The glaciers of the Central Karakoram, inventory of an important resource

a *SEED initiative*

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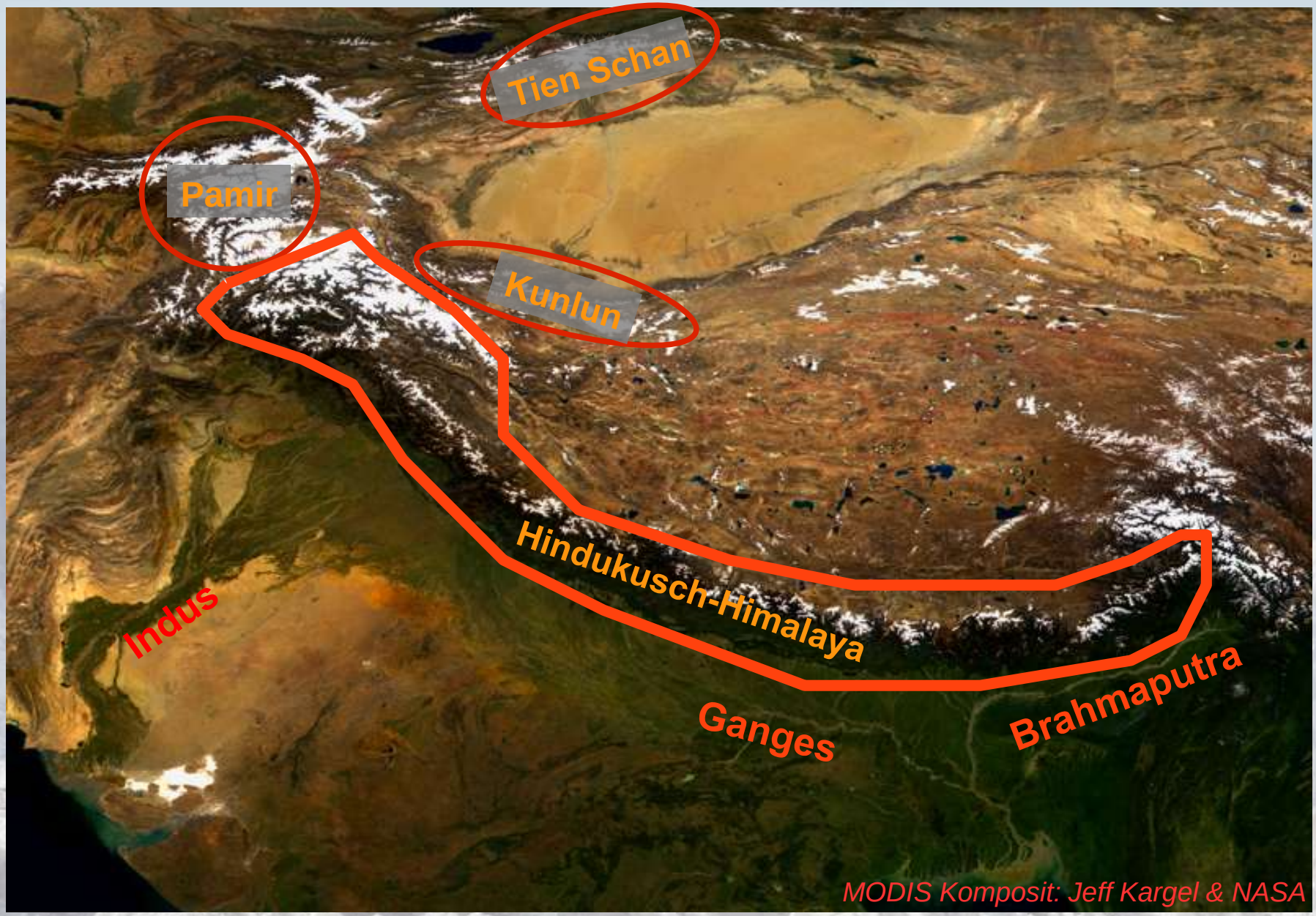
Glaciology in the SEED/SHARE framework

- **Introduction**
- **Remote sensing:**
  - **Glacier inventory**
  - **Snow cover**
- **Field work, past and future**
- **Lessons learned**

Christoph Mayer, Bavarian Academy of Sciences and Humanities, Munich, Germany

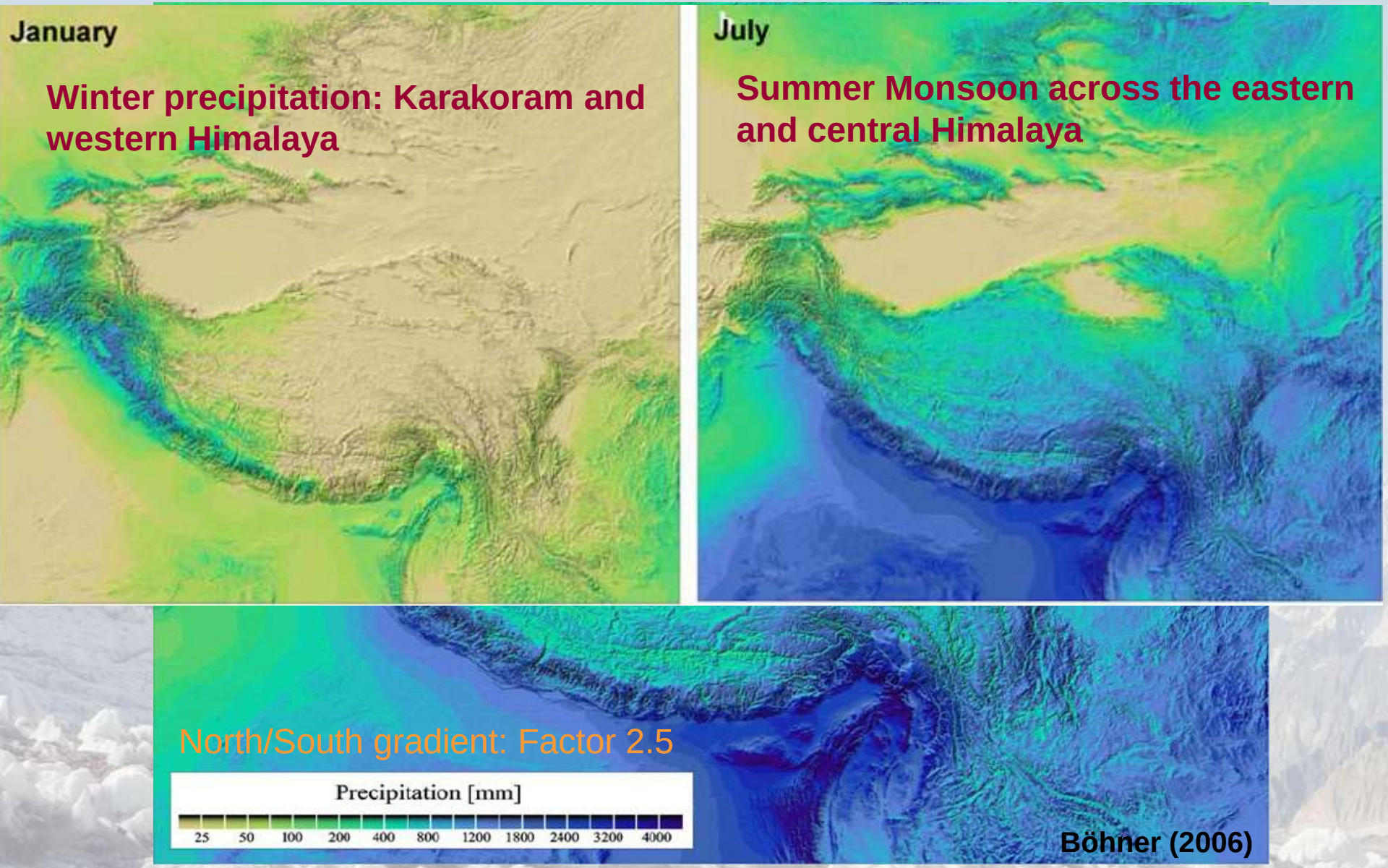

Tien Schan
Pamir
Kunlun
Hindukusch-Himalaya
Indus
Ganges
Brahmaputra
MODIS Komposit: Jeff Kargel & NASA

Glacier areas in High Asia:

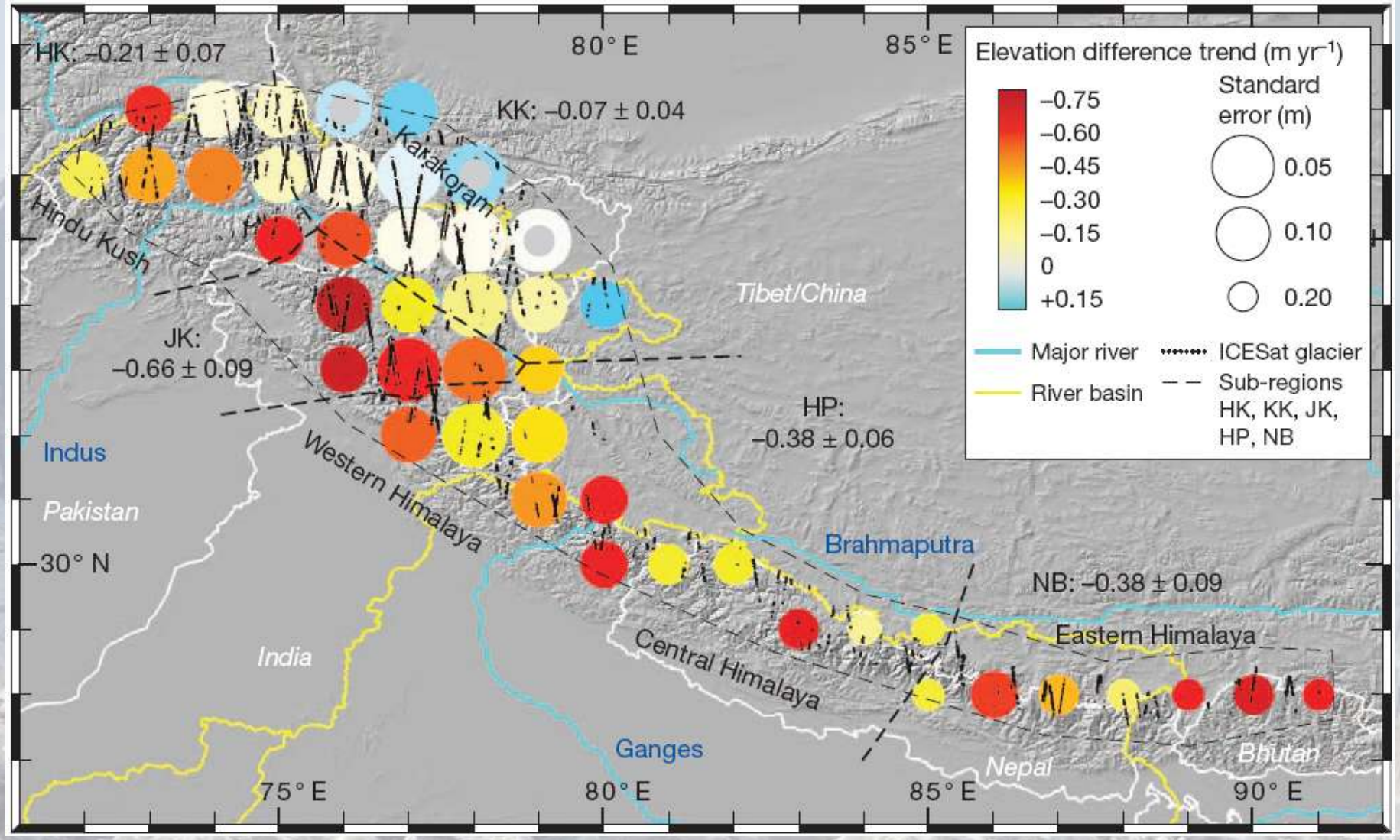
Himalaya:	16 700 km²
Karakoram:	16 600 km²
Hindukush:	9 400 km²
Tian Shan:	15 400 km²
Pamir:	12 200 km²
Kunlun:	12 200 km²
as a comparison:	
Alps:	2 350 km²

Dyurgerov & Meier, 2005

Precipitation and seasonality

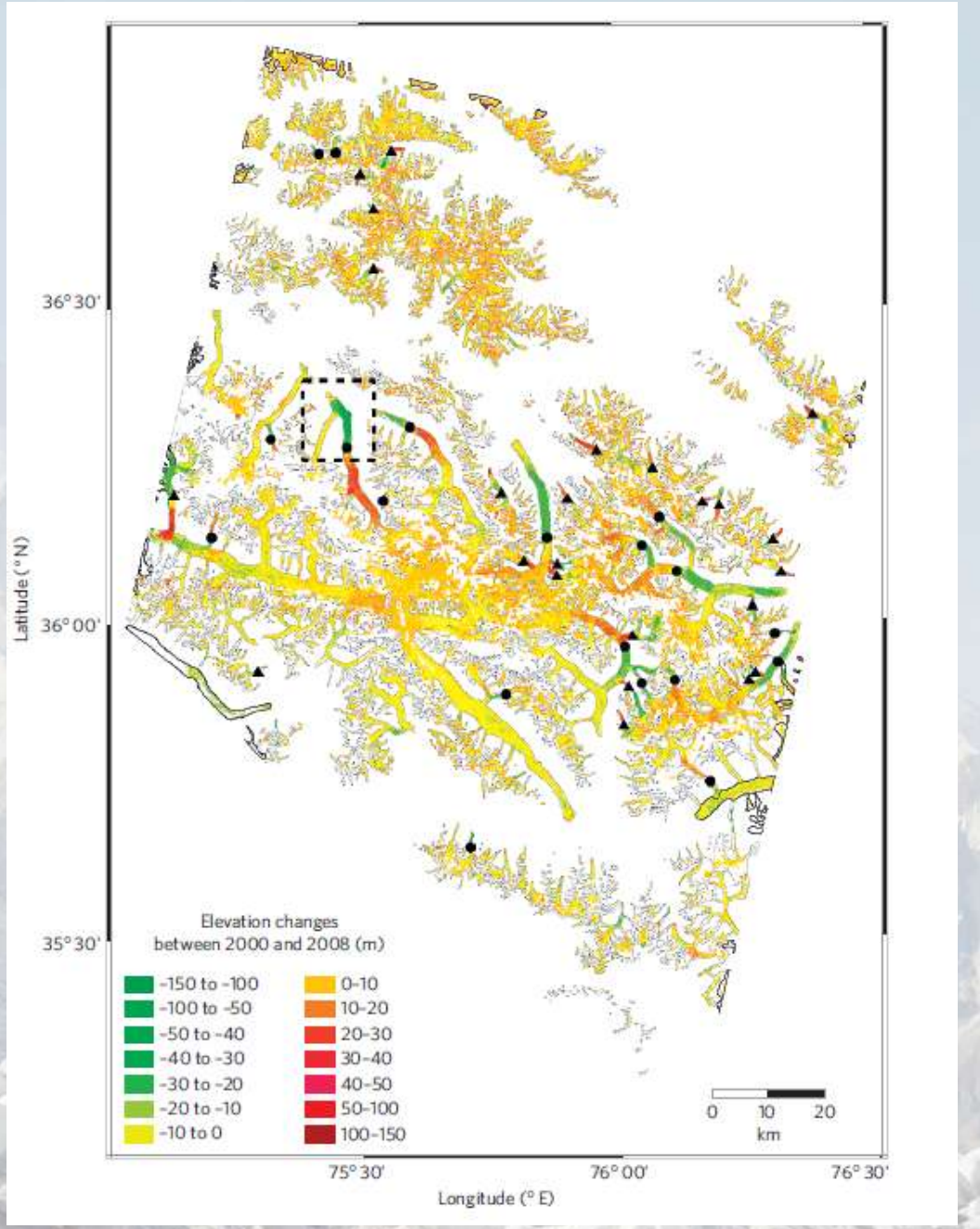


HKH glacier elevation change 2003 - 2008



(Kääb et al, 2012)

Karakoram glacier elevation change 2000 - 2008



(Gardelle et al. 2012)

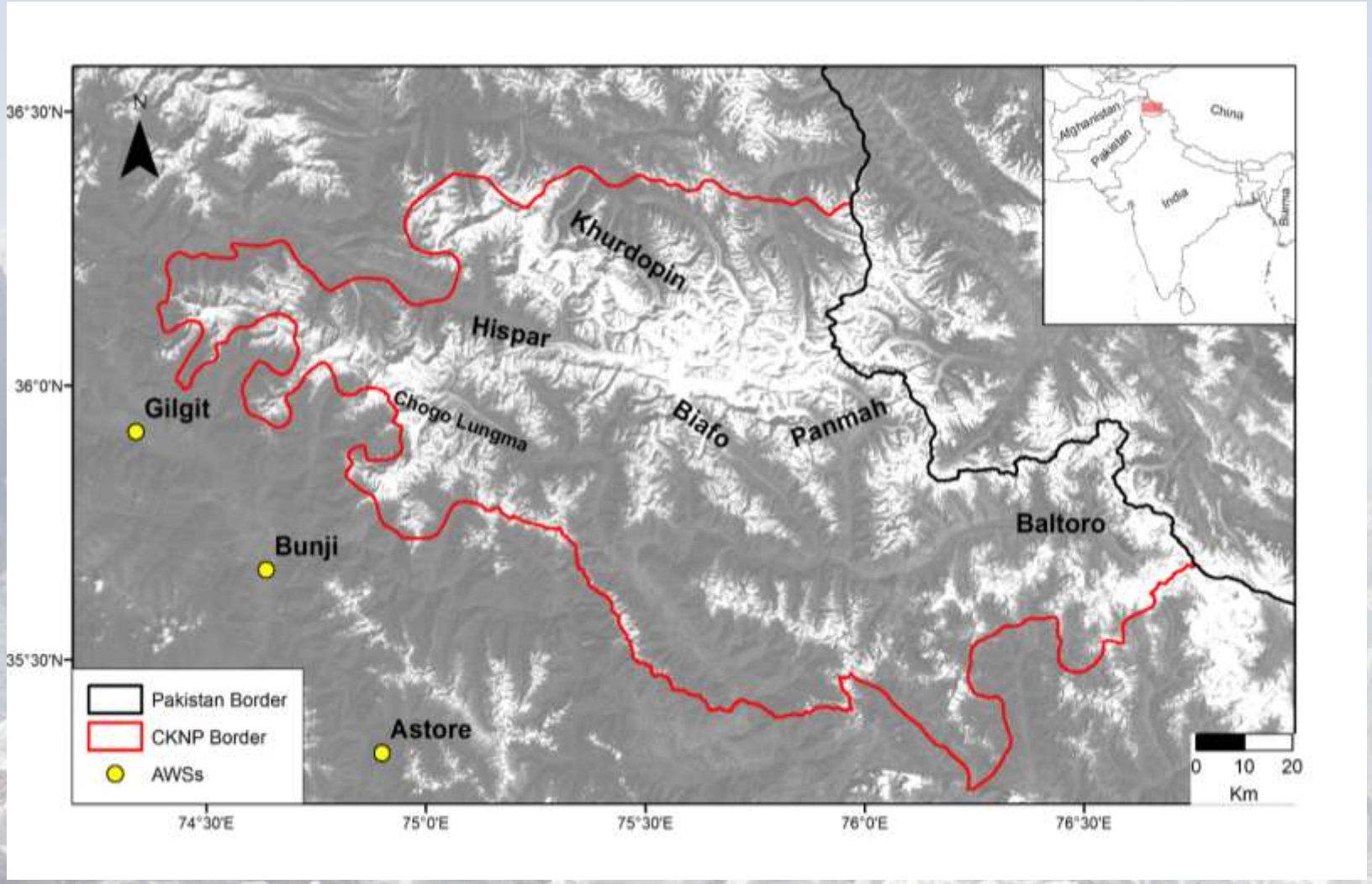
A new glacier inventory for the CKNP

- Two dates: Landsat 7 acquired on 30th September 2001 and on 21st July 2010
- About 700 glaciers in the CKNP (4600 km²)

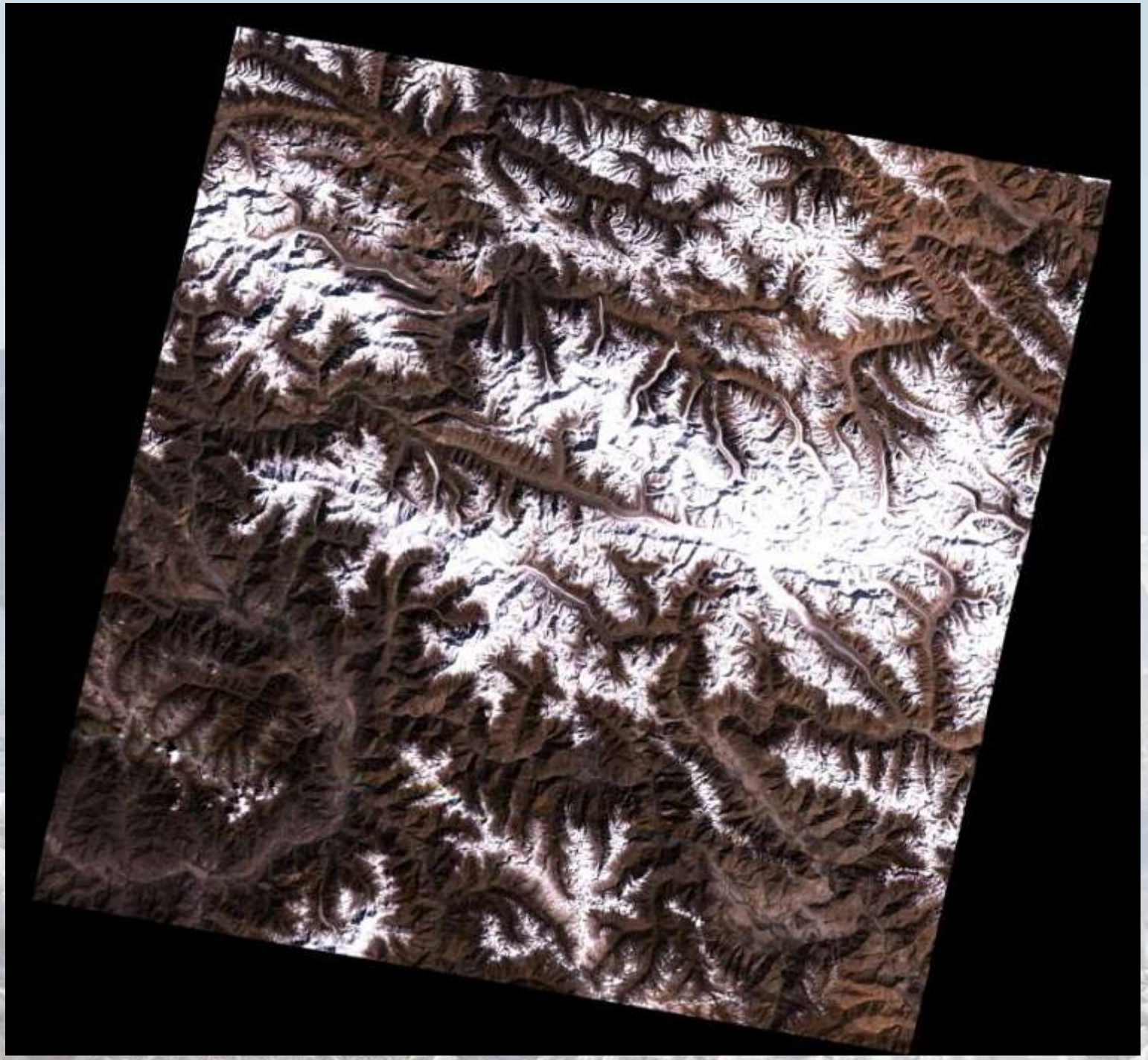
GLACIOLOGICAL PARAMETERS:

- NAME
- NUMBER (code)
- COORDINATES (WGS-1984 DATUM)
- MEAN THICKNESS
- SURFACE AREA
- MAXIMUM AND MEAN LENGHT
- WIDHT
- ORIENTATION AND MEAN ASPECT
- (MAXIMUM, MINIMUM, MEAN) ELEVATION
- MORPHOLOGICAL CLASSIFICATION
- SOURCE OF NOURISHMENT
- SNOW LINE ALTITUDE (SLA)

The National Park and its glaciers

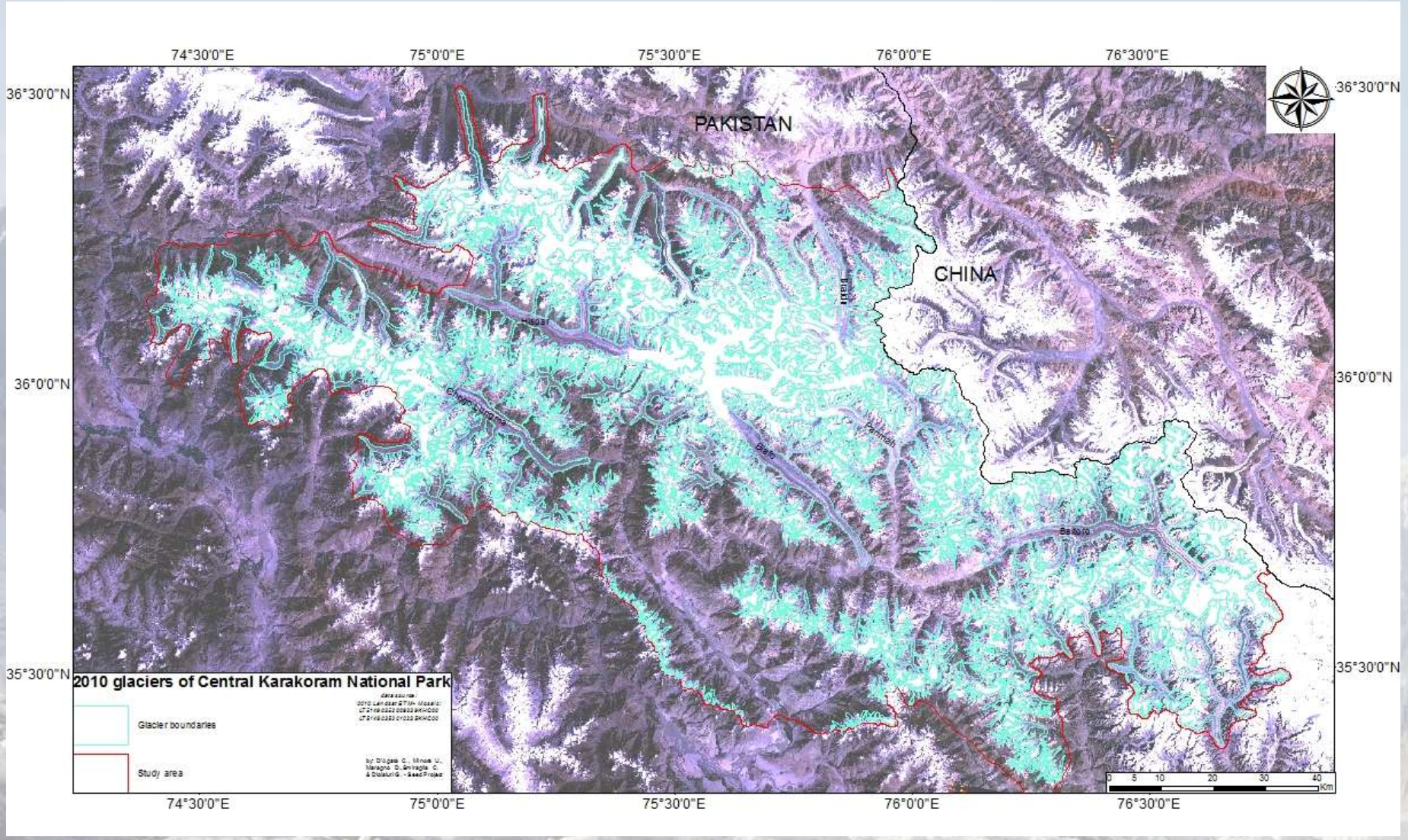


Park area: 12162 km², glacier inventory area: 13200 km²

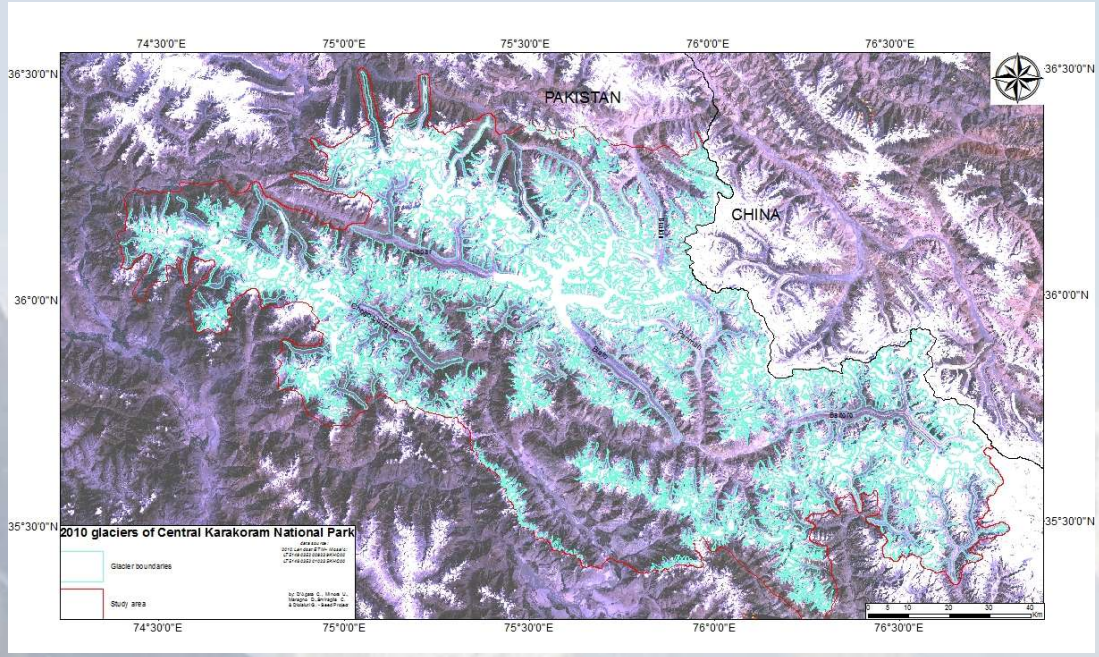


Landsat 7
bands 3,2 1
visible

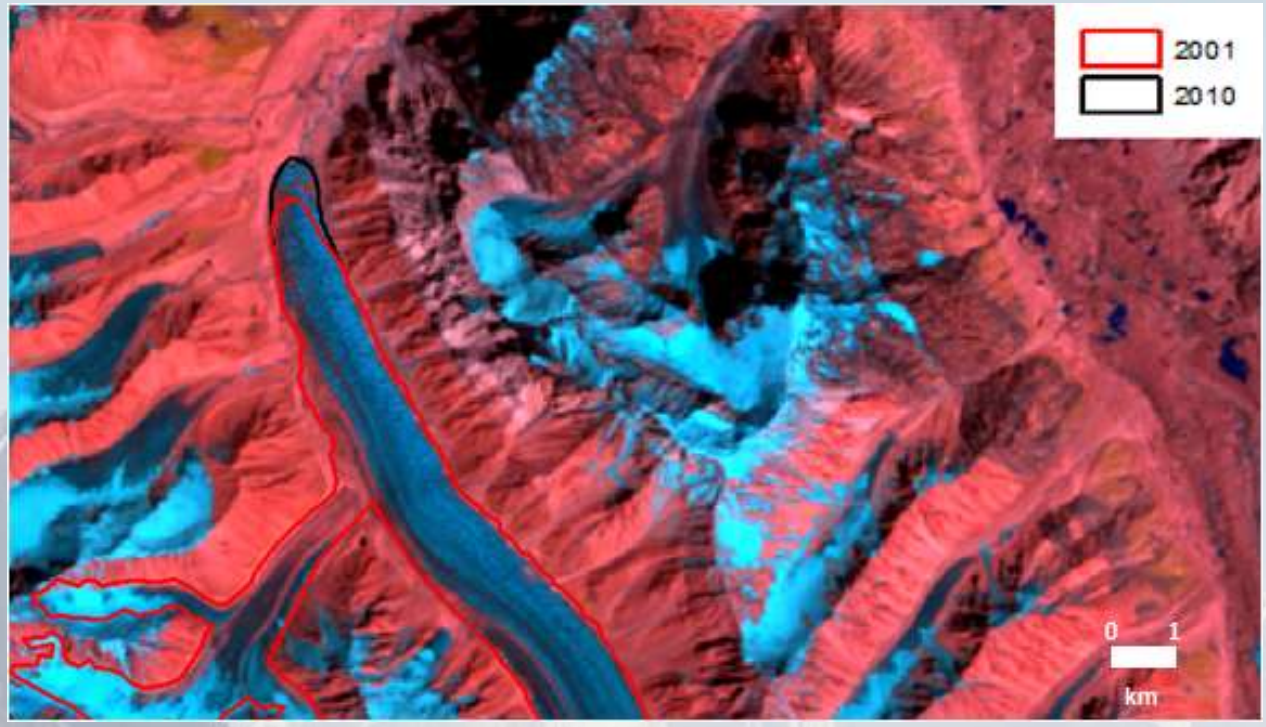
Result: CKNP glacier inventory



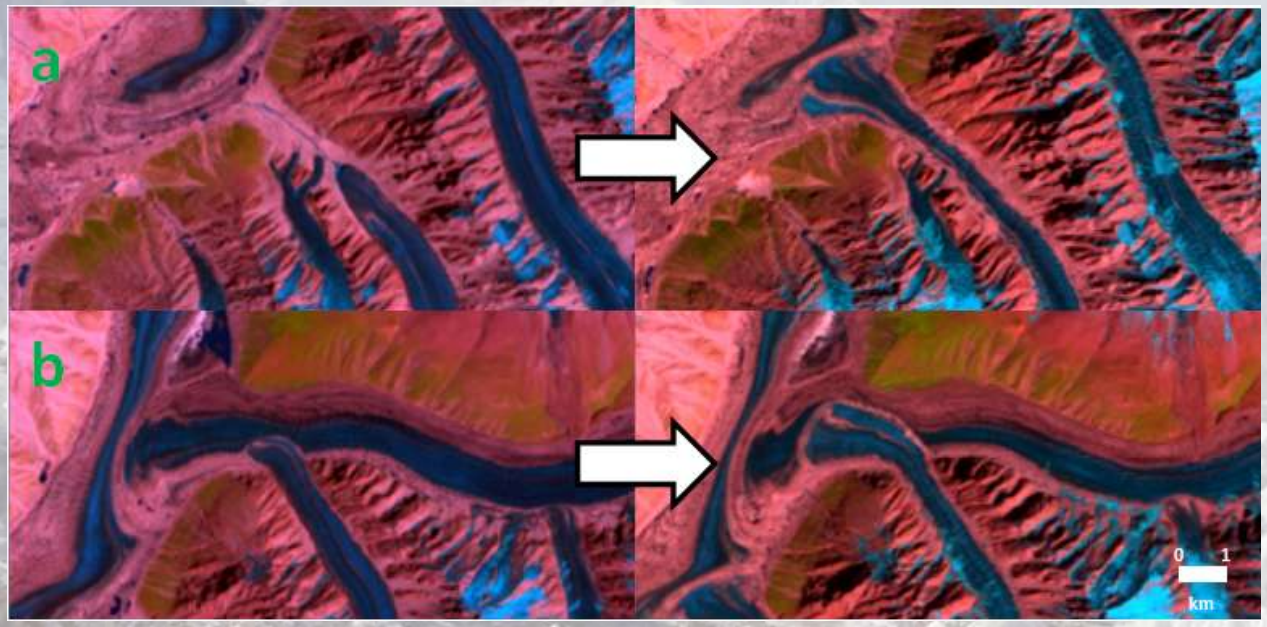
Result: CKNP glacier inventory



711 glaciers
4587 km² glacier area in 2001
4613 km² glacier area in 2010
35% of the AOI
maximum glacier area at ca. 5200 m



Example of an advancing glacier terminus near Braldu glacier from 2001-2010.

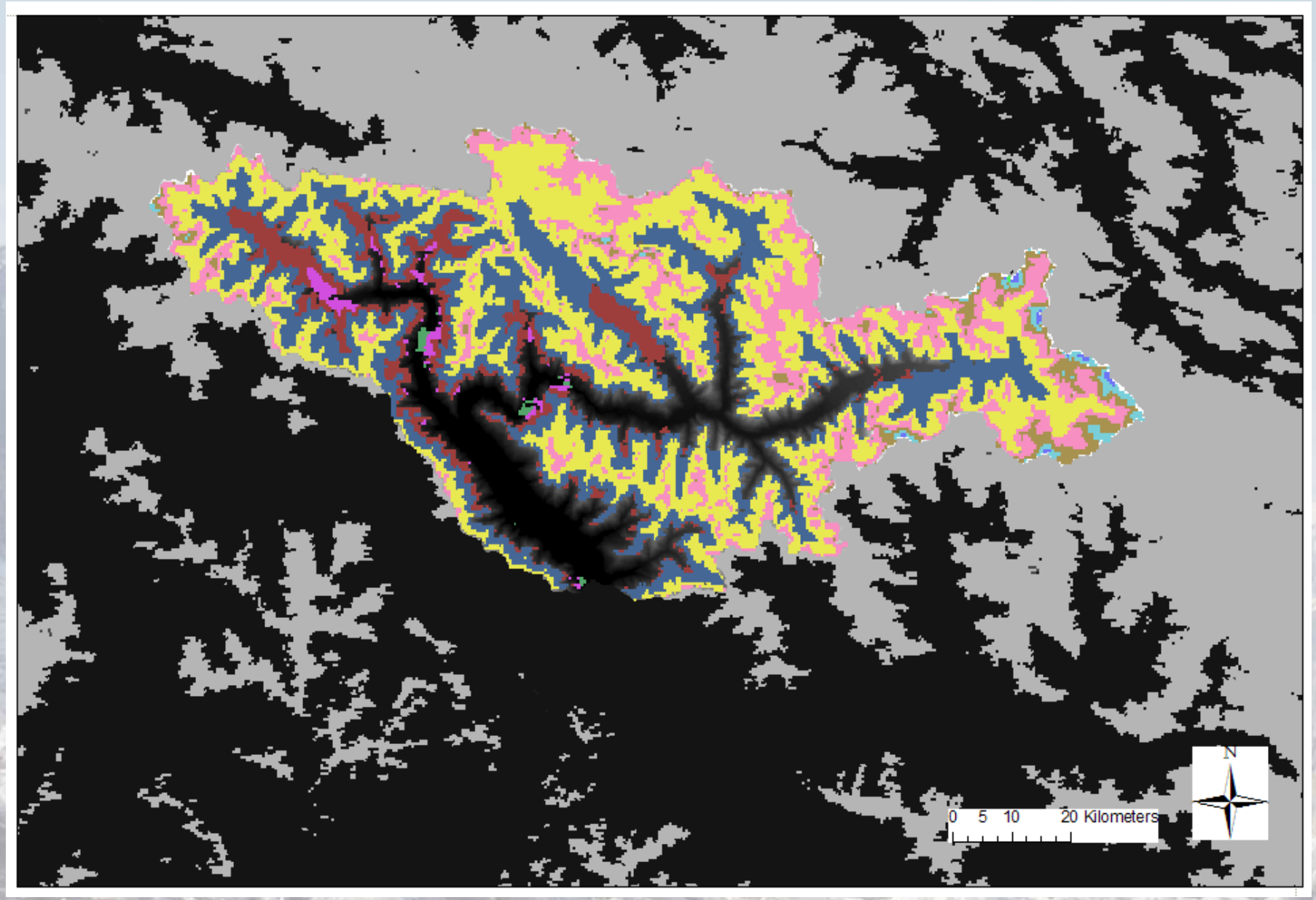


Comparison of Panmah glacier tributaries position in 2001 (left) and 2010 (right).

Moderate Resolution **I**maging **S**pectroradiometer (MODIS) snow products for snow cover investigation

spatial resolution ~500m

Period 2000–2011


0 5 10 20 Kilometers
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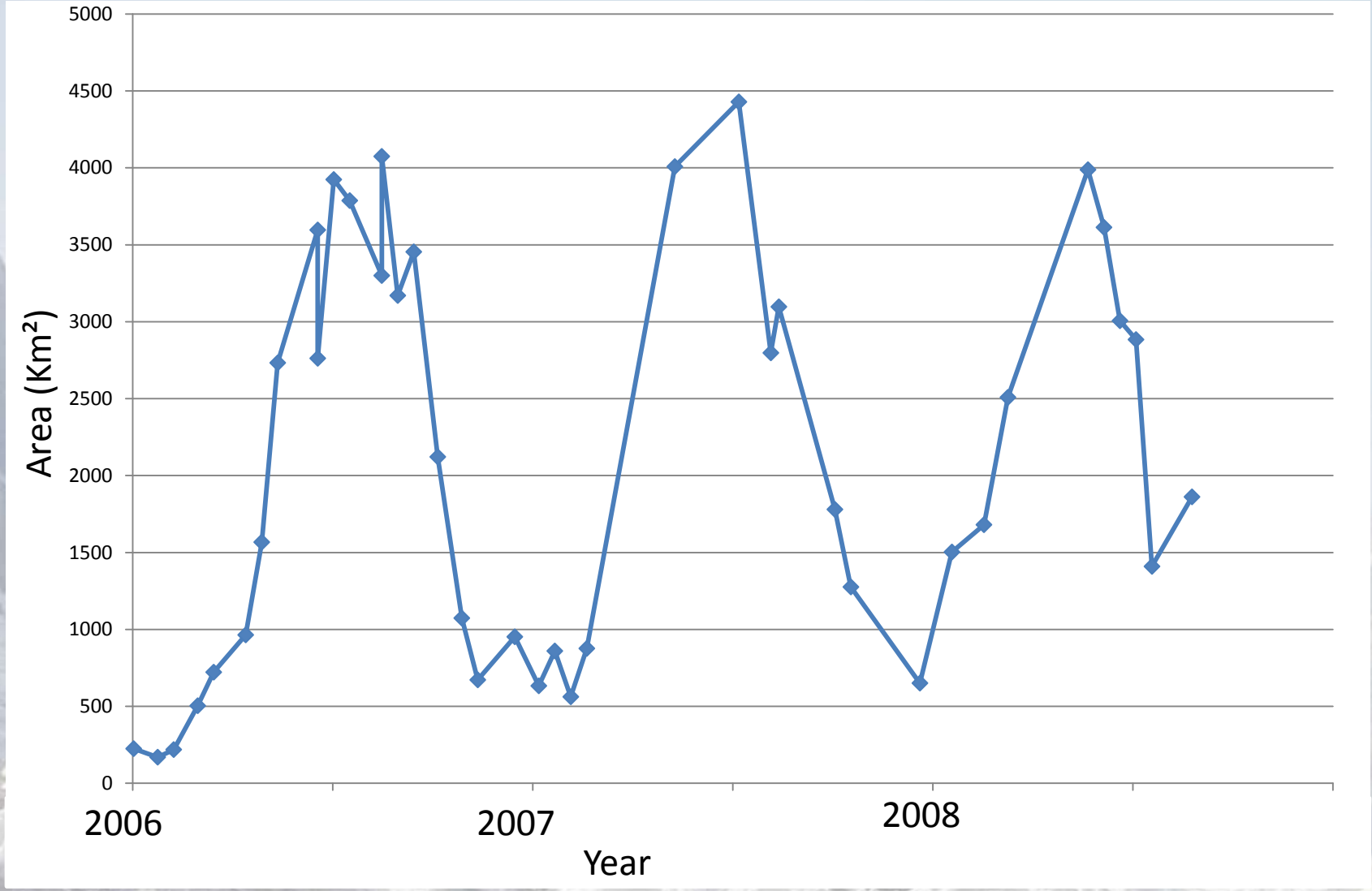
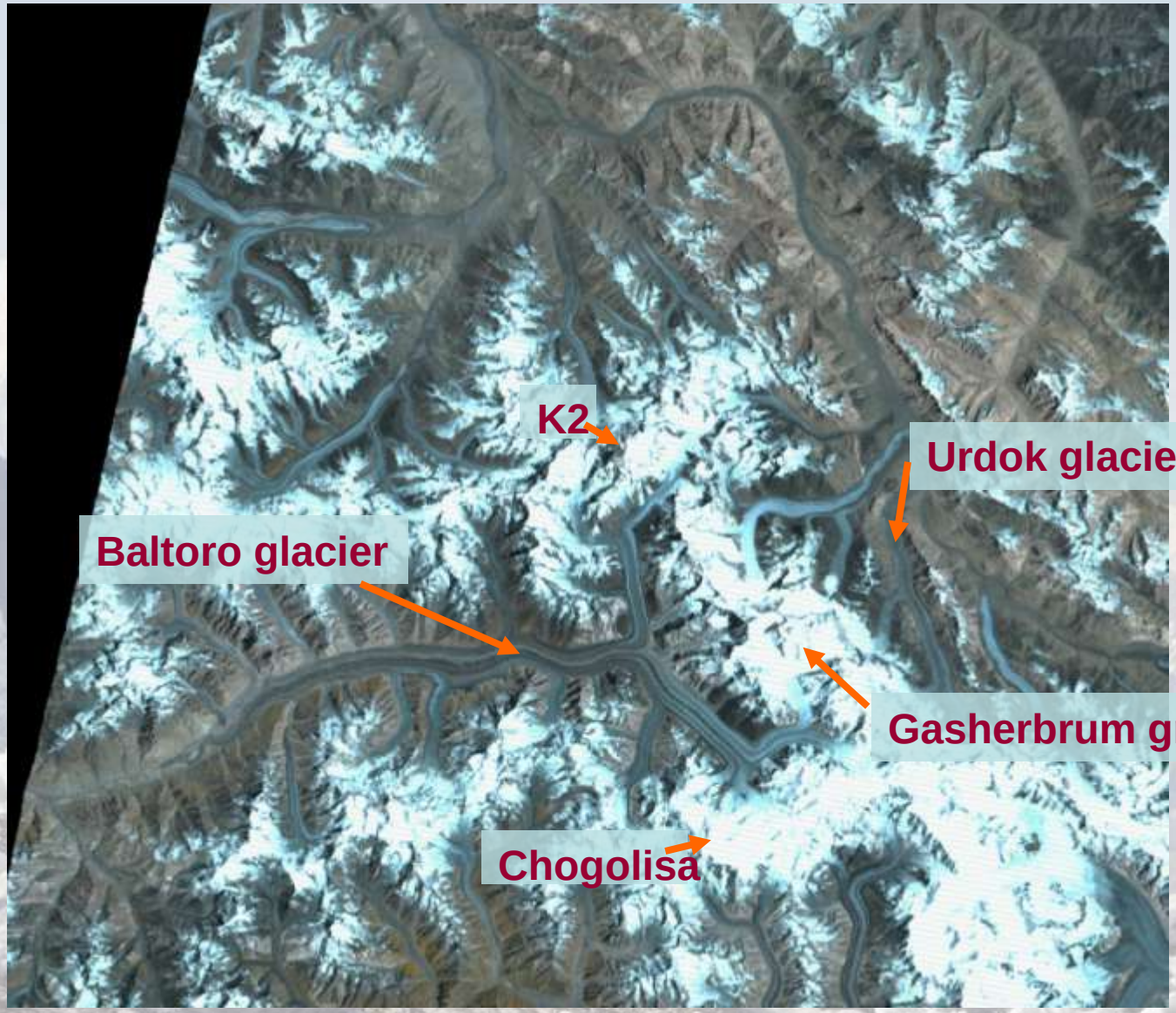
Multiannual snow cover variability



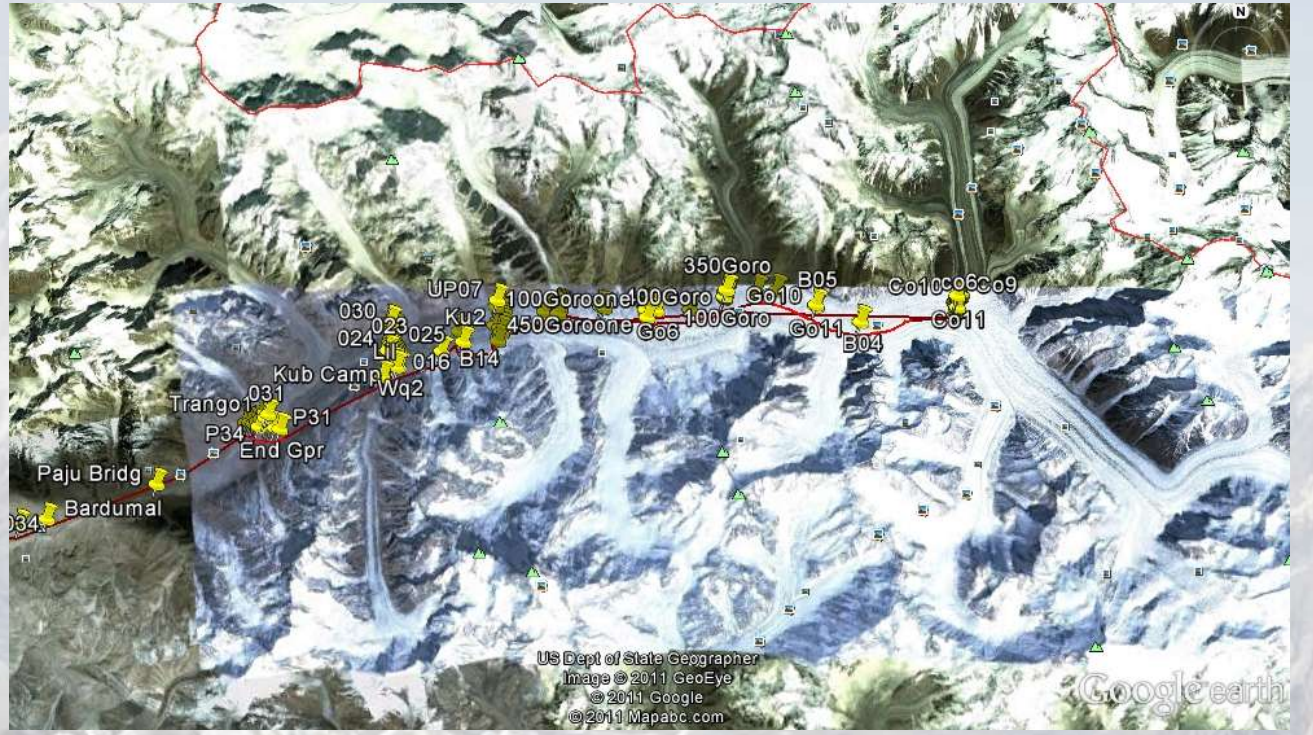
Glaciological activities in the Central Karakoram



Glaciology on Baltoro glacier

Ablation zone activities:

- stake network
- sub-debris ablation
- debris temperature
- stake positions
- surface elevation
- debris thickness
- ice thickness

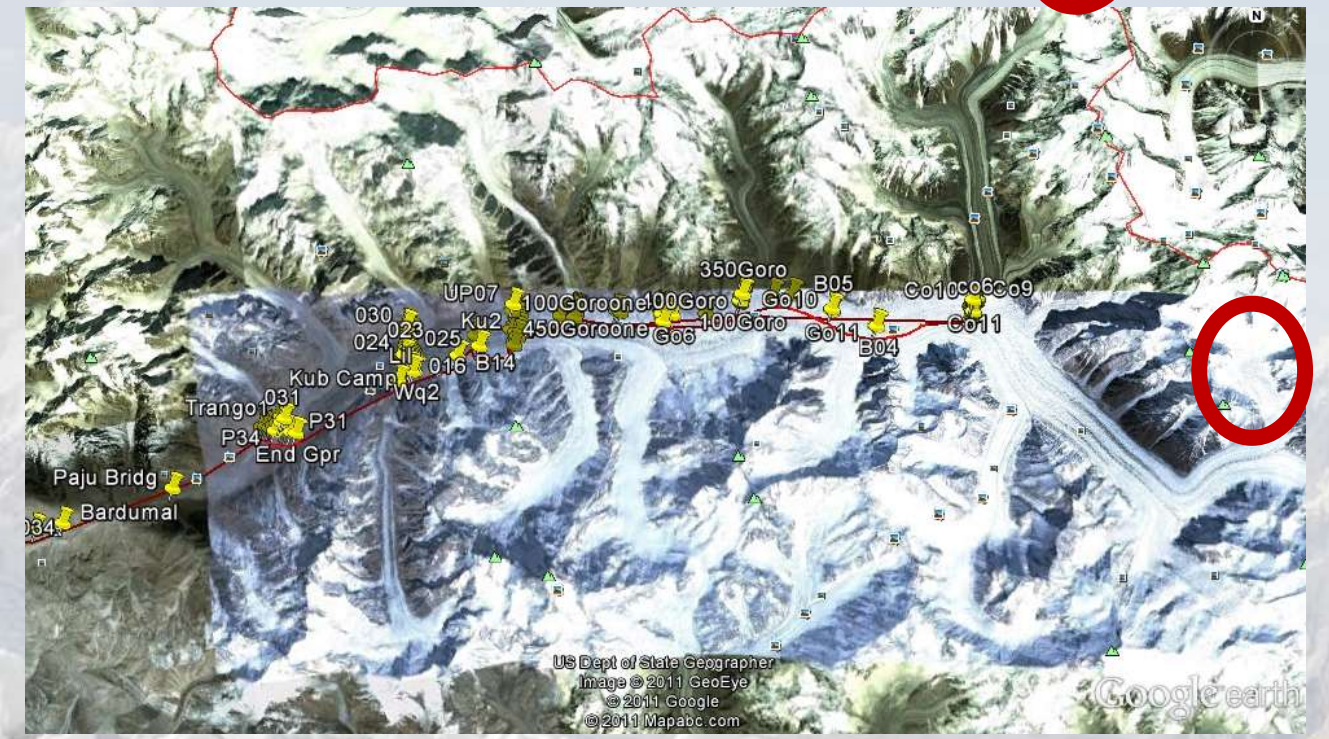


Baltoro Glacier with location of activities

Glaciology on Baltoro glacier

Accumulation studies:

- Snow pits
- Snow/firn samples
- Firn stratification
- Ice thickness

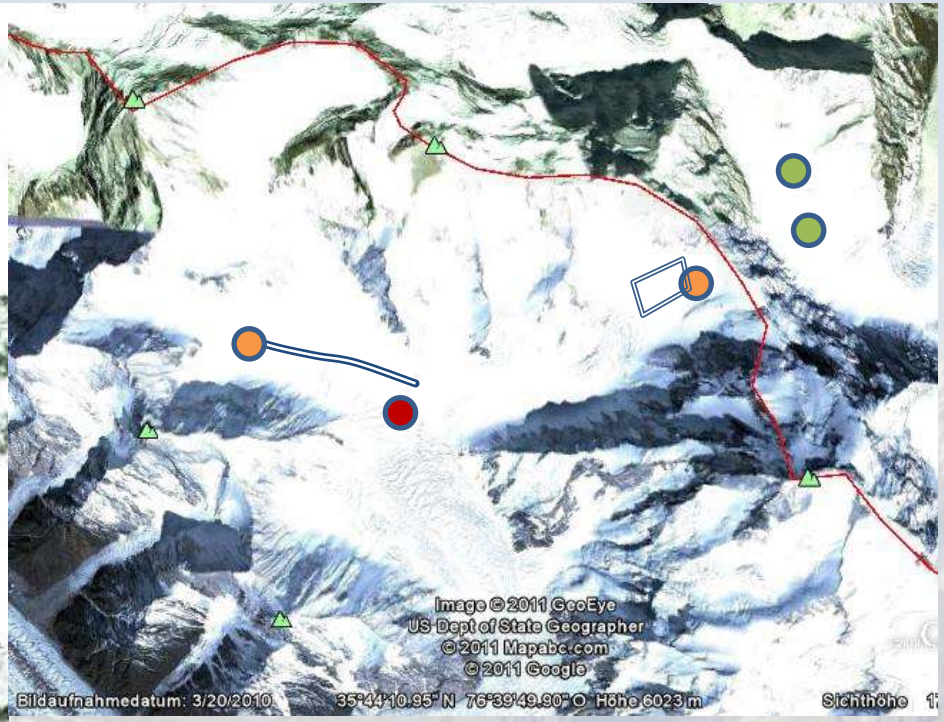


Baltoro Glacier with location of activities

Glaciology on Baltoro glacier

Accumulation studies:

- Godwin Austen, Gasherbrum basin



Baltoro glacier 2011

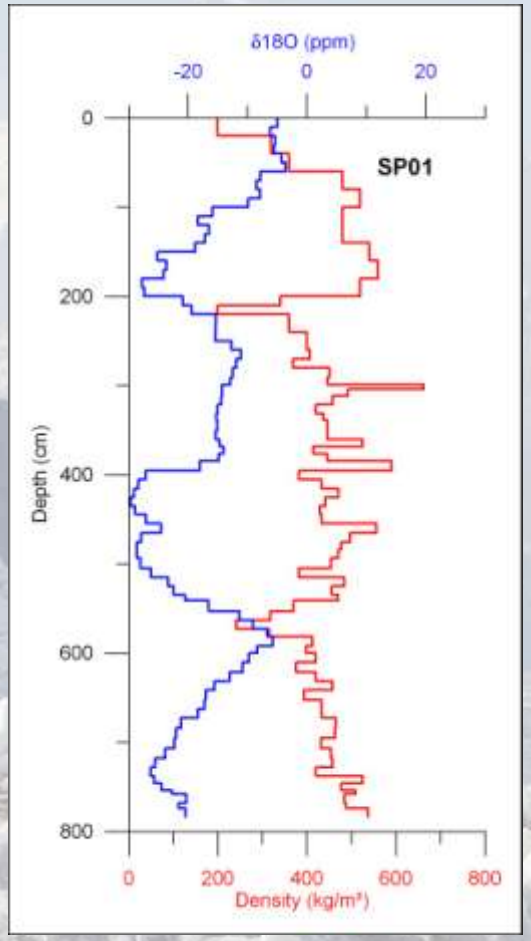
Accumulation studies:

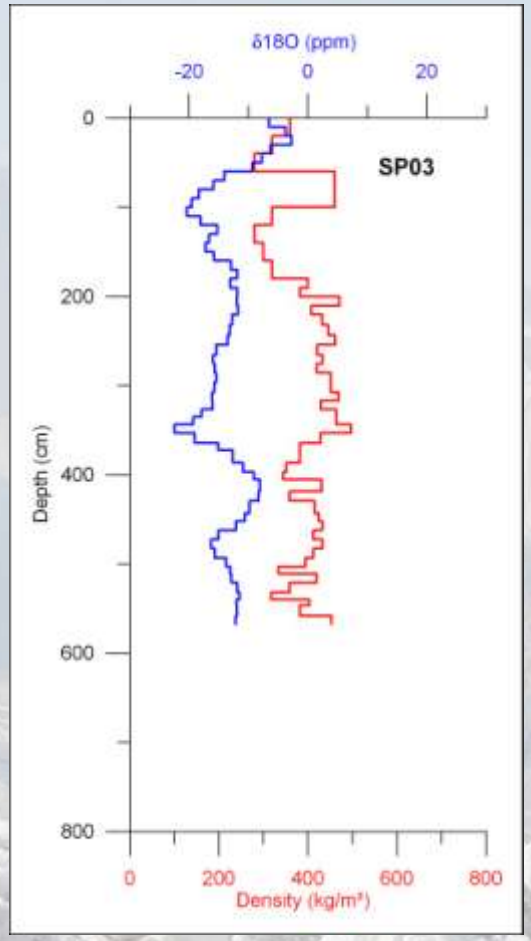
- Snow/firn sampling

Results 2011

Accumulation studies:

- Snow pits, Godwin Austen (5900 m), Gasherbrum (5850 m)

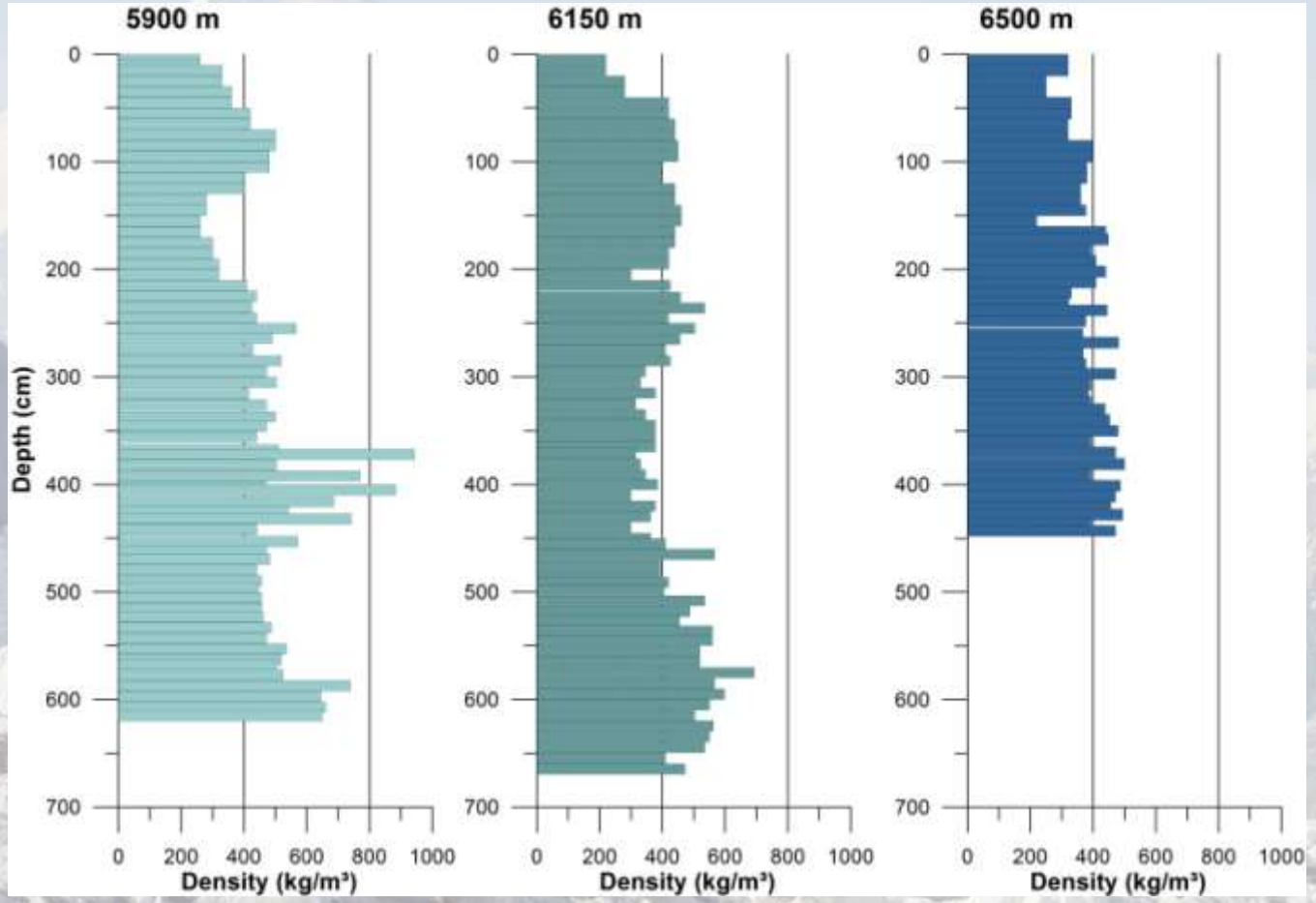




Results 2013

Accumulation studies:

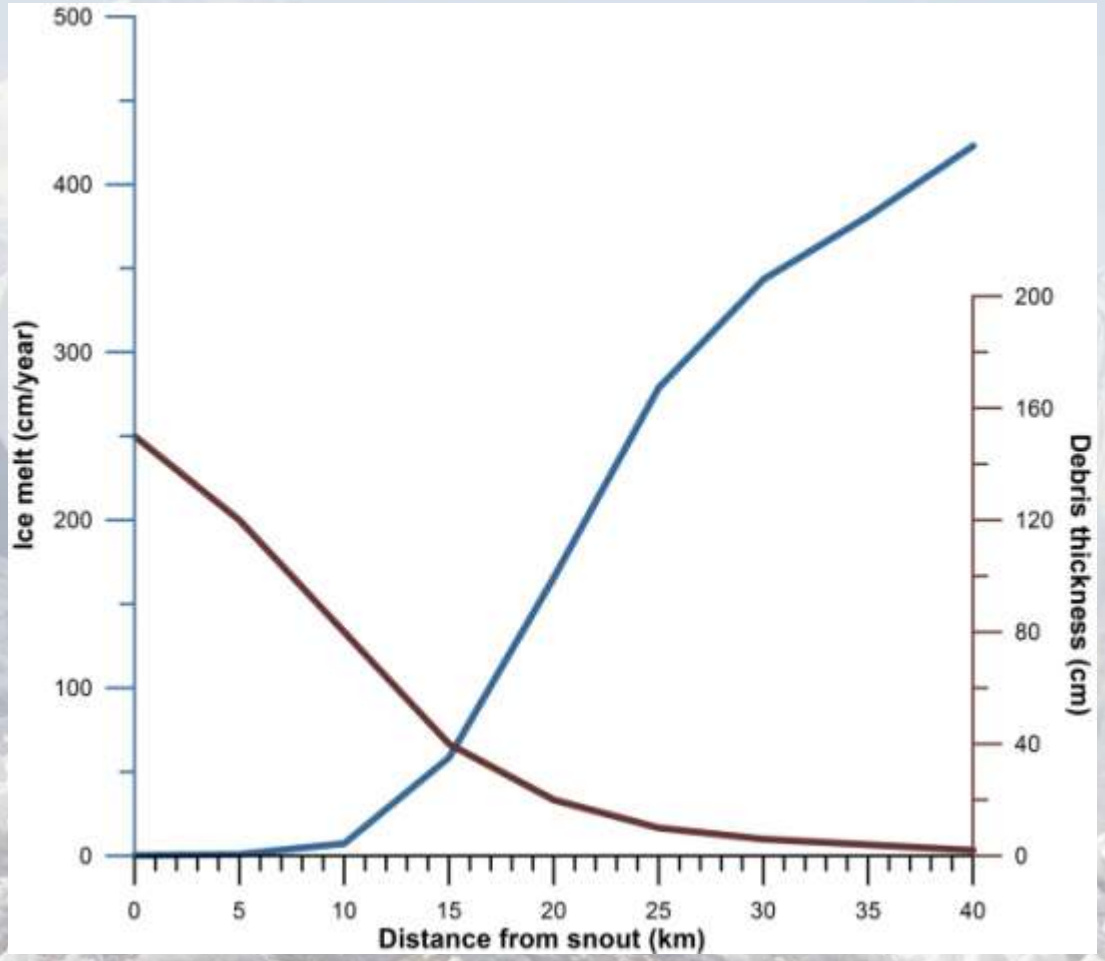
- Snow pits, Camp 1 (5900 m), Gasherbrum basin (6150 m), Gasherbrum La (6500 m)



Results

Ablation studies:

- Melt modelling across the glacier tongue based on stake measurements



Results

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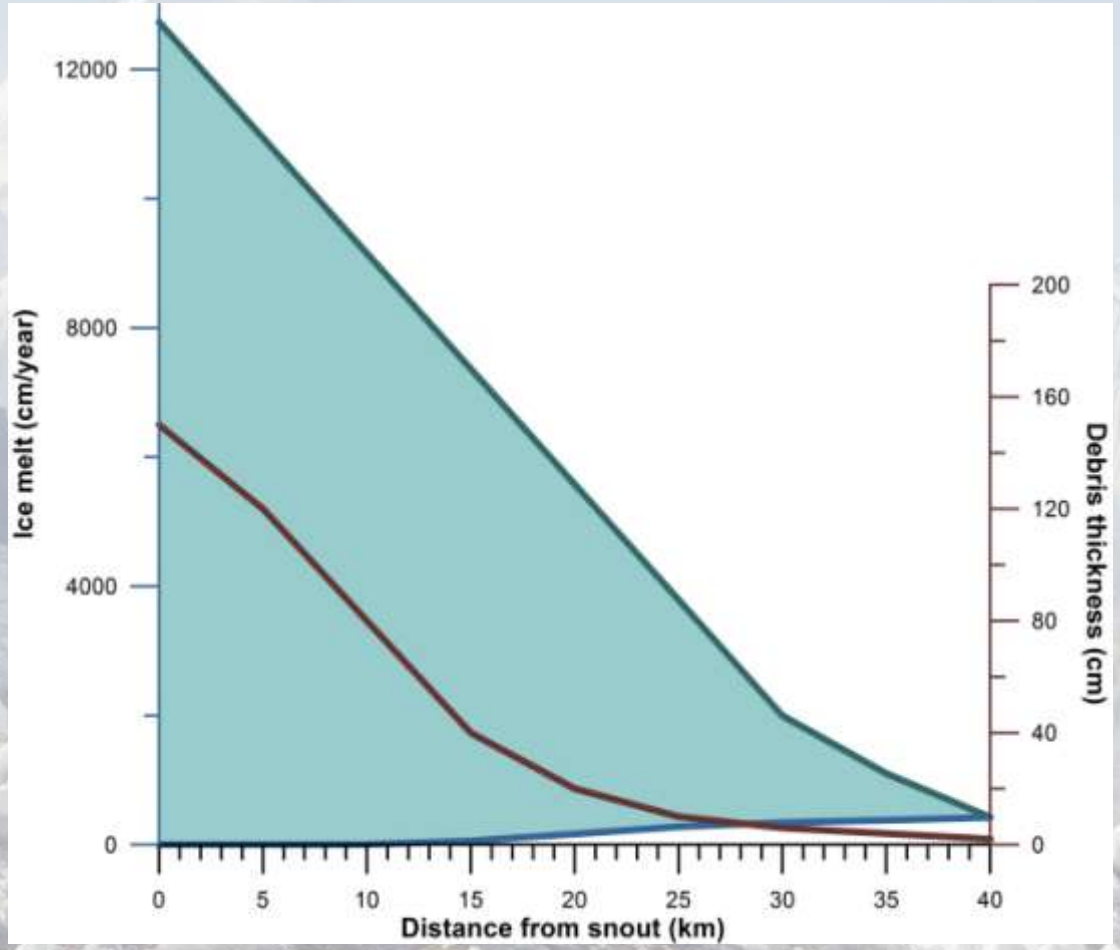
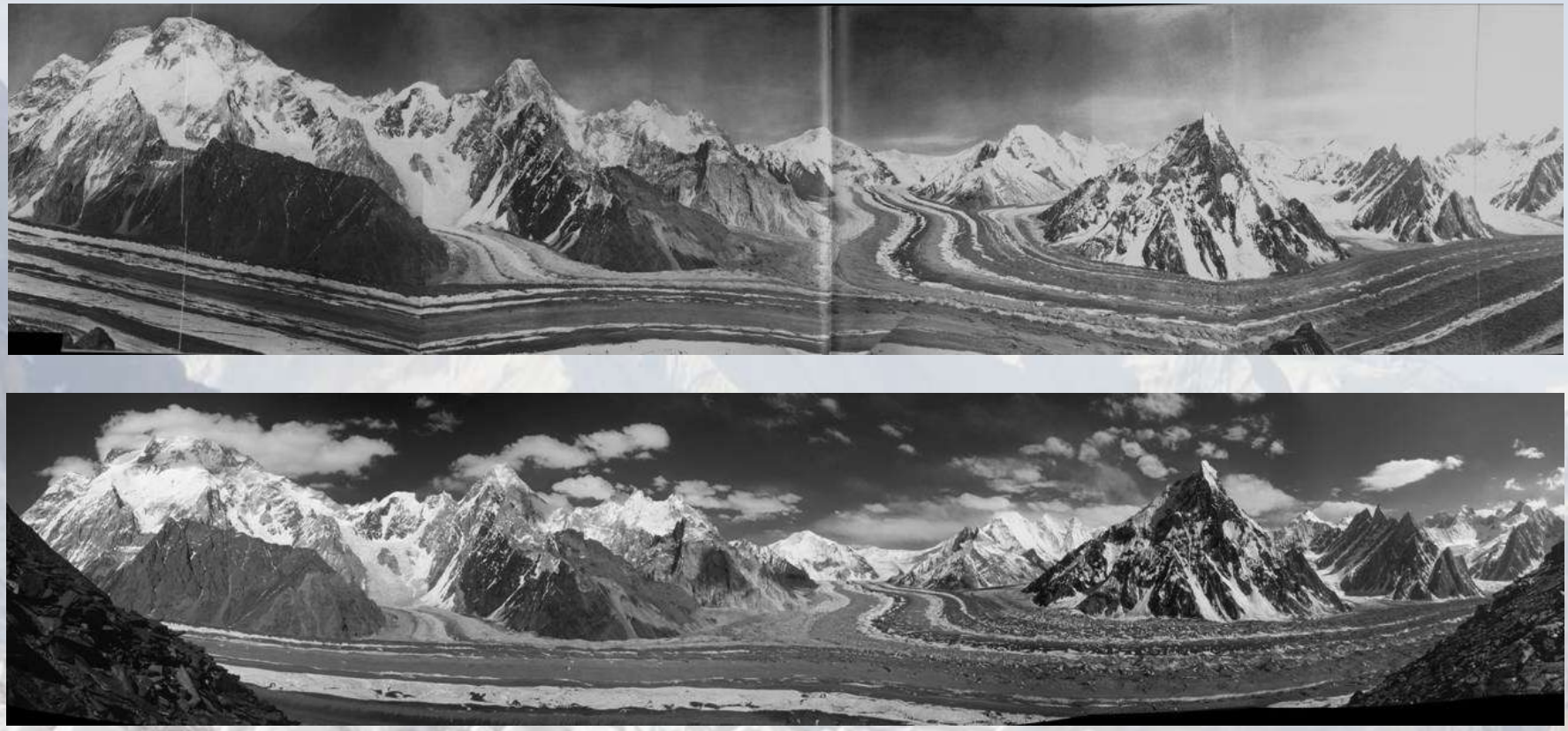


Baltoro Glaciology

- Comparison with historical observations



Baltoro, Concordia, Sella 1909, Mayer 2004

Elevation change derived from Photographs also indicated by geophysical measurements.

Lessons learned

- Glaciers in the Karakoram are more stable than in other regions
- Glacier area change is mainly due to fast glacier advances
- Debris covered glaciers loose mass by elevation change, not area change
- The long term evolution of large glaciers is negative