



Center for Earth Observation and Digital Earth
Chinese Academy of Sciences



Glacier Study of Qinghai-Tibet Plateau

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Qinghai-Tibet Plateau



Main Case Study Areas



Muztagh glacier



Dongkemadi glacier



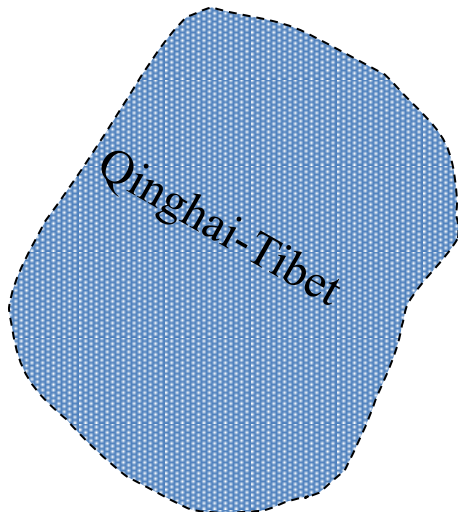
Duofeng glacier

Glacier area change of Qinghai-Tibet

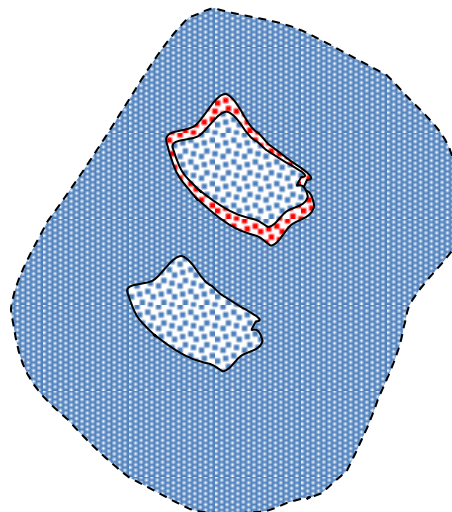


- Data Source:
 - The dataset is download from USGS
 - The datasets are acquired in 1970 and 2000 separately
 - MSS(Multi-Spectral Scanner), Landsat-1, 2, 3
 - TM (Thematic Mapper) , Landsat-4, 5, 7
- Method

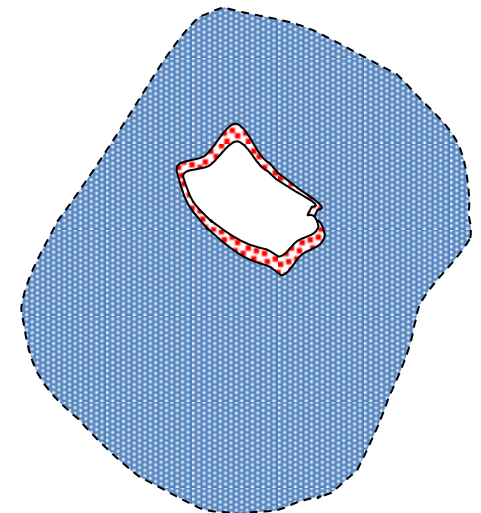
Study area selection



Glacier boundary identify



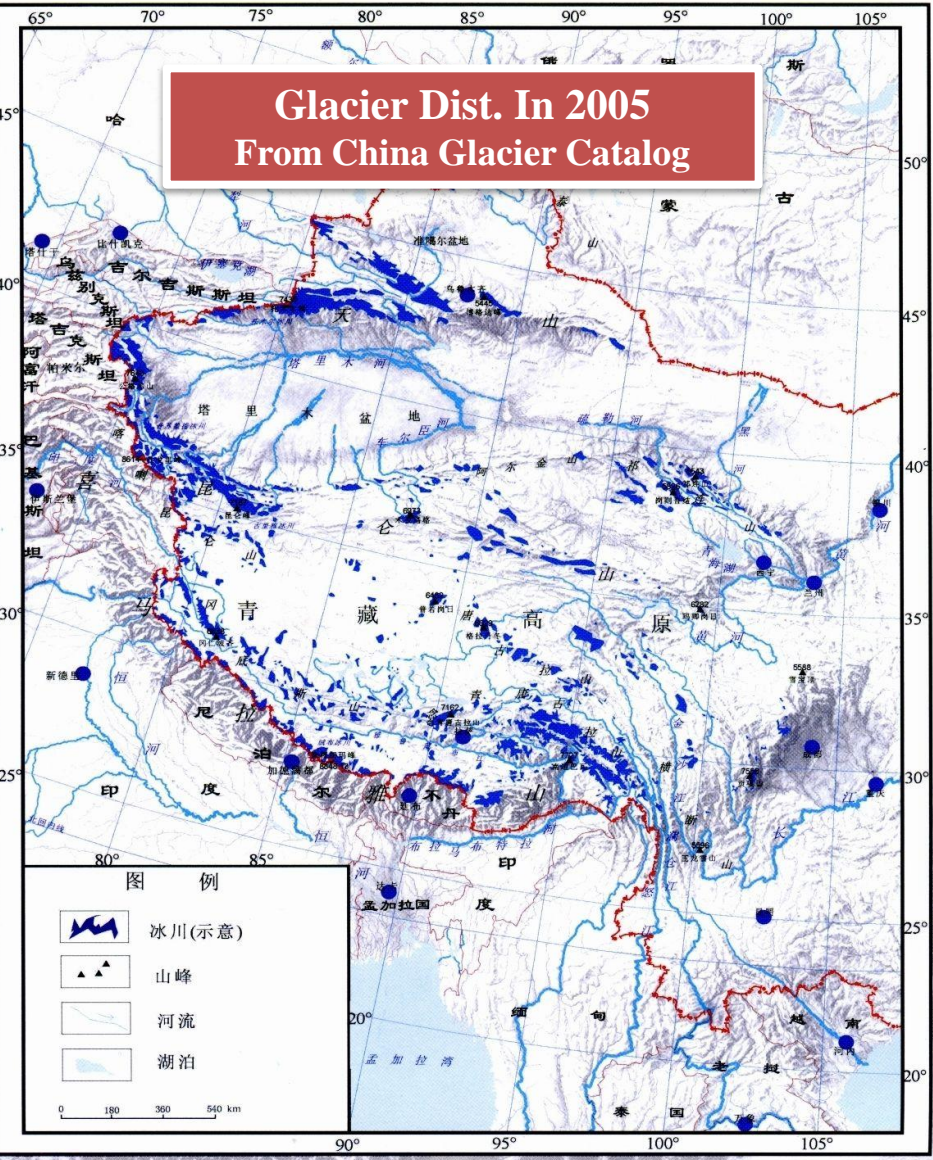
Change detection



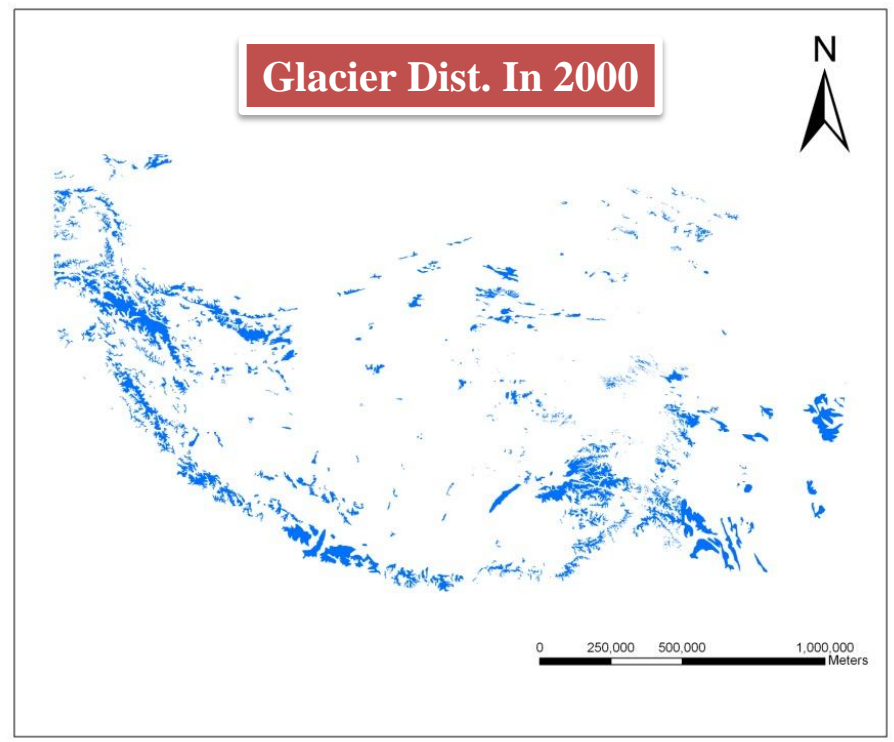
Glacier area change of Qinghai-Tibet



Glacier Dist. In 2005
From China Glacier Catalog



Glacier Dist. In 2000



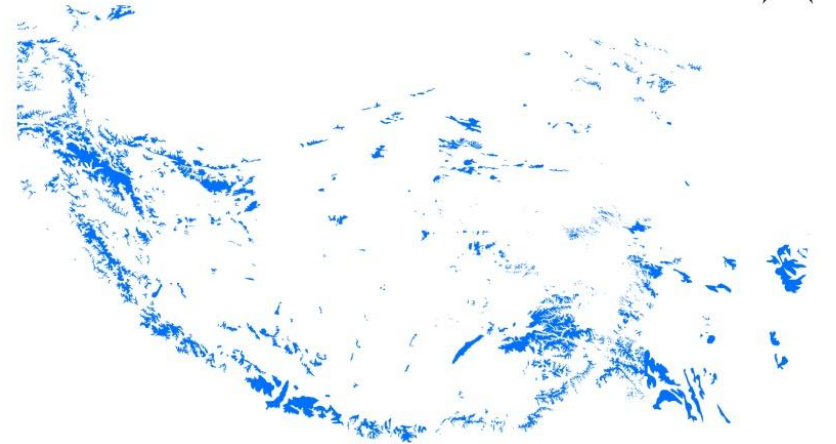
Glacier area change of Qinghai-Tibet



Glacier Dist. In 1970

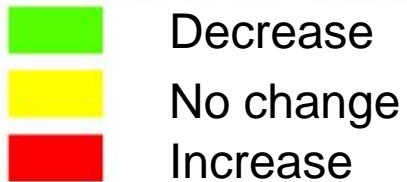
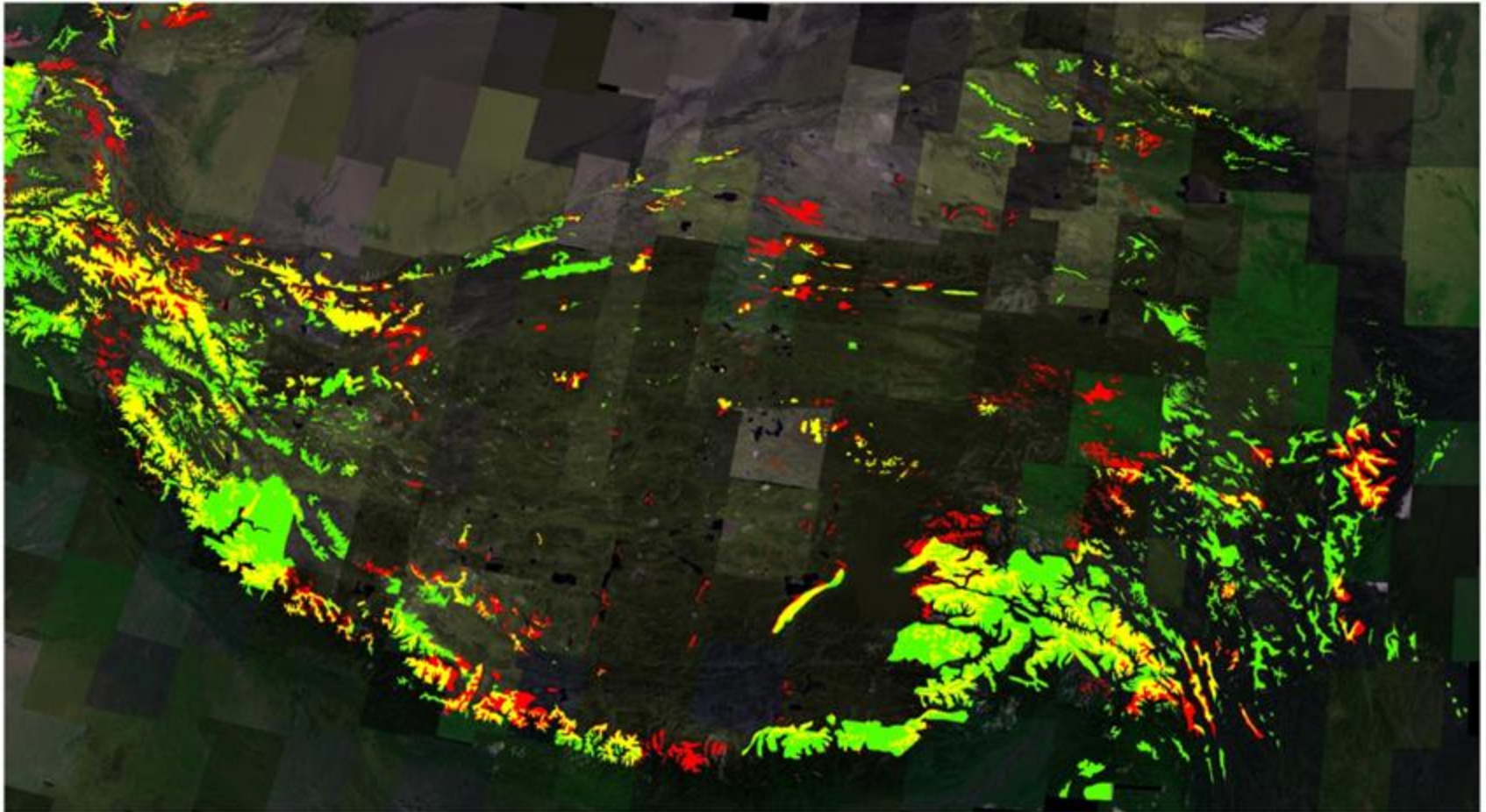


Glacier Dist. In 2000



By remote sensing method, we see that in general, the glacier retreated quite a lot, especially the south part of Qinghai-Tibet plateau.

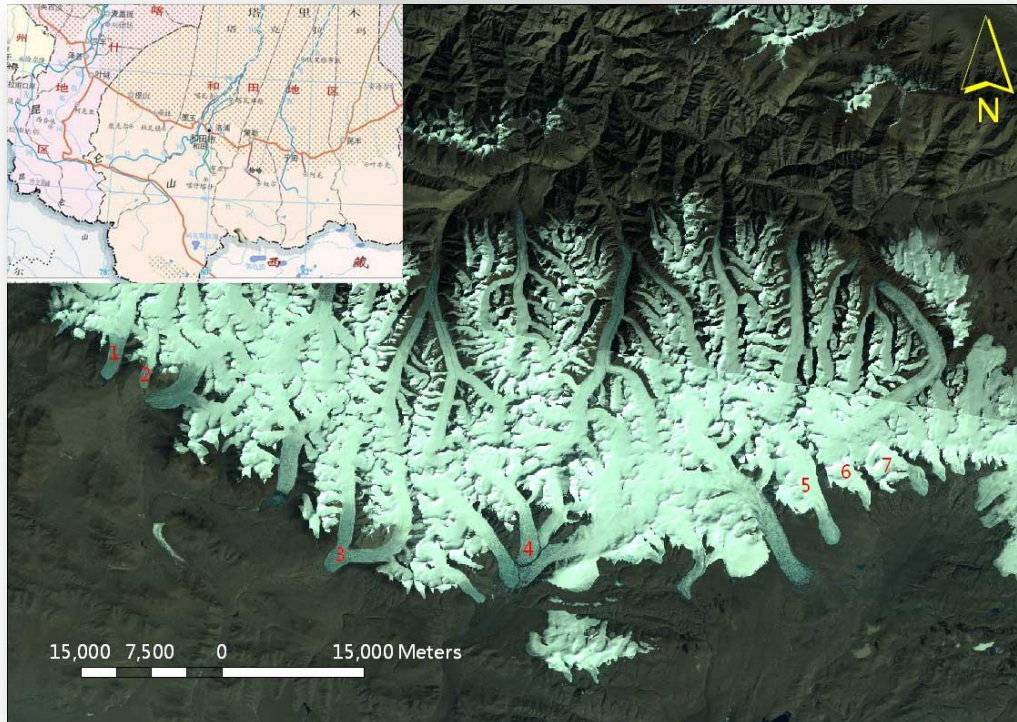
Glacier area change of Qinghai-Tibet



Duofeng glacier



- Northern of Guo Zacu, located at the Xinjiang, is one of glacial core areas
- The glacier types are complete, has the hanging glacier, cirque glacier, valley glacier and the flat topping glacier.
- These glacier provide rich and stable water sources for local rivers.



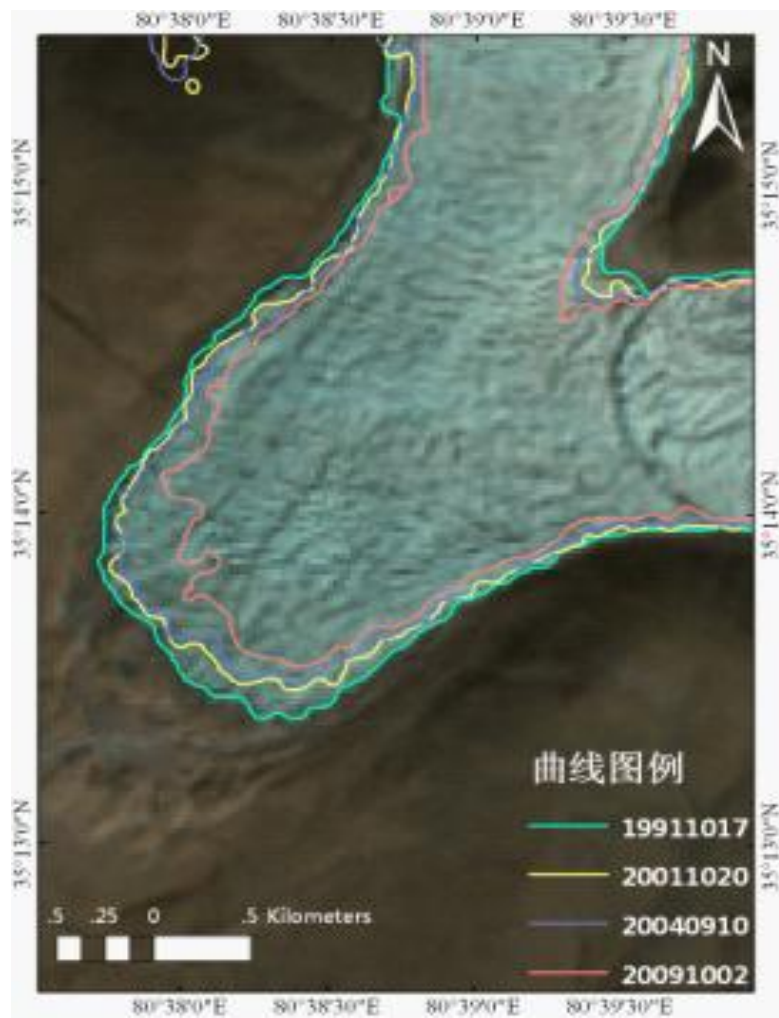
Duofeng glacier



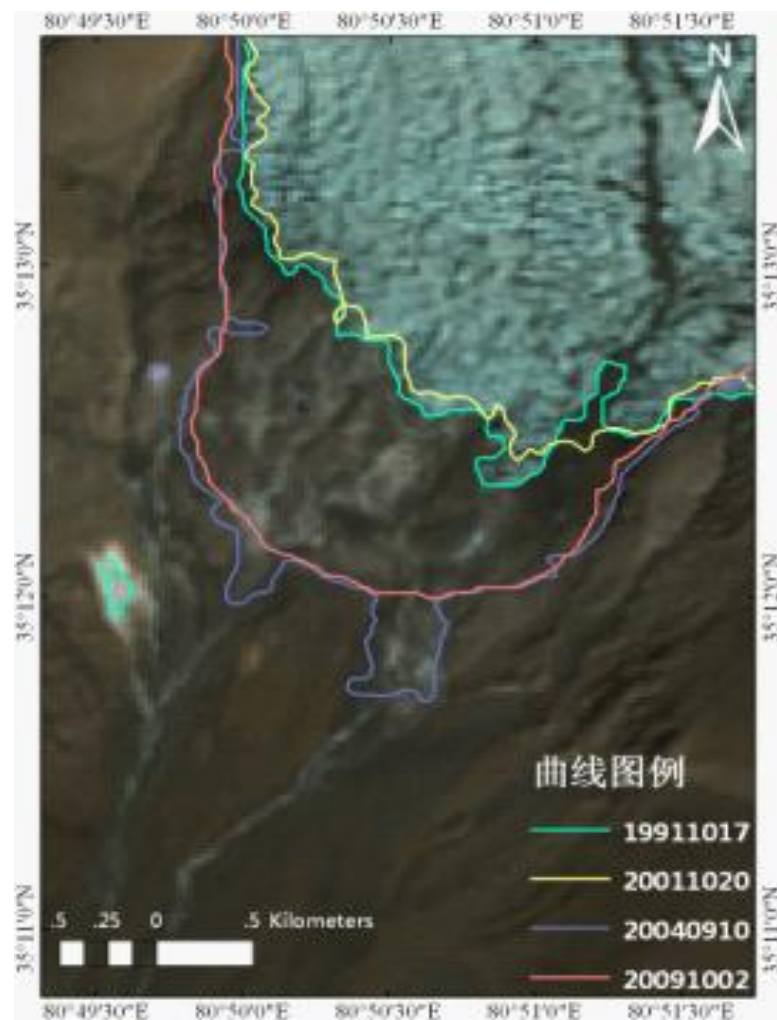
- 1991/10/17 Landsat 5 TM
- 2001/10/20 Landsat 7 ETM+
- 2004/9/10/ Landsat 7 ETM+
- 2009/10/2/Landsat 5 TM

The Landsat program offers the longest continuous global record of the Earth's surface; it continues to deliver visually stunning and scientifically valuable images

Duofeng glacier



Gongxing Glacier (No.3)

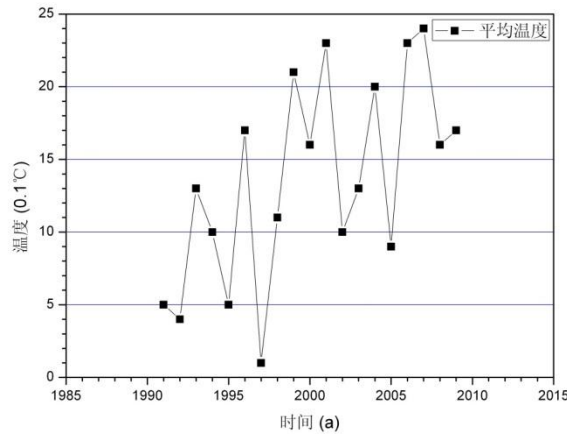


Zhongfeng Glacier (No.4)

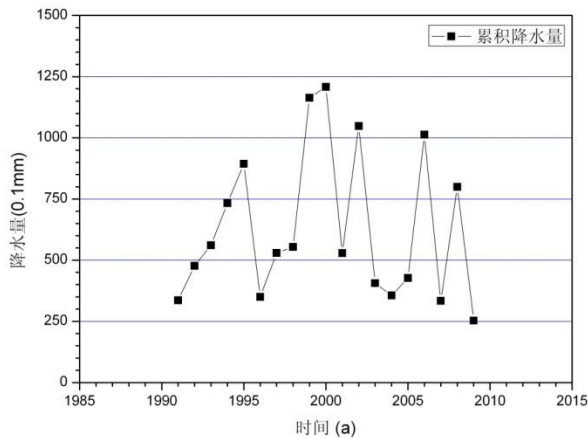
Duofeng glacier



ShiQuanhe Meteorologic Station data from 1991 to 2009



Annual mean temperature



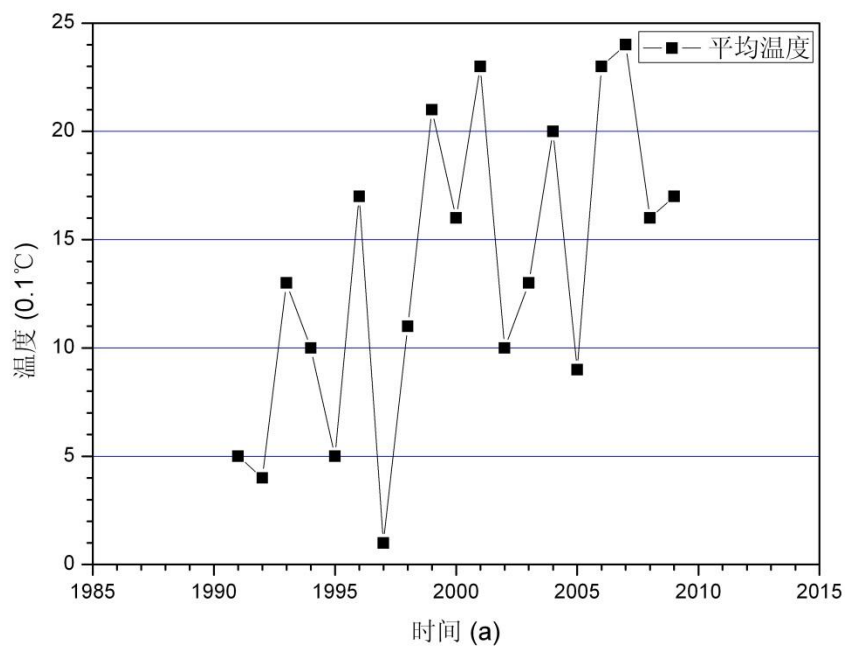
Accumulated precipitation

No.	Name	2001-1991 area (km ²)	2004-2001 area (km ²)	2009-2004 area (km ²)
1	Quanshui	0.05	0	-0.05
2		0.14	-0.1	-0.02
3	Gongxing	-0.63	-0.25	-0.95
4	Zhongfeng	-0.29	3.12	-0.63
5		0.02	-0.02	-0.03
6		0.02	0	-0.02
7		0.05	-0.02	-0.01

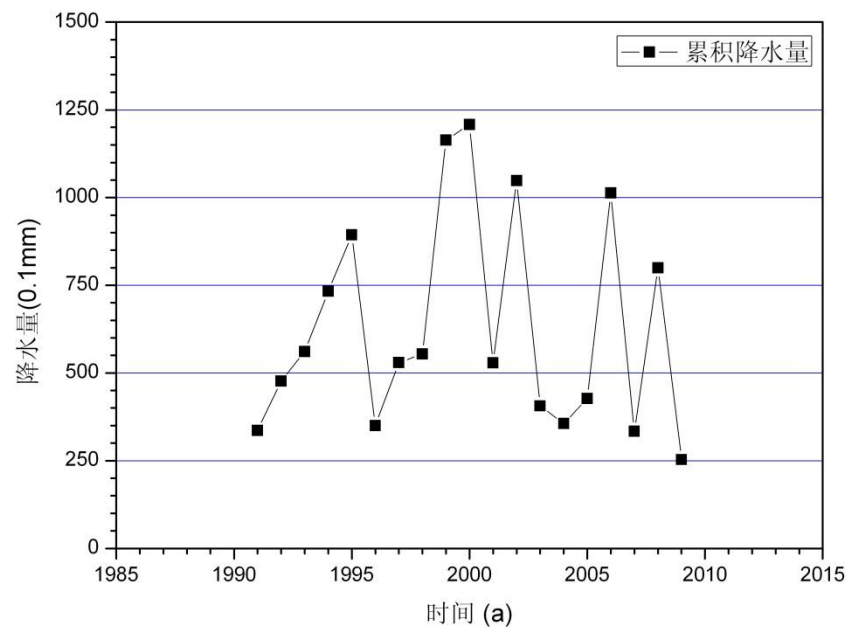
Duofeng glacier



ShiQuanhe Meteorologic Station data from 1991 to 2009



Annual mean temperature



Accumulated precipitation

Dongkemadi glacier



- **Dongkemadi glaciers area in the central part of the Qinghai-Tibetan Plateau**
- **The Dadongkemadi glacier is 5.4 km in length, and the area is about 14.63 km².**
- **The glacier movement is slow for gentle slope.**



Dongkemadi glacier



Exploring Glacier Boundary and Area

Method

The change of backscattering characteristic at glacier surface will cause serious decrease of coherence. Based on the decorrelation of InSAR technique, we can find the glacier boundary.

$$\gamma_c = \frac{E[M \cdot S^*]}{\sqrt{E[M \cdot M^*] \cdot E[S \cdot S^*]}}$$

Dongkemadi glacier

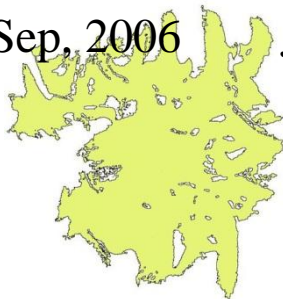


Exploring Glacier Boundary and Area



ALOS/PALSAR

Jun., 2006, Sep, 2006



ALOS/PALSAR

Area: 79.21 KM²
Diff: -5.40 KM²



ENVISAT/ASAR

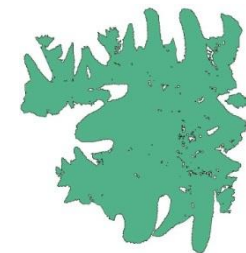
Jul, 2007 Aug, 2007



ENVISAT/ASAR

Area: 75.35 KM²
Diff: -9.26 KM²

The coherence of InSAR pair is related with spatial baseline, temporal baseline, still we can see clear edge from coherence .



Landsat ETM+

Area: 84.61 KM²
Diff: ----

Dongkemadi glacier



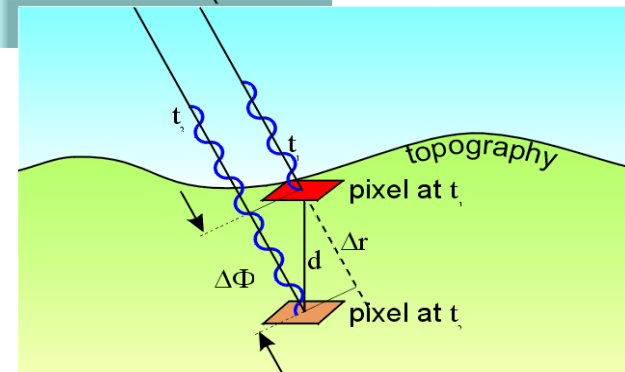
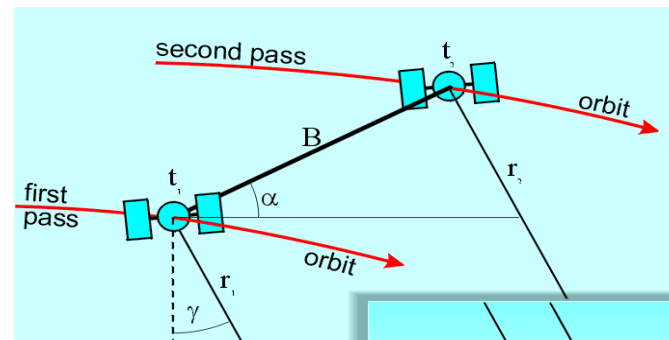
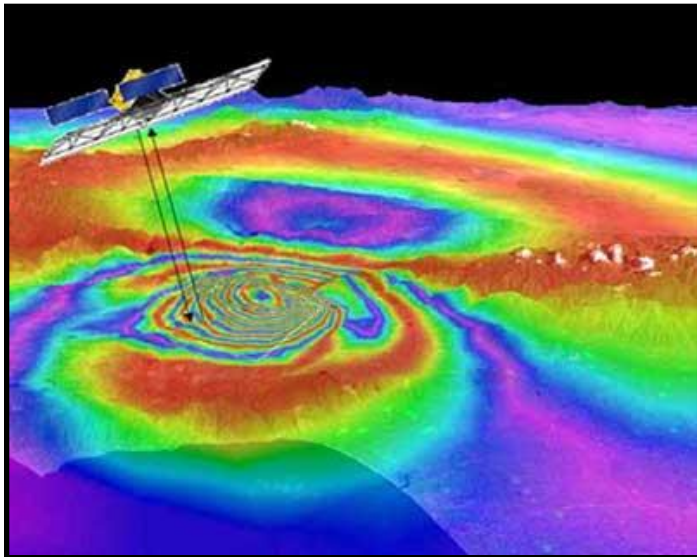
Exploring Glacier Movement

InSAR phase:

$$\phi_{\text{int}} = \phi_{\text{topo}} + \phi_{\text{defo}} + \phi_{\text{orb}} + \phi_{\text{atm}} + \phi_{\text{noise}}$$

DInSAR phase:

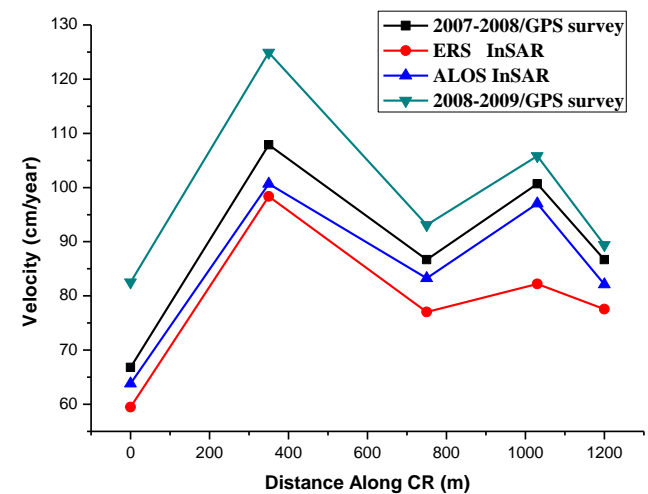
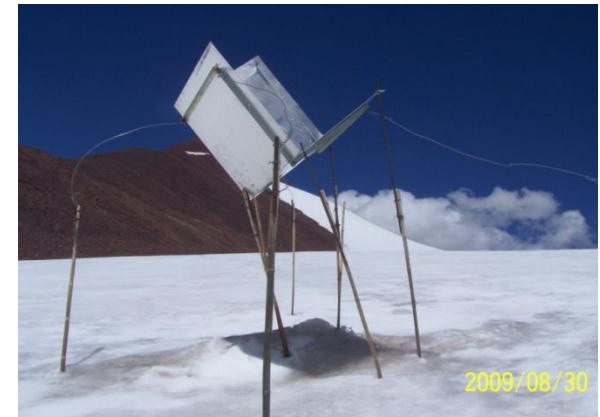
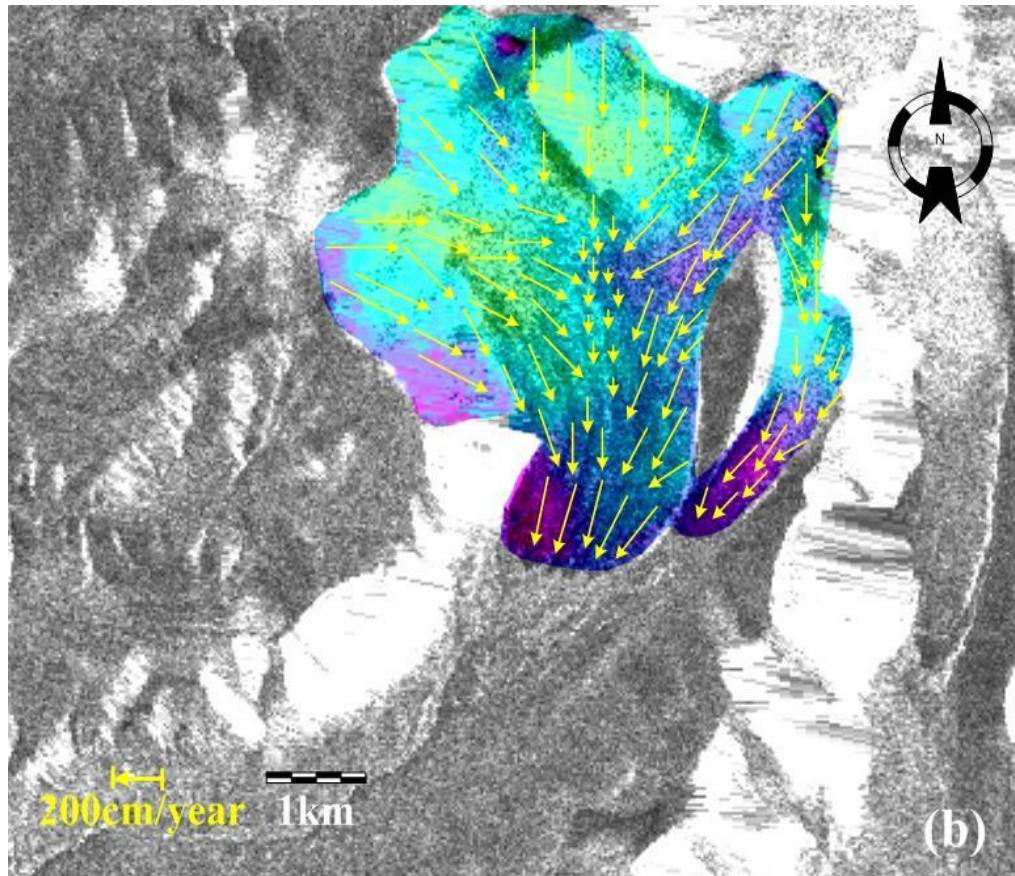
$$\phi_{\text{dif}} = \phi_{\text{defo}} + \phi_{\text{atm}} + \phi_{\text{noise}}$$



Dongkemadi glacier

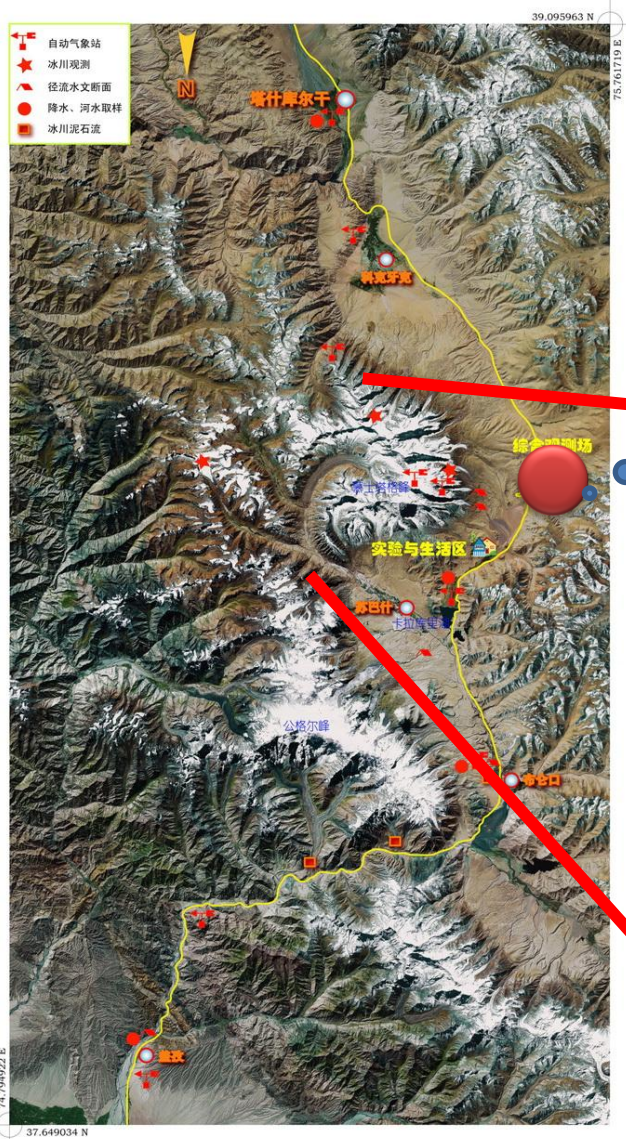


Exploring Glacier Movement



Glacier Surface Movement Map

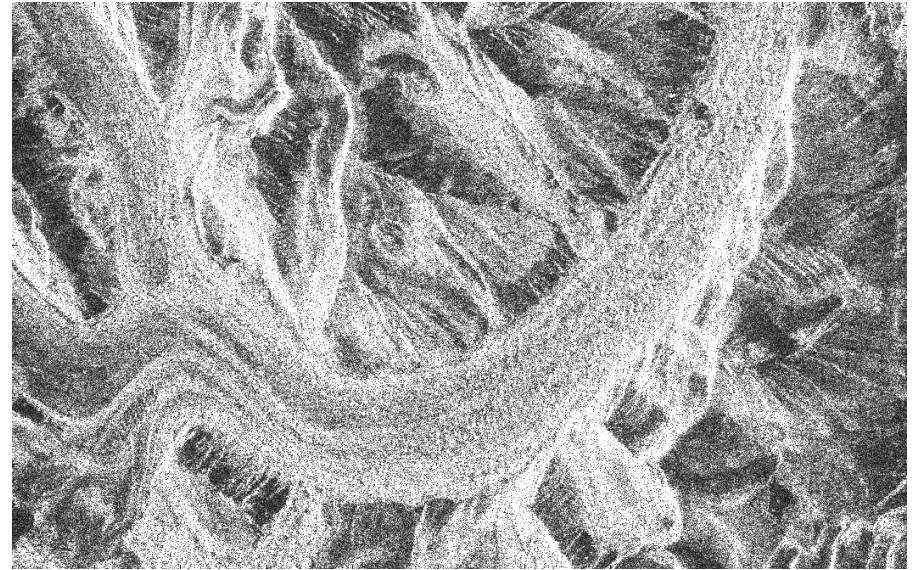
Muztagh Glacier



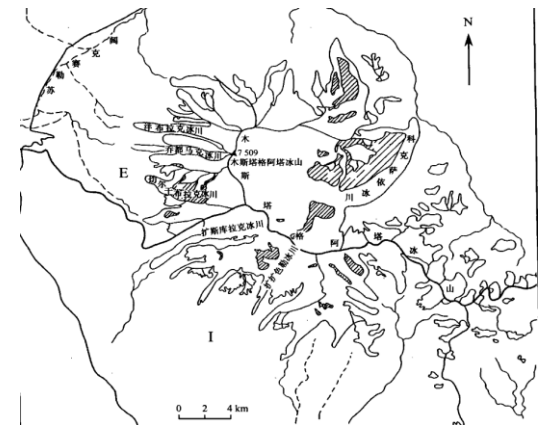
Station



Muztagh Glacier



KekeShayi Glacier is about 8 km long, and the change of elevation is about 800 meters of the main body, this cause a rapid movement of the glacier than in dongkemadi area.

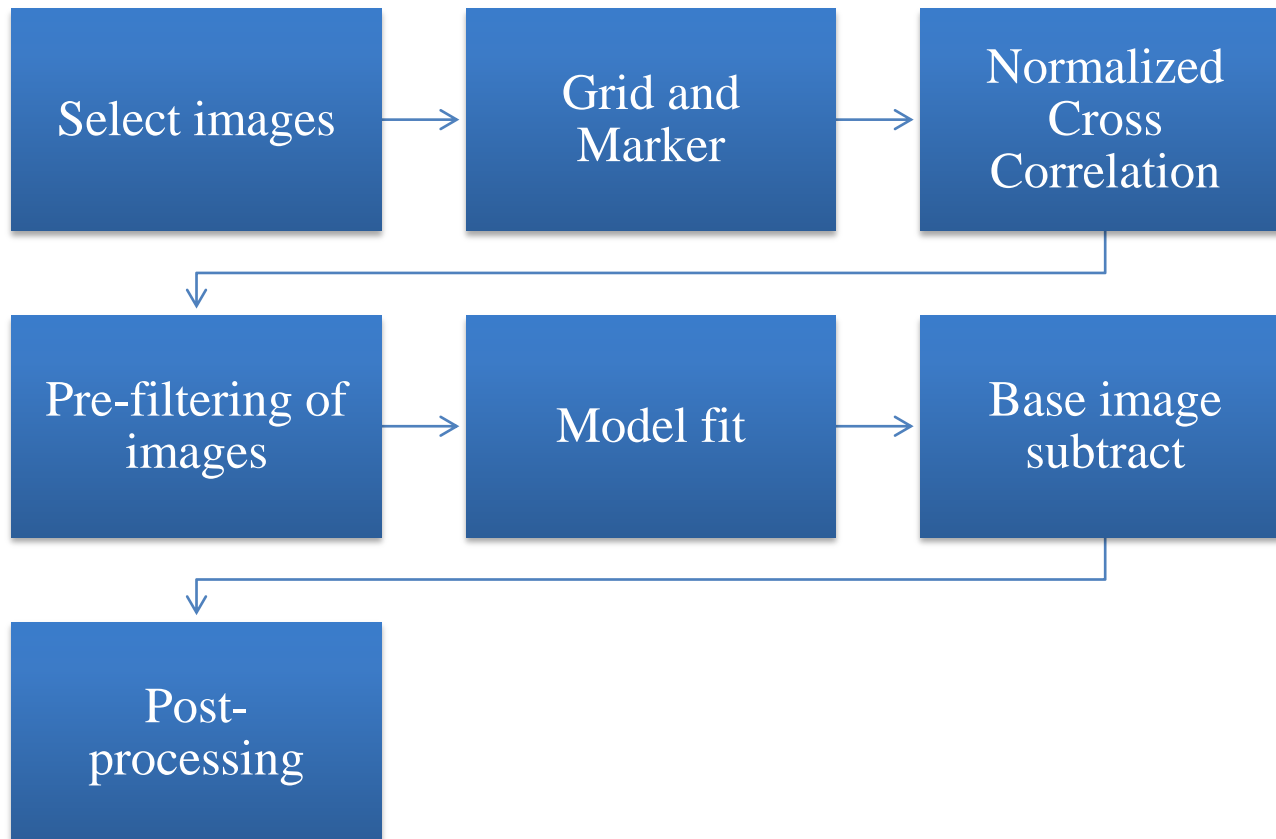


Muztagh Glacier



Glacier Movement Estimation

Pixel Track Method



Muztagh Glacier



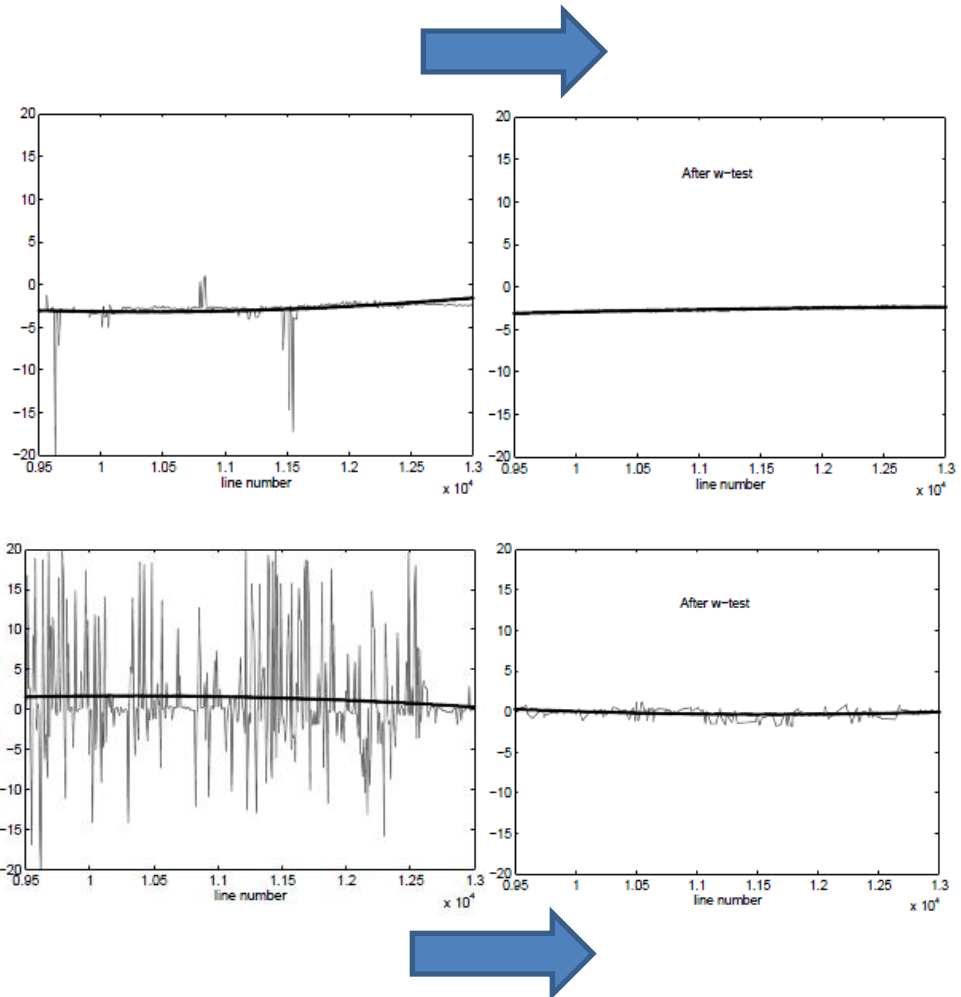
Glacier Movement Estimation

Model Fit – *DIA* Method

Overall Model
Test (OMT)
 $q=m-n$

Model
Adjustment

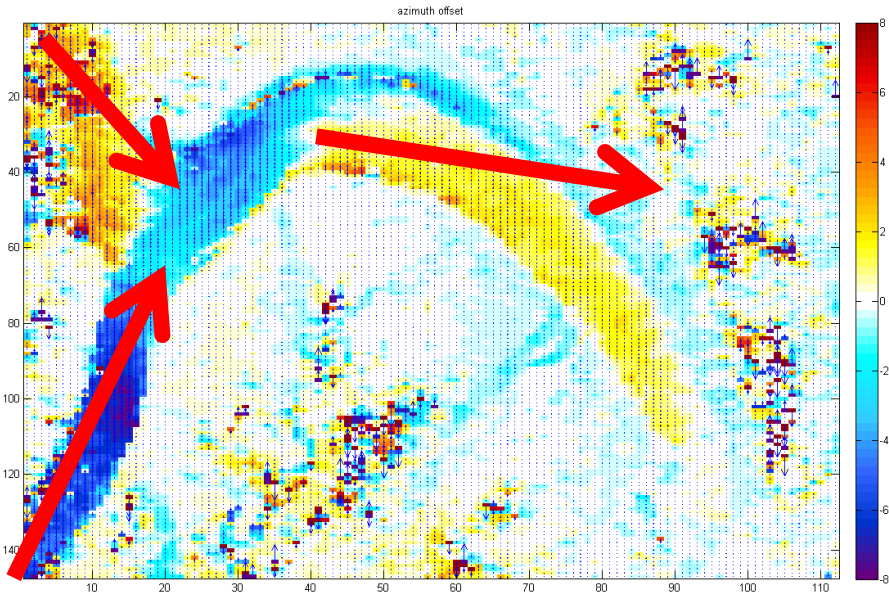
Data Snooping
 $q=1$



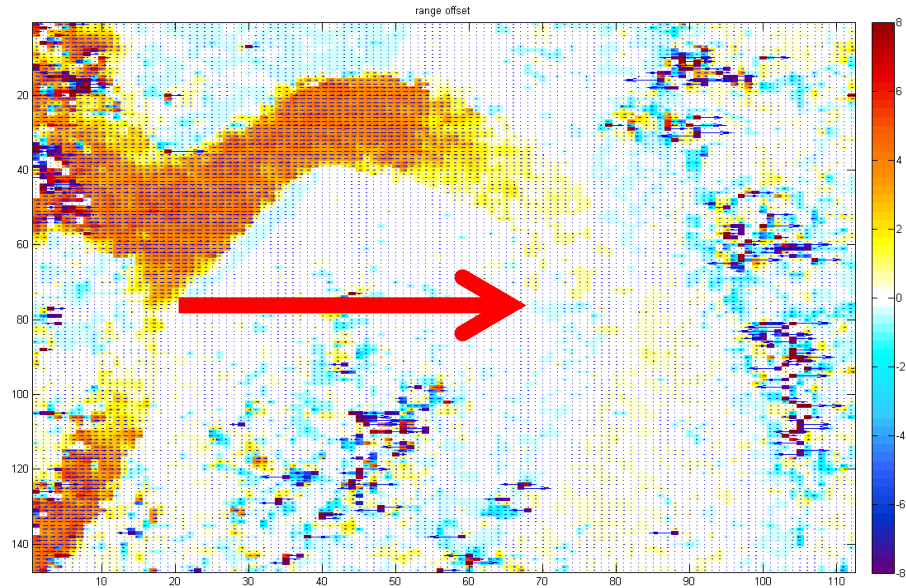
Muztagh Glacier



meters



meters

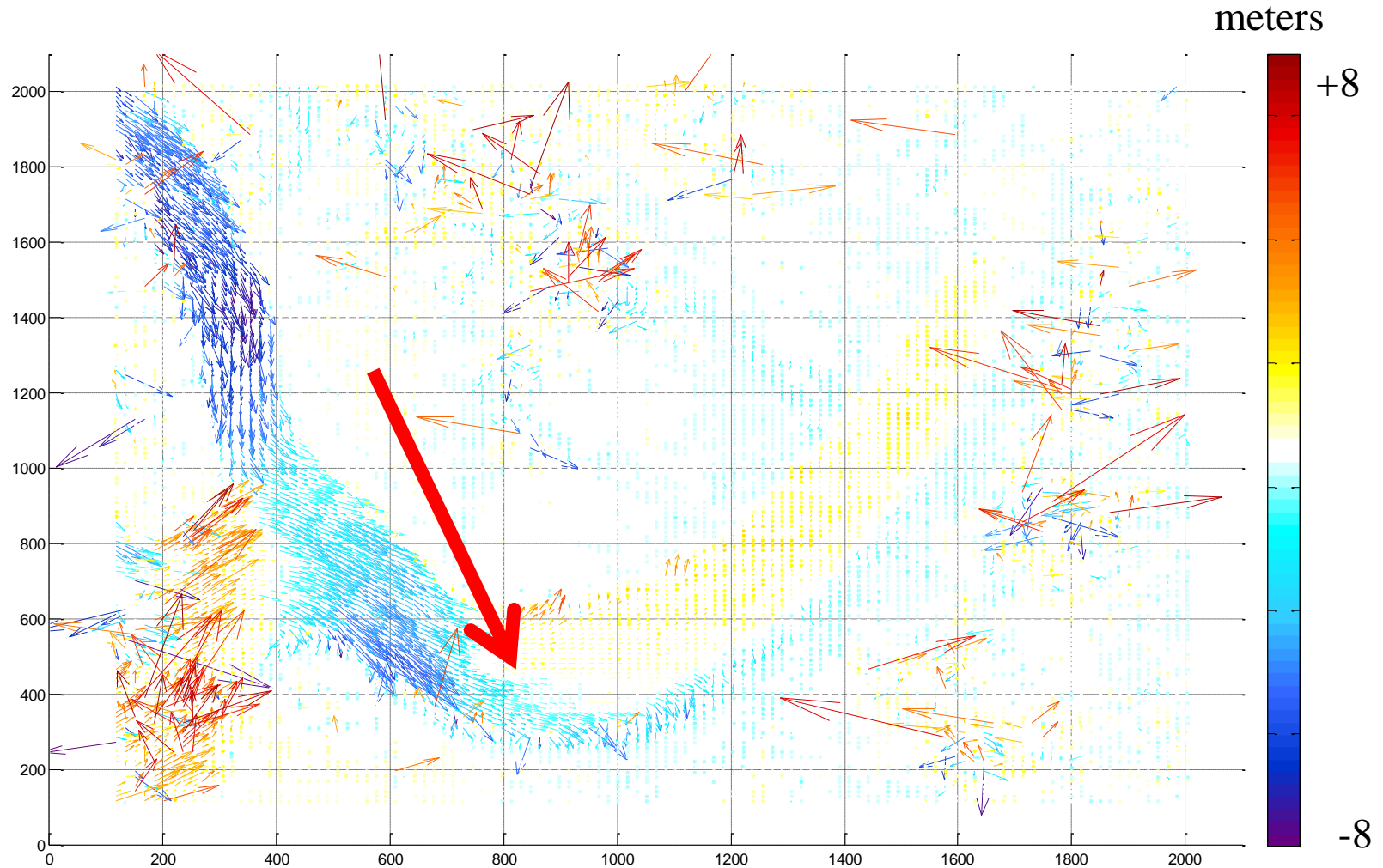


RANGE

Azimuth movement

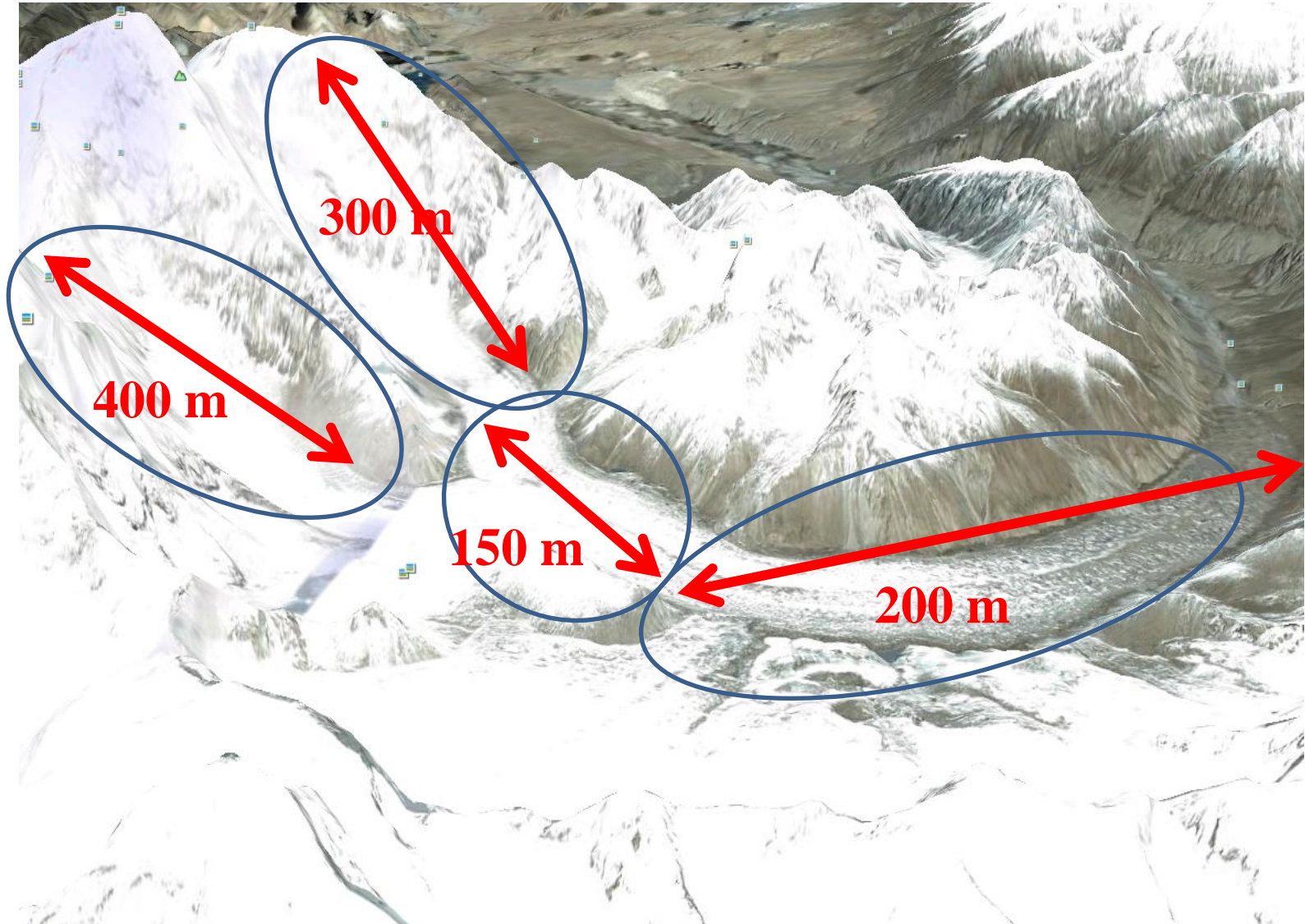
Range movement

Muztagh Glacier



2D Movement Map

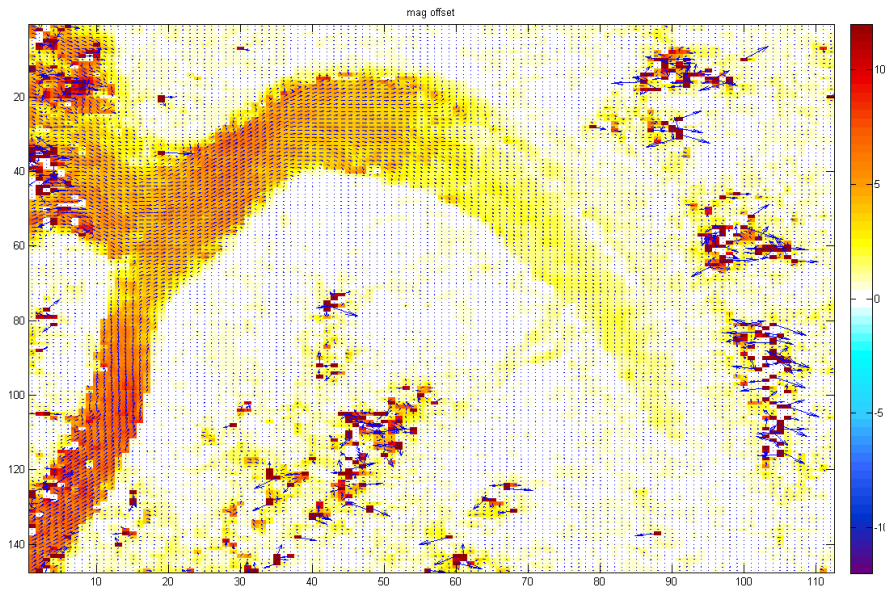
Muztagh Glacier



Muztagh Glacier

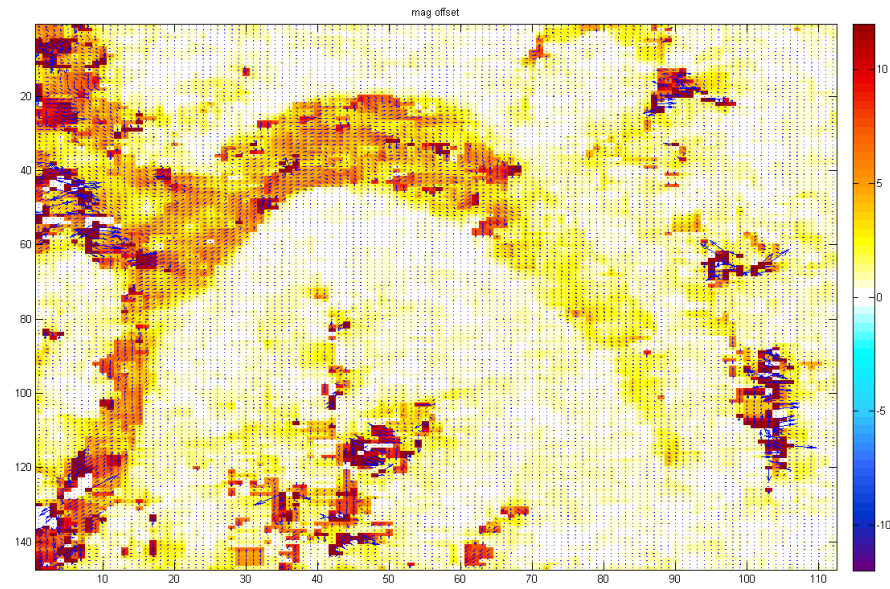


meters



090114_090301

meters



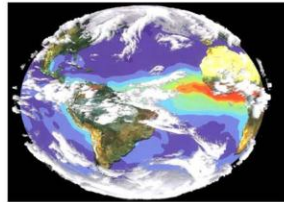
090901_091017

2D Movement Map

Muztagh Glacier



Thanks



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