INTERGOVERNMENTAL OCEANOGRAPHIC COMMISSION
Training Course Reports
87

IOC/JCOMM Training Course for the Global Sea Level Observing System (GLOSS) on Sea Level Observation and Analysis

15–26 May 2006
Tokyo, Japan

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UNESCO

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Abstract

The main objective of the workshop was to train tide gauge operators in the Asia Pacific and Indian Ocean on sea level hardware and software and aspects of sea level science. This report provides a summary of the lectures and training activities of the IOC/GLOSS Workshop on Sea-Level Observation and Analysis held in Tokyo (Japan) from 15–26 May 2006. An overview of sea level observations and processing methods used in the region is also provided.

(IOC/2006/TCR/87)

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1. INTRODUCTION

The Intergovernmental Oceanographic Commission's (IOC) Global Sea Level Observing System programme (GLOSS) has traditionally emphasized strong training, education and mutual assistance components. At the 9th GLOSS Group of Experts (Paris, 2005), Japan (represented by Japan Meteorological Agency (JMA)) offered to host a training workshop on sea level observation and data analysis for the countries in the Asian, African and Oceanian region. In the framework of cooperation between JMA and IOC, a regional training workshop on Sea Level Observation and Data Analysis was held at Tokyo, Japan from 15-26 May 2006. The main objective of this workshop was to train and educate tide gauge operators to gain expertise in sea level hardware and software and in some aspects of sea level science. Hopefully this will encourage more countries to participate in GLOSS and hence contribute data for global science and local applications.

Support for this training workshop was provided by IOC through funding from the Ministry of Foreign Affairs of Finland, the Centre National d'Études Spatiales (CNES, France), Natural Environment Research Council (NERC, UK), National Oceanic and Atmospheric Administration (NOAA, USA) and the Asia-Pacific Network for Global Change Research (APN). Local organization was provided by JMA and is gratefully acknowledged.

2. WORKSHOP

The main part of the Workshop was devoted to formal presentations, discussions and hands-on-training in sea-level measurements and analysis. In addition, a field trip was arranged to visit the JMA tide gauge station at Tokyo. JMA also organized trips to the Geographical Survey Institute (GSI) and the Japan Coast Guard (JCG).

The agenda for the Workshop can be found in Annex I. The list of participants and lecturers are given in Annex II and the list of course reference materials is provided in Annex III. Below is a brief description of the proceedings of the Workshop.

2.1 OPENING

The participants paid a courtesy call on Dr Hiraki, the Director General of JMA, who wished the participants a successful course.

The Workshop was held in the Seminar Room of JMA where Dr Ohnishi, the Director General of Global Environment and Marine Department provided the opening address. He expressed the heartiest welcome to the participants. He highlighted the recent disasters due to coastal flooding, e.g. the tsunami of 2004 in the Indian Ocean, and the hurricane Katrina of 2005 in the Gulf of Mexico. Disasters caused by tsunamis, storm surges and the impacts of global sea level rise are not negligible for many countries with coastal areas. To address these phenomena may likely increase the need for monitoring sea level and for providing accurate data for research and for setting policy on coastal protection and development. Such demands put great expectations and responsibilities on the GLOSS community. In closing Dr Ohnishi expressed his sincere hopes that the participants would make every effort to use their knowledge and technical skills by training colleagues and as a contribution to develop GLOSS further.

2.2 LECTURES

2.2.1 GLOSS – Dr Thorkild Aarup

Dr Thorkild Aarup provided an overview of the GLOSS. The GLOSS Programme was established by IOC in mid-1980s with the aim of improving the quantity and quality of sea level data and its original aim: was the development of GLOSS Core Network (GCN) of 290 sea level stations for range of ocean/climate science and practical applications. In the second GLOSS Implementation Plan endorsed in 1997 by the IOC Assembly, the GCN was redefined, with extra emphasis placed on station sites for satellite altimeter calibration, and monitoring ocean circulation and long term sea level trends. The various needs of sea level data were emphasized and he illustrated how GLOSS data were used such as satellite altimeters calibration, global ocean dynamics studies and monitoring variability (ENSO, EL NINO), long mean sea level records for climate change studies (e.g. for IPCC), many coastal applications, long records of higher frequency climate change (e.g. changes in storm surge statistics) and higher frequency sampling important for storm and tsunami monitoring and warning.

2.2.2 Tides and Tidal Observation – Dr J. Hunter

This lecture initially described the basic properties of ocean tides and the way in which they are generated by the motion of the sun and the moon, leading to the concept of the “equilibrium tide”. Simple physics was then used to illustrate the fundamentals of the semi-diurnal tide, the diurnal inequality and the phase inequality. This basic picture is modified by the effects of the continents, inertia and the Earth’s rotation. For example, a semi-enclosed basin, forced by a tide in the open ocean, can exhibit a significant tidal amplification in the basin if near-resonant conditions occur. Further, the interaction of Kelvin waves may be used to demonstrate the way in which the Earth’s rotation gives rise to amphidromic points in oceans and in gulfs.

Various ways of making tide observations were then discussed, ranging from the older mechanical instruments installed in stilling wells to modern radar gauges, GPS buoys and satellite altimeters. A number of g1obal tide gauge networks were shown.

The basic mathematics of tidal analysis and prediction were described as an introduction to the training in quality control of tide gauge records, which followed later in the course. It was shown how computer models could now be used routinely to simulate tidal motions. The importance of sound data collection and archiving, and good vertical datum control, was stressed.

2.2.3 International Oceanographic and Climate Programme – Dr John Hunter

This lecture sought to place the many international organizations, programmes, projects and partnerships in a coherent structure. It only briefly summarized the activities of any particular entity, as such information is readily accessible on the World Wide Web. In order to aid the understanding of where a specific endeavour fits in this structure, a series of five questions was posed (e.g. “does the organization facilitate others doing science?”; “does the organization comment on science done by others?”).

In particular, the World Climate Research Programme (WCRP), the Earth System Science Partnership (ESSP) and the Integrated G1obal Observing Strategy Partnership (IGOS-P) were discussed. The lecture then concentrated on issues relating to sea level: the Global Sea Leve1 Observing System (GLOSS), and the major centers which provide sea-1evel data (the Permanent

Service for Mean Sea Level (PSMSL), the University of Hawaii Sea Level Center (UHSLC) and the British Oceanographic Data Center (BODC)).

Finally, the two major organizations providing comment and review on environmental issues (the Intergovernmental Panel on Climate Change (IPCC) and the Scientific Committee on Problems of the Environment (SCOPE)) were discussed.

2.2.4 Climate Change and Sea Level Rise – Dr John Hunter

This lecture commenced with a summary of anthropogenic global warming and its effect on sea level. Present sea-1evel rise was discussed in the context of the last glacial cycle (going back 140,000 years), and projections of sea-level rise during the present century and (with much less confidence) during the coming millennium. Global reconstructions of sea level (employing a combination of data from tide gauges and from satellite altimeters) were used to illustrate the spatial and temporal variability of sea-level rise, and in particular the recently-discovered acceleration of sea level during the 20th century. Model simulations have also shown that much of the temporal variability of global-average sea level during the 20th century was caused by ocean cooling due to aerosols emitted during volcanic eruptions.

The effect of sea-level rise on extreme high levels was described, showing that extremes which happen on annual to decadal time scale occurred up to an order of magnitude more frequently after 1950 than before. Finally, various impacts of sea-level rise were noted such as f1ooding, shoreline erosion and increase salinity of groundwater.

2.2.5 Leveling – Mr R. Okada

JMA carries out leveling survey of tide stations periodically to monitor vertical movement of tide stations, which is necessary to obtain net sea level change accurately. The main elements in leveling were addressed, i.e.

- Relations between benchmarks of sea level measurement, e.g. datum Line, elevation (height above Tokyo Peil), fixed point of tide station, and benchmarks on the ground.
- Principle of leveling.
- How to set up and operate instruments of leveling.
- Operation of instruments.
- Data processing method in JMA.

A practical leveling survey between some fix points was also included in this session.

2.2.6 Introduction to SLPR2 and Quality Control Software – Mr Patrick Caldwell

The University of Hawaii Sea Level Center (UHSLC) in collaboration with the US National Oceanographic Data Center (NODC) have developed a PC/DOS software package, SLPR2, for processing sea level data. The goal is to prepare scientifically valid data sets.

A series of five sessions were given on: 1) Introduction, 2) Calibration, 3) Tidal Analysis and Prediction, 4) Quality Control, and 5) Filtering.

The quality control/quality analysis software is used with hourly sea level data maintained in ASCII text files. Most of the programmes can be run from Windows, although a few programmes

require the use of the MS DOS Prompt feature. The procedures include a combination of automated programmes and hands-on editing of data files.

The Tidal Analysis and Prediction routines are based on the package of M.Foreman, Institute of Ocean Sciences, Patricia Bay, British Colombia, Canada. The SLPR2 package is designed to process hourly data with a data input span for analysis of 13 months or less. A user wanting to analyze tides at a different interval, for instance, 15 minutes, and for a longer span, for instance, 19 years, must acquire the complete Foreman package and the manual.

2.2.7 Tide Observation in GSI – Dr T. Noda

This lecture focused on the sea level monitoring activities carried out by the Geographic Survey Institute (GSI). GSI is conducting tide observation to determine the reference level for measuring altitudes. Long-term continuous and thus accumulated data contribute to prevention/research on crustal movements and tsunami. GSI operates 25 tidal stations in Japan. The data is automatically transmitted in real time to control system in GSI. An example of crustal movement detection from changes in sea level was also shown. Based on comparison of mean sea level at two nearby tidal stations it is possible to discover such movements. Another example demonstrated discontinuous change of sea level caused by the large earthquake.

2.2.8 Continuous GPS observation in GSI – Dr Y Hatanaka

This lecture focused on the GPS Earth Observation NETwork System (GEONET). It is operated by GSI for the purpose of crustal deformation monitoring and making reference station for geodetic survey. There are 1,231 GEONET stations (as of 2006) and each station is spaced about 20 kilometers from one another. Data is routinely analyzed in three different time spans for all sites and emergent analysis is done for selected ones to detect large movements. Through coupling with different observation techniques, i.e. tidal observation and leveling to local tide gauge benchmark, it is possible to validate through inter-comparison. Some examples on the use of these techniques were shown.

2.2.9 Introduction of Hydrographic and Oceanographic Department, Japan Coast Guard – Mr Y Niimura

An overview of the activities of Hydrographic and Oceanographic Department of the Japan Coast Guard (JCG) was provided. The Hydrographic and Oceanographic Department of the JCG is responsible for production of nautical charts and marine surveying.

2.2.10 Outline and Data management in JODC – Mr E. Mukainaka

This lecture provided an overview of the Japan Oceanographic Data Center (JODC). JODC collects and manages oceanographical data systematically from government offices (JCG, JMA etc.) and marine survey organizations (universities, research institutes) to contribute effective use. JODC also collects information for planning researches by various organizations (term, area, etc.). The data is arranged in a marine data bank to provide users marine information. As national representative center of International Oceanographic Data and Information Exchange (IODE), JODC exchanges marine data with other national/international data centers.

2.2.11 Utilization of oceanographic observation data with J-DDOS – Mr Y. Tani and Ms N. Maruyama

A demonstration for retrieval of oceanographic observation data through the JODC Data On-line Service System (J-DDOS) was held. J-DDOS system provides a web-based interface for users to search and download JODC's oceanographic data. A full demonstration of the system was provided. Finally an explanation of marine information office in JCG was provided.

2.2.12 Oceanographic Observation in JCG – Mr A. Seta, Mr A. Yamamoto and Mr K. Noguchi

Monitoring the ocean is one of tasks for JCG. Data from survey ships, satellites, winds (JMA) and so on, are included in a real-time database system. The products are used for trajectory prediction and issues Quick Bulletins. Trajectory predictions are provided as an aid for oil spill clean up. Finally JCG carry out research in regards to marine pollution.

JCG also operates 29 tide stations in Japan and one station in Antarctica. Based on observations from this network tide tables and tidal current charts are published.

2.2.13 Sea Level Rise in Japan – Mr K. Sakurai

Mr Sakurai presented the sea level variation along the Japanese coast and explained the drivers of it.

Sea level variation over the past 100 years at 5 tide gauges show little influence from crustal movements. Sea level around Japan has fluctuated in a cycle of roughly 20 years. Sea level has continued to rise since the middle of 1980's and a maximum over past 100 years was recorded in 2004.

The rate of sea level rise (SLR) over the past 34 years corrected for the effect of the crustal movement with leveling data was shown. After the middle of 1980s SLR in western Japan was 5-11mm/year but at some points in northern Japan SLR is negative. There is close correlation between SLR and the rising rate of subsurface temperature.

Lastly it was shown that sea surface dynamic height calculated from ocean temperature and salinity profiles was very useful to estimate the variation of sea level because it was not influenced by the crustal movement.

2.2.14 Analyses for Sea States of the Pacific Ocean – Dr T. Kuragano and Mr S. Ishizaki

This lecture was focused on the ocean information service operated by JMA.

JMA provides the near-real-time information of seawater temperature and current on JMA's website and updates this information every day. The objective is to provide ocean information to various users, background information for weather forecast and to contribute climate change monitoring. Data from floats, ships and satellite are used for the analysis of sea surface temperature, subsurface temperature, ocean current and sea surface height.

Secondly JMA has been operating a data assimilation system since January 2001. Its objective is to represent the oceanographic condition in the mid/high latitudes of the western North Pacific. The system enables calculation of subsurface temperature and ocean current field based on

the dynamic equations. JMA has started an ocean prediction system based on the numerical model (OGCM) which is initialized using the ocean data assimilation system in the seas around Japan.

2.2.15 Storm Surge Prediction – Mr M. Higaki

This lecture focused on the importance of monitoring and forecasting storm surges, as tropical storm surges are the greatest potential for loss of life. The lecture began with the definition of storm surges and provided some examples of past and recent storm surge disasters. The mechanism of storm surges was also outlined. Strong winds and pressure drops accompanying storms play major roles in the generation of storm surges. The explanation on the methods of storm surge forecasting was one of the focuses of this lecture. Presently, numerical models are commonly used both for storm surge hindcasting and for real-time forecasting. The sensitivity of storm surge models to the wind field was emphasized and the effectiveness of an "ensemble" manipulation of tropical cyclone field in storm surge modeling was also demonstrated. Finally, recent JCOMM activities related to storm surges were shown.

2.2.16 Satellite Altimetry and Gravimetry for Earth Science Research – Prof. C.K. Shum

This lecture provided theoretical and practical foundations for contemporary use of two modern space geodetic instruments, satellite altimetry and spaceborne gravimetry, for research in Earth science disciplines, including geodesy, geophysics, oceanography, hydrology, glaciology and the interdisciplinary field of global sea level change. Fundamentals of radar and laser altimetry, satellite mission design, orbit mechanics, perturbation theory, non-linear orbit determination and geophysical inverse problem were described. The use of radar altimeters for collinear analysis, cross-track and along-track gradient corrections, and various instrument, media and geophysical corrections were also outlined. The concepts of spaceborne gravity sensors, in particular, using the satellite-to-satellite (high-low and low-low) tracking and gravimetry was presented. Research using both satellite altimetry and gravimetry for marine gravity, tides, sea level, oceanography, hydrology and geophysics was described. Some examples from historic, current and future missions including Geosat, ERS-1/-2, TOPEX/POSEIDON, GFO, JASON, ENVISAT, ICESAT, CryoSat, GRACE, GOCE were described.

2.2.17 Tsunami Warning System in Japan – Mr Y. Nishimae

The Japan Meteorological Agency (JMA) has carried out tsunami warning services for both local and distant tsunamis in Japan for about half a century. JMA operates a seismic network which consists of about 180 sites that monitor earthquake activity in and around Japan. When an earthquake occurs, JMA immediately determines the epicenter and magnitude of the earthquake. If the earthquake occurs in the ocean area with tsunamigenic potential, JMA conducts the tsunami forecast operation using the database containing tsunami amplitude and travel time constructed by numerical simulation and then issues tsunami warnings and/or advisories. Sea level data are transmitted to JMA on a real time basis from about 100 tidal stations around Japan. A Tsunami warning is upgraded or cancelled based on these observations. When a large earthquake occurs at a distant area from Japan, JMA determines the epicenter and magnitude using seismic data from the global seismological observation network, and exchanges information on the earthquake with the Pacific Tsunami Warning Center (PTWC) and the United States Geological Survey (USGS). In case there is a possibility of tsunami generation, JMA immediately conducts the tsunami forecast operation in the same manner and criteria as the local tsunami procedure.

The International Coordination Group for the Tsunami Warning System in the Pacific (ICG/ITSU) has discussed the establishment of regional tsunami warning centers and ITSU member

states have requested JMA to act as a tsunami information center of the Northwest Pacific region. In response to this request, JMA established the Northwest Pacific Tsunami Advisory Center (NWPTAC) and the Center has been in operation since March 2005. (ICG/ITSU was renamed the Intergovernmental Coordination Group for the Pacific Tsunami and Mitigation System (ICG/PTWS) at the 20th meeting in 2005).

After the unprecedented trans-Indian Ocean tsunami triggered by the large earthquake that occurred off Sumatra on 26 December 2004 JMA started to provide Tsunami Watch Information for the Indian Ocean countries on an interim basis in March 2005. This service will be provided until a tsunami warning system will be in operation in the Indian Ocean region.

2.3 HANDS-ON-TRAINING SESSIONS (HOTS)

There were two hands-on training sessions conducted throughout the workshop. One was the practical usage of the quality control and tidal prediction software and another was the precise leveling survey. Each participant was provided with a computer notebook to allow the individual to practice on the software. The participants were divided into several groups to allow each participant to personally carry out precise leveling equipment.

2.4 COUNTRY REPORTS PRESENTATION

One morning session was allocated for the participants to present the status of tidal observation and analysis in their respective countries. All of the presentations were given in English and a question and answer session followed each presentation to allow the participants to share among themselves their experiences and knowledge in tides and sea level observation.

Myanmar— The participant from Myanmar is an officer with the Department of Meteorology & Hydrology, Myanmar. Mr Aye gave a presentation on the tidal network in Myanmar. There were 10 tide gauges of the float mechanical type along Myanmar coast. However, these gauges have been out of order for a few decades. Under the Indian-Myanmar cooperation, the National Institute of Ocean Technology (NIOT) -India, the Department of Meteorology and Hydrology (DMH) Myanmar, Myanmar Port Authority (MPA) - had already implemented two acoustic tide gauges in Yangon and Pathein. Another two tide gauges are going to be install near future by the GLOSS - UNESCO/IOC/ADPC programme. The float mechanical type gauges were paper chart recording type which makes it difficult to archive data for long time period. The recently installed acoustic tide gauges are digital, but there is no connection yet to communicate real-time data outside Myanmar. The tide gauges, under preparation through the UNESCO-IOC-ADPC project, will have real-time data transmission facility. The intended transmissions from the site will be once every 15 minutes with METEOSAT and downlink to Darmstadt Germany from where it will be transmitted via the WMO Global Telecommunication System (GTS) to the Pacific Tsunami Warning Center.

Philippines— The participant from Philippines is an officer with the National Mapping and Resource Information Authority, Philippines. Mr Baloran gave a presentation on the tidal network in Philippines. There are 10 primary tide stations established and maintained in the different coastal areas of the country. Among them only the Legaspi Tide Station is equipped with telemetry capability which was installed in 1993. Each tide station is annually inspected and checked for proper equipment operation and data accuracy. During annual inspection, tidal leveling is conducted to determine water level datum shift with regard to land elevations. There are four Philippine tide stations that are designated GLOSS stations. As a member of the Intergovernmental Oceanographic Commission, the Philippines sends yearly tidal data to the GLOSS data centers as part of the

country's commitment to various oceanographic surveying activities. Recent events in March and April 2006 saw the upgrading and installation of new and modern tide gauges at the Manila and Legaspi tide stations. In cooperation with GLOSS and University of Hawaii Sea-Level Center, the Manila and Legaspi tide station were provided with a water level sensor, GPS receivers, satellite transmitter. There are also plans to upgrade the tide gauges in Davao in the near future, with the same set of equipment and instruments sponsored again by GLOSS and the UHSLC. Subic Bay was also surveyed by a different funding agency namely the Asian Disaster Prevention center (ADCP) and they plan to install the equipment in the near future. This is part of the Tsunami Warning System and the equipment is installed in collaboration with the Philippine Institute of Seismology and Volcanology.

Indonesia— The participants from Indonesia are officers with the National Coordinating Agency for Surveys and Mapping, Indonesia. Mr Sorongan gave a presentation on the tidal network in Indonesia. The permanent sea level monitoring of the Indonesian archipelagic waters consists of 60 stations located in the main ports. The early implementation was started in stages by the National Coordinating Agency for Survey and Mapping (BAKOSURTANAL) in 1984 with eight tide gauges. It was initially assigned for survey and mapping purposes such as providing mean sea level height for the national height system on the main islands. The sea level monitoring system was expanded to 25 stations in 1998 in support of bathymetric mapping of exclusive economic zone and safe navigation in Indonesian waters. The network does not provide data in real-time and further upgrades of instrumentation, data processing and quality control will be needed in order to support this. Efforts have been made to build joint cooperation with international institutions/community and local governments in Indonesia to establish a real time sea level monitoring system. It is expected by the end of 2006, there will be at least 26 real time stations in place. The commitments so far are 3 stations from IOC, 10 stations from Germany, 7 stations from USA and 6 stations from Indonesia BAKOSURTANAL. The University of Hawaii Sea Level Centre installed the first real time station in Sibolga North Sumatra on April 22, 2005. The data transmission is done via the GTS and the data is available online with open access for scientific community.

China (Hong Kong)— The participant from Hong Kong is a scientific officer of the Hong Kong Observatory, Hong Kong. Mr Chan gave a presentation on the tidal network in Hong Kong. Eleven tide gauge stations are installed in Hong Kong. Six of them are managed by the Hong Kong Observatory (HKO). The HKO tide gauge station at Quarry Bay is registered at the core network of the Global Sea Level Observing System (GLOSS). Three types of the tide gauge (float-type gauges, pneumatic-type gauges and pressure-type gauge) are used with an accuracy of 1 cm. The tide gauges are leveled to the benchmarks at half-yearly intervals. Also a GPS receiver was installed at the Shek Pik tide gauge station in February 2006 for continuous measurement. All tide gauges take 128 samples per second and 1-minute average sea level data are transmitted to HKO, quality controlled and further processed to derive the hourly sea levels and the monthly mean sea levels. 1-minute data recorded at Quarry Bay and Shek Pik tide gauge stations are transmitted to the University of Hawaii Sea Level Center (UHSLC), the Japan Meteorological Agency (JMA) and the Pacific Tsunami Warning Centre (PTWC) on a real-time basis for tsunami monitoring. For long-term mean sea level monitoring, hourly sea level data and monthly mean sea level data recorded at Quarry Bay tide gauge station and sent to UHSLC on a monthly interval, and monthly mean sea level data for all HKO tide gauge stations are sent to the Permanent Service for Mean Sea Level Centre (PSMSL) on an annual basis. Collected tide data are utilized for the prediction of the astronomical tides, the real-time monitoring of storm surges and Tsunamis, the monitoring of long-term sea level changes and the coastal engineering designs.

Malaysia— The participant from Malaysia is an officer with the Malaysian Meteorological Department, Malaysia. Mr Helmi gave a presentation on the tidal network in Malaysia. Sea level

monitoring and measurements are performed by three main agencies in Malaysia, namely the Malaysian Meteorological Department (MMD), the Department of Survey and Mapping Malaysia (DSMM) and the Royal Malaysian Navy (RMN). These three institutes maintain a network of 38 tide gauges spanning across the country. Most of the stations are not equipped for real time data transmission. MMD has installed 5 near real time tide gauges. The recording of the data is on 10 minutes interval and the data is transmitted on hourly basis. A total of 6 water level and tide monitoring stations is planned to be installed in 6 selected outpost islands. These monitoring stations serve as the first line monitoring system. The Department of Survey and Mapping Malaysia (DSMM) is the main government agency in Malaysia responsible for the acquisition, processing, archiving, and dissemination of sea-level data. There are 21 tidal stations in Malaysia. DSMM was also involved in the ASEAN-Australia Tides and Tidal Phenomena Project (AATTP) which was implemented in 1985 for the purpose of improving regional cooperation in marine science. The project aimed to obtain simultaneous observations of sea level time series in the ASEAN region and to centralize all modern sea level data into a certified database. The sea level stations at Lumut and Cendering are included in the GLOSS Core Network. Data is sent to the TOGA/JASL Sea Level Centre at the University of Hawaii, USA on a regular basis. In addition, data from all the 21 stations are also sent to the Permanent Service for Mean Sea Level (PSMSL) in the United Kingdom.

Tanzania— The participants from Tanzania are officers with the Tanzania Fisheries Research Institute and the Zanzibar Department of Surveys and Urban Planning. Mr Mahongo gave a presentation on the tidal network in Tanzania. The network of sea level stations in Tanzania consists of only two operational stations of Zanzibar (GLOSS Station No. 297) and Dar es Salaam. Zanzibar is transmitting data in real-time. Four tide gauges were also installed in the past, but they are now not operational (historical stations). There is no GPS technology employed in the network. However, periodic leveling is carried out in the operational stations. Maintenance and leveling was last performed in February 2003 for Zanzibar station, and in July 1997 for Dar es Salaam station.

Viet Nam— The participant from Vietnam is an officer with the Marine Hydrometeorological Center (MHC), Vietnam. Mr Chuong gave a presentation on the tidal network in Vietnam. The Marine hydrometeorological observing system of Vietnam consists of 20 stations located along the coast and on islands. The observation parameters are main meteorological (Wind, Pressure, Air temperature, Humidity) and oceanographic (wave, sea level, salinity, water temperature). Among 20 stations there are 7 tide gauges recording sea level every one hour. Those stations have been in operation for a long time. One station, Quy Nhon is part of the GCN. Originally the station network was based on the CYM tide gauge recorders made in Russia. Some of the equipment has been replaced with tide gauge recorders from Stevens type A71, A90 and A91 made by USA. Hourly sea level data recorded by the tide gauges are checked carefully at stations, after that they are sent to Marine Hydrometeorological Center, where the data is analyzed, and processed by the ORKAN (European) and TIDE (Canada) software. The processed data are archived on paper, CD and floppy disks. MHC is planning to have a Project “Modernization and Automation of the Marine hydrometeorological observing system” period 2006 - 2010. The purpose of the Project is to enhance the station network and improve quality of data collection.

New Zealand— The participant from New Zealand is a data analyst with the Land Information New Zealand (LINZ). Mr Rowe gave a presentation on the tidal network in New Zealand. Tide predictions are published in the New Zealand Nautical Almanac (NZNA) for seventeen Standard Ports. Tide gauges at these locations are owned and operated by either the local port company or local territorial authority. With the exception of one gauge, all tide measurements are now provided in digital format. The data recording rate is not standard across the network – half of the gauges record data at 1 minute intervals; the remaining ones record once every 5 or 10 minutes. Historic analogue records from these ports have been converted to digital format. Hourly

records for Auckland, Dunedin and Lyttelton are available from the beginning of the 20th century, 60 years' data is available for Wellington. Observations from most of the other standard ports date from the early 1980s.

The National Institute of Water and Atmospheric Research Ltd (NIWA), a Crown-owned research company, coordinates a network of tide gauges at open coast sites. Gauges operated by regional and local territorial authorities, some port companies, the University of Canterbury and Australia's National Tidal Centre supplement NIWA's own installations. The primary purpose of this network is to collect high-quality and accurate measurements of sea level and tides for scientific studies of storm surge, tides and climate change. These open coast sites have been chosen to avoid the effects that port operations and topography such as harbours and river flows might have on sea level observations. Following the Indian Ocean tsunami of 26 December 2004, the New Zealand Government directed LINZ to initiate a project to improve the system of sea level gauges in New Zealand to allow better detection and confirmation of tsunamis. GPS observations have been made at benchmarks at many of the standard ports. This work was carried out as part of a project to establish a vertical datum for New Zealand. In addition, continuous GPS observations are made at four standard ports.

Japan— The participants from Japan is an officer with Japan Meteorological Agency (JMA), Japan. Ms Haraguchi gave a presentation on the tidal network in Japan. In Japan, tide stations are operated by several national and local governmental organizations including JMA, Japan Coast Guard (JCG) and Geographical Survey Institute (GSI). These three organizations run 69, 30 (including Syowa tide station in the Antarctic) and 25 tide stations, respectively. Real time data from the three organizations' stations and several additional stations (run by other organizations) are consolidated/collected on one website and used for disaster mitigation. Among the stations, 14 tide stations of JMA and the Syowa tide station are part of the GLOSS Core Network (GCN). JMA uses Fuess (float) tide gauges with digital encoders at 37 tide stations, acoustic tide gauges at 31 stations and a hydraulic pressure sensor at the Minami-tori-shima tide station. Those instruments measure the sea level with a resolution of 1cm. Newly developed acoustic tide gauges have been installed at the 13 GCN stations in Japan except Minami-tori-shima, and put into operation in January 2006, after a one-year testing phase. The data collected by the JMA headquarters are distributed to the local meteorological observatories every 15 minutes. JMA also processes the data to produce hourly sea level data and monthly mean sea level data. Hourly data of the GCN 14 stations are sent to GLOSS Fast Data Center at Hawaii University and monthly mean data of 10 tide stations are sent to the Permanent Service for Mean Sea Level (PSMSL) at Proudman Oceanographic Laboratory.

2.5 FIELD VISIT

The participants were taken to Harumi tide gauge station in Tokyo. The tide gauge set up and maintenance were explained and demonstrated to the participants. A huge-Tsunami gauge which measure water pressure over the sensor with the effective measuring range of 20 meters was introduced. Also the participants were given instructions in leveling with a portable GPS receiver.

3. RECOMMENDATIONS AND CONCLUSIONS

No specific recommendations were established.

The workshop was concluded with participants from various countries complimenting the organizer JMA for its excellent local arrangements and the training materials. Also the participants

expressed their appreciation to GSI and JCG. The participants stated that lectures and HOTS had been very good and they would make use of the workshop information to enhance the activities and functions of their work in their own countries.

The participants were exposed to the work of the IOC and GLOSS, and many expressed willingness to share their knowledge and tidal data with the larger community, so as to bring about a greater benefit to the global society. The participants also pledged to work with one another to complement any regional project cooperation. It is the hope that collaboration on a regional scale can be set up to allow for greater participation in research and analysis of regional sea level data.

4. CLOSURE

The workshop was officially closed by Dr Ohnishi, the Director General of Global Environment and Marine Department of JMA. He thanked the organizers and the IOC for a job well done and thanked the participants for their kind attention and interest in this workshop. Finally he presented certificates to all participants (Annex III).

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ANNEX I

COURSE SCHEDULE

Date/Day	Time	Programme/Activities	
Mon 15 May	0930 - 1100	Registration / Official Opening	JMA
	1130 - 1300	General Brief of Course Introduction by Attendees	Dr Thorkild Aarup
	1400 - 1530	Tides and Tidal Observation	Dr John Hunter
	1600 - 1730	International Oceanographic and Climate Programmes	Dr John Hunter
Tue 16 May	0930 - 1030	Country Report	Trainees
	1100 - 1300	Climate Change and Sea Level Rise	Dr John Hunter
	1400 - 1530	Leveling	Mr Ryouhei Okada
	1600 - 1730	Study tour in JMA	JMA
Wed 17 May	0930 - 1100	Introduction to SLPR2 and Quality Control Software	Mr Patrick Caldwell
	1130 - 1300		
	1400 - 1530	Hands on Training with Tidal Analysis Software	Mr Patrick Caldwell
	1600 - 1730		
Thu 18 May	0930 - 1100	Introduction to SLPR2 and Quality Control Software	Mr Patrick Caldwell
	1130 - 1300	Hands on Training with Tidal Analysis Software	Mr Patrick Caldwell
	1400 – 1530		
	1600 – 1730		
Fri 19 May	0930 - 1100	Hands on Training with Tidal Analysis Software	Mr Patrick Caldwell
	1130 - 1300		
	1400 - 1500		
	1500 - 1730	Exercises in Checking the Gauge and Tide Gauge Leveling (HOTS)	Mr Ryouhei Okada Mr Masato Ichikawa
Sat 20 May	Free day		
Sun 21 May	Free day		
Mon 22 May	0930 - 1100	Bus Tour to GSI	JMA
	1100-1200	Visit to Geographical Survey Institute (GSI)	GSI
	1300 - 1400	Tide observation in GSI	Dr Toshihiro Noda
	1400 - 1600	Continuous GPS Observation in GSI	Dr Yuki Hatanaka

Date/Day	Time	Programme/Activities	
	1600 - 1730	Return to JMA	JMA
Tue 23 May	0930 - 1000	Visit to Japan Coast Guard(JCG) and their Sea Level Unit	JMA
	1010 - 1040	Introduction of Hydrographic and Oceanographic Department, Japan Coast Guard	Mr Yosuke Niimura
	1045 - 1115	Outline and Data management in JODC	Mr Eiji Mukainaka
	1120 - 1215	Utilization of oceanographic observation data with J-DDOS (Japan Oceanographic Data Center - Data On-line Service System)	Mr Yukio Tani Ms Noriko Maruyama
	1330 - 1500	Oceanographic Observation in JCG	Mr Akihiro Seta Mr Akio Yamamoto Mr Kenichi Noguchi
	1500 - 1700	Visit to Tide Gauge in Tokyo	Mr Ryouhei Okada
	1700 - 1730	Return to JMA	JMA
Wed 24 May	0930 - 1130	Sea Level Rise in Japan and Analyses for Sea States of the Pacific Ocean	Mr Keizo Sakurai Dr Tsurane Kuragano Mr Shirou Ishizaki
	1200 - 1300	Storm Surge Prediction	Mr Masakazu Higaki
	1400 - 1530	Principles of Satellite Altimetry I	Prof. C.K. Shum
	1600 - 1730	Principles of Satellite Altimetry II	
Thu 25 May	0930 - 1100	Tsunami Monitoring System	Dr Yuji Nishimae
	1130 - 1300	Tsunami Warning System	
	1400 - 1530	Interdisciplinary Applications of Satellite Altimetry	Prof. C.K. Shum
	1600 - 1730	Satellite Gravimetry and Altimetry Applications	
Fri 26 May	0930 - 1100	Wind-up Review	JMA
	1130 - 1300	General Debrief of Course	Prof. C.K. Shum
	1400 - 1530	Draft Workshop Report for IOC	JMA
	1600 - 1730		

JMA – Japan Meteorological Agency
GSI – Geographical Survey Institute of Japan
JCG – Japan Coast Guard

ANNEX II

LIST OF PARTICIPANTS

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Group Photo

ANNEX III

COURSE MATERIALS

Hardcopy

1. Changing Sea Levels – Effects of Tides, Weather and Climate
   David Pugh
   Cambridge University Press 2004

2. Global Sea Level Observing System (GLOSS) Implementation Plan - 1997
   Intergovernmental Oceanographic Commission, technical series, UNESCO

3. Manual on Sea-Level Measurement and Interpretation
   Volume III – Reappraisals and Recommendations as of Year 2000
   Intergovernmental Oceanographic Commission, UNESCO 2002

4. Sea Level Data Processing On IBM-PC Compatible Computers Version 3.0 (Year 2000 Compliant)
   Patrick Caldwell
   Joint Archive for Sea Level of the National Oceanographic Data Center and University of Hawaii Sea Level Center
   Jimar Contribution No. 98-319 Dec 28, 1998

5. Satellite Altimetry
   Dudley B. Chelton, John C. Ries, Bruce J. Haines, Lee-Leung Fu and Philip S. Callahan
   Satellite Altimetry and Earth Science, Chapter 1

6. Large Scale Ocean Circulation
   Lee-Leung Fu and Dudley B. Chelton
   Satellite Altimetry and Earth Science, Chapter 2

7. Jason-1 Science Plan
   AVISO Altimetry Newsletter 8 Oct. 2001

8. GRACE – Gravity Recovery and Climate Experiment
   NASA Goddard Space Flight Center
   NP-2002-2-427-GSFC

CDs

1. GLOSS
2. Lecture Presentations
3. Country Reports
4. Photographs at the Workshop

Certificate

This is to certify that

Keiko Haraguchi

successfully completed the

IOC/GLOSS Training Workshop
Course on Sea-Level Measurement
and Interpretation and Related Fields

15-26 May 2006

at the

Japan Meteorological Agency

Mark Merrifield
Chairman
IOC/GLOSS

Tetsu Hiraki
Director-General
Japan Meteorological Agency

ANNEX IV

LIST OF ACRONYMS

AOPC	Atmospheric Observation Panel for Climate
CGPS	Continuous GPS
CLIVAR	Climate Variability and Predictability
DORIS	Doppler Orbitography and Radiopositioning Integrated by Satellite
EOSS	European Sea Level Observing System
ENSO	El Nino Southern Oscillation
GCOS	Global Climate Observing System
GLOSS	Global Sea Level Observing System
GNSS	Global Navigation Satellite System
GOOS	Global Ocean Observing System
GPS	Global Positioning System
GSI	Geographical Survey Institute
HOTS	Hands On Training Sessions
IGS	International GPS Service
IOC	Intergovernmental Oceanographic Commission
IPCC	Intergovernmental Panel on Climate Change
JCG	Japan Coast Guard
JMA	Japan Meteorological Agency
MSL	Mean Sea Level
OOPC	Ocean Observation Panel for Climate
POL	Proudman Oceanographic Laboratory
PSMSL	Permanent Service for Mean Sea Level
TASK	Tidal Analysis Software Kit
TGBM	Tide Gauge Benchmark
TIGA	GPS Tide Gauge Benchmark Monitoring
TIRA	Tidal analysis programme
UHSLC	University of Hawaii Sea Level Center
UNEP	United Nations Environment Programme
UNESCO	United Nations Educational Science and Cultural Organization
WCRP	World Climate Research Programme
WMO	World Meteorological Organization
WOCE	World Ocean Circulation Experiment

IOC Training Course Reports

No.	Title	Language
1.	IOC Indian Ocean Region Training Course in Petroleum Monitoring Perth, 18 February-1 March 1980	English
2.	IOC Regional Training Course for Marine Science, Technicians Cape Ferguson, Queensland, 1-28 June 1980	English
3.	ROPME-IOC-UNEP Training Workshop on Oceanographic Sampling Analysis, Data handling and Care of Equipment, Doha, Qatar, 3-15 December 1983	English
4.	Stage COI d'initiation à la gestion et au traitement de l'information scientifique et technique pour l'océanologie, Brest, France, 28 novembre - 9 décembre 1983	French
5.	Curso mixto COI-OMM de formación sobre el Sistema Global Integrado de Servicios Oceánicos (SGISO), Buenos Aires, Argentina, 15-26 de octubre de 1984	Spanish
6.	UNESCO-IOC-NBO Training Course on Tidal Observations and Data Processing Tianjin, China, 27 August - 22 September 1984	English
7.	Stage COI sur la connaissance et la gestion de la zone côtière et du proche plateau continental Talence, France, 18 septembre - 4 octobre 1984	French
8.	IOC Regional Training Course on Marine Living Resources in the Western Indian Ocean Mombasa, Kenya, 27 August - 22 September 1984	English
9	IOC-UNESCO Summer School on Oceanographic Data, Collection and Management Erdemli, Icel, Turkey, 21 September - 3 October 1987	English
10.	IOC-UNESCO Regional Training Workshop on Ocean Engineering and its Interface with Ocean Sciences in the Indian Ocean Region Madras, India, 17 March - 5 April 1986	English
11.	IOC-UNESCO Training Course on the Use of Microcomputers for Oceanographic Data Management Bangkok, Thailand, 16 January - 3 February 1989	English
12.	IOC Advanced Training Course on Continental Shelf Structures Sediments and Mineral Resources Quezon City, Philippines, 2-13 October 1989	English
13.	IOC/IODE Training Course on GF3 Data Formatting System Obninsk, USSR, 14-24 May 1990	English
14.	IOC Training Course on Microcomputers and Management of Marine Data in Oceanographic Data Centres of Spanish-speaking Countries, Bogotá, Colombia, 21-30 October 1991	English & Spanish
15.	IOC Advanced Training Course on Nearshore Sedimentation and the Evolution of Coastal Environments, Kuala Lumpur, Malaysia, 17-29 February 1992	English
16.	First IOC Training Course on the Applications of Satellite Remote Sensing to Marine Studies Caracas, Venezuela, 24-28 September 1990	English
17.	IOC-KMFRI-RECOSCIX (WIO) Regional Training Course on Microcomputer-based Marine Library Information Management, Mombasa, Kenya, 10-21 August 1992	English
18.	ROPME-IOC Regional Training Course on Management of Marine Data and Information on Microcomputers for the ROPME Region, Kuwait, 18-28 October 1992	English
19.	IOC-SOA Training Workshop on Environmental Effects on Benthic Communities Xiamen, China, 19-23 October 1992	English

No.	Title	Language
20.	IOC Training Course for the Global Sea Level Observing System (GLOSS) directed to the African and South American Portuguese and Spanish-Speaking Countries São Paulo, Brazil, 1-19 February 1993	English
21.	IOC-SSTC-SOA Training Course on Marine Information Management and ASFA Tianjin, China, 19-30 October 1992	English
22.	First IOC/IOCARIBE-UNEP Training Course on Monitoring and Control of Shoreline Changes in the Caribbean Region, Port-of-Spain, Trinidad and Tobago, 21-30 July 1993	English & Spanish
23.	IOC/WESTPAC Training Course on Numerical Modelling of the Coastal Ocean Circulation Matsuyama, Japan, 27 September - 1 October 1993	English
24.	IOC-JODC Training Course on Oceanographic Data Management Tokyo, Japan, 28 September - 9 October 1992	English
25.	IOC-JODC Training Course on Oceanographic Data Management Tokyo, Japan, 27 September - 8 October 1993	English
26.	IOC Training Course on Ocean Flux Monitoring in the Indian Ocean. Organized with the support of the Government of Germany Mombasa, Kenya, 15-27 November 1993	English
27.	IOC-UNEP-SPREP Training Course on Coral Reef Monitoring and Assessment Rarotonga, Cook Islands, 23 February - 13 March 1994	English
28.	IOC-JODC Training Course on Oceanographic Data Management Tokyo, Japan, 26 September - 7 October 1994	English
29.	IOC-UNEP-WHO-FAO Training Course on Qualitative and Quantitative Determination of Algal Toxins Jena, Germany, 18-28 October 1994	English
30.	IOC Training Course on Oceanographic Data Management for Black Sea Countries Obninsk, Russian Federation, 1-12 August 1994	English
31.	COI-CEADO Curso Regional de Capacitación en Gestión de Datos e Información Oceanográficos Buenos Aires, Argentina, 17-28 de octubre de 1994	Spanish
32.	IOC-UNEP-FAO Training Course on Nutrient Analysis and Water Quality Monitoring Zanzibar, Tanzania, 21-26 November 1994	English
33.	IOC-IOMAC Advanced Training Course on Marine Geology and Geophysics off Pakistan. Pakistan, 12-26 November 1994	English
34.	Training Course on Management of Marine Data and Information for the Mediterranean Region Valletta, Malta, 10-21 April 1995	English
35.	IOC-UNEP-WHO-FAO Training Course on Toxin Chemistry and Toxicology related to Harmful Algal Blooms Trieste, Italy, 3-12 September 1995	English
36.	MAST-IOC Advanced Phytoplankton Course on Taxonomy and Systematics Naples, Italy, 24 September - 14 October 1995	English
37.	IOC-JODC Training Course on Oceanographic Data Management Tokyo, Japan, 16-27 October 1995	English
38.	IOC/IODE Training Course on Marine Geological and Geophysical Data Management Gelendzhik, Russian Federation, 13-29 September 1995	English
39.	IOC/GLOSS-GOOS Training Workshop on Sea-Level Data Analysis, Geodetic & Research Branch Survey of India, Dehra Dun, India, 21 November- 1 December 1995	English

No.	Title	Language
40.	IOC-DANIDA Training Course on the Taxonomy and Biology of Harmful Marine Microalgæ; University of Copenhagen, Denmark, 31 July-11 August 1995; IOC-SAREC-DANIDA Training Course on the Taxonomy and Biology of Harmful Marine Microalgæ; University of Mauritius, Republic of Mauritius, 5-14 February 1996; and Annual Report 1995, IOC Science and Communication Centre on Harmful Algæ, DANIDA, University of Copenhagen, Danish Fisheries Research Institute, Danish National Environmental Research Institute	English
41.	IOC-Germany Advanced Training Course on Bathymetric Charting in the Western Indian Ocean METEOR, 15-29 December 1995	English
42.	COI-SHOA-CICESE Curso Sobre Modelación Numérica de Tsunamis Valparaiso, Chile, 11 de Marzo - 11 de Mayo de 1996	Spanish
43.	Seminario/Taller de la COI/GLOSS-SHN sobre Observación y Análisis del Nivel del Mar para países de habla hispano-portuguesa de Latinoamérica Servicio de Hidrografía Naval (SHN), Buenos Aires, Argentina, 19-27 de noviembre de 1996	Spanish
44.	IOC-INCO-ROPME Training Course on Oceanographic Data and Information Management, Tehran, Iran, 19-30 October 1997	English
44.	IOC-ICSU-IAEA-EU Training Course on Marine Geological and Geophysical Data Management for the Countries of the Black and Caspian Seas Regions, Gelendzhik, Russian Federation, 8-19 September 1997	English
45.	IOC-ICSU-IAEA-EU Training Course on Marine Geological and Geophysical Data Management for the Countries of the Black and Caspian Seas Regions Gelendzhik, Russian Federation, 8-19 September 1997	English
46.	Training Course on Management of Marine Data and Information for the IOCINCWIO Region Mombasa, Kenya, 1-11 December 1997	English
47.	IOC/WESTPAC-SIDA-SAREC-SEAPOL Training Workshop on Operational Data and Information System for the Gulf of Thailand Bangkok, Thailand, 18-21 November 1997	English
48.	SZN-IOC Advanced Phytoplankton Course on Taxonomy and Systematics Vico Equense, Naples, Italy, 10-30 May 1998	English
49.	First IOC/WESTPAC Training Course on Monitoring of PSP Plankton and Shellfish Toxicity, Japan, July 1995 Second IOC/WESTPAC Training Course on Species Identification of Harmful Microalgæ, Japan, February 1997 Third IOC/WESTPAC Training Course on Species Identification of Harmful Microalgæ, Japan, August 1997	English
50.	IOC/IODE-NIO Training Course on Oceanographic Data and Information Management Goa, India, 17–27 October 1998	English
51.	IOC/GLOSS-GOOS Training Workshop on Sea-Level Data Analysis South Africa, 16–27 November 1998	English
52.	IOC-UNEP Germany Training Course on Qualitative and Quantitative Determination of Algal Toxins, Jena, Germany, 2-12 March 1999	English
53.	*Cancelled*	
54.	IOC/GLOSS-GOOS Training Workshop on Sea-Level Measurements, Tidal Analysis, GPS and Gravity Measurements, Satellite Altimetry and Numerical Modelling Sao Paulo, Brazil, 30 August-25 September 1999	English

No.	Title	Language
55.	IODE Training on Oceanographic Data and Information Management for the Spanish-Speaking Countries of Central and South America / Curso de Formación del Iode sobre la gestión de datos e información oceanográficos para los países de habla hispana de América Central y del Sur Rio Grande, Brazil, 20-29 September 1999	English/Spanish
56.	*Cancelled*	
57.	PERSGA/ALECSO-IOC/GLOSS-GOOS Training Workshop on Sea-level Data Analysis for the red Sea and Gulf of Aden Region Jeddah, Kingdom of Saudi Arabia, 15-19 April 2000	English
58.	Third IOC/WESTPAC Training Course on NEAR-GOOS Data Management Tokyo, Japan, 24 January-4 February 2000	English
59.	Fourth IOC/WESTPAC Training Course on NEAR-GOOS Data Management; Tokyo, Japan, 27 November–8 December 2000 ***(electronic copy only)***	English
60.	First IOC-Flanders ODINAFRICA Training Course on Marine Data Management, Casablanca, Morocco, 2–13 April 2001 ***(electronic copy only)***	English
61.	First ODINAFRICA Training Course on Marine Information Management, Cape Town, South Africa, 29 October–9 November 2001 ***(electronic copy only)***	English
62.	First ODINCARSA Training Course on Marine Data Management, Guayaquil, Ecuador, 20-31 May 2002 ***(electronic copy only)***	English
63.	Remedial Training Course in Marine Data Management for Côte d'Ivoire, Abidjan, Côte d'Ivoire, 21-29 March 2002 ***(electronic copy only)***	English
64.	Second ODINAFRICA-II Training Course in Marine Data Management, Tunis, Tunisia, 29 April–10 May 2002 ***(electronic copy only)***	English
65.	***under preparation***	
66.	First ODINCARSA Training Course in Marine Information Management, Mazatlan, Mexico, 29 September – 4 October 2002 ***(electronic copy only)***	English & Spanish
67.	IODE Training Course in Ocean Data Management for the Caspian and Black Sea Regions, Tehran, I.R. Iran, 20–30 October 2002 ***(electronic copy only)***	English
68.	Fifth IOC/WESTPAC Training Course on NEAR-GOOS Data Management, Tokyo, Japan, 5–16 November 2001 ***(electronic copy only)***	English
69.	ODINAFRICA II Remedial Training Course in Marine Data Management (Data Short Course), Accra, Ghana, 14–18 April 2003 ***(electronic copy only)***	English
70.	Sixth IOC/WESTPAC Training Course on NEAR-GOOS Data Management, Tokyo, Japan, 21 October–1 November 2002 ***(electronic copy only)***	English
71.	Taller de Entrenamiento en Observación y análisis del Nivel del Mar, Valparaíso, 7-17 de abril de 2003 ***(disponible solamente en formato electrónico)***	Spanish
72.	ODINAFRICA II Combined Madagascar Marine Atlas Workshop and Remedial Training Course in Marine Data Management for Comoros, Tulear, Madagascar, 30 June – 11 July 2003 ***(electronic copy only)***	English
73.	ODINAFRICA II Training Course in Marine Data Management for Mozambique, Maputo, Mozambique, 11–22 August 2003 ***(electronic copy only)***	English
74.	Final ODINAFRICA II Training Course in Marine Data Management, Brussels, Belgium, 1–5 September 2003 ***(electronic copy only)***	English
75.	Second ODINCARSA Training Course in Marine Data Management, Cartagena, Colombia, 13–17 October 2003 ***(electronic copy only)***	English
76.	***under preparation***	
77.	IOC/JCOMM Training Course for the Global Sea Level Observing System (GLOSS) on Sea Level Observation and Analysis, 9–20 February 2004, Kuala Lumpur, Malaysia ***(electronic copy only)***	English
78.	First ODINCINDIO Training Course in Ocean Data Management, 10–21 October 2005, Ostend, Belgium ***(electronic copy only)***	English

No.	Title	Language
79.	First ODINAFRICA-III Training Course in Marine Data Management, , 11–29 April 2005, Ostend, Belgium ***(electronic copy only)***	English
80.	HELCOM/BSRP/ICES and IOC/IODE Training Workshop: Baltic Sea Data Collection— Management, Analysis & Synthesis, 24–28 October 2005, Vilnius, Lithuania ***(electronic copy only)***	English
81.	First ODINCARSA-II Data Management Training Workshop, 7–18 November 2005, Ostend, Belgium ***(electronic copy only)***	English
82.	Second ODINCARSA Training Course in Marine Information Management, 9 November – 19 November 2005, Ostend, Belgium ***(electronic copy only)***	English
83.	Web service development training for ODINAFRICA, 5–9 December 2005, Ostend, Belgium ***(electronic copy only)***	English
84.	ODINAFRICA Training course on development of electronic repositories on marine related publications from Africa, 5–9 December 2005, Ostend, Belgium ***(electronic copy only)***	English
85.	Third ODINCARSA-I Marine Data Management Training Workshop, 21–26 November, 2005, Ostend, Belgium ***(electronic copy only)***	English
86.	IODE/GOOS/JCOMM Combined Modelling and Data Management Training Workshop ("Jamboree"), 5–10 September 2005, Ostend, Belgium ***(electronic copy only)***	English
87.	IOC/JCOMM Training Course for the Global Sea Level Observing System (GLOSS) on Sea Level Observation Analysis, 15–26 May 2006, Tokyo, Japan ***(electronic copy only)***	English