







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

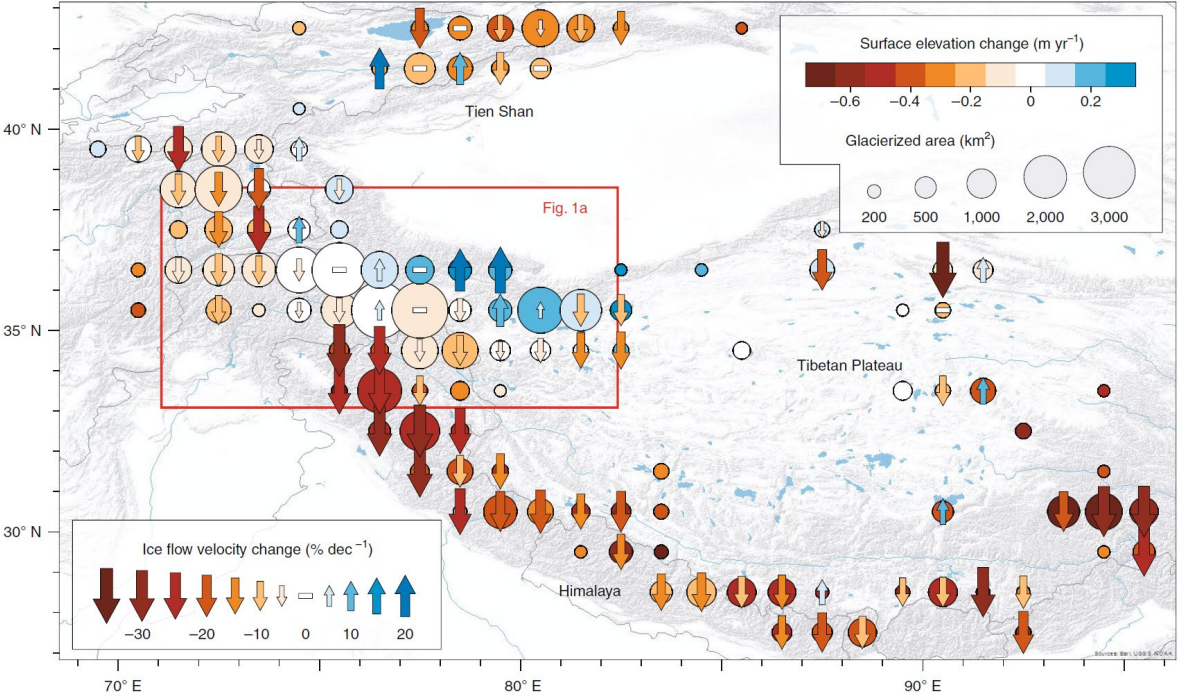
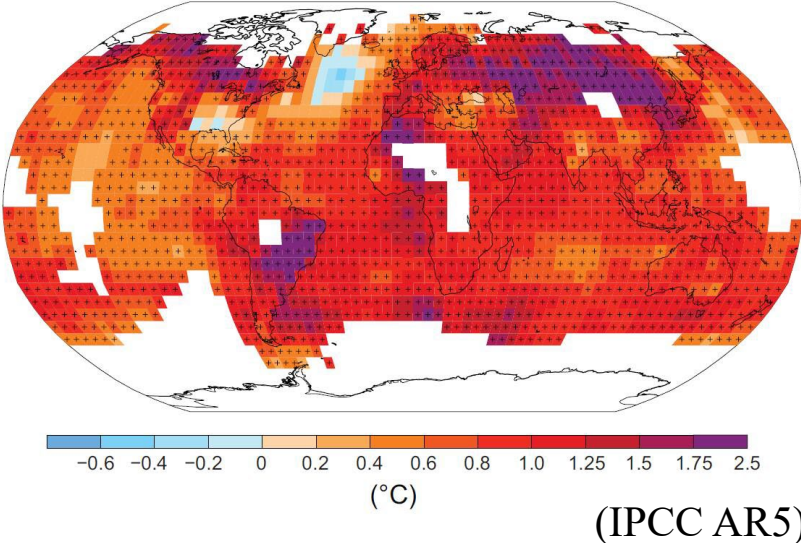
-  Background.....
-  Study area.....
-  Data and Method.....
-  Result and Discussion.....

1. Background

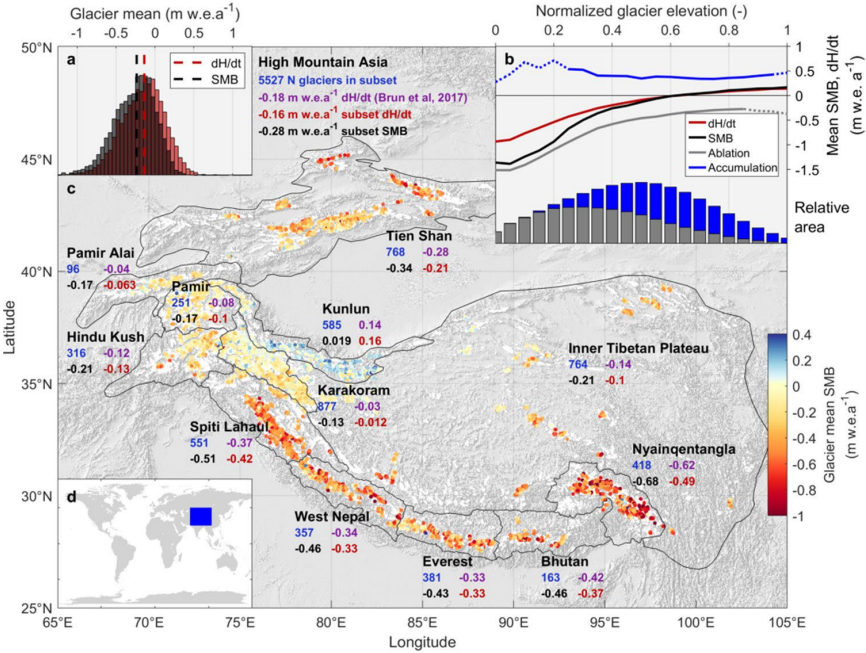
Global warming and glacier retreat

Karakoram Anomaly

Observed change in surface temperature 1901–2012



(Farinotti et al., 2020)

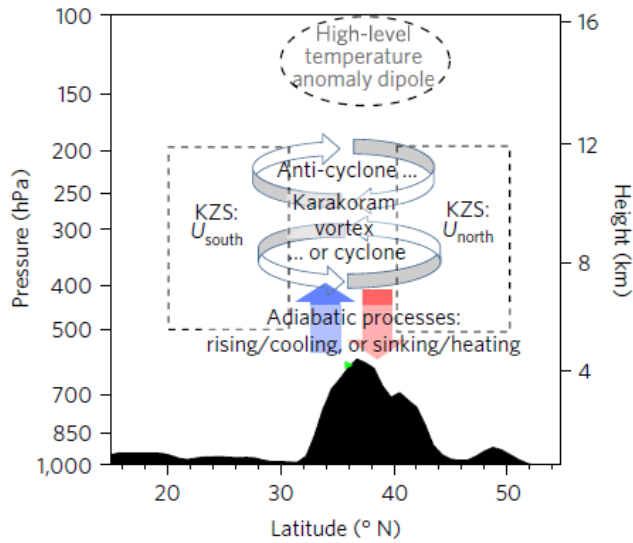


(Miles et al., 2021)

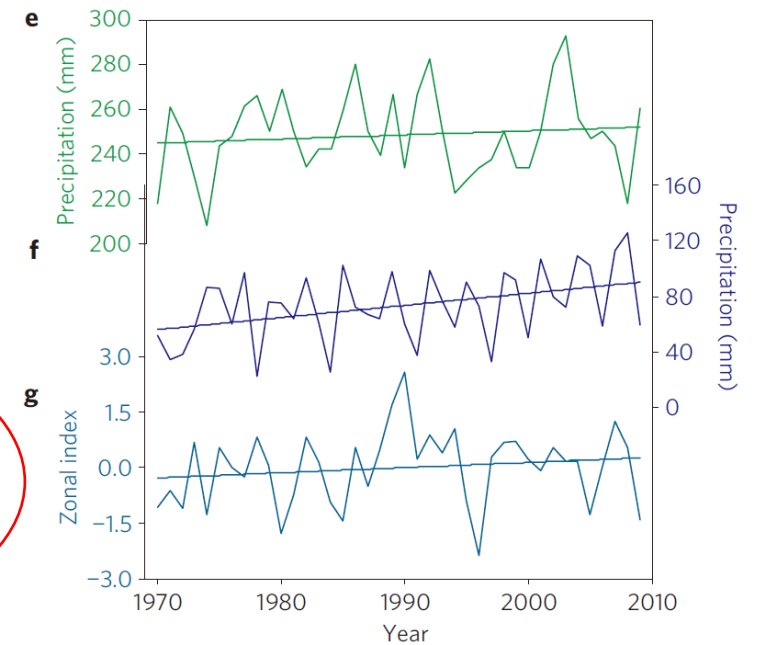
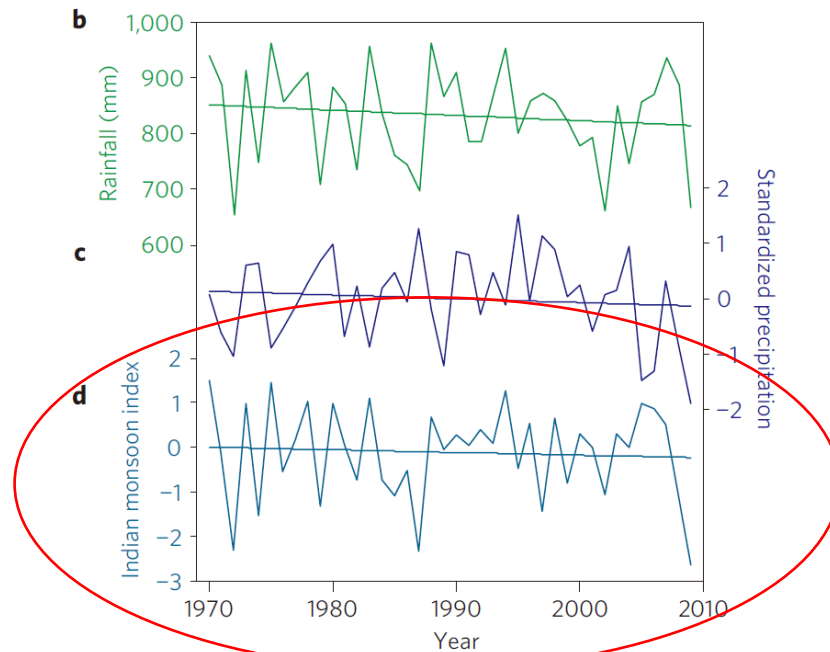
1. Background

❑ 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)



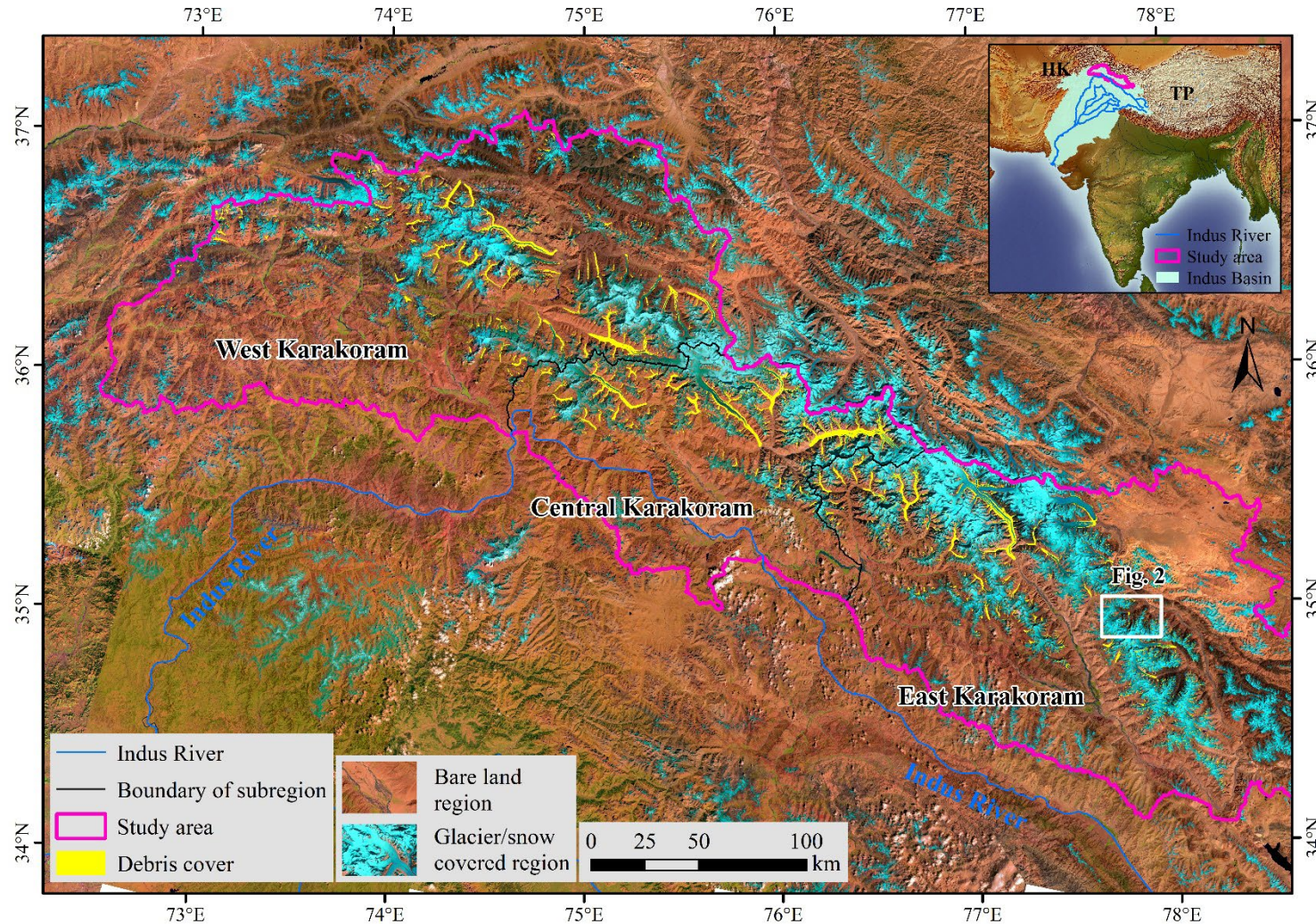
(Yao et al., 2012)

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

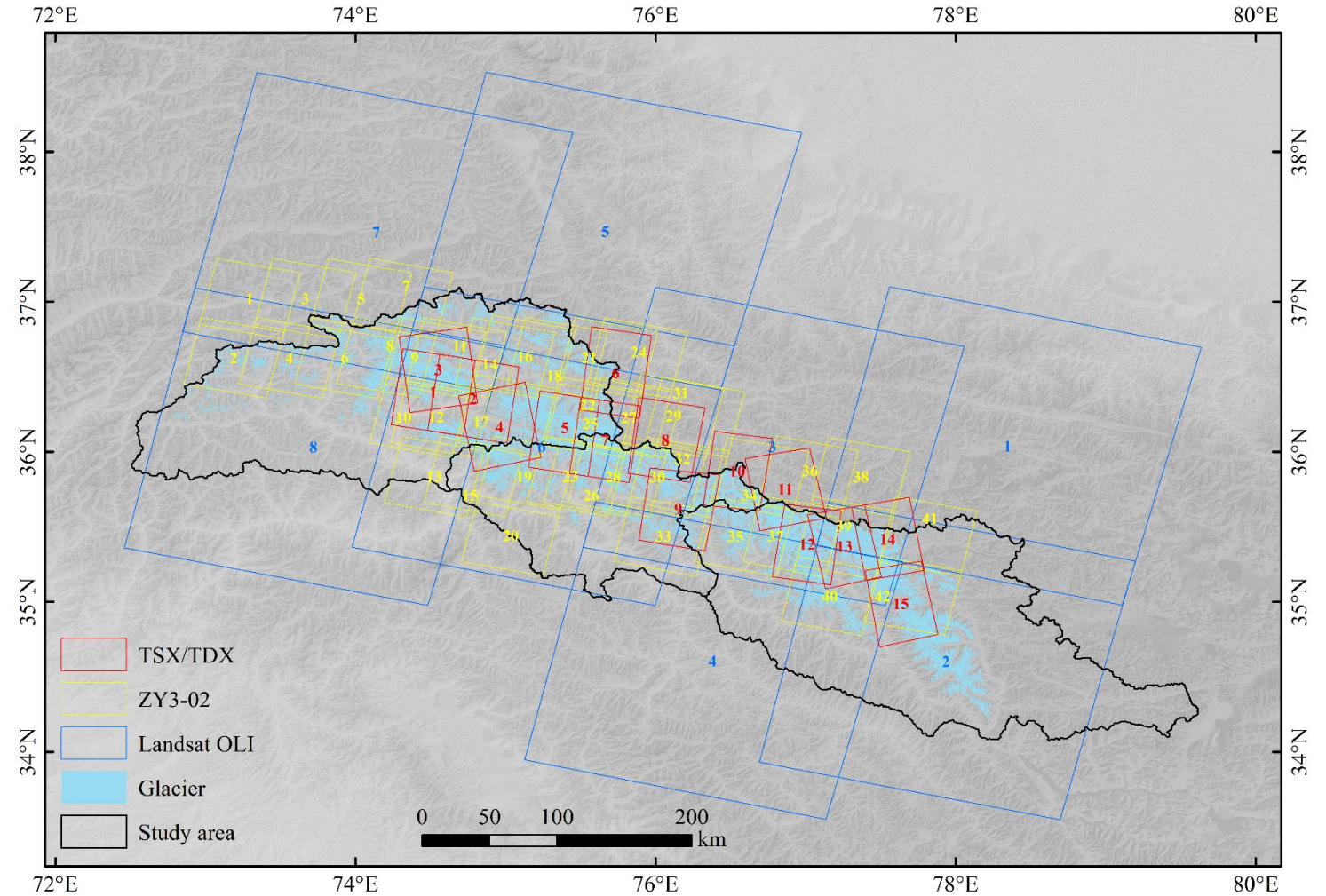
□ The Karakoram region of Upper Indus River Basin (UIBKK)



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

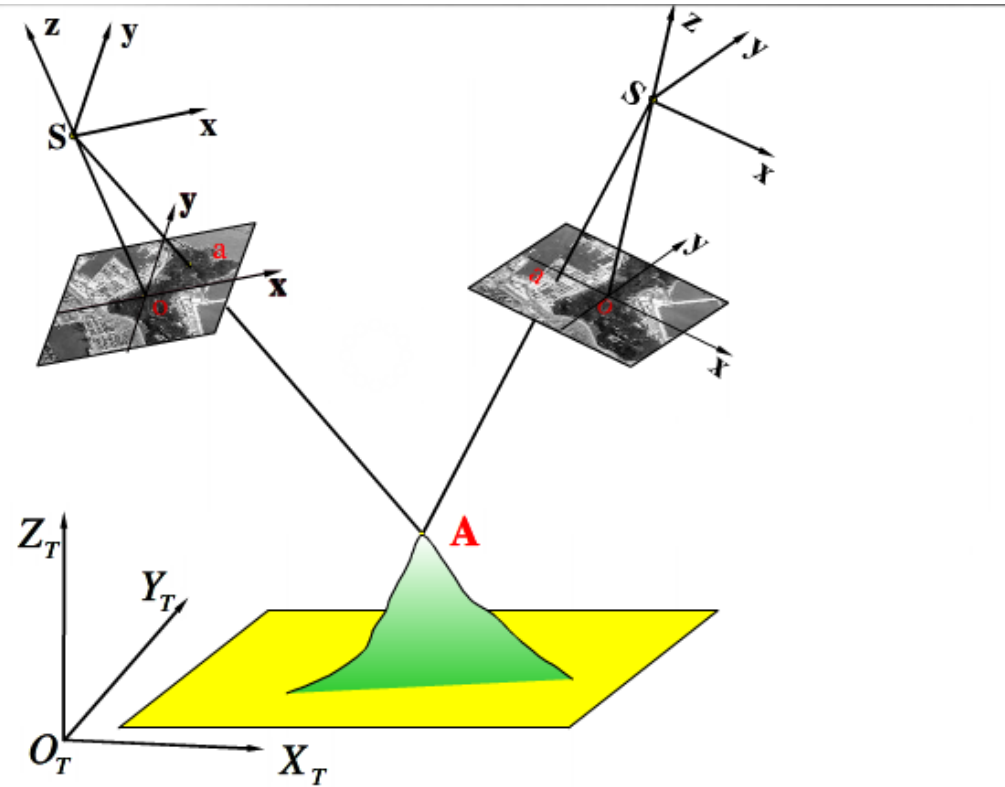
$$(B3-B6) / (B3+B6)$$

The screenshot displays the Google Earth Engine (GEE) interface. The top navigation bar includes the GEE logo, a search bar, and user controls. The main workspace is divided into several panels:

- Scripts Panel:** A list of methods is shown, including ee.Algorithms, ee.Array, ee.Blob, ee.Classifier, ee.Clusterer, ee.ConfusionMatrix, ee.Date, ee.DateRange, ee.Dictionary, ee.ErrorMargin, ee.Feature, and ee.FeatureCollection.
- Code Editor:** A JavaScript script is visible, implementing a GLCM (Global Land Change Model) calculation. The script defines a Luminance variable and adds bands for 'red/swir1', 'red', 'swir1', and 'Luminance' to the input image.
- Inspector Panel:** A message prompts the user to "Click on the map to inspect the layers."
- Map Panel:** A satellite image of a landscape is shown, overlaid with a classification map. The map uses a color scale to represent different land cover types. A legend titled "Classification" is located in the bottom right corner, defining the following categories:
 - Deris (Cyan)
 - Snow/Ice (Blue)
 - Bare (Yellow)
 - Other (Black)

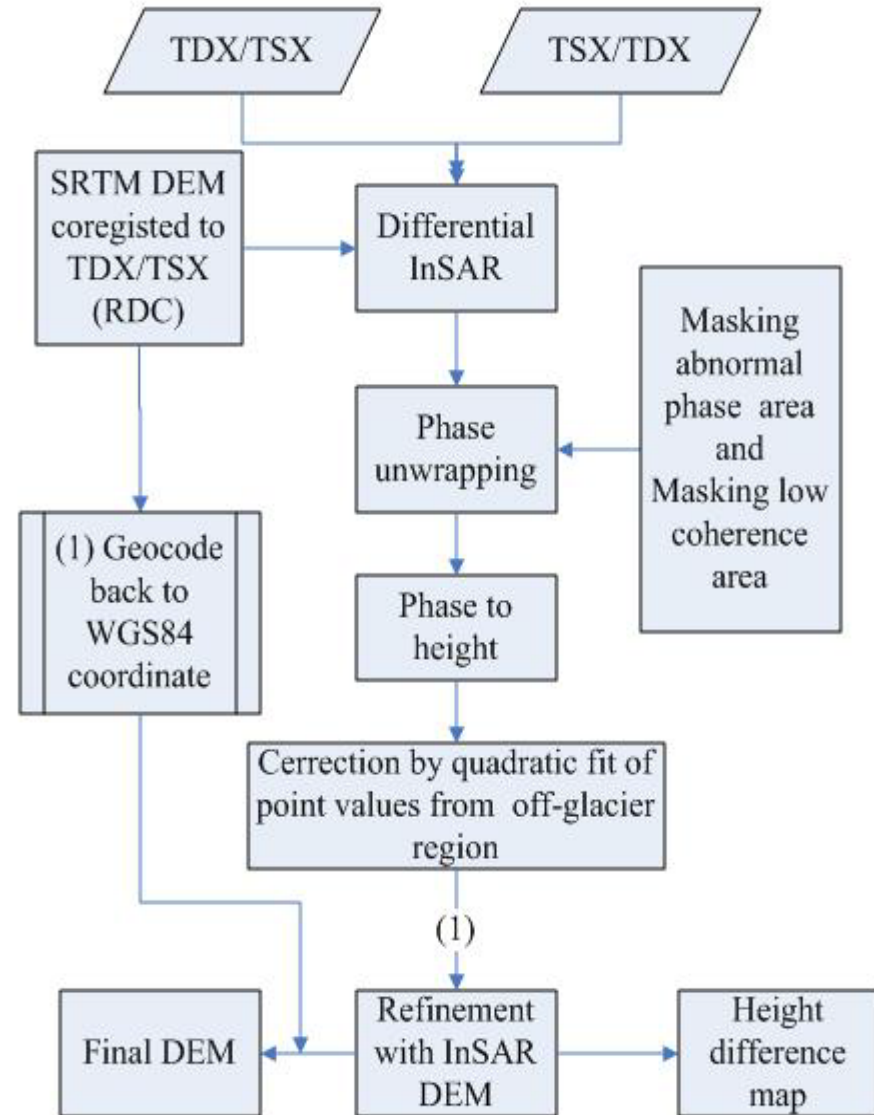
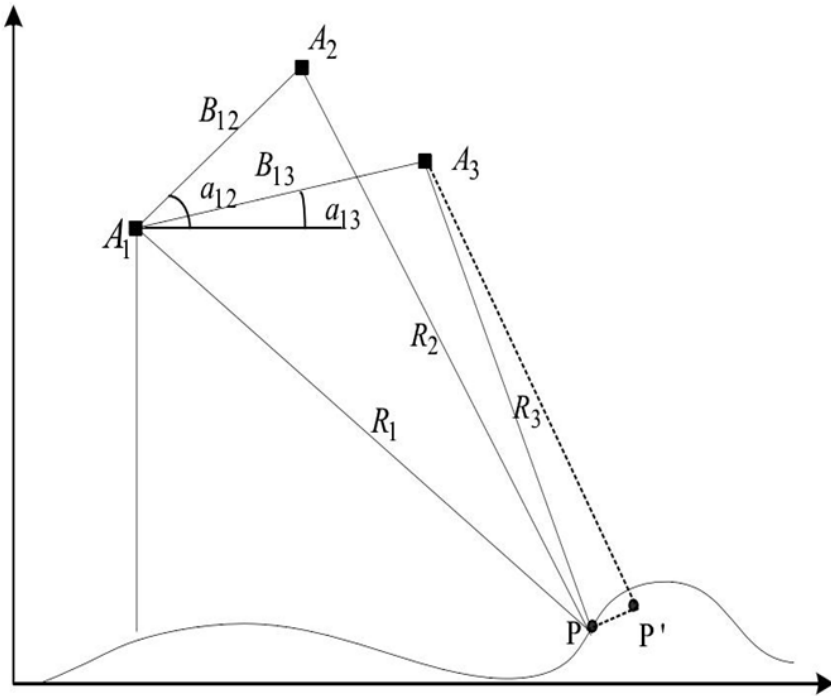
3. Data and method: Method

- DEM extraction from ZY3-02 stereo images



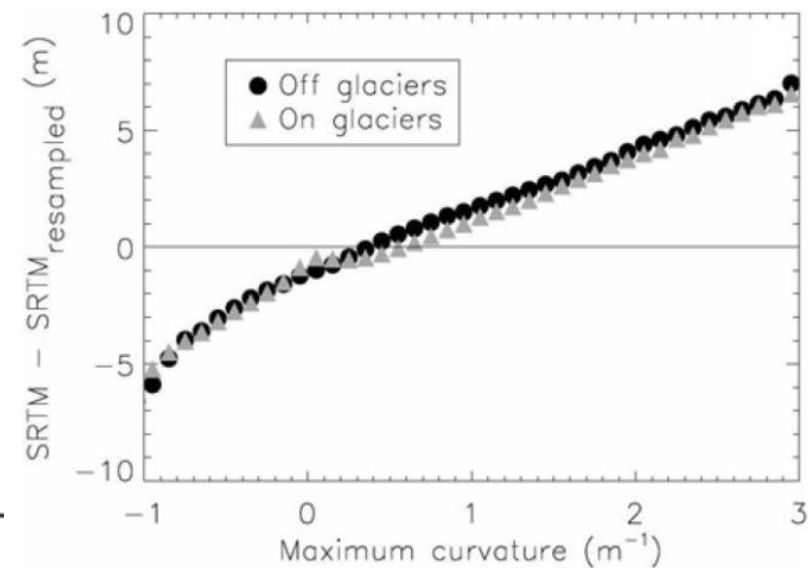
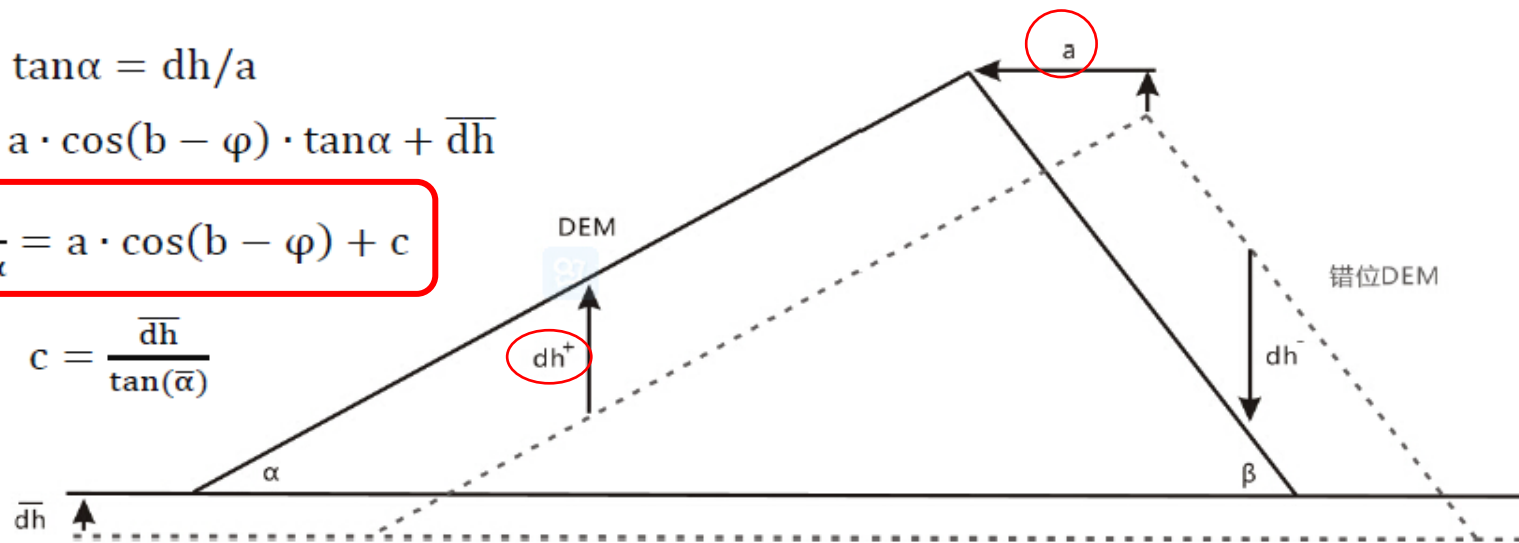
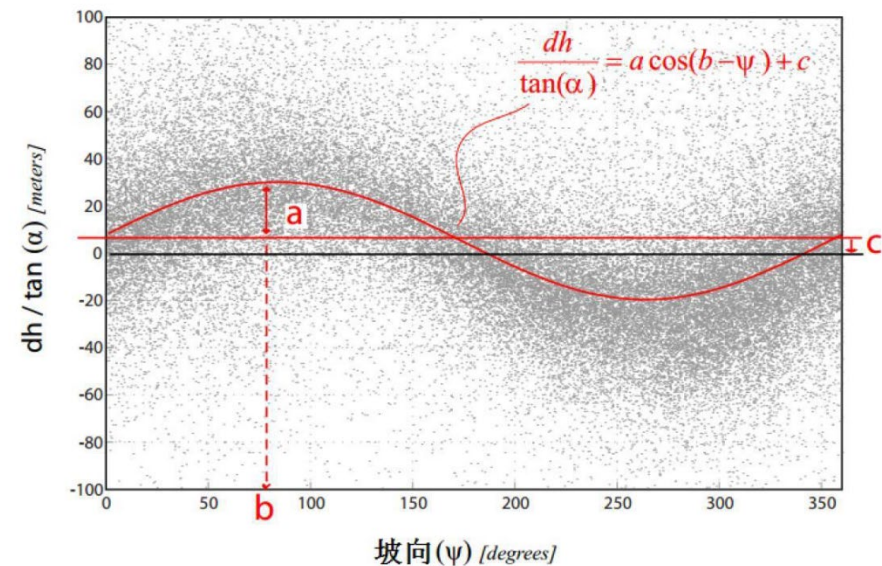
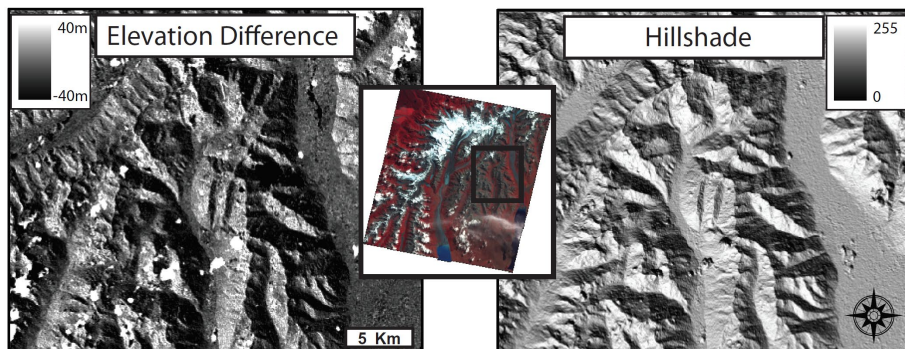
3. Data and method: Method

□ DInSAR



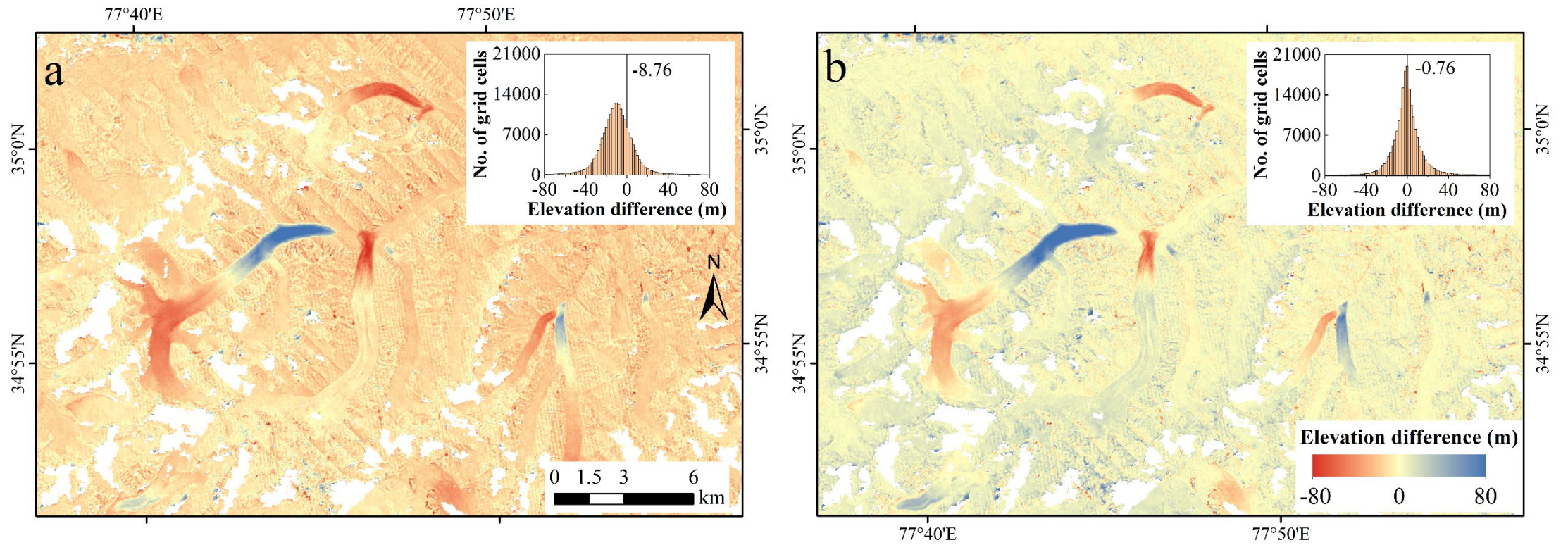
3. Data and method: Method

DEM co-registration and bias corrections



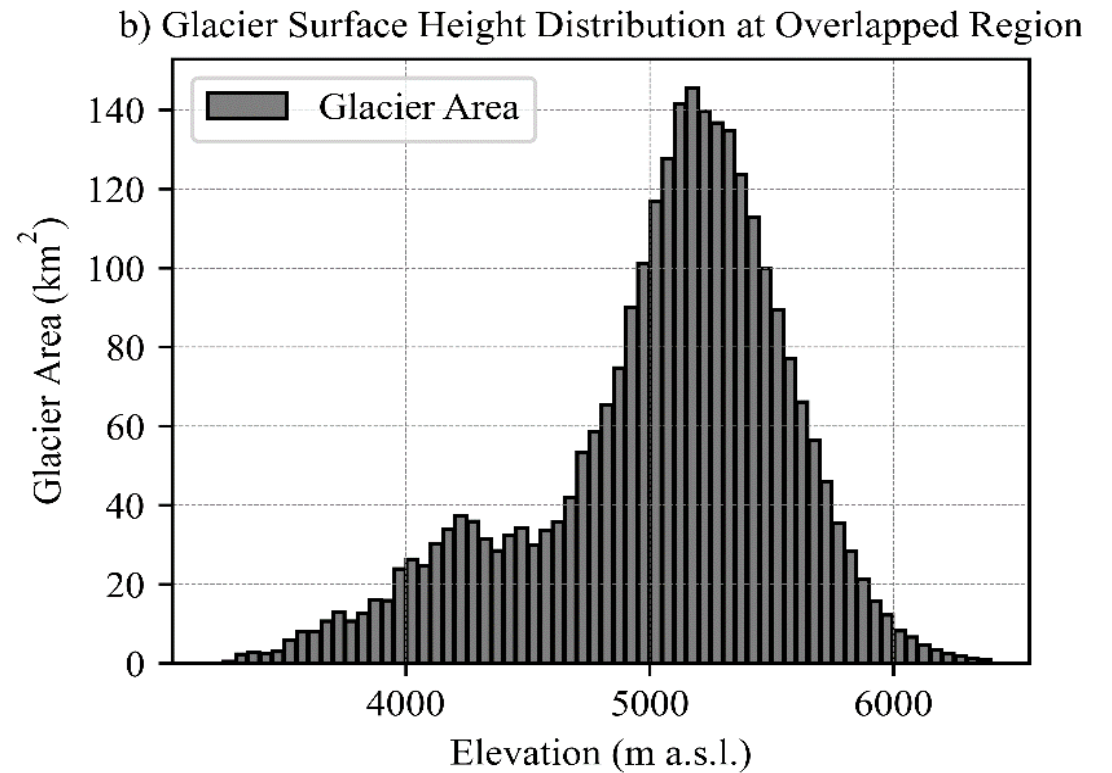
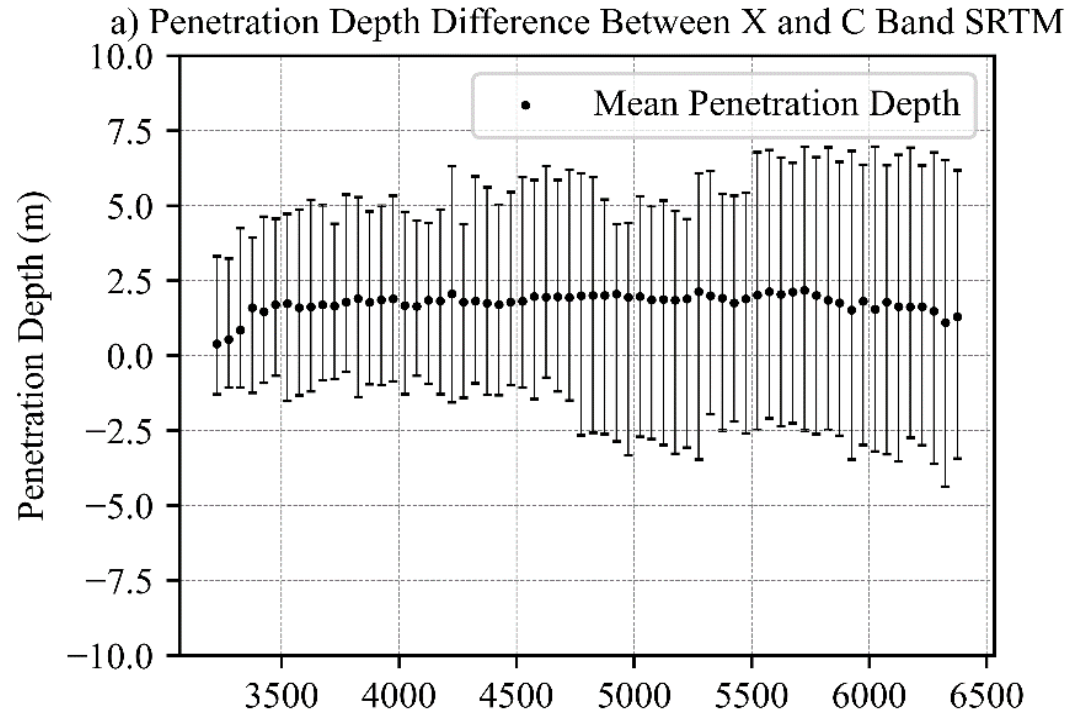
3. Data and method: Method

□ The comparison before and after DEM co-registration



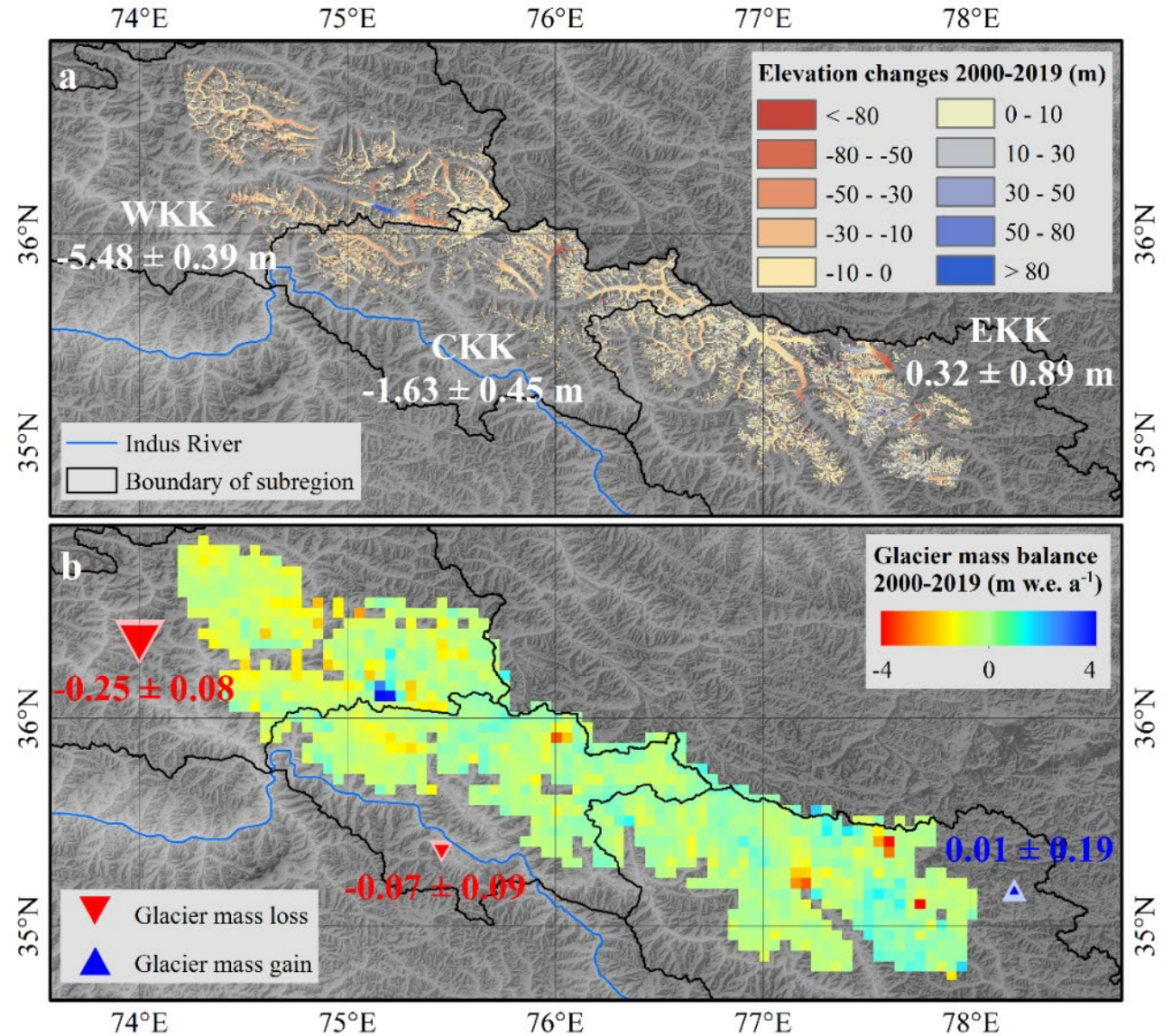
3. Data and method: Method

□ Penetration depth difference between X and C Band SRTM



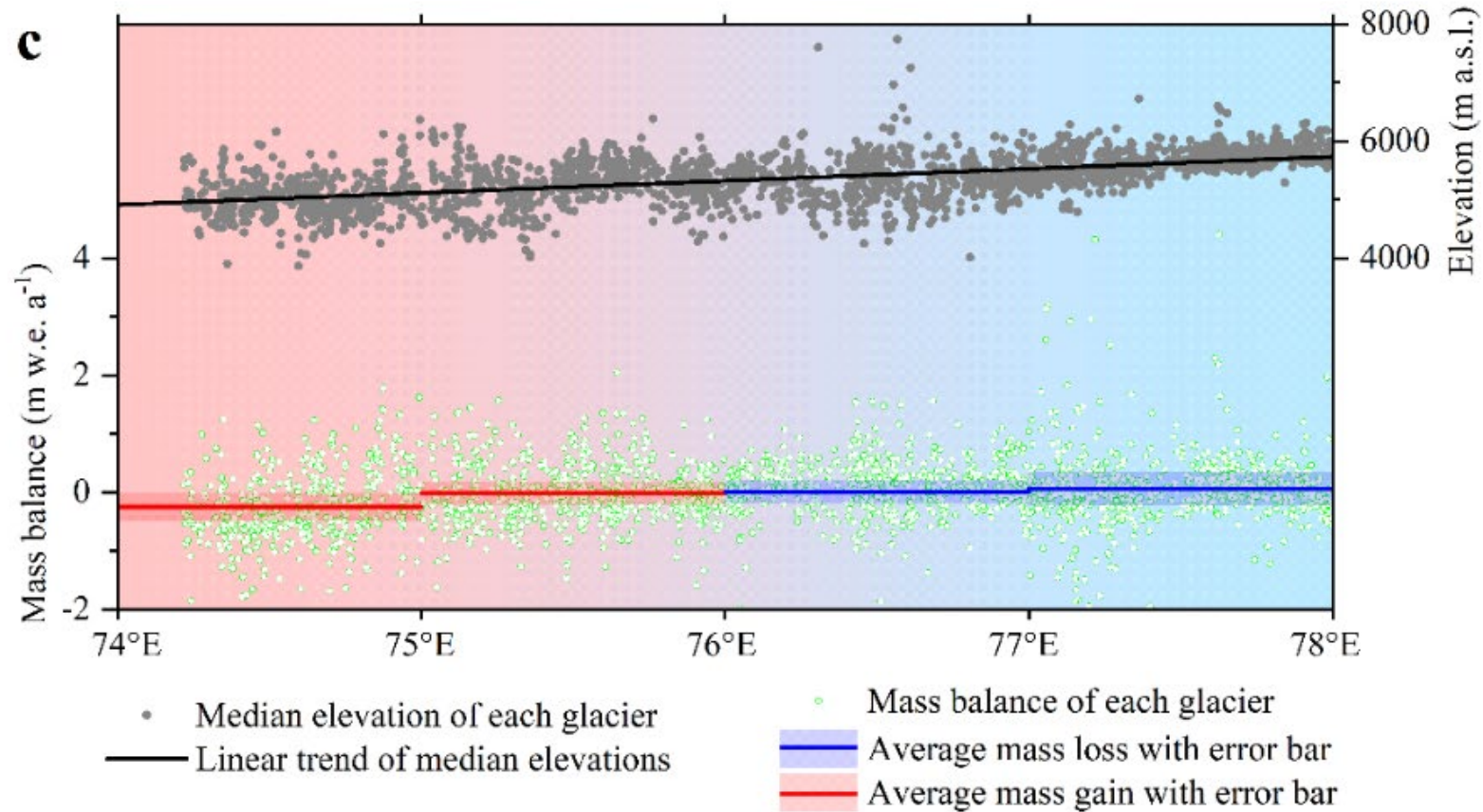
4. Result and Discussion

- 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.



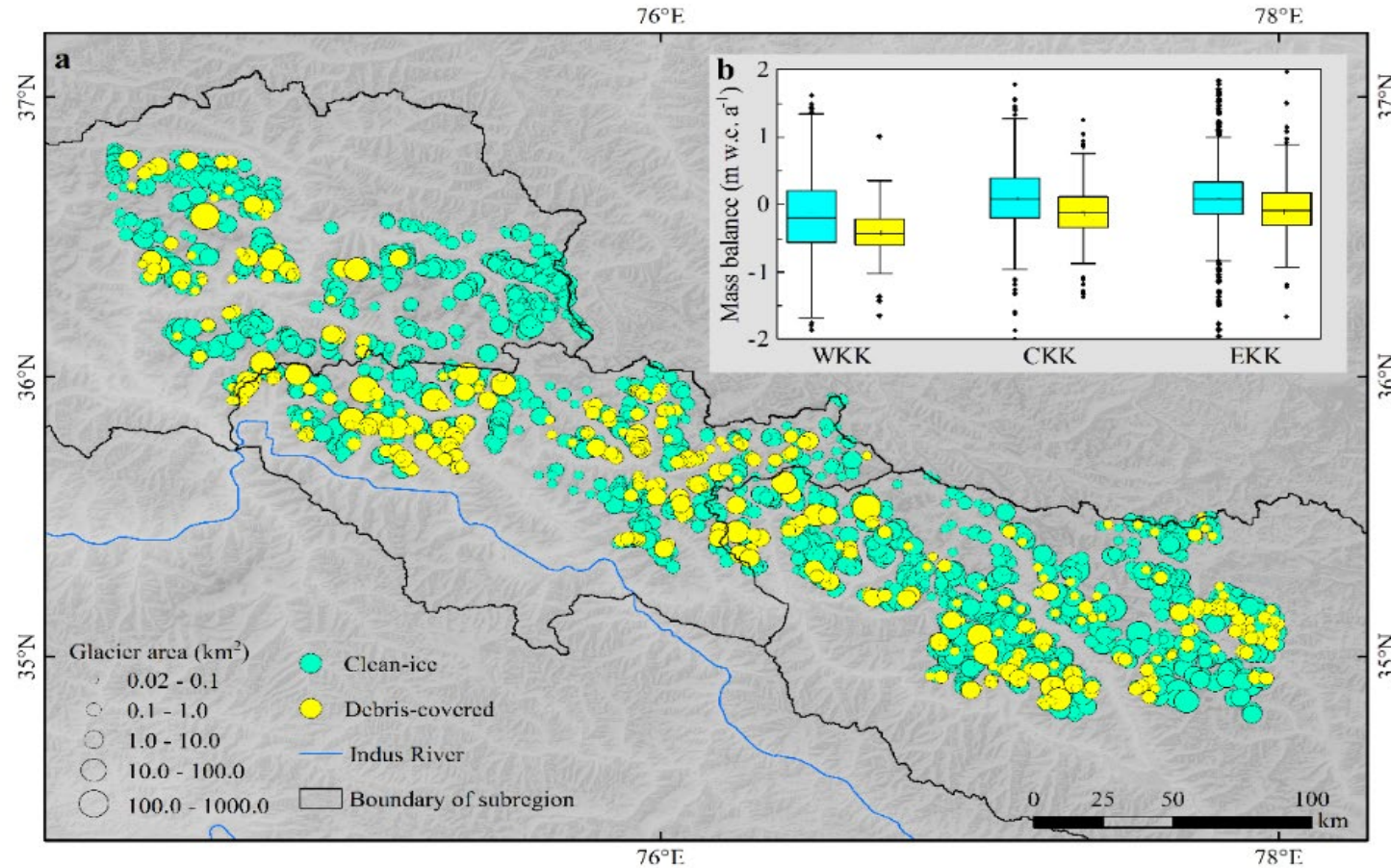
4. Result and Discussion

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



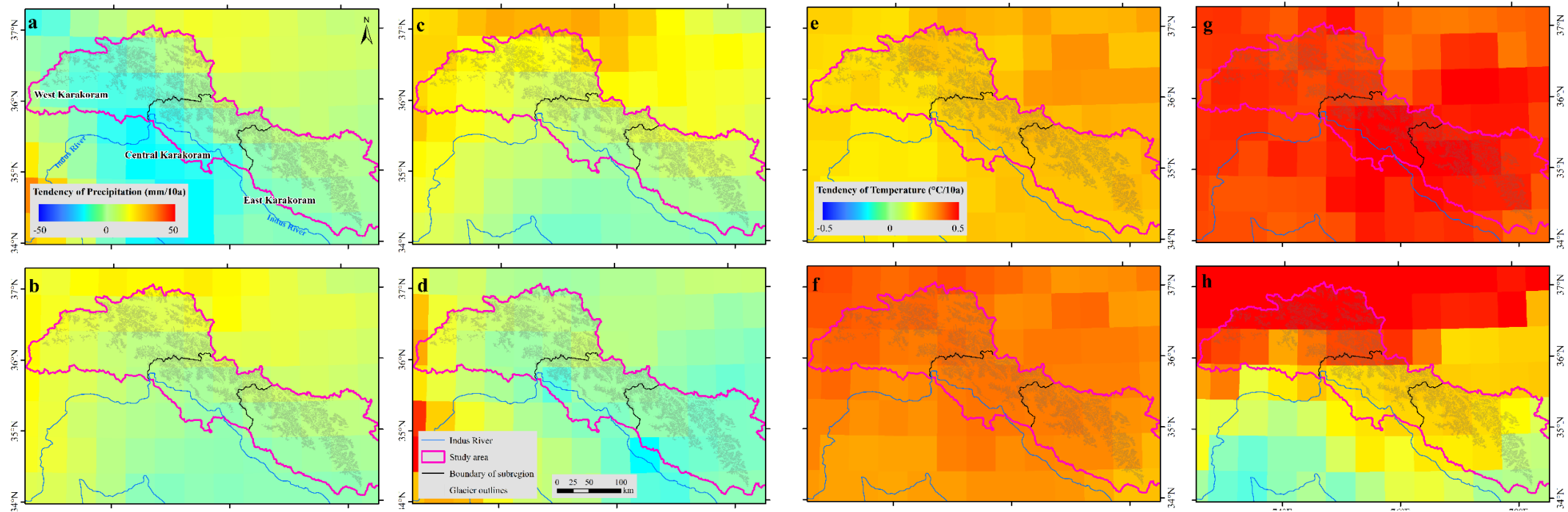
4. Result and Discussion

- 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