GLOBAL CHANGE OBSERVATION MISSION (GCOM)

Keizo Nakagawa

JAXA, Space Applications Mission Directorate, GCOM Project Team, 2-1-1 Sengen, Tsukuba-shi, Ibaraki, Japan – nakagawa.keizo@jaxa.jp

Commission VIII, JAXA Special Session

ABSTRACT

JAXA (Japan Aerospace Exploration Agency) initiated GCOM (Global Change Observation Mission) to monitor the global Earth surface and contribute to the research of the climate change and the operational usage. By using the satellite observation data in the climate system model, it is expected that the prediction accuracy of the climate change will be improved. This information will be useful for making a policy to mitigate and adapt to the climate change.
GCOM consists of 3 generations of satellites to make observation for more than 10 years. The satellites of the first generation, GCOM-W1 and GCOM-C1, have been developed to aim at the launch in Japanese Fiscal Year 2011 and 2014, respectively.

KEY WORDS: GCOM, GCOM-W, GCOM-C, AMSR2, SGLI, VNR, IRS

1. INTRODUCTION

Understanding, assessment, and prediction of global climate change are very important for human life recently. At the Third Earth Observation Summit held in Brussels in February 2005, the 10-year implementation plan for GEOSS (Global Earth Observation System of Systems) was adopted. The vision for GEOSS is to realize a future, when decisions and actions for the benefit of humankind are informed by coordinated, comprehensive, and sustained Earth observations and information. Space agencies are constructing space components, in order to satisfy this vision. In the nine societal benefit areas of GEOSS in space applications, Japan emphasizes monitoring of disaster, climate change, and water circulation.
As a contribution to this activity, JAXA (Japan Aerospace Exploration Agency) initiated GCOM (Global Change Observation Mission). GCOM will take over the mission of the Advanced Earth Observing Satellite-II (ADEOS-II) and be developed into a long-term mission for monitoring the Earth.

2. OVERVIEW OF GCOM

GCOM contains of 2 kinds of satellites, GCOM-W series satellites and GCOM-C series satellites. The W of GCOM-W stands for “water” and GCOM-W will contribute to the observation related to the global water and energy circulations, which installs AMSR2 (Advanced Microwave Radiometer 2). On the other hand the C of GCOM-C stands for “climate” and GCOM-C will contribute to the surface and atmospheric measurements related to the carbon cycle and radiation budget, which installs SGLI (Second Generation Global Imager).
GCOM is a long-term mission to require observation for more than 10 years. To realize this purpose it is planned that 3 generations of satellites of 5 year design life will be launched in series, taking account of one year operational overlap in orbit for calibration. This plan enables over 13-year observation in total. [1]

Table 1. The characteristics of GCOM-W1 and GCOM-C1

	GCOM-W1	GCOM-C1
Orbit	Sun synchronous orbit (A-Train orbit) Altitude：699.6km（on Equator） Inclination：98.2° Local sun time：13:30±15min	Sun synchronous orbit Altitude：798km（on Equator） Inclination：98.6° Local sun time：10:30±15min
Life	5 years	5 years
Launch	JFY 2011 by H-IIA Rocket	JFY 2014 by H-IIA Rocket
Satellite scale	5.1m（X）×17.5m（Y）×3.4m（Z）（on-orbit）	4.6m（X）×16.3m（Y）×2.8m（Z）（on orbit）
Satellite mass	1991kg	2093kg
Power generation	More than 3880W（EOL）	More than 4000W（EOL）

3. GCOM-W1

3.1. Satellite system

GCOM-W1 is the first generation of GCOM-W series satellites. The characteristics of GCOM-W1 system are shown in Table 1. The attitude of GCOM-W1 is controlled by 4 reaction wheels in response to the signal from IRU (Inertial Reference Unit) calibrated by Star Trackers and GPS receivers. The electrical power system has 2 redundant systems including batteries and solar paddles, and therefore the satellite can survive even if one solar paddle has a failure. The satellite is controlled by the tele-commands from the ground stations using S band link. The real-time and stored observation data are transmitted to the ground stations by X band link, together with the real-time and stored telemetries.

The satellite has been developed since 2007. AMSR2 CDR was finished in January, 2009 and the flight model has been manufactured. The AMSR2 integration has been performed and the environmental test will be performed in summer, 2010. The satellite system CDR finished in December 2009. At the present the flight models of satellite bus components are under the electrical and environmental tests. The system test of the GCOM-W1 flight model will be performed from autumn, 2010. GCOM-W1 is planned to be launched in JFY (Japanese Fiscal Year) 2011. Figure 1 shows the configuration of GCOM-W1 in orbit. [2]

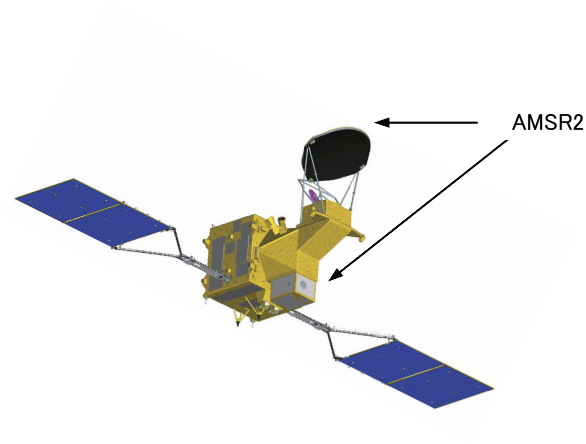

Figure 1. In-orbit configuration of GCOM-W1

3.2. AMSR2

AMSR2 is the follow-on instrument of AMSR-E installed on AQUA. The sensor unit including the main reflector is rotated at 40 rpm and receives the RF radiated from the Earth. The RF level from the Earth is calibrated by both the cold referenced data from the deep space reflected by the cold sky mirror and the hot referenced data from the hot temperature noise source of AMSR2. The configuration of AMSR2 sensor unit is shown in Figure 2.

AMSR2 has receivers of 6 channels, from 7 GHz to 89 GHz. These are basically same as AMSR-E, but 7.3 GHz channel was newly added to mitigate the RF interference of 6.9 GHz by the terrestrial communication link. The detailed channels and frequencies of AMSR2 are indicated in Table 2. The diameter of the main reflector becomes larger to about 2 m. The thermal control of the hot load has been improved and then its surface temperature will be much more stable than AMSR-E. The swath of AMSR2 is 1450 km in a cross track. [3]

The level 2 products of AMSR2 are listed in Table 3.

Table 2. The AMSR2 channels and frequencies

AMSR2 Channel Set				
Center Freq. [GHz]	Band width [MHz]	Polarization	Beam width [deg] (Ground res. [km])	Sampling interval [km]
6.925/ 7.3	350	V and H	1.8 (35 x 62)	10
			1.7 (34 x 58)	
10.65	100		1.2 (24 x 42)	
18.7	200		0.65 (14 x 22)	
23.8	400		0.75 (15 x 26)	
36.5	1000		0.35 (7 x 12)	
89.0	3000		0.15 (3 x 5)	5

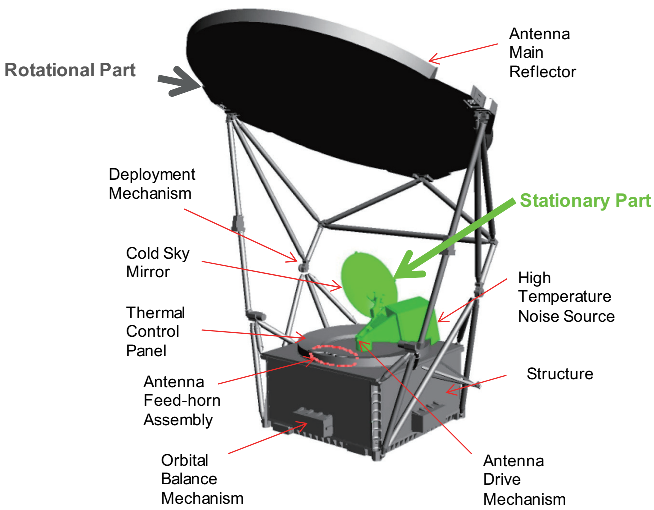

Figure 2. The overview of AMSR2 sensor unit

Table 3. The AMSR2 Level 2 Products

GCOM-W Geophysical Products	Region	Resolution
Integrated Water Vapor	Global Ocean	15km
Integrated Cloud Liquid Water	Global Ocean	15km
Precipitation	Global except Cold Latitudes	15km
Sea Surface Temperature	Global Ocean	50km
Sea Surface Wind Speed	Global Ocean	15km
Sea Ice Concentration	High-Latitude Ocean	15km
Snow depth	Land	30km
Soil Moisture Content	Land	50km

4. GCOM-C1

4.1. Satellite system

GCOM-C1 is also the first generation of GCOM-C series satellites, whose characteristics are shown in Table 1. The design of bus system is almost common between GCOM-W1 and GCOM-C1. The development started in 2009 and the designs of engineering models of SGLI and some bus components, and thermal/structural system model have been performed. The prototype of SGLI was manufactured and had been tested for 4 years. These components are refurbished and will be used in the engineering model test. GCOM-C1 is planned to be launch in JFY 2014. Figure 2 indicates the configuration of GCOM-C1 in orbit.

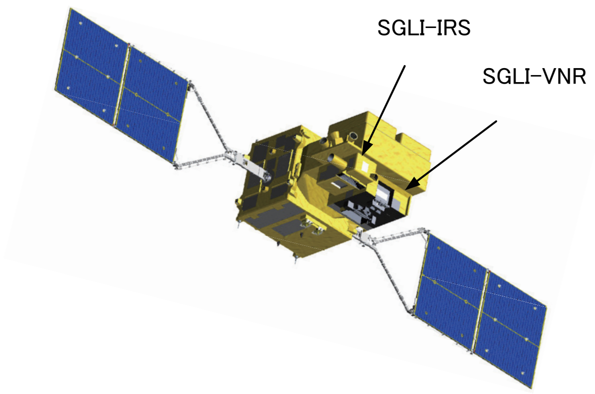

Figure 3. In-orbit configuration of GCOM-C1

4.2. SGLI

GCOM-C1 installs SGLI, which consists of VNR (Visible and Near-Infrared Radiometer) and IRS (Infrared Scanner). The VNR has 11 channels of non-polarized observation and 2 channels of polarized observation, from 380 nm to 870 nm wave length. The polarized channels observe in three polarization angles (0, 60 and 120 degrees) and can tilt forward and backward by 45 degrees in the along-track direction. The IRS has 4 shortwave infrared channels (from 1.05 to 2.21 micro meters wave length) and 2 thermal infrared channels (10.8 and 12 micro meters wave length). The detailed wavelength of each channel is shown in Table 4. The overview of VNR and IRS is illustrated in Figure 4 and 5. The swath of the VNR is 1150 km in a cross track and that of the IRS is 1400 km.
The level 2 products of SGLI are indicated in Table 5.

Table 4. The SGLI channels and wavelengths

SGLI channels					
CH	λ	$\Delta\lambda$	L_{std}	L_{max}	IFOV
	nm		VN, P: $W/m^2/sr/\mu m$ T: Kelvin		m
VN1	380	10	60	210	250
VN2	412	10	75	250	250
VN3	443	10	64	400	250
VN4	490	10	53	120	250
VN5	530	20	41	350	250
VN6	565	20	33	90	250
VN7	673.5	20	23	62	250
VN8	673.5	20	25	210	250
VN9	763	12	40	350	1000
VN10	868.5	20	8	30	250
VN11	868.5	20	30	300	250
SW1	1050	20	57	248	1000
SW2	1380	20	8	103	1000
SW3	1630	200	3	50	250
SW4	2210	50	1.9	20	1000
T1	10800	740	300	340	500
T2	12000	740	300	340	500
P1	673.5	20	25	250	1000
P2	868.5	20	30	300	1000

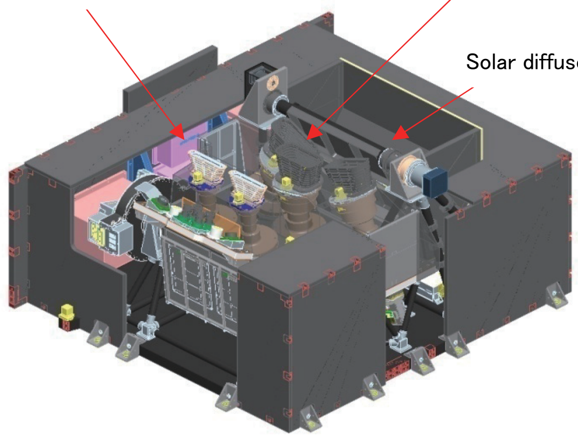

Figure 4. The overview of VNR

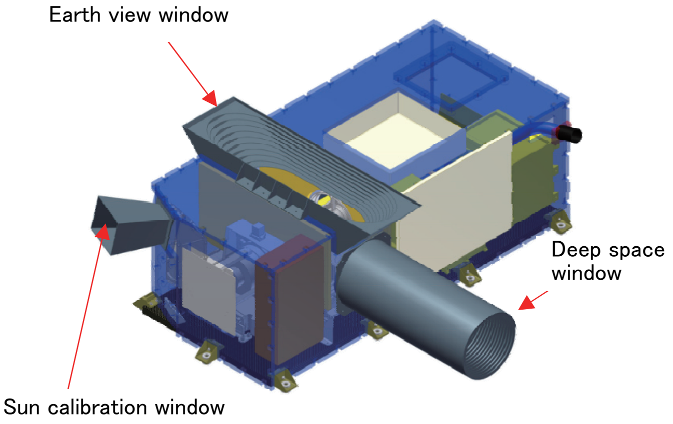

Figure 5. The overview of IRS

Table 5-1. The SGLI Level 2 Products

	GCOM-C Geophysical Products	Resolution
Land	Precise Geometrically Corrected Image	250m
	Atmospherically Corrected Land Surface Reflectance	250m
	Vegetation Index including NDVI and EVI	250m
	Vegetation Roughness Index including BSI_P and BSI_V	1km
	Shadow Index	1km
	Land Surface Temperature	500m
	Fraction of Absorbed Photosynthetically Active Radiation	250m
	Leaf Area Index	250m
	Above-Ground Biomass	1km
	Land Net Primary Production	1km
	Plant Water Stress trend Index	500m
	Fire Detection Index	500m
	Land Cover Type	250m
	Land surface Albedo	1km
Atmosphere	Cloud Flag including Cloud Classification and Phase	1km
	Classified Cloud Fraction	Scene: 1km Global: 0.1deg
	Cloud Top Temperature and Height	
	Water Cloud Optical Thickness and Effective Radius	
	Ice Cloud Optical Thickness	
	Water Cloud Geometrical Thickness	
	Aerosol over Ocean by Visible and Near Infrared	
	Aerosol over Land by Near Ultra Violet	
	Aerosol over Land by Polarization	
	Long-Wave Radiation Flux	
	Short-Wave Radiation Flux	
Ocean	Normalized Water Leaving Radiance	Coast: 250m Open ocean: 1km Global: 4~9km
	Atmospheric Correction Parameters	
	Ocean Photosynthetically Available Radiation	
	Euphotic Zone Depth	
	Chlorophyll-A Concentration	
	Suspended Solid Concentration	
	Absorption Coefficient of Colored Dissolved Organic Matter	
	Inherent Optical Properties	
	Sea Surface Temperature	Coast: 500m Other: ditto
	Ocean Net Primary Production	Coast: 500m Other: ditto
	Phytoplankton Function Type	Coast: 250m Other: ditto
	Red Tide	
	Multi Sensor Merged Ocean Color Parameters	Coast: 250m Open ocean: 1km
	Multi Sensor Merged Sea Surface Temperature	Coast: 500m Open ocean: 1km

Table 5-2. The SGLI Level 2 Products

	GCOM-C Geophysical Products	Resolution
Cryosphere	Snow and Ice Covered Area	Scene: 250m Global: 1km
	Okhotsk Sea-Ice Distribution	250m
	Snow and Ice Classification	1km
	Snow Covered Area in Forest ad Mountain	250m
	Snow and Ice Surface Temperature	Scene: 500m, Global: 1km
	Snow Grain Size of Shallow Layer	Scene: 250m, Global: 1km
	Snow Grain Size of Subsurface Layer	1km
	Snow Grain Size of Top Layer	Scene: 250m, Global: 1km
	Snow and Ice Albedo	1km
	Snow Impurity	Scene: 250m, Global: 1km
	Ice Sheet Surface Roughness	1km
	Ice Sheet Boundary Monitoring	250m

5. DATA ACQUISITION AND DESTRIBUTION

The global observation data stored in the data recorder inside the satellite will be received at Svalbard station in Norway once per orbit. Therefore the data latency of near real-time level 1 products will be achieved in 2.5 hours after the observation time in case of GCOM-W1. GCOM-W1 and GCOM-C1 have capability of direct readout that their real-time observation data can be down-linked to the ground stations. The real-time observation data over Japanese island will be transmitted to the domestic JAXA ground station.
The data product will be obtained at the GCOM website via internet, once researchers register themselves on the website.
In order to develop the algorism of processing data to the level 2 products, JAXA issued the research announcements in 2008 and 2009 for GCOM-W1 and GCOM-C1 respectively. The 29 proposals for GCOM-W1 and 37 proposals for GCOM-C1 were accepted and developing activity has been performed. The PI workshop was held once a year and the progress was confirmed and evaluated.

6. INTERNATIONAL COOPERATION

GCOM-W1 will join the A-Train constellation led by NASA. The position of GCOM-W1 in the constellation is a few minutes prior to AQUA.
JAXA is discussing with NOAA to make cooperation in data exchange, calibration and validation, and data reception support. Both agencies and JPL have performed the feasibility study that the Dual-Frequency Scatterometer provided by NOAA/JPL will be installed on GCOM-W2, the next generation of GCOM-W1, together with AMSR3 which is follow-on instrument of AMSR2.

7. CONCLUSION

The development of GCOM-W1 and GCOM-C1 has been performed as planned. The flight model of GCOM-W1 is manufactured and integrated in order to be launched in JFY 2011. The study for GCOM-W2 is already started. GCOM has been going ahead steadily as a long term observation mission.

8. REHERENCES

[1] K. Imaoka, M. Kachi, H. Fujii, H. Murakami, M. Hori, A. Ono, T. Igarashi, K. Nakagawa, T. Oki, Y. Honda, and H. Shimoda, "Global Change Observation Mission (GCOM) for monitoring carbon, water cycles, and climate change," *Proceedings of the IEEE*, in press.

[2] M. Kachi, K. Imaoka, H. Fujii, A. Shibata, M. Kasahara, Y. Iida, N. Ito, K. Nakagawa, and H. Shimoda, "Status of GCOM-W1/AMSR2 development and science activities," *in Proc. SPIE Europe Remote Sensing*, 2008.

[3] M. Kachi, K. Imaoka, H. Fujii, M. Kasahara, N. Ito, K. Nakagawa, T. Oki, and H. Shimoda, "Long-term observations of water and climate by AMSR-E and GCOM-W," *in Proc. SPIE Europe Remote Sensing*, 2009.