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Assessing cryospheric natural hazards in the northern Tien Shan, Central Asia, with Sentinel-1 data and the open source tool OSARIS

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Sentinel-1 Synthetic Aperture Radar (SAR) data provides cryospheric researchers with information of high temporal and spatial resolution, which, however, poses substantial processing challenges by the sheer amount of scenes and their file size. Designed to focus on cryospheric SAR and interferometric applications, the novel software tool OSARIS ('Open Source SAR Investigation System'; cryo-tools.org/tools/osaris) aims to meet these challenges by parallelizing fast C-based GMTSAR scripts to facilitate processing on high-performance computing clusters.
Here, we present a case study in which ∼50 Sentinel-1 scenes were processed to investigate glacier-related natural hazards in the northern Tien Shan, Central Asia. OSARIS processing yields a comprehensive set of SAR and interferometric data sets for each pair of scenes, including amplitude, coherence, interferometric phase, line-of-sight displacement, and optionally unwrapped interferometric phase. Surface changes through a period of observation from Dec 2015 to Feb 2018 were assessed using OSARIS' 'Damage Proxy Map' (DPM) module. Coherence and phase timeseries were extracted for individual coordinates of interest. Surface deformation and displacement indicated by unwrapped interferograms and line-of-sight displacement results need to be evaluated carefully and may require corrections owing to possible atmospheric delays. Nevertheless, results of surface change analysis yield reasonably good estimations for many scene pairs even without further processing steps owing to the relatively arid climate in the northern Tien Shan. DPM results provide a valuable indicator of locations and timing of mass movements such as moraine collapses and landslides, exhibiting a distinct activation of slope processes in the high-mountain areas in early summer. A combination of coherence timeseries, climate data, and optical satellite imagery allow for detailed investigation of detected events. It is thus possible to identify trigger mechanisms such as heavy rainfall or abrupt warming events as well as to distinguish between actual mass movement and weather-related coherence loss.