Climate Change: Progress on Physical Basis
—— Report from WG1, IPCC AR5

Qin Dahe
Co-Chair IPCC Working Group I (WGI)
State Key Lab. of Cryospheric Sciences, CAS
China Meteorological Administration (CMA)

Denver, USA
28th Oct., 2011
1. Observed climate change in the world and China
2. Emerging questions and response
Station Availability for the Global Historical Climatology Network (GHCN) monthly network reporting:

- **late 19th century**
- **1961–1990 period of maximum station density**
- **most recent \ decade**
Atmospheric observations showing

**Land surface air temperature**

**Troposphere temperature**

**Stratospheric temperature**

**Specific humidity**

From Baringer et al. 2010
Ocean observations showing

Sea level

Ocean heat content

Sea surface temperature

From Baringer et al. 2010
Cryosphere observations showing

Northern hemisphere (March-April) snow cover

September Arctic sea ice extent

Glacier mass balance

From Baringer et al. 2010
Multiple redundant indicators showing warming is unequivocal

- Land surface air temperature
- Sea surface temperature
- Marine air temperature
- Sea level
- Northern hemisphere (March-April) snow cover
- Troposphere temperature
- Ocean heat content (0-700m)
- Specific humidity
- Stratospheric temperature
- September Arctic sea ice extent
- Glacier mass balance

From Baringer et al. 2010
Global mean trend maps from NCDC surface record for 1901–2010 (left hand panel) and 1979–2010.
Extensive thinning of margins of ice sheets

Greenland: $-286 \text{ Gt/yr}_{2007-09}$

Antarctica: $-246 \text{ Gt/yr}_{2006-09}$
Regional evidences
Recent decades accelerated warming in China

Changes of mean annual air temperature of China, **1901 to 2010**

Changes of mean annual air temperature of China, **1961 to 2010**
Percentage of annual precip. anomalies in China, 1961-2010

Number of drought events in China, 1961-2010

中国年降水量距平百分率变化，1961-2010

1961-2010年中国区域性气象干旱事件频次变化
Glacier shrinking of Hailuogou Glacier, Mt. Minya Gongga

1823–1936 AD, 113a, 150m; 1.33 m/a

1936–2006 AD, 70a, 150m; 2.14 m/a
Baishui Glacier, Mt. Yulong

Glacier retreating:
1982-1998, 6.25m/a,
1998-2008, 10m/a
Warming cryosphere in China

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Mass balance of typical glaciers on the basis of in situ measurement data set.

The spatial distribution of glacier mass balance in China simulated by energy balance model.

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<table>
<thead>
<tr>
<th>Trunk river basin</th>
<th>Branch river basin</th>
<th>The Number of glaciers</th>
<th>The area of glaciers (km²)</th>
<th>Ice volume (km³)</th>
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<tbody>
<tr>
<td>Ganges</td>
<td>Pumqu etc.</td>
<td>2192</td>
<td>3609</td>
<td>330</td>
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<tr>
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<td>Yarlung Zangbo River</td>
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<td>1244</td>
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<td></td>
<td>Glang chen gtsang po</td>
<td>789</td>
<td>672</td>
<td>50</td>
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<tr>
<td><strong>Total</strong></td>
<td></td>
<td><strong>15041 glaciers</strong></td>
<td><strong>19553 km²</strong></td>
<td><strong>1717 km³</strong></td>
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</table>
Met stations (12) data show continue warming in the Himalayas.

The warming rate of high elevations might be even higher
Climate change on the Himalayas

1. Warming rate in late 20th Century (C/10a)
2. Warming rate in 21st Century (C/10a)
3. Ratio of 2/1
4. Trends of precipitation changes (~50 a)

Decreasing
Stable
Increasing to decreasing
Field investigation on glacier terminal position

(red: retreated, blue: advanced)

(Xiao and Ming, in prep.)
Glaciers changes of over three regions on the Himalayas, 2000-2009

<table>
<thead>
<tr>
<th>Areas</th>
<th>North slope (%)</th>
<th>South slope (%)</th>
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<tr>
<td></td>
<td>summary</td>
<td>Shrink/</td>
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<tr>
<td></td>
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<td></td>
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<td>disappear</td>
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<td>Everest</td>
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<td>-1.35(V)</td>
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<td>Nanga</td>
<td>-6.41(S)</td>
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<td>Parbat</td>
<td>-3.96(V)</td>
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(S) represents the changes of area; and (V) represents the change of volume
Projections (A1B) of future temperature changes on Himalayas

2020~2030 mean minus 1981-2000 mean (°C)

2041~2050 mean minus 1981~2000 mean (°C)

Warmer in the future!
Projections (A1B) of future precipitation changes on Himalayas


**Annual mean precipitation change, RegCM3, (2041–2050)–(1981–2000), %**

**2020~2030**

2020~2030 mean minus 1981-2000 mean (%)

**2040~2050**

2041~2050 mean minus 1981~2000 mean (%)
The glacial runoff projections for Yangtze river, Aksu River and Shiyang River before 2050 AD.
6500 m a.s.l.

AWS

Mass balance

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Hydrology observation
Cryosphere monitoring in China: a regional network of GCW (Global Cryosphere Watch)
1. Observed climate change in the world and China
2. Emerging questions and response
Emerging Questions on Climate Change

- Has climate change accelerated?
- Is the Greenland ice sheet stable?
- What is the scenarios of SLR responding the warming?
- What is the role of clouds and aerosols?
- Is the carbon cycle feedback positive?
- Will there be more droughts?
- Are the mountain glaciers fast retreating?
- ENSO, monsoon,
IPCC AR5 WGI Outline
approved at IPCC 31st Session in October 2009

- Chapter 1: Introduction
- Chapter 2: Observations: Atmosphere and Surface
- Chapter 3: Observations: Ocean
- Chapter 4: Observations: Cryosphere
- Chapter 5: Information from Paleoclimate Archives
- Chapter 6: Carbon and Other Biogeochemical Cycles
- Chapter 7: Clouds and Aerosols
- Chapter 8: Anthropogenic and Natural Radiative Forcing
- Chapter 9: Evaluation of Climate Models
- Chapter 10: Detection and Attribution of Climate Change: from Global to Regional
- Chapter 11: Near-term Climate Change: Projections and Predictability
- Chapter 12: Long-term Climate Change: Projections, Commitments and Irreversibility
- Chapter 13: Sea Level Change
- Chapter 14: Climate Phenomena and their Relevance for Future Regional Climate Change
- Annex I: Atlas of Global and Regional Climate Projections
IPCC Climate Change Assessments since 1990

- FAR 1990: 11 Chapters
- SAR 1995: 11 Chapters
- TAR 2001: 14 Chapters
- AR4 2007: 11 Chapters
- AR5 2013: 14 Chapters

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From AR4 to AR5

- Workshop: New Science Directions (March 2009)
- Expert Meeting: GHG Metrics (March 2009)
- Expert Meeting: D&A (September 2009)
- Expert Meeting: Multi Model Evaluation (January 2010)
- Workshop: Sea Level Rise & Ice Sheet Instabilities (June 2010)
- Expert Meeting: Uncertainties (July 2010)
- Expert Meeting: Ocean Acidification Impacts (January 2011)
- Expert Meeting: Geoengineering (June 2011)
- Special Report: Extreme Events (2011)
- Climate Change (2013)

Approve SREX SPM and accept underlying document (November 2011)
Rigor 严格
Robustness 确凿 Transparency 透明
Comprehensiveness 全面

Thanks!