Retrieval of forest height using single-pass POLInSAR

Application Domain:
New Techniques: Polarimetric Interferometry

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Main Objectives

• The main objective of this project is to test and validate single-pass X-band polarimetric SAR interferometry (POLInSAR) as a suitable remote sensing tool for forest height/surface topography and vertical structure estimation.

• Our methodology will involve using a subspace method exploiting variations in interferometric coherence as a function of polarization, together with a set of model based inversion techniques that use this variation to provide estimates of ground topography, vegetation height and structure parameters (e.g. vertical scattering profile).

• Our team has full spectrum expertise, ranging from POLInSAR processing to Lidar/Hyperspectral processing for forestry applications. We also have previous experience of working together on forest mapping radar projects involving ALOS-PALSAR and Radarsat-2 data.

As a result of this study, the following outputs are expected:

1) Forest height maps for selected test sites and validation statistics against field and Lidar measurements
2) Coherence statistics for dualpol POLInSAR inversions and an assessment of likely future improvement by using a quadpol mode.
3) An assessment of surface topography accuracy and its impact on vertical structure estimation using coherence tomography and lidar validation.
We propose three test sites in this project:

• The first study site is the Greater Victoria Watershed District (GVWD) on Vancouver Island in British Columbia, Canada 48°34'00"N 123°39'40". The size of the study area is approximately 345 km². The GVWD site is covered by temperate coastal rainforests. Much of this area of the watershed has been logged and reforested over the last 100 years, resulting in various stand age classes in this second growth forest.

• The second study site is further north, located in Hinton, Alberta 53°15'32"N 117°16'18". The size of this study area is approximately 800 km². The ages of the mature dominant species varies between 80 and 110 years and stand heights ranged from 11 to 21+metres. Low to medium crown closure dominates most of the study area.

• The final test site is Glen Affric, Scotland. Lat: 57.271342° Long: -4.923721°. This site of special scientific interest (SSI) contains remnants of the ancient Caledonian forest, an open-canopy heterogeneous pine forest in area with moderate to severe topography.
## Data Requests and Mode Selection

<table>
<thead>
<tr>
<th>Test site</th>
<th>Mode</th>
<th>Polarisation</th>
<th>Baseline</th>
<th>dates</th>
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<tbody>
<tr>
<td>Hinton1</td>
<td>Bistatic</td>
<td>HH and VV</td>
<td>Standard(small)</td>
<td>Dec-Feb 2011</td>
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2006 Specim AISA Dual imaging spectrometer data (2m raster).

- Spectral: 395-2503nm, 492 bands, sampling and FWHM: 2.3 (vnir), 6.3nm (swir).
- Example above: True color (RGB: 640, 550, 460nm) draped over LIDAR DSM 2× vertical exaggeration - z dimension: pseudo color spectral data. Total GVWD acquisition is ~35,000 ha.
- 2009 LIDAR range data (1.2 posting/m²) converted to 2m raster.
- Bare surface model (BSM) represents the ground surface without vegetation.
- Example above: 112.8ha x, z wire surface display of BSM in 3-dimensional view with a 4× vertical exaggeration, total Hinton acquisition is ~11,330 ha.