OCEANIC DYNAMIC PHENOMENA AND SEA ICE IN THE SOUTHERN OKHOTSK SEA: STUDY WITH ALOS PALSAR AND ANCILLARY DATA

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Outlines

• Introduction. ALOS PALSAR
• Selection of test areas
• PALSAR images and ancillary data.
• Okhotsk Sea between Sakhalin and Hokkaido
  - Soya Warm Current
  - Internal waves
  - Ice eddies
• Southeastern Sakhalin shelf. Sea ice.
• Field measurements of the sea surface roughness
• Conclusion
The Southern Okhotsk Sea is characterized by significant seasonal variations of oceanic fields. Intended coastal line, straits connecting the Okhotsk Sea with the Japan Sea and the Pacific Ocean, cyclone’s passing and river's discharge are responsible for complicated water dynamics. Its mesoscale and finescale structure and evolution has not been adequately explored. ALOS PALSAR is a valuable tool providing all-weather images of the sea surface that were used to reveal the signatures caused by currents, eddies, internal waves and sea ice.
ALOS - Advanced Land Observing Satellite

ALOS was launched on 24 January 2006

http://www.palsar.ersdac.or.jp/e/index.shtml

<table>
<thead>
<tr>
<th>Specification</th>
<th>Value</th>
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<tbody>
<tr>
<td>Center frequency, MHz</td>
<td>1270</td>
</tr>
<tr>
<td>Range resolution, m</td>
<td>7 ~ 44, 14 ~ 88, 100</td>
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<tr>
<td>Swath width, km</td>
<td>40 ~ 70, 40 ~ 70, 250 ~ 350</td>
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<tr>
<td>Polarization</td>
<td>VV, HH, VH, HV</td>
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<tr>
<td>Incidence angle, degrees</td>
<td>8-60; 19-43</td>
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The main aims of this ongoing research are:

• to estimate the potential of ALOS L-band PALSAR images to study the oceanic dynamic phenomena and sea ice in the coastal zone and in the open sea and

• to improve interpretation of PALSAR signatures using multisensor observations.
Data

QuikSCAT-derived winds, Terra and Aqua MODIS and NOAA AVHRR visible and infrared images, Aqua AMSR-E brightness temperatures and products, surface analysis maps, bottom topography, etc.

ALOS PALSAR PRI images
ALOS PALSAR QL images
ERS-1/1 SAR and Envisat ASAR images.
Selection of test areas

1. Variety of dynamic oceanic and atmospheric phenomena influencing on radar backscattering

2. Seasonal changes, location at different climatic zones

3. Previous experience based on analysis of C-band ERS-1/2 SAR and Envisat ASAR images

4. Availability of relevant remote and *in situ* data
**1st test area**

The area between **Southern Sakhalin** and **Hokkaido** and **Kuril Straits**:

- currents,
- tidal currents,
- eddies,
- mushroom-like eddies,
- internal waves,
- bottom topography,
- sea ice
The Soya Warm Current area on 13 May 2002: (a) ERS-2 SAR image at 18 UTC and (b) NOAA AVHRR IR image at 03:50 UTC. Contours of SAR signatures are shown by dark lines.
5 September 2006, VV

ALOS PALSAR

4 October 2006, VV

Stones of Dangerous

Internal waves
Soya Warm Current and Aniva Bay on PALSAR image acquired on 17 Sep 2006 at 01:15 UTC:
1 – current front,
2 – warm current waters,
3 – cold waters
4 – packets of internal waves
Surface manifestations of internal waves to the east of Aniva Cape and bottom topography to the south of cape on PALSAR image acquired on 17 Sep 2006 at 01:15 UTC:
Numerous packets of internal waves generated by the bottom signatures in the area of Moneron island on ALOS PALSAR image acquired on 9 September 2006 at 01:04 UTC
PALSAR image of the Southwest Okhotsk Sea acquired on 19 January 2008 at 01:15 UTC.
1 – Rishiri Island,
2 – Cape Soya,
3 – Cape Krilion,
4 – Cape Aniva,
5 – La Perouse Strait,
6 – Aniva Bay,
7 – strong winds,
8 – squall line,
9 – thin ice.
Kuril Straits

ALOS PALSAR 2 July 2008, 01:15 UTC  7 Jan 2008, 12:24 UTC
2nd test area

Okhotsk Sea shelf:

coastal fronts, internal waves, sea ice
Mesoscale convective rolls and cells on satellite images acquired on 10 January 2007
(a) at 11:39 UTC by NOAA-17 AVHRR and
(b) at 11:46 UTC by Envisat ASAR
Okhotsk Sea
10 January 2007

QuikSCAT-derived wind field acquired on 09:13 UTC.

Dark lines mark the boundaries of Envisat ASAR image taken at 11:46 UTC.
Okhotsk Sea. 10 January 2007

Brightness temperatures with H-pol measured by Aqua AMSR-E at 36.5 GHz (a) and at 89.0 GHz (b) at 16:35 UTC
Aqua AMSR-E-derived total water vapor content (a) and total cloud liquid water content (b) over the Okhotsk Sea at 16:35 UTC.
QuikSCAT-derived wind speed is 15-17 m/s.
Parameters of convective rolls in the area of 50.0-50.4°N, 148.3-148.8°E computed from Aqua AMSR-E brightness temperature at 89.0 GHz with horizontal polarization at 16:35 UTC.

Wavelength 20 km.
Brightness temperatures (K) cloud band between

1 186.3 177.9
2 185.4 180.0
3 185.8 180.3
Terra MODIS
01:10 UTC

QuikSCAT-derived wind at 09:30 UTC
Aqua AMSR-E
26 Jan 2008 02:30 UTC
Roll convection

Hokkaido

ALOS PALSAR
Measurements of the sea surface roughness at POI Maine Station “Cape Shults”, Japan Sea
Measurements of the sea surface roughness

Standard deviation of slopes

Wind speed and direction

Envisat ASAR
Conclusion

- **ALOS PALSAR** (ERS-2, Envisat ASAR and RADARSAT SAR) is a great tool for analysis of the oceanic dynamic phenomena with high spatial resolution and all weather capability. **QuikSCAT** can provide low resolution wind data important for synoptic survey and numerical modeling.

- **Terra** and **Aqua MODIS** images with 250-m resolution give better insight in relationships between optical and radar signatures of various types of sea ice, between cloudiness and surface wind.

- Synergy between **SAR images**, **visible and IR images**, **AMSR-E brightness temperatures** and products can be a power tool for study and monitoring both the oceanic and atmospheric phenomena/processes. The area between Southern Sakhalin and Hokkaido can be suggested as a test area for comparison and tuning of theories of the radar backscattering under different oceanic and atmospheric conditions.
Thanks you to JAXA and ESA for satellite SAR images.

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