tscherning	Copenhagen, Denmark
5	1996	Pascal Willis	Paris, France
6	2000	Ole B. Andersen	Copenhagen, Denmark
7	2004	Ole B. Andersen	Copenhagen, Denmark
8	2008	Hermann Drewes, Helmut Hornik / József Ádám, Szabolcs Rózsa	Munich, Germany / Budapest, Hungary
9	2012	Hermann Drewes, Helmut Hornik / József Ádám, Szabolcs Rózsa	Munich, Germany / Budapest, Hungary

Table 8: Bomford Prize Awardees of the IAG

No	*Year*	*Name of Scientist*	*Residence*
1	1975	Erik W. Grafarend	Munich, F.R. Germany
2	1979	Fernandó Sansó	Milan, Italy
3	1983	John Wahr	Boulder, USA
4	1987	Peter J. G. Teunissen	Delft, The Netherlands
5	1991	Shuhei Okubo	Tokyo, Japan
6	1995	Thomas A. Herring	Cambridge, USA
7	1999	Véronique Dehant	Brussels, Belgium
8	2003	Ramon Hanssen	Delft, The Netherlands
9	2007	Masato Furuya	Tokyo, Japan
10	2011	Johannes Böhm	Vienna, Austria

Table 9: Levallois Medal Awardees of the IAG

No	*Year*	*Name of Scientist*	*Residence*
1	1983	Charles A. Whitten	Washington, USA
2	1983	Rudolf Sigl	Munich, F.R.Germany
3	1987	Arne Bjerhammar	Stockholm, Sweden
4	1991	Paul Melchior	Brussels, Belgium
5	1995	Willem Baarda	Delft, The Netherlands
6	1999	Torben Krarup	Copenhagen, Denmark
7	2003	George Veis	Athen, Greece
8	2007	Carl Christian Tscherning	Copenhagen, Denmark
9	2011	Ruth Edwards Neilan	Pasadena, USA

Table 10: IAG Best Young Author Awardees

No	*Year*	*Author's name*	*Country*	*Title of the publication*
1	1993	Hussein Abou-Elsoaad Abd-Elmotaal	Egypt	Vening-Meinesz Moho dephts: traditional, exact and approximated. *Manuscripta Geodaetica*, 18 (1993), 4 (171-181)
2	1994	Jean-Pierre Barriot	France	Line of sight operators in planetary Geodesy *Manuscripta Geodaetica*, 19 (1994), 5 (269-283).
3	1995	Srinivas V. Bettadpur	India	Hotine's geopotential formulation: revisited. *Bulletin Géodésique,* 69 (1995), 3(135-142).
4	1996	Giovanna Sona	Italy	Numerical problems in the computation of ellipsoidal harmonics. *Journal of Geodesy,* 70 (1995), 1-2 (117-126).
5	1997	none		
6	1998	Cheinway Hwang	Taiwan	Inverse Vening-Meinesz formula and deflection geoid formula: applications to the predictions of gravity and geoid over the South China Sea. *Journal of Geodesy*, 72(1998), 5(304-312).
7	1999	Peiliang Xu	China	Biases and accuracy of, and an alternative to, discrete nonlinear filters. *Journal of Geodesy*, 73(1999), 1 (35-46).
8	2000	Christopher Kotsakis Rüdiger Lehmann	Canada Germany	Kotsakis, C.: The multiresolution character of colloction. *Journal of Geodesy*, 74(2000), 3-4 (275-290). Lehmann, R.: Altimetry-gravimetry problems with free vertical datum. *Journal of Geodesy*, 74(2000), 3-4 (327-334).

Table 10 cont:

9	2001	Susan Skone	Canada	The impact of magnetic stourms on GPS receiver performance. *Journal of Geodesy*, 75 (2001), 9-10 (457-468).
10	2002	none		
11	2003	Michael Kern	Germany	A study on the combination of satellite, airborne and terrestrial gravity data (with K.-P. Schwarz and N.Sneeuw). *Journal of Geodesy,* 77 (2003), 3-4 (217-225).
12	2004	Shfaqat Abbas Khan	Pakistan	Shallow water loading tides in Japan from superconducting gravity (with J.L. Hoyer). *Journal of Geodesy*, 78 (2004), 4-5 (245-250).
13	2005	Roland Pail	Austria	A parametric study ont he impact of satellite attitude errors on GOCE gravity field recovery. *Journal of Geodesy*, 79 (2005), 4-5 (231-241).
14	2006	Steffen Schön	Germany	Uncertainty in GPS networks due to remaining systematic errors: the internal approach (with H. Kutterer). *Journal of Geodesy*, 80 (2006), 3 (150 -162).
15	2007	none		
16	2008	Franziska Wild-Pfeiffer	Germany	A comparison of different mass elements for use in gravity gradiometry. *Journal of Geodesy*, 82 (2008), 10(637-653).
17	2009	none		
18	2010	Eilzabeth Petri	UK	A first look at the effects of ionospheric signal bending on a globally processed GPS network. *Journal of Geodesy*, 84 (2010), 8(491-499).

Table 11: IAG Services

No	accronym	Name of the IAG Service (and address of the homepage)	Year of establishment
1	**BGI**	Bureau Gravimetrique International / *http://bgi.cnes.fr*	1951
-	**BIH**	Bureau International de l'Heure (1987 integrated into IERS)	1912
2	**BIPM**	Bureau International des Poids et Measures – Time Department / *http://www.bipm.org*	1875
3	**IAS**	International Altimeter Service / *http://www.dgfi.badw.de/services*	2008
4	**IBS**	IAG Bibliographic Service / *http://www.bkg.bund.de*	(1889) 1984
5	**ICET**	International Center for Earth Tides / *http://www.astro.oma.be/ICET*	1956
6	**ICGEM**	International Centre for Global Earth Models / *http://icgem.gfz-potsdam.de/ICGEM*	2003
7	**IDEMS**	International Digital Elevation Models Service / *http://www.cse.dmu.ac.uk/EAPRS/iag/*	1999
8	**IDS**	International DORIS Service / *http://ids.cls.fr*	2003
9	**IERS**	International Earth Rotation and Reference Systems Service / *http://www.iers.org*	1987
10	**IGeS**	International Geoid Service / *http://www.iges.polimi.it*	1991
11	**IGFS**	International Gravity Field Service / *http://www.igfs.net*	2004
12	**IGS**	International GNSS Service / *http://igscb.jpl.nasa.gov*	1994
13	**ILRS**	International Laser Ranging Service / *http://ilrs.gsfc.nasa.gov*	1998
-	**ILS**	International Latitude Service (1962 renamed International Polar Motion Service, IPMS)	1899
-	**IPMS**	International Polar Motion Service (Successor of ILS, 1987 integrated into IERS)	1962
14	**IVS**	International VLBI Service for Geodesy and Astrometry / *http://ivscc.gsfc.nasa.gov*	1999
15	**PSMSL**	Permanent Service for Mean Sea Level / *http://www.pol.ac.uk/psmsl*	1933

Table 12: Fellows of the IAG

1991:
D.A. Adebekun (Nigeria), *D.-E. Ajakaiye* (USA), *V. Ashkenazi* (UK), *W. Augath* (Germany), *T.F. Baker* (UK), *G. Balmino* (France), *L.W. Baran* (Poland), *G. Birardi* (Italy), *A. Bjerhammar* (Sweden), *D. Blitzkow* (Brazil), *Y. Bock* (USA), *G. Boedecker* (Germany), *J.D. Bossler* (USA), *C. Boucher* (France), *P. Brosche* (Germany), *F.K. Brunner* (Austria), *M. Burša* (Czech Republik), *J. Campbell* (Germany), *G. Carrera* (Canada), *M. Charfi* (Tunisia), *J. Y. Chen* (China), *B. H. Chovitz* (USA), *O. Coker* (Nigeria), *O. L. Colombo* (USA), *A. Comolet-Tirman* (France), *A.H. Cook* (UK), *P.A. Cross* (UK), *K. I. Daugherty* (USA), *P. de Jonge* (USA), *A. Dermanis* (Greece), *J.O. Dickey* (USA), *A.H. Dodson* (UK), *B.C. Douglas* (USA), *A. Drozyner* (Poland), *H. Dufour* (France), *D. Eckhardt* (USA), *O. Fadahunsi* (Nigeria), *F. Fajemirokun* (Nigeria), *M. Feissel-Vernier* (France), *I. Fejes* (Hungary), *I.K. Fischer* (USA), *R. Forsberg* (Denmark), *P. Forsyth* (Canada), *D. Fritsch* (Germany), *J. Gaignebet* (France), *E.M. Gaposchkin* (USA), *C. Gemael* (Brazil), *C.C. Goad* (USA), *E.W. Grafarend* (Germany), *E. Groten* (Germany), *E. Gubler* (Switzerland), *B. Guinot* (France), *B. Heck* (Germany), *G. Hein* (Germany), *H. Henneberg* (Venezuela), *S. Henriksen* (USA), *P. Holota* (Czech Republic), *L. Hora* (Czech Republic), *H.T. Hsu* (China), *J.R. Huddle* (USA), *C. Jekeli* (USA), *G. Jentzsch* (Germany), *I. Joó* (Hungary), *C.S. Joshi* (India), *H.-G. Kahle* (Switzerland), *H.P. Kahmen* (Austria), *J. Kakkuri* (Finland), *K. Kasahara* (Japan), *E. Kausel* (Chile), *H. Kautzleben* (Germany), *A.H.W. Kearsley* (Australia), *R.W. King* (USA), *A. Kiviniemi* (Finland), *R. Klees* (The Netherlands), *K.R. Koch* (Germany), *B. Kolaczek* (Poland), *K. Konan* (Ivory Coast), *J. Kovalevsky* (France), *Y. Kozai* (Japan), *J. Krynski* (Poland), *M. Kumar* (USA), *J.T. Kuo* (USA), *M.P.M. Lefebvre* (France), *D. Lelgemann* (Germany), *G.W. Lennon* (Australia), *G. Lensen* (New Zealand), *J-J. Lavallois* (France), *E. Livieratos* (Greece), *M. Louis* (France), *G.R. Mader (USA)*, *J. Makris* (Germany), *A. Mancini* (USA), *I. Marson* (Italy), *M. McNutt* (USA), *D.D. McCarthy* (USA), *W.G. Melbourne* (USA), *P. Melchior* (Belgium), *C. Morelli* (Italy), *H. Moritz* (Austria), *I.I. Mueller* (USA), *I. Nakagawa* (Japan), *A. Nobili* (Italy), *J.D. Obel* (Kenya), *M.Odlanicki-Poczobut* (Poland), *B.P. Pertsev* (Russia), *K. Poder* (Denmark), *C. Poitevin* (Belgium), *M.T. Prilepin (*Russia), *J. Rais* (Indonesia), *R.H. Rapp* (USA), *C. Reigber* (Germany), *A.R. Robbins* (UK), *R.S. Rostom* (Kenya), *R. Rummel* (Germany), *F. Sacerdote* (Italy), *F. Sansó* (Italy), *N.K. Saxena* (USA), *B. Schaffrin* (USA), *G. Schmitt* (Germany), *B.E. Schutz* (USA), *K.-P. Schwarz* (Canada), *G. Seeber* (Germany), *M.J. Sevilla* (Spain), *P.J. Shelus* (USA), *M.G. Sideris* (Canada), *L.E. Sjöberg* (Sweden), *R.A. Snay* (USA), *H. Sünkel* (Austria), *T. Tanaka* (Japan), *P.J.G. Teunissen* (The Netherlands), *W. Torge* (Germany), *C.C. Tscherning* (Denmark), *P. Vaníček* (Canada), *C. Veillet* (France), *P. Vyskočil* (Czech Republic), *J. Wahr* (USA), *D.E. Wells* (Canada), *W.M. Welsch* (Germany), *L.A. White* (Australia), *P. Wilson* (Germany), *P.L. Woodworth* (UK), *A. Waalewijn* (The Netherlands), *Y.Y. Yatskiv* (Ukraine), *K. Yokoyama* (Japan), *D.B. Zilkoski* (USA) , *J.D. Zund* (USA).

1995:
J. Ádám (Hungary), *R. Barzaghi* (Italy), *M. Becker* (Germany), *G. Beutler* (Switzerland), *W. Bosch* (Germany), *B.F. Chao* (USA), *H. Denker* (Germany), *J. Dow* (Germany), *G.K. Elgered* (Sweden), *B. Engen* (Norway), *A. Geiger* (Switzerland), *T. Kato* (Japan), *A. Kleusberg* (Germany), *J. Kouba* (Canada), *H. Landau* (Germany), *R.B. Langley* (Canada), *K. Linkwitz* (Germany), *S. Molodensky* (Russia), *R. Neilan* (USA), *C. Noll* (USA), *S. Okubo* (Japan), *P. Pâquet* (Belgium), *J.C. Ries* (USA), *J.M. Rüeger* (Australia), *E.J.O. Schrama* (The Netherlands), *C.-K. Shum* (USA), *T.A.Th. Spoelstra* (The Netherlands), *S. Takemoto* (Japan), *C. Thomas* (France), *J.A. Weightman* (UK), *P. Willis* (France), *C. Wilson* (USA), *T. Yunck* (USA).

1999:
N. Andersen (Denmark), *D. Arabelos* (Greece), *M.G. Arur* (India), *L. Ballani* (Germany), *G.B. Benciolini* (Italy), *M.G. Bevis* (USA), *G. Blewitt* (UK), *J.M. Bosworth* (USA), *A. Cazenave* (France), *T.A. Clark* (USA), *J. Degnan* (USA), *V. Dehant* (Belgium), *H. Drewes* (Germany), *B. Ducarme* (Belgium), *W. Featherstone* (Australia), *W. Freeden* (Germany), *T. Herring* (USA), *K.-H. Ilk* (Germany), *J. Johanssen* (Sweden), *P. Knudsen* (Denmark), *Z.-X. Li* (China), *J. Manning* (Australia), *N. Pavlis* (USA), *C. Rizos* (Australia), *C. Rocken* (USA), *I.N. Tziavos* (Greece), *M. Vermeer M.* (Finland), *M. Wei* (Canada), *D. Wolf* (Germany), *S. Zerbini* (Italy).

Table 12 cont:

2003:
E.F. Arias (Argentina),
J.-P. Barriot (France),
P.A. Berry (UK),
C.A. Brunini (Argentina),
C. Bruyninx (Belgium),
D. Gambis (France),
G. Gendt (Germany),
R.S. Gross (USA),
W. Gurtner (Switzerland),
S. Han (Australia),
R. Hanssen (The Netherlands),
B.G. Harsson (Norway),
C. Hwang (Taiwan),
W. Keller (Germany),
S.C. Kenyon (USA),
R. Kursinski (USA),
H. Kutterer (Germany),
R. Lehman (Germany),
A. Marchenko (Ukraine),
R. Scharroo (The Netherlands),
W. Schlüter (Germany),
T. Schöne (Germany),
S. Skone (Canada),
N. Sneeuw (Canada),
M. Stewart (Australia),
G. Strykowski (Denmark),
C. Tiberius (The Netherlands),
H. van der Marel (The Netherlands),
N. Vandenberg (USA).
P. Visser (The Netherlands),
L. Vitushkin (France),
J. Vondrak (Czech Republic),
R. Weber (Austria),
Y. Yuanxi (China).

2007:
Z. Altamimi (France),
R. Biancale (France),
M. Craymer (Canada),
D. Crossley (USA),
R. Dietrich (Germany),
X. Ding (Hong Kong),
L.P.S. Fortes (Brazil),
Y. Gao (Hong Kong),
D. Grejner-Brzezinska (USA),
K. Heki (Japan),
L. Hothem (USA),
J. Huang (China),
J. Ihde (Germany),
M. Kuhn (Australia),
J. Kusche (The Netherlands),
U. Marti (Switzerland),
C. Merry (South Africa),
A.W. Moore (USA),
P. Novák (Czech Republic),
M.C. Pacino (Argentina),
M.R. Pearlman (USA),
H.-P. Plag (USA),
M. Poutanen (Finland),
B. Richter (Germany),
M. Rothacher (Germany),
Sz. Rózsa (Hungary),
M. Scheinert (Germany),
H. Schuch (Austria),
H.-P. Sun (China),
J.A. Torres (Portugal),
Gy. Tóth (Hungary),
P. Tregoning (Australia),
M. Verroneau (Canada),
J. Wang (Australia),
R. Wonnacott (South Africa),
P. Xu (Japan),
J. Yu (China),
S.Y. Zhu (Germany).

2011:
H. Abd-Elmotaal (Egypt),
L. Alfonsi (Italy),
D. Behrend (USA),
S. Bettadpur (USA),
S. Bisnath (Canada),
A. Brzezinski (Poland),
T. van Dam (Luxembourg),
J. Davis (USA),
Y. Fang (Australia),
J. Freymueller (USA),
Y. Fukuda (Japan),
Th. Hobiger (Japan),
H. Hornik (Germany),
S. Jin (South Korea),
M.O. Karslioglu (Turkey),
Ch. Kotsakis (Greece),
S. Lambert (France),
F. Lemoine (USA),
C. Ma (USA),
Z. Malkin (Russia),
S. Matsuzaka (Japan),
Gy. Mentes (Hungary),
A. Michlenz (Germany),
M. Omura (Japan),
R. Pail (Germany),
J. Ray (USA),
A. Reiterer (Germany),
G. Retscher (Austria),
L.J. Rickards (UK),
D. Roman (USA),
L. Sanchez (Germany),
M. Santos (Canada),
M. Schmidt (Germany),
F. Seitz (Germany),
L. Soudarin (France),
G. Tavernier (France),
S. Verhagen (The Netherlands),
Y.M. Wang (USA),
J. Wickert (Germany),
H. Wilmes (Germany).

IAG Statutes

adopted by the IAG Council

on July 9, 2007 at the XXIV IUGG General Assembly in Perugia, Italy

1. Definition of Terms

(a) Geodesy is the discipline that deals with the measurement and representation (geometry, physics, temporal variations) of the Earth and other celestial bodies.

(b) IUGG means the International Union of Geodesy & Geophysics.

(c) IAG or Association means the International Association of Geodesy.

(d) Adhering Body has the same meaning as in the Statutes of the IUGG.

(e) General Assembly means an assembly for scientific and/or administrative purposes of:

(i) the delegates appointed by the adhering bodies; and

(ii) individual members as defined by Statute 6(b)

(f) Period means the interval of time between the closures of two successive ordinary General Assemblies.

2. International Association of Geodesy

(a) The International Association of Geodesy:

(i) is a constituent Association of the IUGG; and

(ii) is subject to the Statutes and Bylaws of the IUGG.

(b) In the event of the dissolution of the IAG, its assets shall be ceded to the IUGG.

3. Mission

The Mission of the Association is the advancement of geodesy. The IAG implements its mission by furthering geodetic theory through research and teaching, by collecting, analyzing, modelling and interpreting observational data, by stimulating technological development and by providing a consistent representation of the figure, rotation, and gravity field of the Earth and planets, and their temporal variations.

4. Objectives

The IAG shall pursue the following objectives to achieve its mission:

(a) Study, at the highest possible level of accuracy, all geodetic problems related to Earth observation and global change, including:

i) Definition, establishment, and maintenance of global and regional reference systems for interdisciplinary use.

ii) Rotation of the Earth and planets.

iii) Positioning and deformation studies.

iv) Gravity field determination.

v) Ocean, ice and sea level.

vi) Time transfer.

vii) Signal propagation through the planets' atmospheres.

(b) Support the maintenance of geodetic reference systems for continuous, long-term observations and archival of results.

(c) Provide observational and processed data, standards, methodologies, and models in a form that ensures the broadest possible range of research and application.

(d) Stimulate development and take advantage of emerging space and other technologies to increase the resolution and accuracy of geodetic data and products in order to advance geodetic and interdisciplinary research.

(e) Initiate, coordinate, and promote international cooperation and knowledge exchange through symposia, workshops, summer schools, training courses, publications, and other means of communication.

(f) Foster the development of geodetic activities and infrastructure in all regions of the world, taking into consideration the specific situation of developing countries.

(g) Collaborate with the international science and engineering community in supporting the application of geodetic theory and techniques and the interpretation of results.

(h) Cooperate with national and international agencies in establishing research goals, missions, and projects.

5. Structure and Administration

(a) The Association's structure shall comprise a small number of components: Commissions, Services, the Global Geodetic Observing System (GGOS) and the Communication and Outreach Branch (COB).

(b) Subcomponents, such as IAG Projects, Sub-commissions, Commission Projects, Inter-commission Committees, and Study and Working Groups, may be formed as provided for in the Bylaws.

(c) The administration of the IAG is carried out by the General Assembly, the Council, the Bureau and the Executive Committee. The COB is the office responsible for the promotional activities of the IAG and the communication with its members.

6. Membership

The membership of the IAG shall comprise:

(a) Adhering Bodies; and

(b) individual members in accordance with the Bylaws.

7. IAG Council

(a) The Council is responsible for governance, strategic policy and direction.

(b) The membership of the Council consists of delegates appointed by adhering bodies.

(c) Each adhering body may appoint one delegate subject to the conditions in (d) (e) and (f) below.

(d) A delegate may only represent one adhering body.

(e) The delegate appointed by an adhering body must have previously participated in IAG activities.

(f) The President, Vice President and Secretary General may not serve as delegates.

(g) The delegate nominated by the adhering body will also perform the function of correspondent for the adhering body except where the adhering body has expressly advised that the delegate and the correspondent are different people.

8. Bureau

(a) The Bureau of the Association shall consist of the President, the Vice-President and the Secretary General.

(b) The duties of the Bureau shall be to administer the affairs of the Association in accordance with these Statutes and Bylaws and with the decisions of the Council and the Executive Committee.

9. President

(a) The President shall be elected by the Council.

(b) The President shall provide general leadership for the Association.

(c) The President presides over the meetings of the General Assembly, the Council, the Executive Committee, and the Bureau, without vote, except in the case of a tie as provided in 14(f).

(d) The President, on completion of his or her term of office of one period, shall serve for the next period in the position of Immediate Past President.

10. Vice President

(a) The Vice President shall be elected by the Council.

(b) The Vice President shall perform such tasks as may be assigned by the President, the Executive Committee or the Council.

(c) The Vice President assumes the functions, duties and powers of the President when the latter is absent or otherwise unable to assume office.

11. Secretary General

(a) The Secretary General shall be elected by the Council.

(b) The Secretary General shall serve as secretary of the General Assembly, the Council, the Executive Committee, and the Bureau and arrange for meetings of these bodies in accordance with the Bylaws.

12. Executive Committee

(a) The Executive Committee shall consist of the following voting members: the Bureau, the immediate Past President, the Presidents of the Commissions, the Chair of GGOS, the President of the COB, the three representatives of the Services, and two Members-at-Large to improve geographical and organizational balance.

(b) Presidents of the Inter-commission Committees, Chairs of the IAG Projects, and the Assistant Secretaries shall attend any meeting of the Executive Committee, with voice but without vote. The Past Presidents, and past Secretaries General may attend any meeting of the Executive Committee, with voice but without vote, (except for the immediate past president, who does have a vote).

(c) The election of Executive Committee members shall be in accordance with the Bylaws.

(d) The duties of the Executive Committee shall be to further the objectives of the Association through effective coordination and through the formulation of general policies.

13. Council Meetings

(a) The Council will meet at the time of a General Assembly.

(b) The Council may hold extraordinary meetings at times other than a General Assembly. Such meetings must be proposed by the Executive Committee and need the support of one third of the delegates before they can be called.

(c) The Council may also deliberate and decide matters at other times by correspondence and mail ballot.

(d) If the delegate and the correspondent are not the same person, the mail ballot must be cast by the correspondent.

(e) The members of the Executive Committee may attend meetings of the Council, with voice but without vote, except for those who are also delegates.

14. Voting in Council Meeting

Voting in Council shall follow the following rules:

(a) An Adhering Body which is not represented at a Council meeting may vote by correspondence on any specific question, provided that the matter has been clearly defined on the final agenda distributed in advance, and that the discussion thereon has not produced any significant new considerations or change in its substance, and that the said vote has been received by the President prior to the voting. In such a case the vote will be cast in accordance with 13(d).

(b) In order that the deliberations of the Council shall be valid, the number of Delegates present must be at least half of the Adhering Bodies represented at the General Assembly of the IUGG. If the meeting is not held at the same time as an IUGG General Assembly, the number present at the most recent IUGG Assembly is used.

(c) On questions not involving matters of finance, each delegate from an Adhering Body, with its IUGG subscriptions paid up to the end of the calendar year preceding the voting, shall have one vote.

(d) On questions involving finance, each delegate from an Adhering Body, which has paid its IUGG subscriptions up to the end of the calendar year preceding the voting, shall have the right to vote. The number of votes allotted to each delegate of an Adhering Body shall then be equal to the number of its category of membership, as defined by IUGG.

(e) Before a vote in a Council meeting, the President shall decide whether or not the matter under consideration is financial in character and whether the procedure of voting by correspondence applies.

(f) Decisions of the Council shall be taken by a simple majority, except as otherwise specified in these Statutes. If a tie should occur in a Council vote, the President shall cast the decisive vote. This procedure also applies if the vote is taken by mail ballot. Simple and two-thirds majorities are determined by the proportion of affirmative votes to the sum of all votes (affirmative, negative and abstention). Blank and invalid ballots and votes not cast by delegates present are counted as abstentions.

(g) Except as otherwise provided in the Statutes or Bylaws, meetings of the Council, as well as those of other IAG administrative bodies, shall be conducted according to Robert's Rules of Order.

15. Decision of Council

(a) Decisions of the Council shall be reported to the individual membership in a meeting of the IAG General Assembly.

(b) If the majority of those present at this meeting disagree with the decisions of the Council, the Council shall reconsider the question, and make a decision, which shall be final.

16. Changes to Statutes and Bylaws

Changes in the Statutes and Bylaws shall be made as follows:

(a) The Association shall review the Statutes and Bylaws to ensure an up-to-date structure of its scientific organization every eight years. To achieve this goal a Review Committee will be appointed by the Executive Committee at its first meeting after the General Assembly in periods where a review must be performed. Proposals for a change of any article of these Statutes and Bylaws must reach the Secretary General at least six months before the announced date of the Council meeting at which it is to be considered. The Secretary General shall notify all adhering bodies of any proposed change at least four months before the announced date of the Council meeting.

(b) The Statutes may not be modified except by the approval of a two-thirds majority of votes cast at a Council meeting, and shall come into force at the close of that meeting.

(c) The Council shall have the power to adopt Bylaws within the framework of the Statutes.

(d) The Bylaws may be modified by a simple majority of votes cast at a Council meeting, and shall come into force at the close of the meeting.

IAG Bylaws

adopted by the IAG-Council

on July 9, 2007 at the XXIV IUGG General Assembly in Perugia, Italy

1. Definition of Terms

(a) **Association Components** or **Components** means Commissions, Services, the Global Geodetic Observing System (GGOS), and the Communication and Outreach Branch (COB).

(b) **Commissions** represent major fields of activity in the IAG which, together, cover the whole geodesy.

(c) **Services** collect and analyze observations to generate products relevant to geodesy and other sciences and applications.

(d) The **Global Geodetic Observing System (GGOS)** works with the IAG Services to provide the geodetic expertise and infrastructure necessary for the monitoring of the Earth system and global change research.

(e) **Association subcomponents** or **sub-components** means long term sub-components and short term sub-components and includes joint sub-components.

(f) **Long term sub-components** means IAG Projects (broad in scope and of high interest for the entire field of geodesy), Inter-commission Committees, Sub-commissions and Commission Projects which may remain established for several periods.

(g) **Short term sub-components** means Study Groups and Working Groups which are established for a maximum term of one period

(h) **Steering Committee** means a group of elected and appointed IAG officers who review the work of Commissions, Inter-commission Committees (see 17), IAG Projects (see 16), and the Communication and Outreach Branch (see 18).

(i) **Period** means the interval of time (approximately 4 years) between the closure of two successive IAG General Assembly meetings.

2. Responsibilities of Association Components

(a) The scientific work of the Association is performed by Commissions, Services and the GGOS.

(b) The responsibilities of the Association components are determined by the Council on the recommendation of the Executive Committee.

(c) Components shall interact with each other where their activities are inter-related.

(d) Each component may set up sub-components and is responsible for the activities of those sub-components.

3. General Responsibilities of Component Presidents or Chairs, and Steering Committees

(a) Each component shall have a President or Chair who will lead a Steering Committee.

(b) The component president or chair is responsible for the scientific development within the component's field of interest. The component president or chair shall:

(i) coordinate the work of the Sub-components;

(ii) keep the officers of the Component as well as the Bureau informed of the component's activities, on an annual basis;

(iii) collect reports of the sub-components two months before each IAG General Assembly meeting (except where the IAG Executive has agreed otherwise) for publication in the "Travaux de l'Association Internationale de Géodésie";

(iv) receive suggestions for new sub-components, and suggestions for continuation of existing ones; and

(v) recommend changes to sub-components to the IAG Executive Committee for approval.

(c) The component steering committee shall meet at least once per year and at least once during each meeting of the IAG General Assembly.

(d) The component steering committee shall review at one of its meetings (usually the IAG General Assembly meeting, or the IAG Scientific meeting):

(i) the activities of the sub-components over the past period;

(ii) the subcomponent structure; and

(iii) the programs for the forthcoming period for those subcomponents that will be recommended for continuation.

(e) The component steering committee shall forward copies of all relevant correspondence of components and subcomponents of the Association to the IAG Secretary General.

(f) The component steering committee may organise scientific and organizational meetings and workshops provided that they are readily distinguished as being of a more limited scope than IAG Scientific symposia or IAG Sponsored Symposia as described in Bylaws 27 and 28.

4. Commission Responsibilities

Commissions shall promote the advancement of science, technology and international cooperation in their field. They establish the necessary links with sister disciplines and with the relevant Services. Commissions shall represent the Association in all scientific domains related to their field of geodesy.

5. Commission Steering Committee

(a) The Commission Steering Committee shall be set up at each meeting of the IAG General Assembly, following the election of the Association officers

(b) The Steering Committee shall have the following voting members:

i. Commission President.

ii. Commission Vice-president.

iii. Chairs of the Sub-commissions and Commission Projects.

iv. Up to three representatives of the Services relevant to the work of the Commission.

v. Up to two Members-at-Large to balance geographical and member country representation.

6. Appointment of Commission Officers

(a) The Commission President shall be elected by the Council for one period without reappointment except where exceptional circumstances justify reappointment.

(b) The Commission Vice President shall be appointed by the IAG Executive Committee for one period without reappointment except where exceptional circumstances justify reappointment.

(c) Chairs of the Sub-commissions and Commission Projects shall be appointed by the Commission President and Vice-President within two months following the General Assembly.

(d) The representatives of the Services shall be appointed by the Commission President and Vice-president upon proposal of the Services.

(e) The Members-at-Large and the chairs of the Sub-commissions and Commission Projects shall be nominated by the Commission President and Vice-President within two months following the IAG General Assembly meeting.

(f) The appointments of Members at Large and Chairs of Sub-commissions and Commission Projects take effect on approval of the nominations by the IAG Executive Committee.

(g) Members-at-Large are appointed for one period without reappointment

7. Duties of Commission Steering Committee

The Commission Steering Committee is subject to the general responsibilities of component steering committees in Bylaw 3(c), 3(d), 3(e), and 3(f) above. In particular, its duties are to:

(a) Review the Commission's field of interests and objectives.

(b) Liaise with the other IAG commissions, the Intercommission Committees, and with similar organizations outside the IAG, as appropriate.

(c) Foster active participation of young geodesists and geodesists from under-represented countries.

(d) Coordinate and review the work of its components and report at the time of the Scientific Assembly to the IAG Executive Committee on the progress and performance of the components.

(e) Encourage and organize Commission and interdisciplinary symposia and/or sessions at major geodesy related international meetings.

(f) Maintain a commission web page and e-mail service.

(g) Nominate up to three editors for the Journal of Geodesy.

8. Current Commissions

On the coming into effect of these bylaws, there shall be four Commissions with areas of scientific responsibility as outlined below:

(1) Commission 1: Reference Frames

(a) Establishment, maintenance, improvement of the geodetic reference frames.

(b) Advanced terrestrial and space observation technique development for the above purposes.

(c) International collaboration for the definition and deployment of networks of terrestrially-based space geodetic observatories.

(d) Theory and coordination of astrometric observation for reference frame purposes.

(e) Collaboration with space geodesy/reference frame related international services, agencies and organizations.

(2) Commission 2: Gravity Field

(a) Terrestrial, marine, and airborne gravimetry.

(b) Satellite gravity field observations.

(c) Gravity field modelling.

(d) Time-variable gravity field.

(e) Geoid determination.

(f) Satellite orbit modeling and determination.

(3) Commission 3: Earth Rotation and Geodynamics

(a) Earth Orientation (Earth rotation, polar motion, nutation and precession).

(b) Earth tides.

(c) Tectonics and Crustal Deformation.

(d) Sea surface topography and sea level changes.

(e) Planetary and lunar dynamics.

(f) Effects of the Earth's fluid layers (e.g., post glacial rebound, loading).

(4) Commission 4: Positioning and Applications

(a) Terrestrial and satellite-based positioning systems development, including sensor and information fusion.

(b) Navigation and guidance of platforms.

(c) Interferometric laser and radar applications (e.g., Synthetic Aperture Radar).

(d) Applications of geodetic positioning using three dimensional geodetic networks (passive and active networks), including monitoring of deformations.

(e) Applications of geodesy to engineering.

(f) Atmospheric investigations using space geodetic techniques.

9. Commission Sub-components and Joint Sub-components

(a) Commission Sub-components are Sub-commissions, Commission Projects, Study Groups, and Working Groups, which all belong to one commission.

(b) If more than one commission is involved in a Sub-component, the term Joint Sub-component will be used, e.g. Joint Sub-commission, Joint Commission Project, Joint Study Group, Joint Working Group.

10. Sub-commissions and Joint Sub-commissions

(a) A Sub-commission may be set up for topics where the Commission plays a leading or coordinating role.

(b) Where a topic relates to the scientific responsibilities of more than one Commission, a Joint Sub-commission shall be established under the lead of one Commission.

(c) A Sub-commission is expected to be established for several periods.

(d) Sub-commissions are established and terminated by the IAG Executive Committee upon recommendation from the Commission President.

(e) A proposal to the Executive Committee for a Joint Sub-commission requires the recommendation of the Presidents of all contributing Components.

(f) Guidelines for the establishment of Sub- commissions are established by the Executive Committee and published in the Geodesist's Handbook.

11. Commission Projects and Joint Projects

(a) A Commission project may be established when a new scientific method or a new technique is being developed, or when it seems appropriate to apply an existing technique to a specific geographic area where international collaboration is required.

(b) Where a topic for a Commission Project relates to the scientific responsibilities of more than one Commission, or a Commission and a Service, a Joint Commission Project shall be established under the lead of one Commission.

(c) A Commission Project is established for one period and may be extended for another period subject to a positive review.

(d) Commission Projects are established and terminated by the IAG Executive Committee upon recommendation from the Commission President.

(e) A proposal to the Executive Committee for a Joint Commission Project requires the recommendation of the Presidents of all contributing Components.

(f) Guidelines for the establishment of Commission Projects are established by the Executive Committee and published in the Geodesist's Handbook.

12. Study Groups, Working Groups, Joint Study Groups and Joint Working Groups

(a) A Study Group or Working Group may be established at any time to address clearly defined well-focused scientific topics of limited scope within the field of the Commission.

(b) Where a topic for a Study Group or Working Group relates to the scientific responsibilities of more than one Commission, or a Commission and a Service, a Joint Study Group shall be established under the lead of one Commission.

(c) A Study Group or Working Group is established for one period or less.

(d) Study Groups and Working Groups, including the position of Group chair, are established and terminated by the IAG Executive Committee upon recommendation from the Commission President.

(e) A proposal to the Executive Committee for a Joint Study Group or Joint Working Group requires the recommendation of the Presidents of all contributing Components.

(f) Guidelines for the establishment of Study Groups and Working Groups are established by the Executive Committee and published in the Geodesist's Handbook.

(g) The Chair of a Study Group or Working Group is responsible for initiating and directing its work and appointing its members.

(h) Study Group and Working Group membership should be balanced so as to reflect international cooperation in its subject.

(i) A Study Group or Working Group may have not more than 20 full members and an unlimited number of correspondent members.

(j) The Chair of each Study Group or Working Group shall issue a brief description of the work to be performed and a list of members, to be published in the Geodesist's Handbook after each General Assembly.

(k) The Chair of each Study Group or Working Group shall report annually to its members and the commission steering committee, on results achieved and outstanding problems.

(l) Guidelines for proposing candidates for the Study Group Chair or Working Group Chair will be established by the Executive Committee.

13. Services

(a) IAG Services generate products, using their own observations and/or observations of other services, relevant for geodesy and for other sciences and applications. Accuracy and robustness of products, quality control, timeliness, and state of the art quality are the essential aspects of the Services.

(b) Each Service shall define its Terms of Reference as appropriate to accomplish its mission and shall submit the Terms of Reference to the IAG Executive Committee for approval.

(c) Each Service shall have an IAG representative, appointed by the IAG Executive Committee, as a voting member of its directing/governing board.

(d) Services are linked to at least one of the Commissions and may be also linked to other scientific organizations, such as the International Astronomical Union (IAU) or the Federation of Astronomical and Geophysical data analysis Services (FAGS).

(e) Services shall collaborate on a scientific basis with the Commissions, establish Joint Commission Projects, and Joint Study Groups and help compile the Commissions' list of themes for Study Groups.

(f) Three representatives shall be elected in accordance with Bylaw 39 to the IAG Executive Committee to serve the interests of all Services.

(g) On any matter relating to the products of a Service, the Service shall represent the IAG.

14. Current Services

On the coming into effect of these bylaws, there shall be fifteen Services as outlined below:

(a) International GNSS Service

(b) International VLBI Service for Geodesy and Astrometry.

(c) International Laser Ranging Service

(d) International Gravimetric Bureau

(e) International Geoid Service

(f) International Centre for Earth Tides

(g) International Earth Rotation and Reference Systems Service

(h) International DORIS Service

(i) International Gravity Field Service

(j) International Centre for Global Earth Models

(k) International DEM Service – to be confirmed

(l) Permanent Service for Mean Sea Level

(m) Time Section of the International Bureau of Weights and Measures

(n) International Altimetry Service (IAS) – to be confirmed

(o) IAG Bibliographic Service.

15. The Global Geodetic Observing System (GGOS)

(a) The GGOS is IAG’s observing system to monitor the geodetic and the global geodynamic properties of the Earth as a system.

(b) GGOS works with other IAG components, such as the IAG Services and the IAG Commissions, as well as the Inter-Commission Committees, to provide unique, mutually consistent, and easily accessible geodetic products (including the geometric reference frames and the gravity field) and the relevant geodetic constants for science and society.

(c) GGOS operates on its own Terms of Reference, defined by the GGOS Steering Committee and approved by the IAG Executive Committee.

GGOS nomination and election procedures are specified in its Terms of Reference. Changes in the GGOS Terms of Reference may be proposed by the GGOS Steering Committee and approved by the IAG Executive Committee.

(d) The GGOS Chair is appointed by the IAG Executive Committee in consultation with the GGOS Steering Committee for one four-year period, which may be renewed once.

16. IAG Projects

(a) IAG Projects are flagship projects of a broad scope and of highest interest and importance for the entire field of geodesy and are expected to be established for a decade or longer.

(b) Planning for the creation of an IAG Project shall be carried out by a planning group established by the Executive Committee.

(c) The Project Steering Committee shall have the following voting members:

(i) The project chair appointed by the IAG Executive Committee

(ii) One member from each Commission appointed by the Commissions' Steering Committee

(iii) Two Members-at-Large proposed by the members of the Project Steering Committee identified in clause (i) and (ii) above and approved by the IAG Executive Committee.

(iv) Chairs of the IAG Project Working Groups (if any).

(v) Representatives of other IAG components, as appropriate.

(d) Guidelines for the establishment of Commission Projects are established by the Executive Committee and published in the Geodesist's Handbook.

(e) IAG Project Sub-components are Working Groups but not Study Groups.

17. Inter-commission Committees

(a) Inter-Commission Committees shall handle well defined, important and permanent tasks involving all Commissions.

(b) Each Inter-commission Committee shall have a steering committee, which shall include the following members:

(i) President appointed by the IAG Executive Committee.

(ii) Vice-president appointed by the IAG Executive Committee on the recommendation of the president.

(iii) One representative appointed by each Commission.

(c) The terms of reference for each Inter-commission Committee shall be developed by a planning group appointed by the IAG Executive Committee for approval by the Executive Committee.

(d) Inter-Commission Committees will be established for at least 2 periods (eight years) and shall be reviewed by the Executive Committee every eight years.

(e) The Inter-commission Committees shall report to the IAG Executive Committee.

18. Communication and Outreach Branch (COB)

(a) The function of the Communication and Outreach Branch is to provide the Association with communication, educational/public information and outreach links to the membership, to other scientific Associations and to the world as a whole.

(b) The responsibilities of the Communication and Outreach Branch shall include the following tasks:

(i) Promote the recognition and usefulness of geodesy in general and IAG in particular.

(ii) Publications (newsletters).

(iii) Membership development.

(iv) General information service and outreach.

(c) The Communication and Outreach Branch shall also assist the IAG General Secretary, in the following tasks as required:

(i) Maintenance of the IAG Web page.

(ii) Setting up Association schools.

(iii) Setting up meetings and conferences

(iv) Maintaining the Bibliographic Service.

(d) The IAG Executive Committee establishes the Branch on a long-term basis by issuing a Call for Participation. The responding organization(s) and the IAG Executive Committee shall then negotiate the Terms of Reference and other conditions.

(e) The President of the Communication and Outreach Branch shall be elected by the Council.

(f) Major decisions related to the operations of the COB shall be made by a Steering Committee consisting of the following voting members:

(i) Communications and Outreach Branch President.

(ii) IAG Secretary General.

(iii) Editor-in-Chief of the Journal of Geodesy.

(iv) Up to 5 other members appointed by the Executive Committee on the recommendation of the President of the Communications and Outreach Branch.

19. Editor-in-Chief and Editorial Board

(a) There shall be one Editor-in-Chief for the journal, hereinafter referred to as the Editor. An Assistant Editor-in-Chief may assist the Editor. The Editor shall be advised and assisted by a Board of Editors, hereinafter referred to as the Board. To ensure broad expertise, each of the Commissions may nominate up to three members of the journal's editorial board.

(b) The Editor shall be responsible for the scientific content of the journal. The Editor shall make the final decision on whether a refereed scientific manuscript is accepted for publication. The Editor shall keep the Executive Committee informed of the activities and status of operations of the journal.

(c) A few months before each meeting of the General Assembly, the current Editor, in consultation with the Bureau, shall recommend a preliminary list of candidates for the new Board of Editors. This list shall be published on the IAG website at least two months in advance of the General Assembly to solicit additional nominations for the Editorial Board from the geodetic community. The additional candidates will be added to the list.

(d) At the meeting of the General Assembly, the current Board shall appoint the members of the new Board from those recommended. After taking office, the new Board shall nominate the new Editor and the new Assistant Editor for the next period. After approval of these nominations by the Executive Committee, the Editor and the Assistant Editor will be considered as elected. Concurrence with the Publisher will be sought.

(e) The Editor, the Assistant Editor, and the members of the Editorial Board shall each hold office for one period, but may be eligible to be re-elected for one further period.

20. IAG Publications

(a) The IAG publications include the Journal of Geodesy, the IAG Newsletter, the Geodesist's Handbook, the "Travaux de l'Association Internationale de Géodésie", IAG Special Publications, and the IAG Symposia series.

(b) The Association's journal is the Journal of Geodesy, hereinafter referred to as the journal. The journal is published monthly through an agreement between the Association and a publishing company, or by other arrangement approved by the Executive Committee. The terms of any agreement for publication of the journal shall be negotiated by the President of the Communications and Outreach Branch and ratified by the Executive Committee.

(c) The journal publishes peer-reviewed papers, covering the whole range of geodesy, including geodetic applications.

(d) The IAG Newsletter is under the editorial responsibility of the Communication and Outreach Branch. It should be published on the IAG web site and distributed to members electronically.

(e) After each IAG General Assembly meeting, a special issue of the Journal of Geodesy shall be published under the name of "The Geodesist's Handbook". This issue provides the actual information on the Association, including the reports of the President and Secretary General presented at the previous IAG General Assembly meeting, the resolutions taken at that meeting, and the Association structure listing all components and sub-components for the running period, rules for the IAG Fund, IAG Awards and for the conduct of scientific meetings as well as relevant scientific information.

(f) After each IAG General Assembly meeting, a collection of the reports by the Association components shall be published in the "Travaux de l'Association Internationale de Géodésie". This publication is supplied free of charge to the officers of the Association and to the adhering body of each member country.

(g) Proceedings of IAG symposia may be published in the IAG Symposia Series. The series editor is the President of the Association, with the symposia convenors acting as volume editors. All manuscripts are peer reviewed, and the volume editor shall make the final decision on whether a manuscript is accepted for publication.

(h) At every IAG General Assembly meeting each member country is encouraged to supply either an adequate number of copies of its National Report on geodetic work done since the previous General Assembly meeting in hard copy or a digital copy of its national report to be placed on the IAG web site. These National Reports, as far as available, are distributed by the IAG Office in the same manner as the "Travaux de l'Association Internationale de Géodésie".

21. Individual Membership

(a) Individuals engaged in geodesy, can become individual members of the Association on application and payment of the membership fee.

(b) Applications for individual membership are submitted to the Secretary General.

(c) The decision on the membership application shall be made by the Bureau.

(d) Benefits of membership include

(i) Substantial reduction on the individual subscription rate to the Journal of Geodesy.

(ii) The right to participate in the IAG election process both as a nominator and a nominee.

(iii) Upon application, correspondent membership in a sub-commission or study group of choice.

(iv) Reduction of the registration fee for IAG meetings as set under Bylaws 25(i), 26(d) and 27(c).

(e) The membership fee per annum is set by the Executive Committee. In setting the fee the Executive Committee will consider a recommendation from the Secretary General.

(f) In individual cases, the Secretary General may consider a discount or full remission of membership fees on application by the member.

(g) Where a member provides a donation in excess of the membership fee, the excess shall be assigned to the IAG Fund in support of young scientists.

(h) Membership is terminated if the membership fee is not paid or if an application for discount or full remission has not been received one year after the fee was due.

22. Fellows

The Executive Committee may invite past officers of the Association to be Fellows. Where the invitation is accepted, the Executive Committee shall confirm the appointment.

23. IAG Fund

The Executive Committee may establish a fund (IAG Fund) for supporting specific IAG activities as defined in the IAG Fund Rules, to be published in the Geodesist's Handbook in accordance with Bylaw 20(e). The fund is under the direct responsibility of the President; the fund's resources are administered by the Secretary General.

24. IAG Awards

The Executive Committee may establish awards for outstanding contributions to geodesy and distinguished service to the Association. The rules for the awards are published in the Geodesist's Handbook in accordance with Bylaw 20(e).

25. Administration of the IAG General Assembly meetings

(a) The IAG General Assembly shall meet at the same time and the same place as the IUGG General Assembly meeting.

(b) Before any meeting of the IAG General Assembly, the Bureau of the Association shall prepare detailed agendas for the Council meetings, Executive Committee meetings, the opening and the closing sessions.

(c) The Executive Committee shall draw up the agenda for the scientific program. Joint Symposia covering topics of interest to two or more Associations within the Union may be arranged.

(d) The agendas developed according to (b) and (c) above are sent to the member countries and to all the officers of the Association so as to reach them at least two months prior to the IAG General Assembly meeting. In principle, only matters on the agenda may be considered during the sessions, unless a decision to do otherwise is passed by a two-thirds majority in the Council concerning the agenda of the Council meeting, or in the Executive Committee concerning the scientific program.

(e) At each meeting of the IAG General Assembly, the President shall present a detailed report on the scientific work of the Association during his/her tenure. The Secretary General shall present a detailed report on the administrative work and on the finances of the Association for the same period. The President and Secretary General should include in their reports, proposals for work to be undertaken during the coming period, within the limits of expected resources. These reports shall be published in "The Geodesist's Handbook".

(f) At each meeting of the IAG General Assembly, the work of each Commission, each Service, the Communication and Outreach Branch, and each IAG Project shall be reported by its President / Chair. IAG Representatives to other scientific bodies report to the Executive Committee.

(g) Individual authors are responsible for the reproduction of their scientific papers. prior to the meeting. Where the IAG office receives sufficient copies of papers at the meeting, it shall distribute these to the delegates.

(h) Assembly Secretaries shall be appointed by the Council on the recommendation of the adhering body of the country in which the next IAG General Assembly meeting or Scientific Assembly will take place. In cooperation with the Bureau, the Assembly Secretary has responsibility for liaison with the organizers working on the preparation of the Assembly.

(i) The Executive Committee may set a reduced registration fee for Individual members in accordance with 20(d) (iv).

26. Scientific Meetings

(a) Scientific meetings of the IAG are:

(i) the Scientific Symposia held during a General Assembly;

(ii) Scientific Assemblies, including Scientific Symposia; and

(iii) IAG sponsored Symposia.

(b) The IAG Newsletter shall include on a regular basis, a Calendar of IAG Symposia and other scientific meetings organized or sponsored by the IAG or its components.

(c) The Executive Committee shall appoint an official IAG Scientific Meeting Representative for each of the scientific meetings to be governed by these Bylaws. The representative is obliged to remind the organizers to obey the Bylaws for scientific meetings and to report back to the Executive Committee.

(d) The Executive Committee may set a reduced registration fee for Individual members in accordance with 21(d) (iv).

27. Scientific Assemblies

(a) Scientific assemblies are generally held mid-way during the period between two meetings of the IAG General Assembly and shall consist of a group of component meetings and/or a group of Scientific Symposia, held at the same time and place.

(b) The Executive Committee shall appoint an Assembly Secretary in accordance with Bylaw 25(h).

(c) The Executive Committee may set a reduced registration fee for Individual members in accordance with 21(d)(iv).

28. Scientific Symposia

(a) Scientific symposia take place at meetings of the IAG General Assembly and Scientific Assembly. In general, they shall be organized by Association components and sub-components, and be led by their respective chairs.

(b) The study of some questions may require joint meetings of several components under a chair, appointed by the Executive Committee. A committee consisting of the component Chairs shall decide on the agenda and on the inclusion of scientific presentations.

(c) At each meeting of the IUGG General Assembly Joint Scientific Symposia covering topics of interest to two or more Associations within the IUGG and/or other international scientific organizations may be arranged. Though the IAG may be asked to act as convenor or co-convenor, these symposia shall follow the rules issued by the IUGG. The IAG may participate also in joint symposia at any other time outside of meetings of the IAG General Assembly obeying the same procedures.

(d) The arrangement of a scientific symposium shall be subject to the usual approval procedure provided by in the Geodesist's Handbook in accordance with Bylaw 20(e).

29. IAG Sponsored Symposia

(a) The IAG may sponsor a symposium covering broad parts of geodesy and having large attendance at any suitable time outside the IAG General Assembly meeting or Scientific Assemblies, and shall call it an IAG Sponsored Symposium, provided the following conditions are fulfilled:

(i) One or more Association component or subcomponent shall sponsor it or at least two Study Groups.

(ii) Host organization of the symposium shall accept a Scientific Organizing Committee (SOC) appointed by the IAG Executive Committee.

(iii) The symposium shall be open to all bona-fide scientists in accordance with the ICSU rules.

(iv) The symposium proceedings shall be published within 6-8 months.

(b) The SOC appointed under 29(a)(ii) above shall be responsible for the quality of science of the symposium being at a high level. A Local Organizing Committee (LOC) shall take care of the organization and logistics.

(c) Applications for approval of an IAG Symposium should be submitted to the Secretary General at least two years before the intended date of the meeting. Detailed guidelines for such applications, and the expectations from the SOC and LOC, may be found in the Geodesist's Handbook in accordance with Bylaw 20(e).

30. International Cooperation

(a) The Association may participate in joint bodies of the IUGG and other scientific organizations, especially those belonging to the International Council for Science (ICSU). These bodies shall be administered according to their specific rules.

(b) The Association shall initiate international cooperation in scientific work of international and interdisciplinary character. This includes the adequate participation in international programs and projects and the representation at scientific congresses, symposia etc. of organizations with related activities.

(c) The President of the Association shall decide on the proper participation or representation. Representatives to international programs and projects shall be appointed by the Executive Committee and shall keep the President informed on the activities, on a biannual basis. The representatives shall also prepare a report to be presented at the IAG General Assembly meeting.

31. Duties of the Council

(a) In addition to any other functions, powers and duties provided in other Statutes and Bylaws, the Council shall:

(i) Examine questions of general scientific policy or administration, and propose actions deemed necessary.

(ii) Elect the voting members of the Executive Committee, with exception of the GGOS Chair; see 15(c).

(iii) Receive reports from the Secretary General and consider for approval the decisions or actions taken by the Bureau and the Executive Committee since the last Council meeting.

(iv) Set up and dissolve Association components.

(v) Appoint the three members of the ad hoc committee created for examining the finances of the Association, consider its recommendations and adopt the final budget.

(vi) Consider proposals for changes in the Statutes and Bylaws.

(vii) Decide on the venue of IAG Scientific Assembly meetings.

(viii) Approve the establishment of Inter-Commission Committees and IAG Projects.

(b) Council meetings shall be convened by the President of the Association. It shall meet at least once during each IAG General Assembly meeting, and may be convened at other times, normally coinciding with a meeting of the IAG Scientific Assembly.

32. Duties of the Executive Committee

(a) In addition to any other functions, powers and duties provided in other Statutes and Bylaws, the Executive Committee shall:

(i) Initiate actions and issue guidelines, as required, to guide the Association towards the achievement of its scientific objectives.

(ii) Fill vacancies occurring between IAG General Assembly meetings, in accordance with the present Statutes and Bylaws.

(iii) Approve the internal structure of Association components.

(iv) Make recommendations to the Council on matters of general policy of the Association and on the implementation of its objectives.

(v) Appoint Fellows of the Association, upon the recommendation of the Bureau..

(vi) Appoint planning groups for Inter-commission Committees and IAG Projects.

(vii) Establish Inter-commission Committees and IAG Projects.

(viii) Appoint an IAG Review Committee every eight years.

(ix) Appoint the Assistant Secretaries of the Association.

(x) Confirm the links between Commissions and Services.

(xi) Adopt the suggested membership fee

(xii) Appoint the Vice-president of Commissions.

(xiii) Appoint representatives to external bodies.

(xiv) Establish an IAG Fund.

(b) Executive Committee meetings shall be convened by the President of the Association. It shall meet at IAG General Assembly meetings and its members are expected to attend the meetings of the Council, with voice but without vote. It shall also meet normally at least once a year, especially one year before the IAG General Assembly meeting, in order to prepare the scientific agenda and the timetable of the next IAG General Assembly meeting.

(c) At a meeting of the Executive Committee, no member may be represented by any other person, except a President of Commission who may be represented by the Vice-President. In order that the deliberations of the Executive Committee shall be valid, at least half of its members must be present or represented.

(d) The agenda for each meeting of the Executive Committee shall be prepared by the Bureau and sent to the members at least three months prior to the meeting.

33. Duties of the Bureau

(a) In addition to any other functions, powers and duties provided in other Statutes and Bylaws, the Bureau shall:

(i) Draw up the agenda of the meetings of the Council and Executive Committee and send these to the members at least three months prior to the meeting.

(ii) Ensure the adequate administration of the Association.

(iii) Receive applications for individual memberships and accept individuals as Members of the Association.

(iv) Recommend Fellows to the Executive Committee.

(b) The Bureau shall normally meet before each meeting of the Executive Committee.

34. Duties of the President

In addition to any other functions, powers and duties provided in other Statutes and Bylaws, the President shall:

(a) Provide general leadership for the Association in all matters.

(b) Convene and preside over the IAG General Assembly meeting and over all meetings of the Council, Executive Committee and Bureau.

(c) Represent the Association in its dealing with national or international organizations or institutions.

(d) Submit a report to the IAG General Assembly meeting on the scientific work of the Association during his/her tenure.

35. Duties of the Vice President

In addition to any other functions, powers and duties provided in other Statutes and Bylaws, the Vice President shall act as the President whenever the President is not present or is unable to perform any of the President's duties, and shall perform such tasks as may be assigned by the President, the Executive Committee or the Council.

36. Duties of the Secretary General

In addition to any other functions, powers and duties provided in other Statutes and Bylaws, the Secretary General shall:

(a) Serve as secretary of the General Assembly, the Council, the Executive Committee and the Bureau; arrange for meetings of these bodies, distribute promptly the agenda and prepare and distribute the minutes of all their meetings.

(b) Act as Director of the IAG Office.

(c) Manage the affairs of the Association, attend to correspondence, and preserve the records.

(d) Circulate all appropriate information related to the Association.

(e) Prepare the reports of the Association's activities.

(f) Perform such other duties as may be assigned by the Bureau.

(g) The function of the Secretary General is unpaid and only expenses incurred in connection with the functions and duties are repayable.

37. Assistant Secretaries

(a) The Secretary General is assisted by a small number of assistant secretaries, one of whom is located in the same office as the Secretary General.

(b) The position of Assistant Secretary is unpaid and only expenses incurred in connection with the functions and duties are repayable.

38. IAG Office

To assist the Secretary General, the Association establishes the IAG Office in the country in which the Secretary General resides. The Executive Committee negotiates logistical and financial support with the host country.

39. Procedure for Nominations and Elections of Officers

(a) Elections shall take place by mail vote before each IAG General Assembly meeting and should be completed one month before the assembly.

(b) The President of the Association, after taking advice from the Executive Committee, shall appoint a Nominating Committee consisting of a Chair and three other members.

(c) The Nominating Committee, after taking advice from the Delegates of the Adhering Bodies, the officers, fellows, and members of the Association, shall normally propose at least two candidates for each position to be filled by election in the Council. Candidates shall be asked to signify their acceptance of nomination and to prepare a resume, maximum 150 words, outlining their position, research interests and activities relating to the Association.

(d) The Adhering Bodies and the individual membership (i.e. the General Assembly membership) shall be informed of these nominations three months before the IAG General Assembly meeting.

(e) During the following month further nominations can be submitted by the Delegates of the Adhering Bodies. Such additional nominations shall be in writing, shall be supported by at least two members of the Council, and shall be submitted with resumes as described above to the Chair of the Nominating Committee.

(f) Nominations shall be checked against the eligibility criteria in Bylaw 40 by the Nominating Committee. Ineligible nominations will not be accepted and the members of Council who supported the

nomination will be advised of the reason for its rejection.

(g) Delegates shall be informed of these further eligible nominations and resumes and of their supporters.

(h) The Chair of the Nominating Committee shall write to all services asking them for one nomination from each service for the Service representatives on the Executive Committee. The Nominating Committee shall recommend normally two nominees for each of the Services' three positions, considering appropriate scientific and national distribution. The procedure for seeking additional nominations in sub clause (e) above does not apply to these positions.

(i) If candidates have been nominated for more than one position, they will be asked to make a decision for which position they will allow their name to stand.

(j) Elections shall be by mail ballot and by majority vote. In this case, the delegates of the Adhering Bodies form the Council.

40. Eligibility & Terms of Office

(a) No person may hold more than one of the following offices at the same time: President of the Association, Vice-President, President of a Commission, President of a Service, Chair of GGOS, President of the Communication and Outreach Branch, Chair of an IAG Project.

(b) A member of the IUGG Bureau or of the IUGG Finance Committee may not occupy the post of President, of Vice-President or of Secretary General of the Association.

(c) The President of the Association is elected for one Period and may not be immediately re-elected to the same office.

(d) The Vice-President is elected for one period and may not be re-elected to the same office.

(e) The Secretary General is elected for one period initially. He/she may be re-elected for two additional periods.

41. Extraordinary Vacancies

(a) Should the position of President become vacant during the Period between two IAG General Assembly meetings, his duties devolve to the Vice-President until the closure of the next IAG General Assembly meeting.

(b) Should the post of Secretary General become vacant, the President shall arrange without delay for the Executive Committee to propose a replacement and for the Council to appoint a new Secretary General so as to ensure the continuity of the work of the IAG Office. This appointment has effect until the closure of the next IAG General Assembly meeting and shall not be counted in the restriction of eligibility for re-election of the Secretary General under Bylaw 40(e).

42. Finance

(a) The Finances of the Association derive from the following sources:

(i) Contributions of IUGG Adhering Bodies of which a portion, determined by the IUGG Council on recommendation of its Finance Committee, is paid to the Association by the Treasurer of the Union.

(ii) Sale of publications.

(iii) IAG Fund collected from individual contributions for specific purposes.

(iv) Membership fees.

(v) A portion of the registration fee charged at IAG symposia.

(vi) Other sources e.g., grants, interests, and funds remaining after a symposium.

(b) The Secretary General is responsible to the Bureau and to the Council for managing the funds in accordance with the Statutes and Bylaws, with the decisions of the Council. The Secretary General alone shall be responsible for control of the financial operations of the Association.

(c) At each IAG General Assembly meeting the budget proposal for the next period shall be presented by the Secretary General and submitted for approval to the Council. The budget as approved by the Council shall be implemented by the Secretary General.

(d) During each IAG General Assembly meeting, the Council shall examine all expenditures during the preceding period to ensure that they were in accordance with the proposed budget previously approved. The Council shall appoint an ad hoc committee for carrying out this examination in detail.

(e) In addition, the accounts shall be audited by a qualified accountant and shall then be reported to the IUGG Treasurer, as prescribed in Article 20 of the IUGG Bylaws.

Rules for IAG Scientific Meetings

1. IAG Scientific Meetings are organized by IAG Components (Commissions, Services, Global Geodetic Observing System) or Sub-components (Inter-commission Committees, Sub-commissions, Projects, Study Groups, Working Groups). They may take place:
   a) during IAG General Assemblies, held in conjunction with the IUGG General Assemblies,
   b) during IAG Scientific Assemblies, held in-between successive General Assemblies, or
   c) at any time and place apart from the General or Scientific Assemblies of the IAG.

2. During the General or Scientific Assemblies the scientific meetings are organized under the chairmanship of the Presidents of the IAG Components. For specific topics there may be joint meetings of several Components under a chair appointed by the IAG Executive Committee. The inclusion of scientific papers for presentation at a General or Scientific Assembly is decided by a Scientific Committee established by the IAG Executive Committee.

3. At General Assemblies joint symposia covering topics of two or more Associations within the Union and/or other international scientific organizations may be organized. Though the IAG may be asked to act as convenor or co-convenor, these symposia follow the IUGG rules for such activities.

4. The IAG may participate also in joint symposia with other Associations at any other time outside of the General Assemblies, following the same procedures.

5. The IAG may sponsor scientific symposia covering appropriate topics of Geodesy at any time outside of the General or Scientific Assemblies, and may call them IAG-Symposium if the following conditions are fulfilled:
   - The Symposium has to be organized by at least one Component or two Sub-components of the IAG.
   - The host organization of the Symposium must accept a Scientific Committee appointed by the IAG Executive Committee with the advice of the proposer of the Symposium.
   - The Symposium must be open to all scientists in accordance with the ICSU Rules.
   - The proceedings of the Symposium should be published within 6-8 months after the end of the Symposium in the series of IAG Symposia.
   - If there is a registration fee, it must be reduced for IAG members by at least 10%.

   IAG expects that immediately after the end of the Symposium the chairperson of the Scientific Committee will prepare a short summary to be published in the Journal of Geodesy and in the IAG Newsletter.

6. Applications for approval to be designated IAG-Symposium should be submitted to the Secretary General of the IAG at least twelve months before the proposed date of the Symposium. The following information must be provided in the application for approval:
   a) Title,
   b) Date and duration,
   c) Location,
   d) Sponsoring and co-sponsoring (Sub-) Components of IAG,
   e) Other co-sponsoring scientific organizations with letters enclosed,
   f) Suggested composition of the Scientific Committee,
   g) Local Organizing Committee, host organization, name and address of contact, etc
   h) Estimated number of participants,
   i) Financial support expected from sources other than the IAG,
   j) Names of the proposed editors of proceedings,
   k) Draft scientific programme,
   l) A detailed account of why the proposed Symposium is useful and necessary at the time proposed, and its relationship with other meetings.

7. Guidelines for the organization of the Symposium:
   a) The Scientific Committee is responsible for ensuring a high standard of scientific value of the Symposium. The chair of the Scientific Committee:
      - invites participants after the Symposium is approved by the IAG Executive Committee,
      - invites contributions and sets a deadline for submissions of abstracts, and
      - informs the IAG Secretary General of all important matters pertaining to the Symposium.
   b) The Local Organizing Committee is responsible for the smooth running of the Symposium. It does not receive financial assistance from the IAG, with all the necessary expenses being met by local funds or by contributions from the participants. The requirements of local organizations are generally as follows:
      - providing meeting rooms suitable for the expected number of participants,

- providing the facilities for oral and visual presentations,
- provide adequate space and logistical support for poster sessions (if any),
- reproduction of participants' document (if necessary), organize publication of proceedings or production of CD version,
- sufficient secretarial and technical assistance,
- undertake full responsibility for registration of participants, maintaining a web page, printing of brochures and programmes, etc.
- information on accommodation (hostels, hotels, etc...), sent to the IAG Executive Committee for acceptance, and to prospective participants, and
- organizing receptions and excursions during a free period within the meeting, or just before or after the meeting.

8. The IAG Executive Committee shall recognize scientific meetings other than symposia (workshops, etc.) organized by IAG (Sub-) Components, alone or jointly with other international and national groups and bodies, at any time outside of the General Assemblies, if they have been approved by the Executive Committee. The Meeting may be announced as "International Meeting, organized by the ..... of IAG". It is not permitted to use the term "IAG-Symposium".

9. The IAG may recognize scientific meetings, organized by national bodies as important scientific events with benefit for the international geodetic community and to sponsor them if the meeting is open to all scientists according to the ICSU Rules, and will be sponsored by at least one IAG (Sub-) Component, and if the organizer undertakes to maintain the expected standard for IAG-Symposia.

   These Meetings may be announced as "International Meeting, organized by ....., sponsored by IAG". It is not permitted to use the term "IAG-Symposium". Sponsorship by the IAG means only official recognition and does not imply financial support by the IAG. The IAG may appoint an official representative to that meeting. The IAG expects that, in the event that proceedings are published, the Proceedings will be prepared by the local organizers and published within 6-8 months after the end of the meeting.

   Applications for sponsorship should be submitted to the IAG Secretary General not later than 18 months before the intended date of the meeting.

10. In its decision whether to approve and/or sponsor a scientific meeting, the IAG Executive Committee takes into account the need for a balanced selection of meetings, a representative coverage of subjects, and a good geographical distribution. The IAG wishes to avoid duplication of symposia or meetings, and to discourage symposia or meetings with overlapping themes that are held with too high a frequency.

The IAG Secretary General shall publish a calendar of IAG-Symposia and other scientific meetings organized by IAG-bodies or sponsored by IAG in the Journal of Geodesy, in the IAG Newsletter and on the IAG Website.

Rules for the IAG Levallois Medal

Purpose

The Levallois Medal was established by the International Association of Geodesy in 1979 to honour Jean-Jacques Levallois, and to recognize his outstanding contribution to the IAG, particularly his long service as Secretary General, 1960-1975.

The award of the Medal will be made in recognition of distinguished service to the Association, and/or to the science of geodesy in general.

The Medal is normally awarded at four year intervals, on the occasion of the General Assemblies of the International Association of Geodesy and International Union of Geodesy and Geophysics; but the award may be omitted if it is considered that there is no candidature of sufficient merit, and an additional award may be made at any time if justified by exceptional circumstances.

Nomination and Election

A nomination for the award shall be made by an ad hoc committee consisting of the Honorary Presidents and must be confirmed by the IAG Executive Committee. The ad hoc committee shall prepare a citation, suitable for publication, setting out the grounds for the proposed award before the General Assembly.

Rules for the IAG Young Authors Award

Purpose

To draw attention to important contributions by young scientists in the Journal of Geodesy and to foster excellence in scientific writing.

Eligibility

The applicant must be 35 years of age or younger when submitting the paper for the competition. The paper must present his or her own research, and must have been published in the two annual volumes of the Journal of Geodesy (J of G) preceding either the IAG General Assembly or the Scientific Assembly. Although multiple author papers will be considered, single author papers will be given more weight in the selection process.

Award

The award consists of a certificate and a cheque of US $1000. Presentation of the awards will be made at each IAG General Assembly and each Scientific Assembly. Up to two awards will be presented on each occasion for the two-year period corresponding to the annual volumes specified above.

Nomination and Selection

For each two-year period the Editor-in-Chief of the Journal of Geodesy will propose a minimum of three candidates for the award. In addition, proposals made by at least three Fellows or Associates will be considered for the competition. The voting members of the IAG Executive Committee will make the final selection. It will be based on the importance of the scientific contribution, which may be either theoretical or practical, and on the quality of the presentation. The name and picture of the award winner and a short biography will be published in Journal of Geodesy.

Procedure

Each year the conditions for the award will be announced in the Journal of Geodesy. Nominations should be sent to the Secretary General of the IAG, giving name, address, and age of the author (at date of submission), the title of the paper on which nomination is based, and a brief justification. Nominations must be received by March 1 of the year in which either an IAG General Assembly or an IAG Scientific Assembly takes place.

Rules for the IAG Guy Bomford Prize

Purpose

The Guy Bomford Prize is awarded by the International Association of Geodesy for outstanding contribution to Geodesy. It was established by the British National Committee for Geodesy and Geophysics to mark the contributions to geodesy of Brigadier G. Bomford, formerly of the University of Oxford and a Past President of the International Association of Geodesy. It has been inaugurated by the IAG in 1975. The Prize is normally awarded at intervals of fours years on the occasion of the General Assembly of the IAG held concurrently with the General Assembly of the International Union for Geodesy and Geophysics. The following rules for the award of the Guy Bomford Prize may be altered by the IAG Executive Committee if a majority of its voting members sees a necessity to do so.

Eligibility

The Guy Bomford Prize is awarded to a young scientist or to a team of young scientists for outstanding theoretical or applied contributions to geodetic studies, particularly in the four year period preceding the General Assembly at which the award is made. Scientists who are under 40 years of age on December, 31, of the year preceding the Assembly at which the award is made, are eligible for the award.

Nominations

Nominations will be invited by the IAG Bureau from all National Committees of IUGG member countries at least one year ahead of the General Assembly. Each committee can make one nomination which has not necessarily to be from its own country. The deadline for nominations will normally be six months before the next General Assembly and will be explicitly started in the letter of invitation. Nominations must be accompanied by:

- The full name, address, age, academic and/or professional qualifications and position of the candidates and the name of the National Committee making the nomination.
- An outline of the reasons for the nomination including a general summary of the career and scientific achievement of the candidate.
- A review of recent achievements of the candidates which would merit the award, including references to key papers, published, alone or jointly, during the preceding four-year period.
- A curriculum vitae, publication list, and copies of up to two key papers which are considered to justify candidature.
- The name and address of two referees who could be consulted.

Selection procedure

A selection committee will be appointed consisting of the presidents of the IAG commissions and two other members to be appointed by the IAG Bureau. Based on the material submitted by the National committees each member of the selection committee will rank the nominations and select the candidate to be awarded the Guy Bomford prize. The decision (not the detailed ranking) will be communicated to all National Committees and to the selected candidate. The prize may be withheld if, in the opinion of the selection committee, there is no sufficiently qualified candidate available.

Presentation of award

The Prize shall be presented to the successful candidate at the opening Plenary Session of the IAG Assembly. He or she shall be invited to deliver a lecture during the course of the IAG Assembly.

Rules for IAG Travel Award

Purpose

The award is established to assist young scientists from member countries to present results of their research at IAG meetings (assemblies, symposia, workshops, etc.).

Eligibility

The applicant must present results of his or her research at the meeting and must be 35 years of age or less at the date of the application. The application must be supported by at least one IAG Fellow or two Associates.

Type of awards

There are two awards, one for meetings in the applicant's own country, and the other for meetings outside the applicant's country. The first is called *IAG National Travel Award* and has a maximum financial value of US $ 500. It is available for meetings in developing countries. The second is called *IAG International Travel Award* and has a maximum financial support of US $ 1000. The amounts can occasionally be adjusted by the IAG Executive Committee. It was adjusted last in 2011.

Application procedure

Applicants are asked to send their application at least three months before the meeting to the IAG Secretary General. As a minimum, the application should contain: title, authors, and abstract of the paper to be presented, acceptance by the organising committee (if available), travel budget and sources of additional funding. The letter(s) of support (one IAG Fellow or two Associates) should be sent separately.

Selection procedure and criteria

Selection of applicants will be done by the IAG Bureau. It will be based on the paper to be presented, the letter(s) of support, and the applicant's ability to actually attend the meeting. Priority will be given to candidates from developing countries.

Additional benefits

The IAG will encourage the organizers of the meetings to waive the registration fees for all IAG Travel award winners.

IAG Travel Award Application Form (to be sent to iag@dgfi.badw.de)

Last name: First name(s):

Institution: Degree, position:

City, zip code: Country:

E-mail: Date of birth:

IAG meeting (Name, city, country, date):

Author(s) and title(s) of presentation(s):
(abstract(s) to be sent separately)

Estimated total costs of travel and stay (budget to be sent separately):

Name(s) of supporting person(s) (letter(s) to be sent separately):

Date of application, signature:

IAG Fund

The IAG Fund aims at supporting specific IAG activities. Its primary goals are:

- to provide travel support for young scientists to attend IAG Symposia and workshops,
- to assist in the organisation of IAG workshops in developing countries, and
- to provide an annual IAG Best Publication Award for young scientists.

The fund was established by the IAG Executive Committee at its meeting in Columbus, Ohio, 1992, see Bulletin Géodésique, Vol. 68, pp. 41-42, 1994.

Contributors are divided in 3 groups:

- Presidents Club (cumulative contributions of USD 1000 and more or equivalent in EUR)
- Special contributors (annual contributors of USD 100 … USD 1000 or equivalent in EUR)
- Contributors (annual contributions of less than USD 100 or equivalent in EUR)

The rules for the IAG Young Authors Award and for the IAG Travel Award for young scientists are given in a separate section of the Geodesist's Handbook.

I wish to contribute to the IAG fund

Annual basis ☐ One-and-for-all ☐

Amount ...…… USD or .. …… EUR

Payment

Please charge my credit card

☐ Master Card, ☐ VISA Card

Card number: .....

Expiry date: ..... Security code: .....

Or bank transfer

Remittee: Staatsoberkasse
Bank: Bayerische Landesbank, Brienner Strasse 18,
D − 80333 Muenchen, Germany
Bank No.: 70050000, Account No.: 24592,
SWIFT code/BIC: BYLADEMM,
IBAN: DE36 7005 0000 0000 024592,

Note to payee: DGFI PK 2504.2100.0078, your name

Title:
_____

Name: _____

Institution/Department: _____

_____
_

_____
_

Address: _____

Country: _____

Phone:
_____

Fax:
_____

E-Mail: _____

Date:
_____

Signature: _____

INTERNATIONAL ASSOCIATION OF GEODESY

Membership Application Form

Please complete and send to:

IAG Office
c/o Deutsches Geodätisches Forschungsinstitut
Alfons-Goppel-Str. 11
D – 80539 München, Germany
Tel.: +49 89 23031 1107, Fax: +49 89 23032 1240
E-mail: iag@dgfi.badw.de

http://www.iag-aig.org
http://iag.dgfi.badw.de

For office use only:	Date received	Membership no.

Please use BLOCK KAPITALS

Personal details

Surname / Last / Family Name	First / Other Names	Title (Prof. / Dr. / Ms.)	Date of Birth dd/mm/yyyy

Address (Affiliation, Street, no. City, zip Country)		Phone:	
		Fax:	
		E-mail:	

Class of membership (tick one)

Individual One year (USD 50)	☐	Individual Four years (USD 150)	☐	Individual at reduced fee Application submitted separately	☐
Student (free, to be renewed annually	☐	University / College certificate submitted separately			
Retired	☐	Reduced fee upon request and acceptance only			
I represent the institution	☐	Institution name:	I want to pay for a membership of		persons, the names submitted separately

IAG Fund (voluntary)

I wish to contribute to the IAG Fund:	Annual basis ☐	One-and-for-all ☐	USD/EUR

Payment details (tick one)

☐	Credit Card no.		Expiry date		Security code	
	Name of holder		Card type	Master ☐	VISA ☐	Eurocard ☐
☐	Bank transfer	Remittee: Staatsoberkasse München Bank: Bayerische Landesbank, Brienner St 18, D-80333 München, Germany Bank no.: 700 500 00, Account no.: 24592, SWIFT code / BIC: BYLADEMM IBAN: DE36 7005 0000 0000 0245 92 Note to payee: DGFI PK 2504.2100.0078, member's name				

The XXV IUGG General Assembly Melbourne, Australia, 2011

Report of the IAG Secretary General

H. Drewes

According to the IAG Bylaws §25(e), the Secretary General shall present a detailed report on the administrative work and on the finances of the Association during the past period at each General Assembly. The report shall be published in the Geodesist's Handbook.

1. Administrative Work

1.1 IAG Council

1.2

The Council is formed by the delegates of the national Adhering Bodies and responsible for governance, strategic policy and direction of the Association. The Council met twice during the General Assembly 2007 in Perugia, Italy, and twice during the General Assembly 2011 in Melbourne, Australia. The minutes of the Council meetings were published on the IAG Homepage and in the Geodesist's Handbook. The list of national correspondents is regularly updated by the IAG Office in contact with the IUGG Secretariat. The correspondents were informed by e-mail about activities of the IAG executive bodies (see below).

1.2 IAG Executive Committee

The Executive Committee is the IAG authority executing the scientific and administrative affairs. The EC met eight times from 2007 to 2011: 2007 in Perugia, Italy; 2007, 2008 and 2010 in San Francisco, USA; 2008 and 2010 in Vienna, Austria, 2009 in Buenos Aires, Argentina, and 2011 in Melbourne, Australia. It reviewed all activities of the IAG Components. Principal agenda items were the regular reports of the Commissions, Services, GGOS, ICCT, COB, and the Editor in Chief of the Journal of Geodesy. They were followed by discussions on specific scientific issues, changes in the structures of GGOS and Services, IAG publications and links to other organisations, e.g. FIG, GEO, IHO, ISO, JBGIS, and UNOOSA.

1.3 IAG Bureau

The IAG Bureau, consisting of the President, the Vice-President and the Secretary General, held regular tele-conferences and met in general before each of the IAG Executive Committee meetings. The President and the Secretary General participated in the IUGG Executive Committee Meetings in Karlsruhe, August 2008, and in Melbourne, October 2009 and June 2011. Bureau members represented IAG at various international meetings and celebrations, e.g. the 50th anniversary of the German IUGG adhering body (BGR), Hannover, Germany, November 2008, the 50th anniversary of the International Cartographic Association, Bern, Switzerland, June 2009, the 10th anniversary of the International VLBI Service (IVS), Bordeaux, France, March 2009, the Centenary of the International Society of Photogrammetry and Remote Sensing (ISPRS), Vienna, Austria, July 2010, and the 150th anniversary of the Swiss Geodetic Commission, Zürich, Switzerland, June 2011.

1.4 IAG Office

With the adoption of the new IAG Bylaws at the General Assembly in Perugia, Italy, July 2007, the former IAG Central Bureau was renamed IAG Office. As a result of the election of the new Secretary General, it moved from the University of Copenhagen, Denmark, to the Deutsches Geodätisches Forschungsinstitut (DGFI) in Munich, Germany, with all the files including budget, databases and homepage. An Office Homepage was established (*http://iag.dgfi.badw.de*) for internal IAG communication, in particular with the IAG Executive Committee members.

The principal task of the Office is the administrative organization of all IAG business and events. This includes the budget management, the record keeping of the IAG membership, and the preparation and documentation of all Council and Executive Committee meetings with detailed minutes for the Council and EC members, respectively, and meeting summaries published in the IAG Newsletters and on the IAG (www.iag-aig.org) and Office Homepages.

Specific activities during the period 2007-2011 were the organisational preparation and execution of the IAG Scien-

tific Assembly 2009 in Buenos Aires, Argentina, and the IAG General Assembly in conjunction with the IUGG General Assembly 2011 in Melbourne, Australia. The Geodesist's Handbook 2008 was published in the Journal of Geodesy (Vol. 82, Issue 11, pp. 661-846) as the organizational guide of the IAG with detailed descriptions of the IAG components and sub-components for the period 2007-2011 (reports, terms of reference, documents). It was regularly updated on the Office Homepage. The IAG Reports 2007-2009 and 2007-2011 (Travaux de l'AIG Vol. 36 and 37) with the actual mid-term and final scientific reports of IAG components and sub-components were published on the IAG Homepages. Publications of the Journal of Geodesy and the IAG Symposia series, both in Springer-Verlag, were administratively supervised. Travel grants were assigned to young scientists for participation in many IAG sponsored symposia.

1.5 IAG Communication and Outreach Branch

The COB maintained the IAG Homepage and published the monthly Newsletters online and in the Journal of Geodesy. The IAG Newsletter is also sent to the Presidents and Secretaries General of the IUGG Associations and members of the Joint Board of Geospatial Information Societies (JBGIS). Another main outreach activity is the compilation and distribution of the IAG leaflet and IAG brochure among institutions and at meetings.

1.6 IAG Membership

The membership of the IAG comprises Adhering Bodies (Council) and individual members. The individual members receive regularly the IAG newsletter and have various other benefits, e.g. reduced registration fees at IAG Symposia. The membership fee was kept in USD 50/a, with a discount of 1 year, if it is paid for 3 (4) years in advance. Institutions may pay the institutional membership fee for a number of co-workers. Students and retired colleagues get a reduced membership fee. At the time of the General Assembly 2011, about 400 persons had signed up for membership.

1.7 IAG Organised and Sponsored Meetings

Important meetings organised by IAG components and sub-components or sponsored by IAG were in 2007 – 2011:

- Workshop on Conventions, Sèvres, France, September 17-19, 2007.
- Joint International GRACE Science Team Meeting, Potsdam, Germany, Oct. 15-17, 2007;
- Unified Analysis Workshop, Monterey, CA, USA, December 5-7, 2007;
- 5th IVS General Meeting and Analysis Workshop, St. Petersburg, Russia, 03-07 March 2008;
- FIG/IAG Symposium "Measuring the Changes", Lisbon, Portugal, 12-15 May 2008;
- Sub-commission 1.3b SIRGAS General Meeting 2008, Montevideo, Uruguay, 26-29 May 2008;
- IGS Workshop, Miami, Florida, USA, 02-06 June 2008;
- 7th e-VLBI Workshop, Shanghai, China, 16-17 June 2008;
- Commission 4 participation in the FIG Working Week, 14-19 June 2008, Stockholm;
- Sub-commission 1.3a EUREF Symposium, Brussels, Belgium, 18-20 June 2008;
- Symposium Gravity, Geoid and Earth Observation, Chania, Greece, 23-27 June 2008;
- Sessions at the 37th COSPAR General Assembly, Montreal, Canada, 01-05 July 2008;
- 16th International Symposium on Earth Tides, Jena, Germany, 01-05 September 2008;
- Journees 2008 "Systemes de reference spatio-temporels", Dresden, Germany, 22-24 September 2008;
- 9th European VLBI Network Symposium, Bologna, Italy, 23-26 September 2008;
- 16th International Workshop on Laser Ranging, Poznan, Poland, 13-17 October 2008;
- IDS Workshop, Nice, France, 12-14 November 2009;
- 3rd Workshop Deformation and Gravity, Lanzarote, Spain, February 23–26, 2009;
- Workshop on Radio Frequencies and Feeds, Wettzell, Germany, March 18–21, 2009;
- 10th Anniversary of the International VLBI Service (IVS), Bordeaux, France, March 25, 2009;
- IVS Workshop, Bordeaux, France, March 26, 2009;
- 5th IVS Technical Operations Workshop, Westford, USA, April 27–30, 2009;
- Sub-commission 1.3a EUREF Symposium, Florence, Italy, May 27–30, 2009;
- Training School on GIA Modelling. Gaevle, Sweden, June 1–5, 2009;
- 8th International Workshop on e-VLBI Science, Madrid, Spain, June 22–26, 2009;
- GGOS Workshop, Espoo, Finland, June 23–26, 2009;
- VII Hotine-Marussi Symposium Theoretical Geodesy, Rome, Italy, July 6–10, 2009;
- SIRGAS School on Reference Systems, Bogotá, Colombia, July 13-17, 2009;
- 16th Advisory Board on the Law of the Sea (ABLOS) conference, Nusa Dua Bali, Indonesia, August 4–5, 2009;
- IAG Scientific Assembly 2009, Buenos Aires, Argentina, Aug. 31 – Sept. 4, 2009;
- Sub-commission 1.3b SIRGAS General Meeting, Buenos Aires, Argentina, August 31 – September 4, 2009;
- International Geoid School, Buenos Aires, Argentina, Sept. 7–11, 2009;
- ILRS Technical Workshop on SLR Tracking, Metsovo, Greece, Sept 14–19, 2009;

- IERS Workshop on EOP Combination and Prediction, Warsaw, Poland, October 19–21, 2009;
- 2009 Workshop on the North American Geoid, Boulder, USA, October 21–23, 2009;
- GGOS Intergovernmental Committee, Frankfurt, Germany, November 2–3, 2009;
- Second GGOS Unified Analysis Workshop, San Francisco, USA, Dec. 11–12, 2009;
- IVS 2010 General Meeting, Hobart, Australia, February 07-14, 2010;
- V Congreso Internacional de Agrimensura, Havanna, Cuba, March 02-05, 2010;
- Geophysics, Geodesy and Tectonics of the North Africa Plate Boundary for Better Earthquake and Tsunami Hazard Assessment, Algiers, Algeria, May 15-21, 2010;
- Subcommission 1.3a EUREF Symposium, Gävle, Sweden, June 02-06, 2010;
- Second Workshop on Application of Artificial Intelligence and Innovations in Engineering Geodesy, Braunschweig, Germany, June 16, 2010;
- Beacon Satellite Symposium, Barcelona, Spain, June 07-11, 2010;
- IAG School on Reference Frames, Mytilene, Lesvos, Greece, June 07-12, 2010;
- Symposium on Terrestrial Gravimetry: Static and Mobile Measurements, St. Petersburg, Russia, June 22-25, 2010;
- 10th International Geoid School, St. Petersburg, Russia, June 28 – July 02, 2010.
- IGS Workshop and Special Workshop on Vertical Rates from GPS, Newcastle, UK, June 28 – July 2, 2010;
- 15th General Assembly of WEGENER, Bogazici University, Istanbul, Turkey, September 14-17, 2010;
- 2nd IGFS General Assembly, Fairbanks, Alaska, USA, September 20-22, 2010;
- IAG Commission 1 Symposium 2010. Reference Frames for Applications in Geosciences (REFAG2010), Marne-La-Vallée, France, October 04-08, 2010;
- 9th International e-VLBI Workshop, Perth, Australia, October 10-20, 2010;
- IGCP 565 Workshop 3: Separating Hydrological and Tectonic Signals in Geodetic Observations, Reno, Nevada, USA, October 11-13, 2010;
- IDS Workshop, Lisbon, Portugal, October 21-22, 2010;
- Observing and Understanding Earth Rotation, Shanghai, China, October 25-28, 2010;
- Sixth ABLOS Conference, Monaco, October 25-27, 2010;
- Second SIRGAS School on Reference Systems, Lima, Peru, November 08-10, 2010;
- Sub-commission 1.3b SIRGAS 2010 General Assembly, Lima, Peru, November 11-12, 2010.
- Cryosat Validation Workshop, Frascati, Italy, February 1-3, 2011.
- 20th EVGA Meeting &12th Analysis Workshop, Bonn, Germany, March 29-31, 2011.
- 4th GOCE Workshop, Munich, Germany, March 31 - April 1, 2011.
- 1st International Workshop on The Quality of Geodetic Observation and Monitoring Systems, Garching/Munich, Germany, April 13-15, 2011.
- 3rd Conference on Earth Observation for Global Changes (EOGC2011), Munich, Germany, April 13-15, 2011.
- 17th International Workshop on Laser Ranging and 23rd General Assembly of the ILRS, May 15-20, 2011, Bad Kötzting, Germany.
- Sub-commission 1.3a EUREF Symposium, Chisinau, Republic of Moldova, May 25-28, 2011.
- 2nd GIA Modeling Training School, Gävle, Sweden, 13-17th June 2011.

2. Finances

The financial report includes the Result 2007-2010 and Balance 2010 (Table 1), the Budget 2011-2014 (Table 2) and the Report of the Audit Committee (Appendix A).

2.1 Comments on the Financial Report 2007-2010

The receipts originate mainly from the IUGG allocation (~70%), which is based on the number of participants in the IUGG General Assemblies registered for IAG. The membership fee (~10%) can exclusively be dedicated to travel awards for young scientists, primarily from developing countries, as originally planned.

The expenditures could be kept much less than planned in the budget (~70%, see Geodesist's Handbook 2008), in particular due to reduced administration costs (e.g. travel costs and bank charges), which were mostly covered by the office hosting institute (DGFI, Munich).

2.2 Comments on the Budget 2011-2014

The budget for the coming period was planned in the same order of magnitude as in the past period. Expenditures for travel grants were considerably increased to support more young scientists from developing countries for participation in IAG sponsored symposia. A deficit was planned for the coming period in order to reduce the large net capital of the previous periods.

Table 1: Financial Report 2007-2010

Result 2007 – 2010 in EUR					
No.	**Expenditures**	€	No.	**Receipts**	€
11.1	Personal	2.285,01			
11.3	Supplies and Equipment	3.800,34			
11.5	Travel Administration	10.459,59			
11.6	Miscellaneous	4.104,86	15	IUGG Allocation	99.721,87
11.8	Meetings (EC and Bureau)	3.735,15	5	Publication	2.567,75
11.9	Representation	2.192,12	6.6	Proceedings	11.222,84
12.1	Publication	31.290,90	6.7	Sale of CD	30,32
14.1	Symposia, Organisation	11.709,62	6.8	IGeS	74,63
14.2	Symposia, Travel grants	22.238,96	6.9	Membership Fee	15.290,83
12.4	Others	535,07	6.12	Receipt of IAG Fund	531,56
6.14	Geoid School	1.737,39	6.14	Geoid School	3.516,43
16.	Prices	5.131,31	15.3	Other Grants	5294,47
18.6	B+S Card Service/PBS	1.829,10	6.1	Gains on exchange	5787,00
19	**Total Expenditures**	101.049,42	7	**Total Receipts**	144.037,70
	Surplus	42.988,28			
	Total	144.037,70		**Total**	144.037,70

Balance 2010-12-31				
No.	**Assets**	€	**Liabilities**	€
20	Dansk Bank 31.12.2007	58.324,39	Net Capital	107.626,42
20.1	Bank IGS 31.12.2007	12.292,00	Deposit IGS	9.647,98
20.1	Transfer to IGS	2.644,02		
18.6	Surplus 2007-2010	42.988,28		
	Loss by exchange	1.025,71		
	Total	117.274,40	**Total**	117.274,40

Table 2: Budget 2011-2014

Budget for the period 2011-01-01 to 2014-12-31 in EUR					
No.	**Expenditures**	€	No.	**Receipts**	€
11.5	Administration, Travel	20.000,00			
11.8	Miscellaneous	3.000,00	15	IUGG Allocation	90.000,00
11.9	Representation	5.000,00	3	Other Grants	3.000,00
12.1	Publication	30.000,00	5	Publication	6.000,00
14.1	Symposia, Organisation	5.000,00	6.6	Proceedings	4.000,00
14.2	Symposia, Travel Grants	80.000,00	6.9	Membership Fee	15.000,00
12.4	Others	1.000,00	6.12	Receipt of IAG Fund	2.000,00
6.14	Geoid School	2.000,00			
16.	Prizes	3.000,00			
18.6	B+S Card Service	1.000,00			
19	**Total Expenditures**	150.000,00	7	**Total Receipts**	120.000,00
				Deficit	30.000,00
	Total	**150.000,00**		**Total**	**150.000,00**

Balance 2014				
	Assets	€	**Liabilities**	€
20	Bank 2014-12-31	78.000,00	Net Capital	78.000,00
	Total	**78.000,00**	**Total**	**78.000,00**

Net Capital 2014				
	Balance 2014-12-31	78.000,00	Open 2011-01-01	108.000,00
			Deficit	30.000,00
	Total	**78.000,00**	**Total**	**78.000,00**

Appendix A

IAG Audit Committee Report

Committee members, appointed by the IAG Council: Richard Biancale, Petr Holota, Markku Poutanen

The Audit Committee performed the following functions

1.1 Noticing the change in accounting: the accounting was moved to the DGFI, Munich at the end of 2007; year 2007 accounts were handled in Denmark by previous IAG Secretary General C.C. Tscherning. The annual IAG accounting 2008 onwards were checked by the Bavarian Ministry for Science, Research and Art ("Bayerisches Staatsministerium für Wissenschaft, Forschung and Kunst") together with the DGFI accounts. The accounting and the bookkeeping and budgeting are only in Euros after 2007.
1.2 Examined a random selection of receipt and bank statements of the IAG account for the period January 2007 to December 2010. Checked the balances appearing in the annual and quadrennial IAG reports.
1.3 Examined expenditure to ensure conformity with the 2007-2010 budget as approved at the IUGG General Assembly in Perugia in July 2007.
1.4 Examined the budget for the period 2011-2014.

The Audit Committee makes the following observations and comments on the IAG accounts

2.1 The accounts were well presented and all expenditures were supported by receipts and bank statements.
2.2 The banking service costs are now completely free of charge. The possibility to use the DGFI account and the use of Euros in bookkeeping has simplified accounting.
2.3 During the review period, the IAG made an operating surplus of approximately 43.000 Euros. This amount is added to the IAG reserve, leaving reserves of approximately 117.000 Euros at the end of 2010.
2.4 The Audit Committee found that the IAG had a surplus on the average over the 4 year period on approximately 10.000 € per year with quite large annual variations, from surplus 30.000 € in 2008 to deficit of 8.600 € in 2007. The Audit Committee concludes that the budget estimates are being based on the experience accumulated over the years and the annual variation depends on the meetings and other activities each year.
2.5 However largest differences between the in 2007 estimated budget and the definitive one over the 2007-2010 period come mainly from over-estimations of proceeding and membership fees. The 2011-2014 provisional budget seems to be more realistic (150.000 € with the reintegration of 30.000 € from 2010).

The Audit Committee makes the following recommendations

3.1 The current positive balance almost reaches the 4-year budget, what is too high. The Executive Committee should think over a wise use of the surplus over a certain security threshold. (to be determined)
3.2 The budget for grants to young scientists should be increased. Some of the surplus could be used for this.
3.2 The organizers of the IAG meetings should be encouraged to publish their proceedings by Springer Verlag series in order to maintain a series of publications with the IAG label and ensuring a high standard as well. This series is now recognized by ISI web of Science.
3.3 Membership benefits should be reconsidered and people should be attracted more effectively to join IAG. Current benefits or additional member functions available on IAG web page are relatively invisible to most potential members.
3.4 All fees, grants allocations should be considered in a unique currency, for instance in Euro.

On behalf of the IAG Council, the Audit Committee has the following acknowledgements and thanks

4.1 Hermann Drewes, IAG Secretary General, for his efficient and cautious administration and management of the IAG Office.
4.2 The German Geodetic Research Institute DGFI for administrative and accounting support.

Melbourne, July 5th, 2011
Richard Biancale, Petr Holota, Markku Poutanen

Levallois Medal
Citation for Ruth Edwards Neilan

I. I. Mueller

The Levallois Medal was established in 1979 to honor Jean-Jacques Levallois for his long service from 1960 to 1975 as General Secretary of the International Association of Geodesy (IAG). It is usually awarded at four year intervals on the occasions of the IAG General Assemblies and is presented "in recognition of distinguished service to the association and/or to the science of geodesy in general".

The past presidents of the IAG, forming a committee, recommended to award the Medal at the General Assembly in 2011 to Ruth Neilan, for her international service related to the geodetic and geophysical applications of the Global Positioning System (GPS). I have the honor to present the citation, unfortunately in absentia.

Proposals for permanent international GPS tracking networks floated around as early as the mid-nineteen eighties, but the vision of organizing such a service within the realm of the IAG was borne in March 1990 at a small gathering at The Ohio State University (OSU). The participants were Gerald Mader, President of IAG's GPS subcommision, J. Bernard Minster, Chairman of the National Research Council Panel on International Network of Fiducial Stations, William G. Melbourne of Jet Propulsion Laboratory (JPL) - GPS Coordinator of the International Earth Rotation Service, and myself as host (the four "M"-s, as the group became to be known later).

It was fortunate that Bill Melbourne, at the time the JPL "mentor" of Ruth Neilan, had the additional vision, of great consequence later, to invite also Ruth to the meeting. As a result of this meeting a recommendation was submitted to the IAG that the next General Assembly in Vienna in August 1991 (almost exactly twenty years ago) develop specific plans for a service, which would promote GPS in the long term interests of the geodetic and geophysical communities. After many conferences and several years of test campaigns and pilot projects the International GPS Service – IGS (now Global Navigation Satellite System – GNSS) – became operational on January 1, 1994 and the rest is history!

As far as I know, the meeting at OSU in March 1990 was Ruth Neilan's first direct involvement in IAG affairs. Since then, and later as the Director of the IGS Central Bureau, she has become the strong thread that kept the Service together and functioning. I believe that she is one of the few persons, possibly the only one, who served the IGS from its conception and birth until this day.

Handing-over of the IAG Levallois Medal to Ruth Neilan by the IAG Past President Gerhard Beutler

This accomplishment, considering that IGS has some 200 participating organizations – mostly public, government, and university research groups – with upwards of 400 permanent ground stations and data and analysis centers in more than 80 countries, needs a person of special qualities. Dealing with government bureaucracies, funding agencies and the many times idiosyncratic egos of scientist, requires tenacity personal skills, wisdom, diplomacy and charm. Ruth is blessed with all!

Neilan is an engineer by education, but never wanted to be such. After realizing that her high school plans to major in Asian studies would probably not result in a fulfilling exciting life of travel with a decent paying job, she enrolled in an Associate Degree in Engineering Technology at Penn State University. Upon completion she worked for

a number of years as a land surveyor in Pennsylvania. After an extended trip around the world, she turned to the University of Wisconsin-Madison and completed a BSc and MSc in Civil and Environmental Engineering (rumor has it that, prior to Wisconsin, she considered OSU, but her impression (of me?) was not favorable). She minored in Asian studies and speaks Mandarin Chinese.

Ruth was employed by JPL in 1984. Since 1993 she has been the International GNSS Service - IGS Central Bureau Director. In addition to the IGS she has or had been involved in more organizations that even she must have difficulty keeping track of. Here are a few probably more than one wants to know:

- Defense Science Board
- IAG Executive Committee
- IAG Global Geodetic Observing System (GGOS)
- Institute of Navigation Council
- Interagency GPS Executive Board
- International Committee on GNSS (ICG)
- International Council of Science (ICSU), Committee on Information and Data
- United Nations Office of Outer Space Affairs
- U.S. Presidential Committee on Positioning, Navigation, and Timing
- World Climate Research program
- American Youth Soccer Organization
- Child Education Center, La Canada, CA

Ruth Neilan has been married to Chad Edwards – "her brilliant jazz pianist" – who as Chief Telecommunications Engineer for the JPL Mars Exploration Program, is figuring out how to talk to spacecraft at Mars and beyond. They have two children Kyle and Drew. Ruth loves soccer, cooking, walking, biking, reading, gardening, sending birthday messages, and still manages to keep her sanity!

I have the great pleasure and honor to present to my friend and former colleague Ruth Edwards Neilan the Levallois Medal in recognition of her distinguished service to the association, geodesy, geophysics, and to the public in general.

Guy Bomford Prize Lecture 2011

Atmospheric Effects in Space Geodesy

J. Böhm, Vienna University of Technology

The atmosphere is surrounding the solid Earth and the oceans, and with its variations at time scales from seconds to decades it opens up a wide field of challenging and fascinating tasks in space geodesy. The investigation of these atmospheric effects and the analysis of geodetic Very Long Baseline Interferometry (VLBI) observations have dominated my research in the past decade. Geodetic VLBI with its very simple geometric concept, the unbelievable observations of extragalactic radio sources billions of light years away, its fundamental advantages of linking the terrestrial and the celestial reference frame or providing the full set of Earth orientation parameters, is still as exciting to me as in 2000 when I first got in touch with this technique at the first General Meeting of the International VLBI Service for Geodesy and Astrometry in Kötzting, Germany. Moreover, VLBI with its high accuracy of single observations has always enabled me to test new models of atmospheric effects, like those for signal propagation, loading, or thermal deformation. I am eagerly looking forward to the new generation of VLBI observations (VLBI2010) that will allow the determination of positions with an accuracy of close to 1 mm in near real-time. And I am aware that this will pose new requirements on the models of atmospheric effects that are needed to correct the observations.

The thorough treatment of atmospheric effects is essential to reach an accuracy of 1 mm and 0.1 mm/year for positions and velocities of observing sites which is the overall goal of the Global Geodetic Observing System (GGOS) of the International Association of Geodesy (IAG) to detect Global Change like sea level rise, the melting of ice masses over Antarctica or Greenland, or hydrology. Atmospheric effects influence all three pillars of geodesy, i.e., figure, gravity field, and rotation of the Earth, and they should be treated consistently by GGOS. Moreover, the atmosphere affects signals from satellites and extragalactic radio sources, which has to be modelled properly or otherwise degrades the accuracy of geodetic parameters.

In terms of signal propagation the atmosphere is usually divided into the neutral atmosphere (up to about 100 km) and the ionosphere (50 to 1500 km) where the number of ions and free electrons is large enough to influence radio waves. The neutral atmosphere is non-dispersive for microwaves as, e.g., observed by the Global Navigation Satellite Systems (GNSS) or geodetic VLBI, and the delays therein are usually modelled as the product of zenith delays and mapping functions. Specifically, the a priori zenith hydrostatic delays are determined from the surface pressure at the site and mapped down to the elevation of the observation with the hydrostatic mapping functions, and the wet mapping functions are then used as partial derivatives to estimate the zenith wet delays. In recent years, the accuracy of mapping functions has been improved considerably by taking to data from numerical weather models, and even more improvement can be expected for ray-tracing strategies. However, VLBI simulations based on turbulence show that the troposphere will remain the limiting factor for the accuracy of space geodetic techniques. On the other hand, space geodetic observations at microwave frequencies contribute to meteorology and even climatology when converting the estimated zenith wet delays to the amount of water vapour in the troposphere in near real-time or for sites with long observation histories, respectively.

The ionosphere is a dispersive medium for microwaves, i.e., different frequencies suffer different group delays and phase advances. Consequently, by observing at two or more frequencies, the ionospheric delays can be determined or eliminated very precisely. These ionospheric delays can then be converted to values of Total Electron Content (TEC) and – together with TEC values from altimetry and occultation missions – expanded into global TEC maps which are highly beneficial for single frequency observations or as source of information about the ionosphere.

Atmospheric excitation of Earth rotation occurs at time scales from hours to decades, i.e., from thermally induced atmospheric tides at 12 and 24 hours, to atmospheric normal modes at about 10 days, to seasonal and in particular annual variations, to El Nino Southern Oscillations (ENSO). In combination with oceanic and hydrological excitation as well as with observed Earth rotation parameters, we can improve the understanding of the system Earth, in particular in combination with the degree-2 coefficients of the gravity field. Furthermore, predicted values of atmospheric excitation of the Earth rotation are highly beneficial for spacecraft navigation or the availability of GNSS orbits in real-time.

Alternating high and low pressure systems as well as seasonal variations not only influence the Earth rotation as described above (degree-2 terms), but they move the centre of mass of the solid Earth with respect to the centre of mass of the whole Earth including atmosphere and oceans (degree-1 terms), they change coefficients of higher degrees and orders of the gravity field of the Earth, and they deform the solid Earth by up to one or two centimetres. Furthermore, the algorithms are complicated by the indirect effect of atmospheric loading on the gravity field or by the oceanic response to the pressure variations, in

particular at coastal regions. This shows the complexity of atmospheric effects in space geodesy, and underlines the importance that all these effects are treated in a consistent way to achieve the goals envisaged by GGOS.

Acknowledgements

It is a great honour for me to receive the Guy Bomford Prize 2011 of the International Association of Geodesy. I would like to thank Austrian Geodetic Commission for the nomination and the IAG Bomford Prize Committee for awarding me with this very prestigious prize.

My sincere gratitude goes to the Vienna University of Technology, and in particular to the research group Advanced Geodesy at the Institute of Geodesy and Geophysics chaired by Prof. Harald Schuh. Without the excellent cooperation and the inspiring atmosphere in this group, it would not have been possible to realize ambitious goals and to actively contribute to many international efforts. In particular, I want to thank Harald Schuh for making me familiar with VLBI, introducing me to the scientific community, and for creating such a positive and productive environment in our group.

Furthermore, I want to thank all the colleagues worldwide for the excellent and friendly cooperation. Also, I would like to acknowledge the Austrian Weather Service (ZAMG) for granting me access to the data of the European Centre for Medium-Range Weather Forecasts (ECMWF), and the Austrian Science Fund (FWF) for supporting various projects.

Johannes Böhm

Young Authors Award

Citation for Elizabeth Petrie

The IAG Young Authors Award is granted at each IAG General or Scientific Assembly for important contributions of young authors in the Journal of Geodesy. In 2011 is was presented to Elizabeth Petrie, Newcastle University, UK, for her paper "A first look at the effects of ionospheric signal bending on a globally processed GPS network" published in Journal of Geodesy, Vol. 84, 491-499, 2010.

Elizabeth Petrie

The paper deals with the general area of higher order ionospheric effects in dual frequency GPS positioning. In particular, it considers for the first time on a global level the effect of presently unmodelled ionospheric signal bending. This effect remains after forming the ionosphere-free linear combination. Elizabeth Petrie shows that its implementation must be considered for most precise geodetic applications. Two things are particularly striking in the results. Firstly, the bending term appears to be almost entirely absorbed by the tropospheric zenith delay terms, hence biasing them, in particular at low latitudes. Secondly, even though this represents an important correction term, the exact approach for modelling the bending term remains unclear, especially for historic data where information on the peak electron content is less well established. The paper will therefore spark further studies on how best to resolve this dilemma.

As part of this project Liz Petrie conducted several IGS-style reprocessing in GAMIT, estimating ground station coordinates, satellite orbits and EOP, with different model options - a considerable undertaking. Fixing pre-computed IGS orbits may well have led to misleading results, so there is a demonstration to scientific rigour in her work.

Minutes of the IAG Council Sessions at the General Assembly 2011

H. Drewes and H. Hornik

Place: Melbourne Convention and Exhibition Centre, Melbourne, Australia

Time**:** 2011**,** June 28, 09:00-12:00 / July 06, 09:00-12:00

Participants

IAG National Delegates: Argentina (Sergio Cimbaro*), Australia (Will Featherstone[+]), Austria (Norbert Höggerl), Belgium (Veronique Dehant*), Brazil (Ana Paula Camargo Larocca*), Canada (Marcelo Santos), Chile (Rodrigo Maturana*), Colombia (Laura Sánchez), Czech Republic (Petr Holota), Denmark (Niels Andersen*), Finland (Markku Poutanen), France (Richard Biancale), Germany (Jürgen Müller), Hungary József Ádám*), India (V.M. Tiwari), Italy (Fernando Sanso), Japan (Suhei Okubo), Korea (Phil-Ho Park), Luxembourg (Tonie van Dam), New Zealand (Matt Amos), Poland (Jan Krynski), Portugal (João Manuel Agria Torres), Russia (Viktor Savinykh), South Africa (Aslam Parker), Sweden (Martin Lidberg*), Switzerland (Beat Bürki), Thailand (Amornthep Rochanasaroj*), Turkey (Soner Özdemir), United Kingdom (Nigel Penna), USA (Jeff Freymueller)

([+] 28 June only, * 6 July only)

IAG Executive Committee (guests): M. Sideris (IAG President), Ch. Rizos (Vice President), Hermann Drewes (Secretary General), Gerhard Beutler (Immediate Past President), Zuheir Altamimi (President Commission 1), Yoichi Fukuda (President Commission 2), Harald Schuh (Representative of the Services), Helmut Hornik (Assistant Secretary General).

I. Tuesday, 28 June 2011, 09:00-12:00, Room MR207

1. Welcome and adoption of agenda

The IAG President, *M. Sideris*, opened the Meeting of the IAG Council. He invited the participants to attend the IUGG Opening Ceremony (June 28) as well as the IAG Opening Session (June 29). The agenda had been distributed before; it was accepted by the Council.

2. IUGG2011 organizational issues

The IAG Secretary General, *H. Drewes*, stated that nearly 50 IUGG member countries are represented in this Assembly. 34 IAG National Delegates were accredited; several countries were not able to send a representative. At present the IUGG has 69 member countries. There are full members, associate members and observers. He then listed the major events of this 25th IUGG General Assembly concerning the IAG. Altogether there are 29 related Symposia, namely 7 IAG Symposia, 6 Joint Symposia and 1 Union Symposium led by the IAG, 8 IAG co-sponsored Union Symposia, and 7 IAG co-sponsored Joint Symposia. Moreover, 19 business meetings of IAG components will be held. *H. Drewes* mentioned in particular the Union Lecture on July 3 by M. Rothacher on "The challenge in Earth observation: From the fast response to catastrophic events to the reliable detection of very small trends".

There are three meetings of the present EC on June 27, July 3 and 5; the new EC will meet on July 7. *Ch. Rizos* invited for the IAG Reception which he had organised in the building of the Melbourne Immigration Museum (June 29) as well as for the IAG Dinner in the rooms of the University Club on the Campus of the University of Melbourne (03.07.2011).

H. Drewes then listed the actual IUGG2011 statistics. Approx. 3400 participants registered, 370 for the IAG. This number corresponds to the usual percentage. More than 500 invited lectures will be presented; nearly 2700 oral presentations and 1900 posters were accepted.

3. Agenda of the Opening and Closing Sessions

The agenda of the IAG Opening Session (June 29) and the Closing Session (July 06) were shown and explained in detail.

4. Information on IAG Awards

According to the proposal of the Nomination Committee composed by the IAG Honorary Presidents, the EC has confirmed to award the Levallois Medal to *Ruth Neilan*, Jet Propulsion Laboratory, Pasadena, USA. *Johannes Böhm*, Technical University Vienna, Austria, was elected by a Selection Committee for the Guy Bomford Prize. The 2010 IAG Young Author Award is granted to *Elizabeth Petrie*, School of Civil Engineering and Geosciences, Newcastle University, Newcastle upon Tyne, UK. The awards will be handed over and the citations will be presented in the IAG Opening Session.

5. Appointment of the Audit Committee

The EC proposed as members of the Audit Committee: *R. Biancale, P. Holota, M. Poutanen*. The Council adopted

these nominations. The Committee will examine in detail all documents in the next days and report on the findings at the next session of the Council on July 06.

6. Proposal of the IAG Budget 2011 – 2015

H. Drewes explained briefly the financial situation for the past four years term 2007 – 2010 and in detail the proposed budget plan for 2011 – 2014. At present, the IAG is in relatively good funds. Considerable costs for banking and other administrative expenditures could be reduced due to the link-up to the budget of DGFI in the Bavarian administration. It is planned to increase the expenditures for travel grants and other financial supports in the next future.

7. Appointment of the Resolutions Committee

The EC proposed the following members of the Resolution Committee: *Z. Altamimi, J. Ádám* and *Ch Rizos*. The Council accepted to these nominations. *H. Drewes* asked all colleagues to submit their suggestions for IAG and IUGG Resolutions to the Committee. The next session of this group was scheduled for July 03. All proposals will then be discussed and formulated.

8. Review of the 2011 election process and results

The IAG Nomination Committee 2011 consists of *G. Beutler* (Chair), *W. Featherstone*, *C. K. Shum* and *R. Wonnacott*. *G. Beutler* explained the process of the nomination and election of IAG Officers 2011-2015, based on the IAG Bylaws and Statutes. The nomination process was started in June 2010 when letters to the IAG National Correspondents, Officers, Fellows, Members and Services were sent out. Until December 2010, more than 50 responses were received. In December/January 2010/11, the selection was made by the Committee, and then the candidates were informed and asked to accept their nominations. The resulting nomination list and resumes were sent in January 2011 to the National Correspondents inviting for additional nominations till February 28. No additional nominations were received.

For the subsequent election process, the IAG Secretary General prepared the list of all Correspondents and Delegates entitled to vote. On April 15, 2011 the mail ballots were sent to the Correspondents/Delegates. Up to the deadline May 17, 2011, 44 valid ballots were received from 57 countries. On May 27, all candidates were informed of their result (success: yes/no). *G. Beutler* presented then the result of votes in detail.

Finally, *G. Beutler* mentioned a remaining issue. Shortly after having accepted the election as President of Commission 3, *R. Gross* informed the Committee that he was nominated as GGOS Chair and that he accepted the nomination. The IAG Bylaws, however, do not allow that the positions of a Commission President and the GGOS Chair are filled by one person at the same time. For the case that R. Gross should be elected, the nomination and election process for the position of the President of Commission 3 would have to be re-initialized. In the discussion it was proposed to change the Bylaws such that the elections for all IAG Officers (including the GGOS Chair) will be done at the same time. Then problems like this one cannot occur anymore. However, it would prevent that a person who was not elected for another position could apply for the GGOS Chair, even if he would be a good candidate.

9. Status of GGOS, GIAC, and ICCT

M. Sideris reported that at present three candidates are competing for the position of the GGOS Chair, namely *R. Gross*, *H. Kutterer*, and *S. Zerbini*. The IAG EC will appoint the new GGOS Chair at its meeting on July 3.

M. Sideris explained then the GGOS Inter-Agency Committee (GIAC) as an activity to support GGOS. A relevant declaration has been signed by 15 agencies. The action has been initiated by the past President of the BKG (Germany), *D. Grünreich*. *J. LaBrecque* (NASA, USA) is the present chairperson. *M. Sideris* appealed all delegates to ask their agencies to join GIAC and to take over obligations in order to support GGOS.

M. Sideris reported that according to the Bylaws, Inter-Commission Committees shall be reviewed every eight years, i.e. the ICCT in 2011 after its establishment in 2003. The review was done by a Committee under *M. Sideris'* chairmanship. It was found that it is very active and should be continued. *N. Sneeuw* has declared to be ready to continue as ICCT Chairman.

10. Status of Journal of Geodesy and IAG Symposia Series

Referring to the detailed report of *R. Klees*, Editor in Chief of the Journal of Geodesy (JoG), to the EC on June 27, *H. Drewes* mentioned the most important issues such as the Editorial Board, the considerably improved ISI Impact Factor and the reduced journal turnaround time.

The publication of the IAG Symposia Proceedings in the Springer Series will be continued. All contributions to IAG led symposia of the present IUGG General Assembly may be submitted for publication. All papers will be peer-reviewed.

11. Status of Statutes and Bylaws, Review Committee

Relating § 16 of the IAG Statutes, *M. Sideris* informed that the Statutes and Bylaws shall be reviewed every eight years. The present versions have been adopted at the 2007 IUGG General Assembly in Perugia, thus the next date is

the 2015 IUGG General Assembly. All colleagues are called to read the texts of the present versions carefully and submit any proposals for updates. The collection of the proposals should be completed till the next IAG Scientific Assembly in 2013 and discussed there. The Cassinis Committee will then compile an updated version and present it to the Council in 2015 for adoption.

12. Status of IAG Reports (Travaux de l'AIG) and National Reports 2007-2011

H. Drewes recalled that according to the IAG Bylaws, all IAG components have to report on their activities at each General Assembly. The components comprise the Commissions, ICCT, COB, GGOS and Services. The reports are collected by the IAG Office and published in the Travaux de l'AIG. The publication is done now in the IAG Homepage, hard copies are available on demand. Annual Reports of the IAG are compiled by the IAG Secretary General and submitted to the IUGG. Moreover a detailed IAG Quadrennial Report is presented.

IAG National Reports 2007-2011 have been submitted to this Assembly by several countries (see http://iag.dgfi.badw.de/index.php?id=302). *H. Drewes* mentioned that these reports represent a valuable documentation of the activities within the international geodesy. Therefore he appealed for contributio to this work also further on.

13. Proposals for the Venue of the IAG Scientific Assembly 2013

H. Drewes informed that Turkey (for Istanbul), Portugal (for Porto), Germany (for Potsdam) and Czech Republic (for Prague) have submitted applications to organize the IAG Scientific Assembly 2013. In the next Council Meeting on July 06, the reports of the candidates will be presented and discussed, and then the National Delegates will vote on the venue.

14. Any other business

A. Parker as National Delegate from South Africa called the IAG for more support to develop geodesy in Africa. This support should relate to all fields of geodesy, especially to a suitable outreach. *M. Sideris* and *Ch. Rizos* responded that the IAG would be very eager to help in this manner, however, the demands for practical projects have to be formulated by the countries. Especially in South Africa various activities have been undertaken and could serve as good examples for other countries. *H. Drewes* mentioned that the ICSU would be ready to provide financial support for clearly defined projects. Applications are to be directed to the IAG and will then be forwarded to the ICSU. *J. A. Torres* mentioned that the AFREF activities imply much support to develop geodesy in Africa. Various European countries and also EUREF support this important project. Especially the installation of suitable reference networks forms the basis for developing countries. *J. A. Torres* also emphasized that such help is necessary, but the national agencies have to initiate and perform the projects basically themselves.

M. Sideris invited again all colleagues to formulate any proposals for IAG/IUGG Resolutions and to submit the drafts to the Resolution Committee to be discussed.

15. Adjourn

II. Wednesday, July 6, 2011, 09:00-12:00, Room MR108

16. Venue proposals for the Scientific Assembly 2013 (Presentations of applicants)

The following applications were presented: Prague, Czech Republic (*P. Holota*), Potsdam, Germany (*J. Müller*), Porto, Portugal (*J. A. Torres*), Istanbul, Turkey (*O. Lenk*).

17. Election of the Venue of the Scientific Assembly 2013

It was agreed to perform the voting in two runs in the case that the results of the candidates with the best results are very close to each other in the first voting. Then a second run restricted to the two candidates with most votes shall be performed.

In the first voting the results were:
- Czech Republic, Prague: 6 votes
- Germany, Potsdam: 10
- Portugal, Porto: 5
- Turkey, Istanbul: 8

According to the agreement, a second run was performed:
- Germany, Potsdam: 20 votes
- Turkey, Istanbul: 9

Thus a clear result was obtained to hold the IAG Scientific Assembly 2013 in Potsdam. The German IAG Correspondent, *J. Müller*, was asked to inform the responsible German institutions in order to start the preparations in time.

18. Report of the Audit Committee

On behalf of the Audit Committee, *M. Poutanen* informed that a complete collection of all relevant budget documents has been handed over by the IAG Office and has been examined carefully. No reasons for any complaint were found. Therefore the Audit Committee moved to approve

the IAG Budget 2007-2010. The IAG Council followed this motion unanimously.

19. Approval of the IAG Budget 2011-2015

The budget plan 2011-2014 was already presented by the IAG Secretary General, *H. Drewes,* in the first session of the Council on June 28 (cf. topic 6). The Audit Committee has examined the budget plan. *M. Poutanen* moved to accept the presented draft as official budget 2011-2014. In agreement with the already mentioned proposal, the Audit Committee suggested in particular to reduce the current surplus of nearly 43.000 € by a deficit of 30.000 € used for increased expenditures for travel grants. The IAG Council followed this motion unanimously.

20. IAG Representatives to external bodies

H. Drewes presented an overview on the IAG Representatives to other scientific bodies (see http://iag.dgfi.badw.de/fileadmin/IAG-docs/iag-representatives-to-scientific-bodies.pdf).

21. Report of the IAG Resolutions Committee

The Chairman of the Resolutions Committee, *Ch. Rizos,* presented the drafts of two IAG Resolutions. The first resolution concerns the "Gravity Field Satellite Missions" while the second one relates to the "Second Realization of the International Celestial Reference"

22. Approval of Resolutions

The plenary discussed the texts of both resolutions; some slight changes in the wording were applied. *M. Sideris* moved to approve the resolutions, the IAG Council followed this motion for Resolution 1 with one abstain and for Resolution 2 unanimously. The texts will also be submitted to the IUGG for approval. Resolution 1 will be proposed in a slightly changed wording to include also the magnetic field satellite missions.

23. Report from IUGG Council and Executive Committees

M. Sideris gave a short report on the meeting of the IUGG Council and Executive Committee. Altogether five countries (Argentina: Buenos Aires, Czech Republic: Prague, Denmark: Copenhagen, India: Hyderabad, USA: Honolulu/Hawaii) had applied for the venue of the 2015 IUGG General Assembly, detailed applications had been presented. The IUGG Council decided for Prague, Czech Republic.

24. Preparation of the IAG Closing Session

H. Drewes presented the programme for the IAG Closing Session on July 06. The programme topics include the reports of the IAG led Symposia by the respective convenors, the presentation of IAG Resolutions and Fellows by the IAG President, the inaugural speech of the new IAG President, *C. Rizos*, and the closing speech of the outgoing President, *M. Sideris*. All colleagues were invited to attend the Closing Session.

25. Any Other Business

The Council discussed intensively the question of the duration of IUGG General Assemblies. As in other IUGG Associations, there is a strong desire for a shorter length of time. On the other side it is already now rather difficult to arrange all oral presentations within the available time period as well as to realise the necessary interdisciplinary contacts, e.g. by attending IUGG Symposia, Joint Symposia etc. The argument for shorter meetings of EGU and AGU was answered by the fact that in the IUGG a broader field of topics is treated.

J. Adam asked all colleagues to contribute continuously to the IAG Newsletter and Website by sending any suitable information to the IAG COB. Moreover proposals to improve the layout of the Website are highly welcome.

26. Closure

M. Sideris closed the session with thanks to the participants for their attendance and contributions at 11:30.

Summary of the IAG Executive Committee Sessions at the General Assembly 2011

H. Drewes and H. Hornik

Place: Melbourne Convention and Exhibition Centre, Melbourne, Australia
Time: 2011, June 27, 9:00-17:00 / July 3, 8:30-11:00 / July 4, 15:15-16:15 / July 5, 13:30-14:40

Attendees

Voting: M. Sideris (IAG President), Ch. Rizos (IAG Vice-President), H. Drewes (IAG Secretary General), G. Beutler (IAG Immediate Past President), Z. Altamimi (President Commission 1), Y. Fukuda (President Commission 2), R. Gross (Vice-President Commission 3), M. Santos (Vice-President Commission 4), M. Rothacher (Chair of GGOS), J. Ádám (President of COB), R. Neilan, H. Schuh (Services Representatives), K. Heki (Member at Large)

Regrets: M. Bevis (President Commission 3), S. Verhagen (President Commission 4), St. Kenyon (Representative of the Services), R. Wonnacott (Member at Large)

Non-voting: N. Sneeuw (President ICC on Theory), H. Hornik (IAG Assistant Secretary), F. Sansò (IAG Past President)

Guests: P. Novák (Vice-President ICC on Theory), R. Klees (Editor in Chief Journal of Geodesy), H. Kutterer (Future Chair of GGOS, only July 5)

Summary of Agenda Items

I. Monday, June 27, 2011, 09:00 – 17:00

1. Welcome and adoption of agenda

M. Sideris welcomed the members of the IAG Executive Committee (11 out of 15 voting members, 3 non-voting members) and two guests. The agenda had been distributed previously by e-mail and was unanimously adopted. The minutes of the previous EC Meeting had been put to the Office Homepage before.

2. IUGG2011 organisational issues

M. Sideris gave a summary of the IUGG EC Meeting held the day before. *H. Drewes* showed an overview of the about 30 General Assembly meetings under IAG responsibility or with IAG involvement, respectively. Besides the scientific symposia, 19 Business Meetings were announced; the schedule had been distributed before. 45 Travel Awards have been granted to scientists younger than 35 years and from developing countries, among them 28 free registrations given by the LOC and 7 given by the IUGG.

3. Agenda of the Council Meeting

There were two IAG Council Meetings scheduled in Melbourne. The agenda had been put on the Office Webpage and was briefly explained by *M. Sideris* and *H. Drewes*. Important decisions are in particular on the IAG Budget and the venue of the IAG Scientific Assembly 2013.

4. Agenda of Opening and Closing Sessions

The agendas for both sessions had been distributed and were briefly explained by *H. Drewes*.

5. IAG Budget 2007-2010

H. Drewes explained the budget for the years of the current period. The financial year 2007 had been completed by C. C. Tscherning as the previous Secretary General. All relevant financial documents are available to be audited by the Audit Committee established by the IAG Council.

6. Pro al for members of the Audit Committee to be presented to the Council

The EC proposed R. Biancale, P. Holota and M. Poutanen as members of the Committee. This proposal will be submitted to the Council for approval.

7. Nomination of members of the IAG Resolution Committee

M. Sideris informed that the Resolution Committee has to be nominated by the Council on proposal of the EC. The EC nominated *J. Ádám*, *Z. Altamimi* and *Ch. Rizos* (chairperson).

8. Levallois Medal

According to the IAG rules, a nomination for the Levallois Medal shall be made by an ad hoc Committee consisting of the Honorary Presidents and must be confirmed by the IAG Executive Committee. *G. Beutler* reported on the recent selection process. The Committee had intensively discussed eligible persons; the only proposal for the award

had then been made for *Ruth Neilan*. The proposal was discussed and finally endorsed by the EC.

9. Guy Bomford Prize, Young Authors Award, new IAG Fellows

The Guy Bomford Prize is awarded to a young scientist or to a team of young scientists for outstanding contributions on the field of geodesy. As *M. Sideris* reported, the EC had collected proposals for this award and finally selected the winner according to the IAG rules. The winner is *Johannes Böhm*, Technical University Vienna. The price will be handed over in the IAG Opening Session.

The IAG Young Authors Award can be granted on occasion of each IAG General Assembly or an IAG Scientific Assembly to draw attention to important contributions by young scientists in the Journal of Geodesy and to foster excellence in scientific writing. According to the IAG rules the voting members of the IAG EC selected *Elizabeth J. Petrie*, Newcastle University, United Kingdom. The price will be handed over in the IAG Opening Session.

According to § 22 of the IAG Bylaws, the EC may invite past officers of the Association to become Fellows. Where the invitation is accepted, the EC shall confirm the appointment. The IAG Office had compiled a list of altogether 57 persons who principally fulfil the requirements. The EC members had been asked for further proposals; some additional persons had been suggested. The final list of the proposed names will be presented on occasion of the IAG Closing Session and published in the Geodesist's Handbook.

10. Results of IAG Officers elections

G. Beutler gave a detailed report on the process and results of the election of the IAG Officers who will form the EC for the period 2011-2015. A written report had been prepared, too. The election procedure is regulated especially by § 39 IAG Bylaws. The Nominating Committee had been formed by *G. Beutler* (chair), *W. Featherstone, C. K. Shum* and *R. Wonnacott*.

The Committee had started its work in 2010 by setting up a list of proposals for the eligible positions; generally two persons had been proposed for each position. This list had been submitted to the IAG Correspondents for nominating further candidates. Finally the list of candidates has been sent to the altogether 57 IAG Delegates or Correspondents, respectively, entitled to vote. 44 votes had been received within the given deadline, which can be considered as a very good result. *G. Beutler* read then the numerical results of the election.

In the following *M. Sideris* referred to the appointment of the GGOS Chair to be done by the EC in consultation with the GGOS Steering Committee. He informed that three candidates were nominated by the Steering Committee. After a long discussion it was agreed not to appoint the GGOS Chair in this session but to have a voting in order to obtain a tendency on the present status and to discuss the Topic again in the next session and then to appoint the GGOS Chair.

11. Status of IAG Report 2007-2011 (Travaux de l'AIG Vol. 37)

H. Drewes informed that after several reminders all reports are now available, the texts will be put into the IAG website a.s.a.p. Hard copies can be received on demand from the IAG Office.

12. Reports and recommendations of the Commissions

Z. Altamimi reported on the highlights in Commission 1, especially the REFAG Symposium 2010). Four SC Meetings had been held in the past period, as well as an International School on References Frames in 2010). Concerning regional activities he highlighted APREF, APREF, the IAG-PAIGH-SIRGAS Schools on Reference Systems (2009, 2010) and the WG on Regional Dense Velocity Field.

Y. Fukuda gave an overview on the recent activities of Commission 2. Various Meetings had been organised or the Commission been involved, respectively. He reported in particular on the activities of the Sub-commissions, Projects, Study and Working Groups, and concluded with an overview on possible future modifications.

R. Gross explained the activities of Commission 3 with its Sub-Commissions, Projects and Study Groups. G. Jentzsch as a very active President of Sub-Commission 3.1 will retire in the next future, so the Commission has to take care to ensure an adequate continuation.

The President of Commission 4, *S. Verhagen* had unfortunately to cancel her participation due to sudden health problems, and *D. Brzezinska* had not yet arrived, thus a summary of the Commission report was presented by *Ch. Rizos*.

13. Report and recommendations of the ICCT

N. Sneuuw explained the activities of the ICCT. Four meetings organised by the ICCT or with involvement of the ICCT were mentioned (VII Hotine-Marussi Symposium, 2009, Rome, Italy; Workshop on Deformation and Gravity Change, 2009, Lanzarote; 1st IAG School on Reference Systems, 2010, Mytilene, Lesvos, Greece; 1st International Workshop on the Quality of Geodetic Observation and Monitoring Systems (QuGOMS'11), 2011, Munich).

14. Report of the ICCT Review Committee

The ICCT was created in 2003; according to the Bylaws it has to be evaluated after these two periods. *N. Sneuuw* explained the future structure with the planned Study Groups for the next period. As the chair of the Review Committee, *M. Sideris*, could not assist the EC session at this stage due to other commitments, his report was postponed to the Session on 03 July 2011. There he moved to continue the ICCT for the next four years with with *N. Sneeuw* as the President and *P. Nóvak* as Vice-President. *F. Sansò* seconded and it was approved unanimously.

15. Report and ommendations of the Services' representatives

A summarizing review of the activities of the IVS and ILRS was presented by *H. Schuh*. At the Session on 03 July 2011, he added that the ToR of the IVS had been updated for a few minor topics and explained the changes. These small changes were adopted be the EC.

R. Neilan presented the updated IGS ToR. She explained the modified details such as policy, structure, etc. and also emphasised the importance of the intensive external connections of the IGS and its numerous Analysis Centers. She explained that a new website is in progress. *M. Sideris* moved to adopt the new IGS ToR; *G. Beutler* seconded and it was unanimously accepted.

As *S. Kenyon* could not assist the EC Meeting in Melbourne, there was no report on the gravity related Services.

16. Report and recommendations of GGOS

M. Rothacher gave a detailed overview on the GGOS activities within the last period: Retreat in Zürich; updated Vision, Mission, Goals and Tasks; Terms of Reference; new Chair selection; Inter-Agency Committee (GIAC); Themes; Action Plans 2011-2015; GEO Activities Outreach Activities; Meetings, Sessions, Workshops. The ToR were modified; the draft will be distributed to the EC members for approval in the Meeting on 03 July 2011. Moreover the new GGOS EC has to be approved within the next two weeks.

17. Proposals for the GGOS Chair of period 2011-2015

This Topic was dealt with in Topic 10 (see there).

18. Report of COB

Standing in for *J. Adam*, *Sz. Rozsa* reported on the activities of the IAG COB. The IAG Website was continuously improved. It is planned to install a "Topic of the month", therefore all colleagues are urgently asked to contribute by sending appropriate material to the COB. Moreover all adequate information for the IAG Newsletter should be continuously submitted.

19. Report of the JoG Editor-in-Chief (RK)

R. Klees reported on the work of the JoG Editorial Board during the last period. The turn around time between paper submission and final publication in the printed version could be improved considerably. The number of submissions has increased, 6 special issues have been published. As most successful results the increase of the ISI Impact Factor from 1.2 to 2.4 was mentioned.

20. Approval of the new Board of Editors of JoG

The Editorial Board presently comprises 22 members and several members are overloaded. Therefore some additional members have to be engaged. *R. Klees* presented a list of the 16 members to continue in the next period and 14 additional members including 5 new proposals.

21. Report on developing countries

As no EC Member at Large was present to give the report, it was deferred to the next sessions.

22. Report on JBGIS (FIG, ISPRS, …)

There was no urgent information. Due to time constraints the Topic was cancelled.

23. Report on ABLOS

There was no urgent information. Due to time constraints the Topic was cancelled.

24. Any other business

There were no other Topics brought up for discussion.

25. Adjourn

M. Sideris thanked the EC members for their contributions and closed the session at 5 pm.

II. Sunday, July 3, 2011, 08:30-11:00

26. Actual status report

M. Sideris and *H. Drewes* summarised the IAG Council session of June 28, 2011. Main topics were the appointments of the Audit Committee and the Resolution Committee which were following the recommendations of the EC, and the information on the status of the IAG Awards, the election process of IAG Officers, GGOS, ICCT, JoG,

IAG Reports, and applications for the venue of the IAG Scientific Assembly 2013.

27. Approval of GGOS Terms of Reference

With reference to Topic 16 of June 27, 2011, *R. Neilan* explained the numerous changes and updates of the GGOS ToR. In the discussion some details were added. *R. Neilan* will compile a new version and submit the text to the EC. *M. Sideris* moved for the approval of the new GGOS ToR with the suggested changes, *Ch. Rizos* seconded, and the EC accepted unanimously.

28. Appointment of the GGOS Chair for the period 2011-2015

Following up the discussion of Topic 17 on June 27, 2011, the EC voted by ballot papers. *Hansjörg Kutterer* was elected as the new GGOS Chair for the period 2011-2015. *M. Sideris* expressed his cordial thanks to *G. Beutler* as Chairperson of the IAG Nomination Committee for his most efficient work.

29. Appointment of IAG Representatives to IUGG Commissions, Services, other bodies

H. Drewes presented the list of IAG Representative as published in the Geodesists Handbook 2008 and updated in the Internet version. The list was revised and is published on the Webpage.

30. Proceedings of IAG Symposia

H. Drewes informed that the Proceedings of the IAG Symposia at the IUGG General Assemblies are generally published in the Springer Series. However, it has be decided which Symposia of the IUGG 2011 GA shall be considered, i.e. IAG Symposia only or also Joint Symposia and Union Symposia. The EC decided to include the papers presented in the IAG Symposia and those in the Joint Symposia led by the IAG. The price for the Proceedings depends on the number of pages. If all contributions should be published, two volumes will be necessary and thus the price is accordingly higher. Therefore it was proposed to limit the number of pages per contribution to 6; this would correspond to about 140 papers to be published.

31. Venue of the IAG Scientific Assembly 2013

Due to time constraints the Topic was deferred to the next session.

32. Adjourn

M. Sideris thanked the EC members for their contributions and closed the session at 11 am.

III. Monday, July 4, 2011, 15:15-16:15

33. IAG/IUGG Resolutions

The session was convened at short notice in order to discuss and draft resolutions for approval by the IAG and IUGG Councils, respectively, and to meet the deadline the very next day. There were two resolutions proposed:

- Gravity field satellite missions (proposed by *N. Sneeuw*): To urge international and national institutions to make all efforts in implementing new gravity field satellite missions;
- Second Realization of the International Celestial Reference Frame (proposed by *H. Schuh*): To recommend that the ICRF2 be used as a standard for future applications in geodesy.

It was decided to formulate the resolutions for both the IAG and the IUGG Council.

IV. Tuesday, July 5, 2011, 13:30-14:40

34. Actual status report

M. Sideris summarised the results of the previous IAG EC sessions and the latest IUGG EC and Council meetings. The IUGG Committee for selecting the venue of the 2015 General Assembly had proposed two candidates. The final decision shall be made by the IUGG Council in its next session on July 06, 2011.

35. IAG Budget 2011-2015

H. Drewes presented his proposal for the IAG Budget 2011-2015 in detail. He suggested awarding more travel grants in order to support young scientists to participate in symposia and explained that the allocation from the IUGG depends on the number of the participants registered for IAG at the latest IUGG General Assembly. After the 2011 GA, about 11% of the total allocation to the Associations will be given to the IAG. *H. Drewes* appealed that all EC Members should urge countries which are not yet IUGG Members to join the IUGG. *G. Beutler* moved to accept the proposed IAG Budget 2011-2015 to be presented in the Session of the IAG Council on July 06, 2011. *M. Sideris* seconded, and the EC agreed unanimously.

36. Report of the Audit Committee

The documents for the budget 2007-2011 had been handed to the Audit Committee which had proved the documents intensively and compiled a relevant report, stating, that no objections could be found and the budget management was fully correct. This report will be presented to the IAG Council on 06.07.2011 for official acceptance. The EC expressed its cordial thanks to *H. Drewes* as the IAG

Secretary General as well as to the Treasurer for their excellent work.

37. Report of the IAG Resolution Committee

Ch. Rizos reported that the Resolution Committee had submitted two resolutions to Uri Shamir to be presented to the IUGG Council as IUGG Resolutions. The resolutions were formulated slightly changed as IAG Resolutions, too, especially for the case that the IUGG would not adopt them. The texts were discussed and concluded by the EC. The final texts will be released by the IAG Council in the coming Session.

38. Corrections of Bylaws and Rules

The IAG Statutes and Bylaws have to be reviewed every eight years, i.e. in 2015 again after the 2007 IUGG General Assembly in Perugia. This is done by the so-called Cassinis Committee (see Topic 39). *M. Sideris* requested all colleagues to prepare any suggestions for updates/changes till the 2013 IAG Scientific Assembly to be discussed there and to give the Committee time to prepare a final version to be adopted by the Council in 2015.

H. Drewes then explained that besides the Bylaws there are other Rules, e.g. those for Travel Grants which can be changed and adopted by the EC at any time. The maximum grants to be awarded are at present 400 USD for travels in the own country and 800 USD for travels abroad. According to the increased costs for travelling, he proposed to mark up to 500 USD for national travels and to 1000 USD for international travels, respectively. The sentence in the rules which is limiting the number of grants per year to 10 should be deleted without substitution. *H. Schuh* moved to accept the updated IAG Rules for Travel Grants, *Ch. Rizos* seconded, and the EC agreed unanimously.

39. Review Committee of Statutes, Bylaws and Rules

The establishment of the so-called "Cassinis Committee" 2011-2015 was delayed for the First Meeting of the IAG EC 2011-2015 on July 07, 2011.

40. Sponsorship of symposia and workshops

H. Drewes mentioned that according to a previous EC decision, all Symposia organised by one IAG Component or IAG Sub-components get automatically the status of IAG Symposia. Then he presented an overview of upcoming symposia within 2011. The EC concluded which of them should be sponsored by the IAG. *M. Sideris* emphasised to urge the organisers to use the IAG Label for such symposia on all relevant occasions, especially on the homepages and covers of the proceedings.

41. Preparation of the IAG Closing Session

H. Drewes presented the agenda of the IAG Closing Session on July 6, 2011. All convenors were asked to give a much summarised report or special highlights of their sessions.

The list of proposed IAG Fellows prepared by the IAG Office had been distributed among the EC Members. The EC discussed this list; several candidates were discarded as they did not show the expected activities. The updated list will be presented in the Closing Session. The certificates will be sent by e-mail.

42. Any other business

According to the IAG Statutes the presidency of *M. Sideris* ends with the IAG Closing Session on July 06. *H. Drewes* moved to appoint *Michael Sideris* as IAG Honorary President. *Ch. Rizos* seconded, and the EC agreed unanimously. *M. Sideris* expressed his deep thanks for this honour.

43. End

G. Beutler stated that with this EC Meeting the legislative period 2007-2011 has come to its end. The EC expresses its cordial thanks to the IAG Bureau, in particular to the President and the IAG Office. Moreover, the EC thanked especially those colleagues who will be no longer in the Committee. *M. Sideris* replied by thanking the EC for the most efficient cooperation as well as friendly atmosphere. Moreover, he included his best wishes for *Ch. Rizos* as the future President. The session was closed at 14:40.

IUGG Resolutions

Adopted by the Council at the XXV IUGG General Assembly, Melbourne, Australia, 26 June – 7 July 2011

Resolution 1:

Standardized schemes for the terminology for glacier mass balance measurements and for classification of snow on the ground

The International Union of Geodesy and Geophysics,

considering

the fundamental importance of common terminology and classification schemes for the exchange of scientific knowledge between nations and across disciplines,

noting

- that a recognized glossary of glacier mass balance terminology and a standardized classification for snow on the ground had not been updated since the 1970s and 1990s respectively, and
- that our scientific understanding and measurement capabilities and techniques have evolved and expanded since then,

recognizing

- the work done by IACS Working Groups to update, publish and freely disseminate new standardized schemes:
- *The International Classification for Seasonal Snow on the Ground*. IHPVII Technical Documents in Hydrology No. 83, IACS Contribution No. 1, UNESCO-IHP, Paris. 2009. 80 p. (http://unesdoc.unesco.org/images/0018/001864/186462e.pdf),
- *Glossary of Glacier Mass Balance and Related Terms*. IHP-VII Technical Documents in Hydrology No. 86, IACS Contribution No. 2, UNESCOIHP, Paris. 2011. 114 p. (http://unesdoc.unesco.org/images/0019/001925/192525E. pdf),

urges

- snow and ice scientists, practitioners, and scientists from related disciplines to adopt these new schemes as standards.

Resolution 2:

Gravity and magnetic field satellite missions

The International Union of Geodesy and Geophysics,

considering

the interest of the IUGG scientific community in knowing with the highest accuracy and resolution the Earth gravity and magnetic fields and their time evolutions as one of the fundamental components of the Earth system, also to understanding the climate evolution of the Earth,

acknowledging

the large experience acquired within the IUGG in the last 10 years in analysing data from dedicated satellite missions like GRACE, GOCE, CHAMP and Oersted, for the purpose of estimating the gravity and magnetic fields and their time variations,

noting

the need for a long-term monitoring of the potential fields for Earth System science beyond the current and decided missions lifetime,

urges

international and national institutions, agencies and governmental bodies in charge of supporting Earth science research to make all efforts in implementing new gravity and magnetic field satellite missions that would respond to the aforementioned need for continued observation.

Resolution 3:

Second Realization of the International Celestial Reference Frame

The International Union of Geodesy and Geophysics,

considering

- that the International Union of Geodesy and Geophysics adopted at the 23rd General Assembly in Sapporo 2003 Resolution 4 on the first realization of the International Celestial Reference Frame,
- that the International Astronomical Union (IAU) adopted Resolution B3 at its XXVII General Assembly (2009) (www.iau.org/static/resolutions/IAU2009_English.pdf) that resolves to consider the Second Realization of the International Celestial Reference Frame (ICRF2) as the fundamental realization of the International Celestial Reference System (ICRS)1,
- that the celestial reference system and the nutation-precession model have a large influence on geodetic and geodynamic observations, analyses and interpretations,
- that the ICRF2 was constructed by the International Earth Rotation and Reference Systems Service (IERS) and the International VLBI Service for Geodesy and Astrometry (IVS),

urges

- that the ICRF2 shall be used as a standard for all future applications in geodesy and astrometry,
- that the organizations responsible for geodetic VLBI observing programs take appropriate measures to continue existing and develop improved VLBI observing and analysis programs to both maintain and improve ICRF2,
- that highest consistency between the ICRF, the International Terrestrial Reference Frame (ITRF), and the Earth Orientation Parameters (EOP) as observed and realized by the IAG and its components such as the IERS should be a primary goal in all future realizations of the ICRS.

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[1] *The Second Realization of the International Celestial Reference Frame by Very Long Baseline Interferometry*, presented on behalf of the IERS / IVS Working Group, Alan Fey and David Gordon (eds.). (IERS Technical Note; 35) Frankfurt a.M.: Verlag des Bundesamts für Kartographie und Geodäsie, 2009. See *www.iers.org/MainDisp.csl?pid=46-25772* or *hpiers.obspm.fr/icrs-pc/*.

Resolution 4:

Adoption of the International Thermodynamic Equation Of Seawater – 2010 (TEOS-10)

The International Union of Geodesy and Geophysics,

considering

- that since the International Thermodynamic Equation Of Seawater – 2010 (TEOS-10) has been adopted by the Intergovernmental Oceanographic Commission (IOC) at its 25th Assembly in June 2009 as the official description for the properties of seawater, of ice and of humid air,

urges

- all marine scientists to use TEOS-102 in place of EOS-80 in their research and publications.

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[2] The software to implement this change is available at the web site www.TEOS-10.org. The formal description of TEOS-10 is the "TEOS-10 Manual"; IOC, SCOR and IAPSO, 2010: *The international thermodynamic equation of seawater – 2010: Calculation and use of thermodynamic properties*. Intergovernmental Oceanographic Commission, Manuals and Guides No.56, UNESCO (English), 196 pp. The following two introductory articles are also available from the TEOS-10 web site *www.TEOS-10.org*:

- "Getting started with TEOS-10 and the Gibbs Seawater (GSW) Oceanographic Toolbox", and
- "What every oceanographer needs to know about TEOS-10:- The TEOS-10 Primer".

Resolution 5:

Thanks

The International Union of Geodesy and Geophysics

gratefully records its appreciation for the organization, arrangements, and hospitality at the XXV General Assembly. On behalf of all participants, the Council expresses its warm thanks to the Australian Academy of Science and the Royal Society of New Zealand, the Local Organizing Committee, the Scientific Program Committee, and all others for their efforts to make the XXV General Assembly a scientific success in the beautiful city of Melbourne.

IAG Resolutions

Adopted by the IAG Council at the XXV IUGG General Assembly, Melbourne, Australia, June 28 – July 7, 2011

Resolution 1

Gravity field satellite missions

The International Association of Geodesy,

considering,

the interest of the scientific community in knowing with the highest accuracy and resolution the Earth gravity field and its time evolution as one of the fundamental components of the Earth system, also to understanding the climate evolution of the Earth;

acknowledging,

the large experience acquired within the IAG in the last 10 years in analyzing data from dedicated satellite missions like CHAMP, GRACE and GOCE for the purpose of estimating the gravity field and its time variation;

noting,

the need for a long-term monitoring of the gravity field for Earth System science beyond the mission lifetime of GRACE and GOCE;

urges,

international and national institutions, agencies and governmental bodies in charge of supporting Earth science research to make all efforts in implementing new gravity field satellite missions that would respond to the aforementioned need for continued observation.

Resolution 2

Second Realization of the International Celestial Reference Frame

The International Association of Geodesy,

considering,

1. that the International Union of Geodesy and Geophysics adopted at the 23rd General Assembly in Sapporo 2003 Resolution 4 on the first realization of the International Celestial Reference Frame;
2. that the International Astronomical Union (IAU) adopted Resolution B3 at its XXVII General Assembly (2009) (www.iau.org/static/resolutions/IAU2009_English.pdf) that resolves to consider the "Second Realization of the International Celestial Reference Frame (ICRF2)" as the fundamental realization of the International Celestial Reference System (ICRS) (see note 1);
3. that the celestial reference system and the nutation-precession model have a large influence on geodetic and geodynamic observations, analyses and interpretations;
4. that the ICRF2 was constructed by the International Earth Rotation and Reference Systems Service (IERS) and the International VLBI Service for Geodesy and Astrometry (IVS);

recommends

1. that the ICRF2 should be used as a standard for all future applications in geodesy and astrometry,
2. that the organizations responsible for geodetic VLBI observing programs take appropriate measures to continue existing and develop improved VLBI observing and analysis programs to both maintain and improve ICRF2,
3. that highest consistency between the ICRF, the International Terrestrial Reference Frame (ITRF), and the Earth Orientation Parameters (EOP) as observed and realized by the IAG and its components such as the IERS should be a primary goal in all future realizations of the ICRS.

Note 1: The Second Realization of the International Celestial Reference Frame by Very Long Baseline Interferometry, Presented on behalf of the IERS / IVS Working Group, Alan Fey and David Gordon (eds.). (IERS Technical Note ; 35) Frankfurt am Main: Verlag des Bundesamts für Kartographie und Geodäsie, 2009. See <www.iers.org/MainDisp.csl?pid=46-25772> or <hpiers.obspm.fr/icrs-pc/>.

Structures for the Period 2011 – 2015

International Union of Geodesy and Geophysics (IUGG)

Executive Committee

Bureau

President:	*Harsh Gupta* (India)
Vice-President:	*Michael Sideris* (Canada)
Secretary General	*Alik Ismail-Zadeh* (Germany)
Treasurer:	*Aksel W. Hansen* (Denmark)
Members:	*Isabella Ansorge* (South Africa)
	Pierre Hubert (France)
	Kenji Satake (Japan)

Retiring President: *Tom Beer* (Australia)

Presidents of the International Associations

IACS:	*Ian Allison* (Australia)
IAG:	*Chris Rizos* (Australia)
IAGA:	*Kathryn Whaler* (UK)
IAHS:	*Gordon Young* (Canada)
IAMAS:	*Athena Coustenis* (France)
IAPSO:	*Evgeny G. Morozov* (Russia)
IASPEI:	*Domenico Giardini*
(Switzerland)	
IAVCEI:	*Ray Cas* (Australia)

Finance Committee

Chair:	*David Collins* (UK)
Members:	*Zoltan Hajnal* (Canada)
	Jan Krynski (Poland)
	David Rhoades (New Zealand)

International Associations

International Association of Cryospheric Sciences
President: *Ian Allison* (Australia)
President Elected: *Charles Fierz* (Switzerland)
Secretary General: *Andrew Mackintosh* (New Zealand)

International Association of Geodesy
President: *Chris Rizos* (Canada)
Secretary General: *Hermann Drewes* (Germany)

International Association of Geomagnetism and Aeronomy
President: *Kathryn Whaler* (UK)
Secretary General: *Mioara Mandea* (France)

International Association of Hydrological Sciences
President: *Gordon Young* (Canada)
President Elect: *Hubert Savenije* (The Netherlands)
Secretary General: *Christophe Cudennec* (France)

International Association of Meteorology and Atmospheric Sciences
President: *Athena Coustenis* (France)
Secretary General: *Hans Volkert* (Germany)

International Association for the Physical Sciences of the Oceans
President: *Evgeny G. Morozov* (Russia)
Secretary General: *Johan Rodhe* (Sweden)

International Association of Seismology and Physics of the Earth's Interior
President: *Domenico Giardini* (Switzerland)
Secretary General: *Peter Suhadolc* (Italy)

International Association of Volcanology and Chemistry of the Earth's Interior
President: *Ray Cas* (Australia)
Secretary General: *Joan Marti* (Spain)

Union Commissions

Data and Information (UCDI)
Chair: *Peter Fox* (USA)
Secretary: *Adelina Geyer Traver* (Spain)

Geophysical Risk and Sustainability (GeoRisk)
Chair: *Kuniyoshi Takeuchi* (Japan)
Secretary: *Diana Greenslade* (Australia)

Mathematical Geophysics (CMG)
Chair: *Yehuda Ben-Zion* (USA)
Secretary: *Claudia Pasquero* (Italy)

Studies of Earth's Deep Interior (SEDI)
Chair: *Satoru Tanaka* (Japan)
Secretary: *Mike Bergman* (USA)

Inter-Unions Commission

Commission on the Lithosphere: International Lithosphere Program (ILP)
President: *Sierd Cloetingh* (The Netherlands)
Secretary General: *Roland Oberhänsli* (Germany)

International Association of Geodesy (IAG)

1. Executive Committee

1.1 IAG Bureau

IAG President: *Chris Rizos* (Australia)
Vice President: *Harald Schuh* (Austria)
Secretary Gen.: *Hermann Drewes* (Germany)

1.2 IAG Immediate Past President

Pres. 2007-2011: *Michael G. Sideris* (Canada)

1.3 IAG Commission Presidents

Commission 1 "Reference Frames"
President: *Tonie van Dam* (Luxembourg)

Commission 2 "Gravity Field"
President: *Urs Marti* (Switzerland)
Commission 3 "Earth Rotation and Geodynamics"
President: *Richard Gross* (USA)

Commission 4 "Positioning and Applications"
President: *Dorota Brzezinska* (USA)

1.4 Global Geodetic Observing System (GGOS)

GGOS Chair: *Hansjoerg Kutterer* (Germany)

1.5 Communication & Outreach Branch (COB)

COB President: *József Ádám* (Hungary)

1.6 Representatives of the Services

Representatives: *Riccardo Barzaghi* (Italy)
Tom Herring (USA)
Ruth Neilan (USA)

1.7 Members at Large

Members: *Claudio Brunini* (Argentina)
Richard Wonnacott (S. Africa)

1.8 Non-voting Members

Inter-Commission Committee on Theory (ICCT)
President: *Nico Sneeuw* (Germany)

IAG Ass. Secr.: *Helmut Hornik* (Germany)

IAG Past Presidents (before 2007)
1979-1983: *Helmut Moritz* (Austria)
1987-1991: *Ivan I. Mueller* (USA)
1991-1995: *Wolfgang Torge* (Germany)
1995-1999: *Klaus-Peter Schwarz* (Canada)
1999-2003: *Fernando Sansó* (Italy)
2003-2007: *Gerhard Beutler* (Switzerland)

IAG Past Secretaries General
1975-1991: *Michel Louis* (France)
1991-1995: *Claude Boucher* (France)
1995-2007: *Christian Tscherning* (Denmark)

2. IAG Office

Deutsches Geodätisches Forschungsinstitut
Secretary General: *Hermann Drewes* (Germany)
Assistant Secretary: *Helmut Hornik* (Germany)

3. IAG Communication & Outreach Branch

Hungarian Academy of Sciences / Budapest University of Technology and Economics
President: *József Ádám* (Hungary)
Secretary: *Szabolcs Rózsa* (Hungary)

4. Journal of Geodesy

Editor in Chief: *Roland Klees* (The Netherlands)

5. IAG Symposia Series

Editor in Chief: *Chris Rizos* (Australia)
Assistant Editor: *Pascal Willis* (France)

6. IAG Commissions

Commission 1: Reference Frames
President: *Tonie van Dam* (Luxembourg)
Vice-Pres.: *Gary Johnston* (Australia)

Commission 2: Gravity Field
President: *Urs Marti* (Switzerland)
Vice-Pres.: *Srinivas Bettadpur* (USA)

Commission 3: Earth Rotation and Geodynamics
President: *Richard Gross* (USA)
Vice-Pres.: *Aleksander Brzezinski* (Poland)

Commission 4: Positioning and Applications
President: *Dorota Grejner-Brzezinska* (USA)
Vice-Pres.: *Allison Kealy* (Australia)

7. IAG Global Geodetic Observing System (GGOS)

Chair: *Hansjörg Kutterer* (Germany)
Vice-Chair: *Ruth Neilan* (USA)

8. IAG Scientific Services

IAG Bibliographic Service (IBS)
Chair: *Annekathrin Michlenz* (Germany)

International Altimeter Service (IAS)
Chair: *Wolfgang Bosch* (Germany)

International Bureau of Weights and Measures, Bureau International des Poids et Mesures (BIPM), Time Department
Director: *Elisa Felicitas Arias* (France)

International Centre for Earth Tides (ICET)
Director: *Jean-Pierre Barriot* (France)

International Centre for Global Earth Models (ICGEM)
Director: *Franz Barthelmes* (Germany)

International Digital Elevation Models Service (IDEMS)
Director: *Philippa Berry* (UK)

International DORIS Service (IDS)
Chair Governing Board: *Pascal Willis* (France)
Director Central Bureau: *Laurent Soudarin* (France)
Analysis Coordinator: *Frank Lemoine* (USA)

International Earth Rotation and Reference Systems Service (IERS)
Chair of Directing Board: *Chopo Ma* (USA)
Director Central Bureau: *Bernd Richter* (Germany)
Analysis Coordinator: *Tom Herring* (USA)

International Geoid Service (IGeS)
President and Director: *Riccardo Barzaghi* (Italy)

International GNSS Service (IGS)
Chair of the Gov. Board: *Urs Hugentobler* (Germany)
Director Central Bureau: *Ruth Neilan* (USA)
Analysis Coordinator: *Jake* Griffiths (USA)

International Gravimetric Bureau, Bureau Gravimetrique International (BGI)
Director: *Sylvain Bonvalot* (France)

International Gravity Field Service (IGFS)
Chair: *Rene Forsberg* (Denmark)
Director Central Bureau: *Iginio Marson* (Italy)
Executive CB Secretary: *Franco Coren* (Italy)

International Laser Ranging Service (ILRS)
Chair Governing Board: *Graham Appleby* (UK)
Director Central Bureau: *Michael Pearlman* (USA)
Secretary: *Carey Noll* (USA)
Analysis Coordinator: *Erricos Pavlis* (USA)

International VLBI Service for Geodesy and Astrometry (IVS)
Acting Chair Dir. Board: *Harald Schuh* (Austria)
Director Coord. Center: *Dirk Behrend* (USA)
Analysis Coordinator: *Axel Nothnagel* (Germany)

Permanent Service for Mean Sea Level (PSMSL)
Director: *Lesley Rickards* (UK)

9. IAG Inter-Commission Committee on Theory (ICCT)

President: *Nico Sneeuw* (Germany)
Vice-President: *Pavel Novak (Czech Republic)*

Commission 1 – Reference Frames

http://iag.uni.lu

President: **T. van Dam** (Luxembourg)
Vice President: **G. Johnston** (Australia)

Terms of Reference

Reference systems and frames are of primary importance for much Earth science based research and applications, satellite navigation as well as for practical applications in geo-information. A precisely defined reference frame is needed for an improved understanding of the Earth's rotation and its gravity field, sea level change with time, tectonic plate motion and deformation, glacial isostatic adjustment, geocentre motion, deformation due to Earthquakes, local subsidence and other crustal displacements.

Commission 1 activities and objectives deal with the theoretical aspects of how best to define reference systems and how reference systems can be used for practical and scientific applications. Commission 1 will closely interact with the other IAG Commissions, ICCT, Services and GGOS components where reference system aspects are of concern. Commission 1 is identical with Sub-commission B2 of COSPAR.

Objectives

The main objectives of Commission 1 include:

- Definition, establishment, maintenance and improvement of the geodetic reference frames;
- Advanced terrestrial and space observation technique development for the above purposes;
- International collaboration for the definition and deployment of networks of terrestrially-based space geodetic observatories;
- Theory and coordination of astrometric observation for reference frame purposes.
- Collaboration with space geodesy/reference frame related international services, agencies and organizations;
- Promote the definition and establishment of vertical reference systems at global level, considering the advances in the regional sub-commissions;
- Work to maintain a reference frame that is valuable for global change studies.

Structure

Sub-Commissions

SC 1.1: Coordination of Space Techniques
Chair: T. Herring (USA)

SC 1.2: Global Reference Frames
Chair: C. Boucher (France)

SC 1.3: Regional Reference Frames
Chair: J. Torres (Portugal)
SC 1.3a: Europe
Chair: J. Ihde (Germany)
SC 1.3b: South and Central America
Chair: C. Brunini (Argentina)
SC 1.3c: North America
Chairs: J. Griffiths (USA), M. Craymer (Canada)
SC 1.3d: Africa
Chair: R. Wonnacott (South Africa)
SC 1.3e: Asia-Pacific
Chair: J. Dawson (Australia)
SC 1.3f: Antarctica
Chair: R. Dietrich (Germany)

SC 1.4: Interaction of Celestial and Terrestrial Reference Frames
Chair: J. Böhm (Austria)

Joint Study Groups

JSG 0.1: Application of time series analysis in geodesy
(joint with ICCT and all Commissions, description see ICCT)
Chair: W. Kosek (Poland)

JSG 0.2: Gravity field modelling in support of height system realization
(joint with ICCT and Commission 2, description see ICCT)
Chair: P. Novák (Czech Republic)

JSG 0.4: Coordinate systems in numerical weather models
(joint with ICCT and all Commissions, description see ICCT)
Chair: Th. Hobiger (Japan)

JSG 0.8: Earth system interaction from space geodesy
(joint with ICCT and all Commissions, description see ICCT)
Chair: S. Jin (China)

JSG 0.9: Future developments of ITRF models and their geophysical interpretation
(joint with ICCT and IERS, description see ICCT)
Chair: A. Dermanis (Greece)

JSG 3.1: Gravity and height change intercomparison
(joint with Commissions 2, 3 and IGFS, description see Commission 3)
Chair: S. Rosat (France)

Joint Working Groups

JWG 1.1: Tie vectors and local ties to support integration of techniques (joint with IERS)
Chair: P. Sarti (Italy)

JWG 1.2: Modelling environmental loading effects for reference frame realizations (joint with IERS)
Chair: X. Collilieux (France)

JWG 1.3: Understanding the relationship of terrestrial reference frames for GIA and sea-level studies (joint with Commission 3)
Chair: T. Schöne (Germany)

JWG 1.4: Strategies for epoch reference frames (joint with IERS)
Chair: M. Seitz (Germany)

JWG 0.1.1: Vertical datum standardization
(joint with GGOS, IGFS, and Commission 2; description see GGOS)
Chair: L. Sánchez (Germany)

Program of Activities

The program of activities for Commission 1 includes:

- Encourage, initiate, and support theoretical and applied research activities related to reference frames;
- Enforce Research and Development activities that impact the reference frame determination and its accuracy, as well as, the best and optimal usage of reference frames in Earth Science applications;
- Closely interact with all established IAG Services: IVS, IGS, ILRS, IDS and the IERS, including their Combination Centres and Working Groups;
- If necessary, improve the theory and application of the transformation between Celestial and Terrestrial Reference Systems and application of the theory to improve the consistency between ICRF, ITRF and EOPs, in cooperation with IVS and IERS;
- Explore advanced methodologies for the combination of products and raw observations of space geodetic techniques;
- Investigate all systematic error sources and factors limiting the precision of space geodetic techniques and their combination;
- Within each regional sub commission, encourage and assist regional sub-commission countries to re-define and modernize their national geodetic systems so that they are compatible with the ITRF;
- Establish a dedicated Web site relating all Commission 1 activities.

Steering Committee

- President: Tonie van Dam (Luxembourg)
- Vice President: Gary Johnston (Australia)
- Chair SC1.1: T. Herring (USA)
- Chair SC1.2: C. Boucher (France)
- Chair SC1.3: J. Torres (Portugal)
- Chair SC1.4: J. Böhm (Austria)
- Representatives of Services:
  IERS: C. Ma
  IDS: P. Willis
  IGS: J. Griffiths
  ILRS: G. Appleby
  IVS: O. Titov
- Member at Large: L. Combrinck (South Africa)

Sub-Commissions

SC 1.1: Coordination of Space Techniques

Chair: Tom Herring (USA)

Terms of Reference

The space geodetic observation techniques, including Very Long Baseline Interferometry (VLBI), Satellite and Lunar Laser Ranging (SLR/LLR), Global Navigation Satellite Systems (GNSS) such as GPS, GLONASS, GALILEO, and COMPASS, and the DORIS system, as well as altimetry, InSAR, LIDAR, and the gravity missions, contribute significantly to the knowledge about and the understanding of the three major pillars of geodesy: the Earth's geometry (point coordinates and deformation), Earth orientation and rotation, and the gravity field as well as its time variations. These three fields interact in various ways and they all contribute to the description of processes in the Earth System. Each of the space geodetic techniques contributes in a different and unique way to these three pillars and, therefore, their contributions are critical to the Global Geodetic Observing System (GGOS).

Sub-Commission 1.1 coordinates efforts that are common to more than one space geodetic technique, such as models, standards and formats. It shall study combination methods and approaches concerning links between techniques co-located at fundamental sites, links between techniques co-located onboard satellites, common modelling and parameterization standards, and perform analyses from the combination of a single parameter type up to a rigorous combination on the normal equation (or variance- covariance matrices) as well as at the observation level. The list of interesting parameters includes site coordinates (e.g. time series of combined solutions), Earth orientation parameters, satellite orbits (combined orbits from SLR, GPS, DORIS, altimetry), atmospheric refraction (troposphere and ionosphere), gravity field coefficients, geocentre coordinates, and others. One important goal of SC1.1 will be the development of a much better understanding of the interactions between the parameters describing geometry, Earth rotation, and the gravity field as well as developing methods to validate combination results, e.g., by comparing them with independent geophysical information.

To the extent possible SC1.1 should also encourage research groups to develop new observation techniques connecting or complementing the existing set of measurements. Sub-Commission 1.1 has the task to coordinate the activities in the field of the space geodetic techniques in close cooperation with GGOS, all of the IAG Services, and with COSPAR.

Objectives

The principal objectives of the scientific work of Sub-Commission 1.1 in collaboration with GGOS are the following:

- Study systematic effects of and between space geodetic techniques.
- Develop common modelling standards and processing strategies.
- Comparison and combination of orbits derived from different space geodetic techniques.
- Explore and develop innovative combination aspects such as, e.g., GPS and VLBI measurements based on the same high-accuracy clock, VLBI observations to GNSS satellites, and the combination of atmospheric information (troposphere and ionosphere) of more than one technique.
- Establish methods to validate the combination results (e.g., with global geophysical fluids data).
- Explore, theoretically and practically, the interactions between the gravity field parameters, EOPs, and reference frames (site coordinates and velocities plus extended models), improve the consistency between these parameter groups, and assess, how a correct combination could be performed.
- Study combination aspects of new geodetic methods such as Synthetic Aperture Radar (InSAR), LIDAR and optical image analysis methods.
- Additional objectives of Sub-Commission 1.1 are:
- Promotion of international scientific cooperation.
- Coordination of common efforts of the space geodetic techniques concerning standards and formats (together with the IERS and GGOS).
- Organization of workshops and sessions at meetings to promote research. - Establish bridges and common activities between SC1.1 and the IAG Services.

Links to Services

Sub-Commission 1.1 will establish close links to the relevant services for reference frames, namely Global Geodetic Observing System (GGOS), International Earth Rotation and Reference Systems Service (IERS), International GPS Service (IGS), International Laser Ranging Service (ILRS), International VLBI Service for Geodesy and Astrometry (IVS), and International DORIS Service (IDS) and the International gravity services.

Working Groups of Sub-Commission 1.1

WG 1.1.1: Creation of common geodetic coordinate time series

Chair: Laurant Soudarin (France)

This working group, formed in collaboration with the IERS, will explore methods for creating position time series for the different geodetic techniques so that they can be displayed in a common format and consistent reference frame. The working group will explore, in the format and interfaces for time series. A common tool that can be used to display and compare these results will also be developed. The working group will have a representative from each technique combination centre, a representative from the ITRS combination centre, and that the GGOS portal manager. There should also be representatives from the geophysics/geodynamics and oceanography communities who are seen as the primary uses of this product. The final product of this working group will be recommendations on how the geodetic community should proceed in developing common positional time series and making such results readily available to the broad scientific community.

WG 1.1.2: Investigate methods for merging geodetic imaging systems (InSAR, LIDAR and optical methods) into a geodetic reference system

Chair: Sebastian Leprince (USA)

With the development of new methods for studying surface deformations, such as InSAR, LIDAR and optical methods, this working group will explore the methods that should be used to ensure that these deformation measurements are made in a well-defined geodetic reference frame. Issues to be addressed include how to establish the reference frame for these classes of measurements, how to ensure the long-term stability of the reference frame, and to make recommendations for changes in future systems that would allow more robust reference frame realization.

SC 1.2: Global Reference Frames

Chair: Claude Boucher (France)

Terms of Reference

Sub-Commission 1.2 is engaged in scientific research and practical aspects of the global reference frames. It investigates the requirements for the definition and realization of the terrestrial reference systems (TRS) and frames (TRF), addresses fundamental issues closely related to TRS, such as global geodetic observatories or methods for the combined processing of heterogeneous observation- data.

Terrestrial Reference Systems refer to an important domain of Geodesy, involving both the theoretical and the applied aspects, as well as deep connections with Astronomy, Earth Sciences and Geo-information. This necessitates several visions:

- An astronomical vision, using the TRS to study translational and rotational motions of the Earth in inertial space;
- An Earth Science vision, using TRS to build physical models of the Earth system, and its various components (solid earth, oceans, atmosphere, hydrosphere);
- A metrological vision, using TRS together with suitable coordinate systems (geographical coordinates, map projections…) to define geographical position of objects in the Earth's vicinity (geo-referencing).

The work in this SC will be carried out in close cooperation with the International Earth Rotation and Reference Systems Service (IERS), other relevant IAG services (IGS, ILRS, IVS, IDS), and the IAG Global Geodetic Observing System (GGOS). Theoretical aspects will be investigated in cooperation with the Inter-Commission Committee on Theory.

Beyond IAG, cooperation with other relevant international organizations such as IAU, FIG or ISO will also be developed.

Objectives

The following research topics will form the fundamental objectives during the next period:

- Relativistic modelling, including extension of the IAU model to geodesy, investigations on the use of emission coordinate systems;
- External evaluation of TRF;
- TRF by multi-technique data analysis versus hierarchical combinations;
- Global Geodetic Observatories, concepts and practical implementation;
- TRF versus dynamical topographic models;

- Relation with standardization or certification activities (ISO, GEO...).

Links to Services

Sub-Commission 1.2 will be closely linked to the relevant services, in particular the International Earth Rotation and Reference Systems Service, (IERS), the International GNSS Service (IGS), the International Laser Ranging Service (ILRS), the International VLBI Service for Geodesy and Astronomy (IVS), and the international DORIS Service (IDS).

Working Groups of Sub-Commission 1.2

WG 1.2.1: External Evaluation of Terrestrial Reference Frames

Chair: Xavier Collilieux (France)

The scientific community has recognized the need for a highly accurate terrestrial reference frame (TRF) for Earth Science applications. Although geodetic measurements are very precise, uncertainty in the modelling of the measurements and correlations between estimated parameters make it complicated to assess geocentric station coordinates. While a precision at a few-millimetre level is thought to be achievable, it is difficult to supply a precise figure of the current coordinate accuracy. The reliability of the station velocities is notably essential to the study of climate change. Any error in the rate of the origin and scale definition of the TRF will especially map directly into the station velocities and into other products such as sea level rise estimates.

The aim of this task force is to review all the methods that could be used to assess the accuracy of the origin, scale and orientation (and/or their time variations) of a TRF. All the activities in which the adopted TRF has a quantitative influence will be studied in order to derive possible constraints on the TRF. Methods that involve datasets that have not been used to derive the TRF will be especially emphasized (tide gauges, gravity, geophysical models etc...). As an example, the quality of ITRF2008 will be investigated using various methods in order to derive the most complete error budget.

Objectives

- Investigate methods to evaluate TRF accuracy, especially TRF datum parameters;
- Supply an assessment of ITRF2008 quality using all available relevant methods.

Specific program activities

- Study all the activities in which the adopted TRF has a quantitative influence;
- Maintain a bibliography about TRF evaluation with any type of data and model;
- Evaluate the interest to derive external constraints on TRF datum fixation, i.e. on its origin, scale, orientation and their time evolutions.

WG 1.2.2: Global Geodetic Observatories

Chair: Perguido Sarti (Italy)

An effective integration of space geodetic instruments at the observing sites is a crucial issue for the computation of the terrestrial reference frame. In fact, the computation of the global terrestrial frame depends, on the one hand, on the number, distribution and quality of the co-located sites and, on the other hand, on the accuracy of the tie vectors that express the relative position of the co-located instruments.

The ITRF is a geodetic product that serves Earth and space sciences. Although, its significance and exploitation goes beyond scientific research: societal application, natural hazards mitigation and Earth observations go beyond purely scientific uses and has an impact on the whole society.

Geophysical research requires a wider concept of integration where co-locations are realized not only with space and terrestrial geodetic instruments but also with other geophysical sensors like seismometers, weather stations, lidars, radio-sondes, gravimeters, tide gauges, radiometers, etc…

In this perspective, the integration of geodetic and geophysical sensors must be realized at the highest level of precision providing the relative positions in a consistent frame at local and global scales.

The task force will examine and revise the state of the art in local tie surveying and tie vector estimation, spotlighting the current deficiencies and promoting cooperation on the relevant research topics. The definition of reference points for each instrument as well as the related calibration issues will also be considered, in close cooperation with individual technique services (IGS, IVS, ILRS, IDS, PSMSL, IGFS...). The most recent and highest standards achieved in the integration of geodetic instruments will be transposed to the problem of co-locating, operating and managing a wider class of geophysical instruments with the purpose of defining the guidelines for their effective co-location and integration towards the creation of multipurpose geophysical observatories.

Other types of considerations will be also investigated, such as operational issues, international governance, labelization, standardization and certification.

Objectives

- Revise the needs related to the co-location of geophysical sensors;
- Revise existing tie vector estimation processes methods and accuracies;
- Transpose the state of the art of tie vector estimation to non-geodetic instruments;
- Liaise with IERS, IAG and GGOS;
- Set guidelines on geophysical co-location surveying and management.

SC 1.3: Regional Reference Frames

Chair: João Torres (Portugal)

Terms of Reference

Sub-Commission 1.3 deals with the definitions and realizations of regional reference frames and their connection to the global International Terrestrial Reference Frame (ITRF). It offers a home for service-like activities addressing theoretical and technical key common issues of interest to regional organisations.

Objectives

In addition to the specific objectives of each regional sub-commission, the main objectives of SC1.3 as a whole are:

- Develop specifications for the definition and realization of regional reference frames, including the vertical component with a special consideration of gravity and other data;
- Coordinate the activities of the regional sub-commissions focusing on exchange and share of competences and results;
- Develop and promote operation of GNSS permanent stations, in connection with IGS whenever appropriate, to be the basis for the long-term maintenance of regional reference frames;
- Promote actions for the densification of regional velocity fields;
- Encourage and stimulate the development of the AFREF project in close cooperation with IGS and other interested organizations;
- Encourage and assist countries, within each regional sub-commission, to re-define and modernize their national geodetic systems, compatible with the ITRF.

Program of Activities

- Organize inter-regional workshops addressing activities, results and key issues of common interest to the regional sub-commissions;
- Develop analysis strategies and compare methods for the implementation of the regional reference frames and their expression in the ITRF, with the full interaction with the IGS;
- Consider studying and promoting consistent specifications for the generation of GNSS-based velocity field solutions;
- Consider developing tectonic deformation models that will enable transformation of locations within a defined reference frame between different epochs;
- At regional levels, contribute to the realization and improvement of local surveys in the collocation sites, with full cooperation with the Sub-commission 1.2 Global Reference Frames.

SC 1.3a: Europe

Chair: Johannes Ihde (Germany)
Secretary: Alessandro Caporali (Italy)

Terms of Reference

EUREF, the Regional Reference Frame Sub-commission for Europe, deals with the definition, realization and maintenance of the European Reference Frames. EUREF is focusing on both the spatial and the vertical components in close cooperation with the pertinent IAG components (Services, Commissions, and Inter-commission projects) and EuroGeographics, the consortium of the National Mapping and Cadastral Agencies (NMCA) in Europe.

Structure

- EUREF is composed of representatives from European IAG member countries;
- The TWG (Technical Working Group) is composed of members elected by the plenary, members in charge of special projects and ex-officio members.

Program of Activities

- Continue to develop the EUREF Permanent Network (EPN) in close cooperation with IGS, for the maintenance of the European Terrestrial Reference Frame, as a contribution to the ITRF and as an infrastructure to support practical applications for precise positioning and referencing geo-information;
- Extend the Unified European Levelling Network (UELN) and prepare it to be computed under a geokinematic approach using the European Combined Geodetic Network (ECGN) for a long-term maintenance of the European Vertical Reference Frame;
- Support new developments in reference frame realization and application by introducing new technologies like real-time data transfer and products, as well as Galileo for precise positioning;
- Establish a dense velocity field model in Europe for the long-term maintenance of the European reference frame;
- Consider the contribution to the IAG Program GGOS (Global Geodetic Observing System) using the installed infrastructures managed by the EUREF members;
- Promote the adoption of the reference systems defined by EUREF (ETRS89-European Terrestrial Reference System 1989 and EVRS - European Vertical Reference System) in the European countries and European-wide initiatives related to geo-referencing activities like INSPIRE;
- Organize annual symposia addressing activities carried out at national and Europe-wide levels related to the global work and objectives of EUREF.

SC 1.3b: South and Central America

Chair: Claudio Brunini (Argentina)
Vice-Chair: Laura Sánchez (Germany)

Terms of Reference

Sub-commission 1.3b (South and Central America) encompasses the activities developed by the "Geocentric Reference System for the Americas" (SIRGAS). As such, it is concerned with the definition, realization and maintenance of a modern geodetic reference infrastructure for South and Central America and the Caribbean. This includes a geometric reference frame consistent with ITRS/ITRF and a gravity field-related vertical reference system, defined and realized globally.

Objectives

The main purposes of the Sub-commission 1.3b are:

- To determine, maintain and make available a geocentric reference frame (a set of stations with high-precise geocentric positions and their variation with time, as a regional densification of the global ITRF;
- To support the SIRGAS countries in the establishment and maintenance of national geodetic reference networks as local densifications of SIRGAS in order to guarantee accessibility to the global ITRF at national and local levels;
- To establish a unified vertical reference system supporting the determination and precise combination of physical and geometric heights as well as their variations with time;
- Contribute to the GGOS program by developing and implementing state-of-the-art products based on the SIRGAS observational infrastructure;
- To promote, support, and coordinate the efforts of the Latin American and Caribbean countries to achieve these objectives.

Structure

The structure of the Sub-commission 1.3b is based on the functioning bodies of SIRGAS. There are currently three Working Groups:

- WG 1.3b.1: Reference System
  Chair: Virginia Mackern (Argentina)
- WG 1.3b.2: SIRGAS at National Level
  Chair: William Martínez (Colombia)
- WG 1.3b.3: Vertical Datum
  Chair: Roberto Luz (Brazil)

The SIRGAS Executive Committee (as it is named in the SIRGAS statutes) is composed of:

- SC 1.3b Chair: C. Brunini (Argentina)
- SC 1.3b Vice-Chair: Laura Sánchez (Germany)

- WG 1.3b.1 Chair: Virginia Mackern (Argentina)
- WG 1.3b.2 Chair: William Martínez (Colombia)
- WG 1.3b.3 Chair: Roberto Luz (Brazil)

Program of Activities

Since the SIRGAS countries are improving their national reference frames by installing an increasing number of continuously operating GNSS stations, it is necessary to outline the best strategy for the appropriate integration of those frames into the continental frame. This includes:

- Promotion of the IGS and IERS standards within the SIRGAS countries to ensure the adequate installation, maintenance, and analysis of continuously operating GNSS stations;
- Establishment of a SIRGAS National Processing Centre in all the member countries;
- Refinement of the SIRGAS station hierarchy. At present, two classes are considered: core and densification stations (the establishment of other categories is under consideration);
- Promotion of the adequate usage of SIRGAS as a reference frame by means of capacity building activities. This comprises SIRGAS schools on reference frames, scientific processing of GNSS data, atmospheric analysis based on the SIRGAS infrastructure, etc.;
- Experimental processing of the GLONASS observational data to identify a suitable analysis strategy and to evaluate if these results can be combined with the corresponding GPS products;
- Promotion and implementation of real-time services based on the SIRGAS infrastructure to make available the reference frame to more users;
- The kinematics of the SIRGAS frame, up to now, have been represented by linear station movements (i.e. constant velocities). This representation is not sufficiently precise due to existing seasonal variations in the station position time series and due to discontinuities caused by the frequent occurrence of seismic events in the SIRGAS region.

According to this, it is necessary:

- To model non-linear station movements within the reference frame computation;
- To implement a methodology aiming at a precise transformation between different epochs and, in general, between pre-seismic and post-seismic reference frame realizations in particular;
- To evaluate the feasibility of computing and using near-real time reference frames instead of those based on epoch station positions and constant velocities.

The establishment of a unified vertical reference system continues to be a big challenge of SIRGAS. The related activities concentrate on:

- Continental adjustment of the national vertical networks in terms of geo-potential numbers;
- Combined analysis of tide gauge registrations, GNSS positioning and satellite altimetry observations to determine the dynamic ocean topography at the classical vertical datums;
- Determination of potential differences between the reference tide gauges and the global reference surface;
- Stronger cooperation with the Sub-Commission 2.4b (Gravity and Geoid in South and Central America - GGSCA) to promote national initiatives regarding the modernization of the gravity reference networks and the computation of geoid models of high resolution.

Hourly SIRGAS ionospheric models (vTEC) based on the GNSS SIRGAS stations have been generated since 2006 on a regular basis. The SIRGAS ionospheric model is being upgraded to include a better distribution of the electron density based on the assimilation of ground- and space-based GNSS observations. In addition, SIRGAS is developing a service for computing water vapour estimations.

SC 1.3c: North America

Chairs: J. Griffiths (USA) and M. Craymer (Canada)

Terms of Reference

To provide international focus and cooperation for issues involving the horizontal, vertical, and three-dimensional geodetic control networks of North America, including Central America, the Caribbean and Greenland (Denmark). For more information, see www.naref.org.

Objectives

In collaboration with the IAG community, its service organisations and the national geodetic organizations of North America, the aims and objectives of this regional sub-commission are to provide international focus and cooperation for issues involving the horizontal, vertical and three dimensional geodetic control networks of North America. Some of these issues include:

- Densification of the ITRF reference frame in North America and the promotion of its use;
- Maintenance and future evolution of plate-fixed geometric reference frames for North America, including the North American Datum of 1983 (NAD83) and any possible successors;
- Maintenance and future evolution of vertical datums (ellipsoidal and orthometric), including the North American Vertical Datum of 1988 (NAVD88) and the International Great Lakes Datum (IGLD);

- Effects of crustal motion, including post-glacial rebound and tectonic motions along, e.g., the western coast of North America and in the Caribbean;
- Standards for the accuracy of geodetic positions;
- Outreach to the general public through focused symposia, articles, workshops and lectures, and technology transfer to other groups.

Working Groups

WG 1.3c.1: North American Reference Frame (NAREF)

Chairs: Michael Craymer (Canada) & Jake Griffiths (USA)

Program of Activities

To densify the ITRF reference frame in the North American region by organizing the computation of weekly coordinate solutions and their associated precision information for continuously operating GPS stations that are not part of the current IGS global network.

- A cumulative solution of coordinates and velocities will also be determined on a weekly basis;
- The working group will organize, collect, analyse and combine solutions from individual agencies, and archive and disseminate the weekly and cumulative solutions.

WG1.3c.2: Plate-Fixed North American Reference Frame

Chair: J. Griffiths (USA)

Program of Activities

To establish a high-accuracy, geocentric reference frame, including velocity models, procedures and transformations, tied to the stable part of the North American tectonic plate which would replace NAD83 and serve the broad scientific and geomatics communities by providing a consistent, mm-accuracy, stable reference with which scientific and geomatics results (e.g., positioning in tectonically active areas) can be produced and compared.

WG1.3c.3: Reference Frame Transformations in North America

Chair: M. Craymer (Canada)

Program of Activities

To determine consistent relationships between international, regional and national reference frames/datums in North America, to maintain (update) these relationships as needed and to provide tools for implementing these relationships.

SC 1.3d: Africa

Chair: R. Wonnacott (South Africa)

Terms of Reference

Sub-commission 1.3d (Africa) is concerned with the definition and realization of a unified continental reference frame (AFREF) for Africa, which will be consistent and homogeneous with the global International Terrestrial Reference Frame (ITRF).

Objectives

In collaboration with the IAG community and its services organisations and the National and Regional Mapping Organisations of Africa, the aims and objectives of Sub-commission 1.3d (Africa) are:

- To define the continental reference system of Africa. The goal is to establish and maintain a unified geodetic reference network as the fundamental basis for the national 3-d reference networks fully consistent and homogeneous with the global reference frame of the ITRF;
- To realize a unified vertical datum and support efforts to establish a precise African geoid, in concert with the African Geoid project activities;
- To establish continuous, permanent GPS stations such that each nation or each user has free access to, and is at most 500km from, such stations;
- To provide a sustainable development environment for technology transfer, so that these activities will enhance the national networks, and numerous applications, with readily available technology;
- To understand the necessary geodetic requirements of participating national and international agencies and;
- To assist in establishing in-country expertise for implementation, operations, processing and analyses of modern geodetic techniques, primarily GPS.

Program of Activities

It is envisaged that the regionalization of AFREF will follow an approach that consists of three major phases:

- The establishment of a framework of permanent or semi-permanent GPS base stations throughout the region that will become part of the worldwide IGS stations network;
- The densification of the network of permanent or semi-permanent base stations, largely on a country-by-country basis, to determine the relationship between the national geodetic system and the ITRS, and to refine the transformation parameters necessary to relate the national systems to a common ITRF;
- The third and equally important phase of the project will be to address the development of a more refined geoid

model for Africa and the definition of a common vertical datum for the continent. This will be done in collaboration with the IAG Africa Geoid Project (Project 2.3 Commission 2).

It is further planned to hold workshops and seminars to strengthen the science and knowledge of geodesy and GNSS within Africa and their application to the development of reference frames.

SC 1.3e: Asia-Pacific

Chair: John Dawson (Australia)

Terms of Reference

To improve regional cooperation that supports the realisation and densification of the International Terrestrial Reference frame (ITRF). This activity will be carried out in close collaboration with the Geodetic Technologies and Applications Working Group of the Permanent Committee for GIS Infrastructure in Asia and the Pacific (PCGIAP), which operates under the purview of the United Nations Regional Cartographic Conference for Asia and the Pacific (UNRCC-AP).

Objectives

The objectives of the Sub-commission1.3e are:

- The densification of the ITRF and promotion of its use in the Asia Pacific region;
- To encourage the sharing of GNSS data from Continuously Operating Reference Stations (CORS) in the region;
- To develop a better understanding of crustal motion in the region;
- To promote the collocation of different measurement techniques, such as GPS, VLBI, SLR, DORIS and tide gauges, and the maintenance of precise local geodetic ties at these sites; and
- To outreach to developing countries through symposia, workshops, training courses, and technology transfer activities.

Program of Activities

The activities of this sub-commission will principally be those of the Asia-Pacific Reference Frame (APREF), see http://www.ga.gov.au/earth-monitoring/geodesy/asia-pacific-reference-frame.html, together with the Geodetic Technologies and Applications Working Group of the Permanent Committee for GIS Infrastructure in Asia and the Pacific (PCGIAP).

SC 1.3f: Antarctica

Chair: R. Dietrich (Germany)

Terms of Reference

Sub-commission 1.3f (Antarctica) is focusing on the definition and realization of a unified reference frame for Antarctica, which will be consistent with the global International Terrestrial Reference Frame (ITRF). It will establish close links to corresponding activities within the Scientific Committee on Antarctic Research (SCAR).

Objectives

- Maintenance and densification of the precise geodetic reference network in Antarctica by permanent observations and GPS campaigns;
- Realization of an unified vertical datum including GPS ties of tide gauges;
- Providing unified reference for other GPS applications like airborne gravimetry, ground truthing for satellite missions, geodynamics and glaciology;
- Develop technologies for remote geodetic observatories.

Structure

The structure of SC1.3f is yet to be finalized in close collaboration with the SCAR program GIANT (Geodetic Infrastructure for Antarctica).

Program of Activities

- Organization of GPS campaigns in Antarctica, maintenance of the data archive;
- Extend activities for the operation of remote permanent GPS stations;
- Data analysis and determination of the Antarctic GPS network as a regional densification of ITRF;
- Support airborne surveys and satellite missions with precise terrestrial reference;
- Provide homogeneous site velocities for e.g. glacial isostatic adjustment determination;
- Collaborate with IAG Sub-Commission 3.4 Cryospheric Deformation.

Organize meetings and workshops on Antarctic geodesy jointly with related SCAR activities in order to strengthen the international cooperation and to make optimum use of field logistics and infrastructure.

Working Groups of Sub-Commission 1.3

WG 1.3.1: Integration of Dense Velocity Fields into the ITRF

Chair: Carine Bruyninx (Belgium)

The main task of this WG is to study and promote consistent specifications for the generation of GNSS-based velocity field solutions and their combination in order to derive a unified dense velocity field in a common global reference frame.

Members

- Carine Bruyninx (Belgium)
- John Dawson (Australia)
- Ambrus Kenyeres (Netherlands)
- Jake Griffiths (USA)
- Mike Craymer (Canada)
- Laura Sanchez (Germany)
- Alvaro Santamaria Gomez (Spain)
- Juliette Legrand (Belgium)
- Zuheir Altamimi (France)

WG1.3.2: Deformation Models for Reference Frames

Chair: Richard Stanaway (Australia)

The primary aim of the WG is to develop tectonic deformation models that will enable transformation of locations within a defined reference frame between different epochs. Such deformation models are essential to support precise point positioning applications and CORS/NRTK operations within deforming zones.

Members

- R. Stanaway (Australia)
- Christopher Pearson (New Zealand)
- Paul Denys (New Zealand)
- Kevin Kelly (USA)
- Rui Fernandes (Portugal)
- Craig Roberts (Craig Roberts)
- Graeme Blick (New Zealand)
- Chris Crook (New Zealand)
- John Dawson (Australia)
- Mikael Lilje (Sweden)
- Laura Sanchez (Germany)
- Rob McCaffrey (USA)
- Norman Teferle (Luxembourg)

SC 1.4: Interaction of Celestial and Terrestrial Reference Frames

Chair: Johannes Böhm (Austria)

Terms of Reference

In recent years, significant progress has been made in astronomical and geophysical modelling for the analysis of space geodetic observations. Thus, there is the need to investigate the impact of those models on the terrestrial and celestial reference frames (TRF and CRF), and on the consistency between the TRF, CRF, and the Earth orientation (EOP) parameters. Special attention needs to be paid to Very Long Baseline Interferometry (VLBI) observations, since it is the only technique to provide consistent sets of TRF/EOP/CRF. However, the present realization of the ITRF (ITRF2008) is based on a combination of VLBI, GNSS, SLR, and DORIS observations, whereas the present realization of the ICRF (ICRF2) is determined from a single VLBI solution. Consequently, research has to be carried out to integrate the ITRF and ICRF solutions, and also new options like VLBI observations to satellites should be considered for future improvement of the consistency. The GAIA mission scheduled for launch in 2013 is expected to achieve an optical realization of the CRF with precision similar to or better than the ICRF2 and with at least an order of magnitude more objects. As the set of extragalactic objects suitable for both optical and radio observation is limited, such objects will have to be identified, and investigations have to be carried out to permit the best possible connection between the radio and optical CRF realizations.

Working Groups of Sub-Commission 1.4

WG 1.4.1: Geophysical and Astronomical Effects and the Consistent Determination of Celestial and Terrestrial Reference Frames

Chair: Zinovy Malkin (Russia)

WG 1.4.1 is created to promote and coordinate investigations of the impact of geophysical and astronomical modelling on the terrestrial and celestial reference frames (TRF and CRF) and the consistency between CRF, TRF, and Earth orientation parameters (EOP), the latter serving as the transformation parameters between TRF and CRF. The primary attention will be given to Very Long Baseline Interferometry (VLBI) as the only technique nowadays that can provide highly consistent global solutions for TRF, CRF, and EOP.

Objectives

- Encourage and develop cooperation and collaboration in theoretical studies, simulations, and processing of real data aimed at a better understanding of the impact of geophysical and astronomical modelling on TRF, CRF, and EOP derived from VLBI observations.
- Advance means of comparing models as well as TRF, CRF, and EOP realizations.
- Compare different theoretical models and their realizations used by VLBI analysis centres. Study the propagation of differences in those models to differences in geodetic and astrometric products.
- Develop practical recommendations for VLBI analysis centres and the IERS Conventions Centre on the optimal models to be used during processing of VLBI observations.

Members

- Z. Malkin (Russia)
- J. Böhm (Austria)
- S. Lambert (France)
- C. Ma (USA)
- R. Haas (Sweden)
- H. Spicakova (Austria)
- R. Heinkelmann (Germany)
- D. MacMillan (USA)

WG 1.4.2: Co-location on Earth and in Space for the Determination of the Celestial Reference Frame

Chair: Sebastien Lambert (France)

VLBI is the only technique sensitive to the "quasi inertial" celestial reference frame, and the most recent realization of the International Celestial Reference System, the ICRF2, was determined in a VLBI-only solution. The other space geodetic techniques (GNSS, DORIS, SLR) define a dynamical celestial reference frame, but all techniques are combined to determine the International Terrestrial Reference Frame (ITRF) without adding the estimation of sources to that combination, thus causing inconsistencies between the ICRF and the ITRF.

The goal of WG 1.4.2 is to investigate the impact on the ICRF when combining VLBI observations with those from satellite techniques. Historically, this combination is based on local tie information at the co-location sites, but in the future troposphere ties and even space ties could also be used, i.e., observing the GNSS constellation or a dedicated micro-satellite like GRASP with VLBI, so that a fully consistent system is created.

Objectives

- Support the realization of a full combination of the VLBI/ GNSS/DORIS/SLR at the normal equation level including estimates of radio source coordinates. This should be done in close cooperation with the IERS Working Group on the Combination at the Observation Level;
- Investigate various analysis options (local and troposphere ties, twin telescopes) on the results (TRF, EOP, CRF);
- Analyze VLBI observations to GNSS satellites.
- Simulate the effect of VLBI observations to GNSS and SLR satellites and assess the impact on the CRF;
- Simulate future micro satellite missions like GRASP in VLBI analysis software packages;
- Simulate the benefits of the upcoming VLBI2010 equipment to propose recommendations for the near future.

Members:

- S. Lambert (France)
- Z. Malkin (Russia)
- C. Ma (USA)
- J. Böhm (Austria)
- R. Haas (Sweden)
- R. Heinkelmann (Geodesy)
- Y. Kwak (Korea)
- Le Poncin-Lafitte
- L. Plank (Austria)
- M. Seitz (Germany)
- V. Tornatore (Italy)

WG 1.4.3: Realization of Celestial Reference Frames

Chair: Chopo Ma (U.S.A.)

To achieve further progress regarding the realization of celestial reference frames it is essential to review the current status, to identify deficiencies and to make proposals for improvements. This task is closely related to various components of the IERS and the techniques analysis coordinators (in particular of the IVS), and requires a close cooperation between the different groups. The activities include the survey of the current status of CRF realization, a review regarding the implementation of IERS Conventions and IAG Fundamental Parameters and different space techniques for CRF realization.

The International Celestial Reference Frame (ICRF2) realized by VLBI is currently defined by the radio positions of 295 extragalactic objects (IERS TN 35, Fey,

Gordon and Jacobs, eds., 2009). The ICRF2 was endorsed by the IAU in 2009 and by the IUGG in 2011. The noise floor is ~40 μas and the uncertainty of the axes is ~10 μas. Precise positions of 3414 extragalactic radio sources are included in the ICRF2 catalogue.

The GAIA (Global Astrometry Interferometer for Astrophysics) mission scheduled for launch in 2013 is expected to achieve an optical realization of the CRF with precision similar to or better than the ICRF2 and with at least an order of magnitude more objects. However, as the set of extragalactic objects suitable for both optical and radio observation is limited, one goal of the Working Group is to identify such objects, oversee the relevant observations, and analyze the data to permit the best possible connection between the radio and optical CRF realizations.

For geodetic use the CRF realization must be accessible from the ground. For the foreseeable future this connection will be through VLBI observations. In cooperation with the IVS and IERS, this Working Group will oversee the maintenance and improvement of the ICRF2, in particular the set of sources used for geodetic observations and the ICRF2 defining sources.

Joint Working Groups of Commission 1

JWG 1.1: Tie vectors and local ties to support integration of techniques

(Joint with IERS)

Chair: Peirguido Sarti (Italy)

Terms of Reference

Tie vectors are crucial elements of the combination of space geodetic solutions. Their accuracy straightforwardly refers to their capability of expressing the relative position of the co-located space geodetic instruments to conventional reference points. They enter the combination of space geodetic solutions as additional observations and can be eventually regarded as the fifth technique involved in the combination. Their role is not strictly limited to the provision of the necessary information for the combination since accurate tie vectors can also highlight the presence of technique- and site-specific biases. In particular, tie vectors can support the investigation of technique-dependent systematic errors and the ability of each technique to connect electronic and conventional reference points.

The whole process related to the planning of on-field operations and the surveying carried out with either terrestrial or GPS methods (i.e. the local tie procedure) needs to be constantly revised and when necessary improved. The definition of new local tie approaches remains central to the activity promoted by the working group. As a group of experts, the working group aims at promoting discussions and serving as a forum for the evaluation of existing as well as new procedures. Equally important, the working group aims at improving the existing analysis strategies applied to the local tie observations and to the data post-processing. The ultimate scope is to achieve the utmost level of accuracy of the tie vector. The consistency between tie vectors and space geodetic solutions is recognized as a crucial aspect on which the improvement of the International Terrestrial Reference Frame depends.

An important by-product of the combination of space geodetic solutions is represented by the post-fit residuals. They are empirically determined during the combination process and express the discrepancies between space geodetic solutions and tie vectors. Particularly, the values of the post-fit residuals of the combination can serve as preliminary indicators of the quality of the space geodetic solution and/or tie information at one specific site. As such, they can highlight the necessity to investigate further the co-location and the techniques involved in the tie. This specific use of post-fit residuals is extremely interesting and promising although their handling requires much attention. Many factors may combine to the final post-fit residual value. The accuracy of the tie vectors has to be certain to effectively use the co-location post-fit residuals for inferring something about site dependent or technique

dependent systematic errors. This clearly highlights the need to attempt a revision of the quality of the existing tie vectors and possibly verify their formal accuracy not only empirically, on the base of the post-fit residuals themselves, but on the base of other factors such as their age and their length.

The working group should serve as a reference for the know-how and the good practice on co-location issues for the geodetic community. It should be ready to support new survey activities, assisting and advising remotely, and it should promote re-surveying if necessary. The link with the relevant branches of GGOS has to be ensured during the terms of the working group activity. Finally, the link between the working group and the single IAG technique services is considered essential and a permanent flow of relevant information must be constantly pursued.

Objectives

- Research objectives:
  - Revise existing local tie procedures
  - Investigate existing tie vector estimation processes
  - Develop and define new methods
  - Direct research towards the investigation of technique specific systematic effects
- Coordination objectives:
  - Liaise with IERS combination centres
  - Liaise with IAG technique service
- Outreach:
  - Support local tie operations and tie vector estimation
  - Spread the know-how
  - Set guidelines

Members

- Claudio Abbondanza (USA)
- Zuheir Altamimi (France)
- Giuseppe Bianco (Italy)
- Xavier Collilieux (France)
- John Dawson (Australia)
- Bruno Garayt (France)
- Maria Hennes (Germany)
- Ulla Kallio (Finland)
- Jim Long (USA)
- Chuck Meertens (USA)
- Valerie Michel (France)
- Axel Nothnagel (Germany)
- Mike Pearlman (USA)
- Jean-Claude Poyard (France)
- Pierguido Sarti (Italy)
- Jerome Saunier (France)
- Ralf Schmid (Germany)
- Manuela Seitz (Germany)
- Luca Vittuari (Italy)
- Pascal Willis (USA)

JWG 1.2: Modelling environmental loading effects for reference frame realizations

(Joint with IERS)

Chair: Xavier Collilieux

Terms of Reference

The accuracy and precision of current space geodetic techniques are such that displacements due to non-tidal surface mass loading are measurable. Many scientific studies have already considered atmospheric loading corrections at the observation level. The modelling of other non-tidal loading effects has also been investigated by various authors. In parallel, a posteriori corrections have been shown to slightly decrease the variance factor of a Terrestrial Reference Frame (TRF) multi-technique combination but the improvement at some sites was also counterbalanced by degradation at others.

There still exist open questions regarding the application of loading corrections for the generation of operational geodetic products, either a priori or a posteriori: accuracy of the models in all frequency bands - sub-daily band is the most important for a priori corrections -, too few studies regarding available loading model agreement have been carried out, proper mass conservation of all contributions and degree 0 of each contribution, methods that should be use for interpolating the loading displacements, required model resolution, reference loads that are or should be used for geodetic products, contribution of ice melting at high latitude which is not modelled in current continental water loading models. The optimal usage of loading models is still to be defined in all possible applications.

The goal of this working group is to ensure that the optimal usage of a loading model is made for TRF computation.

Objectives

The principle objectives of the scientific work are to investigate if loading corrections are necessary for TRF adjustment and if necessary, investigate the optimal methods to deal with loading effects in the ITRF construction.

- Determine how best to apply loading corrections: observation level or daily averages?
- If corrections are applied at the observation level, how can the displacement signal be reapplied to the station displacement time series?
- Address whether all geodetic techniques see the same level of loading contributions. In particular, some studies have shown that GPS seems to have larger annual and semi-annual signals than other geodetic methods and calculations from geophysical fluid loading.

Specific program activities

- Compare and assess differences between existing load models for a given effect.
- Maintain a bibliography on the available models and their evaluation.
- Assessment of the propagation of loading model errors into the site coordinates and the ITRF.
- Define whether models should be applied at the observation level or in the post-processing. In this case, define the best method (if any) to handle loading effects at the observation level (filtering?, interpolation etc...).
- Tie results/findings to IERS conventions.
- Collect user opinions about what signals they need in station position time series (loading corrected or not).

Members

- Zuheir Altamimi(France)
- Johannes Böhm (Austria)
- Jean-Paul Boy (France)
- Tom Herring (USA)
- Laurent Metivier (France)
- Gerard Petit (France)
- Jim Ray (USA)
- Paul Tregoning (Australia)
- Tonie van Dam (Luxembourg)
- Christopher Watson (Australia)
- Xiaoping Wu (USA)

JWG 1.3: Understanding the relationship of terrestrial reference frames for GIA and sea-level studies

(Joint with Commission 3)

Chair: Tilo Schöne (Germany)

Terms of Reference

The combination and assimilation of GNSS information into Glacial Isostatic Adjustment (GIA) models, the correction of GIA effects on altimetry or tide gauges, or combined studies using information from the different sources requires a common understanding of the individual reference frame realizations.

Today the ITRF realization and their respective updates form the basis for the individual space geodetic techniques. But, in every researcher's daily life, individual realizations are used. For example, the IGS time series are in a respective IGS frame close to ITRF, or satellite orbits for radar altimetry are using DORIS-augmented frames. GIA models employ their own ITRF-independent reference.

Many studies now use information or combinations of the above techniques with the different reference frame realizations. This leads to inconsistencies and misinterpretations. This project is proposed to evaluate the different reference frame realizations. The focus will be on the reference frame realizations in GNSS, DORIS, radar altimetry, and GIA modelling.

Objectives

- To provide a reference document for GNSS, DORIS, and radar altimetry satellite missions that indentifies discrepancies in the reference frames.
- To suggest implementation/combination schemes, where possible.

Program of Activities

- Review the individual radar altimetry and satellite missions with the following goals:
  - Evaluate the type of reference frames;
  - Evaluate the handling of loading tides and conventions used;
  - Evaluate time-variable gravity field effects in orbit determination;
  - Possibly extend results to the use of geocentre motion for sea level studies.
- Review the GNSS reference frame realizations
  - Review ITRF2008/IGS08 realization (IGS repro, TIGA)
  - Evaluate handling of loading tides, and other conventions
- Review the DORIS reference frame realization
  - Review in view of the realizations used in RA processing for satellites carrying DORIS;
  - Evaluate the handling of loading tides and conventions used.
- Review the reference frame realization in GIA models.

Members

- Matt King (United Kingdom)
- Pascal Willis (France)
- Sergei Rudenko (Germany)
- Daniela Thaller (Germany)
- Christopher Watson (Australia)
- Xiaoping Wu (USA)
- Xavier Collilieux (France)
- Tonie van Dam (Luxembourg)
- Mirko Scheinert (Germany)
- Mark Tamisea (United Kingdom)
- Erik Ivins (USA)
- Maik Thomas (Germany)
- Cecep Subarya (Indonesia)

JWG 1.4: Strategies for epoch reference frames
(Joint with IERS)

Chair: Manuela Seitz (Germany)

Terms of Reference

The International Terrestrial Reference Frame (ITRF) is based on a mathematical model, which describes the station movement as a piece-wise linear function of time. This motion is mainly driven by lithosphere plate motion and crustal deformations, which are assumed to be linear and constant over long time periods. Thus, the ITRF provides a very high long-term stability. Even if the linear component dominates the station motion, most of the station positions show additional non-linear effects. The most important causing reasons are atmospheric and hydrospheric mass load changes, which lead to seasonal and long-period position variations, and seismic events causing co-seismic abrupt and post-seismic exponentially decreasing movements of the stations. The approximation of non-linear seismic station motions within the ITRF is performed by estimating offsets and piece-wise constant velocities. Loading effects are not considered as they are very difficult to model or parameterize. One possible solution to overcome this problem would be to compute time series of epoch reference frames, which would provide the station positions at consecutive epochs. The mentioned types of non-linear station motion would be captured very well by such time series of epoch reference frames. A second advantage of epoch reference frame would be that a new solution could be available with a short time delay after a seismic event, when updated coordinates are requested.

Today, GPS-based weekly reference frames are a standard product of the IGS and serve as a near real-time reference frame. The datum of these frames is realized by an alignment to ITRF, which depends on the set of stations used for the alignment - due to station non-linear motions – and which does not account for a motion of the centre of figure w. r. t. the centre of mass. Epoch reference frames based on the combination of the four different techniques contributing to the ITRF would provide geocentric frames consistent to the ITRF.

The national reference frames consist of station positions at a certain epoch or are fixed to a moving plate and do often not consider regional station motions. Station positions resulting from today's measurements are derived in the actual ITRF or epoch reference frames and need to be transformed to the officially defined national reference frames. Especially, in the case of seismic active areas, the network geometry changes significantly over time and cannot be well represented by the current ITRF with linear station motions. Strategies must be developed, which allow for a transformation with a minimal reduction of accuracy.

Objectives

The primary objective of the Working Group is to develop strategies for the computation of epoch reference frames, by combining the space geodetic techniques VLBI, SLR, GNSS and DORIS on the normal equation level and to assess their potentials in accuracy, stability and global availability to provide recommendations to the IERS.

The development of computation strategies for epoch reference frames will comprise the following main topics: (i) evaluation of the individual contribution of techniques to an epoch reference frame, (ii) analysis of the technique and combined solutions w. r. t. a suitable temporal resolution of the reference frame, (iii) development of strategies for the weighting of the techniques and the implementation of the terrestrial difference vectors (local ties) for epoch reference frame computations, (iv) study of the datum realization for combined epoch solutions, and (v) finally, the accuracy and stability of the reference frame series will be assessed and recommendations to the IERS will be prepared.

The application of epoch reference frames, in particular on regional level, are a further important aspect, which will be kept in mid. But the full consideration of this topic would be beyond the scope of the actual WG and might be the topic of a subsequent WG.

Planned Activities

- Analysis of the need for an epoch reference frame for practical and scientific applications;
- Development of strategies for the computation of epoch reference frames;
- Analysis of possible frequencies of epoch TRF (weekly, monthly, quarterly, …);
- Set-up of a webpage for dissemination of information and presentation and communication of research results;
- Organization of conference sessions / workshops;
- Contribution to international meetings and conferences;
- Common publications of WG members.

Members

- Thomas Artz (Germany)
- Juan Baez (Chile)
- Mathis Bloßfeld (Germany)
- Xavier Collilieux (France)
- Hermann Drewes (Germany)
- Guido Gonzales (Mexico)
- Erricos Pavlis (USA)
- Takeshi Sagiya (Japan)
- Laura Sanchez (Germany)
- Manuela Seitz (Germany)
- Hana Spicakova (Austria)
- Peter Steigenberger (Germany)
- Daniela Thaller (Switzerland)

Commission 2 – Gravity Field

http://www.iag-commission2.ch

President: **U. Marti** (Switzerland)
Vice President: **S. Bettadpur** (USA)

Terms of Reference

The accurate determination of the gravity field and its temporal variations is one of the Three Fundamental Pillars of modern geodesy (besides of Geometry and Earth rotation). This is essential for applications in positioning and navigation, metrology, geophysics, geodynamics, oceanography, hydrology, cryospheric sciences and other disciplines related to the Earth's climate and environment. IAG Commission 2 was established at the IUGG in Sapporo in summer 2003 for promoting, supporting, and stimulating the advancement of knowledge, technology, and international cooperation in the geodetic domain associated with Earth's gravity field. In the last two periods from 2003 until 2011, Commission 2 has achieved its primary goals and is ready for the next 4-year period. Since most of the scientific themes are of long-term interest, the structure of Commission 2 essentially continues on the same basis as the last period.

Commission 2, at the start of the new period, consists of six sub-commissions (SCs), one Project (P) plus several study groups (SGs) and working groups (WGs), all of them jointly with another Commission or a service (JP, JSG, JWG). The sub-commissions cover the following scientific topics:

- terrestrial, airborne, ship borne gravimetry and relative/absolute gravity networks;
- spatial and temporal gravity field and geoid modelling;
- dedicated satellite gravity missions;
- regional geoid determination;
- satellite altimetry (established in 2007)
- gravity and mass displacements (established in 2011)

The former Commission 2 projects for the continental geoid determination (CP2.1 to CP2.6) have been transferred into new regional Sub-Commissions (in analogy to Commission 1) in order to give them a more permanent status inside the IAG. Their principal goal is to improve the collaboration and the data exchange (gravity, GPS/levelling, digital terrain data) inside a certain region and to aim to a geoid model with a higher resolution than satellite only models.

Commission 2 has strong links to other commissions, GGOS, IGFS, ICCT and other components of IAG. Connections to these components are created through joint working groups (JWGs) and joint study groups (JSGs) that provide a cross-disciplinary stimulus for work in several topics of interest to the commission.

The main tasks of Commission 2 in the next four years are among others:

- Analysis of GOCE data and the release of improved global Gravity field models (satellite only models and in combination with terrestrial data and altimetry)
- Promoting GRACE follow-on missions for assuring the continued monitoring of global gravity and mass flux changes
- Defining and Realizing a new Gravimetric Reference System (IGRS) to replace the outdated IGSN71 and assuring the future of the comparison campaigns of absolute gravimeters
- Establishing of a service for easy accessing Satellite Altimetry data (IAS)
- Transferring the former 'Global Geodynamics Project' (GGP) into a service 'Global Geodynamics) inside the IGFS.
- Assisting the IGFS and its components in improving their visibility and their services
- Assisting GGOS in the realization of a World Height System (WHS)
- Improve the knowledge of the interaction between gravity change and mass transport (Gravity and Mass Displacement)
- Assisting the regional sub-commissions in establishing contacts and in acquiring data.

The necessary WGs and SGs can be established at any time and they can be dissolved when they reached their goals or if they are not active.

Objectives

The main objectives of Commission 2 are as listed in the IAG by-laws:

- Terrestrial, marine and airborne gravimetry
- Satellite gravity field observations
- Gravity field modelling
- Time-variable gravity field
- Geoid determination
- Satellite orbit modelling and determination
- Satellite altimetry for gravity field modelling

Structure

Sub-Commissions

SC 2.1: Gravimetry and Gravity Networks
Chair: Leonid F. Vitushkin (Russia)

SC 2.2: Spatial and Temporal Gravity Field and Geoid Modelling
Chair: Yan Ming Wang (USA)

SC 2.3: Dedicated Satellite Gravity Missions
Chair: Roland Pail (Germany)

SC 2.4: Regional Geoid Determination
Chair: Hussein Abd-Elmotaal (Egypt)
SC 2.4a: Gravity and Geoid in Europe
Chair: Heiner Denker (Germany)
SC 2.4b: Gravity and Geoid in South America
Chair: Maria Cristina Pacino (Argentina)
SC 2.4c: Gravity and Geoid in North and Central America
Chair: David Avalos (Mexico)
SC 2.4d: Gravity and Geoid in Africa
Chair: Hussein Abd-Elmotaal (Egypt)
SC 2.4e: Gravity and Geoid in the Asia-Pacific
Chair: Will Featherstone (Australia)
SC 2.4f: Gravity and Geoid in Antarctica
Chair: Mirko Scheinert (Germany)

SC 2.5: Satellite Altimetry
Chair: Xiaoli Deng (Australia)

SC 2.6: Gravity and Mass Displacements
Chair: Shuanggen Jin (China)

Joint Projects

JP 2.1: Joint Project 2.1 on Geodetic Planetology (JP-GP)
(joint with Commissions 1, 2 and 3, and ICCT)
Chairs: O. Baur (Austria) and S. Han (USA)

Joint Study Groups

JSG 0.1: Applications of time series analysis in geodesy
(joint with ICCT and all Commissions, see ICCT)
Chair: W. Kosek (Poland)

JSG 0.2: Gravity field modelling in support of height system realization
(joint with ICCT, and Comm. 1, see ICCT)
Chair: P. Novak (Czech Republic)

JSG 0.3: Comparison of current methodologies in regional gravity field modelling
(joint with ICCT and Commission 3, see ICCT)
Chairs: M. Schmidt and Ch. Gerlach (Germany)

JSG 0.4: Coordinate systems in numerical weather models
(joint with ICCT and all Commissions, see ICCT)
Chair: Th. Hobiger (Japan)

JSG 0.5: Multi-sensor combination for the separation of integral geodetic signals
(joint with ICCT and Commission 3, see ICCT)
Chair: F. Seitz (Germany)

JSG 0.6: Applicability of current GRACE solution strategies to the next generation of inter-satellite range observations
(joint with ICCT, see ICCT)
Chairs: M. Weigelt (Germany), A. Jäggi (Switzerland)

JSG 0.7: Computational methods for high-resolution gravity field modelling and nonlinear diffusion filtering
(joint with ICCT and Commission 3, see ICCT)
Chairs: R. Čunderlík, K. Mikula (Slovakia)

JSG 0.8: Earth system interaction from space geodesy
(joint with ICCT and all Comm., see ICCT)
Chair: S.G. Jin (China)

JSG 3.1: Gravity and height change intercomparison
(joint with Commissions 1, 3, and IGFS, description see Commission 3)
Chair: S. Rosat (France)

Joint Working Groups

JWG 2.1: Techniques and metrology in absolute gravimetry
(joint with IGFS)
Chair: V. Palinkas (Czech Republic)

JWG 2.2: Absolute gravimetry and absolute gravity reference system
(joint with IGFS)
Chair: H. Wilmes (Germany)

JWG 2.3: Assessment of GOCE geopotential models
(joint with IGFS)
Chair: J. Huang (Canada)

JWG 2.4: Multiple geodetic observations and interpretation over Tibet, Xinjiang and Siberia (TibXS)
(joint with Commission 3)
Chair: Ch. Hwang (Taiwan)

JWG 2.5: Physics and dynamics of the Earth's interior from gravimetry
(joint with Commission 3)
Chair: I. Panet (France)

JWG 2.6: Ice melting and ocean circulation from gravimetry
(joint with Commission 3)
Chair: J. Schröter (Germany)

JWG 2.7: Land hydrology from gravimetry
(joint with Commission 3)
Chair: A. Eicker (Germany)

JWG 2.8: Modelling and inversion of gravity - solid Earth coupling
(joint with Commission 3)
Chair: C. Braitenberg (Italy)

JWG 0.1.1: Vertical datum standardization
(joint with GGOS, IGFS and Commission 1, description see GGOS)
Chair: L. Sánchez (Germany)

Program of Activities

The Gravity Field Commission fosters and encourages research in the areas of its sub-entities by facilitating the exchange of information and organizing Symposia, either independently or at major conferences in geodesy. The activities of its sub-entities, as described below, constitute the activities of the Commission, which will be coordinated by the Commission and summarized in annual reports to the IAG Bureau.

The principal symposium that will be organized by Commission 2 and the IGFS in the next period will be held in Venice in October 2012. A second symposium will be organized by the IGFS in 2014. The other two symposia where a Commission 2 meeting will be held are the IAG scientific assembly 2013 in Potsdam and the IUGG General Assembly 2015 in Prague.

The status of Commission 2, including its structure and membership, as well as links to the internet sites of its sub-entities and parent and sister organizations and services, will be updated regularly and can be viewed on the web site: http://www.iag-commission2.ch.

Steering Committee

- President: Urs Marti (Switzerland)
- Vice President: Srinivas Bettadpur (USA)
- Chair SC 2.1: Leonid F. Vitushkin (Russia)
- Chair SC 2.2: Yan Ming Wang (USA)
- Chair SC 2.3: Roland Pail (Germany)
- Chair SC 2.4: Hussein Abd-Elmotaal (Egypt)
- Chair SC 2.5: Xiaoli Deng (Australia)
- Chair SC 2.6: Shuanggen Jin (China)
- Chair JP 2.1: Oliver Baur (Austria)
- Representative of the IGFS: Rene Forsberg (Denmark)
- Member at large: Maria Cristina Pacino (Argentina)
- Member at large: Yoichi Fukuda (Japan, past president)

The steering committee will meet at least once per year. These meetings are open for all interested IAG members.

Sub-Commissions

SC 2.1: Gravimetry and Gravity Networks

Chair: Leonid F. Vitushkin (Russia)

Terms of Reference and Objectives

IAG Sub-commission 2.1 "Gravimetry and gravity networks" promotes scientific studies of the methods and instruments for terrestrial, airborne, shipboard and planetary gravity measurements, establishment of gravity networks and improvement of strategy in the measurement of gravity networks provided by growing number of absolute gravity determinations and the sites for such determinations. The Sub-commission provides the geodesy-geophysics community with the means to access the confidence in gravity measurements at the well-defined level of accuracy through organizing, in cooperation with metrology community, Consultative Committee on Mass and Related Quantities and its Working Group on Gravimetry (CCM WGG), Regional Metrology Organizations (RMO) the international comparisons of absolute gravimeters on continental scale. The Sub-commission proceeds from such point-wise gravimetry to precise gravimetry/ gradiometry which should cover, in particular, the land-sea border areas to resolve still existing problem of significant biases and errors in determination. The Sub-commission promotes such research and development by stimulating airborne and shipboard gravimetry and gradiometry. It encourages and promotes special absolute/relative gravity campaigns, techniques and procedures for the adjustment of the results of gravity surveys on a regional scale.

The Sub-commission supports the development of the International Gravity Reference System (IGRS) for GGOS technically and through organization of comparisons of absolute gravimeters at the sites of IGRS in cooperation with relevant metrological bodies.

The Sub-commission in collaboration with metrology community promotes the implementation of the system of metrological support (calibration, verification, comparisons) of absolute gravimeters belonging to geodesy-geophysics community.

In collaboration with JWG 2.2 "Absolute Gravimetry and Absolute Gravity Reference System" the Sub-commission works on the standardization of absolute gravity data, software for absolute gravity measurement and appropriate information. The Sub-commission will encourage regional meetings or workshops dedicated to specific problems, where appropriate.

To meet these goals, the SC 2.1 sets up the Joint Working Group JWG 2.1: "Techniques and Metrology in Absolute Gravimetry" and appointed the Steering Committee consisted of the members which are the specialists in the fields of gravimetry related to the activities of SC2.1 and the contact persons for European, East Asia and Western Pacific, South America and North America Gravity Networks)

Program of Activities

- selection in collaboration with Commission 2 – IGFS JWG 2.2 and CCM WGG of the sites for regional comparisons of absolute gravimeters, as the basis for IGRS
- supporting the CCM and RMO Key Comparisons of absolute gravimeters on four-yearly and two year scale, correspondingly
- providing the results of comparisons of absolute gravimeters to data base AGrav at BKG-BGI
- supporting the scientific investigations of absolute and relative (including the superconducting) gravimeters on static and moving platforms
- organization of the Third IAG Commission 2 Symposium "Terrestrial Gravimetry. Static and mobile measurements – TGSMM-2013"

Steering Committee

- Chair: Leonid Vitushkin (Russia)
- Vice Chair: Hideo Hanada (Japan)
- Matthias Becker (Germany, Relative Gravimetry and European Gravity Networks)
- Herbert Wilmes (Germany, Absolute Gravimetry Data and Absolute Gravity Reference System)
- Vojtech Palinkas (Czech Republic, Techniques, Metrology and Comparisons of Absolute Gravimeters)
- David Crossley (USA, Superconductive Gravimetry)
- Uwe Meyer (Germany, Aerogravimetry and Gradiometry)
- Dag Solheim (Norway, Shipboard Gravimetry)
- Yoichi Fukuda (Japan, East Asia and Western Pacific Gravity Networks)
- Maria Cristina Pacino (Argentina, South America Gravity Networks)
- Mark Eckl (USA, North America Gravity Networks)

SC 2.2: Spatial and Temporal Gravity Field and Geoid Modelling

Chair: Yan Ming Wang (USA)

Terms of Reference

Sub-Commission 2.2 (SC2.2) promotes and supports scientific research on modelling the Earth's gravity field, including determination of the geoid which is partially inside the Earth's topography.

In today's satellite age, satellite gravity missions deliver very accurate long to medium wavelength of the gravity field, and the Global Positing System provides positions with cm or better accuracy anywhere on planet Earth. On the other hand, gravity and other related data have been collected and monitored by using airplanes, moving vehicles, relative/absolute gravity projects and networks, and other means. The SC2.2 aims at bringing together scientists concerned with all aspects of the diverse areas of geodetically relevant theory and its applications. Its goal is to advance theories and computational methods to ensure that the static and time varying gravity fields are modelled with the required accuracy.

Objectives

Research related to gravity field determination, e.g., studies of the geodetic boundary value problem (free and fixed boundary value problems); development and refinement of gravity/topographic reduction theories; exploration and implementation of numerical methods of partial differential equations for Earth's gravity field determination (e.g., domain decomposition, spectral combination and others).

In more details, this includes:

- Studies of the effect of topographic density variations on the Earth's gravity field, including the geoid.
- Rigorous yet efficient calculation of the topographic effects, refinement of the topographic and gravity reductions.
- Studies on harmonic downward continuations.
- Non-linear effects of the geodetic boundary value problems on geoid determination.
- Optimal combination of global gravity models with local gravity data.
- Exploration of numerical methods in solving the geodetic boundary value problem (domain decomposition, finite elements, and others).
- Studies on data requirements, data quality, distribution and sampling rate, for a cm- accurate geoid.
- Studies on the interdisciplinary approach for marine geoid determination, e.g., research on realization of a global geoid consistent with the global mean sea surface observed by satellite altimetry.
- Studies on airborne, shipborne gravimetry and the application of satellite altimetry in geodesy.
- Studies on W_0 determination, and on global and regional vertical datum realization.
- Studies on ocean, solid-Earth and polar tides.
- Studies on time variation of the gravity field due to post-glacial rebound and land subsidence.
- Studies on geocentre movement and time variation of J_n and its impact on the geoid.

Program of Activities

- Organizing meetings and conferences.
- Inviting the establishment of Special Study Groups on relevant topics.
- Reporting activities of SC2.2 to the Commission 2.

SC 2.3: Dedicated Satellite Gravity Missions

Chair: Roland Pail (Germany)

Terms of Reference

Sub-commission 2.3 promotes scientific investigations concerning the dedicated satellite gravity field missions CHAMP, GRACE and GOCE, the development of alternative methods and new approaches for global gravity field processing also including complementary gravity field data types, as well as interfacing to user communities and relevant organizations.

Objectives

The successful launches of the German CHAMP (2000), the US/German GRACE (2002) and the ESA GOCE (2009) missions have led to a revolution in global gravity field mapping by space-borne observation techniques. Due to the fact that they are the only measurement system which can directly observe mass and mass transport in the Earth system, they provide valuable contributions to many geoscientific fields of application, such as geodesy, hydrology, oceanography, glaciology, and solid Earth physics. These missions have proven new concepts and technologies, such as high-low satellite-to-satellite tracking (SST) using the GPS constellation, low-low SST based on microwave ranging, and satellite gravity gradiometry (SGG), as well as space-borne accelerometry. GRACE has produced consistent long- to medium-wavelength global gravity field models and its temporal changes. GOCE provides high-accuracy and high-resolution static gravity field models. In combination with complementary gravity field information from terrestrial data, satellite altimetry, an even higher spatial resolution can be achieved. Additionally, based on challenging user requirements, concepts of future gravity field missions are developed and investigated.

Program of Activities

The focus of this sub-commission will be to promote and stimulate the following activities:

- generation of static and temporal global gravity field models based on observations by the satellite gravity missions CHAMP, GRACE, and GOCE, as well as optimum combination with complementary data types (SLR, terrestrial and air-borne data, satellite altimetry, etc.).
- investigation of alternative methods and new approaches for global gravity field modelling, with special emphasis on functional and stochastic models and optimum data combination.
- identification, investigation and definition of enabling technologies for future gravity field missions: observation types, technology, formation flights, etc.
- communication/interfacing with gravity field model user communities (climatology, oceanography/altimetry, glaciology, solid Earth physics, geodesy, ...).
- communication/interfacing with other IAG organizations, especially the GGOS Working Group for Satellite Missions and the GGOS Bureau for Standards and Conventions

Steering committee

- Chair: Roland Pail (Germany)
- Srinivas Bettadpur (USA)
- Sean Bruinsma (France)
- Frank Flechtner (Germany)
- Thomas Gruber (Germany)
- Gerhard Heinzel (Germany)
- Cheinway Hwang (Taiwan)
- Torsten Mayer-Gürr (Austria)
- Federica Migliaccio (Italy)
- Ulrich Meyer (Switzerland)
- Pieter Visser (the Netherlands)

SC 2.4: Regional Geoid Determination

Chair: Hussein Abd-Elmotaal (Egypt)

Terms of Reference and Objectives

Sub-Commission 2.4 is concerned with the following areas of investigation:

- Regional gravity and geoid sub-commissions: data sets, involved institutions, comparison of methods and results, data exchange, comparison with global models, connection of regional models
- Gravimetric geoid modelling techniques and methods, available software, new alternative geoid determination techniques
- GPS/levelling geoid determination: methods, comparisons, treating and interpretation of residuals, common treatment of gravity and GPS/levelling for geoid determination
- Geoid applications: GPS heights, sea surface topography, integration of geoid models in GPS receivers, vertical datums.
- Other topics: topographic effects, downward and upward continuation of terrestrial, airborne, satellite data specifically as applied to geoid modelling.

Program of Activities

Sub-Commission 2.4 is going to initiate and coordinate regional gravity and geoid sub-commissions. It will encourage and support the data exchange between agencies and will assist local, regional and national authorities in their projects of gravity field determination. It will help in organizing courses and symposia for gravity field determination.

Steering Committee

- Chair: Hussein Abd-Elmotaal (Egypt)
- Chair SC2.4a: Heiner Denker (Germany)
- Chair SC2.4b: Maria Cristina Pacino (Argentina)
- Chair SC2.4c: David Avalos (Mexico)
- Chair SC2.4d: Hussein Abd-Elmotaal (Egypt)
- Chair SC2.4e: Will Featherstone (Australia)
- Chair SC2.4f: Mirko Scheinert (Germany)

SC 2.4a: European Gravity and Geoid

Chair: Heiner Denker (Germany)

Terms of Reference

The primary objective of the sub-commission is the development of improved regional gravity field models (especially geoid/quasigeoid) for Europe which can be used for applications in geodesy, oceanography, geophysics and engineering, e.g., height determination with GNSS techniques, vertical datum definition and unification, dynamic ocean topography estimation, geophysical modelling, and navigation.

The modelling will be based mainly on terrestrial gravity and terrain data in combination with the latest available global geopotential models. In this context, the upgrade of the terrestrial data sets as well as the inclusion of the CHAMP and GRACE based global geopotential models lead to significant improvements. The evaluation of the present European Gravimetric Geoid 2008 (EGG2008) by GNSS and levelling data indicates an accuracy potential of 1 – 3 cm on a national basis, and 2 – 5 cm at continental scales, provided that high quality and resolution input data are available within the area of interest. Further improvements are expected from the utilization of the GOCE based geopotential models as well as from further upgrades of the terrestrial data base.

Structure

The regional sub-commission for Europe SC2.4a has national delegates from most of the countries in Europe and reports to sub-commission 2.4. The existing contacts and successful cooperation with the respective delegates and national and international agencies shall be continued and extended.

Program of Activities

- Utilization of new geopotential models based on the GOCE mission.
- Identification and acquisition of new terrestrial data sets including gravity, terrain, and GPS/levelling data.
- Merging and validation of all data sets.
- Refinement of the mathematical modelling and numerical tests.
- Investigation of different data combination approaches.
- Computation of new geoid and quasigeoid models.
- Evaluation of the results by GNSS/levelling data.
- Study of applications, such as vertical datum definition and unification, dynamic ocean topography estimation, etc.

SC 2.4b: Gravity and Geoid in South America

Chair: Maria Cristina Pacino (Argentina)
Co-Chair: Denizar Blitzkow (Brazil)

Terms of Reference and Objectives

The Sub Commission 2.4b entitled Gravity and Geoid in South America, as part of the Commission 2 of IAG, was established as an attempt to coordinate efforts to establish a new Absolute Gravity Network in South America, to carry out gravity densification surveys, to derive a geoid model for the continent as a height reference and to support local organizations in the computation of detailed geoid models in different countries.

Besides, a strong effort is being carried out in several countries in order to improve the distribution of gravity information, to organize the gravity measurements in the continent and to validate the available gravity measurements.

The main objectives of the project are:

- To re-measure existent absolute gravity stations and to encourage the establishment of new stations.
- To validate fundamental gravity network from different countries in order to establish a single and common gravity network for South America.
- To adjust national gravity networks and to link them together.
- To obtain and to maintain files with data necessary for the geoid computation like gravity anomalies, digital terrain models, geopotential models and satellite observations (GPS) on the levelling network of different countries.
- To provide a link between the different countries and the IGFS in order to assure access to proper software and geopotential models for local geoid computation.
- To compute a global geoid model for South and Central America using the available data. To encourage countries to cooperate by releasing data for this purpose.
- To encourage and eventually support local organizations in different countries endeavouring to increase the gravity data coverage, to improve the existing digital terrain models, to carry out GPS observations on the levelling network and to compute a high resolution geoid.
- To organize and/or encourage the organization of workshops, symposia or seminars on gravity and geoid determination in South America.
- To test and to use future geopotential models derived from the modern missions (GRACE and GOCE) as well as any new combined model (e.g. EGM2008).
- To support the IAG Sub-Commission 1.3b (Reference Frame for South and Central America, SIRGAS) in the activities related to the unification of the existing vertical datums.
- Establish close connections with SC2.4c (Gravity and Geoid in North and Central America) to have a good overlap of data coverage in Central America and the Caribbean.

SC 2.4c: Gravity and Geoid in North and Central America

Chair: David Avalos (Mexico)

Terms of Reference and Objectives

The primary objective of this Sub-commission is the development of a regional gravity field and geoid model covering the region of North America and Central America in order to achieve a common vertical datum. The region involved will encompass Iceland, Greenland, Canada, the U.S.A. (including Alaska and Hawaii), Mexico, countries forming Central America, the Caribbean Sea and the northern parts of South America.

The intention is to ensure that a suitable North American Geoid is developed to serve as a common datum for everyone in the region. All countries in the region would be served by having access to a common model for translating oceanographic effects to terrestrial datums for various scientific, commercial, engineering and disaster preparedness applications. Likewise, it shall serve as the basis for a forthcoming International Great Lakes Datum model in 2015 (IGLD 15).

The achievement of a geoid model for North and Central America will be accomplished by coordinating activities among agencies and universities with interest in geoid theory, gravity, gravity collection, gravity field change, geophysical modelling, digital elevation models (DEM), digital density models (DDM), altimetry, dynamic ocean topography, levelling and vertical datums. Of particular interest will be relating geoid and ocean topography models to ocean topography and tidal bench marks, taking advantage of the recent satellite altimetry and geopotential field products.

The determination of a geoid model for North and Central America is not limited to a single agency, which will collect all necessary data from all countries. The Sub-commission encourages theoretical diversity in the determination of a geoid model among the agencies. Each agency takes responsibility or works in collaboration with neighbouring countries in the development of a geoid model for their respective country with an overlap (as large as possible) over adjacent countries. Each solution will be

compared, the discrepancies will be analyzed, and the conclusions will be used to improve on the next model.

Program of Activities

The Sub-commission will support geoid activities in countries where geoid expertise is limited by encouraging more advanced members to contribute their own expertise and software. The Sub-commission will encourage training and education initiative of its delegates (e.g., IGeS geoid school, graduate studies and IPGH technical cooperation projects). Starting on 2011 the Sub-commission will organize regular meetings with representatives of Central American and Caribbean countries to promote an increase of expertise as well as to create a wide network of specialists.

The chair of the Sub-commission will meet with the equivalent European and South American projects to discuss overlap regions and to work towards agreements to exchange data. Finally, the members of the Sub-commission will keep close contact with all related Study Groups of the IAG. The Sub-commission is open to all geodetic agencies and universities across North and Central America with an interest in the development of a geoid model for the region. The meetings of the Sub-commission 2.4c are open to everyone with interests in geodesy, geophysics, oceanography and other related topics.

The delegates will communicate primarily using e-mail. However, the sub-commission plans to arrange annual meetings. Preferably, these meetings will be held during international conferences where most delegates will be present; however, some meetings will be held within the region to minimize travel costs. Minutes of meetings will be prepared and sent to all delegates of the Sub-commission.

Delegates

- Chair: David Avalos (Mexico)
- Rene Forsberg (Denmark)
- Marc Véronneau (Canada)
- Dan Roman (USA)
- Laramie Potts (USA)
- Vinicio Robles (Guatemala)
- Carlos E. Figueroa (El Salvador)
- Anthony Watts (Cayman Islands)
- Oscar Meza (Honduras)
- Alvaro Alvarez (Costa Rica)
- Wilmer Medrano (Nicaragua)
- Christopher Ballesteros (Panama)

SC2.4d: Gravity and Geoid in Africa

Chair: Hussein Abd-Elmotaal (Egypt)

Terms of Reference

The African Gravity and Geoid regional sub-commission (AGG) belongs to the Commission 2 of the International Association of Geodesy (IAG). The main goal of the African Gravity and Geoid regional sub-commission is to determine the most complete and precise geoid model for Africa that can be obtained from the available data sets. Secondary goals are to foster cooperation between African geodesists and to provide high-level training in geoid computation to African geodesists.

Objectives and Activities

The objectives and activities of the regional sub-commission are summarized as follows:

- Identifying and acquiring data sets - gravity anomalies, DTMs, GPS/levelling.
- Training of African geodesists in geoid computation.
- Merging and validating gravity data sets, producing homogenous gravity anomalies data set ready for geoid computation.
- Computing African geoid**.**
- Evaluating the computed geoid using GPS/levelling data.

Steering Committee

- Chair: Hussein Abd-Elmotaal (Egypt)
- Charles Merry (South Africa)
- Ahmed Abdalla (Sudan)
- Benahmed Daho (Algeria)
- J.B.K. Kiema (Kenya)
- Joseph Awange (Kenya)
- Ludwig Combrinck (South Africa)
- Prosper Ulotu (Tanzania)

Delegates

- Addisu Hunegnaw (Ethiopia)
- Adekugbe Joseph (Nigeria)
- Albert Mhlanga (Swaziland)
- Francis Aduol (Kenya)
- Francis Podmore (Zimbabwe)
- Godfrey Habana (Botswana)
- Hassan Fashir (Sudan)
- Ismail Ateya Lukandu (Kenya)
- Jose Almeirim (Mozambique)
- Karim Owolabi (Namibia)

- Peter Nsombo (Zambia)
- Saburi John (Tanzania)
- Solofo Rakotondraompiana (Madagascar)
- Tsegaye Denboba (Ethiopia)

SC 2.4e: Gravity and Geoid in the Asia-Pacific

Chair: Will Featherstone (Australia)

Context

Depending on one's definition of the Asia-Pacific (AP) region, this SC could cover as many as 48 counties. Moreover, these countries are very diverse in terms of language, political persuasions, governments and wealth. This poses a significant challenge for the exchange of gravity and geoid data and expertise.

Not only unique to the AP region, the management and administration of gravity and the geoid can be vastly different in each country, making the coordination of such a group challenging. Taking Australia as an easy example, the gravity database is administered by a different government division to the administration of the national quasigeoid model.

Terms of Reference and Objectives

Promote the cooperation in and knowledge of gravity, geoid and closely related studies in the Asia-Pacific region. The executive committee should be small to ensure efficiency, but the larger committee should comprise one member from each participating country. Because of the need to carry national authority, the national member is logically the officer in the country's geodetic authority responsible for its quasi/geoid and/or vertical datum matters.

Because of the synergy that exists between the objectives of this SC and those of the Geodesy Working Group of the UN Permanent Committee for GIS Infrastructure for Asia and the Pacific (PCGIAP), it is logical to liaise with this working group.

Program of Activities

Liaise with the Geodesy Working Group of the PCGIAP and other nations in the Asia-Pacific region, initially through the production of a flier that outlines the benefits of cooperation and data sharing.

Audit, document and catalogue the gravity and geoid-related that exists – including airborne campaigns. It is also important to establish a protocol for sharing the data. National authorities may be reluctant to give all the data available and at the precision available. It should be possible for geoid evaluation purposes, however, to decrease the resolution and accuracy of data shared along common borders without either comprising the precision of the geoid significantly, or the security of the national data shared.

Topics of interest

a) Gravity and Related Data

Explore ways in which we may
- share available gravity data (e.g. via International Gravity Bureau)
- share available DEMs along common borders (National Geodetic Authorities)
- combine resources for terrestrial gravity surveys along common borders
- combine resources for airborne gravity surveys in the region.

b) Quasi/geoid Control

Explore ways in which countries of the region may cooperate by
- sharing geometric (GNSS/levelling and vertical deflections) geoid control data
- combining efforts in global GNSS campaigns
- undertaking joint campaign for the connection of regional vertical datums.

c) Education & Research

Encourage and sponsor, for the region,
- meetings and workshops, in cooperation with the International Geoid Service, to foster understanding in the evaluation and use of gravimetric quasi/geoids, and in their application to efficient height determination with GNSS.
- technical sessions in scientific and professional conferences
- research into matters of common concern/interest.

SC 2.4f: Gravity and Geoid in Antarctica (AntGG)

Chair: Mirko Scheinert (Germany)

Terms of Reference and Objectives

Antarctica is the region which still possesses the largest data gaps in terrestrial gravity. Especially with regard to the latest satellite gravity field mission GOCE the polar data gap in terrestrial gravity deteriorates the model solutions. Generally, also the existing Antarctic gravity data coverage is heterogeneous and exhibits inconsistencies. However, globally distributed gravity data are needed for the global high-resolution determination of the Earth's gravity field. Regionally densified Antarctic gravity data shall be used for a validation of global gravity field models and, finally, for a regional improvement of the Antarctic geoid. Nevertheless, due to the vast extension of the Antarctic continent, its hostile environment and the difficult logistic conditions it is a long-lasting task to close the Antarctic data gaps in terrestrial gravity. AntGG shall pursue this objective and shall facilitate the necessary coordination to release gridded gravity datasets for Antarctica. It plays an important role to improve the cooperation between all interested scientists of geodesy and of neighbouring disciplines, mainly geophysics.

Program of Activities

- Promoting the collection of surface and airborne gravity data in Antarctica
- Promoting new gravity surveys in Antarctica, especially airborne gravimetry
- Promoting the establishment and (re-)measurement of reference gravity stations utilizing absolute gravity meters
- Promoting the scientific exchange of latest developments in technology (esp. airborne gravimetry) and data analysis
- Evaluation of existing and new surface and airborne gravity data, validation of global gravity field models in Antarctica
- Investigation of optimum strategy for the combination of gravity data of different sources, release of gridded gravity anomaly dataset(s) for Antarctica
- Focus group for all scientists interested in Antarctic gravity and geoid, and cooperation with similar data initiatives, especially within the Scientific Committee on Antarctic Research (SCAR)

Delegates

- Chair: Mirko Scheinert (Germany)
- Don Blankenship (USA)
- Alessandro Capra (Italy)
- Detlef Damaske (Germany)
- Fausto Ferraccioli (UK)
- Christoph Förste (Germany)
- René Forsberg (Denmark)
- Larry Hothem (USA)
- Wilfried Jokat (Germany)
- Gary Johnston (Australia)
- Steve Kenyon (USA)
- German L. Leitchenkov (Russia)
- Jaakko Mäkinen (Finland)
- Yves Rogister (France)
- Kazuo Shibuya (Japan)
- Michael Studinger (USA)
- Yuande Yang (China)

Associates

- Matt Amos (New Zealand)

SC 2.5 Satellite Altimetry

Chair: Xiaoli Deng (Australia)

Terms of Reference

For long-term geodetic and climate change studies, a series of repeat-track radar altimeter satellite missions (e.g., Geosat/GFO, TOPEX/Jason-1/-2/-3, ERS-1/-2/Envisat, Cryosat-2, Altika, and Sentinel-3) have made and will continue to monitor ocean surface height globally. Missions of the CryoSat-2 InSAR/SAR altimetry and ICEsat-1/-2 laser altimetry are significantly improving observations of the cryosphere, sea-ice and ice-covered oceans. CryoSat-2 altimetry in its conventional LRM and SAR modes, will be the best chance to improve the marine gravity field by a factor of two in the near future. The future planned Surface Water and Ocean Topography (SWOT) wide-swath synthetic aperture radar interferometry (InSAR) altimetry mission is about to map high spatial resolution oceanic submesoscale variability and surface water hydrology. Another potential technology under development is the so-called GNSS-R altimetry or reflectometry. With these existing and new technological advances in altimetry, the purpose of this IAG sub-commission is to promote innovative research involving the use of historic and future altimeter observations on the studies of local, regional, and global geophysical processes, with emphasis on emerging cross-disciplinary applications using satellite altimetry, and in combination with other data sets, including *in situ* hydrography data (XBT/MBT/Argo) and GRACE/GOCE. The research results and potential data products will benefit IAG's Global Geodetic Observing System (GGOS) and the International Altimetry Service (IAS).

Objectives

General objectives of the Sub-Commission 2.5 will include:

- To establish a close link between this sub-commission and international altimeter services to bridge the gaps on new research and application data products or services not currently available, in terms of establishing scientific forums to discuss new result results, and as expert users, suggesting to altimeter services to develop more efficient procedures and new data products involving cross-disciplinary applications using satellite altimetry;
- To promote innovative applications of satellite altimetry, including evaluations and cross-disciplinary applications of future satellite altimetry;
- To continue developing techniques to improve altimeter data quality towards new data products in coastal zones including coastal ocean, estuaries, and coastal land;
- To promote cross-disciplinary research to improve the determinations of the shapes and temporal variations of land/ice/ocean surfaces, such as studies of coastal ocean variability, regional sea level change, mountain glaciers/ice-sheet ablations/accumulations, permafrost degradation, coastal and ice-shelf ocean tides, vertical displacements at major tectonic-active zone and due to other geophysical processes;
- To improve the marine geoid, mean dynamic ocean topography, temporal variations induced by solid Earth processes and global terrestrial water cycle; and
- To establish a specific connection with relevant altimetry observing systems in IAG's GGOS and IAS.

Program of Activities

This sub-commission will organize independent workshops or special sessions in major meetings to promote altimetric applications in interdisciplinary earth sciences, and to increase the visibility of IAG in altimetric science. Special study groups will be established to investigate important issues.

Steering Committee

- Chair: Xiaoli Deng (Australia)
- Vice Chair: C.K. Shum (USA)
- Ole Andersen (Demark)
- Cheinway Hwang (Taiwan)
- Walter Smith (USA)
- David Sandwell (USA)
- Per Knudsen (Demark)
- Wolfgang Bosch (Germany)

SC 2.6: Gravity and Mass Displacements

Chair: Shuanggen Jin (China)

Terms of Reference

The variation of gravity field is related to the physic processes and dynamics of the Earth's interior, Earth system coupling and in particular interactions between atmosphere, hydrosphere, cryosphere, land surface and the solid Earth. Nowadays the gravity field, derived from terrestrial and space gravimetry (e.g. CHAMP, GRACE, and GOCE…) with unprecedented accuracy and resolution, provides a unique opportunity to investigate gravity-solid earth coupling, the structure of the globe from the inner core to the Earth's crust, physics and dynamics of the Earth's interior, and mass flux such as within the ocean-land water cycle. It also contributes to a better understanding of the interactions in the Earth's interior and its response to climate change.

Objectives:

- To model and inverse gravity-solid Earth coupling, e.g. crust thickness, isostatic Moho undulation, mass loadings, basin formation, thermal effects on density, gravity tensor and gravity field related deformation as well as interactions with the Earth' interior.
- To understand the physics and dynamics of the Earth's interior using gravity and other geophysical measurement techniques.
- To quantify Earth's mass flux and their interactions and, in particular, to study gravity role in the understanding of the ocean-land-cryosphere cycle.
- To promote/communicate with gravity-related communities (Oceanography, Hydrology, Cryosphere, Solid-Earth, Geodesy...)

Program of Activities

The Sub-commission will establish Work Groups (WGs) on relevant topics, and model and inverse gravity-Earth System coupling, structure and dynamics of the Earth's interior and their interactions. A Steering Committee will work closely with members and other IAG Commissions/Sub-Commissions to obtain mutual goals. Also it will promote and jointly sponsor special sessions at IAG Symposia and other workshop/conferences.

Steering Committee

- Chair: Shuanggen Jin (China)
- Co-Chair: Jürgen Kusche (Germany)
- Carla Braitenberg (Italy)
- Annette Eicker (Germany)
- Isabelle Panet (France)
- Jens Schröter (Germany)
- Séverine Rosat (France)

Joint Projects

JP 2.1: Geodetic Planetology (JP-GP)

Chairs: Oliver Baur (Austria) and Shin-Chan Han (USA)

Terms of Reference

Precise knowledge about the thermal evolution, composition, shape and dynamics of extra-terrestrial bodies is increasingly accessible from science data collected by space-geodetic methods. With growing opportunities from the past, current and future satellite missions to the planets of the solar system and other bodies in outer space, it is timely to explore various space-geodetic theory and methodologies to enhance the scientific return of the planetary missions for improved understanding of the planets or satellites.

In the last decades, geodetic planetology has experienced considerable advance. Data collected by spacecraft orbiting the Earth's moon (e.g., Lunar Prospector, SELENE/ Kaguya, Lunar Reconnaissance Orbiter), Mars (Mars Global Surveyor, Mars Odyssey, Mars Reconnaissance Orbiter), Venus (Magellan), and Mercury (Messenger) revealed increasingly detailed structures of the gravity field, shape, surface and atmosphere of these celestial bodies. Forthcoming missions to the Earth's moon (GRAIL), Mercury (BepiColombo), Jupiter (JUNO), and the Jovian system (EJSM-Laplace) will ensure ongoing progress. The space-geodetic methods used in planetary geodesy include range and range-rate orbit tracking, VLBI, altimetry, and photogrammetric remote sensing; these observation techniques are well-known from terrestrial applications.

The main motivation to constitute a Joint Project on Geodetic Planetology (JP-GP) within the IAG is the scientific proximity of planetary geodesy to the activities of the IAG Commissions, the ICCT and the IAG services. This proximity particularly holds to Commission 1 (Reference Frames), Commission 2 (Gravity Field), Commission 3 (Earth Rotation and Geodynamics), and the ICCT. High-

accuracy determination of reference frames is the basis for the quantification of dynamic processes on and beneath a body's surface, the detection of variations in its rotational behaviour and precise orbit determination of satellites. The gravity field is a key quantity to assess information on a body's composition and interior structure; furthermore, knowledge about the gravity field allows for the tailored orbit design of artificial satellites, for instance with regard to robotic and human landing. Rotation characteristics of celestial bodies include length-of-day variations, polar motion, precession, nutation or libration. These areas of research require sophisticated physical and mathematical modelling in the framework of a concise theoretical background. In summary, promoting geodetic planetology is an inter-disciplinary effort, and hence demands for collaboration with all IAG components.

Within the 4-year horizon 2011-2015, the JP-GP will start to initiate and promote geodetic research of extra-terrestrial bodies. Furthermore, in terms of sustainable follow-on activities, the project envisages the establishment of an Inter-Commission Committee on Geodetic Planetology for the next period 2015-2019. Towards that goal, the JP-GP aims to:

- support scientific activities related to the gravity field and orbit determination, topography, physical shape (geoid), interior structure and rotation characteristics of planetary bodies, together with the establishment and maintenance of reference frames;
- encourage the cooperation between the terrestrial geodesy and planetary geodesy communities by promoting the exploitation of synergies;
- provide an international platform for the transfer of knowledge and experience on geodetic theory and data analysis including radio science, altimetry, and stereo images;
- coordinate interdisciplinary research activities.

Organization

The JP-GP is joint with the ICCT and the Commissions 1, 2, and 3, with Commission 2 being the lead commission. The activities of the JP-GP are coordinated by a Steering Committee consisting of the President, the Vice President, representatives from the Commissions 1, 2, and 3 (one representative from each commission), and a representative from the ICCT.

Objectives

The main objective of the JP-GP is to initiate and promote geodetic research of extra-terrestrial bodies. In particular, the JP-GP will

- act as a framework for geoscientific discussion and cooperation concerning the study of the planets of the solar system and other bodies in outer space;
- promote the integration of advanced space-geodetic methods for planetary purposes, including the development of tailored methodologies for data exploitation and interpretation;
- support interdisciplinary activities of the ICCT in geodetic theory and data analysis;
- help to develop future geodetic technologies and mission designs for planetary geodesy;
- explore the possibility of sustainable collaboration with the IAU/IAG Working Group on Cartographic Coordinates and Rotational Elements (WGCCRE)
- establish an Inter-Commission Committee on Geodetic Planetology for the period 2015-2019.

Output

The outputs after the 4-year time frame 2011-2015 are:

- Establishment of geodetic planetology within the IAG;
- Organization of a Workshop with interdisciplinary emphasis;
- Establishment of an Inter-Commission Committee on Geodetic Planetology for the period 2015-2019.

Steering Committee

- Chair: Oliver Baur (Austria)
- Vice Chair: Shin-Chan Han (USA)
- Commission 1 Representative: Tonie van Dam (Luxembourg)
- Commission 2 Representative: Urs Marti (Switzerland)
- Commission 3 Representative: Richard Gross (USA)
- ICCT Representative: Nico Sneeuw (Germany)

Members

- Markus Antoni (Germany)
- Brent Archinal (USA)
- Ali Ardalan (Iran)
- Georges Balmino (France)
- Veronique Dehant (Belgium)
- Shuanggen Jin (China)
- Anno Löcher (Germany)
- Jürgen Müller (Germany)
- Nico Sneeuw (Germany)
- Dimitrios Tsoulis (Greece)
- Pieter Visser (Netherlands)

Joint Working Groups of Commission 2

JWG 2.1: Techniques and Metrology in Absolute Gravimetry
(Joint with the IGFS)

Chair: Vojtech Palinkas (Czech Republic)

Terms of Reference

Absolute ballistic gravimeters have become the primary measurement standards for the determination of free-fall acceleration. Currently the only way for the realization of the gravity reference is realized by the comparisons of the absolute gravimeters, which has to be organized and accomplished in such a way that the high requirements in gravity measurements in geosciences and metrology are fulfilled. Principal tasks of the Working Group are thus closely connected with the four-yearly International Comparisons of Absolute Gravimeters (ICAGs) and relevant Regional International Comparisons of Absolute Gravimeters (RICAGs) in the frame of regional structures of metrology community Regional Metrology Organizations (RMO) at the sites selected on a continental scale.

The Working Group will participate on the organization of comparisons under close cooperation with the BIPM Working Group on Gravimetry of Consultative Committee on Mass (CCM) and Related Quantities (CCM WGG) and the IAG Joint Working Group on Absolute Gravimetry and Absolute Gravity Reference System (JWG2.2). The connection between ICAGs and RICAGs has to be established by means of reliable absolute gravimeters participating in both kinds of comparisons. An important benefit of a distributed network of Regional Comparison Sites would be that it makes an invaluable contribution to establishing a Global Gravity Reference System. The sites should be related to RMO, for example, EURAMET – European Metrology Organization, SIM – Inter-American Metrology System, APMP - Asia-Pacific Metrology Program, etc.).

The Joint Working Group aims to deal with technical and metrological aspects in absolute gravimetry and theirs realization within a system of comparisons. The increasing demand for reliability and confidence in absolute gravity measurements requires further progress in the comparisons under certain aspects: organization, measurement optimization, combination of different methods of measurements, data analysis, estimation of uncertainties or investigations of systematic effects. In keeping with the above mentioned, the technical protocol of the comparisons has to be developed according to the rules of the international Mutual Recognition Arrangement for national measurement standards and for calibration and measurement certificates issued by National Metrology Institutes.

The WG will work in a close cooperation with metrology community on the implementation of the system of calibration and verification of absolute gravimeters at relevant National Metrology Institutes and designated institutes as other possibility, besides the comparisons, to determine the metrological characteristics of absolute gravimeters.

The relevance to the Working Group is that its members are the specialists as well from geodetic and geophysical communities, as from the metrological community, and this working group focuses more to participation of individual scientists than the more official CCM WGG where the membership is related to the institutes responsible for the traceability in gravimetry. Such inter-communications within the Working Group as well as a linkage between this group and CCM WGG will make it possible to develop the ICAGs and RICAGs to be supported by both communities.

Objectives

- The participation in the organization (in collaboration with CCM WGG and JWGAG2.2) of the four-year period ICAGs and additional RICAGs at the sites selected on a continental scale.
- The elaboration of criteria and recommendations for a distributed network of Comparison Sites.
- The progress of the comparisons of absolute gravimeters in terms of optimization, measurement methods, data analysis, investigations of systematic effects and uncertainties.
- The development of the technical protocol of the comparisons.
- The collaboration with metrology community for the implementation of the system of calibration and verification of absolute gravimeters.

Members

- Chair: Vojtech Palinkas (Czech Republic)
- Henri Baumann, (Switzerland)
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- Reinhard Falk (Germany)
- James Faller (USA)
- Olivier Francis (Luxemburg)
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- Daniel Winester (USA)
- Alexander Yankovsky (Russian Federation)

JWG 2.2: Absolute Gravimetry and Absolute Gravity Reference System

(Joint with the IGFS)

Chair: Herbert Wilmes (Germany)

Terms of Reference and Objectives

IAG Sub-Commission 2.1 “Gravimetry and Gravity Networks” promotes scientific investigations of gravimetry and gravity networks and terrestrial, airborne, shipboard and planetary gravity measurements. One of the outputs of the SC 2.1 activities is the result of gravity measurements, i.e. the gravity data.

The International Gravity Field Service IGFS coordinates the servicing of the geodetic and geophysical community with gravity field related data, software and information.
The IAG’s scientific community demands more detailed information on the Earth’s gravity field and its changes, and precise terrestrial absolute gravity (AG) observations are an important contribution to monitoring and understanding mass transports e.g. by hydrological and atmospheric variations or by changes in the solid Earth’s geometry.

The role of absolute gravimetry increases with the growing number of absolute ballistic gravimeters and the rising number of AG measurements worldwide. The philosophy of gravity measurements has changed from rare AG determinations at a few principal network stations to repeated absolute gravity observations at global networks in combination with geometric geodetic observations. At selected sites, the AG observations are complemented by the high sensitivity of continuously observing superconducting (relative) gravimeters.

GGOS, the IAG Global Geodetic Observing System integrates different geodetic techniques, models and approaches to ensure a long-term, precise monitoring of the Earth's shape, the Earth's gravity field and the Earth's rotational motion. Consistent and precise absolute gravity measurements from a global network would be a valuable contribution to the GGOS infrastructure.

Up until now the Working Group of Absolute Gravimetry has been contributing to the development of the absolute gravity database AGrav which reached operational status and became a fixed part of the BGI (International Gravimetric Bureau) services. The database provides an overview of existing AG stations, observations, instruments and institutions, and facilitates the cooperation. Multidisciplinary cooperation and the combination of gravity data with other geodetic observation types is going to be essential for our future work.

The realisation of a global gravimetric reference relies upon well calibrated instruments and standards which in the case of absolute gravity determination is realized by the repeated comparison of the measuring instruments. Comparisons are carried out as four-yearly International Comparisons of Absolute Gravimeters (ICAGs) and as additional Regional International Comparisons of Absolute Gravimeters (RICAGs). Whereas these comparisons are prepared and carried out by JWG 2.1 this project at hand makes use of the comparison results and the data of the calibrated instruments. Triggered by BIPM's decision to close the comparison site at its premises, future ICAG and RICAG sites will develop to a distributed network with global distribution. Together with additional absolute gravity reference and comparison sites such a network gains the potential to build up a new International Gravity Reference System where the precise gravity reference is available and gravity field variations are monitored. This working group will contribute to this realisation and to the establishment of the necessary standards. The new International Gravity Reference System will be developed to replace the former IGSN71 (International Gravity Standardization Network 1971).

The proposed Working Group on Absolute Gravimetry will focus upon the following objectives:

- Continue the operation and improvement of the AGrav database for global absolute gravity measurements
- Provide AG metadata and data for GGOS to be used for the combination of AG measurements with geometric measurements (GNSS, SLR, VLBI) and for specific investigations
- Extend the AG database to store the comparison results from ICAG and RICAG sites
- Establish a new International Gravity Reference System based upon a distributed network of AG comparison and reference sites which can replace IGSN71
- Contribute to the agreement about the necessary standards and corrections
- Contribute to the Global Geodynamics Project GGP by the storage of repeated AG observations necessary for the determination of superconducting gravimeter drift and calibration parameters

Members

- Chair: Herbert Wilmes (Germany)
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- Martine Amalvict (France)
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- Heping Sun (China)
- V.M. Tiwari (India)

JWG 2.3: Assessment of GOCE Geopotential Models

(Joint with the IGFS)

Chair: Jianliang Huang (Canada)
Co-Chair: Christopher Kotsakis (Greece)

Terms of Reference and Objectives

The GOCE mission by European Space Agency is mapping the Earth's gravity field with the same level of accuracy as GRACE and a higher spatial resolution. GRACE and GOCE are complementary in terms of spectral sensitivity. A series of GOCE and GRACE& GOCE-based global gravity models have been released since 2010. Assessment of these models is commonly based on comparisons with other independent data that are direct and indirect observations of the Earth's gravity field. Such data include geoid heights from GPS and spirit levelled heights, airborne and surface gravity measurements, marine geoid heights from mean oceanographic sea surface topography models and altimetry observations, orbits from other geodetic and altimetry satellites etc. In response to the call of having an independent, coordinated and inclusive team for the assessment of the new GOCE models, a Joint Working Group (JWG) has been approved by IGFS and the IAG Commission 2 during IUGG 2011 in Melbourne, Australia. Its objectives are to develop new standard validation/calibration procedures, and to perform the quality assessment of GOCE-, GRACE&GOCE-based satellite-only and combined solutions for the static Earth's gravity field.

The Joint Working Group reports to IGFS and the Commission 2.

Program of Activities

- The JWG creates opportunities through communication and conferences for international cooperation to develop and propose new standard methods for evaluating global EGMs using external data. A specific research area of interest will be the issue of how to handle the different spectral content of satellite-based global gravity field models and terrestrial gravity data.
- The JWG assesses new GOCE and GRACE&GOCE models.
- The JWG organizes a special session in the next IAG Commission 2 conference in Venice, Italy, in 2012.
- The JWG publishes assessment papers in a dedicated issue of the Newton's Bulletin in 2013.

Members

- Hussein Abd-Elmotaal (Egypt)
- Jonas Ågren (Sweden)
- Ben Ahmed Daho Sid Ahmed (Algeria)
- Riccardo Barzaghi, on behalf of IGeS (Italy)
- Denizar Blitzkow (Brazil)
- Minkang Cheng (USA)
- Sten Claessens (Australia)
- Artu Ellmann (Estonia)
- Christoph Förste (Germany)
- Thomas Gruber (Germany)
- Ali Kilicoglu (Turkey)
- Jiancheng Li (China)
- Pavel Novak (Czech Republic)
- Maria Cristina Pacino (Argentina)
- Dan Roman (USA)
- Gabriel Strykowski (Denmark)
- Viliam Vatrt (Czech Republic)
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- Heiner Denker (Germany)
- Cheinway Hwang (Taiwan)
- Chris Jekeli (USA)
- Jaroslav Klokocnik (Czech Republic)
- Charles Merry (South Africa)
- Peter Morgan) (Australia)
- Nikolaos K. Pavlis (USA)
- Marcelo Santos (Canada)
- Claudia Tocho (Argentina)

JWG 2.4: Multiple geodetic observations and interpretations over Tibet, Xinjiang and Siberia (TibXS)

(Joint with Commission 3)

Chair: Cheinway Hwang (Taiwan)
Vice Chair: Wenbin Shen (China)

Terms of Reference and Objectives

Tibet, Xinjiang and Siberia (TibXS) are regions with active plate tectonics. Evidences from satellite gravimetry and altimetry show the hydrological evolutions over these regions are sensitive to global climate change. For example, inter-annual lake level changes over Tibet and Xinjiang from satellite altimetry are found to be connected to El Nino Southern Oscillation (ENSO). Lakes in central Asia originating in Xinjiang and lakes in eastern Siberia show sharp changes in lake levels that can be explained by climate change. Recent terrestrial gravity, GRACE and GPS observations suggest that the crust over the Tibetan plateau is thickening, and the Himalayan glaciers appear to be thawing. Satellite altimetry is a potential tool to study vertical displacement and permafrost thawing and changes in the active layers in Siberia and Tibet. With more satellite gravimetry and altimetry data to come, decadal changes over TibXS in many aspects can be investigated in connection to global climate change and dynamics of the crust and the upper mantle.

Under the support of IAG commission 2, two international workshops on multiple geodetic observations and interpretations have been held in Urumqi (2009; http://space.cv.nctu.edu.tw/altimetryworkshop/TibXS2009/TibXS2009.htm) and Xining (2011; http://space.cv.nctu.edu.tw/altimetryworkshop/TibXS2011/TibXS2011.htm). The results presented in these workshops have been or will be published in two special issues of the journal Terrestrial, Atmospheric and Oceanic Sciences (TAO). In response to the call to continue the geodetic studies over TibXS, this working group is established and reports to IAG Commission 2 over 2011-2015. The objective is to investigate the long-term records from different geodetic sensors to understand the geodynamic process and climate change over TibXS. This WG will report to IAG Commission 2.

Program of Activities:

- This WG will organize international workshops to investigate the results from multiple geodetic observations over TibXS.
- This WG will establish a link between the geodetic community and the geophysical community to interpret the geodetic results.
- This WG will assess satellite results from GRACE, COSMIC and its follow-on, altimetry and SAR and other remote sensing platforms over TibXS using in situ observations such as superconducting gravimeter and absolute gravimeter data, GPS data, lake gauge and glacier stake and snow pit measurements.
- This WG will publish papers dedicated to the subjects of the WG in journal special issues.

Members of the Standing Committee

- B F Chao (Taiwan)
- Kosuke Heki, (Japan)
- Jeff Freymuller, (USA)
- CK Shum (USA)
- He-Ping Sun (China)
- Qi Wang (China)

Members

- Xiaoli Deng (Australia)
- Xiao-Li Ding (Hong Kong)
- Xiaodong Song (USA)
- Wenke Sun (China)
- Nikolay Shestakov (Russia)
- VM Tiwari (India)
- Carla Braitenberg (Italy)

JWG 2.5: Physics and dynamics of the Earth's interior from gravimetry
(Joint with Commission 3)

Chair: Isabelle Panet (France)

Terms of Reference

To develop approaches for the determination of the physical properties of the Earth interior and its dynamics, from the joint use of gravity and other geophysical measurement techniques. Insights from earthquakes signals and normal modes will be considered. The objective is to better constrain the structure in the mantle and the core as well as their interactions.

Goals

The following, non-restrictive list of goals is proposed (to be discussed in the WG):

Methodological goals:
- to develop methods for extracting a geodynamic signal of interest, related to Earth mantle and/or core, from noisy data (satellite gravity data and other measurements). Some important points: separation from the geofluid variations, in the case of temporal gravity variations, separation from surface contributions, in the case of static gravity.
- to review and develop approaches for the combination of heterogeneous geophysical and gravity data at different spatial and/or temporal scales.

Application goals:
- to review the existing methods and propose approaches for the joint use of seismic and surface/satellite gravity data to infer Earth structure at various scales. The use of magnetic data will also be considered.
- to review and estimate expected amplitudes of core signals in gravity and other geophysical observations,
- to review and address the observation of Earth normal modes in gravity and other geophysical measurements,
- to address the extraction of solid Earth deformations from satellite gravity data combined with surface displacement measurements,
- to address the determination of mantle viscosity from satellite gravity combined with other measurements, from the analysis of post-seismic deformations of large earthquakes / GIA, ...

Members

- Chair: Isabelle Panet (France)
- Shuanggen Jin (China)
- Valentin Mikhailov (Russia)
- Séverine Rosat (France)
- Bert Vermeersen (The Netherlands)
- Tonie Van Dam (Luxembourg)
- Virendra Tiwari (India)
- Lei Wang (USA)
- Kosuke Heki (Japan)
- Fred Pollitz (USA)

JWG 2.6: Ice melting and ocean circulation from gravimetry
(Joint with Commission 3)

Chair: Jens Schröter (Germany)

Terms of Reference

The working group will primarily address the contribution of ice melting to the global and regional sea level. Specifically observation of the Earth's ocean- water and ice sheet variations at all spatial and temporal scales will be considered from GRACE data and other sensors, e.g., Altimetry, ICESat, InSAR and GPS. Furthermore the fate of the melt-water in the ocean, its distribution and impact on ocean circulation will be studied.

Goals

- to estimate individual mass and volume change of major ice sheets and ice caps using a synthesis of different techniques
- separate geometric change on long time scales (e.g. GIA) as well as elastic response/loading/self attraction of sea water from the estimates of volume change in land ice and ocean
- use estimates of land storage of water from JWG 2.7 to close the global water cycle and to improve removal of leakage of land signals into ocean estimates
- close the ocean's regional volume budget by observing sea level from altimetry, steric expansion of sea water from ocean measurements and ocean modelling and mass change from a combination of GRACE and other observations (e.g. GPS, tide gauges, ocean bottom pressure recorders...)
- consider the impact of increased inflow of melt-water into the ocean on ocean circulation, sea level and mass/heat transports
- and finally describe and understand trends and contributions to global and regional sea level rise

Members

- Chair: J. Schröter (Germany)
- J. Bamber (UK)
- D. Chambers (USA)
- JL. Chen (USA)
- M. Horwath (Germany)
- J. Kusche (Germany)
- SB. Luthcke (USA)
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- C.K. Shum (USA)
- D. Stammer (USA)
- CR. Wilson (USA)
- DG Vaughan (UK)
- Velicogna (USA)
- B. Wouters (The Netherlands)
- HJ. Zwally (USA)

JWG 2.7: Land hydrology from gravimetry
(Joint with commission 3)

Chair: Annette Eicker (Germany)

Terms of Reference

The working group will be dedicated to the development of new strategies and algorithms for using time-variable gravity data from GRACE and data from complimentary sensors in the understanding of the terrestrial water cycle. This includes the development of tools and products to encourage adoption of geodetic data by the hydrological community, application and validation of GRACE to investigate water storage changes and the improvement of model reliability and predictability (calibration, assimilation). This Working group was proposed by SC2.6 (Gravity and Earth System).

Goals

The following, non-restrictive list of goals is proposed (to be discussed in the WG):

- to tailor GRACE products towards the specific requirements of hydrological applications (regional solutions, spatial/temporal constraints,…)
- to review existing approaches and develop new strategies for GRACE post-processing (filtering issues, bias correction associated with the leakage problem)
- to discuss the separation of the GRACE mass signal into different storage compartments
- to compare the satellite data with model output and complementary data sets (super-conducting gravimeters, ground water observation,…)
- to review and develop strategies to compare and combine heterogeneous data sets given on different temporal and spatial scales
- to compare and develop approaches to use GRACE and alternative sensor data to calibrate hydrological modelling and to assimilate the observations into the models
- to develop strategies for innovative use of GRACE products for hydrometeorology

Members

- Annette Eicker (Germany)
- Petra Döll (Germany)
- Jean-Paul Boy (France)
- Andreas Güntner (Germany)
- Laurent Longevergne (France)
- Himanshu Save (USA)
- Benjamin Zaitchik (USA)

JWG 2.8: Modelling and Inversion of Gravity-Solid Earth Coupling
(Joint with commission 3)

Chair: Carla Braitenberg (Italy)

Terms of Reference

To model and invert gravity-solid Earth coupling, e.g. explore situations in which gravitative forces have been an important agent in the evolution of the lithosphere. The topics of interest range from the evolution of crustal thickness, isostatic Moho response, lithospheric thickness, lithospheric slab pull, lithospheric cooling, gravity field related deformation. Explore where and to what extent density variations in crust and mantle affect mass loading and geodynamics. We consider the effect of density changes in time through thermal heating and cooling, including magmatic loading, underplating and basin evolution. Methodological aspects include the development of forward and inversion algorithms in a spherical Earth, the use of the gravity tensor and the new GOCE observations. This Working Group belongs to the initiatives coordinated by Sub-Commission 2.6.

Goals

- Create a platform in which density models can be tested through geodynamic models. This needs the interaction of the geodynamic modeller with the geophysical modeller, and allows a consistency check of the density models from the point of view of observations of the potential field and of geodynamics. Vice versa the geodynamic models producing density variations are checked against consistency with density models constrained by further geophysical observations.
- Create a reference database covering the subject of gravity-solid earth coupling (mass loading, underplating, isostatic Moho, crustal thickness, lithospheric thickness, dynamic topography versus mass loading).
- Create a database on methodology of gravity forward and inversion calculations, spherical calculations
- Create a kit of software tools that have been tested and verified by the working group and that will be shared among the members of the working group. It shall cover the different aspects of the goals of the WG. If several software-programs are made available they can be benchmarked against each other.
- Set up a social networking page for the members of the working group.
- Organize a practical-theoretical school on Modelling and Inversion of Gravity-Solid Earth Coupling

Members

- Carla Braitenberg (Italy)
- Jon Kirby (Australia)
- Shuanggen Jin (China)
- Erik Ivins (USA)
- Xiapoping Wu (USA)
- Valeria Barbosa (Brazil)
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Commission 3 - Earth Rotation and Geodynamics

http://euler.jpl.nasa.gov/IAG-C3

President: **R. Gross** (USA)
Vice President: **A. Brzezinski** (Poland)

Terms of Reference

Geodynamics is the science that studies how the Earth moves and deforms in response to forces acting on the Earth, whether they derive from outside or inside of our planet. This includes the entire range of phenomena associated with Earth rotation and Earth orientation such as polar motion, length of day, precession and nutation, the observation and understanding of which are critical to the transformation between terrestrial and celestial reference frames. It includes tidal processes such as solid Earth and ocean loading tides, and crust and mantle deformation associated with tectonic motions and isostatic adjustment.

During the last few decades many geophysicists have come to use geodynamics in a more restricted sense to address processes such as plate tectonics and postglacial rebound that are dominantly endogenic in nature. Because the Earth as a mechanical system responds to both endogenic and exogenic forces, and because these responses are sometimes coupled, Commission 3 studies the entire range of physical processes associated with the motion and the deformation of the solid Earth. The purpose of Commission 3 is to promote, disseminate, and, where appropriate, to help coordinate research in this broad arena.

Sub-Commission 3.1 (Earth Tides and Geodynamics) addresses the entire range of tidal phenomena including its effect on Earth rotation. Sub-Commission 3.2 (Crustal Deformation) addresses the entire range of global and regional crustal deformation including intraplate deformation, the earthquake deformation cycle, aseismic phenomena such as episodic tremor and slip, and volcanic deformation. Sub-Commission 3.3 (Earth Rotation and Geophysical Fluids) addresses the space-time variation of atmospheric pressure, seafloor pressure and the surface loads associated with the hydrological cycle, and Earth's (mainly elastic) responses to these mass redistributions. Sub-Commission 3.4 (Cryospheric Deformation) addresses the Earth's instantaneous and delayed responses to ice mass changes, including seasonal (cyclical) mass changes and progressive changes associated with climate change. This group also studies postglacial rebound at all spatial scales and the elastic deformation taking place in the near-field of existing ice sheets and glaciers. Sub-Commission 3.5 (Tectonics and Earthquake Geodesy) addresses the integration of space and terrestrial approaches for studying the kinematics and mechanics of tectonic plate boundary zones, and in particular of the Eurasian/African/Arabian boundary zone.

Commission 3 interacts with GGOS, other Commissions and Services of the IAG as well as with other organizations such as the International Astronomical Union (IAU). For example, the recent space mission GRACE has expanded our common interests with IAG Commission 2 (Gravity Field) since temporal changes in gravity are associated with both the drivers of Earth deformation (e.g. changing ice and loads) and with Earth's response to these and other forcing.

Objectives

- To promote cooperation and collaboration on the theory, modelling and observation of Earth rotation and geodynamics.
- To ensure development of research in Earth rotation and geodynamics by organizing meetings, symposia, and sessions at conferences and general assemblies, by creating working groups on specific topics, and by encouraging the exchange of ideas and data and the comparison of methods and results with the goal of improving accuracy, content, methods, theories, and understanding of Earth rotation and geodynamics.
- To serve the geophysical community by facilitating interactions with organizations that provide the data needed to study Earth rotation and geodynamics.

Structure

Sub-Commissions

SC 3.1: Earth Tides and Geodynamics
Chair: S. Pagiatakis (Canada)

SC 3.2: Crustal Deformation
Chair: M. Poutanen (Finland)
SC 3.2a: Global Crustal Deformation
Chair: J. Freymueller (USA)
SC 3.2b: Regional Crustal Deformation
Chair: M. Hashimoto (Japan)

SC 3.3: Earth Rotation and Geophysical Fluids
Chair: M. Thomas (Germany)

SC 3.4: Cryospheric Deformation
Chair: M. King (UK)

SC 3.5: Tectonics and Earthquake Geodesy
Chair: H. Ozener (Turkey)

Joint Study Groups

JSG 0.1: Application of time series analysis in geodesy (joint with ICCT and all Commissions, description see ICCT)
Chair: W. Kosek (Poland)

JSG 0.3: Comparison of current methodologies in regional gravity field modelling (joint with ICCT and Commission 2, see ICCT)
Chairs: M. Schmidt, Ch. Gerlach (Germany)

JSG 0.4: Coordinate systems in numerical weather models (joint with ICCT and all Commissions, description see ICCT)
Chair: Th. Hobiger (Japan)

JSG 0.5: Multi-sensor combination for the separation of integrated geodetic signals (joint with ICCT and Commission 2, see ICCT)
Chair: F. Seitz (Germany)

JSG 0.7: Computational methods for high-resolution gravity field modelling and nonlinear diffusion filtering (joint with ICCT and Commission 2, description see ICCT)

JSG 0.8: Earth system interaction from space geodesy (joint with ICCT and all Commissions), description see ICCT)
Chair: S. Jin (China)

JSG 3.1: Gravity and height change intercomparison (joint with IGFS, Commissions 1 and 2)
Chair: S. Rosat (France)

Joint Working Groups

JWG 1.3: Understanding the relationship of terrestrial reference frames for GIA and sea-level studies (joint with Comm. 1, description see Comm. 1)
Chair: Tilo Schöne (Germany)

JWG 2.4: Multiple geodetic observations and interpretation over Tibet, Xinjiang and Siberia (TibXS) (joint with Comm. 2, description see Comm. 2)
Chair: Ch. Hwang (Taiwan)

JWG 2.5: Physics and dynamics of the Earth's interior from gravimetry (joint with Comm. 2, description see Comm. 2)
Chair: I. Panet (France)

JWG 2.6: Ice melting & ocean circulation from gravimetry (joint with Comm. 2, description see Comm. 2)
Chair: J. Schroeter (Germany)

JWG 2.7: Land hydrology from gravimetry (joint with Comm. 2, description see Comm. 2)
Chair: A. Eicker (Germany)

JWG 2.8: Modelling and inversion of gravity-solid Earth coupling (joint with Comm. 2, description see Comm. 2)
Chair: C.Braitenberg (Italy)

Program of Activities

Commission 3 fosters and encourages research in the areas of its sub-entities by facilitating the exchange of information and organizing Symposia, either independently or at major conferences in geodesy or geophysics. Some events will be focused narrowly on the interests of the sub-commissions and other entities listed above, and others will have a broader commission-wide focus.

Steering Committee

- President: R. Gross (USA)
- Vice President: A. Brzezinski (Poland)
- Chair SC 3.1: S. Pagiatakis (Canada)
- Chair SC 3.2: M. Poutanen (Finland)
- Chair SC 3.2a: J. Freymueller (USA)
- Chair SC 3.2b: M. Hashimoto (Japan)
- Chair SC 3.3: M. Thomas (Germany)
- Chair SC 3.4: M. King (UK)
- Chair SC 3.5: H. Ozener (Turkey)
- Chair JSG1: S. Rosat (France)
- Representatives of Services:
- IERS: Brian Luzum (USA)
- IGFS: S. Bettadpur (USA)
- Members at large: B. Chao (China - Taipei)

Sub-Commissions

SC 3.1: Earth Tides and Geodynamics

Chair: S Pagiatakis (Canada)
Co-Chair: J Bogusz (Poland)

Terms of Reference

SC 3.1 addresses the entire range of Earth tidal phenomena, both on the experimental as well as on the theoretical level.

Earth tide observations have a very long tradition. These observations led to the discovery of the Earth's elasticity which allows deformation and variations in Earth orientation and rotation parameters. The phenomena responsible for these variations include the full range of periodic and non-periodic phenomena such as Earth tides and ocean tidal loading, atmospheric dynamics as well as plate tectonics and intraplate deformation. The periods range from seismic normal modes over to the Earth tides and the Chandler Wobble and beyond. Thus, the time scales range from seconds to years and for the spatial scales from millimetres to continental dimensions.

As tidal friction is affecting Earth rotation, all the physical properties of the Earth contribute to the explanation of this phenomenon. Therefore, the research on tidal deformation due to tidal potential and ocean loading are a prerequisite to answer such questions.

Further, direct and indirect tidal phenomena affect the position of fiducial sites and have to be corrected to provide accurate spatial referencing. Such referencing is needed for the observation and monitoring of changes of the Earth's surface at global, regional and local scales. Therefore, there is a considerable contribution of tidal research to global geodynamics as well as to climate change by providing important constraints to geophysical models both, to global and local scales.

Modern gravimetry has helped improve our knowledge on the Earth's global gravity field and its temporal variations, structure and dynamics. Notably, superconducting gravimeters allow continuous monitoring of the gravity signal at selected sites with a precision of better than 10^{-10}. These geophysical observations together with other geodetic observations and geological information provide the means to better understand the structure, dynamics and evolution of the Earth system.

The Chair of SC 3.1 also chairs the Directing Board of the International Centre of Earth Tides - ICET. The Board comprises the Director of ICET, the Chair of GGP plus five additional members. The ICET Directing Board has the responsibility, among others, to monitor the operations of, and provide guidance and supervision to ICET in order to ensure fulfilment of the scientific goals and objectives of the Global Geodynamics Project and of the resolutions of the International Symposia on Earth Tides.

Objectives

Objectives of SC 3.1 include:

- To study and implement new observational techniques and improve existing ones, including clinometric and extensometric techniques;
- To advance tidal data analyses and prediction methods;
- To enhance the models on the interaction among solid Earth, ocean, and atmospheric tides;
- To research the effects of the atmosphere on gravity and other geodetic observations;
- To study the response of the Earth at tidal and non-tidal forcing frequencies;
- To study the interplay between tides and Earth rotation;
- To study tides on the planets;
- To study the effects of ocean loading and global water distribution;
- To create and coordinate working groups on specific topics of interest and relevancy to the understanding of our planet;
- To develop, coordinate and promote international conferences, programs and workshops on data acquisition, analysis and interpretation related to the research fields mentioned above;
- To contribute to the definition and realisation of the International Terrestrial Reference Frame via advanced geodynamic models at global, regional and local scales;
- To promote the systematic calibration and intercomparison of absolute and superconducting gravimeters;
- To promote interdisciplinary research in Earth and planetary tides.

The objectives of the IAG Global Geodetic Observing System (GGOS) are to a significant extent aligned with those of SC 3.1:

- The integral effect on Earth rotation of all angular momentum exchange inside the Earth, between land, ice, hydrosphere and atmosphere, and between the Earth, Sun, Moon, and planets,
- The geometric shape of the Earth's surface (solid Earth, ice and oceans), globally or regionally, and its temporal variations, whether they are horizontal or vertical, secular, periodical or sudden, and
- by adding the Earth's gravity field-stationary and time variable-mass balance, fluxes and circulation are in close relation to our objectives. Therefore, SC 3.1 also relates to 'Tidal effects in the framework of GGOS'.

Structure and Activities

SC 3.1 has a Chair and a Co-Chair. National representatives are involved in the organization of conferences as well as in the considerations concerning the award of the *Paul Melchior Medal*, formerly known as the Earth Tides Commission Medal.

Besides the organization of special sessions at international meetings, SC 3.1 will continue to organize a symposium every four years. Between these symposia, a comprehensive SC meeting together with the GGP-project will continue to be organized. SC 3.1 will continue to publish the outcome of these meetings in proceedings, either as standalone publications or as special issues of scientific journals.

SC 3.1 is linked to the Sub-Commissions 3.2 and 3.3, and the next Earth Tide Symposium will be organized as a joint meeting covering a broad range of topics.

The GGP (Global Geodynamics Project) was promoted by the SC during the previous term, and future cooperation is a main focus of SC 3.1. Other Inter-Commission Projects and Joint Study Groups can be included if possible.

SC 3.1 will also cooperate with GGOS, as mentioned above.

SC 3.2: Crustal Deformation

Chair: M Poutanen (Finland)
Co-Chair: J Freymueller (USA)
http://iagsc32.fgi.fi/

Terms of Reference

There are many geodetic signals that can be observed and are representative of the deformation mechanisms of the Earth's crust at different spatial and temporal scales. This includes the entire range of tectonic phenomena including plate tectonics, intraplate deformation, the earthquake deformation cycle, aseismic phenomena such as episodic tremor and slip, and volcanic deformation. The time scales range from seconds to years and from millimetres to continental dimension for the spatial scales.

Space geodetic measurements now provide the means to observe deformation and movements of the Earth's crust at global, regional and local scales. This is a considerable contribution to global geodynamics by supplying primary constraints for modelling the planet as a whole, but also for understanding geophysical phenomena occurring at local scales. Some phenomena are potentially hazardous, like earthquake related phenomena. On the other hand, there are many slow deformations which are not hazardous, but in long time scales may have considerable effects. These include steady tectonic deformations and postglacial rebound.

One of the key issues nowadays is the definition and stability of global and regional reference frames. Crustal deformations in all time and spatial scales as well as mass transfer will affect reference frames. Gravimetry, absolute, relative, and nowadays also spaceborne, is a powerful tool providing information to the global terrestrial gravity field and its temporal variations. Combined with GNSS observations providing geometric deformation and data from other geophysical and geological sources provide the means to understand the structure, dynamics and evolution of the Earth system.

Organizational Aspects

The Sub-Commission is divided into two Sub-Sub-Commissions, 3.2a Global Crustal Deformation and 3.2b Regional Crustal Deformation. There will be some inevitable overlap between "global" and "regional", so there are good opportunities for joint discussions and work on these topics between the two parts of the Sub-Commission. There is also a natural relationship with IAG Commission 1, as the reference frame definition must be consistent with the actual crustal deformation.

The work of the Sub-Commissions will be organized as working-group like. There will be invited a core group of people who will agree to meet regularly and try to evaluate different models or approaches for computing or evaluating these effects. Due to global distribution of participants, electronic meetings and e-mails will be an essential part of the organization. The Sub-Commission aims to organize 1-2 topical symposia during the 4-year period.

Objectives

General objectives of the Sub-Commission 3.2 will include:

- To study crustal deformation in all scales, from plate tectonics to local deformation;
- To contribute reference frame related work in order to better understand deformations, and to improve global, regional and local reference frames and their dynamical modelling;
- To study sea-level fluctuations and changes in relation to vertical tectonics along many parts of the coastlines and in relation to environmental fluctuations/changes affecting the geodetic observations;
- To promote, develop and coordinate international programs related to observations, analysis and data interpretation for the fields of investigation mentioned above;
- To organize and co-organize meetings and symposia related to the topic.

Objectives of Sub-Commission 3.2a, Global Crustal Deformation will include:

- The long-range impacts of great earthquakes and postseismic deformation on reference frame and relevant geodetic quantities.
- The limits of plate stability and what part of plates could be considered "plate interior" as opposed to "plate boundary" regions.
- Studies to distinguish between slow distributed deformation and errors in the reference frame geocenter, or other non-tectonic effects.

Objectives of Sub-Commission 3.2b, Regional Crustal Deformation will include:

- Studies of deformation during the seismic cycle including episodic slow events and postseismic transients. The strain build-up during interseismic period near the trench axes is one of the central topic in relation to the Tohoku-Oki earthquake.
- The strain partitioning in fault systems with reference to block or continuum mechanics.
- Volcanic and anthropologic deformations also belong among the topics of 3.2b, but activities will be mostly focused on two first items.

SC 3.3: Earth Rotation and Geophysical Fluids

Chair: M Thomas (Germany)
Co-Chair: J Chen (USA)

Terms of Reference

Mass transport in the atmosphere-hydrosphere-mantle-core system, or the 'global geophysical fluids', causes observable geodynamic effects on broad time scales. Although relatively small, these global geodynamic effects have been measured by space geodetic techniques to increasing, unprecedented accuracy, opening up important new avenues of research that will lead to a better understanding of global mass transport processes and of the Earth's dynamic response. Angular momenta and the related torques, gravitational field coefficients, and geocentre shifts for all geophysical fluids are the relevant quantities. They are observed using global-scale measurements and are studied theoretically as well as by applying state-of-the-art models; some of these models are already constrained by such geodetic measurements.

Objectives

The objective of the SC is to serve the scientific community by supporting research and data analysis in areas related to variations in Earth rotation, gravitational field and geocentre, caused by mass re-distribution within and mass exchange among the Earth's fluid sub-systems, i.e., the atmosphere, ocean, continental hydrosphere, cryosphere, mantle, and core along with geophysical processes associated with ocean tides and the hydrological cycle.

The SC complements and promotes the objectives of GGOS with its central theme "Global deformation and mass exchange processes in the Earth system" and the following areas of activities:

- quantification of angular momentum exchange and mass transfer;
- deformation due to mass transfer between solid Earth, atmosphere, and hydrosphere including ice.

Program of Activities

SC 3.3 follows the program of activities defined by Commission 3. In order to promote the exchange of ideas and results as well as of analysis and modelling strategies, sessions at international conferences and topical workshops will be organized. In addition, SC 3.3 interacts with the sister organizations and services, particularly with the IERS Global Geophysical Fluids Centre and its operational component with four Special Bureaus (atmosphere, hydro-

logy, ocean, combination) and its non-operational component for core, mantle, and tides. SC 3.3 will have close contacts to the GGOS activities, in particular to the activities of the newly established GGOS Working Group 'Contributions to Earth System Modelling'. Our meetings will be announced through the Commission 3 web site at http://euler.jpl.nasa. gov/IAG-C3.

Steering Committee

- D. Salstein (USA; atmosphere)
- R. Gross (USA; oceans)
- R. Ray (USA; tides)
- J. Chen (USA; hydrology), Co-Chair
- E. Ivins (USA; mantle)
- T. van Hoolst (Belgium; core)
- M. Thomas (Germany; Earth system), Chair
- M. Watkins (USA, gravity/geocentre)
- T. van Dam (Luxembourg; loading)

SC 3.4: Cryospheric Deformation

Chair: M. King (UK)
Co-Chair: Sh. Abbas Khan (Denmark)

Terms of Reference

Past and present changes in the mass balance of the Earth's glaciers and ice complexes induce present-day deformation of the solid Earth on a range of spatial scales, from the very local to global. Of principal interest is geodetic observations that validate, or may be assimilated into, models of glacial isostatic adjustment (GIA) and/or constrain models of changes in present-day ice masses through measurements of elastic rebound. Using geometric measurements alone, elastic and GIA deformations cannot be separated without additional models or observations. Reference frames of GIA models do not allow direct comparison to measurements in an International Terrestrial Reference Frame and ambiguity currently exists over the exact transformation between the two. Furthermore, there is no publicly available and easy-to-use tool for model computations of elastic effects based on observed elevation/mass changes over the spatial scales of interest (small valley glaciers to large ice streams) and including gravitational/rotational feedbacks. This SC will focus on resolving these technical issues and work on dissemination of these measurements within the glaciological community (notably IACS).

Program of Activities

- Organize a workshop to discuss separation of elastic and GIA signals in key regions of interest, including Greenland, Antarctica, Patagonia and Alaska.
- Organize a workshop with WG 2.6.3 "Glacial isostatic adjustment (GIA) Model and Effects" and SC 1.2 "Global Reference Frames" on global reference frames for validation of GIA models.
- Encourage the inter-comparison and public release of elastic computation code, and advertise its existence.
- Interact where possible with those working on alternative measurements of the same signals (gravimetric or Earth rotation).
- Organize a workshop (with IACS) on "Present-day changes in the mass balance of Earth's glaciers and ice sheets".

Steering Committee

- D. Argus (USA)
- V. Barletta (Denmark)
- R. Bennett (USA)
- M. Bevis (USA)
- P. Clarke (UK)
- I. Howat (USA)
- E. Ivins (USA)
- Sh. Abbas Khan (Denmark), Co-Chair
- M. King (UK), Chair
- L. Metevier (France)
- R. Motyka (USA)
- G. Nield (UK)
- R. Riva (The Netherlands
- M. Craymer (Canada)
- J. Davis (USA)
- R. Dietrich (Germany)
- J. Freymueller (USA)
- A. Groh (Germany)
- I. Sasgen (Germany)
- G. Sella (USA)
- G. Spada (Italy)
- P. Tregoning (Australia)
- T. van Dam (Luxembourg)
- P. Whitehouse (UK)
- P. Willis (France)
- F. Wu (USA)

SC 3.5: Tectonics and Earthquake Geodesy

Chair: H. Ozener (Turkey)

Terms of Reference

Space and terrestrial geodesy provide key observations to investigate a broad range of the Earth's natural systems. These data are collected, analyzed, and interpreted by geodesists and other scientists. Studies of crustal deformation rely on the continuous and/or repeated acquisition of geodetic measurements and their analysis in the frame of active tectonics, and on their combination with results obtained from other geological and geophysical investigations (seismology, neotectonics, gravity, rock physics, electromagnetic, ...).

The evolution of geodetic techniques in the past decade, with unprecedented achievements in the precise detection and monitoring of 3D movements at the millimetre level has opened new prospects for the study of Earth kinematics and geodynamics. However, these achievements also raise new issues that have to be properly taken into account in the processing and analysis of the data, demanding a careful inter-disciplinary approach.

Areas that involve the broad collision zone between Europe, Africa and Arabia, provide natural laboratories to study crucial and poorly understood geodynamic processes. The recent occurrence of giant earthquakes (with Mw > 9), unexpected and in subduction areas with weak geodetic monitoring provide further challenges to the scientific community. Although these active zones were systematically monitored in the last decade by different research groups using a variety of space geodesy and other methods, in general the data analysis and interpretation have been done from the perspective of one discipline and have rarely followed an integrated approach. Never completely explored, the existence of these data (geodata) justifies a new, integrated approach including different observational techniques and input from other disciplines in the Earth sciences (geology, seismology, tectonics, ...). This should lead to the development of interdisciplinary work in the integration of space and terrestrial approaches for the study of, for instance, the Eurasian/African/Arabian plate boundary deformation zone (and adjacent areas), and contribute to the establishment of a European Velocity Field. With this objective, it is important to promote stronger international cooperation between Earth scientists interested in plate boundary zones.

Towards this goal the SC aims to:

- Actively encourage the cooperation between all geoscientists studying the Eurasian/African/Arabian plate boundary deformation zone, by promoting the exploitation of synergies;

- Reinforce the study of subduction zones in Mediterranean regions and elsewhere by increasing and developing infrastructures and geodetic stations;
- Be a reference group for the integration of the most advanced geodetic and geophysical techniques by developing consistent methodologies for data reduction, analysis, integration, and interpretation;
- Act as a forum for discussion and scientific support for international geoscientists investigating the kinematics and mechanics of the Eurasian/African/Arabian plate boundary deformation zone;
- Promote the use of standard procedures for geodetic data acquisition, quality evaluation, and processing, particularly GNSS data;
- Promote earthquake geodesy and the study of seismically active regions with large earthquake potential;
- Promote the role of Geodesy in tectonic studies for understanding the seismic cycle, transient and instantaneous deformation, and creeping versus seismic slip on faults.

Objectives

The primary goals of the SC are to:

- Continue as a framework for geodetic cooperation in the study of the Eurasian/African/Arabian plate boundary zone;
- Identify and develop a "Wegener Supersite";
- Develop scientific programmes in earthquake geodesy for subduction zones (e.g., Hellenic Arc) and possible occurrence of giant earthquakes and associated tsunamis;
- Foster the use of space-borne, airborne and terrestrial hybrid techniques (high-resolution GNSS, InSAR, GOCE, GRACE, ENVISAT, SENTINELLE, LIDAR, ...) for Earth observation;
- Define effective integrated observational strategies for these techniques to reliably identify and monitor crustal movements and gravity variations over all time-scales;
- Facilitate and stimulate the integrated exploitation of data from different techniques in the analysis and interpretation of geo-processes;
- Organize periodic workshops and meetings with special emphasis on interdisciplinary research and interpretation and modelling issues;
- Reinforce cooperation with African and Arab countries and colleagues with scientific projects, that can contribute to understanding the kinematics and dynamics of the Eurasian/African/Arabian plate boundary zone and promote the growth of such research and geodetic expertise in these countries.

Program of Activities

- Build a web-portal and an associated geo-database that enables access to metadata, processed results, and when possible historical data from continuous GNSS stations and episodic geodetic campaigns, as well as other derived products such as strain rates, velocity fields, etc.;
- Promote the application of standards for GNSS network establishment, data acquisition, and guidelines for data processing and reliability checks;
- Define strategies for a full exploitation of different geodata (GNSS, gravimetry, InSAR, etc.);
- In coordination with the IGS and other relevant organizations, establish a GNSS analysis centre specially dedicated to process permanent and episodic campaign data, not analyzed by other GNSS centres, which will contribute to the development of a joint velocity field (EUROVEL) that can support kinematic and geodynamic modelling;
- Organize bi-annual conferences to serve as high-level international forums in which scientists from all over the world can look at a multi-disciplinary interpretation of geodynamics, and strengthen the collaboration between countries in the greater Mediterranean region.

Links to Services

The SC will establish links to relevant services, such as:

- EUREF;
- International Earth Rotation and Reference Systems Service (IERS);
- International GNSS Service (IGS);
- International Laser Ranging Service (ILRS);
- International VLBI Service for Geodesy and Astrometry (IVS);
- International DORIS Service (IDS);
- Regional Reference Frame Northern Africa (AFREF);
- Global Geodetic Observing System (GGOS);
- Supersites;
- UNAVCO.

Steering Committee

- H. Ozener (Turkey), Chair
- S. Zerbini (Italy)
- R. Reilinger (USA)
- M. Meghraoui (France)
- B. Ambrosius (The Netherlands)
- L. Bastos (Portugal)
- M. Becker (Germany)
- C. Bruyninx (Belgium)
- A. Caporali (Italy)
- L. Combrink (South Africa)
- J. M. Davila (Spain)
- T. Mourabit (Morocco)
- J. M. Nocquet (France)
- W. Spakman (The Netherlands)
- S. Stein (USA)
- S. Tatevian (Russia)
- T. van Dam (Luxembourg)
- S. Kahlouche (Algeria)
- S. M. Mahmoud (Egypt)
- A. ArRajehi (Saudi Arabia)

Joint Study Groups

JSG 3.1 Gravity and Height Change Intercomparison

(joint with Commissions 1 and 2)

Chair: S. Rosat (France)
http://www.srosat.com/iag-jsg/

This Study Group is joint between the International Gravity Field Service (IGFS), Commission 1 on Reference Frames, Commission 2 on Gravity Field, and Commission 3 on Earth Rotation and Geodynamics. The activities of this new JSG will be concerned with the comparison of ground and space gravity measurements with geometric measurements of surface deformation.

The motivation of this JSG is to study surface deformation by comparing site displacement observations with both ground- and space-based gravity measurements. Issues that will arise when comparing site displacement with gravity measurements are differences in spatial and temporal scales and differences in sensitivity.

Terms of Reference

Surface deformations are continuously recorded from space or from the ground with increasing accuracy. Vertical displacements and time-varying gravity are representative of various deformation mechanisms of the Earth occurring at different spatial and temporal scales. We can quote for instance post-glacial rebound, tidal deformation, hydrologic loading, co-seismic deformation and volcanic deformation. The time scales involved range from seconds to years and the space scales range from millimetres to continental dimension. Large-scale deformation are well monitored by space geodetic measurements from monthly spatially-averaged GRACE measurements while local deformation are precisely monitored by daily GNSS or VLBI solution and sub-daily gravimeter data at a site. The intercomparison of the space- and ground-gravity measurements with vertical surface displacements enable to infer more information on the structure, dynamics and evolution of the Earth system. In particular, we will focus on the transfer function of the Earth at various time scales related to the elastic and visco-elastic properties of the Earth.

The activities of this JSG will interact with the SC 1.2 on Global Reference Frames and with GGP (Global Geodynamics Project), reporting to the IGFS, Commission 1 (Reference Frames), Commission 2 (Gravity Field), and Commission 3 (Earth Rotation and Geodynamics).

Objectives

The objectives of this JSG are:

- Love numbers determination (*h, k, l*) using co-located gravity and displacement measurements;
- Study of the gravity-to-height ratio *dg/du* at various time and length scales in order to discriminate vertical motion from mass transfer;
- Development of standardized procedures and tools to convert surface gravity points of measure into space-comparable gravity field (e.g. EOF);
- Tidal deformation analysis at long periods in displacements (from VLBI and GNSS) and in gravity (from superconducting gravimeters);
- Applications to co-seismic deformation, volcanic deformation, hydrological loading, ice-melting unloading.

Program of Activities

This JSG will propose a session at the 17th Earth Tides Symposium in Cairo, Egypt, 24-28 September 2012.

A session will be also proposed at the next IAG Scientific Assembly in 2013 and at the next IUGG General Assembly in 2015.

Members

- Chair: S. Rosat (France)
- J. A. Sampedro (Spain)
- O. Francis (Luxembourg)
- Y. Fukuda (Japan)
- R. Haas (Sweden)
- S. Lambert (France)
- L. Metivier (France)
- Y. Rogister (France)
- H. Steffen (Canada)
- P. Tregoning (Australia)
- P. Valty (France)

Corresponding Members

- C. Kroner (Germany)
- S. Zerbini (Italy)

Commission 4 – Positioning and Applications

http://www2.ceegs.ohio-state.edu/IAG-Comm4/

President: **D. Grejner-Brzezinska** (USA)
Vice President: **A. Kealy** (Australia)

Terms of Reference

To promote research that leverages current and emerging positioning techniques and technologies to deliver practical and theoretical solutions for engineering and mapping applications. Commission 4 will carry out its work in close cooperation with the IAG Services and other IAG entities, as well as via linkages with relevant entities within scientific and professional sister organizations.

Recognizing the central role of Global Navigation Satellite Systems (GNSS) in providing high accuracy positioning information today and into the future, Commission 4 will focus on developing tools that enhance and assure the positioning performance of GNSS-based positioning solutions for a range of geodetic applications.

The Sub-Commissions will develop theory, strategies and tools for modelling and/or mitigating the effects of interference, signal loss and atmospheric effects as they apply to precise GNSS positioning technology. They will address the technical and institutional issues necessary for developing backups for GNSS, integrated positioning solutions, automated processing capabilities and quality control measures.

Commission 4 will also deal with geodetic remote sensing, using Synthetic Aperture Radar (SAR), Light Detection And Ranging (LiDAR) and Satellite Altimetry (SA) systems for geodetic applications.

Structure

Sub-Commissions

SC 4.1: Alternatives and Backups to GNSS
Chair: G. Retscher (Austria)

SC 4.2: Geodesy in Geospatial Mapping and Engineering
Chair: J. Wang (Australia)

SC 4.3: Remote Sensing and Modelling of the Atmosphere
Chair: M. Santos (Canada)

SC 4.4: Applications of Satellite and Airborne Imaging Systems
Chair: Z. Li (UK)

SC 4.5: High-Precision GNSS Algorithms and Applications
Chair: Y. Gao (Canada)

SC 4.6: GNSS-Reflectometry and Applications
Chair: S. Jin (China)

Joint Study Groups

JSG 0.1: Application of time series analysis in geodesy
(joint with ICCT and all Commissions, see ICCT)
Chair: W. Kosek (Poland)

JSG 0.4: Coordinate systems in numerical weather models
(joint with ICCT and all Commissions, see ICCT)
Chair: Th. Hobiger (Japan)

JSG 0.8: Earth system interaction from space geodesy
(joint with ICCT and all Commissions, see ICCT)
Chair: S. Jin (China)

Joint Working Group

JWG 0.2.1: New technologies for disaster monitoring and management
(joint with GGOS, description see GGOS)
Chair: I.D. Doukas (Greece)

Steering Committee

- President: D. Grejner-Brzezinska (USA)
- Vice President: A. Kealy (Australia)
- Chair SC 4.1: G. Retscher (Austria)
- Chair SC 4.2: J. Wang (Australia)
- Chair SC 4.3: M. Santos (Canada)
- Chair SC 4.4: Z. Li (UK)
- Chair SC 4.5: Y. Gao (Canada)
- Chair SC 4.6: S. Jin (China)
- Representatives of Services:
  IGS: A. Krankowski (Poland)
- Members at large: P. Wielgosz (Poland)

Representatives of external bodies

ISPRS: Ch. Toth (USA)
FIG: G. Roberts (UK)
ION: L. Hothem (USA)

Sub-Commissions

SC 4.1: Alternatives and Backups to GNSS

Chair: G. Retscher (Austria)
Vice-Chair: V. Gikas (Greece)
Secretary: L. Bonenberg (UK)

Terms of Reference

To coordinate research and other activities that address broader areas of alternatives and backups to GNSS positioning using multi-sensor system theory and applications, with a special emphasis on integrated guidance, navigation, positioning and orientation of airborne and land-based platforms. The primary sensors of interest will be inertial navigation systems; however the important role of other emerging techniques used for indoor and pedestrian navigation environmental monitoring is also recognized. The Sub-commission will carry out its work in close cooperation with other IAG Entities, as well as via linkages with relevant scientific and professional organizations, such as ISPRS, FIG, IEEE and ION.

Objectives

- To follow the technical advances in navigation sensors and algorithms, including autonomous vehicle navigation, based on
  - positioning sensors and techniques such as pseudolites, INS, including MEMS IMU, wheel sensors, ultrasonic and magnetic sensors, and
  - positioning methods based on cellular networks and their hybrid use with GNSS.
- To investigate positioning sensors and techniques integrated in modern smart phones and other mobile devices.
- To follow the technical advances in vision-based sensors, such as CCD cameras in smart phones for indoor positioning and navigation.
- To standardize definitions and measurements of sensor related parameters.
- To study and report on the performance of stand alone and integrated navigation systems.
- To report on the development, possibilities and limitations of new emerging technologies.
- To stimulate new ideas and innovation in
  - navigation algorithms, sensor calibration, synchronization and inter-calibration,
  - real-time sensor information processing,
  - sensor and data fusion, and
  - automation techniques for information extraction from multi-sensor systems using expert systems.
- To study and monitor the progress in new applications (not limited to conventional navigation) of multi-sensor systems (transportation, engineering, car navigation, environmental monitoring personal navigation, indoor navigation, etc.).
- To promote research collaboration and to organize and to participate in professional workshops, seminars, and meetings.
- To promote research and collaboration with countries with no or limited access to modern multi-sensor technology.
- To establish a web page providing information on the SC 4.1 activities, technology updates, and professional meeting calendar.

Working groups

WG 4.1.1: Ubiquitous Positioning Systems
(joint with FIG)

Chair: A. Kealy (Australia)
Co-chair: G. Retscher (Austria)

Description

This WG group will focus on the development of shared resources that extend our understanding of the theory, tools and technologies applicable to the development of ubiquitous positioning systems. It has a major focus on:

- Performance characterization of positioning sensors and technologies that can play a role in the development of ubiquitous positioning systems.
- Theoretical and practical evaluation of current algorithms for measurement integration within ubiquitous positioning systems.
- The development of new measurement integration algorithms based around innovative modelling techniques in other research domains such as machine learning and genetic algorithms, spatial cognition etc.
- Generating formal parameters that describe the performance of current and emerging positioning technologies that can inform FIG and IAG members.

Specific projects to be undertaken include

- Reporting on the performance characteristics of a broad range of MEMS inertial sensors derived from extensive practical testing and benchmarking.
- Reporting on performance characterization of positioning technologies: the development, possibilities and limitations of new technologies.
- Establishing components of an open source platform for researchers to rapidly deploy sensors as well as evaluate and develop integration algorithms.

- Developing and report on taxonomy for users of ubiquitous positioning systems that shows the performance capabilities of sensors and typical applications.
- Establishing links between the outcomes of this WG and other IAG and FIG WGs.

WG 4.1.2: Interference and Jamming

Chair: A. Soloviev (USA)
Co-chair: TBD

Description

This WG group will focus on gaining a deeper understanding of the impact of unintentional interference and intentional jamming on GNSS navigation capabilities for civil users; and, methods for improving the robustness of GNSS receivers in interference and jamming environments. It has a major focus on:

- Characterization of the impact of interference and jamming on the GNSS performance via review of open-literature publications.
- Evaluation of algorithms and methods that enable radio-frequency (RF) awareness.
- Evaluation of GNSS signal processing methods for interference and jamming suppression that are not subject to international traffic in arms (ITAR) regulations and can be thus adopted by the civil community without any restrictions.
- Evaluation of multi-sensor fusion methods for improved interference robustness.

Specific projects to be undertaken include:

- Reporting on the characterization of interference/jamming impact.
- Reporting on algorithms and methods that enable RF awareness.
- Reporting on non-ITAR GNSS-only interference suppression technologies.
- Reporting on the benefits of multi-sensor fusion for enhancing the navigation robustness in interference/jamming environments.
- Establishing links between the outcomes of this WG and other IAG and FIG WGs.

WG 4.1.3: Emerging Technologies

Chair: K. Zhang (Australia)
Co-chair: L. Bonenberg (UK)

Description

This working group will focus on the investigation and development of emerging technologies for innovative positioning and tracking applications. This is not limited to traditional navigation and this WG hopes to cooperate with other WGs on other forms of navigations such as indoor positioning and pedestrian navigation. With new technologies depending on wireless communication this WG plans to monitor relevant changes in legislature and support industry and academy interested in this area. Group actions aim to extend our knowledge and enhance our capability in positioning and tracking in order to complement the GNSS.

Current group focus includes:

- Utilisation of emerging technologies by the industry.
- Promotion and knowledge exchange about new technologies.
- Reporting the development trends, possibilities and limitations of emerging positioning technologies, such as Locata, RFID, UWB and smart phones.
- Promoting the utilisation of new technologies by the industry.
- Developing innovative positioning algorithms using current and emerging technologies and theoretical and practical evaluation of these developments.
- Promoting industry and academy interest into licensing and legislature regime relating to the emerging technologies.
- Reporting on such legislature efforts.
- Generating formal parameters that describe the performance of emerging positioning technologies that can inform both FIG and IAG members.
- Establishing working links between this WG and other IAG and FIG WGs.

Specific techniques include:

- New RFID systems with stable transmitted signal strength.
- Smart phones as multi-sensor integrated platforms.
- Low-cost vision-based positioning techniques (single/ stereo cameras built in smart phones).
- UWB.
- Locata and other indoor/outdoor pseudolite systems.
- Multi-GNSS positioning techniques.

Specific algorithms include:

- Cooperative positioning.
- Ubiquitous positioning (cooperation with WG 4.1.1)
- Single camera-based positioning (cooperation with WG 4.1.4).

WG 4.1.4: Imaging Techniques

Chair: M. Elhabiby (Canada)
Co-chair: J.-A. Paffenholz (Germany)

Description

This WG will focus on the investigation and development of imaging techniques for different navigation problems. Vision Based Navigation (VBN) systems research work will cover two different research streams: the non-inertial vision navigation and the inertial-aided vision navigation approaches. Real time efficient implementation with fast computations will extend the working group research activities to geo-computations, digital signal processing, non-linear optimization and image matching. The working group research work will be connected to the navigation industry in general and UAV industry in specific.

It has a major focus on:
- Evaluation of algorithms and methods for visually aiding inertial and non-inertial navigation systems.
- Evaluation of estimating aircraft position and velocity from sequential aerial images.
- Real-time implementation of a vision based navigation algorithm, which comprises both accuracy and effectiveness (meaning the cheapness of the sensors used, computational load and complexity). The new algorithm is composed of two sections: relative position estimation and absolute position estimation, which are connected with each other through a switching scheme.
- Assessment on the relative position estimation based on stereo modelling of two sequential images.
- Evaluation of the absolute position estimation techniques through matching schemes using reference images.
- Building an effective academic and industrial network worldwide that can help and promote the research activities of the working group.
- Establishing working links between this working group and similar national and international working groups such as ISPRS, ASPRS, CGU, AGU, IAG and FIG working groups.

Specific techniques include:
- Multi-resolution techniques: Curvelet and wavelet transform for image matching.
- Linear and non-linear optimization for position estimation.
- Implementation of Speeded Up Robust Features (SURF) Algorithms for interest point detection, image matching an object recognition.
- Extended Kalman filter update using position estimated from image matching techniques.

SC 4.2: Geodesy in Geospatial Mapping and Engineering

Chair: J. Wang (Australia)
Vice-Chair: G. Roberts (UK)
Secretary: H.-K. Lee (South Korea)

Terms of Reference

Geodesy provides foundations for geospatial mapping and engineering. Modern geospatial mapping as a massive point positioning process has been evolving towards automatic operations, and at the same time, various engineering areas are increasingly relying on highly developed geospatial technologies to deliver improved productivities and safety with minimised negative environment impact. This Sub-Commission (SC) 4.2 will therefore endeavour to coordinate research and other activities that address the broad areas of the theory and applications of geodesy tools in geospatial mapping and engineering, ranging from construction work, geotechnical and structural monitoring, precision farming, mining, to natural phenomena such as landslides and ground subsidence. The SC4.2 will carry out its work in close cooperation with other IAG Entities, as well as via linkages with relevant scientific and professional organizations such as ISPRS, FIG, IEEE, ION, ISM**.**

Objectives

- To develop and promote the use of new geospatial mobile mapping technologies for various applications.
- To develop and report the modelling and quality control framework for geo-referencing procedures.
- To monitor research and development into new technologies that are applicable to the general field of engineering geodesy, including hardware, software and analysis techniques.
- To study advances in geodetic methods for precision farming, mining operations, and large construction sites.
- To study advances in monitoring and alert systems for local geodynamic processes, such as landslides, ground subsidence, etc.
- To study advances in the application of artificial intelligence techniques in engineering geodesy.
- To document the body of knowledge in the field of geospatial mapping and engineering geodesy, and to present such knowledge in a consistent frame work at symposia and workshops.
- To promote research into several new technology areas or applications through the SC4.2 Working Groups.

Working groups

WG 4.2.1: Mobile Mapping Technologies and Applications

Chair: J. Skaloud (Switzerland)
Co-Chair: K.-W. Chiang (Taiwan)

Description

Mobile mapping technologies have been widely used to collect geospatial data for a variety of applications, for example, navigation and online geospatial information services. As mobile mapping sensors are becoming cheaper and easier to access, modelling and quality control procedures for major steps of mobile mapping should be further developed to ensure the reliability of geospatial data from mobile mapping systems. This working group will conduct its work through coordinated activities among the members of the group as well as in collaborations with other professional organizations, such as ISPRS/FIG.

Major objectives of this WG are:
- To monitor new trends in mobile mapping technologies.
- To evaluate the performance of geo-referencing and mapping sensors, such as IMU, GNSS, 3D cameras, optical vision sensors.
- To develop realistic mathematical and functional models for geo-referencing procedures.
- To develop a framework to evaluate the quality of geo-referencing and mapping results.
- To promote the use of geospatial mapping systems for various applications.

WG 4.2.2: Applications of Geodesy in Mining Engineering

Chair: A. Jarosz (Australia)
Co-Chair: J. Gao (China)

Description

Geodesy has been playing an important role in mining operations from geospatial mapping, modern navigation and guidance technologies used in automation at various mine sites to special orientation and location procedures used in underground operations. This working group will conduct its activities in close collaborations with other relevant international professional organizations, such as the International Society of Mining Surveying (ISM) and FIG.

Major objectives of this WG are to study, and report the use of:
- Modern geodesy in various mining sites.
- 3D mapping for mining.
- Navigation and guidance of mining machinery.
- Miner location technologies in underground mining operations.

WG 4.2.3: Geodetic technologies in Precision Farming

Chair: R. Bill (Germany)
Co-Chair: TBD

Description

Modern precision farming operations are highly dependent on high precision positioning, orientation and geospatial mapping, which are based on modern geodetic theory, techniques and services. This working group will coordinate professional activities to look into major geodetic aspects in precision forming areas in various parts of world.

Major objectives of this WG are to study, and report the use of geodetic tools in precision farming, in particular:
- Precise positioning and orientation of agricultural land-machinery and acquisition devices (such as geo-sensor networks, unmanned airborne vehicles, field robotics).
- Precise navigation and guidance for intelligent agricultural vehicles capable of automating tasks.
- Precise mapping, interpretation of space-time heterogeneities in the field, derivation of agricultural application maps.
- Web-based data infrastructures and services used in agricultural environment.

WG 4.2.4: Monitoring of Landslides & System Analysis

Chair: G. Mentes (Hungary)
Co-Chair: J. Guo (China)

Description

Landslides, as natural phenomena, have a local effect on structures and community infrastructure. Monitoring different types of landslides under various operational scenarios is a challenging task. The tools used in landslide monitoring range from conventional terrestrial measurement and alignment technology (optical, RF, etc.), Global Navigation Satellite Systems (GNSS), remote sensing, geotechnical instrumentation, and software systems such as GIS, decision support systems, etc. The WG will carry out its work in close cooperation with other related professional organizations such as ISPRS, FIG, ISM.

Major objectives of this WG are to study and report on:
- Development of new measuring methods.
- New dynamic and kinematic models of landslides.
- Integration of terrestrial and remote sensing measuring technology on multidisciplinary basis with the aim to develop an early alert system;
- Integrated workflow for landslide hazard management.

WG 4.2.5: Applications of Artificial Intelligence in Geospatial Mapping and Engineering Geodesy

Chair: A. Reiterer (Germany)
Co-Chair: U. Egly (Austria)

Description

Artificial Intelligence (AI) has become an essential technique for solving complex problems in many applications. In the areas of geospatial mapping and engineering geodesy, knowledge-based systems are emerging. To develop reliable intelligent systems, this working group will focus on some critical issues ranging from the understanding of the nature of intelligence to the understanding of knowledge representation and deduction processes, eventually resulting in the construction of computer programs, which act intelligently.

Major objectives of this working group are to study and report on, the following major areas:
- Intelligent quality control procedures in geospatial mapping process.
- Robust control of measurement- and guidance-systems.
- Knowledge based deformation analysis.
- Intelligent control of deformation alert systems.
- Evaluation of various complex data streams in geospatial mapping and engineering geodesy with, e.g. knowledge-based systems, genetic algorithms, and artificial neural networks.

SC 4.3: Remote sensing and modelling of the atmosphere

Chair: M. Santos (Canada)
Vice-Chair: J. Wickert (Germany)
Secretary: A. Krankowski (Poland)

Terms of Reference

The objective of this SC is to coordinate research dealing with the treatment, interpretation and modelling of measurements collected in the atmosphere for the purpose of improvements in geodetic positioning as well as for better understanding the atmosphere itself. Even though GNSS techniques are seen here as the primary research tools, other sensors also bring important information on the atmosphere and as such should be considered in the context of this Sub-Commission. Dedicated satellites, having on-board GNSS receivers, can also contribute to atmospheric studies by exploring the atmosphere-induced bending of GNSS signals while propagating through the atmosphere, to furnish round-the-clock weather data, monitor climate change, and improve space weather forecasts. Geodetic positioning can benefit and contribute to atmospheric models, such as Numerical Weather Prediction (NWP) models. Novel advancements in modelling the atmosphere as applied to positioning, error sources, instrumentation, dedicated missions, and real- or near real-time data access should also be contemplated. SC4.3 will foster linkages with sister scientific and professional organizations, such as IAG, ISPRS, FIG, IEEE and ION.

Objectives

- To explore the synergy that exists between Geodesy, meteorology and ionospheric sciences.

To encourage the processing of more and more LEO and also ground based data more and more also in near-real and/or real time.

- To study the application of readily available data from numerical weather prediction models (data provision, assimilation techniques).
- To study and suggest ways for homogenization of long term data set for climatologic investigations
- To investigate the development and enhancement of the GNSS-based sounding techniques, e.g. neutral atmosphere/ionosphere tomography, GNSS reflectometry/ scatterometry for altimetry, meteorology, soil moisture.
- To exploit the potential of new GNSS signals' structures for GNSS based atmospheric remote sensing.
- To suggest additional platforms for GNSS based atmospheric remote sensing (buoys, aircrafts, balloons, more dense ground networks, LEO constellations).
- To follow, study and contribute towards the technical and scientific advances in atmospheric research.

- To suggest standard definitions and terminology as per appropriate in the context of Geodesy and atmospheric sciences.

Program of activities

- To promote research collaboration among research groups worldwide.
- To organize and/or participate in scientific and professional meetings.
- To maintain a web page concatenating the Sub-Commission activities and reports.
- To encourage special issues of the Journal of Geodesy on atmospheric applications to Geodesy.

Study groups

SG 4.3.1: Ionosphere modelling and analysis

Chair: M. Schmidt (Germany)
Co-Chair: M. Karslioglu (Turkey)

Description

The general objective of this study group is the development of ionosphere models based on physics, mathematics and statistics. Within the next four years we will (1) focus on the development of appropriate parameter estimation and assimilation techniques based on the combination of different observation techniques. With respect to physical modelling we (2) will perform first steps by introducing physics-motivated functions such as the Chapman function into the parameter estimation process. Furthermore, we (3) will establish ionosphere models including near real-time applications by introducing Kalman filtering procedures. Other topics are the development of densification strategies of global models using regional approaches as well as applications, e.g. the study of the L3 GNSS frequency.

Working groups

WG 4.3.1: Standards for space weather products for geodetic and ionospheric studies

Chair: A. Krankowski (Poland)

Description

The objective of this WG is to suggest common international standards for the dissemination of space weather products used in geodesy and ionospheric studies. This WG will work in close scientific collaboration with IGS, URSI and COSPAR IRI group.

SC 4.4: Applications of Satellite and Airborne Imaging Systems

Chair: Z. Li (UK)
Vice- Chair: T. Wright (UK)
Secretary: H. Lee (USA)

Terms of Reference

The main objectives of this SC are to promote collaborative research in the development of satellite and airborne imaging systems, primarily including Synthetic Aperture Radar (SAR), Light Detection And Ranging (LiDAR) and Satellite Altimetry (SA) systems, for geodetic applications, and to facilitate communications and exchange of data, information and research results through coordinated efforts.

Objectives

- Development of methods, models, algorithms and software for geodetic applications of satellite and airborne imaging systems.
- Integration of satellite and airborne imaging systems with other geodetic/geospatial technologies such as GPS and GIS.
- Investigation of effects of field and atmospheric conditions on satellite and airborne imaging systems.
- Development and promotion of new geodetic applications of satellite and airborne imaging systems.
- Development of collaboration with sister organisations such as FIG and ISPRS, and liaison with image data providers.

Working groups

WG 4.4.1: Quality Control Framework for InSAR Measurements

Chair: Z. Li (UK)
Co-Chair: S. Samsonov (Canada)

Description

To investigate quality measures and quality control procedures and formulate a quality control framework for InSAR measurements. In particular, the objectives are:

- To investigate the optimal procedure for InSAR measurements
- To demonstrate how accurately InSAR can measure surface movements
- To demonstrate how accurately InSAR can map atmospheric path delays

WG 4.4.2: InSAR Observation and Modelling of Earthquakes, Volcanoes and Tectonics

Chair: T. Wright (UK)
Co-Chair**:** A. Hooper (Netherlands)

Description

To combine InSAR observations of Earth's surface movements, topography and terrestrial observations and modelling to advance understanding of the earthquake cycle, continental deformation and volcanic eruptions, and to quantify seismic and volcanic hazards.

WG 4.4.3: Landslide Hazard Mitigation using InSAR Techniques

Chair: R. Jover (Spain)
Co-Chair**:** R. Furuta (Japan)

Description

The main objectives of this working group is to promote collaborative research in the application of InSAR techniques for landslide measurement, monitoring and modelling and to stimulate communications and exchange of data, information and research outcomes through coordinated efforts. In particular, the primary objectives are:

- Development/improvement of InSAR techniques, algorithms and software for landslide measurement and monitoring.
- Investigation of the spatio-temporal evolution of landslides.
- Integration of InSAR data with in-situ observations, aerial/ground-based remote sensing measurements and geoinformation to improve our understanding of landslide mechanisms.
- Development of landslide models using InSAR measurements.

WG 4.4.4: Vertical land motion from Satellite Altimetry

Chair**:** H. Lee (USA)
Co-Chair: H. Wang (China)

Description

To develop optimal retracking and surface gradient correction algorithms for satellite altimeter measurements toward observing vertical crustal motion due to, e.g., glacial isostatic adjustment (GIA) and land subsidence. The primary focus is to study the application of satellite altimetry for observing vertical crustal motion.

WG 4.4.5: LiDAR and Laser Scanning

Chair: B. Yang (China)
Co-Chair: N. Tate (UK)

Description

To provide a focus for space-borne, airborne and terrestrial laser scanning activity internationally. There are currently four principal themes of research within the group: 3D modelling, data integration, mapping, and applications. In particular, the primary objectives are:

- To develop state-of-the-art laser scanning algorithms
- To collaborate with sister organizations (e.g. ISPRS and UK RSPSoc) to promote geodetic applications of laser scanning

SC 4.5: High-Precision GNSS Algorithms and Applications

Chair: Y. Gao (Canada)
Vice-Chair: P. Wielgosz (Poland)
Secretary: G. Liu (Hong Kong)

Terms of Reference

High-precision GNSS applications continues to grow, largely contributed to the rapid GNSS system developments currently underway including US's GPS modernization, the Russian GLONASS, European GALILEO and Chinese COMPASS systems. The increased number of satellites in view and improved system performance provide opportunities to create new high precision GNSS technologies and applications. Novel technologies are needed to address such opportunities and also challenges to further enhance the accuracy, availability and integrity of high precision GNSS applications, while the cost is to be dramatically reduced. SC4.5 will coordinate research efforts to identify important research problems in high precision GNSS and develop methods and technologies to support high precision GNSS applications. The research subjects include optimal use of signals from multiple GNSS systems, improved error modelling and mitigation methodologies, quality control and integrity monitoring, precise point positioning and RTK, low-cost precision GNSS, GNSS integration with enabling sensors, novel augmentation corrections and services, fast carrier phase ambiguity resolution. SC4.5 will also stimulate strong collaborations among researchers and international organizations, and develop strong linkage with the industry.

Objectives

The major objective of SC4.5 is to promote collective research efforts on the development of high precision GNSS methods and technologies and their novel applications, to facilitate timely dissemination of scientific findings, to stimulate strong collaborations among researchers and international organizations, and to develop strong linkage with the industry.

Program of activities:

- Identify and investigate important technical issues and problems in high precision GNSS.
- Identify and investigate emerging commercialization opportunities of high precision GNSS technologies.
- Publish white papers.
- Promote research collaboration among researchers.
- Develop strong linkage with the industry sector.
- Participate and organize international conferences and workshops.
- Collaborate with other international organizations.

Working groups

WG 4.5.1: Quality Measures for Network-based GNSS RTK

Chair**:** X. Meng (UK)
Co-Chair**:** H.-J. Euler (Switzerland)

Description

To study methods of quality control from both the end users and service providers' point of view. The research will focus on the assessment and improvement of the robustness and processing efficiency of Network-based GNSS RTK algorithms and software tools; the development of methods for integrity and completeness checking, time of arrival of corrections, impacts of incomplete and delayed messages; and the development of methods to increase the overall confidence and awareness of the positional accuracy.

WG 4.5.2: Precise Point Positioning and Network RTK

Chair: Sunil Bisnath (Canada)
Co-Chair: Sue Lynn Choy, (Australia)

Description

To address and investigate issues related to the development of GNSS-based precise point positioning (PPP) and network RTK (Real-Time Kinematic) technology. The main research focus will include the development and integration of PPP and network RTK algorithms, high performance PPP and RTK in the context of multi-GNSS constellations, and methods and algorithms to improve the availability and reliability of PPP and RTK. Promoting innovative application development and increasing user adoption will be a continuous effort.

WG 4.5.3: Integer Ambiguity Resolution for PPP and PPP-RTK

Chair: X. Zhang (China)
Co-Chair: P. Henkel (Germany)

Description

To study methods and algorithms of integer ambiguity resolution for precise point positioning and investigate issues and problems related to ambiguity initialization time, success rate and reliability etc. The research will focus on the following areas: the development of new augmentation corrections to mitigate fractional initial phase biases to recover the integer property of the un-differenced ambiguities; the development of methods and algorithms for integer ambiguity resolution in precise point positioning; and the real-time implementation and standardization of PPP-based RTK systems.

WG 4.5.4: Multi-frequency, Multi-constellation Sub-cm RTK

Chair: B. Li (Australia)
Co-Chair: Y. Feng (Australia)

Description

To study efficient approaches for sub-cm RTK over longer baseline and high-precision large-scale network RTK solutions with multi-frequency, multi-constellation GNSS systems. The research task will focus on the following areas: the efficiency and reliability improvement of ambiguity resolution over longer baselines; new linear combinations for mitigating different error sources and improving the real time kinematic positioning solutions from the current centimeter level to sub-centimeter level; applications to geodesy, geodynamics, engineering and machine automations where sub-cm accuracy is of great interest.

SC 4.6: GNSS-Reflectometry and Applications

Chair: S. Jin (China)
Vice-Chair: M. Martin-Neira (Netherlands)
Secretary: S. Gleason (Canada)

Terms of Reference:

The Global Navigation Satellite System (GNSS) can be characterized as a highly precise, continuous, all-weather and near-real-time microwave (L-band) technique, which implies more and wider applications and potentials. Recently, the versatile reflected and scattered signals of GNSS have been successfully demonstrated to sound the land surfaces (including soil moisture), ocean, and the cryosphere as a new remote sensing tool. The GNSS reflected signals from the ocean and land surface could determine the ocean height, wind speed and wind direction of ocean surface, soil moisture, ice and snow thickness, which could supplement the traditional remote sensing techniques, e.g., radar altimetry and SAR. The focus of this Sub-Commission (SC4.6) is to facilitate collaboration and communication, and to support joint researches with promising GNSS-Reflectometry (GNSS-R) technique. Specific objectives will be achieved through closely collaborating with working groups and other IAG Commissions/Sub-Commissions. Meanwhile, close collaboration with the International GNSS Service (IGS), Institute of Navigation (ION) and IEEE Geoscience and Remote Sensing Society (IGRASS) will be promoted, such as joint sponsorship of international professional workshops and conferences.

Objectives:

- To promote and extend GNSS Reflectometry/Scatterometry developments and tests as well as environment remote sensing applications, including GNSS-R receiver, antenna, signals, system and experiments.
- To improve the existing estimation algorithms, inversion theory and temporal-spatial resolution in GNSS reflectometry from the ocean and land surface and supplement the traditional remote sensors, e.g., Satellite Altimetry and SAR.
- To coordinate data from GNSS-R campaign experiments and provide environment remote sensing products through fusing with other terrestrial and satellite observations.
- To address coastal ocean topography, ocean surface roughness characteristics (wind speed/direction and wave height), ice motion, wetland monitoring and surface soil moisture and snow/ice thickness as well as the condition of sea ice, glacial melting and the freezing/thaw state of frozen ground.

- To facilitate collaboration and communication with mutual Remote Sensing related communities (Oceanography, Hydrology, Cryosphere, Geodesy).

Program of Activities:

This SC will establish WGs on relevant topics, and promote GNSS Reflectometry/Scatterometry developments and remote sensing applications. Chair/Co-Chair will work closely with members and other IAG Commissions/Sub-Commissions to obtain mutual goals. Also we will organize international workshops and symposiums to provide a platform for GNSS-R communication and collaboration and jointly sponsor special sessions at IAG Symposia and other workshop/conferences with IGARSS and ION.

Working Groups

WG 4.6.1: GNSS-R Development and Experiment

Chair: M. Martin-Neira (Netherlands)
Co-Chair: F. Fabra (Spain)

Description

The PARIS (PAssive Reflectometry Interferometric System, also called GNSS-Reflectometry) was successfully designed to use GNSS reflected signals from Earth's surface to act as multiple passive altimetric ranging signals and a bistatic scatterometer. This effort will be dedicated to GNSS-Reflectometry technique development, experiments and processing, e.g.,GNSS-R test and applications in land and ocean surface. In particular, the WG goals are:

- To provide GNSS-R technique information and new developments, including GNSS-R receiver, antenna, signals, and simulations.
- To organize GNSS-R experiments in ocean coast, bridge, aircraft and LEO satellites and analyze and test the GNSS-R for land and ocean surface applications.

WG 4.6.2: GNSS Scatterometry

Chair: S. Gleason (Canada)
Co-Chair: M. Clarizia (UK)

Description

This WG is primarily focused on the study of ocean wind and wave retrieval using scattered GNSS signals as well as ocean sensing applications, including looking into the signal scattering statistics and analyzing the achievable surface resolution for different instrument configurations. The primary goals of this WG is:

- To improve the scattering signal quality and estimated theory for ocean wind and wave retrieval using different instrument and GNSS-R carrier configurations.

WG 4.6.3: GNSS Ocean Altimetry

Chair: S. d'Addio (Netherlands)
Co-Chair: E. Cardellach (Spain)

Description

The ocean surface roughness characteristics can be detected in some cases using GNSS reflected signals comparable with other remote sensors . Further research is needed in detailed analysis of the electromagnetic field scattering theory, power and Delay-Doppler parameter retrieval methods and characterizing the L-band surface slopes' probability density function. The primary goal of this WG is:

- To improve GNSS Altimetry for all currently available GNSS signals and to demonstrate more applications in oceans through closely collaborating with Commission 2, e.g. Altimetry, Gravimetry, ICESat, etc.

WG 4.6.4: Soil and Cryosphere detection by GNSS-R

Chair: M. Jacobson (USA)
Co-Chair: N. Floury (Netherlands)

Description

The soil moisture, ice and snow thickness are related to the amplitude of the reflected signal as a function of the incidence angle or relative amplitudes between different polarizations, which can be retrieved from the GNSS reflected signals. This effort is to develop GNSS reflectometry and multipath for land surface mapping, wetland monitoring and surface soil moisture and snow/ice thickness as well as the condition of sea ice, glacial melting and the frozen state. The primary goal of this WG is:

- To improve the estimate theory and sensitivity to soil moisture, snow and ice condition from the GNSS reflected signals and to precisely determine the soil moisture, ice status and features

Inter-Commission Committee on Theory (ICCT)

http://icct.kma.zcu.cz

President: **N. Sneeuw** (Germany)
Vice President: **P. Novák** (Czech Republic)

Terms of Reference

The Inter-Commission Committee on Theory (ICCT) was formally approved and established after the IUGG XXI Assembly in Sapporo, 2003, to succeed the former IAG Section IV on General Theory and Methodology and, more importantly, to interact actively and directly with other IAG entities. In accordance with the IAG by-laws, the first two 4-year periods were reviewed in 2011. IAG approved the continuation of ICCT at the IUGG XXIII Assembly in Melbourne, 2011.

Recognizing that observing systems in all branches of geodesy have advanced to such an extent that geodetic measurements (i) are now of unprecedented accuracy and quality, can readily cover a region of any scale up to tens of thousands of kilometres, yield non-conventional data types, and can be provided continuously; and (ii) consequently, demand advanced mathematical modelling in order to obtain the maximum benefit of such technological advance, the ICCT (1) strongly encourages frontier mathematical and physical research, directly motivated by geodetic need and practice, as a contribution to science and engineering in general and the theoretical foundations of geodesy in particular; (2) provides the channel of communication amongst the different IAG entities of commissions/services/projects on the ground of theory and methodology, and directly cooperates with and supports these entities in the topical work; (3) helps the IAG in articulating mathematical and physical challenges of geodesy as a subject of science and in attracting young talents to geodesy. The ICCT should strive to attract and serve as home to mathematically motivated/oriented geodesists and to applied mathematicians; and (4) encourages closer research ties with and gets directly involved in relevant areas of the Earth sciences, bearing in mind that geodesy has always been playing an important role in understanding the physics of the Earth.

Objectives

The overall objectives of the ICCT are
to act as international focus of theoretical geodesy,
to encourage and initiate activities to advance geodetic theory in all branches of geodesy,
to monitor developments in geodetic methodology.

To achieve these objectives, the ICCT interacts and collaborates with the IAG Commissions, GGOS and other IAG related entities (services, projects).

Structure

Joint Study Groups

JSG 0.1: Application of time series analysis in geodesy
(joint with GGOS and all Commissions)
Chair: W. Kosek (Poland)

JSG 0.2: Gravity field modelling in support of height system realization
(joint with Commissions 1, 2 and GGOS)
Chair: P. Novák (Czech Republic)

JSG 0.3: Comparison of current methodologies in regional gravity field modelling
(joint with Commissions 2, 3)
Chairs: M. Schmidt, Ch. Gerlach (Germany)

JSG 0.4: Coordinate systems in numerical weather models
(joint with all Commissions)
Chair: Th. Hobiger (Japan)

JSG 0.5: Multi-sensor combination for the separation of integral geodetic signals
(joint with Commissions 2, 3 and GGOS)
Chair: F. Seitz (Germany)

JSG 0.6: Applicability of current GRACE solution strategies to the next generation of inter-satellite range observations
(joint with Commission 2)
Chairs: M. Weigelt (Germany), A. Jäggi (Switzerland)

JSG 0.7: Computational methods for high-resolution gravity field modelling and nonlinear diffusion filtering
(joint with Commissions 2, 3 and GGOS)
Chairs: R. Čunderlík, K. Mikula (Slovakia)

JSG 0.8: Earth system interaction from space geodesy
(joint with all Commissions)
Chair: S. Jin (China)

JSG 0.9: Future developments of ITRF models and their geophysical interpretation
(joint with Commission 1 and IERS)
Chair: A. Dermanis (Greece)

Program of Activities

The ICCT's program of activities include

participation as (co-)conveners of geodesy sessions at major conferences (IAG, EGU, AGU, …),
organization of a Hotine-Marussi symposium,
initiation of a summer school on theoretical geodesy,
maintaining a website for dissemination of ICCT related information.

Steering Committee

• President	N. Sneeuw	Germany
• Vice-President	P. Novák	Czech Rep.
• Representatives:		
• Commission 1	T. van Dam	Luxembourg
• Commission 2	U. Marti	Switzerland
• Commission 3	R. Gross	USA
• Commission 4	D. Brzezinska	USA
• GGOS	H. Kutterer	Germany

JSG 0.1: Application of Time-Series Analysis in Geodesy

Chair: W. Kosek (Poland)
Affiliation: GGOS, all commissions

Introduction

Observations provided by modern space geodetic techniques (geometric and gravimetric) deliver a global picture of dynamics of the Earth. Such observations are usually represented as time series which describe (1) changes of surface geometry of the Earth due to horizontal and vertical deformations of the land, ocean and cryosphere, (2) fluctuations in the orientation of the Earth divided into precession, nutation, polar motion and spin rate, and (3) variations of the Earth's gravitational field and the centre of mass of the Earth. The vision and goal of GGOS is to understand the dynamic Earth's system by quantifying our planet's changes in space and time and integrate all observations and elements of the Earth's system into one unique physical and mathematical model. To meet the GGOS requirements, all temporal variations of the Earth's dynamics – which represent the total and hence integral effect of mass exchange between all elements of Earth's system including atmosphere, ocean and hydrology – should be properly described by time series methods.

Various time series methods have been applied to analyze such geodetic and related geophysical time series in order to better understand the relation between all elements of the Earth's system. The interactions between different components of the Earth's system are very complex, thus the nature of the considered signals in the geodetic time series is mostly wideband, irregular and non-stationary. Therefore, the application of time frequency analysis methods based on wavelet coefficients – e.g. time-frequency cross-spectra, coherence and semblance – is necessary to reliably detect the features of the temporal or spatial variability of signals included in various geodetic data, and other associated geophysical data.

Geodetic time series may include, for instance, temporal variations of site positions, tropospheric delay, ionospheric total electron content, masses in specific water storage compartments or estimated orbit parameters as well as surface data including gravity field, sea level and ionosphere maps. The main problems to be scrutinized concern the estimation of deterministic (including trend and periodic variations) and stochastic (non-periodic variations and random fluctuations) components of the time series along with the application of the appropriate digital filters for extracting specific components with a chosen frequency bandwidth. The application of semblance filtering enables to compute the common signals, understood in frame of

the time-frequency approach, which are embedded in various geodetic/geophysical time series.

Numerous methods of time series analysis may be employed for processing raw data from various geodetic measurements in order to promote the quality level of signal enhancement. The issue of improvement of the edge effects in time series analysis may also be considered. Indeed, they may either affect the reliability of long-range tendency (trends) estimated from data or the real-time processing and prediction.

The development of combination strategies for time- and space-dependent data processing, including multi-mission sensor data, is also very important. Numerous observation techniques, providing data with different spatial and temporal resolutions and scales, can be combined to compute the most reliable geodetic products. It is now known that incorporating space variables in the process of geodetic time series modelling and prediction can lead to a significant improvement of the prediction performance. Usually multi-sensor data comprises a large number of individual effects, e.g. oceanic, atmospheric and hydrological contributions. In Earth system analysis one key point at present and in the future will be the development of separation techniques. In this context principal component analysis and related techniques can be applied.

Objectives

- To study geodetic time series and their geophysical causes in different frequency bands using time series analysis methods, mainly for better understanding of their causes and prediction improvement.
- The evaluation of appropriate covariance matrices corresponding to the time series by applying the law of error propagation, including weighting schemes, regularization, etc.
- Determining statistical significance levels of the results obtained by different time series analysis methods and algorithms applied to geodetic time series.
- The comparison of different time series analysis methods and their recommendation, with a particular emphasis put on solving problems concerning specific geodetic data.
- Developing and implementing the algorithms – aiming to seek and utilize spatio-temporal correlations – for geodetic time series modelling and prediction.
- Better understanding of how large-scale environmental processes, such as for instance oceanic and atmospheric oscillations and climate change, impact modelling strategies employed for numerous geodetic data.
- Developing combination strategies for time- and space-dependent data obtained from different geodetic observations.
- Developing separation techniques for integral measurements in individual contributions.

Program of activities

Updating the webpage, so that the information on time series analysis and its application in geodesy (including relevant multidisciplinary publications and the unification of terminology applied in time series analysis) will be available.
Participating in working meetings at the international symposia and presenting scientific results at the appropriate sessions.
Collaboration with other working groups dealing with geodetic time-series e.g. Cost ES0701 Improved constraints on models of GIA or the Climate Change Working Group.

Members

- W. Kosek (Poland), chair
- R. Abarca del Rio (Chile)
- O. Akyilmaz (Turkey)
- J. Böhm (Austria)
- L. Fernandez (Argentina)
- R. Gross (USA)
- M. Kalarus (Poland)
- M. O. Karslioglu (Turkey)
- H. Neuner (Germany)
- T. Niedzielski (Poland)
- S. Petrov (Russia)
- W. Popinski (Poland)
- M. Schmidt (Germany)
- M. van Camp (Belgium)
- O. de Viron (France)
- J. Vondrák (Czech Republic)
- D. Zheng (China)
- Y. Zhou (China)

JSG 0.2: Gravity Field Modelling in Support of World Height System Realization

Chair: P. Novák (Czech Republic)
Affiliation: Comm. 2, 1 and GGOS

Introduction

Description of the Earth's gravity field still remains a major research topic in geodesy. The main goal is to provide reliable global models covering all spatially-temporal frequencies of its scalar parameterization through the gravity potential. Detailed and accurate gravity field models are required for proper positioning and orientation of geodetic sensors (data geo-referencing). Geometric properties of the gravity field are then studied including those of its equipotential surfaces and their respective surface normals, since they play a fundamental role in definition and realization of geodetic reference systems. Gravity field models will be applied for definition and realization of a vertical reference system (currently under construction) that will support studies of the Earth system.

This study group is an entity of the Inter-Commission Committee on Theory. It is affiliated to Commissions 1 (Reference Frames) and 2 (Gravity Field); its close co-operation with GGOS Theme 1 "Unified Global Height System" is anticipated. It aims at bringing together scientists concerned namely with theoretical aspects in the areas of interest specified below.

Objectives

- Considering different types and large amounts of gravity-related data available today, large variety of gravity field models and the ongoing IAG project of realizing a world height system (WHS), this study group shall focuses on theoretical aspects related to the following (non-exhaustive to WHS) list of problems:
- To study available gravity field models in terms of their available resolution, accuracy and stability for the purpose of WHS realization.
- To define a role of a conventional model of the Earth's gravity field (EGM) to be used for WHS realization including its scale parameters.
- To study relations between an adopted conventional EGM and parameters of a geocentric reference ellipsoid of revolution approximating a time invariant equipotential surface of the adopted EGM aligned to reduced observables of mean sea level.
- To study theoretical aspects of various methods proposed for WHS definition and realization including investigations on tidal system effects.
- To investigate combination of heterogeneous gravity field observables by using spatial inversion, spherical radial functions, collocation, wavelets, etc. and by taking into account their sampling geometry, spectral and stochastic properties.
- To investigate methods of gravity field modelling based on combination of global gravitational models, ground and airborne gravity, GNSS/levelling height differences, altimetry data, deflections of the vertical, etc.
- To study stable, accurate and efficient methods for continuation of gravity field parameters including space-borne observables of type GRACE and GOCE.
- To advance theory and methods for solving various initial and boundary value problems (I/BVP) in geodesy.
- To study methods for gravity potential estimation based on its measured directional derivatives (gravity, gravity gradients) by exploiting advantages of simultaneous continuation and inversion of observations.
- To investigate requirements for gravity data (stochastic properties, spatially-temporal sampling, spectral content etc.) in terms of their specific geodetic applications.

Program of activities

Active participation at major geodetic conferences and meetings.
Organizing a session at the Hotine-Marussi Symposium 2013.
Co-operation with affiliated IAG Commissions and GGOS.
Electronic exchange of ideas and thoughts through a SG web page.
Monitoring activities of SG members and external individuals related to SG.
Compiling bibliography in the area of SG interest.

Members

- Pavel Novák (Czech Republic), chair
- Hussein Abd-Elmotaal (Egypt)
- Robert Čunderlík (Slovakia)
- Heiner Denker (Germany)
- Will Featherstone (Australia)
- René Forsberg (Denmark)
- Bernhard Heck (Germany)
- Jianliang Huang (Canada)
- Christopher Jekeli (USA)
- Dan Roman (USA)
- Fernando Sansò (Italy)
- Michael G Sideris (Canada)
- Lars Sjöberg (Sweden)
- Robert Tenzer (New Zealand)
- Yan-Ming Wang (USA)

JSG 0.3: Comparison of Current Methodologies in Regional Gravity Field Modelling

Chairs: M. Schmidt, Ch. Gerlach (Germany)
Affiliation: Comm. 2, 3

Introduction

Traditionally the gravitational potential of the Earth and other celestial bodies is modelled as a series expansion in terms of spherical harmonics. Although this representation is technically possible for ultra-high expansions, it is well-known that spherical harmonic approaches cannot represent data of heterogeneous density and quality in a proper way. In order to overcome these and other deficiencies regional modelling comes into question.

In the last years many groups have developed sophisticated approaches for regional modelling, e.g. the expansion of the gravity field or functionals of the field in terms of spherical (radial) base functions. Analogously to spherical harmonic approaches, also in regional modelling the unknown model parameters, i.e. the coefficients of the series expansion, can be either determined by means of numerical integration or as the solution of a parameter estimation process. Numerical integration techniques are widely used in the mathematical community and provide efficient and stable solutions. However, numerical integration techniques suffer from important disadvantages. Among others these methods (1) require the input data to be given on a spherical integration grid, (2) cannot provide estimated error variances and covariances of the model parameters and (3) have difficulties to handle the combination of data from different measurement techniques. Due to these disadvantages, parameter estimation is the preferred strategy in the geodetic community. Although solutions in regional modelling based on parameter estimation are generated by several groups since many years, a large number of unsolved problems and open questions still remain. They mostly arise from the condition of the normal equation system and are therefore directly connected to the parametrization of the gravity field, the type and distribution of observation data, the choice and location of base functions, possible regularisation schemes, etc.

The aim of the proposed SG is to find guidelines on suitable strategies for setting up the parameter estimation of regional gravity field modelling. This includes appropriate strategies for the combination of satellite, airborne and terrestrial data. The focus of the SG is on the methodological foundation of regional gravity field modelling based on series expansions in terms of localizing base functions. Therefore numerical studies will be concentrated on simulations based on synthetic data. It is not the aim of the SG to process and compare solutions from real data.

Objectives

The main objectives of this SG are:

- to collect information of available methodologies and strategies for regional modelling, including
  - the type of base functions (splines, wavelets, Slepian function, Mascons, etc.),
  - the point grids for placing the functions (standard grid, icosaeder, Reuter grid, etc. on a sphere, ellipsoid, etc.),
  - the choice and establishment of an appropriate adjustment model (combination strategy, variance component estimation, rank deficiency problems, e.g., due to downward continuation, etc.),
  - the consideration of model errors (truncation errors, edge effects, leakage, etc.),
  - the specific field of application,
- to analyze the collected information in order to find specific properties of the different approaches and to find, why certain strategies have been chosen,
- to create a benchmark data set for comparative numerical studies,
- to carry out numerical comparisons between different solution strategies for estimating the model parameters and to validate the results with other approaches (spherical harmonic models, least-squares collocation, etc.),
- to quantify and interpret the differences of the comparisons with a focus on detection, explanation and treatment of inconsistencies and possible instabilities of the different approaches,
- to create guidelines for generating regional gravity solutions,
- to outline standards and conventions for future regional gravity products.
- Comparable work outside gravity field determination, e.g. in the mathematical communities and in geomagnetic field determination will be taken into account.
- To achieve the objectives, the SG interacts and collaborates with other ICCT SGs as well as IAG Commission 2. As a matter of fact the outcomes of the SG can be also used by other IAG commissions, especially in Commission 3.
- The SG's work will be distributed to IAG sister associations through respective members.

Program of Activities

The SG’s program of activities will include
organization of SG meetings and of one or more scientific workshops on regional modelling
participation in respective symposia (EGU, AGU, etc.),
publication of important findings in proper journals,
maintaining a website for general information as well as for internal exchange of data sets and results,
supporting ICCT activities

Members

- Michael Schmidt (Germany), chair
- Christian Gerlach (Germany); chair
- Katrin Bentel (Norway)
- Annette Eicker (Germany)
- Indridi Einarsson (Denmark)
- Junyi Guo (USA)
- Majid Naeimi (Germany)
- Isabelle Panet (France)
- Judith Schall (Germany)
- Uwe Schäfer (Germany)
- Frederick Simons (USA)
- C.K. Shum (USA)
- Matthias Weigelt (Germany)
- Gongyou Wu (China)

JSG 0.4: Coordinate Systems in Numerical Weather Models

Chair: T. Hobiger (Japan)
Affiliation: all Commissions

Introduction

Numerical weather models (NWMs) contain valuable information that is relevant for a variety of geodetic models. Currently no clear description exists regarding how to deal with the NWM coordinate systems when carrying out the calculations in a geodetic reference frame. The problem can be split into two questions: First, how to relate the horizontal NWM coordinates, which are in most cases geocentric coordinates, derived initially from either Cartesian or spectral representations, properly into an ellipsoidal/geodetic frame? Second, how to transform the NWM height system into elliptical heights as used within geodesy? Although some work has been already done to answer these questions, still no procedures, guidelines or standards have been defined in order to consistently transform the meteorological information into a geodetic reference frame.

The study group will categorize the NWM coordinate systems, create mathematical models for transformation and summarize these findings in a peer-reviewed paper that will act as guidelines for those who intend to utilize NWM information. In addition, it will be necessary to define such transformations in both ways, in order to enable the assimilation of geodetic measurements into meteorological models as well. Moreover, the study group will deal with the issue of surface data contained in NWM and how this information can be consistently used.

Objectives

- Understand the horizontal coordinate systems of the different NWMs, ranging from global to small-scale regional models
- Understand the vertical coordinate systems of the different NWMs, ranging from global to small-scale regional models
- Formulate a clear mathematical description on how to transform between NWMs and a geodetic frame (in both directions)
- Summarize these findings in a peer-reviewed paper that will act as a standard for future use of NWM-produced fields.

Program of activities

Launch a web-page for dissemination of information, presentation, communication, outreach purposes; provide a bibliography
Conduct working meetings in association with international conferences; present research results in appropriate sessions
Organize workshops dedicated mainly to problem identification and to motivation of relevant scientific research
Produce at least one peer-reviewed paper that presents a clear and consistent description of how to transform information from and to NWMs, and the relevance of different NWM structures, and, if possible, a second paper that deals with the uncertainty of the NWM related coordinate information will be considered.

Members

- Thomas Hobiger (Japan), chair
- Johannes Boehm (Austria)
- Tonie van Dam (Luxembourg)
- Pascal Gegout (France)
- Rüdiger Haas (Sweden)
- Ryuichi Ichikawa (Japan)
- Arthur Niell (USA)
- Felipe Nievinski (USA)
- David Salstein (USA)
- Marcelo Santos (Canada)
- Michael Schindelegger (Austria)
- Henrik Vedel (Denmark)
- Jens Wickert (Germany)
- Florian Zus (Germany)

JSG 0.5: Multi-Sensor Combination for the Separation of Integral Geodetic Signals

Chair: F. Seitz (Germany)
Affiliation: Comm. 2, 3 and GGOS

Introduction

A large part of the geodetic parameters derived from space geodetic observation techniques are integral quantities of the Earth system. Among the most prominent ones are parameters related to Earth rotation and the gravity field. Variations of those parameters reflect the superposed effect of a multitude of dynamical processes and interactions in various subsystems of the Earth. The integral geodetic quantities provide fundamental and unique information for different balances in the Earth system, in particular for the balances of mass and angular momentum that are directly related to (variations of) the gravity field and Earth rotation. In respective balance equations the geodetic parameters describe the integral effect of exchange processes of mass and angular momentum in the Earth system. In contrast to many other disciplines of geosciences, geodesy is characterized by a very long observation history. Partly, the previously mentioned parameters have been determined over many decades with continuously improved space observation techniques. Thus geodesy provides an excellent data base for the analysis of long term changes in the Earth system and contributes fundamentally to an improved understanding of large-scale processes.

However, in general the integral parameter time series cannot be separated into contributions of specific processes without further information. Their separation and therewith their geophysical interpretation requires complementary data from observation techniques that are unequally sensitive for individual effects and/or from numerical models. Activities of the study group are focussed on the development of strategies for the separation of the integral geodetic signals on the basis of modern space-based Earth observation systems. A multitude of simultaneously operating satellite systems with different objectives is available today. They offer a broad spectrum of information on global and regional-scale processes at different temporal resolutions. Within the study group it shall be investigated in which way the combination of heterogeneous data sets allows for the quantification of individual contributors to the balances of mass and angular momentum.

The research activities shall be coordinated between the participating scientists and shall be conducted in interdisciplinary collaboration. At all times the group is open for new contacts and members in order to embed the activities in a wide context. The study group is primarily affiliated with the IAG commissions 2 (Gravity field) and 3 (Earth rotation and geodynamics).

Objectives

The primary objective of the study group is the development of strategies for multi-sensor combinations with the aim of separating time series of integral geodetic parameters related to Earth rotation and gravity field. The separation of the parameter time series into contributions of individual underlying effects fosters the understanding of dynamical processes and interactions in the Earth system. This is of particular interest in the view of global change.

Individual contributions from various subsystems of the Earth shall be quantified and balanced. In particular our investigations focus on the separation of the Earth rotation parameters (polar motion and variations of length-of-day) into contributions of atmospheric and hydrospheric angular momentum variations, and on the separation of GRACE gravity field observations over continents into the contributions of individual hydrological storage compartments, such as groundwater, surface water, soil moisture and snow.

Investigations in the frame of the study group will exploit the synergies of various observation systems (satellite altimetry, optical and radar remote sensing, SMOS, and others) for the separation of the signals and combine their output with numerical models. Among the most important steps are compilation and assessment of background information for individual observation systems and sensors (mode of operation, sensitivity, accuracy, deficiencies) as well as theoretical studies which (new) information on the Earth system can be gained from a combination of different observation methods.

In particular the research comprises the following topics:

- potential und usability of contemporary space-borne and terrestrial sensors for an improved understanding of processes within atmosphere and hydrosphere.
- analysis of accuracy, temporal and spatial resolution and coverage of different data sets
- theoretical and numerical studies on the combination of heterogeneous observation types. This comprehends investigations on appropriate methods for parameter estimation including error propagation, the analysis of linear dependencies between parameters and the solution of rank deficiency problems.
- mathematical methods for the enhancement of the information content (e.g. filters)
- quantification of variations of mass and angular momentum in different subsystems from multi-sensor analysis
- analysis of the consistencies of balances between individual effects and integral geodetic parameters on different spatial scales

- formulation of recommendations for future research and (if possible) for future satellite missions on the basis of balance inconsistencies

Planned Activities

- Set-up of a SG webpage for dissemination of information (activities and a bibliographic list of references) and for presentation and communication of research results.
- Organization of conference sessions / workshops:
  - planned in 2013: Conference Session in the Hotine Marussi Symposium
  - planned in 2014: 2nd workshop on the Quality of Geodetic Observing and Monitoring Systems (QuGOMS' 14)
- Common publications of SG members
- Common fund raising activities (e.g. for PhD positions)

Principal Scientific Outcome / Results

By the end of the 4-year period 2011-2015 the following outcome shall be achieved:
Mature experience in geodetic multi-sensor data combination including data availability, formats, combination strategies and accuracy aspects
Numerical results for separated hydrological contributions to integral mass variations observed by GRACE for selected study areas.
Numerical results for separated atmospheric/hydrospheric contributions Earth rotation parameters on seasonal to inter-annual time scales
Initiation of at least one common funded project with positions for PhD students working in the topical field of the study group

Members

- Florian Seitz (Germany), chair
- Sarah Abelen (Germany)
- Rodrigo Abarca del Rio (Chile)
- Andreas Güntner (Germany)
- Karin Hedman (Germany)
- Franz Meyer (USA)
- Michael Schmidt (Germany)
- Manuela Seitz (Germany)
- Alka Singh (India)

JSG 0.6: Applicability of Current GRACE Solution Strategies to the Next Generation of Inter-Satellite Range Observations

Chairs: M. Weigelt (Germany)
A. Jäggi (Switzerland)
Affiliation: Comm. 2

Problem statement

The GRACE-mission (Tapley et al., 2004b) proved to be one of the most important satellite missions in recent times as it enabled the recovery of the static gravity field with unprecedented accuracy and, for the first time, the determination of temporal variations on a monthly (and shorter) basis. The key instrument is the K-band ranging system which continuously measures the changes of the distance between the two GRACE satellites with an accuracy of a few micrometer. Thanks to the success of this mission, proposals have been made for the development of a GRACE-follow-on mission and a next-generation GRACE satellite system, respectively. Apart from options for a multi-satellite mission, the major improvement will be the replacement of the microwave based K-band ranging system by laser interferometry (Bender et al., 2003). The expected improvement in the accuracy is in the range of a factor 10 to 1000.

Two types of solution strategies exist for the determination of gravity field quantities from kinematic observations (range, range-rate and range-acceleration). The first type is based on numerical integration. The most common ones are the classical integration of the variational equations (Reigber, 1989; Tapley et al., 2004a), the Celestial Mechanics Approach (Beutler et al., 2010) or the short-arc method (Mayer-Gürr, 2006). The second type of solution strategies tries to make use of in-situ (pseudo)-observations. The most typical ones are the energy balance approach (Jekeli, 1998; Han, 2003), the relative acceleration approach (Liu, 2008) or the line-of-sight gradiometry approach (Keller and Sharifi, 2005).

From a theoretical point of view all approaches are in one way or the other based on Newton's equation of motion and thus all of them should be applicable to the next generation of satellite missions as well. Practically, problems arise due to the necessity of approximations and linearizations, the accumulation of errors, the combination of highly-precise with less precise quantities, e.g. K-band with GPS, and the incorporation of auxiliary measurements, e.g. accelerometer data. These problems are often circumvented by introducing reference orbits, reducing the solution strategies to residual quantities, and by frequently

solving for initial conditions and/or additional empirical or stochastic parameter. In the context of the next generation of low-low satellite-to-satellite tracking systems, the question is whether these methods are still sufficient to fully exploit the potential of the improved range observations.

Objectives

Observations are related to gravity field quantities by means of geometry, kinematics and dynamics. The gravity field is then represented by global or local base functions. The focus of this study group is primarily on the use of spherical harmonics as base function with different approaches to relate the observations to the gravity field. However, since local methods also proofed to yield high-quality solutions, this group will be affiliated with the proposed study group on the "Methodology of Regional Gravity Field Modelling" by M. Schmidt and Ch. Gerlach in order to investigate the interplay with regional modelling. The usage of other global base functions is also welcome.

The objectives of the study group are therefore to:

- investigate each solution strategy, identify approximations and linearizations and test them for their permissibility to the next generation of inter-satellite range observations,
- identify limitations or the necessity for additional and/or more accurate measurements,
- quantify the sensitivity to error sources, e.g. in tidal or non-gravitational force modelling,
- investigate the interaction with global and local modelling,
- extend the applicability to planetary satellite mission, e.g. GRAIL,
- establish a platform for the discussion and in-depth understanding of each approach and provide documentation.

It will not be the objective of this study group to identify the “best” approach as from a theoretical point of view all approaches are able to yield a solution as long as the necessary observations with sufficient accuracy have been made and approximations and linearization errors remain below the proposed accuracy of the new range observation. Further, solutions need validation which is done best with different and independent solution strategies in order to identify possible systematic effects.

Methodology and Output

The investigation will be based on an in-depth analysis of the theoretical foundations of each approach in combination with a simulation study with step-wise increasing realism. The preparation of the simulated data set and each approach will be assigned separate work packages with subtasks, which include the above mentioned objectives. Each member is supposed to assign himself to at least one work package and contribute by adding to the discussion of the principles of each approach, supplying simulated data sets, carry out numerical investigations or develop solutions to specific problems.

The primary output is the result of the collaborative investigation of the different approaches aiming at the identification of possible challenges and the development of solutions ensuring their applicability to the next generation of inter-satellite range observations. These findings are supposed to be well documented in journal paper, possibly in a special issue of Journal of Geodesy or similar by the end of 2014. A workshop is envisaged in the vicinity of the Hotine-Marussi symposium in 2013.

Members

- Matthias Weigelt (Germany), chair
- Adrian Jäggi (Switzerland), chair
- Markus Antoni (Germany)
- Oliver Baur (Austria)
- Richard Biancale (France)
- Sean Bruinsma (France)
- Christoph Dahle (Germany)
- Christian Gerlach (Germany)
- Thomas Gruber (Germany)
- Shin-Chan Han (USA)
- Hassan Hashemi Farahani (The Netherlands)
- Wolfgang Keller (Germany)
- Jean-Michel Lemoine (France)
- Anno Löcher (Germany)
- Torsten Mayer-Gürr (Austria)
- Philip Moore (UK)
- Himanshu Save (USA)
- Mohammad Sharifi (Iran)
- Natthachet Tangdamrongsub (Taiwan)
- Pieter Visser (The Netherlands)

Corresponding members

- Christian Gruber (Germany)
- Majid Naeimi (Germany)
- Jean-Claude Raimondo (Germany)
- Michael Schmidt (Germany)

JSG 0.7: Computational Methods for High-Resolution Gravity Field Modelling and Nonlinear Diffusion Filtering

Chairs: R. Čunderlík, K. Mikula (Slovakia)
Affiliation: Comm. 2, 3 and GGOS

Introduction

Efficient numerical methods and HPC (High Performance Computing) facilities provide new opportunities in many applications in geodesy. The goal of the IC SG is to apply numerical methods like the finite element method (FEM), finite volume method (FVM), boundary element method (BEM) and others mostly for gravity field modelling and non-linear filtering of data on the Earth's surface. An advantage is that such numerical methods use finite elements as basis functions with local supports. Therefore a refinement of the discretization is very straightforward allowing adaptive refinement procedures as well.

In case of gravity field modelling, a parallelization of algorithms using the standard MPI (Message Passing Interface) procedures and computations on clusters with distributed memory allows to achieve global or local gravity field models of very high-resolution, where a level of the discretization practically depends on capacity of available HPC facilities. The aforementioned numerical methods allow a detailed discretization of the real Earth's surface considering its topography. To get precise numerical solution to the geodetic boundary-value problems (BVPs) on such complicated surface it is also necessary handle problems like the oblique derivative.

Data filtering occurs in many applications of geosciences. A quality of filtering is essential for correct interpretations of obtained results. In geodesy we usually use methods based on the Gaussian filtering that corresponds to a linear diffusion. Such filtering has a uniform smoothing effect, which also blurs "edges" representing important structures in the filtered data. In contrary, a nonlinear diffusion allows adaptive smoothing that can preserve main structures in data, while a noise is effectively reduced. In image processing there are known at least two basic nonlinear diffusion models; (i) the regularized Perona-Malik model, where the diffusion coefficient depends on an edge detector, and (ii) the geodesic mean curvature flow model based on a geometrical diffusion of level-sets of the image intensity.

The aim of the SG is to investigate and develop nonlinear filtering methods that would be useful for a variety of geodetic data, e.g., from satellite missions, satellite altimetry and others. A choice of an appropriate numerical technique is open to members of the SG. An example of the proposed approach is based on a numerical solution of partial differential equations using a surface finite volume method. It leads to a semi-implicit numerical scheme of the nonlinear diffusion equation on a closed surface.

Objectives

- to develop numerical models for solving the geodetic BVPs using numerical methods like FEM, FVM, BEM and others,
- to investigate the problem of oblique derivative,
- to implement parallelization of numerical algorithms using the standard MPI procedures,
- to perform large-scale parallel computations on clusters with distributed memory,
- to investigate methods for nonlinear filtering of data on closed surfaces using the regularized Perona-Malik model or mean curvature flow model,
- to derive fully-implicit and semi-implicit numerical schemes for the linear and nonlinear diffusion equation on closed surfaces using the surface FVM,
- to develop algorithms for the nonlinear filtering of data on the Earth's surface,
- to summarize the developed methods and achieved numerical results in journal papers.

Program of activities

active participation in major geodetic conferences,
working meetings at international symposia,
organization of a conference session.

Membership

- Róbert Čunderlík (Slovakia), chair
- Karol Mikula (Slovakia), chair
- Ahmed Abdalla, New Zealand
- Michal Beneš (Czech Republic)
- Zuzana Fašková (Slovakia)
- Marek Macák (Slovakia)
- Otakar Nesvadba (Czech Republic)
- Róbert Špir (Slovakia)
- Róbert Tenzer (New Zealand)

JSG 0.8: Earth System Interaction from Space Geodesy

Chair: S. Jin (China)
Affiliation: Comm. 2, 3 and 4

Introduction

The gravity field and geodetic mass loading reflect mass redistribution and transport in the Earth's fluid envelope, and in particular interactions between atmosphere, hydrosphere, cryosphere, land surface and the solid Earth due to climate change and tectonics activities, e.g., dynamic and kinematic processes and co-/post-seismic deformation. However, the traditional ground techniques are very difficult to obtain high temporal-spatial resolution information and processes, particularly in Tibet.

With the launch of the Gravity Recovery and Climate Experiment (GRACE) mission since 2002, it was very successful to monitor the Earth's time-variable gravity field by determining very accurately the relative position of a pair of Low Earth Orbit (LEO) satellites. Therefore, the new generation of the gravity field derived from terrestrial and space gravimetry, provides a unique opportunity to investigate gravity-solid earth coupling, physics and dynamics of the Earth's interior, and mass flux interaction within the Earth system, together with GPS/InSAR.

Objectives

- To quantify mass transport within the Earth's fluid envelope and their interaction in the Earth system.
- To monitor tectonic motions using gravimetry/GPS, including India-Tibet collision, post-glacial uplift and the deformation associated with active tectonic events, such as earthquakes and volcanoes.
- To develop inversion algorithm and theories in a Spherical Earth on gravity field related deformation and gravity-solid Earth coupling, e.g. crust thickness, isostatic Moho undulations, mass loadings and geodynamics.
- To develop methods to extract a geodynamic signals related to Solid-Earth mantle and/or core and to understand the physical properties of the Earth interior and its dynamics from the joint use of gravity data and other geophysical measurements.
- To analyze and model geodynamic processes from isostatic modelling of gravity and topography data as well as density structure of the Earth's deep interior.
- To address mantle viscosity from analyzing post-seismic deformations of large earthquakes and post-glacial rebound (PGR) and to explain the physical relationships between deformation, seismicity, mantle dynamics, lithospheric rheology, isostatic response, etc.
- To achieve these objectives, the IC SG interacts and collaborates with the ICCT and all IAG Commissions.

Program of Activities

- Organization of SG workshop and of conference sessions,
- Participation in related scientific conference and symposia,
- Supporting contributions to the ICCT activities.

Membership

- Shuanggen Jin (China)
- David J. Crossley (USA)
- Carla Braitenberg (Italy)
- Isabelle Panet (France)
- Jacques Hinderer (France)
- Séverine Rosat (France)
- Tonie M. van Dam (Luxembour)
- Urs Marti (Switzerland)
- Patrick Wu (Canada)
- Isabella Velicogna (USA)
- Nico Sneeuw (Germany)

JSG 0.9: Future Developments of ITRF Models and their Geophysical Interpretation

Chair: A. Dermanis (Greece)
Affiliation: Comm. 1 and IERS

Terms of Reference

The realization of a reference system by means of a reference frame, in the form of coordinate time series or coordinate functions for a global set of control stations is a complicated procedure. It involves input data from various space techniques each one based on its own advanced modelling and observation analysis techniques, as well as, criteria for the optimal selection of the time evolution of the reference frame among all data compatible possibilities.

The relevant "observed" coordinate time series demonstrate significant signals of periodic, non-periodic variations and discontinuities, which pose the challenge of departing from the current ITRF model of linear time evolution, realized by reference epoch coordinates and constant velocities.

The remaining residual signal in coordinate variations is dominated by an almost periodic term with varying amplitude and phase, especially in the height component. The inclusion of additional terms in the ITRF model is an intricate problem that deserves further research and careful planning.

It is also important to understand the nature of these coordinate variations in order to adopt models that are meaningful from the geophysical point of view and not a simple fit to the observed data.

Since geophysical processes causing coordinate variations also cause variations in the gravity field, it is worthwhile to investigate the possibility of incorporating result results from space gravity missions in ITRF modelling.

The working group is primarily aiming in identification of new ITRF models, investigation of their performance and motivation of relevant scientific research.

Objectives

- Geophysical interpretation of non-linear coordinate variations and sevelopement of relevant models
- Extension of ITRF beyond the current linear (constant velocity) model, treatment of periodic and discontinuous station coordinate time series and establishment of proper procedures for estimation of extended ITRF parameters and quality assessment of the obtained results.

Program of Activities

- Launching of a web-page for dissemination of information, presentation, communication, outreach purposes, and providing a bibliography.
- Working meetings at international symposia and presentation of research results in appropriate sessions.
- Organization of workshops dedicated mainly to problem identification and motivation of relevant scientific research.
- Organization of a second IAG School on Reference Frames.

Membership

- A. Dermanis (Greece), chair
- Z. Altamimi (France)
- X. Collilieux (France)
- H. Drewes (Germany)
- F. Sansò (Italy)
- T. van Dam (Luxembourg)

Global Geodetic Observing System (GGOS)

http://www.ggos.org

Chair of the GGOS Coordinating Board: **Hansjörg Kutterer** (Germany)
Acting Vice-Chair of the GGOS Coordinating Board: **Ruth Neilan** (USA)
Director of the GGOS Coordinating Office: **Guiseppe Bianco** (Italy)

Preamble

The proposal for the Global Geodetic Observing System (GGOS) was developed by the GGOS planning group between 2001 and 2003 according to the Bylaws of the International Association of Geodesy (IAG). The proposal was accepted by the IAG Executive Committee and the IAG Council at their meetings during the XXIII IUGG General Assembly in Sapporo in July 2003. GGOS was endorsed by the IUGG through Resolution No. 3 at the same General Assembly.

Changes in the IAG Bylaws in 2007 resulted in GGOS being recognized as an integral component of IAG along with Services and Commissions. As a historical note, this transformed the status of GGOS from that of an IAG Project to an IAG component. Specific to the GGOS is IAG Bylaw numbers 1(d) and 15.

During 2009-2011, revisions to the structure of GGOS were discussed leading to these 2011 Terms of Reference, primarily to streamline the organizational structure of GGOS.

In February 2011, GGOS Executive Committee, with additional participants, conducted a strategic planning retreat that led to defining the vision, mission, goals and tasks of GGOS for the coming five years. In parallel, the GGOS Terms of Reference were being revised primarily to streamline the governance structure of GGOS. Both documents were approved by the GGOS Steering Committee at its meeting in Melbourne, Australia during the XXV General Assembly of IUGG, July 2011. The IAG Executive Committee then approved the new Terms of Reference (ToR) at its business meetings during IUGG. The ToR are located at http://www.ggos.org.

Vision of GGOS

According to the IAG Bylaws 1(d) "*The Global Geodetic Observing System works with the IAG components to provide the geodetic infrastructure necessary for monitoring the Earth system and global change research"*. The vision is "*Advancing our understanding of the dynamic Earth system by quantifying our planet's changes in space and time"*.

Mission of GGOS

We live on a dynamic planet in constant motion that requires long-term continuous quantification of its changes in a truly stable frame of reference.

The mission of GGOS is:

1. To provide the observations needed to monitor, map and understand changes in the Earth's shape, rotation and mass distribution.
2. To provide the global frame of reference that is the fundamental backbone for measuring and consistently interpreting key global change processes and for many other scientific and societal applications.
3. To benefit science and society by providing the foundation upon which advances in Earth and planetary system science and applications are built.

Recent Activities

With the approval of the new GGOS ToR, we are in the process of implementing the new structure and establishing the necessary elements according to the ToR (Figure 1). As part of this transition, a GGOS retreat is planned for early 2012. One focus of this retreat will be to consider further the role of GGOS within IAG and how to develop the integration of IAG elements within GGOS.

The former GGOS Executive Committee is supporting the newly appointed Chair during this transition period until the GGOS Coordinating Board (CB) is fully established. This is expected to take another six months. During this time, the GGOS Consortium members are being identified. The GGOS consortium then will nominate and elect six open positions on the CB. Once these are filled, the CB will then elect three Members-at-Large to balance the CB for geography and expertise. Once the CB approves those members, then the election of the Vice-Chair can take place and the Chair will then propose the new GGOS Executive Committee.

The plan is to harmonize the GGOS structure and schedule with the IAG schedule of elections every four years. Note that the appointment of the GGOS Chair remains a responsibility of the IAG EC in consultation with the GGOS CB.

The three themes of GGOS: Unified Height System, Geohazards and Sea Level Variability will be a primary focus

for GGOS over the coming four years as these were identified in 2010 as themes that require cross-cutting disciplines and techniques with GGOS, as well as potentials for new partnerships.

The Committee on Earth Observation Satellites (CEOS) met during the week of November 7, 2011, in Lucca, Italy. GGOS made an application to become an associate member of CEOS and was unanimously accepted. GGOS principals are now exploring how best to engage with CEOS and what areas are of mutual benefit between CEOS and GGOS components.

GGOS is also looking towards establishing links with strategic partners and broadening the outreach and development of GGOS. This is demonstrated in one example through our participation and exhibit at the Group on Earth Observations VIII in Istanbul, Turkey Nov. 15-17, 2011. The Chair made a statement to the plenary on the recent activities and directions of GGOS, while a new GGOS exhibit was well received by the attendees.

Key Goals and Tasks of GGOS

The goals of GGOS are:

1. To be the primary source for all global geodetic information and expertise serving society and Earth system science.
2. To actively promote, sustain, improve and evolve the global geodetic infrastructure needed to meeting Earth science and societal requirements.
3. To coordinate the international geodetic services that are the main source of key parameters needed to realize a stable global frame of reference and to observe and study changes in the dynamic Earth system.
4. To communicate and advocate the benefits of GGOS to user communities, policy makers, funding organizations, and society.

In order to accomplish its mission and goals, GGOS depends on the IAG Services and Commissions. The Services provide the infrastructure and products on which all contributions of GGOS are based. The IAG Commissions provide expertise and support for the scientific development within GGOS. In summary, GGOS is IAG's central interface to the scientific community and to society in general.

IAG is a Participating Organization of the Group on Earth Observations (GEO). GGOS acts on behalf of the IAG in GEO and actively contributes to the Global Earth Observation System of Systems (GEOSS).

GGOS addresses relevant science issues related to geodesy and geodynamics in the 21st century, but also issues relevant to society (including but not limited to management of natural resources, natural hazards, global risk management, monitoring of climate change and related phenomena, ocean forecasting and sea level projections, early warning of severe storms, tsunamis, other hazards, and space weather). It is an ambitious program of a dimension that goes beyond IAG, requiring a strong cooperation within the geodetic and Earth science communities, and externally, to related endeavors and communities.

Tasks of Goal 1:

To be the primary source for all global geodetic information and expertise serving society and Earth system science.

a. Identify the components and themes of GGOS needed to plan and meeting evolving user requirements and to provide crucial data and information to the user.
b. Define and implement internal and external interfaces needed for technical and organizational efficiency.
c. Evaluate and review the current GGOS organization and structure.
d. Develop mechanisms for regular review of GGOS quality and performance, including that of its data and products.
e. Expand and broaden user communities by conducting impact studies and organizing joint workshops and symposia.
f. Provide a unique point of access to the user community by creating and maintaining the GGOS portal.

Tasks of Goal 2:

To actively promote, sustain, improve and evolve the global geodetic infrastructure needed to meeting Earth science and societal requirements.

a. Provide the scientific basis for the necessary global geodetic infrastructure, including establishing requirements for station distribution and data quality.
b. Provide a forum for inter-service communication and exchange of information about current activities, infrastructure performance and future plans.
c. Identify major infrastructure deficiencies and propose remedies to the geodetic and user communities and appropriate entitles including the GGOS Interagency Committee (GIAC).
d. Support requests of stations, agencies and other organizations for resources.
e. Advocate for the establishment of geodetic fundamental stations with potential sponsors.
f. Advocate for relevant space-based components including operational chains of geodetic missions like gravity, altimetry, and SAR missions to provide spatial and temporal coverage of continuous and episodic changes in the dynamic Earth system.

Tasks of Goal 3:

To coordinate the international geodetic services that are the main source of key parameters needed to realize a

stable global frame of reference and to observe and study changes in the dynamic Earth system.

a. Improve the interaction and communication amongst GGOS, and IAG Services and Commissions by defining appropriate linkages, organizing inter-Service workshops and, when appropriate, holding joint or co-located GGOS EC and Service GB/DB meetings.
b. Reform the GGOS governance structure in order to facilitate the execution of the Science Themes, manage the relationships between the IAG Executive, GGOS EC, the Services and the Commissions, fulfill GGOS's role in outreach, represent GGOS at forums such as GEO, and other activities as may be tasked.
c. Identify data and product gaps, integrated products, additional Service and Commission components and, if necessary, new Services and Commissions that are needed to fully address the requirements of the GGOS Science Themes.
d. Establish and promote the use of reference frames, common standards and models, open data access, geodetic expertise and information, and even methodologies where appropriate, so as to ensure reliable, consistent and high-quality data and products for the geoscientific community.
e. Promote combination analyses and integrated product generation across Services and Commissions, especially from co-located geodetic sites, in order to address the requirements of the GGOS Science Themes.
f. Promote a culture of continuous quality improvement of the geodetic infrastructure, analysis center operations, effectiveness of the GGOS structural components, and of the generated GGOS data and products.

Tasks of Goal 4:

To communicate and advocate the benefits of GGOS to user communities, policy makers, funding organizations, and society.

a. Organize meetings about GGOS activities and participate in GEO meetings, user community events, conferences, workshops, symposia, etc.
b. Identify GGOS requirements in terms of infrastructure and workforce and interact with funding authorities, national and international and space agencies to advocate the importance of meeting these requirements.
c. Promote the development and submittal to funding agencies of proposals that advance the goals of GGOS.
d. Involve young scientists by means of GGOS scholarships and grants through national and international projects.
e. Foster geodetic educational programs within universities, schools and research organizations.
f. Strengthen outreach capabilities demonstrating GGOS benefits by means of case studies and success stories; release a short GGOS movie to be presented and distributed for educational purposes.
g. Review the respective roles of GGOS and the GIAC.
h. Improve the recognition and visibility of GGOS within GEO, ICSU, COPUOS, CEOS, COSPAR and other organizations.

Overview of GGOS Structural Elements

The organizational structure of GGOS is comprised of the following key elements:

1. **GGOS Consortium** – is the collective voice for all GGOS matters. It will meet annually as possible. The elements of GGOS have the flexibility to determine and designate two representatives to the GGOS Consortium as each (Service, Commission, or other entity) decides. The Consortium is to be comprised of the Chairs of Services and the Directors of the Service's central offices or Central Bureaus; Presidents and Vice-Presidents of IAG Commissions, and other entities essential to GGOS as determined by the Consortium. The GGOS Consortium is the nominating and electing body of elected positions on the GGOS Coordinating Board as noted below. The Chair of GGOS shall act as the Chair of the GGOS Consortium.
2. **GGOS Coordinating Board** – is the central oversight and decision-making body and represents the IAG Services, Commissions and other entities (see below).
3. **GGOS Executive Committee** – serves at the direction of the Coordinating Board to accomplish day-to-day activities of GGOS tasks.
4. **GGOS Science Panel** – advises the Coordinating Board and represents the geodetic and geoscience community.
5. **IAG Services, Commissions and relevant Inter-Commission Committees** – are the fundamental elements comprising GGOS.
6. **GGOS Working Groups and Themes** – address overarching issues common to several or all IAG components, and are a mechanism to bring the various activities of the Services and Commissions together, or to link GGOS to external organizations. Themes are cross-disciplinary and address specific areas where GGOS contributors work together to address broader and critical issues.
7. **GGOS Coordinating Office** – coordinates the work within GGOS and supports the Chairs, the Executive Committee and the Coordinating Board**.**
8. **Bureau for Standards and Conventions** – tracks, reviews, examines, evaluates all actual standards, constants, resolutions and conventions adopted by IAG or its components and recommends their further use or proposes the necessary updates.
9. **Bureau for Networks and Communications** – develops a strategy to design, integrate and maintain the fundamental geodetic infrastructure including communication and data flow.

Details of the Structure of GGOS

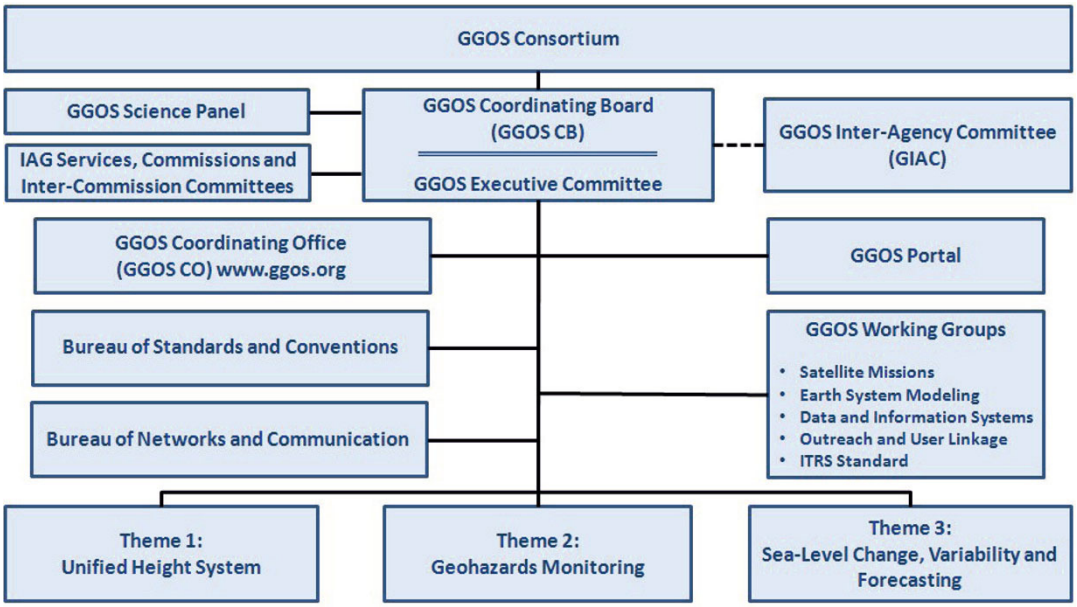

Figure 1: GGOS Organization Chart 2011

1. GGOS Consortium

The GGOS Consortium is the voice and essentially the large steering committee of GGOS. It reviews the GGOS progress, activities, and nominates and votes for the candidates for the elected positions on the GGOS Coordinating Board.

The GGOS Consortium is comprised of two designated representatives from each IAG component, which designate their representatives. The Chair of the Service Governing or Directing Board, and the Director of the Central Bureau or Coordinating Office, the Commission Presidents and Vice Presidents may be those designated members, however, no person can represent two components (but no one may have more than one vote). The Chair of the GGOS Consortium is the presiding Chair of GGOS. GGOS Consortium decisions are based on consensus. Decisions requiring a vote are decided by simple majority of the votes cast. The quorum is when at least one half of members are present, but electronic voting is acceptable provided a quorum responds.

The process for elections to the GGOS Coordinating Board will coincide with IAG's schedule for elections, calling for nominations and elections 3 months prior to the four-year IAG General Assembly, which takes place during the IUGG General Assembly (see IAG Bylaws). Candidates nominated to serve on the CB must be members of the GGOS Consortium. However, the GGOS Chair is appointed by the IAG Executive Committee in consultation with the GGOS Coordinating Board, and is not appointed by the IAG Council (see IAG Bylaws: 15 (d) and 31-a-ii).

2. GGOS Coordinating Board

The Coordinating Board is the decision making body of GGOS. Decisions, to the extent possible, are based on consensus. Decisions requiring a vote are decided by simple majority of the votes cast. The quorum for a valid vote is participation of one half of the voting members of the Coordinating Board. Votes may be held at meetings or by appropriate electronic means at the discretion of the GGOS Executive Committee. The Coordinating Board will meet at least once yearly, although twice yearly is preferable.

Coordinating Board Members (voting members):

• GGOS Chair (ex-officio, votes in case of a tie)	1
• GGOS Vice-Chair (ex-officio)	1
• Chair of GGOS Science Panel (ex-officio)	1
• Head, Coordinating Office (ex-officio)	1
• Directors of GGOS Bureaus (ex-officio)	2
• IAG President or design. representative (ex-officio)	1
• Service Representatives (elected by Consortium)	4
• Commissions Representatives (elected by Consort.)	2
• Members-at-Large (elected by GGOS CB)	3
Total Voting Members	16

Coordinating Board Members (non-voting members):

• Chairs of GGOS Working Groups + (or more, ex-officio)	1
• Theme Chairs (ex-officio)	3
• GGOS Portal Manager (ex-officio)	1
• Immediate Past Chair of the CB (ex-officio)	1
• Representative of the GIAC/GIC (ex-officio)	1
Total Non-Voting Members	7
Total Membership of the Coordinating Board (plus any approved observers)	23

The chair of the GGOS Coordinating Board is determined according to the IAG Bylaws (IAG Bylaw 15 (d)). The Chair of the GGOS CB is also known as the GGOS Chair. The CB elects the Vice-Chair of the GGOS CB.

The Members-at-large are to balance the Coordinating Board with regard to geographical region or unique capability. The Chair, with the assistance of the Coordinating Office, appoints an Election Committee to organize the voting process and to ensure availability of the nominated candidates. The Election Committee presents the final list of nominations for the Members-at-large to the CB for a vote.

3. GGOS Executive Committee

The GGOS Executive Committee (EC) is composed of the following members:

• GGOS Chair	1
• Vice-Chair	1
• Voting Members of the CB selected for the EC	3
Total	5

The GGOS Chair biennially submits his/her list of the three GGOS members for the EC to the GGOS CB for approval. EC candidates recommended by the Chair must be voting members of the CB.

The immediate Past Chair of GGOS, Director of the Coordinating Office, the Chair of the GGOS Science Panel, and the President of IAG are permanent guests at meetings of the Executive Committee. Other observers may be invited to attend EC meetings (usually teleconferences) as needed.

4. GGOS Science Panel

The GGOS Science Panel is an independent and multi-disciplinary advisory board that provides scientific support to the GGOS steering and coordination entities.

The GGOS Science Panel is composed of up to 7-12 members. Members are based on recommendations from the GGOS community and candidates are approved by the CB.

The Science Panel will elect its own Chair to be approved by the CB.

5. Services, Commissions, Inter-Commission Committees

GGOS works with these IAG components to provide the geodetic infrastructure necessary for monitoring the Earth system and global change research. GGOS respects the by-laws and terms of reference for these essential components. GGOS is built on the existing IAG Services and their products. GGOS is not taking over tasks of the existing, and well working IAG Services. GGOS will provide a framework for existing or future Services and strive to ensure their long-term stability.

6. GGOS Working Groups and Themes

GGOS Working Groups (WG) are established by the Coordinating Board as needed. The Coordinating Board appoints the chair of any WG. A charter for each WG will be prepared and approved by the GGOS Coordinating Board. The members of WGs are nominated by the WG Chair and confirmed by the Coordinating Board. GGOS Working Groups can be set up for limited periods of time or as standing Working Groups. Themes are cross-disciplinary and meant to consider gaps and needed future GGOS products. The GGOS CB approves the themes. The CB appoints theme chairs. Themes outline their purpose and propose a work plan to address any noted gap to be addressed by the particular theme focus.

7. GGOS Coordinating Office

The GGOS Coordinating Office (CO) performs the day-to-day activities in support of GGOS, the Executive Committee, the Coordinating Board and the Science Panel, and ensures coordination of the activities of the various components. The CO ensures information flow, maintains documentation of the GGOS activities and manages specific assistance functions that enhance the coordination across all areas of GGOS, including inter-services coordination and support for workshops. The CO in its long-term coordination role ensures that the GGOS components contribute to GGOS in a consistent and continuous manner and adhere to GGOS standards. The CO also maintains, manages and coordinates the GGOS Web presence.

The GGOS Portal is an important additional web presence that provides a unique access to all GGOS data sets and products.

8. Bureau for Standards and Conventions

The Bureau for Standards and Conventions keeps track of the strict observations of adopted geodetic standards, standardized units, fundamental physical constants, resolutions and conventions in all official products provided by the geodetic community. It reviews, examines and evaluates all actual standards, constants, resolutions and conventions adopted by IAG or its components, and recommends further use or proposes the necessary updates. It identifies eventual gaps in standards and conventions and initiates steps to close them with, e.g., resolutions by the IUGG and/or IAG Councils.

9. Bureau for Networks and Communications

The Bureau for Networks and Communications develops a strategy to design, integrate and maintain the fundamental infrastructure in a sustainable way to satisfy the long-term (10 - 20 years) requirements identified by the GGOS Science Panel. Primary emphasis must be on sustaining the

infrastructure needed to maintain the evolving global reference frames, while at the same time ensuring the broader support of the scientific applications of the collected data. Coordinating and implementing the GGOS co-located station network is a key focus for 2010-2020.

10. GGOS Inter-Agency Committee (GIAC)

The purpose of the GIAC is to provide a forum for coordination and support for the development, implementation and operation of those components of the GGOS, whose infrastructure is operated by governmental institutions.

The GIAC supports the IAG Services, particularly those involved in the establishment, maintenance and enhancement of the geodetic infrastructure, observing systems and the International Terrestrial Reference Frame (ITRF) in a sustainable and a cost-efficient way. Furthermore, GIAC members underpin geodetic research activities coordinated by the GGOS Science Committee by providing world class geodetic infrastructure.

The GIAC is a forum that seeks to generate a unified voice to communicate with Governments and Intergovernmental organisations (GEO, UN bodies) in all matters of global and regional spatial reference frames and GGOS research and applications.

According to its Terms of Reference the GIAC coordinates the common efforts of its governmental member organisations to meet the requirements of global geodetic programs, in particular, the terrestrial reference frame, IAG services and capacity building. It supports members to obtain the resources needed for their geodetic observing infrastructure and it maintains liaison with IAG/GGOS regarding GGOS application and research needs.

The GIAC takes into account the special needs and interests of developing countries, including in particular the need to further the capabilities of these countries in geodetic observations for the realization and sustainability of global and regional spatial reference frames and related technology. In the perspective, the GIAC works on the creation of a GGOS Intergovernmental Committee and to explore possibilities to join existing international organisations to serve common interests.

Program of Activities

Working Groups

WG 0.1 Satellite Missions

Chairs: Isabelle Panet (France), Roland Pail (Germany)

The GGOS Satellite Mission Working Group was established in December 2008 with its primary objectives to investigate rationale and interest from the geodetic community to establish a GGOS Bureau of Satellite Missions. An initial Terms of Reference has been drafted. Since early 2011, there are 20 members (see at the end of this section), including the Chairs, I. Panet and R. Pail.

Key objectives

- To assess the satellite mission infrastructure at an international level relevant for achieving the goals of GGOS and make recommendations for needed missions,
- To advise and support proposed missions relevant to GGOS,
- To advocate new satellite mission proposals appropriate to advance GGOS objectives,
- To provide outreach for geodetic satellite missions,
- To facilitate the use of satellite products for users,
- To interface with the other entities, including IAG, GGOS, CEOS, GEO and space agencies, with regard to promoting satellite missions and their data products for scientific and public use.

The working group at present will address only Earth observation missions relevant for the GGOS goals.

Actions 2011 – 2015

- Analysis of satellite infrastructure
  - Identification of observational gaps for critical satellites
  - Proposing needed concepts for future missions
- Focus particular types of satellite mission for advocacy
- Realization of the access to satellite products for users
  - Historical data access
  - Documentation, links to complementary datasets
  - Thematic pages
  - Provide Working Group information to GGOS portal
- Provide inputs on the scientific relevance of proposed missions in the context of GGOS goals
- Plan and continue to undertake setting up of interfaces to CEOS and other relevant organisations
- Rationalizing the possible establishment of the Bureau of Satellite Missions

Members

- Bettadpur Srinivas (USA)
- Biancale Richard (France)
- Chao (Benjamin (Taiwan)
- Cho Sungki (Korea)
- Flechtner Frank (Germany)
- Fotopoulos Georgia (Canada)
- Fukuda Yoichi (Japan)
- Hwang ,Cheinwey (Taiwan)
- Knudsen Per (Denmark)
- Matsumoto Koji (Japan)
- Müller Jürgen (Germany)
- Nerem R. Steve (USA)
- Pail Roland (Germany; co-chair)
- Panet Isabelle (France; co-chair)
- Ping Jinsong (China)
- Shum C.K. (USA)
- Sideris M. (Canada)
- Sneuuw Nico (Germany)
- Joong-Sun Won (Korea)
- Min Zhong (China)

WG 0.2 Earth System Modelling

Chair: Maik Thomas (Germany)

The major goal of the Working Group is the preparation of a physically consistent unconstrained numerical Earth system model focussing on near-surface fluid dynamics. This modular model is expected to allow a homogeneous processing, interpretation, and prediction of geodetic parameters, i.e., Earth rotation, gravity field and deformation, and, thus, to finally contribute to a deeper understanding of dynamical processes in the Earth system reflected in geodetic observables.

Tasks 2011 – 2015

- Selection of appropriate models for the representation of dynamics of the individual near-surface sub-systems, such as atmosphere, oceans, continental hydrosphere, cryosphere, and lithosphere;
- Development of a strategy to ensure physical consistency, in particular mass balance;
- Definition and implementation of standard modules to derive individual contributions to variations of geodetic quantities;
- Identification of relevant interactions among sub-systems as well as of appropriate parameterizations for their numerical consideration.

Objectives 2011 – 2015

Within the period 2011-2015, the main objective is to prepare an unconstrained version of a modular Earth system model of near-surface dynamics. The system model approach has to be designed in such a way that it

- ensures consistent (passive) interactions and physical fluxes among sub-systems,
- is applicable to all geodetic quantities (rotation, gravity field, surface geometry),
- allows self-consistent predictions of geodetic parameters,
- can be used for interpretation and cross-validation of different data sets.

WG 0.3 Data and Information Systems

Chair: Bernd Richter (Germany)

The tasks for data and information (D/I) handling, management and the GGOS Portal fall under the purview of the GGOS Data and Information Working Group. This action plan will address actions for populating and maintaining the portal and metadata standards for capturing information from contributing data centers.

Objectives

The main objective of the D/I handling and management activity is to implement and maintain the GGOS Portal, the access point for all GGOS products.

Actions 2011 – 2015

- Review the proposed portal structure and in particular the list of topics and their associated sub items. Provide text (both brief and long descriptive text) and illustrations for each topic. (GGOS Steering Committee, Science Panel);
- Identify key personnel to coordinate input for these sections of the portal. (GGOS Steering Committee, Science Panel, IAG Services);
- Complete draft of GGOS metadata catalog, review, and distribute to GGOS Steering Committee. (DIWG)
- Conduct monthly Data and Information Working Group telecons to coordinate activities and address actions. (DIWG);
- Implement metadata structures at GGOS contributing data centers (e.g., CDDIS, etc.) and fill the GGOS Portal metadata base for search and other applications. (IAG services);
- Ensure currency of GGOS Portal by continued review and update. (DIWG, SC, SP);
- Implement web features at the GGOS Portal when necessary, e.g. WMS, WFS (DIWG, Portal Manager).

WG 0.4 Outreach and User Linkage

Chair: Guiseppe Bianco (Italy)

The GGOS Component "Outreach" [OR] is chaired by the GGOS Coordinating Office (CO) and managed by the Working Group on Outreach and Education (WG on O&E), approved during the GGOS Steering Committee meeting held in San Francisco on December 11th, 2010; its scope and duties have been discussed during the GGOS Retreat held in Zurich, February 2-4, 2011.

Objectives

Objectives of the Outreach component must take into account GGOS 2020 Recommendation 1.3 (GGOS 2020, p. 283):

"Recognizing that society to a large extent is not aware of the vital role played by geodesy for realizing a sustainable development, and that educational aspects are extremely important (because they have the greatest implication on societal behavior) in order to prepare future generations to make use of the full benefits of geodesy, it is recommended that IAG and GGOS make dedicated outreach efforts to science and society at large with the goal to promote geodesy's role in reaching sustainable development and to integrate this role of geodesy appropriately into education."

Actions 2011 – 2015

Short term actions

- Finalization of the GGOS Outreach Document:
- Planning and design of GGOS Monographs, possibly finalizing the first prototype
- GGOS web site updating (continuous)

GGOS Monographs are short yet complete documents, targeted to non-specialized public, designed to clearly describe the role of geodesy in reaching sustainable development. Monographs may be devoted to specific earth science fields, such as oceanography, crustal deformations, and so on, or to societal issues such as hazard mitigation, water scarcity, global warming, and so on.

Mid-term actions:

- Multimedial monographs production
- Approach and collaboration with international science magazines, TV channels, to promote geodesy
- Approaching ministries of education/research to promote geodesy into curricula of all levels

WG 0.5 ITRS Standard

Chair: Claude Boucher (France)

This Working Group develops a concept for a potential ISO Standard concerning the global geodetic reference system, with ITRS being a prime candidate. It also provides experts to its actual implementation within ISO

Objectives 2011-2015

- Support to the drafting of an ISO standard related to ITRS
- Contribute to the report on geodetic references to be written within ISO TC211 "Geographic information/ Geomatics" following a NWIP submitted by France
- Support of the formal NWIP related to the ITRS standard to be submitted to TC211 in due time.

Bureau for Standards and Conventions

Chair: Detlef Angermann (Germany)

The Bureau for Standards and Conventions (BSC) supports GGOS in its goal to obtain products of highest accuracy, consistency, temporal and spatial resolutions, and referring to a unique reference frame stable over decades.

Objectives

The overall goal is to ensure consistency between products generated by the different IAG services, especially between geometric and gravimetric products, by defining common standards and conventions and consistent modelling, parameterization and analysis strategies. Main objectives of the BSC are:

- Evaluate the geodetic standards and conventions currently in use by all the IAG Services for the generation of geodetic/geophysical products;
- Propagate all geodetic standards and conventions to geodetic and general scientific communities and urge their common use;
- Maintain regular contact with all internal and external institutions involved in the adoption of standards, resolutions and conventions;
- Perform administrative tasks, communications and web support in cooperation with the GGOS Coordinating Office.
- Report regularly to the GGOS Coordinating Board and to the IAG Executive Committee, and – if necessary or appropriate – to the IUGG Executive Committee.

Actions 2011 – 2015

- Numerical standards: Compilation of numerical and processing standards currently used.
- Inconsistencies: Removal of inconsistencies in the IAG/ IERS conventions.
- Metadata: Develop – together with the GGOS Portal – consistent metadata for all products describing underlying standards and conventions.
- Software routines: Make available a set of validated software routines for transformation between tide systems and time systems.
- Standards and Conventions: Development of homogeneous consistent models and standards for the integration of data to combine geometric positioning with physical heights and Earth gravity field parameters.
- IGSN: An extension of standardization activities to a new International Gravity Standardization Network (IGSN) shall be considered.
- Global Geophysical Fluids: Investigations regarding geophysical background models (e.g., loading, dealiasing) shall be carried out in cooperation with the GGFC.

New GRS: Development of a new Geodetic Reference System (GRS) based on a consistent system of best estimates of major parameters related to a geocentric equipotential ellipsoid.

Bureau of Networks and Communication

Chair: Mike Pearlman (USA)

The Bureau provides oversight, coordination, and guidance for the development, implementation and operation of the GGOS Network of Core Sites. Elements of this role are:

- Promote communication and integration among Services;
- Develop and maintain a ground network station information base and data product directory;
- Monitor the development of prototype ground systems to understand performance and availability;
- Monitor network performance and advocate for maximum participation to maintain reference frame and other data product quality;
- Advocate the continued support and maintenance of the current geodetic networks and the implementation of upgraded and new field systems;
- Define the network requirements and scope the size and geometry of gravimetry and tide gauge ground networks; advocate for continued support, upgrade and expansion;
- Interface with upcoming missions to advocate for the best satellite technology to support the reference frame tasks;
- Advocate for reference frame connections through GNSS to other geodetic instruments including tide gauges, gravimeters, etc.
- Promote the formation of key partnerships to establish stations in present network gaps,
- Exploit synergistic opportunities to better integrate or co-locate stations with the infrastructure and communications networks of the many other Earth Observation disciplines.

Actions 2011 – 2015

- Continue development by the Services (VLBI2010, NGSLR, new generation GNSS receivers, modern DORIS ground systems and new satellites; retro arrays on GPS, etc;
- Continue outreach
  - Give presentations; meet with potential participants;
  - Pursue the "American Networks Concept" in the first half of 2011 (1 year);
  - Need to do something about Africa;
- Complete the simulation to scope the GNSS network (1 year);
- Develop Site Specification Document (1 year);
  - Complicated by lack of configuration uniformity;
- Work on the technical and operational issues;
  - Work with IERS WG on Inter-system vectors (co-location);
  - Communications requirement;
  - Multi-instrument control systems;
- Issue the CFP in concert with the GIAC (1 year);
- Strengthen our connection with the non-geometry geodesy techniques
- Characterize performance and trade-offs as the network builds up
- Implement the network

Themes

Theme 1: Unified Height System

Chairs: M. G. Sideris (Canada) and J. Ihde (Germany)

The objective of Theme 1 is the unification of the existing vertical reference systems around the world. This will be achieved through the definition and realization of a global vertical reference system that

- will support geometrical (ellipsoidal) and physical (normal, orthometric, geoidal) heights world-wide with centimetre precision (10^{-9}) in a global frame;
- will enable the unification of all existing physical height systems (i.e., all geopotential differences shall be referred to one and the same reference equipotential surface with potential W_o); and

- will provide high-accuracy and long-term stability of the temporal height changes (dh/dt, dH/dt, dN/dt) with 10^{-9} precision.

A World Height System (WHS) shall be realized with a global combined network, which will integrates at set of terrestrial reference stations high-precision absolute and relative gravity, leveling with gravity reductions, and GNSS and tide gauge observations. For this purpose, it will use contributions from all IAG Commissions, and the available databases, standards and infrastructure of the IAG/GGOS Services.

Planned activities

Short-Term:
Establish a global vertical reference surface and its geopotential value W_o.

1. Refinement of standards and conventions for the definition and realization of a WHS, including unification of standards and conventions that are used by the "geometric" and "gravity" Services of the IAG.
2. Establishment of a global vertical reference level. The work will be carried out by analysis centres for determining and monitoring the relationship between a conventional W_o and the potential of the level surface closely approximating the mean sea surface.

Medium-Term:
Develop GGOS products for the realization of a WHS.

3. Recommendation for a global vertical reference frame.
4. Guidelines/procedures for height system unification.
5. Development of a registry (metadata) containing the existing local/regional height systems and their connections to the global one.

Long-Term:
Maintain and use in practice the WHS.

6. Determination and modeling of the temporal changes of the vertical reference frame.
7. Update the Unified Global Height System definition and realization as needed, based on future improvements in geodetic theory and observations.
8. Servicing the vertical datum needs of other geosciences such as, e.g., hydrography and oceanography.

Efforts are currently underway to establish working groups and processing centres that will focus on one or more of the action items above. One such group is the already established JWG 0.1.1, whose program of activities is outlined below.

Joint Working Group of Theme 1

JWG 0.1.1: Vertical Datum Standardization

(joint with Commissions 1 and 2, and IGFS)

Chair: L. Sánchez (Germany)

Terms of Reference

During the last decades, many initiatives related to vertical datum unification have been developed in IAG. They are oriented to define and realize a global reference level and to determine the connection (transformation) of the local height datums to the global one, i.e. all physical heights (or geo-potential numbers) worldwide shall be referred to only one reference surface that is realized globally.
The main objective in the present period is to provide a reliable W_0 value to be introduced as the conventional reference level for the realization of the Global Height System. Although any W_0 value can arbitrarily be chosen, it is expected that this value is consistent with other defining parameters of geometric and physical models of the Earth. Activities will be based on the state-of-the-art data and methodologies, especially on the available representations of the Earth's surface and gravity field. Computations carried out will be documented in detail in order to guarantee the repeatability and reliability of the results. This documentation shall support the adoption of the obtained W_0 value as official IAG/GGOS convention. Another objective is to provide guidance on the usage of W_0 in practice, in particular for vertical datum unification.

Program of activities

1. To coordinate all individual initiatives for a unified W_0 determination: Groups working on the estimation of a global W_0 value shall be brought together in order to elaborate an inventory describing the methodologies, conventions, standards, and models presently applied in W_0 computations.
2. To refine the W_0 estimation: Each group shall perform a new W_0 computation following its own methodologies, but applying recent models (e.g. GOCE/GRACE gravity models, sea surface models derived from calibrated and combined satellite altimetry observations, etc.). This analysis shall also include an investigation about the time-dependence of W_0.
3. To propose a IAG/GGOS convention on W_0: It is expected that results obtained after applying the different methodologies considered in the previous item are very similar. After a rigorous reliability evaluation, a best estimate of W_0 shall be recommended.
4. To provide a standard about the usage of W_0 in the vertical datum unification: Based on the interchange of experiences within the WG, it is expected to generate a document describing the most appropriate strategy to connect (unify, transform) any local height system with the global W_0 reference level.

Members

- L. Sánchez (Germany), Chair
- J. Agreen (Sweden)
- R. Čunderlík (Slovakia)
- N. Dayoub (Syria)
- Z. Faskova (Slovakia)
- J. Huang (Canada).
- K. Mikula (Slovakia)
- P. Moore (United Kingdom)
- D. Roman (USA)
- Z. Šima (Czech Republic)
- V. Vatrt (Czech Republic)
- M. Vojtiskova (Czech Republic)
- Y. Wang (USA)

Theme 2: Geohazards Monitoring

Mitigating the impact on human life and property of natural hazards such as earthquakes, volcanic eruptions, debris flows, landslides, land subsidence, tsunamis, floods, storm surges, hurricanes and extreme weather is an important scientific task to which GGOS can make fundamental contributions. GNSS and InSAR can be used to monitor the pre-eruptive deformation of volcanoes and the preseismic deformation of earthquake fault zones, aiding in the issuance of volcanic eruption and earthquake warnings. GNSS can also be used to rapidly estimate earthquake fault motion, aiding in the modeling of tsunami genesis and the issuance of tsunami warnings. Gravity measurements can be used to track mass motion within volcanic conduits; and gravity and altimetric measurements can be used to track floodwaters in river basins.

Geodetic observations are essential for understanding the processes causing the hazard, for assessing the risks of the hazard, for monitoring the development of the hazard, for deciding whether or not to issue an early warning, and to support rescue and damage assessment activities.

The objective of Theme 2 is to improve the effectiveness of the geodetic community in supporting natural hazard identification, assessment, prioritization, prediction, and early warning. As an international organization, GGOS can be very effective as an advocate for the role of geodesy in understanding and mitigating natural hazards. GGOS can be an effective advocate for improving the geodetic data needed for natural hazards research including better spatial coverage, higher sampling rate, lower latency, and wider data availability, particularly of SAR and GNSS data. Finally, improved public outreach is needed to better educate and inform the public about the benefits of geodesy for geohazards monitoring.

Joint Working Group of Theme 2

JWG 0.2.1: New technologies for disaster monitoring and management

(joint with Commission 4)

Chair: I.D. Doukas (Greece)

Terms of Reference

United Nations International Strategy for Disaster Reduction (UNISDR) offers the following definition: “Disaster: A serious disruption of the functioning of a community or a society involving widespread human, material, economic or environmental losses and impacts, which exceeds the ability of the affected community or society to cope using its own resources”.

These facts demand actions and therefore they make indispensable the existence of dedicated methodologies and practices that serve for the prevention of environmental risks (in terms of protecting the citizens against the effects resulting from a disaster). So, these facts trigger off the launch of many initiatives throughout the world. Many related serious undertakings have targets such as: the assessment and reduction of urban vulnerability, the boost of information and knowledge exchange concerning the numerous topics and parameters involved into the extremely complicated domain of disasters.

Consequently, there is a very wide and dynamic field for investigation, studying and testing of available technologies, sensors, geosensors, methods, information systems, techniques etc., with a lot of potential.

Objectives

- To gather and register all kinds of disasters, either natural or man-made as a preparation to obtain a final reference base of study.
- To investigate, study and test any kind of available technologies, sensors, geosensors, methods, information systems (web-based or not), techniques etc. that could relate with Disaster Monitoring and risk management.
- To explore both the "Disaster Cycle" (Preparedness, Response, Recovery, Mitigation, Prevention) and the risk management domains, in order to detect where, how and what kind of the above mentioned new technologies could be infused to these domains.
- To dynamically record and register internationally existing disaster management systems, in order to have up-to-date information about the scene, the sophistication and the general advances in this field.
- To experiment with existing or new ideas, for ground based, water/marine based or airborne solutions, into

"standard fields" (Information Technology, Communication Technology, Space Technology).
- To experiment with new ideas into other fields that could appear as unconventional even as "exotic" (e.g. artificial intelligence, Simultaneous Localization and Mapping (SLAM), Simultaneous Localization, Mapping and Moving Object Tracking (SLAMMOT) etc.).
- To use Web-tools (web-site, social networks, blog etc.) in relation to the transmission, communication and propagation of information concerning risks, disasters.
- To attract most interesting cooperation with a variety of other scientific and/or professional institutes, organizations, groups.

Program of activities

- To use Web-tools (Web-site, social networks, blog etc.) in order to provide information about related bibliography, Web-links, events, and other activities of the group.
- To diffuse and promote research and collaboration (also by attracting interdisciplinary aspects), to disseminate of information, to organize and to participate in workshops, meetings, seminars, conferences, symposia (academic, public, professional domains).
- To support ICCT activities.

Members

- Ioannis (John) D. Doukas (Greece), chair
- Günther Retscher (Austria)
- Cheng Wang (China)
- Allison Kealy (Australia)
- Gyula Mentes (Hungary)
- Mikhail Kanevski (Switzerland)
- Melinda Laituri (USA)
- Jonathan Li (USA)
- Beniamino Murgante (Italy)
- Clement A. Ogaja (USA)
- Urbano Fra Paleo (Spain)

Theme 3: Sea-Level Change, Variability and Forecasting

Sea level rise and its impact on human habitats and economic well being have received considerable attention in recent years by the general public, engineers, and policy makers. A GGOS retreat in 2010 has identified sea level change as one of the cross-cutting themes for geodesy. The primary focus is to demonstrate the value of geodetic techniques to mitigation of sea level rise including studies of the impacts of its change over the world's coastal regions and islands, and to support practical applications such as sustainability. Theme 3 interacts with the other two Themes as well as with related GGOS Working Groups. Close cooperation will also be established with groups and organizations working in related fields. One major topic is the identification of gaps in geodetic observing techniques and to advocate additions in the GGOS monitoring network and Services where necessary.

Activities

Through a Call for Participation Theme 3 will progress with the following tasks:
- Identification or (re)-definition of the requirements for a proper understanding of global and regional/local sea-level rise and its variability especially in so far as they relate to geodetic monitoring provided by the GGOS infrastructure, and their current links to external organizations (e.g., GEO, CEOS, and other observing systems).
- Identification of organizations or individuals who can take forward each requirement, or act as points of contact for each requirement where they are primarily the responsibility of bodies not related to GGOS.
- Identification of a preliminary set of practical (as opposed to scientific) pilot projects, which will demonstrate the viability, and the importance of geodetic measurements to mitigation of sea-level rise at a local or regional level. This identification will be followed by construction of proposals for pilot projects and their undertaking.
- The immediate action and pending on the outcomes of the Call for Participation, will be to identify, establish or reaffirm leadership and members of the Theme.
-

In the long-term, the aim is to support forecasting of global and regional sea level for the 21st century. Special emphasis will be given to local and regional projects which are relevant to coastal communities, and which depend on the global perspective of GGOS.

Members

- T. Schöne (Germany)
- M. Tamisea (UK)
- C.K. Shum (USA)
- P. Woodworth (UK)

IAG Scientific Services

IAG Bibliographic Service (IBS)

http://www.bkg.bund.de

Chair: **Annekathrin Michlenz** (Germany)

Overview

The service is based on the literature database geodesy, photogrammetry and cartography (GEOPHOKA), which is maintained by the Federal Agency for Cartography and Geodesy, Branch Office Leipzig. Since 1984 there are stored literature entries. They cover the whole subject of geodesy, cartography and photogrammetry and the neighbouring files. Every year 1000 new entries are included into the database. In July 2011 the database comprises about 63 930 entries.

In addition to the Fast Bibliography within the IAG Newsletter of the Journal of Geodesy the IAG Bibliographic Service serves mainly to inform the geodesists who are associated in the IAG about current geodetic literature from all over the world.

For the IAG Bibliographic Service geodetic journals and other periodicals, publications of research institutes, manuals und text books as well as congress papers are analyzed. The documentalists choose such sources for the service which are relevant to the activities of the Sections, Commissions, Special Commissions und Special Study Groups.

These literature sources are available in the library of the Bundesamt für Kartographie und Geodäsie (BKG) (library symbols F128 and L191).

The topicality of the sources recorded in the IAG Bibliographic Service is dependent on the date of their arriving at the library of the BKG. German-language literature und conference proceedings on geodesy are processes as a rule within 3 weeks after receipt.

Each literature record contains:
- The bibliographic description of the source according to the commonly known rules.
- The descriptors in German. They inform about the content of the recorded source.
- In most cases an abstract, if possible in English. The abstracts are often taken from the source or are processes by the documentalist on the basis of the summary, the conclusions, or the list of contents of the source.

International Altimetry Service (IAS)

http://iag.dgfi.badw.de

Chair: **Wolfgang Bosch** (Germany)

Preamble

In the past two decades satellite altimetry has evolved to an operational remote sensing technique with important interdisciplinary applications. For geodesy, the precise and near global mapping and monitoring of the ocean surface is of particular importance. As the ocean surface is nearly coinciding with an equipotential surface of the Earth gravity field satellite altimetry contributes to essential improvements of the Earth gravity field. Even with the dedicated gravity field missions GRACE and GOCE, satellite altimetry will remain the basic source for the determination of the high resolution marine gravity field. The sampling of short-term tidal variations is possible by sufficient long altimetry time series and allows the empirically estimate ocean tide models which in turn are required to correct any geodetic space techniques. Mapping and monitoring of seasonal and secular changes of the mean sea level helps to understand fundamental processes of the System Earth: the ocean water mass redistribution, one component of the global hydrological cycle, has impact to the Earth centre-of-gravity, to Earth rotation by the ocean angular momentum functions, the temporal variations of the Earth gravity field, as well as to studies on regional sea level changes and the global sea level rise. Finally the discrimination between the ocean surface and the geoid leads to improved knowledge on the dynamic ocean topography which does not only allow to infer mass and heat transfer in the ocean but also helps to globally unify height reference systems. In summary satellite altimetry is a space technique with fundamental application to geodesy and other geosciences. It has to be a basic component of the Global Geodetic Observing System.

Following endorsements by GLOSS, IAPSO and IAG the **International Altimetry Service** was established as IAG initiative. IAS recognizes that there are already many organisations providing altimeter data and value-added products of geophysical and geodetic relevance. The IAS initiative is meant to be non-competitive, but open to identify and pool together all efforts which contribute to geodetic applications of satellite altimetry. Moreover, IAS will try to initiate projects completing or gradually improving existing services for the benefit of geodetic and geophysical applications at large.

IAS General Objectives

The general objectives of IAS shall be:

- to provide general information on satellite altimetry necessary to promote and support geodetic applications;
- to communicate with, and interface to, providers of altimeter mission data, centres which process, archive, and analyse altimeter data, and other related services and organizations;
- to promote satellite altimetry as a core element of Global Geodetic Observing Systems;
- to support the generation, comparison and validation of altimetry based products which are of particular impact to the geodetic user community and
- to help compile and analyse altimeter data, and respond to specific requirements of geodetic users.

The IAS accomplishes its mission by:

- collaborating as appropriate with space agencies, processing centres, research institutes and altimetry experts;
- establishing a web site compiling basic information on satellite altimetry, its data, products and applications as given by data providers, archive and product centres, research laboratories and experienced users;
- supporting users to read, transform, and apply data and products, to assess data and product quality and to compare similar products generated by different organisations.
- establishing pilot projects which will solve, enhance or expand various needs of geodetic users on altimetry data and products,
- considering consolidated procedures for generating value-added altimeter products which may become permanent components of the International Altimeter Service; and
- reporting to IAG, IAPSO, GLOSS, GOOS, GGOS, GEOSS and other bodies related to satellite altimetry on the status, achievements and plans of the altimetry service.

International Bureau on Weights and Measures
Bureau International de Poids et Mesure (BIPM)
– Time Department –

(Time, Frequency and Gravimetry Department until end of 2010)

http://www.bipm.org/en/scientific/tfg/

Director of Department: **E. F. Arias** (France)

The Time Department is one of the five scientific departments of the BIPM. The activities at the Time Department are focused on the maintenance of the SI second and the formation of the international reference time scales.

The International Committee for Weights and Measures (CIPM) decided in October 2009 to discontinue the activities on gravimetry. Consequence of these decisions, the BIPM time, frequency and gravimetry (TFG) section became since 1 January 2011 the BIPM Time Department.

The BIPM provides, together with the US Naval Observatory, the IERS Conventions Centre, with the responsibility of the establishment and publication of the IERS Conventions, providing standards and models for applications in the fields of geodesy, geophysics and astronomy.

The establishment and maintenance of the International System of Units (SI) at the BIPM constitutes a fundamental contribution to the activities relating to the IAG.

International Time Scales at the BIPM

The international time scales International Atomic Time (TAI) and Coordinated Universal Time (UTC) are regularly computed and published in monthly *BIPM Circular T*. The frequency stability of UTC, expressed in terms of an Allan deviation, is estimated to 3×10^{-16} for averaging times of one month. About 400 industrial clocks located in almost 70 national laboratories contribute to the calculation of TAI. Some of these laboratories develop and maintain primary frequency standards – among them caesium fountains – that contribute to the improvement of the accuracy of TAI. The scale unit of TAI has been estimated to match the SI second to about 5×10^{-16}.

The laboratories contributing to the formation of UTC maintain representations of the international time scale named UTC(k). Routine UTC(k) comparison is undertaken using different techniques and methods of time transfer. All laboratories contributing to the calculation of UTC at the BIPM are equipped for GNSS reception. GPS C/A observations from time and geodetic-type receivers are used with different methods, depending on the characteristics of the receivers. Dual-frequency receivers allow performing iono-free solutions. Since October 2009 a combination of code and phase measurements of geodetic-type receivers is used in the computation of TAI. Also at the end of 2009 observations of GLONASS are used for the computation of TAI. Thanks to this evolution, the statistical uncertainty of time comparisons is at the sub-nanosecond level for the best GNSS time links. Some laboratories are equipped of two-way satellite time and frequency transfer (TWSTFT) devices allowing time comparisons independent from GNSS through geostationary communication satellites. The uncertainty of time comparison by GNSS is still limited by the hardware to 5 ns for the calibrated links whilst in the case of TWSTFT it is at the nanosecond order.

The algorithm used for the calculation of time scales is an iterative process that starts by producing a free atomic scale (*Échelle atomique libre* or EAL) from which TAI and UTC are derived. Research into time scale algorithms is conducted in the section with the aim of improving the long-term stability of EAL and the accuracy of TAI.

Because TAI is computed on a monthly basis and has operational constraints, it does not provide an optimal realization of Terrestrial Time (TT), the time coordinate of the geocentric reference system. The BIPM therefore computes an additional realization TT(BIPM) in post-processing, which is based on a weighted average of the evaluation of the TAI frequency by the primary frequency standards. The last updated computation of TT(BIPM), named TT(BIPM10), valid until December 2010, has an estimated accuracy of order 0.3×10^{-15}. Starting with TT(BIPM09), an extrapolation for the current year of the latest realization TT(BIPMYY) is provided and is updated each month after the TAI computation.

Radiations other than the caesium 133, most in the optical wavelengths, have been recommended by the International Committee for Weights and Measures (CIPM) as secondary representations of the second. These frequency standards are at least one order of magnitude more accurate than the caesium. Their use for time metrology is still limited by the state of the art of frequency transfer, still unable to compare these standards at the level of their performances. Studies on the use of optical fibres show excellent results. The time community is engaged in a collective effort for solving this issue, since one of the interests is the possibility of redefining the SI second.

The computation of TAI is carried out every month and the results are published monthly in *BIPM Circular T*. When preparing the *Annual Report*, the results shown in *Circular T* may be revised taking into account any subsequent improvements made to the data. Results are also available from the BIPM website (*www.bipm.org*), as well as all data used for the calculation. The broad real-time dissemination of UTC through broadcast and satellite time signals is a responsibility of the national metrology laboratories and some observatories, following the recommendations of the International Telecommunication Union (ITU-R).

Interruption of activities on gravimetry

The 8th International Comparison of Absolute Gravimetres in 2009 (ICAG 2009) was the last organized by the BIPM. The task of the BIPM on the ICAGs had concluded with the calculation of results of this last comparison and its subsequent publication. As agreed with the IAG, the future ICAGs will be organized at national institutes under a regional scheme. The Consultative Committee for the Mass and Related Quantities (CCM) continues organizing the Working Group on Gravimetry (WGG), and thus cooperating with the IAG in providing support to the future ICAGs.

Conventions and references

Research work is also dedicated to space-time reference systems. The BIPM provides, in partnership with the US Naval Observatory, the Conventions Product Centre of the IERS. A new version of the IERS Conventions (2010) has been published in the IERS Technical Note N°36, also available in electronic version at (http://www.iers.org/nn_11216/IERS/EN/Publications/ TechnicalNotes/tn36.html). Updates to the last published version are made whenever necessary and available on the internet at http://tai.bipm.org/iers/conv2010/conv2010.html, http://maia.usno.navy.mil/conv2010/convupdt.html.

Activities in cooperation with Paris Observatory within the IERS International Celestial Reference System Centre on the realization of reference frames for astrogeodynamics, contribute to the maintenance of the international celestial reference frame in the scope of the activities of the International Astronomical Union and International VLBI Service.

International validation of the International Terrestrial Reference System (ITRS)

Thanks to the actions of the BIPM and the Consultative Committee for Time and Frequency (CCTF), the 24rd General Conference on Weight and Measures adopted in October 2011 by unanimity a resolution that recommends the adoption of the International Terrestrial Reference System, as defined by the IUGG and realized by the IERS, for all metrological applications. The full text of the recommendation is annexed to this report. This resolution, adopted in the frame of an international diplomatic treaty (The Metre Convention), and of an intergovernmental organization (the BIPM) gives world-wide validity to the ITRS, putting it at the level of other international standards as, for example, UTC. This resolution reinforces the Resolution 2 of the IUGG, adopted at the XXIV IUGG General Assembly in 2007 on the Geocentric and International Terrestrial Reference Systems (GTRS and ITRS).

Activities planned for 2012-2015

- Calculation and dissemination of UTC through the monthly publication of *BIPM Circular T*;
- Improvement of techniques of time and frequency transfer for
  - Clock comparison for UTC;
  - Comparison of optical frequency standards requiring an accuracy at the level of 10^{-17} – 10^{-18};
- Improvement of the algorithms for calculation of timescales;
  - Calculation of TT(BIPM) annually, and of its monthly extrapolation;
  - Calculation and dissemination of a “rapid UTC” on a weekly basis for providing a reference to the UTC(k) available on a short delay;
- Supporting with expert advice the organization of the future international comparisons of absolute gravimeters;
- Continuing operating in cooperation with the USNO the IERS Conventions Centre;
- Continuing the cooperation with the IERS for the establishment of space references;
- Liaising with the relevant organizations, such as: IUGG, IAG and GGOS, IERS, IAU, ITU-R, IGS, and the International Committee for GNSS (ICG).

International Centre for Earth Tides (ICET)

http://www.bim-icet.org

Director: **Jean-Pierre Barriot** (France, French Polynesia)

Activities:

The centralized Internet gateway to ICET services is: http://www.bim-icet.org.

• **Summary of Data Held**:

Data from about 360 worldwide tidal gravity stations including GGP stations (hourly values, main tidal waves obtained by least squares analyses, residual vectors, oceanic attraction and loading vectors). The online Data Bank
(http://www.bim-icet.org) contains GGP superconducting gravimeters one minute data files, the off-line data bank contains also data from tiltmeters and extensometers worldwide.

• Data **Products, Publications, Catalogues:**

A "Bulletin d'Informations des Marées Terrestres" is published electronically once per year with a large number of translations of Russian and Chinese papers (also on (*http://www.bim-icet.org*, 146 Bulletins are currently online as pdf files).

A General Bibliography is also regularly kept up to date and published online.

• **User Services:**

The Center provides assistance for the setup of new stations, calibrations of the instruments, data processing as well as for tidal analysis. The assistance is accomplished either by a stay at the Centre or by providing computers programs. ICET is validating on a month-to-month basis one minute data files from the network of superconducting gravimeters of the GGP project.

ICET makes also available tidal predictions for any place and time, which are needed for field gravimetry, absolute gravity measurements and for tilt measurements. These predictions can be computed either on the basis of elastic Earth models and oceanic co-tidal maps, or on basis of the results of direct measurements.

International Centre for Global Earth Models (ICGEM)

web: http://icgem.gfz-potsdam.de

Director: **Franz Barthelmes** (Germany)

Terms of Reference

The determination of the Earth's global gravity field is one of the main tasks of Geodesy: it serves as a reference for geodesy itself, and it provides important information about the Earth, its interior and its fluid envelope for all geosciences. Thus, it is important to make the models of the global gravity field available to the public as products of geodesy. This becomes increasingly important as time variations of the global gravity field can be measured with better and better spatial and temporal resolution.

The calculation of the different functionals of the geopotential (e.g.: geoid, gravity anomaly, gravity disturbance, equivalent water height) from a defined global model, on a specified grid and with respect to a defined reference system, is far from being trivial and a responsibility of geodesy too.

Additionally, it is important to make the spatial structure and temporal variability of the global gravity field available to the general public in a graphic vivid manner.
In particular for temporal gravity models, aspects of consistency in processing, reference frame, and parameterization are becoming more and more important.

ICGEM has been established in 2003 as a new service under the umbrella of the new International Gravity Field Service (IGFS) as one of six centres.

Objectives

- collecting and long-term archiving of existing global gravity field models
- making them available on the web
- use of standardised format (self-explanatory)
- interactive visualisation of the models
- solutions from dedicated time periods (e.g. monthly GRACE models) included
- web-interface to calculate gravity functionals from the spherical harmonic models on freely selectable grids (filtering)
- evaluation of the models

Services

The Models

Currently, 122 models are listed with their references and, apart from 17 older models, all are available in form of spherical harmonic coefficients. If available, the link to the original model web site has been added. Models from dedicated time periods (e.g. monthly solutions from GRACE) of CSR, JPL, CNES/GRGS and GFZ are also available.

The Format

The spherical harmonic coefficients are available in a standardised self-explanatory format which has been accepted by ESA as the official format for the GOCE project.

The Visualisation

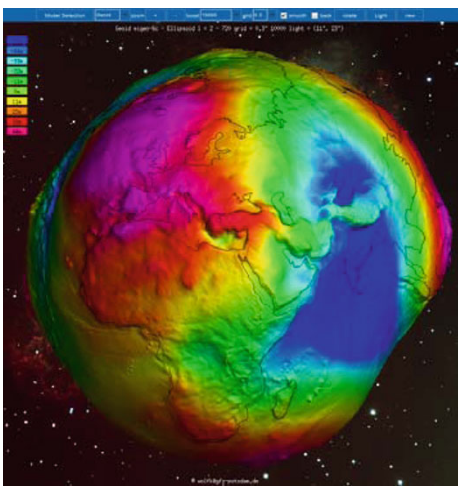

Fig. 1: Visualisation (geoid) of a global gravity field model

An online interactive visualisation of the models (height anomalies and gravity anomalies) as illuminated projection on a freely rotatable sphere is available (see fig. 1). Differences of two models, arbitrary degree windows, zooming in and out, are possible. Additionally, an animation over time of the monthly solutions from GRACE is also included. The visualisation of single spherical harmonics is possible for tutorial purposes.

The Calculation Service

A web-interface to calculate gravity functionals from the spherical harmonic models on freely selectable grids, with respect to a reference system of the user's choice, is provided (see figs. 2 and 3). The following functionals are available:

- pseudo height anomaly on the ellipsoid (or at arbitrary height over the ellipsoid)
- height anomaly (on the Earth's surface as defined)
- geoid height (height anomaly plus spherical shell approximation of the topography)
- gravity disturbance
- gravity disturbance in spherical approximation (at arbitrary height over the ellipsoid)
- gravity anomaly (classical and modern definition)
- gravity anomaly (in spherical approximation, at arbitrary height over the ellipsoid)
- simple Bouguer gravity anomaly
- gravity on the Earth's surface (including the centrifugal acceleration)
- gravity on the ellipsoid (or at arbitrary height over the ellipsoid, including the centrifugal acceleration)
- gravitation on the ellipsoid (or at arbitrary height over the ellipsoid, without centrifugal acceleration)
- second derivative in spherical radius direction (at arbitrary height over the ellipsoid)
- equivalent water height (water column)

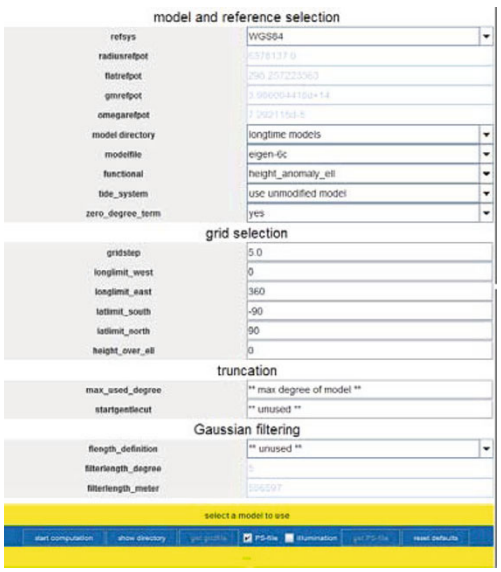

Fig. 2: Input mask of the calculation service

Filtering is possible by selecting the range of used coefficients or the filter length of a Gaussian averaging filter. The calculated grids (self-explanatory format) and corresponding plots (postscript) are available for download after some seconds.

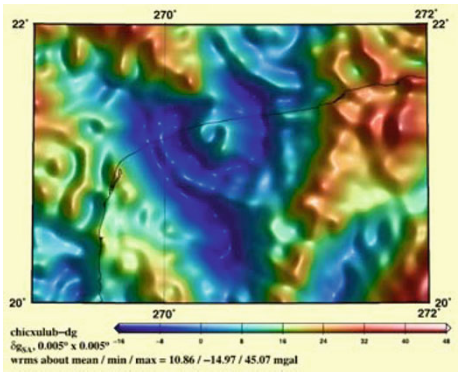

Fig. 3: Example of grid and plot generation by the calculation service: gravity disturbances of the Chicxulub crater region from the model EGM2008

Evaluation

For a concise evaluation of the models, comparisons with GPS-levelling data (see fig. 4) and with the most recent combination model in the spectral domain (see figs. 5 and 6) are provided.

Model	Nmax	USA 6169 points	Canada 1930 points	Europe 1235 points	Australia 201 points
EIGEN-6C	1420	0.247 m	0.136 m	0.214 m	0.219 m
EIGEN-6S	240	0.446 m	0.373 m	0.449 m	0.397 m
GOCO02S	250	0.435 m	0.352 m	0.434 m	0.372 m
AIUB-GRACE03S	160	0.650 m	0.514 m	0.713 m	0.486 m
GO_CONS_GCF_2_DIR_R2	240	0.443 m	0.374 m	0.449 m	0.391 m
GO_CONS_GCF_2_TIM_R2	250	0.436 m	0.355 m	0.434 m	0.376 m
GO_CONS_GCF_2_SPW_R2	240	0.457 m	0.376 m	0.473 m	0.376 m
GO_CONS_GCF_2_DIR_R1	240	0.407 m	0.319 m	0.402 m	0.319 m
GO_CONS_GCF_2_TIM_R1	224	0.455 m	0.378 m	0.474 m	0.371 m
GO_CONS_GCF_2_SPW_R1	210	0.471 m	0.399 m	0.498 m	0.384 m
GOCO01S	224	0.451 m	0.374 m	0.473 m	0.370 m
EIGEN-51C	359	0.335 m	0.245 m	0.289 m	0.234 m
EIGEN-5C	360	0.341 m	0.251 m	0.303 m	0.244 m
AIUB-CHAMP03S	100	0.755 m	0.743 m	1.148 m	1.148 m
EIGEN-CHAMP05S	150	0.784 m	0.763 m	1.216 m	0.661 m
ITG-GRACE2010S	180	0.548 m	0.459 m	0.595 m	0.523 m
AIUB-GRACE02S	150	0.630 m	0.571 m	0.701 m	0.495 m
GGM03C	360	0.346 m	0.279 m	0.334 m	0.259 m
GGM03S-UPTO150	150	0.641 m	0.521 m	0.710 m	0.494 m
AIUB-GRACE01S	120	0.724 m	0.628 m	0.930 m	0.563 m
EGM2008	2190	0.248 m	0.126 m	0.208 m	0.217 m
EIGEN-5S	150	0.630 m	0.547 m	0.737 m	0.475 m
ITG-GRACE03	180	0.633 m	0.557 m	0.658 m	0.603 m
AIUB-CHAMP01S	70	0.843 m	0.906 m	1.513 m	0.893 m
ITG-GRACE02S	170	0.623 m	0.511 m	0.639 m	0.489 m
EIGEN-GL04C	360	0.339 m	0.253 m	0.336 m	0.244 m
EIGEN-GL04S1	150	0.630 m	0.576 m	0.748 m	0.464 m
EIGEN-CG03C	360	0.346 m	0.306 m	0.355 m	0.260 m
GGM02C	200	0.473 m	0.378 m	0.515 m	0.376 m
GGM02S	160	0.977 m	1.116 m	1.416 m	1.356 m
EIGEN-CG01C	360	0.351 m	0.270 m	0.370 m	0.263 m
EIGEN-CHAMP03S	140	0.816 m	0.842 m	1.451 m	0.849 m
EIGEN-GRACE02S	150	0.739 m	0.643 m	0.828 m	0.538 m
TUM2S	60	0.864 m	0.963 m	1.639 m	1.101 m

Fig. 4: Table (truncated) of comparison of the models with GPS-levelling: Root mean square (rms) about mean of GPS / levelling minus gravity field model derived geoid heights [m]

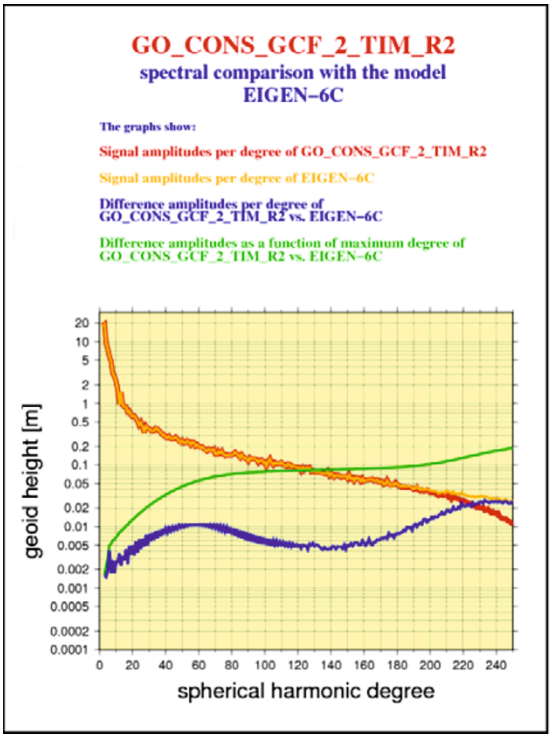

Fig. 5: Comparison of the models in the spectral domain (e.g.: GO_CONS_GCF_2_TIM_R2) with one of the most recent combination models (e.g. EIGEN-6C)

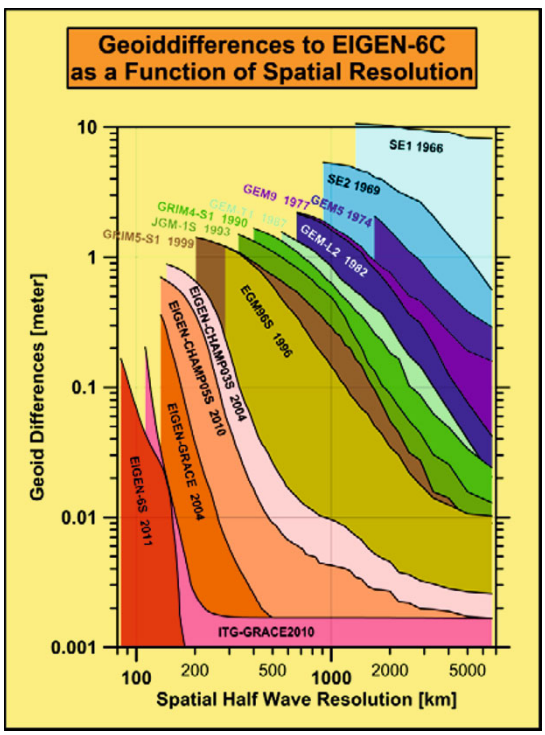

Fig. 6: Visualisation of the improvement of satellite-only models over the past decades: Geoiddifferences to the model EIGEN-6C as a function of spatial resolution

Models of other Celestial Bodies

Although it is not the main purpose of ICGEM, the calculation and visualisation service for some gravity field models of the celestial bodies Moon, Mars and Venus are also offered (see fig. 7).

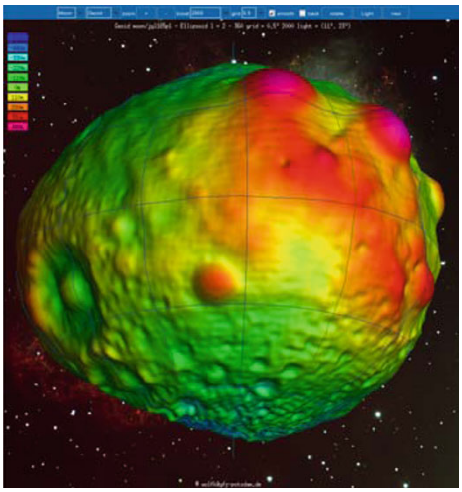

Fig. 7: Visualisation of the "Geoid" of the Moon

Data Policy

Access to global gravity models, derived products and tutorials, once offered by the centre, shall be unrestricted for any external user.

Staff

ICGEM is hosted by GFZ Potsdam. Its staff consists of
- Franz Barthelmes
- Wolfgang Köhler

Point of Contact

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Telegrafenberg
D-14473 Potsdam
Germany
E-mail: bar@gfz-potsdam.de

International DORIS Service (IDS)

web: http://ids.doris.org

Chair: **Pascal Willis** (France)

Terms of Reference

Introduction

The DORIS (Doppler Orbit determination and Radiopositioning Integrated on Satellite) system for satellite orbit determination and precise positioning was developed by the Centre National d'Etudes Spatiales (CNES) in conjunction with the Institut Géographique National (IGN) and the Groupe de Recherche de Géodesie Spatiale (GRGS).

A proof of concept for the International DORIS Service (IDS) was conducted through a pilot phase prior to the establishment of the International DORIS Experiment in 1999 by the International Association of Geodesy (IAG). The IDS formally began on July1, 2003 after the IAG official approval at the IUGG General Assembly in Sapporo. The IDS is an IAG Service and operates in close cooperation with the International Earth rotation and Reference frames Service (IERS).

The IDS Mission

The primary objective of the IDS is to provide a service to support geodetic and geophysical research activities through DORIS data and derived products.

The IDS collects, archives and distributes DORIS observation data sets of sufficient accuracy to satisfy the objectives of a wide range of applications and experimentations. From these data sets the following products are derived:

- Coordinates and velocities of the IDS tracking stations
- Geocenter and scale of the Terrestrial Reference Frame
- High accuracy ephemerides of the DORIS satellites
- Earth orientation parameters (EOPs)

The accuracies of these products are sufficient to support current scientific objectives including:

- Realization of global accessibility to and the improvement of the International Terrestrial Reference Frame (ITRF)
- Monitoring deformations of the solid Earth
- Monitoring crustal deformation at tide gauges
- Monitoring variations in the hydrosphere (sea level, ice-sheets, etc.)
- Orbit determination for scientific satellites
-

The IDS Organization

The IDS accomplishes its mission through the following components:

- Satellites carrying a DORIS receiver
- Network of tracking stations
- Data Centers
- Analysis centers and Analysis Coordinator
- Combination Center
- Working Groups
- Central Bureau
- Governing Board

Satellites Carrying a DORIS Receiver

Since July 2003, the CNES and the European Space Agency (ESA) have provided DORIS data to the IDS. Data from additional agencies are expected and welcome. DORIS receivers are flown on LEO satellites for precise orbit determination as well as for geodetic applications. Satellites with DORIS receivers are listed on the IDS website at *http://ids-doris.org/*.

A representative of the DORIS system serves as a voting member of the Governing Board.

Network of Tracking Stations

The IDS network is composed of DORIS permanent tracking stations located at host institutions and maintained by the IGN. A list of the sites (past and present) is included on the IDS website at *http://ids-doris.org/*.

The network also includes additional DORIS stations proposed by the IDS to observe during specific campaigns of scientific interest.
A representative of the Network serves as a voting member of the Governing Board.

Data Centers

The Data Centers are in direct contact with the CNES, which provides the DORIS data. The Data Centers archive the DORIS data, derived products, and ancillary information required to process these data.

A representative of the Data Centers serves as a voting member of the Governing Board.

Analysis Centers and Analysis Coordinator

The Analysis Centers (ACs) are committed to provide at least one of the above IDS products on a regular basis. Expertise in DORIS data analysis and operational capability are essential factors in the selection of Analysis Centers.

The Analysis Coordinator assists the Analysis Centers and monitors their activities to ensure that the IDS objectives are carried out. The Analysis Coordinator, working with the Analysis Centers, is expected to provide quality control, performance evaluation, and continued development of appropriate analysis standards. The Analysis Coordinator, with the support of the Combination Center, is also responsible for the appropriate combination of the Analysis Centers products into a single set of prescribed data products.

The Analysis Coordinator and a representative of the Analysis Centers serve as voting members of the Governing Board.

Combination Center

The IDS appoints a Combination Center (CC) to combine individual AC solutions and to generate IDS data products for submission to the IERS for the formulation of the periodic update of the ITRF and other geodetic products. The CC is selected by the Governing Board every four years through a Call for Participation initiated six months prior to the end of the current CC term. Interested centers submit proposals outlining their plan for operation of the CC and the resources that they will commit.

A representative of the Combination Center serves as a voting member of the Governing Board.

Working Groups

IDS Working Groups provide expertise on particular topics related to the IDS components and on development of particular IDS product(s) or service(s) relying on the IDS infrastructure.

All Working Groups are created when needed and retired by the IDS Governing Board when their work has been completed or they are no longer needed. Each Working Group must develop a charter that includes a mandate, a list of specific tasks, a schedule, and an identified Chairperson.

The Chairpersons of the Working Groups are non-voting members of the IDS Governing Board (see below).

Central Bureau

The Central Bureau (CB) is the executive arm of the IDS Governing Board and as such is responsible for the general management of the IDS consistent with the directives, policies and priorities set by the Governing Board.

In this role the CB, within available resources, coordinates IDS activities, facilitates communications, maintains documentation, and organizes reports, meetings, and workshops. The CB responds to external inquiries about the IDS, promotes the use of IDS data and products, and coordinates interactions with other services, including the IERS.

The CB supports the Combination Center in combining the various Analysis Centers products and providing all information necessary to validate the final combined products.

The CB operates the information system for the IDS and produces the IDS Annual Reports and IDS Associates directory. The CB coordinates the publication of other documents required for the satisfactory planning and day-to-day operation of the Service, including standards and specifications regarding the performance, functionality and configuration requirements of all Service elements.

Although the Chairperson of the Governing Board is the official representative of the IDS to external organizations, the CB, consistent with the directives established by the Governing Board, is responsible for the day-to-day liaison with such organizations.

The long-term function of the IDS is assured through redundancy and emergency contingency plan for all of its components except for the CB. The Central Bureau serves for a term of four years. One year prior to the end of each term, the GB formally reviews the performance of the Central Bureau. At the behest of the GB, the CB may be asked to reconfirm its commitment to serve another four years. If the CB agrees, it submits a proposal for GB approval. If the CB declines or if the GB chooses to change CB operators, the GB announces a Call for Proposals for a new IDS Central Bureau to take over responsibilities including a six-month transition phase with the outgoing Central Bureau.

In summary, the Central Bureau performs primarily a long-term coordination role to ensure that IDS participants contribute to the Service in a consistent and harmonious manner and adhere to IDS standards.
The Director of the Central Bureau serves as a voting member of the Governing Board.

Governing Board

The principal role of the Governing Board (GB) is to set policy and to exercise broad oversight of all IDS functions and components. It also controls general activities of the Service, including restructuring, when appropriate, to maintain Service efficiency and reliability.

The Governing Board (GB) consists of eleven voting members and a number of non-voting members. The membership is chosen to try to strike the right balance between project specialists and the general community. The voting membership of the GB is distributed as follows:

Elected by IDS Associates (see below):	
Analysis Centers' representative:	1
Data Centers' representative:	1
Analysis Coordinator:	1
Members-at-Large:	2
Appointed members:	
Director of the Central Bureau:	1
IERS representative to IDS:	1
IAG representative to IDS:	1
Combination Center representative:	1
DORIS System representative (CNES):	1
Network representative (IGN):	1
Total number of voting members:	11

During their mandate, the Working Group chairpersons are GB members with voice but without vote.

The elected members have staggered four-year terms, with elections every two years. There is no limit to the number of terms that a person may serve, however he or she may serve only two term consecutively as an elected member. The Analysis Centers' representative, the Data Centers' representative, and one Member-at-Large are elected during the first two-year election. The Analysis Coordinator and the other Member-at-Large are elected in the second two-year election. Although no formula is prescribed, efforts should be made to keep the GB membership properly balanced with regard to supporting organizations and geographic representation.

Members of the GB become IAG Fellows with the appropriate rights and privileges, as described on the IAG website, after an initial two-year period.

GB Elections: The GB elects a Chairperson from its members to serve a term of four years with the possibility of re-election for one additional term. The Chairperson does not vote on GB decisions, except in the case of a tie. The Chairperson is the official representative of the IDS to external organizations.

Five members of the GB are elected by the IDS Associates. A nominating committee conducts the elections for membership on the IDS Governing Board. The nominating committee consists of three members. The Chair of the nominating committee is appointed by the Chair of the GB, and must be a member of the GB not currently up for re-election. The GB chooses the remaining two members of the nominating committee from the list of IDS Associates.

The nominating committee solicits nominations from the IDS Associates for each position to be filled; at least two candidates are required for each position. The Central Bureau runs the election. All IDS Associates are eligible to vote. Election is by a simple majority of votes received for each position. The two Member-at-Large positions are filled by the two candidates receiving the most votes; a vote by the GB will resolve any situation of a tie.

Appointed Members: The IAG and IERS representatives to the IDS Governing Board are appointed respectively by the IAG Executive Committee and by the IERS Directing Board for a maximum of two four-year terms. The DORIS System representative and the Network representative are appointed by CNES and IGN, respectively, for four-year terms without limitation. The Director of the Central Bureau and the Combination Center representative are the two other appointed members.

In case of a resignation from the Governing Board, the CB, after consulting with the appropriate IDS components, nominates a replacement candidate for election by the GB. The replacement will serve until the end of the term of the resigned Board member.

GB Decisions: Most decisions at GB meetings are to be made by consensus or by a simple majority vote of the voting members present, provided that there is a quorum consisting of at least six voting members of the GB. GB decisions can be made through email or other correspondence by a majority vote of the GB voting membership. Changes in the IDS Terms of Reference and Chairperson of the GB can only be made by a 2/3 majority of the members of the GB, i.e., by seven or more votes.

GB Meetings: The Board shall meet at least annually and at such other times as shall be considered appropriate by the Chairperson or at the request of three members. The Central Bureau provides the secretariat of the GB.

IDS representatives to the IERS and the IAG

Through the existing reciprocity agreement between the IDS and the IERS, the IDS Analysis Coordinator serves as the DORIS Technique Center representative to IERS, and as such, subject to Governing Board approval, is a member of the IERS Directing Board (together with another person selected by the IDS Governing Board). This arrangement ensures full cooperation between the two services.

The IDS Governing Board will select the IDS representative to the IAG Executive Committee.

IDS Associates

IDS Associates are persons representing organizations that participate in any of the IDS components. A participating institution can submit a person's name, email, and primary IDS function in its organization to the Central Bureau for application to become an IDS Associate. The Governing Board approves all memberships. The Central Bureau maintains the current list of IDS Associates and makes the list available on the IDS website.

IDS Associates vote for the incoming Analysis Centers' representative, the Data Centers' representative, the Analysis Coordinator, and the Members-at-Large representatives as members of the GB.

The GB must approve the list of IDS Associates eligible for voting in the elections at least three months prior to the election process. For the purposes of the election, current and former GB members are also considered IDS Associates. are considered IAG Affiliates.

International Earth Rotation and Reference Systems Service (IERS)

web: www.iers.org

Chair of the Directing Board: **Chopo Ma** USA)
Director of the Central Bureau: **Bernd Richter** (Germany)

Development

The IERS was established as the International Earth Rotation Service in 1987 by the International Astronomical Union and the International Union of Geodesy and Geophysics, and it began operation on 1 January 1988. Since 2001, the IERS works in a new organizational structure; in 2003, the new name of the Service, without changing its abbreviation, was adopted. The IERS is a member of the Federation of Astronomical and Geophysical Data Analysis Services (FAGS).

Objectives

The primary objectives of the IERS are to serve the astronomical, geodetic and geophysical communities by providing the following:

- The International Celestial Reference System (ICRS) and its realization, the International Celestial Reference
- Frame (ICRF)
- The International Terrestrial Reference System (ITRS) and its realization, the International Terrestrial
- Reference Frame (ITRF)
- Earth orientation parameters required to study earth orientation variations and to transform between the
- ICRF and the ITRF
- Geophysical data to interpret time/space variations in the ICRF, ITRF or earth orientation parameters, and model such variations
- Standards, constants and models (i.e., conventions) encouraging international adherence

Products

IERS collects, archives and distributes products to satisfy the objectives of a wide range of applications, research and experimentation. These products include the following:

- International Celestial Reference Frame
- International Terrestrial Reference Frame
- Monthly earth orientation data
- Daily rapid service estimates of near real-time earth orientation data and their predictions
- Announcements of the differences between astronomical and civil time for time distribution by radio stations
- Leap second announcements
- Products related to global geophysical fluids such as mass and angular momentum distribution
- Annual report and technical notes on conventions and other topics
- Long-term earth orientation information

The accuracies of these products are sufficient to support current scientific and technical objectives including the following:

- Fundamental astronomical and geodetic reference systems
- Monitoring and modeling earth rotation/orientation
- Monitoring and modeling deformations of the solid earth
- Monitoring mass variations in the geophysical fluids, including the atmosphere and the hydrosphere
- Artificial satellite orbit determination
- Geophysical and atmospheric research, studies of dynamical interactions between geophysical fluids and
- the solid earth
- Space navigation.

Structure

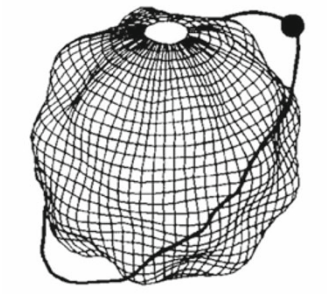
The IERS accomplishes its mission through the following components:

- Technique Centers: International GNSS Service, International Laser Ranging Service, International VLBI Service, and International DORIS Service
- Product Centers: Earth Orientation Center, Rapid Service/Prediction Center, Conventions Center, ICRS Center, ITRS Center, and Global Geophysical Fluids Center with Special Bureaus for the Atmosphere,
- for the Oceans, for Hydrology, and for Combination
- ITRS Combination Centers at Deutsches Geodätisches Forschungsinstitut (DGFI), Geomatics Canada/Geodetic Survey Division, Institut Géographique National (IGN)
- Analysis Coordinator
- Central Bureau
- Directing Board
- Working Groups: WG on Site Survey and Co-location, WG on Combination at the Observation Level, IERS/IVS WG on the Second Realization of the ICRF, WG on SINEX Format.

Some of these components (e.g., Technique Centers) may be autonomous operations, structurally independent from IERS, but which cooperate with the IERS. A participating organization may also function as one or several of these components (except as a Directing Board).

IERS Directing Board 2011

Zuheir Altamimi (France), *ITRS Center Representative*
Aleksander Brzezinski (Poland), *IAU Representative*
Daniel Gambis (France), *Earth Orientation Center Representative*
Rüdiger Haas (Sweden), *IVS Representative*
Thomas Herring (USA), *Analysis Coordinator*
Urs Hugentobler (Germany), *IGS Representative*
Frank Lemoine (USA), *IDS Representative*
Brian J. Luzum (USA), *Rapid Service/Prediction Center Representative*
Chopo Ma (USA), *IVS Representative, Chair*
Jürgen Müller (Germany), *ILRS Representative*
Erricos C. Pavlis (USA), *ILRS Representative*
Gérard Petit (France), *Conventions Center Representative*
Bernd Richter (Germany), *Director of the Central Bureau*
Jean Souchay (France), *ICRS Center Representative*
Tonie van Dam (Luxembourg), *GGFC Representative*
Clark R. Wilson (USA), *IAG / IUGG Representative*



International Geoid Service (IGeS)

web: http://www.iges.polimi.it

President and Director: **R. Barzaghi** (Italy)

Mission / Objectives

The main tasks of IGeS are

- to collect geoid estimates worldwide, when possible to validate them and to disseminate them upon request among the scientific community: other auxiliary data can also be collected by IGeS, when useful for the geoid determination, and might be made available with the sharp exclusion of gravity anomalies data,
- to collect, test and, when allowed, to distribute software for the geoid determination,
- to conduct researches on methods for the geoid determination, particularly trying to define optimal procedures for merging all the available data, including satellite gravity.
- to organize schools on geoid determination where both theoretical and practical aspects are illustrated. During the schools students are trained in the use of the relevant software used for geoid computation,
- to issue, at least once per year, the Newton's Bulletin, collecting papers on gravity and geoid. Also, news and results from the other IGFS Centers are welcome,
- to disseminate special publications on geoid computations, e.g. lecture notes of the schools,
- to establish and update a web page and a forum for discussing practical and theoretical aspects on geoid computation,
- to support Agencies or scientists in computing regional geoids.

The Newton's Bulletin has a technical and applied nature and will not accept papers that could be published on the International Journal of Geodesy.

Data and software given to IGeS remain property of the source, which can dictate the conditions of use and restrict their distribution. IGeS itself can indeed perform geoid computations within different projects, but not in economic competition with Firms or Public Organizations institutionally devoted to that.

Products

- SW for handling global models
- SW for the local geoid estimation
- SW for the evaluation of different functionals of the Gravity Field
- Grids, for specified areas, of local and regional geoid estimates
- Documentation of the SW and of the data sources
- Newtons's Bulletin
- Lecture notes and special publications
- International Schools on geoid computation

Future Programs/Development

Beyond institutional activities of IGeS, the following programs are worth of specific mention:

- participation to the International ESA Gradiometric Mission (GOCE);
- computation of improved geoids for Italy and the Mediterranean area;
- participation within GGOS to the study of the height datum unification problem;
- study of improved methodologies for the determination of the geoid at global and local level;
- organization of International Geoid School, possibly one school every two years;
- participation to the GOCE Global Models validation.

Structure

The Service is for the moment provided by two Centres, one at the Politecnico of Milano, and the other at NIMA (contact person S. Kenyon, steve.c.kenyon@nga.mil) and by individual scientists, called advisors.

IGeS is an official IAG Service which is related to IAG through the International Gravity Field Service and is one of the operative arms of the International Commission for the Gravity Field. The IGeS Milano Centre is supported by

Italian authorities, which nominate upon recommendation of the IGFS, a President, for its international representation and a Director for the operative management.

Its structure, tools and activities are illustrated in the IGeS reports to the Advisory Board of IGFS. In addition the IGeS advisors are individual members of IGeS, which have had an outstanding activity in the field of geoid determination and also can represent IGeS in both research and teaching activities.

At present the following distinguished scientists are IGeS advisors:

- R. Forsberg (Denmark)
- C.C. Tscherning (Denmark)
- M. Sideris (Canada)
- W. Kearsley (Australia)
- S. Kenyon (USA)
- N. Pavlis (USA)
- H. Denker (Germany)
- U. Marti (Switzerland)
- I. Tziavos (Greece)
- A. J. Gil (Spain)
- D. Blitzkow (Brasil)

Finally, within the structure of IGeS, Working Groups can be established for specific purposes, limited in time.

International GNSS Service (IGS)

Web: http://www.igs.org/

Chair of the Governing Board: **Urs Hugentobler** (Germany)
Director of the Central Bureau: **Ruth Neilan** (USA)

Overview

Planning for the years 2011-2014, the International GNSS Service (IGS) has a number of activities and tasks to pursue, both externally and internal to the organization. The mission of the IGS is to provides the highest-quality GNSS data and products in support of the terrestrial reference frame, Earth rotation, Earth observation and research, positioning, navigation and timing and other applications that benefit society.

Key activities are the extension of the IGS' tracking and analysis capabilities to new GNSS and new signals as well as of its real-time capabilities. Basis of the work of the IGS is its global tracking network which requires continuous maintenance and extension in close interaction with the operating agencies and institutions.

A key undertaking through 2012 will be the development of the IGS Strategic Plan for the period 2013-2017. The IGS Strategic Plan 2008-2012 is located here:
http://igs.org/overview/pubs.html

The IGS develops annually a strategic implementation plan with which the progress of the organization is measured. The IGS Implementation plan for 2011 may be found at
ftp://www.igs.org/pub/resource/pubs/IGSImpPlan2011_GB_37.pdf

Figure 1 displays the organizational structure of the IGS and includes the list of Pilot Projects and Working Groups.

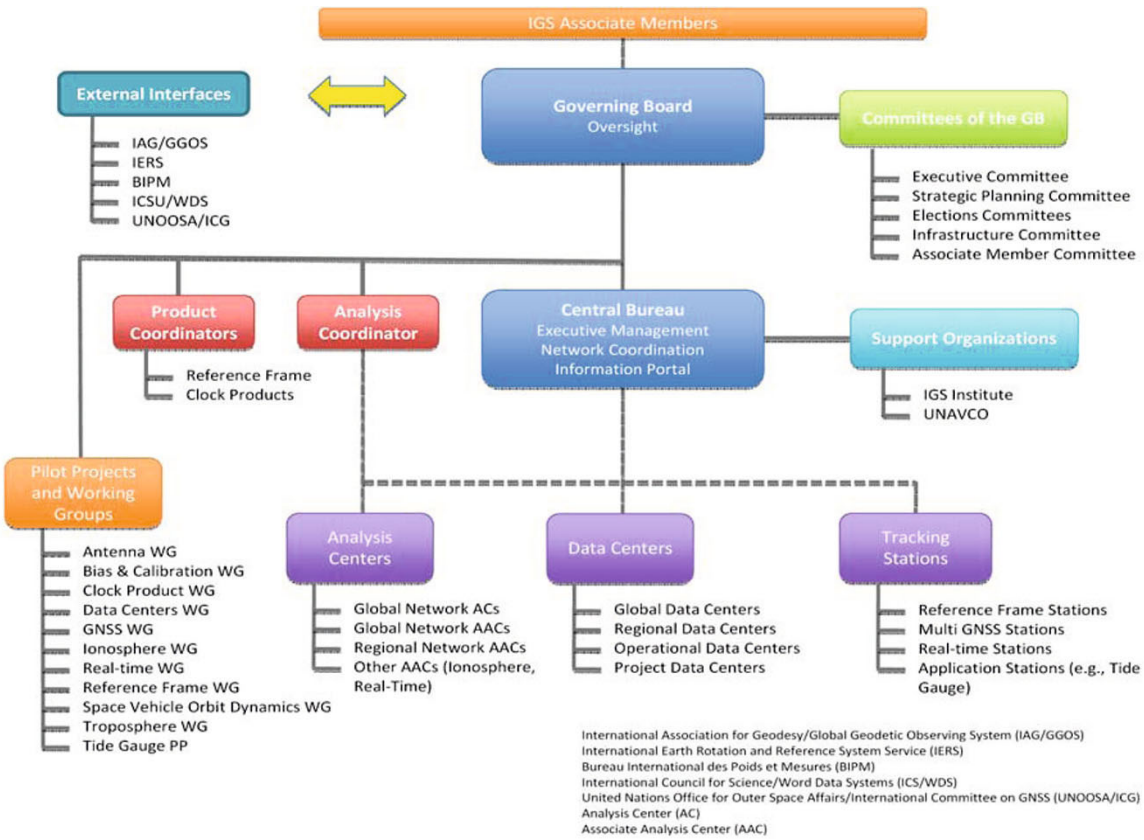


Figure 1. IGS Organization Chart 2011

Key Activities

The global tracking network and the quality of the acquired GNSS data is the basis for the generation of highest-quality products. Fostering of the network, quality monitoring of the station data and facilitating of its extension are high priority tasks also in the coming years. This includes planning for the transition to a GNSS tracking network without disruption of the existing long station coordinate time series required for the maintenance of the reference frame.

The quality of the IGS products are continuously monitored and improved. After the termination of a first complete reanalysis of GPS tracking data from 1994 to 2007 the IGS plans a next reanalysis effort based of the most up-to-date models, standards and conventions as input for the next ITRF frame.

IGS fully supports IAG's Global Geodetic Observing System (GGOS) and considers its products as GGOS products. It works with other IAG components towards the realization of GGOS Mission, Vision and Goals, see:

http://www.ggos.org

In 2011, IGS released a Call for Participation in the IGS Multi-GNSS Global Experiment – IGS M-GEX. The CfP is posted at the IGS website and calls for multi-GNSS observing stations, data centers, analysis centers and cooperative networks and organizations. Main objective of the experiment is to gather experience with new signals and new navigation satellite systems. The experiment will expand the IGS tracking network, currently tracking GPS and GLONASS (Figure 2), to include GNSS observations of new constellations: Galileo (European Union), Compass (China), QZSS (Japan), as well as laying the foundation for tracking the modernized signal of the GPS and GLONASS. Coordinated analysis of the observations and generation of reliable products will be a challenge as the IGS strives to incorporate all GNSS. IGS M-GEX will begin in February 2012 and operate through August 2012, with first discussion of results at the IGS workshop in July 2012 (see below).

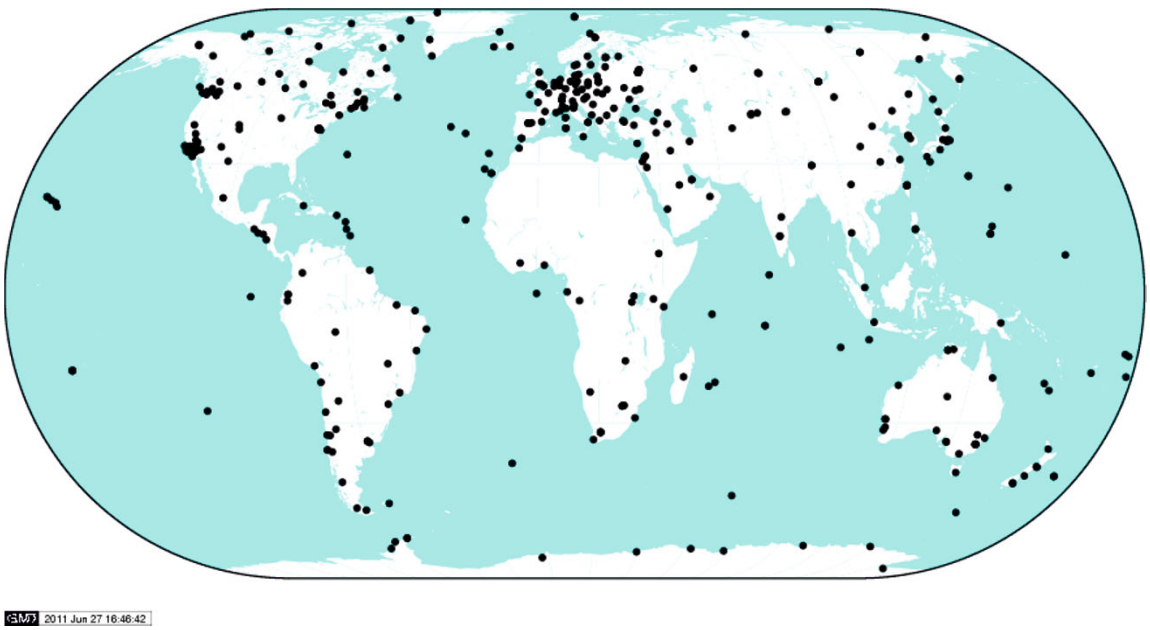


Figure 2. IGS Tracking Network, all stations.

IGS is operating a real-time network as part of the IGS Real-Time Pilot Project (Figure 3). Currently data are available to project participants and real-time analysis is coordinated by the European Space Operations Center in Darmstadt (ESOC), Germany. IGS plans to make real-time products available within the next few years. For more information, visit the project pages:

http://www.rtigs.net/index.php

IGS is an active associate member of the United Nations Office for Outer Space Affairs' (UNOOSA) International Committee on GNSS (ICG). One of the ICG's four Working Groups, the Working Group on Reference Frame, Timing and Applications, is co-chaired by IGS, IAG and the International Federation of Surveyors (FIG). IGS is recently also named co-chair of a new ICG sub-committee on GNSS Monitoring. The sub-committee will be co-chaired by government representatives of China and Japan, and the IGS. This is recognition that IGS, due to multi-GNSS ob-

servations and analysis, may potentially be able to take on a greater service role for system providers by providing independent monitoring of the available GNSS constellations.

A challenge for the IGS in both the IGS M-GEX and Real-time Pilot Project is data format issues. The IGS has formalized its efforts towards standardization of multi-GNSS batch and real time observation and product formats and protocols through cooperation with the Radio Technical Commission for Maritime Services (RTCM). RTCM Special Committees are chartered to address in-depth radio-communication and radio-navigation areas of concern to the RTCM membership. The output documents and reports prepared by these Committees are usually published as RTCM Recommended Standards and include standards for GNSS.

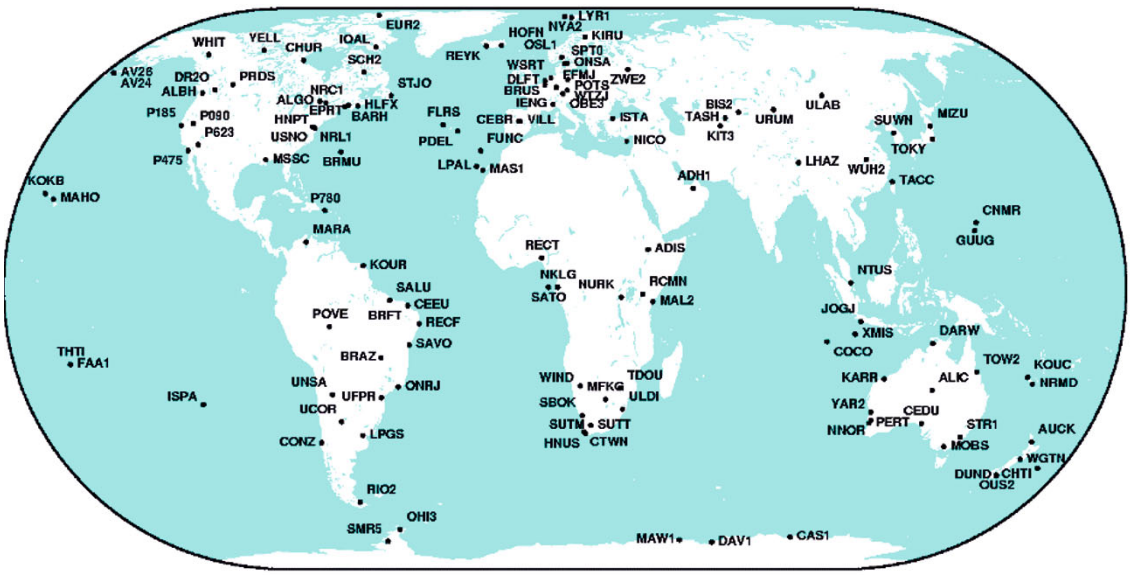


Figure 3. IGS Real- Time Tracking Network 2011

The IGS is applying for membership with the new International Council for Science (ICSU) World Data System (WDS). This is a new interdisciplinary body of ICSU, an integration of the former Federation of Astronomical and Geophysical Data Analysis Services (FAGS) and World Data Center System. See:

h*ttp://www.icsu-wds.org/*

IGS continues to support other IAG elements, with focus on lesser economically developed countries (LEDC). For the past ten years, IGS has been actively supporting efforts within Africa to realize the Unification of African Reference Frames – AFREF. This is progressing, but continued engagement is needed.

Internally, the IGS Central Bureau (CB) is in the process of a complete redesign and implementation of the IGS website. A top goal of the design is to have a state-of-the-art website that has shared administration with other principal people within the IGS. A 'Site Log Manager (SLM)' is being jointly developed with the University NAVSTAR Consortium (UNAVCO), and will permit station operators to manage and updated their own information. The information within the website, and the SLM, will have automatic validation procedures built in, so that managing the 400+ stations and networks within the IGS can be done efficiently. The website, once adequate resources are identified, can be extended to other scientific services within the IAG and specifically to GGOS. Social networking options for the IGS will also be explored and implemented where value can be identified.

The IGS 2012 Workshop will be held in Poland, July 23-27, 2012, and will be hosted by the Geodynamics Research Laboratory of the University of Warmia and Mazury in Olsztyn, Poland. Foci of the workshop are the first results of the M-GEX experiment and progress in IGS real time developments.

Summary

The IGS remains a vital organization that continues to evolve with challenging opportunities. The IGS is preparing for a future with new additional GNSS signals and new constellations to eventually generate highest-quality products for all available GNSS for the benefit of science and society.

International Gravimetric Bureau (Bureau Gravimétrique International – BGI)

web: http://bgi.omp.obs-mip.fr

Director: Sylvain Bonvalot (France)

Terms of Reference

The Bureau Gravimétrique International (BGI) has been created in 1951 as a service of IAG during the IUGG (International Union in Geophysics and Geodesy) General Assembly. The initial task of BGI was to collect, on a world-wide basis, all gravity measurements to generate a global digital database of gravity data for any public or private user. The technological and scientific evolutions which occurred over the last 50 years in the area of gravimetry (improvements in field, airborne and seaborne gravity meters, development of absolute gravity meters, space gravity missions, etc.) provided significant increases of the number, diversity and accuracy of the gravity field observables. Following these evolutions, the BGI has contributed to provide original databases and services for a wide international community concerned by the studies of the Earth gravity field.

The BGI is an official service of the International Association of Geodesy (IAG) and is coordinated since 2003, with others IAG services (IGeS, ICET, ICGEM, IDEMS) by the International Gravity Field Service (IGFS). It also directly contributes to the activities of the IAG Commission 2 "Gravity Field" and of the IAG Global Geodetic Observing System (GGOS). It is recognized by the International Council for Science (ICSU) successively as one of the services of the Federation of Astronomical and Geophysical Services (FAGS) and of the World Data System (WDS) created in 2008.

Mission and objectives

The main task of BGI is to collect, on a world-wide basis, all gravity measurements (relative or absolute) and pertinent information about the gravity field of the Earth, to compile them and store them in a computerized data base in order to redistribute them on request to a large variety of users for scientific purposes.

The database of relative measurements contains over 12 millions of observations compiled and computerized from land, marine and airborne gravity surveys. It has been extensively used for the definition of Earth gravity field models and for many applications in geodesy, satellite orbit computation, oceanography, geophysics, etc.

More recently, a database for absolute gravity measurements was set up and put into operation in joint cooperation between BGI and BKG (Bundesamt für Kartographie und Geodäsie, Germany). The database is capable to store information about stations, instruments, observations and involved institutions. By this, it allows the exchange of meta data and the provision of contact details of the responsible institutions on the one hand and the storage and long term availability of gravity data and processing details on the other hand. The database can be accessed by a web based interface which provides publicly available meta-data as well as complete datasets for community of users contributing to the archive. A simple exchange format was selected which includes all relevant information and is known by the majority of users avoiding additional effort. In this way the upload of data to the database is possible, using a web based upload form.

In addition, BGI develops other additional services in the area of gravimetry (data validation for regional or global projects, online access to reference gravity stations, expertise, bibliography database, etc.). It also contributes to research & development activities (software developments, interpretation) and to educational activities (summer schools on gravity data acquisition and processing, provision of tutorials and educational materials in gravimetry).

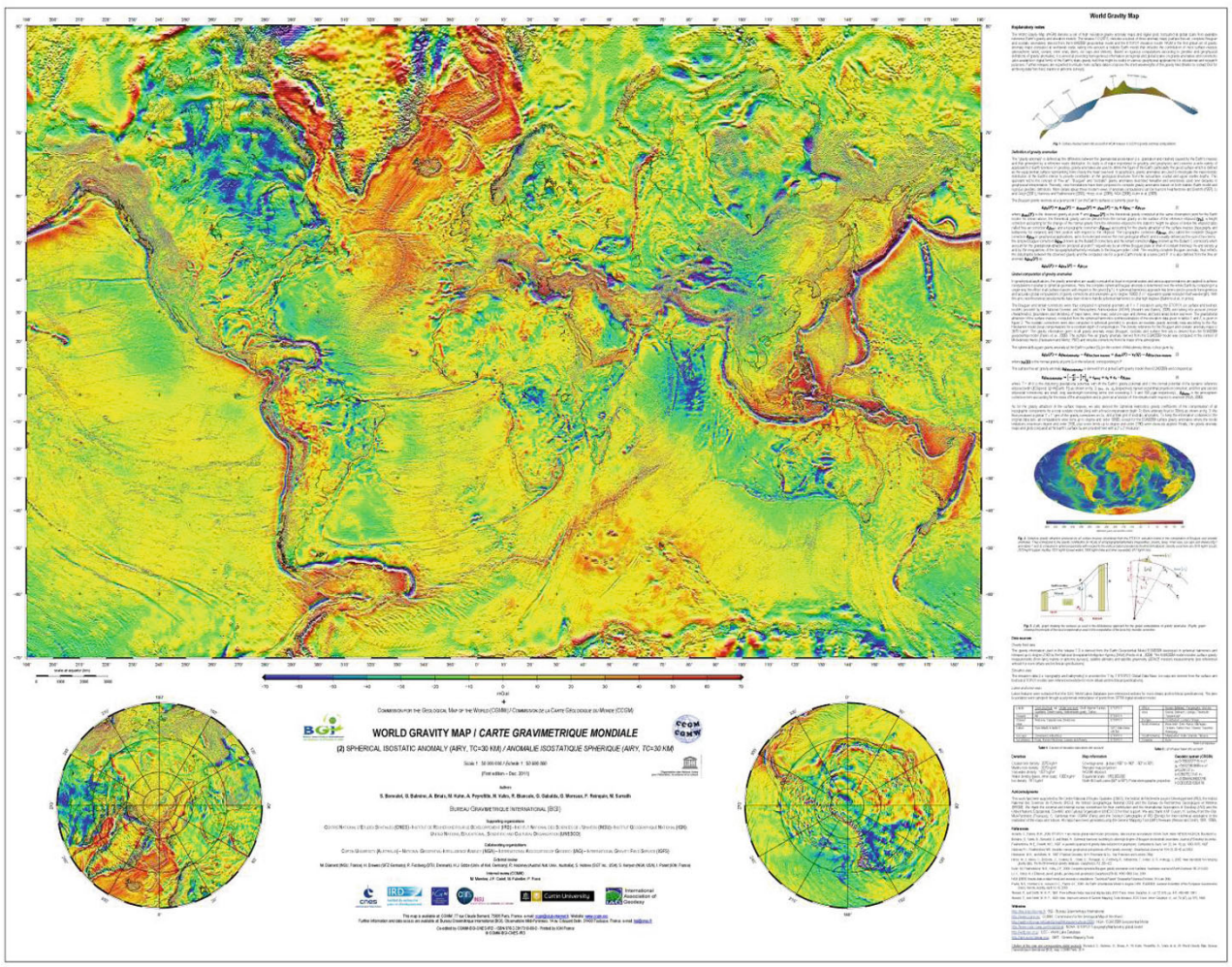
Programs / Activities

The current and future activities are dedicated (i) to consolidate the terrestrial gravity databases (relative and absolute measurements) and (ii) to ease the consultation and retrieval of gravity data and products by end-users. BGI will also continue operating with its supporting organizations, in educational, research and development activities with the aim to maintain a high level of competence and to improve the efficiency and the quality of its services.

- Gravity databases: The main achievements consist in maintaining and developing the three BGI databases (relative measurements, absolute measurements, reference gravity stations). Collection of new dataset (from field, marine or airborne surveys) will be encouraged in order to improve the global data coverage and accuracy. Incoming datasets are carefully evaluated and validated using protocols and software already developed at BGI. Global data and products derived from satellite altimetry

and gravity missions are to be more and more frequently used to validate land and sea measurements.

- Realization and diffusion of data and products: New functionalities are currently implemented in relation with the database management to improve the BGI services (direct requests and downloads of open-file data or products from the BGI webpage, inter-operability between other sites hosting gravity-related databases). BGI also contributes to the release of updated gravity products (digital maps and grids…) for educational and research purposes. The release of the first global spherical gravity anomaly maps and grids (World Gravity Map) realized for the Geological Commission for the Geological Map of the World (CGMW) and UNESCO has been achieved in late 2011. It includes complete Bouguer and Isostatic anomaly maps corrected from the topography (1'x1' resolution) and based on the EGM2008 model. Updated versions will be done as soon as new global gravity model will be available.
- Other activities: Publication of the Newton's Bulletin jointly with the International Geoid Service (IGeS) ; Contribution within the IAG commission "Gravity Field" to the definition of a new global absolute reference gravity network; Contribution to research projects involving gravity data acquisition or validation and combination of surface and satellite gravity observations ; Contribution to summer schools and to dissemination of educative materials related to gravimetry.



Services

The most frequent service BGI can provide is data retrieval over a limited area or over a limited number of observations. Data requests are issued through the BGI website and are processed electronically (email, ftp transfer or direct download).

Data, products or software available at BGI are mostly dedicated to support scientific and academic activities. Digital gravity data or products are usually distributed free of charge to research or academic institutions or to data contributors according to the conditions given below. Other users, individual or private companies, are invited to

specify in their request the expected use of the data and products. See BGI website for diffusion and charging policies.

- Access to non-confidential or non-proprietary relative gravity measurements is provided free of charge to public institutions or data contributors over geographic areas limited to 20°x20° or on the base of a maximum number of 10000 data points (land data) and/or 100000 data points (marine data). Retrieval of full data coverage for a whole country is not included in that case. All other requests (for larger datasets, for extended geographic area or for a whole country) as well as massive data retrieval will be subject to an evaluation by BGI who might require a specific protocol of use of the data or ask authorization of the proprietary Institutions. Charges might be applied
- Access to the Absolute gravity database is provided free of charge without any restriction. Data retrieval is done through the Web interfaces at BGI and BKG mirror sites. Confidential data or proprietary data may appear with restricted information (metadata only).
- Access to the Reference gravity stations database is provided free of charge without any restriction. Please note that reference gravity stations (especially those determined and described decades ago) may have been destroyed or modified.

Other services include: Access to global or regional gravity anomaly grids and maps ; Prediction of gravity value on Earth ; Software ; Documentation, etc.

Structure and membership

Since 2003, the BGI is one of the services of the International Gravity Field Service (IGFS) which coordinates within the IAG, the servicing of the geodetic and geophysical community with gravity field-related data, software and information.

The BGI central office (management, secretariat and technical staff) is located in Toulouse, France, in the premises of the Observatoire Midi-Pyrénées. Since 1998, BGI is supported by French Institutions, Universities and Laboratories (see below) whose contributions to BGI over four year renewable periods are defined by a covenant. The supporting French organizations are:

- the Centre National d'Etudes Spatiales (CNES),
- the Bureau de Recherches Géologiques et Minières (BRGM),
- the Institut National des Sciences de l'Univers (INSU/CNRS),
- the Institut National de l'Information Géographique et Forestière (IGN),
- the Institut de Recherche pour le Développement (IRD),
- the Service Hydrographique et Océanographique de la Marine (SHOM),
- the Groupe de Recherches en Géodésie Spatiale (GRGS)
- the Institut de Physique du Globe de Paris (IPGP),
- the Ecole et Observatoire des Sciences de la Terre (EOST)
- the Ecole Supérieure des Géomètres et Topographes (ESGT),
- the Université de Montpellier 2 (UM2)

Each supporting organization has a representative member in the BGI Advisory Board. The Advisory Board (who also includes a representative member of IAG) contributes once a year to the orientation and evaluation of the BGI activities. The program of BGI activities is also evaluated and discussed by the IGFS Advisory Board at each IGFS meetings and IUGG General Assemblies. A new partnership has been also established in 2008 between BGI and the Bundesamt für Kartographie und Geodäsie (BKG), Germany, for the realization and the maintenance of the global database of absolute gravity measurements (AGRAV).

Providing data to BGI

As a service of IAG/IGFS, the final task of BGI is to give access to the largest scientific community to relative and absolute measurements of the Earth gravity field and related information. The permanent archiving of new incoming gravity data sets is crucial to improve the coverage and accuracy of the global gravity database and to improve our knowledge of the Earth gravity field. It also enables BGI to validate the gravity observations in a global reference frame and restore them in standard and unified formats useful for various users.

BGI currently collect & provides information on:

- Relative gravity measurements from land, marine & airborne surveys
- Absolute gravity measurements
- Reference gravity base stations
- Software for gravimetric applications (data processing, modeling, etc.)
- Other gravimetry-related information (printed or digital maps, bibliography, etc.)

The contribution of scientists, agencies or institutions involved in these fields is welcome to ensure the best service to the community. Contributors interested in archiving their gravity observations as non-confidential or as proprietary data (to be defined by the contributors themselves) are invited to contact BGI. For relative gravity observations, all kind of data from land, marine or airborne surveys can be sent to BGI. ASCII data files containing all necessary information and quantities are preferred (station coordinates, gravity measurements and accuracies; gravity corrections; reference geographic, height and gravity systems, etc.). For absolute gravity observations, the data-

base is maintained on two mirror sites located in Toulouse (France), at BGI and in Frankfurt/Main (Germany), at the Federal Agency for Cartography and Geodesy (BKG). Scientists interested to upload their observations or meta-data only (site positions and approximated values for instance) in the international Absolute Gravity database AGRAV are invited to contact either BGI (http://bgi.omp.obs-mip.fr) or BKG (http:// agrav.bkg.bund). For any contribution (relative or absolute gravity data), it is reminded that BGI will keep the status of diffusion (with or without restrictions of redistribution) as specified by the proprietary institution.

BGI address:
Bureau Gravimétrique International
Observatoire Midi-Pyrénées
14, Avenue Edouard Belin
31401 Toulouse Cedex 9, France
Phone: 33-5 61 33 29 80
E-mail: bgi@cnes.fr, sylvain.bonvalot@ird.fr

International Gravity Field Service (IGFS)

web: www.igfs.net

Chairman: **R. Forsberg**, National Space Institute, Denmark, rf@space.dtu.dk
Director of Central Bureau: Prof. **I. Marson**, OGS, Italy
Executive Secretary of the CB: Dr. **F. Coren**, fcoren@inogs.it

Objectives

IGFS is a unified "umbrella" IAG service, which will
- Coordinate collection, validation, archiving and dissemination of gravity field related data
- Coordinate courses, information materials and general public outreach relating to the earth's gravity field
- Unify gravity products for the needs of GGOS – the Global Geodetic Observing System

The IGFS coordinates the following "Level-1" IAG services and service centres
- BGI (Bureau Gravimetrique International), Toulouse, France
- IGeS (International Geoid Service), Milano, Italy
- ICET (International Center for Earth Tides), Papeete, French Polynesia
- ICGEM (International Center for Global Earth Models), Potsdam, Germany
- IDEMS (International Digital Elevation Model Service), Leicester, UK
- ("Global Geodynamics Project" of superconducting gravimeters - currently in transition to become an IAG Service).

The overall goal of IGFS is to coordinate the servicing of the geodetic and geophysical community with gravity field-related data, software and information. The combined data of the IGFS entities data will include both satellite-derived global models, terrestrial, airborne, satellite and marine gravity observations, earth tide data, GPS leveling data, digital models of terrain and bathymetry, as well as ocean gravity field and geoid from satellite altimetry. Both the static and the temporal variations of the gravity field will be covered by the IGFS.

IGFS will – in cooperation with the services - make a special effort in trying to secure release of data from national and international institutions holding data on the spatial and temporal gravity variations, geoid and the surface heights of the Earth, to make them widely available to the scientific community.

IGFS will coordinate regional conferences, tutorials and schools to train young scientists and members of national institutions in the various aspects of the gravity field science, computations, and data collection. IGFS will maintain a publication activity related to the gravity field, especially through "Newtons Bulletin".

Structure

The Service is organized by means of the following structure:
- Advisory Board
- Central Bureau
- Technical Centre
- Services

The Advisory Board is composed of:
- Directors (or their delegates) of each of the Centres of IGFS
- Chairmen of the IGFS working groups
- Presidents (or their delegates) of the IAG Commissions related to the Service work
- A representative of the IAG Executive Committee (IAG-EC)
- Two members appointed among the affiliates.

The Advisory Board
- Coordinate the scientific strategy
- Coordinates the joint activity of the Centres
- Oversees the participation of the Service in international projects
- Presents to the IAG-EC proposals for associating new centres to the Service
- Elects the IGFS affiliates upon nomination by the Centres or affiliates.

The Advisory Board is appointed for four years between IUGG General Assemblies. The existing Advisory Board selects new members as required, and nominates a president for the IGFS. The election is to be confirmed by the IAG Executive Committee. The Advisory Board makes decisions by majority vote; it can also vote by email. The Advisory Board decides the Terms of Reference for IGFS.

IGFS Services and Centres

The IGFS Services and Centres are the "operating arms" of IGFS. The Centres are committed to produce services and products related to the gravity field of the Earth and/or the planets. The Centres within IGFS are approved by the IAG EC. Centres can include bodies of structures external to the IAG (e.g., the BGI which is reporting to FAGS). The Centres will have their own governing bodies, nominated according to internal rules, also taking into account the interests of the supporting entities. In particular, each governing body will have a Director, elected according to internal rules.

Centres will maintain a list of data and products, providing them to the general public according to their policy of dissemination; they will deliver services in the form of data archiving, data analysis, dissemation, software, training, initiation of measurement and data compilation campaigns etc. The activities of each Centre will be reviewed annually by the IAG-EC. The IGFS Technical Centre, located at the National Geospatial-Intelligence Agency, USA, will play a special role in advice on global models, geoid and gravity, especially related to the global ultra-high resolution geopotential models (EGM2008 and successors).

IGFS Central Bureau

The IGFS Central Bureau will act as the central coordination and communication centre of the IGFS. The Central Bureau will provide a link between the IGFS entities, IAG, and external projects, networks or organizations (oceanic, atmospheric, hydrologic, …); provide link to the GGOS bureau and communicate their requirements and recommendations to the IGFS, and implement standards and recommendations related to gravity field observations, secure consistency with geometric standards, and promote their use within the geoscientific community. The Central Bureau will also maintain the web information of the IGFS, and arrange gravity field-related meetings and workshops.

Working groups

JWG2.1: International and Regional Comparison Campaigns of Absolute Gravimeters (joint with IAG Comm. 2). Chair: V. Palinkas

JWG2.2: Absolute Gravimetry and Absolute Gravity Reference System (joint with IAG Comm. 2). Chair: H.Wilmes.

JWG2.3: Assessment of GOCE Geopotential Models (joint with IAG Comm. 2). Chair: J. Huang.

Working Group on Vertical Datum Standardization (joint with GGOS Theme 1 - Global Vertical Datum). Chair: L. Sanchez

IGFS Advisory Board

- S C Kenyon (USA, Technical Centre chair)
- J P Barriot (French Polynesia)
- S Bonvalot (France)
- R Barzaghi (Italy)
- F Barthelmes (Germany)
- P Berry (UK)
- U Marti (Switzerland)
- S Bettadpur (USA)
- H Denker (Germany)
- J Huang (Canada)
- L Sanchez (Germany/Columbia)
- H Wilmes (Germany)
- M G Sideris (Canada)

The International Laser Ranging Service (ILRS)

http://ilrs.gsfc.nasa.gov/

Chairman of the Governing Board: G. Appleby (Great Britain)
Director of the Central Bureau: M. Pearlman (USA)
Secretary: C. Noll (USA)
Analysis Coordinator: E. C. Pavlis (USA)

Objectives

IGFS is a unified "umbrella" IAG service, which will
- Coordinate collection, validation, archiving and dissemination of gravity field related data
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The IGFS coordinates the following "Level-1" IAG services and service centres
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- IGeS (International Geoid Service), Milano, Italy
- ICET (International Center for Earth Tides), Papeete, French Polynesia
- ICGEM (International Center for Global Earth Models), Potsdam, Germany
- IDEMS (International Digital Elevation Model Service), Leicester, UK
- ("Global Geodynamics Project" of superconducting gravimeters - currently in transition to become an IAG Service).

The overall goal of IGFS is to coordinate the servicing of the geodetic and geophysical community with gravity field-related data, software and information. The combined data of the IGFS entities data will include both satellite-derived global models, terrestrial, airborne, satellite and marine gravity observations, earth tide data, GPS leveling data, digital models of terrain and bathymetry, as well as ocean gravity field and geoid from satellite altimetry. Both the static and the temporal variations of the gravity field will be covered by the IGFS.

IGFS will – in cooperation with the services - make a special effort in trying to secure release of data from national and international institutions holding data on the spatial and temporal gravity variations, geoid and the surface heights of the Earth, to make them widely available to the scientific community.

IGFS will coordinate regional conferences, tutorials and schools to train young scientists and members of national institutions in the various aspects of the gravity field science, computations, and data collection. IGFS will maintain a publication activity related to the gravity field, especially through "Newtons Bulletin".

Structure

The Service is organized by means of the following structure:
- Advisory Board
- Central Bureau
- Technical Centre
- Services

The Advisory Board is composed of:
- Directors (or their delegates) of each of the Centres of IGFS
- Chairmen of the IGFS working groups
- Presidents (or their delegates) of the IAG Commissions related to the Service work
- A representative of the IAG Executive Committee (IAG-EC)
- Two members appointed among the affiliates.

The Advisory Board
- Coordinate the scientific strategy
- Coordinates the joint activity of the Centres
- Oversees the participation of the Service in international projects
- Presents to the IAG-EC proposals for associating new centres to the Service
- Elects the IGFS affiliates upon nomination by the Centres or affiliates.

The Advisory Board is appointed for four years between IUGG General Assemblies. The existing Advisory Board selects new members as required, and nominates a president for the IGFS. The election is to be confirmed by the IAG Executive Committee. The Advisory Board makes decisions by majority vote; it can also vote by email. The Advisory Board decides the Terms of Reference for IGFS.

IGFS Services and Centres

The IGFS Services and Centres are the "operating arms" of IGFS. The Centres are committed to produce services and products related to the gravity field of the Earth and/or the planets. The Centres within IGFS are approved by the IAG EC. Centres can include bodies of structures external to the IAG (e.g., the BGI which is reporting to FAGS). The Centres will have their own governing bodies, nominated according to internal rules, also taking into account the interests of the supporting entities. In particular, each governing body will have a Director, elected according to internal rules.

Centres will maintain a list of data and products, providing them to the general public according to their policy of dissemination; they will deliver services in the form of data archiving, data analysis, dissemation, software, training, initiation of measurement and data compilation campaigns etc. The activities of each Centre will be reviewed annually by the IAG-EC. The IGFS Technical Centre, located at the National Geospatial-Intelligence Agency, USA, will play a special role in advice on global models, geoid and gravity, especially related to the global ultra-high resolution geopotential models (EGM2008 and successors).

IGFS Central Bureau

The IGFS Central Bureau will act as the central coordination and communication centre of the IGFS. The Central Bureau will provide a link between the IGFS entities, IAG, and external projects, networks or organizations (oceanic, atmospheric, hydrologic, …); provide link to the GGOS bureau and communicate their requirements and recommendations to the IGFS, and implement standards and recommendations related to gravity field observations, secure consistency with geometric standards, and promote their use within the geoscientific community. The Central Bureau will also maintain the web information of the IGFS, and arrange gravity field-related meetings and workshops.

Working groups

JWG2.1: International and Regional Comparison Campaigns of Absolute Gravimeters (joint with IAG Comm. 2). Chair: V. Palinkas

JWG2.2: Absolute Gravimetry and Absolute Gravity Reference System (joint with IAG Comm. 2). Chair: H.Wilmes.

JWG2.3: Assessment of GOCE Geopotential Models (joint with IAG Comm. 2). Chair: J. Huang.

Working Group on Vertical Datum Standardization (joint with GGOS Theme 1 - Global Vertical Datum). Chair: L. Sanchez

IGFS Advisory Board

- S C Kenyon (USA, Technical Centre chair)
- J P Barriot (French Polynesia)
- S Bonvalot (France)
- R Barzaghi (Italy)
- F Barthelmes (Germany)
- P Berry (UK)
- U Marti (Switzerland)
- S Bettadpur (USA)
- H Denker (Germany)
- J Huang (Canada)
- L Sanchez (Germany/Columbia)
- H Wilmes (Germany)
- M G Sideris (Canada)

International VLBI Service for Geodesy and Astrometry (IVS)

http://ivscc.gsfc.nasa.gov

Chair of Directing Board (acting): **H. Schuh** (Austria)
Coordinating Center Director: **D. Behrend** (USA)

Development

The International VLBI Service for Geodesy and Astrometry (IVS) is an international collaboration of organizations, which operate or support Very Long Baseline Interferometry (VLBI) components. IVS was established in 1999 and became a service of IAG that year. In 2000, IVS was recognized as a service of the International Astronomical Union (IAU). A membership proposal for the World Data System (WDS) has been submitted. IVS interacts closely with the International Earth Rotation and Reference Systems Service (IERS), which is tasked by IAU and IUGG with maintaining the international celestial and terrestrial reference frames (ICRF and ITRF).

Mission/Objectives

The objectives of IVS are:

- To provide a service to support geodetic, geophysical, and astrometric research and operational activities.
- To promote research and development activities in all aspects of the geodetic and astrometric VLBI technique.
- To interact with the community of users of VLBI products and to integrate VLBI into a global Earth observing system.

To meet these objectives, IVS coordinates VLBI observing programs, sets performance standards for VLBI stations, establishes conventions for VLBI data formats and data products, issues recommendations for VLBI data analysis software, sets standards for VLBI analysis documentation, and institutes appropriate VLBI product delivery methods to ensure suitable product quality and timeliness. IVS closely coordinates its activities with the astronomical community because of the dual use of many VLBI facilities and technologies for both astronomy and astrometry/ geodesy.

Products

VLBI data products currently available are

- All components of Earth orientation
- Terrestrial reference frame
- Celestial reference frame
- Tropospheric parameters

All VLBI data products are archived in IVS Data Centers and are publicly available.

Structure/Board / Members

IVS accomplishes its goals through Permanent Components. As of 2011 the IVS has:

- 30 Network Stations, acquiring high performance VLBI data.
- 3 Operation Centers, coordinating activities of Network Stations.
- 6 Correlators, processing acquired data, providing feedback to stations and providing processed data to analysts.
- 6 Data Centers, distributing products to users, providing storage and archiving functions.
- 26 Analysis Centers, analyzing the data and producing results and products.
- 7 Technology Development Centers, developing new VLBI technology.
- 1 Coordinating Center, coordinating daily and long-term activities of IVS.

All together there are 79 Permanent Components, representing 41 organizations in 20 countries, and ~280 individuals who are Associate Members. The 41 organizations that support IVS components are IVS Member Organizations. There are also 6 Affiliated Organizations that cooperate with IVS on issues of common interest but do not support an IVS component.

In addition the IVS has a Directing Board to determine policies, standards, and goals. The current IVS Directing Board consists of the following members (alphabetical):

1. D. Behrend (USA) *Coordinating Center Director*
2. A. Bertarini (Germany) *Correlators and Operation Centers representative*
3. P. Charlot (France) *IAU representative*
4. J. Gómez González (Spain) *At Large member*
5. R. Haas (Sweden) *Technology Development Centers representative*

6. H. Hase (Germany/Chile) *Network Stations representative*
7. E. Himwich (USA) *Network Coordinator*
8. Sh. Kurihara (Japan) *At Large representative*
9. Ch. Ma (USA) *IERS representative*
10. A.l Nothnagel (Germany) *Analysis Coordinator*
11. H. Schuh (Austria) *IAG representative*
12. F. Shu (China) *At Large member*
13. O. Titov (Australia) *Analysis and Data Centers member*
14. G. Tuccari (Italy) *Network Stations representative*
15. A. Whitney (USA) *Technology Coordinator*

Committees and Working Groups

IVS currently has three active working groups, two committees, and one executive group:

- Working Group 4 on VLBI Data Structures.
- Working Group 5 on Space Science Applications.
- Working Group 6 on Education and Training.
- Observing Program Committee.
- VLBI2010 Committee.
- VLBI2010 Project Executive Group.

Publications and Meetings

IVS publishes an Annual Report, a thrice-annual Newsletter, and Proceedings from its biennial General Meeting. All publications are available from the Coordinating Center and also published on the Web site. IVS holds a General Meeting every two years, a Technical Operations Workshop every two years, and an Analysis Workshop every year. Information about all IVS activities is available at the IVS Web site under the URL http://ivscc.gsfc.nasa.gov.

The Permanent Service for Mean Sea Level (PSMSL)

web: http://www.psmsl.org

Director: **L. J. Rickards** (UK)

Development

Since 1933, the Permanent Service for Mean Sea Level (PSMSL) has been responsible for the collection, publication, analysis and interpretation of sea level data from the global network of tide gauges. It is based at the National Oceanography Centre (NOC), Liverpool, which is a component of the UK Natural Environment Research Council (NERC). It is supported by the Intergovernmental Oceanographic Commission (IOC) and NERC. The PSMSL continues to be one of the main data centres for both the International Association for Physical Sciences of the Oceans (IAPSO) and the IAG. The PSMSL operates under the auspices of the International Council for Science (ICSU) and reports formally to IAPSO's Commission on Mean Sea Level and Tides. Following the discontinuation of the Federation of Astronomical and Geophysical Data Analysis Services and the World Data Centre system, the PSMSL is working towards membership of their successor, the new World Data System of ICSU.

Mission/Objectives

The mission of the PSMSL is to provide the community with a full Service for the acquisition, analysis and interpretation of sea level data. Aside from its central role of operation of the global sea level data bank, the PSMSL provides advice to tide gauge operators and analysts. It occupies a central management role in the development of the Global Sea Level Observing System (GLOSS) and hosts important international study groups and meetings on relevant themes. Several such meetings took place in 2008 to mark the 75th Anniversary of the PSMSL.

Products

The database of the PSMSL contains over 60000 station-years of monthly and annual values of mean sea level (MSL) from over 2000 tide gauge stations around the world received from approximately 200 national authorities. On average, approximately 1500 station-years of data are entered into the database each year. This database is used extensively throughout the sciences of climate change, oceanography, geodesy and geology, and is the main source of information for international study groups such as the Intergovernmental Panel on Climate Change (IPCC).

Data for all stations are included in the PSMSL METRIC (or total) data set. The METRIC monthly and annual means for any one station-year are necessarily required to be measured to a common datum, although, at this stage, datum continuity between years is not essential. The year to-year datum checks become essential, however, if the data are subsequently to be included in the PSMSL 'Revised Local Reference (RLR)' component of the data set.

The 'Revised Local Reference (RLR)' dataset of the PSMSL contains records for which time series analysis of sea level changes can be performed. Long records from this dataset have been the basis of all analyses of secular changes in global sea level during the last century. The geographical distribution of longer RLR records contains significant geographical bias towards the northern hemisphere, a situation which is being rectified by the establishment of the GLOSS global sea level network.

The PSMSL is also responsible for the Higher Frequency Delayed Mode (HF DM) data set of sea level information from the GLOSS Core Network. This consists of the original sea level measurements from each site (typically hourly values) which provide a strategic backup to the MSL information of the main PSMSL data set.

In addition, the PSMSL provides a range of sea level products (e.g. interactive anomaly and trend maps, tables of sea level trends) for its users. These findings are input to national and international scientific study groups regularly. A range of training materials and software products are also made available via its web site which can be consulted for more information

.

Structure/Governing Board Members

The PSMSL reports formally to the IAPSO Commission on Mean Sea Level and Tides (President Dr. G.T. Mitchum, USA). It is also served by an Advisory Group which at present consists of Dr. R. Neilan (JPL, USA), Prof. G. T. Mitchum (University of South Florida, USA), Prof. B. Douglas (University of Maryland, USA), Prof. D. T. Pugh (Liverpool University, UK), Dr. P. Knudsen (Danish National Space Center), Dr. R. Bingley (Nottingham University, UK), Dr. T. Aarup (IOC, UNESCO) and Dr. J. Fierro (SHOA, Chile). Suggestions for improvements in PSMSL activities may be sent directly to the PSMSL or via the IAPSO Commission or via any member of the Advisory Group.

Points of Contact

Permanent Service for Mean Sea Level
National Oceanography Centre
Joseph Proudman Building
6 Brownlow Street
Liverpool L3 5DA, UK.
Email: psmsl@noc.ac.uk
Web site: www.psmsl.org
Telephone: +44 (0)151-795-4800
Fax: +44 (0)151-795-4801

Staff members

- L. J. Rickards (Director)
- P. L. Woodworth
- K. M. Gordon
- S. J. Holgate
- S. Jevrejeva
- A. P. Matthews
- M. E. Tamisiea
- E. A. Bradshaw (GLOSS DM HF data set)

Communication and Outreach Branch (COB)

web: http://www.iag-aig.org

President: **J. Ádám** (Hungary)
Secretary: **Sz. Rózsa** (Hungary)

Development

The Communication and Outreach Branch (COB) was created by the IAG Council at its special meeting in Budapest, 7 September 2001. A *Call for Participation* was issued by the IAG Central Bureau (CB) to fill this position. Two offers were received to host the COB. The offer of the Hungarian Academy of Sciences (HAS)/Budapest University of Technology and Economics (BME) was elected by the Executive Committee (EC) at its meeting in Nice, 11 April, 2003. The IAG Council at the 23rd IUGG/IAG General Assembly (Sapporo, Japan, 30 June-11 July, 2003) has confirmed this election. Thus the COB started its activities in July 2003, and in the period of 2011-2015 will be the third term in the operation of the COB by the HAS/BME.

The Communication and Outreach Branch is one of the components of the Association. According to the new Statutes (§5) of the IAG, the COB is the office responsible for the promotional activities of the IAG and the communication with its members.

Terms of Reference

According to §18 of the new By-laws of the IAG:

(a) The function of the Communication and Outreach Branch is to provide the Association with communication, educational/public information and outreach links to the membership, to other scientific Associations and to the world as a whole.
(b) The responsibilities of the Communication and Outreach Branch shall include the following tasks:
  (i) Promote the recognition and usefulness of geodesy in general and IAG in particular.
  (ii) Publications (newsletters).
  (iii) Membership development.
  (iv) General information service and outreach.
c) The Communication and Outreach Branch shall also assist the IAG General Secretary, in the following tasks as required:
  (i) Maintenance of the IAG Web page.
  (ii) Setting up Association schools.
  (iii) Setting up meetings and conferences
  (iv) Maintaining the Bibliographic Service
d) Major decisions related to the operations of the COB shall be made by a Steering Committee consisting of the following voting members:
  (i) Communications and Outreach Branch President.
  (ii) IAG Secretary General.
  (iii) Editor-in-Chief of the Journal of Geodesy.
  (iv) Up to 5 other members appointed by the Executive Committee on the recommendation of the President of the Communications and Outreach Branch.

Program of Activities

According to the new modernised structure of the IAG, the individual membership has been introduced in addition to the traditional National Members. However the individual membership requires a more commercial, member oriented operation of the Association. The main purpose of the COB is to promote communication and interaction among all of its members and to facilitate the work of IAG in general. Therefore the COB will be a permanent IAG office for publication, publicity and visibility of the Association.

The planned activities of the COB will be split into two main groups:

a) communicational activities, and
b) membership developments and promotional activities

which enable the growth of the IAG itself.

One of the major tasks of the COB is to create the channels of the communication within the Association. Our intention is to make a simple, structured way of communication using various information technologies (IT). The ***communication of the IAG*** will be done using the following channels:

- the official IAG website (see the chapter IAG on the Internet in this issue),
- publication of the IAG Newsletters and Geodesist's Handbook in cooperation with the IAG Office.

The official *IAG website* acts on one hand as the most important interface to the outside community, and on the other hand it is the first pillar of the communicational infrastructure of the Association. Therefore the content of the website is defined to support both roles.

The server operating in the IAG COB, handles *mailing lists,* which will be the major source of information for the

members. The members get all of the announcements and Newsletters via e-mail. Our intention is to operate many mailing lists. Issues for creating/maintaining user database/lists for advertising, circular e-mails, surveys, etc are as follows:

- users can already register themselves by giving contact information and topics of interest (e.g. GPS, Gravity Field, Reference Frames, etc.) for notification;
- registration should be entirely web-based using confirmation e-mails;
- users can access/update/delete their personal contact information with username and password;
- privacy statement is necessary for keeping personal data confident;
- several statistics for geographical user distribution can be shown in simple charts on the IAG website;
- benefits should be clearly stated to be on the user list.

The electronic version of the *IAG Newsletter* is published monthly. It has a unique logo which is *a)* unmistakable and unambiguous, *b)* easy to read and perceive even when printed in black/white, and *c)* simply designed and reproduces to any size. It is available in different formats for distribution: *(i)* plain text for e-mail, *(ii)* HTML for website, and *(iii)* PDF for e-mail and downloading from website. Visitors have following options regarding the distribution of the IAG Newsletter:

- view the Newsletter online or download it directly;
- browse/view/download past issues in the Newsletter archive.

A selection of the Newsletter articles is published in the Journal of Geodesy.

The ***membership developments and promotional activities*** are further our one of the most important tasks. The COB focuses not only on increasing the number of members in the IAG, but also on providing science information service to the members. For the *membership developments* a Membership Application Form (MAF) was designed in the previous period and it is put on the IAG website. In the front-page of our website, there is an indication to download the Membership Application Form.

The major channels of *promotional activities* are the IAG website, and the mailing lists. Some brochures and leaflets are printed, which

- introduce the IAG to the global community,
- emphasize the mission statement of IAG, and
- describe the advantages of being an IAG member.

Our intention is that these brochures should be available at every conference organized and/or sponsored by IAG. Therefore the COB should also represent IAG at all major meeting (including not only IUGG General Assemblies, IAG Scientific Assemblies, AGU and EGS meetings, but also at IAG-sponsored meetings) with different IAG materials (brochures, etc). These brochures can be downloaded from the IAG website (www.iag-aig.org).

Steering Committee

The COB has a Steering Committee (SC) with the following members:

- J. Ádám, President (Hungary)
- Sz. Rózsa, Secretary (Hungary)
- H. Hornik (Germany)
- H. Schuh (Austria)
- G. Tóth (Hungary)
- P. Willis (France)

Ex officio:

- H. Drewes (Germany)
- R. Klees (Netherlands)

Address

The COB operates an office of which address is as follows:

IAG Communication and Outreach Branch
c/o Department of Geodesy and Surveying
Budapest Univ. of Technology and Economics
P.O.Box 91, H-1521 Budapest, Hungary
Phone: +36-1-463 3222/1353, Fax: +36-1-463 3192
E-mail: jadam@sci.fgt.bme.hu / szrozsa@sci.fgt.bme.hu

IAG Representatives to Scientific Bodies

IAG Representatives to the Services

- BGI: *Urs Marti* (Switzerland)
- BIPM: *Claude Boucher* (France) [1]
- IAS: *Wolfgang Bosch* (Germany)
- IBS: *Johannes Ihde* (Germany)
- ICET: *Harald Schuh* (Austria)
- ICGEM: *Franz Barthelmes* (Germany)
- IDEMS: *Philippa Berry* (UK)
- IDS: *Michiel Otten* (Germany)
- IERS: *Clark Wilson* (USA)
- IGeS: *Urs Marti* (Switzerland)
- IGFS: *Steve Kenyon* (USA)
- IGS: *Chris Rizos* (Australia)
  Zuheir Altamimi (France)
- ILRS: *Tonie van Dam* (Luxembourg)
- IVS: *Harald Schuh* (Austria)
- PSMSL: *Per Knudsen* (Denmark)

IAG Representatives to External Bodies

IUGG Commissions

- GRC (Geophysical Risk and Sustainability):
  John Labrecque (USA)
- CMG (Commission on Mathematical Geophysics):
  Shin-Chan Han (USA)
- SEDI (Study of Earth's Deep Interior):
  Véronique Dehant (Belgium)
- UCDI (Union Commission for Data and Information):
  Bernd Richter (Germany), *Ruth Neilan* (USA)

Other Bodies

- ABLOS (Advisory Board on the Law of the Sea):
  Sunil Bisnath (Canada), *Graeme Blick* (New Zealand), *Sobar Sutisna* (Indonesia), *Niels Andersen* (Sweden)
- IAU Commission 19 Rotation of the Earth:
  Z. Malkin (Russia)
- GEO (Group on Earth Observation):
  - Plenary: *Hansjörg Kutterer* (Germany)
  - Representatives to Committees nominated by GGOS
- ISO International Standards Organization
  - TC211 Geographic Information/Geomatics:
    Hermann Drewes, *Johannes Ihde* (both Germany)
  - Control Body for Geodetic Registry Network:
    Michael Craymer (Canada)
- JBGIS (Joint Board of Geospatial Information Societies) WG on Risk and Disaster management:
  John Labrecque (USA)
- SIRGAS (Geocentric Reference System for the Americas):
  Hermann Drewes (Germany)
- UNOOSA (United Nations Offices for Outer Space Affairs, UNOOSA):
  - International Committee on Global Navigation Satellite Systems (ICG): *Ruth Neilan* (USA)
  - Committee on the Peaceful Use of Outer Space (COPUOS), nominated by *GGOS*
  - United Nations Platform for Space-based Information for Disaster Management and Emergency Response (UN-SPIDER) nominated by *GGOS*

[1] identical IUGG Representative to the Consultative Committee for Time and Frequency (CCTF)

IAG-related IUGG Liaisons to International and Intergovernmental Organizations

- UN Cartographic Office: *Luiz Paulo Souto Fortes* (Brazil)
- Pan-American Institute for Geography and History (PAIGH): *Hermann Drewes* (Germany)
- Consultative Committee for Time and Frequency (CCTF): *Claude Boucher* (France)
- World Data System (WDS): *Ruth Neilan* (USA)

General Information

Standards and Conventions for Geodesy

Detlef Angermann (Germany)

Preface

Unified standards and conventions are the basis for the generation of consistent and reliable geodetic products based on geometric and gravimetric observations. The use of identical standards and conventions is crucial for the modelling and processing of the different geodetic observations as well as for the parameter estimation and representation in all fields of geodesy, in order to ensure consistent results for the geometry, the rotation and gravity field of the Earth along with its variations in time. It is equally important that users of geodetic products are aware of the standards and conventions these products are based on, to fully exploit their accuracy and to allow for a coherent interpretation. Standards and conventions are widely used in a broad sense and various international organizations and entities are involved in this subject. In the first part of this document the relevant nomenclature is introduced. We shall distinguish standards, standardized units, fundamental physical standards, resolutions and conventions (Drewes 2008). The second part focuses on the Bureau for Standards and Conventions, which has been installed as a GGOS component in 2009.

1. Nomenclature

1.1 Standards

Various international, regional and national organizations are involved in the development, coordination, revision, maintenance, etc. of standards that address the interests of a wide area of users. Important for geodesy is the ***International Organization for Standardization*** (ISO, http://www.iso.org), an international standard-setting body composed of representatives from a network of national standards institutes of more than 150 countries. ISO was founded in 1947 and promulgates worldwide priority, industrial and commercial standards to enable a consensus to be reached on solutions that meet the requirements needed in science and society. IAG has two representatives to ISO and there is one representative of ISO to IAG. The ***Technical Committee ISO/TC 211*** (http://www.isotc211.org), was formed within ISO to cover the areas of digital geographic information and geomatics. Also relevant for geodesy is the ***Open Geospatial Consortium*** (OGC, http://www.opengeospatial.org), an international voluntary consensus standards organization, originating in 1994. In OGC, more than 400 commercial, governmental, non-profit and research organizations worldwide collaborate in a consensus process encouraging development and implementation of open standards for geospatial content and location-based services, mainstream IT, GIS data processing and data sharing. There is a close cooperation between OGC, ISO/TC211 and IAG institutions.

1.2 Standardized units

The terms “quantities and units” are defined in the ***International Vocabulary of Basic and General Terms in Metrology*** (ISO/IEC Guide, 2007; Bureau International des Poids et Mesures, 2006) . The value of a quantity is generally expressed as the product of a number and a unit. The unit is simply a particular example of the quantity concerned which is used as a reference, and the number is the ratio of the value of the quantity to the unit. Many different units may be used for a particular quantity. For example, the speed may be expressed in the form of v = 25 m/s = 90 km/h. However, because of the importance of a set of well defined and easily accessible units universally agreed for the multitude of measurements that support today's complex society, units should be chosen so that they are readily available to all, are constant throughout time and space, and are easy to realize with high accuracy.

Most relevant for geodesy is the ***International System of Units*** (SI, www.bipm.org/ en/si/si_brochure), which was adopted by the 11th General Conference on Weights and Measures (1960). It is hosted by the ***International Bureau of Weights and Measures*** (Bureau International des Poids et Mesures, BIPM). In order to establish a system of units, it is necessary first to establish a system of quantities, including a set of equations defining the relations between those quantities. This is necessary because the equations between the quantities determine the equations relating the units. The units are divided into two classes – base units and derived units. In a similar way the corresponding quantities are described as base quantities and derived quantities. There are seven base units, each representing, by convention, different kinds of physical quantities. Three of them most relevant for geodesy are:

- Length (standardized unit metre, [m]),

- Mass (standardized unit kilogram, [kg]), and
- Time, duration (standardized unit second [s])

The number of derived units and derived quantities of interest in science and technology can be extended without limit. For example, the derived unit speed is metre per second [m/s], or centimetre per second [cm/s] (in the SI). The kilometre per hour [km/h] is a measurement unit of speed outside the SI but accepted for use with the SI. The knot, equal to one nautical mile per hour, is a measurement unit of speed outside the SI.

Most relevant for geodesy in the BIPM is the Section ***Time, Frequency and Gravimetry,*** a Service of the IAG. IAG is represented among the Section members. Thus, a very close connection and cooperation between them is ensured.

1.3 Fundamental Physical Constants

The formulations of the basic theories of physics and their applications are based on so-called fundamental physical constants. These quantities, which have specific and universally used symbols, are of such importance that they must be known as accurately as possible. A physical constant is generally believed to be both universal in nature and constant in time. In contrast a mathematical constant is a fixed numerical value, which does not directly involve any physical measurement. A complete list of all fundamental physical constants is given by the ***National Institute of Standards and Technology*** (NIST, *http://physics.nist.gov/constants*). NIST publishes regularly a list of the constants. The most relevant for geodesy among them are the gravitational constant, the speed of light in vacuum, the standard acceleration of gravity, and the standard atmosphere.

The ***Committee on Data for Science and Technology*** (CODATA, *http://www.codata.org*) is an interdisciplinary Scientific Committee of the International Council for Science (ICSU). IUGG is a member Union of CODATA. The Committee works to improve the quality, reliability, management and accessibility of data. CODATA is concerned with all types of data resulting from measurements and calculations in all fields of science and technology, including physical sciences, astronomy, engineering, and others. The ***CODATA Task Group on Fundamental Physical Constants*** has recently announced the public release of the 2010 Least Squares Adjustment of the values of the set of fundamental physical constants (CODATA Newsletter 101, August 2011). The values for them are given in http://www.physics.nist.gov/cuu/Constants/index.html. The 2010 values for the most relevant fundamental constants for geodesy are:

- Newtonian constant of gravitation: $6.67384\ 10^{-11} \pm 0.00080\ 10^{-11}$ [$m^3\ kg^{-1}\ s^{-2}$]
- Speed of light in vacuum: 299792458 m/s (exact)
- Standard acceleration of gravity: 9.80665 m/s^2 (exact)
- Standard atmosphere: 101325 Pa (exact)

Please note, that the 2010 value for the Newtonian constant of gravitation differs from the previous estimation of 2006, being $6.67428\ 10^{-11} \pm 0.00067\ 10^{-11}$ [$m^3/kg/s^2$].

1.4 Resolutions

A resolution is a written motion adopted by a deliberating body. The substance of the resolution can be anything that can normally be composed as a motion. In this context we refer to the motion for adopting standards, constants or any parameters to be used by institutions and persons affiliated with the adopting body. Most important resolutions for geodesy are those adopted by the Councils of the ***International Union of Geodesy and Geophysics*** (IUGG, *http://www.iugg.org*), the ***International Association of Geodesy*** (IAG; *http://www.iag-aig.org*), and the ***International Astronomical Union*** (IAU, *http://www.iau.org*).

Resolutions are non-binding laws of a legislature, but more binding than recommendations. In non-legal bodies, such as IUGG, IAG and IAU, which cannot pass laws, they form the highest level of commitment. Resolutions shall be respected by all institutions and persons affiliated with the adopting body. Important resolutions of IUGG/IAG/IAU with respect to standards and conventions are, e.g.,

- IUGG 1979 Resolution No. 7 and IAG 1980 Resolution No. 1 on the Geodetic Reference System 1980 (GRS80, Moritz 2000). The adopted values for the four defining constants of the GRS80 are:
  - Equatorial radius (a): 6378137 [m]
  - Geocentric gravitational constant (GM): $3.986005\ 10^{14}$ [$m^3\ s^{-2}$]
  - Dynamical form factor of the Earth (J_2): $1.08263\ 10^{-3}$ (free of tides)
  - Angular velocity of rotation (ω): $7.292115\ 10^{-5}$ [$rad\ s^{-1}$]
- IAG Resolutions No. 16 (1983) on the tide system. It is recommended to use "zero-tide" values associated with the geopotential and "mean-tide" values for quantities associated with station displacements.
- IUGG Resolution No. 2 (2007) on the Geocentric and International Terrestrial Reference System (GTRS and ITRS).
- IAU2000/2006 Resolutions on the precession-nutation model (Capitaine et al., 2009).
- IAU 2009 Resolution No. B3 on the Second Realization of the International Celestial Reference Frame (Ma et al., 2009)

1.5 Conventions

A convention is a set of agreed, stipulated or generally accepted norms, standards or criteria. In physical sciences, numerical values such as constants or quantities are called conventional if they do not represent a measured property

of nature, but originate in a convention. A conventional value for a constant or a specific quantity (e.g., the potential of the geoid W_o) can be for example an average of measurements, agreed between the scientists working with these values.

In geodesy conventions may be adopted by IAG and its components (Services, Commissions and GGOS). The most established and widely used conventions are those of the ***International Earth Rotation and Reference Systems Service*** (IERS, http://www.iers.org). The latest versions are the IERS Conventions 2010 (Petit and Luzum, 2010). Equivalent conventions will have to be released by the ***International Gravity Field Service*** (IGFS, *http://www.igfs.net*), to serve as the basis for gravity field related data and products. For the gravity field missions (e.g., CHAMP, GRACE, GOCE) different standards or conventions are currently in use (e.g., GOCE Standards; released by the European GOCE gravity consortium, 2010).

Below are the values of the IERS Conventions 2010 for some important geodetic constants:

- Newtonian constant of gravitation (G): $6.67428\ 10^{-11} \pm 0.00067\ 10^{-11}$ [$m^3\ kg^{-1}\ s\text{-}^2$]
- Geocentric gravitational constant (GM): $3.986004418\ 10^{14} \pm 8\ 10^5$ [$m^3\ s^{-2}$]
- Equatorial radius (a): 6378136.6 ± 0.1 [m]
- Flattening factor (1/f): 298.25642 ± 0.00001
- Dynamical form factor of the Earth (J_2): $1.0826359\ 10^{-3} \pm 1\ 10^{-10}$
- Angular velocity of rotation (ω): $7.292115\ 10^{-5}$ [rad s^{-1}]
- Potential of the geoid (W_0): 62636856.0 ± 0.5 [$m^2\ s^{-2}$]

2. GGOS Bureau for Standards and Conventions

The Bureau for Standards and Conventions (BSC) has been established as a GGOS component in 2009. It is the successor of the GGOS Working Group on Conventions, Modelling and Analysis that was chaired by Hermann Drewes. The BSC is jointly operated by the Deutsches Geodätisches Forschungsinstitut (DGFI), and the Institut für Astronomische und Physikalische Geodäsie (IAPG) of Technische Universität München, both in Munich, Germany, under the umbrella of the Forschungsgruppe Satellitengeodäsie (FGS).

2.1 Mission and goals

The implementation of common standards and conventions for the generation of geometric and gravimetric products is of crucial importance for GGOS. The BSC supports GGOS in its goal to obtain products of highest accuracy, consistency, temporal and spatial resolutions, and referring to a unique reference frame stable over decades.

GGOS shall keep track of the strict observance of adopted geodetic standards, standardized units, fundamental physical constants, resolutions and conventions in all official products provided by the geodetic community, identify gaps and deficiencies in standards and conventions, to initiate steps to close them, and to propagate geodetic standards and conventions in the geodetic and general scientific community and promote their use.

To fulfil its mission the BSC works closely together with experts in the field and maintains regular contact and establishes a strong interface with all the IAG Services and Commissions and international bodies involved in the adoption of standards, physical constants, resolutions and conventions.

2.2 Tasks

The main objectives of the GGOS Bureau for Standards and Conventions (BSC) are:

- The BSC evaluates the geodetic standards and conventions currently in use by all the IAG Services for the generation of geodetic/geophysical products. It reviews official products of IAG with respect to the correct use of standards and conventions.
- The BSC propagates all geodetic standards and conventions to geodetic and general scientific communities and urges their common use. If necessary, the BSC proposes the adoption of new standards and conventions, changes and revisions.
- The BSC propagates most important standards to society in general and promotes their use. These outreach activities include the participation at relevant conferences and meetings and submission of papers to journals in neighbouring fields.
- The BSC maintains regular contact with all internal and external institutions involved in the adoption of standards, resolutions and conventions. It thereby takes advantage of representations in IAG Services, IAG Commissions, IUGG and IAU, as well as in other bodies involved in standards and conventions (e.g., BIPM, ISO, CODATA).
- The Bureau is in charge with administrative tasks, communications, data base and web support. For these tasks a close cooperation with the GGOS Coordination Office and the GGOS Portal is established.
- For specific issues dealing with particular fields of geodesy the BSC may set up dedicated Working Groups. Regional or national members may be included in such Working Groups.
- The BSC reports regularly to the GGOS Coordination Board and to the IAG Executive Committee, and – if necessary or appropriate – to the IUGG Executive Committee.

2.3 Staff members of the BSC

- Director: D. Angermann
- Deputy director: T. Gruber
- Geodetic fields and expertise of staff members:
  - Geometry, orbits, TRF: U. Hugentobler, P. Steigenberger, D. Angermann
  - Earth Orientation, CRF: M. Gerstl, R. Heinkelmann
  - Gravity: J. Bouman, T. Gruber
  - Vertical reference systems: L. Sánchez
- Associate members: J. Ádám, M. Craymer, J. Ihde, J. Kusche
- The representation of all IAG Services and other bodies involved in standards and conventions is in progress.

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IAG on the Internet

web: http://www.iag-aig.org

Szabolcs Rózsa, IAG Communication and Outreach Branch

The IAG maintains an Internet site, which is a valuable source of information not only about the Association itself, but also about its scientific disciplines. The primary goal of the website is to communicate with the IAG members, and make information available to the wider Geosciences community in the world as a whole.

Since the maintenance of the IAG website belongs to the activities of the Communication and Outreach Branch (COB) it is still hosted at the Department of Geodesy and Surveying of the Budapest University of Technology and Economics (BME) with the HAS-BME Research Group for Physical Geodesy and Geodynamics of the Hungarian Academy of Sciences (HAS), Budapest, Hungary.

During the past four years, the layout of the website has been redesigned. Some new features have been added to it, which are discussed here.

Topic of the Month

The Topic of the Month section of the opening page aims to promote important scientific achievments and activities to the wider public. The latest scientific results, the establishment of international and interdisciplinary research projects and all other information, which may have a great impact on the geodetic community, can be posted to this section of the website.

Since the COB intends to publish a new topic in each month, Geodesists are kindly encouraged to submit new topics to the COB e-mail address: iagcob@iag-aig.org
The Topics of the Month must include an image and a short introduction, too. Both of them are published on the opening page of the website, and more details are given on separate pages.

The IAG Website with the access to the Contact Database

Members' Area

Each IAG Individual Member has received a personal login name and a password to enter the Members' Area and to access the IAG Contact Database.

IAG Members' Area is a place to publish articles to the IAG Individual Members only. This part of the website is devoted to training materials, conference and symposia presentations and classified IAG related information.

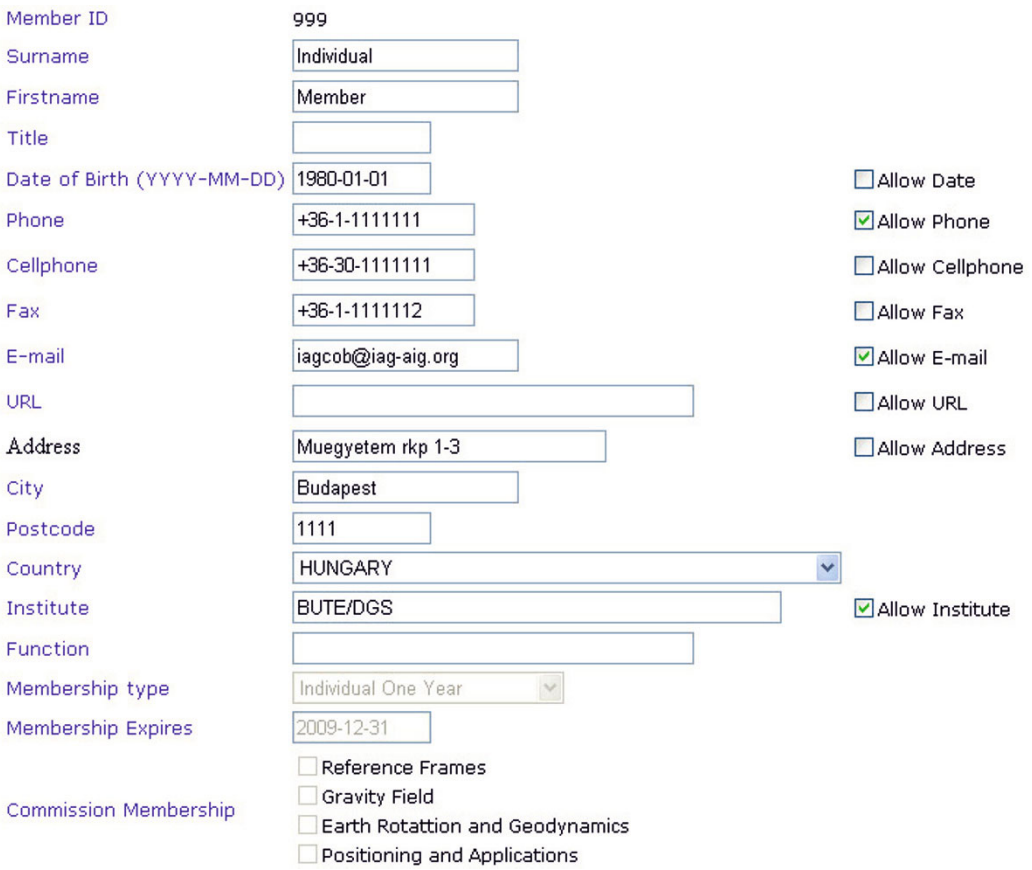
IAG Contact Database

The contact information of each IAG Member has also been stored in a relational database. Every member has the privilege to update his/her own contact information. The information is generally confidential (except the name and the country of origin). However the IAG Individual Members have the option to share theis contact details (phone, e-mail, postal address) with all the Individual Members. It must be noted that the contact database is not open to the public, it can be queried by the IAG Individual Members only.

IAG Individual Members can specify as well their fields of interest in Geodesy. This may enable the COB to send announcements, publications or other information directly to the appropriate members.

Using the Find a Colleague option, one can select the contact details of IAG Individual Members based on Name, Institution, Country and Fields of interest.

The IAG COB has started a campaign to gather contact data from anyone, who is working in, or interested in Geodesy. These data sets will be stored in the IAG Contact Database in the future, in order to add more international contacts and ease the building of international contacts and help to create international co-operations. Those Colleagues, who are not Individual Members of the IAG, will be able to update their own contact information on the web, but the privilege of querying the database will be limited to IAG Members only.



The IAG Forum

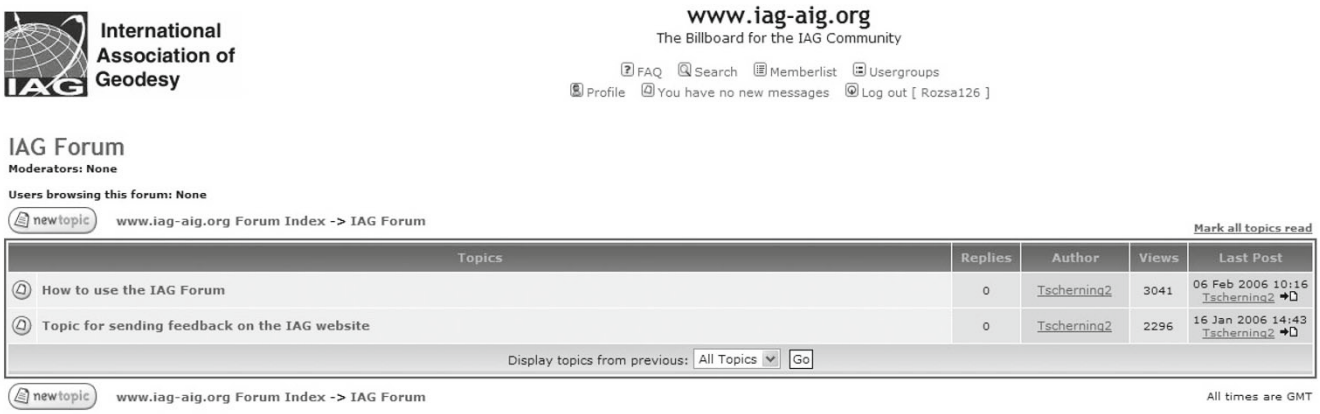
The IAG Forum is a billboard service of the IAG Website. It was established in 2004, but had only marginal number of visits in the last 7 years. Each IAG Individual Member received a personal password to the IAG Forum as well. More information on the Forum will be available on the IAG Website and in the IAG Newsletters.

Publishing on the IAG Website

The IAG COB encourages all the IAG Members and Geodesists in general to publish information on the IAG website. Contributions can be sent to the following e-mail address: iagcob@iag-aig.org.

The IAG Office

The IAG Office maintains an own website, mainly for internal IAG users, at *http//:iag.dgfi.badw.de*.



The opening page of the IAG Forum

Publications of the International Association of Geodesy

I. Journal of Geodesy

Twelve issues per year:
Annual subscription, sale by unit (Springer-Verlag)

Contact:

Springer Verlag
Tiergartenstrasse 17
D – 69121 Heidelberg
www.springer.com

II. Geodesist's Handbook

Quadrennial special issues of Journal of Geodesy, published since 1980, contain the programs of the IAG Components; latest 2008, 2012. A list of all Geodesist's Handbooks published up to now can be found on the reverse side of the foreword in this issue.

III. IAG Symposia Series

Peer reviewed proceedings of IAG Symposia. Latest issues:

Vol. 132: Xu, P., Liu, J., Dermanis, A. (Eds.): VI Hotine-Marussi Symposium on Theoretical and Computational Geodesy, Wuhan, China, 2006.

Vol. 133: Sideris, M. G. (Ed.): Observing our Changing Earth. IAG Symposia at the XXIV General Assembly of the IUGG, Perugia, Italy, 2007.

Vol. 134: Drewes, H. (Ed.): Geodetic Reference Frames. IAG Symposium Munich, Germany, 2006.

Vol. 135: Mertikas, S. P. (Ed.): Gravity, Geoid and Earth Observation. IAG Commission 2 Symposium, Chania, Crete, Greece, 2008.

Vol. 136: Kenyon, S., Pacino, M. C., Marti, U. (Eds.): Geodesy for Planet Earth. Symposia at the IAG Scientific Assembly, Buenos Aires, Argentina, 2009.

Vol. 137: Sneeuw, N., Novák, P., Crespi, M., Sansò, F. (Eds.): VII Hotine-Marussi Symposium on Mathematical Geodesy, Rome, 2009.

Available at

Springer Verlag
Tiergartenstrasse 17
D – 69121 Heidelberg
www.springer.com

IV. Travaux de l'Association Internationale de Géodésie (IAG Reports)

The IAG Reports (Travaux de l'Association Internationale de Géodésie) contain the reports of all IAG components and sub-components. They were published as printed volumes and presented at the IAG General and Scientific Assemblies every two years until 2003. Since 1995 the IAG Reports are also available in digital form, and since 2003 online only: (*http://www.iag-aig.org/index.php?tpl=cat&id_c=18* or *http://iag.dgfi.badw.de/index.php?id=294*). Printed versions may be ordered at the IAG Office (*iag@dgfi.badw.de*)

V. IAG Bibliographic Service (IBS)

The IAG Bibliographic Service for Geodesy is maintained by the Bundesamt für Kartographie und Geodäsie (BKG)

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The IAG Communication and Outreach Branch (COB) compiles and maintains a list of **Geodetic Data Centres**. All data compiled in this list are regularly revised by the IAG National Correspondents.

Considering the fact that addresses are subjected to frequent changes, the directory is stored as a file in the web to sustain the possibility of updates whenever useful. All information is available at the IAG Website (*http://www.iag-aig.org/gdc*).

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IAG Directory

The IAG Directory comprises a list of addresses of geodesists who are in direct contact with the IAG by having attended an IUGG General Assembly, IAG Scientific Meeting, IAG Symposium in the recent years or maintain any other kind of contact. The addresses comprises the name, title, affiliation, postal address as well as phone/fax number and e-mail address of the respective persons.

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Considering the rules of the protection of personal rights this list is not generally open to everybody. The directory is accessible by password for all individual IAG-members via the IAG homepage <*http://www.iag-aig.org/*> as well as on direct request to the IAG Office <*iag@dgfi.badw.de*>