ESA–MOST Dragon Cooperation

中国科技部-欧洲空间局“龙计划”合作

2017 DRAGON 4 SYMPOSIUM

2017年“龙计划”四期学术研讨会

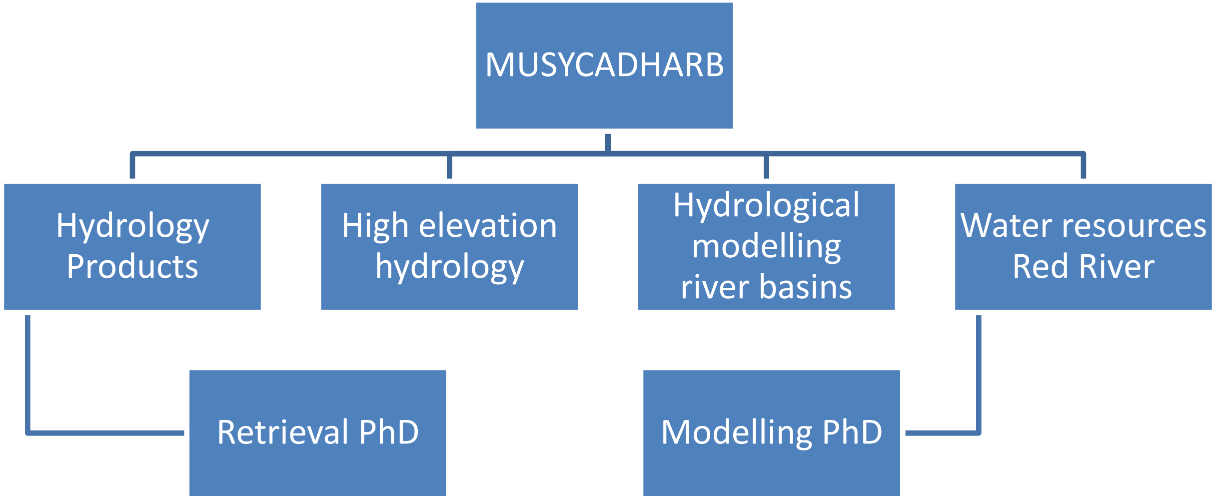
Multi – source hydrological data products to monitor High Asian River Basins and regional water security (MUSYCADHARB)

32449

26–30 June 2017 | Copenhagen, Denmark

2017年6月26-30日，丹麦 哥本哈根

Project logic and structure



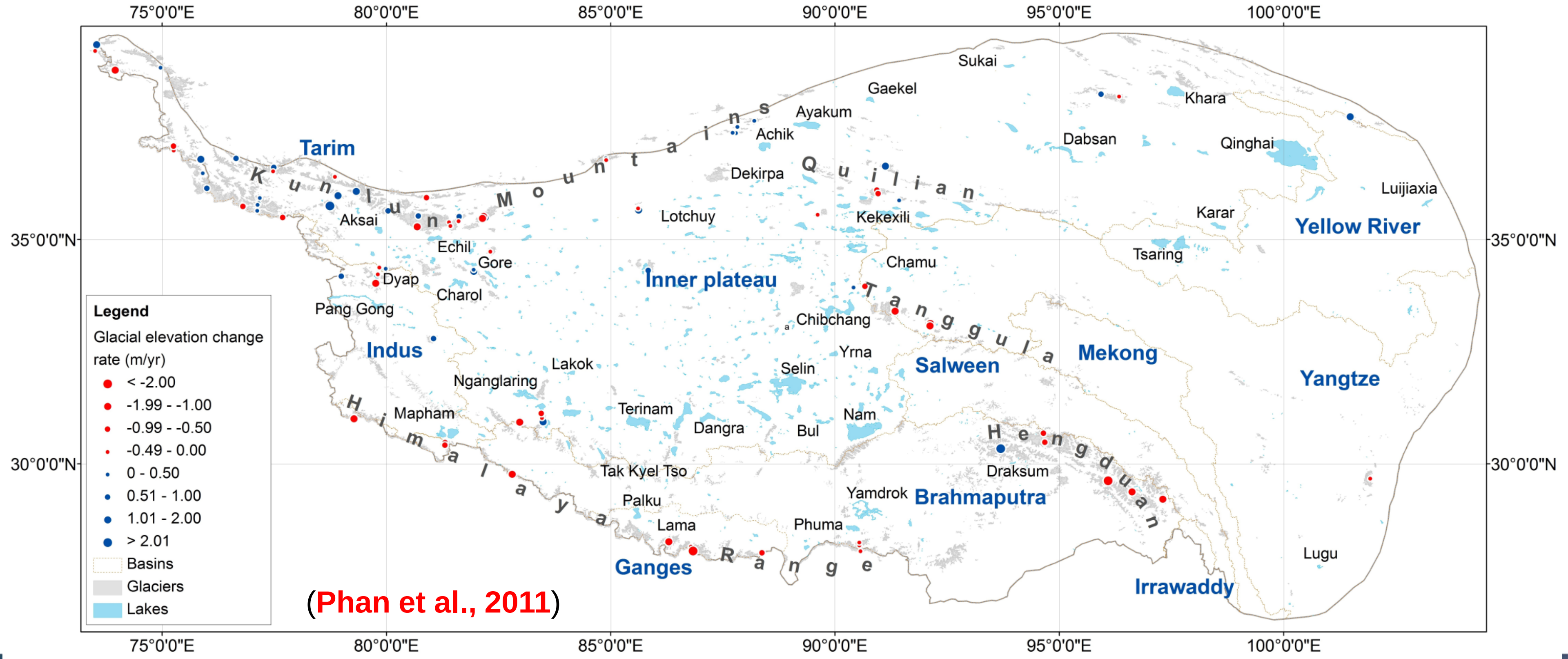
RESPONSE OF SNOW AND GLACIERS TO CLIMATE VARIABILITY: INTEGRATION OF SATELLITE DATA PRODUCTS AND ATMOSPHERIC MODEL VARIABLES

Massimo Menenti, Li Jia, Junchao Shi, Laure Roupioz, Lian Liu, Xinyu Mo, Jingxiao Zhang, Yaoming Ma, Weiqiang Ma

Research subjects and Progress

- Glaciers and lakes: observed trends
- Measuring changes in glacier thickness with ICESAT / GLAS
- Extent of glaciers
- Energy balance of glaciers and snow cover: albedo vs. snow depth and age
- High spatial resolution topographic correction of surface albedo
- WRF modelling of snowfall events: MODIS albedo vs model snow depth

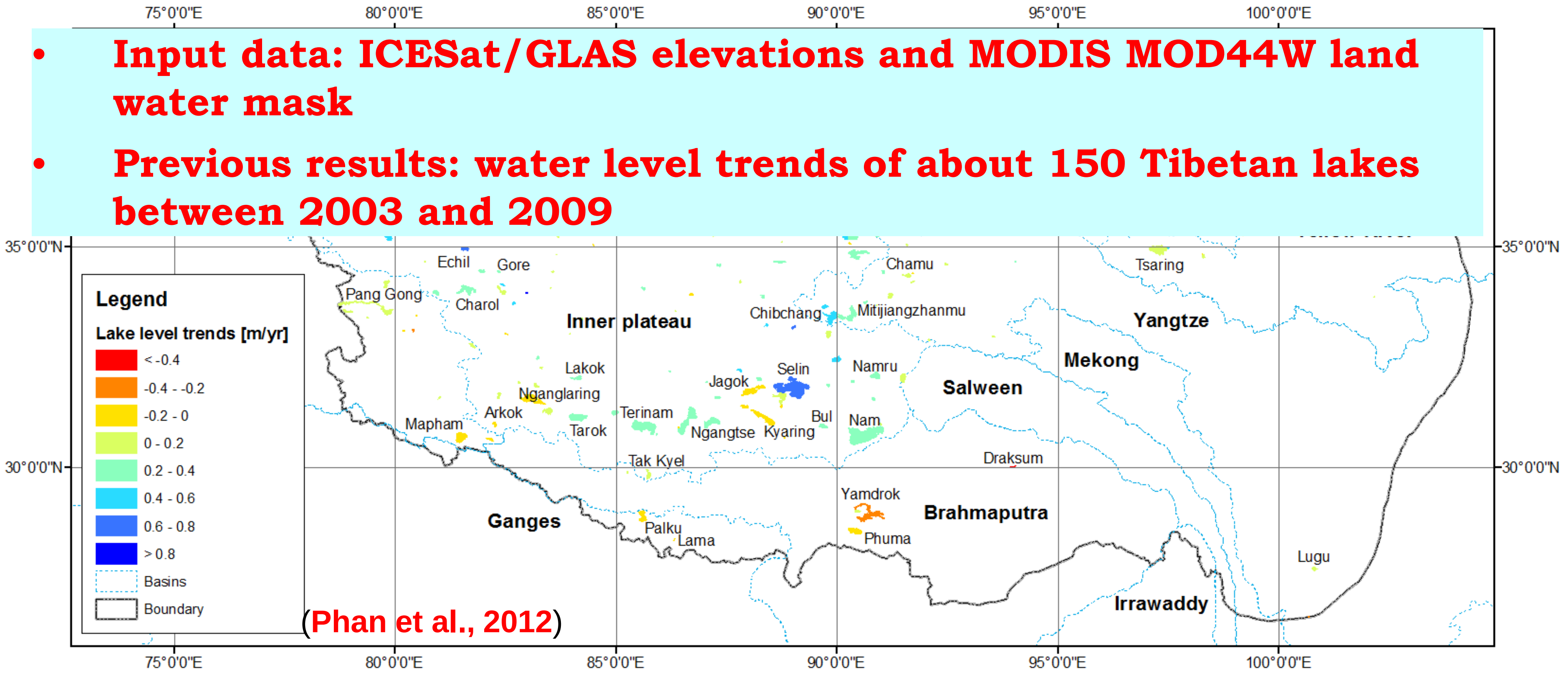
Glacial thickness change rates on the Tibetan Plateau between 2003 and 2009



(Phan et al., 2011)

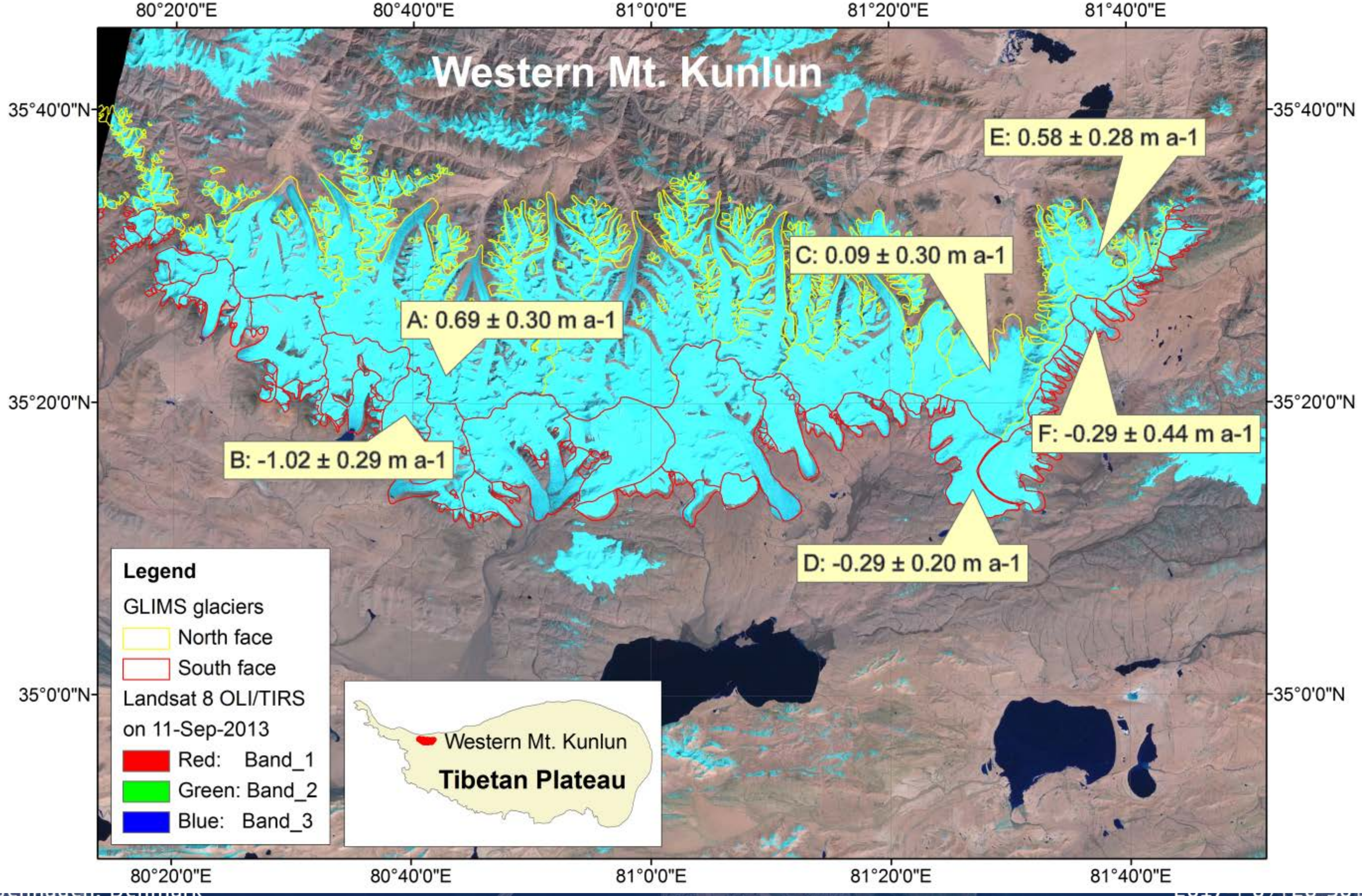
Lake level changes on the Tibetan plateau

- Input data: ICESat/GLAS elevations and MODIS MOD44W land water mask
- Previous results: water level trends of about 150 Tibetan lakes between 2003 and 2009



(Phan et al., 2012)

Glacial thickness change: different rates on the North and South sides



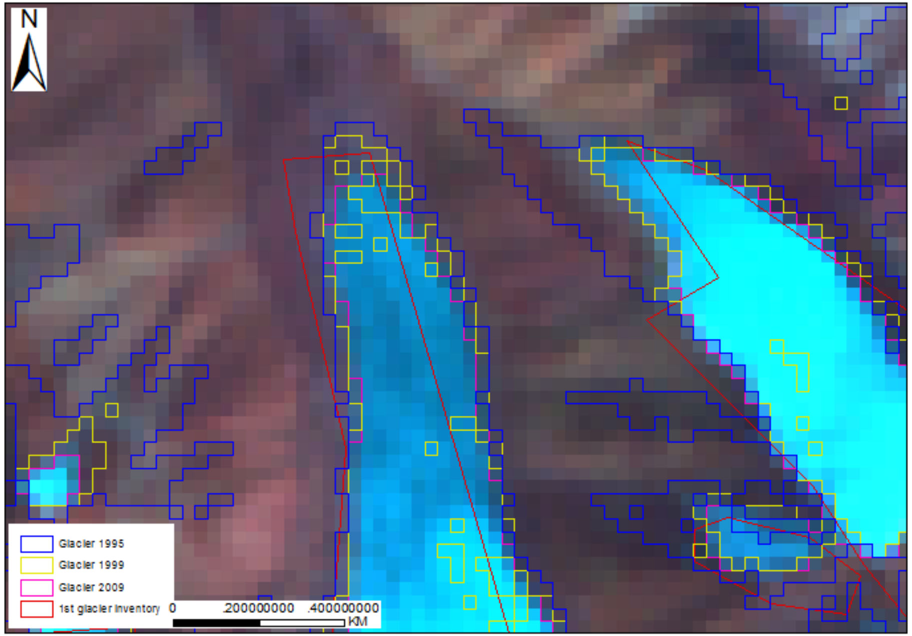
GLAS sampling and surface fitting method

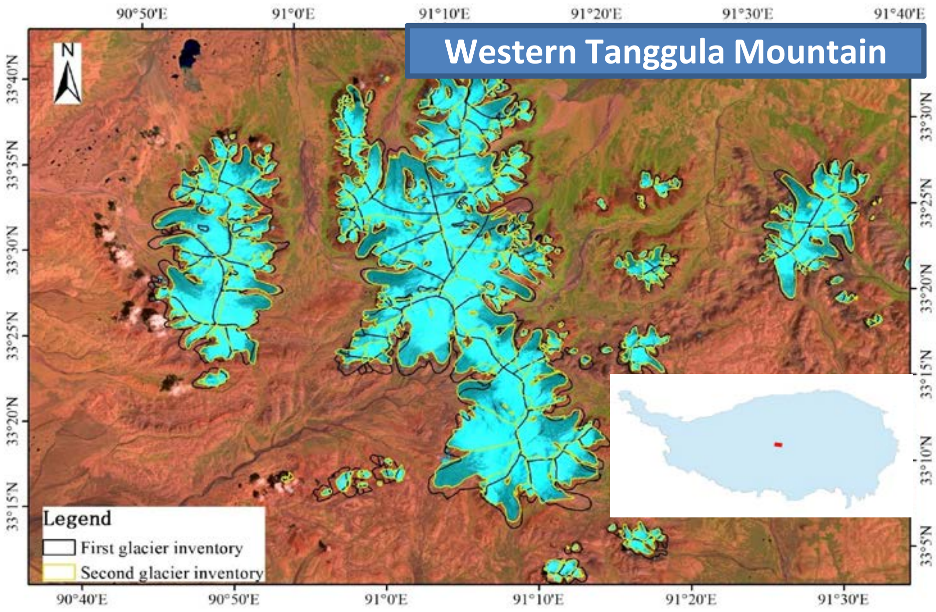
GLACIER ELEVATION TRENDS ON NAIMONA’NYI GLACIER, YANONG GLACIER RESPECTIVELY AND HIMALAYAS GLACIER

dh/dt (m/yr)	By the improved method in this paper(2000-2008/2009)			Fitting a trend (2004-2008/2009)	DGPS Measurement[23] (2008-2010)	DGPS Measurement[22] (2005-2013)
Naimona’nyi glacier	length / p	1	4	-[a]	-0.67	-0.45
	1500(m)	-1.88	-0.76	-0.69		
Yanong Glacier	1500(m)	3.6	-0.49	-0.62	-[c]	-[c]
Himalayas glacier	1500(m)	-2.89	-0.24	-1.26	-[c]	-[c]

length: rectangle length along track. -[b]: Not enough GLAS data. -[a]: No such parameter. -[c] : No measured value

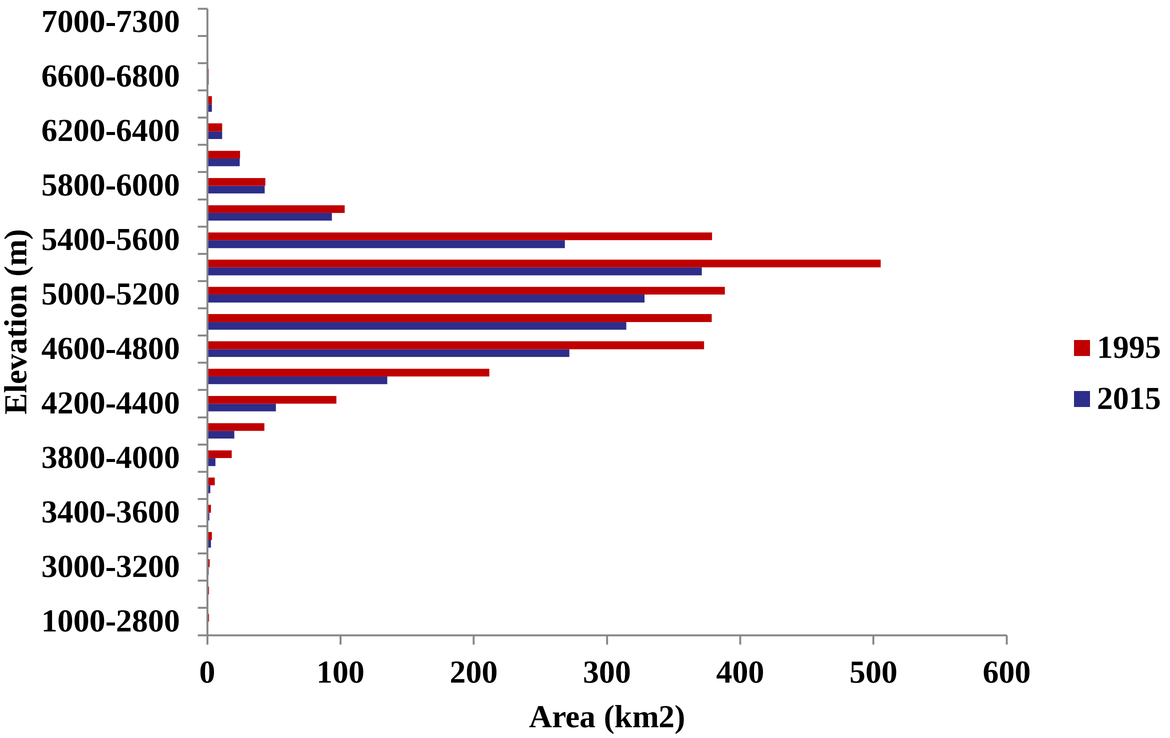
Changes in glacier extent





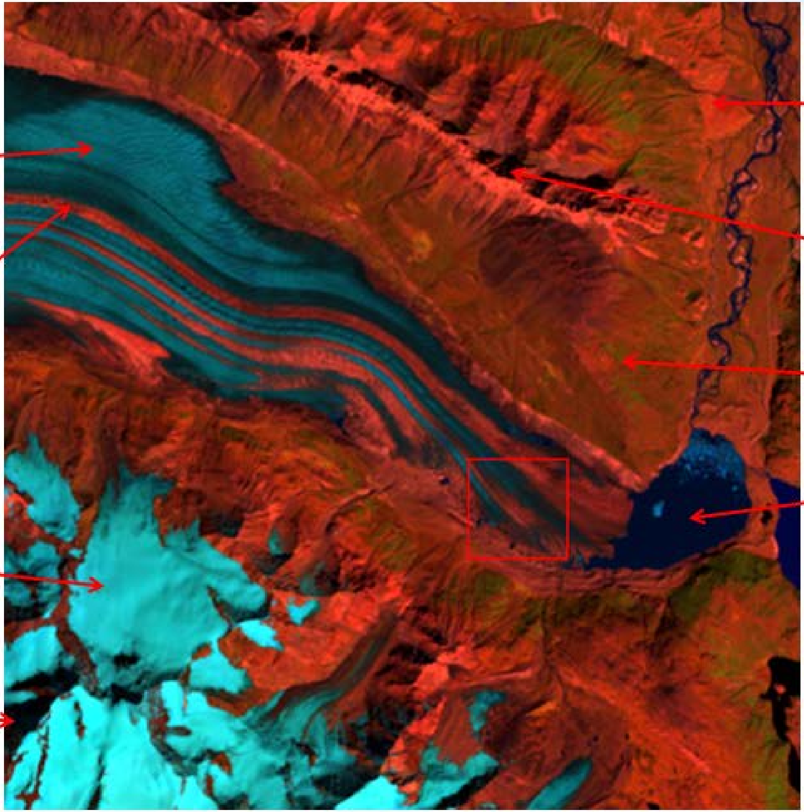
	1956	1995	1999	2010	Change area	Change rate
Glacier area (km²)	3.86	-	3.72	3.67	-0.19	-4.9%

Changes in glacier extent vs. elevation



The glaciers with elevation under 5800 m decreased significantly over 20 years.

Mapping glacier surface materials



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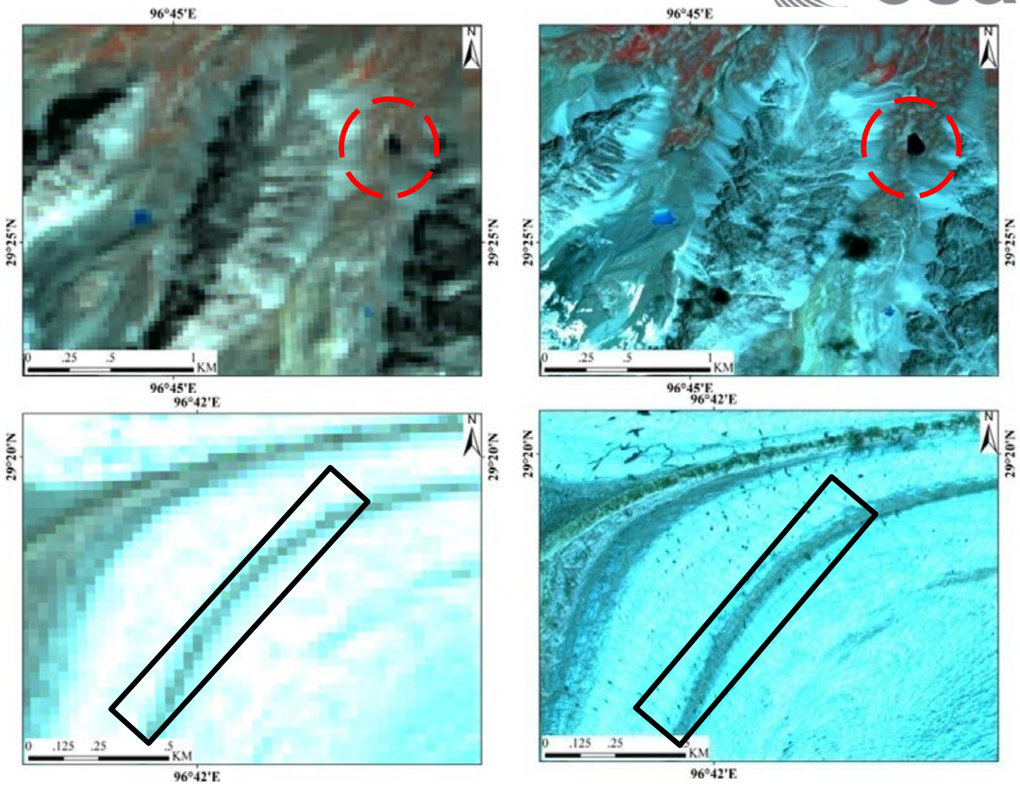
www.radi.cas.cn

Mapping glacier surface materials

GF-1 PMS data

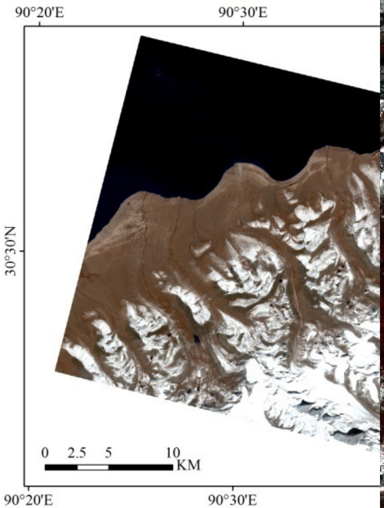
Advantage:

- Free access in RADI
- High resolution
- Uninterrupted from 2013
- Smaller solar zenith angle

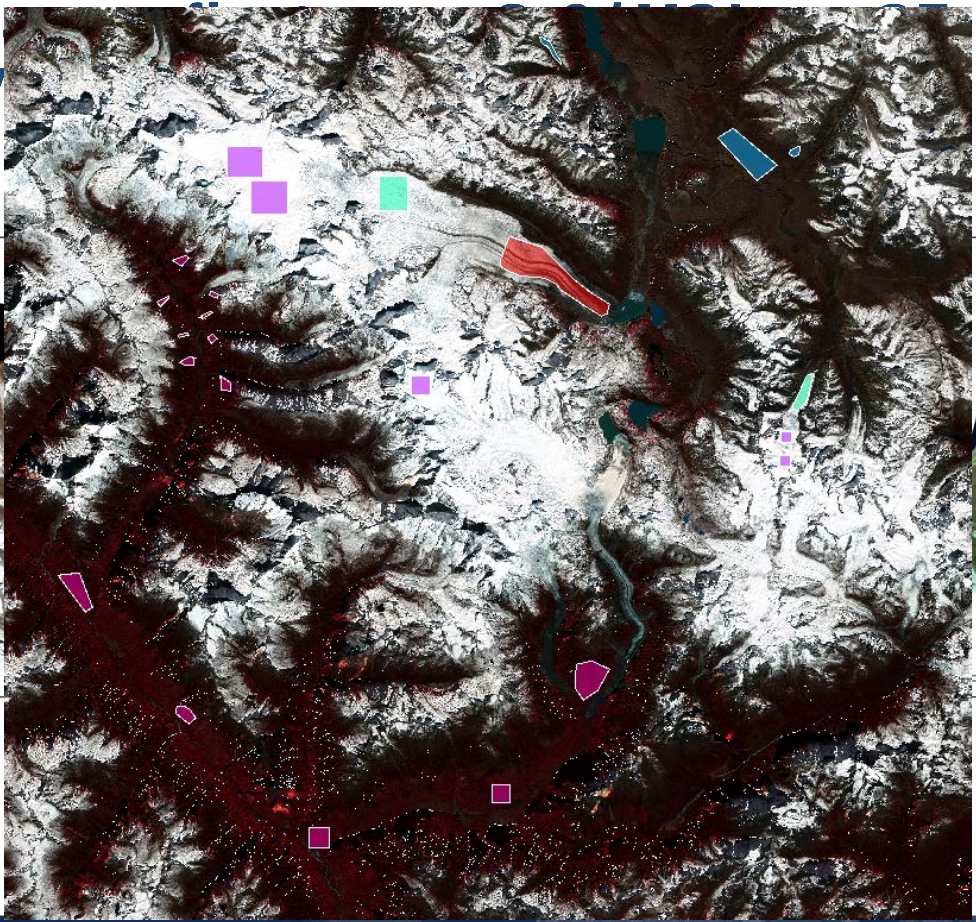


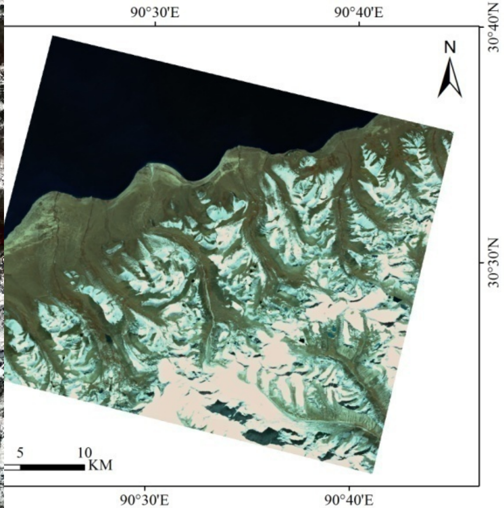
Landsat (resolution 30m) **GF-1 (resolution 2m)**

Surf 1 PMS, WFV



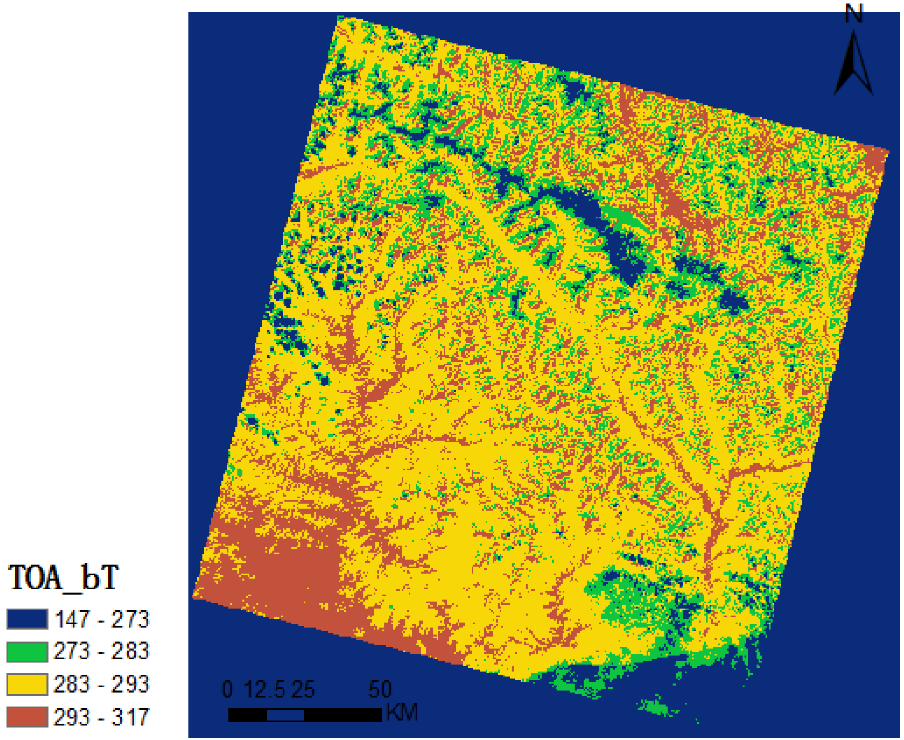
Sentinel-2

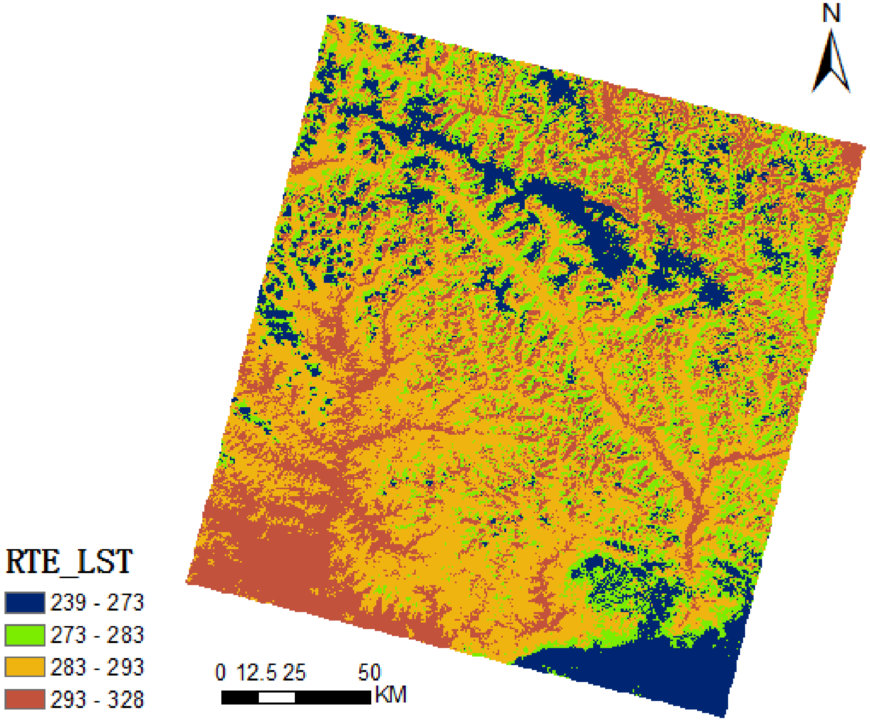




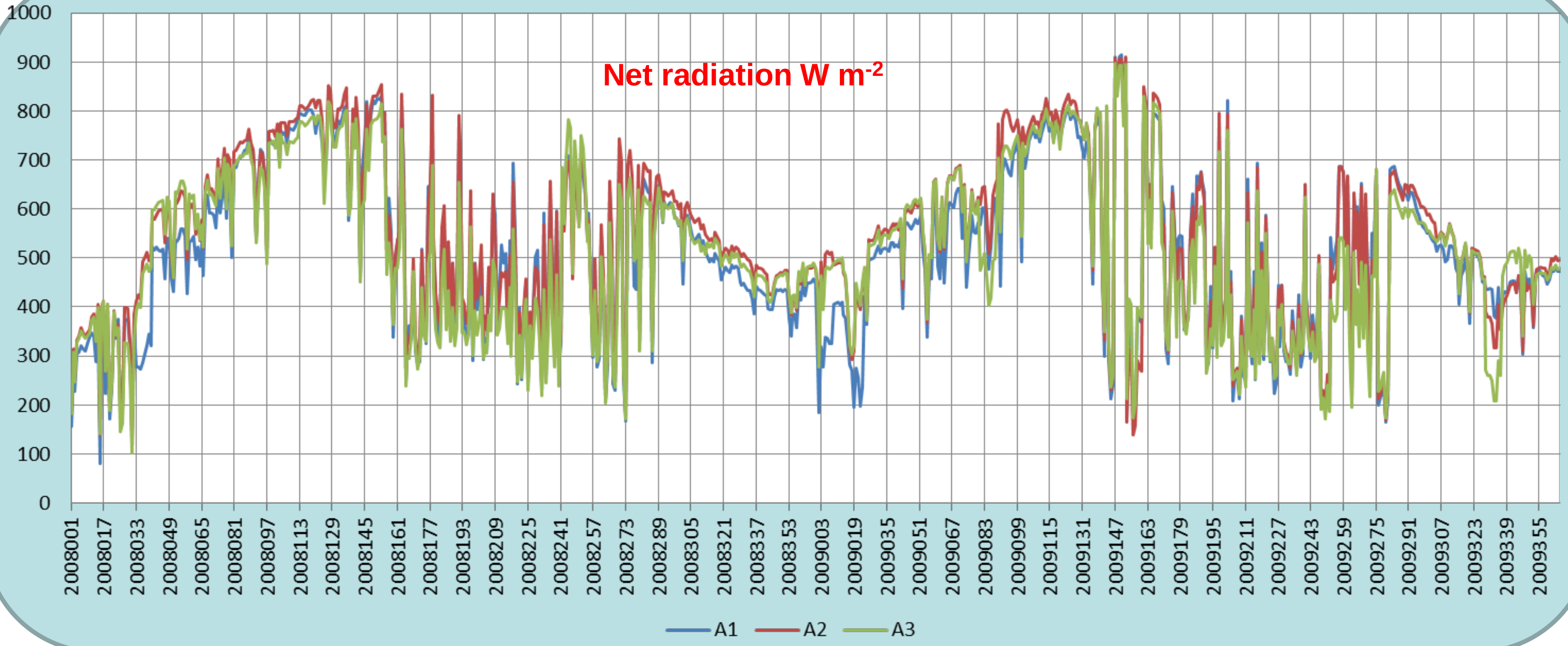
GF-1 WFV

Land surface temperature vs. complex terrain

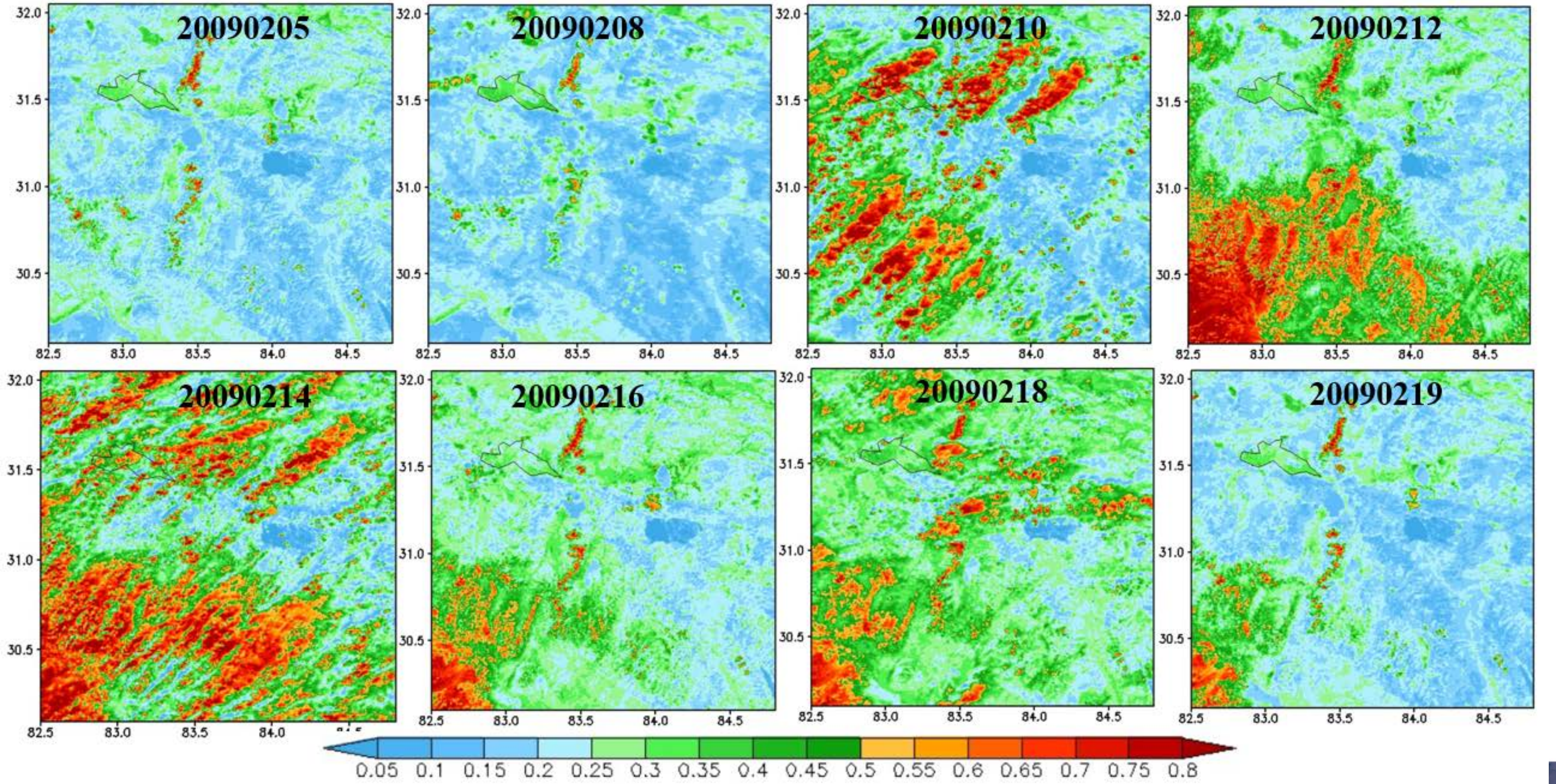




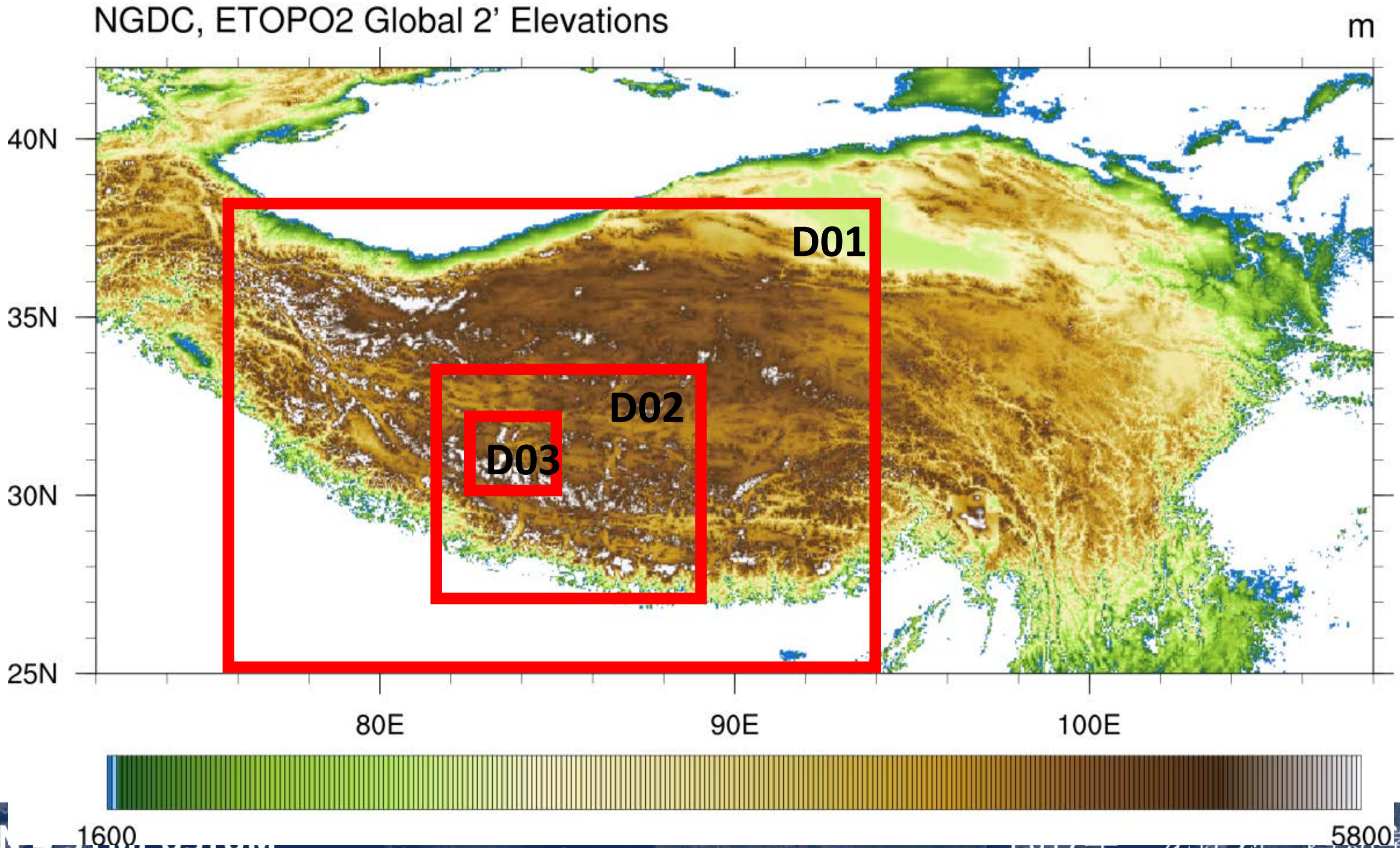
Temporal and spatial variability of glacier albedo



Temporal and spatial variability of glacier albedo

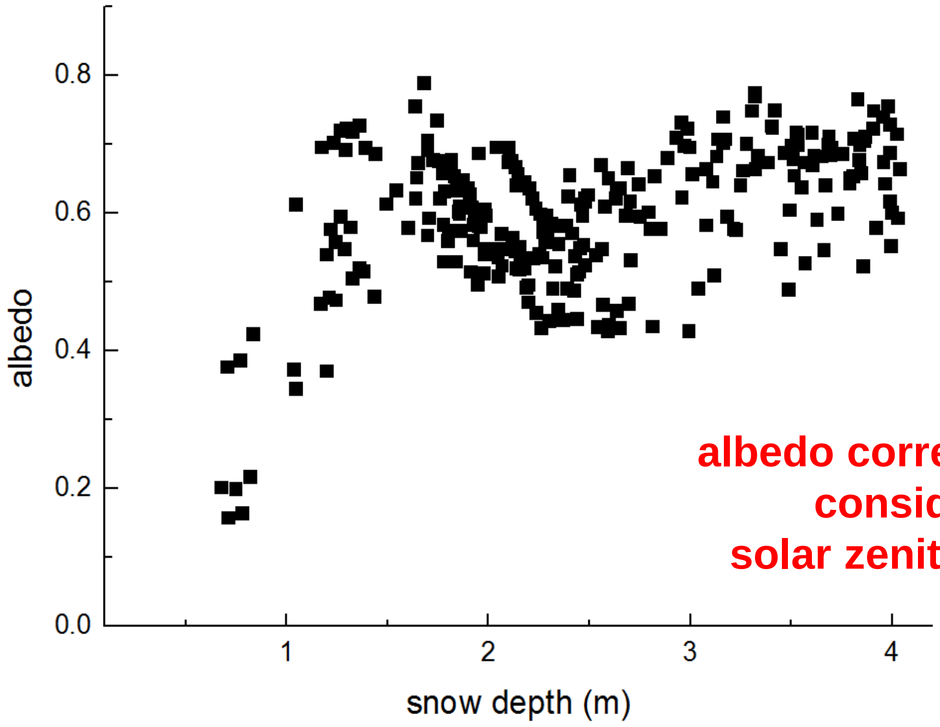


Modelling snowfall events: nested WRF domains

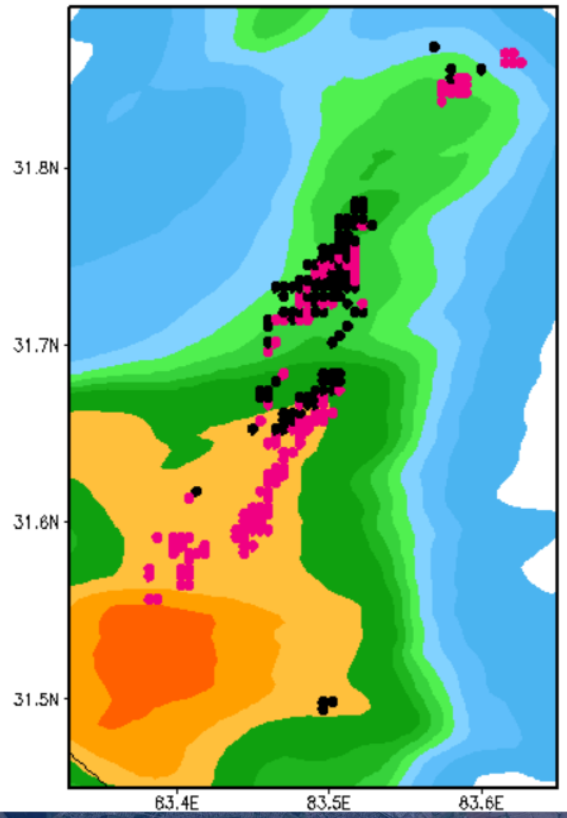


Dependence of snow albedo on snow depth

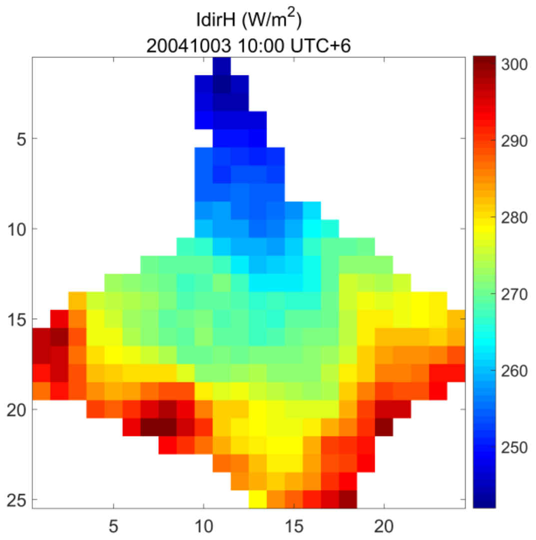
Daily MODIS albedo vs. WRF snow depth



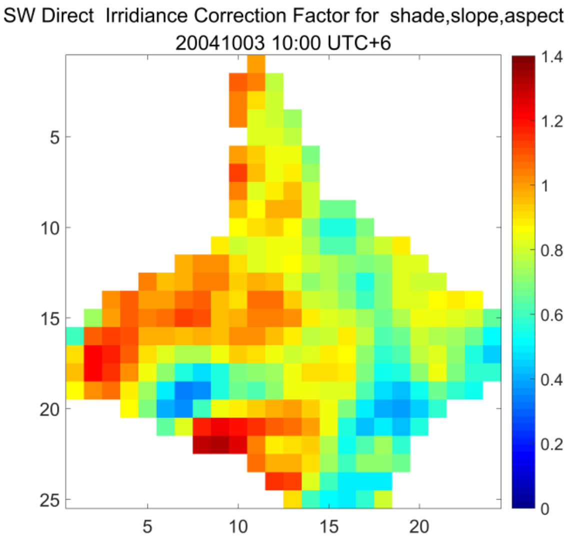
albedo correction considering solar zenith and slope



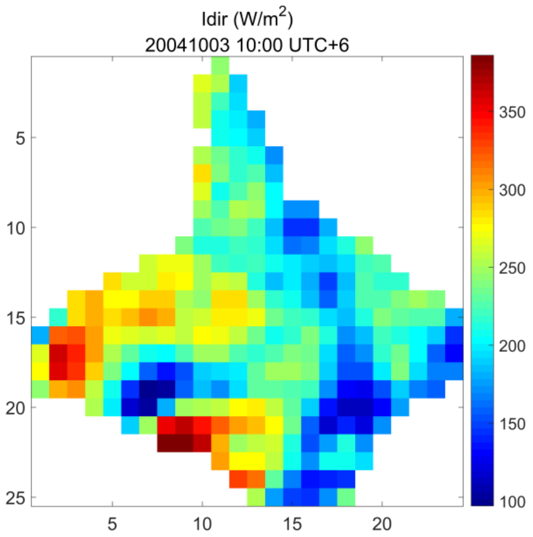
Shortwave Irradiance



All sky direct incidence on flat surface, without shading; elevation only



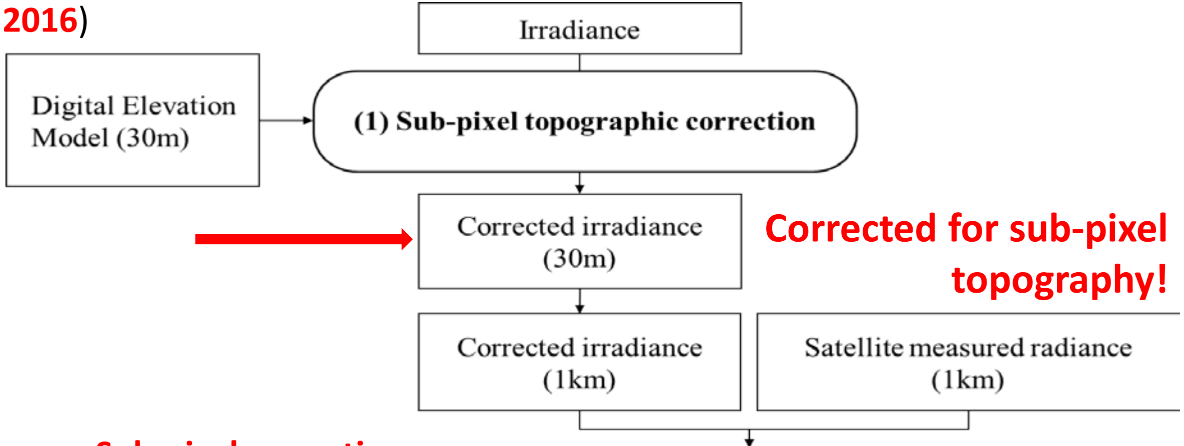
Topography correction factor

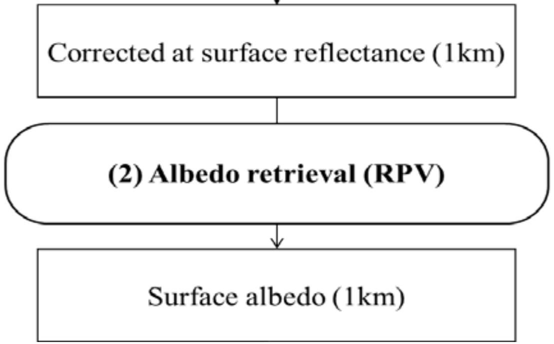


All sky direct incidence on real surface

Surface albedo sub – pixel topography

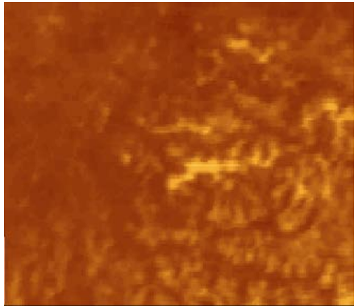
(Roupioz et al., 2015 and 2016)



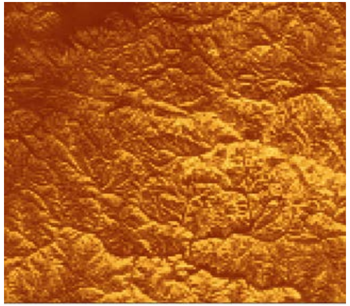


Corrected for sub-pixel topography!

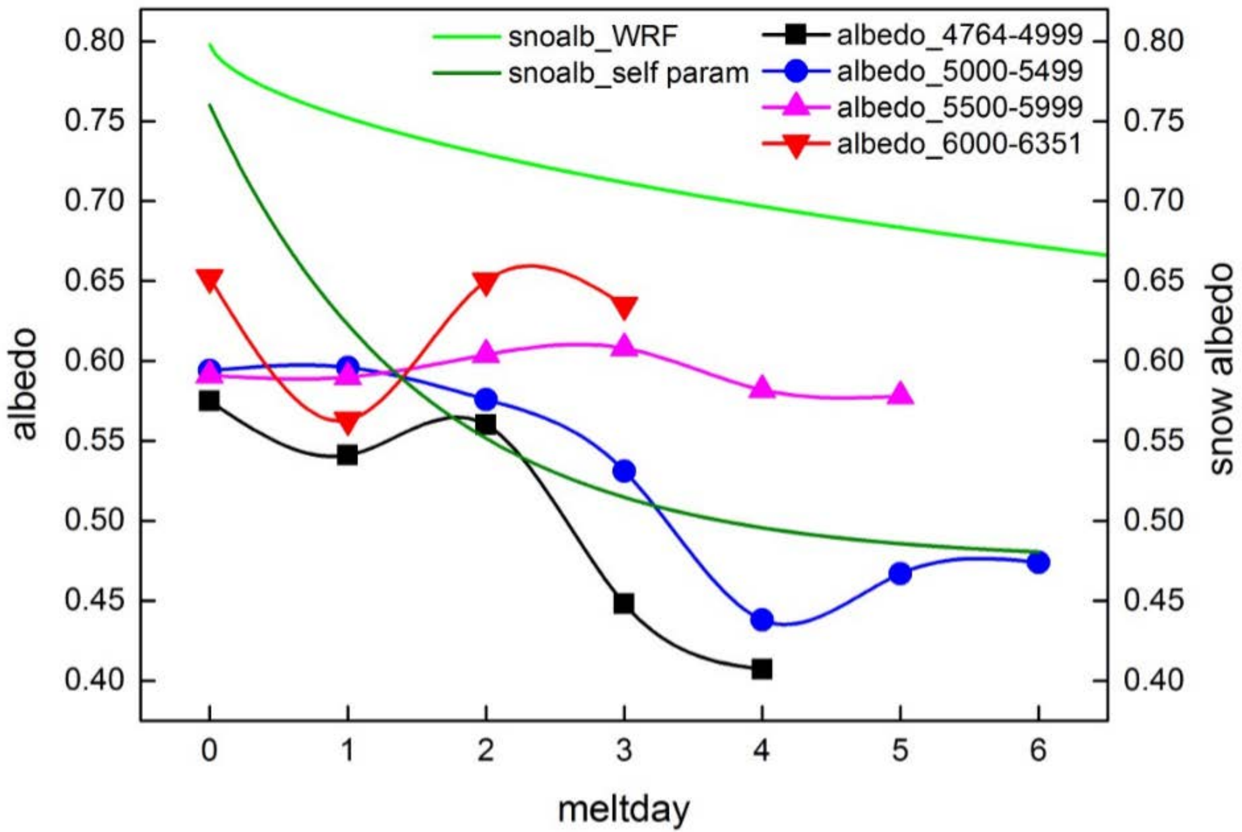
No correction



Sub-pixel correction



Dependence of snow albedo on snow age



Outlook

- Different trends in glacier mass balance across the Plateau and with exposure of glacier facets
- Need to capture more precisely spatial and temporal variability in snowfall and in energy balance;
- Turbulent fluxes, aerodynamic roughness and impact of glacier surface morphology;
- Mapping and monitoring of air temperature using surface temperature
- Large variability in space and time of glacier albedo at multiple scales;
- Impacts of glacier surface materials on albedo
- Dependence of snow depth and age; elevation and air temperature;
- Variability of albedo can be observed with space – borne imaging radiometers, but no predictive capability;
- Parameterize albedo by integrating retrievals of albedo with high resolution atmospheric models