Permafrost Science Workshop

SAR Interferometry for Monitoring Permafrost

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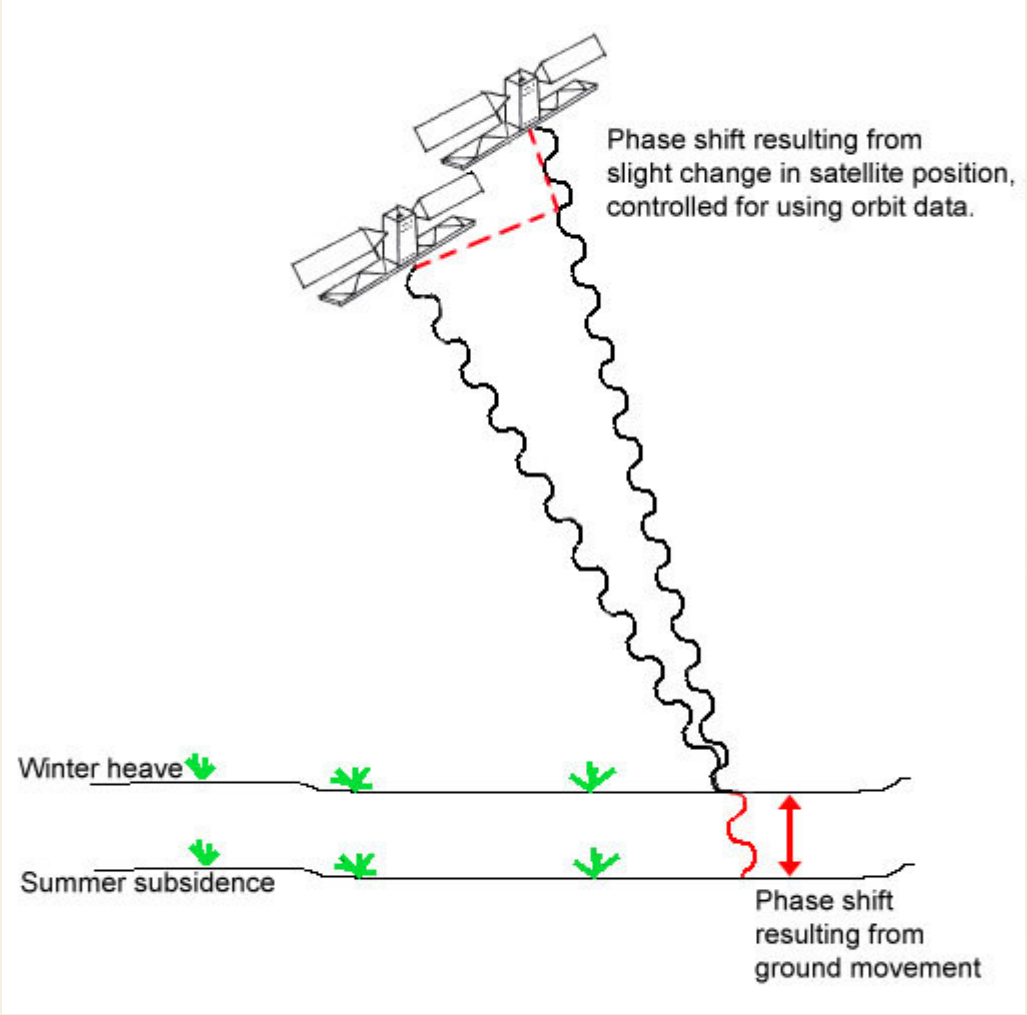
Workshop on State of the Science at ESS

Background

- **What is SAR interferometry?**
- Radar measures distance to the ground very accurately (mm)
- Interferometry detects minute changes in those distances between two observations
- After correcting for differences due to satellite position and topography, can extract ground movement



Coherence

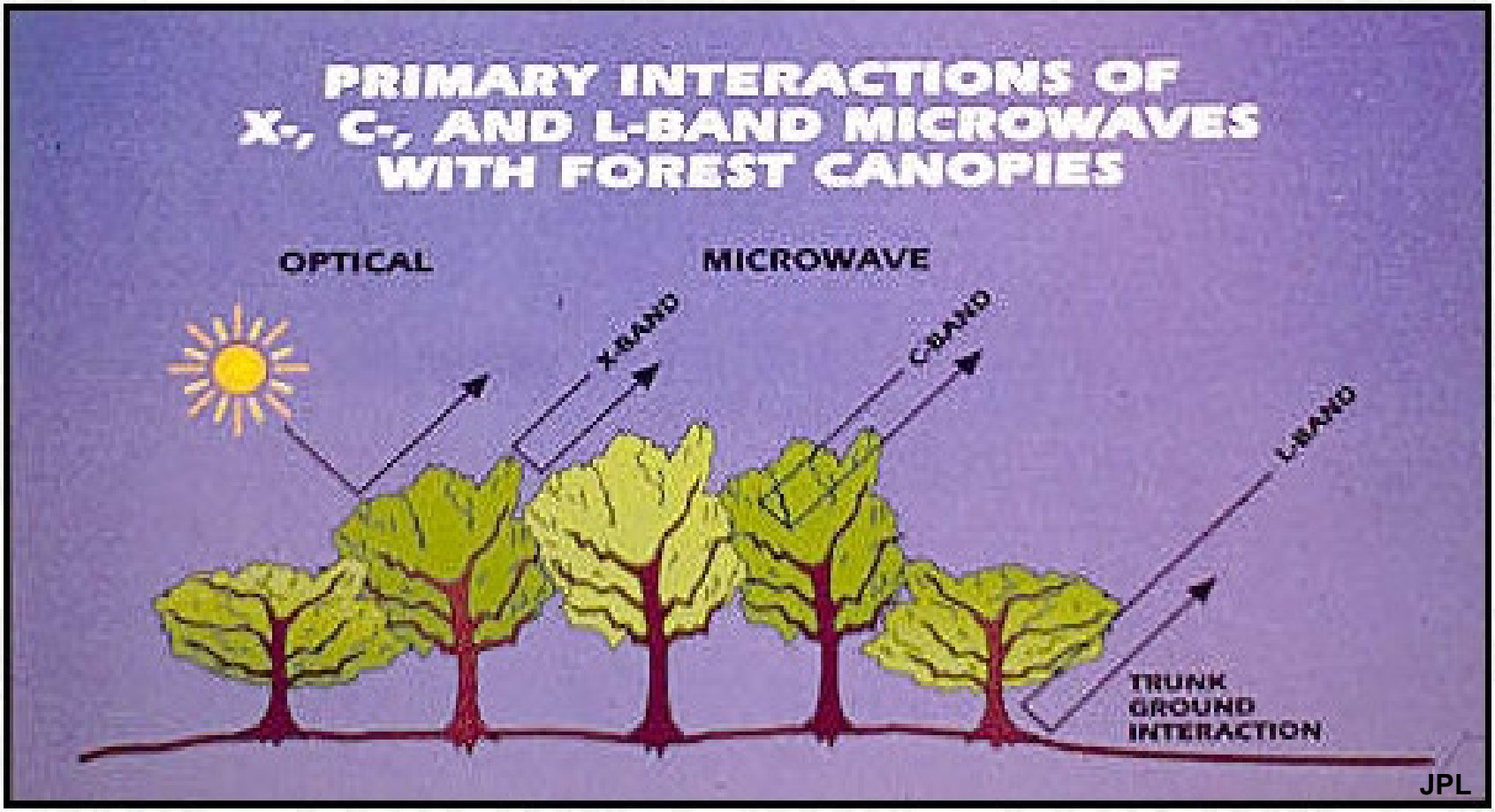
Coherence is the degree to which surfaces are identical, it is measured on a scale of 0 (low) to 1 (high).

Low coherence → usually water (unusable)

Moderate coherence → often growing or moving vegetation (sometimes usable)

High coherence → desert, rock, infrastructure (usable)

Whether you get coherence or not depends largely on landcover, SAR wavelength and satellite revisit period.

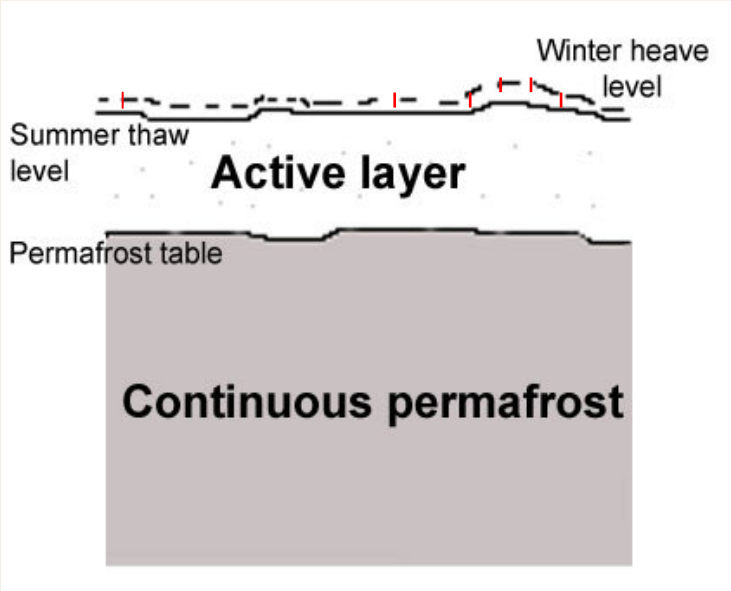


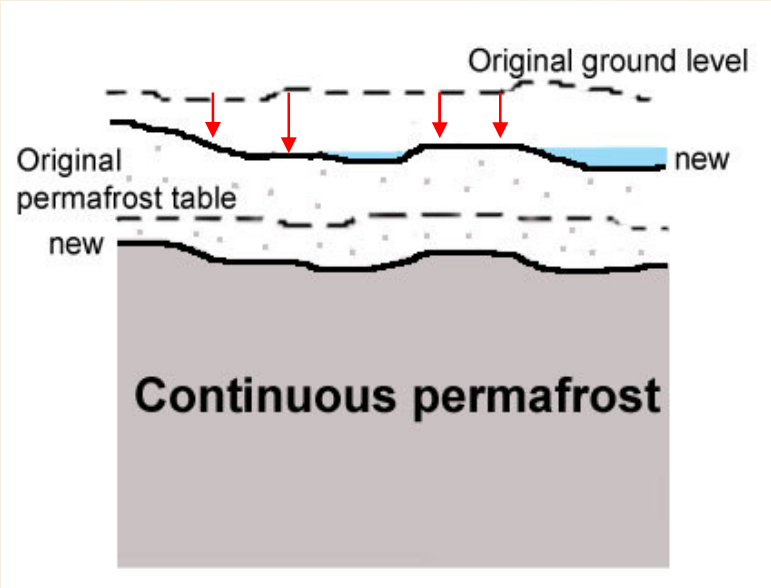
What we want to know:

Can we use SAR interferometry to:

1. Measure seasonal subsidence and heave, therefore getting at active layer thickness and regional patterns.

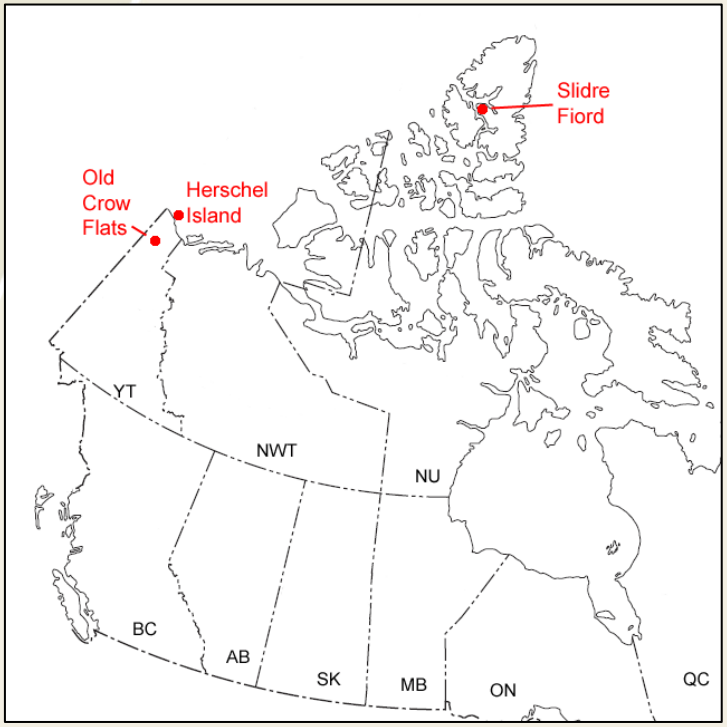
2. Detect areas experiencing long-term thaw settlement, i.e. identify areas that are unstable





Current Activities

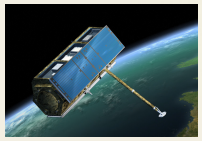
Sites



Sensors

ALOS-PALSAR (Japan)
L-Band, 23.5 cm λ
46 day repeat orbit

RADARSAT-2 (Canada)
C-Band, 5.6 cm λ
24 day repeat orbit

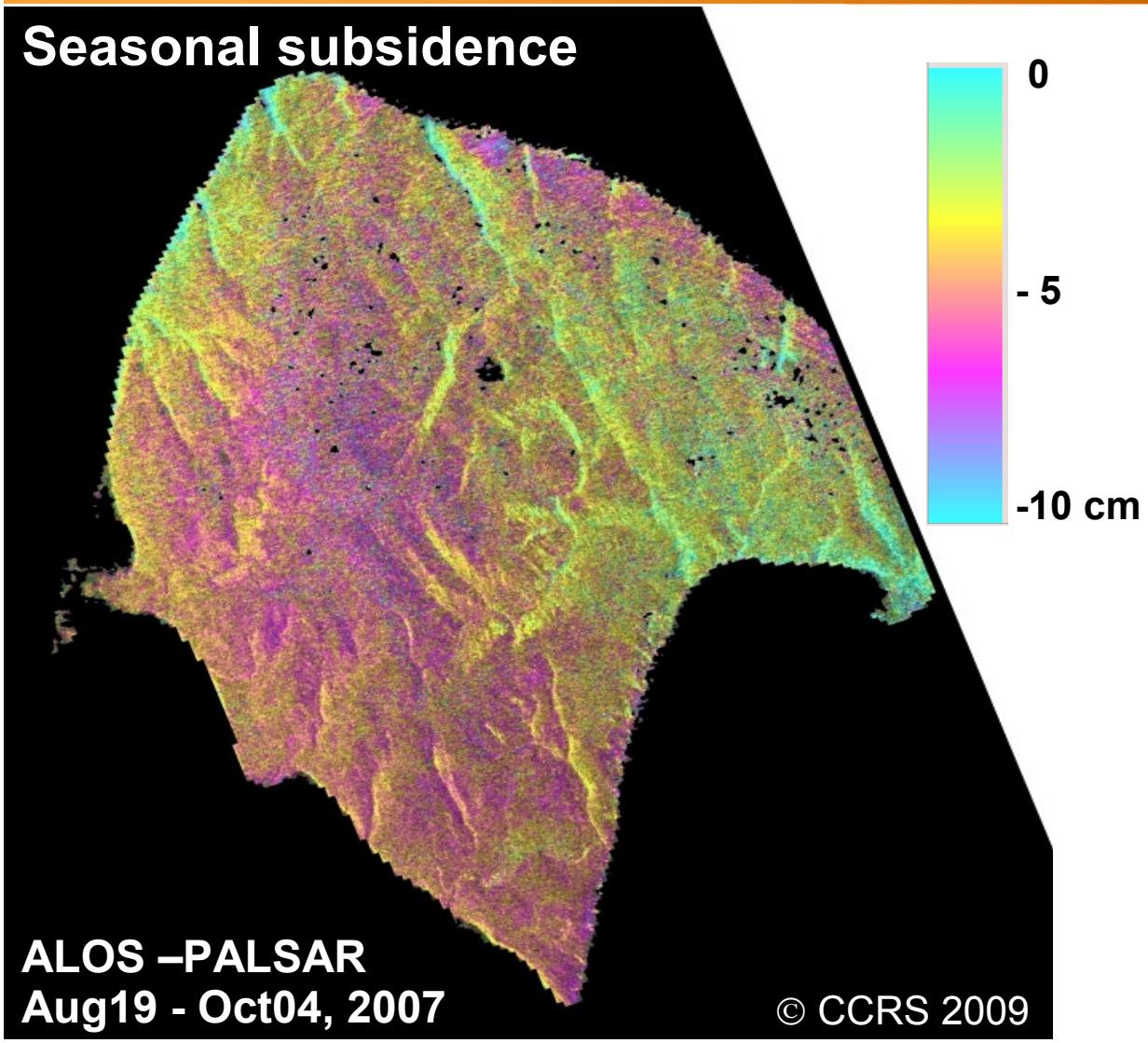


TerraSAR-X (Germany)
X-Band, 3.1 cm λ
11 day repeat orbit

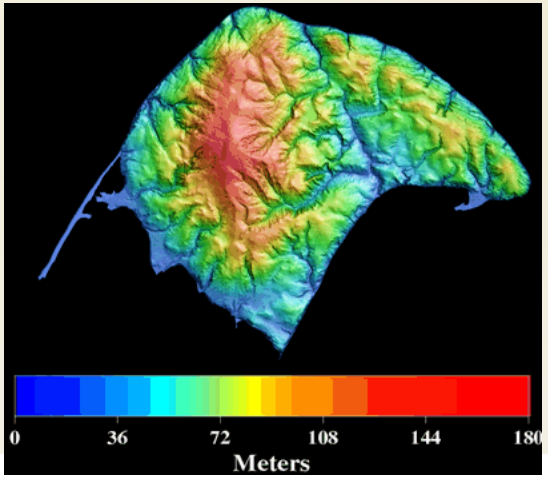
Partners: **Slidre and Herschel – Wayne Pollard, McGill Univ.**

Old Crow Flats, joint Yukon River Basin project - USGS

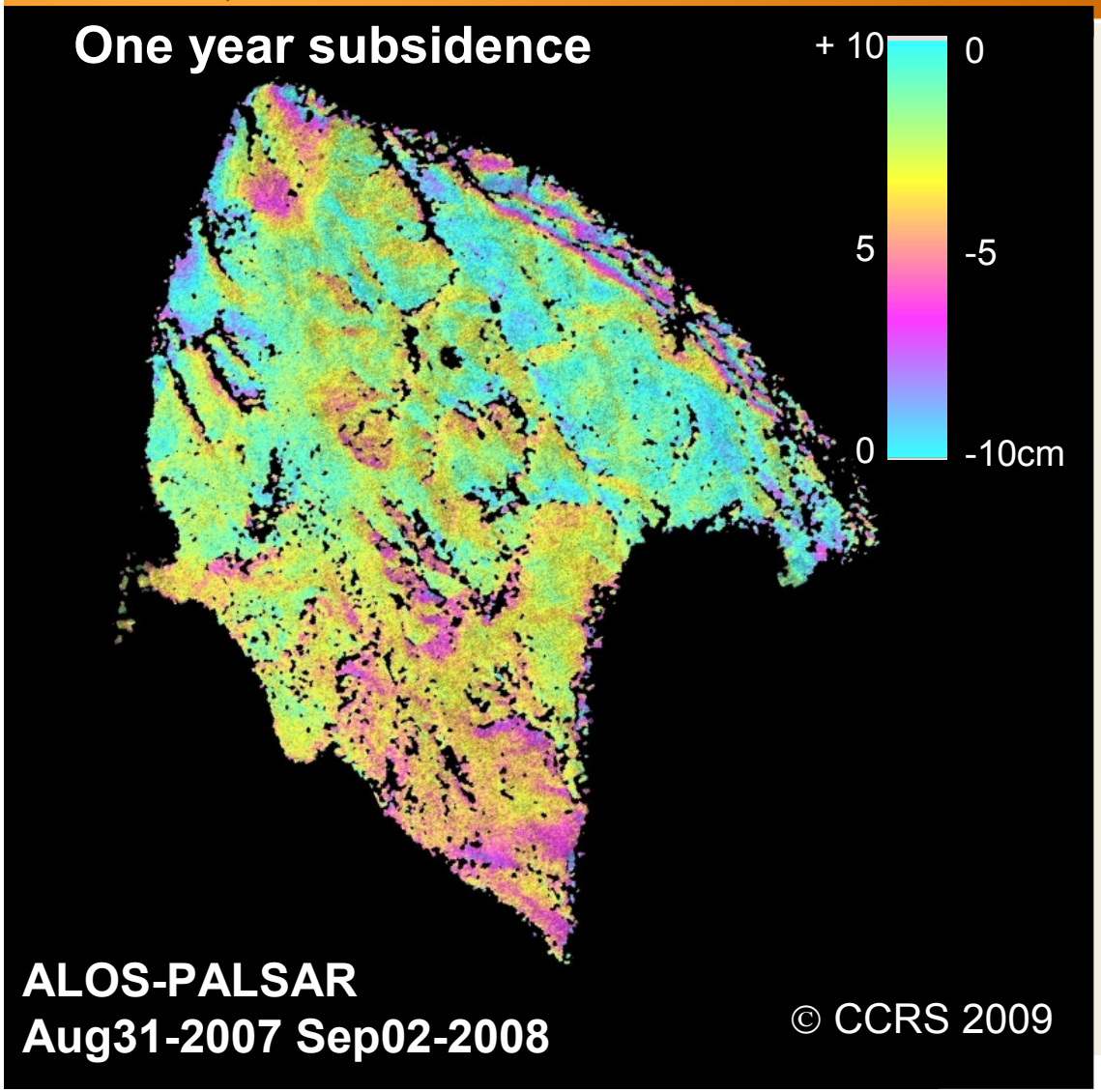
Accomplishments



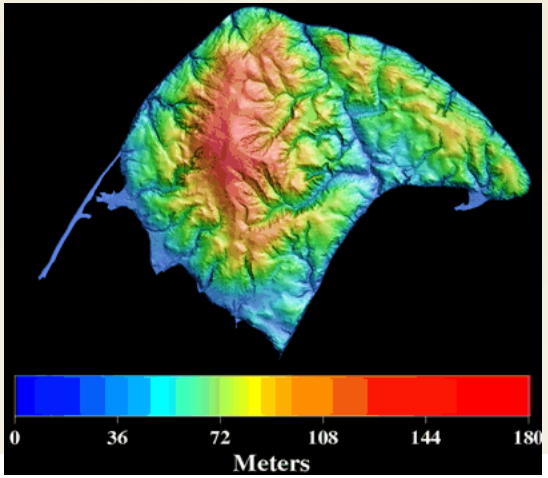
- L-band InSAR
- Herschel Island
- Late summer subsidence
- <7cm of subsidence on exposed hilltops
- Positive air temperatures until early October



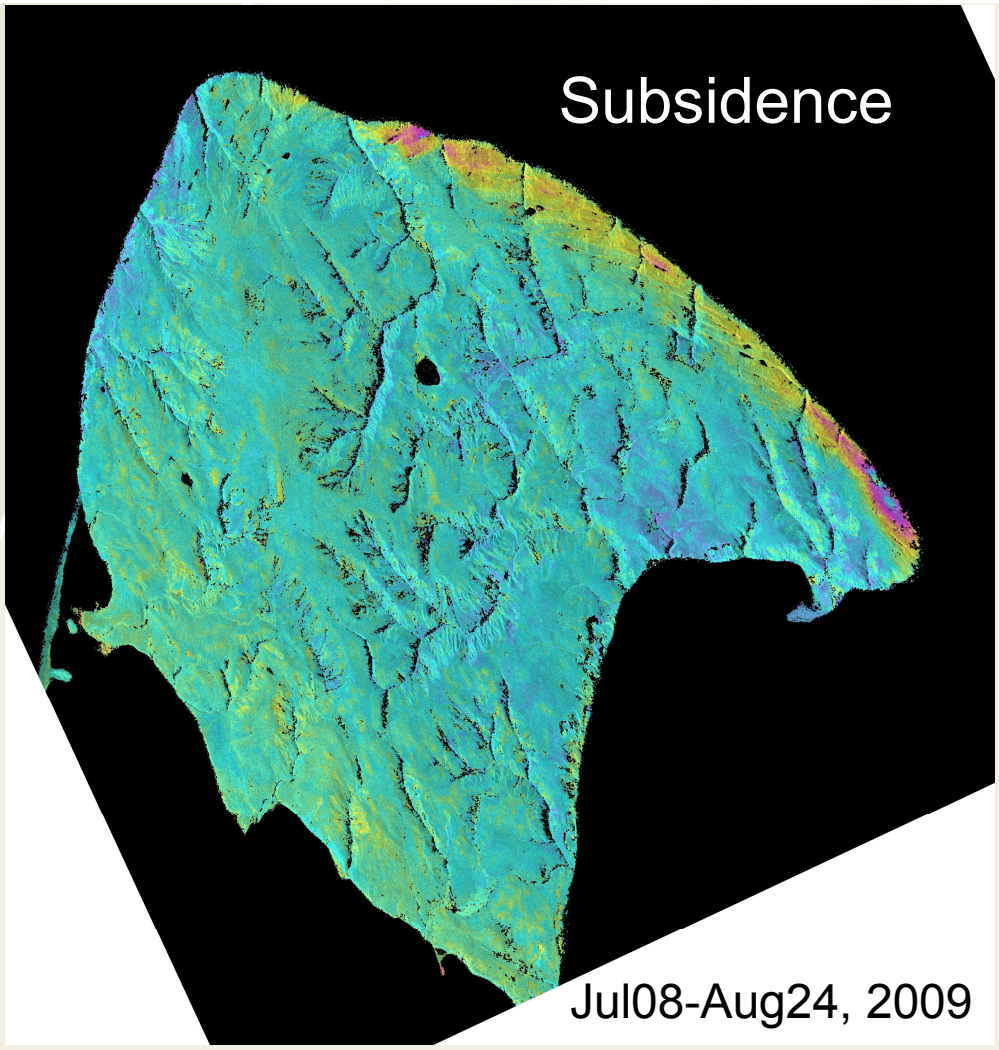
Accomplishments



- L-band InSAR
- Herschel Island
- One year of change
- Subsidence pattern related to hydrology and breaks in slope
- <30 cm of subsidence on north coast



C-band results – Herschel Island



Cool summer?

or

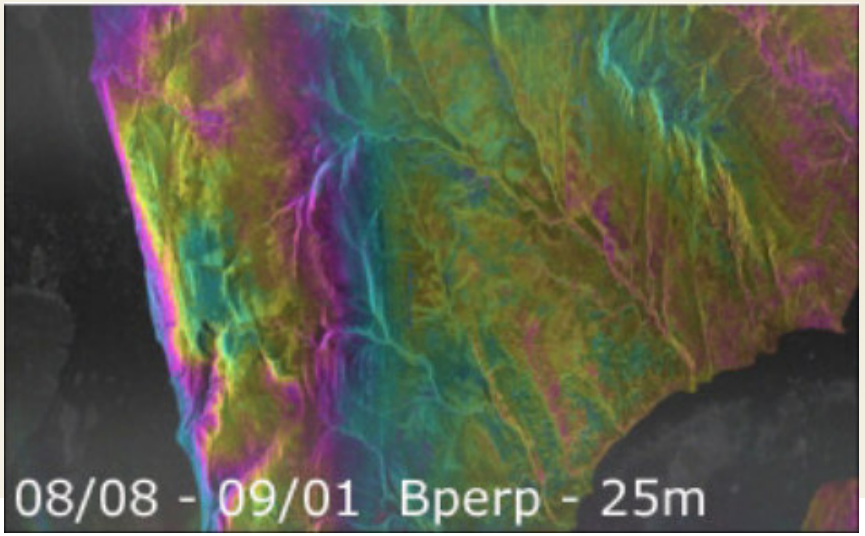
C- and L-bands showing us different things?

Turquoise = ~0
Green/yellow = subsidence of 1-3 cm
Yellow / orange = subsidence of 3-4 cm
Dark pink-purple = maximum subsidence of 6 -8 cm
Dark blue = uplift of < 1cm

Where is the research going?

- Understanding the differences and performance of the different wavelengths and sensors available
- New very high resolution satellites, Spotlight mode
- Many new SAR missions being designed and launched specifically for interferometry (RCM, CosmoSkyMed, Tandem-X, ALOS-2)
- Making InSAR monitoring operational

RADARSAT-2
Spotlight data
Slidre Fiord



Scientific Gaps

- Need field validation, sites with on-going monitoring
- More interesting sites, areas of discontinuous permafrost
- Field experiments to determine how deep the L-band SAR penetrates the ground, what exactly are we measuring?

Products and publications

•Scientific Publications

•Short, N., B. Brisco, L. Gray, P. Budkewitsch, and K. Murnaghan (2008). ALOS InSAR for Permafrost Monitoring Applications, Proceedings of ALOS PI 2008 Symposium, November 3-7, 2008, Rhodes, Greece, SP-664, ESA Communication Production Office.

•Short, N., B. Brisco, P. Budkewitsch, and K. Murnaghan (2009). ALOS-PALSAR Interferometry for Permafrost Monitoring in Canada. Proceedings of ALOS PI Symposium, November 9-13, 2009, The Big Island, Hawaii.