Dynamic response of glaciers on the Tibetan Plateau to climate change - Atmospheric data retrieval at Zhadang Glacier, Tibetan Plateau

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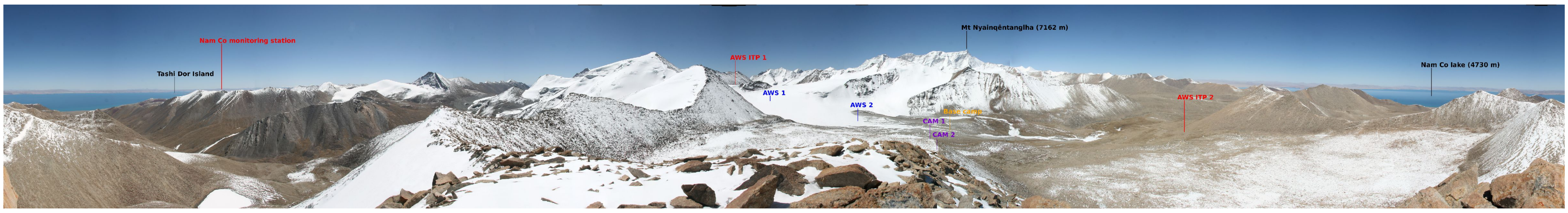

360° panorama of the Zhadang Glacier, the Nyainqentanglha Range and the Nam Co Lake (photo F. Maussion)

1 Study area and overview

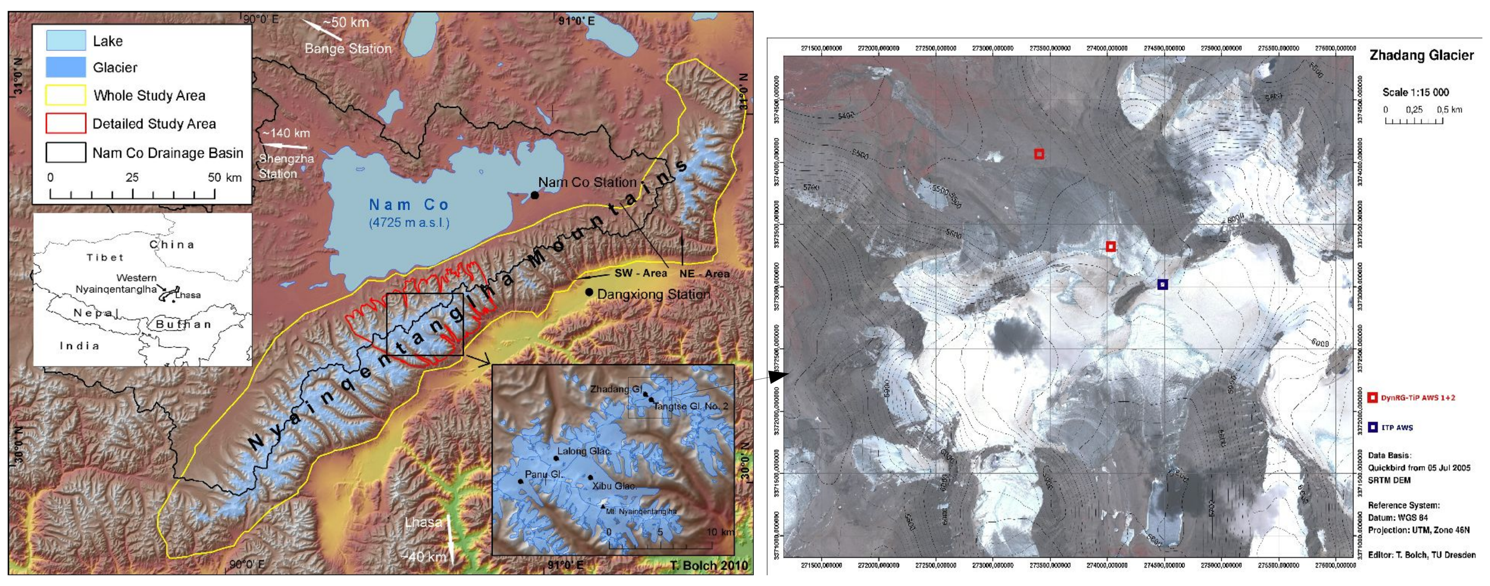

Fig 1: Left: location of the study area; right: locations of both AWS at Zhadang Glacier in October 2010

- In April 2009, two Automatic Weather Stations (AWS) were installed on Zhadang Glacier (~ 5500 m a.s.l.) and are inspected every six months since then.
- The data gathered during 18 months at the glacier station (AWS1) is shown on this poster.

2 The AWS system

Fig 2: The AWS system after the ablation season 2010 (left: atmospheric sensors and data logger, right: sonic ranger)

Atmosphere	3D sonic anemometer
	Windmill anemometer
	Temperature and Humidity
	Pressure
	Net radiation
	Ice surface temperature
	Incoming short wave radiation Reflected short wave radiation
Ice	2 snow water content sensors
	8 snow/ice temperature sensors (up to 9 m depth)
	Snow depth with sonic ranger

Table 1: Measured variables at the AWS with a 10 min. frequency

- In April 2009 both AWS have been initially installed as a single anchored mast drilled into the ice.
- After an unexpected strong ablation season (>2 m of ice melt) the system has been modified in September 2009 by replacing the mast by a tripod standing on the ice surface (Fig. 2).
- At the same time the sonic ranging sensor (measuring the distance to the surface) was installed at an independent construction drilled in the ice, to keep its position constant (Fig. 2).

3 Meteorological measurements

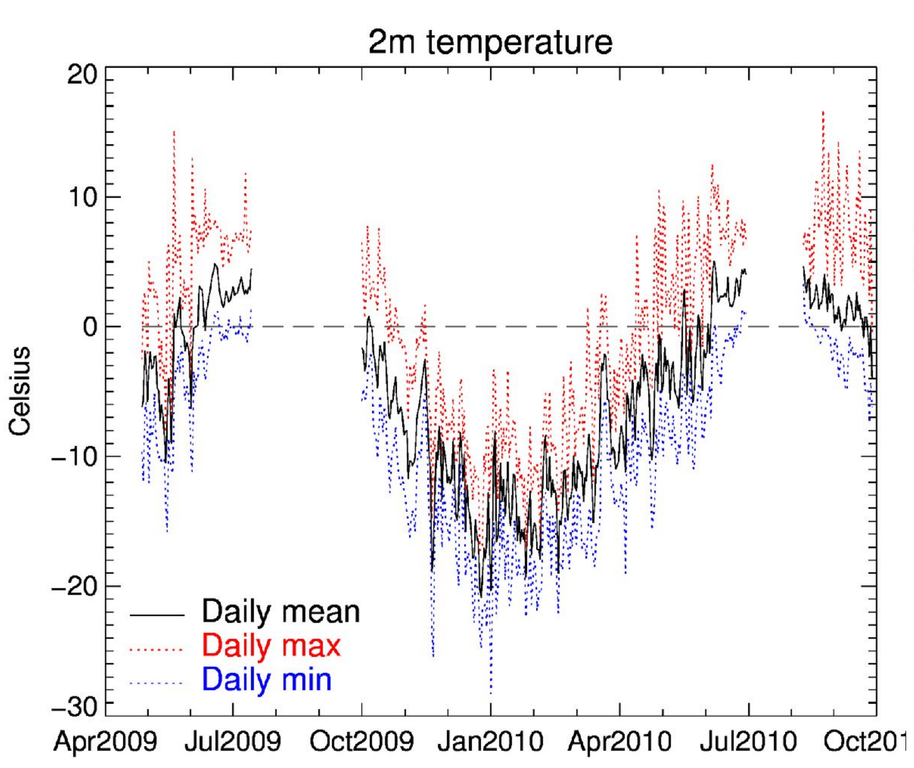

Fig 3: Daily temperatures in 2 m above ground, May 2009 until October 2010

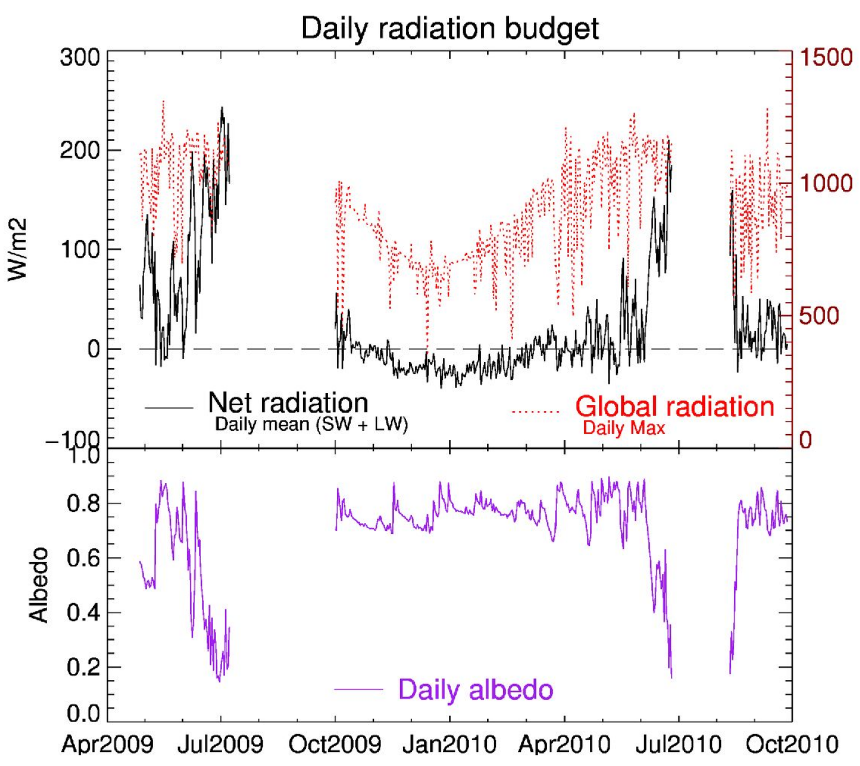

Fig 4: Daily radiation budget and maximum global radiation values (top), daily surface albedo (bottom)

- Both AWS had two breakdowns during summer 2009 and 2010 respectively, due to strong ice melt (see poster Huintjes et al. "Glaciological field studies").
- In spite of these data gaps, the measurements bring a considerable knowledge about the climate in the glacier boundary layer.
- The measured values show a strong seasonal forcing with low temperatures and high wind speeds in winter and short summers with strong radiation and air temperatures up to 16°C (Fig. 3,4).
- Wind direction in 2 m above ground shows distinct seasonal patterns: in winter the valley wind from northeastern directions is predominant, while in summer katabatic wind from southeast seems to be prevailing (Fig. 5).
- This pattern may also indicate the influence of westerlies in winter and of the southeastern monsoon in summer

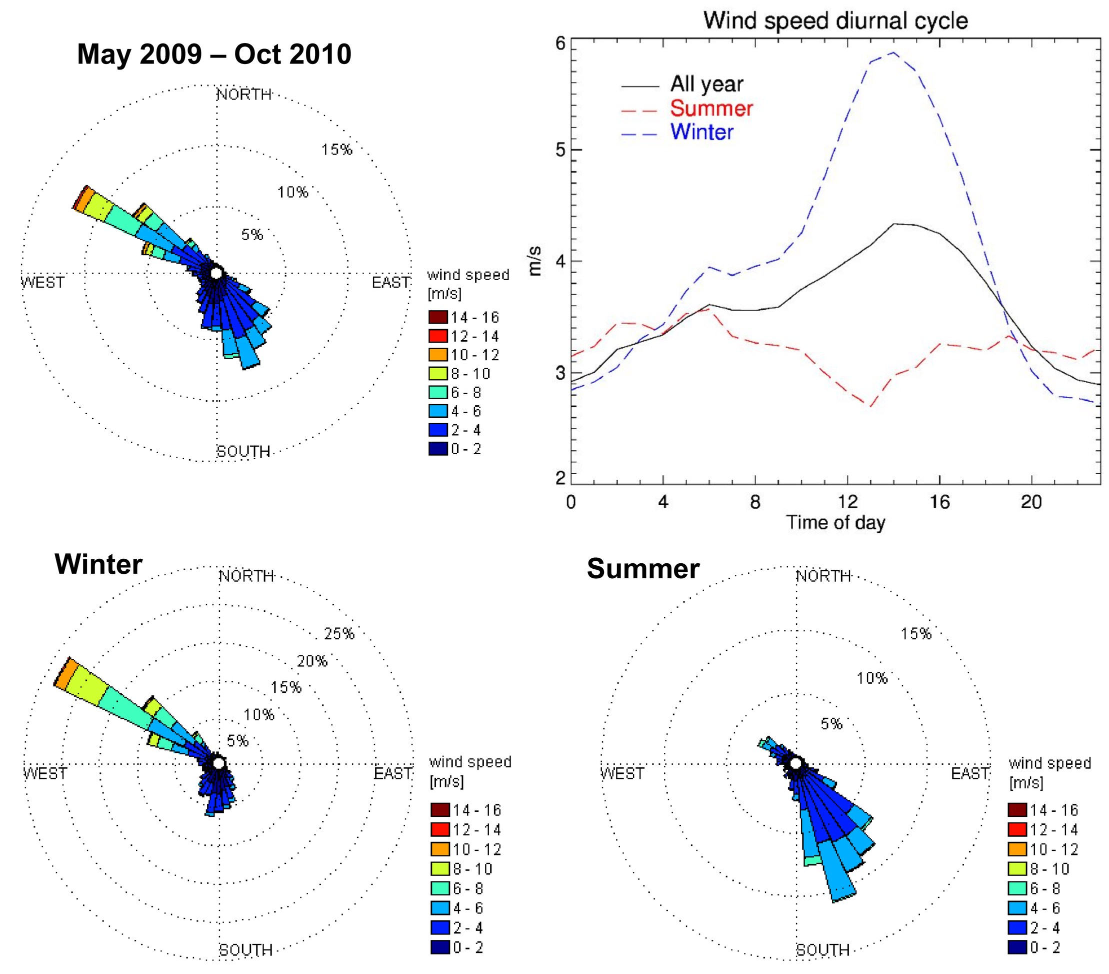

Fig 5: Wind roses for the whole measurement period (upper left), winter season (DJF, lower left) and summer season (JJA, lower right), refer to Fig. 1 for orientation; upper right: diurnal cycle of wind speed for the three considered periods

4 Ultrasonic anemometer

- For the period 24.-30.6.2009 data from the ultrasonic anemometer (USA) at AWS 1 was used to directly calculate the sensible heat flux (Q_H) (see poster Huintjes et al. „Mass balance modelling")
- Data is processed with the software TK2 (*Mauder & Foken 2004*) and footprint climatology is analysed with a routine from *Göckede et al. 2008.*
- The algorithm computes several corrections and plausibility tests to con-trol the performance with regard to the theoretical assumptions underlying the eddy-covariance method.
- Fig. 6 illustrates the effect of a planar-fit rotation correcting the mean vertical wind velocity that is supposed to be zero. Without planar-fit al-most all wind sectors show positive vertical wind velocities (left). After the planar-fit eastern and southwestern sectors show lower velocities (right) while western sections are disturbed by station mast and solar panels.
- The quality of the calculated flux is estimated by testing the existence of steady-state conditions and fully developed turbulence (Integral Turbulence Characteristics, ITC).
- The ITC criteria is strongly depending on stratification; the glacier boundary layer is characterised by neutral and stable conditions most of the time especially in summer and flux is dominated by laminar transport strengthened by katabatic wind from southeastern direction (Fig. 7).
- Unstable conditions are rare. This implies that data quality is limited (see quality distribution including ITC flag for all stratification conditions, Fig. 7b,c).
- When the ITC flag is not considered data quality from most directions strongly increases (Fig. 7a).

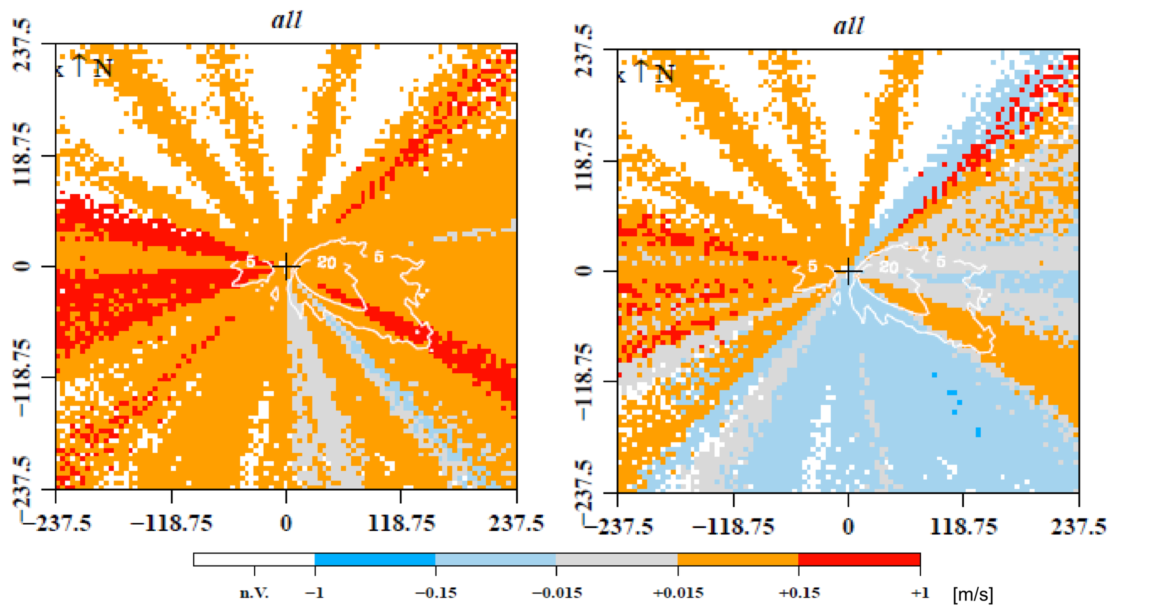

Fig 6: Spatial distribution of the vertical wind velocity without (left) and with (right) planar-fit rotation for all stratification conditions 24.-30.6.2009

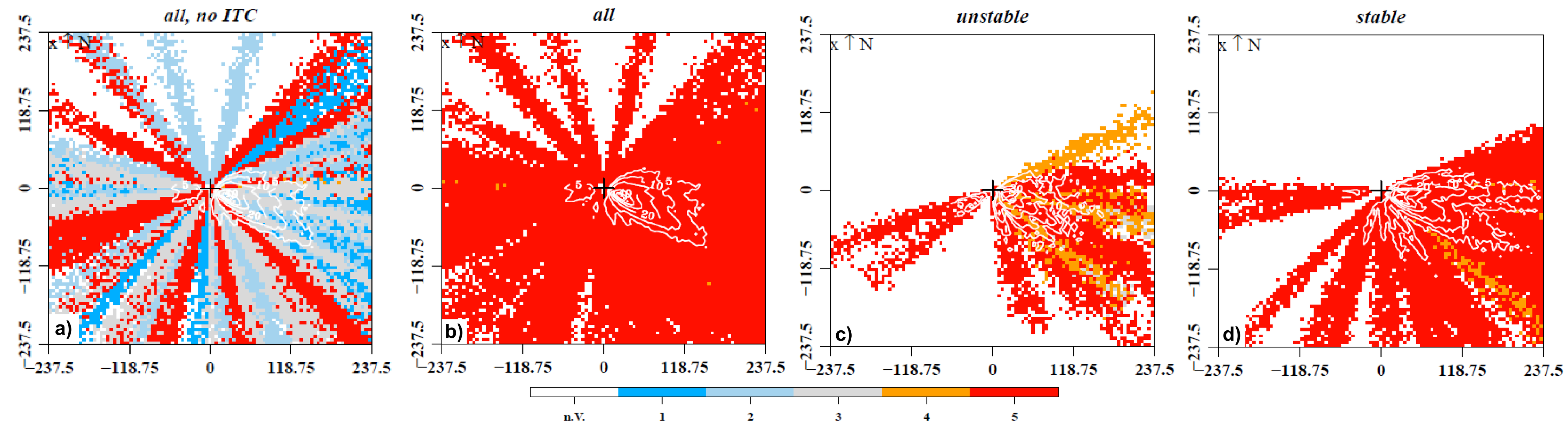

Fig 7: Spatial distribution of the data quality for the sensible heat flux 24.-30.6.2009; a) without consideration of the ITC flag for all stratification conditions; with consideration of the ITC flag: b) for all stratification conditions; c) for unstable conditions; d) for stable conditions (flagging system after Rebmann, 1= high data quality, 5=low data quality; spatial distribution of flags shows median of quality flags for the whole period for every gridcell)

References

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