NASDA- October 26, 1999

# *ALOS*
# *Research Announcement*

## Calibration and Validation, Utilization Research, and Scientific Research

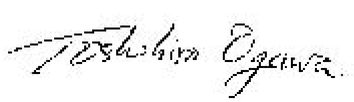
**Proposals Due: January 31, 2000**

**Earth Observation Research Center**
**National Space Development Agency of Japan**

Dear Colleague,

The Earth Observation Research Center (EORC), National Space Development Agency of Japan (NASDA), is pleased to provide you with the ALOS Research Announcement.
The Advanced Land Observing Satellite (ALOS) program, which started in 1995, is an Earth observation satellite program and targets the satellite launch in 2002.
The Japanese Earth observing satellite program consists of two series. One is mainly for atmospheric and marine observation, and the other is mainly for land observation. The ALOS satellite will follow the Japanese Earth Resources Satellite-1 (JERS-1) and the Advanced Earth Observing Satellite (ADEOS) and will utilize advanced land observing technology.
ALOS is a polar-orbiting platform carrying three sensors, 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). ALOS will be launched by an H-IIA launch vehicle by NASDA from the Tanegashima Space Center in August-September 2002.
ALOS will be used for map-making, regional observation, disaster monitoring, resource surveying, and so forth. In order to enhance and demonstrate the ALOS potential in Earth monitoring, this NASDA Research Announcement for ALOS, hereinafter RA, solicits proposals for the primary utilization of sensor data from ALOS. The RA also solicits proposals in the fields of Calibration and Validation, in which the sensors and products are calibrated, validated, and characterized; Utilization Research, in which research promoting applications of ALOS data is conducted; and Scientific Research, in which the Earth's environments are investigated.
RA solicitation is open to all categories of Japanese and foreign investigators, including educational institutions, research institutes, private enterprises, government institutions, and any other organizations. Investigators whose proposals are accepted under this RA will be appointed as members of the ALOS Research Organization.
I would like to express my very deep appreciation to colleagues who have an interest in the ALOS RA, and I hope ALOS data utilization will be promoted by this RA in cooperation with Principal Investigators.

Sincerely,



Toshihiro Ogawa, PhD
Director
Earth Observation Research Center
National Space Development Agency of Japan

# CONTENT

APPLICATION FORMS

## 1. INTRODUCTION

This National Space Development Agency of Japan (NASDA) Research Announcement (RA) is soliciting research proposals for science and utilization research. This research will support the Advanced Land Observing Satellite (ALOS) Research Plan to be carried out by members of a newly formed 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 will utilize advanced land observation technology. ALOS will be used for cartography, regional observation, disaster observation, and resources surveying.
ALOS mission objectives are to:

(1) develop 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 Earth 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).

The ALOS launch is scheduled for August-September 2002, on an H-IIA launcher. The planned operational lifetime is five year. Data, excluding data for calibration and validation, will be released starting not earlier than eight months after launch.
The PIs can cover the full range of ALOS science and applications, including (1) land use and land cover research, (2) topography and geology, (3) terrestrial (vegetation) ecosystem, agriculture and forestry research, (4) climate system, hydrological processes and water resources related research, (5) oceanography and coastal zone related research, (6) disaster and earthquakes, (7) resource exploration, (8) development of spatial data infrastructure, (9) basic studies on scattering and interferometric characteristics, and (10) basic studies for accurate observation with high-resolution optical sensors.
Applicants may submit any time before January 31, 2000. Proposals will be peer reviewed by the end of April 2000. Applicants submitting accepted, applicants will be integrated into the ALOS research team.
Participation as an ALOS Principal Investigator is open to researchers from all categories of organizations: educational institutions, research institutes, private enterprises and government institutions and any other organizations.
Funds for PIs are not available under this RA.
The advantages of a PI are:

- access to relevant ALOS data at no cost and
- data acquisition priority in the mission operation plan.

APPENDIX A provides technical and programmatic information concerning the ALOS system, data products, characteristics of each sensor, and general operation concept.
APPENDIX B provides objectives of the research activities covered by this RA.
APPENDIX C defines ALOS simulation datasets.
APPENDIX D contains the basic guidance needed for preparing proposals in response to this RA.

Future opportunities, but of a more restricted nature, for submitting proposals for the exploitation of ALOS data are envisaged after the launch of the satellite and its successful commissioning, starting about one year after launch.

## 2. SUMMARY OF MISSION INSTRUMENTS

ALOS has three remote sensing instruments: the Panchromatic Remote-Sensing Instrument for Stereo Mapping (PRISM) for generating of Digital Elevation Models (DEMs), 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-hours 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 DEMs 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 which enables all-weather, 24hours 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 NASDA 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 datasets 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 onboard 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 back scattering) and locations and
- the potential of retrieving geophysical parameters (digital elevation model, geo-location, forest distribution, ice-monitoring, intereferometry, disaster monitoring, etc.) for Earth environmental 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. Since NASDA defined 1) digital elevation model and 2) orthophoto images as the geographical products to be produced, NASDA has temporarily established these two as high-priority solicited algorithms.
However, proposals on developing and validating the other geophysical parameters are also welcome.

## 3.2 Utilization Research

The objectives earlier Japanese Earth Observation Satellite emphasized the scientific element. Except for a limited category of data that is already being used operationally, the satellite data has not been used operationally owing to many technical and operational issues. However, 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, and forestry, and fishery will directly lead to national benefits. Providing the ALOS 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 seas 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, etc.)
- Natural disasters (forest fires, flooding, landslide, earthquakes, etc.)
- Pollution monitoring (oil spill, red tide, etc.)
- Geology and natural resources exploration
- Applications related to SAR interferometry
  (digital elevation models, crustal movements, vegetation distribution, etc.),
- Development of the Geographic Information System (GIS) database at 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 the 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

The data products obtained by ALOS will contribute to promoting 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 satellites 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

More 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 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) NASDA (NASDA and MITI for PALSAR data) possesses all intellectual property rights of the provided data and products.
2) Provided data shall be utilized only for the peaceful purposes.
3) Provided data shall be utilized only for conducting RA activities.
4) Provided data shall not be transferred to an unauthorized third party or person.

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

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

NASDA 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 NASDA's control.

## 4.2 Data Distribution before ALOS Launch

### (1) Satellite data belonging to NASDA

To the extent available, the PIs selected in this RA can receive the following satellite data belonging to NASDA upon request. The resources depend on NASDA’s product equipment and the balance with other project requests.

- Satellite data include sensor data of MOS, JERS, ADEOS, TRMM, ADEOS-II (nominal launch date November 2000), ERS*, SPOT*, RADARSAT*, LANDSAT* and IRS*.

* Foreign satellite data are limited to that received at ground stations in Japan, and the amount of available data depends on NASDA's resources. For details on restrictions, see section 4.2 in APPENDIX D.

### (2) ALOS Simulation Datasets

To the extent available, the PIs selected in this RA can receive simulation data for PALSAR and PRISM upon request. These datasets are generated using aerial images covering specific areas in Japan. The covered areas and the geographical features of the data for PIs are listed in APPENDIX C.

## 4.3 Data Distribution after ALOS Launch

NASDA recommends that PIs utilize the data produced in the ALOS standard operation plan which is decided based on the ALOS Operation Concept (APPENDIX A-4). Nevertheless, NASDA will accept observation requests from the selected PIs within resource limitations in this RA.

### (1) Standard Data Products

The PIs will be provided the following data eight months after ALOS launch. Data for Calibration and Validation will be distributed as soon as possible three months after the launch. 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

Beginning one year after ALOS launch, the PI's will be provided higher-level data products of NASDA's selected area as sample datasets. They will also be provided products of some areas they have requested.

- PRISM DEM, Orthophoto Image
- AVNIR-2 Orthophoto Image
- PALSAR DEM, Orthophoto Image

### (3) Satellite data belonging to NASDA

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

## 5. FUNDING

NASDA will not provide funds to PIs.

## 6. QUALIFICATIONS OF APPLICANTS

We welcome all researchers from educational institutions, research institutes, private enterprises, government institutions, and any other organizations, domestic or foreign, to submit research proposals for peaceful purpose.

## 7. BENEFITS AND RESPONSIBILITIES OF PIS

### 7.1 Benefits

PIs can request satellite data and simulation datasets listed in section 4 at no cost. Moreover, after the launch, PIs can submit observation requests (see APPENDIX D 4.2), subject to some limitations.

### 7.2 Responsibilities

#### 7.2.1 Interim Report

The PIs will be required to submit interim reports on the status of their researches in the format given by NASDA. They are encouraged to participate in PI meetings held by NASDA and present the progress and accomplishments of their researches. In particular, PIs must submit an interim report to NASDA during FY2002 (from April 2002 to March 2003) for interim evaluation performed by March 2003.

#### 7.2.2 Final Report

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

## 8. PROPOSAL SUBMISSION

### 8.1 General Conditions

Because a number of proposals are expected to be submitted from all over the world, we might not accept proposals which do not adhere strictly to the format. The following are required in all proposals.

- **Applicants must register their profiles from the ALOS Home Page (*http://www.eorc.nasda.go.jp/ALOS/RA*) by January 31, 2000.**
- The proposal must be submitted in hard copy form using a format defined by NASDA or provided on the ALOS Home Page. (Please refer to this section and APPENDIX D.)
- Applicants must send **six copies** of the proposal including a complete set of attachments, such as reprints of papers, to NASDA.
- All proposals should be type-written in either English or Japanese, with a font size smaller than 12 points.

- Each page must have a page number in the middle of the bottom and the name of the applicant in the upper right corner.

Proposals are not returned.

### 8.2 Language

Applicants must basically submit their proposals to NASDA in either English or Japanese. However, **applicants in Japan** are required to submit the **"information of applicants"** 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

Please send all the necessary application papers for the First RA by post mail to the following address **by January 31, 2000.**

**ALOS Research Announcement Office (Yoshihide Katoh, Project Coordinator)**
Earth Observation Research Center
National Space Development Agency of Japan
Roppongi First Building 14F
1-9-9, Roppongi, Minato-ku, Tokyo 106-0032 Japan
Tel: +81-3-3224-7074 Fax: +81-3-3224-7051
Email: aproject@eorc.nasda.go.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 NASDA based on the evaluation criteria shown in 9.2. Final decisions on acceptance of proposals will be made by NASDA (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 April 2000.

### 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 which 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 a PI, they are required to observe the terms and conditions of the projects including, but not limited to, data distribution and publications of results. NASDA will send an agreement form to the selected PIs later; PIs should follow the procedures therein.

## 10. CANCELLATION AND POSTPONEMENT OF RA

NASDA reserves the right to cancel this RA upon notice delivered by NASDA. NASDA 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

A tentative concept of ALOS research organizations is shown in Fig. 1. An ALOS Research Board chaired by an ALOS program scientist will be established. The ALOS Research Group, composed of Sensor Teams, and the Research Promotion Group will be organized under the NASDA ALOS Research Board. In addition, subteams for Algorithm Development, Calibration and Validation, Datasets Production, and Science and Utilization Research will be organized under the appropriate teams.

The role of the ALOS Research Board established in EORC is to provide advice and make final decisions for selecting proposals, and to provide recommendations for each subteam. The Research Evaluation Committee evaluates research activities based on predetermined criteria, and will be organized outside NASDA to ensure fair evaluation of proposals. The Calibration and Validation subteam will cooperate with the ALOS Project Team, Earth Observation Systems Engineering Department (EOSD), and Calibration and Validation PIs who will be selected by this Research Announcement (RA).

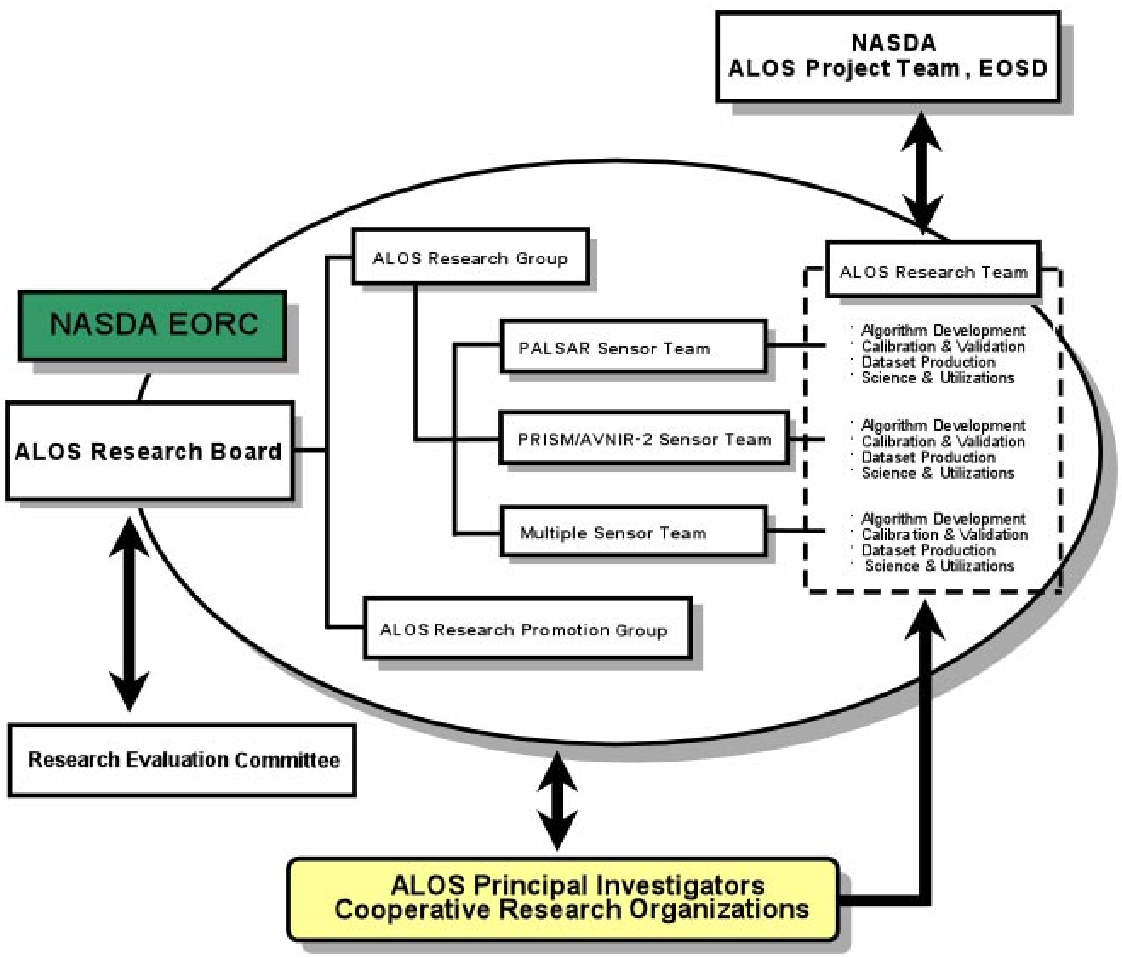



**Fig. 1** Tentative concept of ALOS research organizations.

## 12. SCHEDULE

NASDA plans to release two ALOS RAs. The schedule of this RA is shown in 12.1.

### 12.1 ALOS First Research Announcement (this RA)

| | |
|---|---|
| Document release | October 1999 |
| Deadline for submission of proposals | January 31, 2000 |
| Notification of PI selection | April 30, 2000 |
| Contract | May 2000 ↔ July 2000 |
| PI meeting and Symposia | August 2000 → |
| Interim evaluation | March 2003 (in FY2002)* |

* In principal, the research duration is three years. However, NASDA may grant a two-year extension based on the interim evaluation results.

### 12.2 ALOS second Research Announcement (Now planning)

NASDA intends to solicit proposals for further fields, focusing on Utilization Research and Scientific Research using ALOS data in the second RA. It will be released after the fall of 2002.

## 13. RESEARCH ANNOUNCEMENT OFFICE

**ALOS Research Announcement Office (Yoshihide Katoh, Project Coordinator)**

Earth Observation Research Center
National Space Development Agency of Japan
Roppongi First Building 14F
1-9-9, Roppongi, Minato-ku, Tokyo 106-0032 Japan
Tel: +81-3-3224-7074 Fax: +81-3-3224-7051
Email: aproject@eorc.nasda.go.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: Panchromatic Remote-Sensing Instrument for Stereo Mapping (PRISM), Advanced Visible and Near Infrared Radiometer type 2 (AVNIR-2), and 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 | August 2002 | |
| Lauch 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<br>Semi-Recurrent |
| Sub-cycle | 2 days | |
| Design Life | 3-5 years | |
| Attitude determination accuracy | 2.0 x $10^{-4}$ ° (off-line) | |
| Position determination accuracy | 1 m (off-line) | |
| Data Rate (Down link) | 240Mbps via DRTS, 120Mbps (direct transmission) | |
| Onboard Data recorder | Solid-state data recorder (90Gbytes) | |

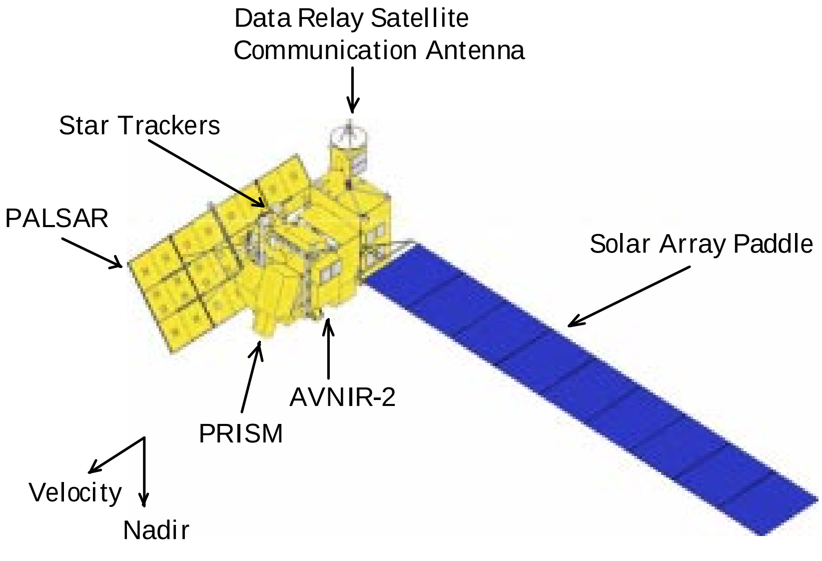



**Fig.1** ALOS in-orbit configuration

## 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 provide 35 km width coverage each.

As shown in Fig.2, the telescopes are installed on both side of its optical bench with precise temprature controll. Forward and backward telescopes are inclined ±24 degrees from nadir to realize a base-to-height ratio of 1. 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 highly accurate digital elevation model (DEM). PRISM Characteristics are shown in Table 2.

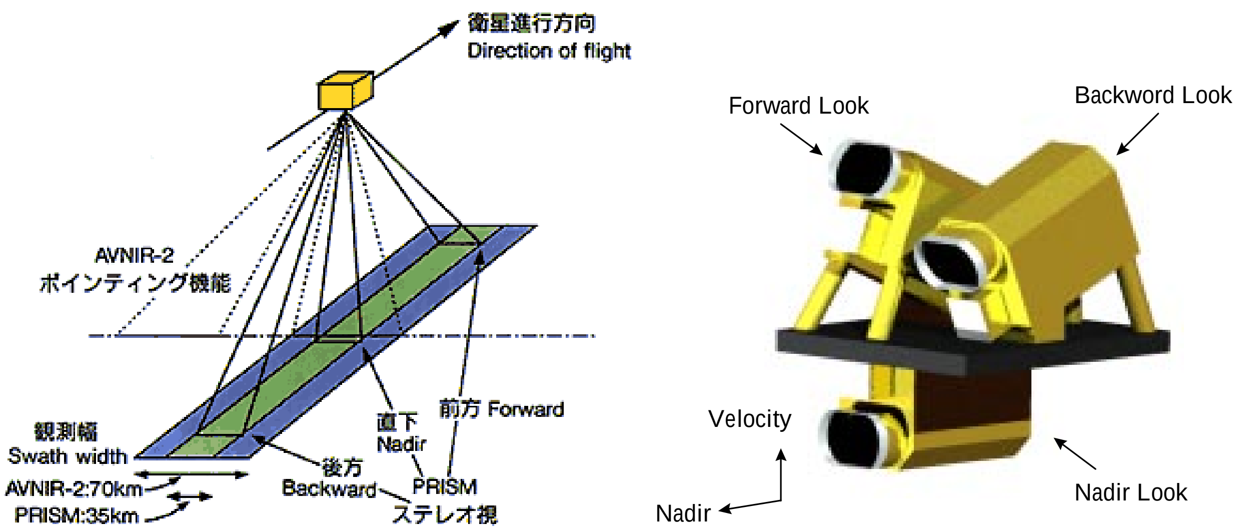



**Fig. 2** PRISM Overview

**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 | 28000 / band (Swath Width 70km)<br>14000 / band (Swath Width 35km) | |
| Number of Bands | 1 | Panchromatic |
| ADC | 7bits | |
| Pointing | -1.5 ° to 1.5 ° | |

NOTE: PRISM can't observe areas beyond 82 degrees south and north latitude.

## 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 onboard the Advanced Earth Observing Satellite (ADEOS) launched in August 1996. AVNIR-2's main improvement over AVNIR's is its instantaneous field-of-view (IFOV). AVNIR-2 provides 10-meter 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.

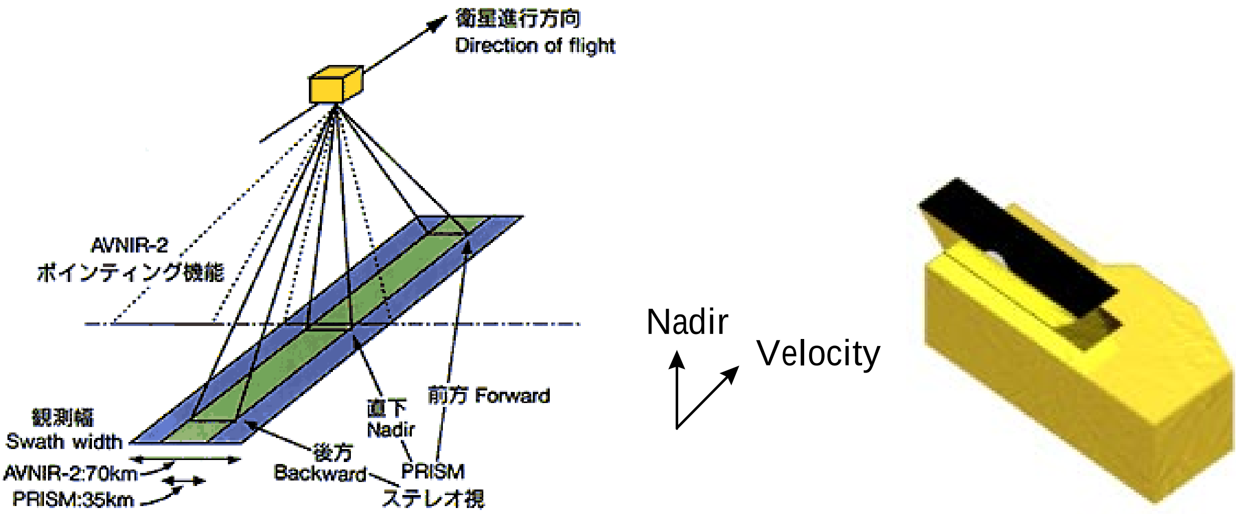



**Fig.3** AVNIR-2 Overview

**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 | 8bits | |
| Pointing | -44 ° to 44 ° | |

NOTE: AVNIR-2 can't observe the areas beyond 85 degrees south and north latitude.

## 3. Phased Array type L-band Synthetic Aperture Radar

The Phased Array type L-band Synthetic Aperture Radar (PALSAR) is Japan's second spaceborne 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 (depends on 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 NASDA and the Japan Resources Observation System Organization (JAROS).

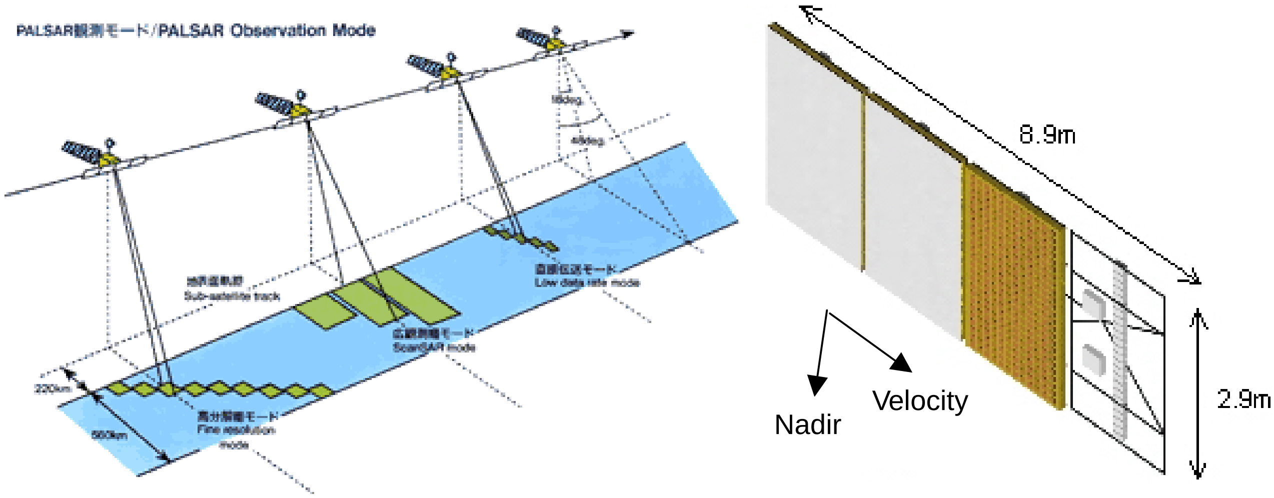



**Fig. 4** PALSAR Overview

**Table 4** PALSAR Characteristics

| Item | Characteristic | | |
|---|---|---|---|
| Mode | High resolution | ScanSAR | Polarimetric (Experimental)* |
| Center Frequency | 1270 MHz | 1270 MHz | 1270 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 ° |
| NE$\sigma^0$ (tentative)** | ≤ -23 dB (Swath Width 70km)<br>≤ -25 dB (Swath Width 60km) | ≤ -25 dB | ≤ -29 dB |
| S/A (tentative)** *** | ≥ 16 dB (Swath Width 70km)<br>≥ 21 dB (Swath Width 60km) | ≥ 21 dB | ≥ 19 dB |
| AD bit | 3 / 5 | 5 | 3 / 5 |
| Data Rate | 240M | 240M | 240M |
| Antenna Size (tentative) | AZ: 8.9m × EL: 2.9m (Electrical) | | |

NOTE: PALSAR can't observe the areas beyond 81 degrees south and north latitude.

| | | |
|---|---|---|
| * | Due to power consumption, the operation time will be limited. | |
| ** | High resolution mode | Off-nadir is 34.3 deg. |
| | ScanSAR mode | 4th 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 a compression (DC) capability. Each telescope of PRISM generates 320 Mbps raw data, so 960 Mbps 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 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, which is a Japanese geostationary data relay satellite, via the DRC subsystem. DRTS-East will be located at 90E, and DRTS-West will be located at 170W above the equator. These two data relay satellites have 240 Mbps handling capability and will be used by ALOS, ADEOS-II, which is another NASDA earth observation satellite, and by the Japanese Experimental Module (JEM), attached to the Space Station.

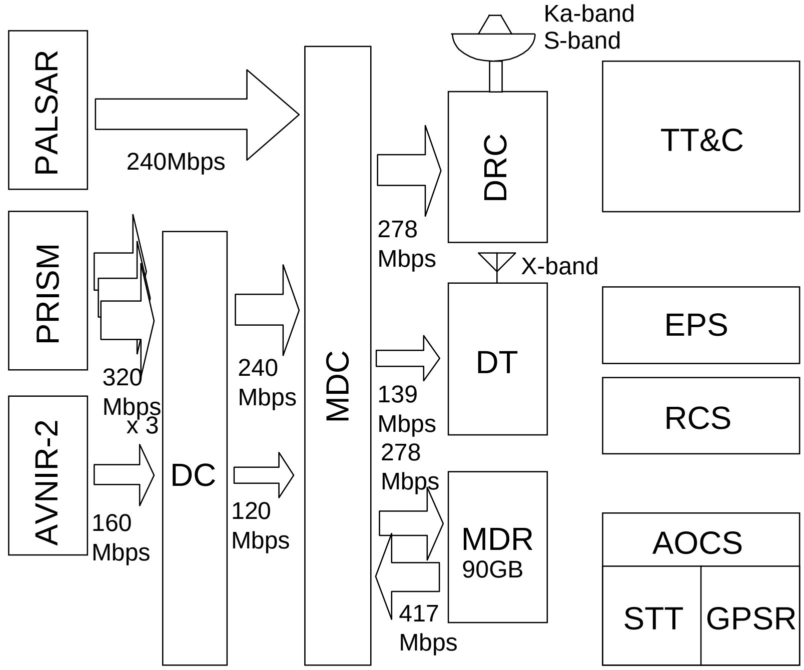



**Fig. 5** ALOS Block Diagram with Data Flow.

## 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 on-board attitude and position determinations, off-line 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 2.5 m.

## 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 temporarily archived in NASDA. Level 0 data is frame-synchronized, de-packetized decoding data. This level 0 data is permanently archived in NASDA 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 NASDA 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 processing with digital elevation models. This will be provided by NASDA's EORC one year after ALOS launch.

### 2. Standard Data Products

**Table 5** Standard data products of each sensor

**Common**

| Level | Definition | Note |
|---|---|---|
| **Raw** | Demodulated bit stream | Packetized<br>Temporarily archived |
| **0** | Frame synchronization and PN decoding of CADUs and R-S Error Detection and Correction of VCDUs<br>Extracted mission telemetry, orbit and attitude data are stored on separate files. | Compressed (except for PALSAR)<br>Permanently archived<br>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).<br>Individual files for forward, nadir, and backward looking data. | |
| **1B1** | Radiometrically calibrated data at Sensor input | |
| **1B2** | Geometrically corrected data<br><br>Options<br>G: Systematically Geo-coded (No option: Geo-referenced) | Map projection<br>Resampling<br>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<br><br>Options<br>G: Systematically Geo-coded (No option: Geo-referenced)<br>D: Correction with coarse DEM | Map projection<br>Resampling<br>Pixel spacing |

**PALSAR**

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

## APPENDIX A-4 ALOS OPERATION CONCEPT

### 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 35 km swath width

**(1)** All Japanese land areas
**(2)** Parts of the Asia-Pacific region
**(3)** Other areas

##### 1.1.2 Nadir viewing mode with 70 km swath width

**(1)** Global land area

#### 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)** All Japanese land areas
**(2)** Parts of the Asia-Pacific region
**(3)** Other areas

##### 1.2.2 Pointing mode along cross-track direction

**(1)** Compensation of 1.2.1(1)
**(2)** Simultaneous regional observation with PALSAR is required
**(3)** Other areas

#### 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 35 degree, HH polarization, in night zone

**(1)** Global land area

##### 1.3.2 Other modes

**(1)** Specified area
**(2)** Simultaneous regional observation with AVNIR-2 is required
**(3)** Other areas

Specified areas will be determined based on requirements presented by the appropriate organizations.

# 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 development coming generation sensors which have high 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) which corresponds to a 1: 25,000 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 sprawl of urban areas and villages, changes of agricultural land and agricultural practices, deforestation, etc. Radar images may also be able to detect tillage variations (variation of tillage surface roughness) and changes of cropping pattern. It is also necessary to promote research for integrating ALOS data with ADEOS-II data.

### 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:** 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 extraction and classification of terrain features and so on.

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 which 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 which describes vegetation dynamics. A method of measuring vegetation biomass with focus 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 crop land:** Developing a method for determining the crop planting area, estimating productivity of pastures and crop land 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 of 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, to 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, such as ADEOS-II data, is also important.

**(2) Estimating of soil moisture distribution:** Development of algorithms for measuring soil moisture with PALSAR need to be facilitated. Development methods for integrating other satellite data, such as ADEOS-II 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 1km 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), and so on.

(1) **Estimating states and changes of snow cover and snow-water equivalent:** Analysis using the observation data from PALSAR and AVNIR-2 can help 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 so on.

(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 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 which 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 rise.

(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 which predicts coastal current by utilizing a numeric simulation model along with these datasets should be also developed. These are useful for giving of a boundary condition for analysis of coastal transformation and sand drift.

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

3.5.2 **Ocean dynamics:** Utilization of PALSAR or development methods using PALSAR together with other satellite data such as ADEOS-II data will contribute to studies on air-sea interaction, sea waves, and 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 interferometoric observation by PALSAR are needed to be developed.

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

3.6.3 **Slope failure:** It is necessary to develop a method for 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 of 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 haven't had enough data. This will contribute to advancing methods for analyzing and investigating those 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 haven't had enough 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 technique:** Disaster monitoring techniques reveal damage due to drought, flood, fire, slope failure, earthquake disaster. Furthermore, these techniques can be applied to quick and accurate damage assesment (for example, the effect on agricultural production).

## 3.7 Resource Exploration

Resource exploration research techniques for mineral resource need to be defeloped. 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 need to be developed for PALSAR. In addition, a method integrating images (from PRISM, AVNIR-2 and PALSAR) with DEM 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 database:** Using ALOS data as a test case, techniques for very large spatial database are expected to be developed. Examples include data storage and management techniques, 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 which 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 multiscattering 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 the 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 development of specific data products and algorithms for promoting the other scientific researches as "strategic goals." These are selected considering the relevance to the ALOS mission and the goals of this plan, resource limitations, etc.

### 4.1 Data products

4.1.1 **Global High-resolution DEM and Orthophoto image (PRISM, AVNIR-2, and PALSAR):** These data products form the basis of many fields of research and practical applications. They are provided by only 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 dataset (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 dataset (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 DEM and orthophoto image:** A large computing capability is usually required to generate high-resolution DEMs and orthophoto 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 orthophoto (including an algorithm to estimate satellite position and altitude) need to be developed.

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

### 4.3 Calibration and Validation for each Sensor and Related Basic Studies

Calibration and validation of each sensor is necessary for improviing 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, basic study for very 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 by 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 challange 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 DEM

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

#### (3) Atmospheric correction

Algorithm should be implroved to estimate the surface albedo on a heterogeneous surface using optical sensors data, taking into account the effect of multi-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 to be one of the strategic objectives.

#### (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 by 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 SIMULATION DATASETS

### 1. Simulation Datasets for the Optical Sensor

| Area | Geographic Features | Data Description | Resolution | Size (pixel) × (line) |
|---|---|---|---|---|
| Numazu (The image center is located at 35°9N and 138°46′E.) | Including ocean, planes, cities, and steep mountains | DEM | 2.5m / pxl | 2048 × 2048 |
| | | Orthophoto image a panchromatic image and a color image | 2.5m / pxl | 2048 × 2048 |
| | | Simulated PRISM data with and without atmospheric effect (forward view and backward view) | 2.5m / pxl | 2100 × 2200 |
| Akanesaki (The image center is located at 35°4N and 139°5′E.) | Including coasts, bluffs, and steep mountains | DEM | 1 m / pxl | 1021 × 981 |
| | | Simulated PRISM data (nadir, forward and backward view) | 2.5m / pxl | 300 × 300 |
| Aso (now plannning) (The image center is located at 32°53N and 131°5′E.) | Including areas with and without vegetation | DEM | 2.5m / pxl | 1024 × 1024 |
| | | Orthophoto image | 2.5m / pxl | 1024 × 1024 |
| | | Simulated PRISM data | 2.5m / pxl | 1024 × 1024 |

### 2. Simulation Datasets for the SAR

| | |
|---|---|
| Area | Tsukuba(The image center is located at 36°03'N and 140°06'E.) |
| Geographic Features | Including urban areas, forests, and paddy fields |
| Data Description | Airborne SAR (PI-SAR L-band) data<br>Polarimetric scattering matrix data (HH,HV,VH,VV)<br>(Calibrated and Uncalibrated) |
| Resolution | Azimuth: 0.6m<br>Range: 2.4m<br>slant range complex data |
| Size (Azimuth x Range) | 9084 x 2059 samples corresponding to 5km x 5km.<br>4ch BSQ format (HH,HV,VH,VV).<br>Each sample is composed of Real (4 Bytes) and Imaginary (4 Bytes) parts.<br>Data format is based on IEEE 32-bit Floating point expression with big-endian. |

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

# APPENDIX D PROPOSAL CONTENTS AND APPLICATION FORMS

## 1. Proposal Coversheet

### 1.1 Information of Applicant (Form 1a)

- Identifying information of principal applicant: Legal name, official title, department, organization, address, country, phone number, facsimile number, and E-mail address
- Co-applicant information: Name, organization, and E-mail 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 (Calibration and Validation, Utilization Research, or Scientific Research)
- 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
- Kind of truth data and the acquisition plan (Area, Product level, Volume, Term, Season, etc.)
- Product Utilization Plan (Product level, Volume, Term, Season, etc.)

## 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 three years and five years.

## 4. Details of Data Requirements

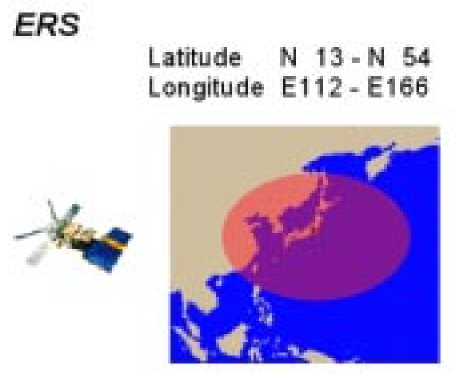
### 4.1 NASDA-Owned Satellite Datasets (Form 3a)

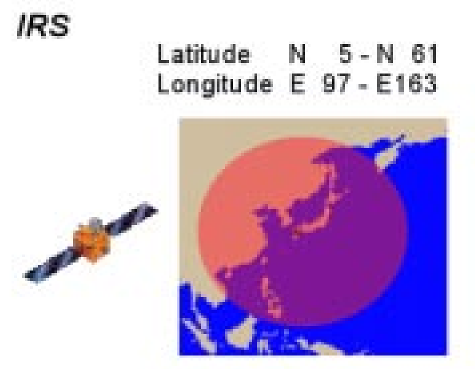
To request the following satellite datasets, complete Form 3a.
NASDA has the authority to provide datasets received from:

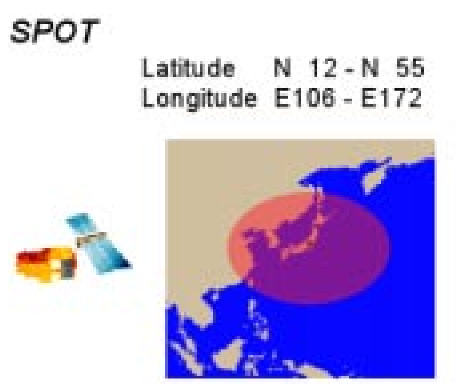
- Marine Observation Satellite (MOS) (global)
- Japanese Earth Resources Satellite (JERS) (global)
- Advanced Earth Observing Satellite (ADEOS) (global)
- Tropical Rainfall Measuring Mission (TRMM) (global)
- European Remote-sensing Satellite (ERS) (only around Japan) *
- LANDSAT (only around Japan)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

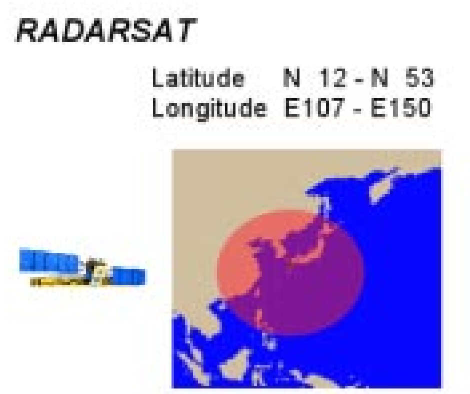
• RADARSAT (only around Japan) *
• Indian Remote Sensing Satellite (IRS) (only around Japan) *

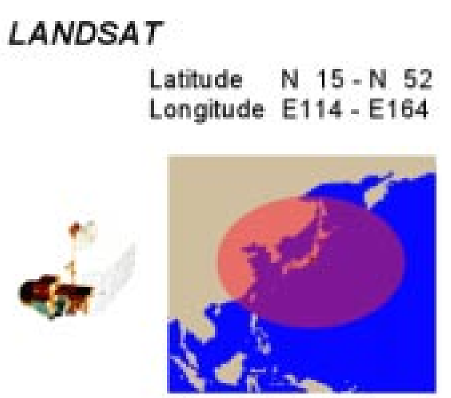
* Data from foreign satellites are limited to the area received at the ground station in Japan, as described the following figure. The red area indicates the visible circle considering the skyline at the ground station. NASDA can receive data inside this circle that shows minimum and maximum latitude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



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

- MOS, JERS, ADEOS, TRMM, ERS, SPOT, LANDSAT data search
  http://eus.eoc.nasda.go.jp
- RADARSAT data search**
  http://www.restec.or.jp/JAPANESE/DATA/DSERCH/RADAR/RADHEAD.HTM
- IRS data search***
  http://www.restec.or.jp/JAPANESE/DATA/DSERCH/IRS/IRSD.HTM

** *** The searching function for the browse data is a Japanese version.

### 4.2 Observation Requests for ALOS (Form 3b)

Complete Form 3b to request observation by ALOS after ALOS launch. These requests will be accepted within resource limitations in this RA if the applicants are selected as PIs and their research is permitted to be continued by interim evaluation.

## 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

Proposal No.
(Leave Blank for NASDA Use)

# Proposal Cover Sheet
# For
# ALOS First Research Announcement

**Information of Applicant**

**Principal Applicant:**

Name: ____________________

Official title: ____________________

Department: ____________________

Organization: ____________________

Address: ____________________

Country: ____________________ E-mail: ____________________

Telephone: ____________________ Facsimile: ____________________

**Co-applicants:**

| Name | Organization | E-mail |
|---|---|---|
| | | |
| | | |
| | | |
| | | |

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

**Signature of principal applicant :** ____________________

Form 1b

Proposal No.
(Leave Blank for NASDA Use)

**Information of Proposal Contents**

**1. Research Category (check one)* [√]**

[ ] Calibration and Validation [ ] Utilization Research [ ] Scientific Research

→[ ] Calibrate Individual Sensors

[ ] Develop and Validate Algorithms for Extracting Physical Parameters

* Our priority for the 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 | SPOT | LANDSAT | RADARSAT | 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

Proposal No.
(Leave Blank for NASDA Use)

# Work Plan (Research Schedule)

Research Title : ______________________________ Name of Principal Applicant: : ______________________

| Year | 2000 | | | 2001 | | | | | | 2002 | | | | | | 2003 | | | | | | 2004 | | | | | | 2005 | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Month | 8 | 10 | 12 | 2 | 4 | 6 | 8 | 10 | 12 | 2 | 4 | 6 | 8 | 10 | 12 | 2 | 4 | 6 | 8 | 10 | 12 | 2 | 4 | 6 | 8 | 10 | 12 | 2 | 4 | 6 |
| Milestone | | | | | | | | | | | | | *ALOS Launch | | | *Interim Evaluation | | | | | | | | | | | | | | |
| Activities | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |

Form 3a

Proposal No.
(Leave Blank for NASDA Use)

## Details of Data Requirements

Research Title: ______________________________________________ Name of Principal Applicant:________________________

**NASDA-Owned Satellite Data (MOS, JERS, ADEOS, TRMM, ADEOS-II, ERS, SPOT, LANDSAT, RADARSAT, 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 on-line transmission or media transfer, will depend on the data volume.

Form 3b

Proposal No.
(Leave Blank for NASDA Use)

# Observation Requests for ALOS

Research Title: ______________________________________________ Name of Principal Applicant: ______________________

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