Dynamic response of glaciers on the Tibetan Plateau to climate change
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Regional atmospheric reanalysis on the Tibetan Plateau using the WRF numerical weather prediction model

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1 Introduction

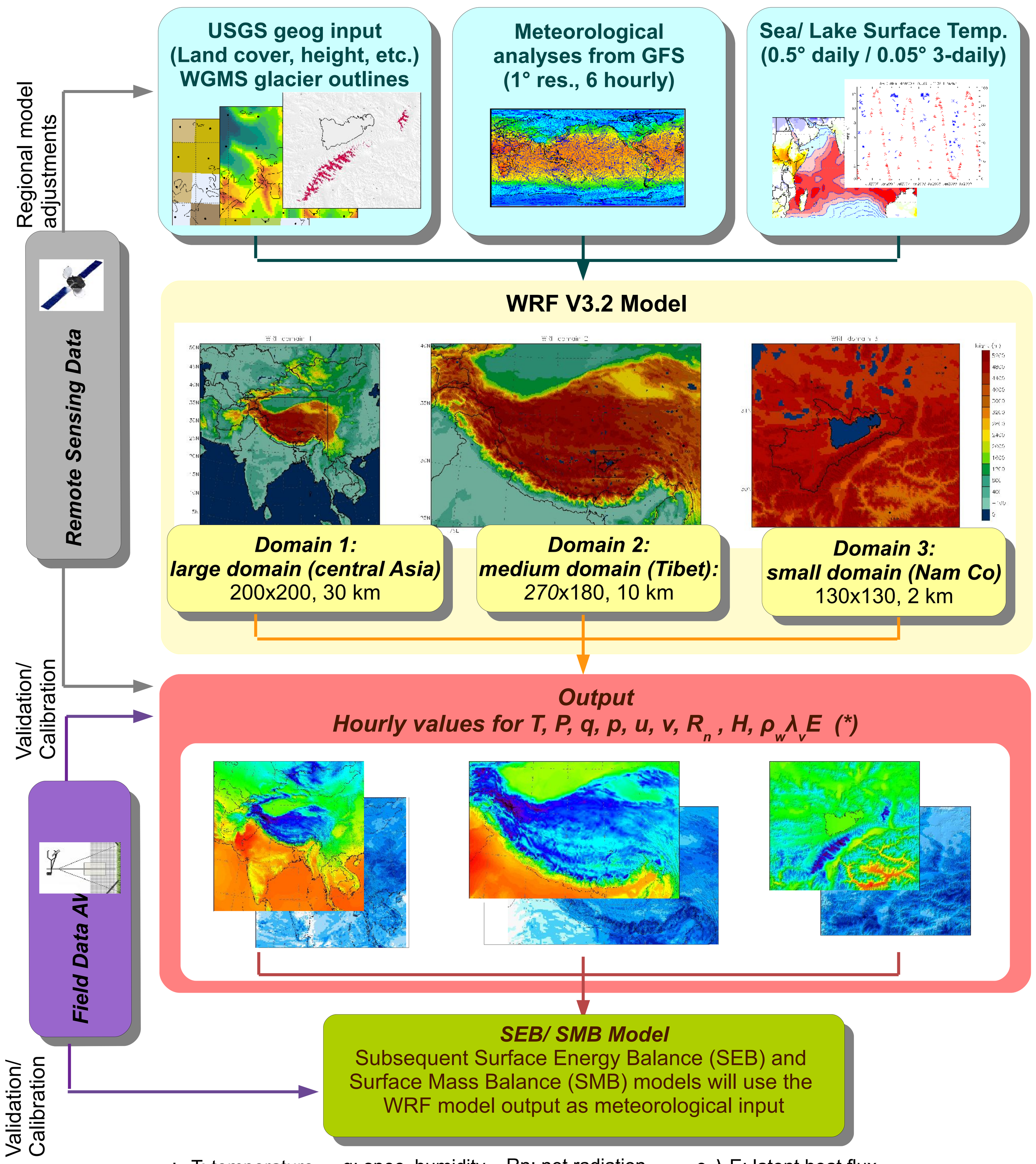
Problem:
Meteorological observations over the Tibetan Plateau are scarce. The standard gridded climatological datasets (ERA-40, CRU, ECHAM...) are often considered as insufficient partly because of their resolution, which is too coarse for the Plateau's complex topography. Meteorological stations on the TiP are rare and unequally distributed, preventing the use of statistical downscaling methods.

Regional atmospheric reanalysis:
Regional Numerical Weather Prediction (NWP) models that are driven by large scale atmospheric data can be used to retrieve meteorological fields at high spatial and temporal resolution, process known as regional reanalysis or dynamical downscaling. For the needs of the TiP community, the Weather Research and Forecasting model (WRF-ARW) has been set up in a "reanalysis mode": three nested domains at 30, 10 and 2 km resolution centered on the Nam Co basin, Tibet (China) used to downscale the Global Forecasting System meteorological dataset (1° resolution, 6-Hourly, global) for the period 2001-2010.

Benefits:
The generated meteorological dataset is of relevance for many projects within the TiP community and further. It can be used as input for subsequent hydrological or glaciological models, or as a basis to understand the complex interactions on the TiP.

Validation and calibration:
18 months of simulation (May 2009 – Oct 2010) are used to validate the model against observations. Our results show that the model, when carefully configured, provides accurate data over the region as shown by Maussion et al., 2010 for a single precipitation event. This poster presents the most recent studies conducted at the TU Berlin.

2 Downscaling Strategy



* T: temperature q: spec. humidity Rn: net radiation $\rho_w \lambda_v E$: latent heat flux
P: precipitation u,v: wind H: sensible heat flux

3 Initialisation strategy

After a two days of simulation, we expect the model to be less accurate than after 12H run. To prevent the model varying too much from an initially observed state, we chose a daily reinitialisation strategy (model reinitialised every 24H and run for 36H, the first 12 hours being removed for spin-up, cf. Fig. 1), that proved to be suitable for such applications (e.g. Box et al., 2006):

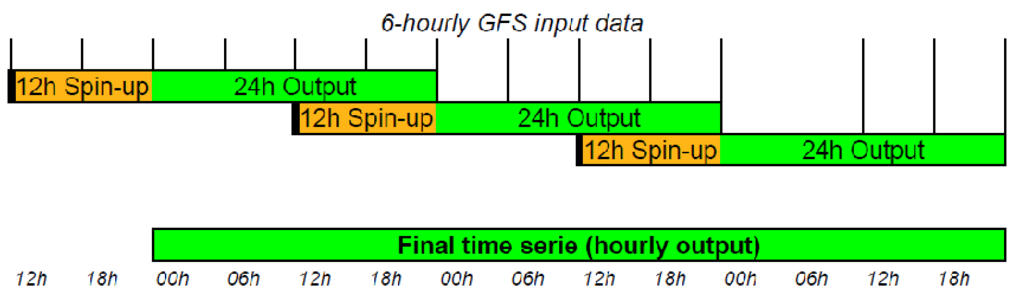


Figure 1: daily reinitialisation strategy followed by DynRG-TiP

+ Constant data quality on a daily basis using WRF in a "short-term simulation" mode
+ Easily parallelisable: possibility to run different days simultaneously
- Continuity problems for variables such as snow cover, soil temperature, …

4 Results and applications

a. Large scale dynamics

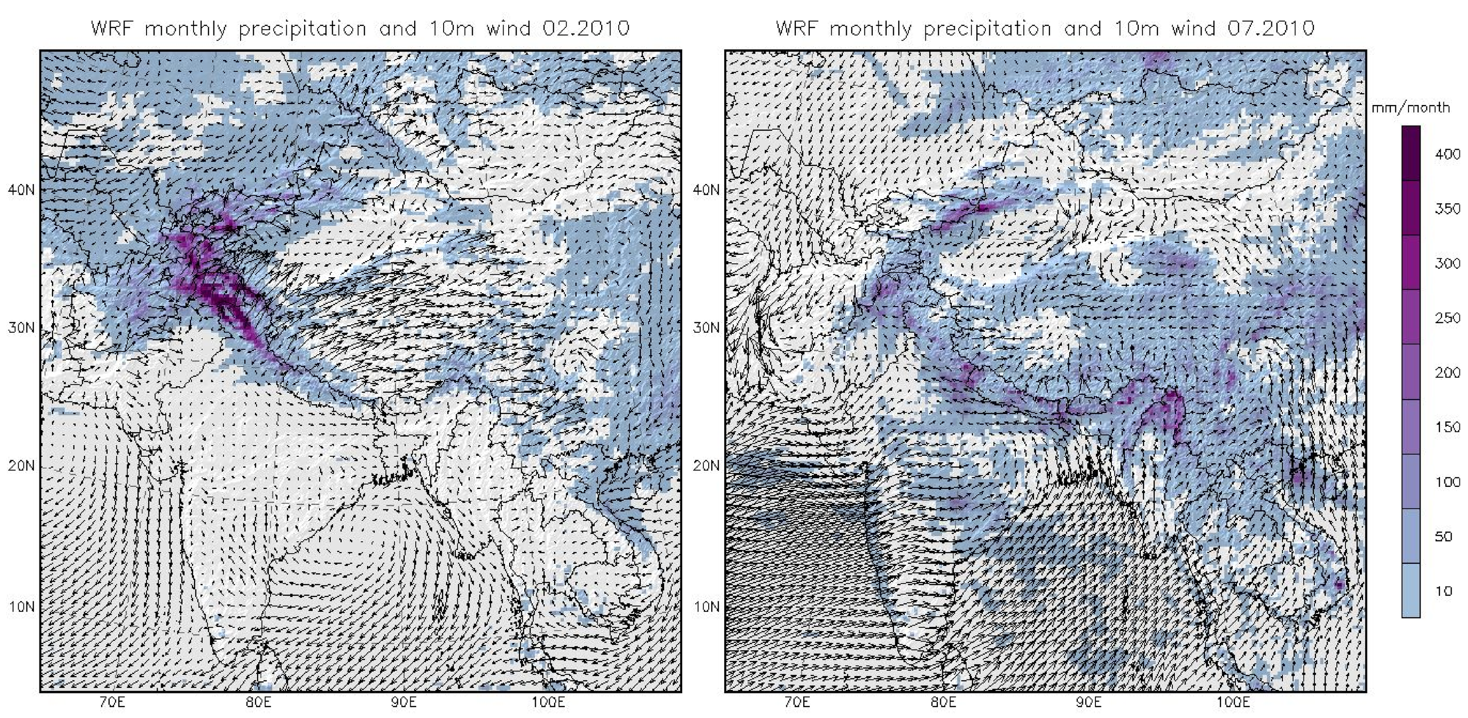


Fig 2: Monthly values of precipitation and near-surface wind fields retrieved from the 30 km domain. In winter, dominant strong western winds are prevailing on the TiP as well as the Indian anticyclone over the Bay of Bengal. Wind fields during the Monsoon are more complex especially at the Plateau's edges. The exceptionally strong snowfall in February 2010 in the North of Pakistan may account for a substantial part of the summer 2010 floods.

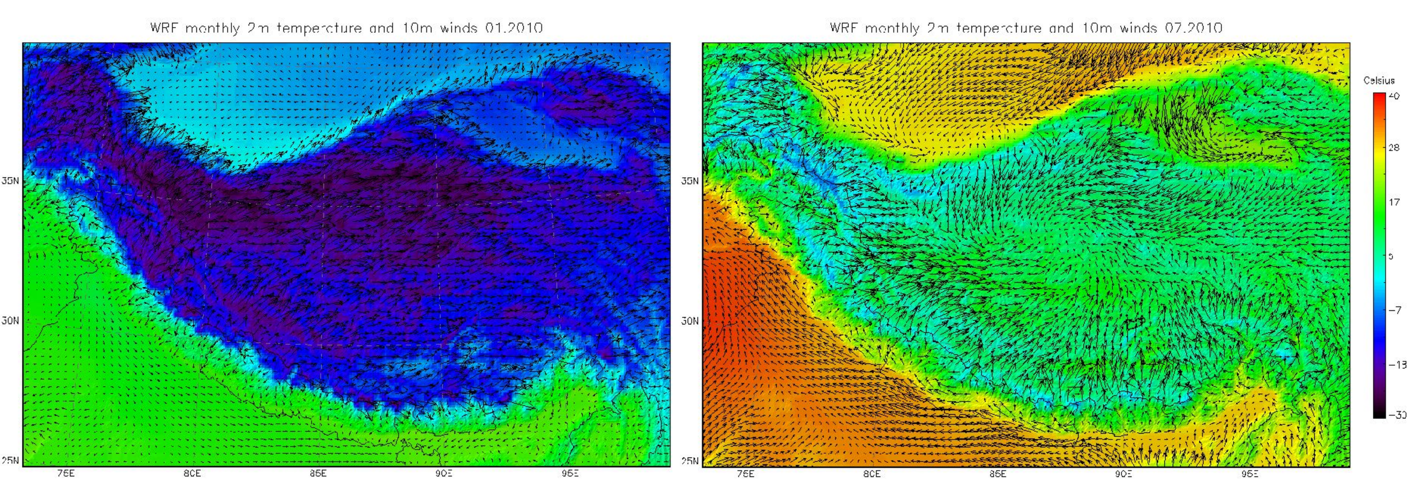


Fig 3: Monthly values of near-surface temperature and wind fields retrieved from the 10 km domain

b. Orographic precipitation

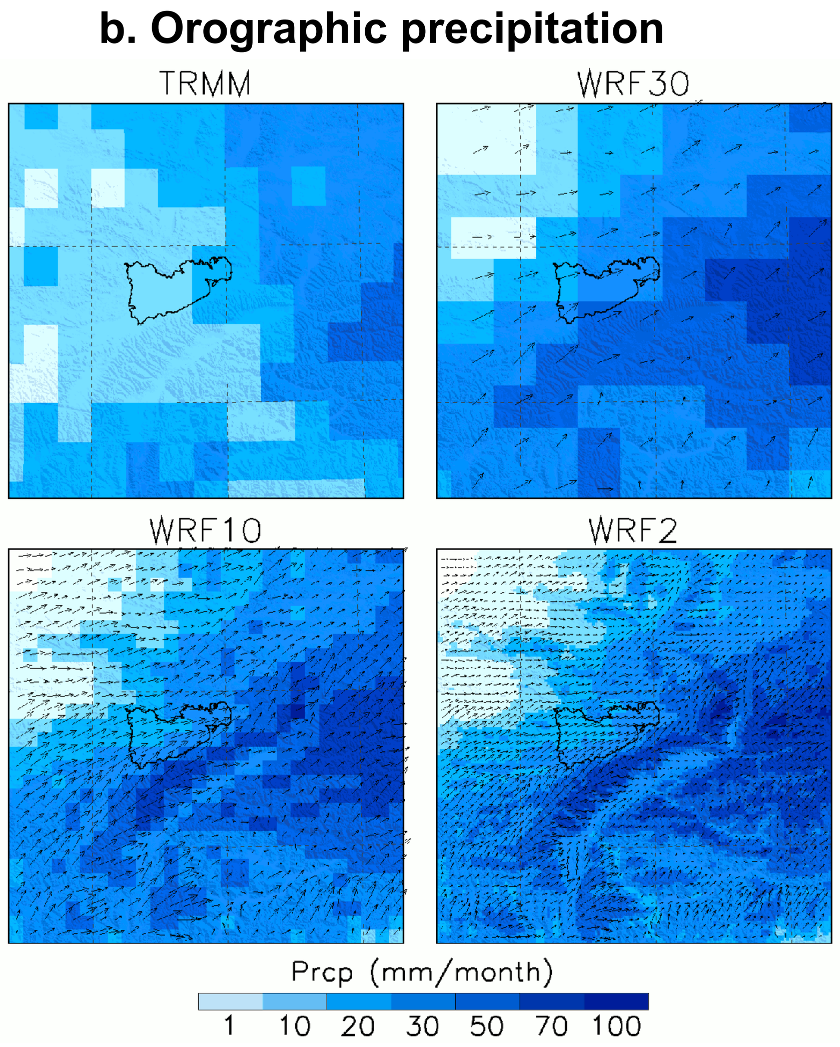


Fig 3: Spatial distributions of precipitation amounts in October 2008 observed by TRMM and predicted by the 30, 10 and 2 km simulations on the Nam Co basin.

c. Climate at the Zhadang Glacier (5500-6095m)

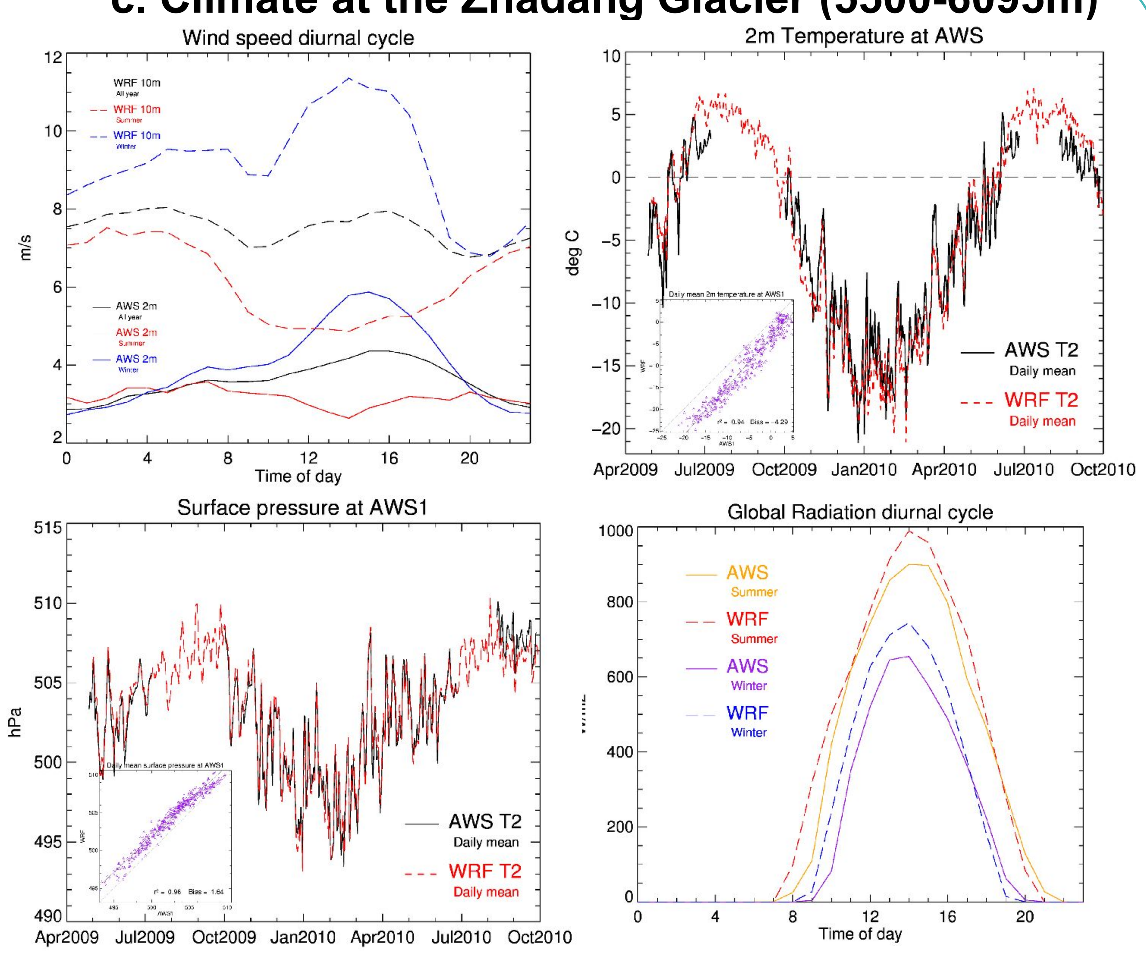
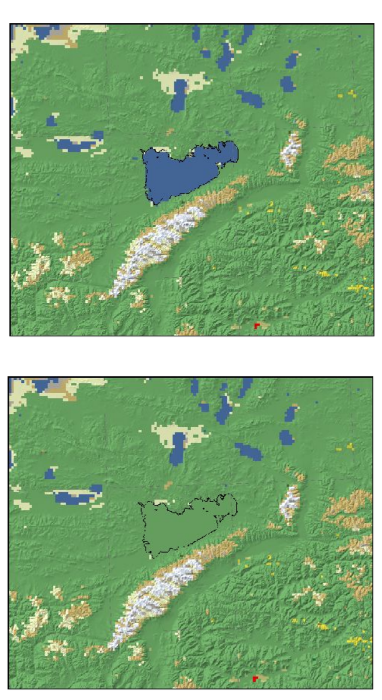


Fig 4: Comparison of WRF model output (2 km) and Automatic Weather Station (AWS) measurements on the Zhadang Glacier (see related DynRG-TiP poster):
- Upper left: wind diurnal cycles from WRF (10 m height) and AWS (2 m height)
- Upper right: 2 m temperatures (bias corrected)
- Down left: 2 m air pressure (bias corrected)
- Down Right: diurnal cycle of global incoming radiation

d. Lake effect



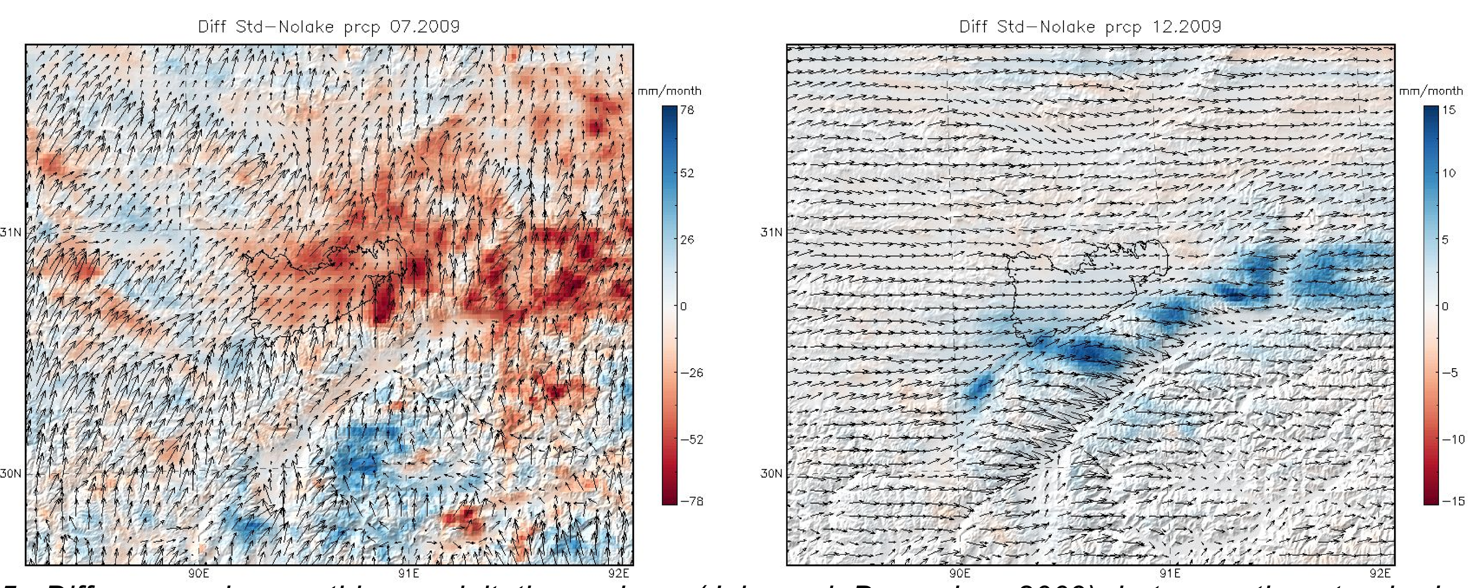


Fig 5: Differences in monthly precipitation values (July and December 2009) between the standard simulation and a sensitivity simulation were the Nam Co lake has been "removed" (see the landcover maps left). The effect of the lake on the local precipitation is more important when precipitation is initiated by local heating rather than large scale processes. The cool air above the water surface in summer will inhibit the growth of convective storms but in winter, the warmer lake may produce local snow storms.

References
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