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Country-wide deformation fields over Iceland using Sentinel-1 SAR images

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Iceland is ideal for satellite radar interferometry (InSAR) as large areas of the country are desert covered with lavas and generally vegetation is limited and sparse. Coherence in interferograms can thus be retained over long periods (> 5 years) in many places. However, snow accumulation in winter makes only summer acquisitions (from mid-June to end-September) useful, in general, for interferometry.
The start of the Sentinel-1 mission in late 2014 has revolutionized the way InSAR monitoring and research can be carried out in Iceland. Prior, SAR acquisitions were limited and usually had to be ordered, without knowing if the images would be acquired. Therefore, having a time-series with good temporal resolution was hard to achieve and usually restricted to specific areas, leaving large parts of the country uncovered. Although the spatial resolution offered by the Sentinel-1 SAR instrument is not has good as for the TerraSAR-X or COSMO-SkyMed missions, the Sentinel-1 mission provides an extensive coverage of Iceland as each image covers about 255 km wide area via three 85 km wide swaths. Moreover, Sentinel-1 images are acquired and delivered every 12-days (6-days since early 2017). Therefore, for each track, there are about 8 acquisition times for summer 2015 and summer 2016, and about 16 acquisitions time for summer 2017.
Here, we analyzed six Sentinel-1 tracks between summer 2015 and summer 2017 to achieve a full high-resolution coverage of the deformation over Iceland. Interferograms were generated with the ISCE software and multi-looked to have approximately a 100 m resolution. Time series analysis of the interferograms were carried out to reveal average line-of-sight (LOS) changes. Tracks were selected so that each part of the country is covered with at least one ascending track and one descending track. The different satellite views from descending and ascending tracks allows to decomposition of observed LOS changes into estimates of the near-East (approximate east) and near-Up (approximate vertical) velocities everywhere in Iceland, with exception of low coherence areas like glaciers and farmland. Glacial isostatic adjustments are the main country-wide source of deformation observable in the near-Up velocities, from a few mm/yr at the coasts and up to a few cm/yr near the ice-caps. On a local scale, geothermal utilization from power plants on the Reykjanes peninsula and north Iceland are also clearly visible. Plate spreading constitutes the main signal in the near-East velocities ($\sim$1.5 cm/yr), but post-rifting relaxation following the Bárðarbunga 2014 rifting episode is also observed. The country-wide deformation fields also show many additional local signals from magmatic and anthropogenic origin, e.g. subsidence in the Askja caldera of about 2 cm/yr. The results are important for improved understanding of the interplay between the many different deformation sources in Iceland, and how interaction of plate spreading, GIA, magmatic, geothermal and tectonic sources contribute to the combined deformation field in Iceland.