September 1, 2009

The Third ALOS Research Announcement

Proposals Due: November 30, 2009

Earth Observation Research Center
Japan Aerospace Exploration Agency

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1. INTRODUCTION

The third Research Announcement (RA) of the Japan Aerospace Exploration Agency (JAXA) is soliciting research proposals for scientific and practical research. The first RA was issued in 1999 for researchers all over the world. After the successful launch of the Advanced Land Observing Satellite (ALOS, “Daichi”) on January 24, 2006, and the completion of its commissioning phase, the second RA was issued specifically for researchers in Asia and Russia. This change was based on the successful construction of the ALOS Data Node (ADN) (see Appendix E) newly developed for the ALOS project. JAXA decided to issue this third RA specifically for researchers in Asia and Russia for further use and popularization of ALOS.

This research will support the ALOS Research Plan to be carried out by members of the ALOS research team exploiting PRISM, AVNIR-2 and PALSAR sensor data. Membership in this team will be conferred on successful respondents to this RA. Proposals are solicited for conducting research in the following three categories:

- Calibration and validation of ALOS data products and sensors
- Utilization research
- Scientific research

ALOS follows the Japanese Earth Resources Satellite-1 (JERS-1) and the Advanced Earth Observing Satellite (ADEOS) and utilizes advanced land observation technology. ALOS is used for cartography, regional observation, disaster observation, and resources surveying.

ALOS mission objectives are to:

(1) develop digital surface models (DSMs), or digital elevation models (DEMs), and related geographic data products for Japan and other countries, including those in the Asian-Pacific region (Map Making),
(2) perform regional observation for "sustainable development" (harmonization between the Earth’s environment and development) (Regional Observation),
(3) conduct disaster monitoring around the world (Disaster Monitoring),
(4) survey natural resources (Resources Survey), and
(5) develop sensor and satellite technology for future Earth-observing satellites (Technology Development).

Principal Investigators (PIs) can cover the full range of ALOS science and applications, including (1) SAR Calibration & Validation, (2) Optical Sensor Calibration & Validation, (3) Agriculture, (4) Disaster Management, (5) Geography, (6) Geology, (7) the International Polar Year, (8) Land Use & Land Cover, (9) Ocean, (10) Snow & Ice, and (11) Vegetation, Forests & Wetlands.

Applicants may submit their proposals any time before November 30, 2009. Proposals will be peer reviewed by the end of April 2010. Once applicants have been accepted, they will be integrated into the ALOS research team.

Participation as an ALOS Principal Investigator (PI) is open to researchers in Asia and Russia, as shown in Fig. 1, (with the exception of the Democratic People’s Republic of Korea) from all categories of organizations: educational institutions, research institutes, private enterprises, government institutions, and any other organizations.

Funds for PIs are not available under this RA.

An advantage of being a PI is having access to relevant ALOS data (50 sceans/first year of the contract) at no cost.

APPENDIX A provides technical and programmatic information concerning the ALOS system, data products, characteristics of each sensor, and the general operation concept.

APPENDIX B provides objectives of the research activities covered by this RA.

APPENDIX C provides information on ALOS sample products.

APPENDIX D contains the basic guidance needed for preparing proposals in response to this RA.
APPENDIX E provides information on the ALOS Data Node.
APPENDIX F contains a draft of the research agreement between JAXA and accepted applicants.

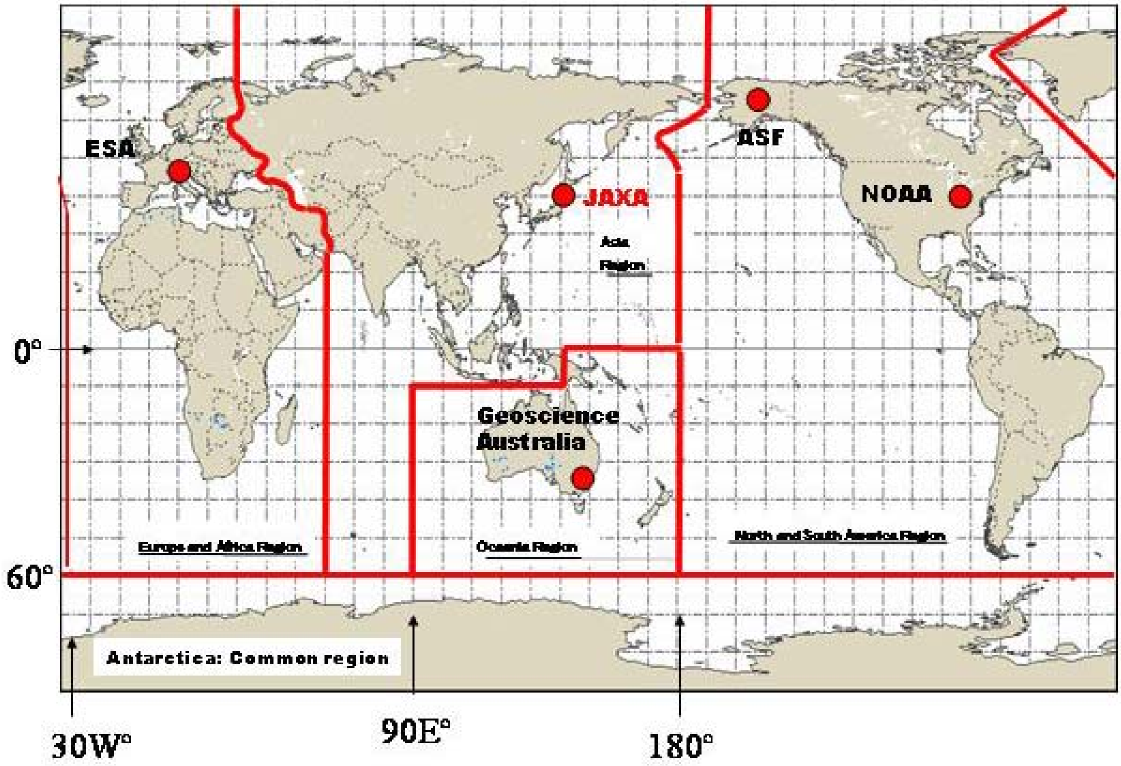


Fig. 1 Zone Definitions for ALOS Data Nodes

2. SUMMARY OF MISSION INSTRUMENTS

ALOS has three remote sensing instruments: the Panchromatic Remote-Sensing Instrument for Stereo Mapping (PRISM) for generating Digital Surface Models (DSMs), the Advanced Visible and Near Infrared Radiometer type 2 (AVNIR-2) for multispectral land coverage observation, and the Phased Array type L-band Synthetic Aperture Radar (PALSAR) for 24-hour, all-weather land observation. These sensors are expected to contribute to high-resolution land observation. (A detailed description of each payload is given in APPENDIX A-2.)

2.1 Panchromatic Remote-Sensing Instrument for Stereo Mapping

The Panchromatic Remote-Sensing Instrument for Stereo Mapping (PRISM) is a panchromatic radiometer with 2.5-meter spatial resolution. It has three telescopes for forward, nadir, and backward views enabling us to generate DSMs with accuracy sufficient for 1:25,000 scale maps.

2.2 Advanced Visible and Near Infrared Radiometer type 2

The Advanced Visible and Near Infrared Radiometer type 2 (AVNIR-2) mainly observes land and coastal zones and can provide land cover and land use information maps for monitoring regional environments. The instrument also has a cross-track pointing function for disaster monitoring.

2.3 Phased Array type L-band Synthetic Aperture Radar

The Phased Array type L-band Synthetic Aperture Radar (PALSAR) is an active microwave sensor that enables all-weather, 24-hour land observation. It has improved performance over the Synthetic Aperture Radar (SAR) on the Japanese Earth Resources Satellite-1 (JERS-1). The sensor has a steerable beam in elevation and the ScanSAR mode, which allows us to obtain a wider swath than conventional SARs. PALSAR was jointly developed by JAXA and the Japan Resources Observation System Organization (JAROS).

3. RESEARCH GOALS AND OBJECTIVES

The various products derived from ALOS data are expected to contribute significantly to the advancement of science. The research results in this RA will be utilized effectively for various applications, such as Earth environment monitoring, natural resource exploration, disaster monitoring, and regional development planning. This RA specifically solicits research that uses ALOS data alone or in conjunction with other data sets in three categories, (1) Calibration and Validation, (2) Utilization Research, and (3) Scientific Research.

3.1 Calibration and Validation of ALOS Data Products and Sensors

The three imaging sensors on board ALOS are designed for superior performance in various aspects of high-resolution Earth observation.
These sensors must be calibrated and validated for us to achieve:

- realistic performance in measuring an image's radiance (radar backscattering) and locations, and
- the potential of retrieving geophysical parameters (digital elevation model, geo-location, forest distribution, ice-monitoring, interferometry, disaster monitoring) for Earth environment monitoring.

In this RA, we have set two research goals related to the above. We would like to solicit your research proposals for achieving these goals.

(1) Calibrate Individual Sensors

This category seeks to clarify the sensor's input and output relationship (including determining calibration coefficients) as well as the sensor characterization with or without ground truth data. The target sensors are PRISM, AVNIR-2, and PALSAR.
More detailed research items are given below:

PRISM

- Sensor performance evaluation (including image quality evaluation)
- Geometric calibration
- Radiometric calibration (including stripe removal and determining calibration coefficients)

AVNIR-2

- Sensor performance evaluation (including image quality evaluation)
- Geometric calibration
- Radiometric calibration (including stripe removal and determining calibration coefficients)

PALSAR

- Sensor performance evaluation (including image quality evaluation)
- Geometric calibration
- Radiometric calibration (including antenna pattern determination and polarimetry)

(2) Develop and Validate Algorithms for Extracting Physical Parameters

It is important to develop algorithms that extract geophysical parameters from the calibrated images and truth data. It is also important to validate the estimated geophysical parameters using the above algorithms.
The many geophysical parameters that might be derived from ALOS data are listed in APPENDIX B. JAXA defined 1) DEM/DSM and 2) orthophoto images as the geographical products to be produced preferentially; however, proposals on developing and validating other geophysical parameters are also welcome.

3.2 Utilization Research

The objectives of the earlier Japanese Earth Observation Satellites emphasized the scientific element. However, except for a limited amount of data that is already being used operationally, the satellite data has not been used operationally due to many technical and operational issues. Therefore, in the preparatory operational phase of Earth observation data, utilization technology must be urgently established, and operational use in social systems is expected. A significant effort will thus be made to enhance opportunities fully employing data processing technology cultivated by JERS-1 and ADEOS, as well as for promoting new developments.
The integration of ALOS data with numerical prediction models of sea ice, sea state, and disasters, as well as monitoring and managing agricultural products, forestry, and fishery, will directly lead to national benefits. Providing ALOS data for international utilization will also lead to the discovery of potential users and the enhancement of the market. Moreover, a wide range of provided data and user-oriented or value-added services will be able to satisfy a variety of market needs from personal to commercial applications.
Examples of utilization research are given below:

- Land use and land cover change monitoring
- Forecasting of sea-state conditions and sea ice for off-shore applications
- Ship traffic monitoring and fishery management in coastal waters
- Agriculture and forestry management
  (planting status, agricultural productivity estimation, vegetation changes)

- Natural disasters (forest fires, flooding, landslides, earthquakes)
- Pollution monitoring (oil spills, red tides)
- Geology and natural resources exploration
- Applications related to SAR interferometry
  (digital elevation models, crustal movements, vegetation distribution),
- Development of the Geographic Information System (GIS) database of national land
- Educational use

Some utilization research will require providing of data products satisfying user requirements in near real time. In this case, applicants must specify their requirements and clarify the propriety.
Proposals should indicate research and development activities requiring operational use of ALOS data products, whether derived from ALOS data alone or from ALOS data integrated with that of other satellites. Such proposals should also include the definition of new products and algorithms required for application development.
In addition, applicants should define objectives, methods, and implementation plans of the projects as precisely as possible, and their plan should indicate the means, the feasibility of realization, and the anticipated economic effects gained by achieving the objectives.
See APPENDIX B for details on utilization research.

3.3 Scientific Research

Data products obtained by ALOS will contribute to the promotion of science. It will be essential to address many environmental issues (such as vegetation change, biomass burning, water resource management, resource assessment, disaster and earthquake mitigation, and cryosphere monitoring) in a broad range of Earth science disciplines. Our current knowledge of the complex interactions between the various components of the Earth system is not yet sufficient to predict environmental changes with the accuracy required for effective strategic development.
Proposals in response to this RA may address one or several Earth Science domains, including both basic scientific research (e.g., land surface properties, measurement principles, and algorithm development for derivation of geophysical parameters) and studies of Earth science processes. The targets have various time and spatial scales from local to regional and global. It may be possible to compare these analyses with analyses for other satellite data (such as from JERS-1 or ADEOS). Examples of major objectives are presented below:

- Land use and land cover change
- Topography and geology
- Terrestrial ecosystem, agriculture, and forestry
- Climate system, hydrological processes, and water resource related research
- Oceanography and coastal zone related research
- Process studies for microwave scattering and SAR interferometry
- Basic studies for measuring accuracy by optical sensors with fine spatial resolution
- Polar research to correspond with the International Polar Year (IPY)

Further detailed information is given in APPENDIX B. In addition, proposals should include the definition of objectives, scope, and approach, as well as an implementation plan for the research. The implementation plan should also indicate time horizons and means necessary for the achievement of the prospected results.

4. DATA DISTRIBUTION

4.1 Data Policy

For this RA, the data will be provided free of charge to PIs who agree to the following:

1) JAXA (JAXA and METI for PALSAR data) possesses all intellectual property rights of the provided data and products.
2) Provided data shall be utilized only for peaceful and non-commercial purposes.
3) Provided data shall be utilized only for conducting RA activities that comply with the research proposal.
4) Provided data shall not be transferred to any unauthorized third party or person without JAXA's prior written consent, with the exception of authorized Co-Investigators (CIs).

Other detailed conditions, such as the number of data scenes, shall be determined through review by JAXA.

Applicants must realize that data for PIs will be limited by satellite operations, the position of the Data Relay and Tracking Satellites (DRTS), and other eventualities. Refer to APPENDIX A-2 for the non-observable areas of each sensor.

JAXA shall not be liable for data loss, deterioration in data quality, or delay of data supply resulting from problems of ALOS or ground facilities, or for not providing ALOS data due to bad weather or matters beyond JAXA's control.

4.2 Data Distribution

The selected PIs shall utilize the archived JAXA data acquired from observation by ALOS, other satellites, and airborne SAR. The ALOS data for use in the ALOS standard operation plan is primarily based on the ALOS Operation Concept and Observation Strategy (APPENDIX A-4). JAXA will not accept observation requests from the selected PIs. It is highly recommended that applicants consider their own research proposals based on the Observation Strategy, as well as the observation constraints of each sensor.

(1) Standard Data Products

The PIs will be provided the following data after the conclusion of their research agreements. Further detailed information is presented in Table 5 of APPENDIX A-3.

- PRISM Level 1A, Level 1B1, and Level 1B2
- AVNIR-2 Level 1A, Level 1B1, and Level 1B2
- PALSAR Level 1.0, Level 1.1, and Level 1.5

(2) Higher-level Data Products of EORC

JAXA has been producing the following higher-level data products since March 2007. The data products from JAXA's selected area may be provided to PIs as sample datasets. Other products may also be provided for some requests. However, PIs should not base their research plans on the expectation of such products, and should be responsible for utilizing such products.

- PRISM DSMs, Orthorectified Images
- AVNIR-2 Orthophoto Images
- PALSAR DEMs, Orthophoto Images

(3) Satellite Data Belonging to JAXA

Satellite data here means sensor data from MOS, JERS, ADEOS, TRMM, ADEOS-II, ERS*, LANDSAT*, and IRS*.

(4) Airborne L-band SAR (Pi-SAR) Data

JAXA has operated its own airborne L-band SAR on test sites in Japan since 1998. PIs may utilize the archived data; however, the database is available only in Japanese, at the following web site:

http://www.eorc.jaxa.jp/ALOS/Pi-SAR/index.html

5. FUNDING

JAXA will not provide funds to PIs.

6. QUALIFICATIONS OF APPLICANTS

We welcome all researchers in Asia and Russia, as shown in Fig. 1 above, (with the exception of the Democratic People's Republic of Korea) from educational institutions, research institutes, private enterprises, government institutions, and any other organizations, domestic or foreign, to submit research proposals for peaceful, non-commercial purposes.

7. BENEFITS AND RESPONSIBILITIES OF PIS

7.1 Benefits

Upon acceptance by JAXA, PIs may request satellite data and airborne SAR data listed in section 4 at no cost.

7.2 Responsibilities

7.2.1 Final Report

All PIs must submit their final reports to JAXA in English in accordance with the instructions in the agreement. They must present their results or part of their results at a meeting, symposium, or workshop conducted by JAXA.

8. PROPOSAL SUBMISSION

8.1 General Conditions

Because quite a number of proposals are expected to be submitted from many countries, we might not accept proposals that do not adhere strictly to the format. The following are required in all proposals:

- **Applicants must register their profiles through the ALOS Home Page (http://www.eorc.jaxa.jp/ALOS/ra/schedule.htm) by November 30, 2009. JAXA will use these profiles only for RA purposes.**
- The proposal must be written in the format defined by JAXA and provided on the ALOS home page. (Please refer to this section and APPENDIX D.)
- It is highly recommended that applicants send their proposals and complete sets of all attachments, such as reprints of papers, in PDF, to the email address of the ALOS Research Announcement Office (aproject@jaxa.jp) by November 30, 2009. The maximum acceptable file size by email is 10 MB. If email transmission is not possible, applicants must send **six copies** of the proposal, including a complete set of attachments, such as reprints of papers, to the ALOS Research Announcement Office by postal mail. They must be received by JAXA no later than November 30, 2009
- All proposals should be typed in either English or Japanese, with a font size smaller than 12 points.
- Each page must have a page number centered at the foot of the page and the name of the applicant in the upper right corner.

Proposals will not be returned.

8.2 Language

Applicants must submit their proposals to JAXA in either English or Japanese. However, **applicants in Japan** are required to submit the **"Information of Applicants"** portion in the proposal cover sheet (APPENDIX D form 1a) **in both English and Japanese.**

8.3 Length

Unless otherwise specified in this RA, proposals should be as brief as possible, concentrating on substantive material. Proposals should not exceed 20 pages.
For further details, see APPENDIX D.

8.4 Proposal Contents

Please refer to APPENDIX D.

8.5 Where to Send Proposal (by postal mail)

Please send all necessary application papers for the third RA by postal mail to the following address. **These must be received no later than November 30, 2009.**

ALOS Research Announcement Office (Masanobu Shimada, ALOS Science Project Manager)

Earth Observation Research Center (EORC)
Japan Aerospace Exploration Agency (JAXA)
2-1-1, Sengen, Tsukuba, Ibaraki 305-8505, Japan
Tel: +81-29-868-2474 Fax: +81-29-868-2961
Email: aproject@jaxa.jp

9. SELECTION OF PROPOSALS

9.1 Evaluation and Selection Procedures

Proposals will be reviewed and evaluated by experts on the Research Evaluation Committee assigned by JAXA based on the evaluation criteria shown in 9.2. Final decisions on acceptance of proposals will be made by JAXA (the ALOS Research Board), taking into account the overall balance of different proposals and their resource requirements, as well as the evaluation result. PIs will be notified of proposal acceptance by the end of March 2010 (current plan).

9.2 Evaluation Criteria

1) Overall social, scientific, or technical merit of the proposal, or unique and innovative methods, approaches, or concepts demonstrated by the proposal.
2) Applicant's capabilities, related experience, facilities, techniques, or unique combinations of these that are integral factors for achieving the proposal objectives.
3) Relevance to the objectives of the ALOS Research Plan.
4) Technical possibility within the research period.

9.3 Follow-on Action

After applicants are notified of selection as PIs, they are required to observe the terms and conditions of the projects, including, but not limited to, data distribution and publications of results. APPENDIX F is the draft of the agreement prepared for this RA. We request that the chosen PIs conclude their research agreements to comply with this draft agreement. JAXA will later send the actual agreement form to the chosen PIs, who should follow the procedures therein.

10. CANCELLATION AND POSTPONEMENT OF RA

JAXA reserves the right to cancel this RA upon notice delivered by JAXA. JAXA assumes no liability for canceling the RA, for postponing the RA schedule, or for anyone's failure to receive actual notice of cancellation.

11. RESEARCH ORGANIZATIONS

The following research organizations are being established to evaluate and select the proposals at the Earth Observation Research Center (EORC) of JAXA.

A new ALOS Research Board, chaired by an ALOS program scientist, will be established. The existing ALOS Research Group, led by the ALOS Science Project Manager, will support the ALOS Research Board, and the selected PIs will participate in the activities of the ALOS Research Group.

The ALOS Research Board in EORC will review the evaluation results provided by the Research Evaluation Committee, and make recommendations to EORC for final selections. The Research Evaluation Committee, whose members are selected by the ALOS Research Board, evaluates research proposals based on predetermined criteria, and will be organized outside JAXA to ensure fair evaluation of proposals.

Touru. Fukuda, Director of EORC at JAXA, will supervise all of the activities.

12. SCHEDULE

The schedule of this RA is shown in 12.1.

12.1 ALOS Third Research Announcement (this RA)

Document release	September 1, 2009
Deadline for registration and submission of proposals	November 30, 2009
Notification of PI selection	March 31, 2010 (subject to change)
Contract (agreement procedure)	April 2010
PI meeting and symposia (annual)	November 2010 (subject to change)

13. RESEARCH ANNOUNCEMENT OFFICE

ALOS Research Announcement Office (Masanobu Shimada, ALOS Science Project Manager)

Earth Observation Research Center (EORC)
Japan Aerospace Exploration Agency (JAXA)
2-1-1, Sengen, Tsukuba, Ibaraki 305-8505, Japan
Tel: +81-29-868-2474 Fax: +81-29-868-2961
Email: aproject@jaxa.jp

APPENDIX A: ALOS SYSTEM DESCRIPTION
APPENDIX A-1: ALOS CHARACTERISTICS

The Advanced Land Observing Satellite (ALOS) is a Japanese solution to high-resolution Earth observation. It is equipped with three mission instruments: the Panchromatic Remote-Sensing Instrument for Stereo Mapping (PRISM), the Advanced Visible and Near Infrared Radiometer type 2 (AVNIR-2), and the Phased Array type L-band Synthetic Aperture Radar (PALSAR). In order to fully utilize the data obtained by these sensors, ALOS was designed with a mass data handling capability and precision position and attitude determination capabilities that will be essential to high-resolution remote-sensing satellites in the next decade.

Table 1 ALOS Characteristics.

Item	Characteristics	Remarks
Launch Date	January 24, 2006	
Launch Vehicle	H-IIA	
Launch Site	Tanegashima Space Center, Japan	
Spacecraft Mass	Approx. 4 tons	
Generated Power	Approx. 7 kW	End of Life
Altitude	691.65 km	At Equator
Inclination	98.16°	
Repeat Cycle	46 days	Sun-Synchronous Semi-Recurrent
Sub-cycle	2 days	
Design Life	3-5 years	
Attitude Determination Accuracy	2.0×10^{-4}° (off-line)	
Position Determination Accuracy	1 m (off-line)	
Data Rate (Down link)	240 Mbps via DRTS, 120 Mbps (direct transmission)	
Onboard Data recorder	Solid-state data recorder (90 Gbytes)	

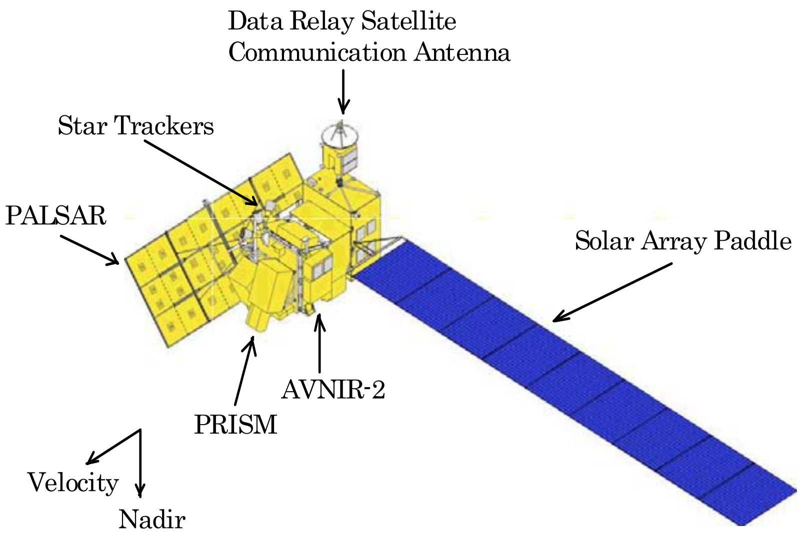


Fig.1 ALOS In-orbit Configuration

APPENDIX A-2: CHARACTERISTICS OF EACH SENSOR

1. Panchromatic Remote-Sensing Instrument for Stereo Mapping

The Panchromatic Remote-Sensing Instrument for Stereo Mapping (PRISM) is a major instrument of ALOS. It has three independent catoptric systems for nadir, forward, and backward looking to achieve along-track stereoscopy. Each telescope consists of three mirrors and several CCD detectors for push-broom scanning. The nadir-looking telescope provides 70-km width coverage; forward and backward telescopes each provide 35-km width coverage.

As depicted in Fig. 2, the telescopes are installed on both sides of its optical bench with precise temperature control. Forward and backward telescopes are inclined ±24 degrees from nadir to realize a base-to-height ratio of one. PRISM's wide field of view (FOV) provides fully overlapped three-stereo (triplet) images (35-km width) without mechanical scanning or yaw steering of the satellite. Without this wide FOV, forward, nadir, and aft-looking images would not overlap each other due to the Earth's rotation.

PRISM's 2.5-meter resolution data will be used for extracting a highly accurate digital surface model (DSM). PRISM Characteristics are shown in Table 2.

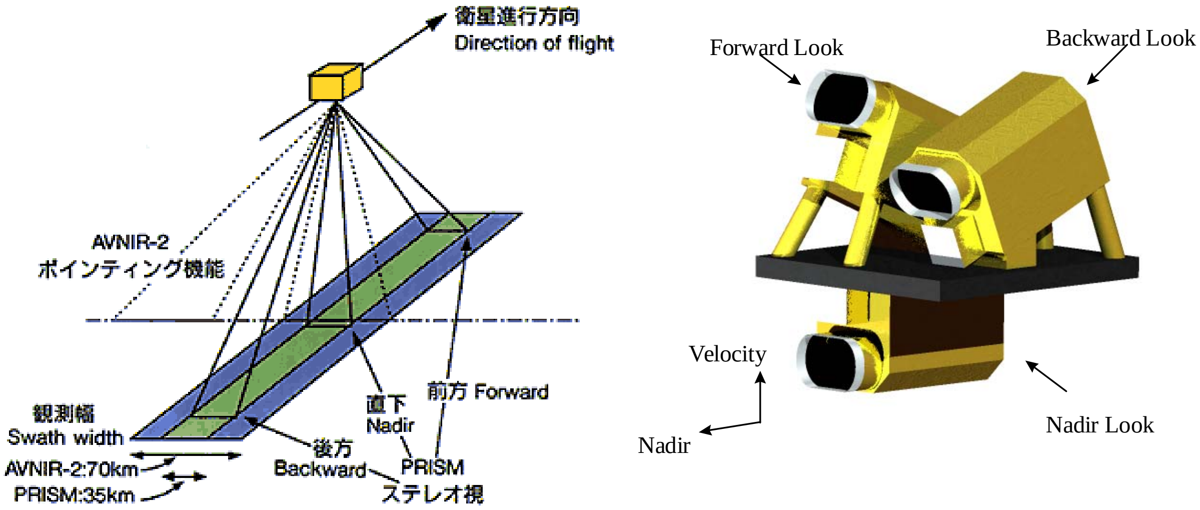


Fig. 2 PRISM Overview

Table 2 PRISM Characteristics

Item	Characteristics	Remarks
Number of Telescopes	3	
Wavelength	0.52 - 0.77 µm	
Base to Height Ratio	1.0	between fore and aft looking
IFOV	2.5 m	
Swath Width	70 km/35 km	Nadir/fore and aft
S/N	≥70	
MTF	≥ 0.2	
Number of Detectors	28,000/band (Swath Width 70 km) 14,000/band (Swath Width 35 km)	
Number of Bands	1	Panchromatic
ADC	7 bits	
Pointing	-1.2° to 1.2°	

NOTE: PRISM cannot observe areas beyond latitudes 82 degrees south and north.

2. Advanced Visible and Near Infrared Radiometer type 2

The Advanced Visible and Near Infrared Radiometer type 2 (AVNIR-2) is a successor to AVNIR on board the Advanced Earth Observing Satellite (ADEOS) launched in August 1996. AVNIR-2's main improvement over AVNIR is its instantaneous field-of-view (IFOV). AVNIR-2 provides 10-m resolution images compared with the 16-m resolution of AVNIR in the multispectral region. The higher resolution was realized by improving the CCD detectors (AVNIR: 5,000 pixels per CCD, AVNIR-2: 7,000 pixels per CCD) and their electronics. Another improvement is the pointing angle. The pointing angle of AVNIR-2 is +/-44 degrees for prompt observation of disaster areas.

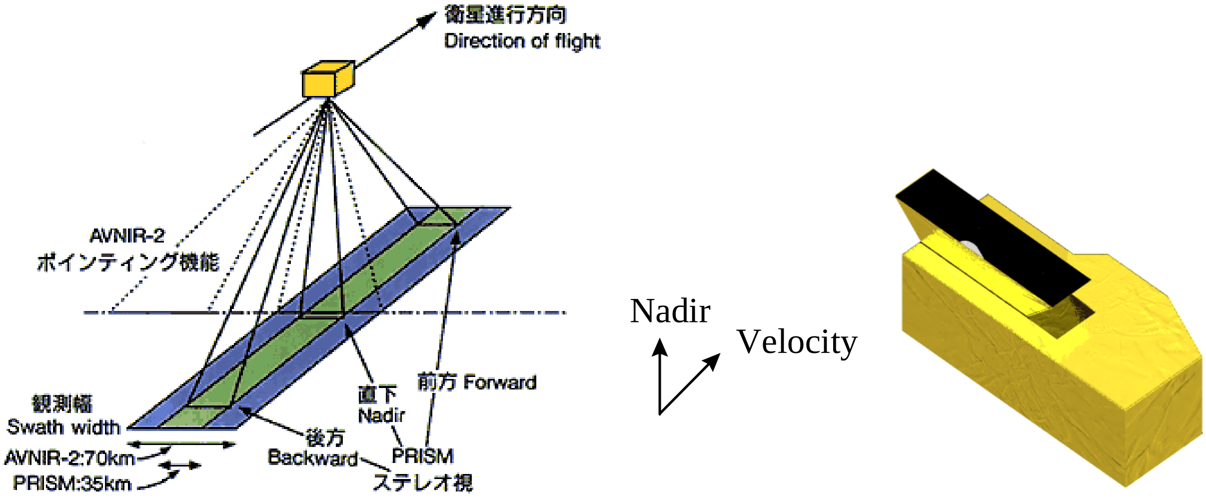


Fig. 3 AVNIR-2 Overview

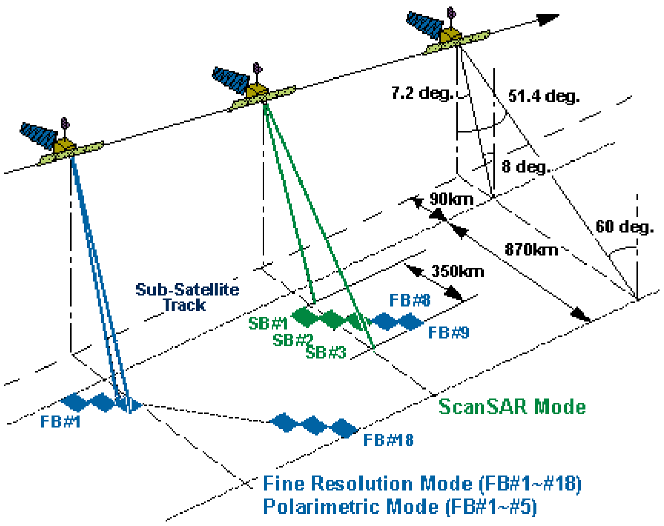
Table 3 AVNIR-2 Characteristics

Item	Characteristics	Remarks
Number of Bands	4	
Wavelength	Band 1 0.42 - 0.50 µm Band 2 0.52 - 0.60 µm Band 3 0.61 - 0.69 µm Band 4 0.76 - 0.89 µm	
IFOV	10 m	
Swath Width	70 km	
S/N	≥ 200	
MTF	Band 1 - 3: ≥ 0.25 Band 4: ≥ 0.20	
Number of Detectors	7000 / band	
ADC	8 bits	
Pointing	-44° to 44°	

NOTE: AVNIR-2 cannot observe areas beyond latitudes 85 degrees south and north.

3. Phased Array type L-band Synthetic Aperture Radar

The Phased Array type L-band Synthetic Aperture Radar (PALSAR) is Japan's second space borne SAR using L-band frequency. The high-resolution mode is a conventional one. PALSAR will have another attractive observation mode, the ScanSAR mode. This mode will allow us to acquire a 250 to 350 km width (depending upon the number of scans) of SAR images at the expense of spatial resolution. This is three to five times wider than conventional SAR images and is considered to be useful for sea ice extent and rain forest monitoring. PALSAR was jointly developed by JAXA and the Japan Resources Observation System Organization (JAROS).



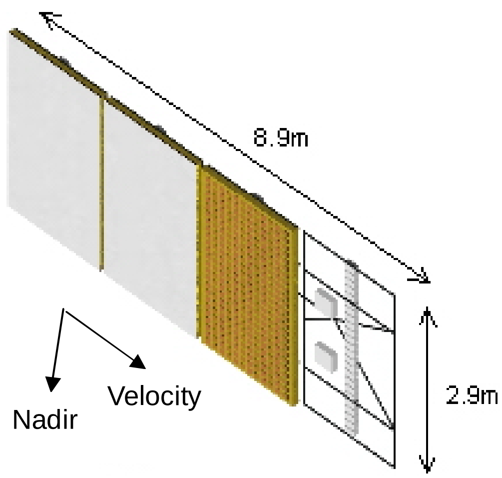


Fig. 4 PALSAR Overview

Table 4 PALSAR Characteristics

Item	Characteristic		
Mode	High resolution	ScanSAR	Polarimetric (Experimental)*
Center Frequency	1,270 MHz	1,270 MHz	1,270 MHz
Bandwidth	28/14 MHz	28/14 MHz	28/14 MHz
Polarization	HH or VV/HH+HV or VV+VH	HH or VV	HH+HV+VH+VV
Resolution**	10 m (2 look)/20 m (4 look)	100 m (multi look)	30 m
Swath Width**	70 km	250 – 350 km	30 km
Incidence Angle	8 - 60°	18 - 43°	8 - 30°
NEσ^0 (tentative)**	≤ -23 dB (Swath Width 70 km) ≤ -25 dB (Swath Width 60 km)	≤ -25 dB	≤ -29 dB
S/A (tentative)** ***	≥ 16 dB (Swath Width 70 km) ≥ 21 dB (Swath Width 60 km)	≥ 21 dB	≥ 19 dB
AD bit	3/5	5	3/5
Data Rate	240 M	240 M	240 M
Antenna Size (tentative)	AZ: 8.9 m × EL: 2.9 m (Electrical)		

NOTE: PALSAR cannot observe areas beyond latitudes 81 degrees south and north.

*	Due to power consumption, the operation time will be limited.	
**	High resolution mode	Off-nadir is 34.3 deg.
	ScanSAR mode	fourth scan (Off-nadir is 34.1 deg.)
	Polarimetric mode	Off-nadir is 21.5 deg.
***	S/A level may deteriorate due to engineering changes in PALSAR.	

4. Mass Data Handling

In order to handle the enormous volume of data generated by PRISM and AVNIR-2, ALOS has data compression (DC) capability. Each telescope of PRISM generates 320 Mbps of raw data, so 960 Mbps of data is transferred to DC (Fig. 5). The data is compressed to 240 Mbps using a JPEG-like technique consisting of the discrete cosine transform (DCT) and Huffman encoding. Although the technique is lossy compression, the accuracy of extracting DEM from the lossy compressed data is almost the same as extracting it from uncompressed data.

AVNIR-2 generates 160 Mbps of raw data that is compressed using Differential Pulse Code Modulation (DPCM), a lossless data compression technique based on that of AVNIR.

Compressed data of PRISM and AVNIR-2, and uncompressed PALSAR data are then transferred to the Mission Data Coding (MDC) system where an error correction code (Reed-Solomon (255,223) interleave depth 5) is added. The Bit Error Rate requirement of ALOS mission data is 1 x 10^{-16}.

The Mission Data Recorder (MDR) is a mass data storage device. It will hold 720 Gbits, enough for a 50-minute data recording at 240 Mbps. The recorder will be a Solid State Data Recorder (SSR) using 64 Mbit DRAM with Flip-Chip bonding.

Real-time or recorded data will then be transferred to the Data Relay Technology Satellite (DRTS), which is a Japanese geostationary data relay satellite, via the DRC subsystem. DRTS is located at 90˚E above the equator. DRTS has 240 Mbps handling capability and is currently used by ALOS and will be used by the Japanese Experiment Module (JEM, "Kibo"), attached to the International Space Station.

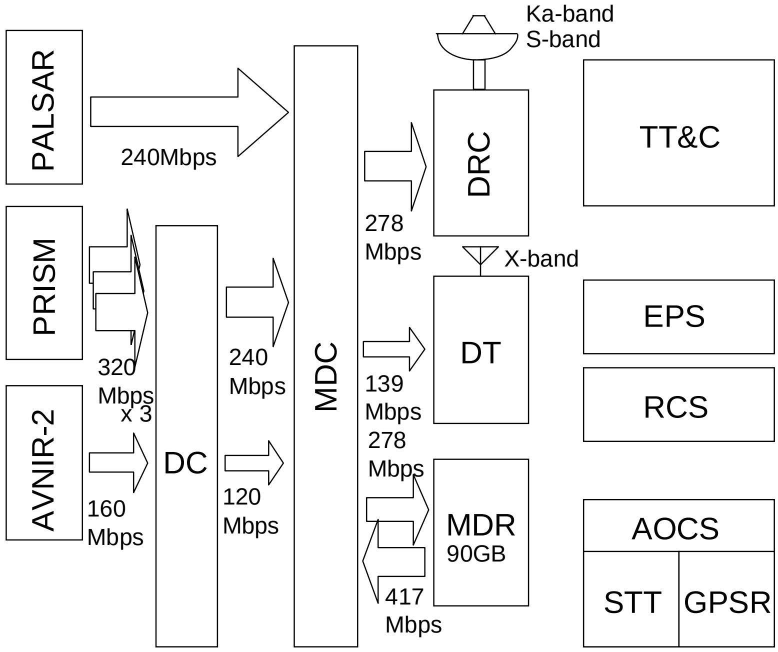


Fig. 5 ALOS Block Diagram with Data Flow.

5. Position and Attitude Determination

For geometric correction, we need precise position and attitude knowledge of satellites. ALOS has high-precision star-trackers and an inertial reference unit for precision attitude determination, and a dual-frequency GPS receiver for precision position determination. In addition to onboard attitude and position determinations, offline precision attitude and position determinations are provided to improve precision. The goal is to determine the position of each PRISM pixel on the ground to within 2.5m.

APPENDIX A-3: DATA PRODUCTS

1. Definition of ALOS Data Products

Three categories of data products are defined: Raw or Level 0 data, level 1 products, and higher level products.

1.1 Raw Data or Level 0 Data

Raw data is the demodulated bit stream and is archived temporarily in JAXA. Level 0 data is frame-synchronized, de-packetized decoding data. This level 0 data is permanently archived in JAXA and is for distribution to ALOS data node organizations.

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1.2 Level 1

Level 1 is radiometrically and geometrically corrected data and is a standard JAXA product for ALOS users, though only a relatively small percentage of Level 0 data is processed to Level 1 product.

1.3 Higher-level Data Product

Products above level 2 are higher-level data products. Higher-level data products are made more sophisticated by, for example, processing with digital elevation models. These products will be provided by JAXA's EORC from March 2007.

2. Standard Data Products

Table 5 Standard Data Products of Each Sensor

Common

Level	Definition	Note
Raw	Demodulated bit stream	Packetized Temporarily archived
0	Frame synchronization and PN decoding of CADUs and R-S Error Detection and Correction of VCDUs Extracted mission telemetry, orbit, and attitude data are stored on separate files.	Compressed (except for PALSAR) Permanently archived Level for distribution to Data Node

PRISM

Level	Definition	Note
1A	Uncompressed, reconstructed digital counts appended with radiometric calibration coefficients and geometric correction coefficients (appended but not applied). Individual files for forward, nadir, and backward looking data.	
1B1	Radiometrically calibrated data at Sensor input	
1B2	Geometrically corrected data Options G: Systematically Geo-coded (No option: Geo-referenced)	Map projection Resampling Pixel spacing

AVNIR-2

Level	Definition	Note
1A	Uncompressed, reconstructed digital counts appended with radiometric calibration coefficients and geometric correction coefficients (appended but not applied).	
1B1	Radiometrically calibrated data at Sensor input	
1B2	Geometrically corrected data Options G: Systematically Geo-coded (No option: Geo-referenced) D: Correction with coarse DEM	Map projection Resampling Pixel spacing

PALSAR

Level	Definition	Note
1.0	Reconstructed, unprocessed signal data appended with radiometric and geometric correction coefficients (appended but not applied). In Polarimetric Mode, polarimetric data is separated.	
1.1	Range and azimuth compressed complex data on slant range. Full resolution	Beam modes: Full resolution mode, Low data rate mode, Polarimetric mode SLC: Single Look Complex Used for interferometry
1.5	Multi-look processed image projected to map coordinates. Option G: Systematically Geo-coded (No option: Geo-referenced)	Map projection Resampling Pixel spacing

APPENDIX A-4: ALOS OPERATION CONCEPT AND OBSERVATION STRATEGY

1. Priority of Sensor Observation Mode

1.1 PRISM Observation Mode

The priorities of observation over land areas (including coastal zones) and polar regions in the day light zone are as follows:

1.1.1 Observation in three-line mode with 35km swath width

(1) Global land area

1.1.2 Nadir viewing mode with 70km swath width

(1) On demand

1.2 AVNIR-2 Observation Mode

The priorities of observation over land areas (including coastal zones) and polar regions in the day light zone are as follows:

1.2.1 Nadir viewing mode with 70-km swath width

(1) Global land area

1.2.2 Pointing mode along cross-track direction

(1) Post disaster observation
(2) Simultaneous observation with PALSAR for specified areas
(3) On demand

1.3 PALSAR Observation Mode

The priorities of observation over land areas (including coastal zones) and polar regions are as the follows:

1.3.1 High-resolution mode with off-nadir angle 34.3 degrees, HH and HH/HV polarizations, in night zone

(1) Global land area

1.3.2 Other modes (ScanSAR, Polarimetry, other off-nadir angles)

(1) Specified areas
(2) Post disaster observation
(3) On demand

Specified areas will be determined based on the requirements of the appropriate organizations. “On demand” observations will only be available when there are no conflicting observations having higher priority.

2. ALOS Observation Strategy

The ALOS mission features an observation strategy for pre-launch, systematic, and global-observation plans for all three instruments. The current observation strategy is on the following web page:

http://www.eorc.jaxa.jp/ALOS/en/obs/overview.htm

This observation strategy will be updated every 6 months based on the actual results of observation and other considerations.

APPENDIX B: ALOS RESEARCH PLAN

1. Goals of ALOS Research Plan

To achieve the ALOS mission, it is essential not only to distribute data products to users, but also to promote scientific and utilization research for ALOS data in broad categories ranging from the environmental and resource sciences to computer science. This Plan suggests research categories that are strongly related to acquisition and application of ALOS data and that will be promoted by association and efforts of PIs in this RA and EORC.

2. Calibration and Validation of Each Sensor and Related Basic Studies

Calibration and Validation of PRISM, AVNIR-2, and PALSAR on processing Level 1 data from Level 0 data are most important and necessary to improve the accuracy of high resolution DEM and biomass distribution data. Moreover, related basic studies required for Calibration and Validation of these sensors are essential for the development of the next generation of sensors that will have higher performance.

3. General Goals

The general goals determine which categories to select, how to contribute to each category, and what kinds of data products and algorithms are required. The categories mentioned below are classified based on the categories of undergoing core projects of the International Geosphere-Biosphere Program (IGBP).

3.1 Land Use and Land Cover Research

This research reveals land use and land cover changes, and contributes to clarifying the mechanism of such changes and the development of change models. It is important to develop the following products and algorithms for these purposes:

3.1.1 **High-resolution Digital Elevation Model:** Topographical conditions strongly influence land use determination and its change process as well as environmental impacts, such as soil erosion and runoff changes. In these research categories, a Digital Elevation Model (DEM), or Digital Surface Model (DSM), which corresponds to a 1:5,000- to 1:100,000-scale topographical map is useful. Algorithms for stereo matching and interferometric measurement need to be developed.

3.1.2 **Orthophoto image (PRISM, AVNIR-2, PALSAR images) and land use and land cover data:** These can reveal the sprawl of urban areas and villages, changes of agricultural land and agricultural practices, and deforestation. Radar images may also be able to detect tillage variations (variation of tillage surface roughness) and changes of cropping patterns.

3.2 Topography and Geology

This research contributes to measuring changes in terrain and watercourses due to soil erosion and slope failure as well as to classifying and analyzing terrain features with elevation data. It is thus essential that the following data products and algorithms be developed:

3.2.1 **High-resolution DEM:** A high-resolution DEM can be used for terrain classification and analysis as well as watercourse analysis.

3.2.2 **Orthophoto image (particularly PALSAR image):** An orthophoto image can be used for the extraction and classification of terrain features among other uses.

3.2.3 **Elevation change due to soil erosion and sedimentation:** Interferometric measurement is expected to provide a method for measuring time-series changes of land elevation. An area where a topographic condition changes remarkably due to soil erosion and sedimentation, such as the Yellow River basin, is selected as the objective area.

3.3 Terrestrial (Vegetation) Ecosystem, Agriculture, and Forestry Research

This research contributes to clarifying vegetation dynamics with emphasis on the carbon cycle, monitoring agricultural production, estimating productivity of pastures based on the vegetation dynamics, and investigating biomass changes caused by human activities. For this purpose, the following data products and algorithms need to be developed using AVNIR-2 data or other satellite data:

3.3.1 **Forest distribution monitoring:** Methods for measuring global forestry distribution are expected to be advanced using PALSAR or AVNIR-2.

3.3.2 **Vegetation biomass distribution measurement:** Vegetation biomass is a key parameter that describes vegetation dynamics. A method of measuring vegetation biomass focusing on forests with simultaneous observations by PRISM and AVNIR-2 is expected to be developed.

3.3.3 **Application to forest management:** A method of monitoring deforestation and afforestation and estimating forest growth should also be developed concurrently with the development of a biomass measurement method.

3.3.4 **Monitoring the productivity of pastures and cropland:** The development of a method for determining the crop planting area, estimating productivity of pastures and cropland in a specific area, based on intensive observation by both PALSAR and AVNIR-2, is expected. In addition, a method of monitoring the changes of agricultural production and productivity of pastures caused by drought should also be developed.

3.3.5 **Monitoring vegetation change due to human activities, such as biomass burning:** A method for measuring and monitoring the variation of biomass density and vegetation structure due to biomass burning in specific areas, with intensive observations using PALSAR together with AVNIR-2, needs to be developed.

3.3.6 **Desertification monitoring:** This aims at monitoring the decline of land productivity and soil degradation due to excessive cultivation and pasturage and improper irrigation. Methods of indirectly monitoring desertification need to be developed by observing vegetative deterioration using PALSAR and AVNIR-2 as well as directly monitoring salt accumulation on the soil surface using AVNIR-2.

3.4 Climatic System, Hydrological Processes, and Water Resources Related Research

3.4.1 **Surface process:** In research on surface processes, it will be useful to develop methods to understand vegetation distribution, measure soil moisture, and to prepare soil moisture datasets.

(1) Vegetation monitoring: Development of algorithms for measuring key parameters for water vapor estimation, such as biomass density or Leaf Area Index (LAI) is expected. Development of methods for integrating other satellite data is also important.

(2) Estimating soil moisture distribution: Development of algorithms for measuring soil moisture with PALSAR needs to be facilitated. Development methods for integrating other satellite data with PALSAR data may also be essential.

(3) Run-off analysis: ALOS data will contribute to run-off analysis under various conditions related to climate and land even in areas where there is insufficient available data.

- **High-resolution DEM:** A high-resolution DEM, having much higher resolution than the existing 1-km DEM, has the potential of making the run-off analysis more accurate and reliable.
- **Datasets of land use/land cover and their changes:** These datasets will help analyze water valance and run-off variation due to land use and land cover changes. Using additional satellite data will make this research more successful.

3.4.2 **Water pollution analysis:** This research aims at estimating the quantity of water pollutant load and analyzing flow-down conditions by providing more accurate topographical data, and land use and land cover datasets.

(1) High-resolution DEM: A high-resolution DEM will enable more accurate analysis of the flow-down of the water pollutant load due to soil erosion and estimation of the amount.

(2) Datasets of land use/land cover and their change: These datasets facilitate analyzing the quantity of the water pollutant load by land use and land cover changes. Combined with hydrological analysis, these datasets reveal the condition of the pollution effluent. Using additional satellite data will make this research more successful.

3.4.3 **Snow and ice related analysis:** Accurately analyzing snow and ice in the following categories using high resolution sensor data from ALOS will contribute to understanding changes of climate and water resources (hydrological cycles), the International Polar Year (IPY) related research, and others.

(1) Estimating states and changes of snow cover and snow-water equivalent: Analysis using the observation data from PALSAR and AVNIR-2 will help to accurately predict and understand the seasonal or annual change of snow cover and snow-water equivalent.

(2) Measuring and analyzing variations of ice sheets and glaciers: Analysis of Interferometric measurements by PALSAR and observation by AVNIR-2 will contribute to understanding the ice sheet mass balance and mountain glacier variation in the South Pole, Greenland, and other areas.

(3) Sea ice monitoring: Analyzing the observation data from PALSAR and AVNIR-2 will contribute to determining the extent and seasonal or annual variation of ice sheets in the Polar Regions and coastal zones. Furthermore, using ScanSAR data from PALSAR will contribute to the methodological development of extensive sea ice monitoring, and using polarimetric data of PALSAR will improve the accuracy of sea ice classification.

3.5 Oceanography and Coastal Zone Related Research

3.5.1 **Coastal zone related research:** Providing information on wave, sea surface wind, water current, sea ice, topographical change, and sand drift in coastal areas can support economic activities in coastal areas such as sea traffic, pollution control, and fisheries. For this purpose, it is necessary to develop and prepare the following algorithms and products:

(1) Oil spill datasets of coastal zones: Techniques for extracting the polluted areas from PALSAR images is expected to be developed. It is necessary to analyze sea surface wind and the spectrum of ocean waves around the area to accurately extract polluted areas. At the same time, datasets that analyze these factors must be developed.

(2) High-resolution DEM of coastal zones: High-resolution DEM of coastal zones combined with water depth data will contribute to analyzing transformation of sea wave and coastal topography and impacts of sea level rises.

(3) Datasets of sea surface wind and wave height in coastal zones: It is possible to prepare datasets for coastal sea surface winds and waves using PALSAR data. A method that predicts coastal current by utilizing a numeric simulation model along with these datasets should also be developed. These are useful for giving a boundary condition for the analysis of coastal transformation and sand drift.

(4) Datasets of sea ice: Methods for monitoring coastal sea ice and for providing data accurately using PALSAR and AVNIR-2 need to be developed. Coastal ice datasets are useful for the various coastal activities of human beings.

3.5.2 **Ocean dynamics:** Utilization of PALSAR or development methods using PALSAR together with other satellite data will contribute to studies on air-sea interaction, sea waves, and the dynamics of various ocean phenomena in coastal zones and the open seas.

(1) Coastal topography-air-sea interaction: Strong or weak wind zones are generated locally in a coastal sea because of coastal topography. Though such changes of sea surface are essentially important to coastal waves and water currents, little research has been conducted in these areas. High-spatial resolution information collected by PALSAR on ocean waves and sea surface winds is expected to greatly contribute to studying the coastal topography-air-sea interaction and probing its mechanism.

(2) Wave-current interaction and various phenomena in the ocean: Studies on the interactions between ocean waves and currents using data acquired in the ScanSAR mode of PALSAR need to be promoted. Based on these studies, large-scale ocean currents (like the Black Current), cold/warm water masses, coastal water currents, and internal waves can be visualized from ScanSAR images. This will help us to understand ocean dynamics.

3.6 Disasters and Earthquakes

3.6.1 **Diastrophism:** Methods for monitoring land surface deformations due to diastrophism employing interferometric observation by PALSAR need to be developed.

3.6.2 **Volcano monitoring:** A method for monitoring the deformation of mountains caused by volcanic activities should be developed.

3.6.3 **Slope failure:** It is necessary to develop a method for the risk analysis of slope failure using high-resolution DEMs generated by PRISM and PALSAR. Datasets of land use and land cover in slope areas will contribute to estimating surface erosion and water infiltration as well as forecasting the damage due to slope failure.

3.6.4 **Analysis and simulation of flooding and inundation:** By applying high-resolution DEMs, we can conduct run-off (flooding) analysis and inundation in areas where we previously lacked sufficient data. This will contribute to advancing methods for analyzing and investigating these phenomena. At the same time, land cover and land use data will improve the reliability of these analyses as well as damage forecasting and refuge planning.

3.6.5 **Tidal wave analysis:** It is expected that tidal wave tracing analysis with high-resolution DEMs can be conducted in areas where we previously lacked sufficient data. This will contribute to advancing the methods of analyzing and investigating these phenomena. Furthermore, land cover and land use data together with high-resolution DEMs will improve the reliability of these analyses as well as damage forecasting and refuge planning.

3.6.6 **Disaster monitoring techniques:** Disaster monitoring techniques reveal damage due to drought, floods, fire, slope failure, tidal waves, and earthquakes. Furthermore, these techniques can be applied to quick and accurate damage assessment (for example, the effect on agricultural production).

3.7 Resource Exploration

Resource exploration research techniques for mineral resources need to be developed. Analysis methods integrating PRISM, AVNIR-2, and PALSAR images with DEMs will be examined.

3.8 Development of Spatial Data Infrastructure

3.8.1 **Techniques for developing spatial data infrastructure:** Automatic recognition and three-dimensional measurement of terrain features need to be developed to efficiently generate high-resolution DEMs and spatial data on artificial structures, which are the basis of various scientific research and practical uses. For three-dimensional measurement, orientation methods and stereo matching methods for PRISM images need to be developed. Furthermore, an algorithm for interferometric measurement needs to be developed for PALSAR. In addition, a method integrating images (from PRISM, AVNIR-2, and PALSAR) with DEMs needs to be developed for automatic recognition and three-dimensional measurement of terrain features, such as roads, large structures, and urban areas.

3.8.2 **Management and retrieval techniques for very large databases:** Using ALOS data as a test case, techniques for very large spatial databases are expected to be developed. Examples include data storage and management techniques, and an efficient retrieval method based on a map or coordinates.

3.9 Basic Studies on Scattering and Interferometric Characteristics

In order to expand the application fields of PALSAR data, including improvements of interferometric analysis, polarimetric analysis, and terrain correction methods, the following study will be performed:

3.9.1 Decomposition method for polarimetric SAR data

Decomposition methods for PALSAR polarimetric data should be studied and developed. This methodology will be applied to land cover classification using scattering characteristics of the targets.

3.9.2 Polarimetric and interferometric data analysis

Interferometric analysis is applied to the polarimetric data acquired from PALSAR repeat-pass observation. An applied field example is tree height estimation in forested areas.

3.10 Basic Studies for Accurate Observation with High-Resolution Optical Sensors

Research on the following topics needs to be conducted to develop the next-generation high-resolution optical sensors.

(1) The accuracy of satellite position and attitude determination, including the rate of the variation of the attitude that will affect the pointing accuracy and resolution of the optical sensors, needs to be analyzed and evaluated.

(2) Impacts of the shock during launch, temporal degradation, and temperature changes inside the instruments on optical alignment (including the optical benches and the structures with optical alignment), photoelectric transfer characteristics, and sensor resolution need to be analyzed and evaluated.

(3) It is necessary to develop a code to analyze the effect of multiple scattering of the atmosphere, especially regarding aerosols, whose spatial conditions fluctuate largely with time, and to estimate the surface albedo with high speed and high accuracy.

(4) A suitable filter for modulation transfer function (MTF) correction needs to be developed to restore observation data degraded by the MTF of each sensor or atmospheric influences.

4. Strategic Goals

We define the development of specific data products and algorithms for promoting other scientific researches as "strategic goals." These are selected considering their relevance to the ALOS mission and the goals of this plan, and resource limitations.

4.1 Data products

4.1.1 **Global high-resolution DEMs and orthorectified images (PRISM, AVNIR-2, and PALSAR):** These data products form the basis of many fields of research and practical applications. They are provided only by ALOS at the moment. However, resources required to generate these data are so large that the accuracy and resolution may change according to the objective area. Global coverage will be pursued by coordinating with other data node organizations.

4.1.2 **Global biomass density datasets (PALSAR and AVNIR-2):** Biomass is not only one of the most important parameters for estimating the carbon cycle, but also provides a basis for forestry management. However, it is difficult to measure on the ground and there is no data covering a large area. Since only ALOS is equipped with L-band, which favors biomass observation, it is expected that biomass density data will be generated using PALSAR images along with AVNIR-2 images and high-resolution DEMs. These activities will allow us to conduct time series analysis with Global Forest Mapping (GFM) datasets from JERS-1 SAR data.

4.1.3 **Land surface deformation datasets (earthquake-prone areas only):** The distribution of deformed land surfaces can be extracted by interferometric measurement. Monitoring diastrophism is essential in the Pacific Rim area, including Japan, which is always threatened by earthquakes. Land surface deformation data will be collected by periodic satellite observation and continuous ground observation

4.2 Algorithms

4.2.1 **Automated generation of high-resolution DEMs and orthorectified images:** A large computing capability is usually required to generate high-resolution DEMs and orthorectified images, and the quality of these products is affected strongly by the performance of the algorithms used. Algorithms for automated generation of high-resolution DEMs and orthorectified images (including an algorithm to estimate satellite position and altitude) need to be developed.

4.2.2 **Accuracy improvement of the biomass measurement method:** The development of algorithms using DEMs and AVNIR-2 images together with other satellite images for measuring global biomass distribution with higher accuracy is requested.

4.3 Calibration and Validation for Each Sensor and Related Basic Studies

Calibration and validation of each sensor is necessary for improving the quality of the data products, such as high-resolution DEMs and biomass density data. In addition, basic studies on calibration and validation for improving the accuracy of each sensor should also be pursued as strategic goals.

4.3.1 Calibration and validation for optical Sensors

To generate high-quality products from optical sensors, AVNIR-2, and PRISM, the basic study for accurately evaluating radiance characteristics, geometric characteristics, spatial resolution, system noises, and other factors is considered to be one of the strategic objectives.

(1) Accuracy improvement of radiance and brightness calibration

The radiance and brightness of optical sensors will be calibrated using pre-flight test data, internal calibration source data, and external calibration data after launch. The main output of this study is to estimate absolute calibration coefficients. In particular, an important challenge will be the improvement of stability characteristics with ground-based experiments with calibration after launch and development of the radiative transfer model with high accuracy.

(2) Accuracy improvement of DSM

Algorithms for automatically evaluating and correcting registration and pointing accuracy and for automatically producing high-resolution DSMs using stereo matching images will be developed.

(3) Atmospheric correction

Algorithms should be improved to estimate the surface albedo on a heterogeneous surface using optical sensor data, taking into account the effect of multiple scattering in the atmosphere, especially spatial and temporal changes of aerosols.

4.3.2 Calibration and validation for PALSAR system

A basic study for achieving high radiometric accuracy of the PALSAR system is considered a strategic objective.

(1) Accurate estimation of normalized radar cross section

The relation between the digital number and the normalized backscattering coefficient for PALSAR standard products will be determined by using the pre-flight test data, internal calibration source data, and external calibration data. The main outputs of this study are the estimated in-orbit antenna elevation patterns and the absolute calibration coefficients.

(2) Accuracy improvement of interferometric SAR data

In order to derive accurate digital elevation models as well as crustal movements, a study on achieving an accurate phase difference will be done using repeat-pass interferometric datasets acquired by the PALSAR system.

(3) Accuracy improvement of polarimetric SAR data

PALSAR's polarimetric observation mode is currently an experimental mode. However, this observation mode will be the main operation mode in future SAR systems. In order to prepare for the practical use of fully polarimetric data, polarimetric calibration with the data acquired from PALSAR polarimetric observation mode should be studied. The methodology to derive phase correction, cross talk, and gain imbalance will be developed and investigated.

APPENDIX C: ALOS SAMPLE PRODUCTS

The following web page contains samples of the standard products of each sensor processed at the Earth Observation Center (EOC) at JAXA. Please use it to confirm data formats.

http://www.eorc.jaxa.jp/ALOS/en/doc/sproduct.htm

APPENDIX D: PROPOSAL CONTENTS AND APPLICATION FORMS

1. Proposal Cover Sheet

1.1 Information of Applicant (Form 1a)

- Identification of principal applicant: Legal name, official title, department, organization, address, country, phone number, facsimile number, and email address
- Co-applicant information: Name, organization, and email of each co-applicant
- Biographical Information, experience and papers in related fields of principal applicant
- Signature of principal applicant

1.2 Information of Proposal Contents (Form 1b)

- Research Category (choose 1)
- Research Title : A brief and valid project title
- Main Sensor (PRISM, AVNIR-2, PALSAR, or none)
- Supplemental Sensor (PRISM, AVNIR-2, PALSAR, or none)
- Data Requirement (Required, not Required, the minimum and maximum number of required scenes)
- Abstract (200-300 words): Objective, significance in the research field, method, result, and schedule

2. Detailed Description of Proposal (Up to five pages)

The main body of the proposal should be a detailed statement of the work to be undertaken and should include objectives and expected significance in relation to knowledge of the art in the field 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 experimental methods and procedures. The project should be described in terms of the following items:

- Table of contents
- Objective
- Significance in the research field
- Methodology
- Algorithm to be used
- Anticipated results
- Type of truth data and its acquisition plan (Area, Product level, Volume, Term, Season)
- Product Utilization Plan (Product level, Volume, Term, Season)

3. Work Plan (Research Schedule) (Form 2)

Provide the research schedule in Form 2. Include descriptions of the major activities of the research and associated schedules. This schedule should be planned between April 2010 and the end of March 2012.

4. Details of Data Requirements

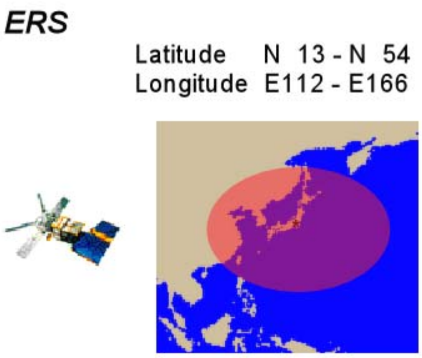
4.1 JAXA-owned Satellite Datasets (Form 3a)

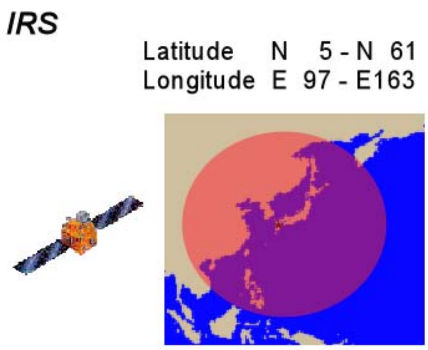
To request the following satellite datasets, complete Form 3a.
JAXA has the authority to provide datasets received from the following:

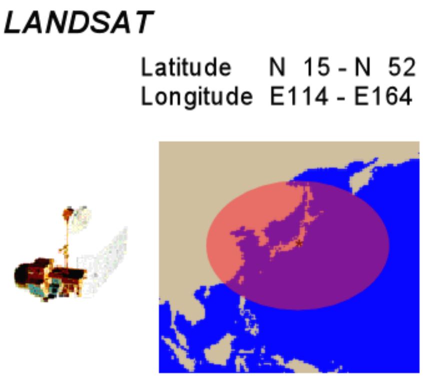
- Marine Observation Satellite (MOS) (global)
- Japanese Earth Resources Satellite (JERS) (global)
- Advanced Earth Observing Satellite (ADEOS) (global)
- Tropical Rainfall Measuring Mission (TRMM) (global)
- European Remote-sensing Satellite (ERS) (only around Japan)*
- LANDSAT (only around Japan)*

- SPOT (only around Japan)*
- RADARSAT (only around Japan)*
- Indian Remote Sensing Satellite (IRS) (only around Japan)*

* Data from foreign satellites are limited to the area received at the ground station in Japan, as portrayed in the following figure. The red area indicates the visible circle considering the skyline at the ground station. JAXA can receive data inside this circle that shows minimum and maximum latitude and longitude. If the antenna angle is changed, the circle may be extended somewhat.







You cannot order data, but you can search for the browse data via the Internet if you access the following address. JAXA recommends that you search for the data of the requested area in advance.

- MOS, JERS, ADEOS, TRMM, ERS, LANDSAT**/*** data search
  https://www.eoc.jaxa.jp/iss/en/index.html
- IRS** data search
  https://cross.restec.or.jp/

** IRS, LANDSAT (#2 - #5) data archived through March 31, 2001.
*** LANDSAT (#7) data archived through March 31, 2002.

4.2 JAXA-owned Airborne L-band SAR (Pi-SAR) Datasets (Form 3b)

To request data from JAXA's airborne L-band SAR (Pi-SAR), complete Form 3b. Detailed information of this Pi-SAR data is available on the following web page, and only in Japanese, because all the available data sets were originally acquired in Japan.

http://www.eorc.jaxa.jp/ALOS/Pi-SAR/index.html

5. Personnel

A short biographical sketch of the principal applicant, a list of principal publications, and any exceptional qualifications should be included. Provide similar biographical information on the co-applicants as well.

6. Data Processing and Analysis Equipment

Please describe available facilities and major items of equipment especially adapted or suited to the proposed research project, and any additional major equipment that will be purchased by applicants. Please state whether you have institutional support from your organization for implementing your proposal.

Form 1a

RA3 Proposal No.
(Leave Blank for JAXA Use)

Proposal Cover Sheet
for
ALOS Third Research Announcement

Information of Applicants

Principal Applicant:

Name: ____________________

Official title: ____________________

Department: ____________________

Organization: ____________________

Address: ____________________

Country: ____________________ Email: ____________________

Telephone: ____________________ Facsimile: ____________________

Co-applicants:

Name	Organization	Email

Biographical Information, Experience, Papers in Related Fields of Principal Applicant:

Signature of principal applicant: ____________________

Form 1b RA3 Proposal No.
(Leave Blank for JAXA Use)

Information of Proposal Contents

1. Research Category (check one)* [√]

[ ] SAR Cal/Val [ ] Optical Sensors Cal/Val [ ] Agriculture [ ] Disaster Management

[ ] Geography [ ] Geology [ ] the International Polar Year [ ] Land Use & Land Cover

[ ] Ocean [ ] Snow & Ice [ ] Vegetation、Forests、Wetlands

* Our priority for proposal selection will not be judged from your selected category.

2. Main Sensor (check one or more)

[ ] PRISM [ ] AVNIR-2 [ ] PALSAR [ ] none

3. Supplemental Sensor (check one or more)

[ ] PRISM [ ] AVNIR-2 [ ] PALSAR [ ] none

4. Data Requirements

[ ] Required [ ] Not Required

→ Satellite Data (Enter the maximum and minimum number of required scenes)

	MOS	JERS	ADEOS	TRMM	ADEOS -II	ERS	LAND SAT	IRS	ALOS
Minimum									
Maximum									

→ ALOS Simulation Data (check one or more.)

[ ] For the Optical Sensors [ ] For the SAR

5. Research Title:

____

6. Abstract of Proposal:

____

____

____

____

____

Form 2

RA3 Proposal No.
(Leave Blank for JAXA Use)

Work Plan (Research Schedule)

Research Title:____ Name of Principal Investigator:________________________

Abstract of RA Activities:

Year	2009			2010						2011						2012		
Month	10	12	2	4	6	8	10	12	2	4	6	8	10	12	2	4	6	8
Milestones				△Contract											△Final Report			
Activities																		

Form 3a

RA3 Proposal No.
(Leave Blank for JAXA Use)

Details of Data Requirements

Research Title:____ Name of Principal Applicant:__________________________

JAXA-owned Satellite Data (MOS, JERS, ADEOS, TRMM, ADEOS-II, ERS, LANDSAT, IRS)

Satellite	Sensor	Location (Path/Row or Lat/Lon)	Observation Period	Number of Scenes		Level of Processing
				Minimum	Maximum	

NOTE: The form in which the data is supplied, either by online transmission or media transfer, will depend on data volume.

Form 3b

RA3 Proposal No.
(Leave Blank for JAXA Use)

Details of Data Requirements

Research Title:____ Name of Principal Applicant:___________________________

JAXA-owned Pi-SAR Data

Scene ID	Location	Observation Date

APPENDIX E: ALOS DATA NODE

ALOS Data Node (ADN): Concept

All data produced by the ALOS sensors on a daily basis (approximately 700 Gbyte) will be well beyond the management capabilities of any single agency. As there is still a worldwide interest in the use of ALOS data, JAXA has established the concept of ALOS Data Nodes with local archives. These should aid in processing and distribution.

Through agreement with JAXA, each ALOS Data Node (ADN) is managed by a partner organization or consortium. Each partner participates in certain tasks. These include reception and near-real-time processing, offline processing, promotion, distribution, archiving of ALOS data to support data users within their region, and research study of ALOS data. Each Node is associated with a geographical zone defining the physical location of the ALOS users, which the Node supports by mandate as an ADN partner. These zones are approximated in Fig. 1. GISTDA of Thailand will serve as an additional sub-Node in Asia (*).

(*) The group of countries determined to be in the sub-Node zone are the Kingdom of Thailand, Union of Myanmar, Lao People's Democratic Republic, Socialist Republic of Vietnam, Kingdom of Cambodia, Malaysia, Republic of Indonesia, Republic of Singapore, Brunei Darussalam, and the Republic of the Philippines

Each Node produces the same quality of Standard Products as those of JAXA. Higher level products may be defined by the individual Nodes.

Although each Node is the focal point for support of ALOS users within its own zone, the regional distributor(s) appointed by each Node will serve as commercial data distributor(s) and service agent(s) for commercial users within the relevant zone(s). JAXA appointed the Remote Sensing Technology Center (RESTEC) as the Primary Distributor (PD), which serves as both the regional distributor in Asia and Russia, and the coordinating agency among all of the regional distributors. RESTEC will also serve as the Regional Distributor (RD) of the Oceania Node by coordinating with Geoscience Australia, the Oceania Node organization, and JAXA. Each of the other Nodes will soon announce their Regional Distributors.

There is only one exception for PALSAR data distribution. Because JAXA and the Ministry of Economy, Trade and Industry (METI) developed the PALSAR instrument jointly, METI has an equal right to distribute PALSAR data. The Earth Remote Sensing Data Analysis Center (ERSDAC), with METI agreement, will also distribute PALSAR data, although ERSDAC is outside of this ADN concept. PALSAR data products processed by ERSDAC resemble JAXA Standard Products, but may differ slightly because of the variations in processing algorithms and application formats.

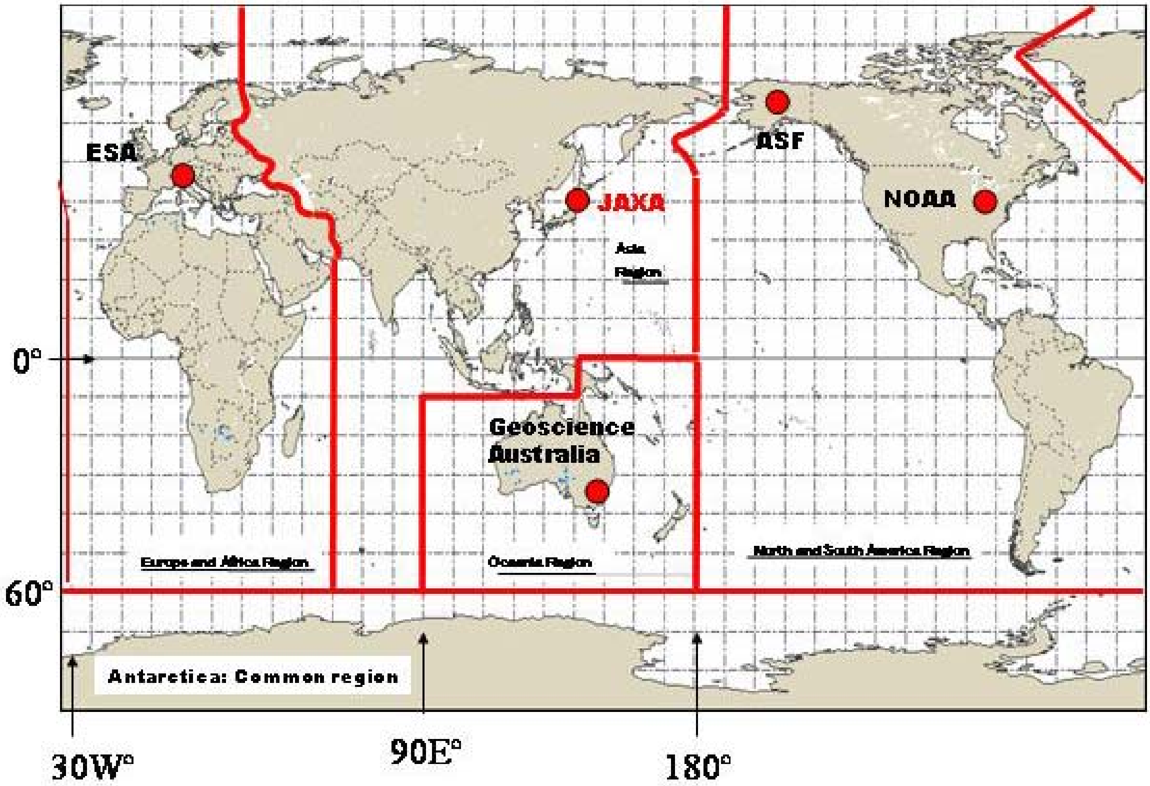


Fig. 1 Zone Definitions for ALOS Data Nodes

ALOS Data Node organizations

Asia: Japan Aerospace Exploration Agency (JAXA)

Asia Sub-Node: Geo-Informatics and Space Technology Development Agency (GISTDA)

Oceania: Geoscience Australia

North and South America: National Oceanic & Atmospheric Administration (NOAA) and Alaska Satellite Facility (ASF) of the University of Alaska Fairbanks

Europe and Africa: European Space Agency (ESA)

RESEARCH AGREEMENT
FOR THE
ADVANCED LAND OBSERVING SATELLITE
BETWEEN THE
JAPAN AEROSPACE EXPLORATION AGENCY (JAXA)
AND
THE RESEARCH ORGANIZATION
(FOR THE THIRD RESEARCH ANNOUNCEMENT)

September1, 2009

JAPAN AEROSPACE EXPLORATION AGENCY

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This agreement is made between the Japan Aerospace Exploration Agency (hereinafter referred to as "JAXA"), established under the provisions of the Japan Aerospace Exploration Agency Law of December 13, 2002, represented by its President and having its principal office at 7-44-1 Higashimachi, Jindaiji, Choufu-shi, Tokyo, Japan and the Research Organization (hereinafter referred to as the "Research Organization") that submitted the application form for this agreement to JAXA, hereinafter collectively referred to as "the Parties".

Recognizing that the Advanced Land Observing Satellite (hereinafter referred to as "ALOS") was launched by JAXA from Japan on January, 2006 to contribute to the global and regional land observation in cooperation with the Ministry of Economy, Trade and Industry (hereinafter referred to as "METI") for peaceful purposes;

Recognizing that JAXA shall provide the Panchromatic Remote-sensing Instrument for Stereo Mapping (hereinafter referred to as "PRISM") and the Advanced Visible and Near Infrared Radiometer type 2 (hereinafter referred to as "AVNIR-2") for flight on the ALOS spacecraft;

Recognizing that JAXA and METI shall jointly develop the Phased Array type L-band Synthetic Aperture Radar (PALSAR) which will also fly on the ALOS spacecraft:

Recognizing that JAXA issued the Third Opportunity of Research Announcement (hereinafter referred to as "RA") in September 2009, for PRISM, AVNIR-2 and PALSAR on the ALOS spacecraft, and the Principal Investigator (hereinafter referred to as "PI"), who belongs to the Research Organization, submitted a proposal in response to the RA;

And recognizing that JAXA has selected, based on the proposal, PIs for three categories (1) Calibration, and Validation of ALOS data products and each sensor, (2) Utilization research, and (3) Science research;

The Parties hereto agree as follows:

1. Definitions

As used in this agreement, the following terms shall have the meanings indicated.

"ALOS" consists of the spacecraft plus all the instruments on board the spacecraft, whether provided by JAXA or by any other agency.

"ALOS data" means all primary data originating from ALOS, including a processed product that retains the original pixel structure and can be converted back to the original data.

"JAXA archived dataset" means sensor data received from Earth Observation Satellites (EOS) and airbone sensor that JAXA has the authority to distribute (see the list of satellites and airborne sensor, observation periods and observable areas in the attachment A).

A "PI" is the person who has been selected to perform these RA activities and who belongs to the Research Organization, and whose name is shown on the "Work Plan";

The “Co-Investigator” (CI) is the person who supports the PI in performing the research defined in this agreement with approval by the Research Organization and notification to JAXA.

“Research” is defined in the RA and further detail is described in the “Work Plan.”

“Research Results” means the results derived from the implementation of this RA.

“Commercial use” of ALOS data involves for-profit activities and all uses other than its application for scholarly or scientific investigations.

2. Purpose and Scope

The purpose of this agreement is to establish the terms and conditions under which the Research Organization shall conduct the RA activities. The Research is described in the Work Plan.

3. Period of Performance

This agreement shall come into force upon issuance of a confirmation sheet prescribed by JAXA and shall continue in effect until March 31, 2012, unless terminated as described in article 23.
In spite of the previous paragraph, articles 72)3), 8, 9, 10, 11, 12, 18, 19, 20, 26, and 27 shall remain in force after the expiration of this agreement.

4. Affiliation

1. In the event that the Research Organization intends to 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 in order to obtain JAXA's consent. If JAXA does not agree to the proposed list of candidates of CIs, then JAXA will send notification to the Research Organization within 7 days upon receipt of the list of candidates of CIs.
2. 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 avoidance of doubt, with regard to this Agreement, the PIs and CIs shall not be deemed to be a third party.

3. In the event that the PI dies, retires from the Research Organizaion, takes a leave absent from work, or come to be no longer engaged in the Research Projects, the Research Organization shall immediately notify to JAXA as such and JAXA and the Research Organization may terminate this Agreement; provided however, if the Research Organizaion designates a reseacher who belongs to the Research Organization as the PI’s successor, the Research Organization can continue RA activities by sending notification to JAXA with the succeeding researcher being a new PI. If JAXA does not agree to the proposed new PI, then JAXA will send notification to the Research Organization within 14 days upon receipt of the notification proposing new PI.

5. Responsibilities of JAXA

JAXA shall make reasonable efforts to perform the following tasks.

a) Accept data processing requests from the PI and deliver the ALOS data, other EOS data and airborne sensor data from the JAXA archived dataset in the Attachmnt A to the PI. JAXA shall not accept observation requests from the PI.

b) Supply the necessary information to PIs in order to conduct RA activities including satellite operation data.

c) Hold workshops and meetings and exchange information among PIs and JAXA.

6. Responsibilities of the Research Organization

a) The Research Organization shall conduct and complete the RA activities in accordance with the Work Plan.

b) Deliver the Research Results as a final report by the end of performance period as described in article 3.

c) Participate in workshops and meetings

7. Provision of JAXA Archived Dataset

1. JAXA will provide the Research Organization with the JAXA archived dataset for the Research Projects free of charge subject to the following conditions:

   a) A PI can request up to 50 ALOS data scenes per Japanese fiscal year, from April 1 to March 31.
   Regarding other EOS data, a PI can request up to 50 scenes in sum per Japanese fiscal year.Regarding airborne sensor data, a PI can request up to 5 Pi-SAR data scenes per Japanese fiscal year.The Research Organization agrees and accepts that JAXA may not provide all the JAXA archived dataset which the Research Organization may request;

   b) JAXA does not guarantee a specific quality or the timely provision of the JAXA archived dataset;

   c) JAXA reserves the right to curtail or suspend JAXA archived dataset 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 JAXA archived dataset provided by JAXA, the Research Organization shall:

   a) Only use the JAXA archived dataset for the singular purpose of advancing the efforts of the Research Projects;

   b) Not duplicate the JAXA archived dataset except for distributing to authorized CIs the necessary data backups;

   c) Not distribute the JAXA archived dataset to any third party without JAXA's prior written consent; and

   d) Return or otherwise appropriately manage the JAXA archived dataset upon completion of this Agreement, according to the directives of JAXA.

3. Any rights regarding the JAXA archived dataset provided by JAXA shall conform to the following:
   a) Any rights relating to the JAXA archived dataset shall belong to JAXA or to an institute designated by JAXA except in the case mentioned in b) below. For ALOS data, JAXA retains the intellectual property rights of all ALOS data, except METI is the joint owner of PALSAR data.
   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 JAXA archived dataset, 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.

8. Transfer of Technical Data

Except as otherwise provided in this article, each party under this agreement shall transfer all technical data, excluding JAXA archived dataset, considered to be necessary to fulfill the receiving party's responsibilities under this agreement, to the extent feasible. The parties will undertake to handle expeditiously any request for technical data presented by the other party for the purpose of this agreement. Neither party shall have any right to require the other party to transfer any data, the transfer of which would violate the laws or regulations of the country having jurisdiction of such transfer.

The furnishing party shall mark with a notice or otherwise clearly indicate the technical data that are to be protected for proprietary rights purposes or export control purposes. Such a notice shall indicate any specific conditions regarding how such technical data may be disclosed or used by the receiving party including, for export control (a) that such technical data shall be used or disclosed only for the purpose of fulfilling the receiving party's responsibilities under this agreement, and, for proprietary rights (b) that such 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.

Each party shall observe any clearly indicated limitation on the handling of transferred technical data.

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.

9. Intellectual property rights

For 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.

For 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.

10. 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 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 Final Reports); provided, however, JAXA shall use such Research Results (and derivative works thereof including 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 Final Reports, regardless of whether they relates to the Research Organization's Research Result or not, the Research Organization agrees not to exercise and to cause its directors, officers, employees including PIs and CIs, regardless of whether such persons are employed by the Research Organization, to agree not to exercise any related moral rights to the copyrights in the Final Reports and agrees not to rescind such

non-exercise and shall cause such directors, officers, employees including PIs and CIs to agree not to rescind such non-exercise.

11. Commercial Use

Commercial use of the research results obtained through this agreement is beyond the scope of this agreement. In such cases, the two parties shall agree as otherwise to define the necessary conditions.

12. Publication of Research Results

1. The results obtained through the performance of these RA activities by the Research Organization will be made available to the general public in a timely manner. Regardless of 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. The publishing parties shall add a statement to the publication that indicates, as appropriate, that the research results have been obtained through the cooperation between the research organization and JAXA (JAXA/METI for PALSAR, if necessary) in JAXA's ALOS RA.
3 The publishing party shall, as between the parties hereto, have all rights in such publication as are protected by copyright law.
4. The Research Organization shall provide JAXA with three (3) copies of such publication. The Research Organization shall grant JAXA an irrevocable, royalty-free, non-transferable and non-exclusive right to use, edit, copy, or distribute the provided publications, unless the copyright of such publication is owned or held by an academic society.
5. Neither party shall, without the consent of the other party, publish information disclosing an invention prior to filing a patent application on that invention.

13. 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.

14. Language

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

15. Force Majeure

Neither party is liable for failure, delay or suspension to perform its part of this agreement when such failure is due to the reason including, but not limited to, fire, war, inevitable accident, act/policy of government, legal restrictions beyond the control of the party.

16. Taxes and Customs

If any customs fees and/or taxes of any kind are levied on the transactions necessary for the implementation of this agreement, after seeking to develop the necessary free customs clearance and waiver of applicable duties and taxes, such customs fees and/or taxes shall be borne by the party of the country levying the fees and/or taxes.

17. 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.

18. Limitations on Liabilities

JAXA and the Research Organization agree to waive any claim against the other with respect to any injury or death of its employees or the employees of its related entities, 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 (hereinafter referred to as “Damages”), except such Damages which arise through willful misconduct and gross negligence and except intellectual property rights.

19. Invention and Patent

Except as set forth in paragraph 2 of this article, nothing in this agreement shall be construed as granting or implying any right to, or interest in, patents owned or inventions that are independently developed by the parties or their contractors or subcontractors.

If an invention is jointly made by any combination of the parties during the implementation of this agreement, patent protection shall be requested jointly by the parties involved on the basis of equal rights, unless otherwise agreed by the parties involved, taking into consideration their contribution to the invention.

20. 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 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.

21. Government Approvals

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

22. Suspension

When the Research Organization fails to meet the purposes of this agreement or to comply with the terms of this agreement, JAXA may suspend execution of this agreement, in whole or in part, pending corrective action by the Research Organization or a decision by JAXA to revoke this agreement.

23. Termination

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) When the Parties consent to terminate
2. 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.
3. The preceeding paragraph shall apply to termination upon the occurence of the events

contemplated in Article 4 Paragraph 3.

24. Amendment

JAXA may amend this agreement without prior notice to the Research Organization.

25. 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.

26. Dispute Resolution

The parties agree to make their best efforts to solve amicably any dispute, controversy, or difference arising out of, in connection with, or resulting from this agreement.

27. Arbitration

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

Attachment A

Table1. “JAXA archived dataset”

Name of Satellite	Observation Period (YY/MM/DD)	Observable Area
ALOS (Advanced Land Observing 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 2003/01/18～2003/10/24	Global
TRMM (Tropical Rainfall Measuring Mission)	1997/12/01～	Global
Pi-SAR (Polarimetric and Interferometric Airborne Synthetic Aperture Radar)	1998/10/22～	Japan
ERS (European Remote-Sensing Satellite)	1991/08/18～2003/03/29	Around Japan and Antarctic (See the following figure 1.)
IRS (Indian Remote Sensing Satellite)	1998/10/13～2001/03/31	Around Japan (See the following figure 1.)
LANDSAT* (Land Satellite)	1979/02/19～2002/11/30	Around Japan (See the following figure 1.)

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

Figure 1. Observable area around Japan

Red indicates the observable area considering the skyline at JAXA's ground station. JAXA can receive data inside the circle with the following minimum and maximum latitude and longitude.