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Mapping and Monitoring of Permafrost phenomena using Differential Interferometry: First results from test-sites in South Tyrol, Italy

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Located in the South-Eastern Alps South Tyrol is affected by an ongoing pressure of settlement and exploitation of further tourist areas where special attention has to be given to environmental conditions, sustainable development and natural hazards, like slope instabilities or permafrost phenomena. Changes, either of anthropogenic or natural origin, in the regular and repeating cycles of thawing and freezing in high mountain terrains where permafrost is located can significantly affect the alpine environment, causing debris flows, rock avalanches and other mass movements endangering human lives and infrastructures. Permafrost phenomena, which in the Alps have to be expected in altitudes above 2000 m asl, are mostly at some distance from human settlements and infrastructures making investigations and surveying more difficult. Remote sensing data have the capability to deliver information about surface changes in these terrains allowing a detailed multi-temporal analysis of permafrost areas. In the last decades, especially differential SAR interferometry (DiffSAR) has shown a great potential of measuring directly geometric surface deformations on sparse vegetated areas with millimeter accuracy. Besides ground-based mapping techniques the directives for hazard zone mapping in South Tyrol explicitly recommend the use of remote sensing data initiating a project between the Geological Service and the Hydrographic Office in South Tyrol supported by private companies aiming at mapping and monitoring of permafrost phenomena.

This paper presents first results obtained from differential interferometric processing both of C-band and L-band data (ERS, Envisat and JERS) on different test-sites in

South Tyrol.

As permafrost is regarded, the phenomena are concentrated but not limited to the zone above the timberline, where the observation of moving phenomena by DiffSAR using C-band data shows some limitations due to signal decorrelation. The complementary use of L-band SAR data increases significantly the reliability regarding the interferometric processing results since L-band with a higher wavelength is less influenced by temporal decorrelation or vegetation coverage. Furthermore, the use of multi-temporal optical images allow an interpretation of signals coming from the DiffSAR processing and showing the temporal development of specific permafrost phenomena. These results will be used to establish a permafrost inventory giving an overview of the permafrost occurrences within the Autonomous Province of South Tyrol. Additionally spatial-statistical analyses of the relationships between permafrost, climate and mass movements are planned and validation campaigns will be carried out in the course of the project.