Project co-funded by the European Union

SAME First International Seminar

Morning session

Climate Change, causes and effects

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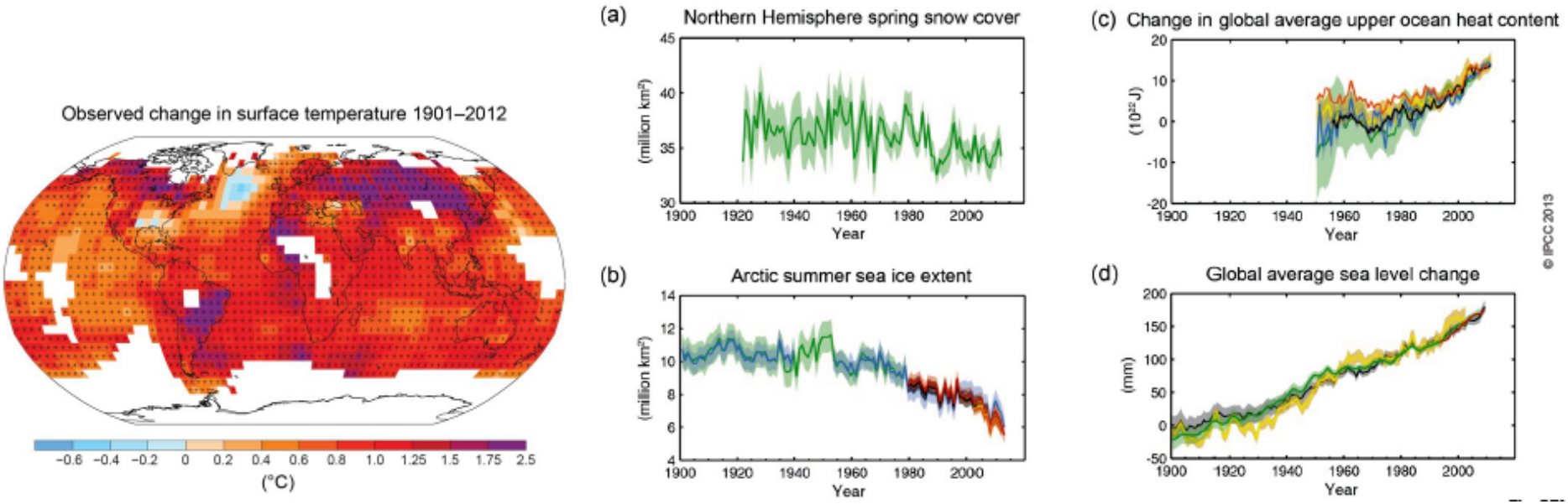
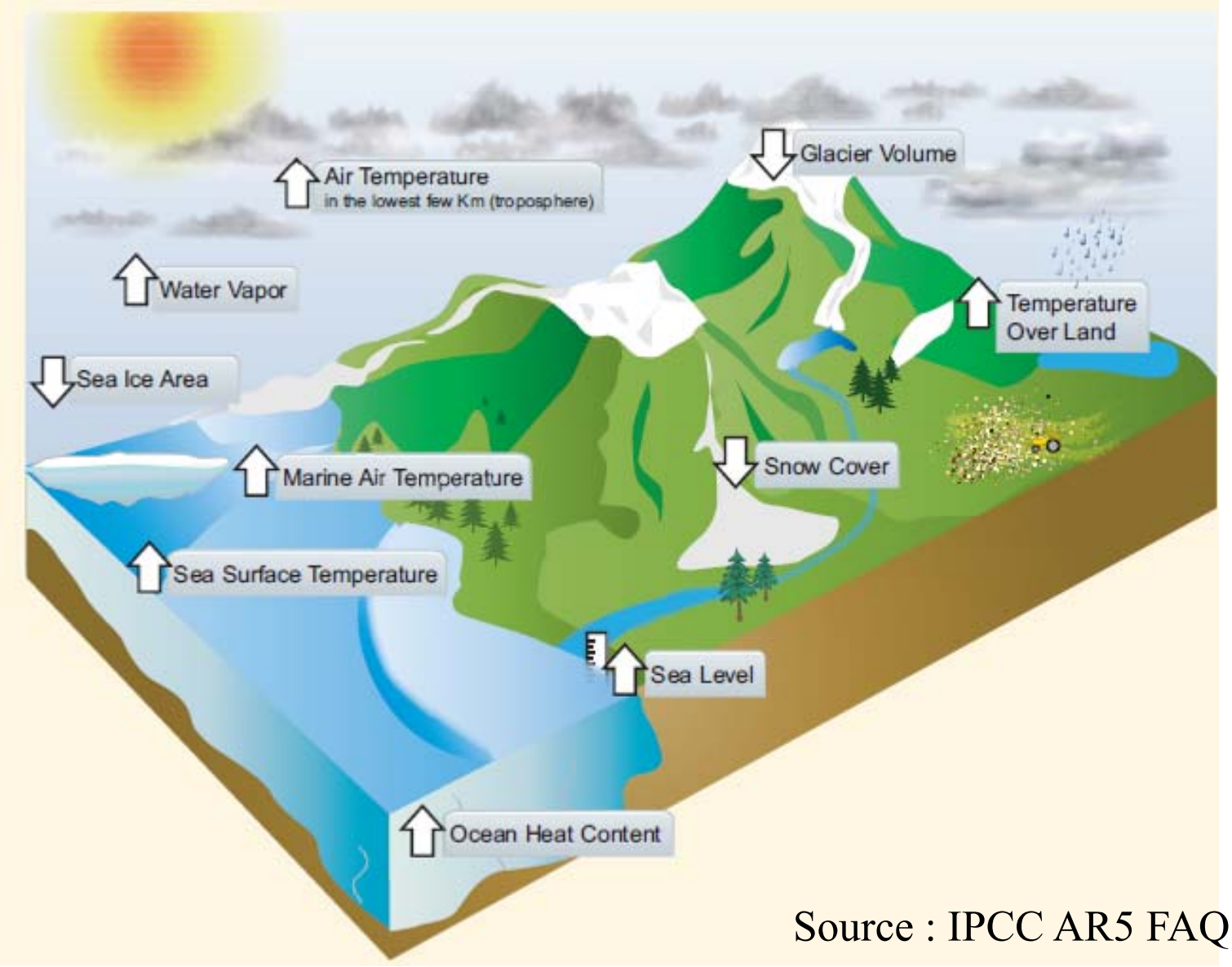
Warming of the climate system is unequivocal

- Each of the last three decades has been successively warmer at the Earth's surface than any preceding decade since 1850.
- Since the 1950s, many of the observed changes are unprecedented over decades to millennia.
- The atmosphere and ocean have warmed, the amounts of snow and ice have diminished, sea level has risen, and the concentrations of greenhouse gases have increased.



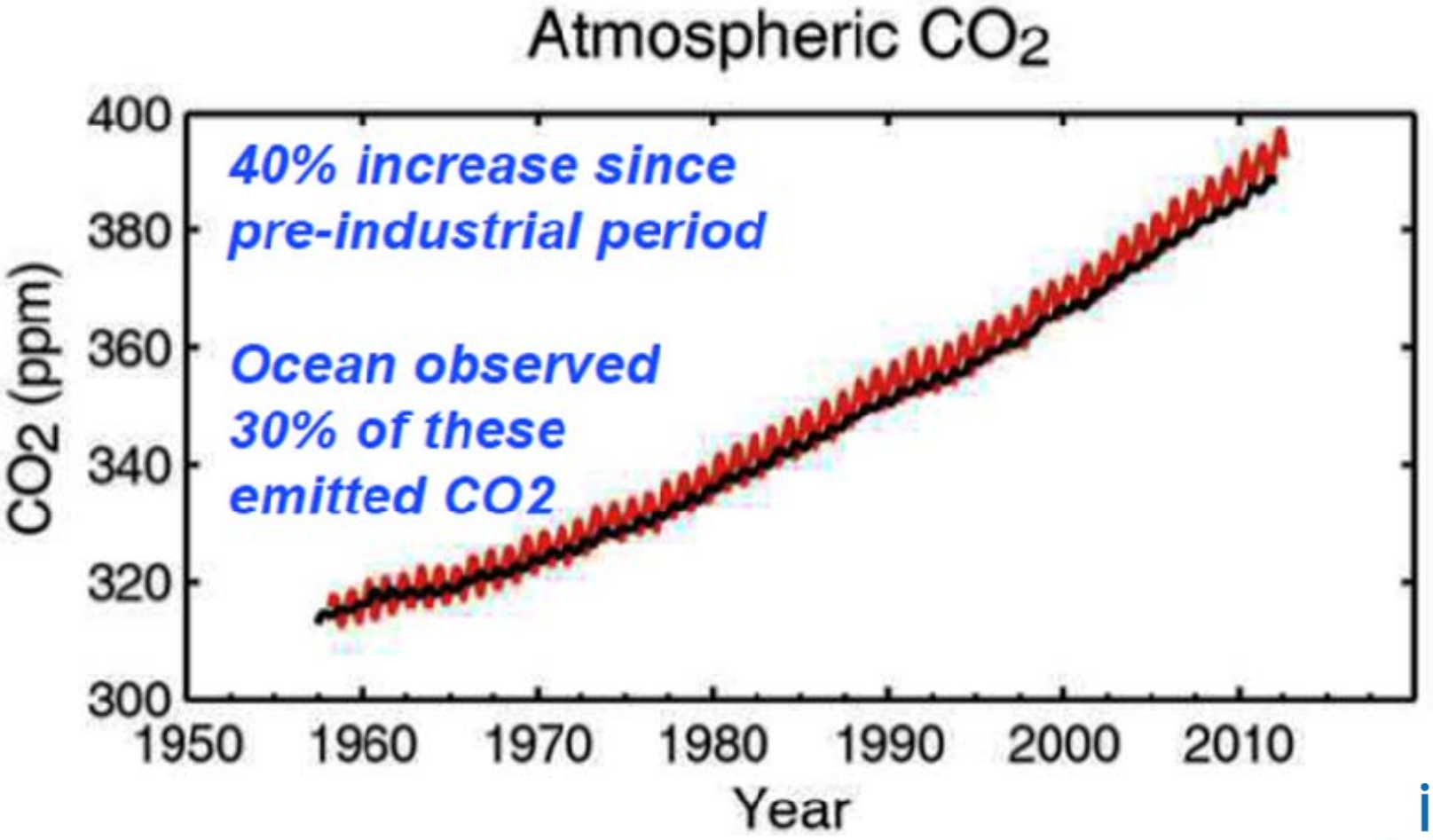
Independent analyses of many components of the climate system that would be expected to change in a warming world exhibit trends consistent with warming (arrow direction denotes the sign of the change)



Source : IPCC AR5 FAQ 2.1, Figure 1

Understanding the causes

The atmospheric concentrations of CO_2, CH_4 and N_2O have increased to levels unprecedented in at least the last 800.000 years



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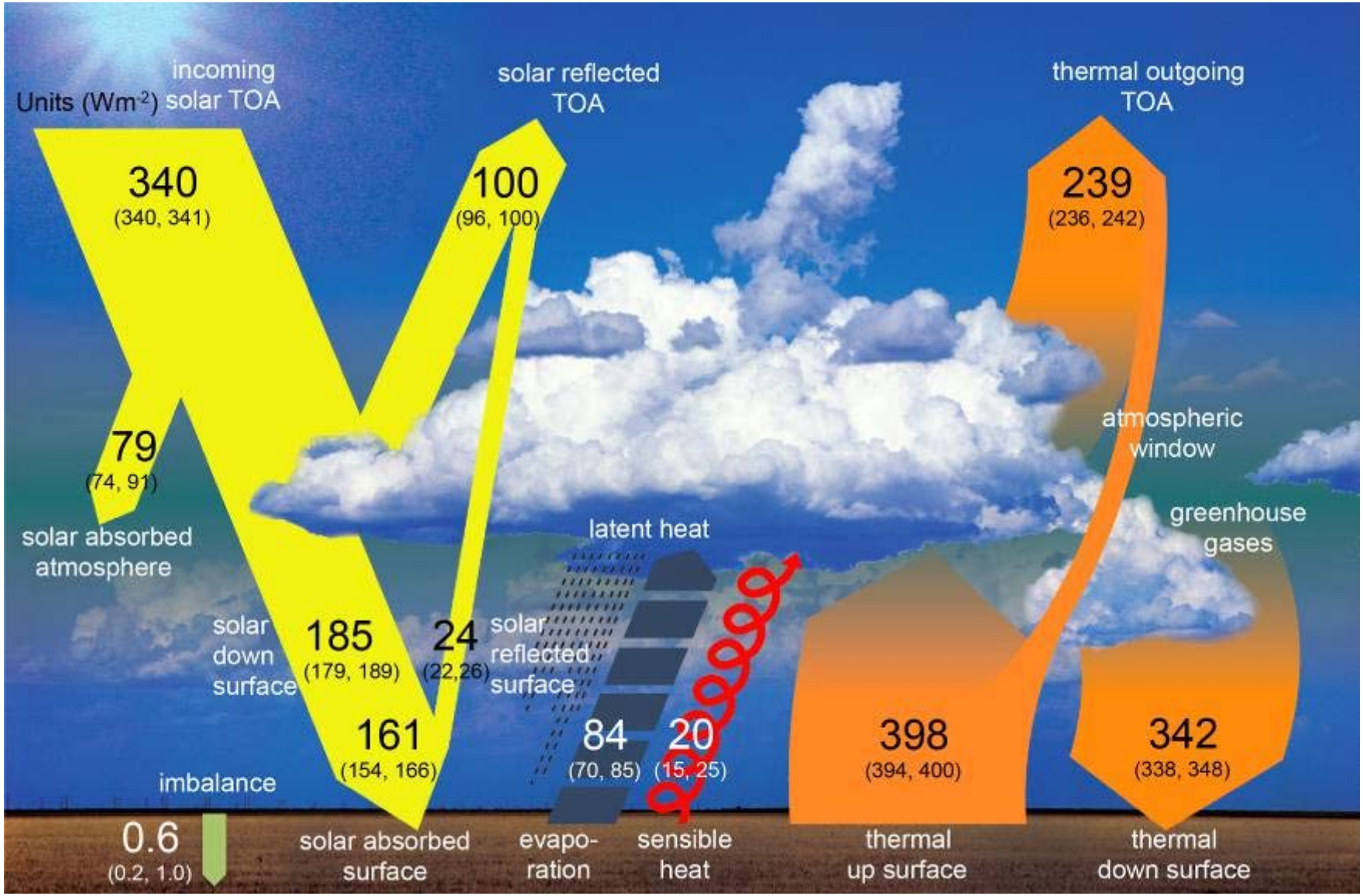
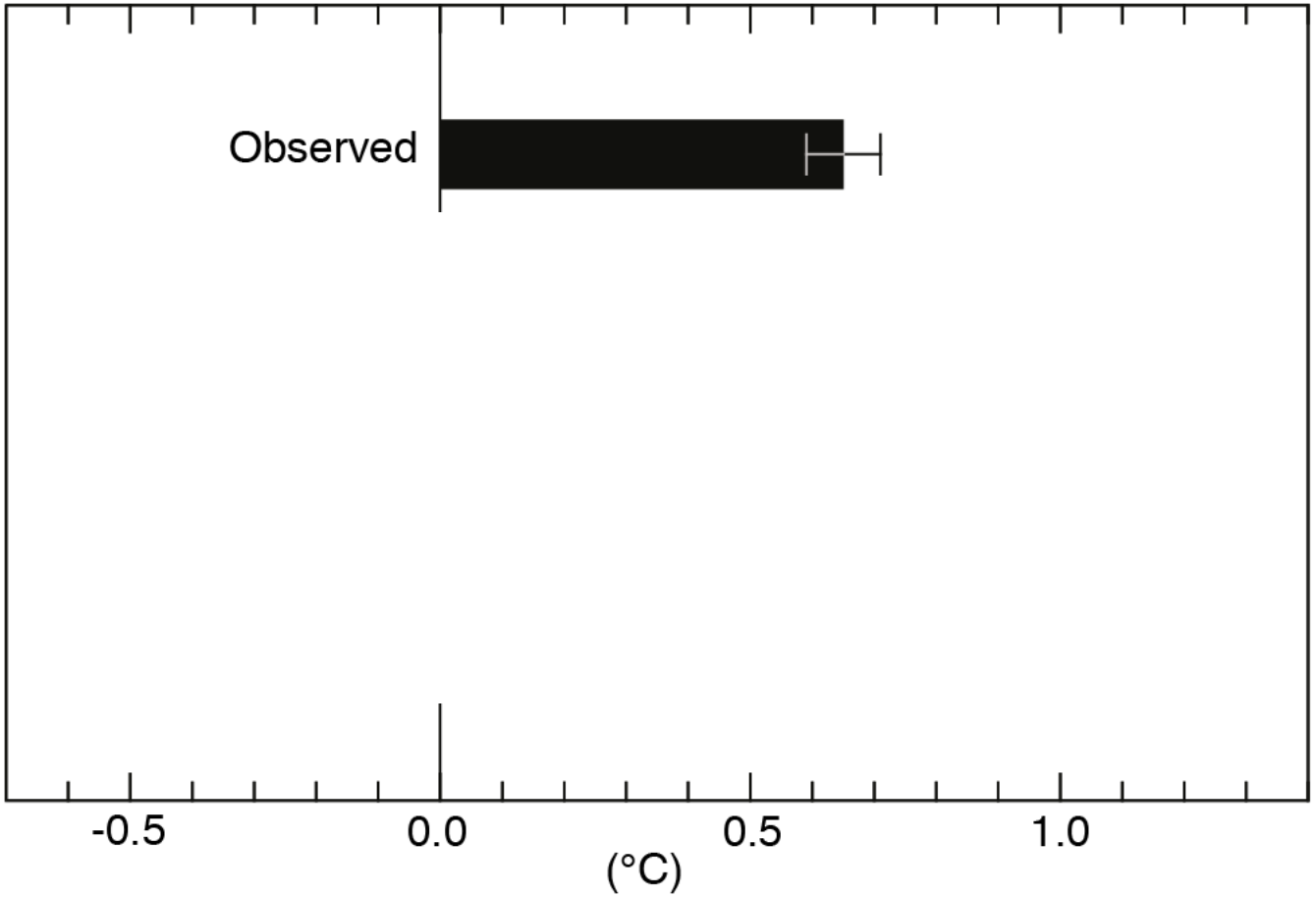
INTERGOVERNMENTAL PANEL ON climate change

Global mean energy budget under present-day climate conditions

Fonte: IPCC, 2013. AR5-WG1-Fig.2.11



The observed warming 1951−2010 is approximately 0.6°C to 0.7°C.



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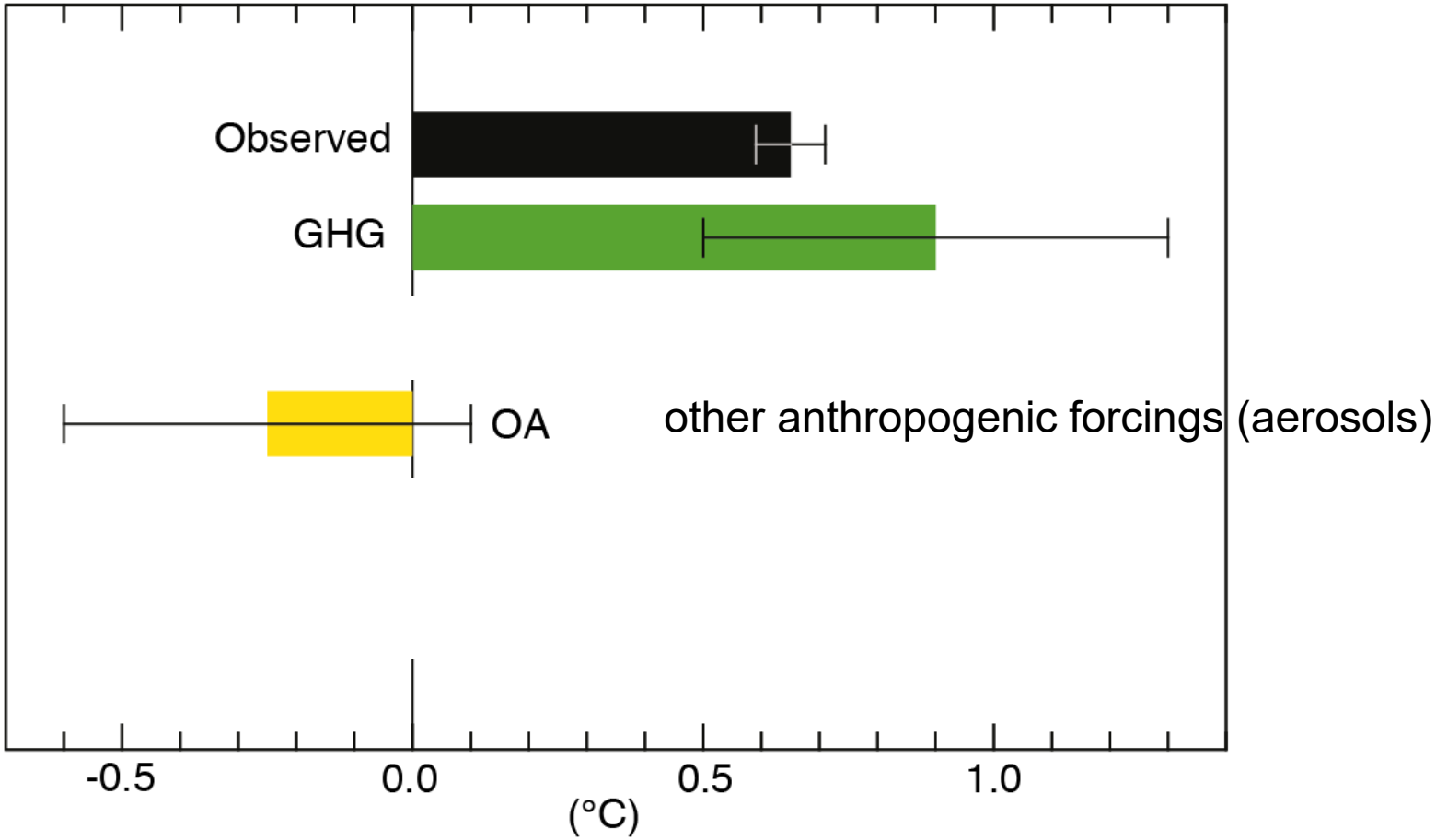
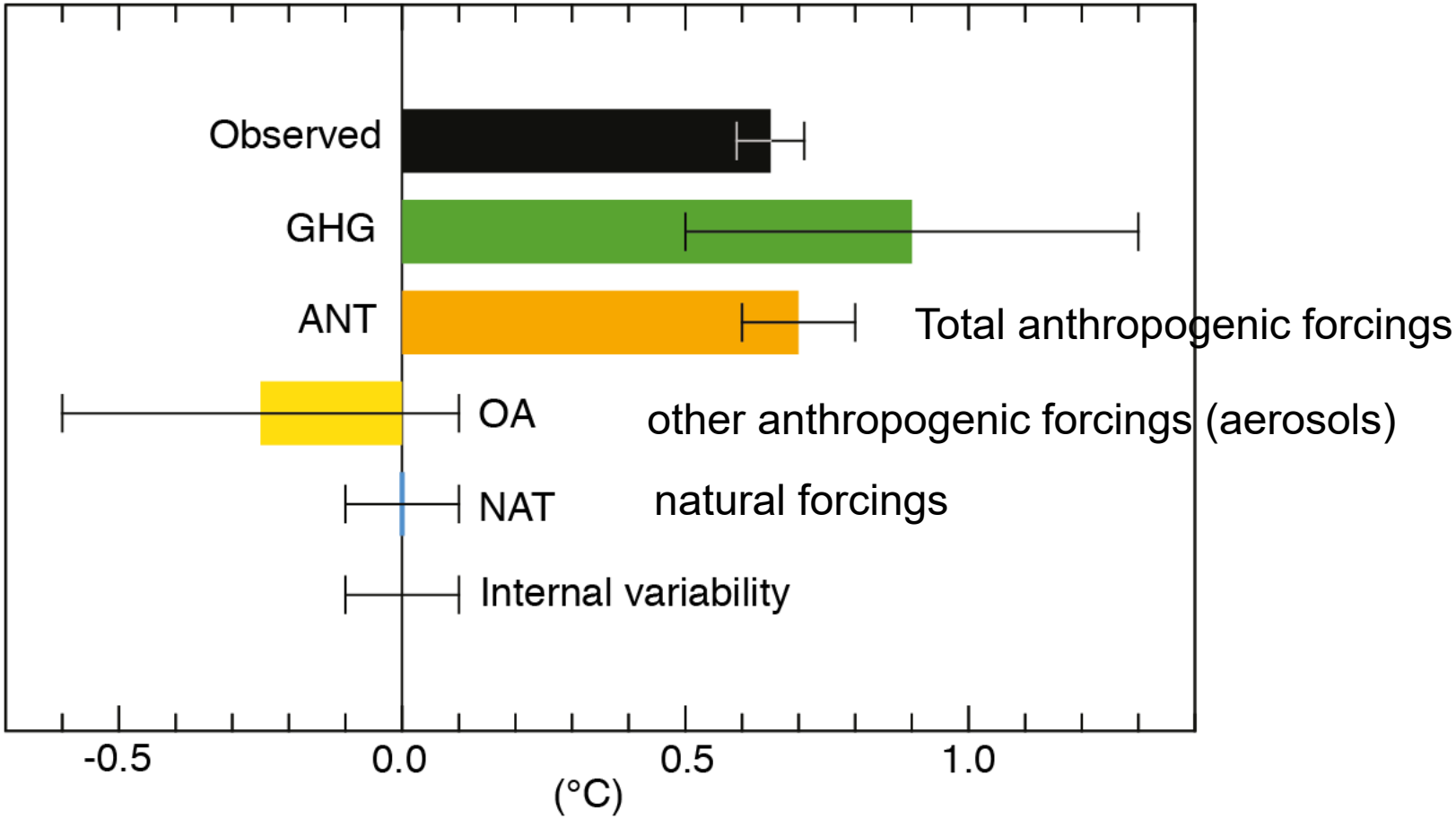


It is *extremely likely* that *human influence* has been the dominant cause of observed warming since the mid-20th century

The observed warming 1951−2010 is approximately 0.6°C to 0.7°C.



Human influence on the climate system is clear

Donald J. Trump @realDonaldTrump 1 Gen

This very expensive GLOBAL WARMING bullshit has got to stop. Our planet is freezing, record low temps,and our GW scientists are stuck in ice

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1.897 RETWEET **1.112** PREFERITI

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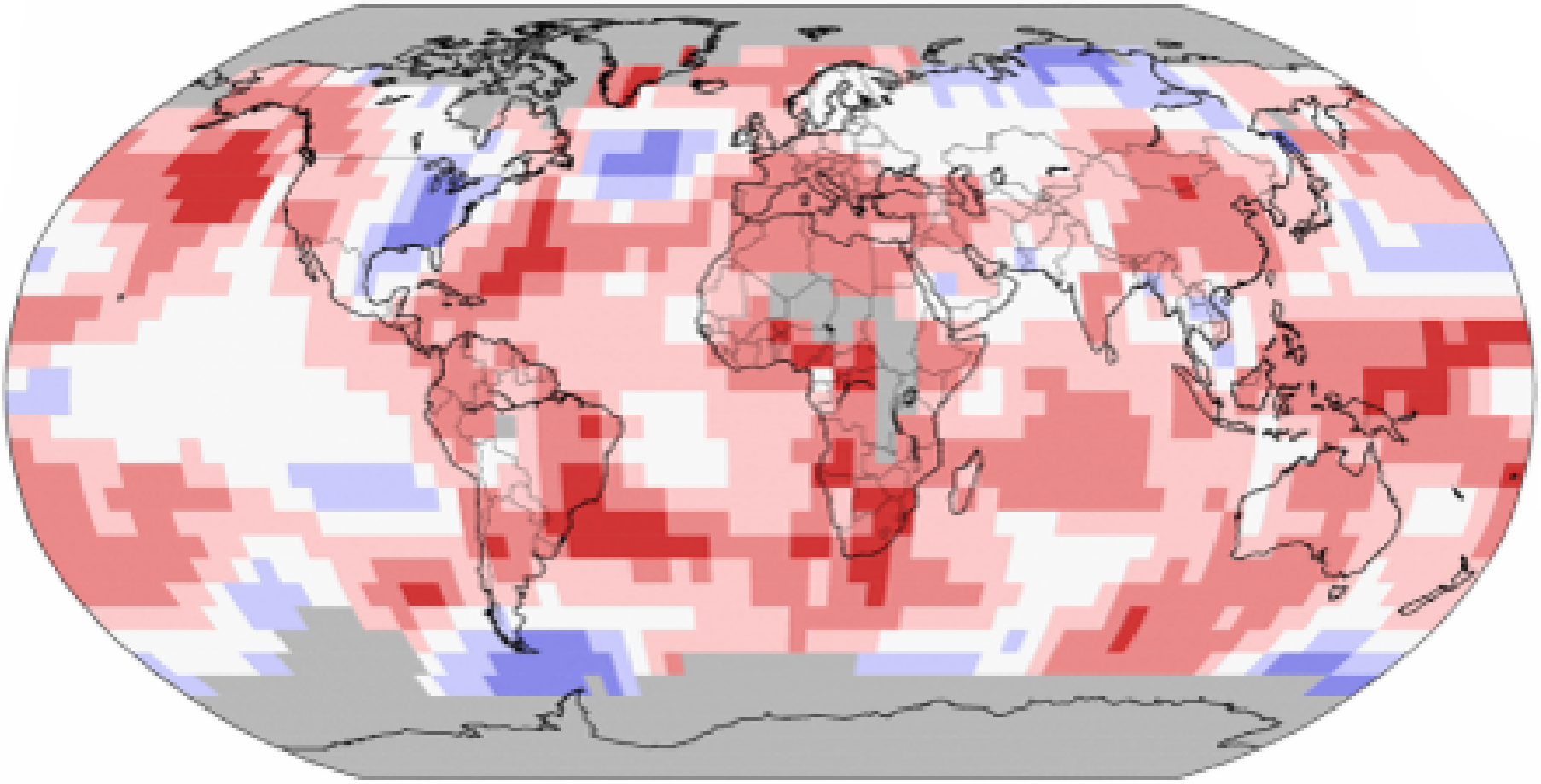
Land & Ocean Temperature Percentiles Jan 2014

NOAA's National Climatic Data Center

Data Source: GHCN–M version 3.2.2 & ERSST version 3b



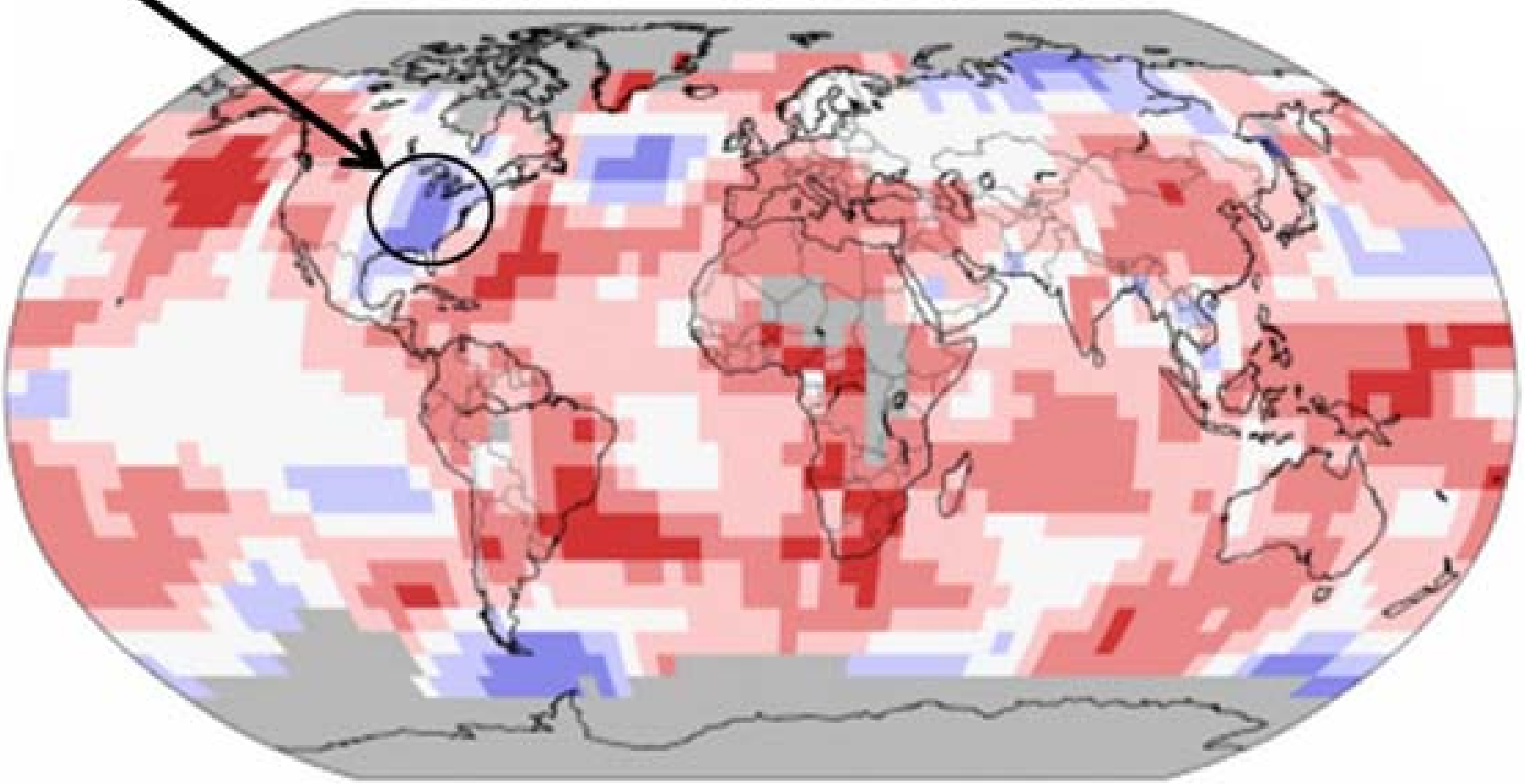
Record Coldest | Much Cooler than Average | Cooler than Average | Near Average | Warmer than Average | Much Warmer than Average | Record Warmest

Wed Feb 12 07:43:39 EST 201

Land & Ocean Temperature Percentiles Jan 2014

NOAA's National Climatic Data Center

Data Source: GHCN–M version 3.2.2 & ERSST version 3b

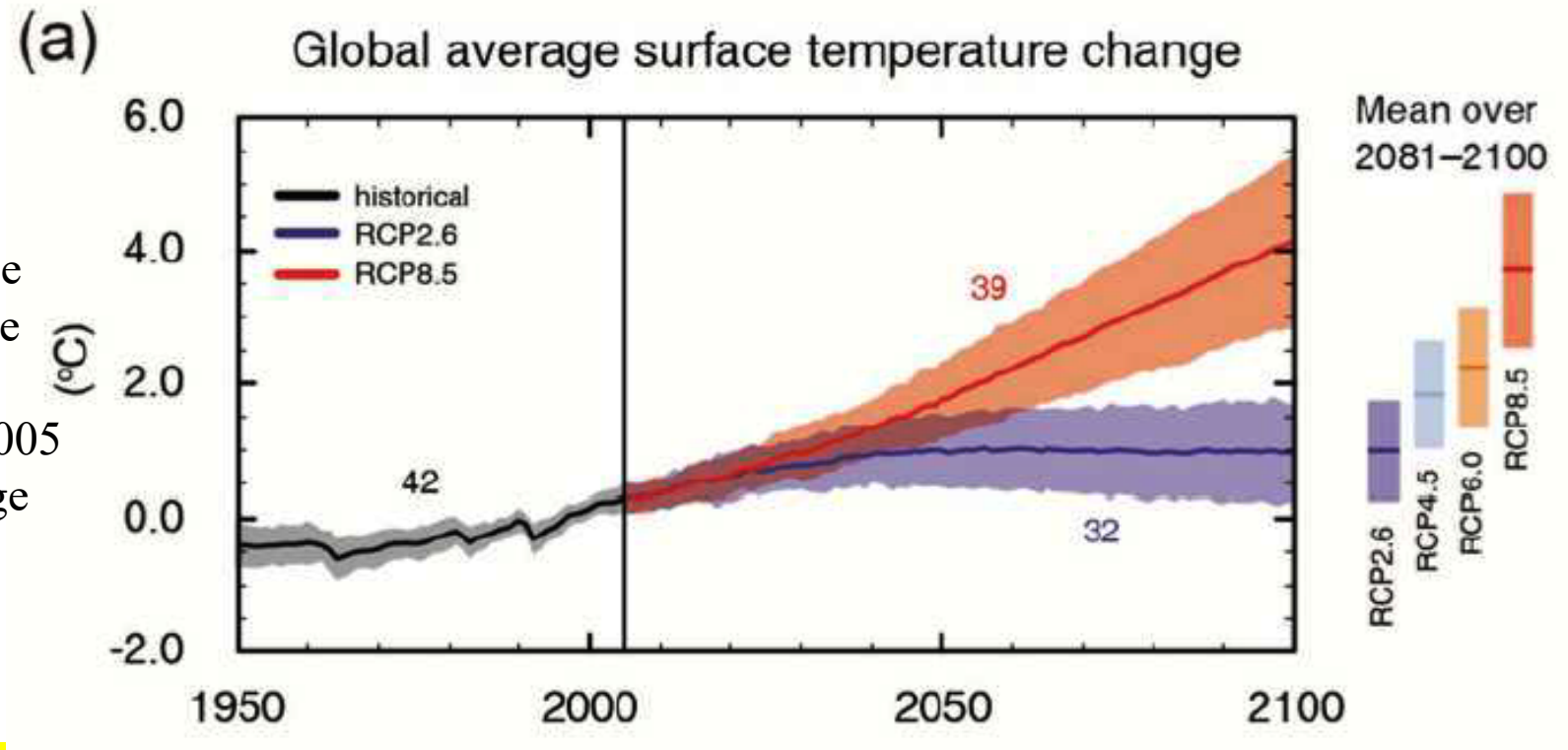


Record Coldest | Much Cooler than Average | Cooler than Average | Near Average | Warmer than Average | Much Warmer than Average | Record Warmest

Wed Feb 12 07:43:39 EST 201

Projected Global Average Temperature Change by end of 21st Century

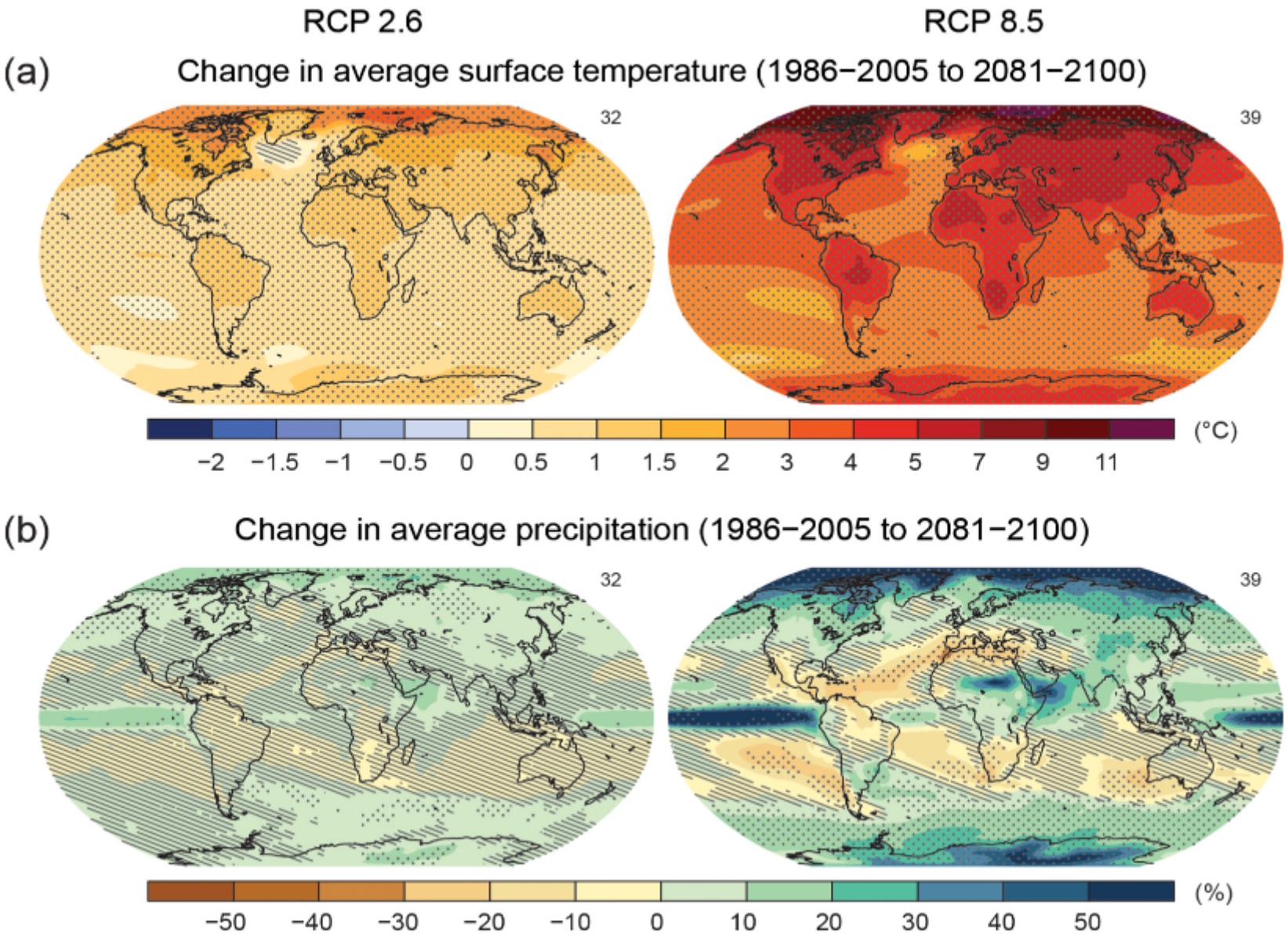
Change relative to 1986–2005 average



The temperature increase during the last 100 years: about **0.8°C**.

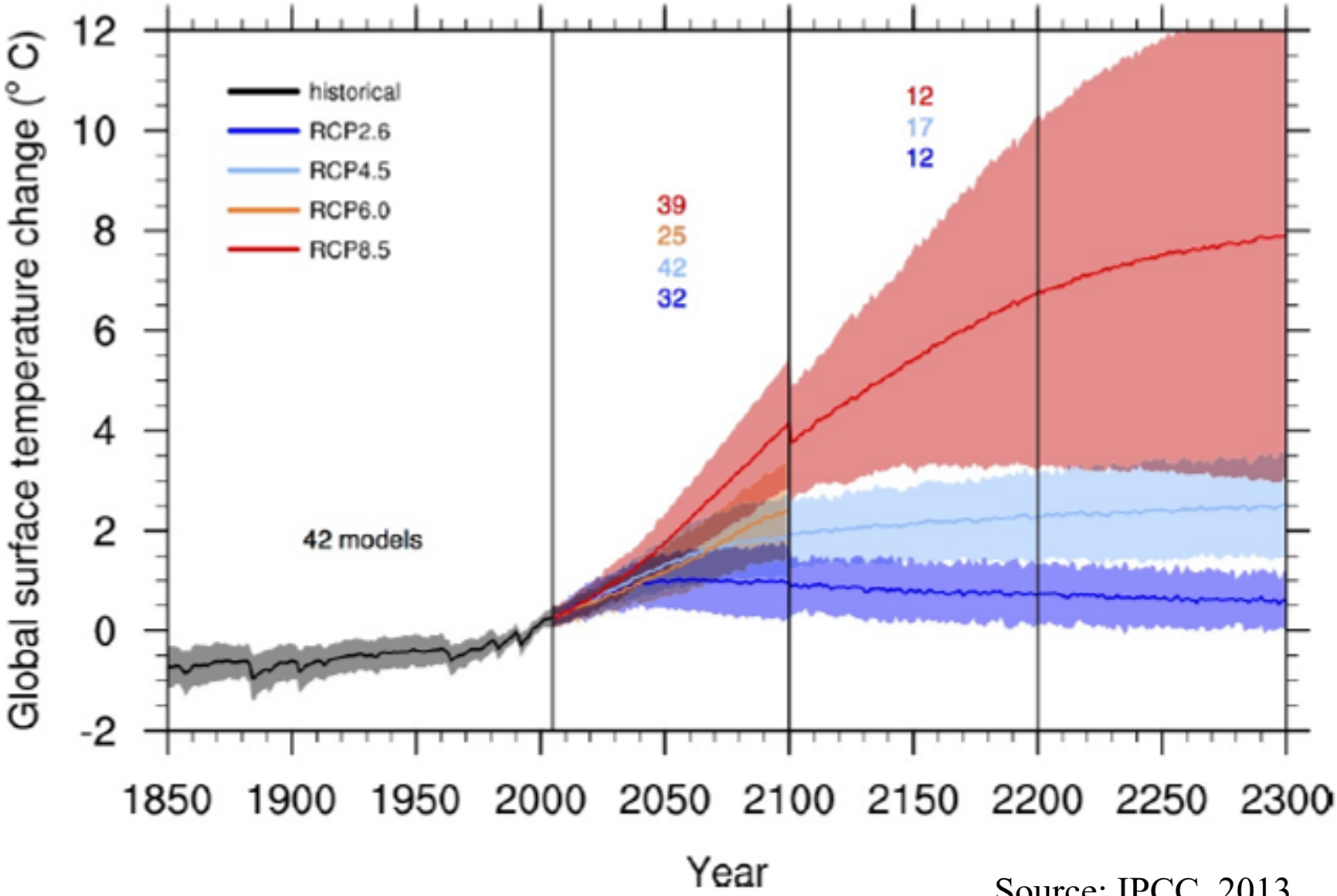
Global surface temperature change for the end of the 21st century is *likely to exceed* 1.5°C relative to 1850–1900 for all scenarios except RCP2.6.

Maps of CMIP5 multi-model mean results

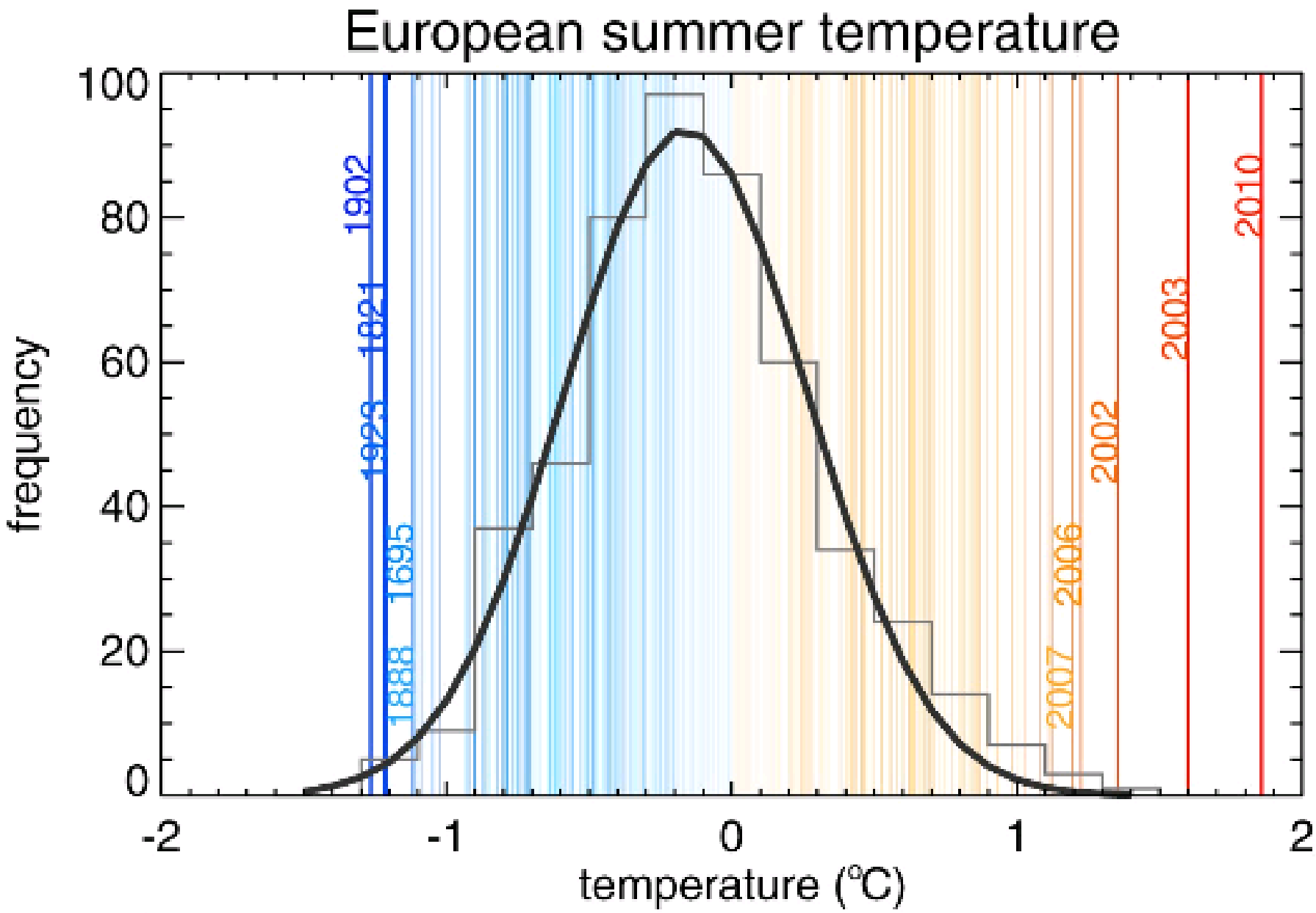


Source: IPCC AR5-WG1, Figure SPM.8a,b

Increase of global temperatures (compared to the average from 1986 to 2005) in CMIP5 models



Source: IPCC, 2013


European summer temperature
frequency
temperature (°C)
100
80
60
40
20
0
-2
-1
0
1
2
1902
1921
1923
1695
1888
2007
2006
2002
2003
2010

nature climate change

PERSPECTIVE

PUBLISHED ONLINE: 25 MARCH 2012 | DOI: 10.1038/NCLIMATE1452

A decade of weather extremes

Dim Coumou and Stefan Rahmstorf*

The ostensibly large number of recent extreme weather events has triggered intensive discussions, both in- and outside the scientific community, on whether they are related to global warming. Here, we review the evidence and argue that for some types of extreme — notably heatwaves, but also precipitation extremes — there is now strong evidence linking specific events or an increase in their numbers to the human influence on climate. For other types of extreme, such as storms, the available evidence is less conclusive, but based on observed trends and basic physical concepts it is nevertheless plausible to expect an increase.

For the United States, 2011 was a year of extreme weather, with 14 events that caused losses in excess of US$1 billion each[1]. The US National Oceanic and Atmospheric Administration spoke of "a year seemingly full of weather extremes" after July had set new monthly heat records for Texas, Oklahoma and Delaware[2]. The period from January to October was the wettest on record for several northeastern states, with wet soils contributing to the severe flooding when Hurricane Irene hit the region in August. During spring, the southern United States had been hit by the worst recorded tornado outbreak in history: April saw 753 tornadoes, beating the previous monthly record of 542 (from May 2003) by a large margin[3]. Other regions in the world were affected by extreme weather in 2011 as well: rainfall records were set in Australia, Japan and Korea, whereas the Yangtze Basin in China experienced record drought[1]. In western Europe, spring was exceptionally hot and dry, setting records in several countries (Table 1)[1].

But 2011 was not unique: the past decade as a whole has seen an exceptional number of unprecedented extreme weather events, some causing major human suffering and economic damage[4] (Table 1 and Fig. 1). In August 2010, the World Meteorological

Simple physical considerations

For some types of extreme, there are simple physical reasons why they would increase in a warming climate. If the average temperature rises, then obviously so will the number of heat records, all else remaining equal. Cold extremes will decrease, but if the probability distribution for temperature is shifted unchanged towards warmer conditions, the total number of extremes (hot plus cold) will increase[9]. That is fundamentally because what is considered extreme is always based on past experience, and a change in climate moves us out of the familiar range.

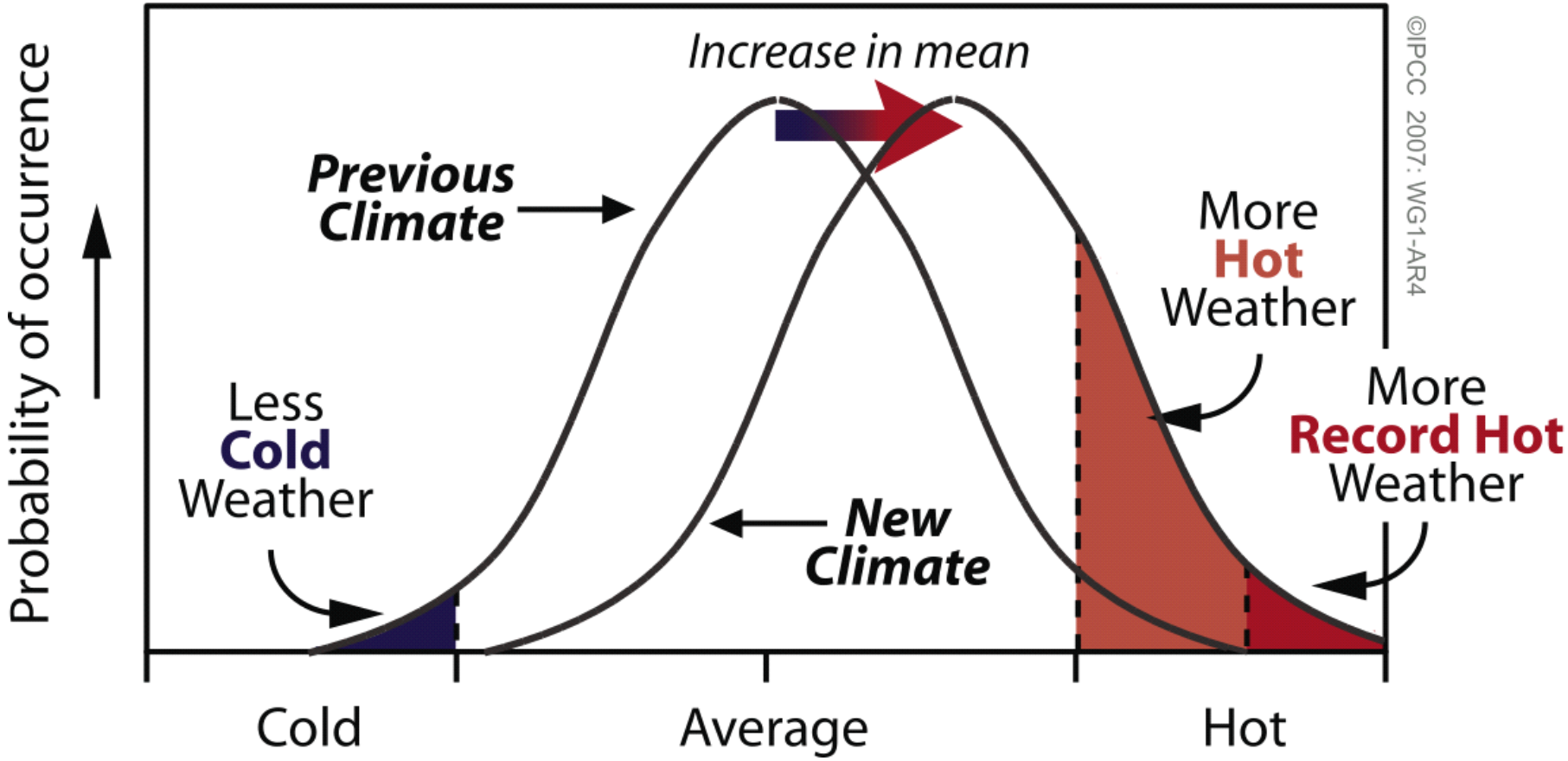
Warming will lead to more evaporation, too, and thus surface drying, increasing the intensity and duration of drought[10]. Warmer air can also be expected to enhance precipitation extremes as it can hold more moisture. According to the Clausius–Clapeyron equation, for each 1 °C of warming, saturated air contains 7% more water vapour, which may rain out if conditions are right. Increased atmospheric moisture content also provides more latent energy to drive storms. Furthermore, the potential intensity of tropical storms increases with warmer sea surface temperatures, all else remaining equal.

Table 1 | List of record-breaking meteorological events in the past decade and their impacts.

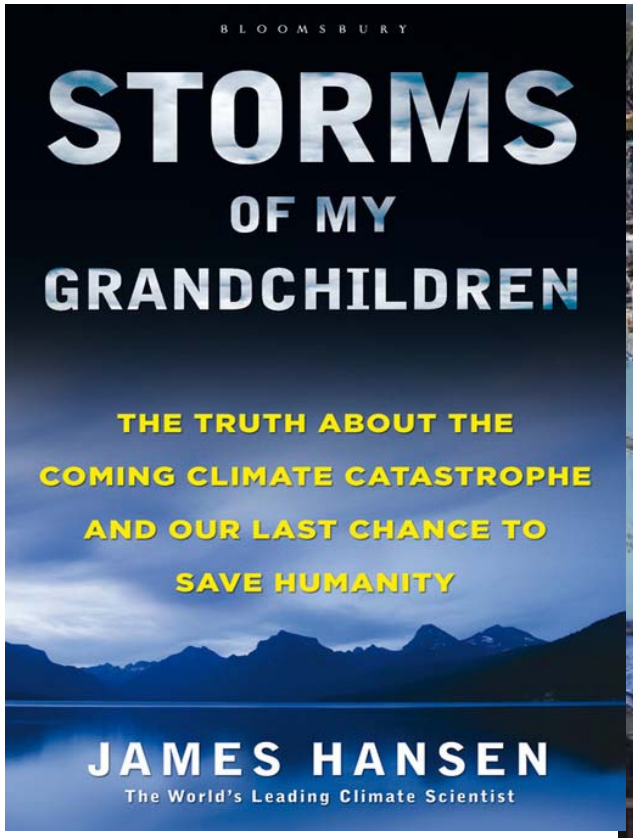
Year	Region	Meteorological record-breaking event	Impact, costs
2000	England and Wales	Wettest autumn on record[83] since 1766.	£1.3 billion (ref. 27).
2002	Central Europe	Highest daily rainfall record in Germany[42] since at least 1901.	Flooding of Prague and Dresden, US$15 billion (ref. 84).
2003	Europe	Hottest summer in at least 500 years[30].	Death toll exceeding 70,000 (ref. 31).
2004	South Atlantic	First hurricane in the South Atlantic[51] since 1970.	Three deaths, US$425 million damage[85].
2005	North Atlantic	Record number of tropical storms, hurricanes and category 5 hurricanes[52] since 1970.	Costliest US natural disaster, 1,836 deaths (Hurricane Katrina).
2007	Arabian Sea	Strongest tropical cyclone in the Arabian Sea[53] since 1970.	Biggest natural disaster in the history of Oman[53].
	England and Wales	May–July wettest since records began in 1766 (ref. 43).	Major flooding causing ~£3 billion damage.
	Southern Europe	Hottest summer on record in Greece[33] since 1891.	Devastating wildfires.
2009	Victoria (Australia)	Heatwave breaking many station temperature records (32–154 years of data)[34]	Worst bushfires on record, 173 deaths, 3,500 houses destroyed[34].
2010	Western Russia	Hottest summer since 1500 (ref. 69).	500 wildfires around Moscow, grain-harvest losses of 30%.
	Pakistan	Rainfall records[44].	Worst flooding in Pakistan's history, nearly 3,000 deaths, affected 20 million people[6].
	Eastern Australia	Highest December rainfall recorded since 1900 (ref. 45).	Brisbane flooding in January 2011, costing 23 lives and an estimated US$2.55 billion[86].
2011	Southern United States	Most active tornado month on record (April)[3] since 1950.	Tornado hit Joplin causing 116 deaths.
	Northeastern United States	January–October wettest on record[1] since 1880.	Severe floods when Hurricane Irene hit.
	Texas, Oklahoma (United States)	Most extreme July heat and drought since 1880[2].	Wildfires burning 3 million acres (preliminary impact of US$6–8 billion).
	Western Europe	Hottest and driest spring on record in France[1] since 1880.	French grain harvest down by 12%.
	Western Europe	Wettest summer on record (The Netherlands, Norway)[1] since 1901.	Not yet documented.
	Japan	72-hour rainfall record (Nara Prefecture)[1].	73 deaths, 20 missing, severe damage.
	Republic of Korea	Wettest summer on record[1] since 1908.	Flooding of Seoul, 49 deaths, 77 missing, 125,000 affected.

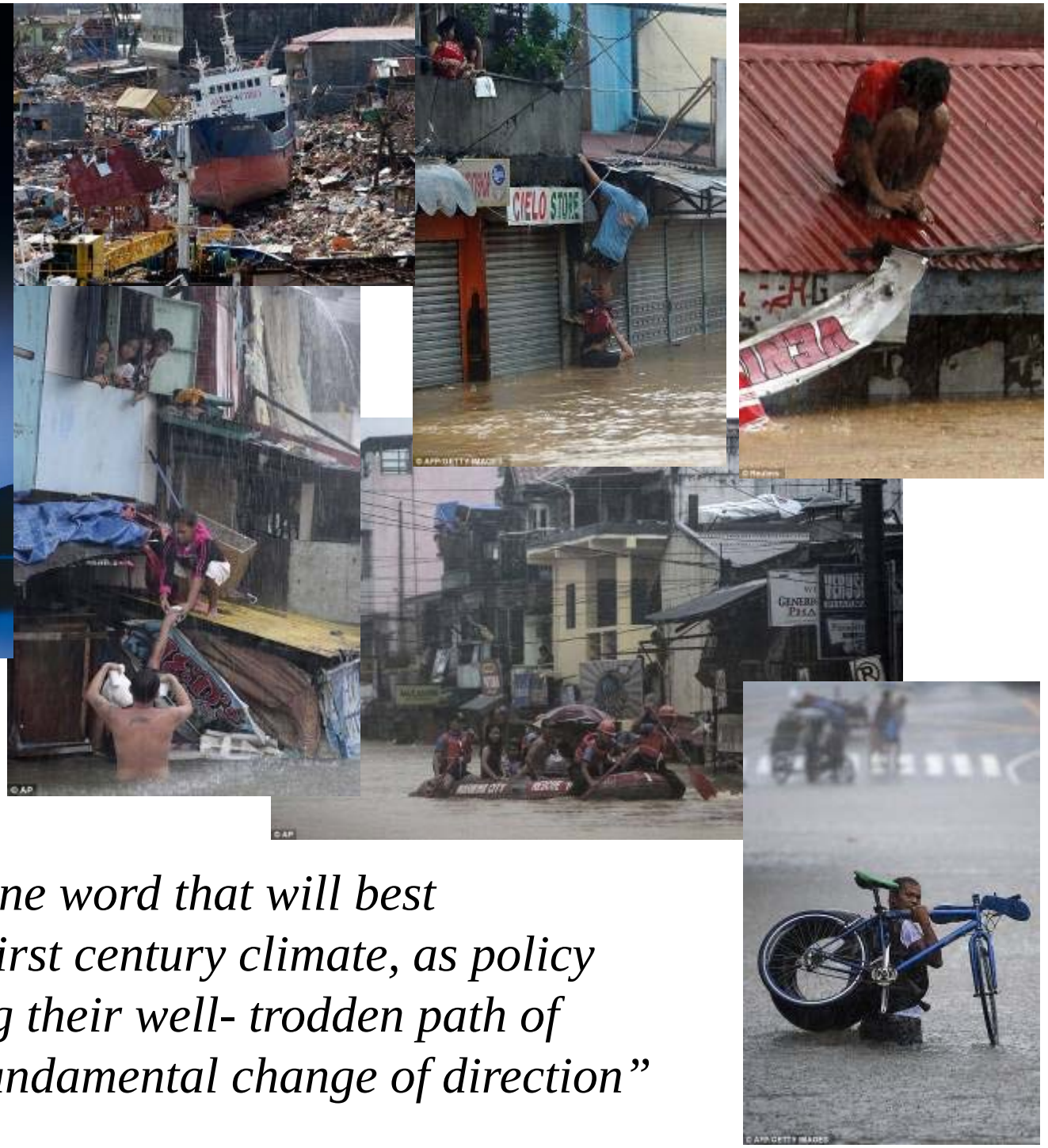
The selection criterion for this (incomplete) list was that the event was documented to be record-breaking (that is, unprecedented) in a long measurement series.

Fonte: Coumou e Rahmstorf (2012) A decade of weather extremes. Nature Climate Change



The change of the mean implies a higher probability of occurrence of extreme values.





"Storms. That is the one word that will best characterize twenty- first century climate, as policy makers continue along their well- trodden path of much talk without a fundamental change of direction"

- Over 400,000 Brazilians homeless from flooding in 2009
- More than 40 dead

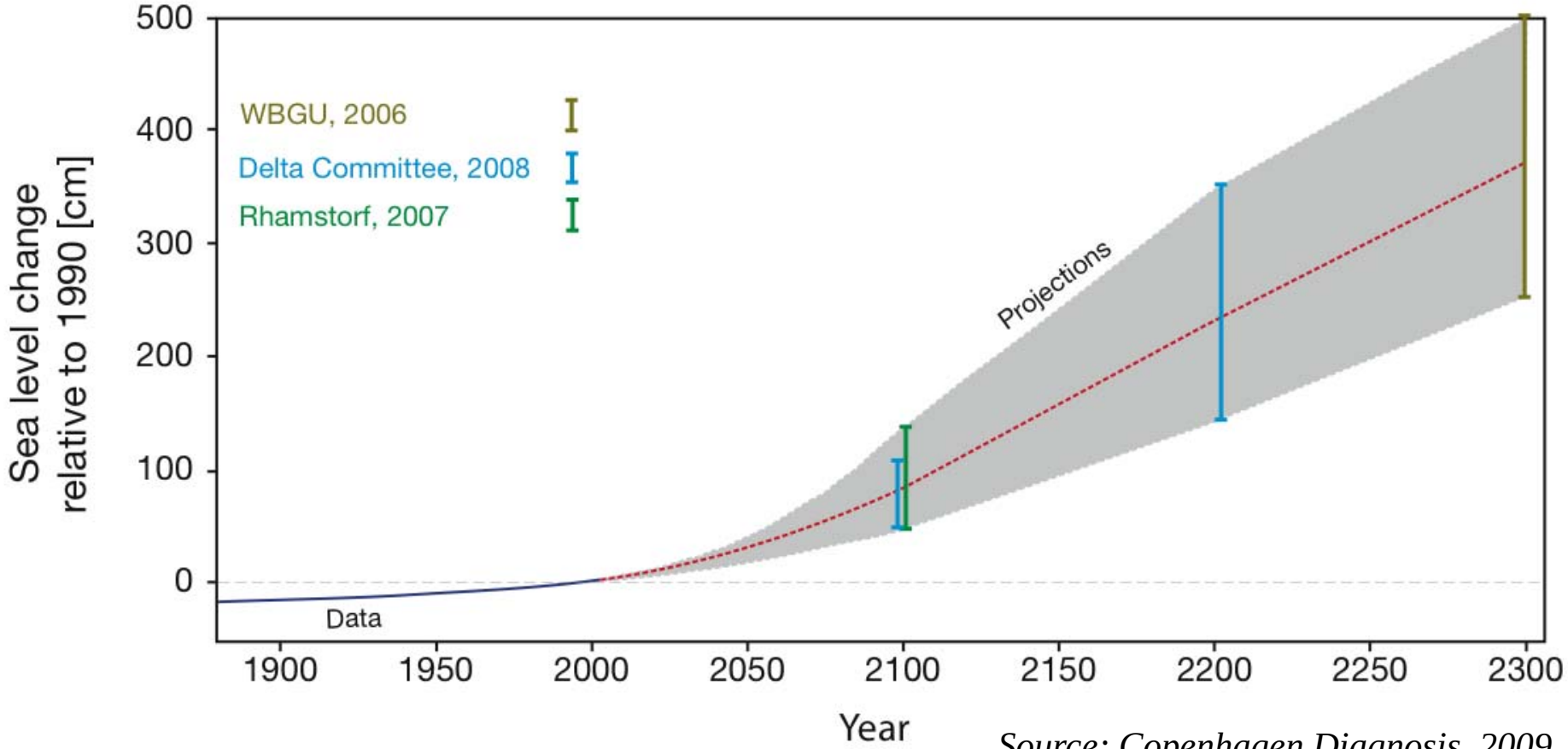
Piaui, Brazil- May 10, 2009


福来火锅
Guilin, China
July 3, 2009
© 2009 AP Photo/Imaginechina


Cainta, Philippines
September 27, 2009
NO U-TURN ALONG ORTIGAS AVENUE
LOADING AND UNLOADING ZONE
Drive Thru
FACE OFF
© 2009 EPA/Francis R. Malasig/Landov


Alipur, Pakistan
August 10, 2010
© 2010 AP Photo/Shakil Adil

SEA LEVEL PROJECTIONS

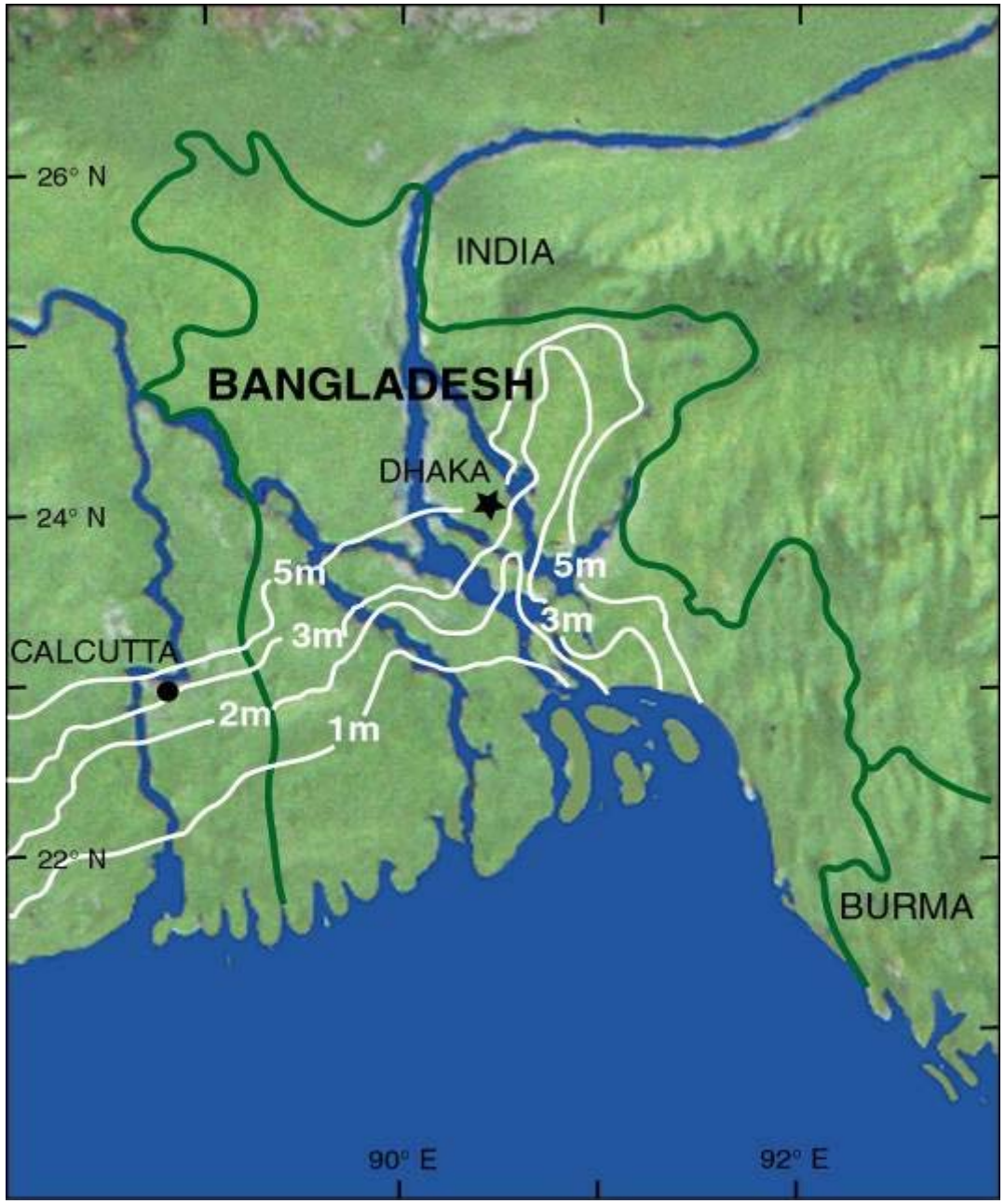


Source: Copenhagen Diagnosis, 2009

Anthropogenic carbon emissions lock in long-term sea-level rise that greatly exceeds projections for this century, posing profound challenges for coastal development and cultural legacies.

Source: Strauss et al., 2015 Carbon choices determine US cities committed to futures below sea level, PNAS

Sea-level transgression scenarios for Bangladesh



Fonte: AR3. Adapted from Milliman *et al.* (1989).

The double challenge:

CHALLENGE 1: MITIGATION

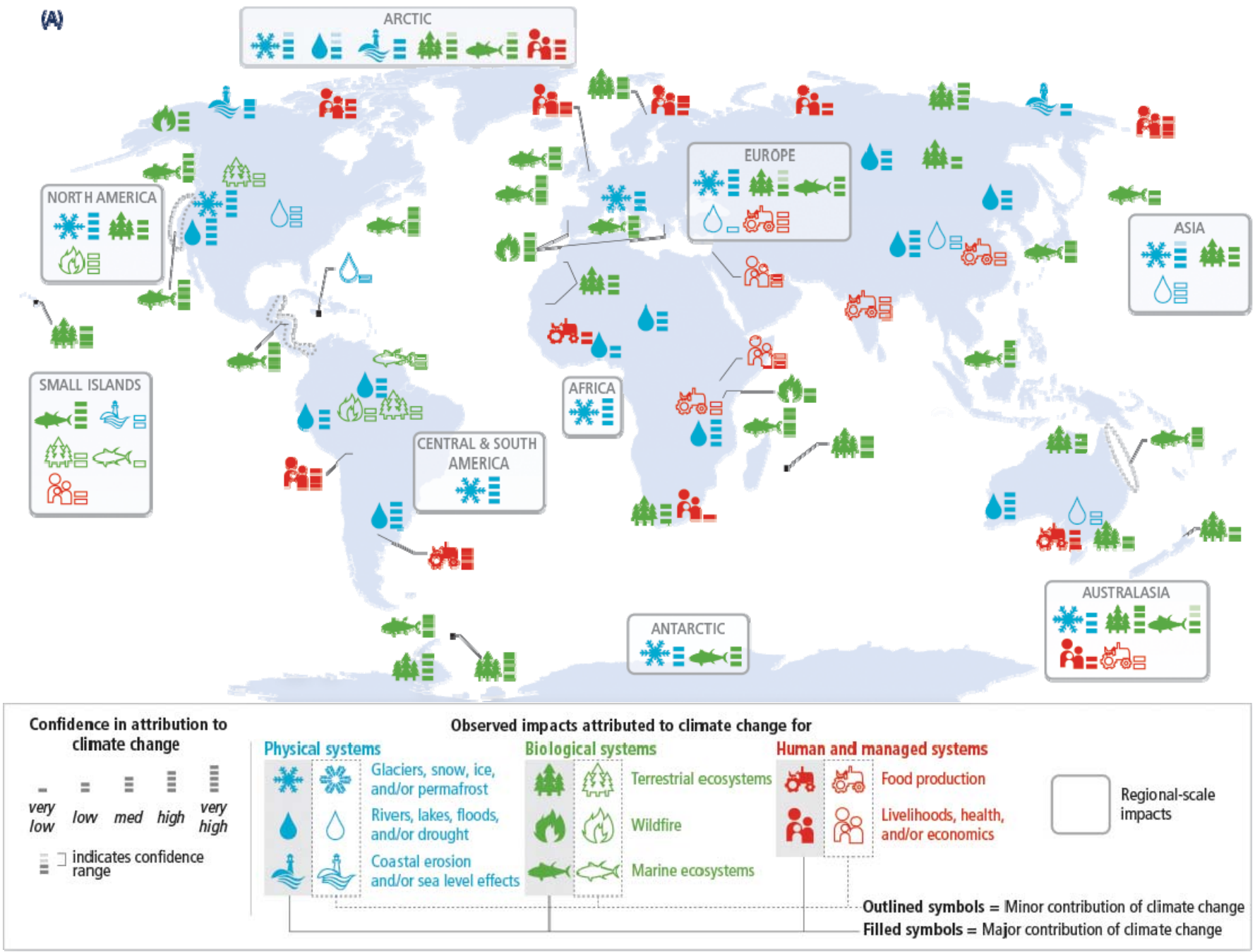
In order to stabilize GHGs concentrations in the atmosphere, **emissions would need to peak and decline thereafter.**
Mitigation efforts over the **next decade** will have a large impact on opportunities to achieve lower stabilization levels.

CHALLENGE 2: ADAPTATION

Even if policies and efforts to reduce emissions prove effective, **some climate change is inevitable**; therefore, **strategies and actions to adapt** to its impacts are also **needed.**

The size of the challenge

- Climate change is one of the biggest challenges facing the world
- Action is needed to stabilise rising temperatures to avoid irreversible and catastrophic changes
- Global measures are needed – we have a small window of opportunity
- Action now is less costly than acting later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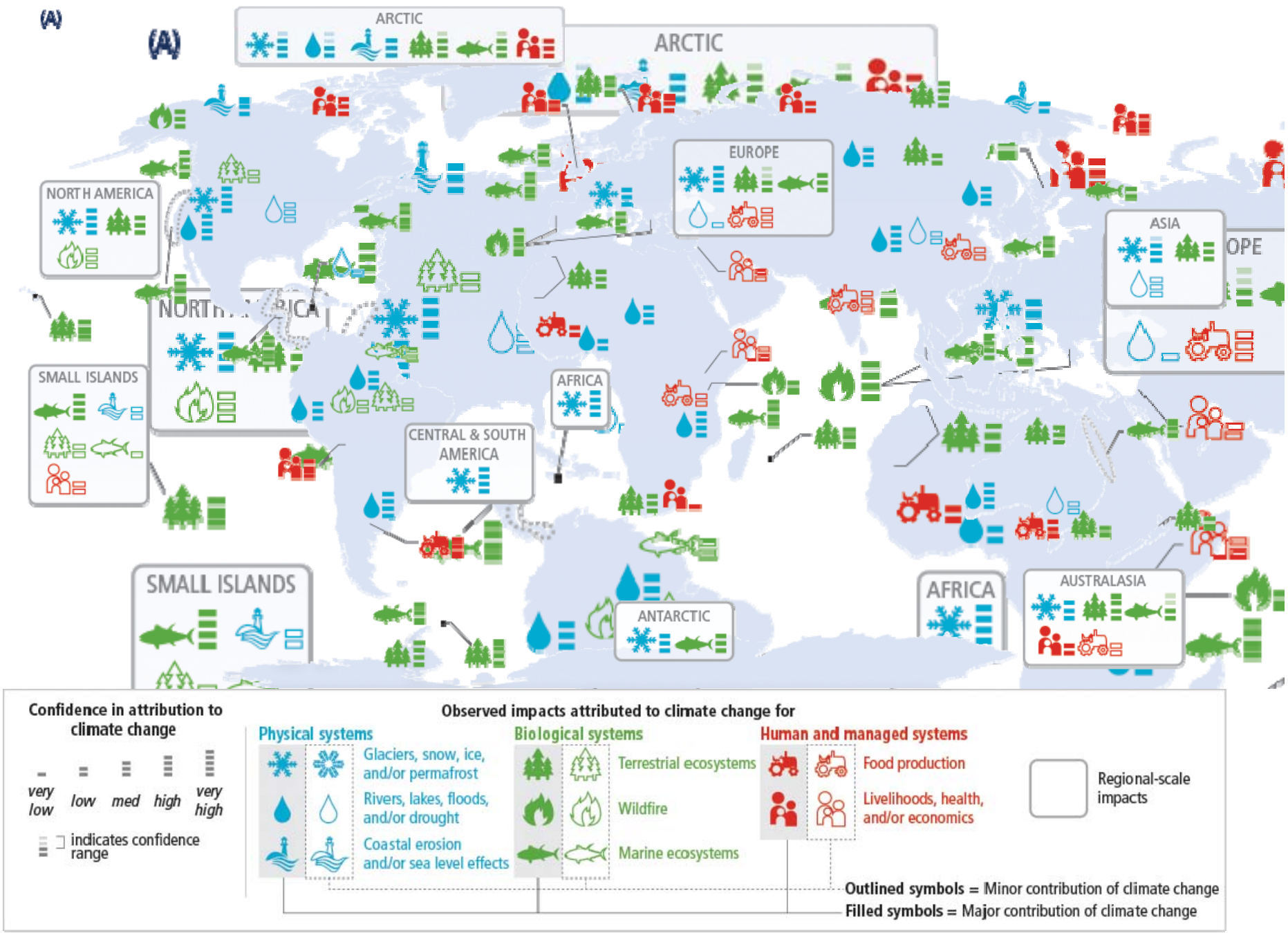
Confidence in attribution to climate change
very low
low
med
high
very high
indicates confidence range
Observed impacts attributed to climate change for
Physical systems
Glaciers, snow, ice, and/or permafrost
Rivers, lakes, floods, and/or drought
Coastal erosion and/or sea level effects
Biological systems
Terrestrial ecosystems
Wildfire
Marine ecosystems
Human and managed systems
Food production
Livelihoods, health, and/or economics
Regional-scale impacts
Outlined symbols = Minor contribution of climate change
Filled symbols = Major contribution of climate change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Confidence in attribution to climate change
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Wildfire
Marine ecosystems
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Livelihoods, health, and/or economics
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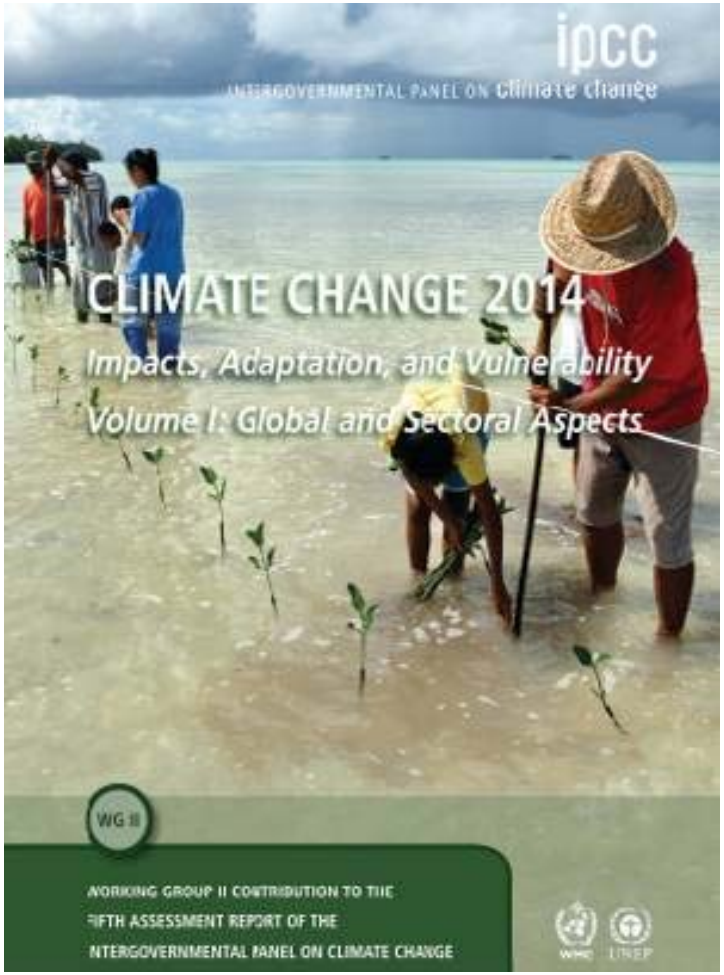
Outlined symbols = Minor contribution of climate change
Filled symbols = Major contribution of climate change



IPCC WGII AR5
Chapter 7. Food Security and Food Production Systems

PNAS

Global food security under climate change

Josef Schmidhuber*† and Francesco N. Tubiello*§

*Global Perspective Studies Unit, Food and Agriculture Organization, 00100 Rome, Italy; †Center for Climate Systems Researc
New York, NY 10025; and §Land Use Change Program, International Institute for Applied Systems Analysis, A-2361 Laxenbur

PNAS

Climate change and the adequacy of food and timber in the 21st century

William
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REVIEW

Edited by

University, University Pa

tober 31, 2007)

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mand are likely to shif

Climate Change Impacts on Global Food Security

Tim Wheeler[1,2*] and Joachim von Braun[3]

Climate change could potentially interrupt progress toward a world witho
coherent global pattern is discernible of the impacts of climate change o
have consequences for food availability. The stability of whole food syste

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ENVIRONMENTAL RESEA
Environ. Res. Lett. 7 (2012) 034032 (8pp)
doi:10.1088/1748-9326

Climate change impacts on crop productivity in Africa and South Asia

Jerry Knox[1], Tim Hess[1], Andre Daccache[1] and Tim Wheeler[2]

[1] Cranfield University, Cranfield, Bedfordshire MK43 0AL, UK
[2] Walker Institute for Climate System Research, Department of Agriculture, University of Reading, Reading RG6 6AR, UK

Climate Change and Food Systems

Sonja J. Vermeulen,[1,2] Bruce M. Campbell,[2,3] and John S.I. Ingram[4,5]

JOURNAL OF Urban Economics
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Climatic change and rural–urban migration: The case of sub-Saharan Africa

Political Geography
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Climate change-induced migration and violent conflict

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Climate change, human security and violent conflict

PNAS

Linkages among climate change, crop yields and Mexico–US cross-border migration

PNAS

Climate change in the Fertile Crescent and implications of the recent Syrian drought

Climate change is a ethical and political problem

1 Week's Food for a Family in USA: $ 342

1 Week's Food for a Family in Chad: $ 1.37

- Climate change has the structure of the world's largest collective problems.
- The twin challenges of climate change and poverty need to be tackled together and cannot be prioritized over each other.
  If we fail on one, we fail on the other