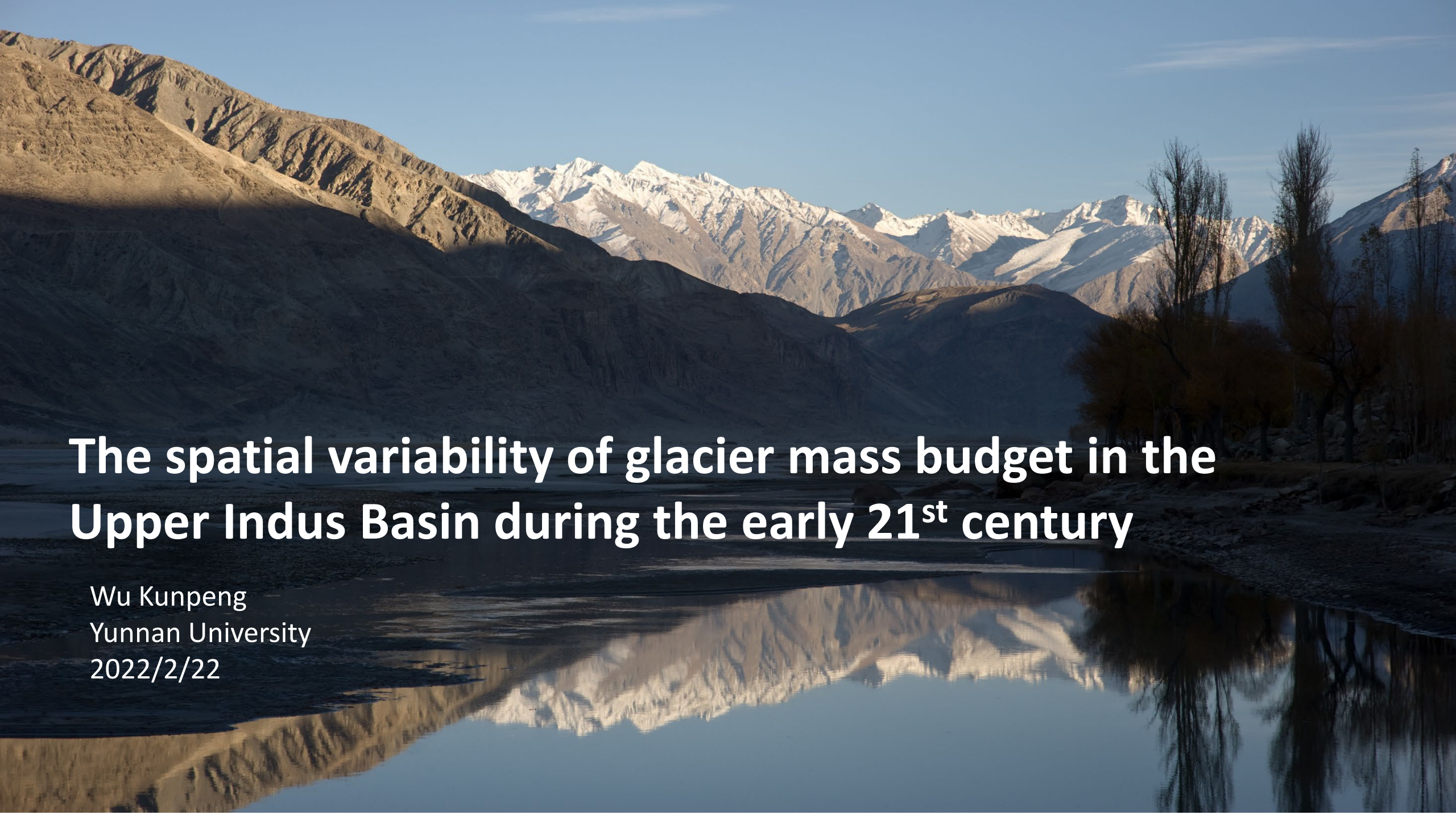


The spatial variability of glacier mass budget in the Upper Indus Basin during the early 21st century

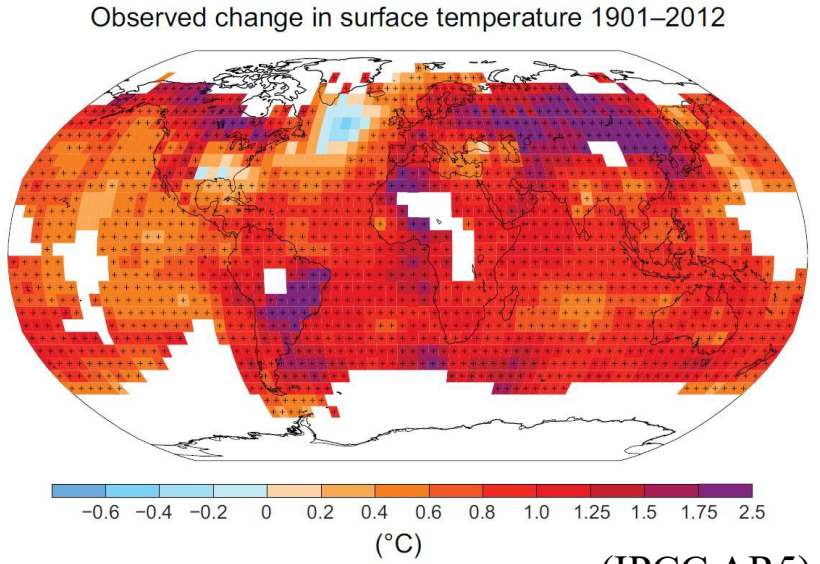
Wu Kunpeng
Yunnan University
2022/2/22

Content

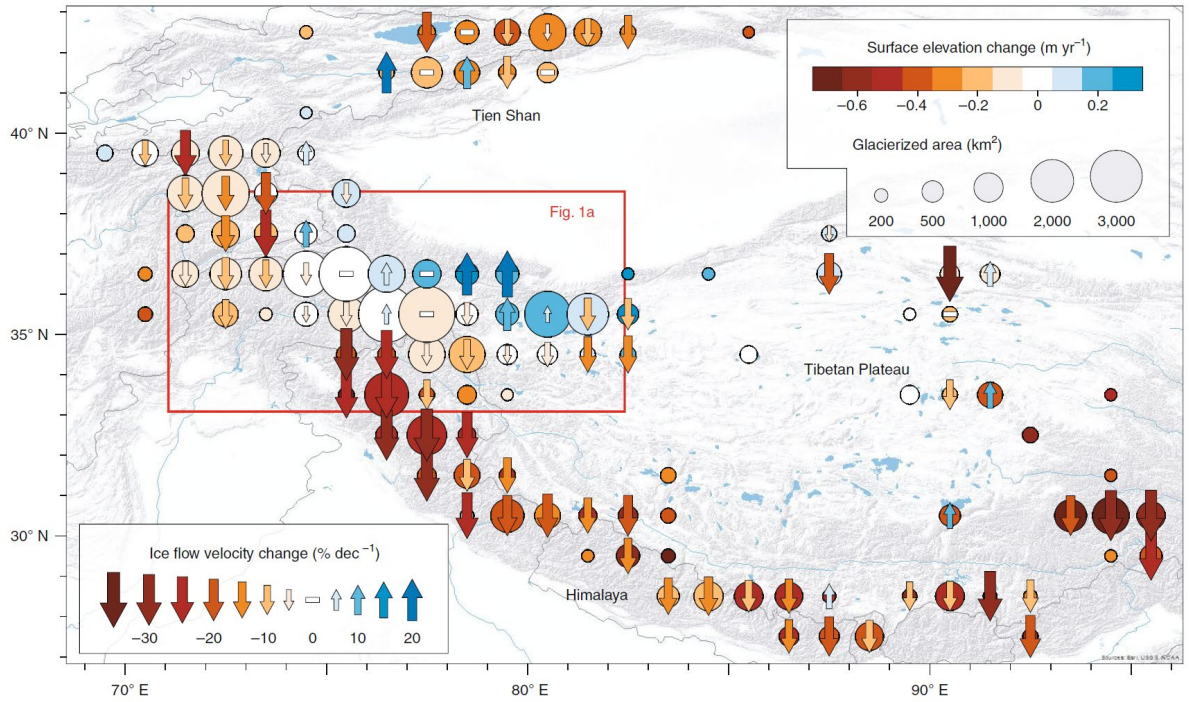
1. Background

- Global warming and glacier retreat

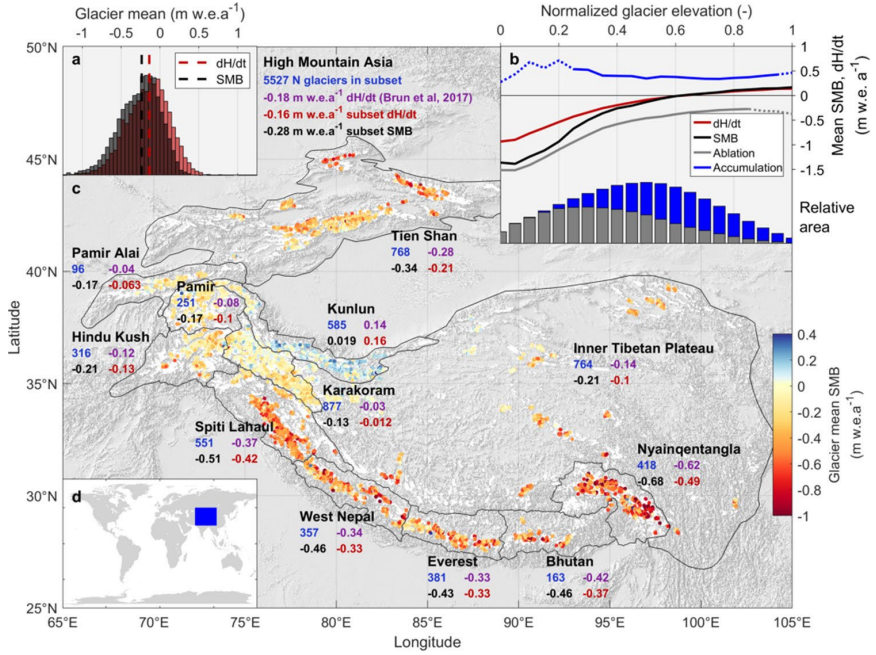
- Karakoram Anomaly



(IPCC AR5)



(Farinotti et al., 2020)

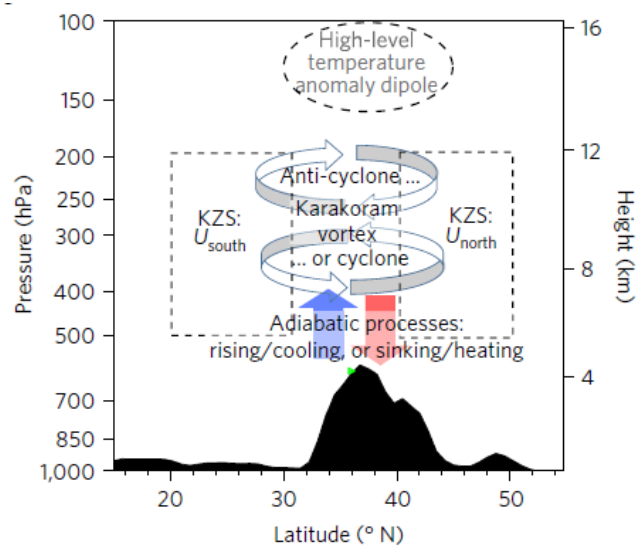


(Miles et al., 2021)

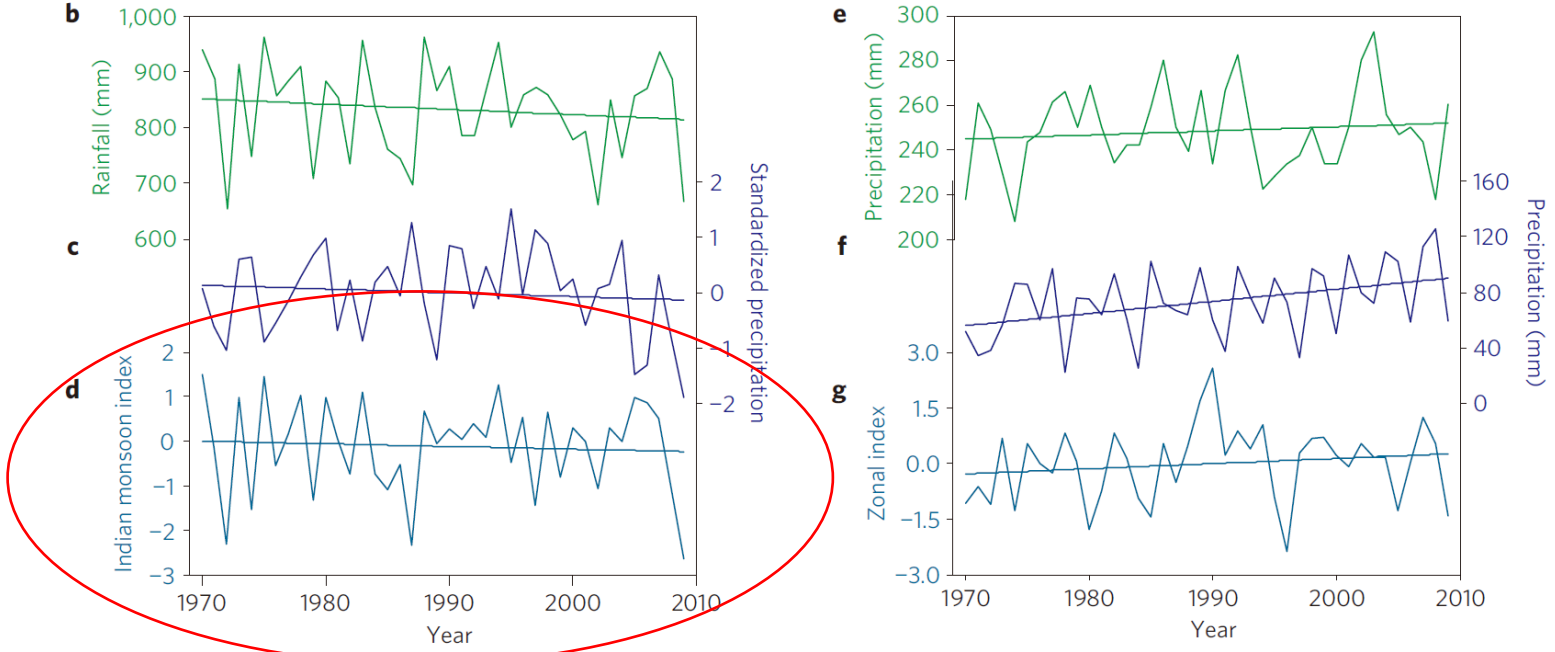
1. Background

- Glacier melt in the Karakoram is driven by regional atmospheric circulation variability [Forsythe et al., 2017]

- The weakening Indian monsoon and the strengthening westerlies had been found in recent decades [Yao et al., 2012].



(Forsythe et al., 2017)



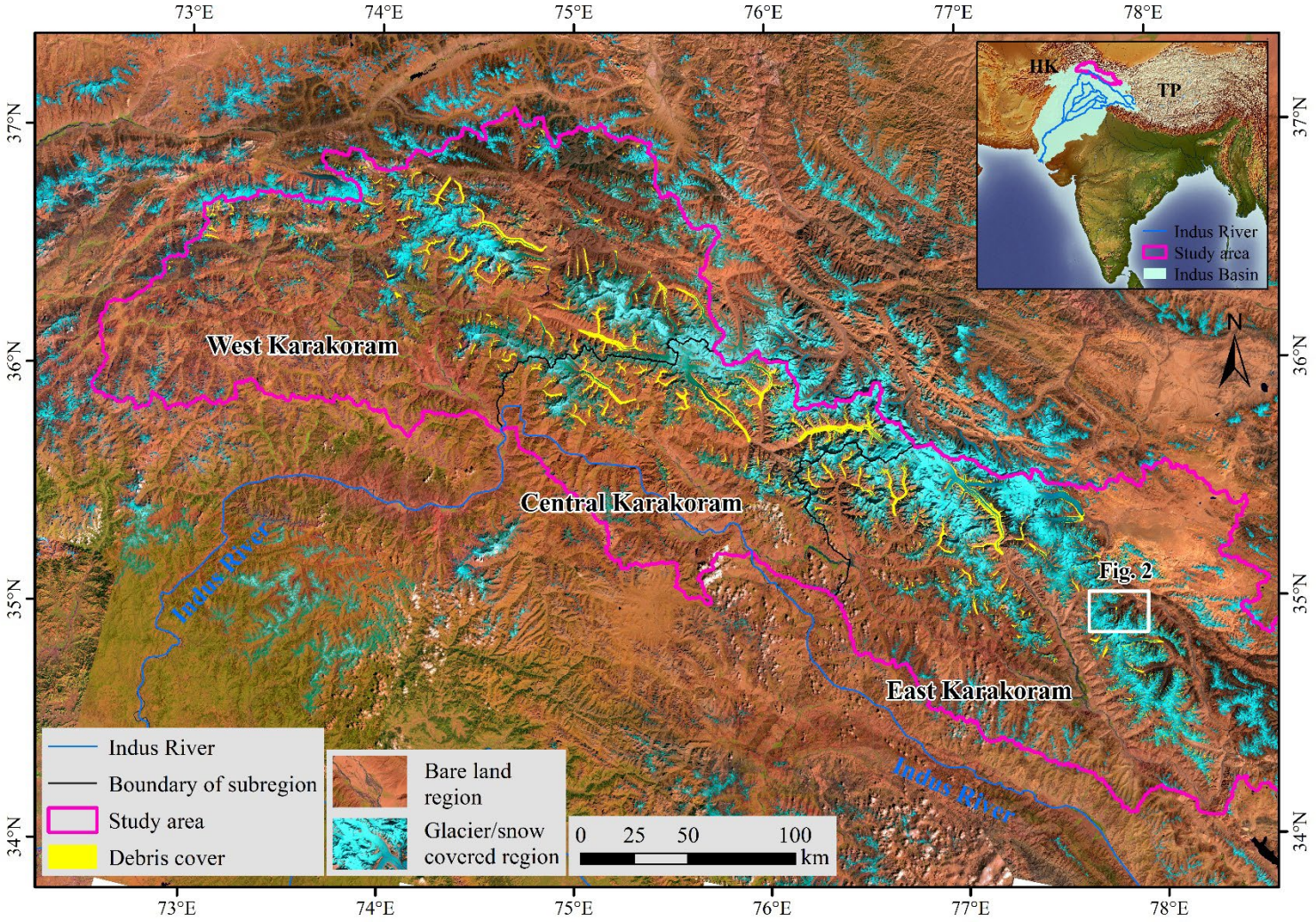
(Yao et al., 2012)

Key activities：

The changes of glacier mass budget in the Karakoram region of Upper Indus River Basin (UIBKK) over the early twenty-first century was estimated from geodetic methods on three DEMs.

2. Study area

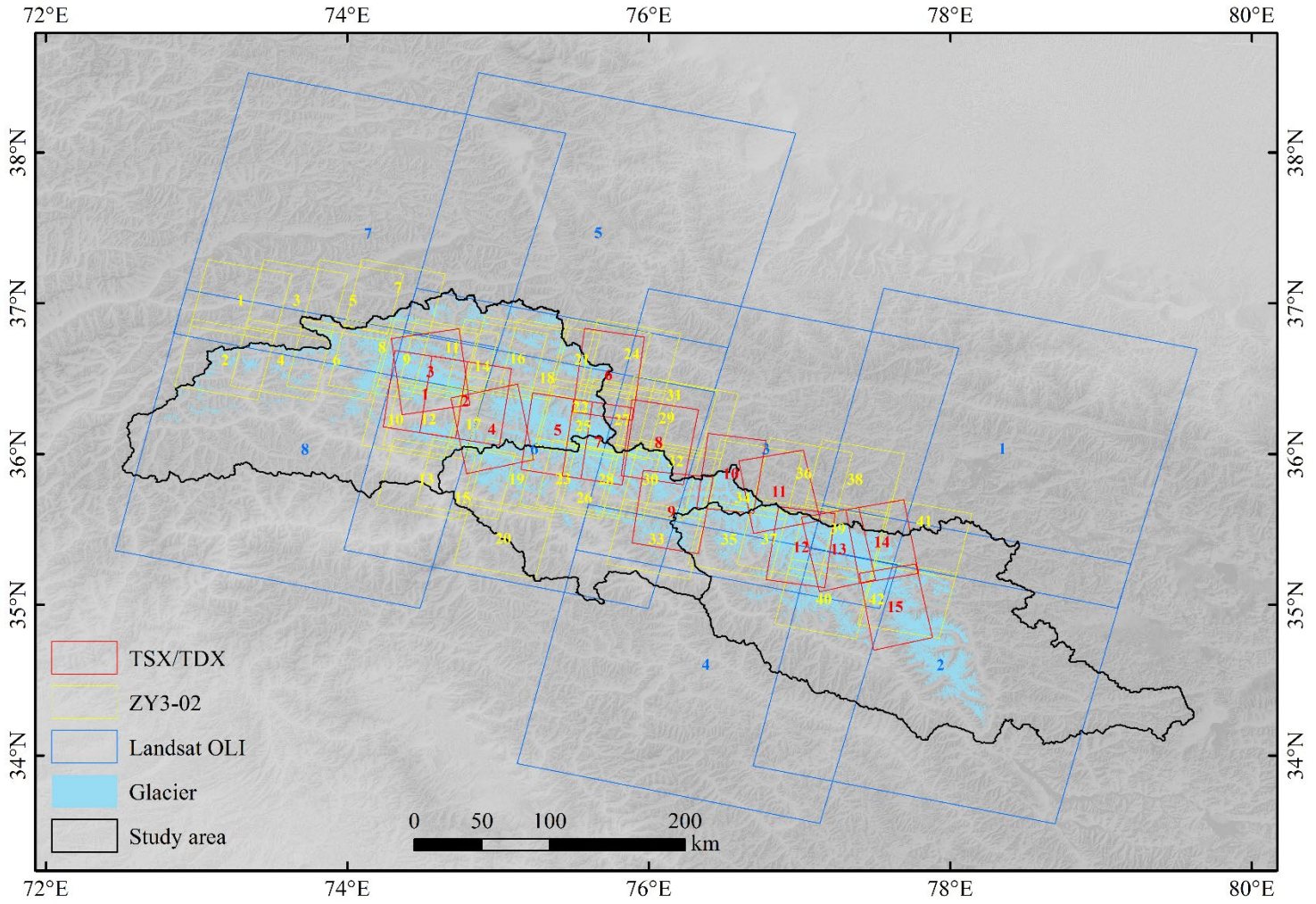
- The Karakoram region of Upper Indus River Basin (UIBKK)



3. Data and method: Data

- SRTM, TerraSAR-X/TanDEM-X, ZY3-02 stereo images

Mission	Acquisition Date	Pixel size (m)	Application
RGI6.0	2000	–	Glacier outlines for 2000
SRTM C-band	11–22 Feb 2000	30	Estimation of glacier height change
Landsat OLI	2013	15	Glacier outlines for 2013
TSX/TDX	2013–2014	12	Estimation of glacier height change
Landsat OLI	2019	15	Glacier outlines for 2019
ZY3-02	2019–2020	5	Estimation of glacier height change



3. Data and method： Method

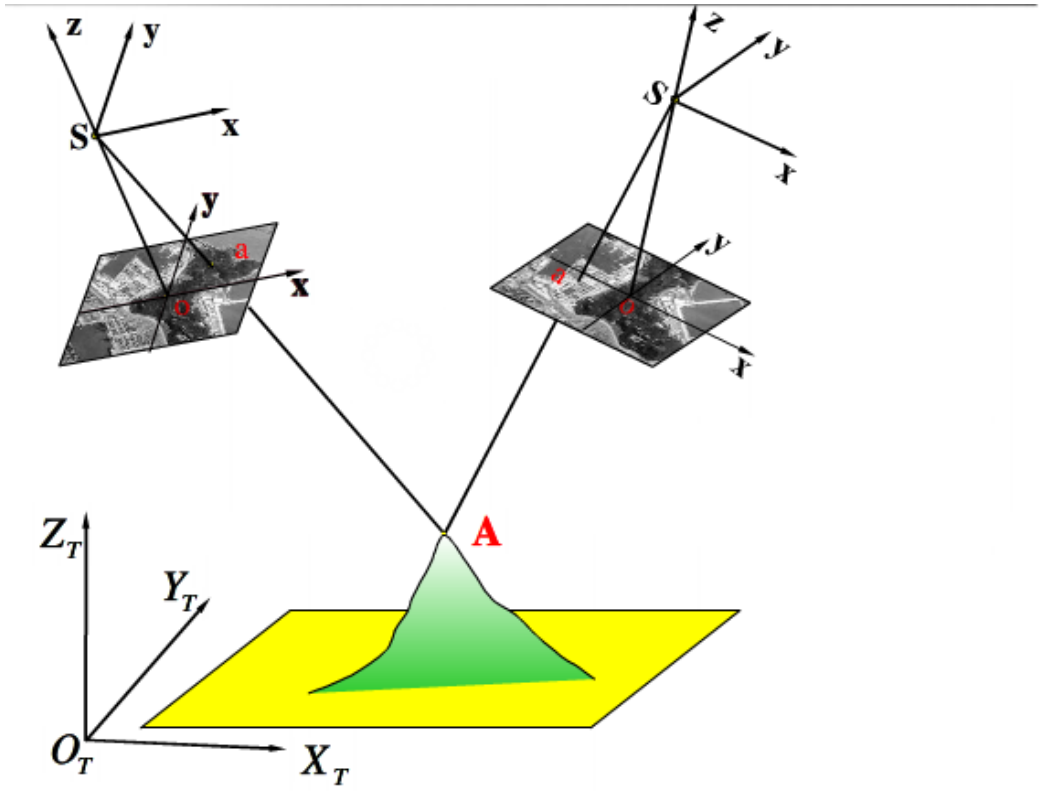
◘ Glacier outlines

- GEE
- NDSI

（B3-B6）/（B3+B6）

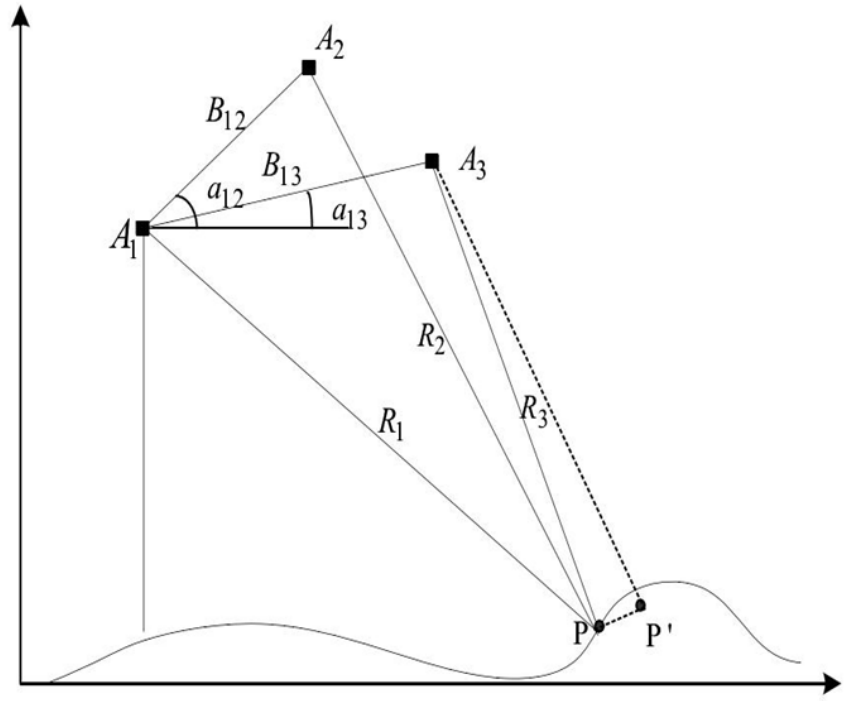
3. Data and method： Method

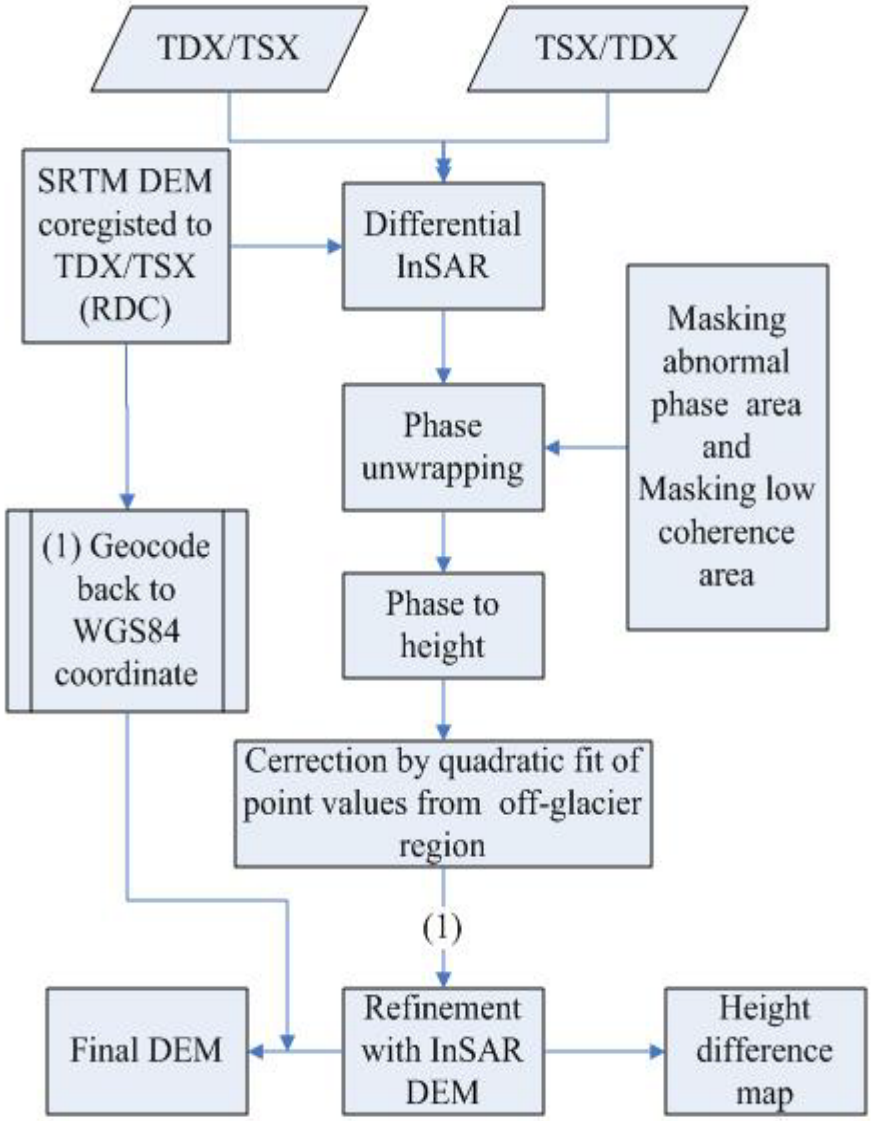
- DEM extraction from ZY3-02 stereo images



3. Data and method： Method

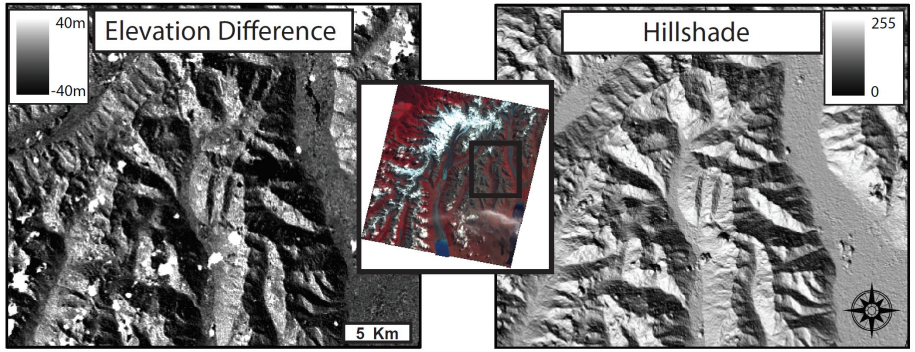
- DInSAR





3. Data and method： Method

- DEM co-registration and bias corrections

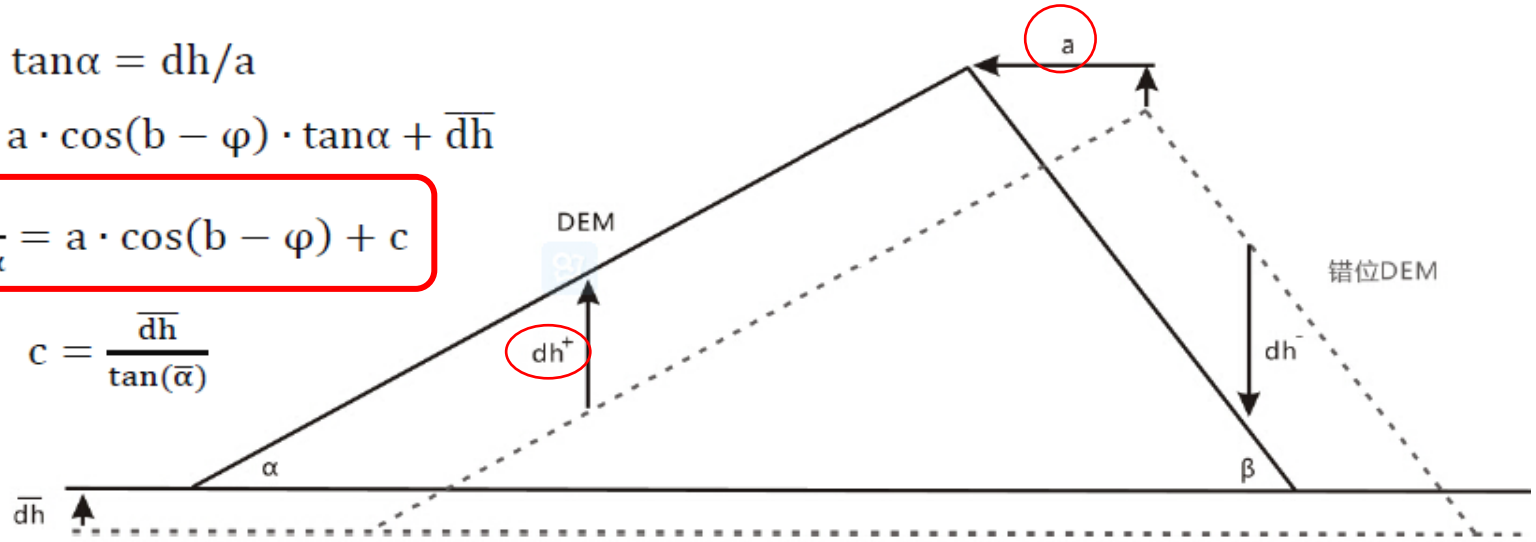


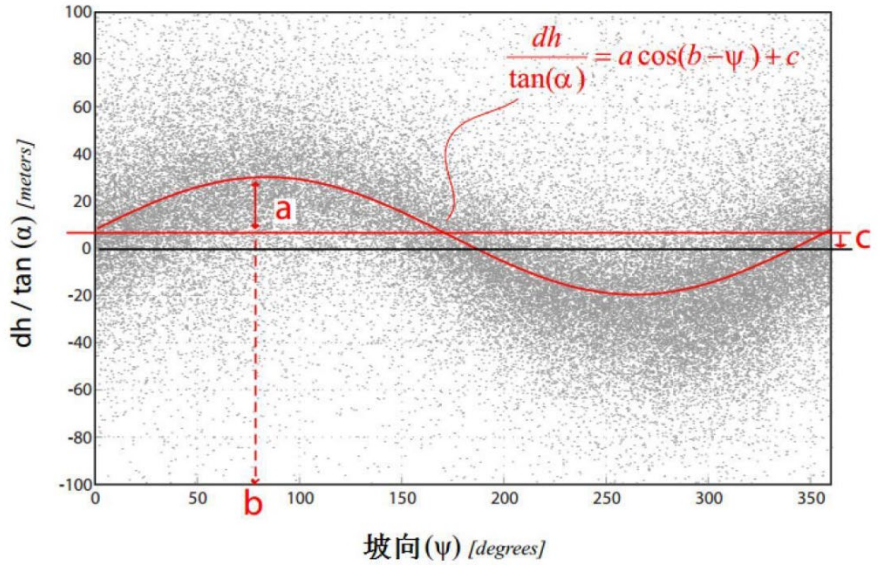
$$\tan\alpha = dh/a$$

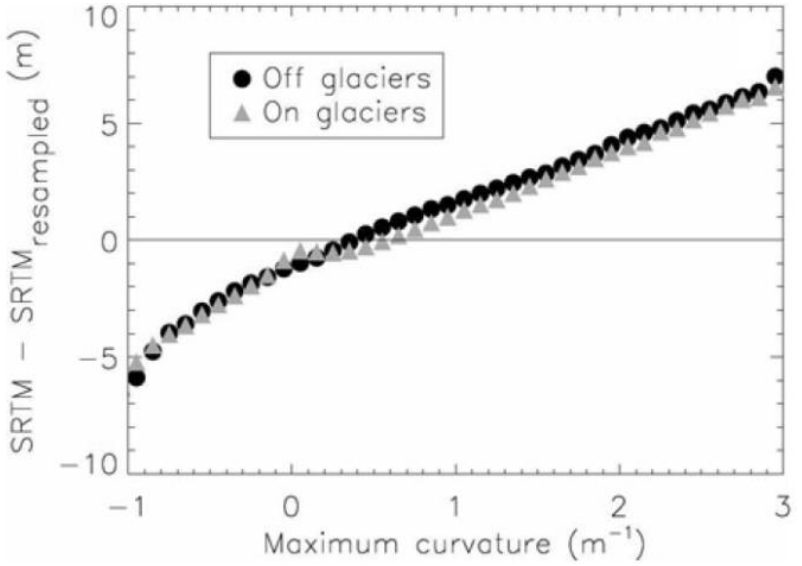
$$dh = a \cdot \cos(b - \varphi) \cdot \tan\alpha + \overline{dh}$$

$$\frac{dh}{\tan\alpha} = a \cdot \cos(b - \varphi) + c$$

$$c = \frac{\overline{dh}}{\tan(\overline{\alpha})}$$

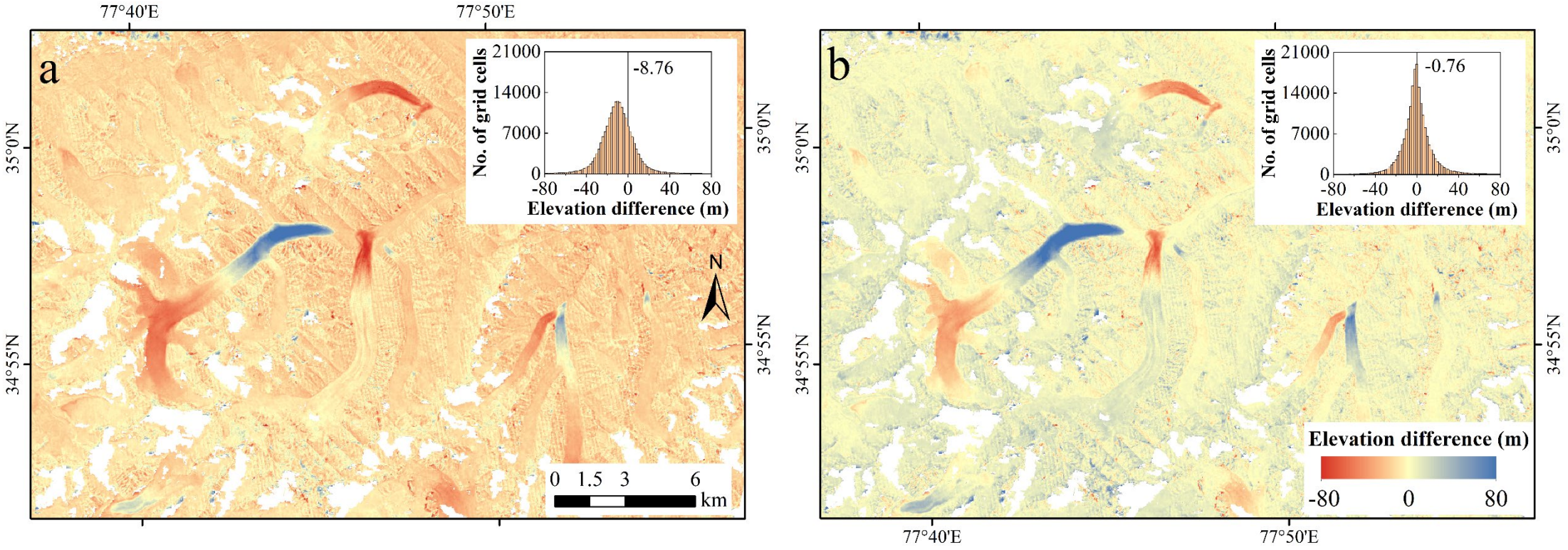






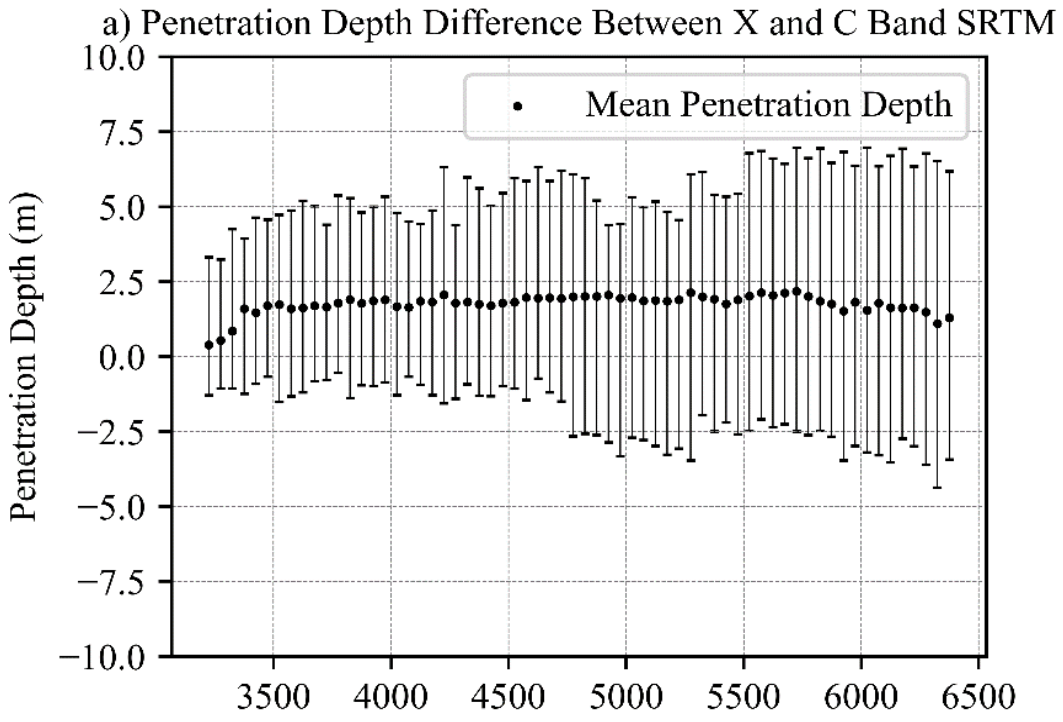
3. Data and method： Method

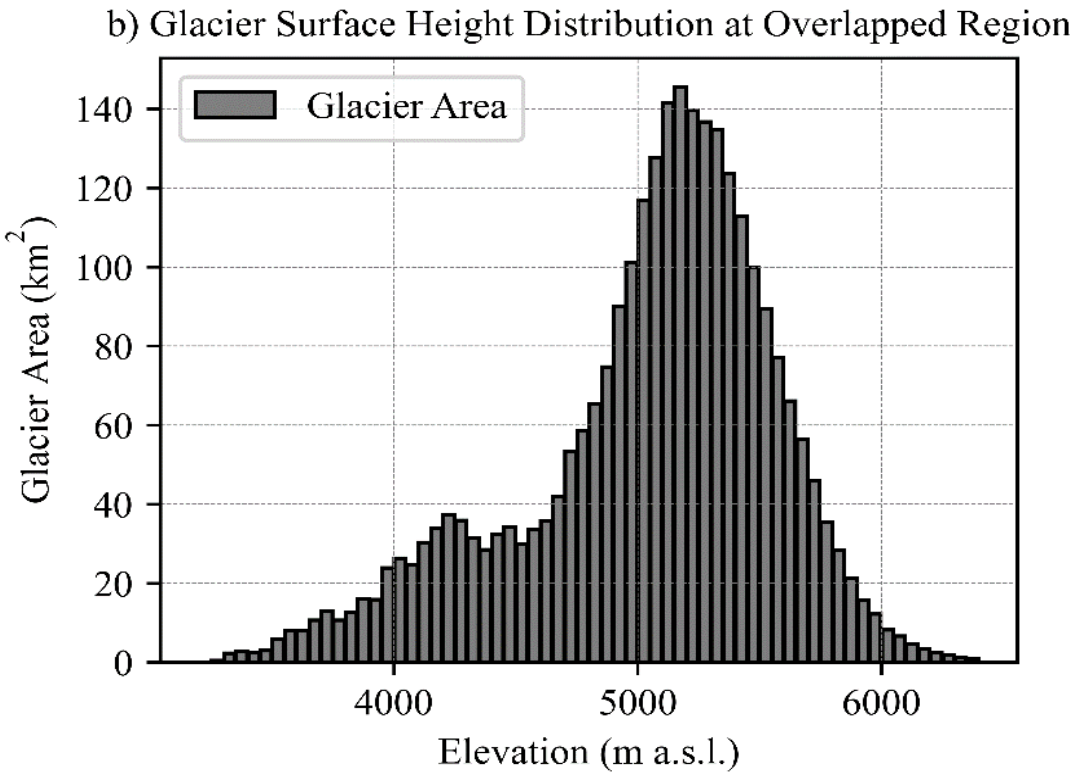
- The comparison before and after DEM co-registration



3. Data and method： Method

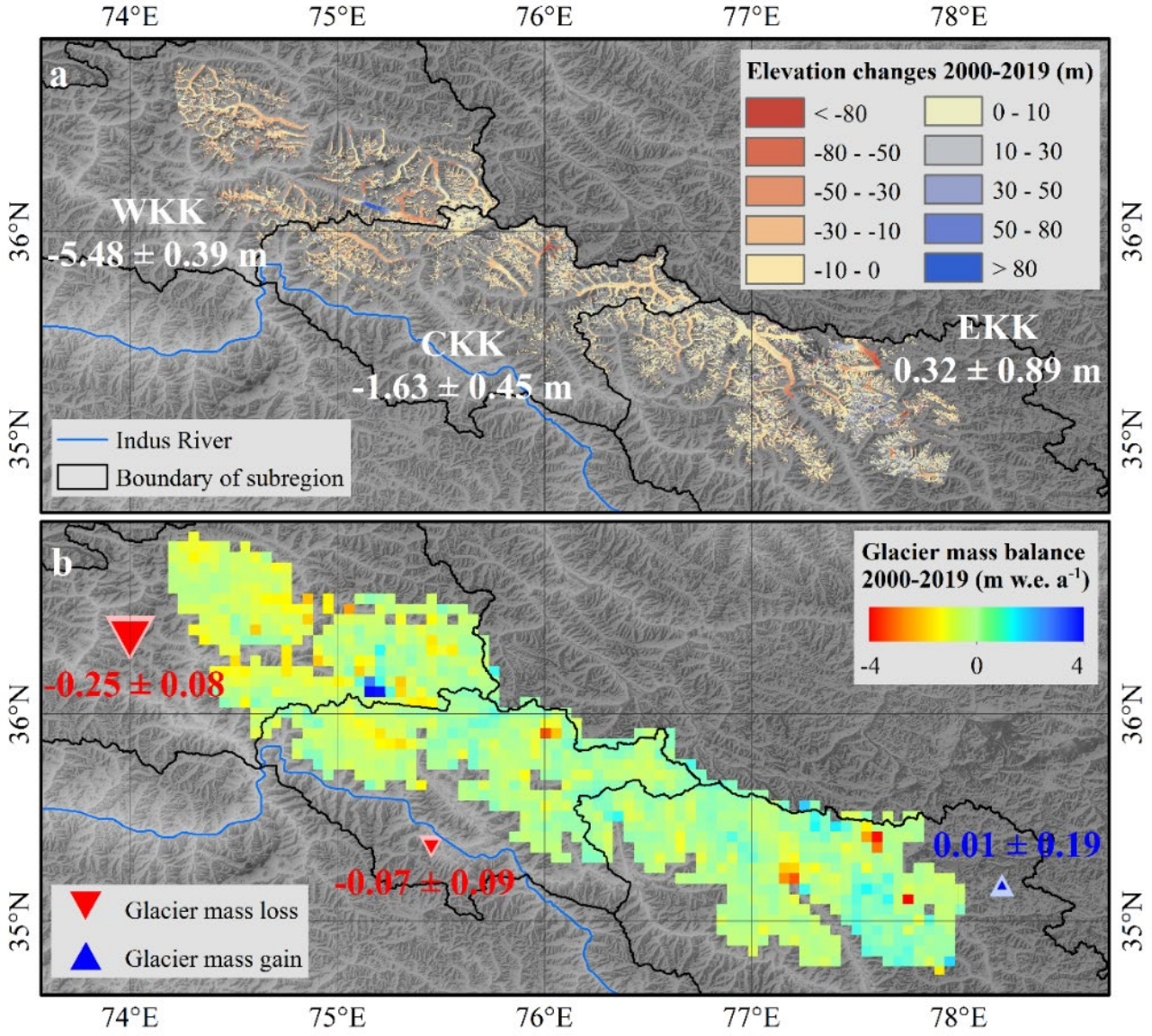
- Penetration depth difference between X and C Band SRTM





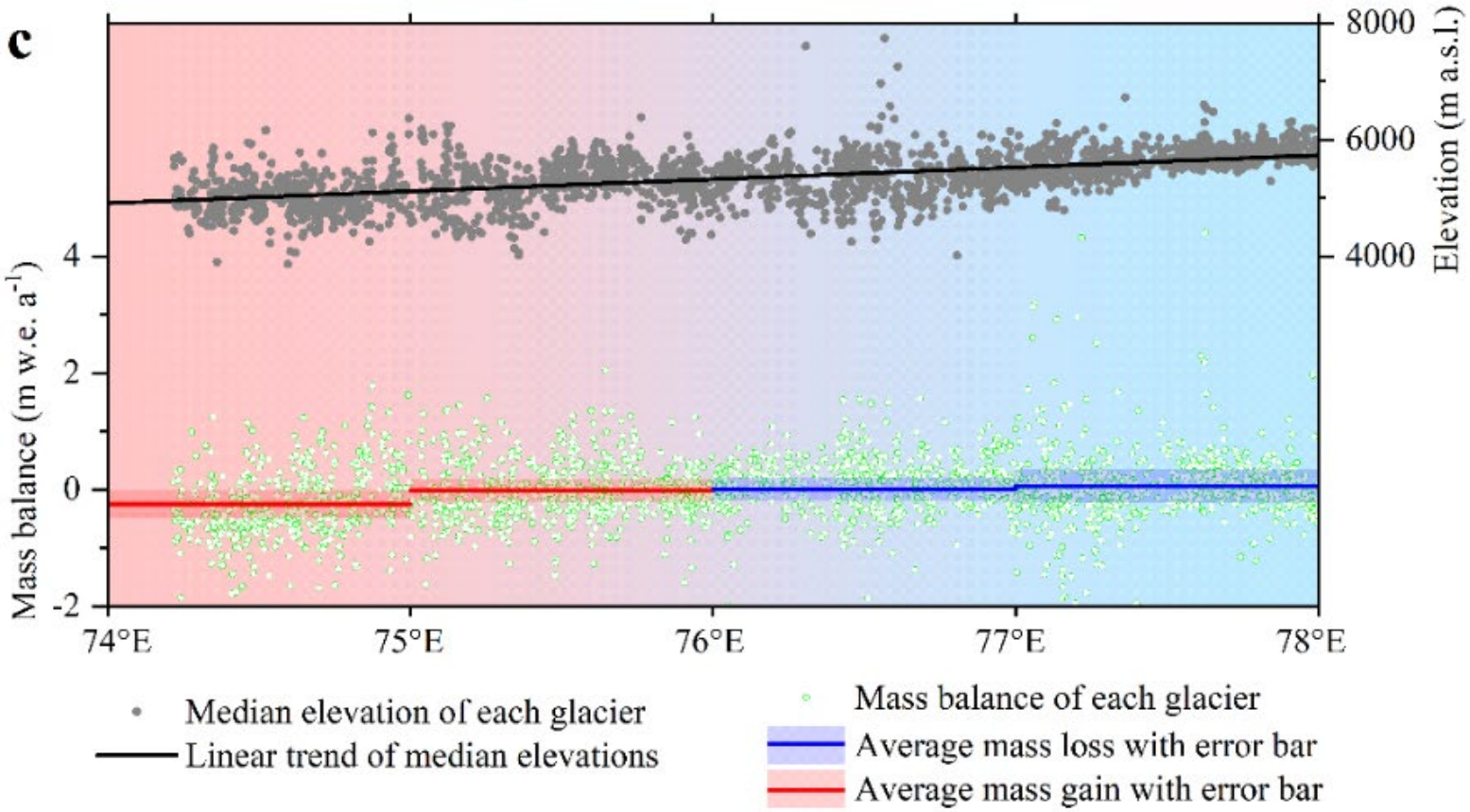
4. Result and Discussion

- A balanced or slight negative mass budget was estimated for the UIBKK glaciers, and heterogeneous mass budget were found between different sub-regions and between different time intervals.



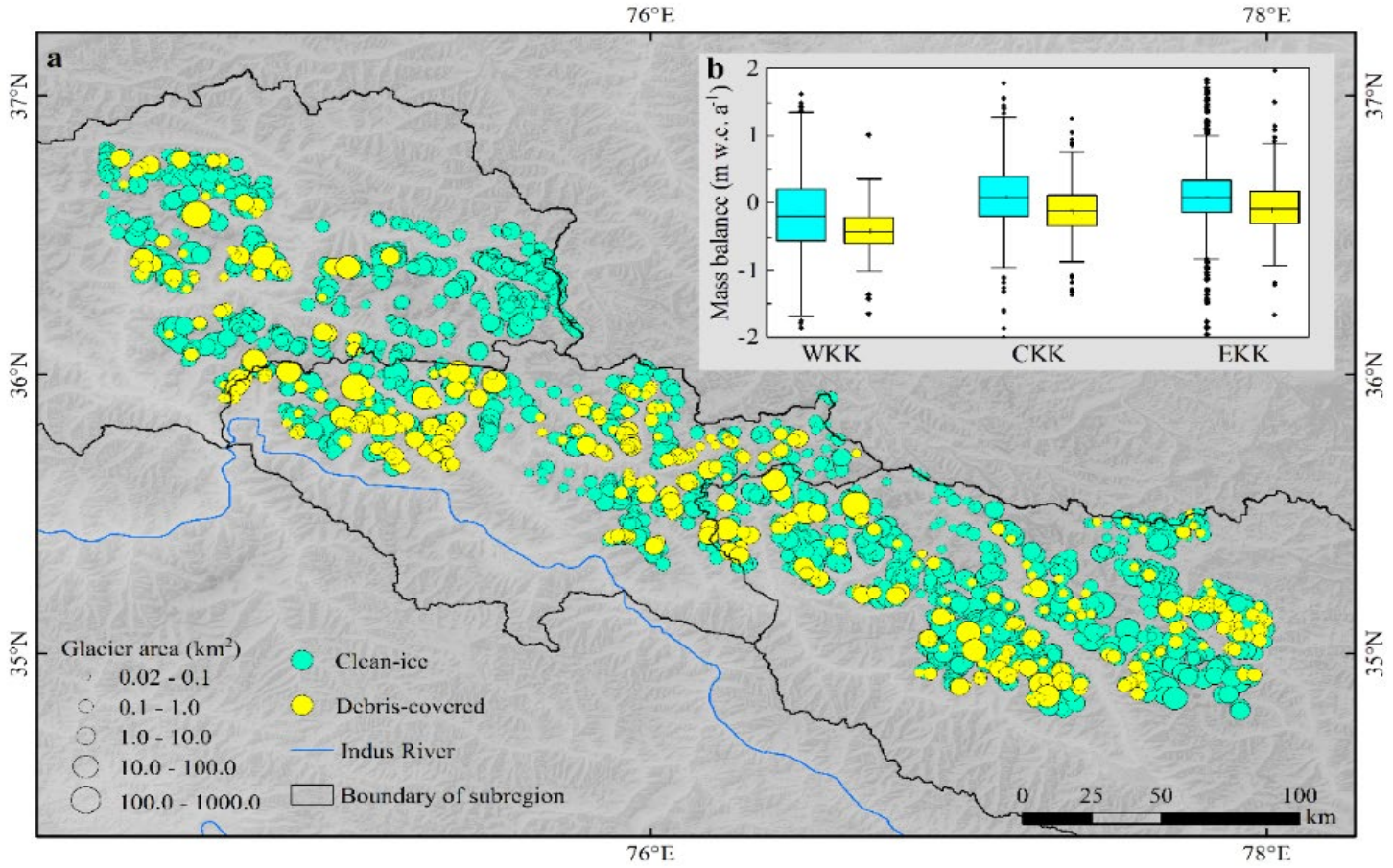
4. Result and Discussion

- The spatial distribution pattern of glacier mass budget in the UIBKK showed that mass budgets shifted from negative to positive, respectively, along longitude.



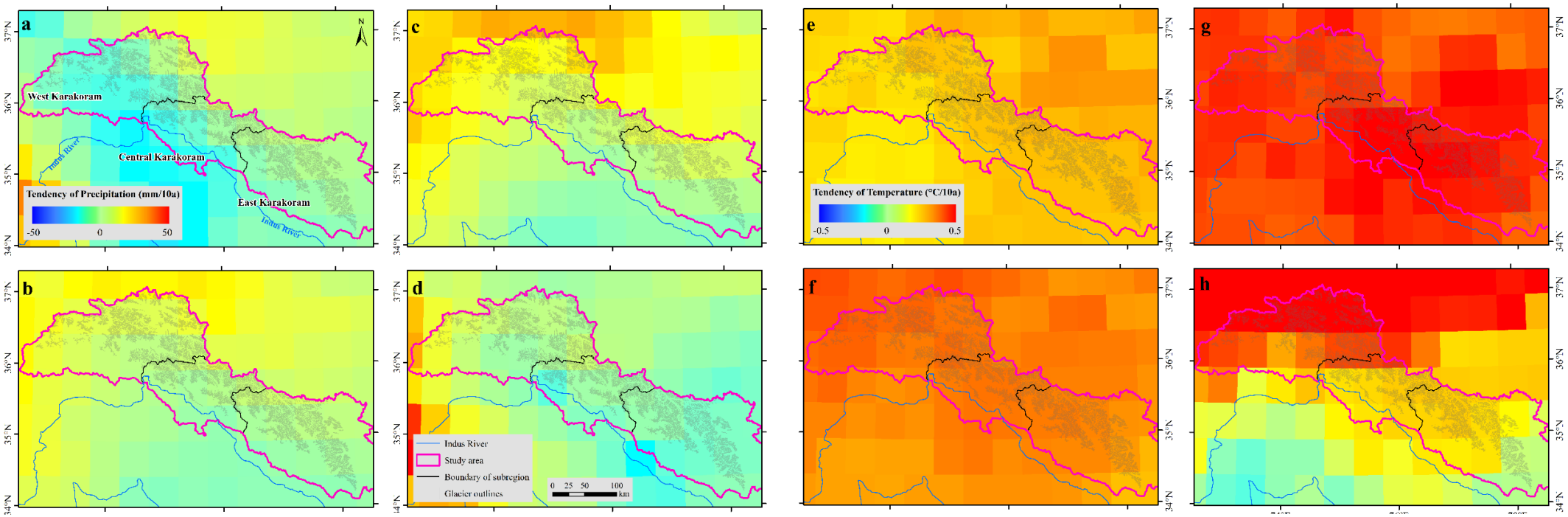
4. Result and Discussion

- Geodetic mass-budget estimations showed that debris cover has a positive influence on ice melt overall: thinning rate on debris-covered ice was significantly greater than that on clean ice.



4. Result and Discussion

- The spatiotemporal patterns of glacier mass budgets in the UIBKK were consistent with the tendencies of winter precipitation and summer temperature.



Summary

- A balanced or slight negative mass budget was estimated for the UIBKK glaciers.
- The spatial distribution pattern of glacier mass budget in the UIBKK showed that mass budgets shifted from negative to positive, respectively, along longitude.
- Geodetic mass-budget estimations showed that debris cover has a positive influence on ice melt overall.
- Climate warming may play more important role in glacier changes in the UIBKK.


THANK YOU