Global Change Observation Mission:

Second Research Announcement

SGLI on GCOM-C1

Algorithm development,
fundamental data acquisition and validation preparation,
and application study

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Earth Observation Research Center
Japan Aerospace Exploration Agency

Contents

1. Introduction

1.1 About the Second Research Announcement

In this second Global Change Observation Mission (GCOM) research announcement (RA), the Japan Aerospace Exploration Agency (JAXA) is announcing the opportunity to conduct development of retrieval algorithms for geophysical products, fundamental data acquisition and validation preparation, and application research directly related to GCOM-C1, which is planned to be launched in the winter of Japanese Fiscal Year (JFY) 2013 as the first generation of GCOM-C (Climate) series. This RA covers a four-year research period beginning in early JFY 2009.

1.2 GCOM and GCOM-C1

GCOM seeks to establish and demonstrate a global, long-term satellite observing system to measure essential geophysical parameters for understanding global climate change and the water cycle mechanism, and eventually contribute to improving future climate projection through a collaborative framework with climate model institutions. Demonstrating capabilities of operational applications through providing continuous data to operational agencies is another important purpose. GCOM will take over the Advanced Earth Observing Satellite-II (ADEOS-II) mission and transition into long-term monitoring of the Earth. To achieve global, comprehensive, long-term, and homogeneous observation, GCOM will consist of two satellite types and three consecutive generations with a one-year overlap, resulting in a 13-year observation period. The two satellites are GCOM-W and GCOM-C (Climate). The GCOM-W1 satellite will carry the Advanced Microwave Scanning Radiometer-2 (AMSR2) to contribute to understanding the water and energy cycle. The GCOM-C1 satellite will be equipped with the Second-generation Global Imager (SGLI) to observe the Earth's atmosphere and surface for contributing to the understanding of the carbon cycle and radiation budget.

SGLI will have special features of wide spectral coverage from 380nm to 12um, a high spatial resolution of 250m, a field of view exceeding 1000km, two-direction simultaneous observation, and polarization observation. The GCOM-C1 mission aims to contribute to improving our knowledge and prediction of the global carbon cycle and radiation budget through high-accuracy observation of global vegetation, ocean color, temperature, cloud, aerosol, and polar regions through the SGLI observations. Details of the SGLI specification are presented in Appendix C.

1.3 Targets of GCOM-C1 and Mission Success Criteria

Objectives, targets and success criteria of GCOM-C1 are set as follows (Tables 1 and 2) considering the long-term objectives of GCOM. This RA advertises research for retrieval algorithms of geophysical products, fundamental data acquisition and validation preparation, and data application to actualize these GCOM-C1 targets by collaboration with JAXA.

Table 1 . GCOM Objectives and GCOM-C1 targets

GCOM Objectives	GCOM-C1 targets
1. Build a long-term observation system that can observe effective physical parameters (e.g., sea-surface temperature, soil moisture, and so on.) continuously (10 to 15 years) for solving the global climate change and water-cycle mechanism, and establishing its usability	1. Produce and distribute satellite observed radiance, 9 land, 8 atmosphere, 7 ocean, and 4 cryosphere products as the standard products
2. Improve the prediction accuracy of long-term climate change by improving the process research on the climate-change mechanism and numerical models, and provide information service in support of national policy decisions by cooperation with user organizations that have climate models.	2. Process and provide satellite data to the Data Integration and Analysis System established by Tokyo Univ., JAMSTEC, and JAXA.
3. Establish a satellite Earth-observation system to obtain important physical parameters to assess the global environment and seek integrative use with other observation systems.	3. Improve the accuracy of predicting climate change by assimilating the data and improving model parameters by cooperating with application research organizations. Through the above activities, confirm the quality of the GCOM data and demonstrate its ability to contribute to predicting the long-term climate change. Contribute to predicting the global environment response to the climate change by observing snow-surface temperature, snow grain size, ocean chlorophyll-a concentration, and so on.
4. Contribute directly to operational fields, such as predicting intense weather that may bring disasters by distributing data to operational organizations that provide weather forecasts, fishery information service, sea-route information control, etc.	4. Improve fishery management by providing data to the Japan Fisheries Information Service Center within the required time frame.
5. Develop new products for effectively clarifying climate change and the water cycle mechanism, which are difficult with the current analysis technology	5. Produce 5 land, 3 atmosphere, 7 ocean, and 8 cryosphere research products by cooperating with research and application organizations.

Table 2. GCOM-C1 Success Criteria

Assessment condition \ Success level		***Minimum success***	***Full success***	***Extra success***
data production	***Standard product***1* *(Set release threshold/ standard/ target accuracies)*	Complete the calibration and validation phase and start data distribution of more than 20 products (*3) achieving the release threshold accuracy (*2) about one year after launch.	Achieve standard accuracies of all standard products, five years after launch,	Achieve the target accuracy of one or more products in five years after launch.
	Research product1* *(Set only target accuracy)*	NA	NA	Achieve the target accuracy of one or more products in five 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 release threshold accuracy to five 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 five years after launch.	NA

*1 The standard products are defined as products especially important for achieving the mission goal, sufficiently confirm the application reality from ADEOS-II results etc., and suitable for operational data distribution. Research products are defined as products still in the research phase of development and application, or 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-C1 standard products.
*4 This means to obtain observation data continuously during the planned Earth-observation operation period

1.4 This RA and Algorithm Development Phases

This RA covers a four-year research period from JFY 2009 to JFY 2012 corresponding to algorithm phase (1), (2), and the first half of (3) in Table 3. This RA emphasizes product development and acquisition of fundamental data for the algorithms (especially for new products, or significant improvement of existing products by applying new ideas). The research plans of this RA have to correspond to the above development phases.

Following this RA, i.e. one year before GCOM-C1 launch, we plan to restart the RA to conduct research more weighted toward operation and product validation during the three years before and after the launch (corresponding to Table 3 RA#2).

Table 3. Main events of GCOM-C1 and algorithm development phases

Japanese Fiscal Year Apr~	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018
Events (launch, evaluations)	♦Project start		♦System PDR	System CDR♦		C1 launch♦	Data Release♦			Mission result evaluation♦ C2 Launch♦	
Research announcement		♦RA#1				♦RA#2			♦RA#3		
Workshop	WS#0♦	WS#1♦	WS#2♦	WS#3♦	WS#4♦	WS#5♦	WS#6♦	WS#7♦	WS#8♦	WS#9♦	WS#10♦
Product release, version up							♦ Ver.1		♦ Ver.2		C-1&2 Ver.3♦
Algorithm implementation				PLI-1 (using other satellite data)		PLI-2 (for the operational system)	Ver.1 development	Improvement with product version up		Implement for C2 (=Ver.2.5)	Version-up implement
Algorithm development/ improvement phase	1. Initial development phase		2. Performance development phase		3. Operational algorithm development phase		4. Post-launch development and improvement phase				
Sensor development/ calibration phase	1. Design and trial manufacturing BBM		2. Sensor manufacturing & performance tests EM PFM				3. Initial calibration phase	4. Operational phase			

Algorithm development phases are defined as follows.

(1) Initial development phase (-JFY2009)

- Select candidates for development.
- Start development of new algorithm and resolve remaining issues of existing algorithms.
- Improve theoretical accuracy using existing satellite and in-situ data.
- Evaluate product sensitivity to the sensor design (BBM and EM).

(2) Performance development phase (JFY2010-2011)

- Develop performance of candidate algorithms (theoretical validity, estimation accuracy, and operational stability using test inputs).
- Develop and validate theoretical performance and applicability by obtaining fundamental data (in-situ, laboratory, and satellite data, etc.).
- Conduct pre-launch implementation test-1 (PLI-1) to evaluate algorithm fundamental performance.
- Evaluate product sensitivity to the sensor design (EM and PFM).
- Prepare Algorithm Theoretical Basis Document (ATBD).

(3) Operational algorithm development phase (JFY2012-2013)

- First half -- Select at-launch algorithms based on the PLI-1 results (the selection will be reflected in the next RA).
- Develop, evaluate, and improve the selected operational codes.
- Last half -- Conduct pre-launch implementation test-2 (PLI-2) to evaluate operational consistency and performance.

(4) Post-launch development and improvement phase (JFY2014-2018)

- Perform initial validation and product improvement (version upgrades) using real SGLI data.
- Perform intensive validation and improvement of algorithms as initial calibration validation phase for one year after launch.
- Develop new research algorithms and usage.
- Obtain fundamental data and validation data for improvement.

・Achieve GCOM-C science targets.

・Achieve succession to and consistency with GCOM-C2.

1.5 Role of PI and the RA process

JAXA plans to select 15 to 20 proposals under this RA. The principal investigator (PI) of each selected proposal will become a member of the SGLI science team (name is provisional). The PI will have frequent discussion and collaboration with JAXA members from the Earth-Observation Research Center (EORC), particularly for developing, validating, improving and integrating retrieval algorithms, and must attend and present their status at PI workshops held once a year. The science team leader will participate in the GCOM general board to feed back our activities to the GCOM overall objectives and mission requirements.

For this RA, JAXA will give budget allocation priority to the areas of algorithm development to meet the product accuracy requirements. Although it will depend on the budget situation, JAXA plans to spend 20 million yen in the first year and 100 million yen in subsequent years of the RA period. JAXA may also select non-funded PIs for research without requirement of additional costs for GCOM or research equally responsible.

All categories of domestic and foreign organizations with nonprofit and peaceful purposes may apply under this RA. However, funding may differ for each research category and applicant. Funding by JAXA is basically restricted to domestic PIs, although some exceptions may be made for research necessary to realize the GCOM mission success.

Proposals will be selected based on a peer-review process and discussions in science/project evaluation boards. JAXA plans to announce the selection results in May 2009. Descriptions of the GCOM mission, satellite and sensor systems, and definition of the products will be found in Appendix C.

2. Technical descriptions

2.1 Purposes of RA

To meet the mission objectives of GCOM-C1, which are to understand global environment variation and to improve its forecast accuracy, this RA seeks to conduct effective research necessary to generate global, long-term, and highly accurate and stable GCOM-C1 products, as well as demonstrate research in climate and carbon-cycle changes using those products by inviting research themes from both domestic and overseas scientists. The RA research will be conducted with collaboration and work-sharing among the JAXA EORC GCOM research and application group, which succeeded the ADEOS-II GLI algorithm implementation team (GAIT).

2.2 Research areas

Based on the GCOM-C1 objectives, JAXA seeks proposals in the following three research areas: development of retrieval algorithms for geophysical products, fundamental data acquisition and validation preparation, and application research directly related to GCOM-C1 data. In particular, this RA emphasizes product development and acquisition of fundamental data for algorithms (especially for new products, or significant improvement of existing products by applying new ideas) because the period corresponds to the one-year preparation period before the GCOM-C1 launch. Details are listed below.

(1) Development of retrieval algorithms for geophysical products

The GCOM-C1 algorithm development process is described below.

- Develop algorithms efficiently by building on the ADEOS-II/GLI experience and systems (e.g., GAIT).
- Develop algorithms effectively by applying broad knowledge obtained from cooperation with PIs.
- Develop algorithms for making long-term, stable, and highly accurate datasets.
- Develop algorithms considering research on global environmental change and operational use.
- By developing software enabling a stable process, perform data distribution and data analysis studies quickly and smoothly
- By developing new data analysis and application schemes, enhance future possibility of remote-sensing in Earth-environment observation.
- By developing performance of the total observation system while harmonizing algorithms with satellite and sensor designs, improve data product quality and accuracy, and feed the results to the next satellite and sensor development.

Generally, GCOM-C1 algorithms will be developed through these procedures: (1) definition of products, (2) construction of fundamental data base, (3) development of algorithm theory, (4) coding of radiative transfer, and (5) implementation, tests, and optimization of the JAXA operation system.

This RA mainly covers procedures (2), (3), and (4) ((5) will be included in the last part of the RA period), and seeks research on algorithms for new SGLI functions as well as newly defined products, new ideas significantly improving existing algorithms, radiative transfer of observation targets, and new products and applications. Details of the research issues we propose now are listed in section 2.3.

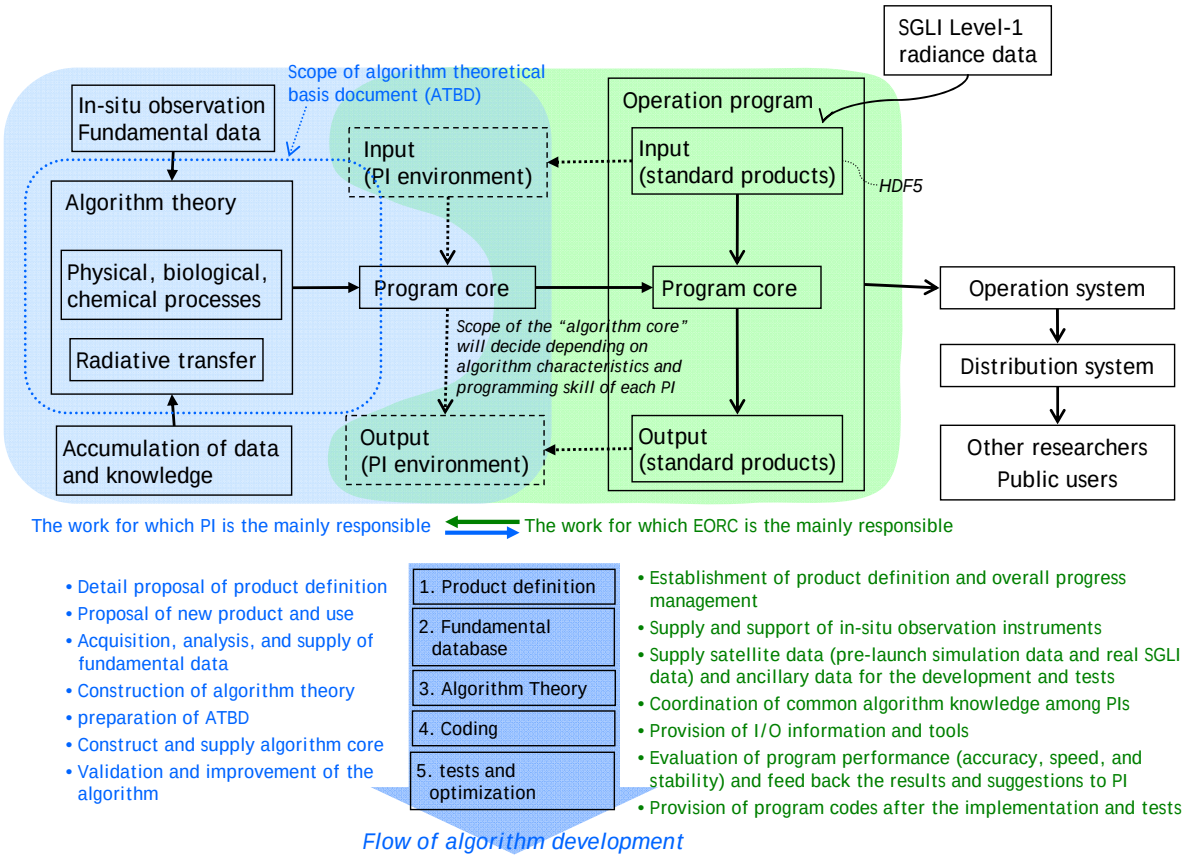

Fig. 1. Example of collaboration and sharing between PI and JAXA in algorithm development. The map should be modified according to algorithm characteristics and volume of the code (C or Fortran code).

Table 4 lists geophysical parameters to be produced as standard and research products of the GCOM-C1 mission; their accuracies are defined as mission success criteria. Those accuracies were defined in consultation with users based on the performance of ADEOS-II/GLI products. The "release threshold accuracy" denotes the minimum accuracy for the first data release, "Standard accuracy" is defined as valuable and standard accuracy, and the "Target accuracy" includes many challenges in improving algorithm performance and/or calibration accuracy and is to be achieved on a research basis. Algorithms accepted in this research area will produce products that meet requirements in Table 4 in the operational phase of the GCOM-C1 mission.

To meet the GCOM objectives, retrieval algorithms will require global applicability, robustness, long-term stability, and low cross-talk. Algorithms that can be extended and applied for similar microwave radiometers and historical data records are preferable for integrated retrieval. Computationally efficient, fast-processing algorithms are important for the operational applications of the products.

As described in chapter 5, this research theme is generally supported through a "Commissioned Research Agreement."

(2) Fundamental data acquisition and validation preparation

The research category includes (a) fundamental data acquisition for improving new or existing algorithms (observation, measurement, and analysis), (b) required preparation of observation sites and validation strategy before the launch, and (c) research contributing to effective validation in

collaboration with other research/observation programs. Additional details of the validation study will be provided in a future RA starting one year before the launch.

Fundamental parameters weighted by the RA are data and knowledge relating bio/physical characteristics and optical observations of the Earth's surface (land, ocean, and snow/ice). One important preparation task for validation is establishing an effective validation strategy of cloud aerosols. Acquired data and knowledge must be provided to JAXA and algorithm PIs speedily.

If you conduct tasks in both algorithm development and this category, you can propose your research as either (1) algorithm development or (2) fundamental data acquisition and validation preparation.

As described in chapter 5, this research theme is generally supported through a Collaborative Research Agreement.

(3) Application research directly related to GCOM-C1 data

Perform research on monitoring environmental changes and improving future prediction and research leading to social benefits including practical applications such as monitoring fishery management and assessing biological carbon fixation using SGLI and other data. Development of new SGLI research products based on new ideas, social needs, and combination with other satellite data and numerical models is also solicited.

As described in chapter 5, this research theme will generally be implemented through a Collaborative Research Agreement.

All applicants should keep in mind that JAXA is not a general funding body for the scientific community. This RA seeks to accomplish the GCOM-C1 mission's goals and to find new possibilities for utilizing GCOM-C1 data. Proposals should clearly describe plans for GCOM-C1 data usage.

Table 4. GCOM-C1 Products (1/3)

Area	*Group*	*Product*	*Category*	*GLI heritage*1*	*Day/night*	*Production unit*	*Grid size*	*Release threshold*2*	*Standard accuracy*2*	*Target accuracy*2*
common	Radiance	TOA radiance (including system geometric correction)	Standard	A(non-Pol) B(Pol)	TIR and land 2.2μm: 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<TBD pixel
Land	Surface reflectance	Precise geometric correction	Standard	A	Both	Scene, Global (mosaic 1, 16 days, month)	250m	<1pixel	<0.5pixel	<0.25pixel
		Atmospheric corrected reflectance (incl. cloud detection)	Standard	B	Daytime	Scene, Global (1, 16 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	A	Daytime	Scene, Global (1, 16 days, month)	250m	Grass: 25%, forest: 20% (scene)	Grass: 20%, forest: 15% (scene)	Grass: 10%, forest: 10% (scene)
		fAPAR	Standard	B				Grass: 50%, forest: 50%	Grass: 30%, forest:20%	Grass: 20%, forest: 10%
		Leaf area index	Standard	B				Grass: 50%, forest: 50%	Grass: 30%, forest:30%	Grass: 20%, forest: 20%
		Above-ground biomass	Standard	B	Daytime	Scene, Global (1, 16 days, month)	1km	Grass: 50%, forest: 100%	Grass: 30%, forest: 50%	Grass: 10%, forest: 20%
		Vegetation roughness index	Standard	B			1km	Grass and forest: 40% (scene)	Grass and forest: 20% (scene)	Grass and forest: 10% (scene)
		Shadow index	Standard	B			250m, 1km	Grass and forest: 30% (scene)	Grass and forest: 20% (scene)	Grass and forest: 10% (scene)
	Temperature	Surface temperature	Standard	B	Both	Scene, Global (1, 16 days, month)	500m	<3.0K (scene)	<2.5K (scene)	<1.5K (scene)
	Application	Land net primary production	Research	C	Daytime	Global (month, year)	1km	N/A	N/A	30% (yearly)
		Water stress trend	Research	C	N/A	Scene, Global (1, 16 days, month)	500m	N/A	N/A	10% *13 (error judgment rate)
		Fire detection index	Research	B	Both*12	Scene	500m	N/A	N/A	20% *14 (error judgment rate)
		Land cover type	Research	B	Daytime	Global (month, season)	250m	N/A	N/A	30% (error judgment rate)
		Land surface albedo	Research	B	N/A	Scene, Global (1, 16 days, month)	1km	N/A	N/A	10%
Atmosphere	Cloud	Cloud flag/Classification	Standard	A	Both	Scene, Global（1 day, month）	1km	10% (with whole-sky camera)	Incl. below cloud amount	Incl. below cloud amount
		Classified cloud fraction	Standard	A	Daytime	Global（1 day, month）	1km (scene), 0.1deg (global)	20% (on solar irradiance)*9	15% (on solar irradiance)*9	10% (on solar irradiance)*9
		Cloud top temp/height	Standard	A	Both	Scene, Global（1 day, month）		1K*4	3K/2km (top temp/height)*5	1.5K/1km (temp/height)*5
		Water cloud OT/effective radius	Standard	B	Daytime	Scene, Global（1 day, month）		10%/30% (Cloud OT/radius)*6	100% as CLW*7	50%*7 / 20%*8
		Ice cloud optical thickness	Standard	B	Daytime	Scene, Global（1 day, month）		30%*6	70%*8	20%*8
		Water cloud geometrical thickness	Research	C	Daytime	Scene, Global（1 day, month）		N/A	N/A	300m
	Aerosol	Aerosol over the ocean	Standard	A	Daytime	Scene, Global（1 day, month）		0.1 (Monthly τa_670,865)*10	0.1(scene τa_670,865)*10	0.05 (scene τa_670,865)
		Land aerosol by near UV	Standard	B	Daytime	Scene, Global（1 day, month）		0.15 (Monthly τa_380)*10	0.15 (scene τa_380)*10	0. 1(scene τa_380)
		Aerosol by Polarization	Standard	B	Daytime	Scene, Global（1 day, month）		0.15 (Monthly τa_670,865)*10	0.15 (scene τa_670,865)*10	0.1 (scene τa_670,865)
	Radiation budget	Long-wave radiation flux	Research	C	Daytime	Scene, Global（1 day, month）		N/A	N/A	Downward 10W/m2, upward 15W/m2 (monthly)
		Short-wave radiation flux	Research	B	Daytime	Scene, Global（1 day, month）		N/A	N/A	Downward 13W/m2, upward 10W/m2

Table 4 GCOM-C1 Products (2/3)

Area	*Group*	*Product*	*Category*	*GLI heritage*1*	*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	B	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	A				80% (AOT@865nm)	50% (AOT@865nm)	30% (AOT@865nm)
		Photosynthetically available radiation	Standard	A	Daytime	Scene, Global (1, 8 days, month)		20% (10km/month)	15% (10km/month)	10% (10km/month)
		Euphotic zone depth	Research	B	Daytime	Scene, Global (1, 8 days, month)		N/A	N/A	30%
	In-water	Chlorophyll-a concentration	Standard	A	Daytime	Scene, Global (1, 8 days, month)		−60 to +150% (offshore)	−60 to +150%	−35 to +50% (offshore), −50 to +100% (coast)
		Suspended solid concentration	Standard	A				−60 to +150% (offshore)	−60 to +150%	−50 to +100%
		Colored dissolved organic matter	Standard	A				−60 to +150% (offshore)	−60 to +150%	−50 to +100%
		Inherent optical properties	Research	C	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	A	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	C	Daytime	Scene, Global (1, 8 days, month)	Coast: 500m Others: Same as above	N/A	N/A	70% (monthly)
		Phytoplankton functional type	Research	C	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	B	Daytime	Scene, Global (1, 8 days, month)		N/A	N/A	error judgment rate <20%
		multi sensor merged ocean color	Research	B	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	A	Both			N/A	N/A	0.8K (day & night time)
Cryosphere	Area/ distribution	Snow and Ice covered area (incl. cloud detection)	Standard	A	Daytime	Scene, Global (1, 16 days, month)	250m (scene), 1km (global)	10% (vicarious val with other sat. data)	7%	5%
		Okhotsk sea-ice distribution	Standard	A	Daytime	Area (1day)	250m	10%	5%	3%
		Snow and ice classification	Research	B	Daytime	Global (16 days, month)	1km	N/A	N/A	10%
		Snow covered area in forests and mountains	Research	B	Daytime	Area (1, 8 days)	250m	N/A	N/A	30%
	Surface properties	Snow and ice surface Temperature	Standard	A	Daytime	Scene, Global (1, 16 days, month)	500m (scene), 1km (global)	5K (vicarious val with other sat. data and climatology)	2K	1K
		Snow grain size of shallow layer	Standard	B	Daytime	Scene, Global (1, 16 days, month)	250m (scene), 1km (global)	100% (vicarious val. with climatology between temp-size)	50%	30%
		Snow grain size of subsurface layer	Research	B	Daytime	Scene, Global (1, 16 days, month)	1km	N/A	N/A	50%
		Snow grain size of top layer	Research	C	Daytime	Scene, Global (1, 16 days, month)	250m (scene), 1km (global)	N/A	N/A	50%
		Snow and ice albedo	Research	B	Daytime	Global (1, 16 days, month)	1km	N/A	N/A	7%

Table 4 GCOM-C1 Products (3/3)

Area	*Group*	*Product*	*Category*	*GLI heritage*1*	*Day/night*	*Production unit*	*Grid size*	*Release threshold*2*	*Standard accuracy*2*	*Target accuracy*2*
Cryosphere	Surface properties	Snow impurity	Research	B	Daytime	Scene, Global (1, 16 days, month)	250m (scene), 1km (global)	N/A	N/A	50%
		Ice sheet surface roughness	Research	C	Daytime	Area (Season)	1km	N/A	N/A	0.05 *15
	Boundary	Ice sheet boundary monitoring	Research	B	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.

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

2.3 Science area, Product groups, and Research issues

The science areas, product groups, and research items weighted as "needed" and "desired" by this RA are described below. These definitions of areas (L, A, O, S, and C) and groups do not need to agree to the research unit of the RA, and you can propose research about several products across these areas and groups. When making a research proposal for a single product or a group, you should also carefully consider the relation to products in the same group and between different groups.

These product definitions and their development and validation schemes will be refined in detail through discussion among users, PIs, and JAXA after the RA. You should also propose the details together with the research plans.

L. Land

L-1 Precise Geometric Correction Group

- Precise Geometrically Corrected Image PGCI (Radiance after geometric correction with ground control point also taking into account the pixel altitude; standard product)
  - ✓ SGLI sensor characteristics, especially combined push-broom and whisk-broom sensors, must be considered for the SGLI geometric algorithm/model.
  - ✓ Close collaboration with the geometric system calibration of Level-1 processing that will be conducted by mainly JAXA (C-5) is desired.

L-2 Land Atmospheric Correction Group

- Atmospherically Corrected Land-Surface Reflectance, ACLR (Ground-surface reflectance after the correction of the atmospheric effects such as scattering and absorption by molecules; standard product)
- Vegetation Index, VI (Index parameter as a measure of density and activity of green vegetation. Normalized Difference Vegetation Index, NDVI (calculated from red and near-infrared channel reflectances) and Enhanced Vegetation Index, EVI (an extended vegetation index using visible channel reflectance) are expected; standard product)
- Land surface albedo, LALB（The ratio of upward reflected radiation energy divided by downward solar radiation energy estimated from the type of land cover and the surface reflectances in SGLI spectral bands; research product）
  - ✓ Atmospheric correction is needed to appropriately identify clouds, snow, and fine areas; to separate surface radiance and atmospheric radiances considering error propagation in estimating vegetation and land-cover; and to perform accurate aerosol correction in cooperation with atmospheric algorithms.
  - ✓ The albedo product is desired to consider future usage such as numerical models using multi-channels or directionality.
  - ✓ Collaboration with activities of C-1, C-2, and C-5 is desired.

L-3 Land Primary Production Group

- Fraction of Absorbed Photosynthetically Active Radiation, fAPAR (Fraction of photosynthetically active radiation (wavelength: 400 to 700nm) absorbed by vegetation; standard product)
- Leaf area index, LAI (The ratio of total upper leaf surface of vegetation divided by the surface area

of the land on which the vegetation grows; standard product)

- Water stress trend, WST (Trend of water stress on vegetation estimated from diurnal variation of the surface temperature; research product)
- Land net primary production, LNPP (The net carbon amount fixed by land vegetation, which is the difference between photosynthetic production and the vegetation respiration; research product)
  - ✓ Accurate algorithms are needed to provide sufficient primary production and its input data.
  - ✓ It is desired to estimate land CO_2 fixation in cooperation with studies of carbon cycle and ecological models.
  - ✓ Collaboration with activities of L-6 is desired.

L-4 Above-ground Biomass Group

- Above-ground biomass, AGBIO (Dry weight of above-ground biomass; standard product)
- Vegetation Roughness Index, VRI (Bidirectional reflectance factor Structure Index on Principal plane and Vertical plane BSI_P and BSI_V derived by SGLI multi-angle observation; standard product)
- Shadow index, SI (Fraction of vegetation shadow resulting from its three-dimensional structure. This parameter is estimated using the wavelength dependence of the surface reflectances; standard product.)
  - ✓ Modeling of three-dimensional vegetation structures and directional reflectance from satellite observation is needed.
  - ✓ The above-ground biomass algorithm needs to combine information from multi-angle observation and multi-spectral observation (i.e., use of vegetation indexes).
  - ✓ Comparison and validation between the estimated biomass and time change of NPP are desired.
  - ✓ Collaboration with activities of L-6 is desired for global applicability (VRI is expected to improve land cover classification).

L-5 Land Temperature Group

- Land-surface temperature, LST (Surface temperature of the land surface; standard product)
- Fire detection index, FDI (Position of fire detected using the radiation data in the thermal- and shortwave- infrared bands; research product)
  - ✓ Collaboration with observation of visible and shortwave-infrared reflectance and land cover (L-6) is needed for estimating surface emissivity.
  - ✓ Real-time processing is needed for fire detection.
  - ✓ Collaboration with observation of visible and shortwave-infrared reflectance and land cover (L-6) is desired for detecting burned areas.

L-6 Land Cover Group

- Land cover type, LCT (Land cover type classified using vegetation indices and the surface reflectances in each channel; research product)
  - ✓ Classification considering various applications (including algorithms of NPP, biomass, and LST) is needed.
  - ✓ Effective analysis of SGLI data in combination with higher-resolution satellite data and in-situ validation data is desired.

- ✓ Algorithm using 3D information (L-4) and seasonal change from multi-season SGLI observations is desired.

A. Atmosphere

A-1 Cloud Product Group

- Cloud flag, CLFG (Cloud/Clear discrimination and the type/phase of cloud cover; standard product)
- Classified Cloud Fraction, CLFR (Cloud fraction statistically derived for each cloud type with ISCCP Radiometric Cloud Classification; standard product)
- Cloud-top temperature and height, CLTTH (Cloud-top temperature and height derived from brightness temperature data in the thermal infrared channels; standard product)
- Water Cloud Optical Thickness and Particle Effective Radius, CLOTER_W (Optical thickness of water cloud and the size of cloud droplets; standard product)
- Ice cloud optical thickness, CLOT_I (Optical thickness of ice cloud; standard product)
  - ✓ Collaboration with common subject C-1 is needed.
  - ✓ Comparison with algorithms and products of MODIS, NPOESS, etc. is needed.
  - ✓ Cooperation (research partnership, work sharing, participation in workshops, etc.) with EarthCARE, GPM, and GCOM-W is desired for investigating cloud radiative forcing.
  - ✓ Combined analysis with the numerical model through a radiative transfer model and extension to model assimilation are desired.

A-2 Aerosol Product Group

- Aerosol over the ocean, ARV (Aerosol properties including optical thickness, size distribution (Angstrom Exponent), and aerosol classification; standard product)
- Land aerosol by near ultra violet, ARU (Aerosol over the land detected by near UV including aerosol optical thickness and aerosol absorption coefficient; standard product)
- Aerosol by Polarization, ARP (Optical thickness and angstrom exponent derived from the SGLI polarization observations; standard product)
  - ✓ Contribution to aerosol correction over land and the ocean is needed.
  - ✓ Comparison with algorithms and products of MODIS, NPOESS, etc. is needed.
  - ✓ Effective algorithms for unifying the ocean and land algorithms and for estimating aerosol size distribution, component ratio, etc. are desired in the future.
  - ✓ Cooperation (research partnerships, work sharing, participation in workshops, etc.) with EarthCARE is desired for investigating the cloud-aerosol interaction.
  - ✓ Combined analysis with the numerical model through a radiative transfer model and extension to model assimilation are desired.
  - ✓ Cooperation with the calibration activities such as vicarious calibration (C-3) is requested.

A-3 Radiation Flux Group

- Short-wave radiation flux, SWRF (Downward and upward shortwave radiation flux at the ground surface; research product)

- Long-wave radiation flux, LWRF (Downward and upward longwave radiation flux at the ground surface. Upward flux in cloudy weather conditions will be estimated using the surface temperature derived by AMSR2, etc.; research product.)
- Water cloud geometrical thickness, CLGT_W (Geometrical thickness of water cloud derived using the radiance data in the oxygen band (763nm). Combined use of this parameter with cloud-top height enables us to estimate cloud bottom height, which will then contribute to improving the retrieval accuracy of the longwave radiation budget at the ground surface; research product.)
  - ✓ Cooperation with products of cloud detection, cloud properties, aerosol properties, surface reflectance, etc. is needed.
  - ✓ Combined analysis with the numerical model through a radiative transfer model and extension to model assimilation are desired.

O. Ocean

O-1 Ocean Atmospheric Correction Group

- Normalized water-leaving radiance, NWLR (Water-leaving radiance in each channel at the ocean surface after the correction of atmospheric effects; standard product)
- Atmospheric correction parameters, ACP (Aerosol properties including optical thickness and Angstrom exponent necessary for atmospheric correction; standard product)
- Photosynthetically available radiation, PAR (Downward radiation at wavelengths of 400 to 700nm at the ocean surface that is available for phytoplankton; standard product)
  - ✓ Improvement of treatment of aerosols (C-2) and sea-surface reflection is needed.
  - ✓ Collaboration with the SGLI characterization, calibration including vicarious calibration (C-5), and in-situ observation of NWLR, etc. are desired since ocean color needs highly precise calibration.

O-2 Ocean Color Group

- Chlorophyll-a concentration, CHLA (Concentration (mg/m^3) of phytoplankton Chlorophyll-a in the ocean surface layer; standard product)
- Suspended solid concentration, SS (Density of suspended solids (g/m^3) consisting of organic matter such as plankton and inorganic matter such as soil particles, in the ocean surface layer expressed in dry weight per unit volume; standard product)
- Colored dissolved organic matter, CDOM (attenuation coefficient (m-1) at 440nm (TBD) of colored dissolved organic matter in the ocean surface layer; standard product)
- Inherent optical properties, IOP (Optical properties of ocean water such as absorption coefficients of plankton pigment, SS, CDOM, and scattering coefficients of SS, which are estimated using the normalized water-leaving radiances; research product)
- Phytoplankton functional type, PHFT (Phytoplankton existence rate for every function, such as nitrogen fixation, silicon fixation, and carbon dioxide discharge. It determines what kind of function plankton has for climate change analyses, such as cloud nucleus formation; research product)
- Red tide, RTD (Discrimination of red tide using the characteristic of ocean color; research product)
  - ✓ Improvement of algorithms considering application to the ONPP estimation, operational stability and inter-sensor consistency through construction and analysis of fundamental datasets and in-water optical

model development is desired.

- ✓ Combined analysis with the numerical model through in-water bio-optical models and extension to model assimilation are desired.

O-3 Temperature

- Sea-surface temperature, SST (bulk sea-surface temperature (observed by drifting buoy at 1m) by degree C; standard product)
  - ✓ Stable and highly accurate algorithm considering operational purpose and model research and combined use with other sensors such as AMSR-2 are desired.
  - ✓ Algorithm and product effectively using 500m resolution of SGLI is desired.

O-4 Primary Productivity

- Ocean net primary productivity, ONPP (Net primary productivity of phytoplankton (Respiration is not considered) ; research product)
- Euphotic zone depth, EZD (Total direction illumination defined by a depth that PAR is decreased to 1% (denominator: E0-); research product)
  - ✓ Combined analysis with the numerical model through in-water bio-optical models and extension to model assimilation are desired.
  - ✓ In order to contribute to estimating CO_2 absorption of the ocean, cooperation with carbon-cycle and marine-ecosystem model research activities (C-4) is desired.

O-5 Multi-Sensor Merged Product

- Multi-sensor Merged Ocean Color parameters, MOC (Data sets that combine with the products of other satellites and improve time resolution; research product)
- Multi-sensor Merged Sea-Surface Temperature, MSST (Data sets that combine with the products of other satellites and improve time resolution; research product)
  - ✓ Combined products overcoming differences among channel wavelengths, sensor characteristics, algorithms, data formats, etc. are desired.

S. Cryosphere

S-1 Snow Area Discrimination

- Snow- and Ice-covered area, SICA (Snow and ice discrimination; standard product)
- Okhotsk sea-ice distribution, OKID (Sea-ice distribution in Okhotsk Sea processed in near real time; standard product)
- Snow and ice classification, SIC (Snow and ice cover type such as new snow or old snow, or first year ice/multi-year ice, etc.; research product)
- Snow-covered area in forests and mountains, SCAFM (Snow-covered area in forest and mountain regions where vegetation cover is likely mixed with snow; research product)
- Ice sheet boundary monitoring, ISBM (Position of major Ice sheet boundary; research product)
  - ✓ Contribution to other groups through C-1 activities, such as discrimination between cloud and snow/ice area

is needed.

S-2 Snow-Surface Properties

- Snow and ice surface Temperature, SIST (Surface temperature of snow and ice surface; standard product)
- Snow grain size of shallow layer, SNGSL (Snow grain size retrieved with the reflectance in the 865nm channel. Retrieved sizes represent the snow properties in a shallow layer of 0 to 30cm; standard product)
- Snow grain size of subsurface layer, SNGSS (Snow grain size retrieved with the reflectance in the 1050nm channel. Retrieved sizes represent the snow properties at a subsurface layer above that retrieved with the 865nm channel; research product)
- Snow grain size of top layer, SNGST (Snow grain size retrieved with the reflectance of the 1640nm channel. Retrieved sizes represent the properties of the top snow layer; research product)
- Snow impurity, SNIP (Ratio of impurity in snow such as soot and dust; research product)
  - ✓ In order to contribute to Earth-environment monitoring and climate prediction, cooperation with research on snow physical-optical processes (S-3) and numerical models (C-4) is desired.

S-3 Snow Albedo

- Snow and ice albedo, SIALB (Upward reflected radiation energy divided by downward solar radiation energy estimated using the snow-surface reflectances in each channel considering atmospheric effects; research product)
- Ice sheet surface roughness, ISRGH (Roughness of the ice sheet (defined as the ratio of the height divided by the width of the roughness) derived by multi-angle observation; research product)
  - ✓ Cooperation with S-2 group, which measures the snow grain size and impurities that significantly influence the albedo, is desired.

C. Common issues

The common issues that encourage interaction among PI activities are coordinated by JAXA EORC.

C-1 Clear, Cloud, Cryosphere discrimination

- A common task in most SGLI products is distinguishing among clear, cloud, and snow/ice surfaces. However, it is necessary to develop a proper discrimination scheme specific for each algorithm. JAXA will encourage PI teams to share their knowledge of spectral features of each observation target and the discrimination schemes, and to effectively implement the individual algorithms.

C-2 Aerosol Correction

- It is necessary to separate the light reflected from observation targets from atmospherically scattered light in order to estimate the surface reflectance (land, ocean, and snow) from the satellite-observed radiances (especially related to the aerosol properties A-2). For this purpose,

JAXA will promote sharing and exchange of knowledge and processing techniques for the radiative transfer process of the atmosphere-surface system.

C-3 Polarization Study

・Polarimetry is a unique function of SGLI. Besides aerosol products derived from polarization (A-2), we will explore the development of new products to be derived from polarization observation and their application. Because polarimetry is a new function also from the point of view of hardware development, close collaboration between JAXA's calibration activity and polarization study by PIs is encouraged.

C-4 Integrated Analysis of Global Environmental Change

・It is necessary to reflect the new requirement and knowledge into our satellite product development through cooperation with research on Earth environmental change such as monitoring and predicting the carbon cycle and radiative forcing. This common group encourages exchange of knowledge and skill from research of model assimilation and combined analysis in each area and group.

C-5 Consideration of SGLI Calibration Performance

・Accuracy of satellite products depends on performance of the total system from the sensor to the algorithm software. It is necessary, therefore, to develop algorithms optimized for actual SGLI performance in step with the progress of SGLI characterization and calibration. For example, the common group will promote close cooperation between the team evaluating the radiative transfer process in the algorithms and the teams conducting ground truth observations and vicarious calibration. Also, collaboration between system geometric correction and precise geometric correction (using GCP) is encouraged.

3. Instructions for responding to this RA

3.1Qualifications

If a proposal is for peaceful purposes and has non-commercial objectives, researchers from all categories of domestic and foreign organizations including educational institutions, government offices, public companies, private enterprises and the other groups can apply for this RA.

3.2 Research agreement conclusion

After the proposals are selected, a research agreement should be made between JAXA and the organization to which the PI belongs, using associated terms and conditions to be prepared by JAXA. All applicants should read carefully Section 5, which describes detailed information on contract matters, and associated terms and conditions of the research agreement attached as APPENDIX D.

3.3 Research period

The total research period of this RA will be four years from JFY 2009. However, the performance will be evaluated based on an interim report at the end of each Japanese fiscal year in order to verify and decide whether the research is to be continued the next year.

3.4 Resources

(1) Funding

JAXA will reserve funds to support selected proposals. The basic policy for funding is as follows.

A) Based on the purpose of this RA, funding will be mainly available for the development of retrieval algorithms category, within JAXA's budget limitation. Proposals related to fundamental data acquisition and validation preparation and to application research directly related to GCOM-C1 may be funded depending on the importance and relevancy to the GCOM mission.

B) JAXA funding is basically restricted to domestic PIs, although some exceptions may be made for research that is necessary for the GCOM mission success.

C) If funding is not available for an applicant, the applicant may be selected as a non-funded PI upon consultation with JAXA.

(1) Data sets

Data including GLI data sets necessary for conducting research and owned by JAXA ("data sets") will basically be provided free of charge within the limitations of the distribution capability. Available data sets are listed in Appendix B. Provision of data sets that JAXA is not authorized to disclose will be discussed separately. The following policy shall be observed by participants for using satellite, in-situ, and other data sets provided through this RA.

A) Data sets shall be used only for research purposes that are proposed and selected under this RA.

B) Data sets shall not be disclosed to a third party or parties.

3.5 Obligations

PIs have different obligations depending on the funding status.

(1) Funded PIs shall submit to JAXA an interim report on the results at the end of each JFY and a final report at the end of the four-year research period. Furthermore, funded PIs are required to participate in the workshop organized by JAXA once a year and present a status report. PIs must cover necessary travel expense for participating in the workshop within funds provided by this RA.
(2) Non-funded PIs shall also submit an interim report and a final report. However, such reports can be substituted with papers published during the term. Participation in the workshop is highly recommended but not mandatory. Support of travel expense will depend on JAXA's budget.

3.6 Selection

Selection of proposals will be based on a peer-review process and discussions in science/project evaluation boards. JAXA selection officials make the final decisions. The principal elements considered in evaluating a proposal are its relevance to the objectives, intrinsic merit and cost. Evaluation of its intrinsic merit includes consideration of the following equally important factors.

(1) Overall scientific and technical merit of the proposal or unique and innovative methods, approaches, or concepts demonstrated by the proposal.
(2) Proposer's capabilities, related experience, facilities, techniques, or unique combinations of these that are integral factors for achieving the proposal objectives.
(3) The qualifications, capabilities, and experience of the proposed PI and CI.
(4) Overall standing among similar proposals and/or evaluation against the state-of-the-art.

3.7 Late proposals

Proposals or modifications received after the date specified in this RA may be considered if the selecting official deems them to offer JAXA a significant scientific and/or technical advantage or cost reduction.

3.8 Withdrawal of proposal

Proposals may be withdrawn by the applicant at any time. To withdraw a proposal, the applicant should immediately notify JAXA.

3.9 Cancellation and postponement

JAXA reserves the right to cancel this RA upon notice delivered by JAXA. In addition, JAXA assumes no liability for canceling this RA or for postponing this RA schedule.

3.10 Important dates

January	9, 2009	2nd Research Announcement issued
March	**31, 2009**	**Proposal Due Date**
July	2009	Notification of Selection Results

3.11 Proposal submission and contact point

Proposals with complete sets of attachments, such as reprints of papers, should be converted to **PDF format and sent via E-mail** to the GCOM RA Office. The maximum file size acceptable by E-mail is 10MB.

E-mail address of GCOM RA Office: GCOM_RA@jaxa.jp

In case of difficulty sending via E-mail, five copies of both proposals and the complete set of attachments should be sent via postal mail to:

Mr. Hiroshi Sasaki (GCOM RA Office)
Earth Observation Research Center (EORC)
Tsukuba Space Center
Japan Aerospace Exploration Agency
2-1-1, Sengen, Tsukuba, Ibaraki, 305-8505, Japan

The point of contact is:

Mr. Hiroshi Sasaki (GCOM RA Office)
Earth Observation Research Center
Tel: +81-29-868-2729
Fax: +81-29-868-2961
E-mail address: GCOM_RA@jaxa.jp

4. Instructions for proposal contents

4.1. General

(1) Proposals received in response to this RA will be used only for evaluation purposes.
(2) The following types of proposals are not acceptable.
   A) Proposals that include restrictions or patents from other institutions.
   B) Proposals that are restricted when distributed or published.
(3) Proposals will not be returned to applicants.

4.2. Format

(1) It is highly recommended that applicants send their proposals and complete sets of all attachments, such as reprints of papers, in **PDF format via E-mail.**
(2) Forms for cover sheet, work plan, and resource requirements can be found in Appendices A and B. No mandatory formats are applied to other parts of the proposal except the following.
   A) The page or paper size should be A4 or Letter size.
   B) The page number must appear at the middle of the bottom of each page, and the name of the applicant must appear in the upper right corner.
   C) Proposals should be word-processing documents in either English or Japanese, with a font size not smaller than 12 points.
(3) Proposals should be brief and to the point, concentrating on substantive materials. The main body of the proposals should not exceed 20 pages in length. Necessary detailed information, such as reprints, should be included as attachments. A complete set of attachments must accompany each copy of a proposal when submitting via postal mail.

4.3 Proposal contents

(1) Cover sheet
   A) Research title
      State your research title precisely and clearly. The title should be brief, reflecting an especially valid project intelligible to a science-literate reader and suitable for use in the public process.
   B) Research category
      Choose the relevant category to which the proposal belongs.
   D) Information of applicants
      - Identifying information of PI.
        State the name, job title, organization, address, E-mail address, and telephone and facsimile numbers of the PI.
      - Identifying information of Co-investigator.
        State the name, organization, telephone number, and E-mail address of each Co-investigator (CI). One research team should consist of only one PI, or one PI and several CIs.
   E) Budget
      Provide a four-year budget broken down by year and the four-year total amount in Japanese Yen (from JFY 2009 through 2012).
   F) Endorsement
      Signature of a responsible official or authorized representative of the proposing organization, or any other person authorized to legally bind the organization.

(2) Abstract

Include a concise, one-page abstract describing the objective, significance, method of approach, and anticipated results.

(3) Description of proposal
This is the main body of the proposal and should not exceed 20 pages in length. This main body shall be a detailed statement of the work to be undertaken, including its objectives and significance, relation to the present state of knowledge, and relation to previous work done on the project and to related work in progress elsewhere. The statement should outline the plan of work, including the broad design of experiments to be undertaken and a description of experiment methods and procedures. The project description should address the evaluation factors in these instructions and any specific factors in the RA. Any substantial collaboration with individuals not referred to in the budget or use of consultants should be described. Subcontracting significant portions of a research project is discouraged.

(4) Work plan (Research schedule)
The research schedule should be outlined in the form indicated in Appendix A.

(5) Management approach
For large or complex efforts involving interactions among numerous individuals or other organizations, plans for distribution of responsibilities and arrangements for ensuring a coordinated effort should be described.

(6) Personnel
A) Biographical information, experience, papers in related fields
A short biographical sketch, a list of publications, experiences related to this RA, and professional qualifications of the PI should be included. Also provide similar biographical information on each CI.
B) Role of CI
The PI is responsible for supervising the work and CIs in the research. State each CI's role in the proposed research.

(7) Resource requirements
Resource requirements should be described in the form indicated in Appendix B. Information of required resources will be considered during the selection process. After deciding the total amount of funding for each PI, JAXA will send more detailed forms for resource requirements to selected PIs for the final adjustment of funding. Before beginning the second, third and fourth years, JAXA will send the same forms for resource requirements again. Instructions for the budget summary and data request are also included in Appendix B.

5. Description of research agreement

5.1 Contractual procedure

(1) After selecting the proposal and the PI, JAXA will send the PI guidelines and an application form for making an agreement. Please note that JAXA will make an agreement with the organization to which the PI belongs ("the Organization"), not to the PI or CI.
(2) A research agreement will be made by using associated terms and conditions as in attached APPENDIX D. The Organization should submit the application form with necessary documents according to the guidelines within the submission due date. The submission of the application form will be regarded as definite intention of making an agreement with JAXA, and the agreement will be effective upon issuance of the confirmation sheet by JAXA.
(3) If JAXA determines that an extension of a research project is justified by the interim report at the end of the Japanese Fiscal Year (JFY), the research agreement will be extended for one year, but no later than March 31, 2013. Funded organizations should submit the continuing agreement application form to JAXA at the every beginning of the JFY.
(4) The organizations shall comply with terms and conditions defined in the research agreement.

5.2 Research agreement summary

There are two types of associated terms and conditions of research agreements based on the applicable category of research, Commissioned Research Agreement and Collaborative Research Agreement. There are also two types of agreements for Collaborative Research Agreement, funded or not funded by JAXA.

(1) Commissioned Research Agreement (Funding)

- In principle, the Commissioned Research Agreement will be applied to research in the development of retrieval algorithms for geophysical products category. The Organization shall conduct the research according to the Statement of Work provided by JAXA.
- JAXA will provide necessary funds and the data sets to the Organization to conduct the research as described in the Statement of Work.
- JAXA will own research results required to be delivered by the Statement of Work (Deliverable Research Results).
- JAXA will retain royalty-free rights to use the Research results other than Deliverable Research Results only for its own research and development purposes.
- In the event JAXA provides prior written consent, the Organization may use Deliverable Research Results for its own research and development purposes.
- If the Agreement is terminated, the Organization will refund to JAXA any unexpended research funds that have already been paid by JAXA.

(2) Collaborative Research Agreement (Funded/Non-funded)

- In principle, the Collaborative Research Agreement will be applied to research in the "fundamental data acquisition and validation preparation" and "application research directly related to GCOM-C1" categories.
- JAXA will provide necessary funds (for funded cases) and the data sets to the Organization to

conduct the research.

- In principle, the research results will be jointly owned by the parties.
- JAXA will retain the right to use all results including results belonging to the Organization (if any), and the Organization will retain the right to use jointly-owned research results only for its own research and development purposes, without prior consent of the other.
- JAXA will provide necessary funds (for funded cases) and the data sets to the Organization to conduct the research.

Difference between funded agreement and non-funded agreement

-Collaborative Research Agreement (Funded)
JAXA provides part of the research funds and the data sets. The Organization shall submit an interim report and a final report to JAXA, and shall participate in the workshops to report research progress. If this agreement is canceled or terminated, the Organization shall refund to JAXA any unexpended funds that have already been paid by JAXA.

-Collaborative Research Agreement (Non-funded):
JAXA provides the data sets. The Organization shall submit an interim report and a final report to JAXA. However, such reports can be substituted with papers published during the research term. Participation in the workshops is highly recommended, but not mandatory.

(3) Publication of results

A PI who wishes to release his or her research results derived from this research activities to a third party shall

- Provide JAXA with a copy of the publication before release,
- State in the publication that he or she obtained the results through participating in this RA research, and
- Grant JAXA an irrevocable and royalty-free right to use the provided publications, unless an academic society responsible for its publication requires the PI to transfer the copyright to it.

APPENDIX A
PROPOSAL COVER SHEET AND SCHEDULE

Proposal Cover Sheet
JAXA GCOM Research Announcement

Proposal No.	_____ (Leave Blank for JAXA Use)
Title	
Research category (circle one)	Algorithm Validation Application

Principal Investigator

Name		Job Title	
Department			
Institution			
Address			
Country			
E-mail			
Telephone			
Facsimile			

Co - Investigator

Name	Institution	Telephone	E-mail

Budget (thousand yen)

JFY2009	JFY2010	JFY2011	JFY2012	TOTAL

(Leave Blank for JAXA Use)

Authorizing Official: _____ _____
(Name and Title) (Institution)

Research Schedule

JFY	2009				2010				2011				2012			
Month	4-6	7-9	10-12	1-3	4-6	7-9	10-12	1-3	4-6	7-9	10-12	1-3	4-6	7-9	10-12	1-3
Milestone																
Activities																

APPENDIX B
RESOURCE REQUIREMENTS

BUDGET SUMMARY

1. Personnel Expenses (unit: thousand yen)

	2009	2010	2011	2012	Total

2. Purchases

2.1 Computers / Peripheral Equipment (unit: thousand yen)

ITEM	2009	2010	2011	2012	Total

2.2 Software (unit: thousand yen)

ITEM	2009	2010	2011	2012	Total

2.3 Expendable Materials and Supplies (unit: thousand yen)

ITEM	2009	2010	2011	2012	Total

3. Subcontracts (unit: thousand yen)

ITEM	2009	2010	2011	2012	Total

4. **Travel Expenses** (unit: days / times or days / travelers)

Departure Point – Destination	2009	2010	2011	2012

5. **Observation Equipment** (unit: thousand yen)

ITEM	2009	2010	2011	2012	Total

6. **Satellite Data** (unit: thousand yen)

Name of Satellite / Sensor	Distributor	Purpose	Cost				
			2009	2010	2011	2012	Total

7. **Other Data** (unit: thousand yen)

Name of Dataset	Distributor	Purpose	Cost				
			2009	2010	2011	2012	Total

8. **Others** (unit: thousand yen)

ITEM	2009	2010	2011	2012	Total

TOTAL (unit: thousand yen) (except "4.Travel Expenses")					

BUDGET SUMMARY (***EXAMPLE***)

1. Personnel Expenses (unit: thousand yen)

	2009	2010	2011	2012	Total
Part-time job for DSD data analysis	*320 (40x8)*	*320 (40x8)*	*160 (20x8)*	*800 (100x8)*	*320 (40x8)*

2. Purchases

2.1 Computers / Peripheral Equipment (unit: thousand yen)

ITEM	2009	2010	2011	2012	Total

2.2 Software (unit: thousand yen)

ITEM	2009	2010	2011	2012	Total

2.3 Expendable Materials and Supplies (unit: thousand yen)

ITEM	2009	2010	2011	2012	Total
8mm tape (112m)	*60*	*50*	*50*	*50*	*210*
CD-R	*100*	*100*	*120*	*120*	*440*
MO (640MB)	*10*	*15*	*10*	*10*	*45*
A4 Paper (package of 500 sheets)	*2*	*2*	*1*	*1*	*6*
CD-RW Drive	*50*				*50*

3. Subcontracts (unit: thousand yen)

ITEM	2009	2010	2011	2012	Total
Software development for DSD data analysis	*300*	*1,500*	*600*	*600*	*3,000*

4. **Travel Expenses** (unit: days / times or days / travelers)

Departure Point – Destination	2009	2010	2011	2012
Tokyo - Washington, D.C.	*7/2*	*7/1*		
Tokyo - Paris		*5/1*	*8/1*	
Tokyo - Paris			*6/1*	*6/1*
Tokyo - Osaka	*3/1*			*3/1*

5. **Observation Equipment** (unit: thousand yen)

ITEM	2009	2010	2011	2012	Total
Micro Rain Radar	*1,500*				*1,500*

6. **Satellite Data** (unit: thousand yen)

Name of Satellite / Sensors	Distributor	Purpose	Cost				
			2009	2010	2011	2012	Total

7. **Other Data** (unit: thousand yen)

Name of Dataset	Distributor	Purpose	Cost				
			2009	2010	2011	2012	Total

8. **Others** (unit: thousand yen)

ITEM	2009	2010	2011	2012	Total

TOTAL (unit: thousand yen) (except "4.Travel Expenses")	*2,342*	*1,987*	*941*	*1,581*	*6,851*

JAXA DATA REQUIREMENTS

1. JAXA-Archived Satellite Datasets

(ADEOS, JERS-1, ERS, MOS, LANDSAT, TRMM, Aqua, ADEOS-II, ALOS)

Name of Satellite / Sensor	Quantity (scenes)	Purpose

B.1 Instructions for budget summary

Provide a budget summary by cost element (Personnel Expenses, Computers/Peripheral equipment, Software, Expendable Materials and Supplies, Subcontracts, Travel Expenses, Observation Equipment, Satellite Data, Other Data, and Others), sorted by Japanese fiscal year as in the example attached to this form. An annual summary budget should also appear on the last line.

(1) Personnel expenses
Enter expenses for part-time workers here as the total cost calculated by multiplying the unit cost per day by the number of days. For part-time workers, use your own cost estimates.
(2) Computers/peripheral equipment/software
Enter the lease and rental cost of computers and/or peripheral equipment. Note that JAXA has the right to change specifications of all equipment. Also enter the cost of software here.
(3) Expendable materials and supplies
Enter the quantity of each item, following the example.
(4) Subcontracts
Provide the cost of subcontracts to outside companies or organizations here.
(5) Travel expenses
Describe the proposed domestic and/or international travel including information on destination and number of days/number of times (or travelers).
(6) Observation equipment
Enter costs of observation equipment including installation cost.
(7) Satellite data
Investigators requesting satellite data other than JAXA-owned or archived data (listed in the next section) should provide cost information here.
(8) Other data
Enter costs for data other than satellite data.
(9) Others
Enter costs for publication and others here.

B.2 Instructions for data requirements

JAXA-owned satellite data includes AMSR and AMSR-E data and other satellite data listed below. JAXA will provide requested data judged necessary for the proposed research, subject to availability of data processing.

- Marine Observation Satellite (MOS) (only around Japan)
- LANDSAT (only around Japan)
- European Remote-sensing Satellite (ERS)-1, 2 (only around Japan; for Japanese researchers only; available until JFY2002)
- Japanese Earth Resources Satellite (JERS)-1 (global)
- Tropical Rainfall Measuring Mission (TRMM)
- Advanced Earth Observing Satellite (ADEOS)
- Advanced Microwave Scanning Radiometer for EOS (AMSR-E) aboard EOS-Aqua satellite
- Advanced Earth Observing Satellite-II (ADEOS-II)
- Advanced Land Observing Satellite (ALOS) (10 scenes from JAXA archives)

Data availability can be checked on JAXA's Earth Observation Satellite Data Distribution Service (linked from EORC website, http://www.eorc.jaxa.jp/en/about/distribution/index.html).

APPENDIX C
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 and multiple generations (e.g., three generations) with one-year overlaps between consecutive generations for inter-calibration. The two satellite series are 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 will perform observations related to the global water and energy cycle, while the SGLI will conduct 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-W1 satellite has been approved for actual development as the first satellite in the GCOM series. Both GCOM-W1 and GCOM-C1 satellites will be 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, follow-on satellites will be launched so as to overlap the preceding satellite by one year. The concept is summarized in Fig. 1.

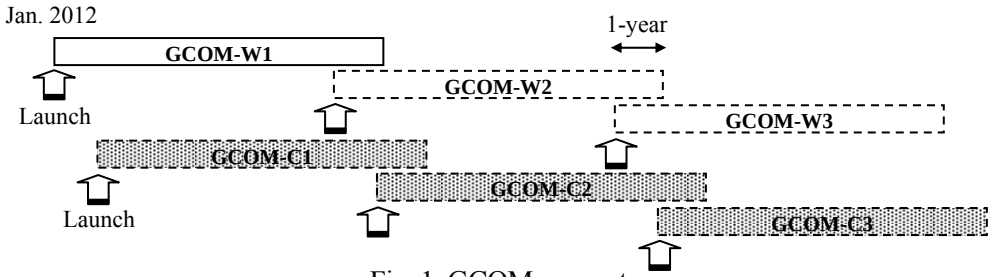

Fig. 1. GCOM concept

3.2. GCOM-W1 and AMSR2 instrument

Figure 2 presents an overview of the GCOM-W1 satellite; its major characteristics are listed in Table 1. GCOM-W1 will carry 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 1330, to maintain consistency with Aqua/AMSR-E observations.

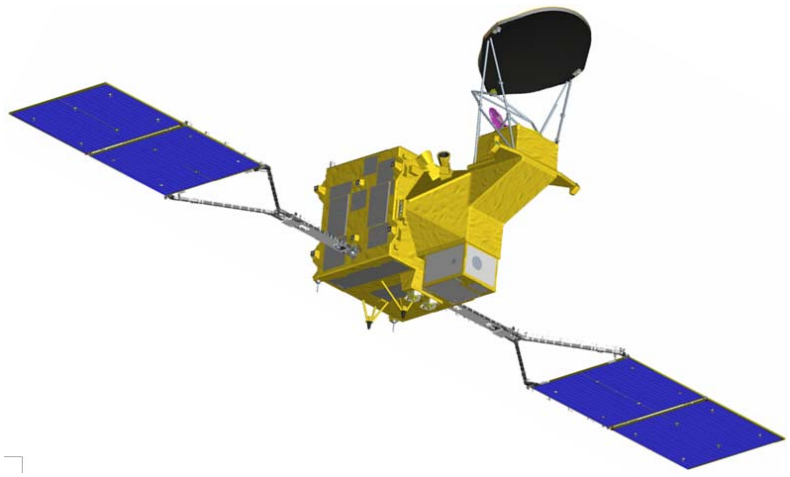

Fig. 2. Overview of GCOM-W1 satellite

TABLE 1
MAJOR CHARACTERISTICS OF GCOM-W1 SATELLITE

Instrument	Advanced Microwave Scanning Radiometer-2 (AMSR2)
Orbit	Sun-synchronous orbit Altitude: 700km (over the equator)
Size	5.1m (X) * 17.6m (Y) * 5.0m (Z) (on-orbit)
Mass	1940kg
Power	4050W @ EOL
Launch	JFY2001 (beginning of CY2012)
Design Life	5 years
Status	Phase-C

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.

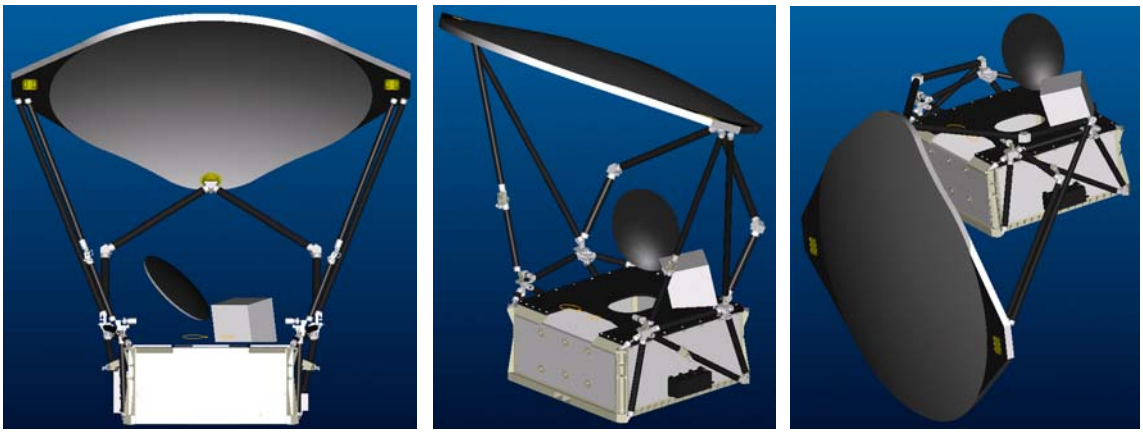

Fig. 3. Sensor unit of AMSR2 instrument in deployed (left and center) and stowed (right) conditions.

TABLE 2
FREQUENCY CHANNELS AND RESOLUTIONS OF AMSR2 INSTRUMENT

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

3.3. GCOM-C1 and SGLI instrument

Figure 4 gives an overview of the GCOM-C1 satellite; its major characteristics are listed in Table 3. GCOM-C1 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 1030, to maintain a wide observation swath and reduce cloud interference over land.

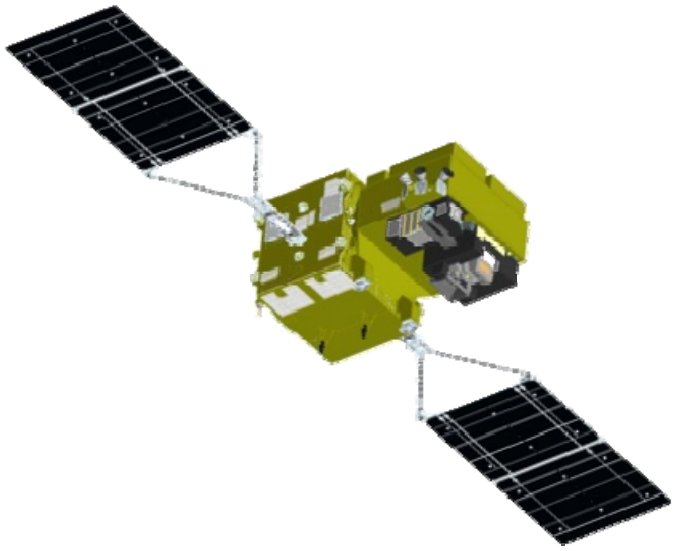

Fig. 4. Overview of GCOM-C1 satellite

TABLE 3
MAJOR CHARACTERISTICS OF GCOM-C1 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)
Mass	1950kg
Power	4250W @ EOL
Launch	JFY2013 (TBD)
Design Life	5 years
Status	Phase-A

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.

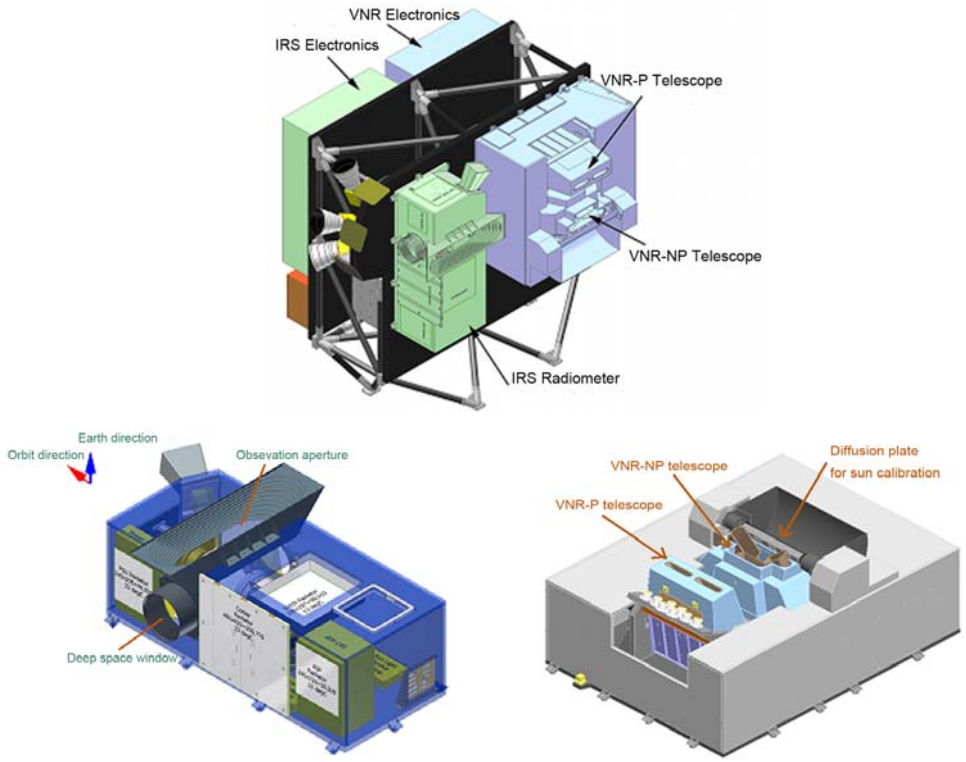

Fig. 5. Overview of SGLI radiometer layout (upper), IRS instrument (lower-left), and VNR radiometers (lower-right).

TABLE 4

SGLI MAJOR PERFORMANCE REQUIREMENTS

Item	Requirement	
Spectral Bands	VNR-NP VNR-P IRS SWI IRS TIR	11CH 380-865nm 2CH 670, 865nm / 0, 60, 120deg Polarization 4CH 1.05-2.21μm 2CH 10.8, 12.0μm
Scan Angle	VNR-NP VNR-P IRS SWI/TIR	70deg (Push-broom scanning) 55deg (Push-broom scanning) 80deg (45deg rotation mirror scanning)
Instantaneous field of view (IFOV) at nadir	VNR-NP VNR-P IRS SWI IRS TIR	1000m (VN9CH), 250m 1000m 250m (SW3CH), 1000m SW1,2,4CH) 500m
Quantization	12 bit	
Absolute Calibration Accuracy	VNR : ≤3% IRS : ≤5% TIR : ≤0.5K	
Life Time	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	670	10	250	400	23
	VN8	670	20	250	250	25
	VN9	763	8	1000	400	40
	VN10	865	20	250	400	8
	VN11	865	20	250	200	30
VNR-P	P1	670	20	1000	250	25
	P2	865	20	1000	250	30
IRS SWI	SW1	1050	20	1000	500	57
	SW2	1380	20	1000	150	8
	SW3	1630(TBD)	200	250	57	3
	SW4	2210	50	1000	211	1.9
IRS TIR	T1	10.8	0.7	500	0.2	300 (K)
	T2	12.0	0.7	500	0.2	300 (K)

4. Products

Geophysical products made available by GCOM-C1 and GCOM-W1 are listed in Tables 6 and 7. 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
GEOPHYSICAL PRODUCTS OF GCOM-C1

	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 6 (continued)
GEOPHYSICAL PRODUCTS OF GCOM-C

	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 and 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

TABLE 7
GEOPHYSICAL PRODUCTS OF GCOM-W1

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

APPENDIX D

ASSOCIATED TERMS AND CONDITIONS OF RESEARCH AGREEMENTS

(FOR THE GCOM RESEACH ANNOUNCEMENT)

COMMISSIONED RESEARCH AGREEMENT
FOR THE
GLOBAL CHANGE OBSERVATION MISSION
BETWEEN THE
JAPAN AEROSPACE EXPLORATION AGENCY (JAXA)
AND
THE RESEARCH ORGANIZATION
(FOR THE RESERACH ANNOUNCEMENT)

JAPAN AEROSPACE EXPLORATION AGENCY

CONTENTS

COMMISSIONED RESEARCH AGREEMENT

This agreement ("Agreement") is entered into between the Japan Aerospace Exploration Agency, established under the provision of the Law Concerning the Japan Aerospace Exploration Agency on October 1, 2003, represented by its President and having its principal office at 7-44-1 Higashimachi, Jindaiji, Choufu-shi, Tokyo, Japan ("JAXA") and a research organization ("Research Organization") that submitted an application form for the below described research activities to JAXA, hereinafter collectively referred to as "the Parties."

WITNESSETH

WHEREAS, the Global Change Observation Mission ("GCOM") aims to construct, use, and verify systems that enable continuous global-scale observations of effective geophysical parameters for clarifying global climate change and water circulation mechanisms;

WHEREAS, JAXA issued the Research Announcement ("RA") to engage in research activities directly related to retrieval algorithms for geophysical products, product validation, and data application of GCOM, and the Research Organization applied pursuant to such RA;

WHEREAS, JAXA accepted the Research Organization's proposal that was in response to the RA, delivered the confirmation sheet and JAXA further desires to utilize such proposal in JAXA's project; and

WHEREAS, JAXA desires to commission the Research Organization to engage in the above research activities.

NOW, THEREFORE, in consideration of the mutual agreements hereinafter set forth, and for other good and reasonable consideration, the receipt and adequacy of which are hereby acknowledged, the Parties hereby agree as follows:

Article 1. Definitions

The following capitalized terms shall have the following meanings:

"Annual Evaluation" means JAXA's annual review, which is scheduled by JAXA at the end of

each Japanese fiscal year, of the Research Results (as defined below) from the PIs.

"Application Form" means the application form for the Research Projects (as defined below) submitted by the Research Organization.

"Co-Investigator" ("CI") means a person who supports the PI (as defined below) in performing the Research Projects (as defined below) with approval by JAXA.

"Commissioned Research Plan" means the plan described in Attachment A of the Application Form.

"Confirmation Sheet" means the confirmation sheet or the acceptance form prescribed by JAXA with regard to the Application Form.

"Earth Observation Satellite Data" means data sets obtained from satellites which are retained by JAXA at the time of execution of this Agreement. The available data sets (including names of satellites, sensors, observation period that can be offered, and observation areas) are listed in Attachment A of this Agreement.

"Industrial Property Rights" means all domestic and foreign patents, utility models and industrial designs.

"Principal Investigator" ("PI") means the Research Organization employee who was selected to be responsible for the Research Projects, and who is named in the " Commissioned Research Plan" (as defined below).

"Potential Industrial Property Rights" means all domestic and foreign application rights for patents, utility models, or industrial designs.

"Program/Data Copyrights" means all domestic and foreign copyrights related to computer programs, software and databases.

"Research Funding" means the total amount of funds payable to the Research Organization by JAXA under Article 8 of this Agreement.

"Research Projects" has the meaning given to it in Article 2, Paragraph 2.

"Research Results" means the technical results and scientific knowledge derived from the implementation of the Research Projects pursuant to this Agreement, including all inventions, ideas, designs, literary works, algorithms, and technological developments, such as programs, that can execute the algorithm(s).

Article 2. Purpose and Scope of Research Projects

1. Under the terms and conditions of this Agreement, JAXA hereby commissions the Research Organization and the Research Organization hereby accepts the commission to engage in the research activities as set forth in the RA and/or the statement of work issued by JAXA ("Statement of Work"), and/or the Commissioned Research Plan and/or otherwise under this Agreement.
2. The Research Organization's research activities ("Research Projects") shall be carried out in accordance with (i) the Statement of Work, and (ii) the Commissioned Research Plan.

Article 3. Effective Term

1. The Agreement shall become effective as of the date of the issuance of the Confirmation Sheet prescribed by JAXA and shall continue in effect until the end of each Japanese Fiscal Year ("Agreement Term").
2. The Research Organization may renew the Agreement annually under the same terms and conditions provided that JAXA approves an extension of the research period in the Annual Evaluation; provided, however, that the Parties mutually agree upon the amount to be paid by JAXA for such extended period; further provided, however, the Research Organization shall submit a renewal Application Form to JAXA and JAXA shall issue a new Confirmation Sheet; further provided, however, that the Agreement Term shall not extend beyond March 31, 2011.
3. Termination of this Agreement shall not affect a Party’s continuing obligation under Paragraph 3 of Article 9, Article 13, Paragraph 3 of Article 14, Article 15, Article 16, Article 27, Article 28 and Article 29.

Article 4. Researchers

1. In the event that the PI is no longer employed by the Research Organization, JAXA may terminate this Agreement and utilize the services of the Research Organization for whom the previous PI is employed for carrying out the Research Projects.
2. In the event that the Research Organization intends to select or add CIs, the Research

Organization shall first obtain the consent of JAXA for such personnel. The Research Organization shall submit to JAXA the list of such candidates of CIs and consult with JAXA in order to obtain JAXA's consent.

3. The Research Organization shall supervise the PI's and CI's engaging in the Research Projects and shall ensure all PI's and/or CI's engaging in the Research Projects in accordance with the terms and conditions of the Agreement. For the avoidance of doubt, with regard to this Agreement, the PIs and CIs shall not be deemed to be a third parties.

Article 5. JAXA's Performance for Research Projects

JAXA shall make reasonable efforts to perform the following tasks related to the Research Projects:

a) Deliver the Earth Observation Satellite Data to the PI;
b) Provide satellite operation data, ground validation data and meteorological data; and
c) Hold workshops and meetings to evaluate the Research Results and the Progress Reports (as defined below) and to promote information exchange among PIs and JAXA.

Article 6. The Research Organization's General Responsibilities for Research Projects

1. The Research Organization shall conduct and complete the Research Projects in accordance with the Commissioned Research Plan and the Statement of Work. The progress and results of the Research Projects by the Research Organization shall be subject to the review of JAXA.
2. For the purpose of ensuring the Research Organization's performance of the above obligations, the Research Organization shall perform certain actions including, but not limited to:
   a) Participate in necessary workshops and meetings for the Research Projects and report upon request from JAXA;
   b) Deliver periodically to JAXA the Research Results and the reports ("Progress Reports") in the form specified by JAXA, and in all instances, at least one (1) month before the Annual Evaluation;
   c) Deliver the reports as a final report ("Final Reports") by the end of the Agreement Term; and
   d) Take necessary measures to ensure the PI's and/or CI's compliance with this Agreement.

Article 7. Subcontract

The Research Organization shall not subcontract the Research Projects to a third party, without prior written approval of JAXA. JAXA may provide and Research Organization shall adhere to

instructions regarding the terms and conditions of any subcontract entered into by the Research Organization in relation to this Agreement and the activities contemplated herein. If the Research Organization subcontracts the Research Projects to a third party, any act of such third party in connection with the subcontract shall be deemed to be an act of the Research Organization and the Research Organization shall be responsible therefore.

Article 8. Research Funding

1. The Confirmation Sheet identifies the amount of funding to be provided by JAXA to the Research Organization for the Research Projects ("Research Funding"). JAXA shall, within thirty (30) days from the date when JAXA receives an invoice duly issued by the Research Organization, make payment for the Research Funding by wire transfer. All payments stipulated in this Agreement shall include any charges, taxes or duties levied by any official authorities of the country where the Research Organization exists.
2. If JAXA fails to pay the Research Funding within the above period, JAXA shall pay to the Research Organization default interest of six (6) percent per annum on such unpaid amount for the period from the immediately succeeding day of due date for payment to the date of actual payment; provided, however, that if such nonpayment was due to an Act of God or any other reasons outside of the control of JAXA, the period for which such reasons exist shall not be counted in the number of days subject to payment of default interest.
3. Throughout the performance of the Agreement, the Research Organization shall maintain books, records, logs, documents and other evidence sufficient to record all actions taken with respect to the completion of the Research Projects. The Research Organization shall agree to allow JAXA to inspect, copy, and audit such books, records, documents and other evidence at any reasonable time.

Article 9. Providing of Earth Observation Satellite Data by JAXA

1. JAXA will provide the Research Organization with the Earth Observation Satellite Data for the Research Projects free of charge subject to the following conditions:
   a) The Research Organization agrees and accepts that JAXA may not provide all the Earth Observation Satellite Data which the Research Organization may request;
   b) JAXA does not guarantee a specific quality or the timely provision of the Earth Observation Satellite Data;
   c) The Advance Land Observing Satellite data, which is one portion of the Earth Observation Satellite Data and is to be provided to the Research Organization, shall be limited to ten scenes every fiscal year; and

d) JAXA reserves the right to curtail or suspend Earth Observation Satellite Data supply to the Research Organization due to faults or difficulties relating in the satellites, limitations on their operations, or any other reasons.

2. With respect to the Earth Observation Satellite Data provided by JAXA, the Research Organization shall:
   a) Only use the Earth Observation Satellite Data for the singular purpose of advancing the efforts of these Research Projects;
   b) Not duplicate the Earth Observation Satellite Data except for distributing to authorized CIs the necessary data backups;
   c) Not distribute the Earth Observation Satellite Data to any third party without JAXA's prior written consent; and
   d) Return or otherwise appropriately manage the Earth Observation Satellite Data upon completion of this Agreement, according to the directives of JAXA.
3. Any rights regarding the Earth Observation Satellite Data provided by JAXA shall conform to the following:
   a) Any rights relating to the Earth Observation Satellite Data shall belong to JAXA or to an institute designated by JAXA except in the case mentioned in b) below; and
   b) If value-added products, which means highly processed products that do not retain the original pixel structure and that cannot be converted back to the primary Earth Observation Satellite Data, are developed in the course of executing the Research Projects, the ownership of such products shall be determined upon mutual agreement between the Parties, taking into consideration the degrees of contribution by JAXA and the Research Organization.

Article 10. Providing of Meteorological Data by JAXA

1. For the purpose of performing the Research Projects, JAXA will attempt to provide the Research Organization with the meteorological data provided by the Japan Meteorological Agency pursuant to the agreement between JAXA and the Japan Meteorological Agency ("Meteorological Data"). The Research Organization agrees that JAXA's provision of the Meteorological Data may be limited or otherwise affected by the fact that some rights to the Meteorological Data belong to the Japan Meteorological Agency.
2. The Research Organization shall use the provided Meteorological Data solely for the purpose of conducting Research Projects. The Research Organization may not disclose the provided Meteorological Data to any party.
3. The Research Organization shall return or otherwise appropriately keep the Meteorological Data

in accordance with the instructions of JAXA upon the termination of this Agreement.

Article 11. Disclosure of Technical Data

1. To the extent feasible, each party shall disclose all necessary technical data ("Technical Data") which does not include the Earth Observation Satellite Data and the Meteorological Data. The Parties will undertake to handle expeditiously any request for the Technical Data presented by the other party.
2. The Technical Data shall be used and/or disclosed by the receiving party only for the purpose of fulfilling the receiving party's responsibilities under this Agreement. The receiving party shall protect Technical Data from unauthorized use and/or disclosure.
3. The Technical Data shall not be disclosed, duplicated or used by persons or entities other than the receiving party, or for any other purpose, without the prior consent of the furnishing party.
4. According to directives of the furnishing party, the receiving party shall return or otherwise dispose of Technical Data provided under the Agreement upon completion of the activities under the Agreement.

Article 12. Review and Confirmation of Research Results

1. The Research Organization shall deliver the Deliverable Research Results (as defined below) before the expiration of the Agreement Term. After receiving all Deliverable Research Results, JAXA may examine the Deliverable Research Results and the performance of the Research Organization to confirm the completion of the Research Projects.
2. If JAXA reasonably determines that 1) the Deliverable Research Results are not of the required quality and/or 2) the performance of the Research Organization is inadequate, JAXA may request the Research Organization to perform remedial activities during a period specified by JAXA and within the amounts of the Research Funding.
3. The failure to perform the remedial activities contemplated in the foregoing paragraph shall constitute a default under the Agreement; hence Article 21 of the Agreement shall apply.

Article 13. Ownership and Usage of the Research Results

1. All Research Results required by the Statement of Work to be delivered to JAXA ("Deliverable Research Results") shall be owned solely by JAXA unless the Research Organization has reasonably proven that rights related to the Deliverable Research Results were already owned by the Research Organization on the date of execution of this Agreement. The Research Organization may not use in any way JAXA's Deliverable Research Results unless JAXA

provides the Research Organization prior written consent. In the event JAXA provides prior written consent to use JAXA's Deliverable Research Results, the Research Organization may use such Deliverable Research Results only for its own non-militaristic (i.e., peaceful) and non-commercial purposes.

2. With regard to copyrights in the written documents related to the Deliverable Research Results including Progress Reports and Final Reports, the Research Organization shall assign such copyrights to JAXA at the time of delivering the Deliverable Research Results. Such assigned copyrights include, but not limited to, the rights to translate, transform or otherwise adapt works and to use derivative works. The Research Organization waives and shall cause its directors, officers, employees including PIs and CIs, regardless of whether such persons are employed by the Research Organization, to waive any related moral rights to the assigned copyrights in the written documents related to Deliverable Research Results including Progress Reports and Final Reports and agrees not to rescind such waivers and shall cause such directors, officers, employees including PIs and CIs to agree not to rescind such waiver.
3. The Research Results other than the Deliverable Research Results ("Non-Deliverable Research Results") shall be owned by the Research Organization. The Research Organization hereby grants and will be deemed to have granted to JAXA and JAXA's affiliates a perpetual, irrevocable, royalty-free, non-exclusive, worldwide right to use the Non-Deliverable Research Results (and derivative works thereof); provided, however, JAXA shall use such Non-Deliverable Research Results (and derivative works thereof) for its own research and development work including, but not limited to, the granting to commissioned research organizations and/or collaborating research organizations the use of such Non-Deliverable Research Results (and derivative works thereof)
4. JAXA may request the Research Organization to disclose any Research Results including the Non-Deliverable Research Results and other related materials to JAXA.
5. The Research Organization may not disclose the Deliverable Research Results to a third party without prior written consent of JAXA.

Article 14. Publication of Research Results

1. If the Research Organization intends to publish the JAXA's Deliverable Research Results, the Research Organization shall provide JAXA with a written document regarding the description of the subjected JAXA's Deliverable Research Results to be published and request a written consent of JAXA. JAXA will not unreasonably withhold consent from the publishing party's request for such publication.
2. Before publishing, the Research Organization shall provide JAXA with a copy of the publication. JAXA is entitled to an irrevocable and royalty-free right to use the provided publications, unless

the copyright of such publication is owned or held by an academic society.

3. The Research Organization shall state in the publication that such JAXA's Deliverable Research Results have been obtained pursuant to this Agreement and identify the owner of the rights to the Earth Observation Satellite Data and Meteorological Data used in such publication.
4. In the event that a PI or CI wishes to publish or disclose the JAXA's Deliverable Research Results, the Research Organization shall cause the PI and/or CI to act in accordance with the terms and conditions of this Article and shall cause the PI and/or CI to grant JAXA an irrevocable and royalty-free right to use the provided publications, unless the copyrights to such publication belongs to an academic society.

Article 15. Industrial Property Rights

1. The Research Organization shall report the existence of Potential Industrial Property Rights generated in the course of the Research Projects, if any, to JAXA without delay and take the necessary procedures to file and prosecute applications in JAXA's name, if possible, for the registration of the resulting Industrial Property Rights, at JAXA's expense and with the approval of JAXA. The Research Organization shall consult with JAXA and seek JAXA's instructions in advance regarding every material matter concerning the application for the registration of the resulting Industrial Property Rights. If the Research Organization successfully is granted such Industrial Property Rights it shall notify JAXA without delay.
2. Unless the Research Organization currently has stipulated work rules regarding the following, the Research Organization shall institute rules governing, and/or agreements with its employees which provide that any Potential Industrial Property Rights and/or Industrial Property Rights owned by and/or held by the employees shall be transferred by such employees to the Research Organization in the event the employees' inventions and Potential Industrial Property Rights and/or the Industrial Property Rights related thereto were created or otherwise arose within the scope of the Research Organization's business.
3. If the technology developed by the Research Organization in the course of the Research Projects has Potential Industrial Property Rights, JAXA may make an application for such Potential Industrial Property Rights to be registered Industrial Property Rights in JAXA's name. In this case, the Research Organization shall submit to JAXA the materials required for the application and otherwise cooperate with JAXA in accordance with JAXA's instructions.
4. The Research Organization shall assign any Potential Industrial Property Rights and/or Industrial Property Rights contemplated in Paragraph 1 and 2 of this Article 15 to JAXA immediately after their acquisition, if acquired in the name of the Research Organization. For the avoidance of doubt, the consideration for such assignment of Potential Industrial Property Rights and/or the Industrial Property Rights is included in the Research Funding.

5. If the Research Organization requests a license to use the Industrial Property Rights assigned to JAXA under the preceding paragraph, JAXA will grant the Research Organization a nonexclusive license unless it is reasonably deemed to be inappropriate. The conditions for the approval shall be determined by mutual agreement between the Parties as necessary.
6. The Research Organization shall obtain approval of JAXA in advance if the Research Organization wishes to grant to a third party a license to use the Industrial Property Rights.
7. JAXA shall bear the total or a portion of the costs which the Research Organization paid to the Research Organization's employee who created the technology which is subject of the Potential Industrial Property Rights and/or the Industrial Property Rights and transferred such Potential Industrial Property Rights and/or Industrial Property Rights to the Research Organization in accordance with Paragraph 2 of this Article 15. The amount to be paid by JAXA shall be based upon a standard determined solely by JAXA.

Article 16. Program/Data Copyrights

1. The Research Organization shall notify JAXA without delay in the event that the Research Organization creates a program, software and/or database that may potentially constitute the Program/Data Copyrights.
2. The Research Organization shall assign to JAXA all Program/Data Copyrights required by the Statement of Work to be delivered to JAXA ("Deliverable Program/Data Copyrights") including, but not limited to, rights to translate, transform or otherwise adapt works and to use derivative works. The Research Organization waives and shall cause its directors, officers, and employees including PIs and CIs, regardless of whether such persons are employed by the Research Organization, to waive any related moral rights to the Deliverable Program/Data Copyrights and agrees not to rescind such waivers and shall cause such directors, officers, employees including PIs and CIs to agree not to rescind such waiver. For the avoidance of doubt, the consideration for such assignment of the Deliverable Program/Data Copyrights is included in the Research Funding. Provided, however, that the Research Organization may retain the Deliverable Program/Data Copyrights, if the Research Organization has reasonably proven that it owned on the date of execution of this Agreement; futher provided, howeve that the Research Organization may retain the Deliverable Program/Data Copyrights regarding the know-how, routine, subroutine and modules, if the Research Organization designate some portion of it. In this case, JAXA is entitled to an irrevocable and royalty-free right to use such know-how, routine, subroutine and modules in the form as it is provided to JAXA, even if such know-how, routine, subroutine and modules whose ownerships are retained by the Research Organization. Such use by JAXA includes the right of JAXA to grant a third party the right to use the know-how, routine, subroutine and modules in the form as it is provided to JAXA

without paying royalties to the Research Organization.

3. Notwithstanding the preceding paragraph, and in JAXA's sole discretion, the Research Organization may own the Deliverable Program/Data Copyrights solely or jointly with JAXA.
4. The Research Organization shall extend the terms and conditions of this Article to its researcher who created the copyrightable item and shall prevent that researcher from executing the related Deliverable Program/Data Copyrights.
5. If the Research Organization requests of JAXA a license to use the assigned Deliverable Program/Data Copyrights, JAXA will grant the Research Organization such rights unless it is reasonably deemed to be inappropriate. The conditions for the approval shall be determined upon mutual agreement between the Parties as necessary.
6. After such Deliverable Program/Data Copyrights has been assigned to JAXA, JAXA may modify a program, software and/or database which is subject of the Deliverable Program/Data Copyrights and shall bear the risk and responsibility related to such modification.
7. The Program/Data Copyrights other than the Deliverable Program/Data Copyrights ("Non-Deliverable Program/Data Copyrights ") shall be owned by the Research Organization. The Research Organization hereby grants and will be deemed to have granted to JAXA and JAXA's affiliates a perpetual, irrevocable, royalty-free, non-exclusive, worldwide right to use the Non-Deliverable Program/Data Copyrights (and derivative works thereof) ; provided however, JAXA shall use such Non-Deliverable Program/Data Copyrights (and derivative works thereof) for its own research and development work including, but not limited to, the granting to commissioned research organizations and/or collaborating research organizations the use of programs, software and databases related to Non-Deliverable Research Results (and derivative works thereof).

Article 17. Impossibility of Performance

In the event it becomes impossible for the Research Organization to carry out all or any part of the Agreement due to reasons attributable to the Research Organization, such failure to carry out its duties shall constitutes a default and JAXA may terminate all or any part of the Agreement.

Article 18. Delay of Performance

1. In the event there is a reasonable basis for which the Research Organization is unable to complete the Research Projects by the due date set forth in this Agreement, the Research Organization may make a written request to JAXA for its consideration to extend the due date.
2. If the Research Organization fails to submit the Final Reports and deliverables to JAXA by the extended due date, such failure shall constitutes a default and JAXA may terminate all or any

part of the Agreement.

Article 19. Termination and Refund

1. Either party may terminate the Agreement:
   a) When the other party commits a dishonest and/or inequitable act that irreparably harms the mutual trust between the Parties; provided, that breaching party fails to offer any effective and satisfactory remedial measures within seven (7) days after getting demands for corrective action from the harmed party;
   b) When the other party violates any of the terms and conditions of this Agreement provided that the breaching party fails to offer any effective and/or satisfactory remedial measures within seven (7) days after getting demands for corrective action from the harmed party; and
   c) Consent of both Parties.
2. JAXA may terminate the Agreement at its sole direction upon the occurrence of:
   a) The events contemplated in Article 11 Paragraph 3, Articles 17, 18 and Paragraph 1 a) and b) of this Article 19 ("Agreement Termination Events"); and
   b) Any other material breach of this Agreement by the Research Organization, PI and CI.
3. Upon the termination of the Agreement, the Research Organization shall promptly deliver to JAXA all work including, but not limited to, all works in progress and all work that is completed and otherwise ready for delivery.
4. If the Agreement is terminated as set forth in the preceding paragraph, the Research Organization shall refund to JAXA any unexpended Research Funding. The Research Organization shall remit such funds within thirty (30) days from the date when the Research Organization receives an invoice issued by JAXA with regard to such funds.

Article 20. Ownership of the Rights to the Acquired Equipments

The Research Organization shall transfer, upon the expiration of this Agreement, all rights and ownership in the equipment acquired by the Research Organization with the Research Funding; provided, however, that JAXA may determine that any or all such rights and ownership will be retained by the Research Organization.

Article 21. Liquidated Damages

If the Agreement is terminated by reasons attributed to the Research Organization, PI and/or CI including, but not limited to, the occurrence of the Agreement Termination Events, the Research Organization shall pay liquidated damages to JAXA in the amount of ten (10) percent of the

portion of the remaining Research Funding in addition to any amount to be refunded under Article 19 Paragraph 4.

Article 22. Force Majeure

Neither party is liable for failure, delay or suspension to perform its part of the Agreement when such failure is due to circumstances including, but not limited to, fire, war, unavoidable accidents, government acts or policies, or legal restrictions beyond the reasonable control of the party. Either party may terminate this Agreement in the event of the above-mentioned circumstances.

Article 23. Confidentiality

1. In this Agreement, "Confidential Information" means any information that a party discloses or presents in writing or by other media, to the other party in the course of these Research Projects, provided however, Confidential Information does not include the following:
   a) Information that is already known to the public when disclosed by the disclosing party;
   b) Information that becomes known to the public after the disclosure by the disclosing party without intentional misconduct or negligence of the receiving party;
   c) Information that the receiving party already had before the disclosure by the disclosing party;
   d) Information that the receiving party acquires from a duly authorized third party not subject to confidentiality obligations;
   e) Information that the receiving party independently develops without utilizing information obtained from the disclosing party;
   f) Information with a prior written consent of the disclosing party for the disclosure and the publication; or
   g) Information that is required to be disclosed by applicable laws, judgment or order of a competent court. In this case, the receiving party shall promptly notify the disclosing party of the necessity of disclosure.
2. The receiving party shall keep the Confidential Information secret and shall not disclose or divulge any Confidential Information to a third party without a prior written consent of the disclosing party.
3. The confidentiality obligation under this Article shall remain effective for a period of five (5) years after the termination of the Agreement. However this period of keeping confidentiality may be extended or shortened by mutual agreement.

Article 24. Government Approvals

Each party shall obtain such permits, licenses, and other government authorizations as are required for it to perform its responsibilities under the Agreement, and shall comply with all respective laws and regulations.

Article 25. Language

All communications between the Research Organization and JAXA under this Agreement shall be in English.

Article 26. Special Agreement

Any supplement, modification or amendment of this Agreement shall only be binding if made upon the Parties' mutual written agreement which makes specific reference to this Agreement.

Article 27. Dispute Resolution

The Parties agree to put forth their best efforts to solve amicably any dispute, controversy, or difference arising out of, in connection with, or resulting from this Agreement.

Article 28. Arbitration

All disputes that cannot be amicably settled by the method defined in the previous Article hereof will be settled by arbitration in Tokyo in accordance with the Commercial Arbitration Rules of the Japan Commercial Arbitration Association.

Article 29. Governing Law

The Agreement shall be governed and interpreted under the laws of Japan.

Attachment A "Earth Observation Satellite Data"

Name of Satellite or Sensor	Observation Period (YY/MM/DD)	Observable Area
ALOS (Advanced Land Observation Satellite)	2006/05/16～	Global
MOS (Marine Observation Satellite)	1987/02/23～1996/04/19	Around Japan, Antarctic and Southeast Asia
JERS (Japanese Earth Observation Satellite)	1992/09/01～1998/10/11	Global
ADEOS (Advanced Earth Observation Satellite)	1996/10/15～1997/6/29	Global
ADEOS-Ⅱ (Advanced Earth Observation Satellite-Ⅱ)	2003/01/18～2003/10/24	Global
AMSR-E (Advanced Microwave Scanning Radiometer for EOS-Aqua satellite)	2002/06/19～	Global
TRMM (Tropical Rainfall Measuring Mission)	1997/12/01～	Global
ERS (European Remote-Sensing Satellite)	1991/08/18～2003/03/29	Around Japan and Antarctic
LANDSAT* (Land Satellite)	1979/02/19～2002/03/31	Around Japan

* LANDSAT-5 data received by 2001/3/31 will be available in the dataset.

COLLABORATIVE RESEARCH AGREEMENT (FUNDED)
FOR THE
GLOBAL CHANGE OBSERVATION MISSION
BETWEEN THE
JAPAN AEROSPACE EXPLORATION AGENCY (JAXA)
AND
THE RESEARCH ORGANIZATION
(FOR THE RESERACH ANNOUNCEMENT)

JAPAN AEROSPACE EXPLORATION AGENCY

CONTENTS

COLLABORATIVE RESEARCH AGREEMENT

This agreement ("Agreement") is entered into between the Japan Aerospace Exploration Agency, established under the provision of the Law Concerning the Japan Aerospace Exploration Agency on October 1, 2003, represented by its President and having its principal office at 7-44-1 Higashimachi, Jindaiji, Choufu-shi, Tokyo, Japan ("JAXA") and a research organization ("Research Organization") that submitted an application form for the below described research activities to JAXA, hereinafter collectively referred to as "the Parties."

WITNESSETH

WHEREAS, the Global Change Observation Mission ("GCOM") aims to construct, use, and verify systems that enable continuous global-scale observations of effective geophysical parameters for clarifying global climate change and water circulation mechanisms;

WHEREAS, JAXA issued the Research Announcement ("RA") to engage in collaborative research activities directly related to retrieval algorithms for geophysical products, product validation, and data application of GCOM, and the Research Organization applied pursuant to such RA;

WHEREAS, JAXA accepted the Research Organization's proposal that was in response to the RA, delivered the confirmation sheet to the Research Organization and JAXA further desires to utilize such proposal in JAXA's project; and

WHEREAS, JAXA desires to engage in the above research activities in collaboration with the Research Organization.

NOW, THEREFORE, in consideration of the mutual agreements hereinafter set forth, and for other good and reasonable consideration, the receipt and adequacy of which are hereby acknowledged, the Parties hereby agree as follows:

Article 1. Definitions

The following capitalized terms shall have the following meanings:

"Annual Evaluation" means JAXA's annual review, which is scheduled by JAXA at the end of

each Japanese fiscal year, of the Research Results (as defined below) from the PIs.

"Application Form" means the application form for the Research Projects (as defined below) submitted by the Research Organization.

"Co-Investigator" ("CI") means a person who supports the PI (as defined below) in performing the Research Projects (as defined below) with approval by JAXA.

"Collaborative Research Plan" means the plan described in Attachment A of the Application Form.

"Confirmation Sheet" means the confirmation sheet or the acceptance form prescribed by JAXA with regard to the Application Form.

"Earth Observation Satellite Data" means data sets obtained from satellites which are retained by JAXA at the time of execution of this Agreement. The available data sets (including names of satellites, sensors, observation period that can be offered, and observation areas) are listed in Attachment A of this Agreement.

"Intellectual Property Rights" means the following:
(i) Industrial Property Rights (as defined below);
(ii) Potential Industrial Property Rights (as defined below); and
(iii) Program/Data Copyrights (as defined below).

"Industrial Property Rights" means all domestic and foreign patents, utility models, and industrial designs.

"Potential Industrial Property Rights" means all domestic and foreign application rights for patents, utility models, or industrial designs.

"Principal Investigator" ("PI") means the Research Organization employee who was selected to be responsible for the Research Projects, and who is named in the Collaborative Research Plan.

"Program/Data Copyrights" means all domestic and foreign copyrights related to computer programs, software and databases.

"Research Funding" means the total amount of funds payable to the Research Organization by

JAXA under Article 7 of this Agreement.

"Research Projects" has the meaning given to it in Article 2, Paragraph 2.

"Research Results" means the technical results and scientific knowledge derived from the implementation of the Research Projects pursuant to this Agreement, including all inventions, ideas, designs, literary works, algorithms, and technological developments, such as programs, that can execute the algorithm(s).

Article 2. Purpose and Scope of Research Projects

1. Under the terms and conditions of this Agreement, JAXA and the Research Organization hereby agree to work in collaboration with regard to the research activities as set forth in the RA, and/or the Collaborative Research Plan and/or otherwise under this Agreement.
2. The Parties' research activities ("Research Projects") shall be carried out in accordance with the Collaborative Research Plan.

Article 3. Effective Term

4. The Agreement shall become effective as of the date of the issuance of the Confirmation Sheet prescribed by JAXA and shall continue in effect until the end of each Japanese Fiscal Year ("Agreement Term").
5. The Research Organization may renew the Agreement annually under the same terms and conditions provided that JAXA approves an extension of the research period in the Annual Evaluation; provided, however, that the Parties mutually agree upon the amount to be paid by JAXA for such extended period; further provided, however, the Research Organization shall submit a renewal Application Form to JAXA and JAXA shall issue a new Confirmation Sheet; further provided, however, that the Agreement Term shall not extend beyond March 31, 2011.
6. Termination of this Agreement shall not affect a Party’s continuing obligation under Paragraph 3 of Article 8, Article 11, Paragraph 3 of Article 12, Article 13, Article 14, Article 23, Article 24 and Article 25.

Article 4. Researchers

1. In the event that the PI is no longer employed by the Research Organization, JAXA may terminate this Agreement and utilize the services of the Research Organization for whom the previous PI is employed for carrying out the Research Projects.

2. In the event that the Research Organization intends to select or add CIs, the Research Organization shall first obtain the consent of JAXA for such personnel. The Research Organization shall submit to JAXA the list of such candidates of CIs and consult with JAXA in order to obtain JAXA's consent.
3. The Research Organization shall supervise the PI's and CI's engaging in the Research Projects and shall ensure all PI's and/or CI's engaging in the Research Projects in accordance with the terms and conditions of the Agreement. For the avoidance of doubt, with regard to this Agreement, the PIs and CIs shall not be deemed to be a third party.

Article 5. JAXA's Performance for Research Projects

JAXA shall make reasonable efforts to perform the following tasks related to the Research Projects:

a) Deliver the Earth Observation Satellite Data to the PI;
b) Provide satellite operation data, ground validation data and meteorological data;
c) Evaluate the Research Result and the Progress Reports (as defined below) for the Annual Evaluation and send the results to the PI; and
d) Hold workshops and meetings to evaluate the Research Results and the Progress Reports and to promote information exchange among PIs and JAXA.

Article 6. The Research Organization's General Responsibilities for Research Projects

1. The Research Organization shall conduct and complete the Research Projects in accordance with the Collaborative Research Plan.
2. For the purpose of ensuring the Research Organization's performance of the above obligations, the Research Organization shall perform certain actions including, but not limited to:
   a) Participate in necessary workshops and meetings for the Research Projects and report upon request from JAXA;
   b) Deliver periodically to JAXA the Research Results and the reports ("Progress Reports") in the form specified by JAXA , and in all instances, at least one (1) month before the Annual Evaluation;
   c) Deliver the reports as a final report ("Final Reports") by the end of the Agreement Term; and
   d) Take necessary measures to ensure the PI's and/or CI's compliance with this Agreement.

Article 7. Research Funding

1. The Confirmation Sheet identifies the amount of funding to be provided by JAXA to the

Research Organization for the Research Projects ("Research Funding"). JAXA shall, within thirty (30) days from the date when JAXA receives an invoice duly issued by the Research Organization, make payment for the Research Funding by wire transfer. All payments stipulated in this Agreement shall include any charges, taxes or duties levied by any official authorities of the country where the Research Organization exists.

2. If JAXA fails to pay the Research Funding within the above period, JAXA shall pay to the Research Organization default interest of six (6) percent per annum on such unpaid amount for the period from the immediately succeeding day of due date for payment to the date of actual payment; provided, however, that if such nonpayment was due to an Act of God or any other reasons outside of the control of JAXA, the period for which such reasons exist shall not be counted in the number of days subject to payment of default interest.
3. Throughout the performance of the Agreement, the Research Organization shall maintain books, records, logs, documents and other evidence sufficient to record all actions taken with respect to the completion of the Research Projects. The Research Organization shall agree to allow JAXA to inspect, copy, and audit such books, records, documents and other evidence at any reasonable time.

Article 8. Providing of Earth Observation Satellite Data by JAXA

1. JAXA will provide the Research Organization with the Earth Observation Satellite Data for the Research Projects free of charge subject to the following conditions:
   a) The Research Organization agrees and accepts that JAXA may not provide all the Earth Observation Satellite Data which the Research Organization may request;
   b) JAXA does not guarantee a specific quality or the timely provision of the Earth Observation Satellite Data;
   c) The Advance Land Observing Satellite data, which is one portion of the Earth Observation Satellite Data and is to be provided to the Research Organization, shall be limited to ten scenes every fiscal year; and
   d) JAXA reserves the right to curtail or suspend Earth Observation Satellite Data supply to the Research Organization due to faults or difficulties relating to the satellites, limitations on their operations, or any other reasons.
2. With respect to the Earth Observation Satellite Data provided by JAXA, the Research Organization shall:
   a) Only use the Earth Observation Satellite Data for the singular purpose of advancing the efforts of the Research Projects;
   b) Not duplicate the Earth Observation Satellite Data except for distributing to authorized CIs the necessary data backups;

c) Not distribute the Earth Observation Satellite Data to any third party without JAXA's prior written consent; and

d) Return or otherwise appropriately manage the Earth Observation Satellite Data upon completion of this Agreement, according to the directives of JAXA.

3. Any rights regarding the Earth Observation Satellite Data provided by JAXA shall conform to the following:

a) Any rights relating to the Earth Observation Satellite Data shall belong to JAXA or to an institute designated by JAXA except in the case mentioned in b) below; and

b) If value-added products, which mean highly processed products that do not retain the original pixel structure and that cannot be converted back to the primary Earth Observation Satellite Data, are developed in the course of executing the Research Projects, the ownership of such products shall be determined upon mutual agreement between the Parties, taking into consideration the degrees of contribution by JAXA and the Research Organization.

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1. For the purpose of performing the Research Projects, JAXA will attempt to provide the Research Organization with the meteorological data provided by the Japan Meteorological Agency pursuant to the agreement between JAXA and the Japan Meteorological Agency ("Meteorological Data"). The Research Organization agrees that JAXA's provision of the Meteorological Data may be limited or otherwise affected by the fact that some rights to the Meteorological Data belong to the Japan Meteorological Agency.
2. The Research Organization shall use the provided Meteorological Data solely for the purpose of conducting the Research Projects. The Research Organization may not disclose the provided Meteorological Data to any party.
3. The Research Organization shall return or otherwise appropriately keep the Meteorological Data in accordance with the instructions of JAXA upon the termination of this Agreement.

Article 10. Disclosure of Technical Data

1. To the extent feasible, each party shall disclose all necessary technical data ("Technical Data") which does not include the Earth Observation Satellite Data and the Meteorological Data. The Parties will undertake to handle expeditiously any request for the Technical Data presented by the other party.
2. The Technical Data shall be used and/or disclosed by the receiving party only for the purpose of fulfilling the receiving party's responsibilities under this Agreement. The receiving party shall

protect any such Technical Data from unauthorized use and/or disclosure.

3. The Technical Data shall not be disclosed, duplicated or used by persons or entities other than the receiving party, or for any other purpose, without the prior consent of the furnishing party.
4. According to directives of the furnishing party, the receiving party shall return or otherwise dispose of Technical Data provided under the Agreement upon completion of the activities under the Agreement.

Article 11. Ownership and Usage of Research Results

1. All Research Results shall be jointly owned by the Parties ("Jointly-Owned Research Results") unless one party reasonably proves that it solely generates the Research Results solely in the course of the Research Projects. For the avoidance of doubt, only if the product is the result of the Research Organization's sole work and sole funding shall such product be deemed to be the solely generated Research Results by the Research Organization.
2. Generally, JAXA and the Research Organization shall enter into a separate agreement and obtain the consent of the other party with regard to the usage of Jointly-Owned Research Results. However, if each party uses such Jointly-Owned Research Results peacefully (i.e., non-militaristic purposes) and for non-commercial purposes, consent of the other party is not required. In the event that a party intends to grant a third party a license to use such Jointly-Owned Research Results, the party shall obtain the prior written consent from the other party.
3. In the event that the Research Organization solely owns some portion of the Research Results, the Research Organization hereby grants and will be deemed to have granted to JAXA an irrevocable, royalty-free, non-exclusive, worldwide right to use such Research Results (and derivative works thereof including Progress Reports and Final Reports); provided, however, JAXA shall use such Research Results (and derivative works thereof including Progress Reports and Final Reports) for its own research and development work including, but not limited to, the granting to commissioned research organizations and/or collaborating research organizations the use of such Research Results (and derivative works thereof).
4. With regard to copyrights in the Progress Reports and Final Reports, regardless of whether they relates to the Research Organization's Research Result or not, the Research Organization waives and shall cause its directors, officers, employees including PIs and CIs, regardless of whether such persons are employed by the Research Organization, to waive any related moral rights to the copyrights in the Progress Reports and Final Reports and agrees not to rescind such waivers and shall cause such directors, officers, employees including PIs and CIs to agree not to rescind such waiver.

Article 12. Publication of Research Results

1. Regardless as to whether the Research Results are owned solely or jointly, if either party intends to publish the Research Results which are owned by the other party, the publishing party shall provide the other party with a written document regarding the description of the subjected Research Results to be published and request a written consent of the other party. The other party will not unreasonably withhold consent from the publishing party's request for such publication.
2. Before publishing, the publishing party shall provide the other party with a copy of the publication. Each party is entitled to an irrevocable and royalty-free right to use the provided publications, unless the copyright of such publication is owned or held by an academic society.
3. The Research Organization shall state in the publication that such Research Results have been obtained pursuant to this Agreement and identify the owner of the rights to the Earth Observation Satellite Data and Meteorological Data used in such publication.

4. In the event that a PI or CI wishes to publish or disclose the Research Results, the Research Organization shall cause the PI and/or CI to act in accordance with the terms and conditions of this Article and shall cause the PI and/or CI to grant JAXA an irrevocable and royalty-free right to use the provided publications, unless the copyright of the paper belongs to an academic society.

Article 13. Jointly-Owned Intellectual Property Rights

1. All Intellectual Property Rights generated in the course of the Research Projects shall be jointly owned by the Parties unless such rights are deemed to be Solely-Owned Intellectual Property as defined in Article 14 below. JAXA or the Research Organization Results shall give the other party prompt written notice of Intellectual Property Rights generated and discuss the ownership of such generated Intellectual Property Rights, as well as whether it is necessary to submit an application for registration of such Intellectual Property Rights.
2. JAXA and the Research Organization shall enter into a separate joint ownership agreement ("Joint Ownership Agreement") unless they decide not to make an application for the registration of the resulting Intellectual Property Rights. The Joint Ownership Agreement shall provide the allocation of Intellectual Property Rights related to, or the allocation of an interest in, such joint innovation or work.
3. After entering into the Joint Ownership Agreement, JAXA and the Research Organization shall take the necessary procedures to secure the joint ownership of the Intellectual Property Rights.
4. JAXA and/or Research Organization shall take any necessary procedures for any Industrial

Property Rights owned by and/or held by each employees to be transferred by such employee to JAXA or the Research Organization in the event the employees' inventions and the Industrial Property Rights related thereto were created or otherwise arose within the scope of the Research Organization's business.

5. If a party alters or improves the Jointly-Owned Intellectual Property within one (1) year from the completion of this Agreement, the party shall provide a written notice to the other party describing the alterations or improvements.
6. A party may grant to any third party a license to use the Jointly-Owned Intellectual Property Rights, provided, however that the relevant party shall obtain the written prior consent of the other party, and determine the licensing terms after discussion with the other party. In this case, the relevant party shall collect the usage fee from such third party as set forth in the separate usage agreement. The usage fee to be collected from the third party shall be distributed between JAXA and Research Organization pro rata in proportion to their respective interests in those rights.
7. JAXA and the Research Organization may transfer their respective interests to the Jointly-Owned Intellectual Property Rights only to their respective designees after discussion between JAXA and the Research Organization pursuant to a separate transfer agreement. In this event, the relevant party shall cause its designee to succeed to all of its rights and obligations with respect to those Intellectual Property Rights.
8. If JAXA or the Research Organization disclaims its interests in the Jointly-Owned Intellectual Property Rights, the relevant party shall give the other party prior notice thereof and transfer its interests to the other party, only if the other party wishes to acquire it.
9. Any expenses, costs and charges required for the application procedure and protection of the Jointly-Owned Intellectual Property Rights shall be borne by JAXA and Research Organization pro rata in proportion to their respective interests.

Article 14. Solely-Owned Intellectual Property Rights

1. If a party solely generates Potential Intellectual Property Rights in the course of the Research Projects ("Solely-Owned Intellectual Property Rights") the party shall notify such fact to the other party without delay. In this case, the party may take steps to apply for the registration of the resulting Intellectual Property Rights as solely-owned ones at its own expense, provided that it shall obtain prior confirmation of the other party. For the avoidance of doubt, only if Potential Intellectual Property Rights are generated or created by the Research Organization's sole work and sole funding shall such Potential Intellectual Property Rights be deemed to be solely generated or created by the Research Organization.
2. In the event of an emergence of Solely-Owned Intellectual Property Rights, the Research

Organization and/or the PI shall grant JAXA an irrevocable, royalty-free and non-exclusive right to use such Intellectual Property Rights for JAXA's own research and development.

Article 15. Termination and Refund

5. Either party may terminate the Agreement:
   a) When the other party commits a dishonest and/or inequitable act that irreparably harms the mutual trust between the Parties; provided, that breaching party fails to offer any effective and satisfactory remedial measures within seven (7) days after getting demands for corrective action from the harmed party;
   b) When the other party violates any of the terms and conditions of this Agreement provided that the breaching party fails to offer any effective and/or satisfactory remedial measures within seven (7) days after getting demands for corrective action from the harmed party; and
   c) Consent of both Parties.
6. Upon the termination of the Agreement, the Research Organization shall promptly deliver to JAXA all work including, but not limited to, all works in progress and all work that is completed and otherwise ready for delivery.
7. If the Agreement is terminated as set forth in the preceding paragraph, the Research Organization shall refund to JAXA any unexpended Research Funding. The Research Organization shall remit such funds within thirty (30) days from the date when the Research Organization receives an invoice issued by JAXA with regard to such funds.

Article 16. Ownership of the Rights to the Acquired Equipments

The Research Organization shall transfer, upon the expiration of this Agreement, all rights and ownership in the equipment acquired by the Research Organization with the Research Funding; provided, however, that JAXA and the Research Organization may determine through mutual agreement that any or all such rights and ownership will be retained by the Research Organization.

Article 17. Limitations on Liabilities

JAXA and the Research Organization agree to waive any claim against the other with respect to damage of any kind, or any loss of its own property or property of its related entities arising out of activities under this Agreement ("Damages"), except such Damages which arise through willful misconduct and except Intellectual Property Rights.

Article 18. Confidentiality

1. In this Agreement, "Confidential Information" means any information that a party discloses or presents in writing or in by other media, to the other party in the course of these Research Projects, provided however, Confidential Information does not include the following:
   a) Information that is already known to the public when disclosed by the disclosing party;
   b) Information that becomes known to the public after the disclosure by the disclosing party without intentional misconduct or negligence of the receiving party;
   c) Information that the receiving party already had before the disclosure by the disclosing party;
   d) Information that the receiving party acquires from a dully authorized third party not subject to confidentiality obligations;
   e) Information that the receiving party independently develops without utilizing information obtained from the disclosing party;
   f) Information with a prior written consent of the disclosing party for the disclosure and the publication; or
   g) Information that is required to be disclosed by applicable laws, judgment or order of a competent court. In this case, the receiving party shall promptly notify the disclosing party of the necessity of disclosure.
2. The receiving party shall keep the Confidential Information secret, and shall not disclose or divulge any Confidential Information to a third party without prior written consent of the disclosing party.
3. The confidentiality obligation under this Article shall remain effective for a period of five (5) years after the termination of the Agreement. However this period of keeping confidentiality may be extended or shortened by mutual agreement.

Article 19. Designation of Know-How

1. After mutual agreement by the Parties, JAXA and the Research Organization shall promptly designate as know-how the Research Results which are appropriately to be treated as know-how ("Know-How").
2. After designating the Know-How, such Know-How should be kept in confidence in principle, for five (5) years commencing on the day immediately following the date of the completion of this Agreement; provided, however, that JAXA and the Research Organization may extend or shorten that period upon mutual agreement.

Article 20. Government Approvals

Each party shall obtain such permits, licenses, and other government authorizations as are required for it to perform its responsibilities under the Agreement, and shall comply with all respective laws and regulations.

Article 21. Language

All communications between the Research Organization and JAXA under this Agreement shall be in English.

Article 22. Special Agreement

Any supplement, modification or amendment of this Agreement shall only be binding if made upon the Parties' mutual written agreement which makes specific reference to this Agreement.

Article 23. Dispute Resolution

The Parties agree to put forth their best efforts to solve amicably any dispute, controversy, or difference arising out of, in connection with, or resulting from this Agreement.

Article 24. Arbitration

All disputes that cannot be amicably settled by the method defined in the previous Article hereof will be settled by arbitration in Tokyo in accordance with the Commercial Arbitration Rules of the Japan Commercial Arbitration Association.

Article 25. Governing Law

The Agreement shall be governed and interpreted under the laws of Japan.

Attachment A "Earth Observation Satellite Data"

Name of Satellite or Sensor	Observation Period (YY/MM/DD)	Observable Area
ALOS (Advanced Land Observation Satellite)	2006/05/16～	Global
MOS (Marine Observation Satellite)	1987/02/23～1996/04/19	Around Japan, Antarctic and Southeast Asia
JERS (Japanese Earth Observation Satellite)	1992/09/01～1998/10/11	Global
ADEOS (Advanced Earth Observation Satellite)	1996/10/15～1997/6/29	Global
ADEOS-Ⅱ (Advanced Earth Observation Satellite-Ⅱ)	2003/01/18～2003/10/24	Global
AMSR-E (Advanced Microwave Scanning Radiometer for EOS-Aqua satellite)	2002/06/19～	Global
TRMM (Tropical Rainfall Measuring Mission)	1997/12/01～	Global
ERS (European Remote-Sensing Satellite)	1991/08/18～2003/03/29	Around Japan and Antarctic
LANDSAT* (Land Satellite)	1979/02/19～2002/03/31	Around Japan

* LANDSAT-5 data received by 2001/3/31 will be available in the dataset.

COLLABORATIVE RESEARCH AGREEMENT (NON-FUNDED)
FOR THE
GLOBAL CHANGE OBSERVATION MISSION
BETWEEN THE
JAPAN AEROSPACE EXPLORATION AGENCY (JAXA)
AND
THE RESEARCH ORGANIZATION
(FOR THE RESERACH ANNOUNCEMENT)

JAPAN AEROSPACE EXPLORATION AGENCY

CONTENTS

されていません。

Article 17. Confidentiality ***D-****エラー! ブックマークが定義されていません。*

Article 18. Designation of Know-How ***D-****エラー! ブックマークが定義されていません。*

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Article 24. Governing Law ***D-****エラー! ブックマークが定義されていません。*

Attachment A "Earth Observation Satellite Data" ***D-****エラー! ブックマークが定義されていません。*

COLLABORATIVE RESEARCH AGREEMENT

This agreement ("Agreement") is entered into between the Japan Aerospace Exploration Agency, established under the provision of the Law Concerning the Japan Aerospace Exploration Agency on October 1, 2003, represented by its President and having its principal office at 7-44-1 Higashimachi, Jindaiji, Choufu-shi, Tokyo, Japan ("JAXA") and a research organization ("Research Organization") that submitted an application form for the below described research activities to JAXA, hereinafter collectively referred to as "the Parties."

WITNESSETH

WHEREAS, the Global Change Observation Mission ("GCOM") aims to construct, use, and verify systems that enable continuous global-scale observations of effective geophysical parameters for clarifying global climate change and water circulation mechanisms;

WHEREAS, JAXA issued the Research Announcement ("RA") to engage in collaborative research activities directly related to retrieval algorithms for geophysical products, product validation, and data application of GCOM, and the Research Organization applied pursuant to such RA;

WHEREAS, JAXA accepted the Research Organization's proposal that was in response to the RA, delivered the confirmation sheet to the Research Organization and JAXA further desires to utilize such proposal in JAXA's project; and

WHEREAS, JAXA desires to engage in the above research activities in collaboration with the Research Organization.

NOW, THEREFORE, in consideration of the mutual agreements hereinafter set forth, and for other good and reasonable consideration, the receipt and adequacy of which are hereby acknowledged, the Parties hereby agree as follows:

Article 1. Definitions

The following capitalized terms shall have the following meanings:

"Annual Evaluation" means JAXA's annual review, which is scheduled by JAXA at the end of

each Japanese fiscal year, of the Research Results (as defined below) from the PIs.

"Application Form" means the application form for the Research Projects (as defined below) submitted by the Research Organization.

"Co-Investigator" ("CI") means a person who supports the PI (as defined below) in performing the Research Projects (as defined below) with approval by JAXA.

"Collaborative Research Plan" means the plan described in Attachment A of the Application Form.

"Confirmation Sheet" means the confirmation sheet or the acceptance form prescribed by JAXA with regard to the Application Form.

"Earth Observation Satellite Data" means data sets obtained from satellites which are retained by JAXA at the time of execution of this Agreement. The available data sets (including names of satellites, sensors, observation period that can be offered, and observation areas) are listed in Attachment A of this Agreement.

"Intellectual Property Rights" means the following:
(i) Industrial Property Rights (as defined below);
(ii) Potential Industrial Property Rights (as defined below); and
(iii) Program/Data Copyrights (as defined below).

"Industrial Property Rights" means all domestic and foreign patents, utility models, and industrial designs.

"Potential Industrial Property Rights" means all domestic and foreign application rights for patents, utility models, or industrial designs.

"Principal Investigator" ("PI") means the Research Organization employee who was selected to be responsible for the Research Projects, and who is named in the Collaborative Research Plan.

"Program/Data Copyrights" means all domestic and foreign copyrights related to computer programs, software and databases.

"Research Projects" has the meaning given to it in Article 2, Paragraph 2.

"Research Results" means the technical results and scientific knowledge derived from the implementation of the Research Projects pursuant to this Agreement, including all inventions, ideas, designs, literary works, algorithms, and technological developments, such as programs, that can execute the algorithm(s).

Article 2. Purpose and Scope of Research Projects

3. Under the terms and conditions of this Agreement, JAXA and the Research Organization hereby agree to work in collaboration with regard to the research activities as set forth in the RA, and/or the Collaborative Research Plan and/or otherwise under this Agreement.
4. The Parties' research activities ("Research Projects") shall be carried out in accordance with the Collaborative Research Plan.

Article 3. Effective Term

7. The Agreement shall become effective as of the date of the issuance of the Confirmation Sheet prescribed by JAXA and shall continue in effect until the end of each Japanese Fiscal Year ("Agreement Term").
8. The Research Organization may renew the Agreement annually under the same terms and conditions provided that JAXA approves an extension of the research period in the Annual Evaluation; provided, however, the Research Organization shall submit a renewal Application Form to JAXA and JAXA shall issue a new Confirmation Sheet; further provided, however, that the Agreement Term shall not extend beyond March 31, 2011.
9. Termination of this Agreement shall not affect a Party’s continuing obligation under Paragraph 3 of Article 8, Article 11, Paragraph 3 of Article 12, Article 13, Article 14, Article 22, Article 23 and Article 24.

Article 4. Researchers

1. In the event that the PI is no longer employed by the Research Organization, JAXA may terminate this Agreement and utilize the services of the Research Organization for whom the previous PI is employed for carrying out the Research Projects.
2. In the event that the Research Organization intends to select or add CIs, the Research Organization shall first obtain the consent of JAXA for such personnel. The Research Organization shall submit to JAXA the list of such candidates of CIs and consult with JAXA in order to obtain JAXA's consent.

3. The Research Organization shall supervise the PI's and CI's engaging in the Research Projects and shall ensure all PI's and/or CI's engaging in the Research Projects in accordance with the terms and conditions of the Agreement. For the avoidance of doubt, with regard to this Agreement, the PIs and CIs shall not be deemed to be a third party.

Article 5. JAXA's Performance for Research Projects

JAXA shall make reasonable efforts to perform the following tasks related to the Research Projects:

a) Deliver the Earth Observation Satellite Data to the PI;
b) Provide satellite operation data, ground validation data and meteorological data;
c) Evaluate the Research Result and the Progress Reports (as defined below) for the Annual Evaluation and send the results to the PI; and
d) Hold workshops and meetings to evaluate the Research Results and the Progress Reports and to promote information exchange among PIs and JAXA.

Article 6. The Research Organization's General Responsibilities for Research Projects

1. The Research Organization shall conduct and complete the Research Projects in accordance with the Collaborative Research Plan.
2. For the purpose of ensuring the Research Organization's performance of the above obligations, the Research Organization shall perform certain actions including, but not limited to:

e) Participate in necessary workshops and meetings for the Research Projects and report upon request from JAXA;
f) Deliver periodically to JAXA the Research Results and the reports ("Progress Reports") in the form specified by JAXA , and in all instances, at least one (1) month before the Annual Evaluation;
g) Deliver the reports as a final report ("Final Reports") by the end of the Agreement Term; and
h) Take necessary measures to ensure the PI's and/or CI's compliance with this Agreement.

Article 7. Research Funding

There will be no exchange of funds under this agreement. Each party shall bear necessary costs to fulfill its own responsibilities under this agreement.

Article 8. Providing of Earth Observation Satellite Data by JAXA

4. JAXA will provide the Research Organization with the Earth Observation Satellite Data for the

Research Projects free of charge subject to the following conditions:

a) The Research Organization agrees and accepts that JAXA may not provide all the Earth Observation Satellite Data which the Research Organization may request;
b) JAXA does not guarantee a specific quality or the timely provision of the Earth Observation Satellite Data;
c) The Advance Land Observing Satellite data, which is one portion of the Earth Observation Satellite Data and is to be provided to the Research Organization, shall be limited to ten scenes every fiscal year; and
d) JAXA reserves the right to curtail or suspend Earth Observation Satellite Data supply to the Research Organization due to faults or difficulties relating to the satellites, limitations on their operations, or any other reasons.

5. With respect to the Earth Observation Satellite Data provided by JAXA, the Research Organization shall:

a) Only use the Earth Observation Satellite Data for the singular purpose of advancing the efforts of the Research Projects;
b) Not duplicate the Earth Observation Satellite Data except for distributing to authorized CIs the necessary data backups;
c) Not distribute the Earth Observation Satellite Data to any third party without JAXA's prior written consent; and
d) Return or otherwise appropriately manage the Earth Observation Satellite Data upon completion of this Agreement, according to the directives of JAXA.

6. Any rights regarding the Earth Observation Satellite Data provided by JAXA shall conform to the following:

a) Any rights relating to the Earth Observation Satellite Data shall belong to JAXA or to an institute designated by JAXA except in the case mentioned in b) below; and
b) If value-added products, which mean highly processed products that do not retain the original pixel structure and that cannot be converted back to the primary Earth Observation Satellite Data, are developed in the course of executing the Research Projects, the ownership of such products shall be determined upon mutual agreement between the Parties, taking into consideration the degrees of contribution by JAXA and the Research Organization.

Article 9. Providing of Meteorological Data by JAXA

1. For the purpose of performing the Research Projects, JAXA will attempt to provide the Research Organization with the meteorological data provided by the Japan Meteorological Agency pursuant to the agreement between JAXA and the Japan Meteorological Agency

("Meteorological Data"). The Research Organization agrees that JAXA's provision of the Meteorological Data may be limited or otherwise affected by the fact that some rights to the Meteorological Data belong to the Japan Meteorological Agency.

2. The Research Organization shall use the provided Meteorological Data solely for the purpose of conducting the Research Projects. The Research Organization may not disclose the provided Meteorological Data to any party.
3. The Research Organization shall return or otherwise appropriately keep the Meteorological Data in accordance with the instructions of JAXA upon the termination of this Agreement.

Article 10. Disclosure of Technical Data

5. To the extent feasible, each party shall disclose all necessary technical data ("Technical Data") which does not include the Earth Observation Satellite Data and the Meteorological Data. The Parties will undertake to handle expeditiously any request for the Technical Data presented by the other party.
6. The Technical Data shall be used and/or disclosed by the receiving party only for the purpose of fulfilling the receiving party's responsibilities under this Agreement. The receiving party shall protect any such Technical Data from unauthorized use and/or disclosure.
7. The Technical Data shall not be disclosed, duplicated or used by persons or entities other than the receiving party, or for any other purpose, without the prior consent of the furnishing party.
8. According to directives of the furnishing party, the receiving party shall return or otherwise dispose of Technical Data provided under the Agreement upon completion of the activities under the Agreement.

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4. All Research Results shall be jointly owned by the Parties ("Jointly-Owned Research Results") unless one party reasonably proves that it solely generates the Research Results solely in the course of the Research Projects. For the avoidance of doubt, only if the product is the result of the Research Organization's sole work and sole funding shall such product be deemed to be the solely generated Research Results by the Research Organization.
5. Generally, JAXA and the Research Organization shall enter into a separate agreement and obtain the consent of the other party with regard to the usage of Jointly-Owned Research Results. However, if each party uses such Jointly-Owned Research Results peacefully (i.e., non-militaristic purposes) and for non-commercial purposes, consent of the other party is not required. In the event that a party intends to grant a third party a license to use such Jointly-Owned Research Results, the party shall obtain the prior written consent from the other

party.

6. In the event that the Research Organization solely owns some portion of the Research Results, the Research Organization hereby grants and will be deemed to have granted to JAXA an irrevocable, royalty-free, non-exclusive, worldwide right to use such Research Results (and derivative works thereof including Progress Reports and Final Reports); provided, however, JAXA shall use such Research Results (and derivative works thereof including Progress Reports and Final Reports) for its own research and development work including, but not limited to, the granting to commissioned research organizations and/or collaborating research organizations the use of such Research Results (and derivative works thereof).

4. With regard to copyrights in the Progress Reports and Final Reports, regardless of whether they relates to the Research Organization's Research Result or not, the Research Organization waives and shall cause its directors, officers, employees including PIs and CIs, regardless of whether such persons are employed by the Research Organization, to waive any related moral rights to the copyrights in the Progress Reports and Final Reports and agrees not to rescind such waivers and shall cause such directors, officers, employees including PIs and CIs to agree not to rescind such waiver.

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1. Regardless as to whether the Research Results are owned solely or jointly, if either party intends to publish the Research Results which are owned by the other party, the publishing party shall provide the other party with a written document regarding the description of the subjected Research Results to be published and request a written consent of the other party. The other party will not unreasonably withhold consent from the publishing party's request for such publication.

2. Before publishing, the publishing party shall provide the other party with a copy of the publication. Each party is entitled to an irrevocable and royalty-free right to use the provided publications, unless the copyright of such publication is owned or held by an academic society.

3. The Research Organization shall state in the publication that such Research Results have been obtained pursuant to this Agreement and identify the owner of the rights to the Earth Observation Satellite Data and Meteorological Data used in such publication.

4. In the event that a PI or CI wishes to publish or disclose the Research Results, the Research Organization shall cause the PI and/or CI to act in accordance with the terms and conditions of this Article and shall cause the PI and/or CI to grant JAXA an irrevocable and royalty-free right to use the provided publications, unless the copyright of the paper belongs to an academic society.

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2. JAXA and the Research Organization shall enter into a separate joint ownership agreement ("Joint Ownership Agreement") unless they decide not to make an application for the registration of the resulting Intellectual Property Rights. The Joint Ownership Agreement shall provide the allocation of Intellectual Property Rights related to, or the allocation of an interest in, such joint innovation or work.
3. After entering into the Joint Ownership Agreement, JAXA and the Research Organization shall take the necessary procedures to secure the joint ownership of the Intellectual Property Rights.
4. JAXA and/or Research Organization shall take any necessary procedures for any Industrial Property Rights owned by and/or held by each employees to be transferred by such employee to JAXA or the Research Organization in the event the employees' inventions and the Industrial Property Rights related thereto were created or otherwise arose within the scope of the Research Organization's business.
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7. JAXA and the Research Organization may transfer their respective interests to the Jointly-Owned Intellectual Property Rights only to their respective designees after discussion between JAXA and the Research Organization pursuant to a separate transfer agreement. In this event, the relevant party shall cause its designee to succeed to all of its rights and obligations with respect to those Intellectual Property Rights.
8. If JAXA or the Research Organization disclaims its interests in the Jointly-Owned Intellectual Property Rights, the relevant party shall give the other party prior notice thereof and transfer its

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2. In the event of an emergence of Solely-Owned Intellectual Property Rights, the Research Organization and/or the PI shall grant JAXA an irrevocable, royalty-free and non-exclusive right to use such Intellectual Property Rights for JAXA's own research and development.

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   a) When the other party commits a dishonest and/or inequitable act that irreparably harms the mutual trust between the Parties; provided, that breaching party fails to offer any effective and satisfactory remedial measures within seven (7) days after getting demands for corrective action from the harmed party;
   b) When the other party violates any of the terms and conditions of this Agreement provided that the breaching party fails to offer any effective and/or satisfactory remedial measures within seven (7) days after getting demands for corrective action from the harmed party; and
   c) Consent of both Parties.
9. Upon the termination of the Agreement, the Research Organization shall promptly deliver to JAXA all work including, but not limited to, all works in progress and all work that is completed and otherwise ready for delivery.

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JAXA and the Research Organization agree to waive any claim against the other with respect to

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4. In this Agreement, "Confidential Information" means any information that a party discloses or presents in writing or in by other media, to the other party in the course of these Research Projects, provided however, Confidential Information does not include the following:
   a) Information that is already known to the public when disclosed by the disclosing party;
   b) Information that becomes known to the public after the disclosure by the disclosing party without intentional misconduct or negligence of the receiving party;
   c) Information that the receiving party already had before the disclosure by the disclosing party;
   d) Information that the receiving party acquires from a dully authorized third party not subject to confidentiality obligations;
   e) Information that the receiving party independently develops without utilizing information obtained from the disclosing party;
   f) Information with a prior written consent of the disclosing party for the disclosure and the publication; or
   g) Information that is required to be disclosed by applicable laws, judgment or order of a competent court. In this case, the receiving party shall promptly notify the disclosing party of the necessity of disclosure.
5. The receiving party shall keep the Confidential Information secret, and shall not disclose or divulge any Confidential Information to a third party without prior written consent of the disclosing party.
6. The confidentiality obligation under this Article shall remain effective for a period of five (5) years after the termination of the Agreement. However this period of keeping confidentiality may be extended or shortened by mutual agreement.

Article 18. Designation of Know-How

1. After mutual agreement by the Parties, JAXA and the Research Organization shall promptly designate as know-how the Research Results which are appropriately to be treated as know-how ("Know-How").
2. After designating the Know-How, such Know-How should be kept in confidence in principle, for five (5) years commencing on the day immediately following the date of the completion of

this Agreement; provided, however, that JAXA and the Research Organization may extend or shorten that period upon mutual agreement.

Article 19. Government Approvals

Each party shall obtain such permits, licenses, and other government authorizations as are required for it to perform its responsibilities under the Agreement, and shall comply with all respective laws and regulations.

Article 20. Language

All communications between the Research Organization and JAXA under this Agreement shall be in English.

Article 21. Special Agreement

Any supplement, modification or amendment of this Agreement shall only be binding if made upon the Parties' mutual written agreement which makes specific reference to this Agreement.

Article 22. Dispute Resolution

The Parties agree to put forth their best efforts to solve amicably any dispute, controversy, or difference arising out of, in connection with, or resulting from this Agreement.

Article 23. Arbitration

All disputes that cannot be amicably settled by the method defined in the previous Article hereof will be settled by arbitration in Tokyo in accordance with the Commercial Arbitration Rules of the Japan Commercial Arbitration Association.

Article 24. Governing Law

The Agreement shall be governed and interpreted under the laws of Japan.

Attachment A "Earth Observation Satellite Data"

Name of Satellite or Sensor	Observation Period (YY/MM/DD)	Observable Area
ALOS (Advanced Land Observation Satellite)	2006/05/16～	Global
MOS (Marine Observation Satellite)	1987/02/23～1996/04/19	Around Japan, Antarctic and Southeast Asia
JERS (Japanese Earth Observation Satellite)	1992/09/01～1998/10/11	Global
ADEOS (Advanced Earth Observation Satellite)	1996/10/15～1997/6/29	Global
ADEOS-Ⅱ (Advanced Earth Observation Satellite-Ⅱ)	2003/01/18～2003/10/24	Global
AMSR-E (Advanced Microwave Scanning Radiometer for EOS-Aqua satellite)	2002/06/19～	Global
TRMM (Tropical Rainfall Measuring Mission)	1997/12/01～	Global
ERS (European Remote-Sensing Satellite)	1991/08/18～2003/03/29	Around Japan and Antarctic
LANDSAT* (Land Satellite)	1979/02/19～2002/03/31	Around Japan

* LANDSAT-5 data received by 2001/3/31 will be available in the dataset.