GCOM-C Mission design

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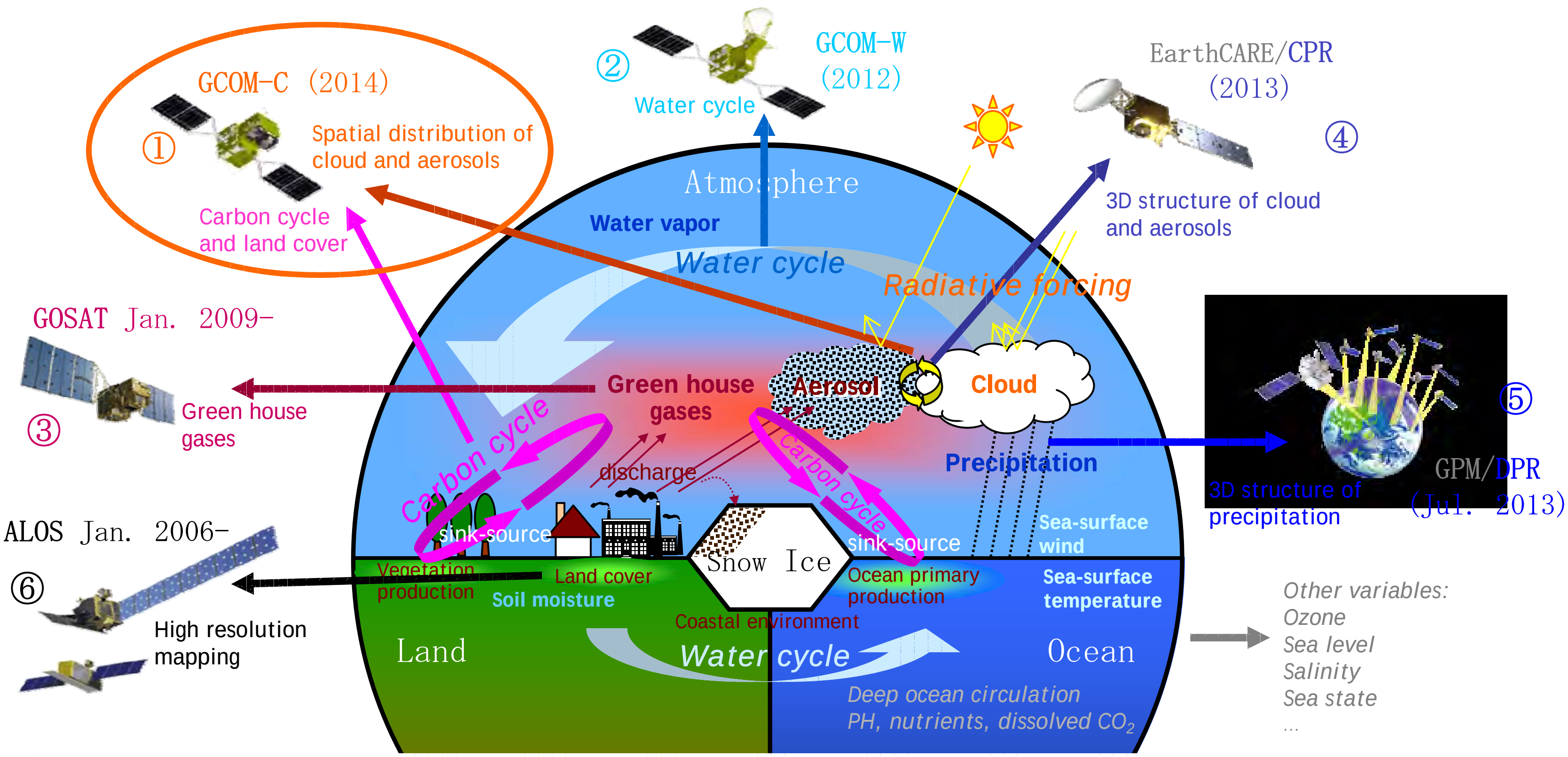
1. Mission Concept of GCOM-C

1.1 JAXA global earth observation missions

- *GCOM-C for the global surface radiation budget and carbon cycle*



① GCOM-C: Long-term observation of the horizontal distribution of aerosol, cloud, and ecosystem CO_2 absorption and discharge

② GCOM-W: Long-term observation of water-cycle such as the snow/ice coverage, water vapor, and SST

③ GOSAT: Observation of distribution and flux of the atmospheric greenhouse gases, CO_2 and CH_4

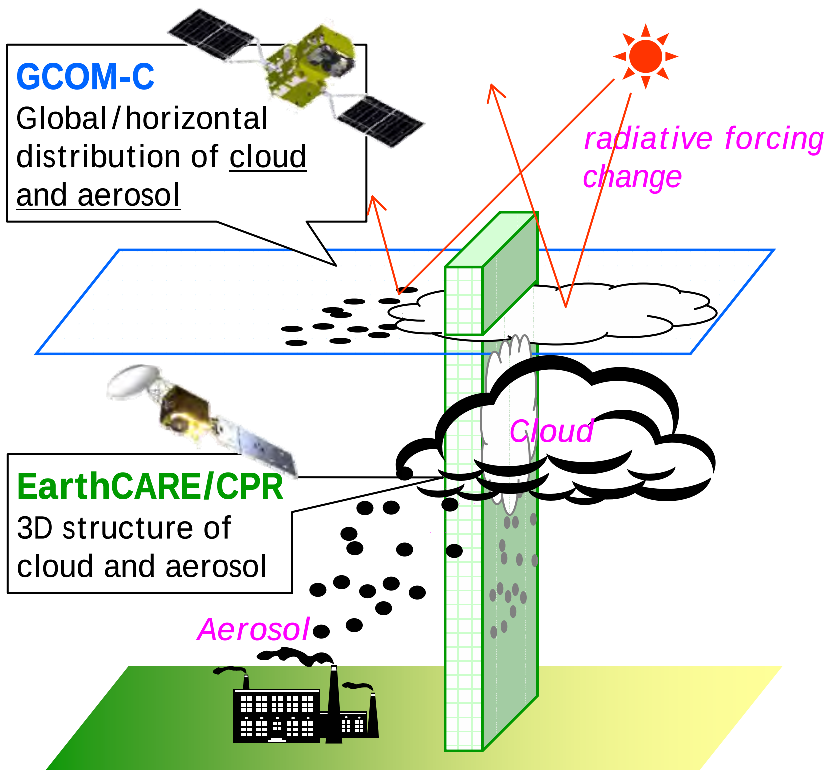
④ EarthCARE/CPR: Observation of vertical structure of clouds and aerosols

⑤ GPM/DPR: Accurate and frequent observation of precipitation with active and passive sensors

⑥ ALOS: Fine resolution mapping by optical and SAR instruments

1. Mission Concept of GCOM-C

1.2 Radiation budget by the atmosphere-surface system



Monitoring and process investigation about
cloud and aerosol by GCOM-C & EarthCARE

Today's the most significant factor: atmospheric CO_2

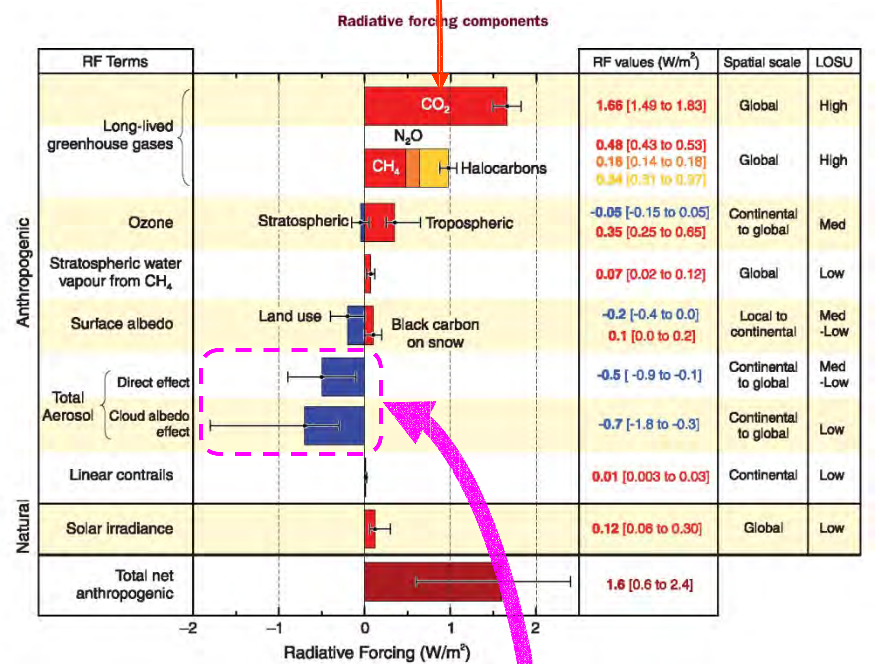


Figure 2.4. Global average radiative forcing (RF) in 2005 (best estimates and 5 to 95% uncertainty ranges) with respect to 1750 for CO_2, CH_4, N_2O and other important agents and mechanisms, together with the typical geographical extent (spatial scale) of the forcing and the assessed level of scientific understanding (LOSU). Aerosols from explosive volcanic eruptions contribute an additional episodic cooling term for a few years following an eruption. The range for linear contrails does not include other possible effects of aviation on cloudiness. {WGI Figure SPM.2}

Improvement

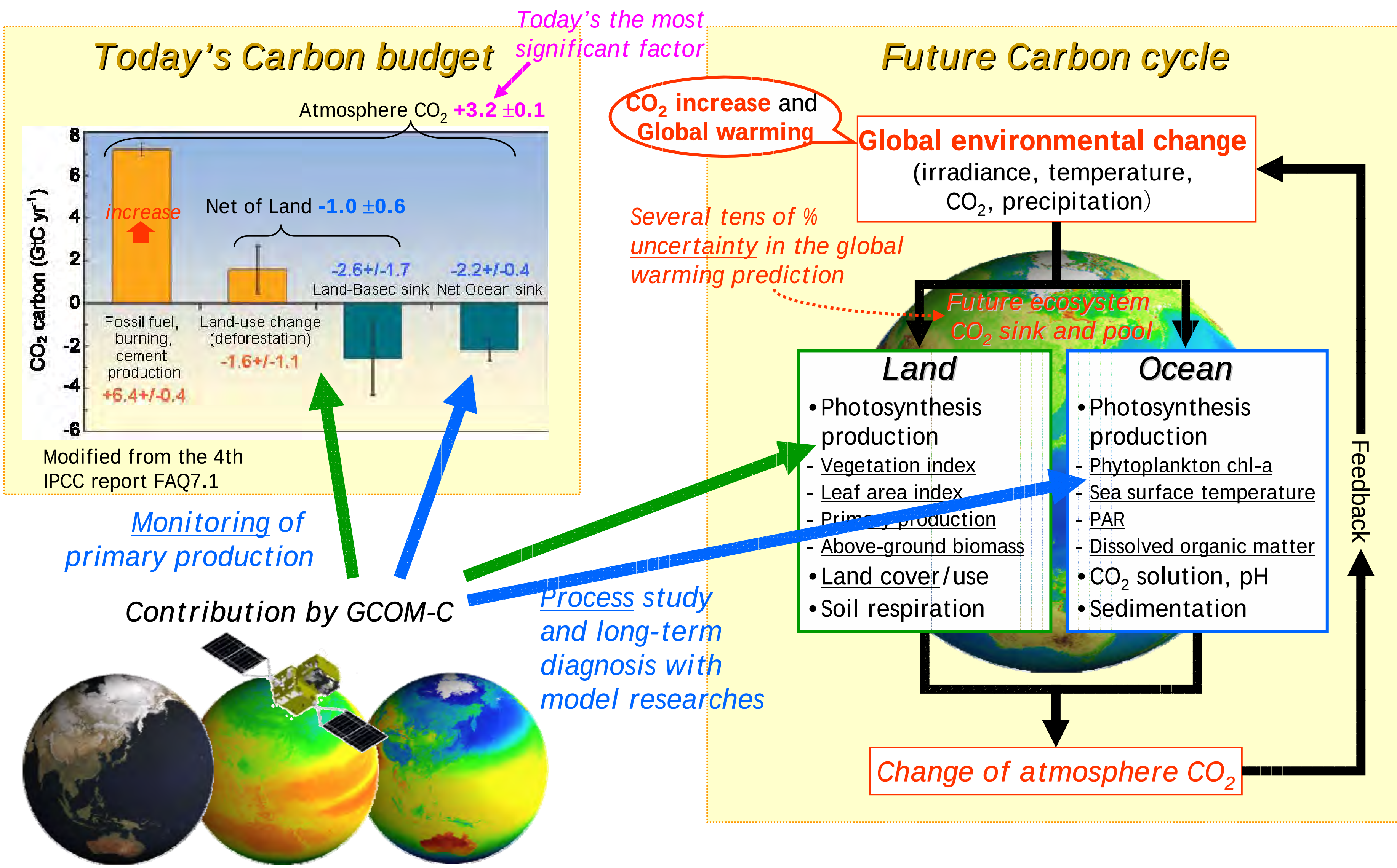
Evaluation of model outputs and process parameterization

Climate model prediction
present and future cloud and aerosol roles in the global warming scenarios

Today's the most significant uncertainty of radiative forcing is direct/indirect role of cloud-aerosol system

1. Mission Concept of GCOM-C

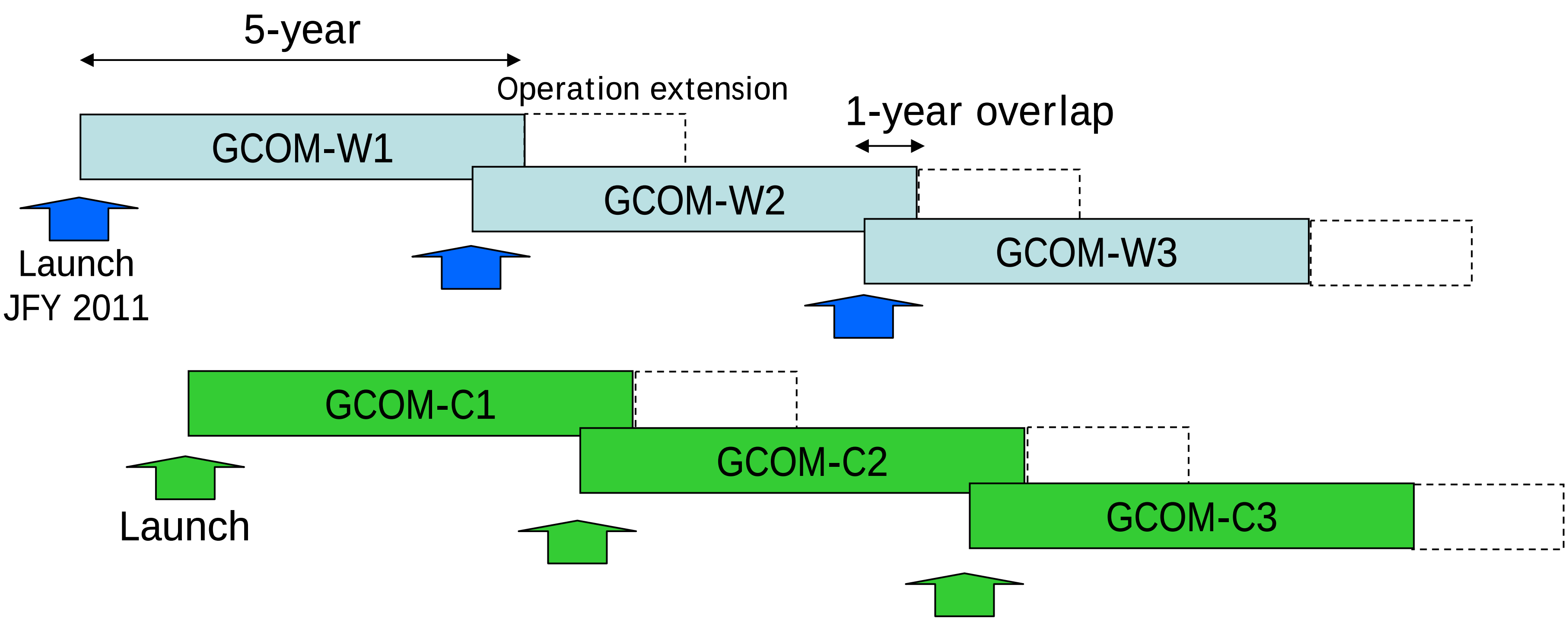
1.3 Carbon cycle in the Land and Ocean



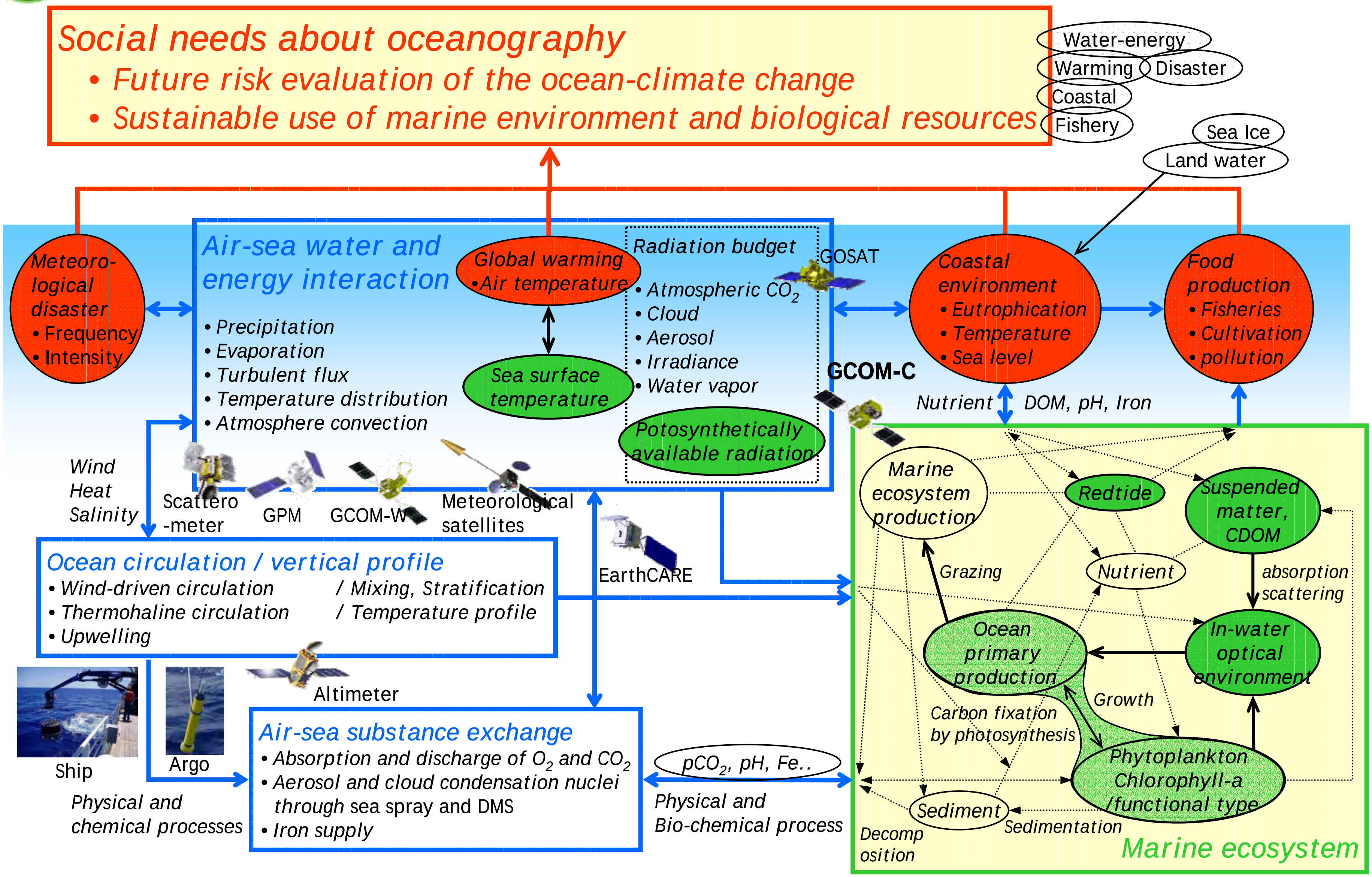
1. Mission Concept of GCOM-C

1.4 Long-term observation

- Climate monitoring and research need long-term consistent observation
- GCOM-W/C observe more than 10 years by three satellites with one-year overlap.



1.5 Social needs of ocean area



Effective ocean-color-ecosystem research for the social needs

1.6 Science Targets

Social needs / *Ocean science targets*	Global warming	Water-energy (heat) cycle	Coastal environment	Fishery
(1) *Ocean primary production*	O		O	O
(2) *Coastal ocean* eutrophication and land-sea substance exchange	O		O	O
(3) *Marine biological resources*				O
(4) *Ocean-climate system by effective use* of satellite-ground and ocean-land-atmosphere observations	O	O	O	
(5) *Satellite sensor & data product improvement*	O	O	O	O

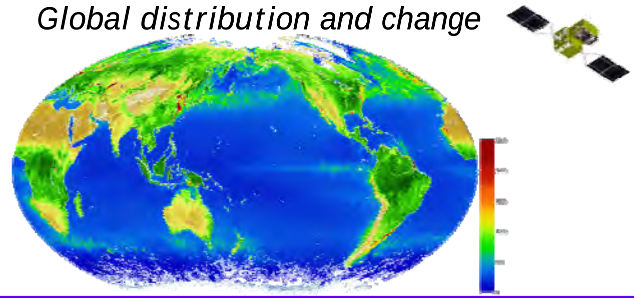
They will also contribute to the implement plan and targets of GEOSS.

(1) Ocean Primary Production

- The ocean primary production can be a sink of the atmospheric CO_2 regulating the global warming.
  - Global trend and distribution
- The estimation needs integrative analysis of ocean colour with related parameters, such as solar irradiance (PAR), nutrient, water temperature, and a vertical mixing/stratification.
- Solutions: *global ocean color observation by GCOM-C*
  - On going:
    - Improvement of satellite ONPP algorithm
    - Improvement of input parameters (CHL, SST, PAR, nLw, IOP, species..)
    - Sample number and accuracy of in-situ observation
  - *Begin ning*:
    - *Combination with ocean ecosystem production models*

Estimation of Ocean net primary production using satellite data

Global distribution and change



a) model input

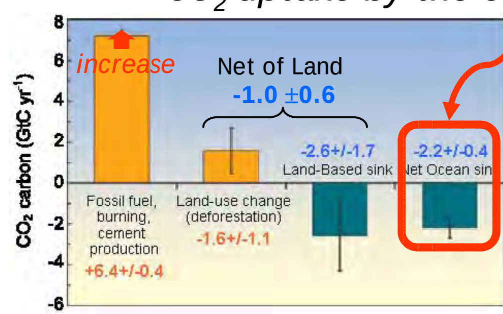
b) Improve ocean photosynthetic parameters

c) model – satellite comparison

Ocean ecosystem production model

ONPP, grazing, transport, decomposition, sedimentation, pCO_2, pH, ocean circulation…

Today's and future abilities of CO_2 uptake by the ocean



Atmosphere CO_2 **+3.2 ±0.1**

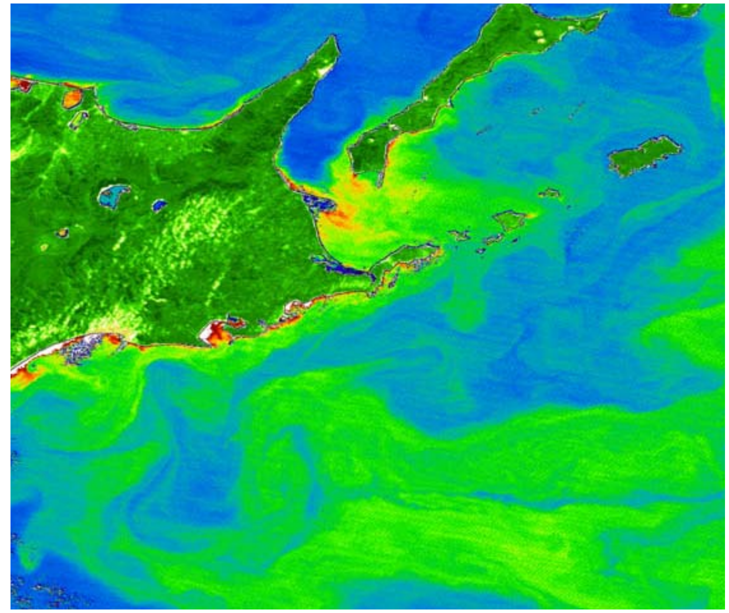
Modified from the 4th IPCC report FAQ7.1

(2) Coastal Ocean

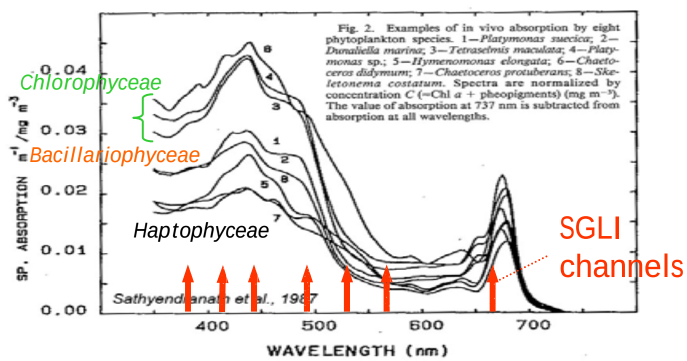
- Coastal ocean has large productivity and strong relation to the human activities.
- Estimation of coastal primary production needs special considerations about irregular light, nutrient, plankton species and their vertical profiles due to inland-water and substance (including carbon).
- Solutions : *250m observation by GCOM-C*

On going
  - Local characterization/ standardization of *plankton taxa and optical properties*
  - Land aerosol correction
  - Sunglint correction (coastal area)

Beginning
  - *High spatial resolution sensor (<250m)*
  - *Adjacent scattering from bright surface*
  - *Land water inflow by cooperation with hydrology and land surface model*



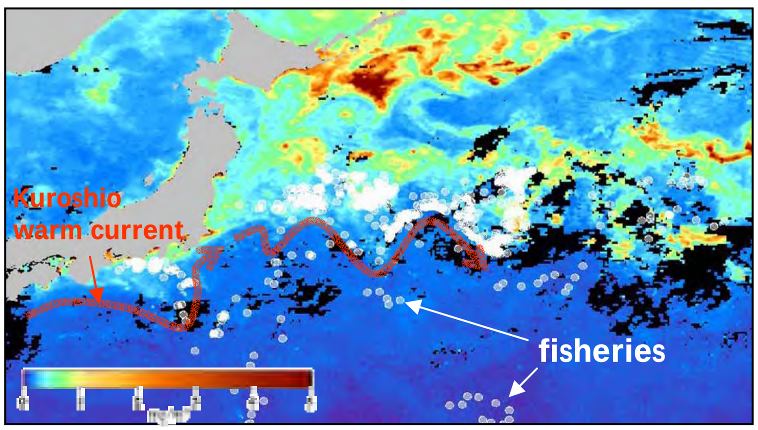
Chlorophyll-a concentration east of Hokkaido Japan on 24 Sep. 2003 estimated by ADEOS-II/GLI 250m channels.



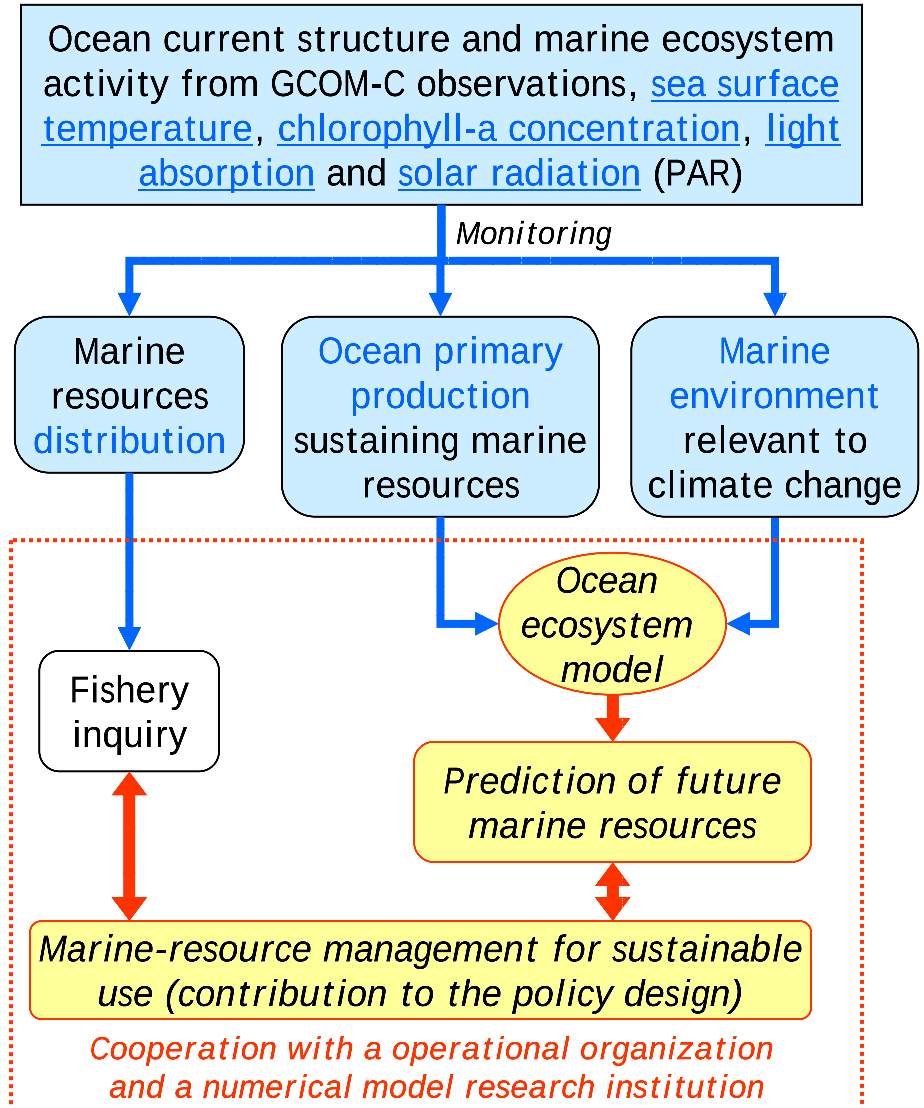
Absorption spectra of different algae

(3) Marine biological resources

- Fishery estimation has been operated since OCTS
- Prediction and catch management of the marine resources are required today
- Solutions: *Ocean color observation by GCOM-C*
  - Near-real time *robust* products
  - *Plankton taxa*
  - *Cooperation with ocean ecosystem/ bioresources model*



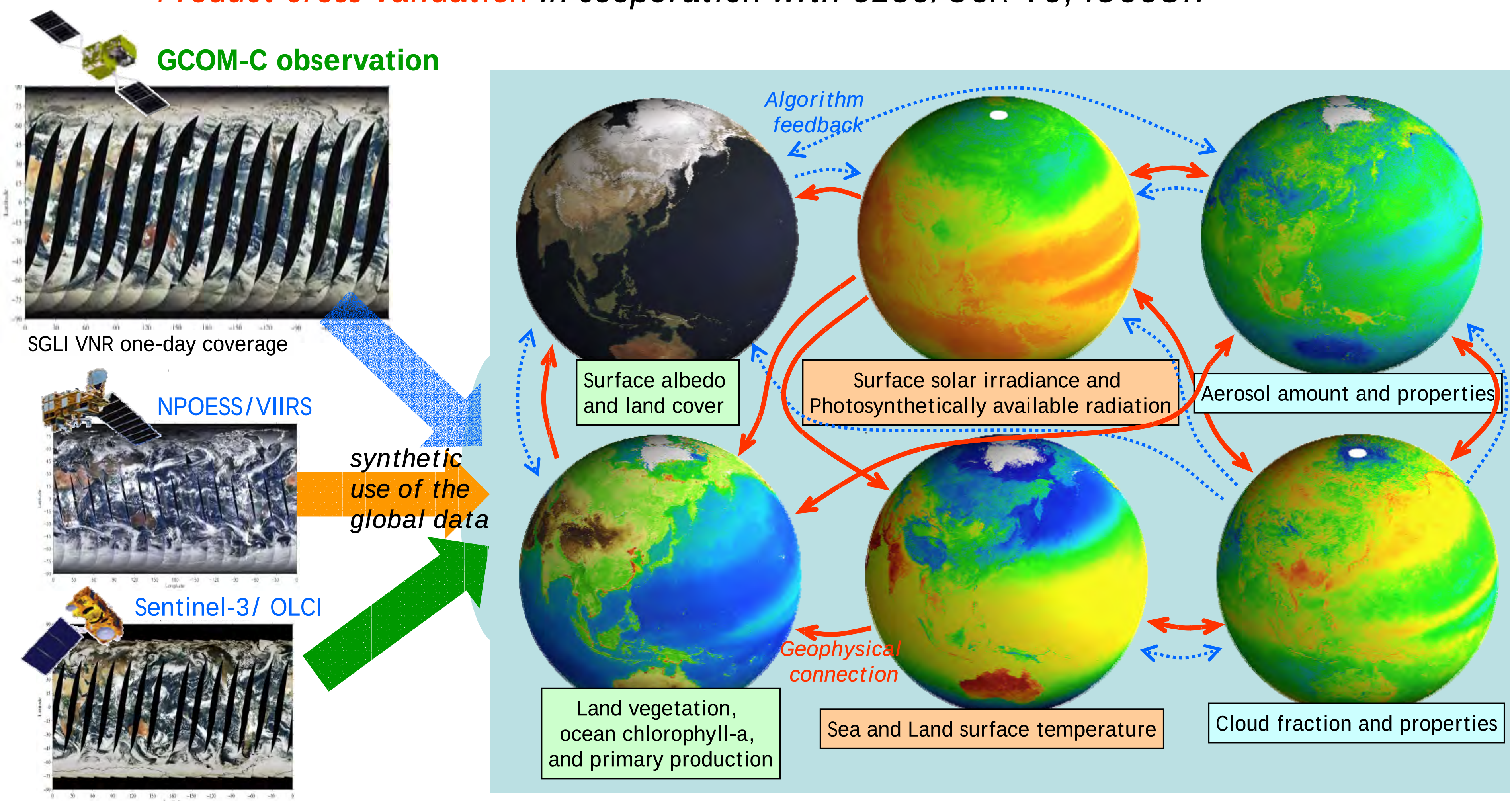
Chlorophyll-a concentration in the northwestern Pacific in June 2003 overlaid on fisheries of skipjack and tuna.



(4) Ocean-climate system by effective use

(4-1) Integrated use of different sensors and parameters

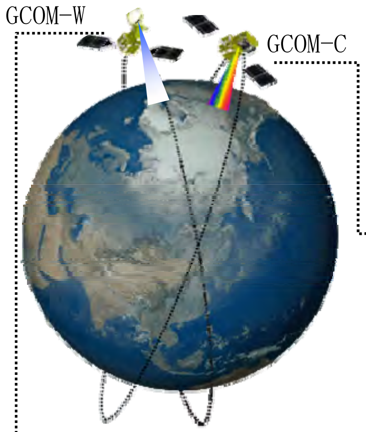
- *Data merger through* sensor cross-calibration and product cross-validation
  - *Sensor cross-calibration in cooperation with CEOS/WGCV/IVOS*
  - *Product cross-validation in cooperation with CEOS/OCR-VC, IOCCG..*



(4) Ocean-climate system by effective use

(4-2) Data/knowledge integration using numerical models

Satellite observation — *Main responsibility of JAXA*



Frequent and long-term (>10yer) global observation system required for earth environment change monitoring and prediction

GCOM observation

Radiation budget
- Surface albedo
- Snow ice
- Cloud/ aerosol
- Temperature

Carbon cycle
- Vegetation cover
- Primary production
- Coastal exchange

Water cycle
- Water vapor, cloud, precipitation
- Soil moisture
- Sea ice, snow
- SST, wind

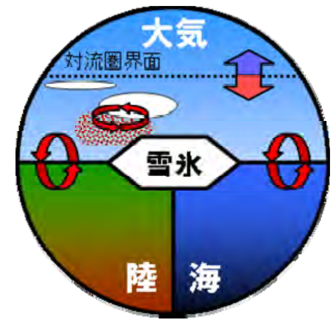
Input

Comparison

Products or radiance with radiative transfer

Model prediction — *Cooperation with the climate model research institutions*

Climate system model



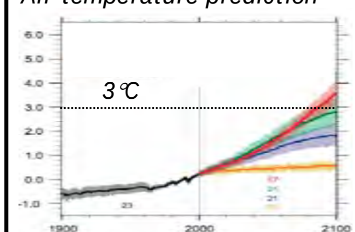
- Improvement of parameterization about radiation budget and carbon cycle, etc. in climate prediction model.
- Verification and improvement of prediction of the earth environment change including the water cycle by comparison with the satellite observation.

Improve accuracy

Prediction results

- Surface temperature
- Sea level
- Snow and sea ice area
- Environmental change
- Rain/drought distribution
- Extreme weather frequency
- Land cover

Air temperature prediction



Data application → Operational use for fishery, sea route, weather forecast, etc.

Knowledge → monitoring and understanding of the earth environment change

Scenario → Policy design through prediction improvement

Solutions: *Cooperation with model research,*

Connecting model parameters with satellite observations directly

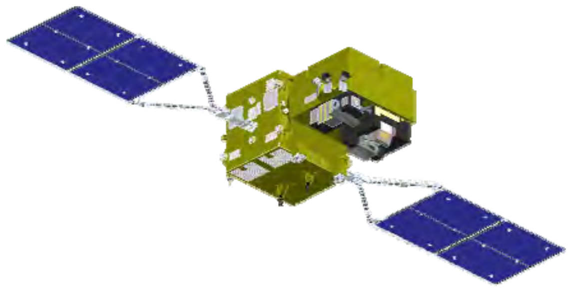
(5) Satellite sensor & data products

(5-1) High accuracy products for the climate research

- For every purposes, improvement of satellite products accuracy is still the most essential
- Solutions :
  - Improvement of in-water algorithms of complicated substance composition (e.g., coastal area),
  - *Combination with bio-physical-optical model*
  - Improvement of atmospheric correction (extraction of the water-leaving signals) in conditions of much suspended matter, whitecaps, sunglint and *irregular aerosols including absorptive aerosols*
  - *Long-term/inter-sensor continuity & consistency*
  - *High sensor performance (SNR and perfect sensor calibration model)*

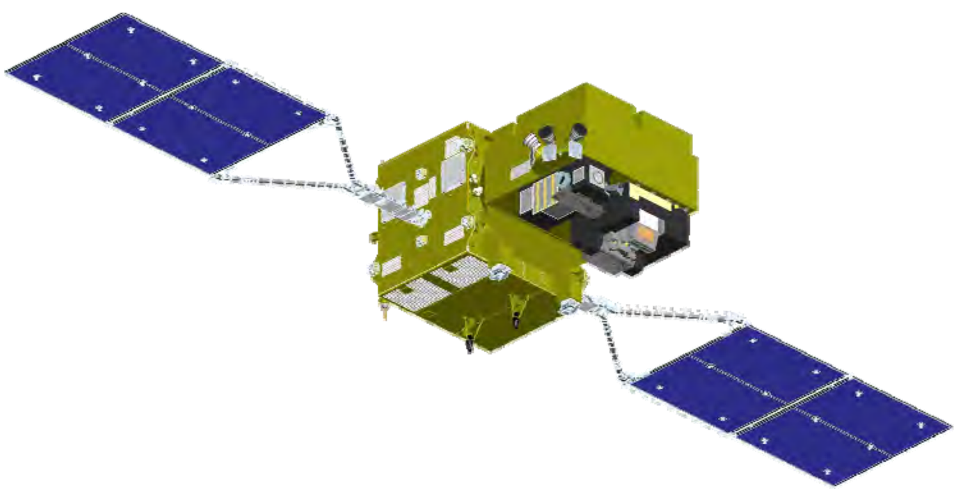
(5) Satellite sensor & data products

(5-2) GCOM-C/SGLI



- The next Japanese ocean color mission is Global Change Observation Mission for Climate research (GCOM-C)
- The mission focuses the carbon cycle and radiation budget, and will consist of three satellites for 13 years from early 2014 to contribute detection of the "global change".
- The GCOM-C will carry Second-generation Global Imager (SGLI) which is a radiometer of 380-12000nm wavelength, 1150-1400km swath width, and descending orbit around 10:30am, as a follow-on mission of ADEOS-II/GLI.
- Features of SGLI are 250m-spatial resolution (500m for thermal infrared) and polarization/along-track slant view channels (red and near-infrared), which will improve coastal ocean, land, and aerosol observations.

2. GCOM-C/SGLI design



2.1 GCOM-C observation products

Common	
Radiance	• TOA radiance (including system geometric correction)

- *Radiation budget by the atmosphere-surface system*
- *Carbon cycle in the Land and Ocean*

Land	
Surface reflectance	• Precise geometric correction
	• Atmospheric corrected reflectance
Vegetation and carbon cycle	• Vegetation index
	• Above-ground biomass
	• Vegetation roughness index
	• Shadow index
	• Fraction of Absorbed Photosynthetically available radiation
	• Leaf area index
Temp.	• Surface temperature
Application	Land net primary production
	Water stress trend
	Fire detection index
	Land cover type
	Land surface albedo

Atmosphere	
Cloud	• Cloud flag/Classification
	• Classified cloud fraction
	• Cloud top temp/height
	• Water cloud optical thickness /effective radius
	• Ice cloud optical thickness
	Water cloud geometrical thickness
Aerosol	• Aerosol over the ocean
	• Land aerosol by near ultra violet
	• Aerosol by Polarization
Radiation budget	Long-wave radiation flux
	Short-wave radiation flux

Ocean	
Ocean color	• Normalized water leaving radiance
	• Atmospheric correction parameter
	• Photosynthetically available radiation
	Euphotic zone depth
In-water	• Chlorophyll-a conc.
	• Suspended solid conc.
	• Colored dissolved organic matter
In-water	Inherent optical properties
Temp.	• Sea surface temp.
Application	Ocean net primary productivity
	Phytoplankton functional type
	Redtide
	multi sensor merged ocean color
	multi sensor merged SST

Cryosphere	
Area/distribution	• Snow and Ice covered area
	• OKhotsk sea-ice distribution
	Snow and ice classification
	Snow covered area in forest and mountain
Surface properties	• 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
Boundary	Ice sheet boundary monitoring

Blue: standard products

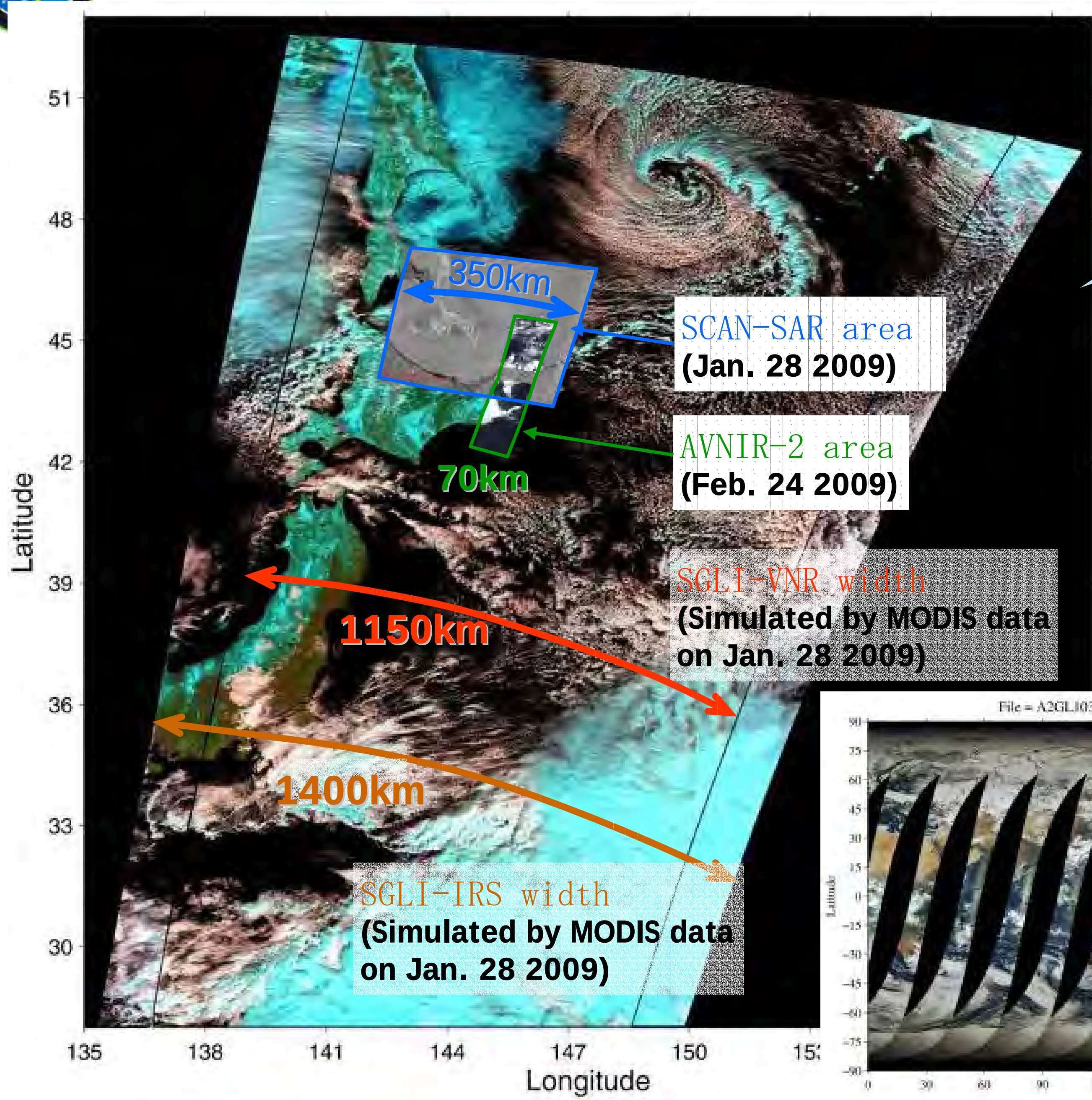
Red: research products

2.2 SGLI products and channels

CH	λ	Δλ	L_{std}	L_{max}	SNR	IFOV*3	Land														Atmosphere											Ocean														Cryosphere											
-	VN, P: nm T: µm		VN, P: W/m²/sr/µm T: Kelvin		at L_{std} VN, P: - T: NEΔT	m	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	Water Stress trend	Fire Detection Index	Land Cover Type	Land surface ALBedo	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	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	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	380	10	60	210	250	250	U	U																			U			I	I	T	E			I	I	U	U		I	R	R	U							U	I		U	M		
VN2	412	10	75	250	400	250	U	T	U		U	U	I	I	I	U			U	U							U	E		I	I	T		U				E	U		I	R	R	U										R	R		
VN3	443	10	64	400	300	250	U	T	U		U	U	I	I	I	U			U	U							U			I	I	T		U	U	E		E	U		I	U	U	U		U	U	U	U	S	U	U	S	U	M	S	U
VN4	490	10	53	120	400	250																										T			U	M	U		U		I	U	U	U													
VN5	530	20	41	350	250	250	U	T			U	U	I	I	I	U			U	U	U	C	C	C	C	C	C	C	C			T		U	U	E			U	C	I	R	R	U	C	U	U	U	U	S	S	S	S	E	S	S	U
VN6	565	20	33	90	400	250																										T			U	M	E	U	U		I	U	U	U													
VN7	673.5	20	23	62	400	250																					U			I	I	T	M		I	I	E	I	U		I	R	R	U													
VN8	673.5	20	25	210	250	250	E	T	M	M	U	U	I	I	I	E			E	I	U	C	C	C	C	C	C	C	C				R	U						C	I			R	C	U	U	U	U	S	S	S	S	U	S	R	U
VN9	763	12	40	350	1200	1000																				M				I	I															R											
VN10	868.5	20	8	30	400	250																					U			I	I		M		I	I	I	I			I			U													
VN11	868.5	20	30	300	200	250	U	T	U	U	U	U	I	I	I	U			U	U	U	C	C	C	C	C	C	C	C				R	U						C	I			R	C	U	U	U	U	S	M	S	S	U	U	R	U
P1	673.5	20	25*1	250*1	250*1	1000	U	U		U	R		I	I	I	R			R	R									E				R	R														R								R	
P2	868.5	20	30*1	300*1	250*1	1000	U	U		U	R		I	I	I	R			R	R									E				R															R								R	
SW1	1050	20	57	248	500	1000															M	C	C	M	C	U				I	I		R	C							I					U	U	U	U	S	S	R	S	U	S	S	U
SW2	1380	20	8	103	150	1000															U																									M	U	C	C	C	C	C	C	C	C	C	
SW3	1630	200	3	50	57	250	U	T				U				U	R	U	E	U	U	C	C		C								R													M	U	U	U	C	C	C	R	U	C	C	U
SW4	2210	50	1.9	20	211	1000	U	T				U						U	U					M		U				I	I		R													U			U								
T1	10.8*2	0.7*2	300	180~340	0.2	500*4	U					U					U	U			U	C	U		U	U				I	I									M	I		R		M	U	U	U	U	M	S	S	S	S	S	S	
T2	12.0*2	0.7*2	300	180~340	0.2	500*4	U					M					U	U			U	C	U		U					R	R									E					E	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: 250m mode possibility
Green: Succession of GLI standard products, Red: New standard products, and White: research products.

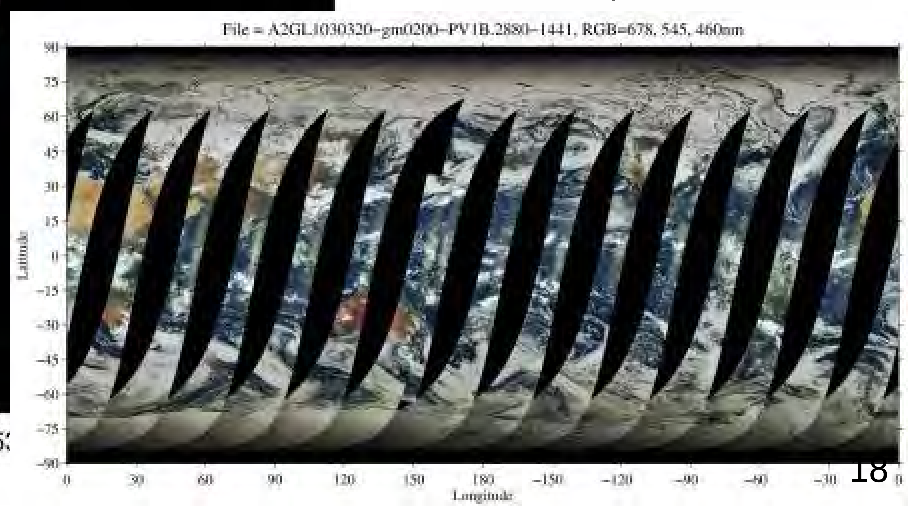
2.3 Swath width of SGLI VNR and TIR



Higher (250-m) resolution, multi-band and frequent observation

Optimized for detecting seasonal change of land cover and vegetation

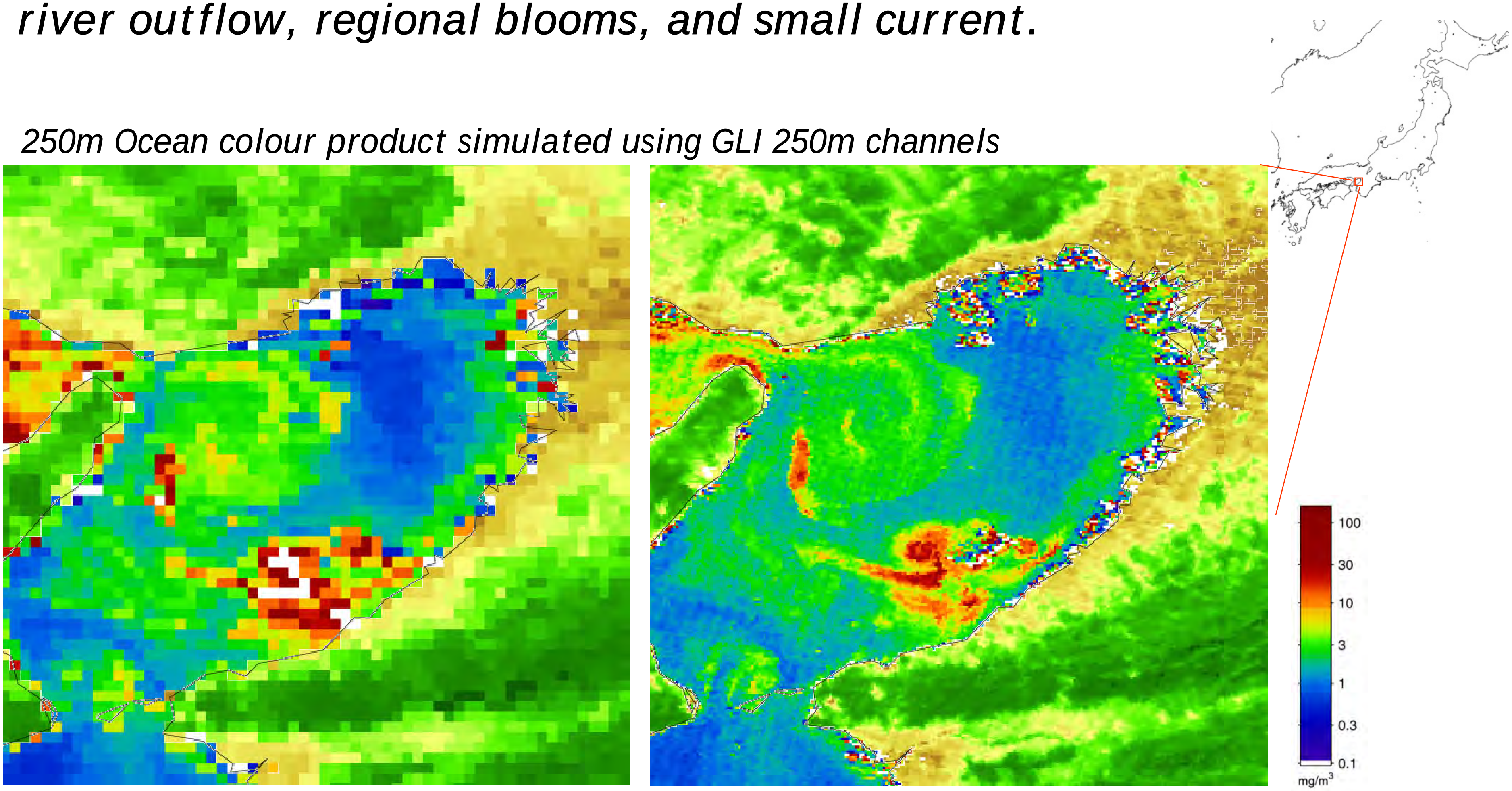
Daily coverage of SGLI VNR (Simulated by GLI data on 20 March 2003)



2.4 Special resolution of SGLI VNR (1)

250m resolution to detect finer structure in the coastal area such as river outflow, regional blooms, and small current.

250m Ocean colour product simulated using GLI 250m channels

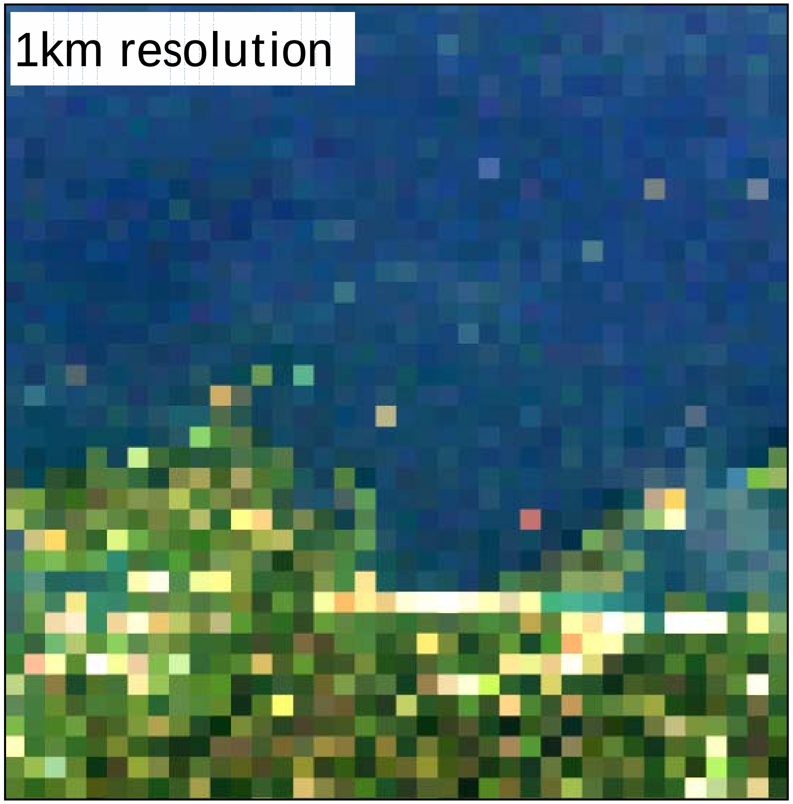


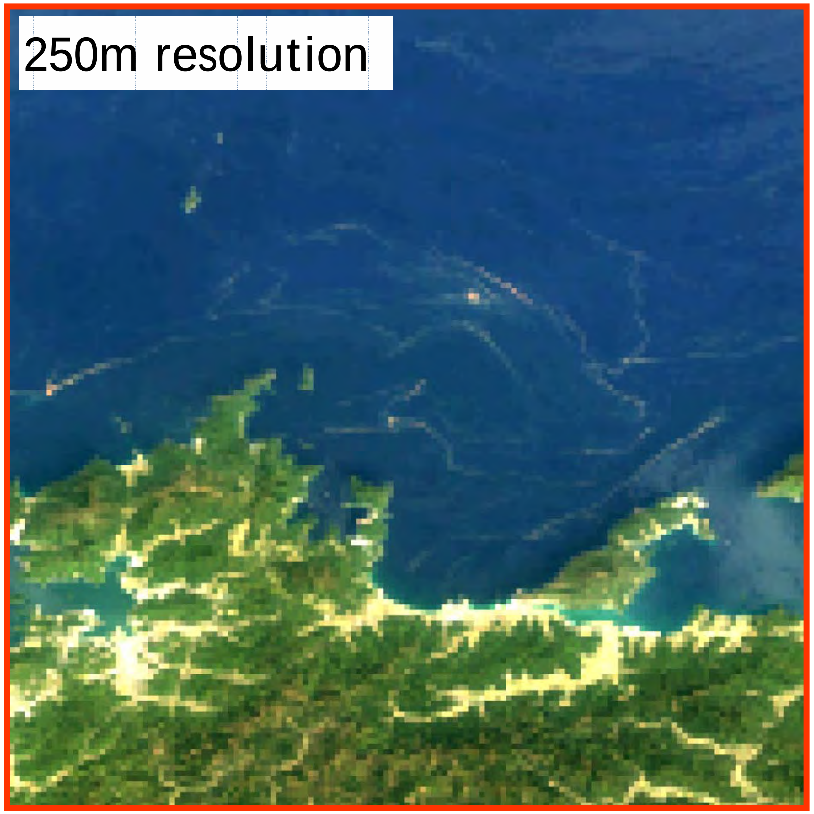
(a) GLI 1km Osaka Bay
(1 Oct. 2003, CHL by LCI)

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

2.4 Special resolution of SGLI VNR (2)

250m resolution and 1150-km swath for regular monitoring of the land and coastal environment such as redtide

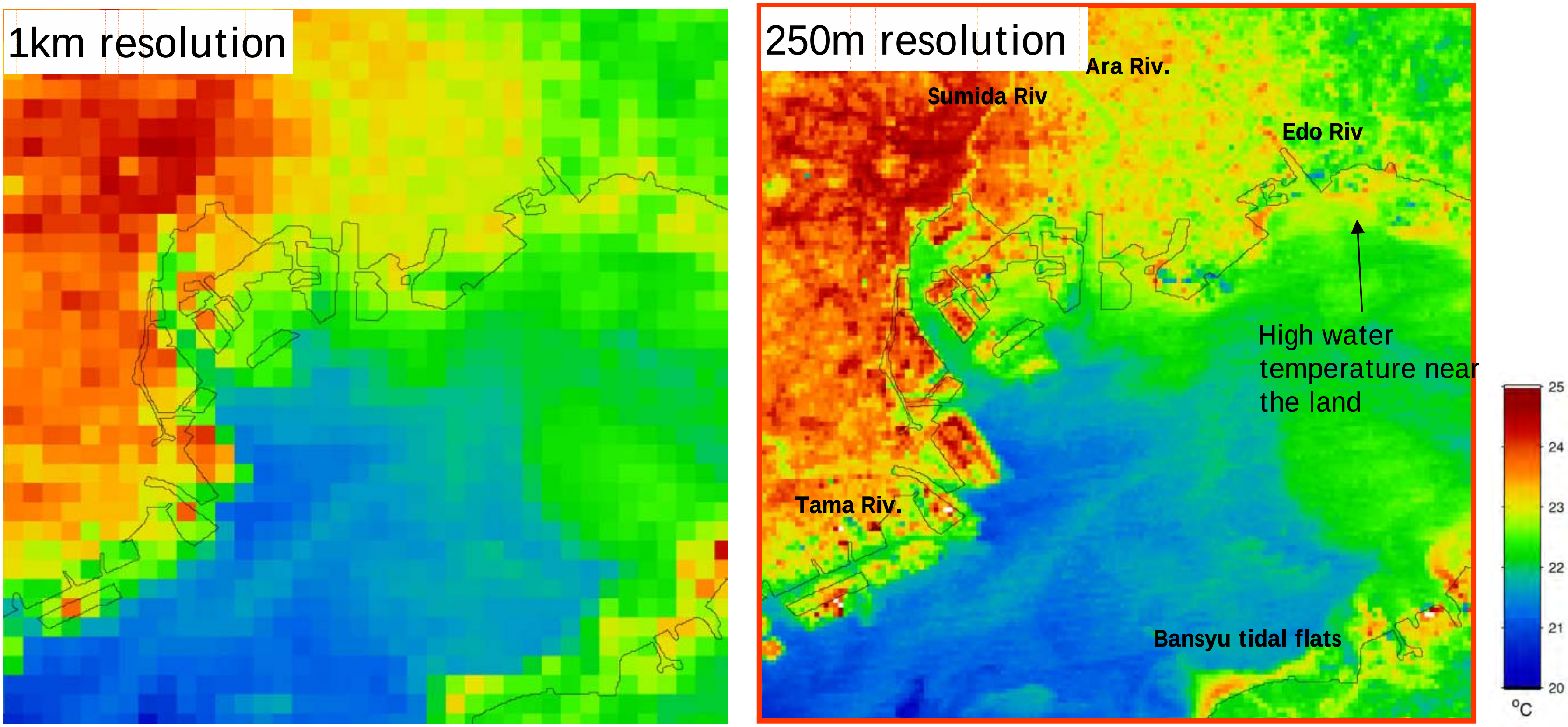




1-km and 250-m resolution RGB image simulated using AVNIR-2.
Light red filaments in the 250m image were the Noctilca redtide on 19 April 2009 in Wakasa-Bay.

2.5 Special resolution of SGLI thermal infrared

500/250-m thermal bands and 1400-km swath for regular monitoring of the land and coastal heat condition influenced by the land cover and river outflow



1-km and 250-m thermal images on 4 August 2003 simulated using ASTER 11um data

2.6 Summary of the *GCOM-C orbit and SGLI specification*

- The SGLI features are finer spatial resolution (250m (VNI) and 500m (T)) and polarization/along-track slant view channels (P), which will improve land, coastal, and aerosol observations.

GCOM-C SGLI characteristics (Current baseline)	
Orbit	Sun-synchronous (descending local time: 10:30) Altitude: 798km, Inclination: 98.6deg
Launch Date	Jan. 2014 (HII-A)
Mission Life	5 years (3 satellites; total 13 years)
Scan	Push-broom electric scan (VNR: VN & P) Wisk-broom mechanical scan (IRS: SW & T)
Scan width	1150km cross track (VNR: VN & P) 1400km cross track (IRS: SW & T)
Digitalization	12bit
Polarization	3 polarization angles for P
Along track direction	Nadir for VN, SW and T, +45 deg and -45 deg for P
On-board calibration	VN: Solar diffuser, Internal lamp (PD), Lunar by pitch maneuvers, and dark current by masked pixels and nighttime obs. SW: Solar diffuser, Internal lamp, Lunar, and dark current by deep space window T: Black body and dark current by deep space window All: Electric calibration

Multi-angle obs. for 674nm and 869nm

250m over the Land or coastal area, and 1km over offshore

SGLI channels						
CH	λ	Δλ	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	*673.5*	*20*	23	62	400	250
VN8	*673.5*	20	25	210	250	250
VN9	763	*12*	40	350	*1200*	1000
VN10	*868.5*	20	8	30	400	250
VN11	*868.5*	20	30	300	200	250
P1	*673.5*	20	25	250	250	1000
P2	*868.5*	20	30	300	250	1000
SW1	1050	20	57	248	500	1000
SW2	1380	20	8	103	150	1000
SW3	*1630*	200	3	50	57	250
SW4	2210	50	1.9	20	211	1000
T1	10.8	0.7	300	340	0.2	500
T2	12.0	0.7	300	340	0.2	500

250m-mode possibility ~15min /path (TBC)

2.7 GCOM-C products accuracy targets

- Product definition and accuracy targets of GCOM-C have been set by GCOM advisory committee basing GLI achievements and current and future requirements from application organizations
- The accuracy value includes errors from

  (1) Calibration of sensor observed radiance

  (2) Sub-pixel (IFOV) mixing due to the spatial variation of observation targets

  (3) Algorithm theory and input ancillary data

  (4) In-situ observation for the validation (comparison)

  We used practical accuracy values of current achievements, because these error sources vary with each observation condition.

- SGLI specification is set to achieve the accuracy targets of products within realistic sensor design and costs
- Target accuracy of SGLI ocean color products is set as same level of the GLI products* (by Mean Percent Difference), but try to do by 250m resolution

(* Murakami et al., 2006: Validation of ADEOS-GLI ocean color products using in-situ observations, J. Oceanography, 62, 373-393)

2.7 GCOM-C products accuracy targets (Standard-1)

Area	group	Product	Day/night	Grid size	Release threshold[*1]	Standard accuracy[*1]	Target accuracy[*1]
Common	radiance	TOA radiance (including system geometric correction)	TIR and land 2.2μm: both Other VNR,SWI: daytime (+special operation)	VNR,SWI Land/coast: 250m, offshore: 1km, polarimetory:1km TIR Land/coast: 500m, offshore: 1km	Radiometric 5% (absolute[*3])[*5] Geometric<1pixel	VNR,SWI: 5% (absolute[*3]), 1% (relative[*4]) TIR: 0.5K (@300K) Geometric<0.5pixel	VNR,SWI: 3% (absolute[*3]), 0.5% (relative[*4]) TIR: 0.5K (@300K) Geometric<0.3pixel
Land	Surface reflectance	Precise geometric correction	both	250m	<1pixel[*6]	<0.5pixel[*6]	<0.25pixel[*6]
		Atmospheric corrected reflectance (incl. cloud detection)	Daytime	250m	0.3 (<=443nm), 0.2 (>443nm) (scene) [*7]	0.1 (<=443nm), 0.05 (>443nm) (scene) [*7]	0.05 (<=443nm), 0.025 (>443nm) (scene)[*7]
	Vegetation and carbon cycle	Vegetation index		250m	Grass:25%(scene), forest:20%(scene)	Grass:20%(scene), forest:15%(scene)	Grass:10%(scene), forest:10%(scene)
		Above-ground biomass		1km	Grass:50%, forest: 100%	Grass:30%, forest:50%	Grass:10%, forest:20%
		Vegetation roughness index		1km	Grass&forest: 40% (scene)	Grass& forest:20% (scene)	Grass&forest:10% (scene)
		Shadow index		250m, 1km	Grass&forest: 30% (scene)	Grass& forest:20% (scene)	Grass&forest:10% (scene)
		fAPAR		250m	Grass:50%, forest: 50%	Grass:30%, forest:20%	Grass:20%, forest:10%
		Leaf area index		250m	Grass:50%, forest: 50%	Grass:30%, forest:30%	Grass:20%, forest:20%
	temperature	Surface temperature	Both	500m	<3.0K (scene)	<2.5K (scene)	<1.5K (scene)

Common note:

*1: The "release threshold" is minimum levels for the first data release at one year from launch. The "standard" and "research" accuracies correspond to full- and extra success criteria of the mission respectively. Accuracies are shown by RMSE basically.

Radiance data note:

*2: TOA radiance is derived from sensor output with the sensor characteristics, and other products are physical parameters estimated using algorithms including knowledge of physical, biological and optical processes

*3: absolute error is defined as offset + noise

*4: relative error is defined as relative errors among channels, FOV, and so on.

*5: Release threshold of radiance is defined as estimated errors from vicarious, onboard solar diffuser, and onboard blackbody calibration because of lack of long-term moon samples

Land data note:

*6: Defined as RMSD from GCP

*7: Defined with land reflectance~0.2, solar zenith<30deg, and flat surface. Release threshold is defined with AOT@500nm<0.25

2.7 GCOM-C products accuracy targets (Standard-2)

Area	Group	Product	Day/night	Grid size	Release threshold[*1]	Standard accuracy[*1]	Target accuracy[*1]
Atmosphere	Cloud	Cloud flag/Classification	Both	1km	10% (with whole-sky camera)	Incl. below cloud amount	Incl. below cloud amount
		Classified cloud fraction	Daytime	1km (scene), 0.1deg (global)	20% (on solar irradiance)[*8]	15%(on solar irradiance)[*8]	10%(on solar irradiance)[*8]
		Cloud top temp/height	Both		1K[*9]	3K/2km (top temp/height)[*10]	1.5K/1km (temp/height)[*10]
		Water cloud OT/effective radius	Daytime		10%/30% (CloudOT/radius) [*11]	100% (as cloud liquid water[*13])	50%[*12] / 20%[*13]
		Ice cloud optical thickness			30%[*11]	70%[*13]	20%[*13]
	aerosol	Aerosol over the ocean			0.1(Monthly τa_670,865)[*14]	0.1(scene τa_670,865)[*14]	0.05(scene τa_670,865)
		Land aerosol by near ultra violet			0.15(Monthly τa_380)[*14]	0.15(scene τa_380)[*14]	0.1(scene τa_380)
		Aerosol by Polarization			0.15(Monthlyτa_670,865)[*14]	0.15(scene τa_670,865)[*14]	0.1(scene τa_670,865)
Ocean	Ocean color	Normalized water leaving radiance (incl. cloud detection)	Daytime	250m (coast) 1km (offshore) 4~9km (global)	60% (443~565nm)	50% (<600nm) $0.5W/m^2/str/um$ (>600nm)	30% (<600nm) $0.25W/m^2/str/um$ (>600nm)
		Atmospheric correction param			80% (AOT@865nm)	50% (AOT@865nm)	30% (AOT@865nm)
		Photosynthetically available radiatioin			20% (10km/month)	15% (10km/month)	10% (10km/month)
	In-water	Chlorophyll-a concentration			−60~+150% (offshore)	−60~+150%	−35~+50% (offshore), −50~+100% (coast)
		Suspended solid concentration			−60~+150% (offshore)	−60~+150%	−50~+100%
		Colored dissolved organic matter			−60~+150% (offshore)	−60~+150%	−50~+100%
	temperature	Sea surface temperature	Both	500m (coast) 1km (offshore) 4~9km (global)	0.8K (daytime)	0.8K (day&night time)	0.6K (day&night time)
Cryosphere	Area/distribution	Snow and Ice covered area (incl. cloud detection)	Daytime	250m (scene) 1km (global)	10% (vicarious val with other sat. data)	7%	5%
		OKhotsk sea-ice distribution		250m	10% (vicarious val with other sat. data)	5%	3%
	Surface properties	Snow and ice surface Temperature		500m (scene) 1km (global)	5K (vicarious val with other sat. data and climatology)	2K	1K
		Snow grain size of shallow layer		250m (scene) 1km (global)	100%(vicarious val with climatology between temp-size)	50%	30%

Atmosphere note:

*8: Comparison with in-situ observation on monthly 0.1-degree

*9: Vicarious val. on sea surface and comparison with objective analysis data

*10: Inter comparison with airplane remote sensing on water clouds of middle optical thickness

*11: Release threshold is defined by vicarious val with other satellite data (e.g., global monthly statistics in the mid-low latitudes)

*12: Comparison with cloud liquid water by in-situ microwave radiometer

*13: Comparison with optical thickness by sky-radiometer (the difference can be large due to time-space inconsistence and large error of the ground measurements)

*14: Estimated by experience of aerosol products by GLI and POLDER

2.7 GCOM-C products accuracy targets (Research product)

Area	Group	Product	Day/night	Grid size	Release threshold[*1]
Land	Application	Land net primary production	Daytime	1km	30% (yearly)
		Water stress trend	N/A	500m	10% [*15] (error judgment rate)
		Fire detection index	Both	500m	20% [*16] (error judgment rate)
		Land cover type	Daytime	250m	30% (error judgment rate)
		Land surface albedo		1km	10%
Atmosphere	Cloud	Water cloud geometrical thickness	Daytime	1km (scene), 0.1deg (global)	300m
	Radiation budget	Long-wave radiation flux			Downward 10W/m2, upward 15W/m2 (monthly)
		Short-wave radiation flux			Downward 13W/m2, upward 10W/m2
Ocean	Ocean color	Euphotic zone depth	Daytime	250m (coast), 1km (offshore), 4~9km (global)	30%
	In-water	Inherent optical properties			a(440): RMSE<0.25, bbp(550): RMSE<0.25
	Application	Ocean net primary productivity		500m (coast), 1km (offshore), 4~9km (global)	70% (monthly)
		Phytoplankton functional type		250m (coast), 1km (offshore), 4~9km (global)	error judgment rate of large/ small phytoplankton dominance<20%; or error judgment rate of the dominant phytoplankton functional group <40%
		Redtide			error judgment rate <20%
		multi sensor merged ocean color		250m (coast), 1km (offshore)	–35~+50% (offshore), –50~+100% (coast)
		multi sensor merged SST	Both	500m (coast), 1km (offshore)	0.8K (day&night time)
Cryosphere	Area/ distribution	Snow and ice classification	N/A	1km	10%
		Snow covered area in forest and mountain	Daytime	250m	30%
	Surface propaties	Snow grain size of subsurface layer		1km	50%
		Snow grain size of top layer		250m(scene), 1km (global)	50%
		Snow and ice albedo		1km	7%
		Snow impurity		250m(scene), 1km (global)	50%
		Ice sheet surface roughness	N/A	1km	0.05 (height/width)
	Boundary	Ice sheet boundary monitoring	N/A	250m	<500m

Research product note:
*15: Evaluate in semiarid regions (steppe climate etc.)
*16: Fires >1000K occupying >1/1000 on 1km pixel at night (using 2.2um of 1 km and thermal infrared channels)