Inventory and state of activity of rockglaciers in the Ile and Kungöy Ranges of Northern Tien Shan from satellite SAR interferometry

GAMMA REMOTE SENSING

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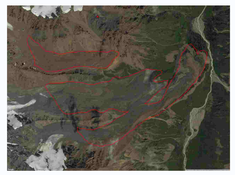
Rockglaciers in Northern Tien Shan

The Ile and Kungöy mountain ranges at the border between Kazakhstan and Kyrgyzstan contain a high number of large and comparably fast (> 1m/yr) rockglaciers and is of interest as dry-season water resource and source of natural hazards.

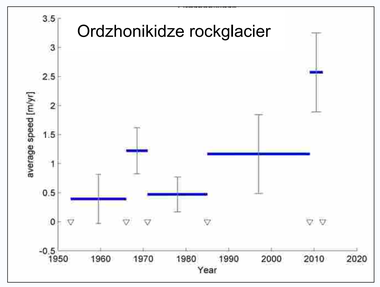
Chon Aksu (Kalgan Tash)
Foto: T. Bolch



Ordzhonikidze rockglacier on Google Earth imagery

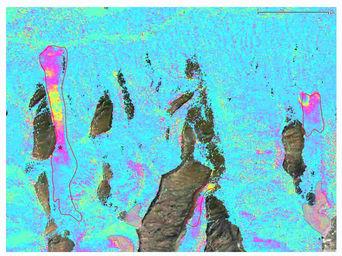
Matching of repeat optical data

Synergies between optical and InSAR data will be considered for long-term monitoring of rockglaciers. Historical rates of motion are computed from repeat optical data.



Outlook

Shorter InSAR repeat intervals (e.g. 6 days for Sentinel-1 or 14 days for PALSAR-2) would improve the monitoring capability on active rock glaciers.



Area B

PALSAR-2
06.03.2015
20.03.2015

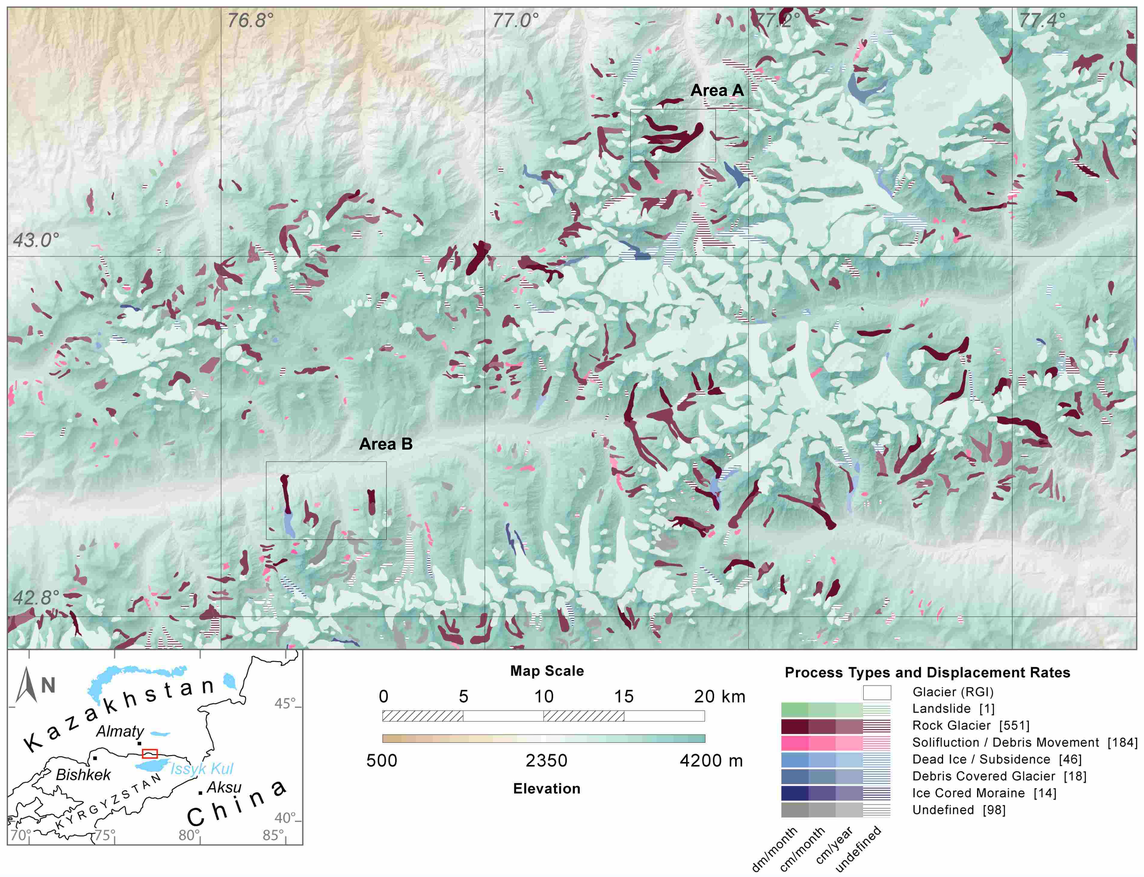
2π ⇔ 11.8 cm

Aim of the work

Rockglaciers are the best visual expression of mountain permafrost and can be mapped directly using remotely sensed data. Studies carried out in various parts of the European Alps have shown surface acceleration of rockglaciers over the two last decades. Changes in rockglacier motion are therefore believed to be the most indicative short- to medium-term response of rockglaciers to environmental changes and thus an indicator of mountain permafrost conditions in general. We aim at quantifying the rate of movement and relative changes of rockglaciers over time with matching of repeat optical data and satellite SAR interferometry (InSAR). In this contribution, we focus on the potential of recent high spatial resolution SAR data.

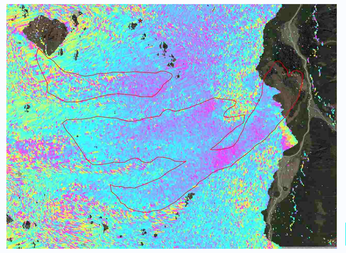
Rockglacier and slope instability inventory

By visual analysis of InSAR data we estimted the surface deformation rate of rockglaciers and other mountain slope instabilities. Deformation rates are expressed using different classes. Classification of the process types and validation of the the aerial extent was done using optical imagery provided by Google and Bing maps. Images acquired along both ascending and descending geometries and during summer (snow-free) and winter (frozen snow) conditions were employed. For topographic reference and orthorectification we computed in-house a DEM from TanDEM-X data. Our inventory includes so far more than 500 objects over an area of more than 3000 km^2. Currently, work is ongoing to validate and refine the inventory.



SAR interferograms

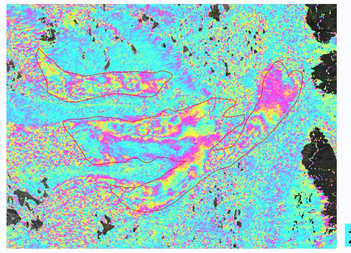
SAR interferograms with short baselines and time intervals between 1 day and one year from the ERS-1/2 tandem mission (1998-1999), ALOS-1 PALSAR-1 (2006-2010), ALOS-2 PALSAR-2 (2014-2016) and Sentinel-1 (2015-2016) were considered.



Area A

ERS-1/2
09.06.1999
10.06.1999

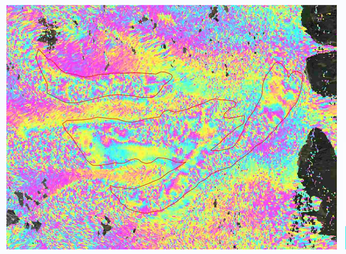
2π ⇔ 2.8 cm



Area A

PALSAR-1
17.08.2007
02.10.2007

2π ⇔ 11.8 cm



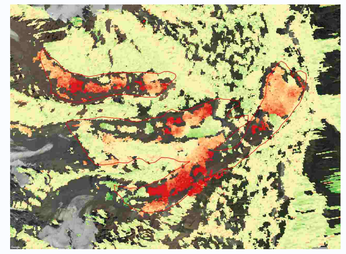
Area A

Sentinel-1
11.08.2016
04.09.2016

2π ⇔ 2.8 cm

Phase unwrapping

Phase unwrapping to derive the LOS displacement was attempted only locally for selected landforms with a moderate (e.g. < 50 cm/yr) rate of motion.



Area A

PALSAR-1
17.08.2007
02.10.2007

-10 cm +10