SAR Marine Applications

Practicals

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# SAR Marine Applications

## Friday, 9 Sep, Morning:

### 1 - History & Basics
- Introduction
- Radar/SAR History
- Basics
- Scatterometer

### 2 - Wind and Waves
- SAR Wind Fields
- Storms, Tropical Cyclones
- Ocean Surface Waves
- Oceanic Internal Waves
- Marine Surface Films
- Rain

## Friday, 9 Sep, Afternoon:

### 3 - Currents and Objects
- Surface Currents
- Sea Bottom Topography
- Ship Detection
- Oil Pollution Monitoring
- Sea Ice

### 4 - Practicals
- SNAP Toolbox:
  - Georeferencing, Mosaics
- Image Interpretation:
  - Wind Fields, Oil Pollution,
  - Sea Ice, Objects
## Ocean Features on SAR Imagery

<table>
<thead>
<tr>
<th>Feature</th>
<th>Scale</th>
<th>Derived Measurement</th>
<th>Imaging Mechanism</th>
<th>Wind Speed Range [m s⁻¹]</th>
<th>Characteristics and Considerations</th>
</tr>
</thead>
<tbody>
<tr>
<td>Surface Waves</td>
<td>100 - 600 m wavelength</td>
<td>Wavelength</td>
<td>Tilt Hydrodynamic Velocity Bunching</td>
<td>3 – 40</td>
<td>Azimuth-traveling waves may be nonlinear without correction. Other limiting factors include wavelength, wave height and fetch.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Propagation direction</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Wave height</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Internal Waves</td>
<td>0.3 - 3 km wavelength</td>
<td>Wavelength</td>
<td>Convergence/Divergence</td>
<td>2 – 10</td>
<td>Curvilinear packets with multiple waves, decreasing wavelength from front to back. Sensitive to wind conditions, wave crest orientation to platform.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Direction</td>
<td>Amplitude</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Mixed layer depth</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Internal Tides</td>
<td>10 - 20 km</td>
<td>Wavelength</td>
<td>Interaction of centimeter Waves/Currents/Surfactants</td>
<td>3 – 7</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Direction</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Currents and Fronts</td>
<td>1 - 100 km</td>
<td>Location</td>
<td>Shear/Convergence</td>
<td>3 - 10</td>
<td>Sensitive to wind conditions. Often multiple mechanisms present simultaneously.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Shear</td>
<td>Convergence</td>
<td>3 - 10</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Strain</td>
<td>Wind stress</td>
<td>3 - 10</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Velocity</td>
<td>Surfactants</td>
<td>3 - 7</td>
<td></td>
</tr>
<tr>
<td>Eddies</td>
<td>1 - 200 km diameter</td>
<td>Location and source</td>
<td>Shear/Convergence</td>
<td>3 - 10</td>
<td>Sensitive to wind conditions. Often multiple mechanisms present simultaneously.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Diameter</td>
<td>Convergence</td>
<td>3 - 10</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Velocity Shear</td>
<td>Wind Stress</td>
<td>3 - 10</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Strain</td>
<td>Surfactants</td>
<td>3 - 7</td>
<td></td>
</tr>
<tr>
<td>Shallow Water Bathymetry</td>
<td>5 - 50 m depth</td>
<td>Location/change detection</td>
<td>Convergence</td>
<td>3 - 12</td>
<td>Sensitive to wind, current properties, depth.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Depth</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

[Jackson & Apel, 2004]
## Air-Sea Interactions on SAR Imagery

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<tr>
<td>Surface Winds</td>
<td>&gt; 1km grid</td>
<td>Wind speed Wind direction</td>
<td>Wind stress Indirectly via windrows, models, or sensors</td>
<td>3 – 25</td>
<td>For mesoscale, coastal variability. Requires good calibration.</td>
</tr>
<tr>
<td>Roll Vortices</td>
<td>1 - 5 km wavelength</td>
<td>Boundary Layer: Stratification</td>
<td>Wind stress</td>
<td>3 – 15</td>
<td>Long axis/crests parallel to wind direction.</td>
</tr>
<tr>
<td>Gravity Waves</td>
<td>2 - 10 km wavelength</td>
<td>Height Turbulence spectrum Drag coefficient</td>
<td>Wind stress</td>
<td>3 – 15</td>
<td>Long axis/crests perpendicular to wind direction, often associated with topography</td>
</tr>
<tr>
<td>Rain Cells</td>
<td>2 - 40 km diameter</td>
<td>Rain rate</td>
<td>Wind stress Rain damping</td>
<td>3 - 15</td>
<td>Appearance sensitive to frequency, rain rate, wind speed.</td>
</tr>
</tbody>
</table>

[Jackson & Apel, 2004]
## Surface Films on SAR Imagery

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<tr>
<td>Biogenic Surfactants</td>
<td>&gt; 100m² area</td>
<td>Areal extent</td>
<td>Convergence</td>
<td>2 – 8</td>
<td>Both forms have signatures similar to low wind, cold thermal water masses, etc.</td>
</tr>
<tr>
<td>Mineral Oils</td>
<td>&gt; 100m² area</td>
<td>Areal extent</td>
<td>Seeps Ship discharge Run-off</td>
<td>3 – 15</td>
<td>Wind speed, combination of L- and C-/X-bands may enable discrimination of each form.</td>
</tr>
</tbody>
</table>

[Jackson & Apel, 2004]
Seasat SAR Image

What is shown here?

Seasat SAR Image (L-HH, 80 km × 75 km)
Nantucket Island
(27 August 1978, 12:34 UTC)
Practicals !
Two Sentinel 1A – SAR Images

Sentinel 1A SAR Images (C-VV, 259 km × 167 km)
Baltic Proper
(19 August 2016, 16:36 UTC)
Two Sentinel 1A – SAR Images

Georeferencing

SNAP:
- Radar
  - Geometric
    - Terrain Correction
  - Range-Doppler TC

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Two Sentinel 1A – SAR Images

SAR Mosaicking

SNAP:
- Radar
- Geometric
- SAR-Mosaic

Sentinel 1A SAR Images (C-VV, 259 km × 167 km)
Baltic Proper
(19 August 2016, 16:36 UTC)
Two Sentinel 1A – SAR Images
One Sentinel 1A – SAR Mosaic

Sentinel 1A SAR Images (C-VV, 259 km × 167 km)
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One Sentinel 1A – SAR Mosaic

Landmask

SNAP:  
- Raster  
- Masks  
- Land/Sea Mask

Sentinel 1A SAR Images (C-VV, 259 km × 167 km)  
Baltic Proper  
(19 August 2016, 16:36 UTC)
Two Sentinel 1A – SAR Images

- Landmask

SNAP:
- Raster
- Masks
  - Land/Sea Mask

Different projection!

Sentinel 1A SAR Images (C-VV, 259 km × 167 km)
Baltic Proper
(19 August 2016, 16:36 UTC)
Books: Basics & Theory
Books: Examples and Applications
Some Articles on Basics and Theory


Some Articles on Examples and Applications


Liels paldies!