

Satellite data synergy for analysis of the glacier daily lowering rate in the Pskem River basin, Uzbekistan

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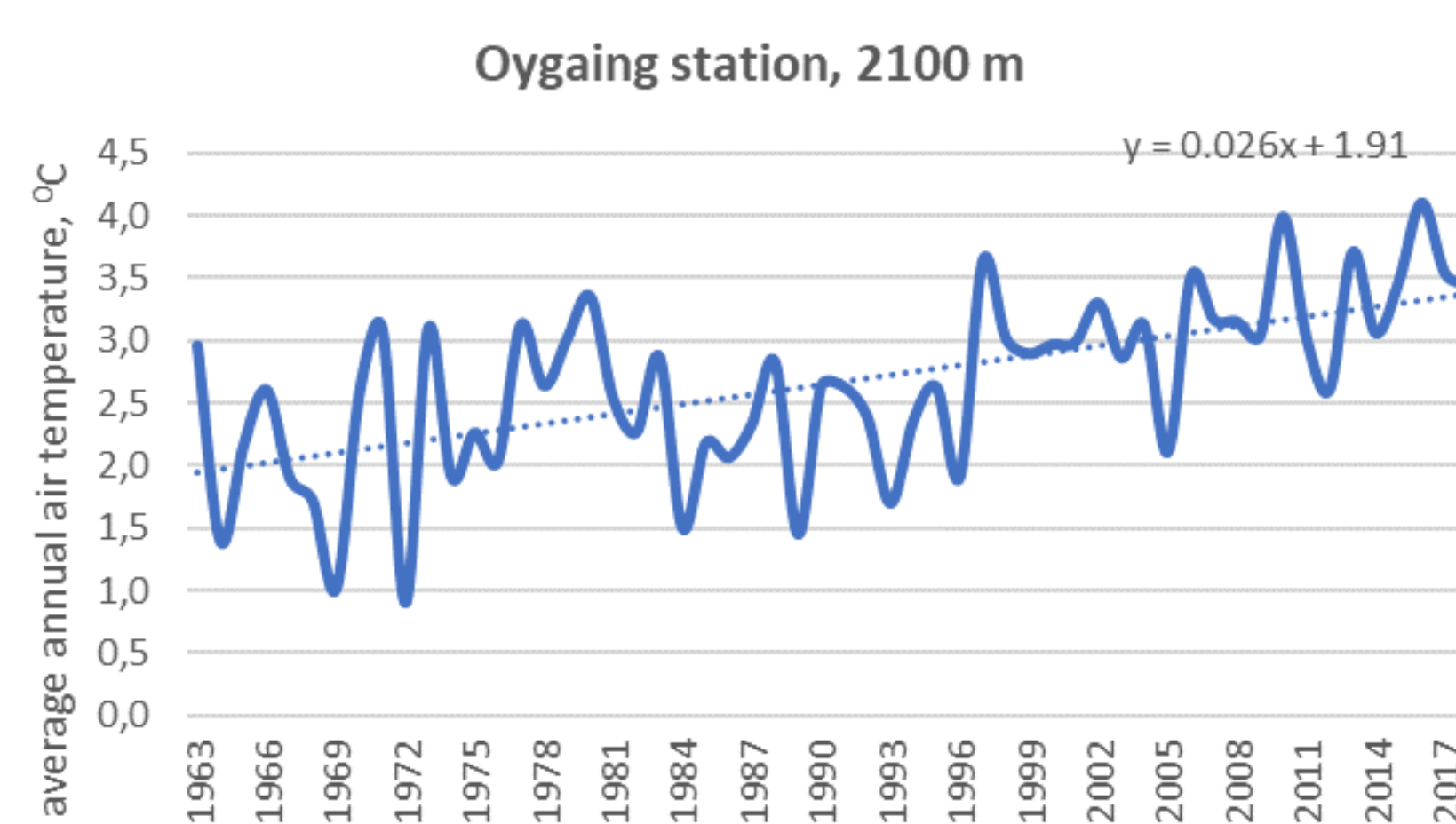
Study areas



- 1 - Pskem River basin, Western Tien-Shan
- 2 - Kashkadarya and Surkhandarya River basins, Hissar-Alay.

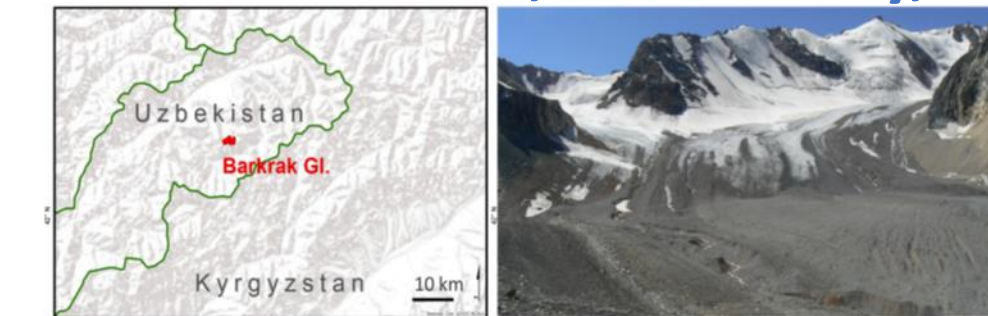
Size of glaciers: up to 3 km², < 0.5 km² in average
Pskem River basin: total area 100 km² (2000- 2020)

Elevation range: 3600-4200 m a.s.l.



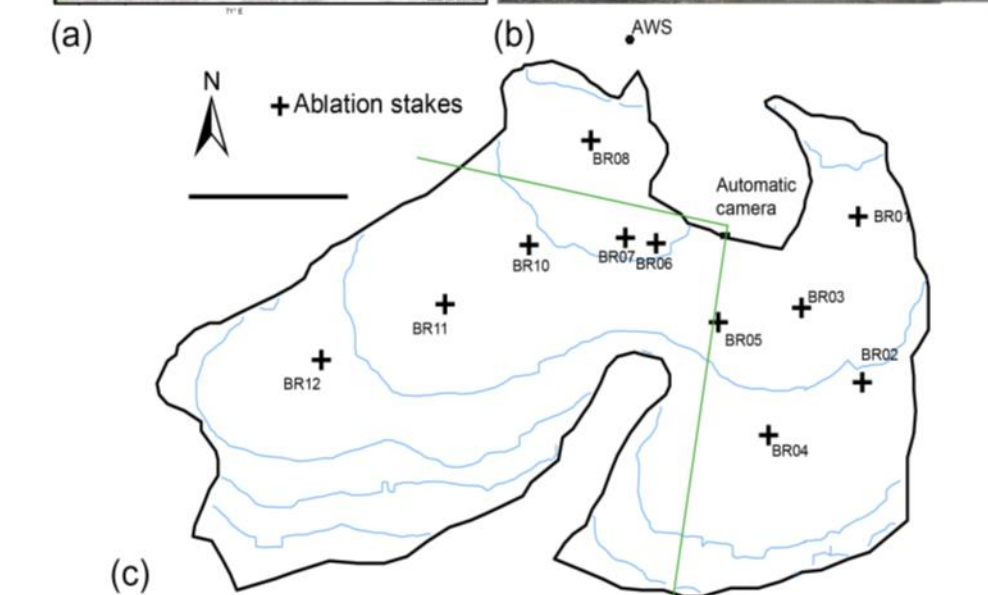
Glaciological observations

Barkrak Glacier, 1.89 km². Since 2016:
Ablation stakes, GPS-survey, weather station, video-camera



CATCOS / CICADA Projects,
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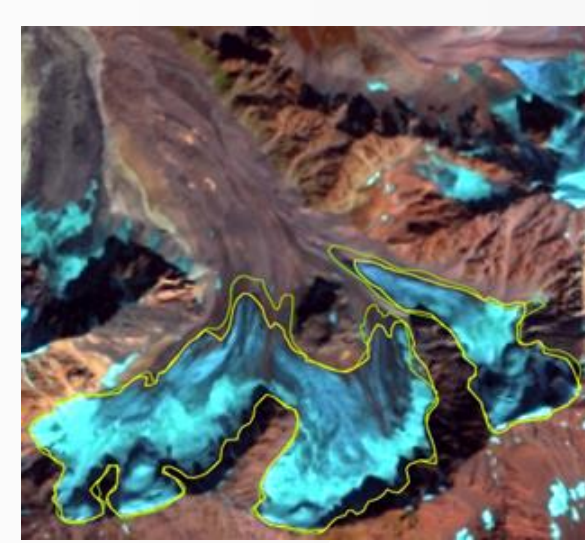
Hydrometeorological Research
Institute, GFZ

Pakhtakor Glacier, 2.7 km². Since 2023:
Hydrometeorological Research Institute, GFZ



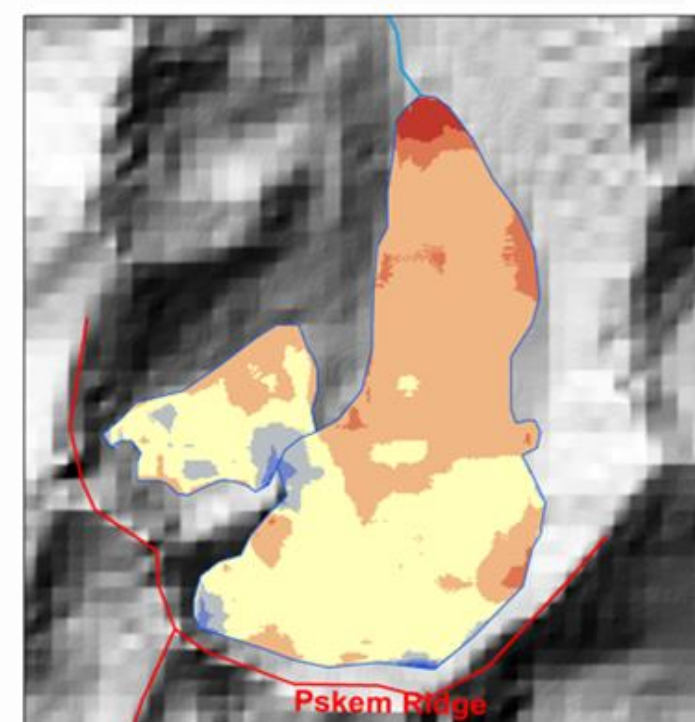
Tekesh Glacier, 1.3 km². Episodic observations

Area change and surface elevation change



Barkrak Glacier:

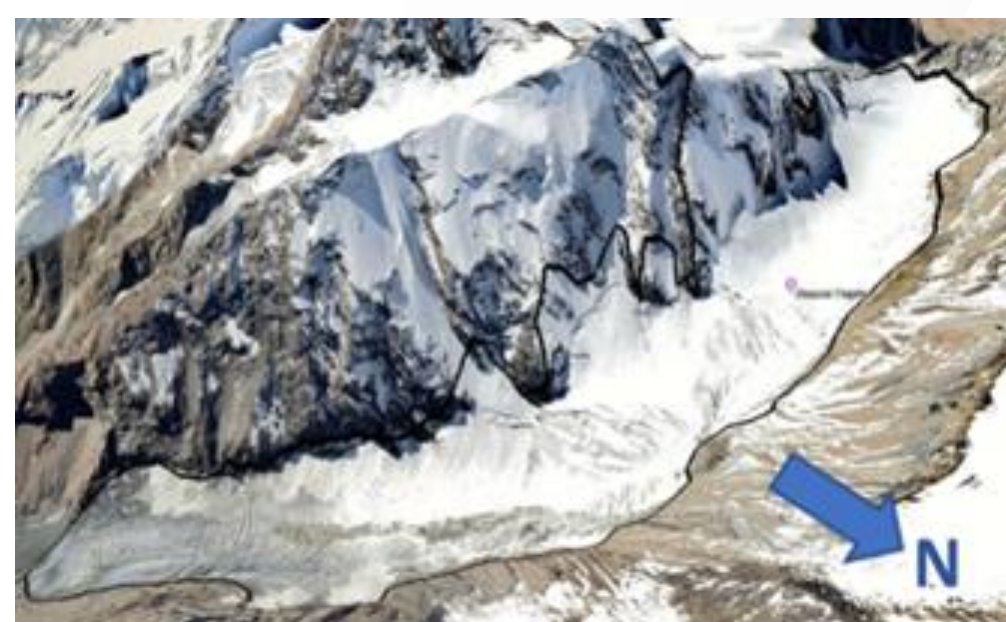
- Average annual local mass balance -0.82 ± 0.36 m w.e. from 2000 to 2012 (ice density 0.9 g/cm³; DEMs differences TanDEM-X and SRTM DEMs; ICESat elevation).
- Daily lowering rate 2 mm/d from August to October in 2023 (DInSAR with TerraSAR-X/PAZ; Reference Global TanDEM-X DEM)
- mass balance in 2023 -0.628 m w.e.



Pakhtakor Glacier:

- Mean surface lowering rate on non-steep slopes:
 -1.3 ± 0.5 m/y from 2000 to 2012

Mean surface lowering rate for 10 glaciers in the Pskem:
 -0.68 m/yr from 2012 to 2014
Annual mass balance is -1.08 m w.e.
Glacier mass loss is 932.7 kt /yr

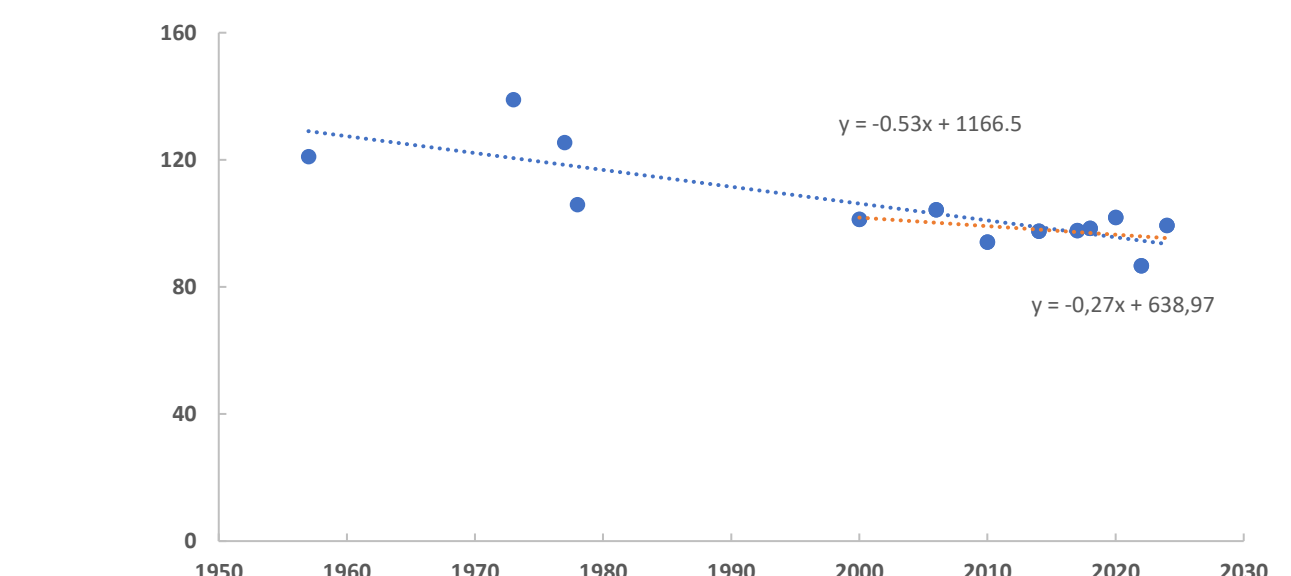


Tekesh Glacier:

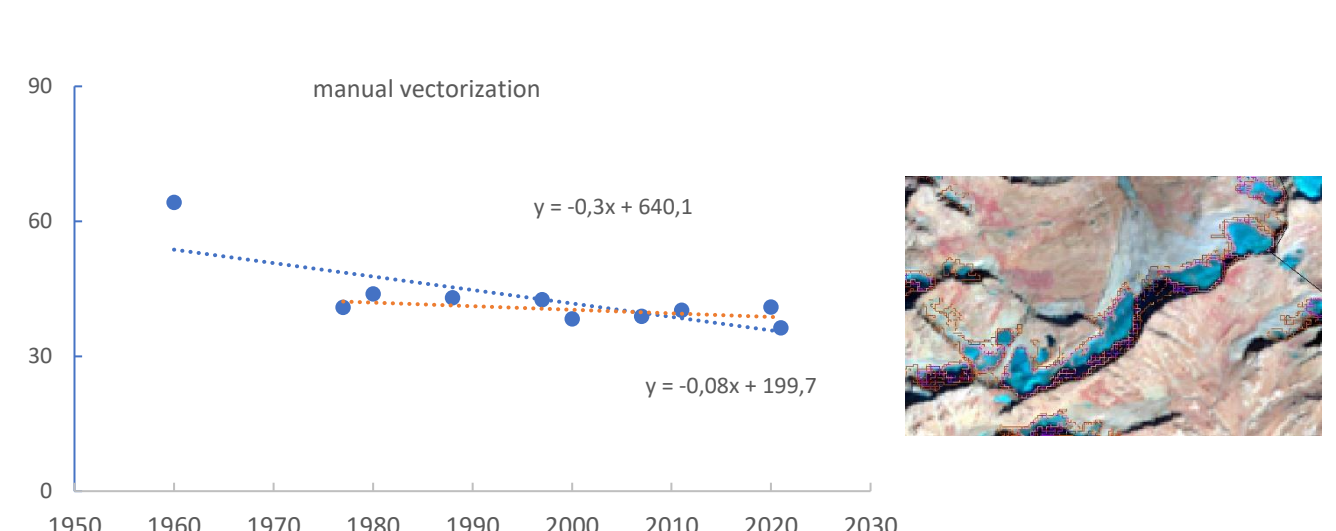
- Annual mass balance is -0.136 m w.e. from 2012 to 2014.
- Glacier mass loss is 172 t /yr

Glacier area reduction:

Pskem River basin 1957 - 2024



Hissar-Alay River basins 1957 - 2024



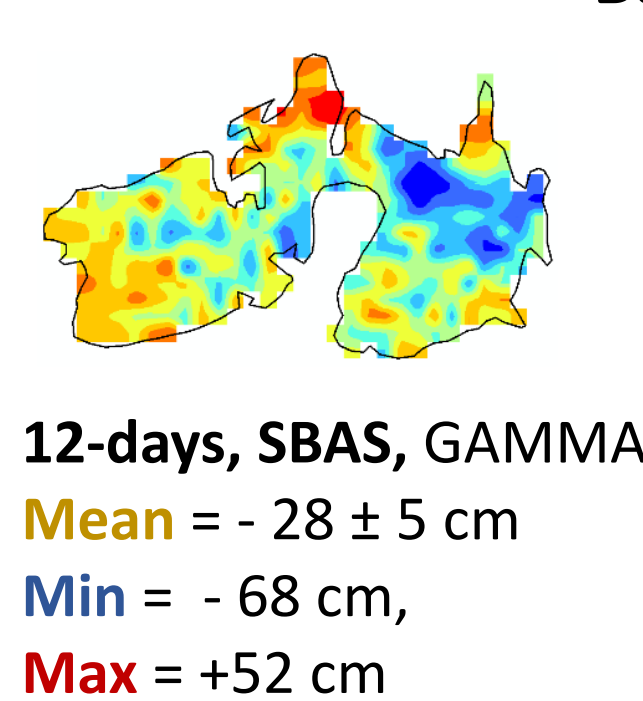
Vertical deformation

Cumulative vertical deformation of the glaciers with Sentinel-1A SLC DInSAR and ASF DAAC HyP3 products, SBAS

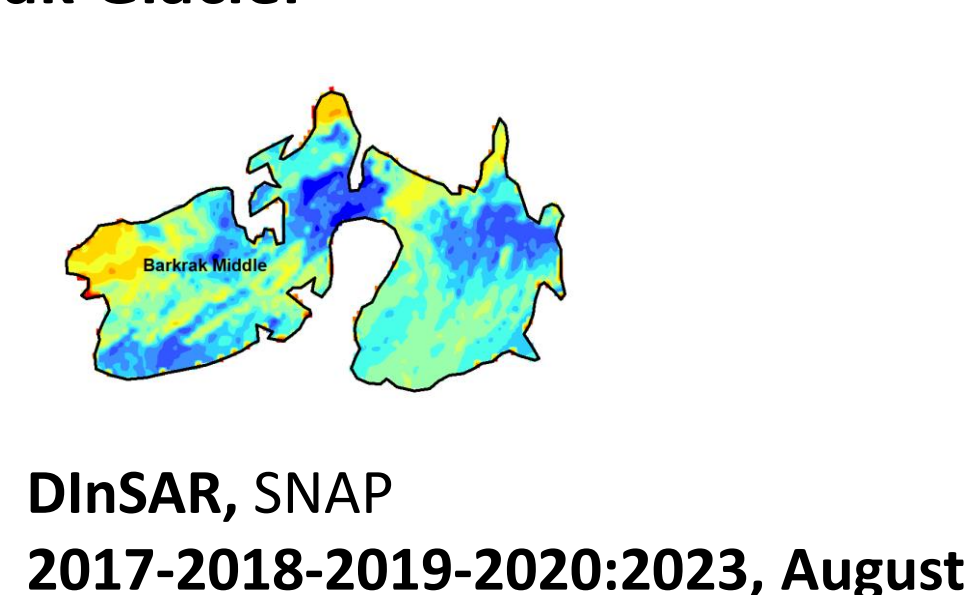
1. GACOS atmospheric correction,
2. GCP with high coherence binding near glacier area

SBAS, 12-days acquisitions: 112 pairs of images, 2021-2024;
1 year acquisitions: 18 pairs for two rows: August, September, 2015-2024

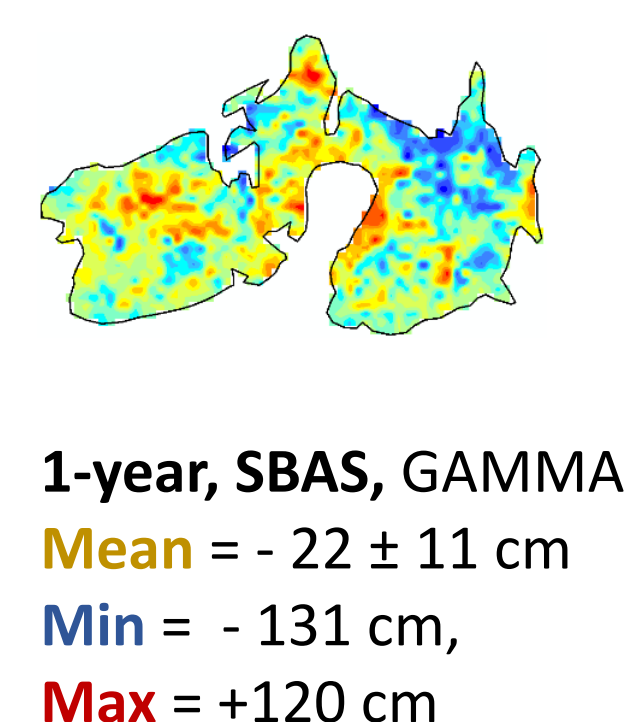
Barkrak Glacier



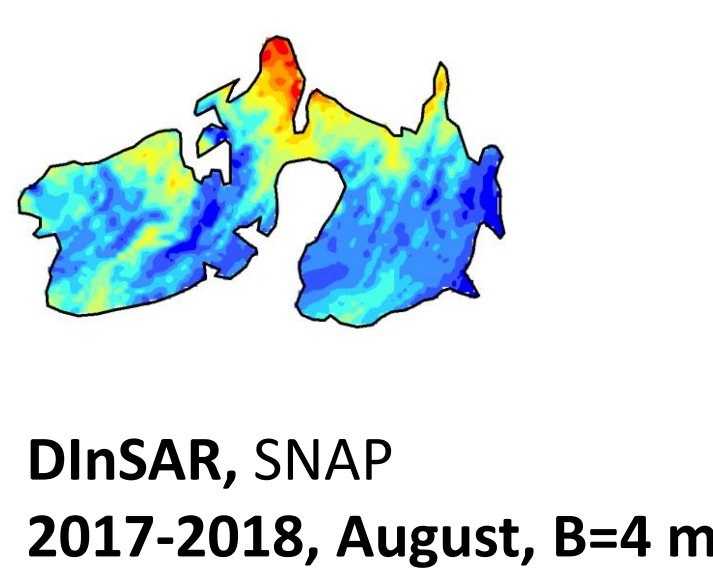
12-days, SBAS, GAMMA
Mean = -28 ± 5 cm
Min = -68 cm,
Max = $+52$ cm



DInSAR, SNAP
2017-2018-2019-2020-2023, August

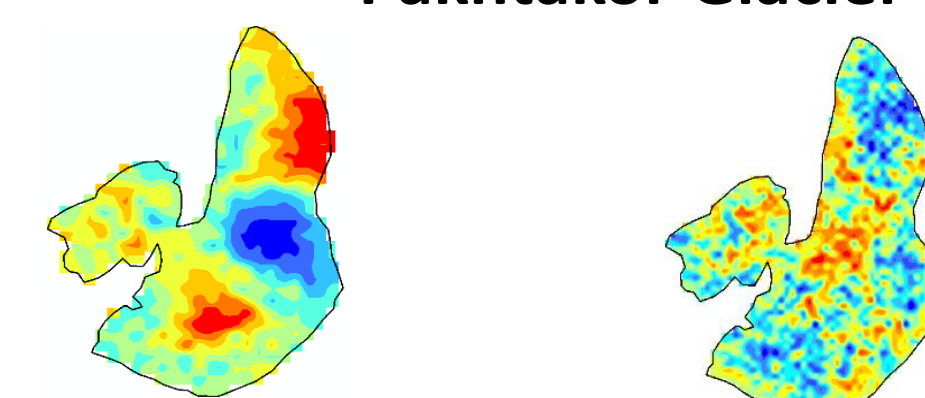


1-year, SBAS, GAMMA
Mean = -22 ± 11 cm
Min = -131 cm,
Max = $+120$ cm

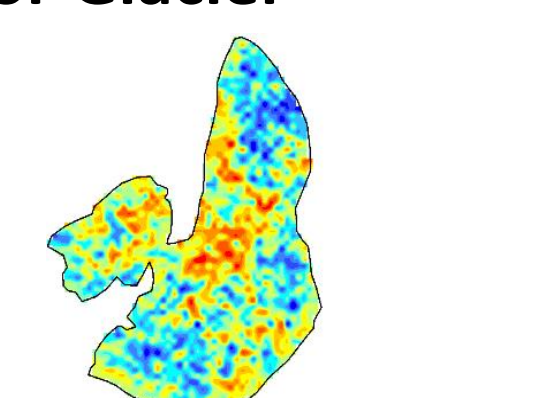


DInSAR, SNAP
2017-2018, August, B=4 m

Pakhtakor Glacier



12-days, 2021-2024
Mean = -11 ± 5 cm
Min = -141 cm,
Max = $+93$ cm



1-year, 2015-2024
Mean = -21 ± 11 cm
Min = -121 cm,
Max = $+110$ cm

References:

Hoelzle et al.: Re-establishing glacier monitoring in Kyrgyzstan and Uzbekistan, Central Asia: EGU- 2017; Geoscientific Instrumentation, Methods and Data Systems, Vol. 6(2), 397–418. <https://doi.org/10.5194/gi-6-397-2017>

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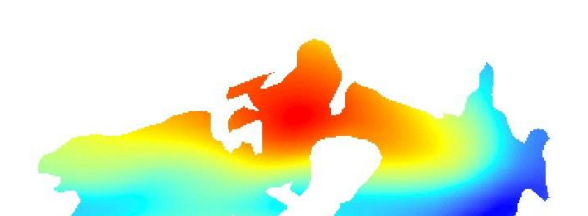
Daily glacier movement

Sentinel-1A GRDH: 2017 - 2023 (August-October)
SNAP (ESA), Offset Tracking

Barkrak Glacier mean velocity = 5-8 cm/d,
max = 10 cm/d



2019, 22 Aug- 15 Sep



2023, 12 Oct– 5 Nov