APPENDIX 1

OVERVIEW OF THE GLOBAL CHANGE OBSERVATION MISSION (GCOM)

1. Introduction

Comprehensive observation, understanding, assessment, and prediction of global climate change are common and important issues for all mankind. This is also identified as one of the important socio-economic benefits by the 10-year implementation plan for Earth Observation that was adopted by the Third Earth Observation Summit to achieve the Global Earth Observation System of Systems (GEOSS). International efforts to comprehensively monitor the Earth by integrating various satellites, in-situ measurements, and models are gaining importance. As a contribution to this activity, the Japan Aerospace Exploration Agency (JAXA) plans to develop the Global Change Observation Mission (GCOM). GCOM will take over the mission of the Advanced Earth Observing Satellite-II (ADEOS-II) and develop into long-term monitoring of the Earth.

As mentioned in the fourth assessment report of the Intergovernmental Panel on Climate Change (IPCC), warming of the climate system is unequivocal as is now evident from observations of increases in global average air and ocean temperatures and widespread melting of snow and ice. However, climate change signals are generally small and modulated by natural variability, and are not necessarily uniform over the Earth. Therefore, the observing system of the climate variability should be stable, and should cover a long term over the entire Earth.

To satisfy these needs, GCOM consists of two medium-size, polar-orbiting satellite series, GCOM-W (Water) and GCOM-C (Climate). Two instruments were selected to cover a wide range of geophysical parameters: the Advanced Microwave Scanning Radiometer 2 (AMSR2) on GCOM-W and the Second-generation Global Imager (SGLI) on GCOM-C. The AMSR2 instrument performs observations related to the global water and energy cycle, while the SGLI conducts surface and atmospheric measurements related to the carbon cycle and radiation budget. This chapter presents an overview of the mission objectives, observing systems, and data products of GCOM.

2. Mission Objectives

The major objectives of GCOM can be summarized as follows.

- Establish and demonstrate a global, long-term Earth-observing system for understanding climate variability and the water-energy cycle.
- Enhance the capability of climate prediction and provide information to policy makers through process studies and model improvements in concert with climate model research institutions.
- Construct a comprehensive data system integrating GCOM products, other satellite data, and in-situ measurements.
- Contribute to operational users including weather forecasting, fishery, and maritime agencies by providing near-real-time data.
- Investigate and develop advanced products valuable for understanding of climate change and water cycle studies.

Detailed explanations of the objectives are as follows.

(1) Understanding global environment changes

A) Establish and demonstrate a global, long-term Earth-observing system that is able to observe valuable geophysical parameters for understanding global climate variability and water cycle mechanisms.

B) Contribute to improving climate prediction models by providing accurate values of model parameters.

C) Clarify sinks and sources of greenhouse gases.
D) Contribute to validating and improving climate prediction models by forming a collaborative framework with climate model institutions and providing long-term geophysical datasets to them.
E) Detect trends of global environment changes (e.g., global warming, vegetation changes, desertification, variation of atmospheric constituents, wide area air pollution, and depletion of ozone layers) from long-term variability of geophysical parameters by extracting short-term (three- to six-year) natural variability.
F) Advance process studies of Earth environmental changes using observation data.
G) Estimate radiative forcing, energy and carbon fluxes, and albedo by combining satellite geophysical parameters, ground in-situ measurements, and models.
H) Advance the understanding of the Earth's system through the activities above.
I) Contribute to an international environmental strategy utilizing the results above.

(2) Direct contribution to improving people's lives
A) Improvement of weather forecast accuracy (particularly typhoon track prediction, localized severe rain, etc.).
B) Improvement of forecast accuracy for unusual weather and climate.
C) Improvement of water-route and maritime information.
D) Provision of fishery information.
E) Efficient coastal monitoring.
F) Improved yield prediction of agricultural products.
G) Monitoring and forecasting air pollution including yellow dust.
H) Observation of volcanic smoke and prediction of the extent of the impact.
I) Detection of forest fires.

3. Observing Systems

3.1. Overall concept

As mentioned in the previous section, the entire GCOM will consist of two satellite series spanning three generations. However, a budget will be approved for each satellite. Currently, only the GCOM-W and GCOM-C satellites have been launched as the first satellite in the GCOM series, and successor of GCOM-W, AMSR3, will be installed on the Global Observing SATellite for Greenhouse gases and Water cycle (GOSAT-GW), a joint mission with greenhouse gases observation mission, to be launched in JFY 2024 (see APPENDIX 7).

Both GCOM-W and GCOM-C satellites are medium-size platforms that are smaller than the ADEOS-II satellite. This is to reduce the risk associated with large platforms having valuable and multiple observing instruments. Also, since the ADEOS-II problem was related to the solar paddle, a dual solar-paddle design was adopted for both satellites. To assure data continuity and consistent calibration, original idea was that follow-on satellites will be launched so as to overlap the preceding satellite by one year. The concept is summarized in Fig. 1.

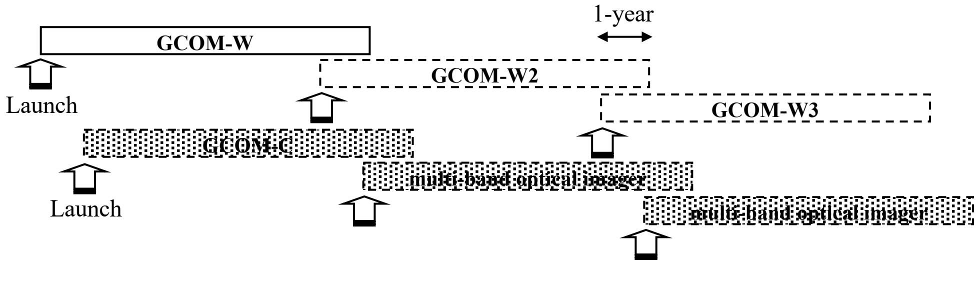

Figure 1: **GCOM Concept**

3.2. GCOM-W and AMSR2 instrument

Figure 2 presents an overview of the GCOM-W satellite; its major characteristics are listed in Table 1. GCOM-W carries AMSR2 as the sole onboard mission instrument. The satellite will orbit at an altitude of about 700km and will have an ascending node local time of 13:30, to maintain consistency with Aqua/AMSR-E observations.

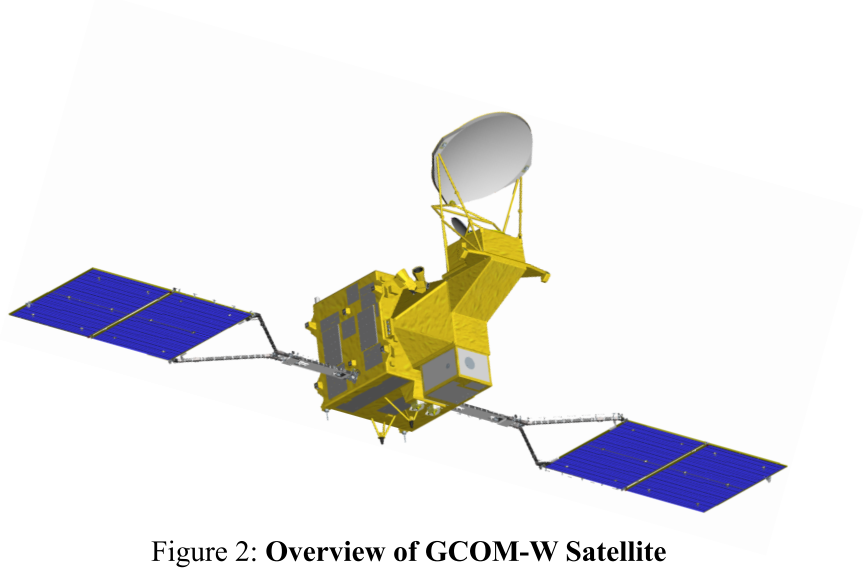

Figure 2: **Overview of GCOM-W Satellite**

Table 1: **Major Characteristics of GCOM-W Satellite**

Instrument	Advanced Microwave Scanning Radiometer 2 (AMSR2)
Orbit	Sun-synchronous orbit Altitude: 700km (over the equator)
Size	5.1m (X) * 17.5m (Y) * 3.4m (Z) (on-orbit)
Mass	1991kg
Power	More than 3880W (EOL)
Launch	May 18, 2012 by H-IIA Rocket
Design Life	5 years
Status	Post-Mission Phase since Nov. 2018

Figure 1 presents an overview of the AMSR2 instrument in two different conditions. Also, basic characteristics including center frequency, bandwidth, polarization, instantaneous field of view (FOV), and sampling interval are indicated in Table 2. The basic concept is almost identical to that of AMSR-E: a conical scanning system with a large offset parabolic antenna, feed horn cluster to realize multi-frequency observation, external calibration with two temperature standards, and total-power radiometer systems. The 2.0m diameter antenna, which is larger than that of AMSR-E, provides better spatial resolution at the same orbit altitude of around 700km. The antenna will be developed based on the experience gained from the 2.0m diameter antenna for ADEOS-II AMSR except the deployment mechanism. For the C-band receiver, we adopted additional 7.3GHz channels for possible mitigation of radio-frequency interference. An incidence angle of 55 degrees (over the equator) was selected to maintain consistency with AMSR-E. The swath width of 1450km and the selected satellite orbit will provide almost complete coverage of the entire Earth's surface within two days independently for ascending and descending observations.

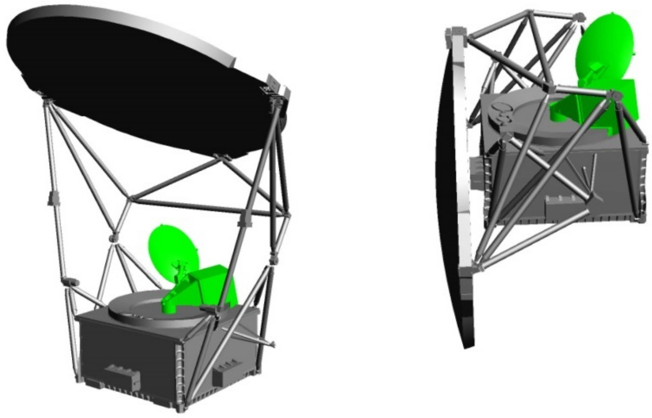

Figure 3: **Sensor Unit of AMSR2 Instrument in Deployed (left) and Stowed (right) Conditions.**

Table 2: **Major Characteristics of AMSR2 Instrument**

Parameter	**Performance and characteristics**					
Center Frequency (GHz)	6.925/7.3	10.65	18.7	23.8	36.5	89.0
Bandwidth (MHz)	350	100	200	400	1000	3000
Polarization	Vertical and Horizontal polarization					
NEΔT (K) [1]	< 0.34/0.43	< 0.70	< 0.70	< 0.60	< 0.70	< 1.20/1.40 [2]
Dynamic range (K)	2.7 to 340					
Nominal incidence angle (deg.)	55.0					55.0/54.5 [2]
Beam width (deg.)	1.8	1.2	0.65	0.75	0.35	0.15
IFOV (km) Cross-track x along-track	35x62	24x42	14x22	15x26	7x12	3x5
Approximate sampling interval (km)	10					5
Swath width (km)	> 1450					
Digital quantization (bits)	12					
Scan rate (rpm)	40					

3.3. GCOM-C and SGLI instrument

Figure 4 gives an overview of the GCOM-C satellite; its major characteristics are listed in Table 3. GCOM-C will carry SGLI as the sole mission onboard instrument. The satellite will orbit at an altitude of about 800km; the descending node local time will be 10:30, to maintain a wide observation swath and reduce cloud interference over land.

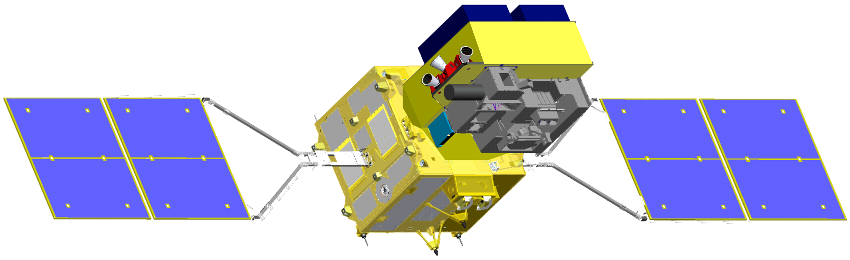

Figure 4: **Overview of GCOM-C Satellite**

Table 3: **Major Characteristics of GCOM-C Satellite**

Instrument	Second-generation Global Imager (SGLI)
Orbit	Sun-synchronous orbit Altitude: 798km (over the equator)
Size	4.6m (X) * 16.3m (Y) * 2.8m (Z) (on orbit)
Mass	2093kg
Power	More than 4000W (EOL)
Launch	Dec. 23 2017 by H-IIA Rocket
Design Life	5 years
Status	Phase-D

The SGLI instrument has two major new features: 250m spatial resolution for most of the visible channels and polarization/multidirectional observation capabilities. The 250m resolution will provide enhanced observation capability over land and coastal areas where the influences of human activity are most obvious. The polarization and multidirectional observations will enable us to retrieve aerosol information over land. Precise observation of global aerosol distribution is a key for improving climate prediction models.

SGLI consists of two major components: the Infrared Scanner (IRS) and the Visible and Near-infrared Radiometer (VNR). An overview of the SGLI instrument is shown in Fig. 5 for the entire radiometer layout, IRS, and VNR components. Also, requirements for sensor performance are listed in Tables 4 and 5. VNR can be further divided into two components: VNR-Non Polarized (VNR-NP) and VNR-Polarized (VNR-P). VNR-NP and VNR-P are the 11-channel multi-band radiometer and the polarimeter with three polarization angles (0, 60, and 120 degrees). VNR-P has a tilting function to meet the scatter angle requirement from aerosol observation. The IRS is an infrared radiometer covering wavelengths from 1μm to 12μm. It consists of short infrared (SWI; 1.05 to 2.21μm) and thermal infrared (TIR 10.8 and 12.0μm) sensors. It employs a scanning mirror system with a 45-degree tilted flat mirror rotating continuously to realize an 80-degree observation swath and calibration measurement in every scan.

Through intensive discussions and optimizing studies, the number of SGLI channels was decreased from the 36 channels of GLI aboard ADEOS-II to 19 channels, while the number of SGLI standard products will increase compared to those of GLI.

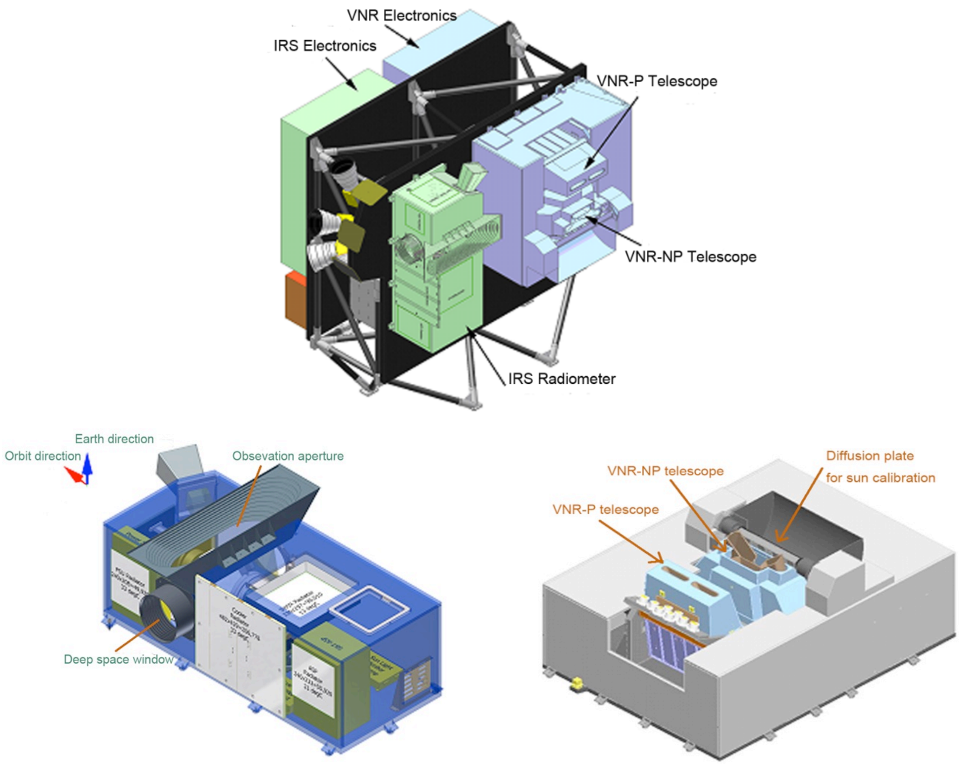

Figure 5: **Overview of SGLI Radiometer Layout (upper), IRS Instrument (lower-left), and VNR Radiometers (lower-right).**

Table 4: **SGLI Major Performance Requirements**

Item	Requirement
Spectral Bands	VNR-NP : 11CH 380-865nm VNR-P : 2CH 673.5, 868.5nm / 0, 60, 120deg Polarization IRS SWI : 4CH 1.05-2.21μm IRS TIR : 2CH 10.8, 12.0μm
Scan Angle	VNR-NP : 70deg (Push broom scanning) VNR-P : 55deg (Push broom scanning) IRS SWI/TIR : 80deg (45deg rotation mirror scanning)
Swath width	1150km for VNR-NP/P 1400km for IRS SWI/TIR
Instantaneous field of view (IFOV) at nadir	VNR-NP : 250m VNR-P : 1000m IRS SWI : 250m(SW3CH), 1000m(SW1,2,4CH) IRS TIR : 250m
Observing direction	±45 degrees in along track direction for VNR-P Nadir for VNR-NP, IRS SWI, and IRS TIR
Quantization	12bit
Absolute Calibration Accuracy	VNR : ≤3% IRS : ≤5% TIR : ≤0.5K
Lifetime	5 Years

Table 5: **SGLI Observation Requirement Details**

	CH	λ	Δλ	IFOV	SNR	L (for SNR)
		nm: VNR, IRS SWI μm: IRS TIR		m	SNR: VNR, IRS SWI NEΔT(K): IRS TIR	$W/m^2/sr/\mu m$
VNR-NP	VN1	380	10	250	250	60
	VN2	412	10	250	400	75
	VN3	443	10	250	300	64
	VN4	490	10	250	400	53
	VN5	530	20	250	250	41
	VN6	565	20	250	400	33
	VN7	673.5	20	250	400	23
	VN8	673.5	20	250	250	25
	VN9	763	12	250	1200 (@1km IFOV)	40
	VN10	868.5	20	250	400	8
	VN11	868.5	20	250	200	30
VNR-P	P1	673.5	20	1000	250	25
	P2	868.5	20	1000	250	30
IRS SWI	SW1	1050	20	1000	500	57
	SW2	1380	20	1000	150	8
	SW3	1630	200	250	57	3
	SW4	2210	50	1000	211	1.9
IRS TIR	T1	10.8	0.74	1000/500/250	0.2 (@500m IFOV)	300 (K)
	T2	12.0	0.74	1000/500/250	0.2 (@500m IFOV)	300 (K)

4. Products

Geophysical products made available by GCOM-W and GCOM-C are listed in Tables 6, 7, and 8. There are two categories of data products: standard product and research product. A "standard" product is defined as a product with proven accuracy that is to be operationally processed and distributed. In contrast, a "research" product is a prototype for a standard product and is processed on a research basis. Both tables indicate standard products with shading.

Table 6: **Standard Geophysical Products of GCOM-W**

Product	Areas	Resolution (km)	Accuracy [1]			Range	
			Release threshold	Standard	Goal		
Integrated water vapor	Global, over ocean	15	±3.5 kg/m^2	±3.5 kg/m^2	±2.0 kg/m^2	0-70 kg/m^2	Vertically integrated (columnar) water vapor amount. Except sea ice and precipitating areas.
Integrated cloud liquid water	Global, over ocean	15	±0.10 kg/m^2	±0.05 kg/m^2	±0.02 kg/m^2	0-1.0 kg/m^2	Vertically integrated (columnar) cloud liquid water. Except sea ice and precipitating areas.
Precipitation	Global, except cold latitudes	15	Ocean ±50 % Land ±120 %	Ocean ±50% Land ±120 %	Ocean ±20% Land ±80 %	0-20 mm/h	Surface precipitation rate. Accuracy is defined as relative error (ratio of root-mean-square error to average precipitation rate) in 50km grid average.
Sea surface temperature	Global, over ocean	50	±0.8 °C	±0.5 °C	±0.2 °C	-2-35 °C	Except sea ice and precipitating areas. Goal accuracy is defined as monthly mean bias error in 10 degrees latitudes.
Sea surface wind speed	Global, over ocean	15	±1.5 m/s	±1.0 m/s	±1.0 m/s	0-30 m/s	Except sea ice and precipitating areas.
Sea ice concentration	Polar region, over ocean	15	±10 %	±10 %	±5 %	0-100 %	Accuracy is expressed in absolute value of sea ice concentration (%).
Snow depth	Land	30	±20 cm	±20 cm	±10 cm	0-100 cm	Except ice sheets and dense forest areas. Accuracy is expressed in snow depth and defined as mean absolute error of instantaneous observations.
Soil moisture	Land	50	±10 %	±10 %	±5 %	0-40 %	Volumetric water content over global land areas including arid and cold regions, except areas covered by vegetation with 2kg/m^2 water equivalent. Accuracy is defined as mean absolute error of instantaneous observations.

1: Accuracy is defined as root-mean-square error of instantaneous values unless otherwise stated. Assumed validation methodologies are not explained here.

Table 7: **Research Products of GCOM-W**

Products	Area	Resolution (km)	Target accuracy	Range
All-weather sea surface wind speed	Ocean	60	± 7 m/s	0 - 70 m/s
High-resolution (10-GHz) sea surface temperature	Ocean	30	± 0.8 °C	-2 - 35 °C
Multi-band SST	Ocean	30-50	± 0.8 °C	-2 - 35 °C
Soil moisture and vegetation water content based on the land data assimilation	Global over land (snow free area)	25	soil moisture: ± 8% vegetation water: ± 1 kg/m^2	soil moisture: 0 - 100 % vegetation water: 0 - 2 kg/m^2
Land surface temperature	Land	15	forest area: ± 3 °C nondense vegetation: ± 4 °C	0 - 50 °C
Vegetation water content	Land	10	± 1 kg/m^2	0 - 4 kg/m^2
High resolution sea ice concentration	Ocean in high latitude	5	± 15 %	0 - 100 %
Thin ice detection	Ocean in high latitudes	15	± 80 %	N/A
Sea ice motion vector	Ocean in high latitude	50	2 components: 6 cm/s	0 - 40 cm/s
Total precipitable water over land	Land	15	± 6.5 kg/m^2	0 – 70 kg/m^2
Thin Ice Thickness (Thermal Ice Thickness)	Polar region, over ocean	12.5	Thin solid ice: ± 10 cm Active frazil ice: ± 3 cm	0 – 20 cm
Sea Ice Thickness (>= 20 cm)	Polar region, over ocean	15	± 20 cm	0.2 – 1.2 m

Table 8: **Geophysical Products of GCOM-C (1/3)**

Area	*Group*	*Product*	*Category*	*Developer*	*Day/night*	*Production unit*	*Grid size*	*Release threshold**2	*Standard accuracy**2	*Target accuracy**2
common	Radiance	TOA radiance (including system geometric correction)	Standard	JAXA	TIR and land SWI: both, Other VNR, SWI: daytime (+special operation)	Scene	VNR,SWI Land/coast: 250m, offshore: 1km, polarimetory:1km TIR Land/coast: 500m, offshore: 1km	Radiometric 5% (absolute)*3 Geometric<1 pixel	VNR,SWI: 5% (absolute), 1% (relative) *3 TIR: 0.5K (@300K) Geometric<0.5 pixel	VNR,SWI: 3% (absolute), 0.5% (relative) *3 TIR: 0.5K (@300K) Geometric<0.3 pixel
Land	Surface reflectance	Precise geometric correction	Standard	JAXA	Both	Tile, Global (mosaic 1, 8 days, month)	250m	<1pixel	<0.5pixel	<0.25pixel
		Atmospheric corrected reflectance (incl. cloud detection)	Standard	JAXA	Daytime	Tile , Global (1, 8 days, month)	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	Standard	JAXA	Daytime	Tile , Global (1, 8 days, month)	250m	Grass: 25%, forest: 20% (scene)	Grass: 20%, forest: 15% (scene)	Grass: 10%, forest: 10% (scene)
		fAPAR	Standard	PI	Daytime	Tile , Global (1, 8 days, month)	250m	Grass: 50%, forest: 50%	Grass: 30%, forest:20%	Grass: 20%, forest: 10%
		Leaf area index	Standard					Grass: 50%, forest: 50%	Grass: 30%, forest:30%	Grass: 20%, forest: 20%
		Above-ground biomass	Standard	PI	Daytime	Tile , Global (1, 8 days, month)	1km	Grass: 50%, forest: 100%	Grass: 30%, forest: 50%	Grass: 10%, forest: 20%
		Vegetation roughness index	Standard				1km	Grass and forest: 40% (scene)	Grass and forest: 20% (scene)	Grass and forest: 10% (scene)
		Shadow index	Standard	PI	Daytime	Tile , Global (1, 8 days, month)	250m, 1km	Grass and forest: 30% (scene)	Grass and forest: 20% (scene)	Grass and forest: 10% (scene)
	Temperature	Surface temperature	Standard	PI	Both	Tile , Global (1, 8 days, month)	500m	<3.0K (scene)	<2.5K (scene)	<1.5K (scene)
	Application	Land net primary production	Research	PI	Daytime	Global (month, year)	1km	N/A	N/A	30% (yearly)
		Evapotranspiration	Research	PI/ JAXA	N/A	Tile , Global (8 days, half-month, month)	500m	N/A	N/A	10% *13 (error judgment rate)
		Fire detection index	Research	JAXA	Both*12	Scene or Tile	500m	N/A	N/A	20% *14 (error judgment rate)
		Land cover type	Research	PI/JAXA	Daytime	Global (month, season)	250m	N/A	N/A	30% (error judgment rate)
		Land surface albedo	Research	JAXA/PI	N/A	Tile , Global (1, 8 days, month)	1km	N/A	N/A	10%
		Photosynthetically Active Radiation*16	Research	JAXA	Daytime	Tile, Global (1, 8 days, month)	250m (Japan), 5km (global)	N/A	N/A	10% (10 km/month)
		Vegetation phenology*16	Research	PI	Daytime	Tile (1 day)	250m	N/A	N/A	8 日
Atmosphere	Cloud	Cloud flag/Classification	Standard	PI	Both	Tile , Global（1, 8 day, month）	1km	10% (with whole-sky camera)	Incl. below cloud amount	Incl. below cloud amount
		Classified cloud fraction	Standard		Daytime	Global（1, 8 day, month）	1km (Tile), 0.1deg (global)	20% (on solar irradiance)*9	15% (on solar irradiance)*9	10% (on solar irradiance)*9
		Cloud top temp/height	Standard		Both	Tile , Global（1, 8 day, month）		1K*4	3K/2km (top temp/height)*5	1.5K/1km (temp/height)*5
		Water cloud OT/effective radius	Standard		Daytime	Tile , Global（1, 8 day, month）		10%/30% (Cloud OT/radius)*6	100% as CLW*7	50%*7 / 20%*8
		Ice cloud optical thickness	Standard		Daytime	Tile , Global（1, 8 day, month）		30%*6	70%*8	20%*8

		Water cloud geometrical thickness	Research	PI	Daytime	Tile , Global（1, 8 day, month）		N/A	N/A	300m
	Aerosol	Aerosol properties (using both NP and PL)	Standard	JAXA	Daytime	Tile , Global（1, 8 day, month）		Ocean: 0.1 (Monthly τa _670,865)*10 Land: 0.15 (Monthly τa_380)*10	Ocean: 0.1(scene τa_670,865)*10 Land: 0.15 (scene τa_380)*10	Ocean: 0.05 (scene τa_670,865) Land: 0.1(scene τa_380)
	Radiation budget	Long-wave radiation flux	Research	PI	Daytime	Tile , Global（1, 8 day, month）		N/A	N/A	Downward 10W/m2, upward 15W/m2 (monthly)
		Short-wave radiation flux	Research	JAXA/PI	Daytime	Tile , Global（1, 8 day, month）		N/A	N/A	Downward 13W/m2, upward 10W/m2

Table 8: **Geophysical Products of GCOM-C (2/3)**

Area	*Group*	*Product*	*Category*	*Developer*	*Day/night*	*Production unit*	*Grid size*	*Release threshold**2	*Standard accuracy**2	*Target accuracy**2
Ocean	Ocean color	Normalized water-leaving radiance (incl. cloud detection)	Standard	PI	Daytime	Scene, Global (1, 8 days, month)	Coast: 250m Offshore: 1km Global: 4-9km	60% (443~565nm)	50% (<600nm) 0.5W/m^2/str/um (>600nm)	30% (<600nm) 0.25W/m^2/str/um (>600nm)
		Atmospheric correction parameter	Standard					80% (AOT@865nm)	50% (AOT@865nm)	30% (AOT@865nm)
		Photosynthetically available radiation	Standard	JAXA/ PI	Daytime	Scene, Global (1, 8 days, month)		20% (10km/month)	15% (10km/month)	10% (10km/month)
		Euphotic zone depth	Research	PI	Daytime	Scene, Global (1, 8 days, month)		N/A	N/A	30%
	In-water	Chlorophyll-a concentration	Standard	JAXA	Daytime	Scene, Global (1, 8 days, month)		−60 to +150% (offshore)	−60 to +150%	−35 to +50% (offshore), −50 to +100% (coast)
		Total suspended matter concentration	Standard	PI				−60 to +150% (offshore)	−60 to +150%	−50 to +100%
		Colored dissolved organic matter	Standard	PI				−60 to +150% (offshore)	−60 to +150%	−50 to +100%
		Inherent optical properties	Research	PI	Daytime	Scene, Global (1, 8 days, month)		N/A	N/A	a (440): RMSE<0.25, bbp (550): RMSE<0.25
	Temperature	Sea-surface temperature	Standard	JAXA	Both	Scene, Global (1, 8 days, month)	Coast: 500m Others: Same as above	0.8K (daytime)	0.8K (day & night time)	0.6K (day and night time)
	Application	Ocean net primary productivity	Research	PI	Daytime	Scene, Global (1, 8 days, month)	Coast: 500m Others: Same as above	N/A	N/A	70% (monthly)
		Phytoplankton functional type	Research	PI	Daytime	Scene, Global (1, 8 days, month)	Coast: 250m Others: Same as above	N/A	N/A	error judgment rate of large/ small phytoplankton dominance<20%; or error judgment rate of the dominant phytoplankton functional group <40%
		Red tide	Research	PI	Daytime	Scene, Global (1, 8 days, month)		N/A	N/A	error judgment rate <20%
		multi sensor merged ocean color	Research	JAXA/PI	Daytime	Area, Global (1, 8 days, month)	Coast: 250m Offshore: 1km	N/A	N/A	−35 to +50% (offshore), −50 to +100% (coast)
		multi sensor merged SST	Research	JAXA	Both			N/A	N/A	0.8K (day & night time)
		Floating algae index*16	Research	JAXA	Daytime	Area (1 day)	250m (Japan)	N/A	N/A	TBD
Cryosphere	Area/ distribution	Snow and Ice covered area (incl. cloud detection)	Standard	PI	Daytime	Tile, Global (1, 8 days, month)	250m (Tile), 1km (global)	10% (vicarious val with other sat. data)	7%	5%
		Okhotsk sea-ice distribution	Standard		Daytime	Area (1day)	250m	10%	5%	3%
		Snow and ice classification	Research	PI	Daytime	Global (8 days, month)	1km	N/A	N/A	10%
		Snow covered area in forests and mountains	Research	PI	Daytime	Area (1, 8 days)	250m	N/A	N/A	30%
	Surface properties	Snow and ice surface Temperature	Standard	PI	Daytime	Tile, Global (1, 8 days, month)	500m (Tile), 1km (global)	5K (vicarious val with other sat. data and climatology)	2K	1K
		Snow grain size of shallow layer	Standard		Daytime	Tile, Global (1, 8 days, month)	250m (Tile), 1km (global)	100% (vicarious val. with climatology between temp-size)	50%	30%
		Snow grain size of subsurface layer	Research		Daytime	Tile, Global (1, 8 days, month)	1km	N/A	N/A	50%
		Snow grain size of top layer	Research		Daytime	Tile, Global (1, 8 days, month)	250m (Tile), 1km (global)	N/A	N/A	50%
		Snow and ice albedo	Research	PI	Daytime	Global (1, 8 days, month)	1km	N/A	N/A	7%

Table 8: **Geophysical Products of GCOM-C (3/3)**

Area	*Group*	*Product*	*Category*	*Developer*	*Day/night*	*Production unit*	*Grid size*	*Release threshold**2	*Standard accuracy**2	*Target accuracy**2
Cryosphere	Surface properties	Snow impurity	Research	PI	Daytime	Tile, Global (1, 8 days, month)	250m (Tile), 1km (global)	N/A	N/A	50%
		Ice sheet surface roughness	Research	PI	Daytime	Area (Season)	1km	N/A	N/A	0.05 *15
	Boundary	Ice sheet boundary monitoring	Research	JAXA	Daytime	Area (Season)	250m	N/A	N/A	<500m

Common notes:
*1. Heritage levels from ADEOS-II/GLI study are shown by A-C; A: high heritage, B: Remaining issues, C: new or many issues remaining to be resolved
*2. 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. Accuracies are basically shown by RMSE.
*16 Candidate for research products.

Radiance data notes:
*3. Absolute error is defined as offset + noise; relative error is defined as relative errors among channels, FOV, and so on. 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

Atmosphere notes:
*4. Vicarious val. on sea-surface temperature and comparison with objective analysis data
*5. Inter comparison with airplane remote sensing on water clouds of middle optical thickness
*6. Release threshold is defined by vicarious val. with other satellite data (e.g., global monthly statistics in the mid-low latitudes)
*7. Comparison with cloud liquid water by in-situ microwave radiometer
*8. Comparison with optical thickness by sky-radiometer (the difference can be large due to time-space inconsistence and large error of the ground measurements)
*9. Comparison with in-situ observation on monthly 0.1-degree
*10. Estimated by experience of aerosol products by GLI and POLDER

Land data notes:
*11. Defined with land reflectance~0.2, solar zenith<30deg, and flat surface. Release threshold is defined with AOT@500nm<0.25
*12. Night time 250m product can be produced by special observation requests of 1.6μm channel
*13. Evaluate in semiarid regions (steppe climate, etc.)
*14. Fires >1000K occupying >1/1000 on 1km pixel at night (using 2.2um of 1 km and thermal infrared channels)

Cryosphere notes:
*15. Defined as height/width of the surface structures

APPENDIX 1-C

SUPPLEMENTAL TABLES FOR THE PRODUCT VALIDATIONS OF THE GLOBAL CHANGE OBSERVATION MISSION-CLIMATE (GCOM-C)

Table C1 Definition and validation method of GCOM-C L1B and L2 products

Cate-gory	Product [Definition・Unit]	Accuracy[*16]		Cal/Val Method
Common	Satellite-observed radiance (Level-1B) Def.: Satellite-observaed radiances which are radiometrically and geometrically corrected with inter-band registration. Calibration information is added. Unit: $W/m^2/str/\mu m$	Release (Data release thresh-old)	5% (absolute[*11]) geometric accr.<1pixel	Accuracy of radiance is evaluated as RMS error based on vicarious calibration, on-board calibrations with solar diffuser and blackbody and so on. Geometrical accuracy is evaluated using GCP as RMS error of pixel position after systematic geometric correction.
		Stan-dard	except TIR: 5%(abs.[*11]), 1% (relative) TIR: 0.5K (@300K) geometric accr.<0.5pixel	Accuracy of radiance is evaluated as RMS error based on vicarious calibration, on-board calibrations with solar diffuser and blackbody, and maneuver operations for moon calibration and inter-band calibration (yaw-direction maneuver). Geometrical accuracy is evaluated using GCP as RMS error of pixel position after systematic geometric correction.
		Goal	Except TIR: 3%(abs.[*11]), 0.5% (relative) TIR: 0.5K (@300K) geometric accr.<0.3pixel	
Land	Precise geometric corrected radiance (LTOA) Def.: This product contains 1) PGCP parameters which indicate geometric biases estimated using GCP, and 2) radiance images which are projected to sinusoidal projection plane with the center longitude of 0 degree after the correction of the geometric biases using the PGCP. Unit: W/m2/str/μm	Release	<1pixel	Accuracy of precise geometric correction is evaluated as RMS error of pixel position using GCPs.
		Stan-dard	<0.5pixel	
		Goal	<0.25pixel	
	Land atmospheric corrected reflectance (LSRF) Def.: Land surface reflectance corrected for the effects of atmospheric scattering and absorption. Correction of directional anisotropic effects are also made for 8-day and monthly composite products. Unit: none	Release	0.3 (<=443nm), 0.2 (>443nm) (scene)[*8]	RMS error between satellite-derived reflectances and ground truth measurements is estimated at a region where aerosol optical thickness at 500nm is less than 0.25.
		Stan-dard	0.1 (<=443nm), 0.05 (>443nm) (scene)[*8]	RMS error between satellite-derived reflectances and ground truth measurements is estimated.
		Goal	0.05 (<=443nm), 0.025 (>443nm) (scene)[*8]	
	Vegetation index (VGI) Def.: Indices indicating vegetation cover and activity such as NDVI and EVI Unit: none	Release	Grass land： 25% (scene), Forest： 20% (scene)	RMS error is evaluated comparing SGLI-derived VI with in-situ measured VI derived from spectroradiometer data at JaLTER, JapanFlux, PEN, Yatsuga-take tower site etc. and also with other satellite VI products.
		Stan-dard	Grass land: 20% (scene), Forest： 15% (scene)	RMS error is evaluated comparing SGLI-derived VI with in-situ measured VI derived from spectroradiometer data at JaLTER, JapanFlux, PEN, Yatsuga-take tower site etc.
		Goal	Grass land： 10% (scene), Forest: 10% (scene)	
	Above-ground biomass (AGB) Def.: Dry weight of above-ground vegetation Unit: t/ha	Release	Grass land： 50%, Forest： 100%	RMS error is evaluated comparing SGLI-derived AGBIO with in-situ measured AGBIO at JaLTER, JapanFlux, PEN, Yatsuga-take tower site etc. (derived from direct measurements of dry weight of grass at grass land, indirect estimation with allometry equation as functions of tree diameter at brest height (DBH) and tree height, or 3-D laser scanner measurements at forest), and also with AGBIO derived from other satellites and numerical ecosystem models.
		Stan-dard	Grass land：30%, Forest：50%	RMS error is evaluated comparing SGLI-derived AGBIO with in-situ measured AGBIO at JaLTER, JapanFlux, PEN, Yatsuga-take tower site etc.
		Goal	Grass land：10%, Forest：20%	

	Vegetation roughness index (VRI) Def.: An index indicating plant vertical structure observed from multi-angle directions. Unit: none	Release	Grass land・Forest : 40% (scene)	RMS error is evaluated comparing SGLI-derived VRI with in-situ measured VRI at JaLTER, JapanFlux, PEN, Yatsuga-take tower site etc. (derived from spectoral reflectance data acquired using tower and RC helicopter and so on).
		Stan-dard	Grass land・Forest : 20% (scene)	
		Goal	Grass land・Forest : 10% (scene)	
	Shadow index (SI) Def.: An index indicating shadow fraction of vegetation area inferred from spectral reflectance. Unit: none	Release	Grass land・Forest : 30% (scene)	RMS error is evaluated comparing SGLI-derived VRI with in-situ measured SI at JaLTER, JapanFlux, PEN, Yatsuga-take tower site etc. (derived from spectoral reflectance data acquired using tower and RC helicopter and so on), or comparing with SI inferred from data of high spatial resolution optical sensor.
		Stan-dard	Grass land・Forest : 20% (scene)	
		Goal	Grass land・Forest : 10% (scene)	
	Fraction of absorbed PAR (FAPAR) Def.: Fraction of photosynthetically active radiation absorbed by vegetation Unit: none	Release	Grass land : 50%, Forest : 50%	RMS error is evaluated comparing SGLI-derived FAPAR with in-situ measured FAPAR at JaLTER, JapanFlux, PEN, Yatsuga-take tower site etc. (derived from data of PAR meter or spectroradiometer data measuring upward and downward PAR at forest canopy and floor.), and with other satellite FAPAR products.
		Stan-dard	Grass land : 30%, Forest : 20%	RMS error is evaluated comparing SGLI-derived FAPAR with in-situ measured FAPAR at JaLTER, JapanFlux, PEN, Yatsuga-take tower site etc. (derived from data of PAR meter or spectroradiometer data measuring upward and downward PAR at forest canopy and floor.).
		Goal	Grass land : 20%, Forest : 10%	
Land	Leaf area index (LAI) Def.: The sum of the one sided green leaf area per unit ground area. Unit: none	Release	Grass land : 50%, Forest : 50%	RMS error is evaluated comparing SGLI-derived LAI with in-situ measured LAI at JaLTER, JapanFlux, PEN, Yatsuga-take tower site etc. (derived from data of litter trap or LAI-2000 and spectroradiometer data measuring downward radiant flux etc. at forest floor.), and with other satellite LAI products.
		Stan- dard	Grass land : 30%, Forest : 30%	RMS error is evaluated comparing SGLI-derived LAI with in-situ measured LAI at JaLTER, JapanFlux, PEN, Yatsuga-take tower site etc. (derived from data of litter trap or LAI-2000 and spectroradiometer data measuring downward radiant flux etc. at forest floor.).
		Goal	Grass land : 20%, Forest : 20%	
	Land surface temperature (LST) Def.: Temperature of terrestrical land surface. Unit: Kelvin	Release	Less than 3.0K (scene)	RMS error is evaluated comparing SGLI-derived LST with in-situ measured LST at the ground surface with uniform land cover and also comparing with other satellite LST products.
		Stan- dard	Less than 2.5K (scene)	RMS error is evaluated comparing SGLI-derived LST with in-situ measured LST at the ground surface with uniform land cover (TBD).
		Goal	Less than 1.5K (scene)	
	Land net primary production (LNPP) Def.: Net primary productivity which is how much carbon dioxide vegetation takes in during photosynthesis (GPP) minus how much carbon dioxide the plants release during respiration or decay. Unit: $gC/m^2/year$	Release	N/A	N/A
		Stan- dard	N/A	N/A
		Goal	30％(annual ave.)	RMS error is evaluated comparing SGLI-derived LNPP with in-situ measured LNPP at JaLTER, JapanFlux, PEN sites and also comparing with other satellite LNPP products.
	Evapotranspiration index (ETI) Def.: An index to understand the droughty state of vegetation. Unit: none	Release	N/A	N/A
		Stan- dard	N/A	N/A
		Goal	10%(as classification error)[*13]	Classification error is evaluated comparing SGLI derived ETI with in-situ measured latent heat transport at flux sites (TBD).
	Fire detection index (FDI) Def.: Location of fire hot spots detected using thermal and shortwave infrared bands. Unit: none	Release	N/A	N/A
		Stan- dard	N/A	N/A
		Goal	20% (as classification error)[*14]	Classification error is evaluated comparing SGLI derived FDI with that derived from high spatial resolution optical sensors which has shortwave and thermal infrared bands.
	Land cover type (LCT)	Release	N/A	N/A

	Def.: Land cover type classified using vegetation indices and land reflectance. Unit: none	Stan- dard	N/A	N/A
		Goal	30% (as classification error)	Classification error is evaluated comparing SGLI derived LCT with the ground truth derived from Degree Confluence Project data on a global scale, and also comparing with regional LCT (such as Japan area) derived from high spatial resolution sensors.
	Land surface albedo (LALB) Def.: Ratio of upward reflected energy to downward solar radiation energy. Unit: none	Release	N/A	N/A
		Stan- dard	N/A	N/A
		Goal	10%	RMS error is evaluated comparing SGLI-derived LALB with in-situ measured LALB derived from spectroradiometer data at JaLTER, JapanFlux, PEN, Yatsuga-take tower site etc. (derived from spectoral reflectance data acquired using tower and RC helicopter and so on) and also with other satellite LALB products.
Atmosphere	Cloud flag (CLFG) Def.: Cloud discrimination flag including the classification of cloud type and phase (liquid/solid). Unit: none	Release	10% (comparison with sky-camera binary image)	Overall classification error is evaluated comparing SGLI derived CLFG with those derived from other satellite sensors, cloud amounts collected through GTS (The Global Telecommunication System), and skycamera images.
		Stan- dard	Evaluated as the cloud fraction products.	Same as the classified cloud fraction.
		Goal	Evaluated as the cloud fraction products.	Same as the classified cloud fraction.
	Classified cloud fraction(CLFR) Def.: Cloud fractions for 9 cloud types which are classified based on the ISCCP classification rule. Unit: percent	Release	20% (as solar radiation)[*6]	Overall classification error is evaluated comparing SGLI derived solar radiation which is monthly average for every 0.1 degree global grid with in-situ measured solar radiation, skycamera images, and existing cloud fraction climatology datasets such as ISCCP(the International Satellite Cloud Climatology Project).
		Stan- dard	15%(as solar radiation)[*6]	
		Goal	10%（as solar radiation)[*6]	
	Cloud top temp/height (CLTTH) Def.: Temperature and height of cloud top layer. Unit: Kelvin for temperature, km for height	Release	1K [*1]	The release criterion shown in the left column indicates a threshold for SGLI TIR band brightness temperature by which the ability to sense cloud top temperature is evaluated indirectly. The accuracy of TIR band is assessed through the product evaluation process of sea surface temperature etc. Also confirmed is the consistency of SGLI derived cloud top temperature with object analysis data of air temperature profile over ocean in daytime.
		Stan- dard	3K [*2] /2km [*2]	RMS error is evaluated comparing SGLI derived CLTTH with those derived from airbone and satellite borne lidar and radiometer etc. for uniform liquid clouds with moderate optical thickness.
		Goal	1.5K [*2] /1km[*2]	
	Water-cloud optical thickness & effective radius (CLOTER_W) Def.: Optical thickness and effective radius of water cloud droplets Unit: none for thickness, μm for radius	Release	10%/30% (optial thickess/radius) [*3]	RMS error is evaluated comparing SGLI derived CLOTER_W with those from other satellite sensors for clouds of mid- to low latitude regions (monthly average).
		Stan- dard	100% (as cloud liquid water[*4])	RMS error is evaluated comparing cloud liquid water converted from SGLI derived CLOTER_W with those measured with microwave radiometer on the ground.
		Goal	50% [*4] /20% [*5]	Overall RMS error is evaluated comparing SGLI derived CLOTER_W with those derived from microwave radiometer and skyradiometer (for optical thickness) and other satellite sensors (both param.).
	Ice-cloud optical thickness (CLOT_I) Def.: Optical thickness of ice cloud. Unit: none	Release	30% [*3]	RMS error is evaluated comparing SGLI derived CLOT_I with those from other satellite sensors for clouds of mid- to low latitude regions (monthly average). .
		Stan- dard	70% [*5]	RMS error is evaluated comparing SGLI derived CLOT_I with those from skyradiometers at ground observation network and other satellite sensors.
		Goal	20 % [*5]	
	Aerosol over the ocean and land (ARNP) Def.: Optical thickness, Ångström exponent, and	Release	Ocean: 0.1(monthly ave. of τa_670, 865) Land: 0.15(monthly ave. ofτa_380)	Overall RMS error is evaluated comparing SGLI derived AROT with those from other satellite sensors and climatology based on the past satellite observations (monthly average).

	characterization of aerosols (light absorption coefficient of aerosol over land) estimated using non-polarization and polarization bands. Unit: none	Stan- dard	Ocean: 0.1(scene's τa_670, 865)[*7] Land: 0.15(scene's τa_380) [*7]	RMS error is evaluated comparing SGLI derived AROT with those from other satellite sensors and in-situ observations (Skynet, AERONET and AERONET Maritime Aerosol Network).
		Goal	Ocean: 0.05(scene's τa_670, 865) Land: 0.1(scene's τa_380)	
	Water cloud geometrical thickness (CLGT_W) Def.: Geometrical thickness of water cloud. Unit: m	Release	N/A	N/A
		Stan- dard	N/A	N/A
		Goal	300m	RMS error is evaluated comparing SGLI derived CLGT_W with those measured at the ground and from space (satellite) with cloud radar and lidar instruments.
	Long-wave radiation flux (LWRF) Def.: Longwave radiation flux at the ground including downward longwave radiation flux and upward longwave radiation flux. Unit: W/m^2	Release	N/A	N/A
		Stan- dard	N/A	N/A
		Goal	Downward flux: $10W/m^2$, Upward flux: $15W/m^2$ (0.1 deg., monthly ave.)	RMS error is evaluated comparing SGLI derived monthly averaged LWRF with those from ground radiation observation network (ARM, BSRN), ground observation network (JaLTER, JapanFLux, PEN, Fluxnet etc.), and other satellite sensors.
	Short-wave radiation flux (SWRF) Def.: Shortwave radiation flux at the ground including downward shortwave radiation flux and upward shortwave radiation flux. Unit: W/m^2	Release	N/A	N/A
		Stan- dard	N/A	N/A
		Goal	Downward: $13W/m^2$, Upward: $10W/m^2$ (0.1deg. , monthly ave.)	RMS error is evaluated comparing SGLI derived monthly averaged SWRF with those from ground radiation observation network (ARM, BSRN), ground observation network (JaLTER, JapanFLux, PEN, Fluxnet etc.), and other satellite sensors.
	Normalized water leaving radiance (NWLR) Def.: The upwelling radiance just above the sea surface. Unit: W/m^2/str/um or 1/sr	Release	60% (443~565nm)	RMS error is evaluated comparing SGLI derived NWLR with in-situ optical measurements conducted during simultaneous ship observations campaign and also comparing with other satellite products.
		Stan- dard	50% (<600nm) 0.5W/m2/str/um (>600nm)	RMS error is evaluated comparing SGLI derived NWLR with in-situ optical measurements conducted during simultaneous ship observations campaign.
		Goal	30% (<600nm) 0.25W/m2/str/um (>600nm)	RMS error is evaluated comparing SGLI derived monthly averaged LWRF with those from ground radiation observation network (ARM, BSRN), ground observation network (JaLTER, JapanFLux, PEN, Fluxnet etc.), and other satellite sensors.
	Atmospheric correction param.(ACP) Def.: Aerosol optical properties for the atmospheric correction over ocean. Unit: none	Release	80% (τa_865)	RMS error is evaluated comparing SGLI derived aerosol optical thickness with those from in-situ measurements using radiometers during simultaneous ship observations campaign and also comparing with other satellite sensors.
		Stan- dard	50% (τa_865)	RMS error is evaluated comparing SGLI derived aerosol optical thickness with those from in-situ measurements using radiometers during simultaneous ship observations campaign.
		Goal	30%	RMS error is evaluated comparing SGLI derived monthly averaged SWRF with those from ground radiation observation network (ARM, BSRN), ground observation network (JaLTER, JapanFLux, PEN, Fluxnet etc.), and other satellite sensors.
Ocean	Photosynthetically Available Radiation (PAR) Def.: Photon flux density within the visible wavelength range (400 to 700 nm) over ocean which is potencially available to plant for photosynthesis. Unit: Ein/m^2/day or mol photons/m^2/day	Release	20% (10km/month)	RMS error is evaluated comparing SGLI derived monthly averaged PAR with those derived from mooring buoy such as NDBC, TAO/TRITON etc. as solar radiation or PAR.
		Stan- dard	15% (10km/month)	RMS error is evaluated comparing SGLI derived NWLR with in-situ optical measurements conducted during simultaneous ship observations campaign.
		Goal	10% (10km/month)	

	Chlorophyll-a concentration (CHLA) Def.: Concentration of the green pigment in phytoplankton in sea surface layer. Unit: mg/m^3	Release	-60~+150% (open sea)	RMS error is evaluated comparing SGLI derived CHLA with those derived from sea water samples by fluorescence method or HPLC analysis and also with other satellite products.
		Stan- dard	-60~+150%	RMS error is evaluated comparing SGLI derived CHLA with those derived from sea water samples by fluorescence method or HPLC analysis.
		Goal	-35~+50% (open sea), -50~+100% (coastal)	
	Total Suspended Matter concentration (TSM) Def.: Dry weight of suspended matter in a unit volume of surface water which is the sum of organics such as phytoplankton and inorganics such as soil. Unit: g/m^3	Release	-60~+150% (open sea)	RMS error is evaluated comparing SGLI derived SS with those derived from sea water samples by filtration method and also with other satellite products.
		Stan- dard	-60~+150%	RMS error is evaluated comparing SGLI derived SS with those derived from sea water samples by filtration method.
		Goal	-50~+100%	
	Colored dissolved organic matter (CDOM) Def.: Light absoption coefficient of organics dissolved in surface water. Unit: 1/m	Release	-60~+150% (open sea)	RMS error is evaluated comparing SGLI derived CDOM with those derived from sea water samples by optical measurements and also with other satellite products.
		Stan- dard	-60~+150%	RMS error is evaluated comparing SGLI derived CDOM with those derived from sea water samples by optical measurements.
		Goal	-50~+100%	
Ocean	Sea surface temperature (SST) Def.: Temperature of sea surface. Unit: ° C	Release	0.8K (daytime only)	Overall RMS error is evaluated comparing SGLI derived SST with those derived from other satellite sensors and also comparing with those from buoy measurements (daytime only) obtained through GTS and internet.
		Stan- dard	0.8K	Overall RMS error is evaluated comparing SGLI derived SST with those derived from other satellite sensors and also comparing with those from buoy measurements obtained through GTS and internet.
		Goal	0.6K	
	Euphotic zone depth (EZD) Def.: The sea depth where photosynthetic available radiation (PAR) is 1% of its surface value. Unit: m	Release	N/A	N/A
		Stan- dard	N/A	N/A RMS error is evaluated comparing SGLI derived EZD with those derived from simultaneous measurements of in-water downward irradiance (in-situ EZD is determined from the slope of measured irradiance).
		Goal	30% (inferred from extinction coefficient)	
	Inherent optical properties (IOP) Def.: Optical properties of sea water such as spectral absorption, scattering, and backscattering coefficients for characterizing the marine optical environment and remote-sensing applications. Unit: 1/m	Release	N/A	N/A
		Stan- dard	N/A	N/A RMS error is evaluated comparing SGLI derived IOP with those derived from simultaneous optical measurements.
		Goal	Absorption coefficient @440nm: RMSE<0.25 and backscattering coefficient of phytoplankton@550nm : RMSE<0.25	
	Ocean net primary productivity (ONPP) Def.: Net primary productivity which is gross photosynthetic carbon fixation minus the carbon respired to support maintenance requirements of the whole plant. Unit: mgC/m^2/day	Release	N/A	N/A
		Stan- dard	N/A	N/A
		Goal	70% (monthly ave.)	RMS error is evaluated comparing SGLI derived monthly averaged ONPP with those derived from simultaneous in-situ measurements.
	Phytoplankton functional type (PHFT) Def.: Conceptual groupings of phytoplankton species, which have a ecological functionality in common such as nitrogen fixation, calcification, silicification, DMS production and so on.	Release	N/A	N/A
		Stan- dard	N/A	N/A
		Goal	Classification error of dominant/non-dominant spesies of large/small phytoplankton: 20%, or classification error of	Classification error is evaluated comparing with SGLI derived PHFT with the dominant type of phytoplankton group (such as Bacillariophyceae, Chlorophyceae, and Haptophyta etc.) determined from the plant pigment analysis of sea water samples using HPLC.

	Unit: none		dominant functional type in a phytoplankton group: 40%	
	Redtide (RTD) Def.: Detection of a red tide phenomenon known as an algal bloom. Unit: none	Release	N/A	N/A
		Stan- dard	N/A	N/A
		Goal	20% (as classification error)	Classification error is evaluated comparing SGLI derived RTD with the occurrence of red tide events determined by eye during simultaneous ship observations campaign.
	Multi sensor merged ocean color parameters (MOC) Def.: Multi-sensor merged chrollophyl-a concentration product with higher temporal resolution than that of SGLI original product. Unit: mg/m³	Release	N/A	N/A
		Stan- dard	N/A	N/A
		Goal	-35~+50% (Open sea), -50~+100% (Coastal)	Same as the SGLI original product (CHLA).
	Multi sensor merged sea surface temperature (MSST) Def.: Multi-sensor merged seasurface temperature product with higher temporal resolution than that of SGLI original products. Unit: °C	Release	N/A	N/A
		Stan- dard	N/A	N/A
		Goal	0.8K	Same as the SGLI original product (SST).
	Snow and Ice covered area (SICA) Def.: The extent of global snow and ice cover. Unit: none	Release	10% (comparison with other satellite products)	Overall classification error is evaluated comparing SGLI derived SICA with other satellites' same products and climatology of related geophysical parameters derived from the past observations.
		Stan- dard	7%	Overall classification error is evaluated comparing SGLI derived SICA with those derived from moderate and high spatial resolution satellite sensors and also with snow and ice information obtained at ground stations etc.
		Goal	5%	Same as the SGLI original product (CHLA).
	Okhotsk sea-ice distribution (OKID) Def.: The extent of sea ice in Okhotsk Sea. Unit: none	Release	10% (comparison with other satellite products)	Overall classification error is evaluated comparing SGLI derived OKID with other satellites' same products and climatology of related geophysical parameters derived from the past observations.
		Stan- dard	5%	Overall classification error is evaluated comparing SGLI derived OKID with those derived from moderate and high spatial resolution satellite sensors and also with ice information obtained at ship etc.
		Goal	3%	Same as the SGLI original product (SST).
Cryosphere	Snow and ice surface Temperature (SIST) Def.: Temperature of snow and ice surface. Unit: Kelvin	Release	5K (comparison with other satellite products and meteorological measurements)	Overall RMS error is evaluated comparing SGLI derived SIST with those from other satellite sensors, air temperatures from GTS and ice buoys, and climatology derived from the past observations.
		Stan- dard	2K	RMS error is evaluated comparing SGLI SIST with those from in-situ radiometer measurements and snow pit works, air temperatures from GTS and ice buoys.
		Goal	1K	
	Snow grain size of shallow layer (SNGSL) Def.: Grain size of snow ice particle in shallow layer derived mainly from SGLI 865nm band reflectance. Unit: μm	Release	100%(evaluated with climatology of temperature-snow grain size relationship)	Overall error is evaluated comparing SGLI derived SNGSL with other satellites' products and climatology derived from the past observations.
		Stan- dard	50%	RMS error is evaluated comparing SGLI SNGSL with those from in-situ radiometer measurements and snow pit works.
		Goal	30%	
	Snow and ice classification (SIC)	Release	N/A	N/A

	Def.: Classification of snow and ice cover types derived using spectral reflectance and temperature. Unit: none	Stan- dard	N/A	N/A Classification error is evaluated comparing SGLI derived SIC with those derived from other moderate and high spatial resolution satellite sensors and also with snow and ice information obtained at ground station etc.
		Goal	10%	
	Snow area in forest and mountain (SCAFM) Def.: The extent of snow cover in forest and mountaneous region. Unit: none	Release	N/A	N/A
		Stan- dard	N/A	N/A Classification error is evaluated comparing SGLI derived SCAFM with those derived from other moderate and high spatial resolution satellite sensors and also with snow information obtained at ground station etc.
		Goal	30%	
	Snow grain size of subsurface layer (SNGSS) Def.: Grain size of snow ice particle in sub-surface layer derived mainly from SGLI 1050nm band reflectance. Unit: µm	Release	N/A	N/A
		Stan- dard	N/A	N/A
		Goal	50%	RMS error is evaluated comparing SGLI SNGSS with those from in-situ radiometer measurements and snow pit works.
	Snow grain size of top layer (SNGST) Def.: Grain size of snow ice particle in top-surface layer derived mainly from SGLI 1640nm band reflectance. Unit: µm	Release	N/A	N/A
		Stan- dard	N/A	N/A
		Goal	50%	RMS error is evaluated comparing SGLI SNGST with those from in-situ radiometer measurements and snow pit works.
	Snow and ice albedo (SIALB) Def.: Spectrally integrated albedo of snow surface. Unit: none	Release	N/A	N/A
		Stan- dard	N/A	N/A
		Goal	7%	RMS error is evaluated comparing SGLI SIALB with those from in-situ radiometer measurements and snow pit works.
	Snow impurity (SNIP) Def.: Mass fraction of snow impurity mixed in snow layer which is optically equivalent to soot. Unit: ppmw	Release	N/A	N/A
		Stan- dard	N/A	N/A
		Goal	50%	RMS error is evaluated comparing SGLI SNIP with those from in-situ radiometer measurements and snow pit works.
	Ice sheet surface roughness (ISRGH) Def.: Surface roughness of ice sheets defined as the ratio of height to width of a roughness pattern. Unit: none	Release	N/A	N/A
		Stan- dard	N/A	N/A
		Goal	0.05 *15	RMS error is evaluated comparing SGLI derived ISRGH with those derived from other moderate and high spatial resolution satellite sensors and with numerical simulation results.
	Ice sheet boundary monitoring (ISBM) Def.: Boundary line between ice sheets and sea surface. Unit: none	Release	N/A	N/A
		Stan- dard	N/A	N/A
		Goal	500m 以下	Overall bias of ice sheet boundary line is evaluated comparing SGLI derived ISBM with those derived from other moderate and high spatial resolution satellite sensors.

Common notes:

*1. Heritage levels from ADEOS-II/GLI study are shown by A-C; A: high heritage, B: Remaining issues, C: new or many issues remaining to be resolved

*2. 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. Accuracies are basically shown by RMSE.

Radiance data notes:

*3. Absolute error is defined as offset + noise; relative error is defined as relative errors among channels, FOV, and so on. 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

Atmosphere notes:
*4. Vicarious val. on sea-surface temperature and comparison with objective analysis data
*5. Inter comparison with airplane remote sensing on water clouds of middle optical thickness
*6. Release threshold is defined by vicarious val. with other satellite data (e.g., global monthly statistics in the mid-low latitudes)
*7. Comparison with cloud liquid water by in-situ microwave radiometer
*8. Comparison with optical thickness by sky-radiometer (the difference can be large due to time-space inconsistence and large error of the ground measurements)
*9. Comparison with in-situ observation on monthly 0.1-degree
*10. Estimated by experience of aerosol products by GLI and POLDER

Land data notes:
*11. Defined with land reflectance~0.2, solar zenith<30deg, and flat surface. Release threshold is defined with AOT@500nm<0.25
*12. Night time 250m product can be produced by special observation requests of 1.6μm channel
*13. Evaluate in semiarid regions (steppe climate, etc.)
*14. Fires >1000K occupying >1/1000 on 1km pixel at night (using 2.2um of 1 km and thermal infrared channels)

Cryosphere notes:
*15. Defined as height/width of the surface structures

TABLE C2 Expected reference data for the validation of GCOM-C/SGLI standard products

Cate gory	Product [Unit]	Accuracy Targets	Val. Data Type (Main/Auxiliary)	Algorithm PIs	Validation PIs	In-situ Data	Instruments	Observation Sites	Period, Frquency, Obs. Cycles
Common	**Satellite-observed radiance (Level-1B) [W/m^2/str/μm]**	Release: 5% (Abs. *11) Geometric: <1pixel	**In-situ & various cal.data (Main)**	**JAXA**	**JAXA**	Ground reflectance data, MOBY data etc. (cooperation with NOAA) Onboard calibration data Other satellite data (TBD)	Spectrometer SGLI MODIS(MOD02,MYD02) CAI(L1,L1B) ASTER(L1B)	CEOS cal sites Global	Year-round Year-round
		Standard: VIS-SWIR: 5% (Abs.*11), 1% (Relative) TIR: 0.5K (@300K) Geometric: <0.5pixel Goal: VIS-SWIR : 3% (Abs.*11), 0.5% (Relative) TIR: 0.5K (@300K) Geometric: <0.3pixel	**In-situ & various cal.data (Main)**			Ground reflectance data, MOBY data etc. (cooperation with NOAA) Onboard calibration data Other satellite data (TBD)	Spectrometer SGLI MODIS(MOD02,MYD02) CAI(L1,L1B) ASTER(L1B)	CEOS cal sites Global	Year-round Year-round
Land	**Precise geometric corrected radiance [W/m2/str/μm]**	Release: <1pixel	**Other satellites (Main)**	**JAXA (RESTEC, Tokai U.)**	**JAXA**	GCP database derived from AVNIR-2 etc.	MODIS (MCD43C4) CAI AVNIR-2	(Defined in GCP library)	Year-round
		Standard: <0.5pixel Goal: <0.25pixel	**Other satellites (Main)**			GCP database derived from AVNIR-2 etc.	MODIS (MCD43C4)		
							CAI		
	Land atmospheric corrected reflectance [—]	Release : 0.3 (<=443nm), 0.2 (>443nm) (scene)(*8)	**In-situ (Main)**	**JAXA**	**Honda-Kajiwara** **Nasahara**	Spectral reflectance (incl. BRDF) data measured from UAV Spectral data measured from Tower Spectral data measured from UAV (combined with	FieldSpec, MS-720 Hyperspectral Camera MS-700 MS-720	Yatsugatake JaLTER, JapanFlux, PEN sites	Campaign Year-round

						BiRS simulations for uniform surfaces)			
			Other satellites (Auxiliary)		**JAXA**	L2 atmospheric corrected reflectance product (MOD09, MYD09)	MODIS of Terra & Aqua	Global but every typical LCC (TBD)	Year-round or Seasonally
		Standard: 0.1 (<=443nm), 0.05 (>443nm) (scene)(*8) Goal: 0.05 (<=443nm), 0.025 (>443nm) (scene)(*8)	**In-situ (Main)**		**Honda-Kajiwara** **Nasahara**	Spectral data measured from UAV Spectral data measured from Tower Spectral data measured from UAV	FieldSpec, MS-720 Hyperspectral Camera MS-700 MS-720	Yatsugatake JaLTER, JapanFlux, PEN sites	Campaign Year-round
	Vegetation index [—]	Release: grass： 25% (scene), forest： 20% (scene)	**In-situ (Main)**	**JAXA**	**Honda-Kajiwara** **Nasahara**	Spectral data measured from UAV Spectral data measured from Tower Spectral data measured from UAV	FieldSpec, MS-720 Hyperspectral Camera MS-700 MS-720	forest：Yatsugatake grass・forest：JaLTER, JapanFlux, PEN sites	Campaign Year-round
			Other satellites (Main)		**JAXA**	L2 VI products (MOD13,MYD13)	MODIS of Terra & Aqua JASMES CAI	Global	Year-round
		Standard: grass： 20% (scene), forest： 15% (scene) Goal: grass： 10% (scene), forest： 10% (scene)	**In-situ (Main)**		**Honda-Kajiwara** **Nasahara**	Spectral data measured from UAV Spectral data measured from Tower Spectral data measured from UAV	FieldSpec, MS-720 Hyperspectral Camera MS-700 MS-720	forest：Yatsugatake grass, forest：JaLTER, JapanFlux, PEN sites	Campaign Year-round

	Above-ground biomass [t/ha]	Release: grass： 50%, forest： 100%	**In-situ (Main)**	**Honda**	**Honda-Kajiwara-Nasahara**	AGBIO estimated from Every Tree Measurements (DBH, Tree Hight, Tree Density etc.)	Tree (direct) measurements	forest：Yatsugatake, grass・forest：JaLTER, JapanFlux, PEN sites Mine site (GOSAT2) of Australia、Fuji-hokuroku, Tomakomai, Uryuu, Mase, Alaska (boreal, 200m sq scale), Pasoh/ Malaysia (Tropical-rain)	Campaign
					Honda-Kajiwara-JAXA Nakaji	AGBIO estimated from 3D-Laser Scanner data measured at ground	3D-Laser Scanner	forest：Yatsugatake, grass・forest：JaLTER, JapanFlux, PEN sites	Campaign
			Other satellites (Main)		**Honda-Kajiwara**	L2-L3 AGBIO products derived from satellite borne lider and SAR	PALSAR-2, ISS/MOLI (L+5yr), ISS/GEDI (L+5yr)		Year-round
			model (Main)		**Nagai**	Output of eco-system model	BEAMS (Sasai)	Global but every typical LCC (TBD)	Year-round
		Standard: grass：30%, forest：50% Goal: grass：10%, forest：20%	**In-situ (Main)**		**Honda-Kajiwara-Nasahara**	AGBIO estimated from Every Tree Measurements (DBH, Tree Hight, Tree Density)	Tree (direct) measurements	forest：Yatsugatake, grass・forest：JaLTER, JapanFlux, PEN sites Mine site (GOSAT2) of Australia、Fuji-hokuroku, Tomakomai, Uryuu, Mase, Alaska (boreal, 200m sq scale), Pasoh/ Malaysia (Tropical-rain)	Campaign
					Honda-Kajiwara-JAXA Nakaji	AGBIO estimated from 3D-Laser Scanner data measured at ground	3D-Laser Scanner	forest：Yatsugatake, grass・forest：JaLTER, JapanFlux, PEN sites	Campaign
	Vegetation roughness index [—]	Release: grass・forest： 40% (scene)	**In-situ (Main)**	**Honda**	**Honda-Kajiwara**	VRI derived from 3D-Laser Scanner data measured from UAV or near surface (Tower)	3D-Laser Scanner	forest：Yatsugatake, grass・forest：JaLTER, JapanFlux, PEN sites	Campaign

		Standard: grass・forest: 20% (scene) Goal: grass・forest: 10% (scene)	**In-situ (Main)**		**Honda-Kajiwara**	VRI derived from 3D-Laser Scanner data measured from UAV or near surface (Tower)	3D-Laser Scanner	forest: Yatsugatake, grass・forest: JaLTER, JapanFlux, PEN sites	Campaign
	Shadow index [—]	Release: grass・forest: 30% (scene)	**In-situ (Main)**	**Moriyama**	**Honda-Kajiwara** **Nasahara**	Spectral reflectance from UAV 3D-Laser Scanner data & images from UAV Spectral reflectance from Tower Spectral data measured from UAV	FieldSpec, MS-720 3D-Laser Scanner Digital camera etc. MS-700 MS-720	forest: Yatsugatake, Goto grass・forest: JaLTER, JapanFlux, PEN sites forest: Yatsugatake, Goto grass・forest: JaLTER, JapanFlux, PEN sites	Campaign Campaign
			Other satellites (Auxiliary)		**Moriyama**	L1 radiance of high-rsol. satellite imagers	Landsat8	grass: forest: Goto Is.	Year-round
		Standard: grass・forest: 20% (scene) Goal: grass・forest: 10% (scene)	**In-situ (Main)**		**Honda-Kajiwara** **Nasahara**	Spectral reflectance from UAV 3D-Laser Scanner data & images from UAV Spectral reflectance from Tower Spectral data measured from UAV	FieldSpec, MS-720 3D-Laser Scanner Digital camera etc. MS-700 MS-720	forest: Yatsugatake, Goto grass・forest: JaLTER, JapanFlux, PEN sites forest: Yatsugatake, Goto grass・forest: JaLTER, JapanFlux, PEN sites	Campaign Campaign
			Other satellites (Auxiliary)		**Moriyama**	L1 radiance of high-rsol. satellite imagers	Landsat8	grass: forest: Goto Is.	Year-round
	Fraction of absorbed photosynthetically active radiation (fPAR) [—]	Release: grass: 50%, forest: 50%	**In-situ (Main)**	**Kobayashi(Univ. Tsukuba), Kobayashi(JAMSTEC)**	**Honda, Kajiwara, Nasahara, Nagai**	PAR derived with PAR meter or spectrometer (incident, reflercted, transmitted PAR) measured from Towers Combine canopy model. <= Ground LIDER+ Heli DSM	PAR meters MS700 Spectrometer 3D-Laser Scanner Digital camera etc.	forest: Yatsugatake, grass・forest: JaLTER, JapanFlux, PEN sites, Australia, Fuji-hokuroku, Tomakomai, Uryuu, Mase 500m square sites	Year-round

			Other satellites (Main)		**JAXA**	L2 FPAR products (MOD15, MYD15)	MODIS of Terra & Aqua	Global	Year-round
		Standard: grass：30%、forest：20% Goal: grass：20%, forest：10%	**In-situ (Main)**		**Honda, Kajiwara, Nasahara, Nagai**	PAR derived with PAR meter or spectrometer (incident, reflercted, transmitted PAR) measured from Towers Combine canopy model. <= Ground LIDER+ Heli DSM	PAR meters MS700 Spectrometer 3D-Laser Scanner Digital camera etc.	forest：Yatsugatake, grass･forest：JaLTER, JapanFlux, PEN sites Australia, Fuji-hokuroku, Tomakomai, Uryuu, Mase 500m square sites	Year-round
	Leaf area index [—]	Release: grass： 50%, forest：50%	**In-situ (Main)**	**Kobayashi(Univ. Tsukuba), Kobayashi (JAMSTEC)**	**Honda, Kajiwara, Nasahara, Nagai**	In-situ measured LAI (from instrument (indirect) or grass cutting (direct) method)	LAI-2000 Litter trap etc.	forest：Yatsugatake, grass･forest：JaLTER, JapanFlux, PEN sites Australia, Fuji-hokuroku, Tomakomai, Uryuu, Mase Alaska (boreal, 200m sq scale), Pasoh/ Malaysia (Tropical-rain) (500m square sites)	Campaign
			Other satellites (Main)		**JAXA**	L2 LAI products (MODIS)	MODIS of Terra & Aqua	Global but every typical LCC (TBD)	Year-round
		Standard: grass：30%、forest：30% Goal: grass：20%, forest：20%	**In-situ (Main)**		**Honda, Kajiwara, Nasahara, Nagai**	In-situ measured LAI (from instrument (indirect) or grass cutting (direct) method)	LAI-2000 Litter trap etc.	forest：Yatsugatake, grass･forest：JaLTER, JapanFlux, PEN sites Australia, Fuji-hokuroku, Tomakomai, Uryuu, Mase Alaska (boreal, 200m sq scale), Pasoh/ Malaysia (Tropical-rain) (500m square sites)	Campaign

	Land surface temperature [K]	Release: 3.0K 以下 (scene)	**In-situ (Main)**	**Moriyama**	**Moriyama** **Honda-Kajiwara** **Nasahara** **JAXA**	in situ BT measured from ground In-situ BT measured from UAV In-situ BT measured from Tower LST converted from Tair obtained at Fluxsite, GTS, GSOD or other sites	IR thermometer IR thermometer IR thermometer Thermometer	Railroad Valley, ND & Ivanpah playa, CA Yatsugatake JaLTER, JapanFlux, PEN sites Fluxnet, GTS sites	Campaign Campaign Year-round Year-round
			Other satellites (Main)		**JAXA**	L2 LST products (MOD11, MYD11) L2 LST products from Sentinel-3	MODIS of Terra & Aqua Sentinel-3	Global but every typical LCC (TBD)	Year-round
		Standard: 2.5K 以下 (scene) Goal: 1.5K 以下 (scene)	**In-situ (Main)**		**Moriyama** **Honda-Kajiwara** **Nasahara** **JAXA**	in situ BT measured from ground In-situ BT measured from UAV In-situ BT measured from Tower Tair obtained from Fluxsite, GTS, GSOD or other sites	IR thermometer IR thermometer IR thermometer Thermometer	Railroad Valley, ND & Ivanpah playa, CA Yatsugatake JaLTER, JapanFlux, PEN sites GTS sites	Campaign Campaign Year-round Year-round
Atmosphere	**Cloud flag [—]**	Release: 10% (comparisonwith sky-camera binary image)	**In-situ (Main)**	**Nakajima (main), Ishimoto, Riedi, Stamnes, JAXA**	**Irie** **Nakajima** **Kuji** **JAXA**	Cloud amount derived from skycamera GTS cloudiness	Sky-Camera Human-eye	Kumamoto, Greenland, Abashiri, Tsukuba, Shirase, Noto, Yoyogi, Iriomote, Osaka, Tomakomai, Polar region (Sbalvard, Syowa St.)	Year-round
			Other satellites (Main)			L2 cloud flag product (MOD35, MYD35)	MODIS VIIRS etc.	Global	Year-round
		Standard&Goal: Eavaluated as the	**In-situ (Main)**			same as CLFR	same as CLFR		

		cloud fraction products							
	Classified cloud fraction [%]	Release: 20% (as solar radiation)(*6)	**In-situ (Main)**	**Nakajima (main), Ishimoto, Riedi, Iwabuchi**	**Nakajima, Yamazaki, Irie, Kuji, Khatri**	BSRN solar radiation data Whole sky image data	Solar radiation base Sky-Camera (supplemental)	BRSR etc. Kumamoto, Greenland, Abashiri, Tsukuba, Shirase, Noto, Yoyogi, Iriomote, Osaka, Tomakomai, Polar region (Sbalvard, Syowa St.)	Year-round Year-round
			Climatology (Main)			ISCCP climatological dataset	Various satellites	Global	Year-round
		Standard: 15%(as solar radiation)(*6) Goal: 10%（ as solar radiation)(*6)	**In-situ (Main)**			BSRN solar radiation data Whole sky image data	Solar radiation base Sky-Camera (supplemental)	BRSR etc. Kumamoto, Greenland, Abashiri, Tsukuba, Shirase, Noto, Yoyogi, Iriomote, Osaka, Tomakomai, Polar region (Sbalvard, Syowa St.)	Year-round Year-round
	Cloud top temp & height [K], [km]	Release: 1K(*1)	**Climatology (Main)**	**Nakajima (main), Ishimoto, Riedi, Iwabuchi**	**JAXA**	ISCCP climatological dataset	Various satellites	Global	Year-round
		Standard: 3K(*2)/2km(*2) Goal: 1.5K(*2)/1km(*2)	**In-situ (Main)**		**Irie, Nakajima,Yamazaki,Kuji, Khratri**	Data measured with ground-based radar *Data measured with airborne lidar*	FALCON(radar) *NASA Airborne lidar*	Chiba, etc., Nieolson (Contact to Shiobara-san (Irie)) *Flight courses (TBD, Shinozuka-san (CI of Sano PI) has info.)*	Year-round *Campaigns*
			Other satellites (Main)		**JAXA**	Data measured with satellite-borne lidar	Satellite borne lidar	Global	Year-round

	Water-cloud optical thickness & effective radius [—], [μm]	Release: 10%/30% (optical thickess/radius) (*3)	**Other satellites (Main)**	**Nakajima (main), Ishimoto, Riedi, Iwabuchi**	**Irie, Nakajima, Yamazaki, Kuji, Khatri**	L2 Cloud effective radius prd. (MOD06, MYD06)	MODIS of Terra & Aqua	Mid- to Low latitude area	Year-round
		Standard: 100% (as cloud liquid water: *4)	**In-situ (Main)**			Cloud liquid water data from Ground based passive microwave radiometer (PMR)	Microwave radiometer	Fukue, Hedo, Chiba (Skynet supersites) PMR by NICT@ Okinawa (TBD)	Year-round
		Goal: 50% (*4) /20% (*5)	**In-situ (Main)**			Cloud liquid water data from ground based passive microwave radiometer (PMR) Cloud optical thickness data from skyradiometer	Microwave radiometer Skyradiometer	Fukue, Hedo, Chiba (Skynet supersites) Thai, Gouhi, Chiba, Fukue, Hedo	Year-round Year-round
			Other satellites (Main)			L2 Cloud effective radius prd. (MOD06, MYD06)	MODIS of Terra & Aqua	Global	Year-round
	Ice-cloud optical thickness [—]	Release: 30%(*3)	**Other satellites (Main)**	**Nakajima (main), Ishimoto, Riedi, Iwabuchi**	**Irie, Nakajima, Yamazaki, Kuji, Khatri**	L2 Cloud optical thickness prd. (MOD06, MYD06)	MODIS of Terra & Aqua	Mid- to Low latitude area	Year-round
		Standard: 70%(*5) Goal: 20 %(*5)	**In-situ (Main)**			SKYNET data	Skyradiometer	Thai, Gouhi, Chiba, Fukue, Hedo (Skynet super sites)	Year-round
			Other satellites (Main)			L2 Cloud optical thickness prd. (MOD06, MYD06)	MODIS of Terra & Aqua	Global	Year-round
	Aerosol over the ocean [—]	Release: 0.1(monthly ave. of τa_670, 865)	**In-situ (Auxiliary)**	**JAXA, Mukai, Sekiguchi, Ishimoto, Riedi**	**Irie, Yamazaki, Aoki, K., Kobayashi, Mukai, Sano,**	Skyradiometer data on Mirai, Shirase etc. Microtops data from Maritime Aerosol Network *Airborne Sunphoto data by NASA Ames*	Skyradiometer Microtops *Airbone Sunphoto*	Cruise route of Mirai, Shirase etc. Various sites *Flight courses (TBD, Shinozuka-san (CI of Sano PI) has info.)*	Campaign *Campaign* *Campaigns*
			Other satellites (Main)		**JAXA**	L2 Aersosol products (MOD04, MYD04)	MODIS of Terra & Aqua CAI VIIRS	Global	Year-round

		Standard: 0.1(scene's τa_670, 865)(*7) Goal: 0.05(scene's τa_670, 865)	**In-situ** **(Main)**		**Irie, Yamazaki,** **Aoki, K.,** **Kobayashi,** **Mukai, Sano,** ***NASA***	Skyradiometer data on Mirai, Shirase etc. Microtops data from Maritime Aerosol Network Airborne Sunphoto data by NASA Ames	Skyradiometer Microtops Airbone Sunphoto	Cruise route of Mirai, Shirase etc. Various sites *Flight courses (TBD, Shinozuka-san (CI of Sano PI) has info.)*	Campaign *Campaign* *Campaigns*
			Other satellites **(Main)**		**(JAXA)**	L2 Aersosol products (MOD04, MYD04)	MODIS of Terra & Aqua CAI VIIRS	Global	Year-round
	Aerosol over the land [—]	Release: 0.15(monthly ave. of τa_380)	**In-situ** **(Main)**	**JAXA, Mukai, Sekiguchi, Ishimoto, Riedi**	**Irie,** **Aoki K., Mukai, Sano** **Yamazaki,Kobayashi,** **Various PI/CI**	SKYNET (Aoki), AERONET (Sano), Skyradiometer (Yamazaki, etc.) Microtops data Airborne Sunphoto data by NASA Ames	Skyradiometer Aeronet Skyradiometer Microtops Airbone Sunphoto	Many Skynet sites (<100) Many Aeronet sites (<100) MRI sites Various sites *Flight courses (TBD, Shinozuka-san (CI of Sano PI) has info.)*	Year-round Year-round Year-round *Campaigns* *Campaigns*
			Other satellites **(Main)**		**JAXA**	L2 Aersosol products (MOD04, MYD04)	MODIS of Terra & Aqua CAI VIIRS	Global	Year-round
		Standard: 0.15(scene's τa_380) (*7) Goal: 0.1(scene's τa_380)	**In-situ** **(Main)**		**Irie,** **Aoki K.,** **Mukai,** **Sano,** **Yamazaki,Kobayashi,** **Various PI/CI**	SKYNET (Aoki), AERONET (Sano), Skyradiometer (Yamazaki, etc.) Microtops data Airborne Sunphoto data by NASA Ames	Skyradiometer Aeronet Skyradiometer Microtops Airbone Sunphoto	Many Skynet sites (<100) Many Aeronet sites (<100) MRI sites Various sites *Flight courses (TBD, Shinozuka-san (CI of Sano PI) has info.)*	Year-round Year-round Year-round *Campaigns* *Campaigns*
			Other satellites **(Main)**		**JAXA**	L2 Aersosol products (MOD04, MYD04)	MODIS of Terra & Aqua CAI VIIRS	Global	Year-round

Ocean	**Normalized water leaving radiance [W/m2/str/µm or 1/sr]**	Release: 60% (443~565nm)	**In-situ (Main)**	**Toratani, Frouin, JAXA, Stamnes**	**Toratani, Frouin, Hirawake, Ishizaka, Suzuki, Kobayashi, Khahru, Antoine, Kuwahara, Isada, Higa, Hirata**	In-situ measured optical data	PRR (Hirawake, etc.) TRIOS (Ishizaka, etc.) C-OPS (Suzuki)	ECS, A-line, O-line, Funka-bay, Tokyo-bay,Seto Inland sea, Chukchi Sea, Bering Sea, North Pacific, Ise-bay, Akkeshi-bay, Toyama-Bay	Campaign
			Other satellites (Main)		**JAXA**	MOD18	AQUA/MODIS, NPP/VIIRS	Global	Year-round
		Standard: 50% (<600nm) 0.5W/m2/str/um (>600nm) Goal: 30% (<600nm) 0.25W/m2/str/um (>600nm)	**In-situ (Main)**		**Toratani, Frouin, Hirawake, Ishizaka, Suzuki, Kobayashi, Khahru, Antoine, Kuwahara, Isada, Higa, Hirata**	In-situ measured optical data	PRR (Hirawake, etc.) TRIOS (Ishizaka, etc.) C-OPS (Suzuki) Aeronet-OC	ECS, A-line, O-line, Funka-bay, Tokyo-bay,Seto Inland sea, Chukchi Sea, Bering Sea, North Pacific, Ise-bay, Akkeshi-bay, Toyama-Bay	Campaign
	Atmospheric correction param. [—]	Release: 80% (τa_865)	**In-situ (Main)**	**Toratani, Frouin, JAXA, Stamnes**	**Kobayashi Toratani *NASA***	Aerosol optical thickness data Aerosol optical thickness data	Skyradiometer AERONET/maritime(NASA)	Cruise track of Shirase etc. Many Aeronet sites (<100)	Campaign
			Other satellites (Main)		**JAXA**	Aerosol optical thickness data	AQUA/MODIS、NPP/VIIRS	Global	Year-round
		Standard: 50% (τa_865) Goal: 30%	**In-situ (Main)**		**Kobayashi, Toratani, etc. *NASA, Cooperation with Atmos. Gr.***	Aerosol optical thickness data	Skyradiometer AERONET/maritime(NASA), SKYNET	Cruise track of Shirase etc. Many Aeronet sites (<100)	Campaign
	Photosynthetically Available Radiation [Ein/m²/day or mol photons/m²/day]	Release: 20% (10km/month)	**In-situ (Main)**	**JAXA & Frouin**	**Hirawake, Ishizaka, Suzuki, Hirata, *Saikaiku,***	Buoy: NDBC, TAO/TRITON etc. Ship: PRR data	PRR	Buoy sites ECS, A-line, O-line, Funka-bay, Tokyo-bay, Coast of Oita, Chukchi Sea, Bering Sea, North Pacific	Year-round Campaign

		Standard: 15% (10km/month) Goal: 10% (10km/month)	**In-situ (Main)**		***Tohoku, SEABASS***	Buoy: NDBC, TAO/TRITON etc. Ship: PRR data	PRR	Buoy sites ECS, A-line, O-line, Funka-bay, Tokyo-bay, Coast of Oita, Chukchi Sea, Bering Sea, North Pacific	Year-round Campaign
	Chlorophyll-a concentration [mg/m^3]	Release: -60~+150% (open sea)	**In-situ (Main)**	**JAXA, Toratani, Hirata**	**Hirawake, Ishizaka, Suzuki, Kobayashi, *Saikaiku, Tohoku, SEABASS***	Pigment concentration data measured with fluorescense method and HPLC at Ship	Fluorescense method, HPLC	ECS, A-line, O-line, Funka-bay, Tokyo-bay,Seto Inland sea, Chukchi Sea, Bering Sea, North Pacific, Ise-bay, Akkeshi-bay, Toyama-Bay	Campaign
			Other satellites (Main)		**JAXA**	MOD20, MOD21	AQUA/MODIS、NPP/VIIRS	Global	Year-round
		Standard: -60~+150% Goal: -35~+50% (open sea), -50~+100% (coastal)	**In-situ (Main)**		**Hirawake, Ishizaka, Suzuki, Kobayashi, *Saikaiku, Tohoku, SEABASS***	Pigment concentration data measured with fluorescense method and HPLC at Ship	Fluorescense method, HPLC	ECS, A-line, O-line, Funka-bay, Tokyo-bay,Seto Inland sea, Chukchi Sea, Bering Sea, North Pacific, Ise-bay, Akkeshi-bay, Toyama-Bay	Campaign
	Total suspended matter concentration [g/m^3]	Release: -60~+150% (open sea)	**In-situ (Main)**	**JAXA, Toratani, Hirata**	**Ishizaka, Kobayashi, SeaBASS**	Dry weight of filtered SS sampled at Ship	Sampling and filtering	ECS, Tokyo-bay	Campaign
			Other satellites (Main)		**JAXA**	MOD23	AQUA/MODIS、NPP/VIIRS	Global	Year-round
		Standard: -60~+150% Goal: -50~+100%	**In-situ (Main)**		**Ishizaka, Kobayashi, SeaBASS**	Dry weight of filtered SS sampled at Ship	Sampling and filtering	ECS, Ariake, Tokyo-bay	Campaign
	Colored dissolved organic matter [m^{-1}]	Release: -60~+150% (open sea)	**In-situ (Main)**	**JAXA, Toratani, Hirata**	**Hirawake, Ishizaka, Kobayashi, *Saikaiku, SeaBASS***	Ship: Absorption data of sampling water	Absorption meter	ECS, Ariake, Tokyo-bay, Ise-bay, Chukchi Sea, Bering Sea, Akkeshi-bay	Campaign
			Other satellites (Main)		**JAXA**	MOD24	AQUA/MODIS	Global	Year-round
		Standard: -60~+150% Goal: -50~+100%	**In-situ (Main)**		**Hirawake, Ishizaka, Kobayashi,**	Ship: Absorption data of sampling water	Absorption meter	ECS, Tokyo-bay, Ise-bay, Chukchi Sea, Bering Sea, Akkeshi-bay	Campaign

					Saikaiku, SeaBASS				
	Sea surface temperature [℃]	Release: 0.8K (daytime only)	**In-situ (Main)**	**JAXA**	**JAXA**	GTS iQuam (buoy data for AMSR2 val)		GTS sites	Year-round
					Hirawake, Ishizaka, Kobayashi, ***Saikaiku, Tohoku, SEABASS***	In-situ measured SST Bucket SST, Nautical SST, Argo float SST, etc.	Bucket, thermometer	ECS, A-line, O-line, Funka-bay, Tokyo-bay,Seto Inland sea, Chukchi Sea, Bering Sea, North Pacific, Ise-bay, Akkeshi-bay, Toyama-Bay	Campaign
			Other satellites (Main)		**JAXA**	MOD28 SST of AMSR2	MODIS AMSR2	Global	Year-round
		Standard: 0.8K Goal: 0.6K	**In-situ (Main)**		**JAXA**	GTS iQuam (buoy data for AMSR2 val)	thermometer onboard buoy	GTS sites	Year-round
					Hirawake, Ishizaka, Kobayashi, ***Saikaiku, Tohoku, SEABASS***	In-situ measured SST Bucket SST, Nautical SST, Argo float SST, etc.	Bucket, thermometer	ECS, A-line, O-line, Funka-bay, Tokyo-bay,Seto Inland sea, Chukchi Sea, Bering Sea, North Pacific, Ise-bay, Akkeshi-bay, Toyama-Bay	Campaign
			Other satellites (Main)		**JAXA**	MOD28 SST of AMSR2	MODIS AMSR2	Global	Year-round
Cryosphere	**Snow and Ice covered area [—]**	Release: 10% (comparison with other satellites products)	**In-situ (Auxiliary)**	**Stamnes**	**JAXA**	In-situ snow depth from WMO(GSOD), In-situ snow depth from NOAA(GHCND)	supersonic or laser supersonic or laser	GTS sites GTS sites	Year-round
			Other satellites Climatology (Main)		**JAXA**	L2 snow cover prd. (MOD10、MYD10) L2 snow cover product L1 radiance	MODIS VIIRS Landsat8 etc.	Global	Year-round
		Standard：7% Goal：5%	**In-situ (Auxiliary)**		**JAXA**	In-situ snow depth from WMO(GSOD), In-situ snow depth from NOAA(GHCND)	supersonic or laser supersonic or laser	GTS sites GTS sites	Year-round

			Other satellites **Climatology** **(Main)**		**JAXA**	L2 snow cover prd. (MOD10、MYD10) L2 snow cover product L1 radiance	MODIS VIIRS Landsat8 etc.	Global	Year-round
	Okhotsk sea-ice distribution **[—]**	Release: 10% (comparison with other satellite products)	**Other satellites** **(Main)**	**Stamnes**	**JAXA**	L2 sea-ice cover product (MOD10、MYD10) L2 sea-ice cover product L1 radiance	MODIS VIIRS Landsat8 etc.	Sea of Okhotsk	Dec.-May
		Standard：5% Goal：3%	**In-situ** **(Auxiliary)**		**JAXA**	Sea ice conc. measured from ground, airplane etc.	Human-eye, Camera	Sea of Okhotsk	Dec.-May
			Other satellites **Climatology** **(Main)**		**JAXA**	L2 sea-ice cover product (MOD10、MYD10) L2 sea-ice cover product L1 radiance	MODIS VIIRS Landsat8 etc.	Sea of Okhotsk	Dec.-May
	Snow and ice surface Temperature **[K]**	Release: 5K (comparison with other satellite products and meteorological measurements)	**In-situ** **(Main)**	**Stamnes**	**Aoki, JAXA**	In-situ Tair obtained from GTS, GSOD, GC-Net etc. Longwave radiation observation from PROMICE AWSs.	Thermometer at GTS ArCS II-SIGMA, GC-Net and PROMICE AWSs or ocean bouys	GTS sites etc. ArCS II-SIGMA, GC-Net and PROMICE AWSs on Greenland	Year-round
			Other satellites **(Main)** **Climatology** **(Main)**		**JAXA**	GLI snow surface temp. (Climatology) MODIS snow surf. temp. (Climatology) VIIRS snow surface temp. Landsat8 snow surface temp. (High resol.) Climatology of Tair etc.	GLI MODIS VIIRS Landsat8 etc. Thermometer at GTS sites or ocean bouys	Global, Greenland, Antarctica etc. GTS sites etc.	Year-round Year-round
		Standard：2K Goal：1K	**In-situ** **(Main)**		**Aoki, JAXA**	In-situ Tair obtained from GTS, GSOD, GC-Net etc. In-situ Tsnow, Tair and Longwave radiation data	Thermometer at GTS ArCS II-SIGMA, GC-Net and PROMICE AWSs or ocean bouys IR thermoeter, FT-IR, Thermometer etc.	GTS sites etc. ArCS II-SIGMA, GC-Net and PROMICE AWSs on Greenland Hokkaido, Finland, Greenland, Antarctica etc.	Year-round Campaign

	Snow grain size of shallow layer [μm]	Release: 100% (evaluated with climatology of temperature-snow grain size relationship)	**Other satellites Climatology (Main)**	**Stamnes**	**JAXA**	GLI snow grain size (Climatology) MODIS snow grain size (Climatology) VIIRS snow grain size Landsat8 snow grain size (High resol.) SGLI SIST product In-situ Tair obtained from GTS etc	GLI MODIS VIIRS Landsat8 etc. SGLI Thermometer at GTS	Global, Greenland, Antarctica etc. GTS sites etc.	Year-round
		Standard：50% Goal：30%	**In-situ (Main)**		**Aoki, JAXA**	Snow grain size derived from in-situ snow pit data and optical measurements (reflectance, SSA etc.)	Snow Pit Work Tools, FieldSpecFR, NIR Camera, IceCube, HISSGraS etc.	Hokkaido, Finland, Greenland, Antarctica etc.	Campaign
			Other satellites Climatology (Auxiliary)		**JAXA**	GLI snow grain size (Climatology) MODIS snow grain size (Climatology) VIIRS snow grain size Landsat8 snow grain size (High resol.)	GLI MODIS VIIRS Landsat8 etc.	Global, Greenland, Antarctica etc.	Year-round

Common notes:
*1. Heritage levels from ADEOS-II/GLI study are shown by A-C; A: high heritage, B: Remaining issues, C: new or many issues remaining to be resolved
*2. 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. Accuracies are basically shown by RMSE.

Radiance data notes:
*3. Absolute error is defined as offset + noise; relative error is defined as relative errors among channels, FOV, and so on. 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

Atmosphere notes:
*4. Vicarious val. on sea-surface temperature and comparison with objective analysis data
*5. Inter comparison with airplane remote sensing on water clouds of middle optical thickness
*6. Release threshold is defined by vicarious val. with other satellite data (e.g., global monthly statistics in the mid-low latitudes)
*7. Comparison with cloud liquid water by in-situ microwave radiometer
*8. Comparison with optical thickness by sky-radiometer (the difference can be large due to time-space inconsistence and large error of the ground measurements)
*9. Comparison with in-situ observation on monthly 0.1-degree
*10. Estimated by experience of aerosol products by GLI and POLDER

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

*12. Night time 250m product can be produced by special observation requests of 1.6µm channel
*13. Evaluate in semiarid regions (steppe climate, etc.)
*14. Fires >1000K occupying >1/1000 on 1km pixel at night (using 2.2um of 1 km and thermal infrared channels)

Cryosphere notes:
*15. Defined as height/width of the surface structures

TABLE C3 Expected reference data for the validation of GCOM-C/SGLI research products

Category	Product [Unit]	Accuracy Targets	Val. Data Type (Main/Auxiliary)	Algorithm PIs	Validation PIs	In-situ Data	Instruments	Observation Sites	Period, Frquency, Obs. Cycles
Land	**Land net primary production [gC/m2/year]**	Goal: 30%(annual ave.)	**In-situ (Main)**	**Yang Tachiiri**	**Nasahara Nagai**	LNPP data derived from various variables measured at flux tower sites	Thermometer, spectrometer, pyranometer etc.	forest：Yatsugatake, grass・forest：JaLTER, JapanFlux, PEN sites	Year-round
			Other satellites (Main)			LNPP products derived from other satellites	MODIS VIIRS etc.	Global covering every typical LCT	Year-round
	ET index [—]	Goal: 10% (as classification error)(*13)	**In-situ (Main)**	**Tasumi**	**Nasahara JAXA**	Latent heat flux measured at flux tower sites	Eddy Correlation Flux Measurement System	forest：Yatsugatake, grass・forest：JaLTER, JapanFlux, PEN sites AmeriFlux, AsiaFlux	Campaign /Year-round
	Fire detection index [—]	Goal: 20% (as classification error)(*14)	**Other satellites (Main)**	**JAXA**	**JAXA**	Hotspots data derived from other satellites	MODIS Landsat8	Global covering every typical vegetation type	Year-round
	Land cover type [—]	Goal: 30% (as classification error)	**In-situ (Main)**	**JAXA Soyama Takagi Nasahara**	**Soyama Nasahara**	Degree Confluence Project (DCP) data		Global covering every typical LCT	Every year (TBD)
			Other satellites (Main)		**JAXA Soyama Nasahara**	L1 radiance data of high resolution satellite Google Earth	Landsat8 AVNIR-2 etc.	Global covering every typical LCT	Seasonally (TBD)
	Land surface albedo [—]	Goal: 10%	**In-situ (Main)**	**JAXA, Susaki**	**Honda-Kajiwara** **Nasahara**	Spectral reflectance data measured at flux tower, RC helocopter etc	Spectometer	forest：Yatsugatake, grass・forest：JaLTER, JapanFlux, PEN sites	Campaign /Year-round
			Other satellites (Main)		**JAXA**	LALB products derived from other satellites	MODIS VIIRS etc.	Global covering every typical LCT	Year-round
Atmosphere	**Water cloud geometrical thickness [m]**	Goal: 300m	**In-situ (Main)**	**Kuji, Nagao**	**Irie, Kuji**	Cloud profile data Cloud bottom height obtained with ceilometer onboard Shirase	Falcon radar Ceilometer	Falcon sites Cruise course of Shirase between Japan and the Antarctica	Year-round Campaign
			Other satellites (Main)			Cloud top height data etc. measured from space	Calipso etc.	Global	Year-round

	Long-wave radiation flux [W/m2]	Goal: Downward flux: 10W/m², Upward: 15W/m² (0.1deg., monthly ave)	**In-situ (Main)**	**Kuji, Nagao**	**Khatri, Yamazaki**	Longwave radiation data from radiation network Longwave radiation data from from flux network	Net radiometer etc.	BSRN, Skynet, JMA etc sites JaLTER, JapanFLux, PEN, Fluxnet sites	Year-round
			Other satellites Climatology (Main)			Clouds and aerosol data Global radiative flux data (ISCCP-FD) Surface Radiation Budget (GEWEX-SRB)	MODIS ISCCP GEWEX	Global	Year-round
	Short-wave radiation flux [W/m2]	Goal: Downward: 13W/m², Upward: 10W/m² (0.1deg., monthly ave)	**In-situ (Main)**	**JAXA, Nagao**	**Khatri, Yamazaki**	Longwave radiation data from radiation network Longwave radiation data from from flux network	Net radiometer etc.	BSRN, Skynet, JMA etc sites JaLTER, JapanFLux, PEN, Fluxnet sites	Year-round
			Other satellites Climatology (Main)			Clouds and aerosol data Global radiative flux data (ISCCP-FD) Surface Radiation Budget (GEWEX-SRB)	MODIS ISCCP GEWEX	Global	Year-round
Ocean	**Euphotic zone depth [m]**	Goal: 30% (inferred from extinction coefficient)	**In-situ (Main)**	**Hirata**	**Toratani Frouin Hirawake, Ishizaka, Suzuki, Kobayashi, Khahru, Antoine, Kuwahara, Isada, Higa, Hirata**	In-situ measured optical data	PRR (Hirawake, etc.) TRIOS (Ishizaka, etc.) C-OPS (Suzuki)	ECS, A-line, O-line, Funka-bay, Tokyo-bay,Seto Inland sea, Chukchi Sea, Bering Sea, North Pacific, Ise-bay, Akkeshi-bay, Toyama-Bay	Campaigns
	Inherent optical properties [1/m]	Goal: Absorption coefficient @440nm: RMSE<0.25 and backscattering coefficient of phytoplankton@550nm: RMSE<0.25	**In-situ (Main)**	**Hirata**	**Toratani, Hirawake, Ishizaka, Suzuki, Kobayashi, Khahru, Antoine, Kuwahara, Isada, Higa,**	Pigment concentration data measured with fluorescense method and HPLC at Ship	Fluorescense method, HPLC	ECS, A-line, O-line, Funka-bay, Tokyo-bay,Seto Inland sea, Chukchi Sea, Bering Sea, North Pacific, Ise-bay, Akkeshi-bay, Toyama-Bay	Campaigns

					Hirata **Frouin**				
	Ocean net primary productivity [mgC/m2/day]	Goal: 70% (monthly ave.)	**In-situ (Main)**	**Hirawake, Ishizaka, Tachiiri**	**Hirawake, Ishizaka, Tachiiri**	ONPP derived from in-situ measurements	FRRF	ECS, A-line, O-line, Funka-bay, Tokyo-bay, Coast of Oita, Chukchi Sea, Bering Sea, North Pacific	Campaigns
	Phytoplankton functional type [—]	Goal: Classification error of dominant/non-dominan t spesies of large/small phytoplankton: 20%, or classification error of dominant functional type in a phytoplankton group: 40%	**In-situ (Main)**	**Hirawake, Hirata**	**Hirawake, Hirata**	Pigment concentration data measured with fluorescense method and HPLC at Ship	Fluorescense method, HPLC	ECS, A-line, O-line, Funka-bay, Tokyo-bay, Coast of Oita, Chukchi Sea, Bering Sea, North Pacific, Okhotsk, East and west of tohoku, east setonai-kai, Ise-bay	Campaigns
	Redtide [—]	Goal: 20% (as classification Error)	**In-situ (Main)**	**Ishizaka, Kobayashi, Higa**	**Ishizaka, Kobayashi, Higa**	Existence of red tide observed by human eyes	Human eye	Funka-bay, Tokyo-bay, Coast of Oita, East and west of tohoku, east setonai-kai, Ise-bay	Campaigns
	Multi sensor merged ocean color parameters [mg/m3]	Goal:-35~+50% (open sea), -50~+100% (coastal)	**In-situ (Main)**	**JAXA, Wang**	**JAXA, Wang**	Pigment concentration data measured with fluorescense method and HPLC at Ship	Fluorescense method, HPLC	ECS, Ariake, A-line, O-line, Funka-bay, Tokyo-bay, Coast of Oita, Chukchi Sea, Bering Sea, North Pacific, Okhotsk, East and west of tohoku, east setonai-kai, Ise-bay	Campaigns
	Multi sensor merged sea surface temperature [℃]	Goal: 0.8K	**Other satellites (Main)**	**JAXA**	**JAXA**	L2 SST products	MODIS, VIIRS	Global	Year-round
			In-situ (Main)		**JAXA**	GTS iQuam (buoy data for AMSR2 val)	Thermometer	GTS sites	Year-round

Cryosphere	**Snow and ice classification [—]**	Goal : 10%	**Other satellites (Main)**	**Stamnes, Aoki**	**JAXA**	L2 snow cover prd. (MOD10、MYD10) L2 snow cover product L1 radiance	MODIS VIIRS Landsat8 etc.	Global	Year-round
			In-situ (Main)		**JAXA**	In-situ photograph taken at Buoy, Ship, etc. Photograph taken from Airplane	Web camera etc.	Buoys, Ships, etc.	Year-round
	Snow area in forest and mountain [—]	Goal : 30%	**Other satellites (Main)**	**JAXA (Stamnes)**	**JAXA**	L2 snow cover prd. (MOD10、MYD10) L2 snow cover product L1 radiance	MODIS VIIRS Landsat8 etc.	Global	Year-round
			In-situ (Auxiliary)		**JAXA**	In-situ photograph taken at ground sites etc. Photograph taken from Airplane	Web camera etc.	Mountain and forest sites, etc.	Year-round
	Snow grain size of subsurface layer [μm]	Goal : 50%	**In-situ (Main)**	**Stamnes, Aoki**	**Aoki**	Snow grain size derived from in-situ snow pit data and optical measurements	Snow Pit Work Tools, FieldSpecFR, NIR Camera, IceCube, HISSGraS etc.	Hokkaido, Greenland, Antarctica etc.	Campaign
	Snow grain size of top layer [μm]	Goal : 50%	**In-situ (Main)**	**Stamnes, Aoki, Kokhanovsky**	**Aoki**	Snow grain size derived from in-situ snow pit data and optical measurements	Snow Pit Work Tools, FieldSpecFR, NIR Camera, IceCube, HISSGraS etc.	Hokkaido, Greenland, Antarctica etc.	Campaign
	Snow and ice albedo [—]	Goal : 7%	**In-situ (Main)**	**Stamnes, Aoki, Kokhanovsky**	**Aoki**	Albedo calculated based on in-situ measured optical data and snow pit work data	Spectrometer (FieldSpecFR etc.), Snow Pit Work Tools, NIR Camera, IceCube, HISSGraS etc.	Hokkaido, Greenland, Antarctica etc.	Campaign
	Snow impurity [ppmw]	Goal : 50%	**In-situ (Main)**	**Stamnes, Aoki, Kokhanovsky**	**Aoki**	Snow impurity concentration estimated from in-situ measured optical data and also directly measured by filtering method	Spectrometer (FieldSpecFR etc.), Snow Pit Work Tools, Snow filteration system	Hokkaido, Greenland, Antarctica etc.	Campaign
	Ice sheet surface roughness [—]	Goal : 0.05 (*15)	**Other satellites (Main)**	**Aoki**	**Aoki**	Roughness estimated from other satellite data	MODIS, MISR, VIIRS Landsat8 etc.	Greenland, Antarctica	Annually

			Model (Main)			Roughness estimated through simulations of snow BRDF using radiative transfer code	Radiative transfer code (ARTMASS)	Greenland, Antarctica etc.	Annually
	Ice sheet boundary monitoring [—]	Goal：<500m	**Other satellites Climatology (Auxiliary)**	**JAXA**	**JAXA**	L1 radiance data	MODIS VIIRS Landsat8 etc.	Antarctica etc.	Monthly

Common notes:
*1. Heritage levels from ADEOS-II/GLI study are shown by A-C; A: high heritage, B: Remaining issues, C: new or many issues remaining to be resolved
*2. 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. Accuracies are basically shown by RMSE.

Radiance data notes:
*3. Absolute error is defined as offset + noise; relative error is defined as relative errors among channels, FOV, and so on. 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

Atmosphere notes:
*4. Vicarious val. on sea-surface temperature and comparison with objective analysis data
*5. Inter comparison with airplane remote sensing on water clouds of middle optical thickness
*6. Release threshold is defined by vicarious val. with other satellite data (e.g., global monthly statistics in the mid-low latitudes)
*7. Comparison with cloud liquid water by in-situ microwave radiometer
*8. Comparison with optical thickness by sky-radiometer (the difference can be large due to time-space inconsistence and large error of the ground measurements)
*9. Comparison with in-situ observation on monthly 0.1-degree
*10. Estimated by experience of aerosol products by GLI and POLDER

Land data notes:
*11. Defined with land reflectance~0.2, solar zenith<30deg, and flat surface. Release threshold is defined with AOT@500nm<0.25
*12. Night time 250m product can be produced by special observation requests of 1.6μm channel
*13. Evaluate in semiarid regions (steppe climate, etc.)
*14. Fires >1000K occupying >1/1000 on 1km pixel at night (using 2.2um of 1 km and thermal infrared channels)

Cryosphere notes:
*15. Defined as height/width of the surface structures

Table C4 Definition of the disclosure level (DL)

Disclosure level (A-D) to be set by data provider	EORC researchers	GCOM PI	EarthCARE PI	Registered users	General users	Usage
(A) EORC Internal use only	OK	-	-	-	-	1) Cal & Val of SGLI products and/or applications for Earth sciences (such as scatter plots, statistics from which raw data cannot be reproduced) are possible to be published. It is necessary to describe the use of JAXA's database and the organization of data acquisition in the acknowledgement *1 2) Redistribution of the raw data is prohibited.
(B1) GCOM related PIs only	OK	OK	-	-	-	1) Cal & Val of GCOM products and/or applications for Earth sciences are possible to be published. It is necessary to agree with data provider about how to acknowledge the favor (e.g., including data provider as a co-author or in the acknowledgement) and to describe the use of JAXA's database and the organization of data acquisition in the acknowledgement*1. 2) Data use beyond the objectives of the GCOM mission is prohibited. 3) Redistribution of the raw data is prohibited.
(B2) GCOM & EarthCARE PIs only	OK	OK	OK	-	-	1) Cal & Val of EarthCARE products and/or applications for Earth sciences are possible to be published. It is necessary to agree with data provider about how to acknowledge the favor (e.g., including data provider as a co-author or in the acknowledgement) and to describe the use of JAXA's database and the organization of data acquisition in the acknowledgement *1. 2) Data use beyond the objectives of the EarthCARE & GCOM mission is prohibited. 3) Redistribution of the raw data is prohibited.
(C) Registered users	OK	OK	OK	OK	-	1) User registration is required. 2) Applications for Earth sciences are possible to be published. It is necessary to submit an application form to JAXA prior to the publication. Also, it is necessary to to describe the use of JAXA's database and the organization of data acquisition in the acknowledgement*1. 3) Redistribution of the raw data is prohibited.
(D) Open to the public (no limitation)	OK	OK	OK	OK	OK	1) It is necessary to describe the use of JAXA's database when using the data and publishing results. It is also necessary to report the results of publication to JAXA*1. 2) Redistribution of the raw data is prohibited.

*1 follow the JAXA's policy on data use

Table C5 GCOM-C PIs in the previous RA

	PI_Name	Affiliation	Research title
Land	Yoshiaki HONDA	Chiba Univ.	Upgrading AGB estimation using BRDF based on SGLI observation data.
	Kenlo Nasahara	Tsukuba Univ.	Development of LAI/FAPAR product and global land cover maps
	Hideki KOBAYASHI	JAMSTEC	Development of the voxel-based plant canopy radiative transfer and estimation and validation of large-scale ecosystem parameters from SGLI
	Tatsuro Nakaji	Hokkaido Univ.	Development of multiscale forest AGB validation sites equipping tree census and 3D forest volume data set
	Wei Yang	Chiba Univ.	Generation of global land surface phenology and carbon flux products using GCOM-C/SGLI data
	Masao MORIYAMA	Nagasaki Univ.	Development and improvement of GCOM-C/SGLI LST estimation algorithm, Development and improvement of GCOM-C/SGLI Shadow index estimation algorithm
	Noriko SOYAMA	Tenri Univ.	Development of global land cover classification algorithms and validation methods
	Masahiro Tasumi	Miyazaki Univ.	Development of GCOM-C Global ETindex Estimation Algorithm
	Takayuki KANEKO	Tokyo Univ. ERI	Advanced volcano observation using GCOM-C SGLI images: elucidation of the eruptive process and examinations towards operational monitoring
	Masataka TAKAGI	Kochi Univ. of Technology	Improvement of Mapping Tender Green and Autumn Color using GCOM-C
Atmosphere	Takashi Nakajima	Tokai Univ.	Global observations of cloud from the GCOM-C SGLI for improving cloud sciences and contributing climate change studies, -Algorithms and validation-
	Kentaroh Suzuki	Tokyo Univ. AORI	A study of cloud microphysical structures and processes with a combined use of GCOM-C/SGLI multi-wavelength measurements
	Hironobu Iwabuchi	Tohoku Univ.	Development of an algorithm for three-dimensional cloud from multispectral and multidirectional measurement by SGLI and validation of cloud products
	Hiroshi Ishimoto	JMA MRI	Advanced volcanic ash algorithm using multiple satellites observation
	Sonoyo Mukai	The Kyoto College of Graduate Studies for Informatics	Elucidation of the characteristics of atmospheric particulates through the integrated use of "polarization and simultaneous multi-wavelength (including near-ultraviolet) observation data" by SGLI
	Miho Sekiguchi	Tokyo Univ. of Marine Science and Technology	Improvement of an advanced remote sensing algorithm for atmospheric aerosols using SGLI
	Makoto KUJI	Nara Women's Univ.	Retrieval and validation of cloud geometrical properties
	Hitoshi Irie	Chiba Univ.	Promotion of applied researches with GCOM-C atmosphere products by precise validation utilizing SKYNET and A-SKY international ground-based remote sensing observation networks
	Akihiro Yamazaki	JMA MRI	Acquisition of validation data by ground-based radiation observation and evaluation of GCOM-C atmospheric products
	Kazuma Aoki	Toyama Univ.	Aerosol optical properties of atmosphere and their effects of earth climate change
	Pradeep Khatri	Soka University	Quality assessment of cloud properties observed by SGLI/GCOM-C
	Hiroshi Kobayashi	Yamanashi Univ.	Validation of GCOM-C products related to marine aerosols by shipboard observation and development of mineral dust index
	Jérôme RIEDI	Université de Lille	Investigation of the cloud top thermodynamic phase from the synergistic use of polarimetric, multi-directional, and high temporal resolution observations
Ocean	Hiroto Higa	Yokohama National Univ.	Development of high accuracy GCOM-C ocean color products and water quality data assimilation system for coastal areas and lakes
	Taka Hirata	Hokkaido Univ.	Validating and updating SGLI ocean colour products for marine ecosystem applications
	Joji Ishizaka	Nagoya Univ.	Validation of GCOM-C coastal products and the application
	Shintaro Takao	NIES	Effects of phytoplankton community composition and new production on nitrogen and carbon dynamics: A GCOM-C/SGLI perspective
	Toru Hirawake	NIPR	Practical use of the GCOM-C/SGLI 250 m resolution data in the Antarctic sea ice zone and its implication for estimations of phytoplankton biomass and primary production
	Robert Frouin	Scripps Institution of Oceanography	Estimating the fraction of PAR absorbed by live phytoplankton from SGLI data (A global time series of the fraction of photosynthetically available radiation absorbed by live phytoplankton from GCOM-C SGLI data)
	David Antoine	Curtin Univ.	Validation of GCOM-C/SGLI geophysical products over varied oceanographic regimes
	Victor S. Kuwahara	Soka Univ.	Characterization and Application of GCOM-C Bio-optical Products in Oceanic, Coastal and Inland Waters
	Eko Siswanto	JAMSTEC	GCOM-C SGLI-based near-real-time observing system for monitoring ocean color in Asian waters
	Joaquim I. Goes	Columbia Univ.	(A) Sea Surface Nitrate and Nitrate Based New Production - two innovative research products from SGLI on board GCOM-C, and (B) Exploiting multi-platform, multi-sensor data for improved measurements of Net Primary Production from GCOM-C SGLI for climate change studies

Cryosphere	Fumihiro Takahashi	Green & Life Innovation, Inc	Application examination research on the use of GCOM-C data for predicting and preventing biofouling on fixed nets in coastal areas
	Menghua Wang	NOAA/NESDIS/STAR	NOAA-JAXA Collaborations: Evaluation and Applications of SGLI/GCOM-C Ocean Color Products
	Lachlan McKinna	Go2Q Pty Ltd	Advanced NASA inherent optical properties algorithm support for SGLI
	Teruo Aoki	NIPR	Algorithm improvement and validation for GCOM-C/SGLI snow and ice products
	Knut Stamnes	Stevens Institute of Technology	GCOM-C/SGLI snow/ice products: Improvements and continued validation with post-launch data
	Masahiro Hori	Toyama Univ.	Development of an advanced method for monitoring the Arctic environments using GCOM-C/SGLI and the in-situ data collection and the collaboration with a numerical climate model for enhancing the value of the SGLI cryosphere products
Multidisciplinary	Keiya Yumimoto	Kyusyu Univ.	Development of aerosol assimilation and forecasting system with data from multiple space-borne observation platforms
	Daisuke Goto	NIES	Research on air pollution prediction by assimilating aerosol products retrieved from satellites
	Sei-Ichi Saitoh	Digital Hokkaido	Sustainable use of salmon resource under changing climate using multiple satellite datasets
	Tomonori Isada	Hokkaido Univ.	Validation for ocean color products and development of marine spatial information using multiple satellite applications in the coastal waters of Hokkaido: toward sustainable management of fisheries resources
	Atsushi Matsuoka	Univ. New Hampshire	Decadal trends in organic carbon stocks in a changing Arctic Ocean: multi-sensor approach
	Takemasa Miyoshi	RIKEN	Advances and applications of satellite data assimilation of clouds, precipitation, and the ocean
	Kaoru Tachiiri	JAMSTEC	Contribution to satellite products development by sharing needs and results of a climate change research project
	Naohiko Hirasawa	NIPR	The current state of snowfall and surface melting on the Antarctic ice sheet and understanding the relationship with global warming using ground-based and satellite observations

Table C6

Assessment condition	Success level	***Minimum success***	***Full success***	***Extra success***
data production	***Standard product**** [1] *(Set release threshold/ standard/ target accuracies)*	Complete calibration and validation phase and start data distribution of more than 20 products[*3] achieving the release threshold accuracy[*2] about 1 year after launch.	Achieve standard accuracies of all standard products, within 5 years after launch,	Achieve the target accuracy of one or more products within 5 years after launch.
	Research product* [1] *(Set only target accuracy)*	NA	NA	Achieve the target accuracy of one or more products within 5 years after launch or add new important products for climate change research.
data distribution	*Real-time availability*	When the products achieve the release threshold accuracy, confirm ability to distribute the data within the required time.	Continue required-time data distribution during the operation period from confirmation of the release threshold accuracy to 5 years after launch.	NA
	Continuity	When the products achieve the release threshold accuracy, confirm ability to continuously observe and distribute products.	Continue observation[*4] and data distribution from confirmation of release threshold accuracy to 5 years after launch.	NA

*1 Standard products are defined as products that are especially important for achieving the mission goal, sufficiently confirm the application reality from ADEOS-II results etc. and are suitable for operational data distribution. Research products are defined as products still in the research phase of development and application or are unsuitable for operational data distribution.

*2 Release threshold accuracy: Minimum accuracy for release as available for climate research

*3 The threshold number of products, 20, corresponds to the number of ADEOS-II GLI standard products in the GCOM-C standard products.

*4 This means to obtain observation data continuously during the planned Earth-observation operation period