Elevation Changes of Fedchenko Glacier and its Tributaries in the Pamir Mountains

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Fedchenko Glacier, Pamir Mountains, Central Asia

Fedchenko Glacier:

- more than 70 km long

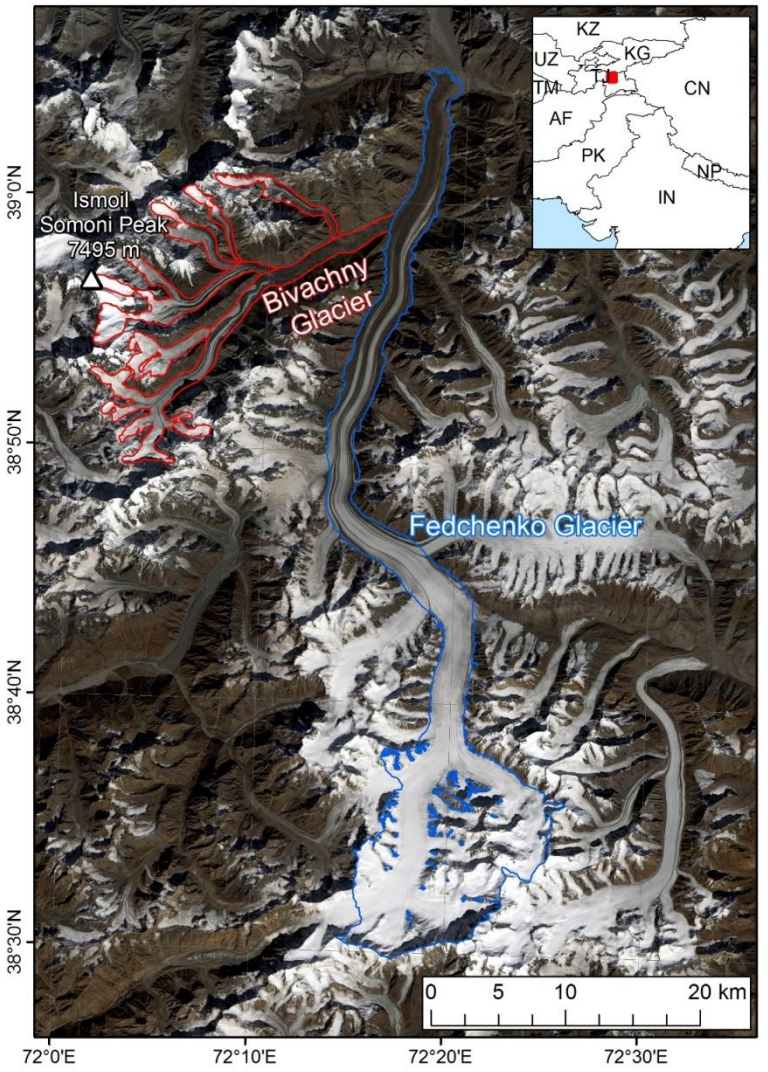
⇨ longest glacier outside the polar regions

- lower part completely debris covered
- ranging from 2900 m to 5400 m

Bivachny Glacier:

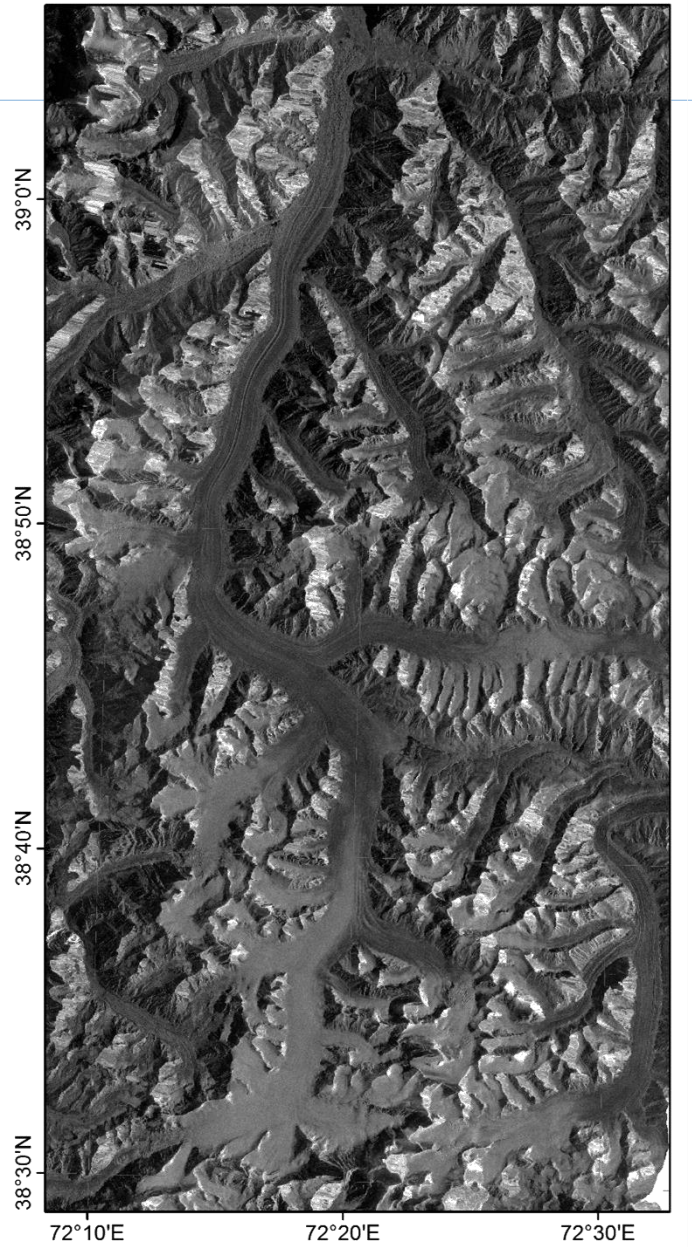
- 25 km long with 3 tributaries
- known historical surges (Kotlyakov 2008):

  1958, 1976-1978, 1996
- recent event: 2011-2015

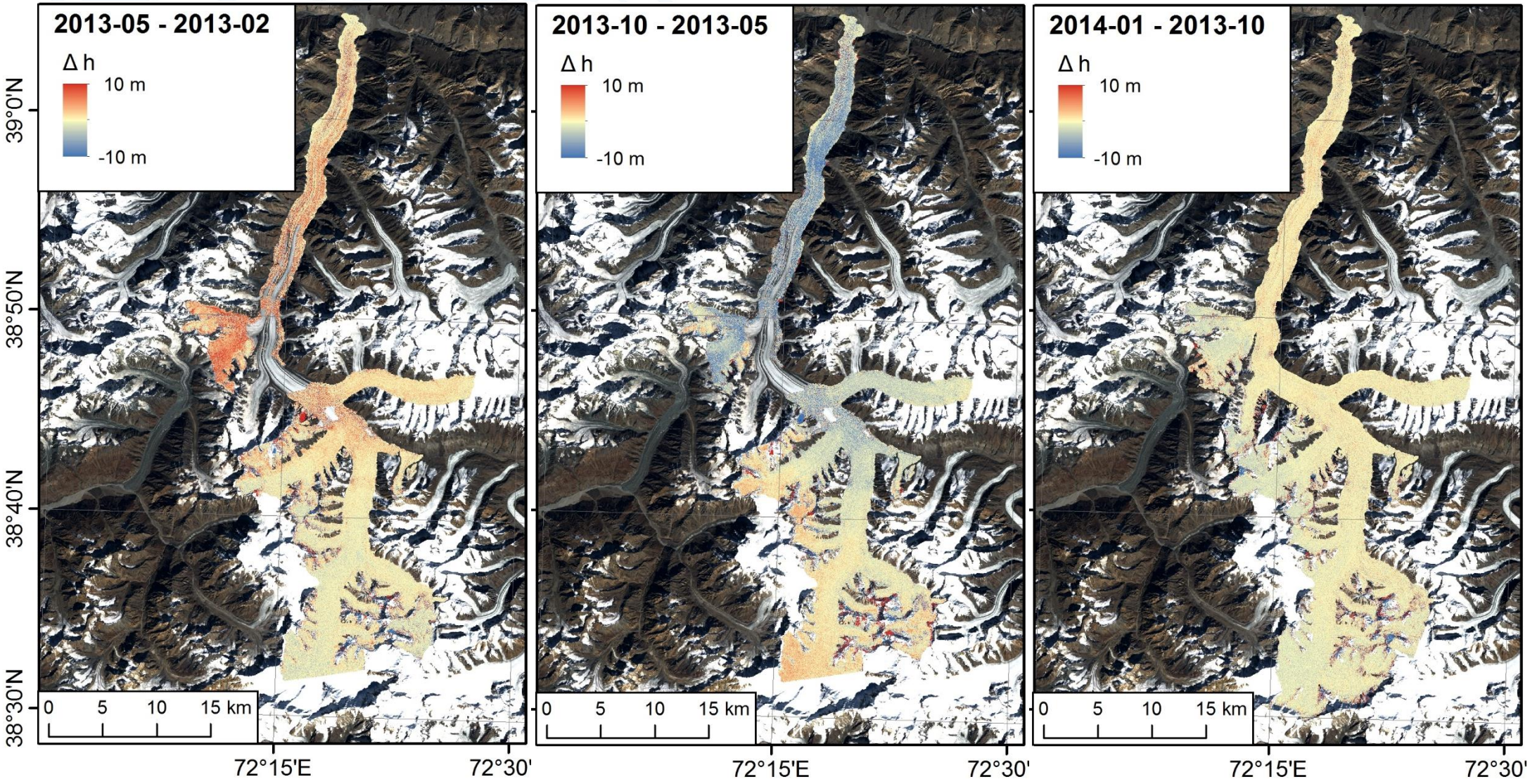


Bistatic Tandem-X data

Date	Orbit direction	$B_{\perp}$ (m)	H_a (m)
2011-08-16	A	139.5	44
2012-01-28	A	85.4	73
2013-02-16	A	121.9	52
2013-05-26	A	144.6	44
2013-10-20	D	94.5	-65
2013-10-31	D	93.2	-61
2014-01-05	D	108.4	-55
2014-05-13	A	181.4	-35
2014-09-11	A	101.8	65
2015-10-05	D	300	20
2015-10-16	D	23.5	257
2015-12-28	A	134.8	-47
2016-09-10	D	311	18



Elevation differences

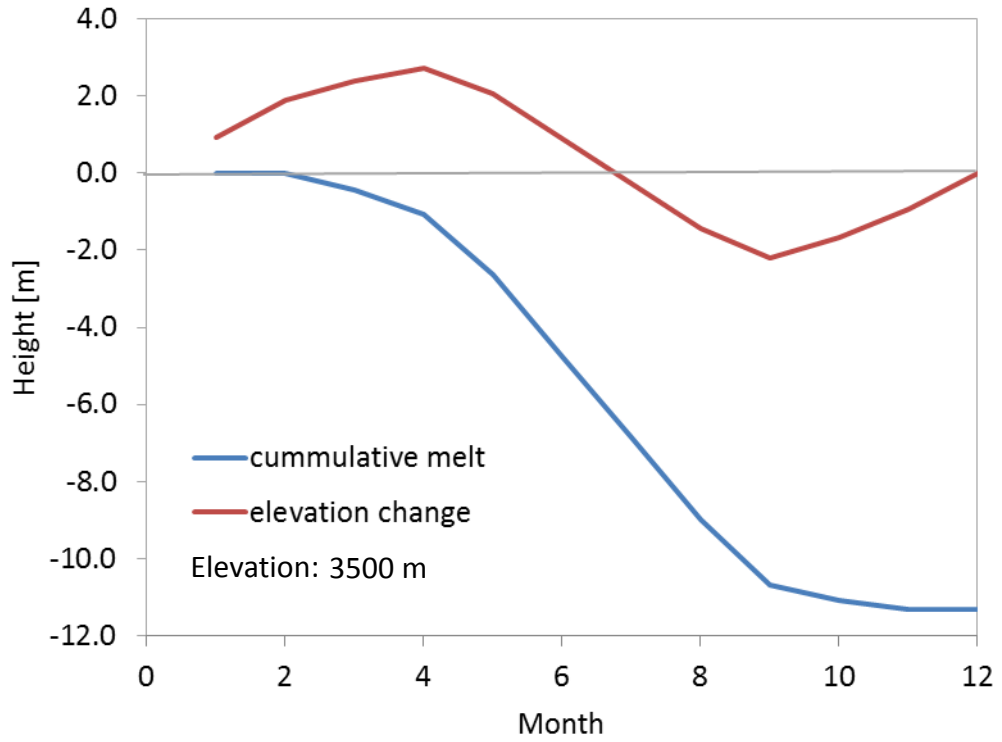


Emergence velocity in the ablation area

Assumption: equilibrium state + constant flow velocity

- on the yearly average ablation is compensated by inflow from accumulation area
- seasonal differences in melt

⇨ elevation increase in winter and elevation decrease in summer



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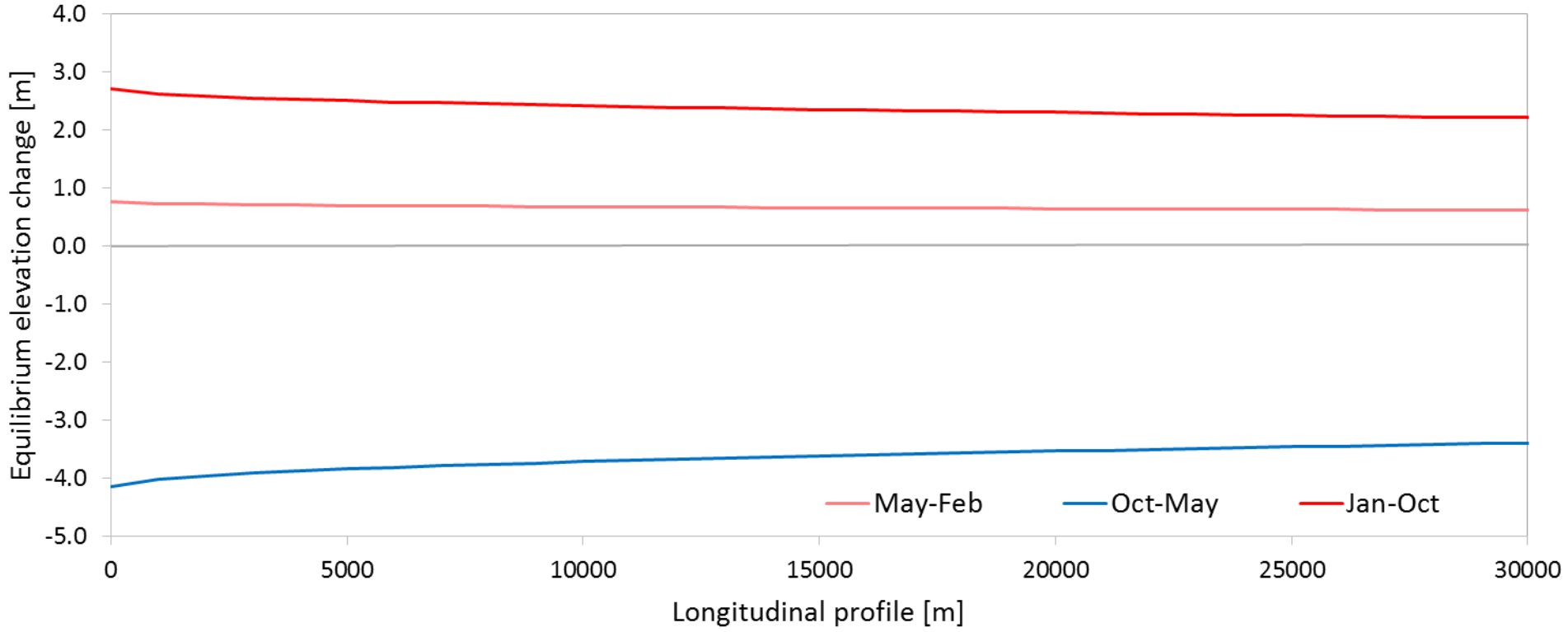
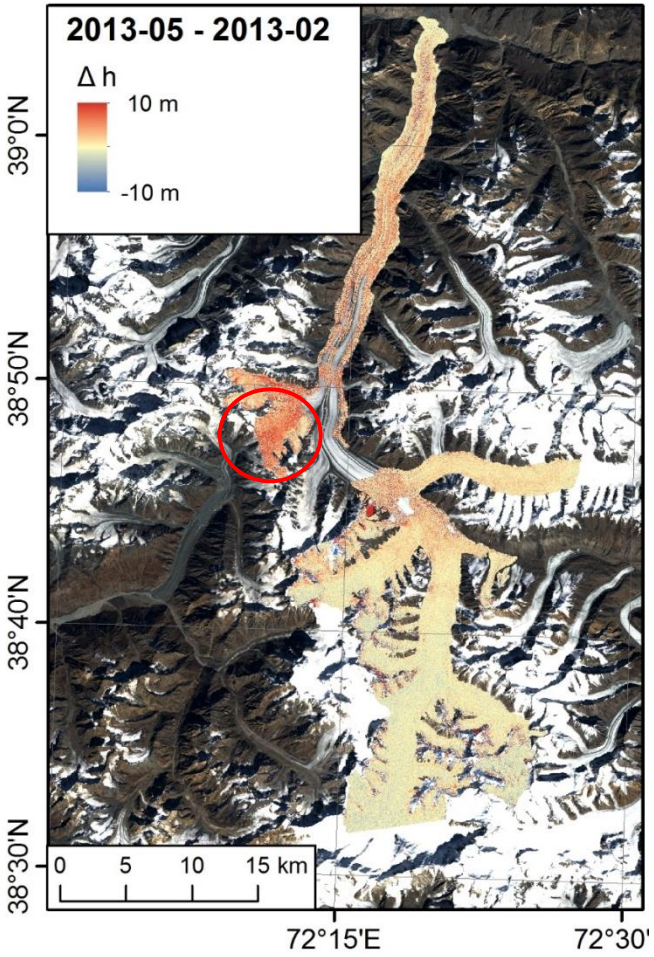
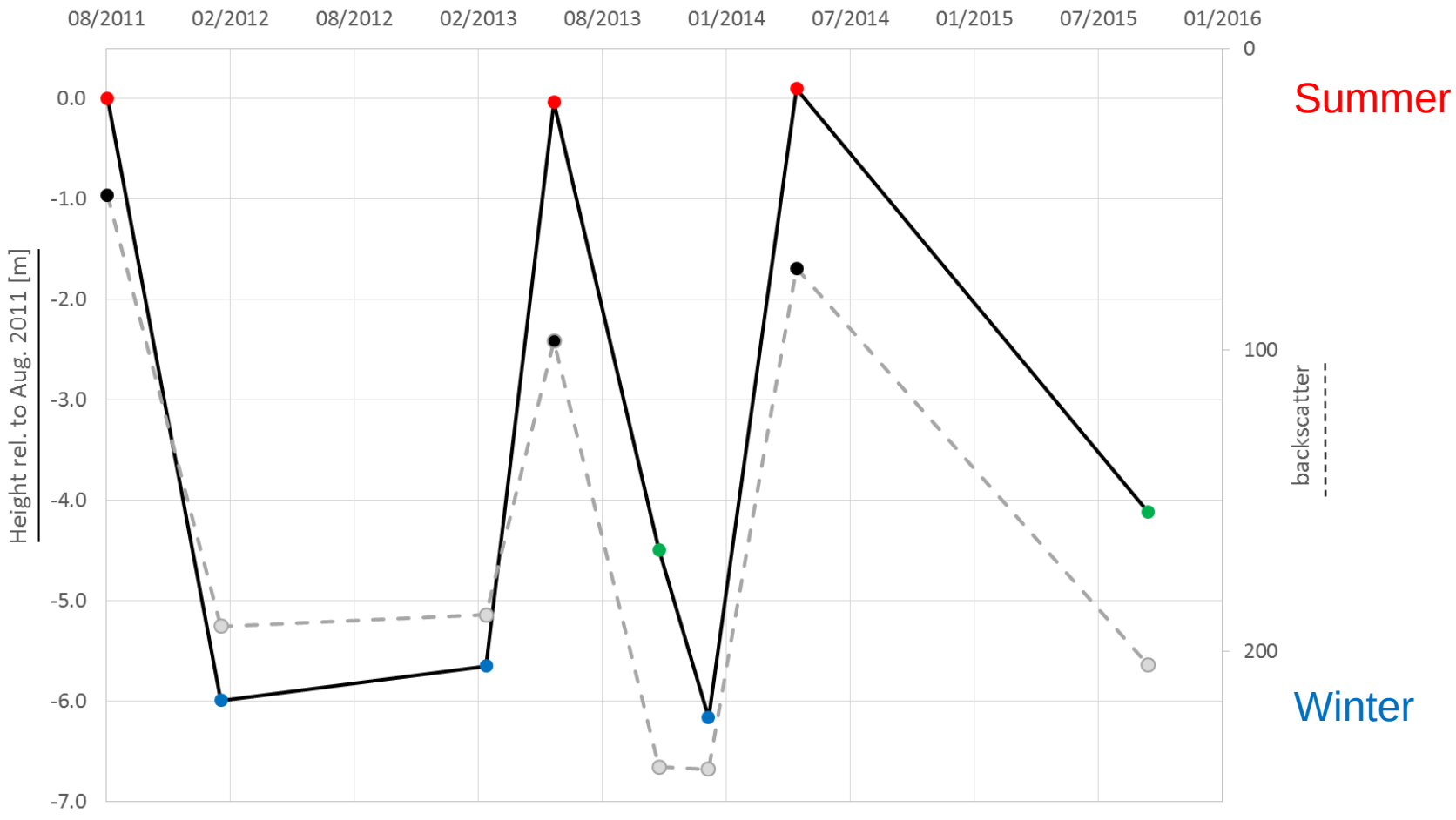


Penetration depths in the accumulation area

Example: Kashal Ajak (4300 m)



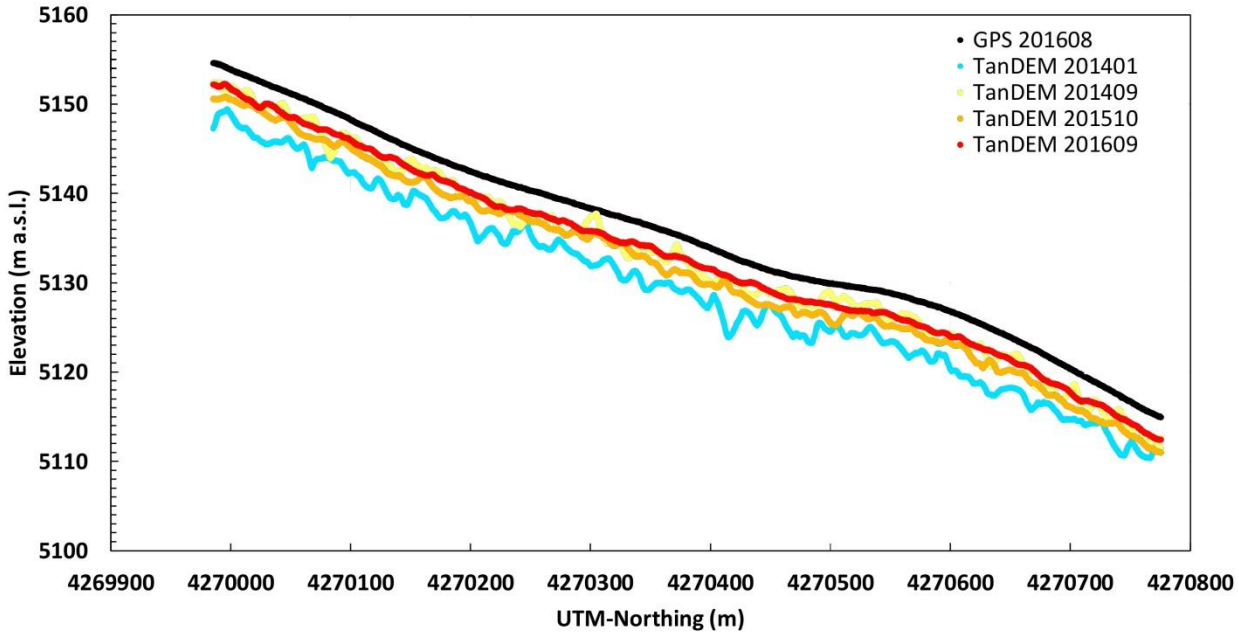


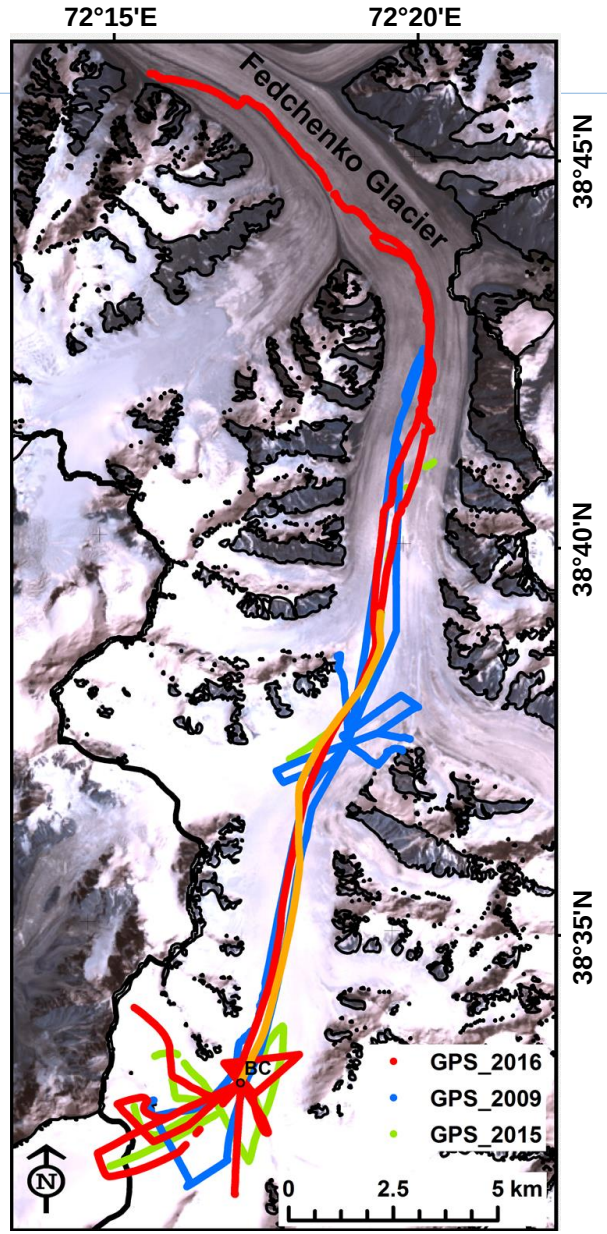
Penetration depths - field work 2015/2016

Reconnaisance for a deep drilling site

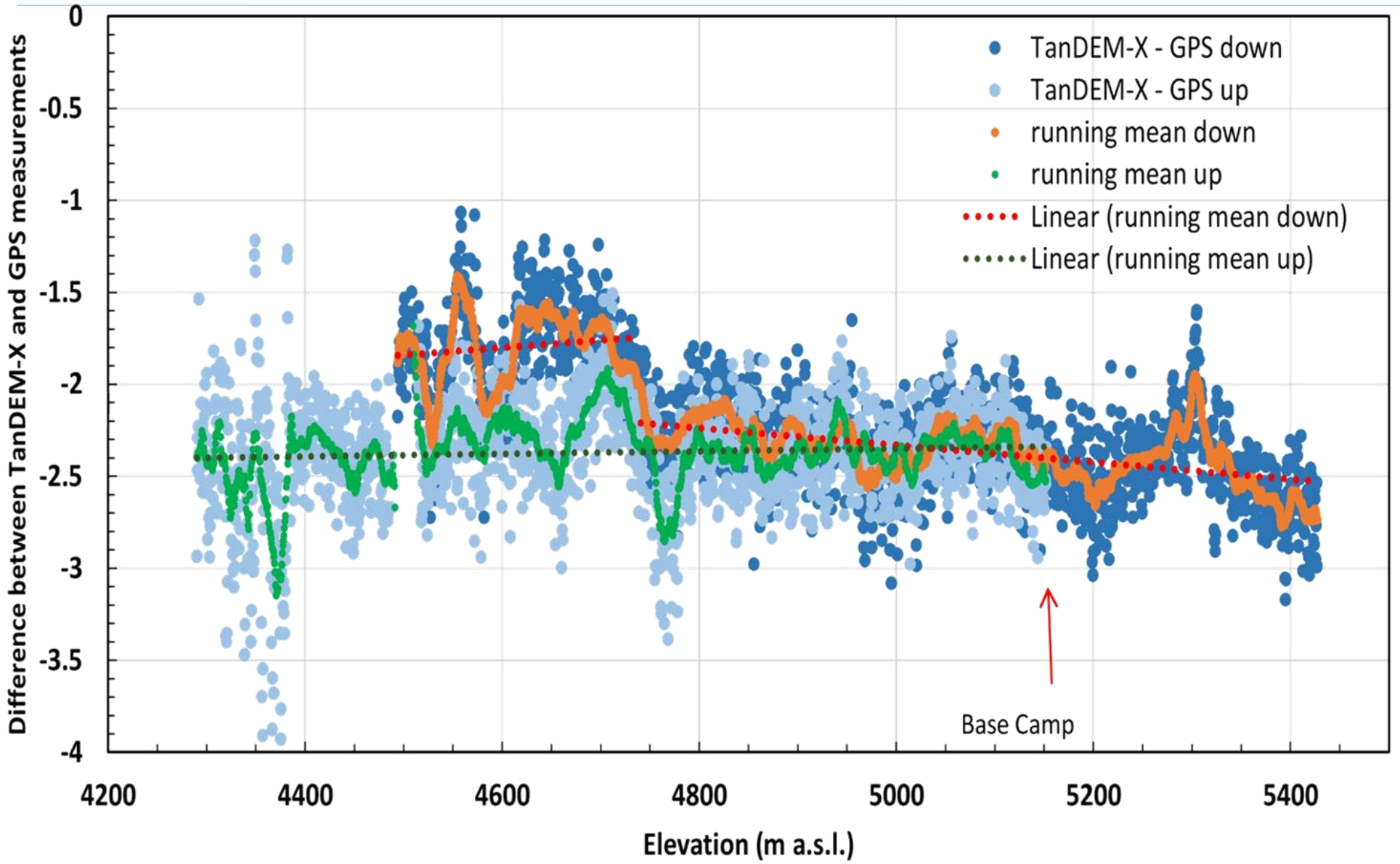
Over-snow traverses on foot from 4700 m to 5200 m

GNSS and ground penetrating radar measurements

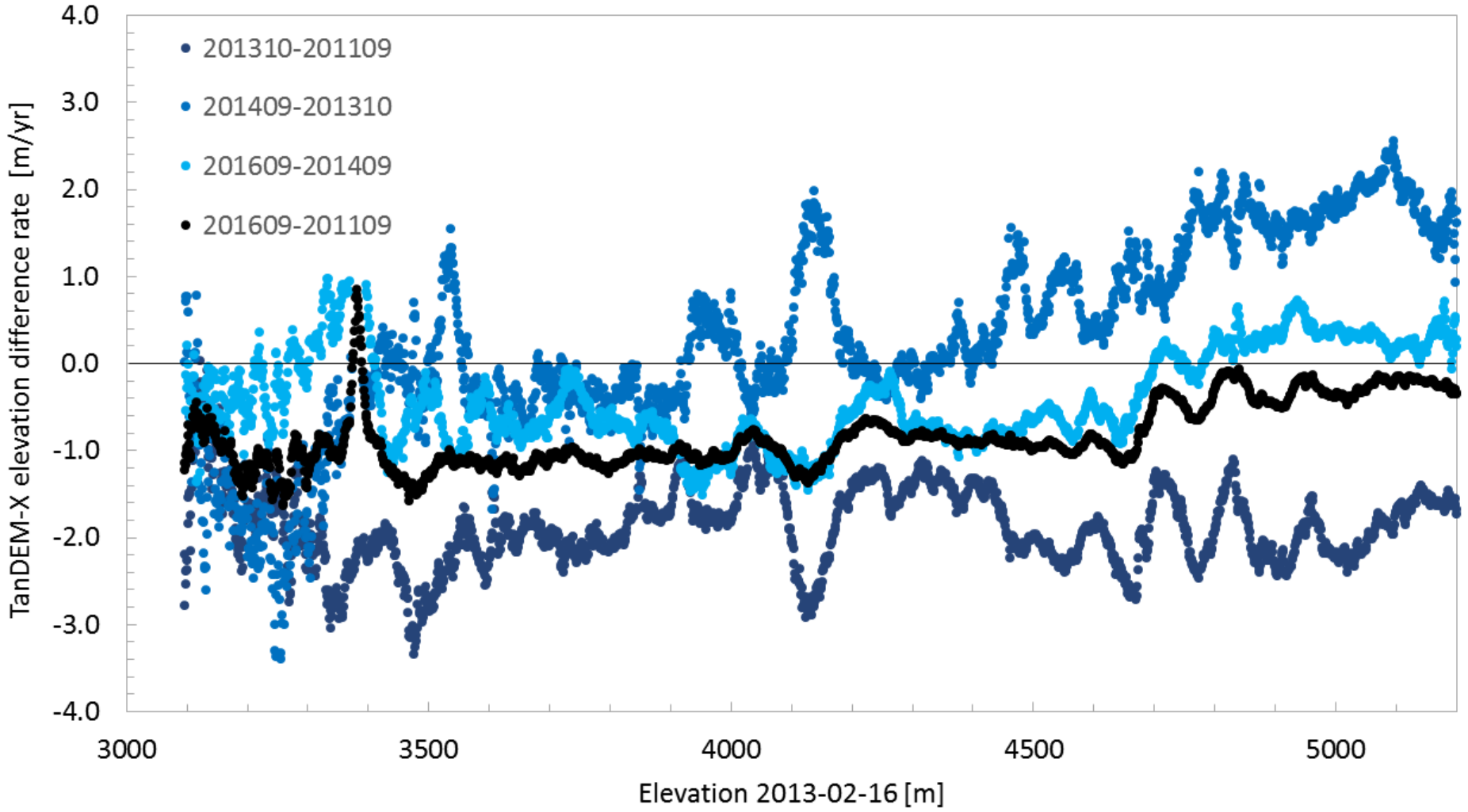




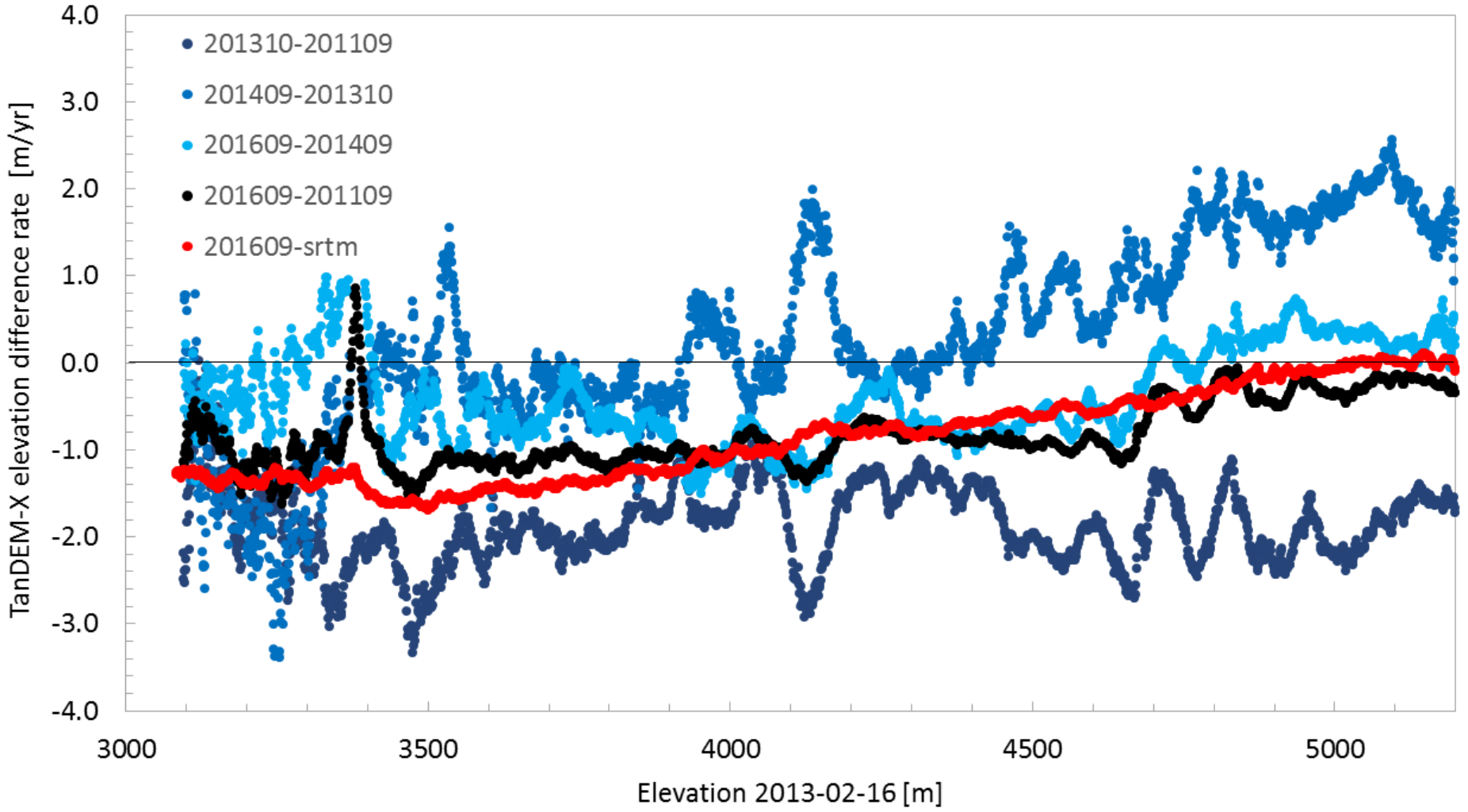
Penetration depths – comparison GPS-TanDEM-X 2016



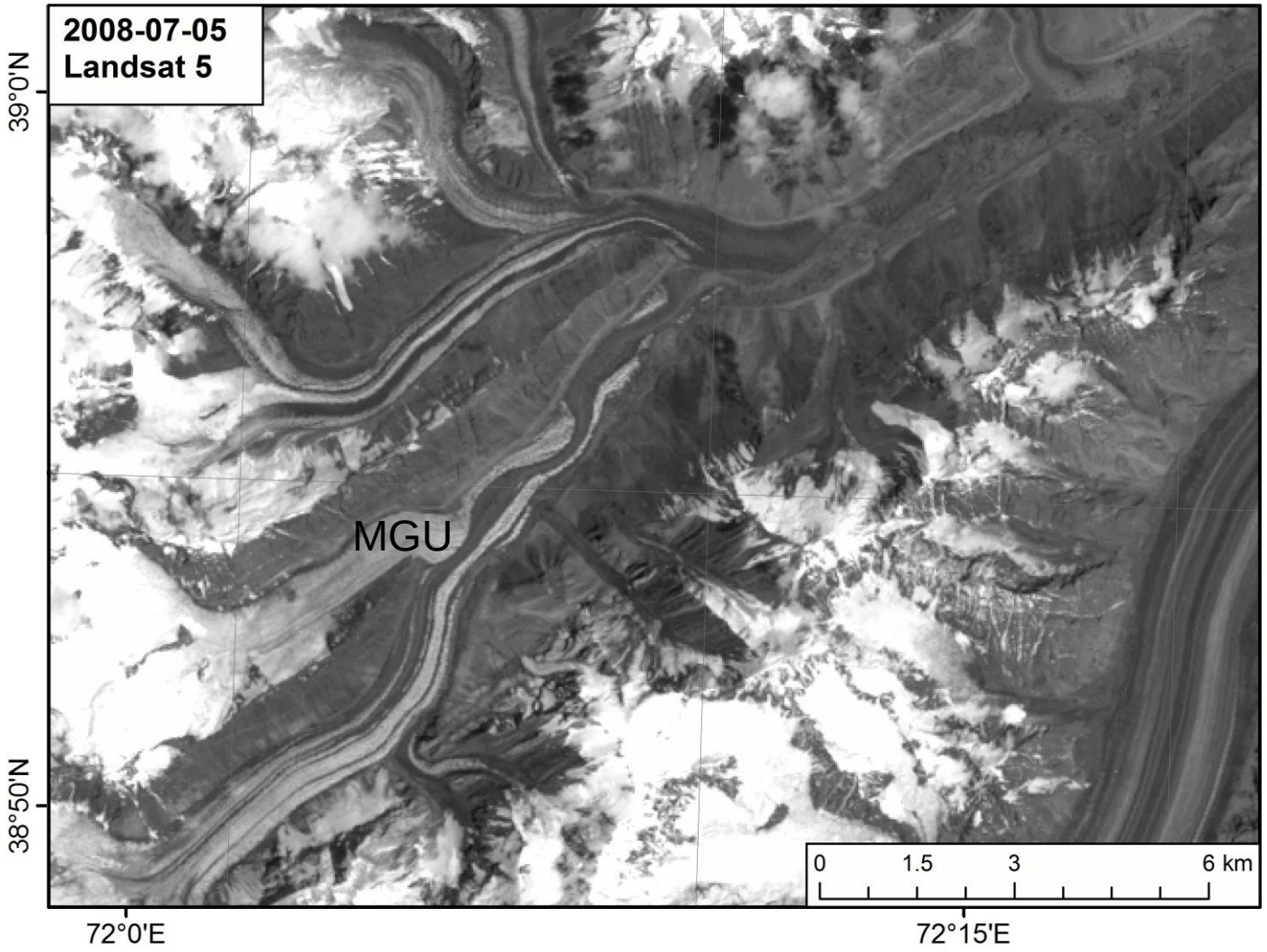
Annual elevation change rates 2011 – 2016



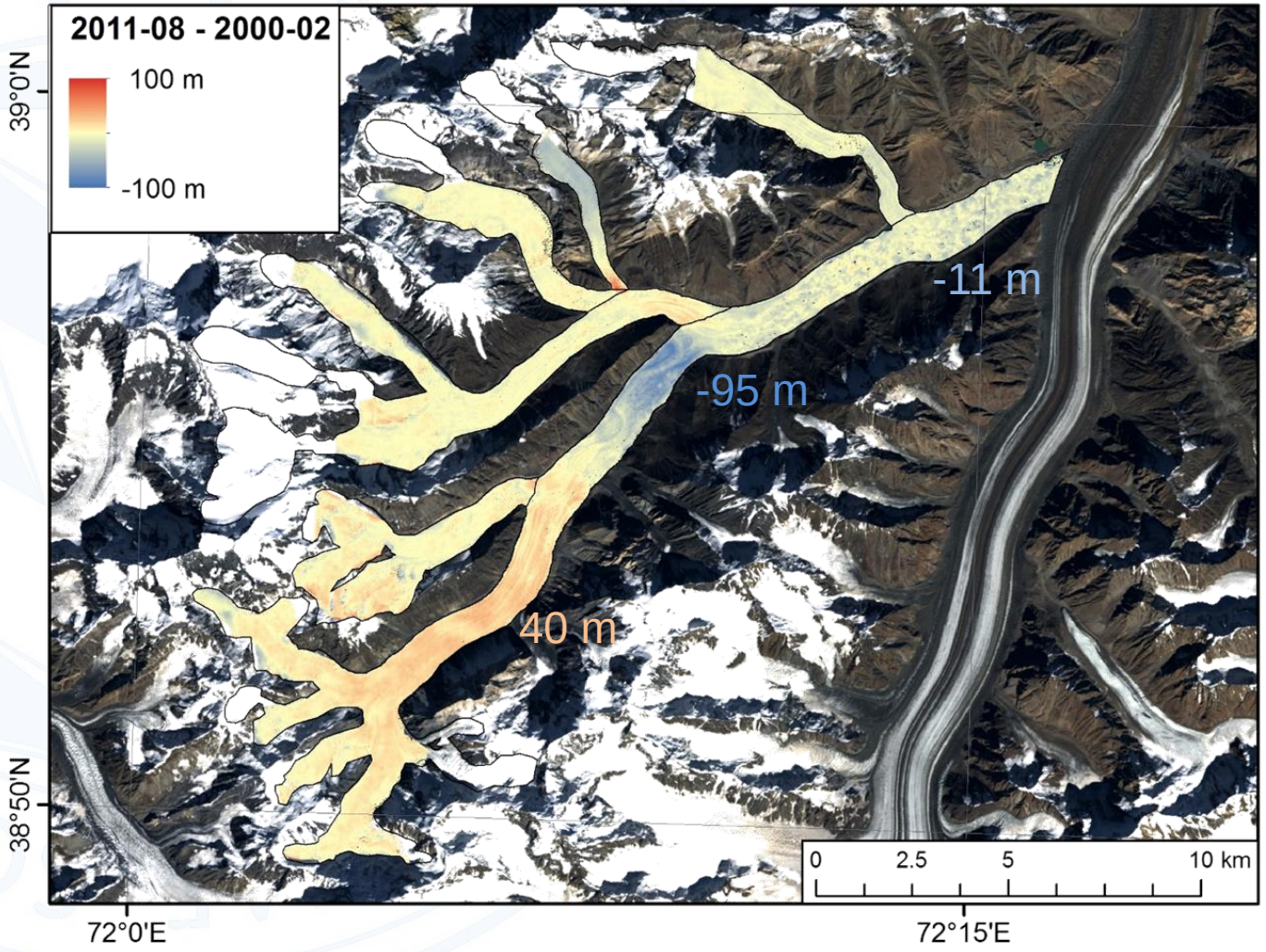
Annual elevation change rates 2000 – 2016, penetration corrected

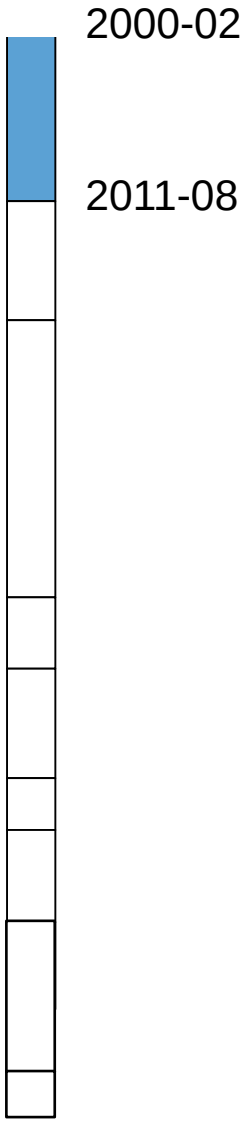


Bivachny Glacier: Landsat time series 2008 - 2015

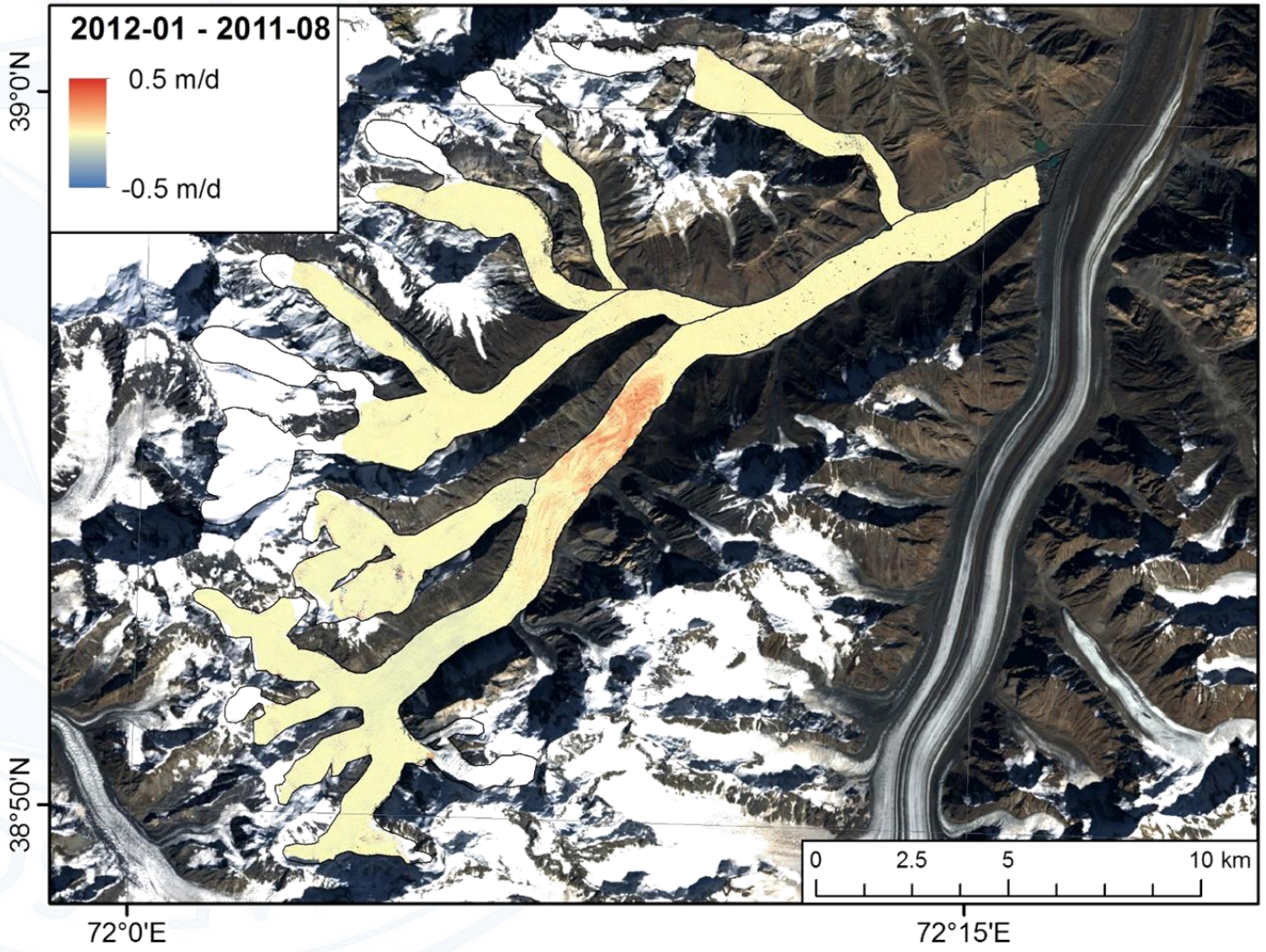


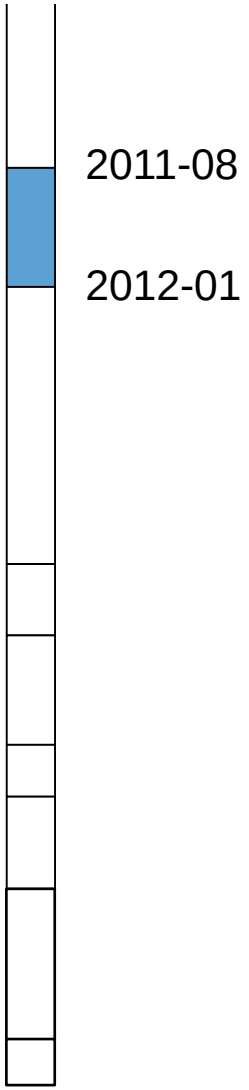
Pre-surge elevation changes 2000 - 2011





Elevation change rates during the surge





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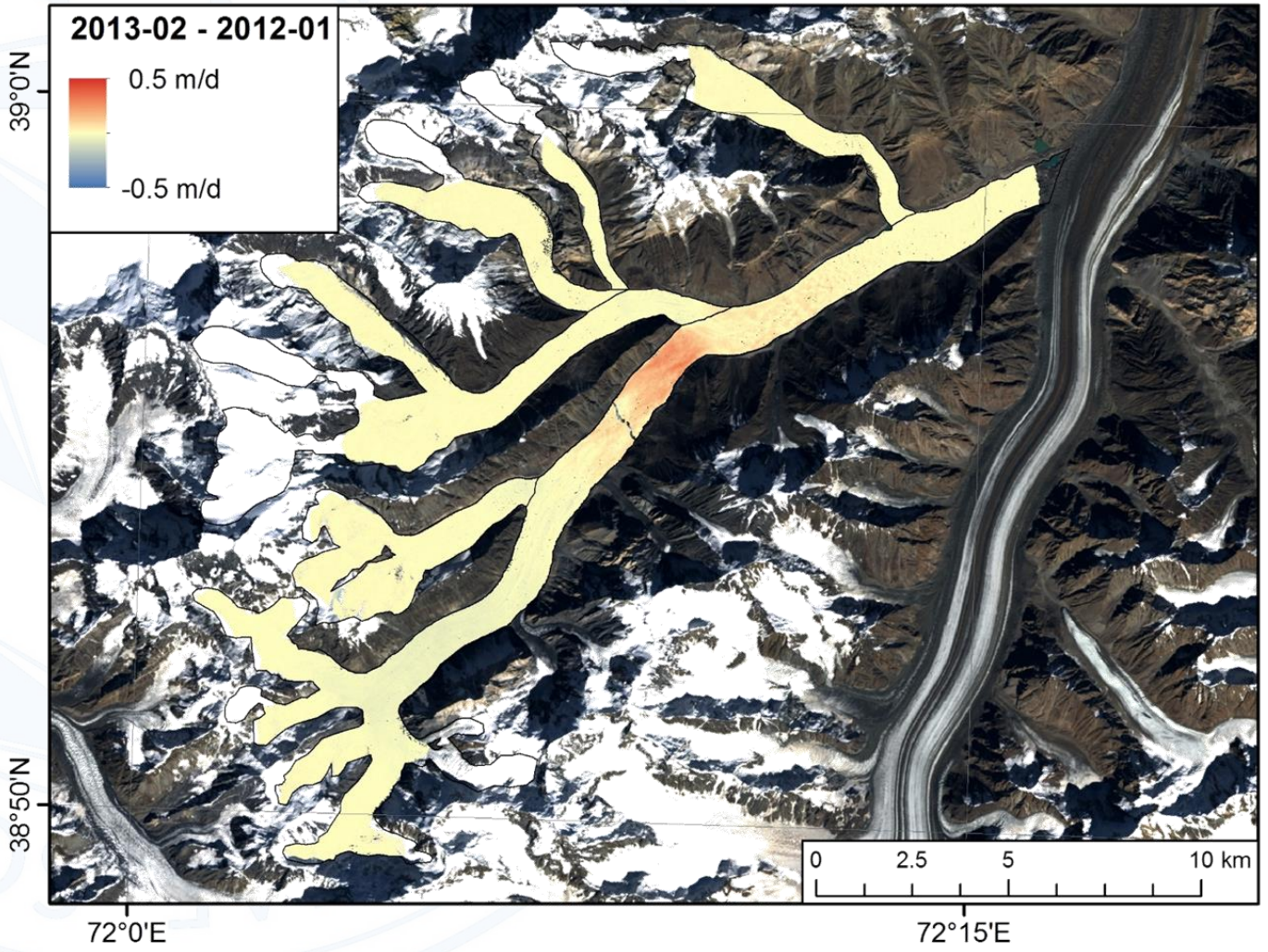

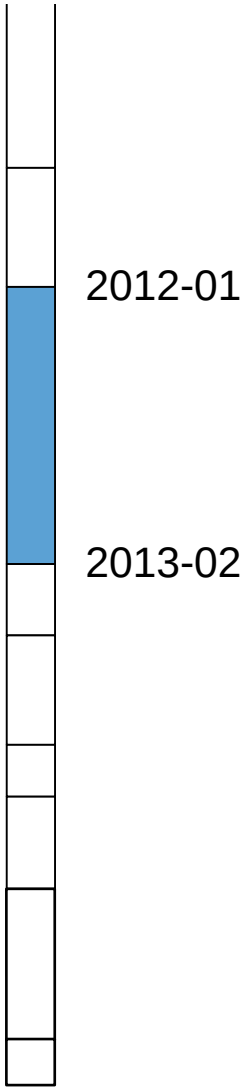

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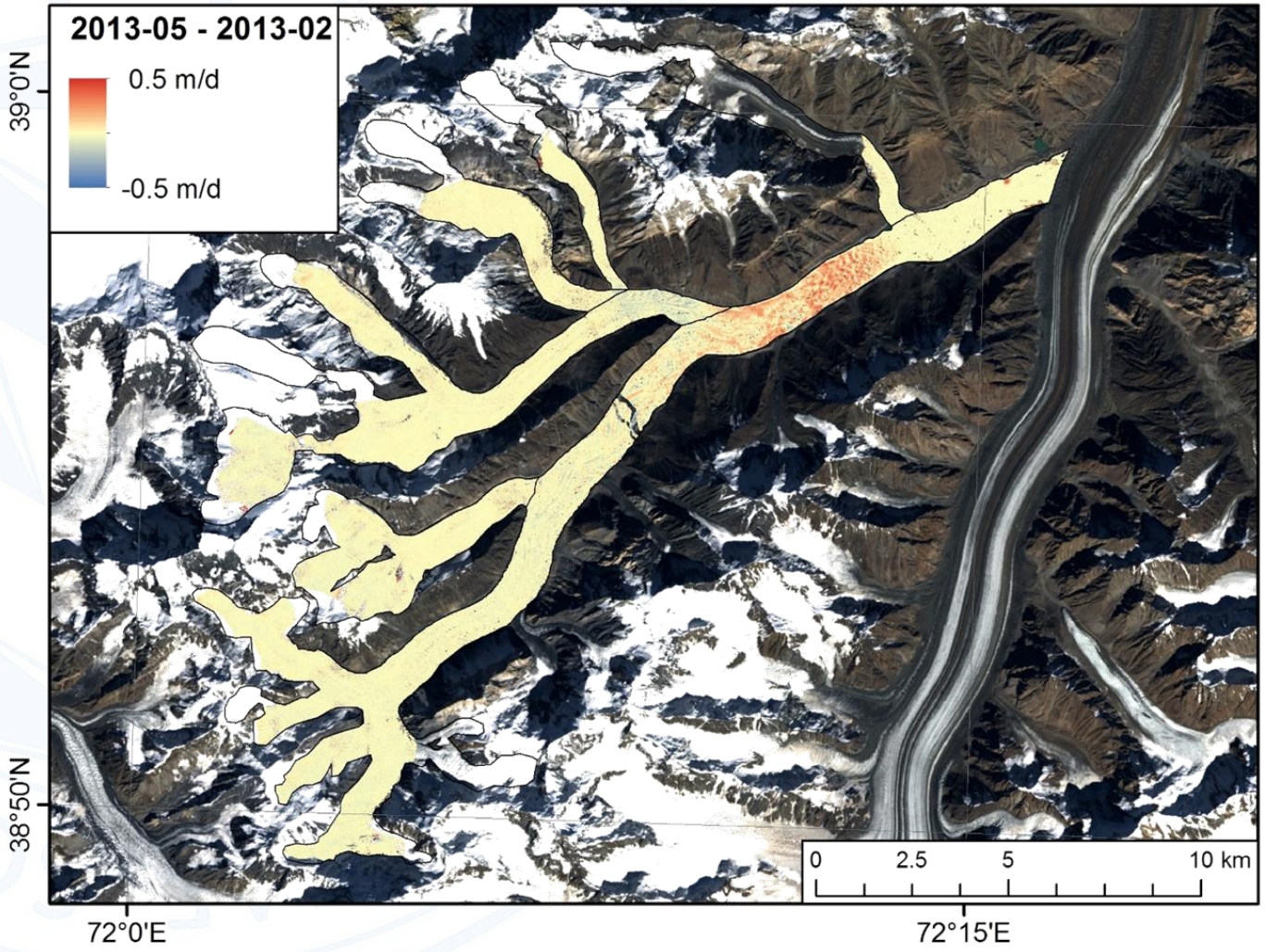

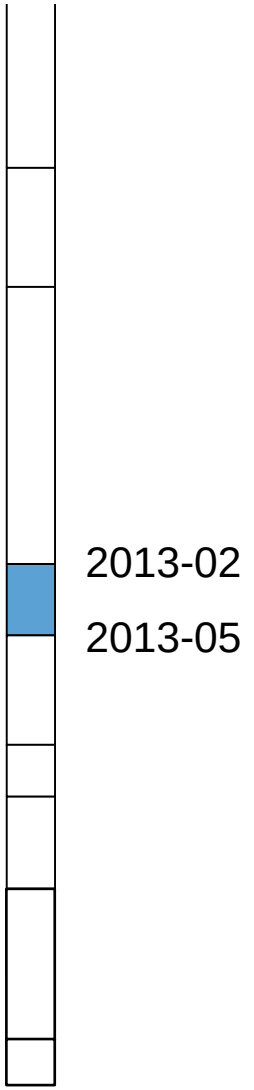

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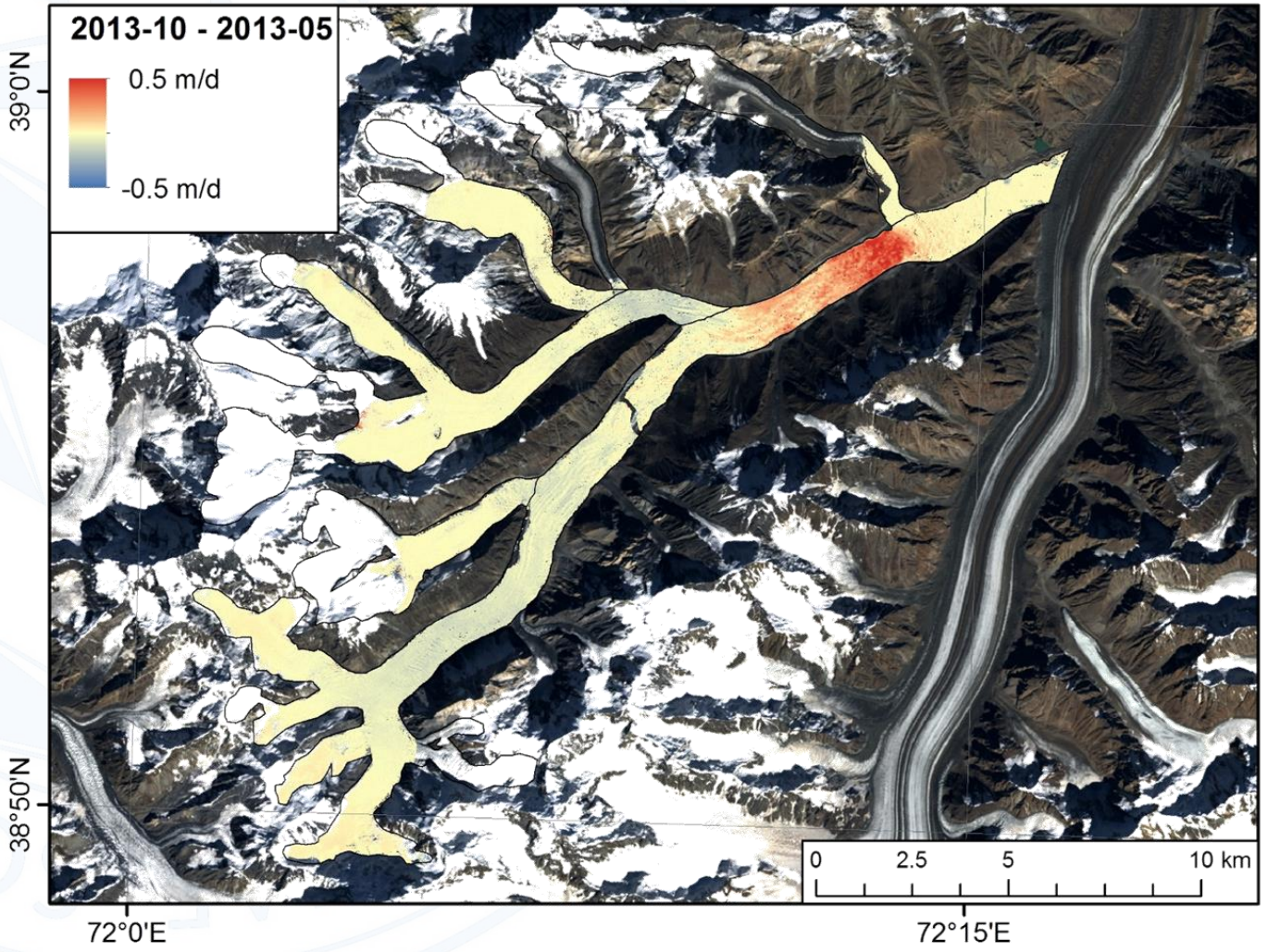

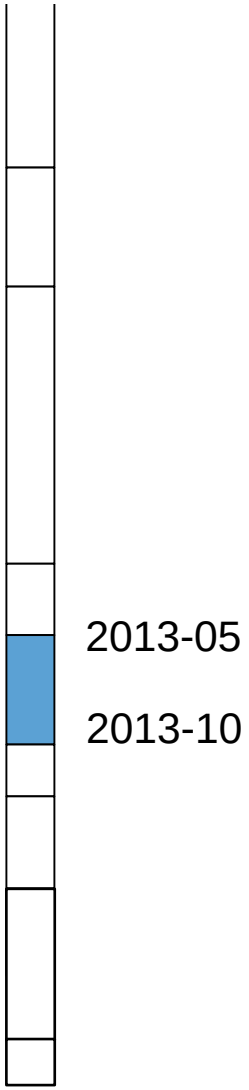

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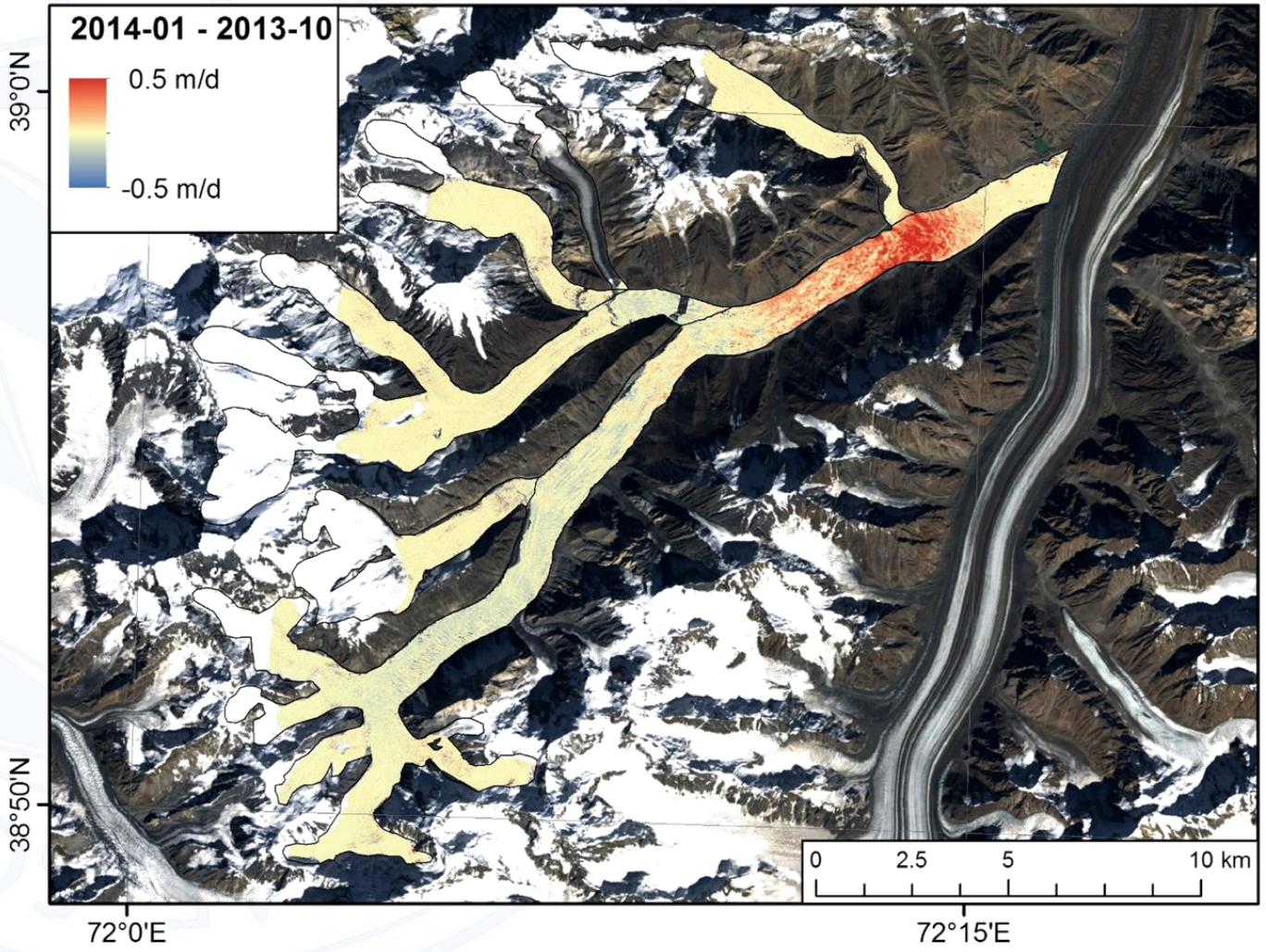

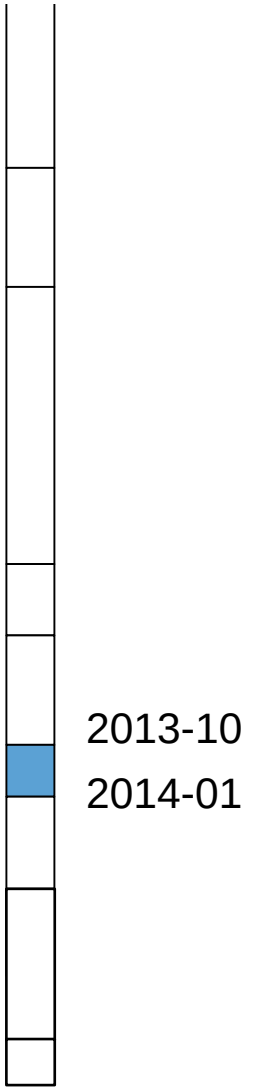

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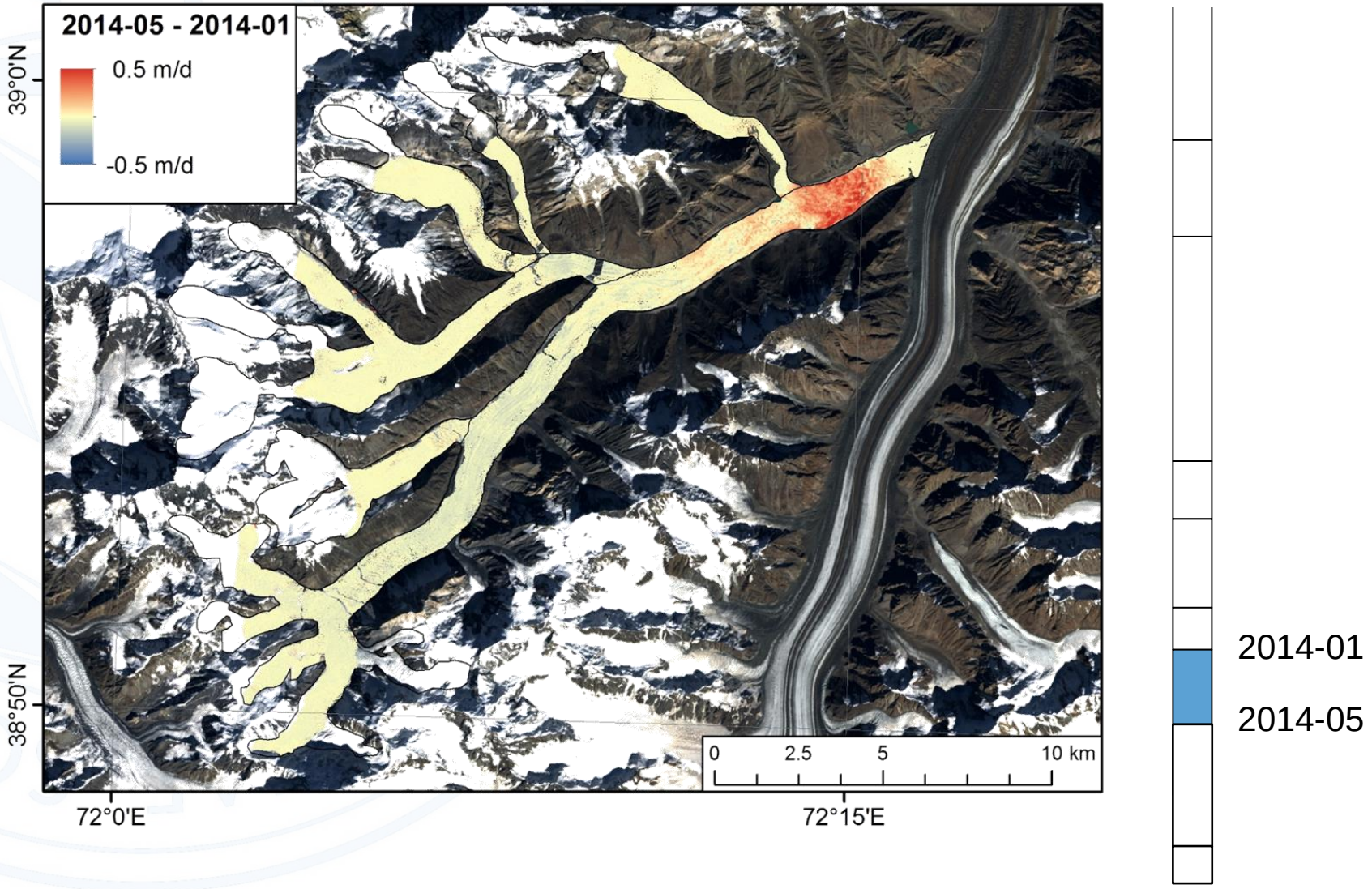

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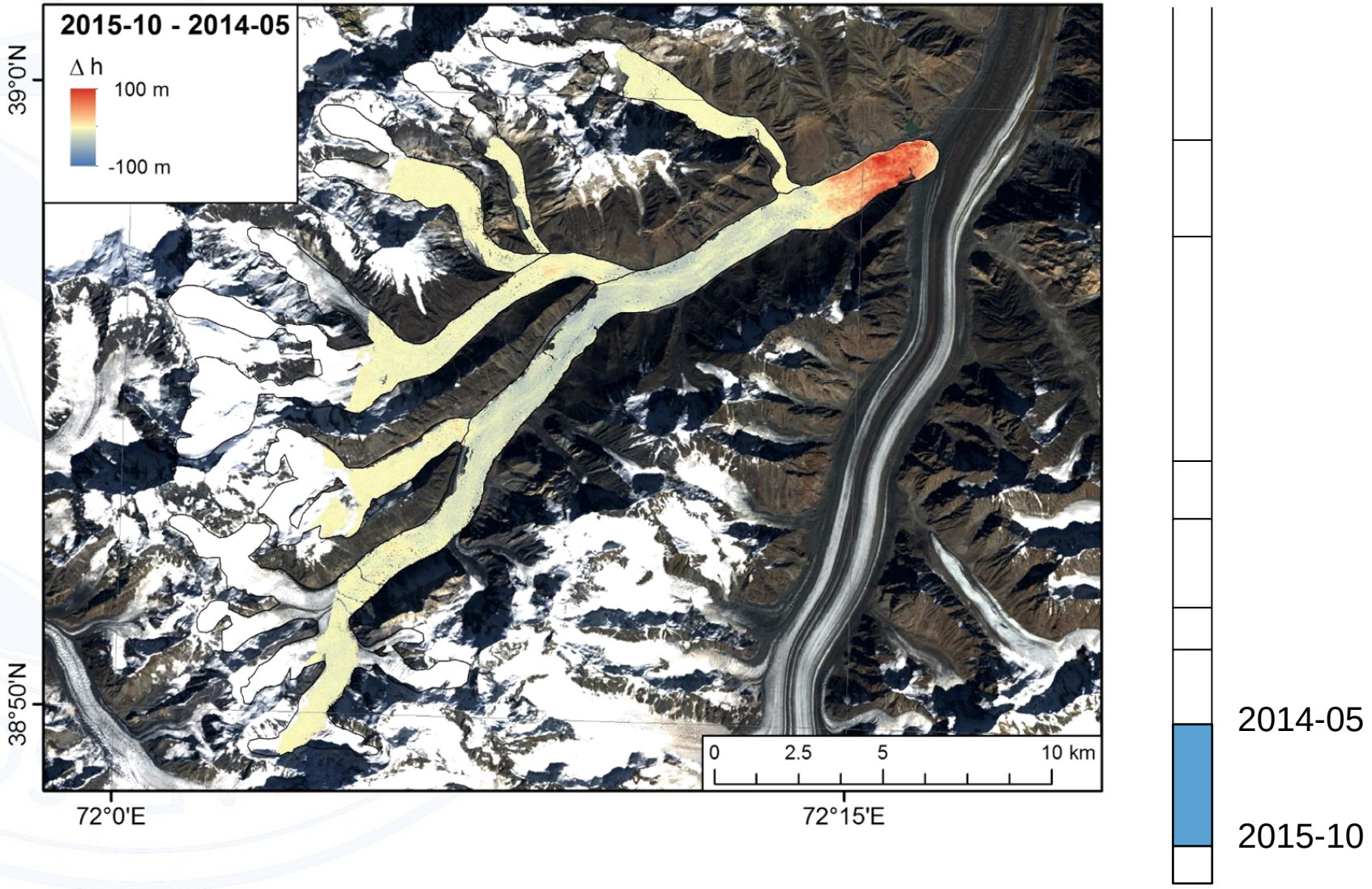

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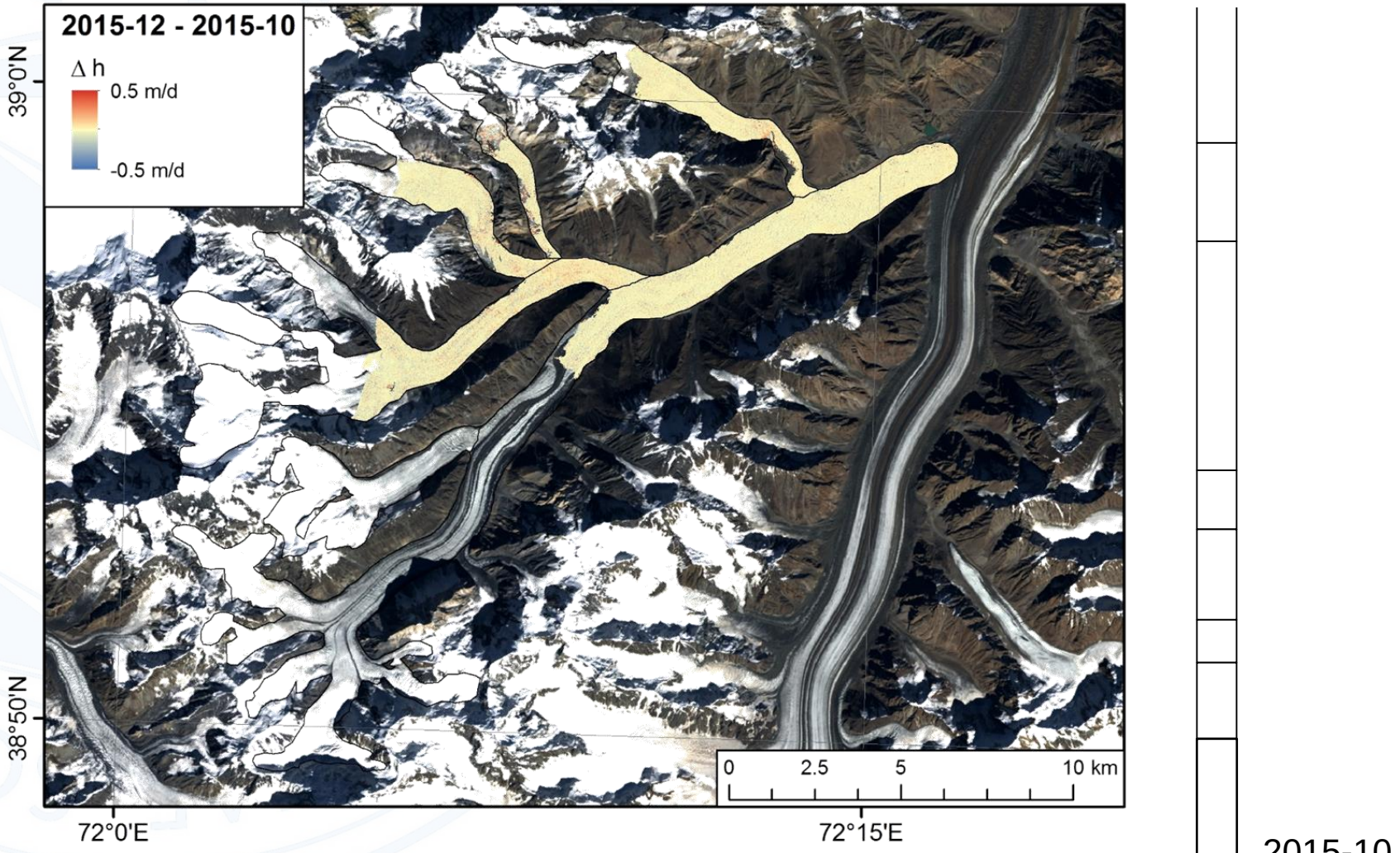
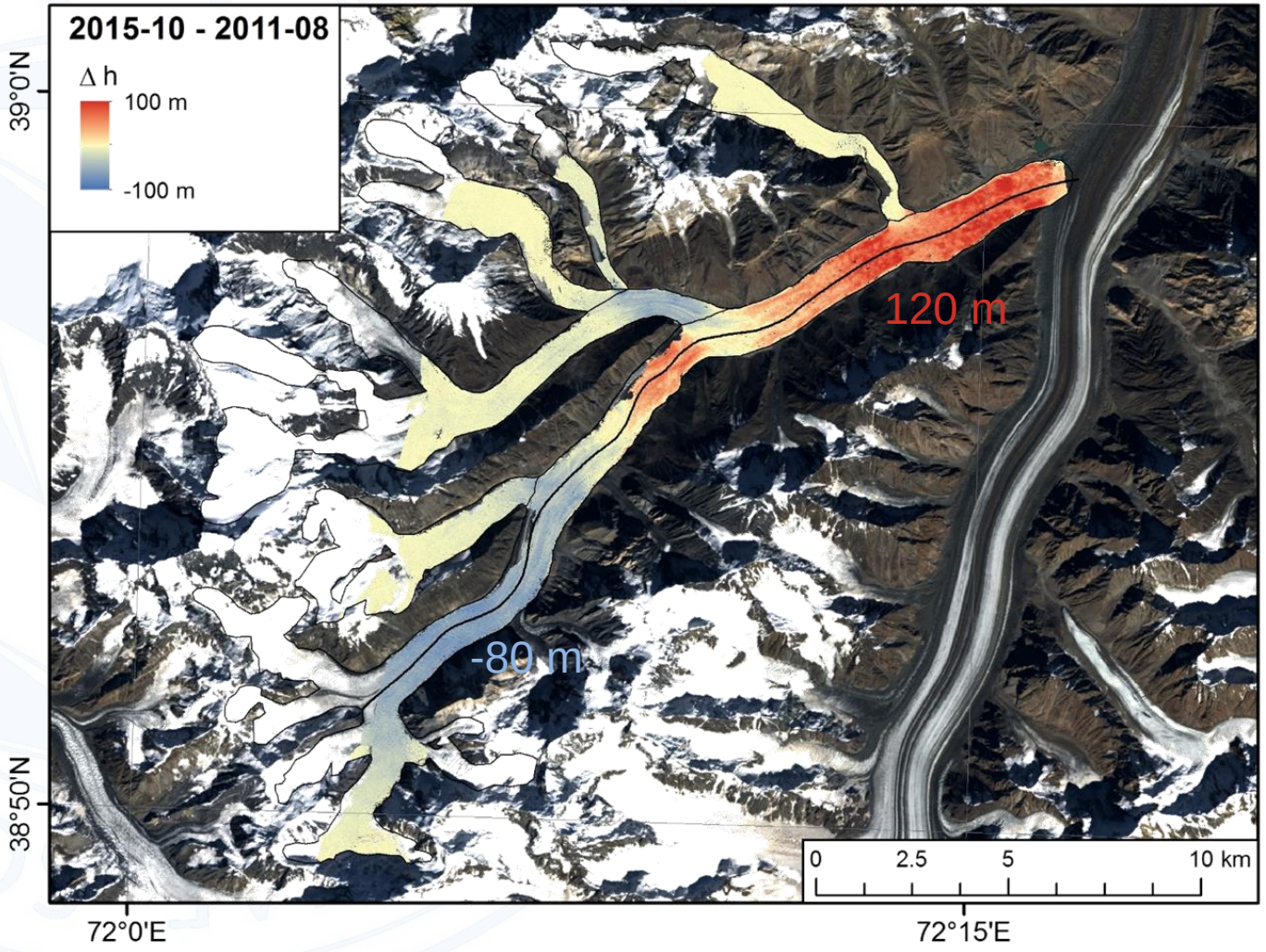
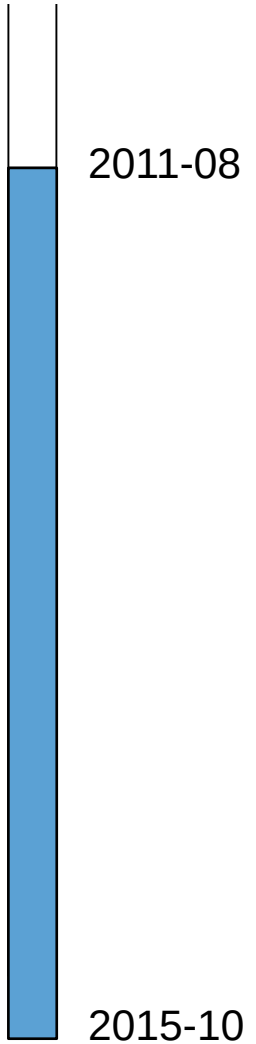
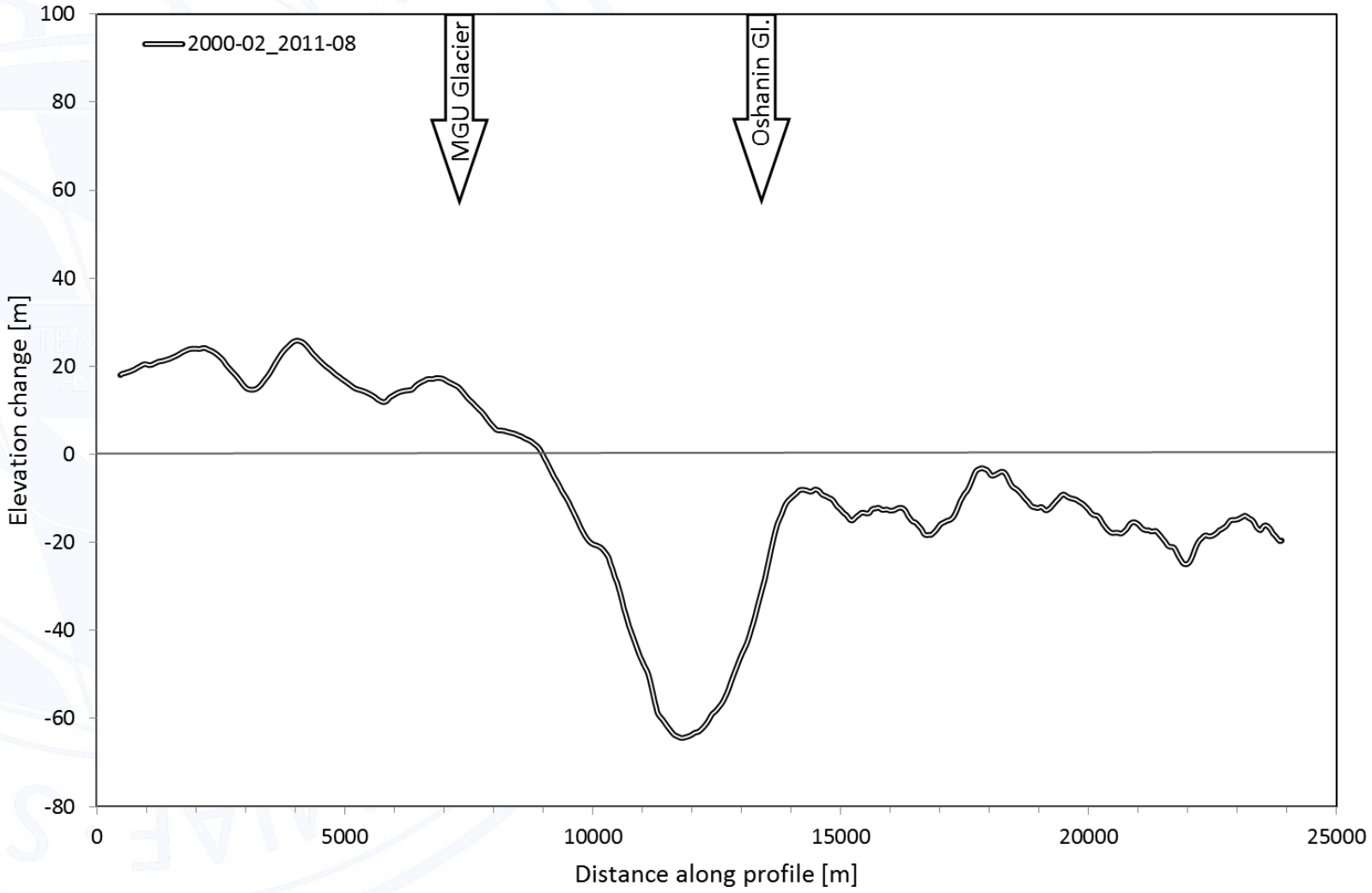


Total elevation change during the surge





Elevation changes along cental flowline



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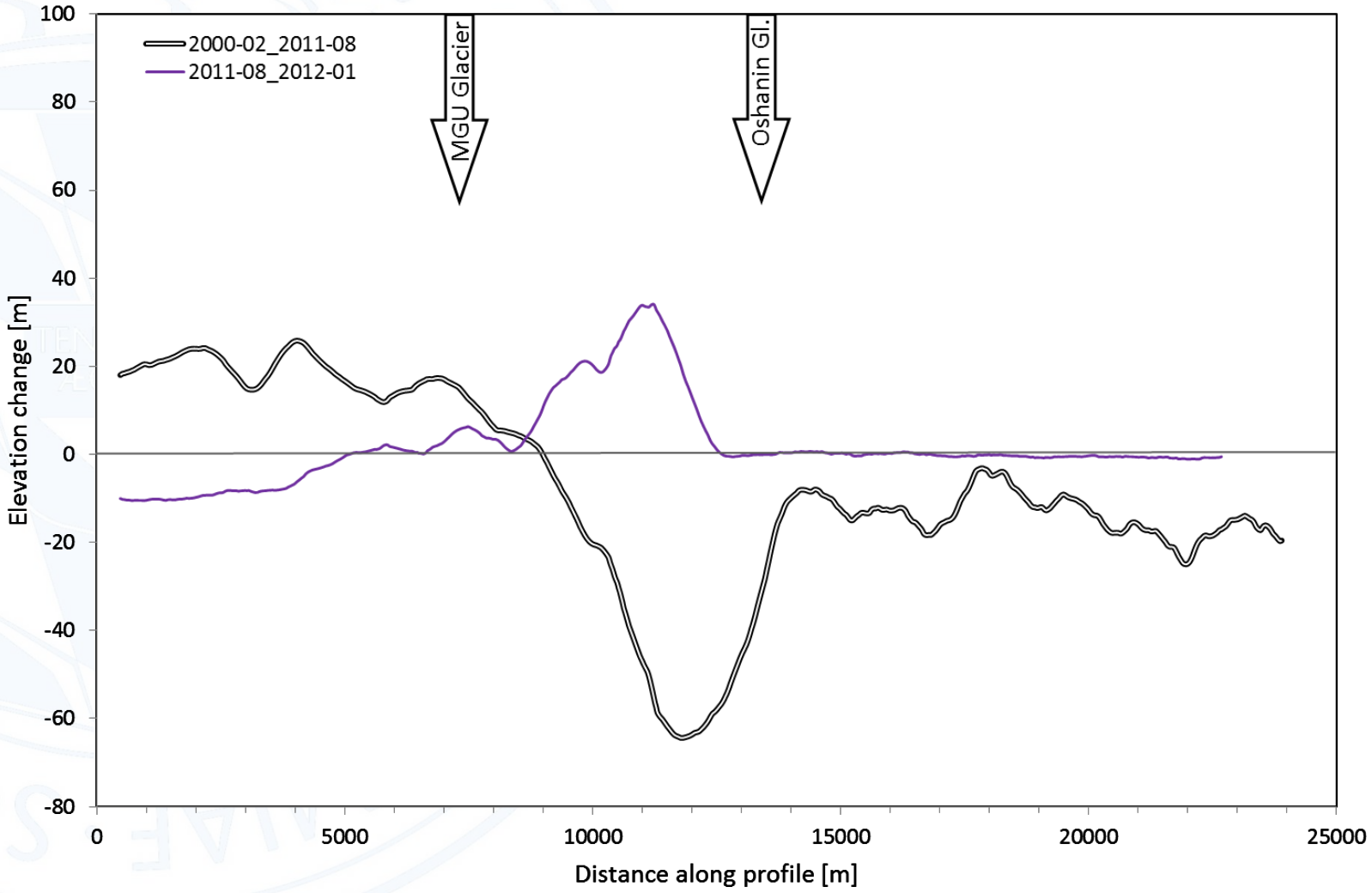

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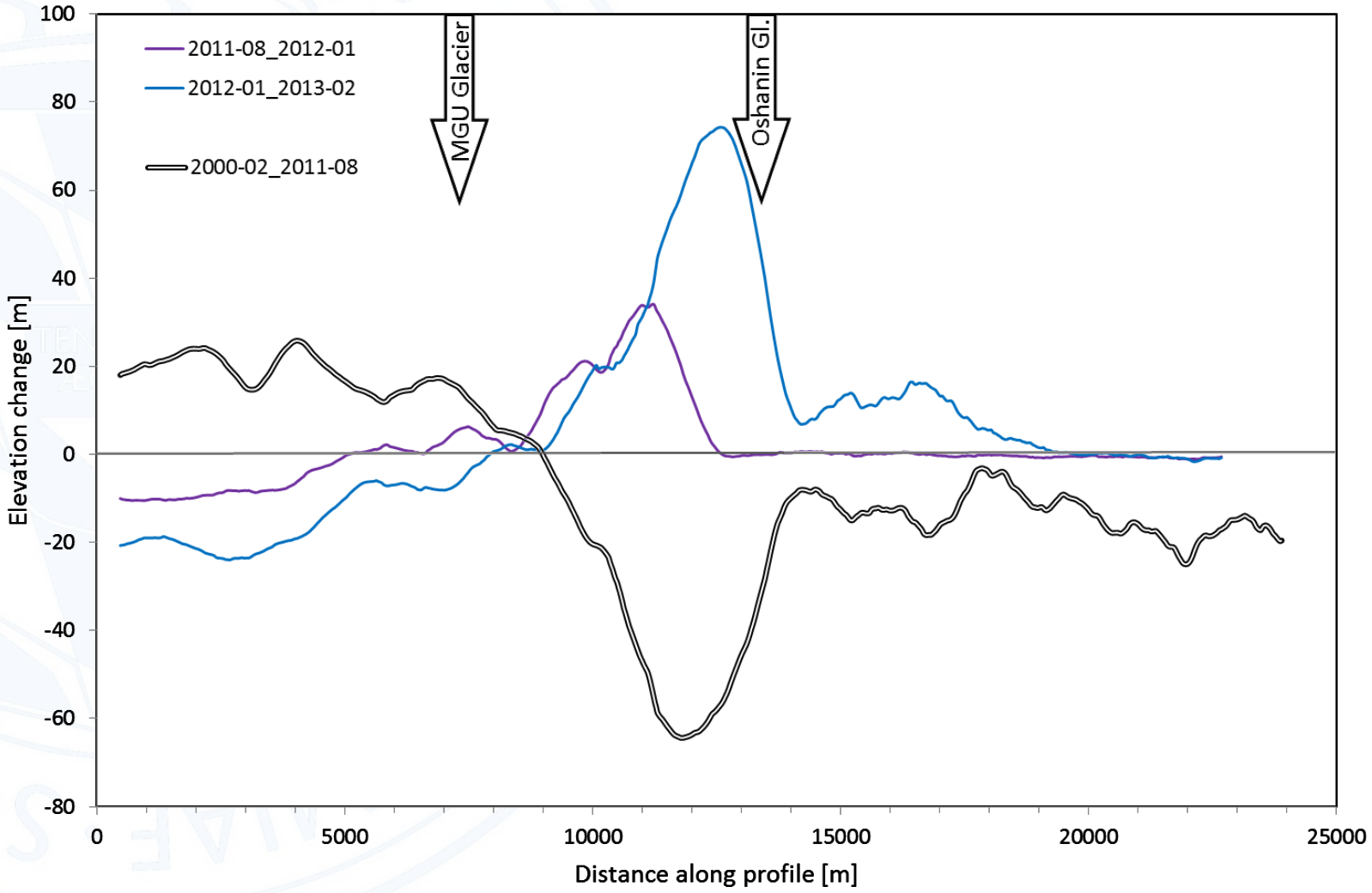

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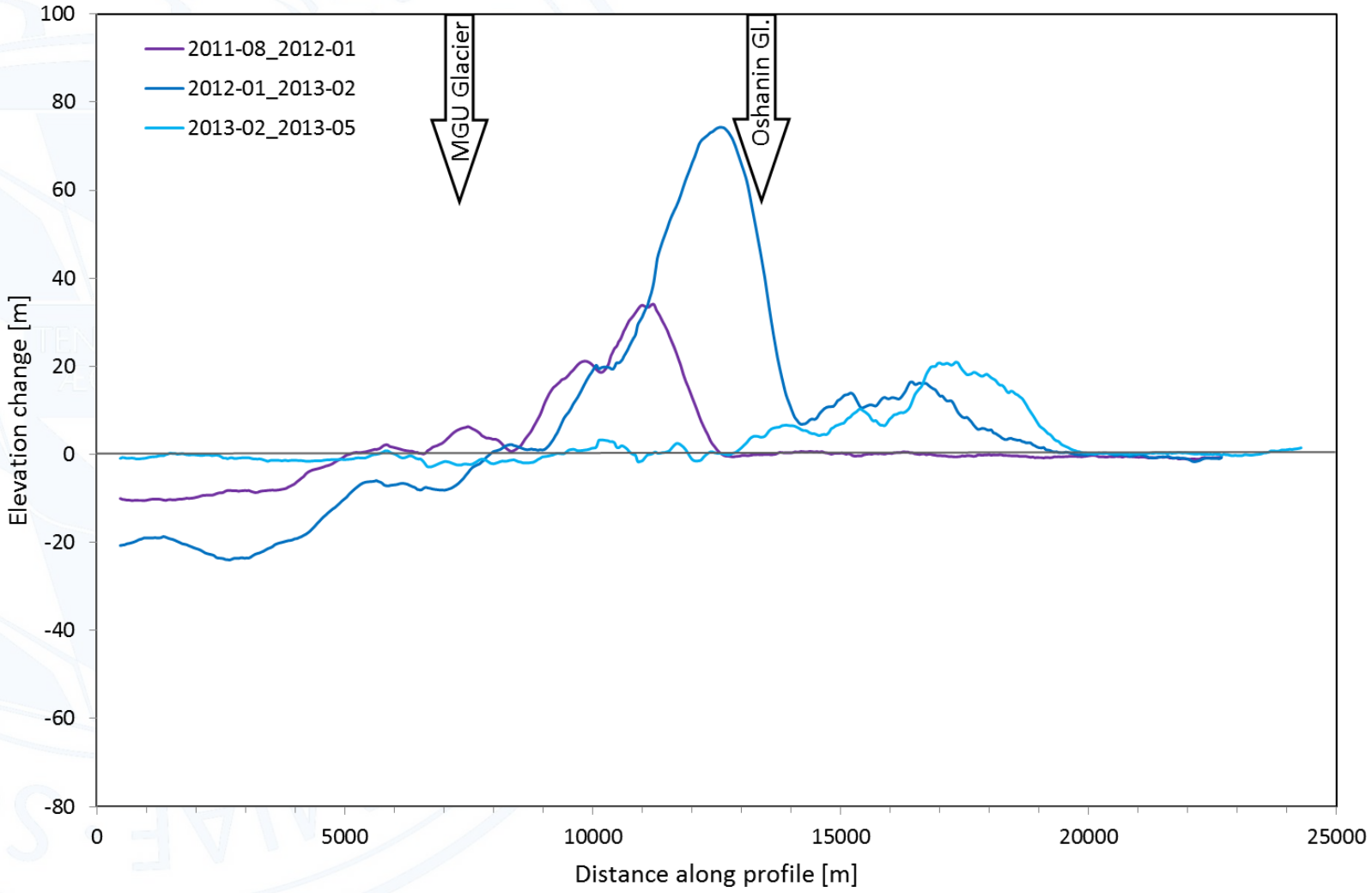

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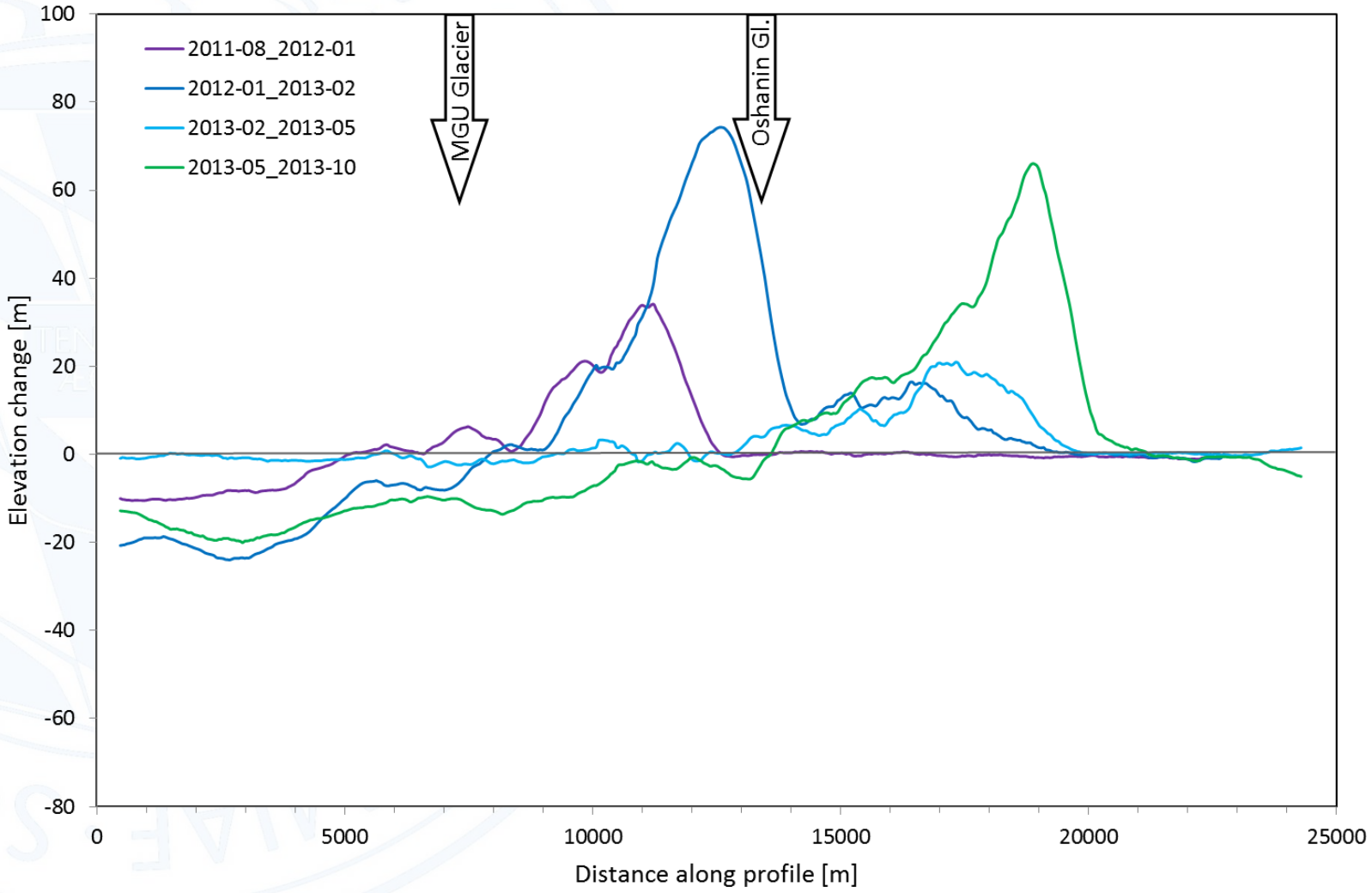

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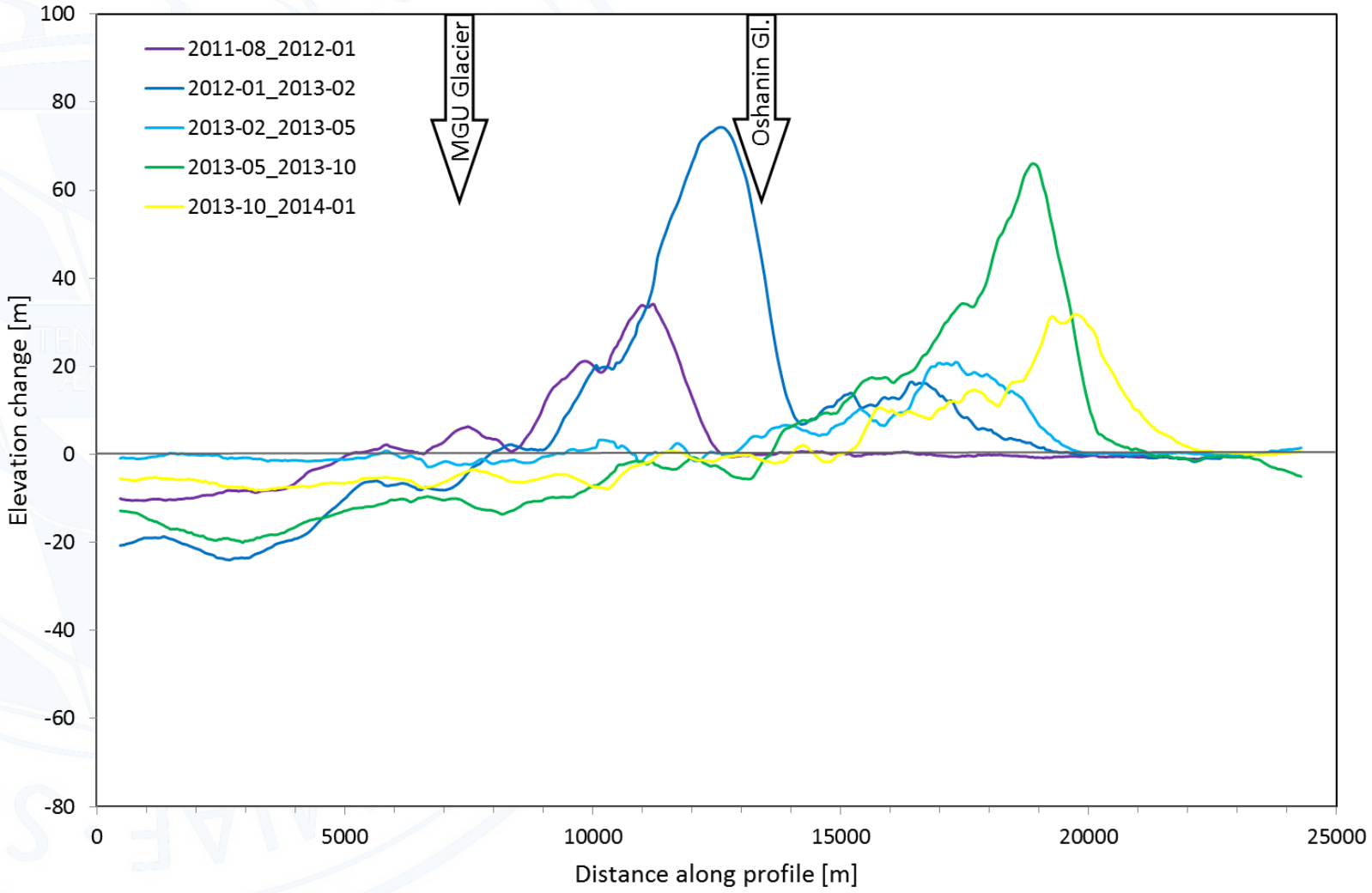

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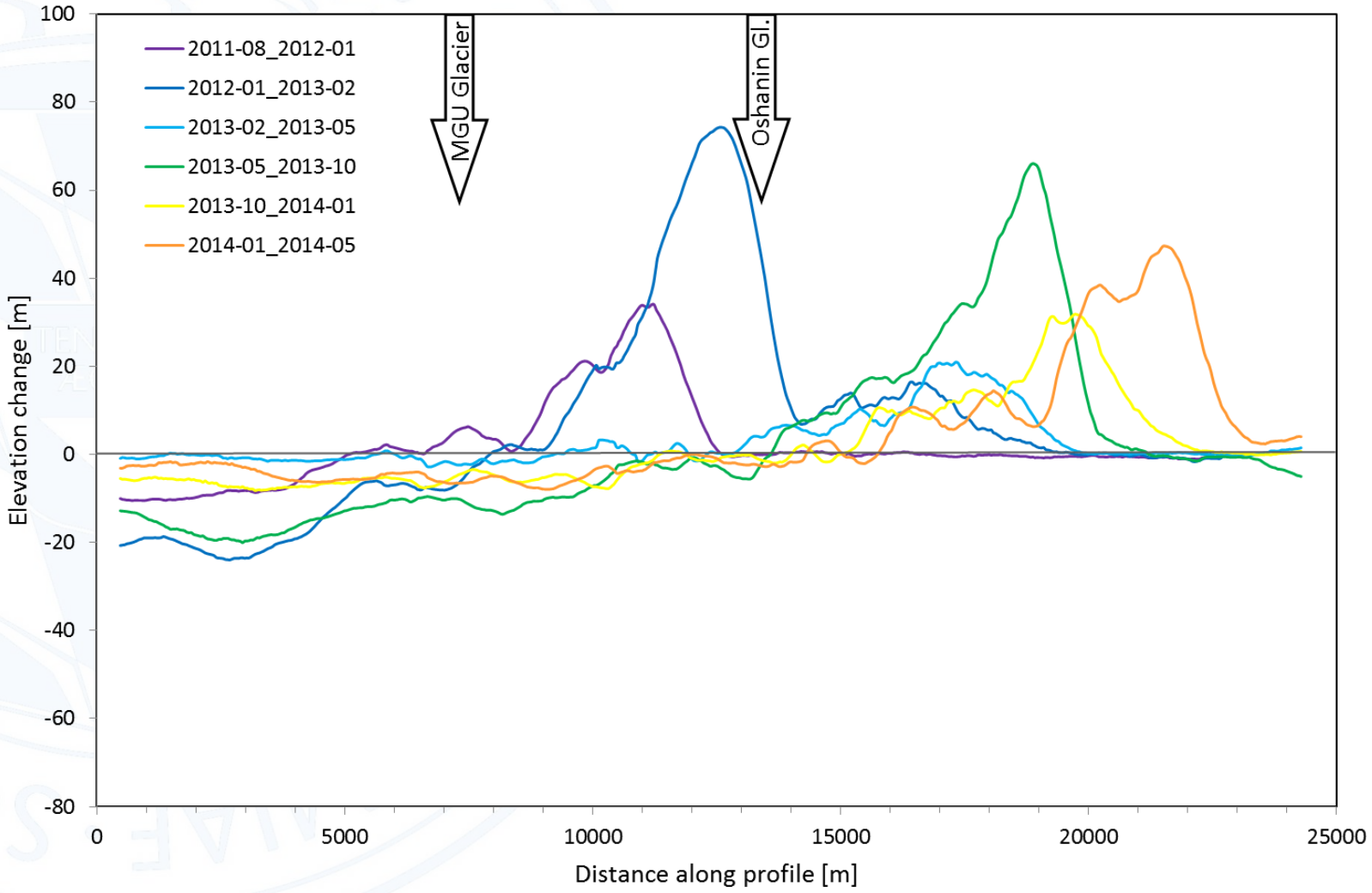

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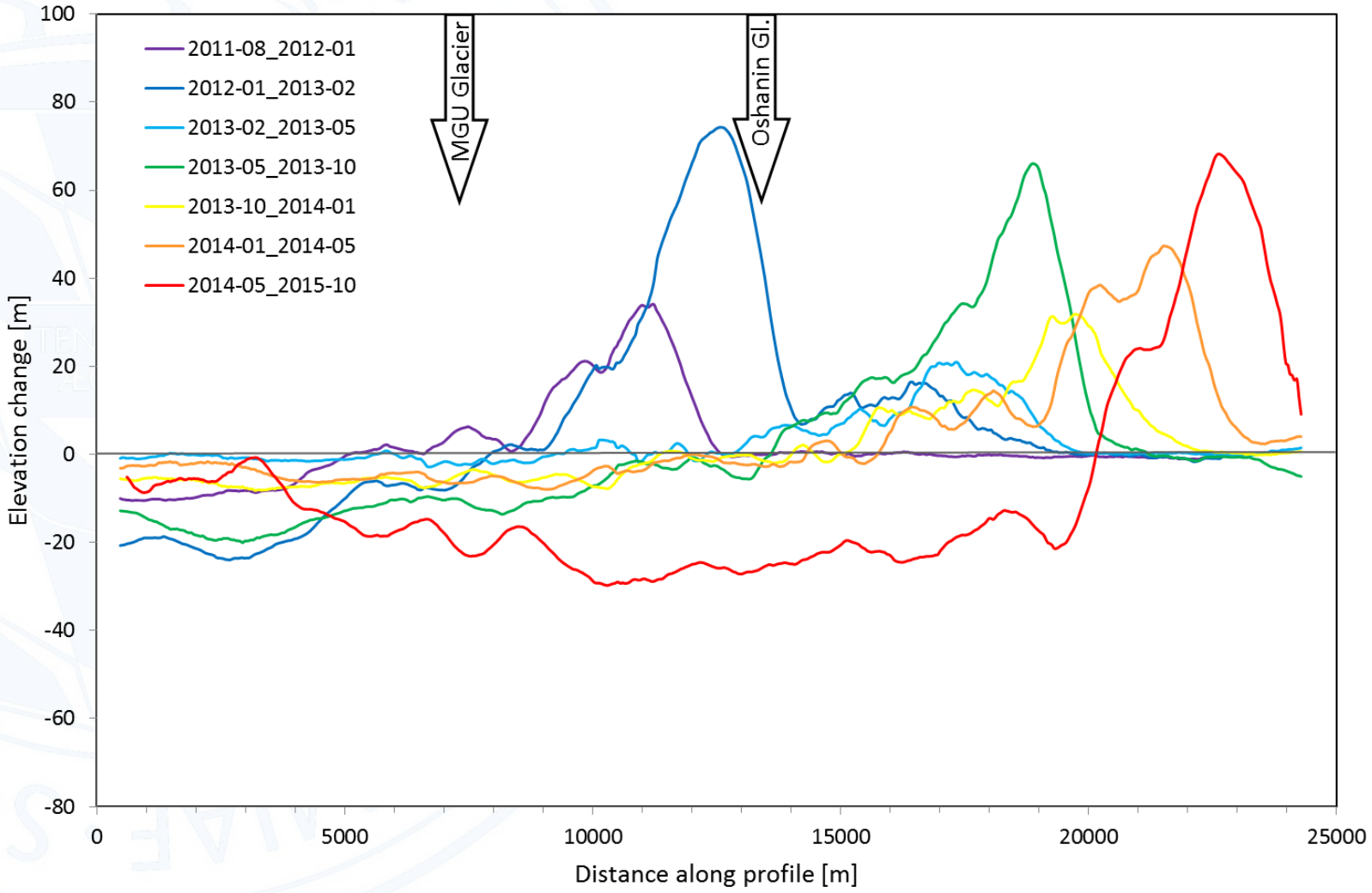

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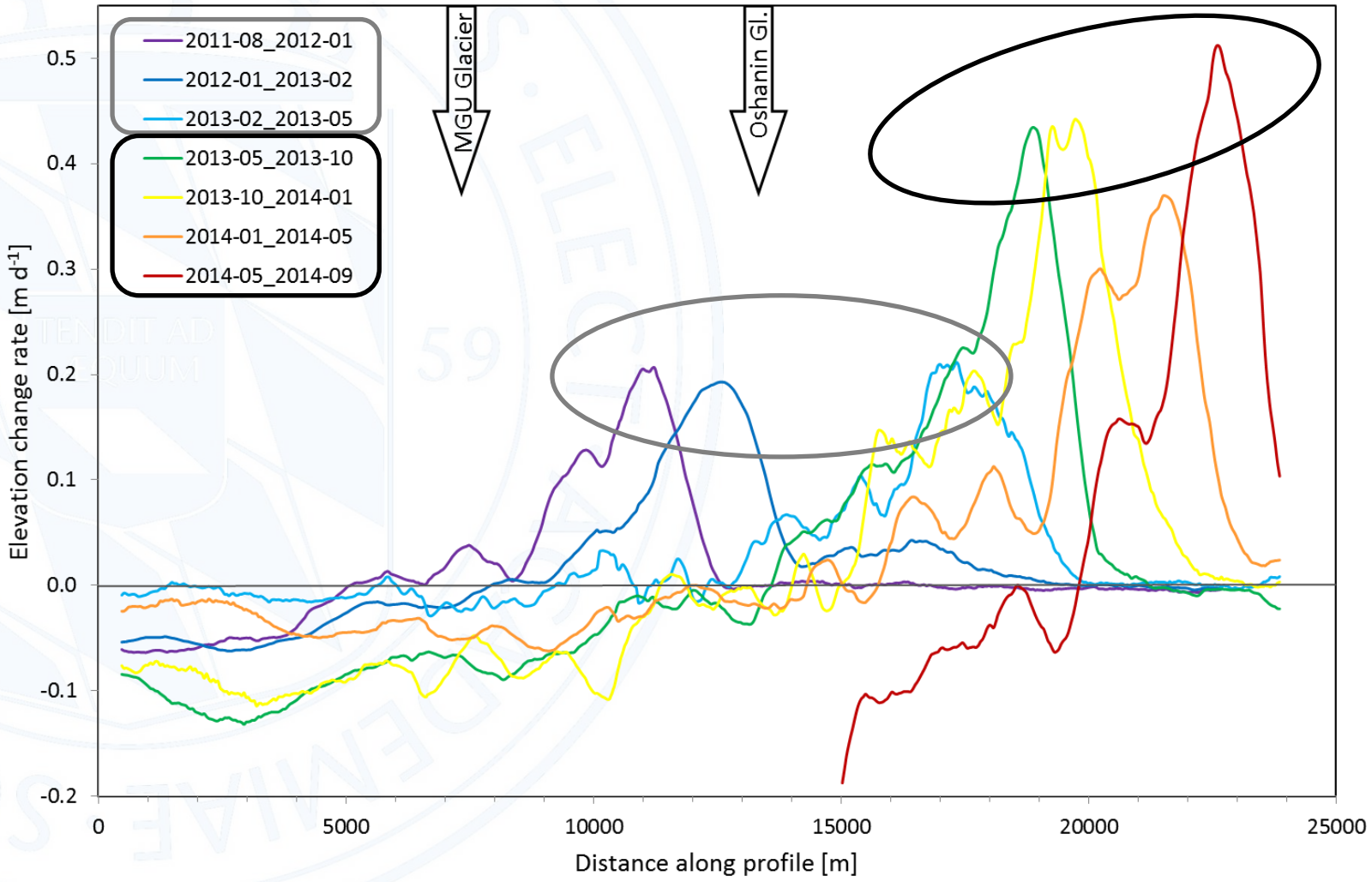

Elevation Changes of Fedchenko Glacier, Pamir Mountains

- Geodetic mass balance signals derived from InSAR are superimposed by short term elevation changes related to:
  - Changes in penetration depths
  - Seasonal cycle due to emergence in ablation area
  - Dynamic effects, e. g. surge behaviour
- For TanDEM-X penetration depth up to 6 m in the accumulation area
- Seasonal uplift in winter and subsidence in summer in the ablation area
- Surge-related elevation changes up to 120 m at Bivachny Glacier
- Negative elevation changes at multi-annual time scales along all the glacier