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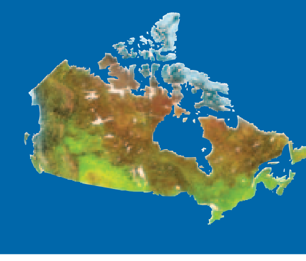

InSAR monitoring of permafrost activity, NWT, Canada

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The region of interest is located approximately 200 km southeast of Inuvik in the Northwest Territories, Canada, and in the downstream part of the Mackenzie River. The Thunder River valley has been affected by hundreds of landslides in the last three decades. Our study focuses on guidelines to process interferometric C-band data in a permafrost environment and on permafrost activity over 1 year and a half. The satellite radar interferometric techniques are providing useful monitoring capabilities at both the site specific and regional scales. We have used SAR (Synthetic Aperture Radar) imaging techniques to monitor permafrost activity and landslide motions in the Thunder River area. The interferometric method used was the Differential SAR interferometry technique (D-InSAR) with ~100 interferograms performed.

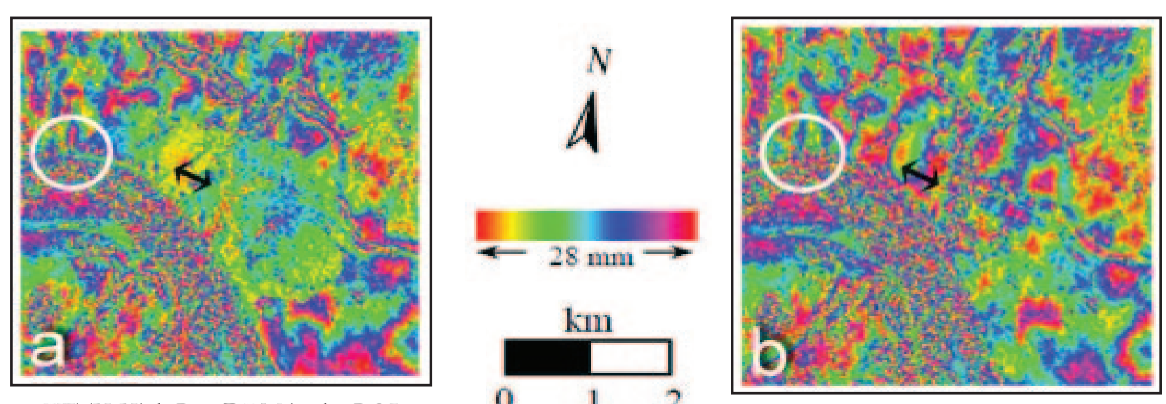
The main conclusions about the methodology are:

- Shorter satellite revisit time intervals are necessary for us to better understand permafrost melting behaviour. We analysed and compared essentially 24-day, 48-day and 72-day revisit intervals for C-band RADARSAT-1. The best results are generally obtained with the shortest time interval between 2 successive passes. This suggests that there is a need for more frequent SAR acquisitions to understand slope movement under permafrost melt conditions.
- High resolution Digital Elevation Models (DEM) are essential to ensure InSAR processing accuracy for small deformations associated with permafrost melt. A 10m and 90m DEM were used for this study and it was found that the higher resolution DEM improved the quality of the differential interferogram by more accurately removing the topographic phase (see figure 1).

The permafrost sustained several changes during a year of monitoring due to temperature variations observed by the Meteorological Service of Canada. Weather stations indicate freezing temperatures during 7 months a year. The thaw activity starts during end of April-mid of May, and the freezing around mid October. The winter season (~ 7 months) is characterized by a high level of coherence and by a relative phase stability of the interferograms suggesting very low activity in the permafrost. The thaw activity of the permafrost starts in April along the southern aspect slopes with decorrelation noise observed in the interferograms. Data in May also shows very low coherence and no deformations map can be therefore extracted. The deformation peak is reached in the summer time between mid of May and July (see figure 2, up to 15 ± 2mm).

To better estimate the permafrost activity, measurements from both RADARSAT-1 F3F descending and ascending passes were used. From line-of-sight direction deformation maps, calibrated using a relatively stable area, profiles for a flat area and northern aspect slope points were obtained (3 points for each respectively). The measured deformation pattern shows relative stability during freezing season (mid October to mid April) and activity along slopes during the May to August period compared to flat area. This activity can be linked to air temperatures, snow cover and day light.

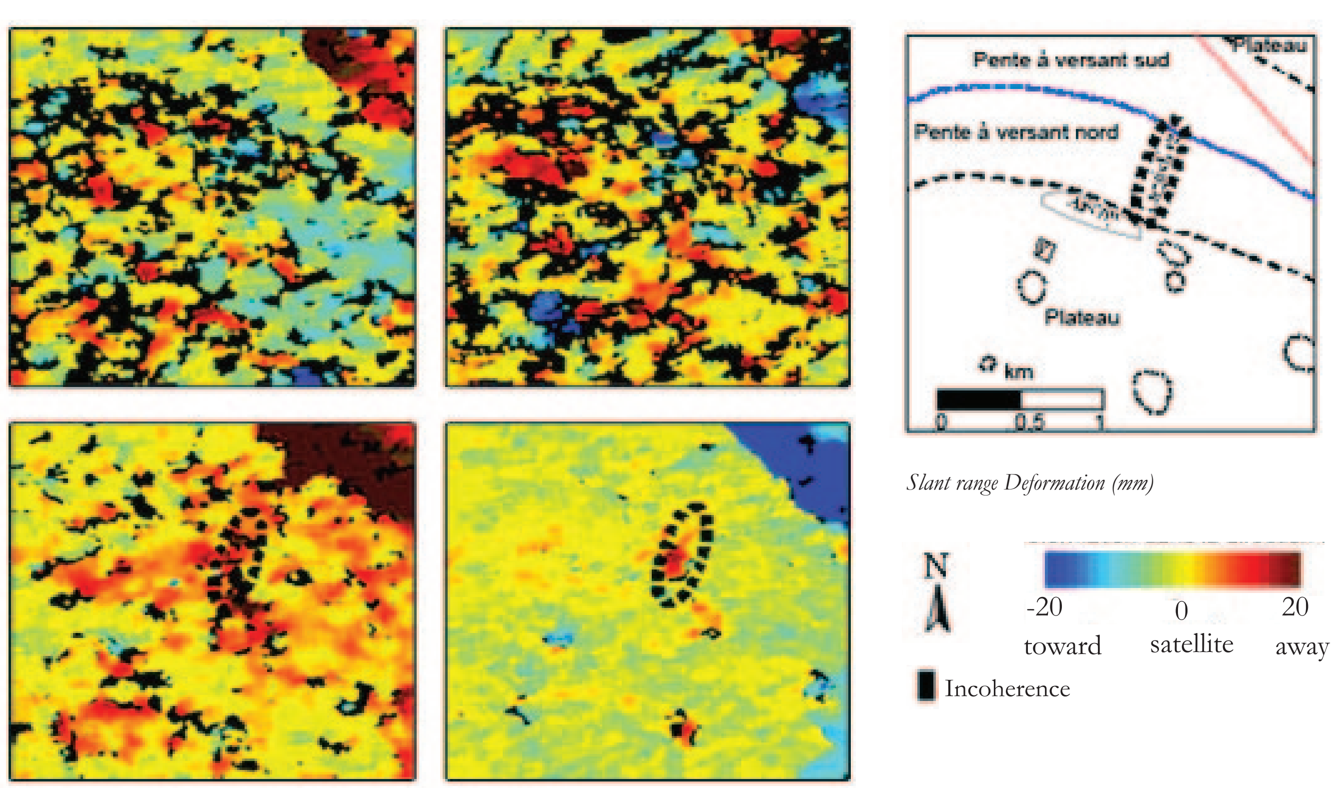
Figure 1: Enhanced interferogram along the Mackenzie River from Radarsat-1 Fine beam mode Ascending pass between 23-Aug-2006 and 19-Sep-2006. a) Interferogram with high resolution Digital Elevation Model (DEM ~3m) in the centre of the frame: b) Interferogram without high resolution DEM, using a regular 90+m resolution of DEM. The orthogonal baseline (~distance between the 2 acquisitions) is 527m. The black arrow shows an interferometric fringe on the right which does not exist at the corresponding location on image a). This fringe is due to a residual topographic phase component.



a - WITH High Res. DEM in the ROI

b - WITHOUT High Res. DEM in the ROI

Figure 2: Successive deformation maps in the Line-of-Sight (LOS) direction from Radarsat-1 ascending pairs with a 24 day time interval during spring and summer 2007. The top left image corresponds to 24-May-2007/17-Jun-2007, the bottom right picture corresponds to a deformation between 04-Aug-2008/28-Aug-2008.



RSAT-1 Ascending F3F pairs – 24 day time interval

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