

PermaSAR – Improving TanDEM-X D-InSAR techniques for the detection of small-scale vertical movements in arctic permafrost regions

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Surface dynamics, such as subsidence and heave, as a result of permafrost thawing and freezing is a well-known phenomenon. Ground measurements are indicating that such movements exist and first attempts to use satellite data to detect these changes on a larger scale have been undertaken. In particular data from radar satellites have been used to generate differential interferograms (D-InSAR) in order to detect areas of movements. However there are still many uncertainties and limitations related to this method, such as the influence of vegetation and microtopography on the radar signal.

Within the PermaSAR project a multi-source approach, using TanDEM-X data, ground truth measurements (subsidence stations and RTK GNSS), but also highly precise terrestrial 3D LiDAR data shall help to identify influences of the captured surface characteristics on high-resolution D-InSAR. In a subsequent working step the identified influences will be quantified and a method developed in order to mask, reduce, or even eliminate, these effects.

For the study, a region in Northwest Canada, 50 km North of Inuvik has been chosen. The site, so-called Trail Valley Creek, lies in the continuous permafrost zone and the thickness of the permafrost is up to 370 m. The dominant vegetation in the basin are open tundra areas consist mostly of grasses, lichens and mosses. Research activities of the past reveal a potential of subsidence due to permafrost thawing in this region.

In 2015 two field campaigns in the region could be realized: One in early June, after the freezing period and one in late August at the end of the thaw-

ing period. During the first campaign 8 automated ground temperature loggers and manual 24 subsidence stations were installed. Active layer thaw depth, as well as subsidence was recorded at 12 sites manually. During both campaigns the high-performance terrestrial LiDAR system Riegl VZ-400 was used to survey at two different sites (40 × 50 m) the microtopography and vegetation in 3D. The used LiDAR has full-waveform recording, with each single 3D measurement having a range precision and accuracy of about 3-5 mm at 100 m. Both test sites have been scanned with a point spacing of 3 mm at a distance of 10 m from 7 different scan positions. Additionally the Leica GNSS RTK GS10/GS15 system was used to get exact information about ground height and coordinates of certain features.

First results indicate

- i) a very good co-registration of the LiDAR data and RTK GNSS data of the two campaigns and
- ii) a high correlation between the subsidence records of the LiDAR data, the RTK GNSS records and the subsidence stations.

The corresponding mean subsidence rates derived from the three independent sources (LiDAR, GNSS RTK and subsidence stations) range from -2.31 cm (LiDAR) to -2.72 cm (subsidence station) (std. deviations from 0.89 (LiDAR) to 1.01 (subsidence station)). First analysis of subsidence using the TanDEM-X data are shown and compared to our multi-source ground truth measurements.