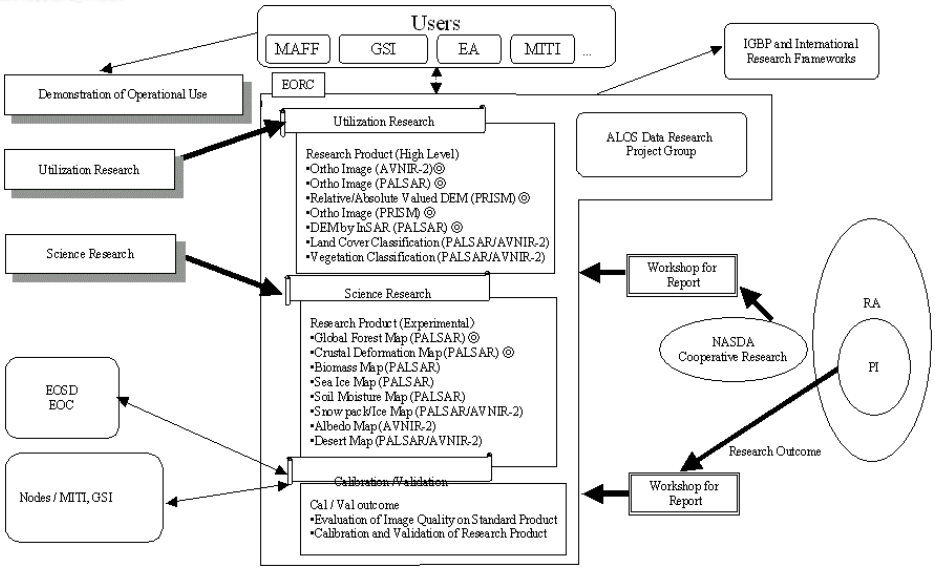
EORC's Science and Applications Research Project using ALOS Data

27 March 2001
Symposium for ALOS Data Application Users
Kogakuin University, Shinjuku, Tokyo

Tamotsu Igarashi
NASDA/EORC

1.1 ALOS Science



1.2 Global Forest Mapping

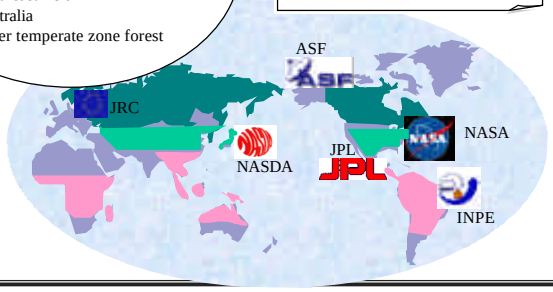
Objectives
(1) Global Rain Forest / Boreal Forest SAR Data Set Generation
(2) Monitoring of deforestation using PALSAR and AVNIR-2
(3) Geographic Map Generation of Africa using SAR
(4) Monitoring Forest Fire (Amazon, South East Asia, Australia)
(5) Land use classification (7～11classes)
(6) Biomass Estimation towards Kyoto protocol

Area
- North America
- East west Siberia
- Africa
- South Africa (Amazon)
- Southeast Asia
- Australia
- Other temperate zone forest

Satellite Data
- PALSAR
- AVNIR-2

10000 scenes / year

Global Observation of Forest Cover



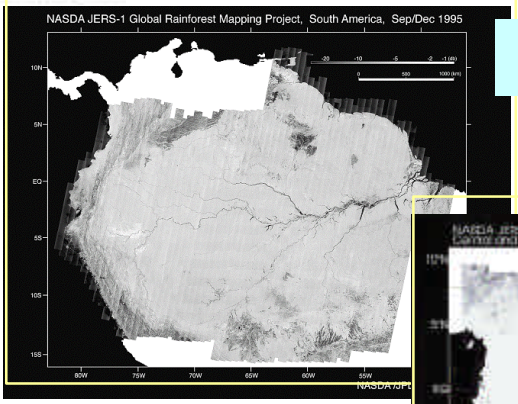
NASDA/EOC and Data Node

Anticipated Cooperative Organization
- NASDA/ERSDAC
- JPL,ASF,(NASA/NOAA)
- JRC (EU)
- CEOS / GOFC Project partners

Anticipated Users
- Forestry Environmental Institutes, Universities (INPE/PETROBRAS)
- IGBP, WCRP, IGOS / TCO, FAO, UNEP
- Japan
  -MAFF
  -EA
  - Universities, Institutes

Established JERS-1 Program is applicable

1.2 Global Forest Mapping

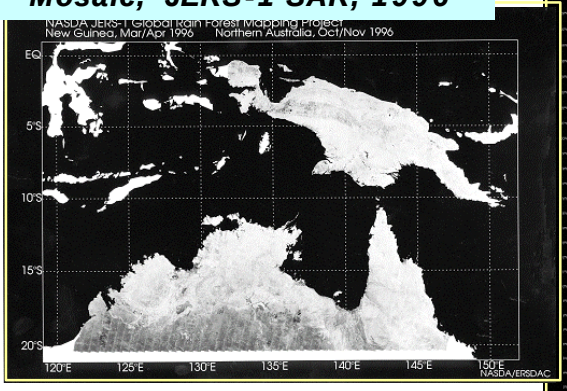


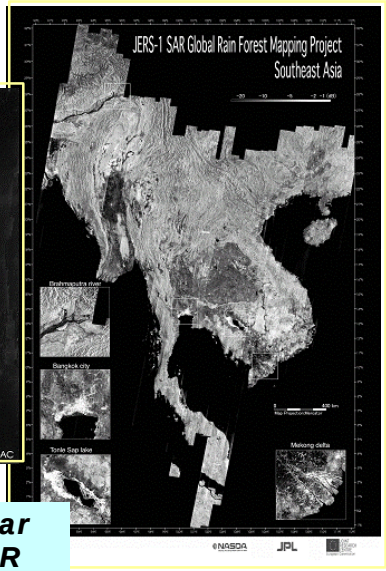
South America Mosaic, JERS-1 SAR, 1995

Central Africa Mosaic, JERS-1 SAR, 1996

1.2 Global Forest Mapping

New Guinea and N. Australia Mosaic, JERS-1 SAR, 1996





Indochina Peninsular Mosaic, JERS-1 SAR

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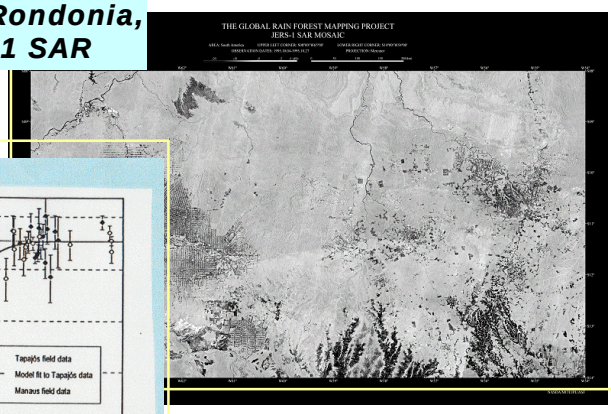
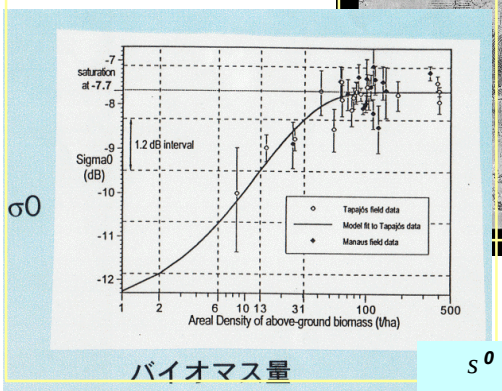
1.2 Global Forest Mapping

Deforestation in Rondonia, Amazon, JERS-1 SAR





s^0 vs Biomass Density, JERS-1 SAR

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1.3 Disaster Management

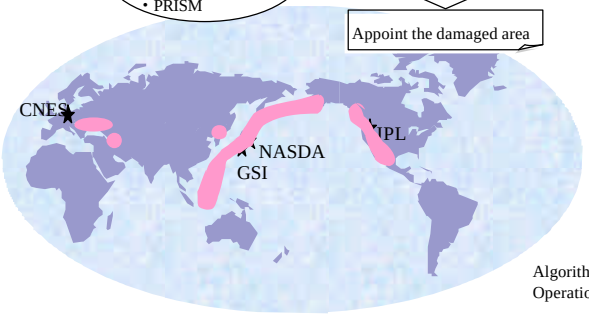
Objectives
(1) Measurement of crustal deformation due to earthquake (InSAR)
(2) Monitoring of topographic deformation due to volcanic activity (InSAR)
(3) Delineation of flood area (PALSAR)
(4) Oil spill detection (PALSAR / AVNIR-2 / PRISM)

Area
- Global

Satellite Data
- PALSAR
- AVNIR-2
- PRISM

1000 scenes / year

Appoint the damaged area



NASDA/EOC and Data Node

Anticipated Cooperative Organization
- CRL, GSI
- NIED
- Univ. of Tokyo (Earthquake Research Institute)
- JPL / CNES

Anticipated Users
- Coordinating Committee for Earthquake Prediction
- Damaged Area / UNESCO
- NOAA etc.
- Japan
  -Local Governments
  -Governmental Agencies (MOC, Asian Disaster Reduction Center etc.)

Algorithm has been established in JERS-1 project.
Operational Structure should be considered

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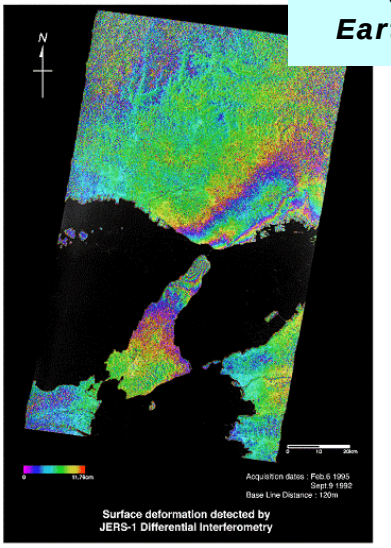
1.3 Disaster Management



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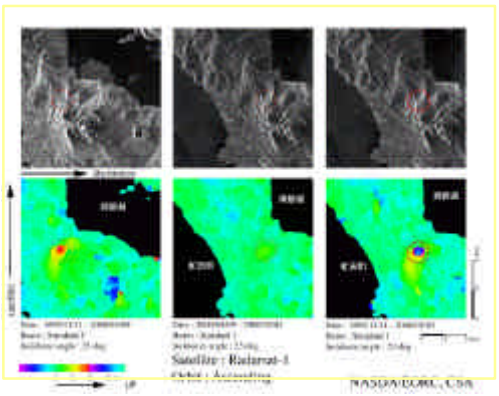
Southern Hyogo-pref. Earthquake, JERS-1 DinSAR, 1995



Mt. Usu Eruption, RADARSAT DinSAR, 2000

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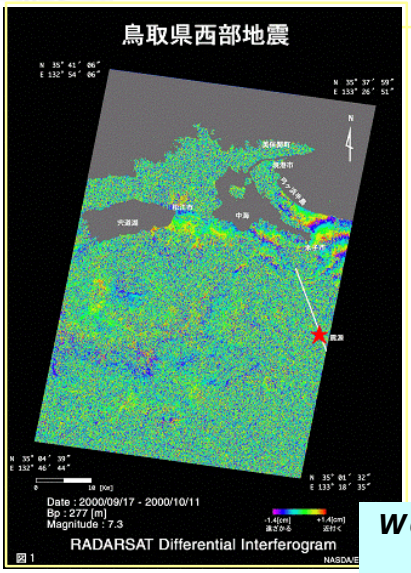
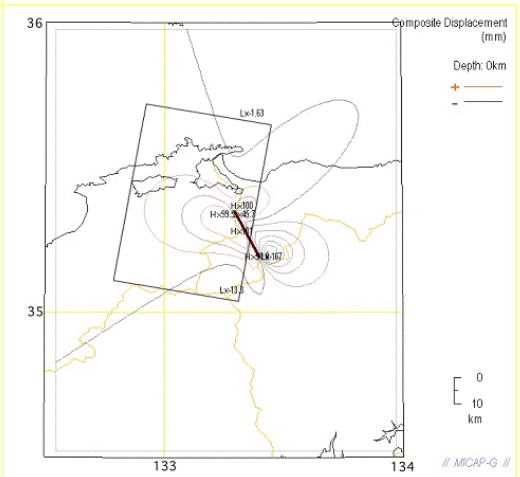
1.3 Disaster Management





Western Tottori-pref. Earthquake, RADARSAT DinSAR, 2000

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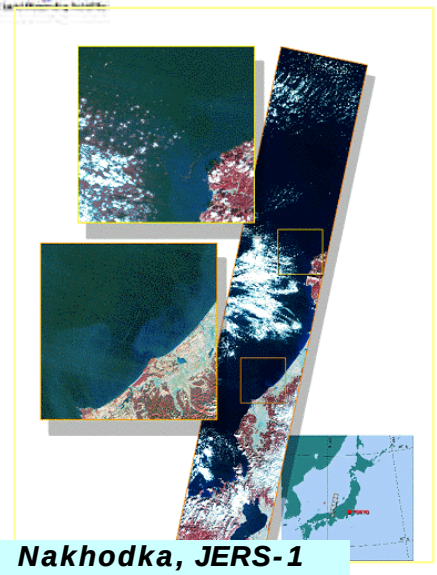
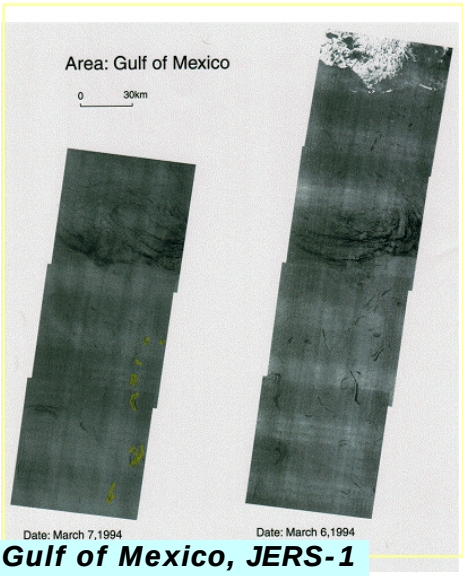
1.3 Disaster Management



Nakhodka, JERS-1 OPS, 1997



Gulf of Mexico, JERS-1 SAR, 1994

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1.4 Map / GIS Applications

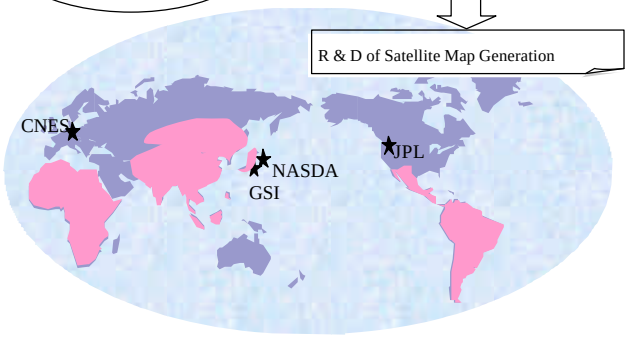
Objectives
(1) R&D of Ortho image and DEM generation using optical sensors (PRISM, AVNIR-2, and PALSAR
(2) Evaluation of Image Quality, Geometric and Radiometric Accuracy
(3) Demonstration of Map Generation

Area
- Japan
- Asian Region
- Developing Countries

Satellite Data
- PALSAR
- AVNIR-2
- PRISM

TBD scenes / year

R & D of Satellite Map Generation



NASDA/EOC and Data Node

Anticipated Cooperative Organization
- GSI
- CNES, JPL
- Universities, Institutes

Anticipated Users
- GSI, NIED, MOC, MAFF
- Local Governments
- Developing Countries (JICA Project)
- Universities, Institutes

-Product
- Map (Generation, Update)
- Hazard Map
- Thematic Maps / GIS (Agriculture, Environment, Ecosystem, Urban Area Planning)

etc.

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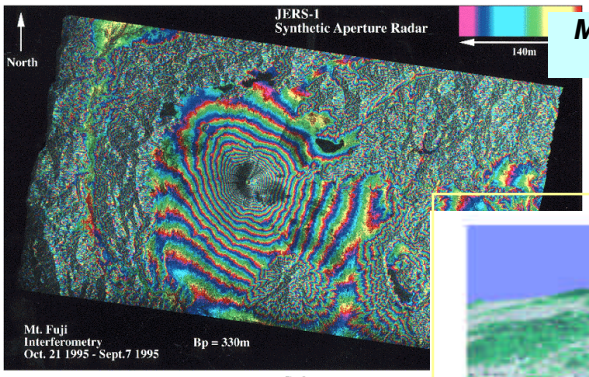
1.4 Map / GIS Applications



Mt. Fuji DEM, JERS-1 InSAR, 1995

Gulf of Hakata, JERS-1 OPS Stereo, 1997

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1.5 Land Use / Land Cover Change Applications

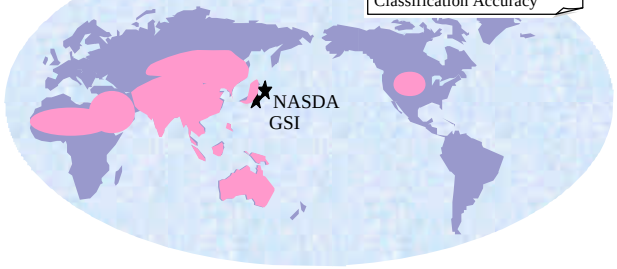
Objectives
(1) Albedo Map (AVNIR-2)
(2) Desert Map(PALSAR/AVNIR-2)
(3) Land Cover Map (AVNIR-2,PRISM,PALSAR)
(4) Vegetation Map (AVNIR-2,PRISM,PALSAR)
(5) Improvement of classification accuracy using fusion technique of SAR, optical sensors, high resolution data and polarimetric SAR data

Area
- Japan
- Asian Region
- Desert Area

Satellite Data
- PALSAR
- AVNIR-2
- PRISM

TBD scenes / year

Improvement of Land Cover Classification Accuracy



NASDA/EOC and Data Node

Anticipated Cooperative Organization
- GSI
- MAFF
- EA
- MITI / ERSDAC
- Universities, Institutes

Anticipated Users
- GSI
- EA, MAFF, MITI, Local Governments
- International Research Programs / Organization (IGBP, WCRP, IGOS / TCO, FAO, UNEP, etc.)
- Universities, Institutes

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1.5 Land Use / Land Cover Change Applications

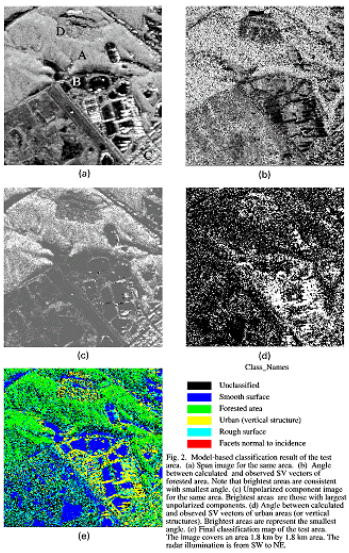

Fig. 2. Model-based classification result of the test area. (a) Span image for the same area. (b) Angle between calculated and observed SV vectors of forested area. Note that brightest areas are consistent with smallest angle. (c) Unpolarized component image for the same area. Brightest areas are those with largest unpolarized components. (d) Angle between calculated and observed SV vectors of urban areas (or vertical structures). Brightest areas are represent the smallest angle. (e) Final classification map of the test area. The image covers an area 1.8 km by 1.8 km area. The radar illumination is from SW to NE.

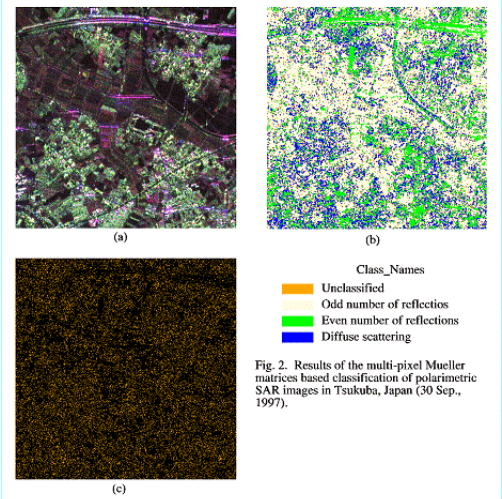

Fig. 2. Results of the multi-pixel Mueller matrices based classification of polarimetric SAR images in Tsukuba, Japan (30 Sep., 1997).

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1.6 Terrestrial Hydrology Applications

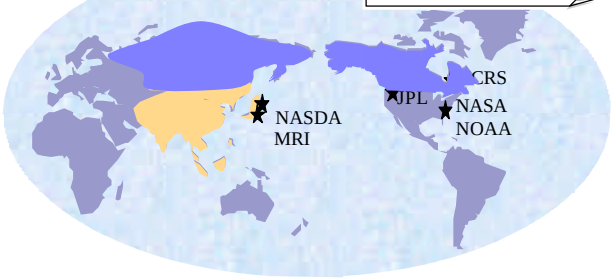
Objectives
(1) Soil Moisture(PALSAR)
(2) Snow Pack Distribution (PALSAR, AVNIR-2)
(3) Evaluation of Accuracy

Area
- Japan
- Asia
- Siberia
- North America

TBD scenes / year

Satellite Data
- PALSAR
- AVNIR-2

Terrestrial Hydrological Data Set Generation



NASDA/EOC and Data Node

Anticipated Cooperative Organization
- NASA, NOAA, CCRS
- CRL
- MRI
- International Research Programs
- Local Governments
- Universities, Institutes

Anticipated Users
- MAFF, MOC
- JMA
- Local Governments
- International Research Programs / Organization (WCRP, FAO, UNEP, etc.)
- Universities, Institutes

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1.6 Terrestrial Hydrology Applications

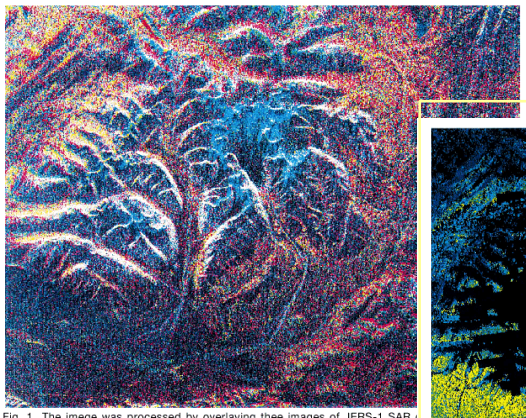
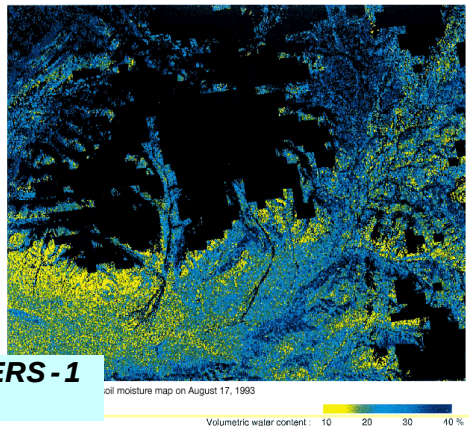


Fig. 1 The imege was processed by overlaying thee images of JERS-1 SAR (blue), May (red), and August (red), 1993



oil moisture map on August 17, 1993

Volumetric water content : 10 20 30 40 %

Soil Moisture, JERS-1 SAR, 1993

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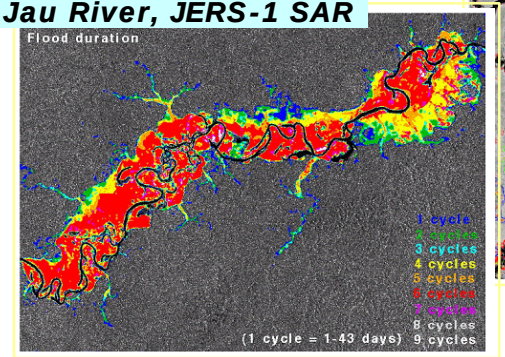
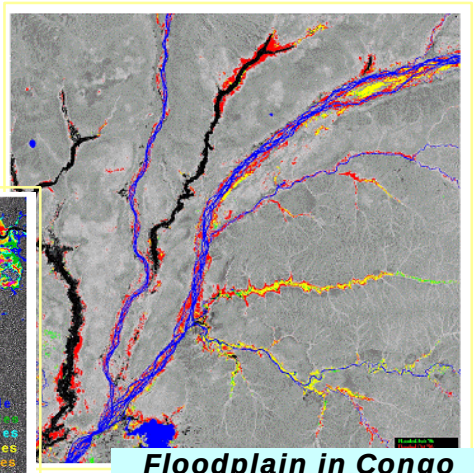
1.6 Terrestrial Hydrology Applications

Forest Innundation Jau River, JERS-1 SAR





Floodplain in Congo River, JERS-1 SAR

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1.7 Sea Ice Monitoring in Sea of Okhotsk and Polar-Region

Objectives

(1) Evaluation of measurement accuracy of sea ice concentration, type, velocity and ridge density

(2) Evaluation of Scan SAR, Polarimetric SAR characteristics

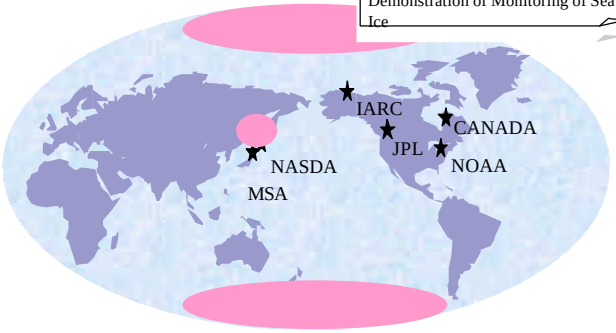
(3) Validation and demonstration

Area
- Polar-Region
- Okhotsk Sea

Satellite Data
- PALSAR
- AVNIR-2

TBD scenes / year

Demonstration of Monitoring of Sea Ice



NASDA/EOC and Data Node

Anticipated Cooperative Organization
- CRL
- MSA
- CCRS
- ASF

Anticipated Users
- MSA
- JAMSTEC, IARC
- Canadian Ice Center / CCRS etc.
- NOAA, National Snow and Ice Data Center (Ice Information Service for Ship Navigation)
- International Research Programs

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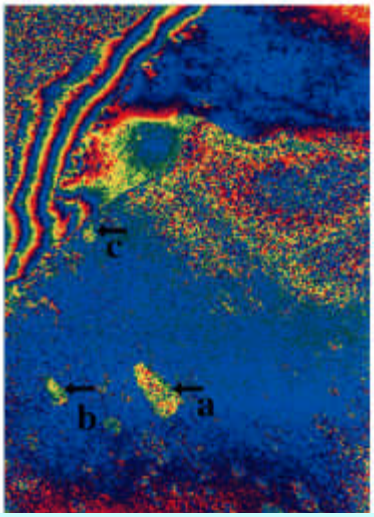
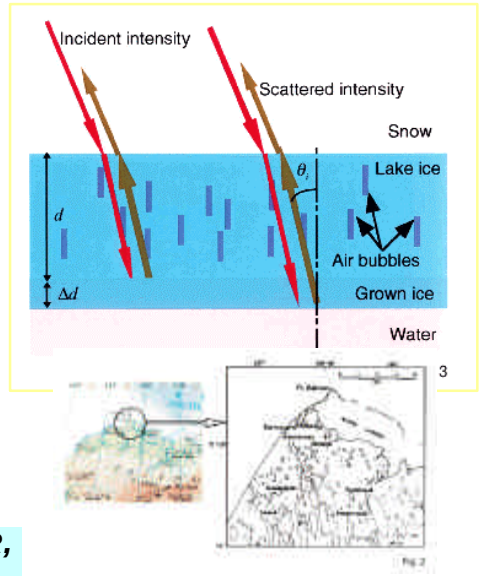
1.7 Sea Ice Monitoring in Sea of Okhotsk and Polar-Region



Ice Thickness, JERS-1 InSAR, Alaska,1997



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2. EORC System Design Policy

(1) To develop system to implement calibration and validation for the high quality processed / analyzed data distribution to meet research requirement.

(2) To process each sensor data effectively on a quasi-automatic basis.

(3) To develop highly reliable algorithm for data processing and analysis.

(4) To provide information on data utilization for researchers.

(5) To equip EORC with main part of data utilization system.

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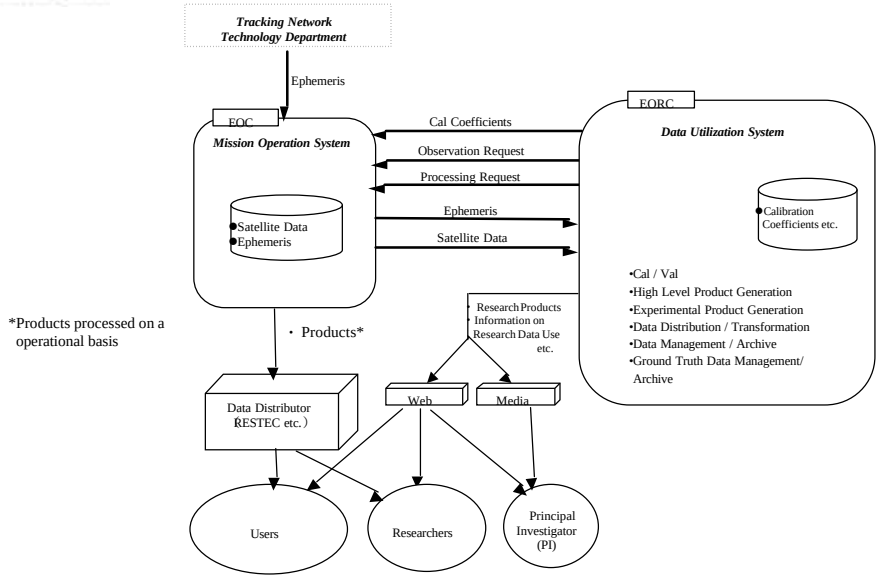
3. Interface Requirement



4. Requirement for Operation

(1) Generation of Research Product (High Level and Experimental)

(a) Quasi-automatic operation (24 hours operation) should be available.

(2) Data Archive

(a) Ground Truth Data and Research Product should be archived independently.

(b) Back-up function for Cal / Val data and Research Product should be available.

(3) Data Distribution

(a) Data distribution of archived data (2)(a)) should be available.

(b) Quasi-automatic operation (24 hours on-line) should be available.

(c) Data retrieval and distribution for PIs should be available.

(4) Service for PIs

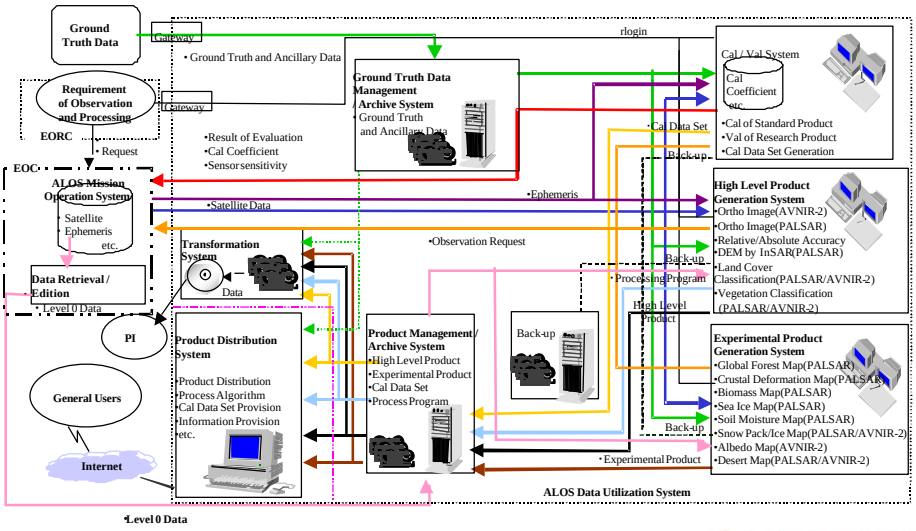
(a) Help Desk to serve for PIs and CIs request should be set up.

(5) Service for General Users

(a) Information Service (Event, Cal Coefficient, Data Distribution etc.) on Web site of EORC, quasi-automatic basis should be available.

5. System Requirement

(1) Function and Flow



6. Definition of Cal / Val

(1) PALSAR Calibration

Evaluation Item	Radiometric Characteristics	Geometric Characteristics
A.Sensor Characteristics	• Attenuator (STC, AGC) • Antenna Pattern (AZ., El.) • Noise Level • Basic Characteristics (Saturation, SNR, I-Q Perpendicularity, I-Q Gain Balance) • Transmitted Chirp • Doppler Center Frequency • Stability of Transmitted Power • Polarization • Resolution	• Attitude Determination Accuracy • Orbit Determination Accuracy • Data Acquisition Start Time
B. Calibration of Absolute Value	• Calibration of Intensity and Polarization using ARC, CR, PARC, REC • Cross- Calibration using under flight airborne SAR	• Data Acquisition Start Time Offset
C. Image Quality	Resolution, PSLR, ISLR, SA	• Resolution

6. Definition of Cal / Val

(2) PRISM Calibration

Evaluation Item	Radiometric Characteristics	Geometric Characteristics
A.Sensor Characteristics	• Dummy Pixel • Dark Currents • Deviation of detector sensitivity	• Alignment • Attitude Determination Accuracy • Orbit Determination Accuracy
B. Calibration of Absolute Value	• Absolute sensitivity (Vicarious Cal, Under fight Airborne observation • Radiometric Accuracy • Geometric Correction Accuracy	• Attitude Offset
C. Image Quality	Resolution, SN, etc.	• Resolution

6. Definition of Cal / Val

(3) AVNIR-Ⅱ Calibration

Evaluation Item	Radiometric Characteristics	Geometric Characteristics
A.Sensor Characteristics	• Dummy Pixel • Dark Currents • Deviation of detector sensitivity	• Pointing Angle Accuracy • Alignment • Attitude Determination Accuracy • Orbit Determination Accuracy
B. Calibration of Absolute Value	• Absolute sensitivity (Vicarious Cal, Under fight Airborne observation • Radiometric Accuracy • Geometric Correction Accuracy	• Attitude Offset
C. Image Quality	Resolution, SN, etc.	• Resolution

6. Definition of Cal / Val

(4) Definition of Validation

1. **Characterization of Physical Parameter on High Level Product**
   -> Goal: Ex.) Position Accuracy 2.5m
   Height Accuracy less than 5m

2. **Characterization of Estimated Geophysical Parameter Accuracy on Experimental Product**
   -> Goal: Ex.) Crustal Deformation 2cm
   Forest Mosaic less than 1dB
   Forest Biomass less than 20ton/ha

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7. Definition of Research Product

(1) High Level Product (1/2)

Product	Definition	Amount of Product	Algorithm Development
Ortho Image ◎ (AVNIR-II)	Ortho Image Generation Using 50m mesh data of GSI	Amount of Product: 10 scenes / day (tentative) Size of 1 scene: 70km×70km	EORC Inhouse (and RA) ① Ortho Image Processing Using DEM
Ortho Image ◎ (PALSAR)	Ortho Image Generation Using 50m mesh data of GSI	Amount of Product: 10 scenes / day (tentative) Size of 1 scene: 70km×70km	EORC Inhouse(and RA) ① Geometric Correction (Improvement of JERS-1 SAR Algorithm)
Ortho Image ◎ (PRISM)	Ortho Image Generation Using ALOS PRISM simulation data (which produced in the process of DEM generation)	Amount of Product: 2 scenes / day (tentative) 500 scenes / year (tentative) Resolution: 2.5m × 2.5m Size of 1 scene: 35km×35km Area: Test site, TBD	EORC Inhouse (and RA) ① Ortho Image Processing Using DEM

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7. Definition of Research Product

(1) High Level Product (2/2)

Product	Definition	Amount of Product	Algorithm Development
Relative Valued DEM◎ (PRISM)	Generation of Relative Valued DEM from PRISM data	Amount of Product: 2 scenes / day (tentative) 500 scenes / year (tentative) Resolution: 2.5m × 2.5m Size of 1 scene: 35km×35km Area: Test site, TBD	EORC Inhouse(and RA) ① Rad ometric Correction EORC Inhouse (or consignment) ① Matching ② Relative DEM Processing ③ Interpolation
Absolute Valued DEM◎ (PRISM)	Generation of Absolute Valued DEM from PRISM data and GCP	Amount of Product: 20 scenes / day (tentative) Resolution: 2.5m × 2.5m Size of 1 scene: 35km×35km Area: Test site, TBD	EORC Inhouse (and RA) ① Absolute Valued DEM Derivation
DEM generated from SAR◎ (PALSAR)	Generation of DEM with 50m spatial resolution and 10m height resolution using SAR Differential Interferometry Processing (1) Applicable for crustal deformation analysis (2) DEM generation in the area where PRISM is not applicable	Amount of Product: 10scene / day (tentative) Resolution: 50m × 50m Size of 1 scene: 70km×70km Area: TBD	EORC Inhouse(and RA) ① Interferometry Processing (Improvement of JERS-1 Algorithm)
Land Cover Classification (PALSAR/ AVNIR-2)	Classification using fusion data processing combining PALSAR and AVNIR-2	Goal: 2 seasons / year (Summer, Winter) ×5 years	RA and/or Inhouse
Vegetation Classification (PALSAR/ AVNIR-2)	Classification using fusion data processing combining PALSAR and AVNIR-2	Goal: 2 seasons / 5years	RA and/or Inhouse

7. Definition of Research Product

(2) Experimental Product (1/2)

Product	Definition	Amount of Product	Algorithm Development
Global Forest Map ◎ (PALSAR)	Mosic Image from 400m spatial resolution data more than four times observation is required to generate two seasons mosic images	Amount of Product: 14 (7 ×2) scenes / year Resolution: 100m×100m Area: Tropical Rain Forest Boreal Forest Temperate Zone Forest / TBD	EORC Inhouse(and RA) ① High Speed Processing from each path image (Improvement of JERS-1 SAR Algorithm) ② Stripe elimination between paths (Improvement of JERS-1 SAR Algorithm)

7. Definition of Research Product

(2) Experimental Product (2/2)

Product	Definition	Amount of Product	Algorithm Development
Crustal Deformation Map (PALSAR)	Mosic Image of differential Interferometry processed data to cover large area of crustal movement Area: Japan Island, Chishima, Kamchatska, Aleutian	Amount of Product: 5 scenes / day (tentative) Resolution: 50m×50m Size of 1 scene: 70km×70km Area: Japan Island Aleutian etc.	EORC Inhouse(and RA) ① Radiometric Correction EORC Inhouse (or consignment) ① Matching ② Relative DEM Processing ③ Interpolation
Biomass Map (PALSAR)	Biomass Map using PALSAR	Goal: 2 times / year × 5years	EORC Inhouse(and RA), Cooperative Research in Ground Truth
Sea Ice Map (PALSAR)	Sea Ice Distribution and Density Map in Sea of Okhotsk, Arctic Ocean, and the fringe of Antarctica	Goal: 5years	EORC Inhouse(and RA)
Soil Moisture Map (PALSAR)	Soil Moisture Map in continental scale from PALSAR	Goal: Once / year × 5years	RA and/or EORC Inhouse
Snow pack / Ice Map(PALSAR/ AVNIR-2)	Snow pack, Glacier Map using PALSAR and AVNIR-2	Goal: Once / year × 5years	RA and/or EORC Inhouse
Albedo Map (AVNIR-2)	Reflectance Map on Earth surface 1) Albedo on Earth surface with atmospheric correction 2) Albedo on top of atmosphere	Goal: 2 times / year × 5years	RA and/or EORC Inhouse
Desert Map (PALSAR/ AVNIR-2)	Desert Map using PALSAR and AVNIR-2 for the monitoring of desertification	Goal: 2 seasons / year × 5years	RA and/or EORC Inhouse

8. Research Announcement

(1) Research Purpose

1. Cal / Val 2. Utilization Research 3. Science Research

(2) Period of Research

- 5 years (Evaluation after 3 years)

(3) Data Provision to PIs

- Existing satellite data possessed by NASDA
- ALOS data after launch

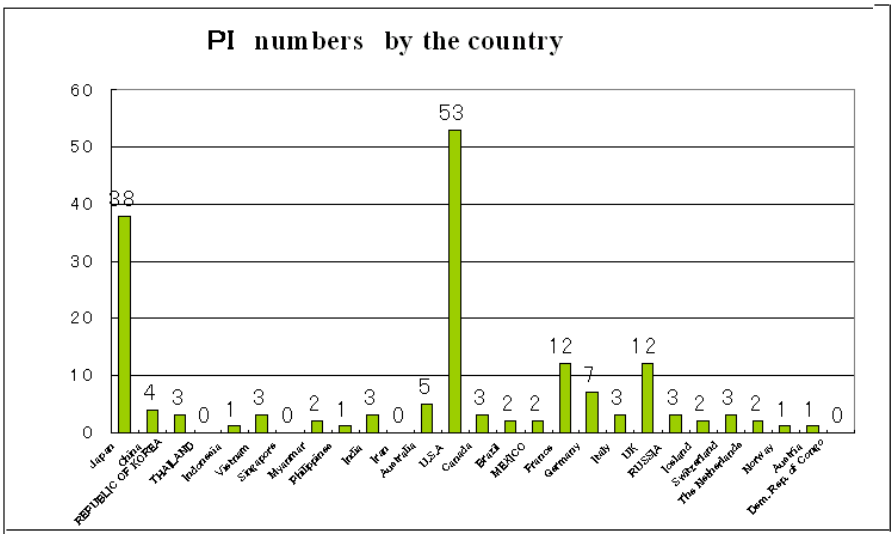
(4) Researchers

- Accept proposal from wide ranging researchers from private research institutes as well as universities / national institutes. Research purpose is restricted to the peaceful purpose.

(6) Schedule

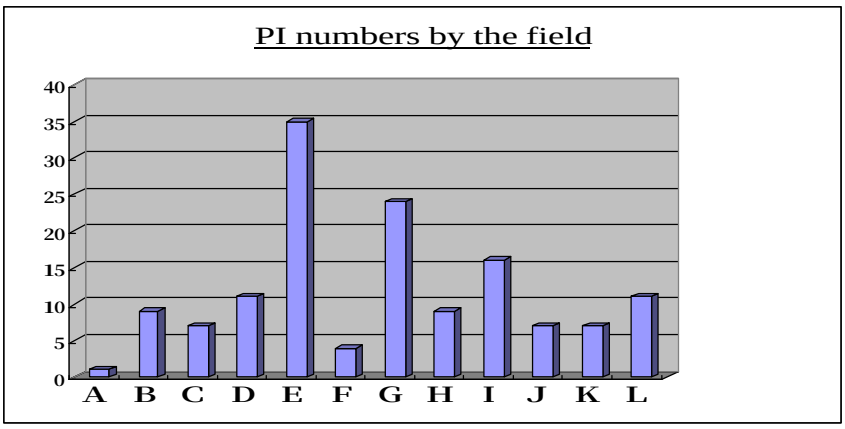
Document release -- October 1999
Deadline for submission of proposals -- January 31, 2000
Notification of PI selection -- September, 2000
Contract -- October 2000 <-- > December 2000
PI meeting and Symposia -- Late March 2001
Interim evaluation -- March 2004 (in FY2003)

8. Research Announcement



NASDA

8. Research Announcement



A: Calibration of optical Sensors
B: Calibration of SAR
C: DEM & Mapping
D: Land use & Land Cover
E: Disaster Management
F: Geology & Non renewable Resources
G: Terrestrial
H: Oceanography & Coastal Zone Applications
I: Cryoshere,Snow and Ice Distribution
J : Agricultural Applications
K : Hydrology & Water Resources
L: Geography & GIS Applications

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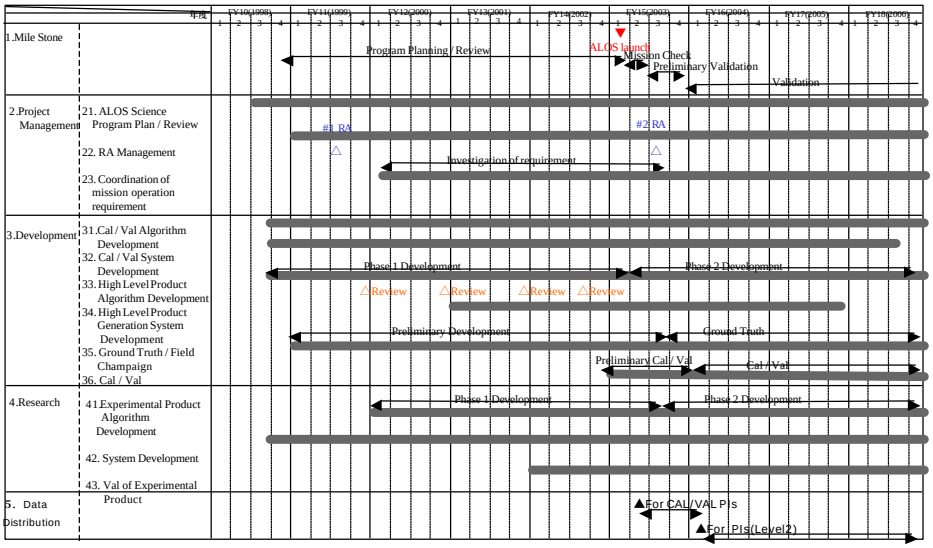
9. Master Schedule



10. Conclusions

ALOS is a land remote sensing satellite of the following mission concept.

1) Global high resolution observation and wide swath width observation will be available.
2) Three dimensional land topography, and two dimensional spectral images and geodetic land surface deformation will be measured simultaneously.
3) ALOS program will improve algorithms based on experiences of JERS-1 and ADEOS to realize above mentioned mission concept.
4) ALOS will develop possibility of new science and applications, such as Kyoto forest mapping, global observation of forest cover for the estimation and elucidation of carbon cycle system on the earth.
5) The strategic application to integrate remote sensing and GIS.
6) EORC Responsibility
   (1) Algorithm development for research product including high level and experimental product.
   (2) Support in calibration of standard product and validation of research product.
   (3) Research product data set generation and data distribution to PIs.
   (4) Research announcement activities.