Regional climate change in Tibet: past and future

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Outline

• Big data in Climate & Earth System Science perspectives

• Assessment of climate changes over Tibet
Big data

- **Volume**: big size
- **Velocity**: high speed of data availability & transfer
- **Variety**: different formats and forms
- **Veracity**: data messiness/trustworthiness
- **Value**: Data is only useful when we turn it into value.
Humanity’s period of grace – the last 10,000 years

Source: GRIP ice core data (Greenland) and S. Oppenheimer, “Out of Eden”, 2004
International global change research

four Global Environmental Change Programmes

- WCRP (World Climate Research Programme)
- DIVERSITAS (an international programme of biodiversity science)
- IGBP (International Geosphere-Biosphere Programme)
- IHDP (International Human Dimensions Programme on Global Environmental Change)

all co-sponsored by ICSU

Earth System Science Partnership

- ESSP
- DIVERSITAS
- IGBP
- WCRP
- IHDP

Future Earth

My ICSU time

and their partnership towards transdisciplinary integrative science

GCOS as the climate observing component of GEOSS
Global Framework for Climat services

Users
Government, private sector, research, agriculture, water, health, construction, disaster reduction, environment, tourism, transport, etc

USER INTERFACE PLATFORM

CLIMATE SERVICES INFORMATION SYSTEM

OBSERVATIONS AND MONITORING

RESEARCH, MODELLING AND PREDICTION

CAPACITY BUILDING
Earth System Science for Global Sustainability: Grand Challenges

W. V. Reid,1* D. Chen,2 L. Goldfarb,2 H. Hackmann,3 Y. T. Lee,2 K. Mokhele,4 E. Ostrom,5 K. Raivio,2 J. Rockström,6 H. J. Schellnhuber,7 A. Whyte8

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Earth System Visioning led to Future Earth
A Call to Action

Grand Challenges in Earth System Research for Global Sustainability
The climate research community responded promptly to the call....

AN EARTH-SYSTEM PREDICTION INITIATIVE FOR THE TWENTY-FIRST CENTURY

by Melvyn Shapiro, Jagadish Shukla, Gilbert Brunet, Carlos Nobre, Michel Béland, Randall Dole, Kevin Trenberth, Richard Anthes, Ghassem Asrar, Leonard Barrie, Philippe Bougeault, Guy Brasseur, David Burridge, Antonio Busalacchi, Jim Caughey, Deliang Chen, John Church, Takeshi Enomoto, Brian Hoskins, Øystein Hov, Arlene Laing, Hervé Le Treut, Jochem Marotzke, Gordon McBean, Gerald Meehl, Martin Miller, Brian Mills, John Mitchell, Mitchell Moncrieff, Tetsuo Nakazawa, Haraldur Olafsson, Tim Palmer, David Parsons, David Rogers, Adrian Simmons, Alberto Troccoli, Zoltan Toth, Louis Uccellini, Christopher Velden, and John M. Wallace

An international interdisciplinary initiative to accelerate advances in knowledge, prediction, use, and value of weather, climate, and Earth system information.
Fig. 1. Evolution of forecast skill for the extratropical Northern and Southern Hemispheres, January 1980–March 2010. Anomaly correlation coefficients of 3-, 5-, 7-, and 10-day ECMWF 500-mb height forecasts plotted as 12-month running means. Shading shows differences in scores between hemispheres at the forecast ranges indicated (adapted and extended from Simmons and Hollingsworth 2002).
10 major rivers in Asia are originated from the Tibet Plateau
Potential policy-relevant tipping elements in the climate system and overlain on global population density

Timothy M. Lenton et al. PNAS 2008;105:1786-1793
Assessment of past, present and future environmental changes on the Tibetan Plateau

Participants & Duration: 80 authors, 24 reviewers, 2012-2015

Environment indices covered: Climate, water, ecosystem, anthropogenic impact, disaster/risk

Past Millennia based on proxy data


Future climate: CMIP5 models driven by RCPs emission scenarios

Instrumental data

Recent decades
Annual anomalies of temperature (a) and precipitation (b) over Tibet
Trends of annual changes over the period of 1984-2006 (Yang et al., 2014, GPC)
Scale for interannual surface temperature variation

Source: Chen et al., Sci Rep (under revision)
Scale for interannual precipitation variation

Source: Chen et al., Sci Rep (under revision)
Elevation dependent warming over Tibet (Pepin et al., 2015, NCC)

(mean surface air temperature)

(mean min temperature)
5 plausible mechanisms and processes behind elevation dependent warming (Pepin et al., 2015, NCC).
Increased vegetation activity

The greening -> evapotranspiration↑ & warming↓

Mean annual temperature from 24 CMIP5 models.

Source:
Mean annual precipitation from 24 CMIP5 models.

Source:
Added value by downscaling with WRF (30 km resolution), means for 1979-2011

Added value by downscaling with WRF (30 km resolution), means for 1979-2011

Mean change (°C) of mean annual temperature from 20 CMIP5 models.

Source:
Mean change (%) of annual precipitation from 20 CMIP5 models.

Source:
Exceedance probability curve for the peak flow at the Nuxia in the upper Brahmaputra

a) 2020-2049
b) 2070-2099

Intensity and frequency of extreme discharges would likely increase in the upper Brahmaputra.
Take home messages

• Climate over Tibet has experienced significant changes in the past, with warming and overall wetting and stilling, along with distinctive regional changes in precipitation and solar radiation over the last decades.

• Big data framework and data assimilation approaches hold great potential to fill the observation gaps and provide more insights into details of and processes behind the climate change in this challenging and important region.
Figure 17. Causes of the temperature increase on the TP and the results of the increasing temperature. The upward arrow means increasing and the downward arrow means decreasing.
Figure 18. Causes of the precipitation increase on the TP and the results of the increasing precipitation. The upward arrow means increasing and the downward arrow means decreasing.