ALOS / PALSAR
- Overviews and Expected Results -

Takeo Tadono and Masanobu Shimada
Earth Observation Research and Application Center (EORC)
Japan Aerospace Exploration Agency (JAXA)
Outlines

■ The overview of the PALSAR
  ➢ Launch and deployment of PALSAR’s antenna
  ➢ Characteristics of PALSAR
  ➢ Definition of products and accuracy goal
  ➢ Calibration and validation, and data release plans

■ Example of PALSAR Data Utilization
  ➢ ALOS Kyoto & Carbon Initiative (K&C Project)
  ➢ Global mosaic
  ➢ Disaster monitoring by SAR Interferometry
  ➢ Hydrology, snow and ice applications
  ➢ Polarimetric SAR analysis

■ Summary
**Mission objectives:**
- Cartography (1:25,000 scale),
- Regional environment observation,
- Disaster monitoring, and
- Resources surveying.

**ALOS “Daichi”**
(Advanced Land Observing Satellite)

**Data Relay Antenna (DRC)**
[Data rate: 240Mbps]

**Star Tracker**

**GPS Antenna**

**PALSAR**

**PRISM**

**AVNIR-2**

**Solar Array Paddle**

**Mission objectives:**
- Cartography (1:25,000 scale),
- Regional environment observation,
- Disaster monitoring, and
- Resources surveying.

**PRISM**: Panchromatic Remote-sensing Instrument for Stereo Mapping

**AVNIR-2**: Advanced Visible and Near Infrared Radiometer type 2

**PALSAR**: Phased Array type L-band Synthetic Aperture Radar
### ALOS Characteristics

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Launch Date</td>
<td>10:33, January 24\textsuperscript{th}, 2006 (JST)</td>
</tr>
<tr>
<td>Orbit</td>
<td>Sun-synchronous</td>
</tr>
<tr>
<td>Local Time at DN</td>
<td>10:30 +/- 15 min.</td>
</tr>
<tr>
<td>Altitude</td>
<td>691.65 km @Equator</td>
</tr>
<tr>
<td>Inclination</td>
<td>98.16 degrees</td>
</tr>
<tr>
<td>Recurrent Period</td>
<td>46 days (Sub-cycle: 2 days)</td>
</tr>
<tr>
<td>Revolution</td>
<td>14 + 27/46 (/day), 671 (/recurrent)</td>
</tr>
<tr>
<td>Period</td>
<td>98.7 minutes</td>
</tr>
<tr>
<td>Longitude Repeatability</td>
<td>+/-2.5 km @Equator</td>
</tr>
<tr>
<td>Data Collection</td>
<td>1 DRTS (Data Relay Test Satellite), 240 Mbps</td>
</tr>
<tr>
<td></td>
<td>HSSR (High Speed Solid state Recorder)</td>
</tr>
<tr>
<td></td>
<td>+ DT (X-band direct downlink), 120 Mbps</td>
</tr>
<tr>
<td>Yaw Steering</td>
<td>Off / On</td>
</tr>
<tr>
<td>Attitude Error each axis</td>
<td>2.0e-4 degree (determination)</td>
</tr>
<tr>
<td></td>
<td>0.1 deg. (maintain)</td>
</tr>
<tr>
<td>Satellite Mass</td>
<td>4,000 Kg</td>
</tr>
<tr>
<td>Power</td>
<td>7 KW @EOL</td>
</tr>
</tbody>
</table>
PALSAR Antenna Deployment

1st step
90deg.
Off nadir

2nd step
Panel

Successfully Completed!!
PALSAR
Phased Array type L-band Synthetic Aperture Radar

L-band (1.27GHz)

Fine Resolution Mode
8.0-60.0 deg.
HH or VV / HH+HV or VV+VH
7.0-44.3m / 14.0-88.6m
40-70km / 40-70km

ScanSAR Mode
18.0-43.0 deg.
HH or VV / 100m / 250-350km

Polarimetric Mode
8.0-30.0 deg.
HH + HV + VH + VV
24.1-88.6m / 20-60km
## PALSAR Operation Modes

* Total: 132 modes

<table>
<thead>
<tr>
<th>Mode</th>
<th>Fine Resolution</th>
<th>Direct Downlink (DT)</th>
<th>ScanSAR</th>
<th>Polarimetry</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Single-Pol. (FBS)</td>
<td>Dual –Pol. (FBD)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Frequency</td>
<td>L-band (1270 MHz)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Chirp Bandwidth</td>
<td>28 MHz</td>
<td>14 MHz</td>
<td>14 MHz</td>
<td>14 MHz</td>
</tr>
<tr>
<td>Polarization</td>
<td>HH or VV</td>
<td>HH/HV or VV/VH</td>
<td>HH or VV</td>
<td>HH+HV +VH+VV</td>
</tr>
<tr>
<td>Incidence Angle</td>
<td>8-60 deg (typ 39 deg)</td>
<td>8-60 deg (typ 39 deg)</td>
<td>8-60 deg</td>
<td>8-30 deg (typ 24 deg)</td>
</tr>
<tr>
<td>Range Resolution</td>
<td>7-44 m 10m@39deg</td>
<td>14-88 m 20m@39deg</td>
<td>14-88 m 20m@39deg</td>
<td>100 m (Multi-look) 24-89 m 30m@24deg</td>
</tr>
<tr>
<td>Swath Width</td>
<td>40-70 km</td>
<td>40-70 km</td>
<td>40-70 km</td>
<td>250-350 km 20-65 km</td>
</tr>
<tr>
<td>Bit Length</td>
<td>5 bits</td>
<td>5 bits</td>
<td>3/5 bits</td>
<td>5 bits</td>
</tr>
<tr>
<td>Data Rate</td>
<td>240 Mbps</td>
<td>240 Mbps</td>
<td>120 Mbps</td>
<td>120/240 Mbps 240 Mbps</td>
</tr>
</tbody>
</table>

**Major operation modes: 6 (9) modes**

<table>
<thead>
<tr>
<th>Mode</th>
<th>FBS</th>
<th>FBD</th>
<th>(DT)</th>
<th>ScanSAR</th>
<th>Polarimetry</th>
</tr>
</thead>
<tbody>
<tr>
<td>Off-nadir angle (deg)</td>
<td>21, 34, 41</td>
<td>41</td>
<td>21, 34, 41</td>
<td>5 SCAN (17-43)</td>
<td>21</td>
</tr>
<tr>
<td>Polarization</td>
<td>HH</td>
<td>HH+HV</td>
<td>HH</td>
<td>HH</td>
<td>HH+HV +VH+VV</td>
</tr>
</tbody>
</table>

---

*Source: JAXA Earth Observation Research and Application Center (EORC)*
**Definition of Products (1/2)**

**Standard Products** : Processed at JAXA Earth Observation Center (EOC)

**PALSAR** – 1.0 : Uncorrected image, scene unit
- Raw data + Orbit + Telemetry (384-847MB)
- 1.1 : Single-Look Complex data on slant range (SLC)
  - 4 bytes IEEE (I+Q) + Ancillary
- 1.5 : Multi look processed image (Amplitude, Georeference/Geocode)
  - 2 bytes Int + Ancillary (160-280MB@6.25m, 40-71MB@12.5m)

Example of Slant range image.

Geo-reference image.

Geo-coded image.
**Definition of Products (2/2)**

**High Level Products**: will be generated at **EORC**.
- **PALSAR**: DEM by Interferometry, and Ortho-rectified image

**Research Products** (tentative): will be produced at **EORC**.
- Forest and biomass map, Surface deformation, sea-ice, soil moisture, and snow parameter products using **PALSAR** data

---

**Ortho-rectified image.**

**Interferometric SAR DEM of Mt. Fuji derived from JERS-1/SAR.**

**EORC** Earth Observation Research and Application Center
### Accuracy Goal and Achievement

<table>
<thead>
<tr>
<th>Products</th>
<th>Accuracy Goal</th>
<th>Validation method</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Standard Products</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1.0</td>
<td>Geometry: 200 m</td>
<td>CR, ARC’s location, Validation CR, ARC</td>
</tr>
<tr>
<td>1.1</td>
<td>Radiometry: 1.5 dB (abs.)</td>
<td>Amazon forest area</td>
</tr>
<tr>
<td>1.5</td>
<td>Radiometry: 1.0 dB (relative)</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Geometry: 5 deg. (phase)</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Radiometry:</td>
<td></td>
</tr>
<tr>
<td><strong>High Level Products</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Ortho-rectified</td>
<td>Geometry: 50 m (horizon)</td>
<td>CR, ARC’s location, GCP, Reference DEM</td>
</tr>
<tr>
<td>DEM</td>
<td>Radiometry: 30 m (vertical)</td>
<td>Validation CR, ARC</td>
</tr>
<tr>
<td></td>
<td>Radiometry: 1.5 dB (ext. layover)</td>
<td></td>
</tr>
<tr>
<td><strong>Research Products</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Deformation</td>
<td>Geometry: 100 m</td>
<td>Landsat images, Amazon images, GPS’s positions</td>
</tr>
<tr>
<td>Forest map</td>
<td>Radiometry: 1.5 dB</td>
<td>Ground Truth data etc.</td>
</tr>
<tr>
<td>Soil moisture</td>
<td>5 mm</td>
<td></td>
</tr>
<tr>
<td>Snow map</td>
<td>10 % (abs.)</td>
<td></td>
</tr>
<tr>
<td>Biomass</td>
<td>10 % (abs.)</td>
<td></td>
</tr>
<tr>
<td>Sea Ice</td>
<td>...</td>
<td></td>
</tr>
</tbody>
</table>

CR: Corner Reflector, ARC: Active Radar Calibrator, GCP: Ground Control Point
### Cal/Val and Data Release Schedule

**24th January, 2006**  
**ALOS Launch**

<table>
<thead>
<tr>
<th>Pre launch CAL.</th>
<th>Initial mission check Phase</th>
<th>Initial CAL Phase</th>
<th>Operational CAL.</th>
</tr>
</thead>
<tbody>
<tr>
<td>3 months</td>
<td>5 months</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

- **Data release (limited for PI, via Web for general)**

**EOC (Standard products) software version**
- Ver.0

**EORC (Higher level products) software version**
- Ver.0

- **Cal/Val Team Meetings**
- **Data release**
  - Ver.1
  - Ver.2
  - Ver.n

- **1 year after**

---

**CAL/VAL review boards**
ALOS Data Nodes (ADN)

ALOS Data Node Concepts are

- to increase capacity for ALOS data processing and archiving,
- to accelerate scientific and practical use of ALOS data,
- to increase international co-operation including joint validation and joint science study activities, and
- to enhance service for potential users of ALOS data.

Each Node is associated with a geographical zone which defines the extent of its area of activity (supporting the physical residents therein as potential ALOS users) as an ADN partner.

- ESA: Europe and Africa
- NOAA/ASF: North and South America
- Geoscience Australia: Oceania
- JAXA: Asia
- GISTDA: Asian Sub-Node
Heritage and objectives

The Kyoto & Carbon Initiative* is an international collaborative project forming the continuation and extension of the JERS-1 SAR GRFM/GBFM project into the era of the Advanced Land Observing Satellite - ALOS (and as far as possible, ADEOS-II GLI).

Aims to support information needs posed by the “3 C’s”:
- The terrestrial Carbon cycle science community (CO2 & CH4 sources and sinks);
- Multinational Environmental Conventions and Declarations:
  - UNFCCC Kyoto Protocol (Forest and Land Cover Change);
  - Ramsar Convention (wetland characteristics and disturbances);
  - UN Millenium Declaration & UNCCD (water supply and desertification)
- Environmental Conservation

*Support to Multi-national Environmental Conventions and Terrestrial Carbon Cycle Science by ALOS and ADEOS-II.
K&C Project Organization

**Project Lead**
Ake Rosenqvist (JAXA EORC)

**Advisors**
Carbon: S. Quegan, C. Dobson
Conventions: Y. Yamagata; Max Finlayson

**Forest Theme**
Theme Coordinator:
Richard Lucas (UW-aber)

**Wetlands Theme**
Theme Coordinators:
Laura Hess (UCSB)
John Lowry (ERISS)

**Desert & Water Theme**
Theme Coordinator:
Philippe Paillou (OAB)

**Mosaic Products Theme**
Theme Coordinator:
Bruce Chapman (JPL)

**Product Leaders**
- Responsible for the generation of data- or information products.

**Carbon & Convention Advisors**
- Advice Theme Coordinators and Product Leaders on:
  - carbon cycle science (TCO) information needs;
  - convention information requirements;
  - conservation issues.

**Theme Coordinators**
- Coordinate, focus and align products within and between the Themes.
- Assure synergy with TCO and convention information needs
- Authors of Theme chapter in the K&C Science Plan.
Examples of K&C Project Output

- Global SAR image mosaics @ 100m
- Annual forest change
- Global Land Cover classification @ 250m
- Rice mapping
- Flood duration mapping

The Kyoto & Carbon Initiative
JERS-1 SAR Mosaic in SE Asia
Disaster Monitoring by DInSAR

SAR differential interferometry by JERS-1 (Hyogo Pref., Japan, 1995)

SAR differential interferometry by RADARSAT (Niigata, Japan, 2004)

L-band SAR has advantage to monitor the mountain area due to longer wave length than C-band as well as X-band.
Hydrological Applications using SAR

Flood duration by JERS-1 SAR (Jau River, Brazil)

Soil moisture map by JERS-1 SAR (Tibetan Plateau, China)
Snow & Ice Applications using SAR

Ice thickness change by JERS-1 SAR interferometry (Barrow, Alaska)

Snow parameter mapping by RADARSAT (Niigata, Japan)
Monitoring Urban Development by Pol-SAR

Monitoring coastline development by Polarimetric Airborne SAR (Pi-SAR).
(Tokyo bay area, Japan, Oct. 13, 1999)
Polarimetric SAR Analysis

Surface classification using Polarimetric analysis by Polarimetric Airborne SAR (Pi-SAR).
(Niigata, Japan, Aug. 20, 2003)
PALSARが観測した夜間の富士山
PALSAR Night View of Mt. Fuji

http://www.eorc.jaxa.jp/ALOS/

観測日：2006年2月15日22時16分
Summary

I introduced the overviews of the ALOS and PALSAR, in particular,
1) characteristics of the PALSAR and its products,
2) examples of PALSAR data utilization, and
3) potentials and advantages of L-band SAR.

For more information related to research, application and science,
- **EORC/ALOS** : New images, data utilization, and technical documents

For satellite and sensors development status,
- **ALOS Project Team** :
  http://alos.jaxa.jp/index-e.html

For data search and general information,
- **EOC/ALOS** : Data search (after launch)
  http://www.eoc.jaxa.jp/satellite/satdata/alos_e.html
- **HQ/Topics** : General information
  http://www.jaxa.jp/missions/projects.sat/eos/alos/index_e.html