Modelling and Interpretation of Polarimetric Scattering from Subarctic Lakes at L-Band
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Abstract
This work is focused on investigating the capabilities of fully polarimetric SAR (Synthetic Aperture Radar) at low frequencies (L-Band) in revealing facts about the subsurface and the inhomogeneities above it which are dominated mainly by methane bubbles for the case of frozen subarctic lakes. A model for the polarimetric backscattering is developed in [1]. The forward simulations of the model are compared to experimental quad-pol data obtained by ALOS-PALSAR over frozen shallow sub-arctic lakes in several regions in the northern wetlands.

Based on those comparisons, an entropy-alpha colour scheme is generated and entropy-alpha colour coded maps (power normalised) are presented.

Test Sites
1. Churchill (N58.5°, E-94°)
   - At 27/07/2010 (summer) and 10/05/2009 (winter)
   - Ice thickness during winter acquisition is around 1.6m.
2. Baker Lake (N64.3°, E-96°)
   - At 15/03/2007 and 30/04/2007
   - Ice thickness varied from 1.5m to 1.85m during the two winter acquisitions.
3. Inuvik (N68°, E-132°)
   - At 11/03/2007 and 26/04/2007
   - Ice thickness measurements are not available. Average temperatures above 0°C during a week before the second acquisition. (ice melting)

Summer versus winter (Churchill)

With ice presence: Shh/Svv increases, no change in the co-polarisation phase difference (0°), and Entropy-Alpha increases (summer values matches X-Bragg predictions).

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in der Helmholtz-Gemeinschaft

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Model predictions and results

<table>
<thead>
<tr>
<th>Dominating mechanism</th>
<th>Backscattered power</th>
<th>Co-polarisation power ratio Shh/Svv</th>
<th>Position in the entropy-alpha plane</th>
</tr>
</thead>
<tbody>
<tr>
<td>Water surface/ Water + thin layer of ice</td>
<td>Surface</td>
<td>Low</td>
<td>Low (&lt; 0.9)</td>
</tr>
<tr>
<td>Thin layer of grounded ice</td>
<td>Surface + volume</td>
<td>Low / medium (if subsurface is rough)</td>
<td>Low (≤ 0.9)</td>
</tr>
<tr>
<td>Medium thickness layer of floating ice</td>
<td>Surface + volume + dihedral</td>
<td>High</td>
<td>High (≈ 1.1)</td>
</tr>
<tr>
<td>Medium thickness layer of grounded ice</td>
<td>Surface + volume</td>
<td>Low (for smooth subsurface)</td>
<td>Low (≈ 0.9)</td>
</tr>
<tr>
<td>Thick layer of floating ice</td>
<td>Surface + volume + dihedral</td>
<td>High</td>
<td>High (≈ 1.2)</td>
</tr>
</tbody>
</table>

1. Churchill: Power versus entropy-alpha colour coded map for floating and grounded ice
   - Lakes with low power appear green while lakes with high power appear red except the lake indicated with a red circle.
2. Baker Lake: Increase in red and green colour indicating an increase in the volume and dihedral contribution, and accordingly the inhomogeneities within the ice (increase in ice thickness).
3. Inuvik: Some lakes indicated by the numbers 1 to 4 change their colour from green standing for grounded ice to red standing for floating ice because of melting.

Power normalised colour scheme generated from the forward simulation of the model for two lines, one for floating ice and the other for grounded ice.