An overview of the Japan Aerospace Exploration Agency L-band SAR programme

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on behalf of

the Japan Aerospace Exploration Agency (JAXA)

Helmholtz Alliance Week
1 July 2014
Garmisch-Partenkirchen, Germany
1. L-band SAR heritage
   - From JERS-1 to ALOS-2
   - ALOS-2 characteristics

2. Systematic acquisition strategies
   - JERS-1
   - ALOS
   - ALOS-2

3. Users – science and operations

4. The Next Generation L-band SAR
Japan and L-band SAR: 2 decades of operations

- ALOS (2006-2011)
- ALOS-2 (2014+)
- Next-G (2020+?)

Trends towards:
- Higher spatial resolutions
- Wider observational (access) areas
- Polarisations: SP → DP → QP
- Local → global observations

Technical Demonstrations
Local / semi-continental scales

Solutions (application and science)
Systematic global monitoring
Beginning of the ALOS-2 era

24 May 2014
12:05:14 JST
H-IIA #24
<table>
<thead>
<tr>
<th></th>
<th>ALOS</th>
<th>ALOS-2</th>
</tr>
</thead>
<tbody>
<tr>
<td>Orbit altitude</td>
<td>692 km (sun-synchronous)</td>
<td>628 km (sun-synchronous)</td>
</tr>
<tr>
<td>Revisit cycle</td>
<td>46 days</td>
<td>14 days</td>
</tr>
<tr>
<td>Orbital revolutions</td>
<td>14+27/46 rev/day</td>
<td>14+11/14 rev/day</td>
</tr>
<tr>
<td></td>
<td>671 rev/cycle</td>
<td>207 rev/cycle</td>
</tr>
<tr>
<td>Ground track dist. (@Equator)</td>
<td>60 km</td>
<td>194 km</td>
</tr>
<tr>
<td>Equator pass time</td>
<td>10:30 am/pm</td>
<td>12:00 am/pm</td>
</tr>
<tr>
<td>Look direction</td>
<td>Right</td>
<td>Right (nominal) + Left</td>
</tr>
<tr>
<td>Mission Data Recorder</td>
<td>96 GB</td>
<td>130 GB</td>
</tr>
<tr>
<td>Downlink capacity</td>
<td>120 Mbps (X-band) and 240 Mbps (Ka-band)</td>
<td>800 Mbps (X-band) and 277 Mbps (Ka-band)</td>
</tr>
<tr>
<td>Transmission (peak)</td>
<td>2.0 kW</td>
<td>5.1 kW</td>
</tr>
<tr>
<td>Target mission life time</td>
<td>3-5 years (actual: 5 yrs 3 mths)</td>
<td>5-7 years</td>
</tr>
</tbody>
</table>
ALOS vs ALOS-2

Improvement in observation area and resolution

<table>
<thead>
<tr>
<th>Observable</th>
<th>Stripmap</th>
<th>ScanSAR</th>
<th>Observable</th>
<th>Stripmap</th>
<th>ScanSAR</th>
<th>Spotlight</th>
</tr>
</thead>
<tbody>
<tr>
<td>Swath</td>
<td>870 km</td>
<td>40 to 70 km</td>
<td>250 to 350 km</td>
<td>1160 km x 2 (right &amp; left)</td>
<td>50 or 70 km</td>
<td>350 or 490 km</td>
</tr>
<tr>
<td>Resolution</td>
<td>10 m</td>
<td>100 m</td>
<td>3 to 10 m</td>
<td>100 m</td>
<td>ALOS/PALSAR</td>
<td>ALOS-2/PALSAR-2</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>25 x 25 km</td>
<td>1 x 3 m</td>
</tr>
</tbody>
</table>
## PALSAR-2 Technical Specifications

<table>
<thead>
<tr>
<th></th>
<th>Spotlight</th>
<th>Ultra Fine</th>
<th>High sensitive</th>
<th>Fine</th>
<th>ScanSAR nominal</th>
<th>ScanSAR wide</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bandwidth</td>
<td>84MHz</td>
<td>84MHz</td>
<td>42MHz</td>
<td>28MHz</td>
<td>14MHz</td>
<td>28MHz</td>
</tr>
<tr>
<td>Resolution</td>
<td>Rg × Az: 3 × 1m</td>
<td>3m</td>
<td>6m</td>
<td>10m</td>
<td>100m</td>
<td>60m</td>
</tr>
<tr>
<td>Swath</td>
<td>Rg × Az: 25 × 25km</td>
<td>50km</td>
<td>50km</td>
<td>70km</td>
<td>350km</td>
<td>490km</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>(5-scan)</td>
<td>(7-scan)</td>
</tr>
<tr>
<td>Polarization</td>
<td>SP</td>
<td>SP/DP</td>
<td>SP/DP/QP/CP</td>
<td>SP/DP</td>
<td></td>
<td></td>
</tr>
<tr>
<td>NESZ</td>
<td>-24dB</td>
<td>-24dB</td>
<td>-28dB</td>
<td>-26dB</td>
<td>-26dB</td>
<td>-23dB</td>
</tr>
<tr>
<td>S/A</td>
<td>Rg</td>
<td>25dB</td>
<td>23dB</td>
<td>25dB</td>
<td>25dB</td>
<td>20dB</td>
</tr>
<tr>
<td></td>
<td>Az</td>
<td>20dB</td>
<td>20dB</td>
<td>23dB</td>
<td>20dB</td>
<td>20dB</td>
</tr>
</tbody>
</table>

**SP**: HH or VV or HV, **DP**: HH+HV or VV+VH, **QP**: HH+HV+VH+VV, **CP**: Compact pol (Experimental)

**Main applications:**
- Fine beam (DP): Forest and land cover monitoring
- ScanSAR (DP): Rapid deforestation / wetlands / InSAR (ScanSAR beam burst sync)
- Spotlight (SP): Emergency observations
- Ultra Fine (SP): Global map, InSAR base mapping
- High sensitive (QP): Global map
- ScanSAR wide (SP): Polar ice
ALOS-2 first image acquisitions

JERS-1

ALOS

ALOS-2

FUYO-1 SAR, April 21, 1992, (Resolution: about 18 m)

DAICHI PALSAR, April 27, 2006, (Resolution: about 10 m)

DAICHI-2 PALSAR-2, June 19, 2014 (Resolution: about 3 m)
ALOS-2 first image acquisitions

Oshima, Tokyo, 19 June 2014
3m Ultra-Fine stripmap mode, dual-pol
ALOS-2 first image acquisitions

Roraima, Brazil, 21 June 2014
3m Ultra-Fine stripmap mode, dual-pol
ALOS-2 first image acquisitions

Roraima, Brazil
ALOS PALSAR, June 2009
ALOS-2 PALSAR-2 June 2014
Systematic acquisition strategies

- Continuation of the building of long-term L-band archives
Systematic Observation Strategies

Basic Observation Scenarios – BOS - have been developed and implemented by JAXA for 2 decades:

- **JERS-1** SAR (1995-1998: *Pan-tropical, Pan-boreal*)
- **ALOS** PALSAR (2006-2011: *Global*)
- **ALOS-2** PALSAR-2 (2014+ *Global*)
- **Next Generation SAR** (Key component. 2020+ *Global*)

Long-term time-series of spatially and temporally consistent satellite data of key importance for both science and operational applications, and for the development of national monitoring systems of forests, wetlands and agriculture.
First wall-to-wall snapshot of the Amazon River Basin (1995 ← 19 years ago! Pre-Landsat LTAP 1999)

JERS-1 SAR:
JAXA (NASDA) first agency to develop and implement a systematic observation strategy for a fine-resolution mission (JERS-1 18m)
ALOS Systematic Observation Strategy ("BOS")

Dual-season strategy has accommodated
To continue with ALOS-2 from 2014

Publicly available at
ALOS-2 Basic Observation Scenario

• Descending acquisitions (noon, ~12:00)
  - Global observations in Stripmap (3m SP) mode once per 3 years
  - Observations of Wetlands, Rapid Deforestation and Crustal Deformation in ScanSAR (350km DP) mode
  - Observations of Crustal Deformation and Forests in Stripmap (10m DP) mode during two successive cycles for InSAR applications (Super Sites)
  - Observations of Boreal and sub-Arctic in ScanSAR (490km DP) mode
  - InSAR observations of Antarctica Glaciers in Stripmap (10m DP) mode

• Ascending acquisitions (midnight, ~24:00)
  - Global observations in Stripmap (10m DP) mode twice per year
  - Observations of polar regions in ScanSAR (350km DP) mode three times per year to cover summer/winter seasons. Antarctica will be observed in left-looking mode to cover higher latitudes.
  - Global observations in Polarimetric (6m QP) mode once per 5 years
  - Observations of special focus areas with Polarimetric (6m QP) mode annually (Super Sites)
  - InSAR observations of Greenland Glaciers with Stripmap (10m DP) mode
Global land areas – baseline mapping
Temporal repeat: 2 cov/year
GSD: 10 m (off-nadir 28.2° -36.2° )
Mode: Stripmap Dual-pol (HH+HV/28MHz)
ALOS-2 Basic Observation Scenario

Forest monitoring

Temporal repeat: 2-6 cov/year (tropics 6 cov)

GSD: 10 m (off-nadir 28.2° -36.2° )

Mode: Stripmap Dual-pol (HH+HV/28MHz)
Global land areas – VHR baseline mapping

Temporal repeat: 1 cov/ 3 years

GSD: 3 m (off-nadir 29.1° -38.2°)

Mode: Stripmap Single-pol (HH/84MHz)

*3 years required for global coverage in 3m mode
Global land areas – Quad-polarimetric baseline

Temporal repeat: 1 cov/ 5 years

GSD: 6 m (off-nadir 25.0° -34.9°)

Mode: Stripmap Quad-pol (HH+HV+VV+VH/42MHz)

* 5 years required for global coverage in 6m QP mode
Wetlands & Rapid deforestation monitoring

Temporal repeat: 9 cov/year

GSD: 100 m (off-nadir 26.2° -41.8°)

Mode: ScanSAR 350km Dual-pol (HH+HV/14MHz)
Crustal Deformation

Temporal repeat: 2-6 cov/year & 9 cov/year

GSD: 10 m (off-nadir 28.2° – 36.2°) & 100 m (off-nadir 26.2° – 41.8°)

Mode: Stripmap Dual-pol (HH+HV/28MHz) & ScanSAR 350km (HH+HV/14MHz)
ALOS-2 Basic Observation Scenario

Polar Ice

Temporal repeat: 3 cov/year

GSD: 100 m (off-nadir 26.2° – 41.8°)

Mode: ScanSAR 350km (HH+HV/14MHz)
Users – science and operations
Users – Science and Operations

Scientific users are always involved
Users – Science and Operations

Long-term involvement with int'l SAR expert community

- 2001–now: ALOS Kyoto & Carbon Initiative, ALOS-2 phase started
- Aim to stimulate regional-scale SAR applications development facilitated by the (J-1, A-1, A-2) systematic observations
- Some 35 user groups from 15 countries
- 30+ science meetings
The Next Generation L-band SAR
The Next Generation L-band SAR

Present
High-Resolution or Wide Swath

Future
High-Resolution and Wide Swath

Next Generation L-band SAR (Stripmap)
The Next Generation L-band SAR

JAXA and DLR undertaking a study on a joint Japan/Germany mission

- L-band tandem constellation with monostatic and bistatic capacity
- Large Deployable Reflector Antenna Technology
- Digital Beam-forming to achieve wide swath at high resolution
- Global systematic observations continuity
- Launch horizon ~2020
Thank you.