Climate Change: Progress on Physical Basis

—— Report from WG1, IPCC AR5

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China Meteorological Administration (CMA)

Denver, USA

28th Oct., 2011

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1. Observed climate change in the world and China
2. Emerging questions and response

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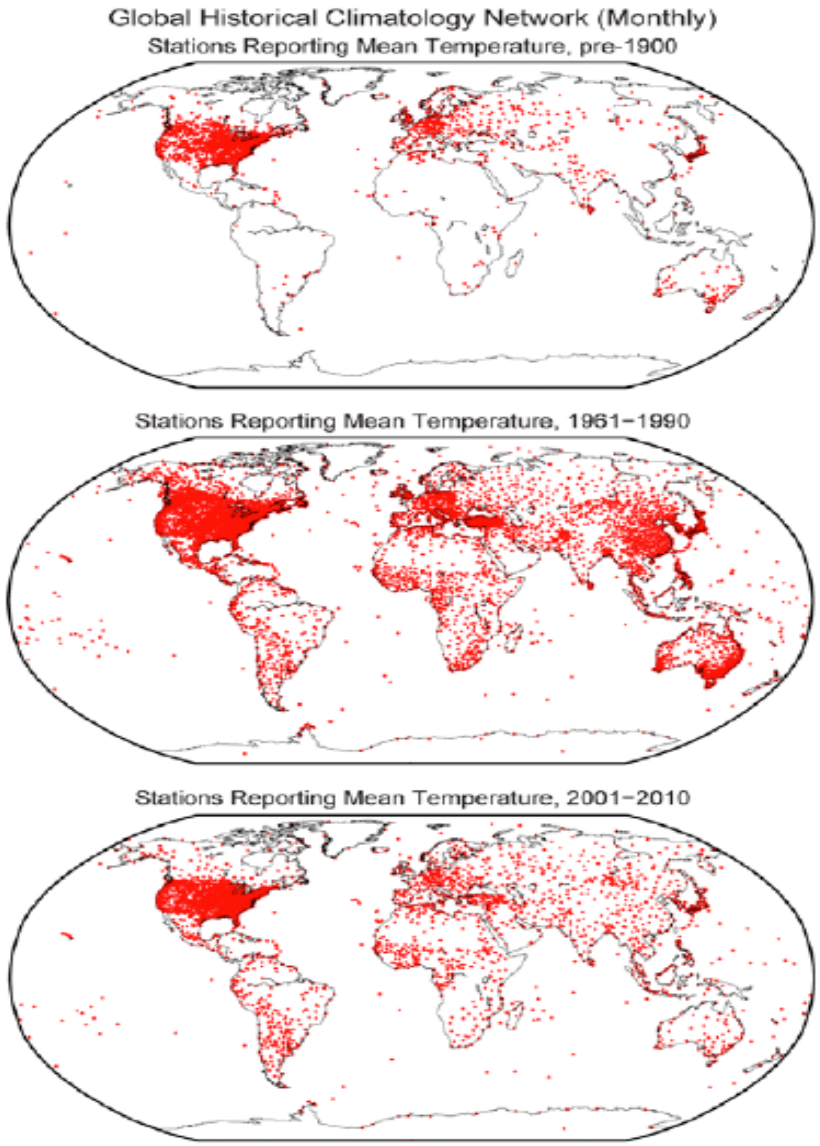
Station Availability for the Global Historical Climatology Network (GHCN) monthly network reporting:

late 19th century

1961–1990 period of maximum station density

most recent \ decade



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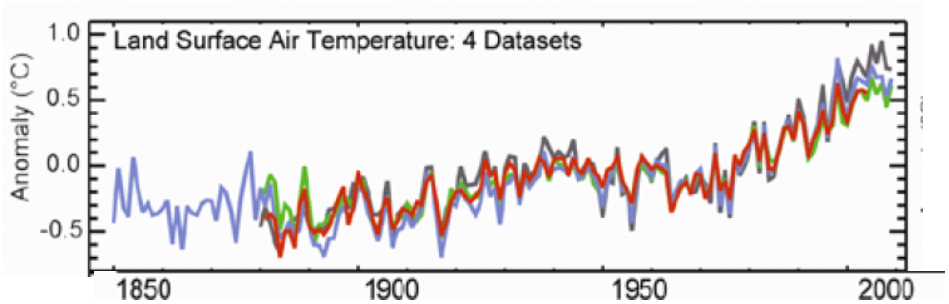
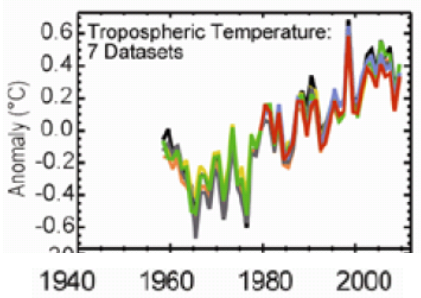
Atmospheric observations showing

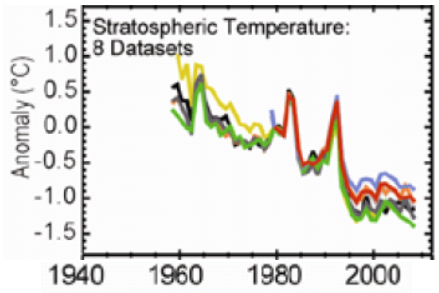
Land surface air temperature



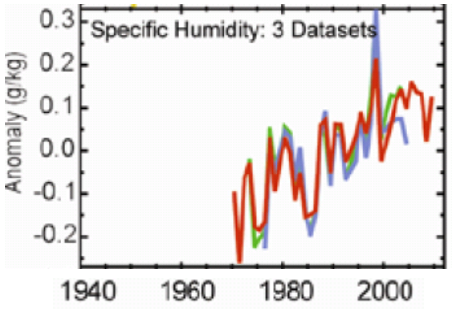
Troposphere temperature



Stratospheric temperature



Specific humidity



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From Baringer et al. 2010

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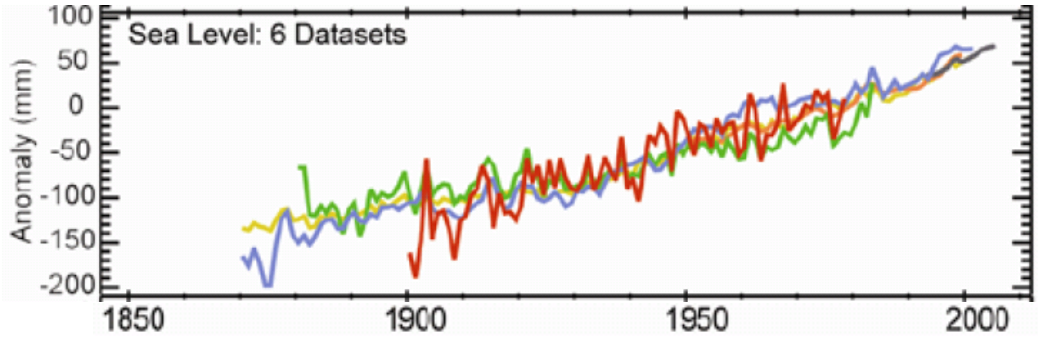
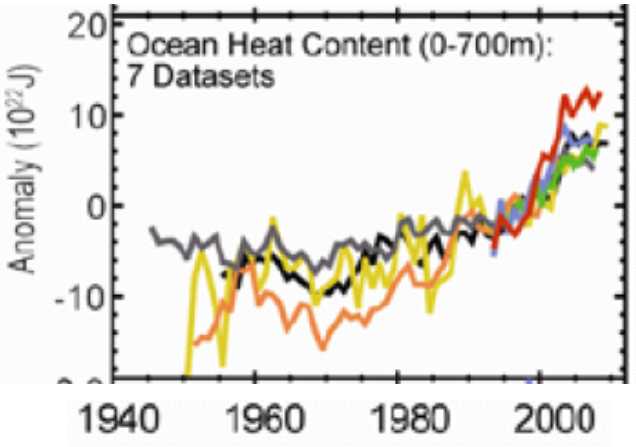
Ocean observations showing

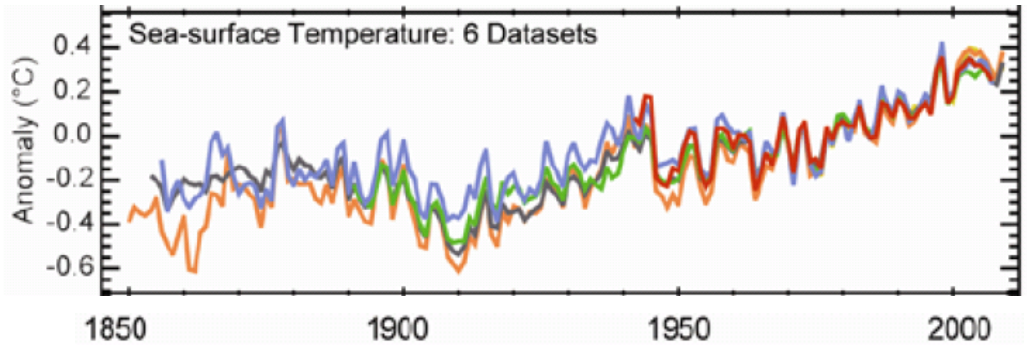
Sea level



Ocean heat content



Sea surface temperature



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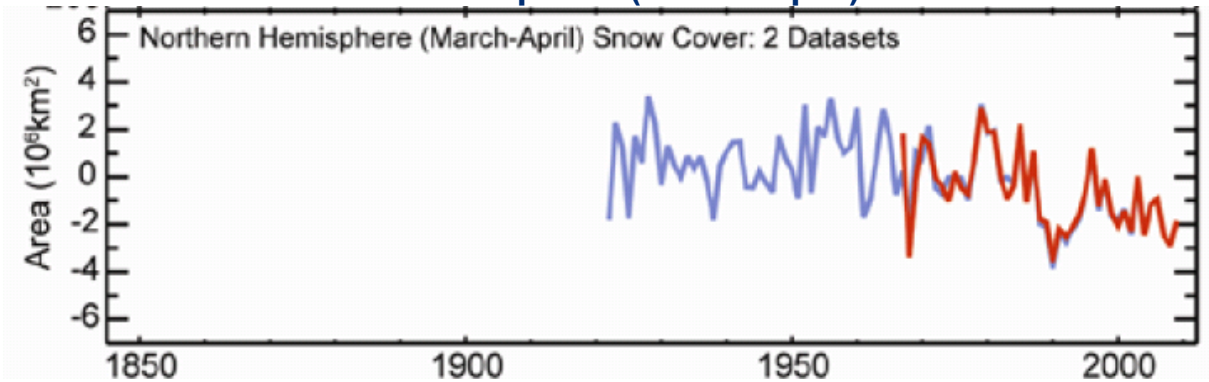
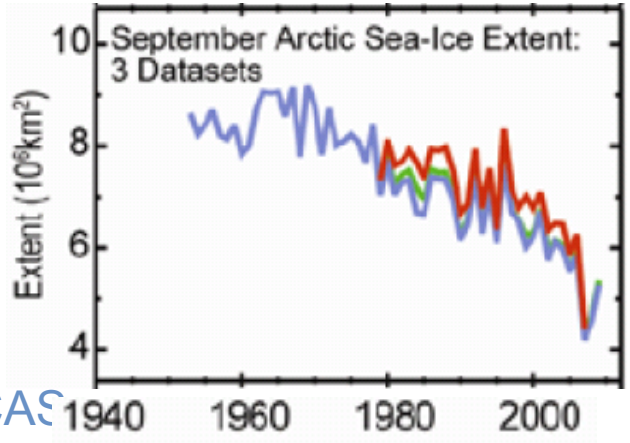
Cryosphere observations showing

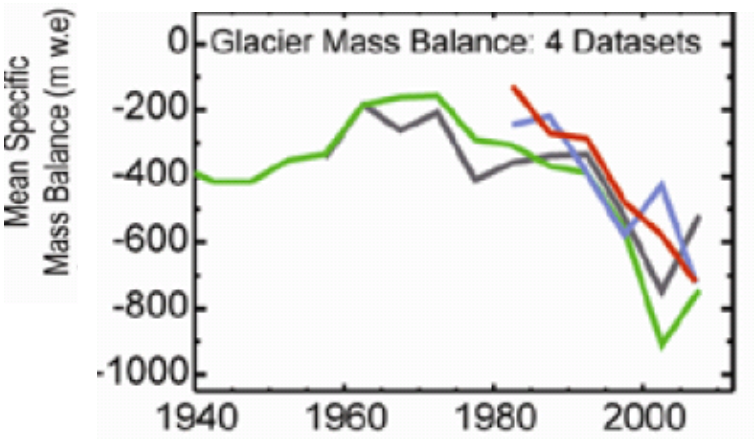
Northern hemisphere (March-April) snow cover



September Arctic sea ice extent



Glacier mass balance



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From Baringer et al. 2010

Multiple redundant indicators showing ***warming is unequivocal***

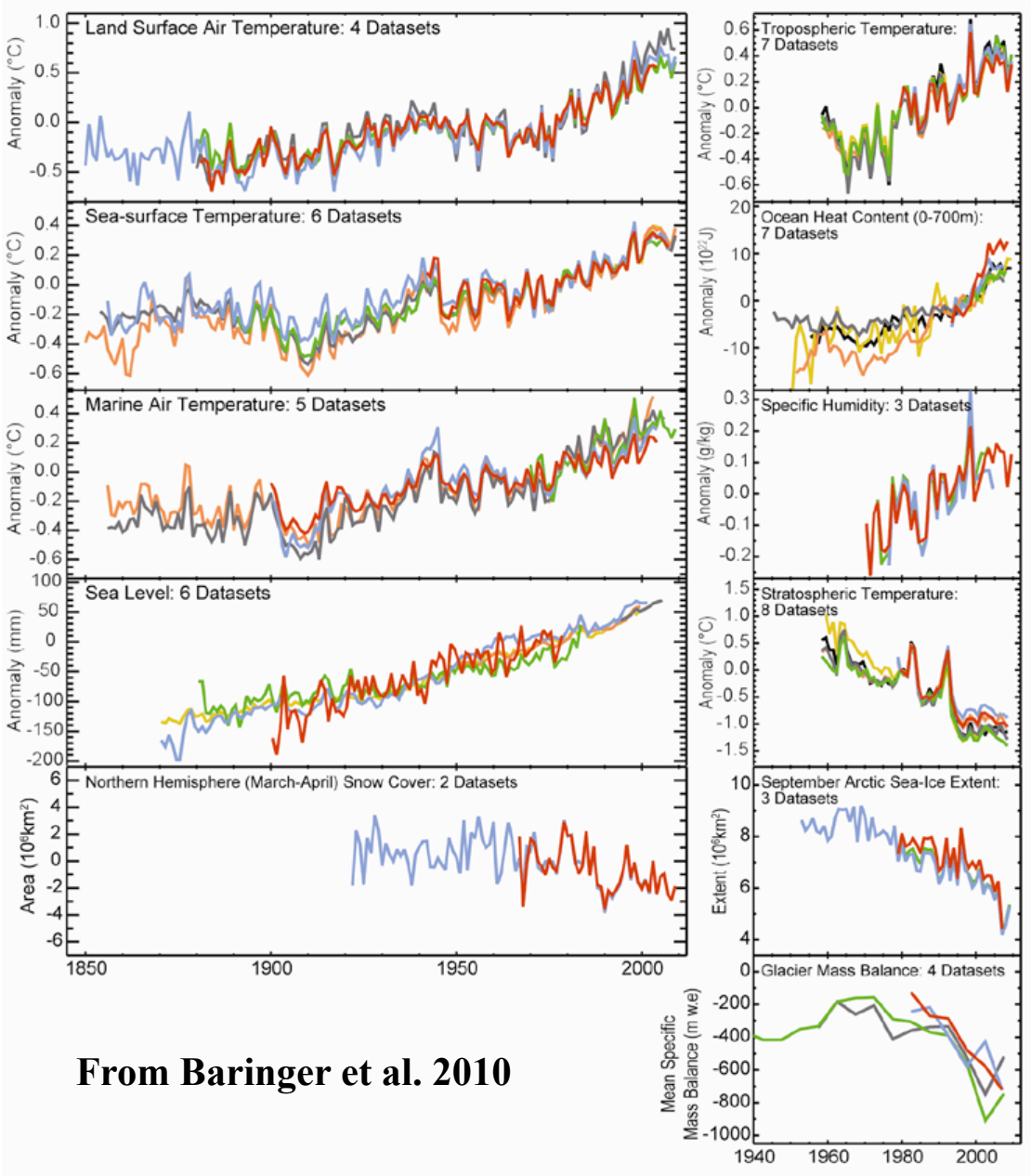
Land surface air temperature

Sea surface temperature

Marine air temperature

Sea level

Northern hemisphere (March-April) snow cover



From Baringer et al. 2010

Troposphere temperature

Ocean heat content (0-700m)

Specific humidity

Stratospheric temperature

September Arctic sea ice extent

Glacier mass balance

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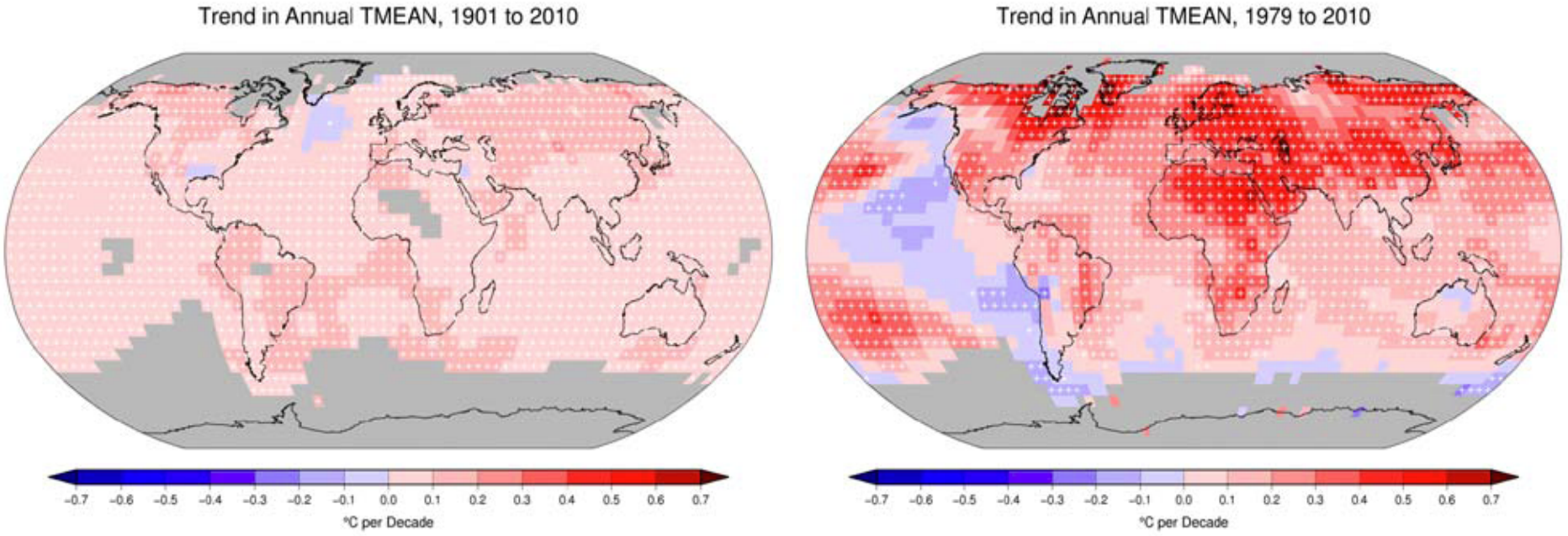
Global mean trend maps from NCDC surface record for 1901– 2010 (left hand panel) and 1979–2010.



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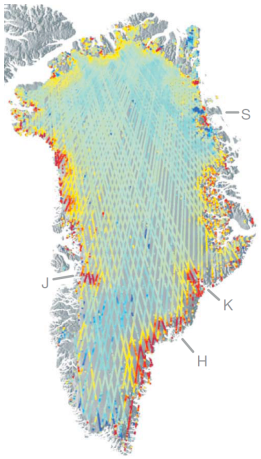
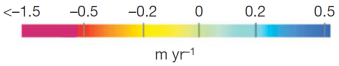
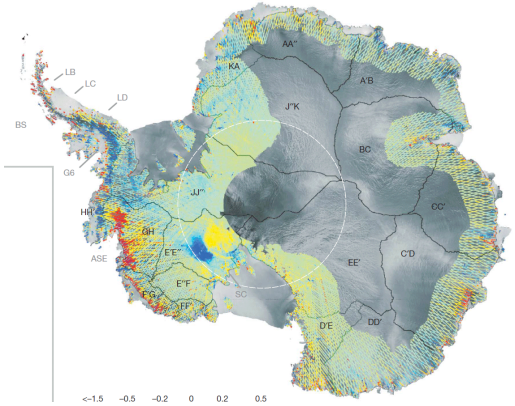
Mass loss of the Ice Sheets: Greenland and Antarctica

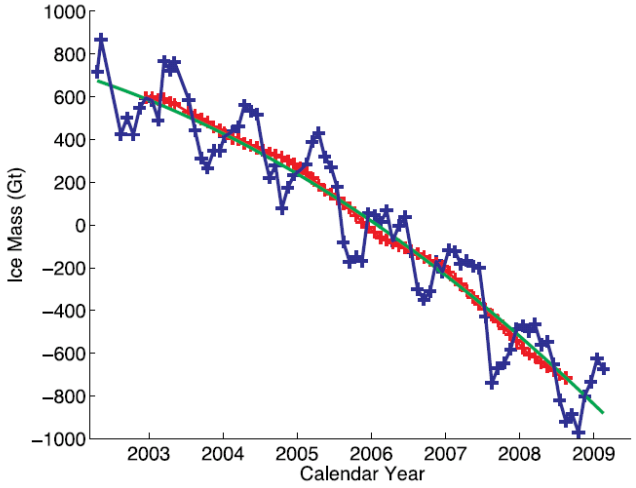




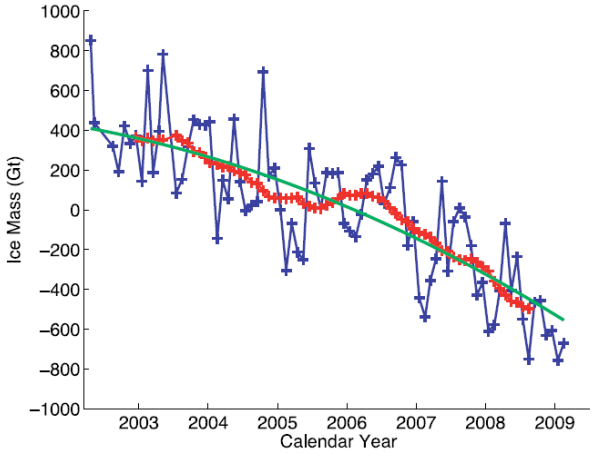


(Pritchard et al. 2009)

Extensive thinning of margins of ice sheets



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



Antarctica: –246 Gt/yr$_{2006\text{-}09}$

(Velicogna, 2009)

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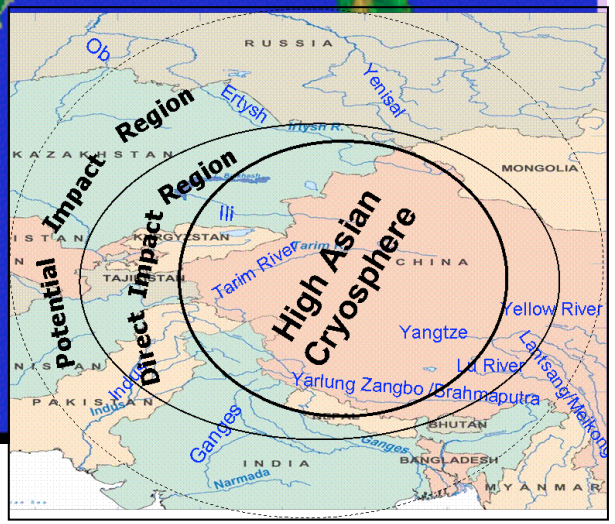
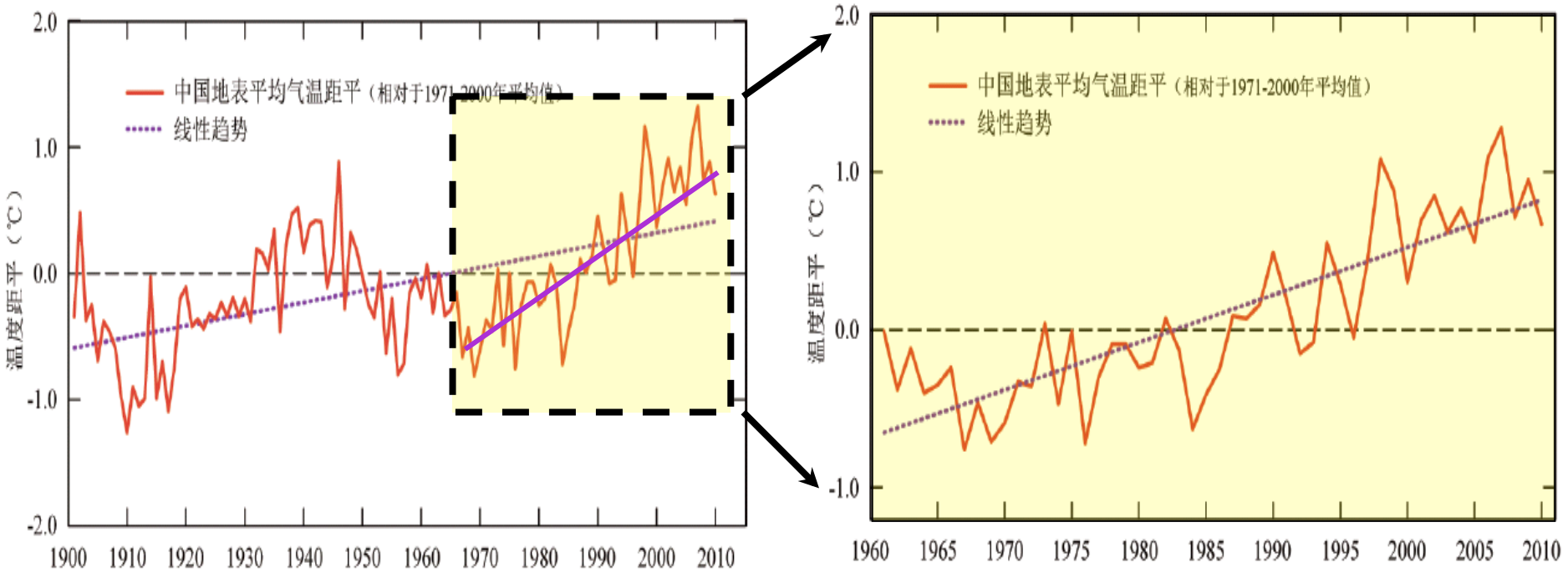
Regional evidences



Recent decades accelerated warming in China



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

1901-2010年中国地表平均气温变化

Changes of mean annual air temperature of China, 1961 to 2010

1961-2010年中国地表平均气温变化

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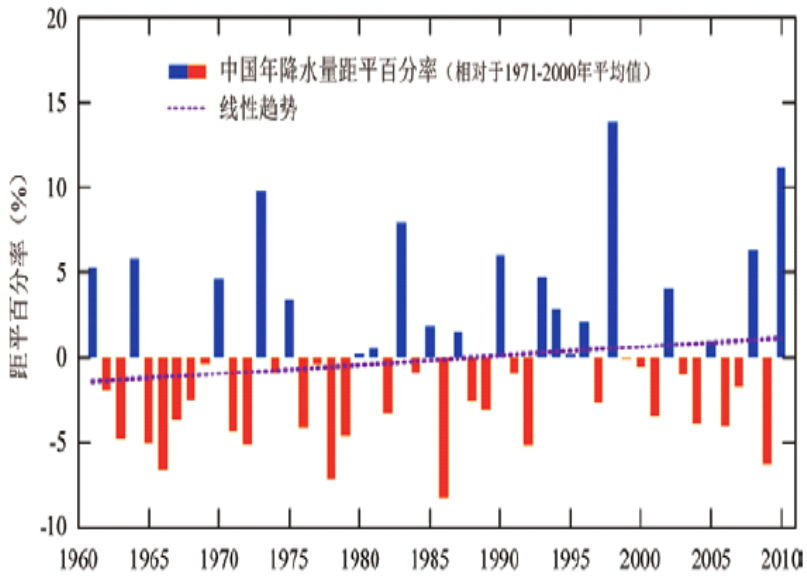
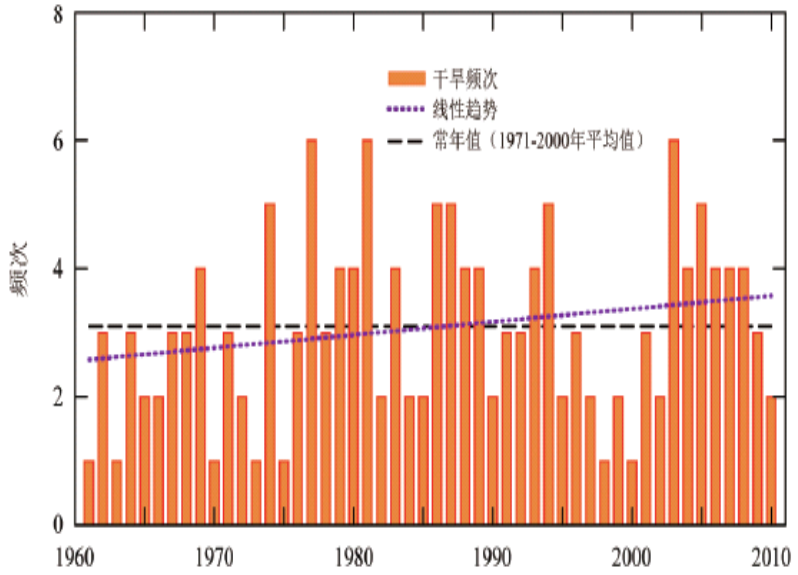


Percentage of annual precip. anomalies in China, 1961- 2010

中国年降水量距平百分率变化, 1961-2010



Number of drought events in China, 1961-2010

1961-2010年中国区域性气象干旱事件频次变化

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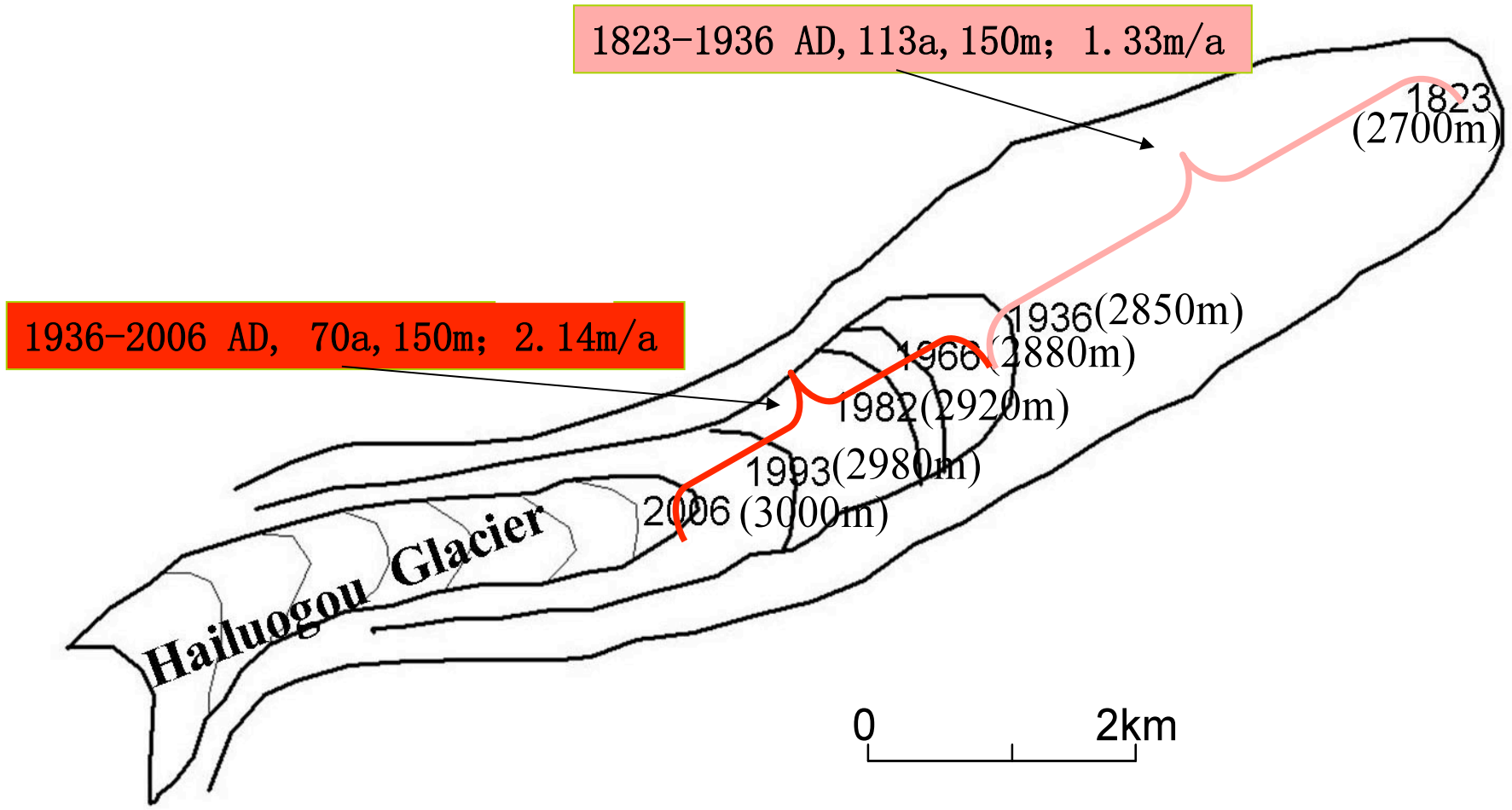
Glacier shrinking of Hailuogou Glacier, Mt. Minya Gongga

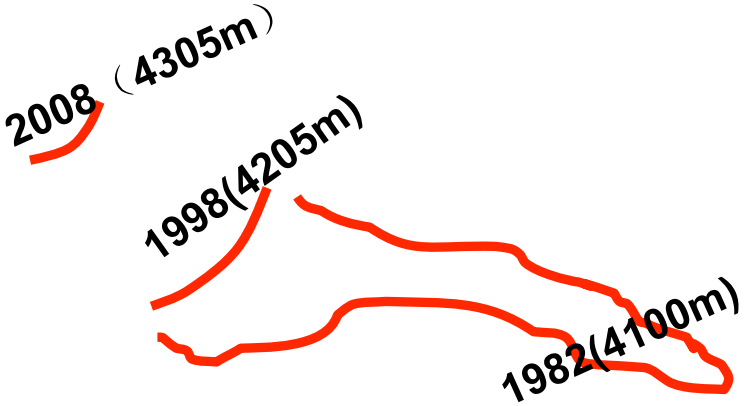


Baishui Glacier, Mt. Yulong

Glacier retreating:

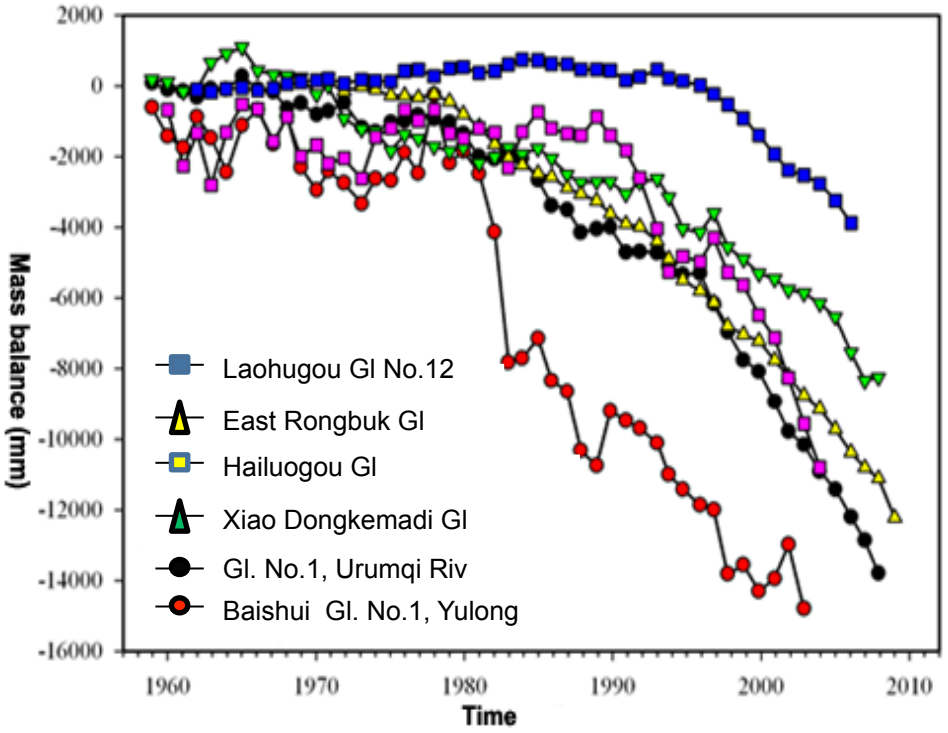
1982-1998, 6.25m/a,

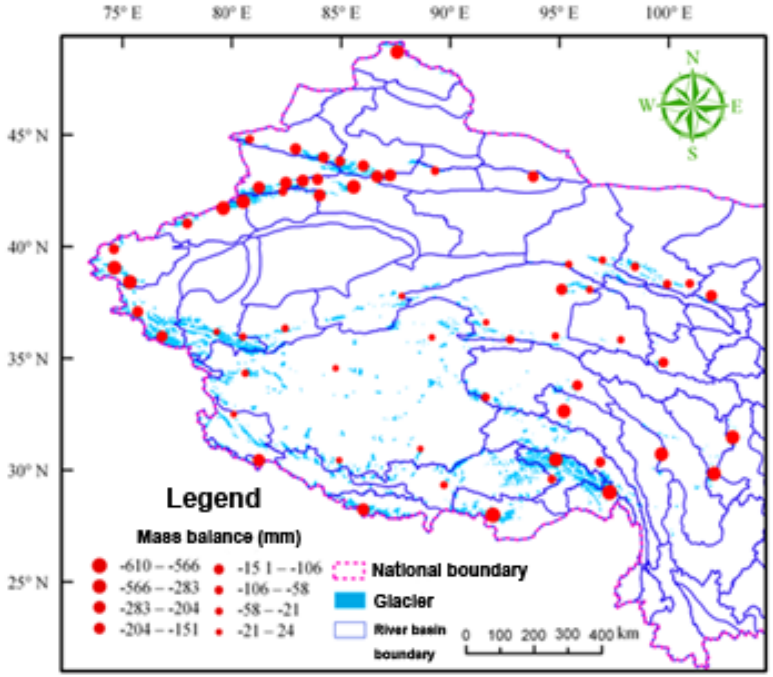
1998-2008, 10m/a



Warming cryosphere in China

——glacier





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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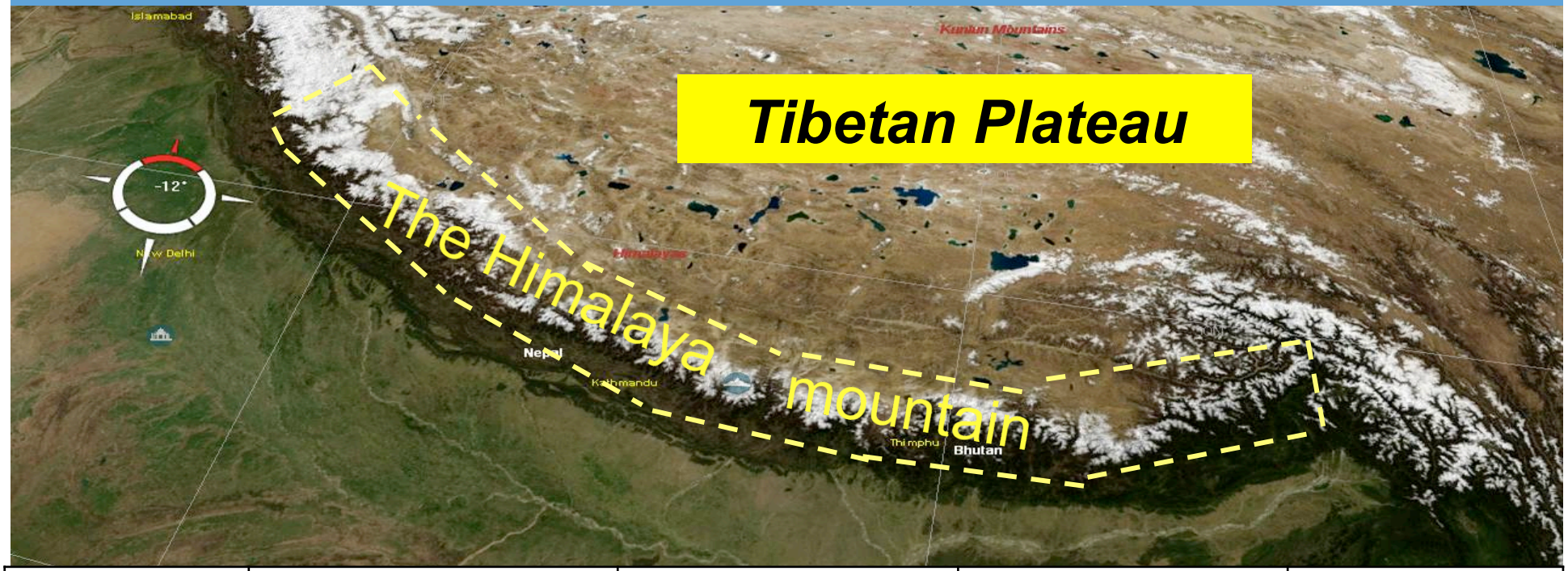
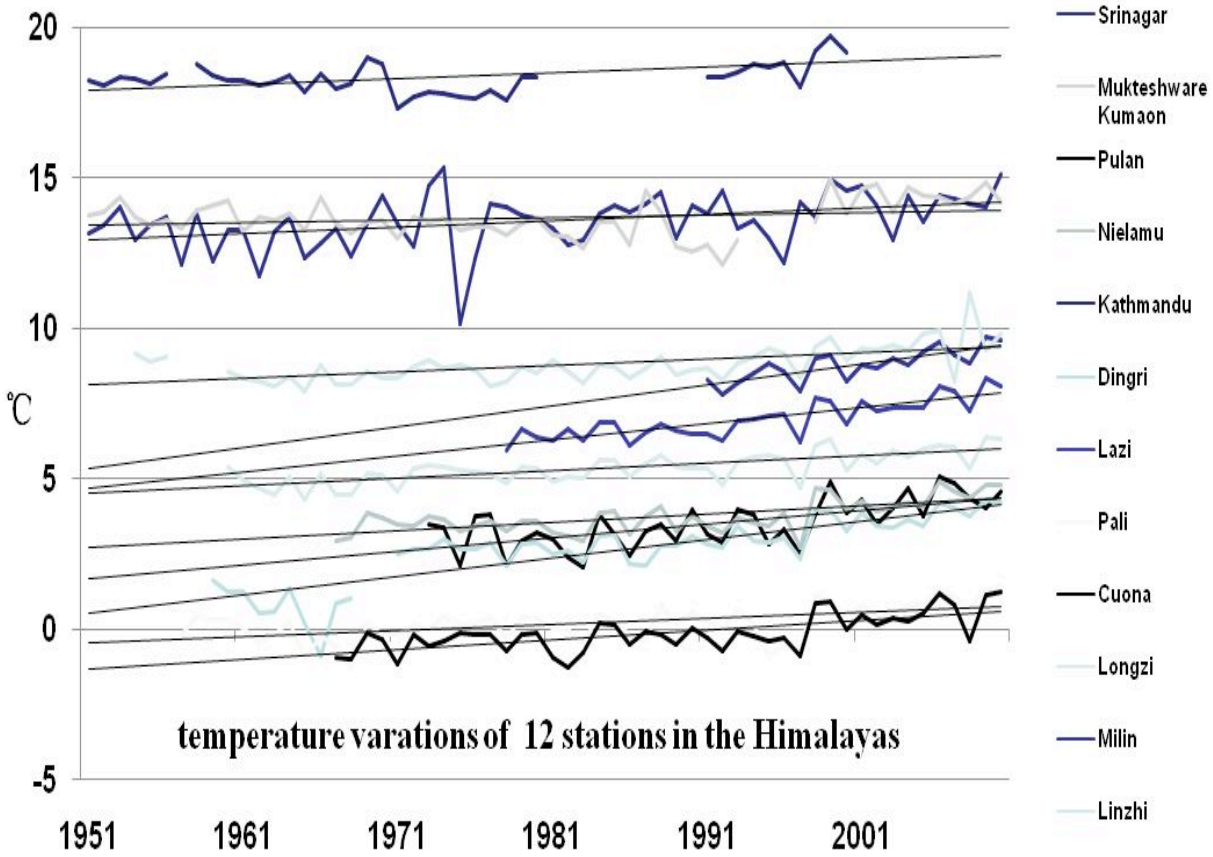
The Himalayas glacier



Trunk river basin	Branch river basin	The Number of glaciers	The area of glaciers（km^2）	Ice volume (km^3)
Ganges	Pumqu etc.	2192	3609	330
	Yarlung Zangbo River	10816	14493	1293
Indian River	Senger Zangbo	1244	779	44
	Glang chen gtsang po	789	672	50
Total		**15041** glaciers	**19553** km^2	**1717** km^3



Met stations (12) data show continue warming in the Himalayas.

The warming rate of high elevations might be even higher

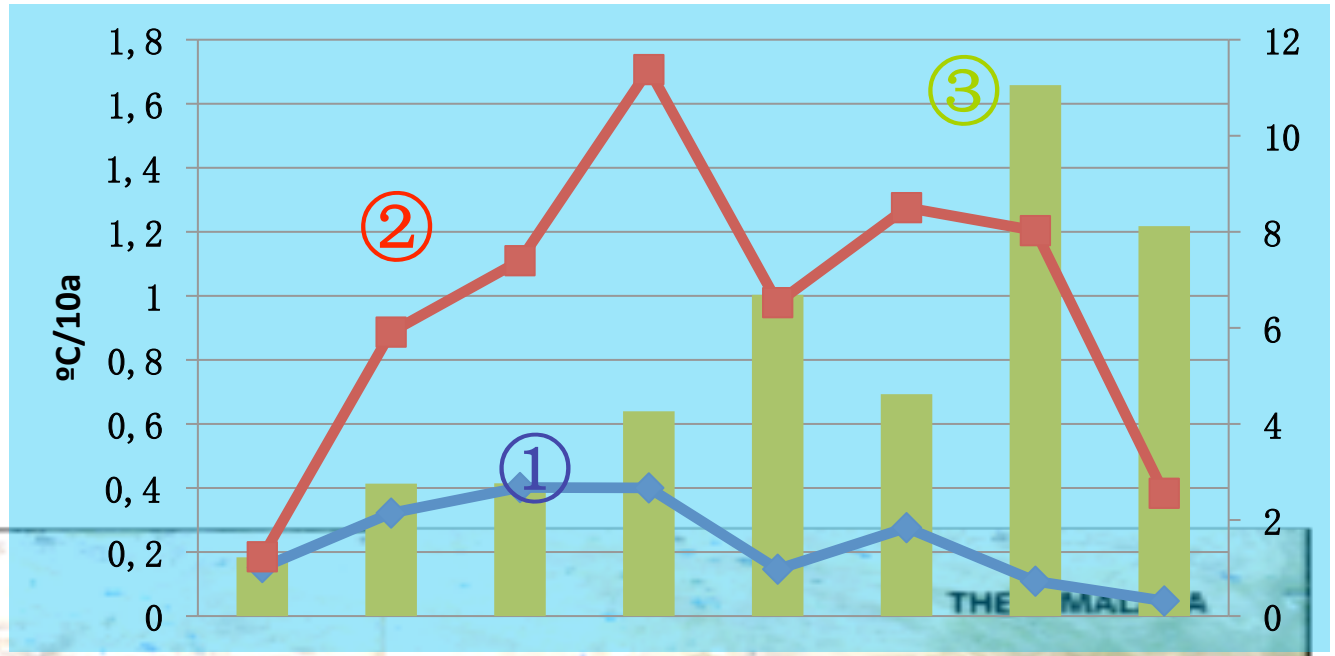
Climate change on the Himalayas

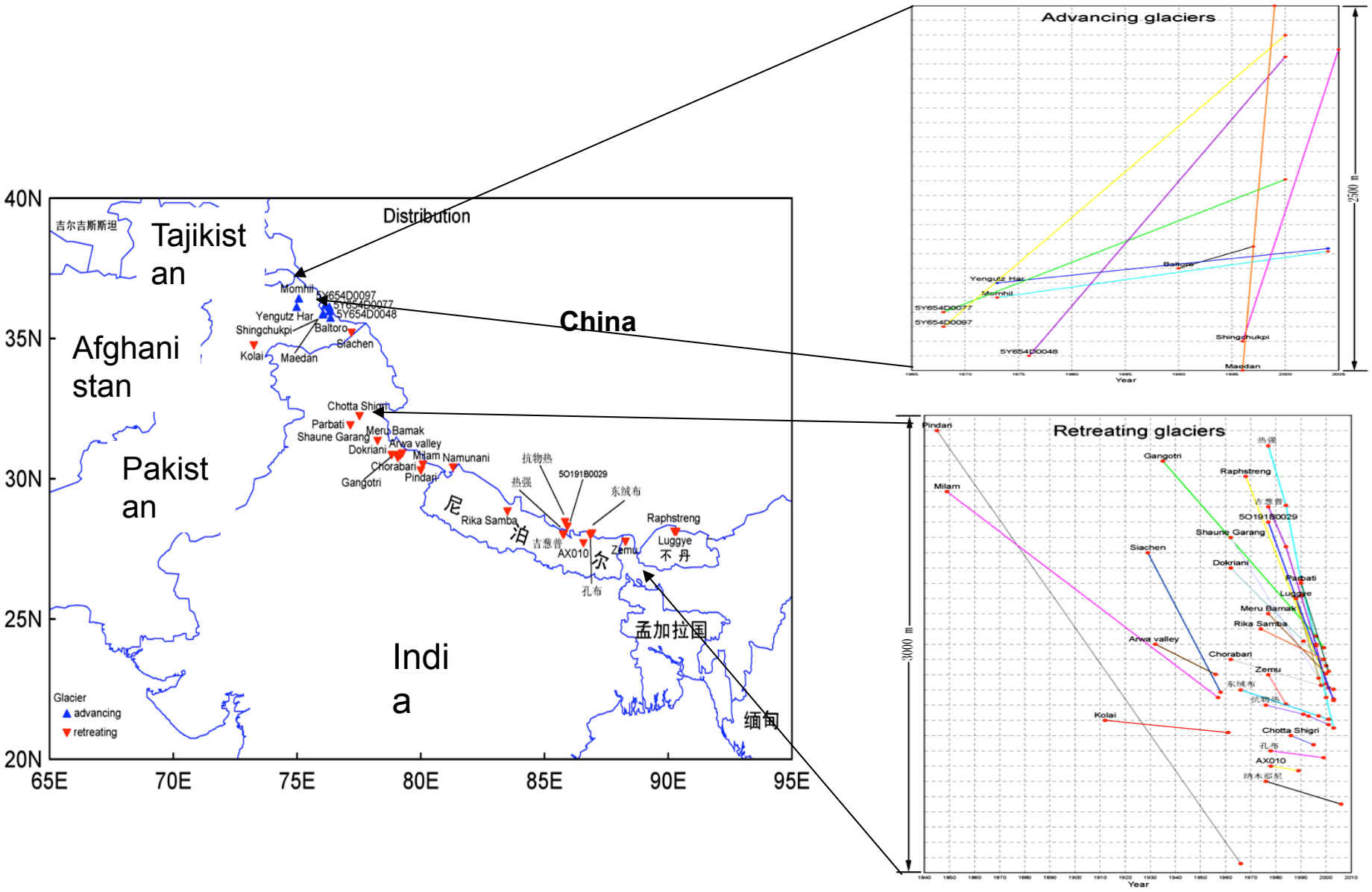
1 Warming rate in late 20th Century （C/10a)

2 Warming rate in 21th Century (C/10a)

3 Ratio of 2/1

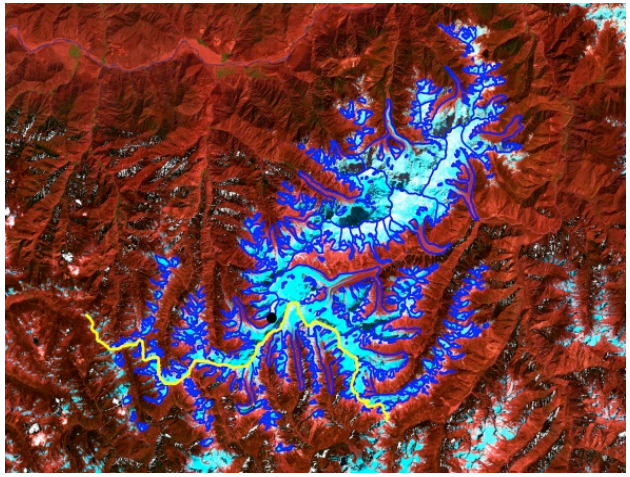
4 Trends of precipitation changes (~50 a)



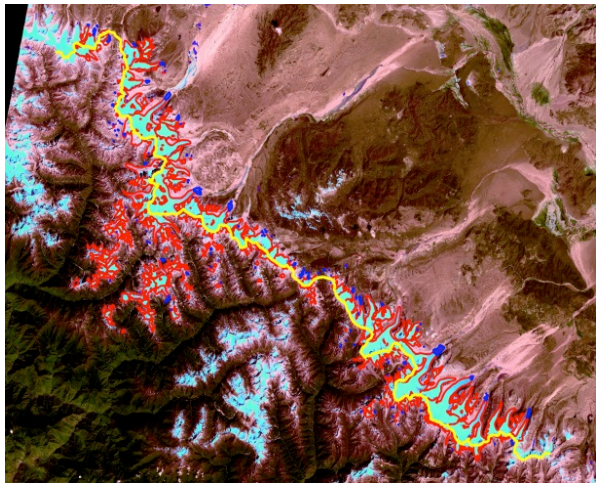


Field investigation on glacier terminal position (red: retreated, blue: advanced)

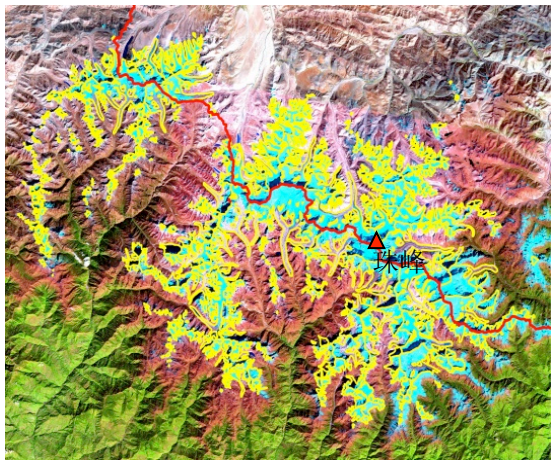
(Xiao and Ming, in prep.)



Nanga Parbat



Gymayangzong



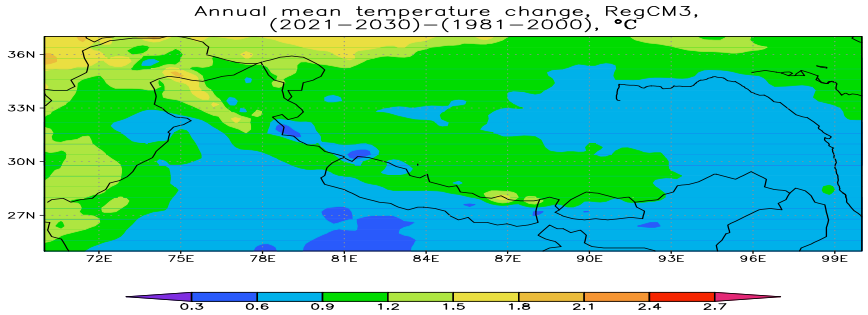
Qomolangma

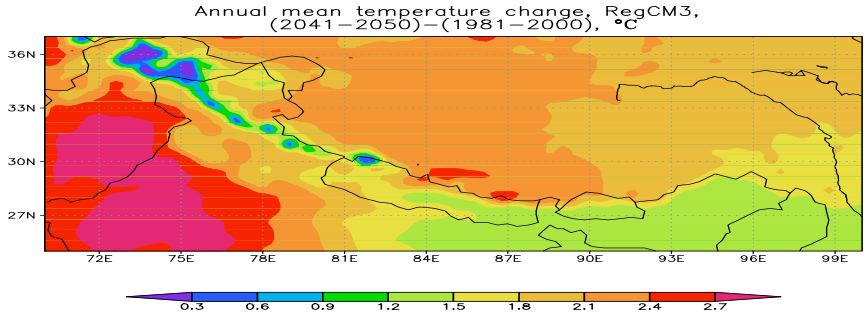
Glaciers changes of over three regions on the Himalayas, 2000-2009

Areas	North slope （%）				South slope （%）			
	summary	Shrink/ disappear	Advance	Stable	summary	Shrink/ disappear	Advance	Stable
Everest	-2.17(S) -1.35(V)	53.91	1.89	44.2	-2.34(S) -2.3(V)	45.39	0.18	54.43
Gymma Yangzong	-2.44(S) -2.2(V)	85.86	0	14.14	-2.61(S) -2.51(V)	49.1	0	50.9
Nanga Parbat	-6.41(S) -3.96(V)	94.04	0	5.96	-8.66(S) -9.49(V)	92	0	8

(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 (℃)

2041~2050 mean minus 1981~2000 mean (℃)

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Warmer in the future !

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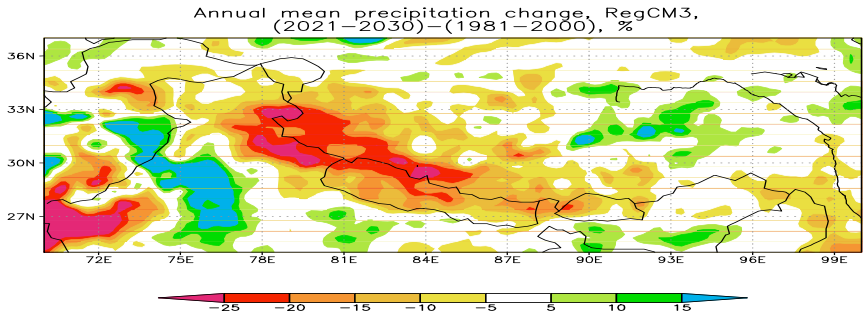
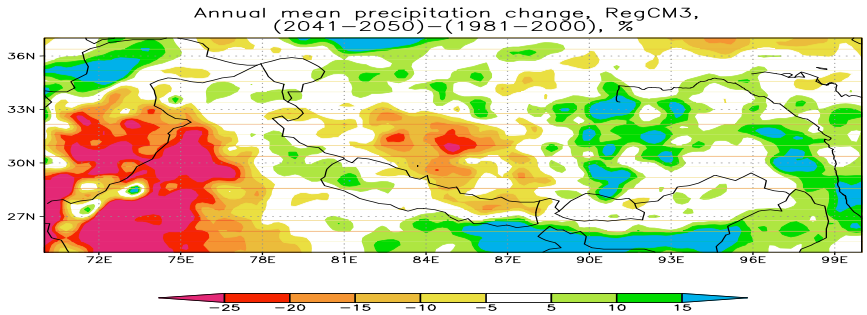
Projections (A1B) of future precipitation changes on Himalayas





2020~2030 **2040~2050**

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

2041~2050 mean minus 1981~2000 mean (%)

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Drier in the future, too !

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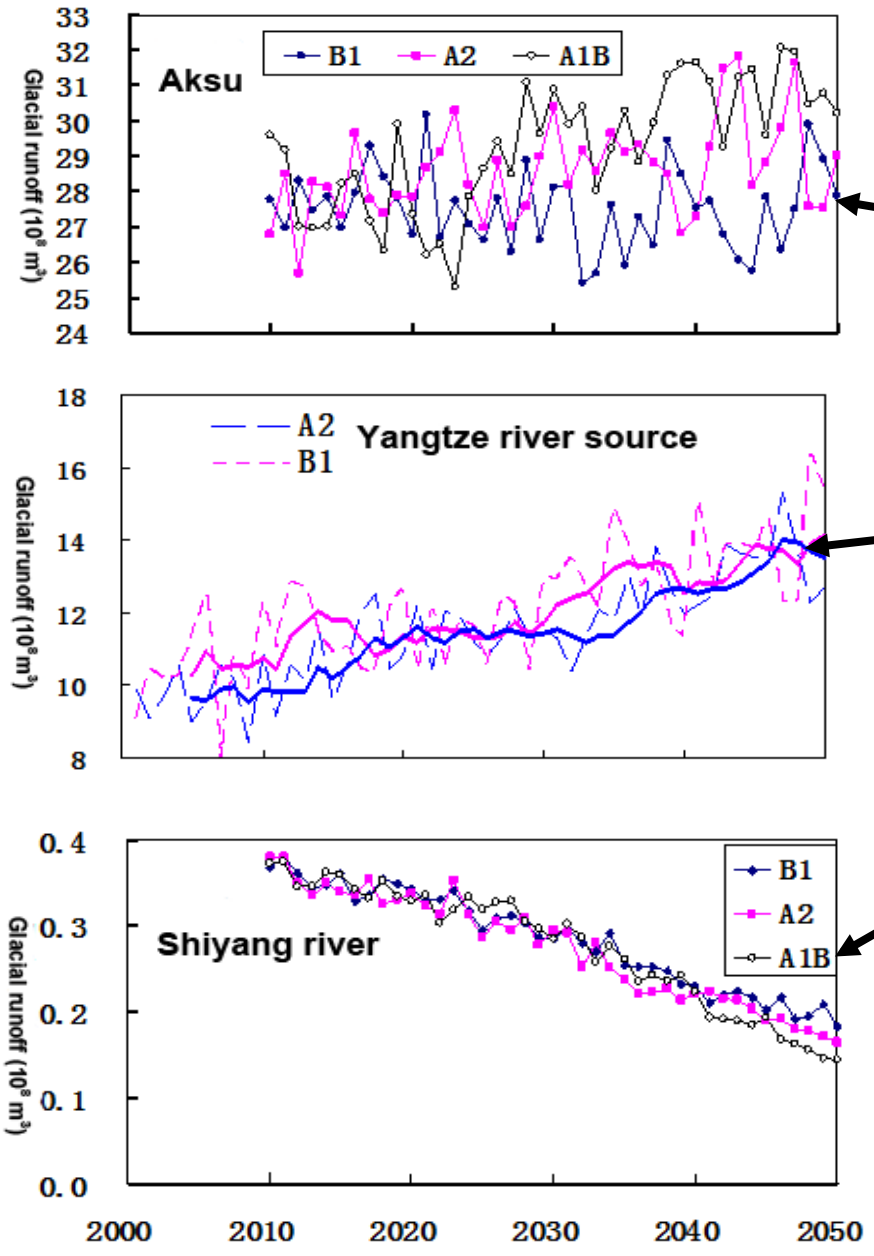

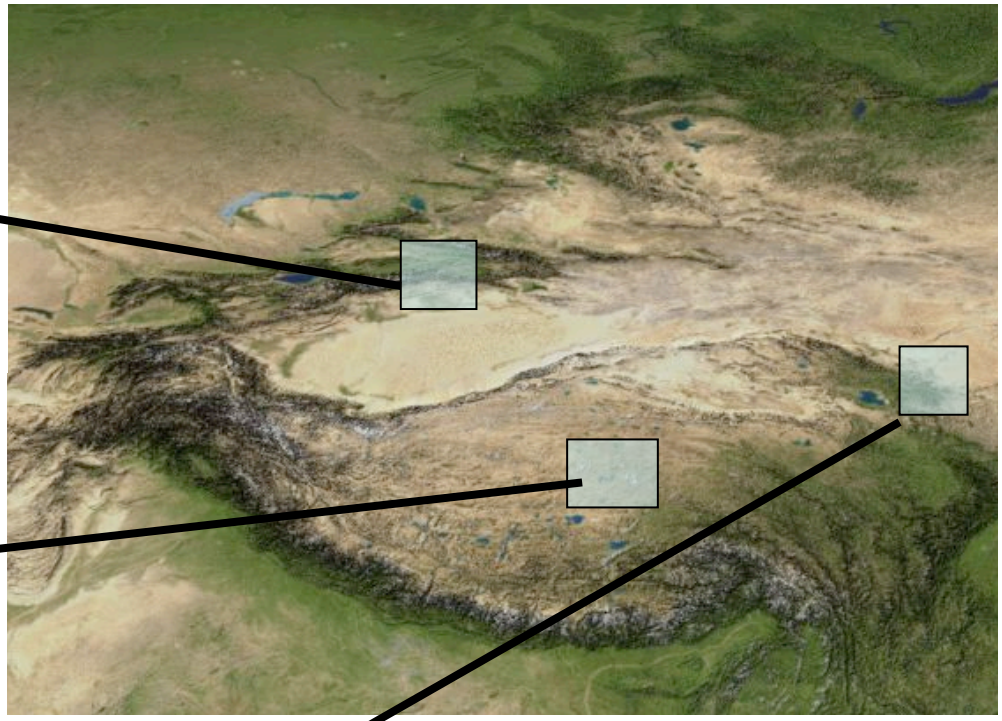

The glacial runoff projections for Yangtze river, Aksu River and Shiyang River before 2050 AD.

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6500 m a.s.l.

Mass balance

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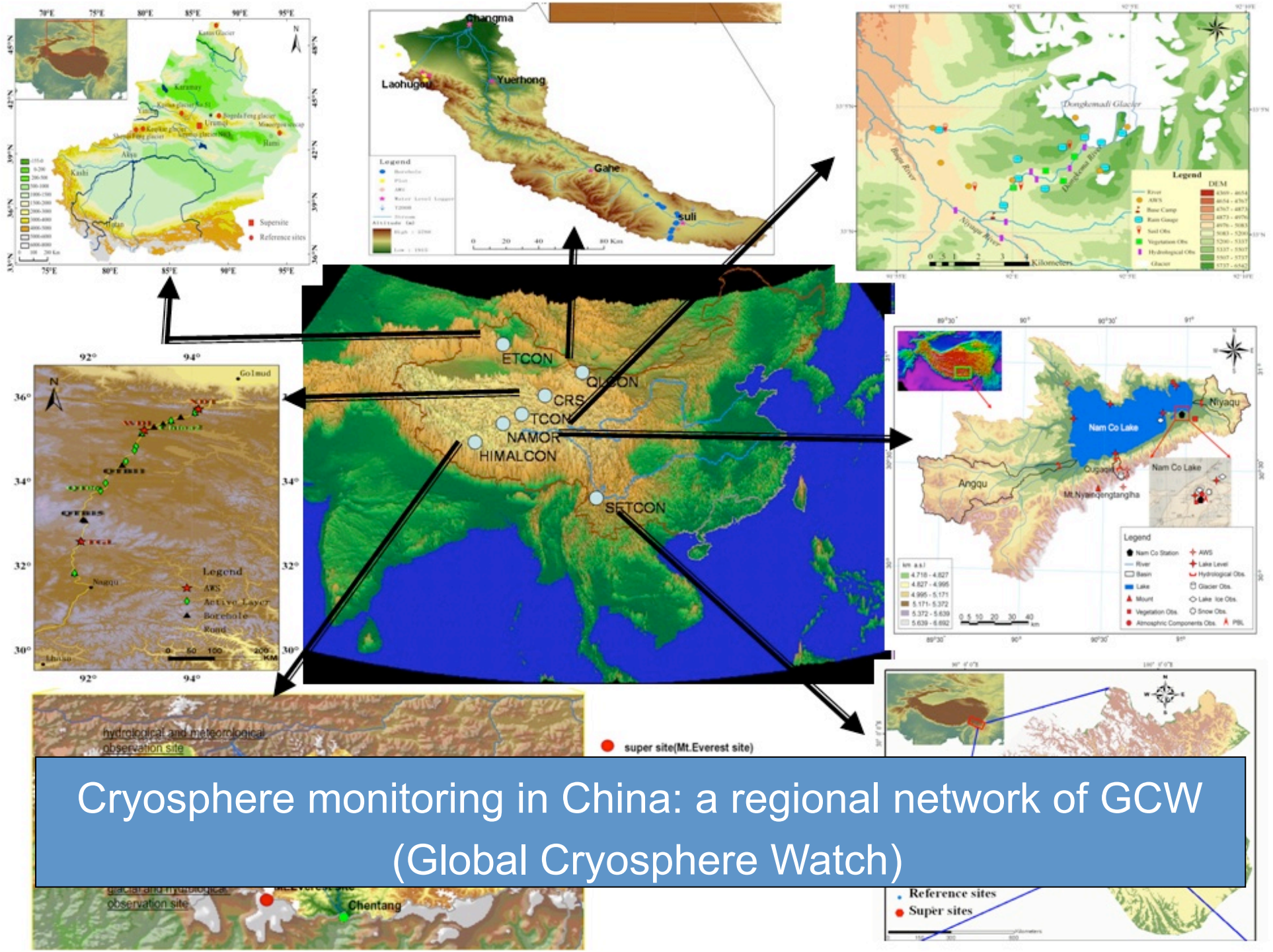

Cryosphere monitoring in China: a regional network of GCW (Global Cryosphere Watch)

1. Observed climate change in the world and China

2. Emerging questions and response

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Emerging Questions on Climate Change

- Has climate change accelerated?
- Is the Greenland ice sheet stable?
- What is the senarias 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 mounytain glaciers fast retreating?
- ENSO, monsoon,

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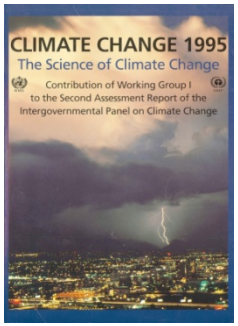
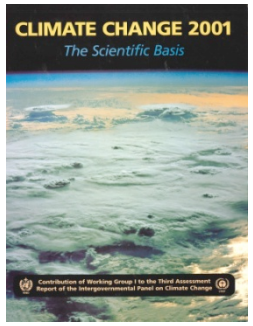
IPCC AR5 WGI Outline

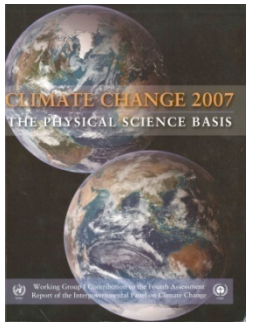
approved at IPCC 31st Session in October 2009

- 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**
observations	✓	✓	✓	✓✓✓	✓✓✓
paleoclimate				✓	✓
sea level	✓	✓	✓		✓
clouds					✓
carbon cycle			✓		✓
regional change			✓	✓	✓✓✓

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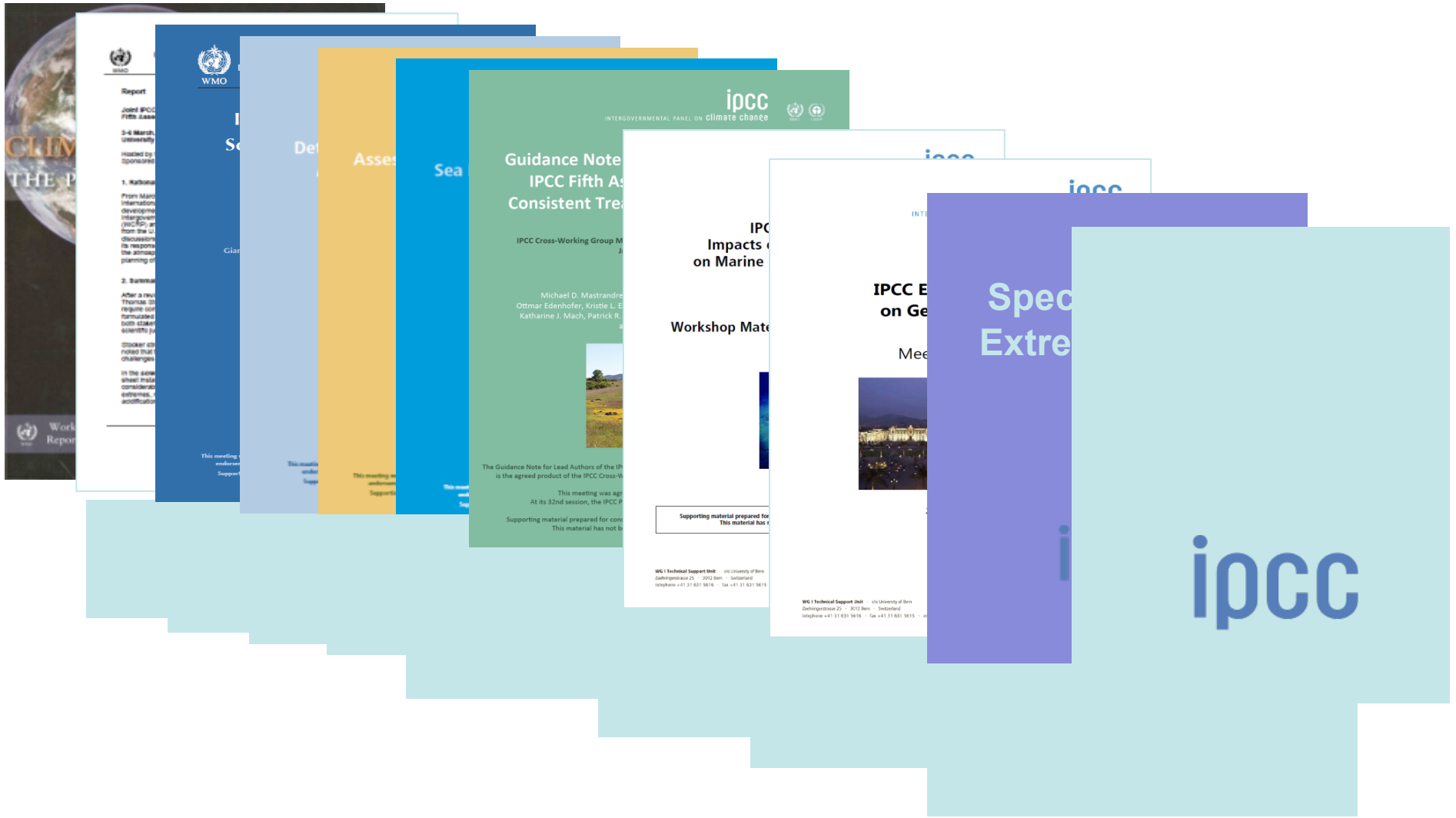
From AR4 to AR5



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Rigor 严格

Robustness 确凿Transparency 透明

Comprehensiveness 全面

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