Permafrost long-term monitoring network

WP6 Permafrost and Natural Hazards
Action 6.1 – Method sheet
Differential Interferometry Synthetic Aperture Radar (DInSAR)

Michel GAY[1]

General information	
Category	Remote sensing
Background	Space-borne, synthetic aperture radars
Basic principles	
Technology	The SAR interferometry differential (DInSAR) technique relies on the processing of two SAR images of the same portion of the Earth's surface. In the repeat pass interferometry method, the detection and the quantification of the ground displacement that occurred between the two acquisitions can be achieved by Differential InSAR (DInSAR).
Data processing	The DInSAR technique provides an image, called differential interferogram, representing the ground motion occurring between the acquisitions with a centimetric accuracy and a decametric resolution [Masson net *et al.*, 1993]. The displacement is calculated by differentiating the phase component of the two coregistrated SAR images after the removal of the topographic effect.
Possible applications	
Why?	Since radar satellites pass over the same area once every 11, or 35 days, it is possible to detect, and to monitor the permafrost with this frequency. Detection and quantification of morphological changes, monitoring, quantitative interpretation, displacement rates measurements.
What?	Rock glaciers, moraines, landslides, glacial debris-cover.
Where?	High mountain, inaccessible study objects, large scale.
Main results	
- Displacement (cm) - 1D, along LOS, 2D, along LOS, with ascendant and descendant pass - Geographic dataset including permafrost location and related displacements	

[1]GIPSA-Lab - Université de Grenoble, CNRS, INPG - BP 46 38402 Saint Martin d'Hères cedex - France - michel.gay@gipsa-lab.grenoble-inp.fr

Main advantages

- Data available since 1992.
- Cost-efficient monitoring of a large number of slow-moving permafrost over a wide area.
- The monitored area can be inaccessible.
- All-time/weather monitoring possibility.
- Easy comparison of slope mass movements with stable area.
- A part from the case in which corner reflectors are used there is no need for any field device.
- High density measured displacements.
- Since radar satellites pass over the same area once every 11 days (average); but with CSK (4 days) we are not very far from real time.
- The differential interferometry software is available free.

Main disadvantages/problems

- Only displacements along line of sight (LOS) in 2D between satellite and field can be measured.
- The technique is not applicable in vegetation covered area.
- Temporal changes in the physical or geometrical nature of the soil lead to a decorrelation in radar echoes.
- Variation in atmospheric conditions in the lower part of the atmosphere (troposphere) between distinct acquisitions modifies the radar signal time delay, leading to a rotation of the radar signal phase.
- Since satellite orbits are NS oriented; displacements along EW oriented slopes are difficult to detect with ERS but not for CSK or TSX or/and others...
- Real time monitoring is non possible.
- The filtering step and the phase unwrapping step are sensitive.
- Data processing is fairly long and complex.
- Highly specific software.

References

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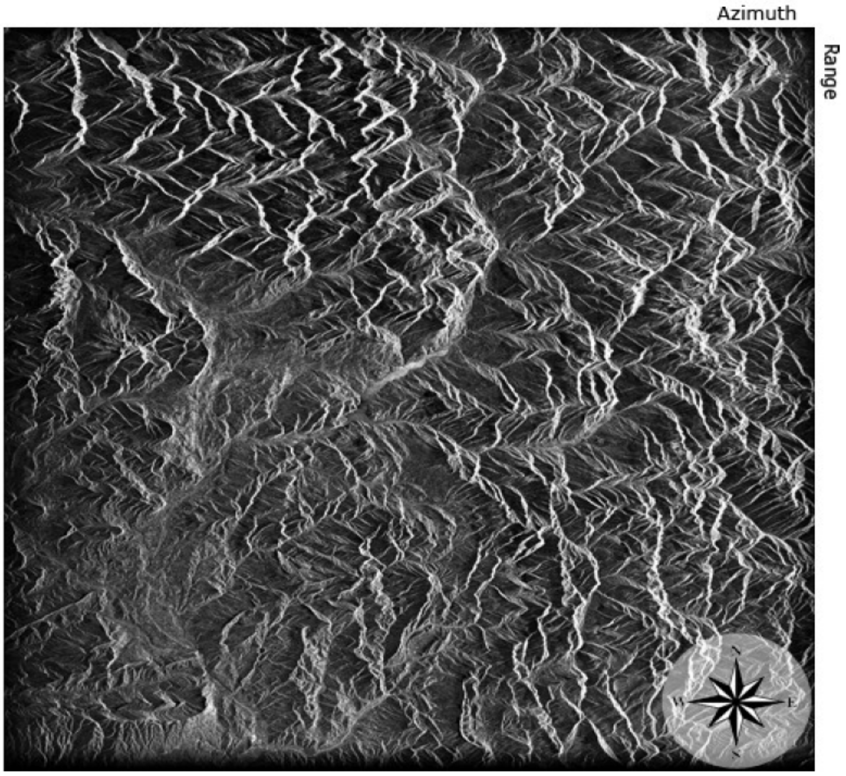
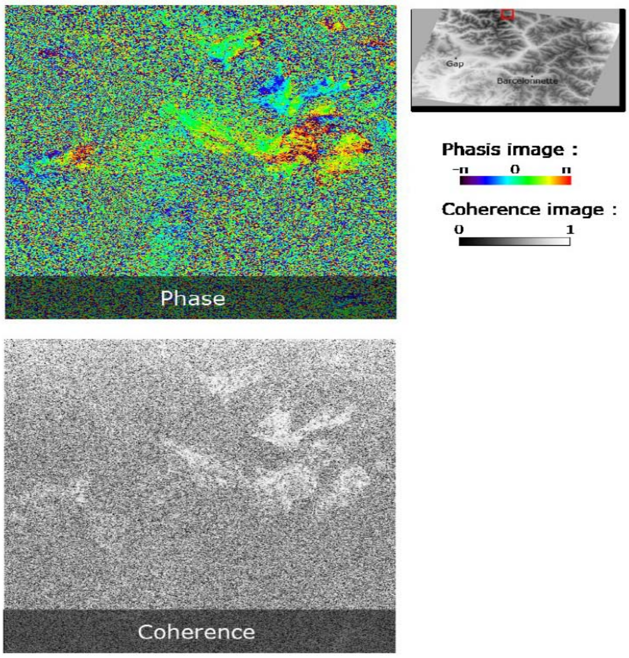
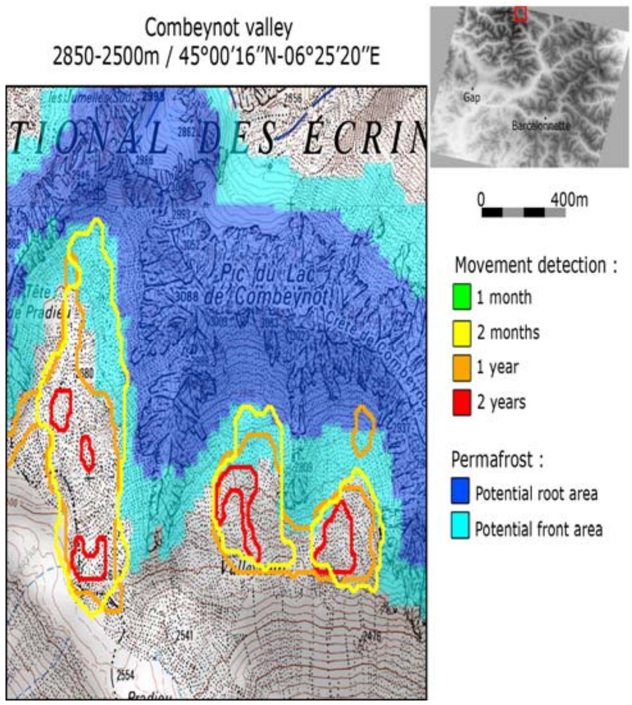


Intensity radar image of the Lake of Serre-Ponçon area (Southern French Alps) from ERS1 (04 September 1992).



ROIPAC interferometric phase and coherence images from ERS1-2 radar images from two dates.



Detected polygons potentially related to slope instabilities in the Combeynot valley (Ecrins massif, France)