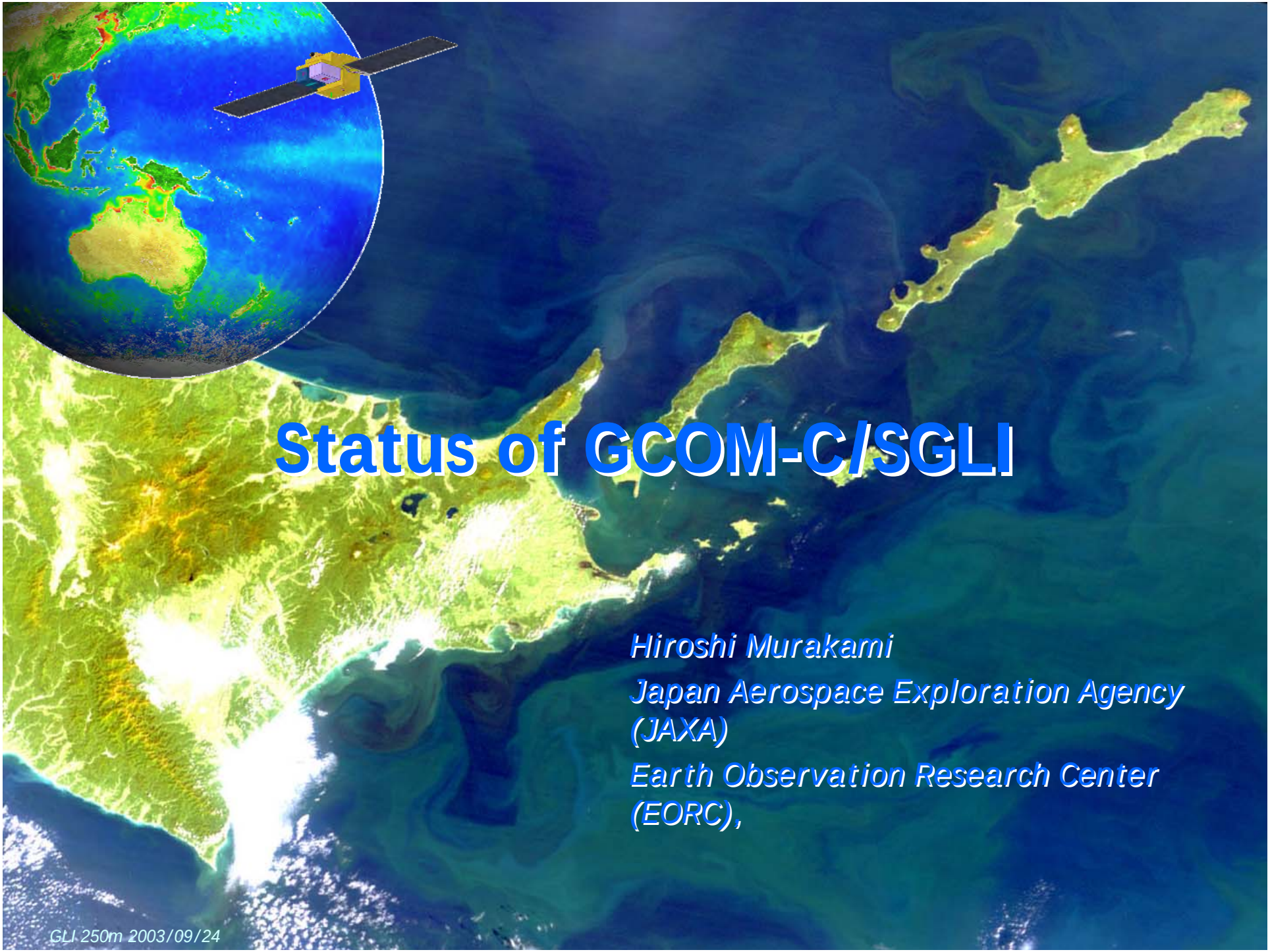

Status of GCOM-C/SGLI

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Earth Observation Research Center (EORC),

GLI 250m 2003/09/24

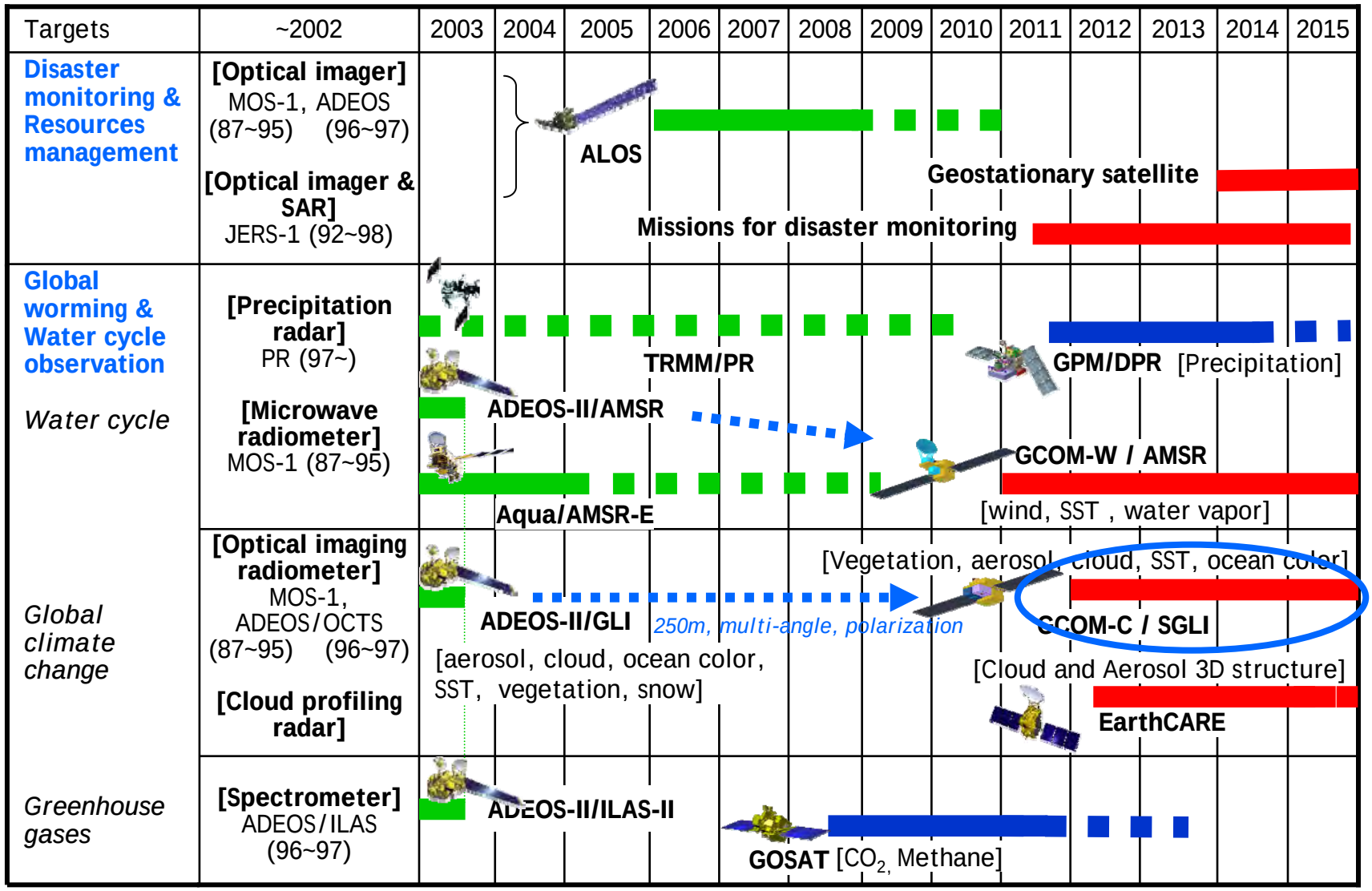
1. Introduction of GCOM and SGLI

1.1 History and targets of GCOM

- JAXA and science groups (Global Climate Observation Mission (GCOM) and SGLI application committees) have discussed about the Second generation Global Imager (SGLI), which is a radiometer of visible-infrared, middle-resolution, and global and frequent observation, for more than five years.
- After the trouble of ADEOS-2, we are setting 2011 as the launch date of the first GCOM-C satellite which will carry SGLI. The SGLI have to be mature sensor with low risk, long life (consists of series of three satellites; total 13 years), and wide applicability. *"2011" is perhaps delayed by a difficulty of financial resources*
- Targets of GCOM (consists of GCOM-W and GCOM-C satellite series) are followings.
  - Build an **long-term observation system** which can observe effective physical parameters continuously (10~15 years) for **solving the global climate change and water-cycle mechanism**, and establish its usability
  - Process the satellite data aiming at **integrative use** into other observation systems, model data, etc., and provide users
  - **Contribute to improvement in the predictive accuracy** of a long-term climate change, which connects with national policy decision, through the improvement of the process research about a climate-change mechanism and a numerical climate model with cooperation to the user organizations.
  - **Contribute to the operational fields**, such as prediction of intense weather which brings about disaster, through data distribution to the operational organizations which perform a weather forecast, fishery information service, sea route information control, etc.
  - **Develop new products** effective in the elucidation of a climate change and a water cycle mechanism which are difficult to make with the present analysis technology.

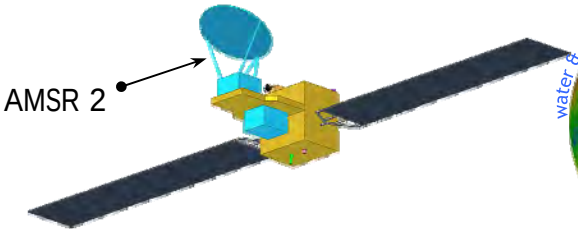
1. Introduction of GCOM and SGLI

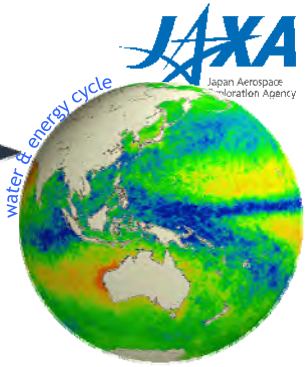
1.2 JAXA's earth observation scenario



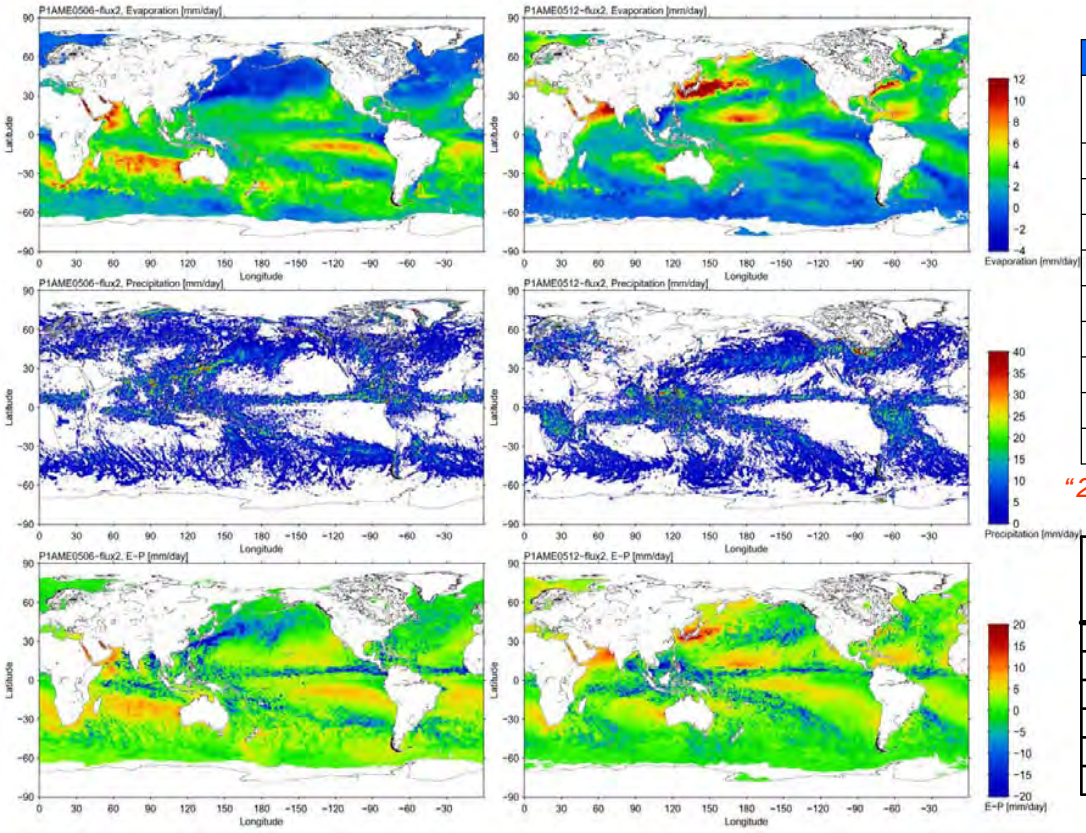
1. Introduction of GCOM and SGLI

1.3 Outline of GCOM-W/AMSR2





Targets of GCOM-W are water-energy cycle.
GCOM-W1 will carry AMSR-follow on, AMSR-2.



GCOM-W AMSR-F/O characteristics	
Orbit (TBD)	Sun-synchronous (ascending local time: 13:30) Altitude: 699.6km, Inclination: 98.19deg
Launch Date	2010 (HII-A)
Mission Life	5 years (3 satellites; total 13 years)
Scan	Conical scan microwave radiometer
Swath width	1450km
Antenna	2.0m offset parabola antenna
Digitalization	12bit
Incident angle	Apporox. 55 degree
Polarization	Vertical and Horizontal
Dynamic range	2.7-340K

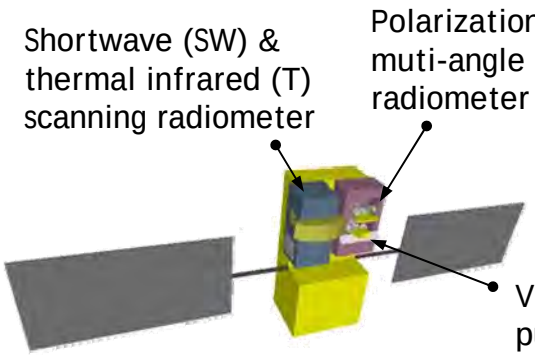
"2010" is perhaps delayed by a difficulty of financial resources

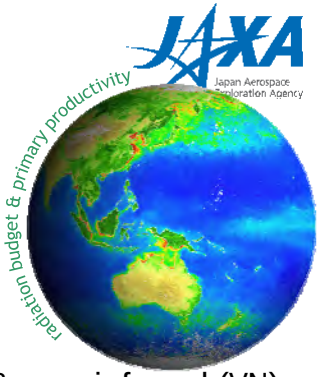
Band (GHz)	Band width (MHz)	Polarization	Beam width [deg] (Ground resolution [km])	Sampling interval [km]
6.925	350	V and H	1.8 (35 x 62)	10
10.65	100		1.2 (24 x 42)	
18.7	200		0.65 (14 x 22)	
23.8	400		0.75 (15 x 26)	
36.5	1000		0.35 (7 x 12)	
89.0	3000		0.15 (3 x 5)	5

- AMSR-2 will continue AMSR-E observations (water vapor, cloud liquid water, precipitation, SST, wind speed, sea ice concentration etc.).
- Above images show evaporation (top), precipitation (middle), and their difference (bottom) in Jun (left) and December (right) 2005 estimated using AMSR-E L3 products.

1. Introduction of GCOM and SGLI

1.4 Outline of GCOM-C/SGLI





Targets of GCOM-C are carbon cycle and radiation budget.

SGLI will continue almost of the GLI observations (sea surface temperature, ocean colour, aerosols, cloud, vegetation, snow/ ice, and so on). The new SGLI features (250m (VN) and 500m (T) channels and two polarization/ multi-direction channels (P)) will enable improvement of land and coastal monitoring and retrieval of land aerosols.

Narrow $\Delta\lambda$ and relatively high SNR for ocean products

New features of SGLI from ADEOS-2/GLI

GCOM-C SGLI characteristics	
Orbit (TBD)	Sun-synchronous (descending local time: 10:30) Altitude: 798km, Inclination: 98deg
Launch Date	2011 (HII-A)
Mission Life	5 years (3 satellites; total 13 years)
Scan	Push-broom electric scan (VN & P) Wisk-broom mechanical scan (SW & T)
Scan width	1150km cross track (VN & P) 1400km cross track (SW & T)
Digitalization	12bit
Polarization	3 polarization angles for P
Along track direction	+45 deg and -45 deg for P Nadir for VN, SW and T

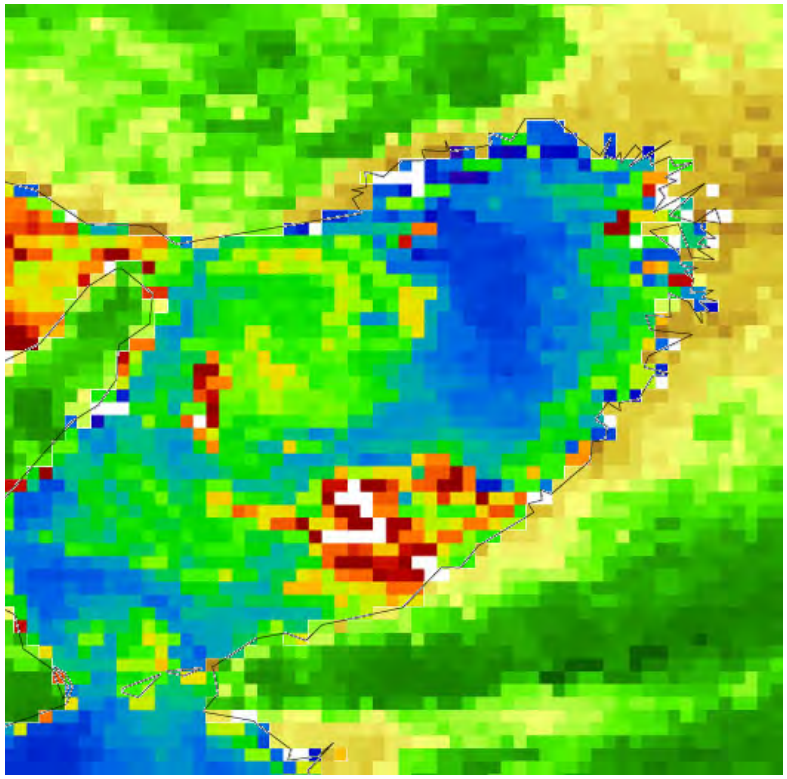
"2011" is perhaps delayed by a difficulty of financial resources

SGLI channels						
CH	λ	$\Delta\lambda$	L_{std}	L_{max}	SNR at Lstd	IFOV
	VN, P, SW: nm T: μm		VN, P: W/m²/sr/μm T: Kelvin		VN, P, SW: - T: NEΔT	m
VN1	380	10	60	210	250	250
VN2	412	10	75	250	400	250
VN3	443	10	64	400	300	250
VN4	490	10	53	120	400	250
VN5	530	20	41	350	250	250
VN6	565	20	33	90	400	250
VN7	670	10	23	62	400	250
VN8	670	20	25	210	250	250
VN9	763	8	40	350	400	1000
VN10	865	20	8	30	400	250
VN11	865	20	30	300	200	250
P1	670	20	25	250	250	1000
P2	865	20	30	300	250	1000
SW1	1050	20	57	248	500	1000
SW2	1380	20	8	103	150	1000
SW3	1640	200	3	50	57	250
SW4	2210	50	1.9	20	211(TBD)	1000
T1	10.8	0.7	300	340	0.2	500
T2	12.0	0.7	300	340	0.2	500

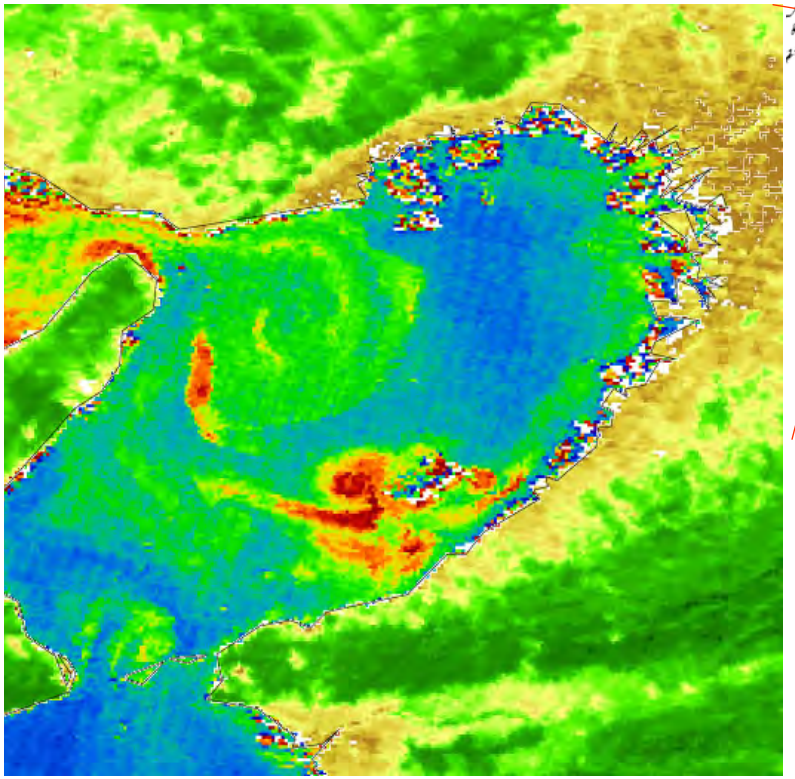
1. Introduction of GCOM and SGLI

1.5 Features of SGLI ocean observation

250m Ocean colour product simulated using GLI 250m channels



(a) GLI 1km Osaka Bay
(1 Oct. 2003, CHL by LCI)



(b) GLI 250m Osaka Bay
(1 Oct. 2003, CHL by LCI)

SGLI 250m resolution will enable to detect more fine structure in the coastal area such as river outflow, regional blooms, and small current.

2. Status of GCOM SGLI program

2.1 Time table

	Time	*Event*
JFY 2005	**2005 Sep.**	**Review of GCOM-W/C Breadboard Model (BBM) study**
	2005 Oct.	**Start BBM design and trial manufacture ~JFY2007**
		--
JFY 2006	**2006 Jun 15**	**GCOM Symposium (Tokyo)**
	2006 Jun ~Jul.	GCOM-W1 Evaluation in the Space Activity Commission sub-groups
	2006 Sep.~Oct.	Evaluation by Committee for Scientific and Technological Policy
	2006 Dec. 27	**Design review of the SGLI BBM**
	2007 Jan 29~31	AMSR/E GLI workshop
	…	
JFY 2007	*2007 Spring*	*GCOM/EarthCARE Symposium in Tokyo (TBD)*
	…	
	200X	*Pre-evaluation of GCOM-C1 (TBD)*
		•SGLI have to approved by this evaluation to go to the following steps.
		•Now we are trying to undergo the evaluation…
	2008 March	**Review of the SGLI BBM**
JFY 2008~	??	*Develop Engineering Model (not approved)*
	…	
	??	*Develop Pre-Fright Model (not approved)*
	…	
	JFY2010 (TBD)	*GCOM-W1 Launch (TBD)*
	JFY2011 (TBD)	*GCOM-C1 Launch (TBD)*

" 2010" and "2011" are perhaps delayed by a difficulty of financial resources

3. SGLI Ocean Science Plan

3.1 Products and target accuracy

SGLI radiance product (L1B)

Category	*Product*	*Type*[*1]	*File unit*	*Resolution*	*Threshold for data release*	*Standard accuracy*[*1]	*Target accuracy*[*1]
radiance	Radiometric corrected radiance with geometric information	S	Scene, global (day)	250m (land and coast) 1km (offshore)	TBD	VN/SWIR 5%[*2], 1% (relative) TIR: 0.5K(@300K)	VN/SWIR 3%[*2], 0.5% (relative)

SGLI Ocean products

Category	*Product*	*Type*	*File Unit*	*Resolution*	*Threshold for data release*	*Standard accuracy*[*1]	*Target accuracy*[*1]
Atmospheric correction	Normalized Water Leaving Radiance	S	scene, global (day/8 day/month)	250m (coast) 1km (offshore) 4~9km (global bin)	60% (443~565nm)	50% (<600nm) 0.5W/m^2/sr/um (>600nm)	30% (<600nm) 0.25W/m^2/sr/um (>600nm)
	Atmospheric Correction Parameters	S			80% (τ_a_865)	50% (τ_a_865)	30%
	Photosynthetically Available Radiation	S			20% (10km/month)	15% (10km/month)	10% (10km/month)
	Euphotic Zone Depth	R	scene, global (day/8 day/month)		N/A	N/A	30%(TBD)
In-water parameters	Chlorophyll-a Concentration	S	scene, global (day/8 day/month)		–60~+150% (offshore)	–60~+150%	–35~+50% (offshore), –50~+100% (coastal)
	Suspended Solid concentration	S			–60~+150% (offshore)	–60~+150%	–50~+100%
	Colored Dissolved Organic Matter	S			–60~+150% (offshore)	–60~+150%	–50~+100%
	Inherent Optical Properties	R	scene, global (day/8 day/month)		N/A	N/A	TBD
Temperature	Sea Surface Temperature	S	scene, global (day/8 day/month)	500m (coast) 1km (offshore) 4~9km (global bin)	0.8K (daytime)	0.8K	0.6K
Application	Ocean Primary Productivity	R	scene, global (day/8 day/month)	500m (coast) 1km (offshore) 4~9km (global bin)	N/A	N/A	TBD
	Phytoplankton Functional Type	R	scene, global (day/8 day/month)	250m (coast) 1km (offshore) 4~9km (global bin)	N/A	N/A	TBD
	Redtide	R			N/A	N/A	TBD
	Multi-sensor Ocean Color	R	scene, global (day/8 day/month)	250m (coast) 1km (offshore)	N/A	N/A	TBD
	Multi-sensor SST	R	scene, global (day/8 day/month)	500m (coast) 1km (offshore)	N/A	N/A	TBD

S: Standard products, R: Research products

3. SGLI Ocean Science Plan

3.2 SGLI products and channels

CH	λ	Δλ	L_{std}	L_{max}	SNR	IFOV*3
-	VN, P: nm T: µm		VN, P: W/m²/sr/µm T: Kelvin		at L_{std} VN, P: - T: NEΔT	m
VN1	380	10	60	210	250	250
VN2	412	10	75	250	400	250
VN3	443	10	64	400	300	250
VN4	490	10	53	120	400	250
VN5	530	20	41	350	250	250
VN6	565	20	33	90	400	250
VN7	670	10	23	62	400	250
VN8	670	20	25	210	250	250
VN9	763	8	40	350	400	1000
VN10	865	20	8	30	400	250
VN11	865	20	30	300	200	250
P1	670	20	25*1	250*1	250*1	1000
P2	865	20	30*1	300*1	250*1	1000
SW1	1050	20	57	248	500	1000
SW2	1380	20	8	103	150	1000
SW3	1640*4	200	3	50	57	250
SW4	2210	50	1.9	20	211(TBD)	1000
T1	10.8*2	0.7*2	300	180~340	0.2	500
T2	12.0*2	0.7*2	300	180~340	0.2	500

Land

CH	Precise Geometrically Corrected Image	Atmospherically Corrected Land surface Reflectance	Vegetation Index including NDVI and EVI	Vegetation Roughness Index including BSI_P and BSI_V	Shadow Index	Land Surface Temperature	Fraction of Absorbed Photosynthetically Active Radiation	Leaf Area Index	Above-Ground BIOmass	Land Net Primary Production	Plant Water Stress trend Index	Fire Detection Index	Land Cover Type	Land surface ALBedo
VN1	U	U												
VN2	U	T	U		U	U	I	I	I	U			U	U
VN3	U	T	U		U	U	I	I	I	U			U	U
VN4														
VN5	U	T			U	U	I	I	I	U			U	U
VN6														
VN7														
VN8	E	T	M	M	U	U	I	I	I	E			E	I
VN9														
VN10														
VN11	U	T	U	U	U	U	I	I	I	U			U	U
P1	U	U		U	R		I	I	I	R			R	R
P2	U	U		U	R		I	I	I	R			R	R
SW1														
SW2														
SW3	U	T				U				U	R	U	E	U
SW4	U	T				U						U	U	
T1	U					U					U	U		
T2	U					M					U	U		

Atmosphere

CH	CLoud FlaG including Cloud Classification and Phase	Classified CLoud Fraction	Cloud Top Temperature and Height	Water Cloud Optical Thickness and Particle Effective Radius	Ice Cloud Optical Thickness	Water Cloud Geometrical Thickness	AeRosol over the ocean by Visible and near infrared	Land AeRosol over the land by near Ultra violet	AeRosol by Polarization	LongWave Radiation Flux	ShortWave Radiation Flux
VN1								U		I	I
VN2							U	E		I	I
VN3							U			I	I
VN4											
VN5	U	C	C	C	C	C	C	C	C		
VN6											
VN7							U			I	I
VN8	U	C	C	C	C	C	C	C	C		
VN9						M				I	I
VN10							U			I	I
VN11	U	C	C	C	C	C	C	C	C		
P1									E		
P2									E		
SW1	M	C	C	M	C	U				I	I
SW2	U										
SW3	U	C	C		C						
SW4				M		U				I	I
T1	U	C	U		U	U				I	I
T2	U	C	U		U					R	R

Ocean

CH	Normalized Water Leaving Radiance	Atmospheric Correction Parameters	Ocean Photosynthetically Available Radiation	Euphotic Zone Depth	CHLorophyll-A concentration	Suspended Solid concentration	absorption coefficient of Colored Dissolved Organic Matter	Inherent Optical Properties	Sea Surface Temperature	Ocean Net Primary Productivity	PHytoplankton Functional Type	Red TiDe	multi sensor Merged Ocean Color parameters	multi sensor Merged Sea Surface Temperature
VN1	T	E			I	I	U	U		I	R	R	U	
VN2	T		U				E	U		I	R	R	U	
VN3	T		U	U	E		E	U		I	U	U	U	
VN4	T			U	M	U		U		I	U	U	U	
VN5	T		U	U	E			U	C	I	R	R	U	C
VN6	T			U	M	E	U	U		I	U	U	U	
VN7	T	M		I	I	E	I	U		I	R	R	U	
VN8		R	U						C	I			R	C
VN9														
VN10		M		I	I	I	I			I			U	
VN11		R	U						C	I			R	C
P1		R	R											
P2		R												
SW1		R	C							I				
SW2														
SW3		R												
SW4		R												
T1									M	I		R		M
T2									E					E

Cryosphere

CH	Snow and Ice Covered Area	OKhotsk sea-Ice Distribution	Snow and Ice Classification	Snow Covered Area in Forest and Mountain	Snow and Ice Surface Temperature	SNow Grain Size of shaLLow layer	SNow Grain Size of Subsurface layer	SNow Grain Size of Top layer	Snow and Ice ALBedo	SNow ImPurity	Ice Sheet surface RouGHness	Ice Sheet Boundary Monitoring
VN1						U	I		U	M		
VN2									R	R		
VN3	U	U	U	U	S	U	U	S	U	M	S	U
VN4												
VN5	U	U	U	U	S	S	S	S	E	S	S	U
VN6												
VN7												
VN8	U	U	U	U	S	S	S	S	U	S	R	U
VN9	R											
VN10												
VN11	U	U	U	U	S	M	S	S	U	U	R	U
P1			R								R	
P2			R								R	
SW1	U	U	U	U	S	S	R	S	U	S	S	U
SW2	M	U	C	C	C	C	C	C	C	C	C	
SW3	M	U	U	U	C	C	C	R	U	C	C	U
SW4	U			U								
T1	U	U	U	U	M	S	S	S	S	S	S	
T2	U		R		M							

M: Most essential, **E**: essential, U: used channel, T: correction targets, R: future research, I: indirect use, C: cloud detection, S: Snow detection
*1: defined as intensity of non-polarized light, *2 :Unit is µm, *3: 1km in the open ocean, *4: the light limit is at 1740nm
Green: Succession of GLI standard products, Red: New standard products, and White: research products.

3. SGLI Ocean Science Plan

3.3 SGLI ocean standard products definitions and development methods

- **Normalized Water Leaving Radiance (NWLR) and Atmospheric Correction Parameters (ACP)**
  - Definition: Standardized radiance of the SGLI spectral channels leaving from a sea surface in the case of atmospheric transmittance 1.0 , the solar zenith angle zero and the sun-earth distance 1AU. The reflective ingredient of a sea surface is not included ($mW/cm^2/str/um$). This is same as OCTS, GLI, SeaWiFS, and MODIS.
  - Development: Evaluation and improvement of the aerosol processing by the match up of a past satellite and in situ optical observations.
- **Photosynthetically Available Radiation (PAR)**
  - Definition: daily average of the light at wavelengths from 400nm to 700nm which phytoplankton uses for photosynthesis by $Ein/m^2/day$.
  - Development: Improvement of treatment of the daily variation of cloud amount, and evaluation using ground PAR observations
- **CHLorophyll-A concentration (CHLA)**
  - Definition: phytoplankton chlorophyll-a concentration by mg/m^3
  - Development: Evaluation and improvement of bio-optical models (formulas) by in situ bio-optical observations
- **Suspended Solid concentration (SS)**
  - Definition: Filter dry weight by g/m^3 (total suspended matter)
  - Development: Same as CHLA
- **absorption of Colored Dissolved Organic Matter (CDOM)**
  - Definition: attenuation coefficient (m^{-1}) of the colored dissolved organic matter at 440nm (TBD)
  - Development: Same as CHLA
- **Sea Surface Temperature (SST)**
  - Definition: bulk sea surface temperature (observed by drifting buoy at 1-m) by degree C
  - Development: Atmospheric correction, and cloud detection accuracy evaluation and improvement by comparison with existing satellite data and in-situ SST data distributed on GTS or the Internet. Pre-launch evaluation of the atmospheric correction coefficient equivalent to the SGLI spectrum response by a radiation transfer simulation.

3. SGLI Ocean Science Plan

3.4 SGLI ocean research products definitions and development methods

- **Euphotic Zone Depth (EZD)**
  - Definition: Total direction illumination (observation is cosine) defines by PAR as depth which becomes 1% (denominator: E0-).
  - Development: Formulize relations between nLw and EZD calculated by in-situ measurements of underwater downward irradiance.
- **Inherent Optical Properties (IOP)**
  - Meaning: It can be used for the primary productivity model, plankton classification presumption, etc.
  - Development: Formulize relations between in-situ bio-optical observations, such as CHLA, SS and CDOM, and a scattering and absorption coefficients, and evaluate applicability to satellite data.
- **multi sensor Merged Ocean Color parameters (MOC)**
  - Definition: Data sets which combined with the product of other satellites and improved time resolution
  - Development: Same as an ocean color product peculiar to SGLI.
- **multi sensor Merged Sea Surface Temperature (MSST)**
  - Definition: Data sets which combined with the product of other satellites and improved time resolution
  - Development: Same as an ocean color product peculiar to SGLI.
- **Ocean Net Primary Productivity (ONPP)**
  - Definition: Net primary productivity by phytoplankton (breathing respiration is not taken into consideration)
  - Development: Evaluation of the applicability by the satellite data based on presumption and improvement of the parameter of the biological production model by in situ observation, and processing of the existing satellite data.
- **PHytoplankton Functional Type (PHFT)**
  - Definition: The phytoplankton existence rate for every functions, such as nitrogen fixation, silicon fixation, and carbon dioxide discharge. It grasps what kind of function plankton with exists, and it is used for climate change analyses, such as cloud nucleus formation.
  - Development: The relation of the functional classification and the water-leaving radiance spectrum in in situ observation is put in a database (the existence rate for every phytoplankton function and NWLR are associated), and it applies to satellite data.
- **Red TiDe (RTD)**
  - Definition: The coloring phenomenon which man distinguishes from red tide
  - Development: From correspondence with in situ visual observation, classification observation, and the observation example by the existing satellite, the relation between a nLw spectrum, and red tide and its classification is typified.

4. Summary

- JAXA is planning Global Climate Observation Mission (GCOM), which consists of GCOM-W and GCOM-C satellite series.
- GCOM-C carries a radiometer of visible-infrared, middle-resolution, and global and frequent observation, Second generation GLI (SGLI).
- Aiming to the target launch year 2011, we have started sensor Breadboard Model (BBM) study (design and trial manufacture) from autumn in 2005. *(This may be delayed by today's difficulty of financial resources.)*
- We are trying to undergo the evaluation of mission approval from points of view of social benefit, costs and reality (the evaluation is very important for the next procedures).
  - *JAXA is looking for data requirement from operational agencies or user groups (IOCCG can be?) making commitment to use, and the present use examples, in order to make a decision of the mission approval.*
- We hope that SGLI science project, which does not exist yet, can support IOCCG to promote application and merger of SGLI ocean-colour products.