Climate Change and peace:
The 5th IPCC assessment report (AR5)

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Thanks to the Walloon government and to my team at the Université catholique de Louvain for their support

INTERGOVERNMENTAL PANEL ON climate change

WMO UNEP

“Climate Change War” Is Not a Metaphor

The U.S. military is preparing for conflict, retired Navy Rear Adm. David Titley says in an interview

On our current path, climate change could pose an irreversible, **existential risk to civilization as we know it**—but we can still fix it if we decide to work together.

http://www.slate.com/articles/technology/future_tense/2014/04/david_titley_climate_change_war_an_interview_with_the_retired_rear_admiral.html

“Climate Change War” Is Not a Metaphor

Climate change worsens the divide between haves and have-nots, **hitting the poor the hardest**. It can also drive up food prices and spawn megadisasters, creating refugees and taxing the resiliency of governments.

When a threat like that comes along, it’s impossible to ignore. Especially if your job is national security.

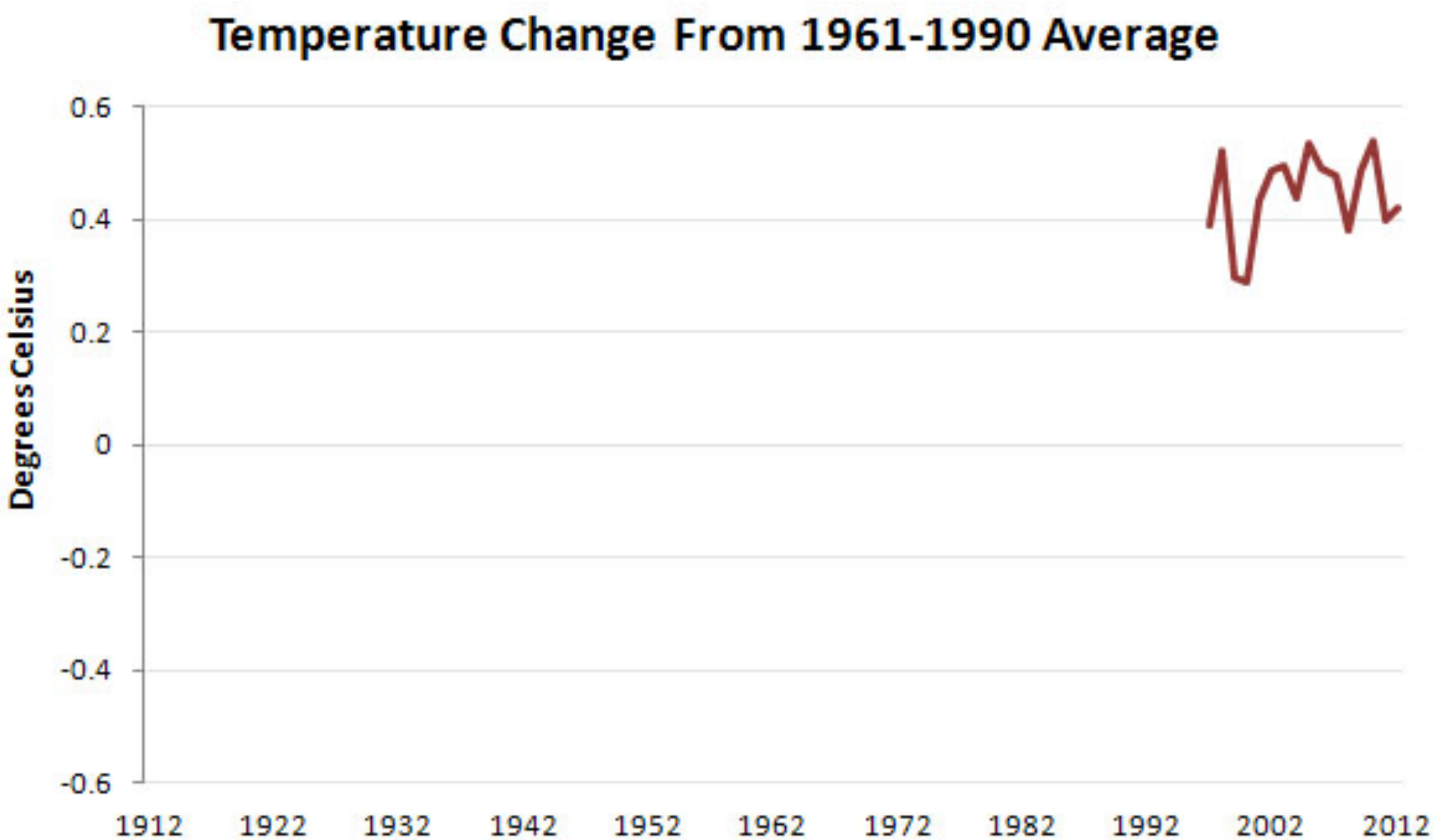
http://www.slate.com/articles/technology/future_tense/2014/04/david_titley_climate_change_war_an_interview_with_the_retired_rear_admiral.html

"Climate Change War" Is Not a Metaphor

Retired Navy Rear Adm. David Titley co-wrote an op-ed for Fox News:

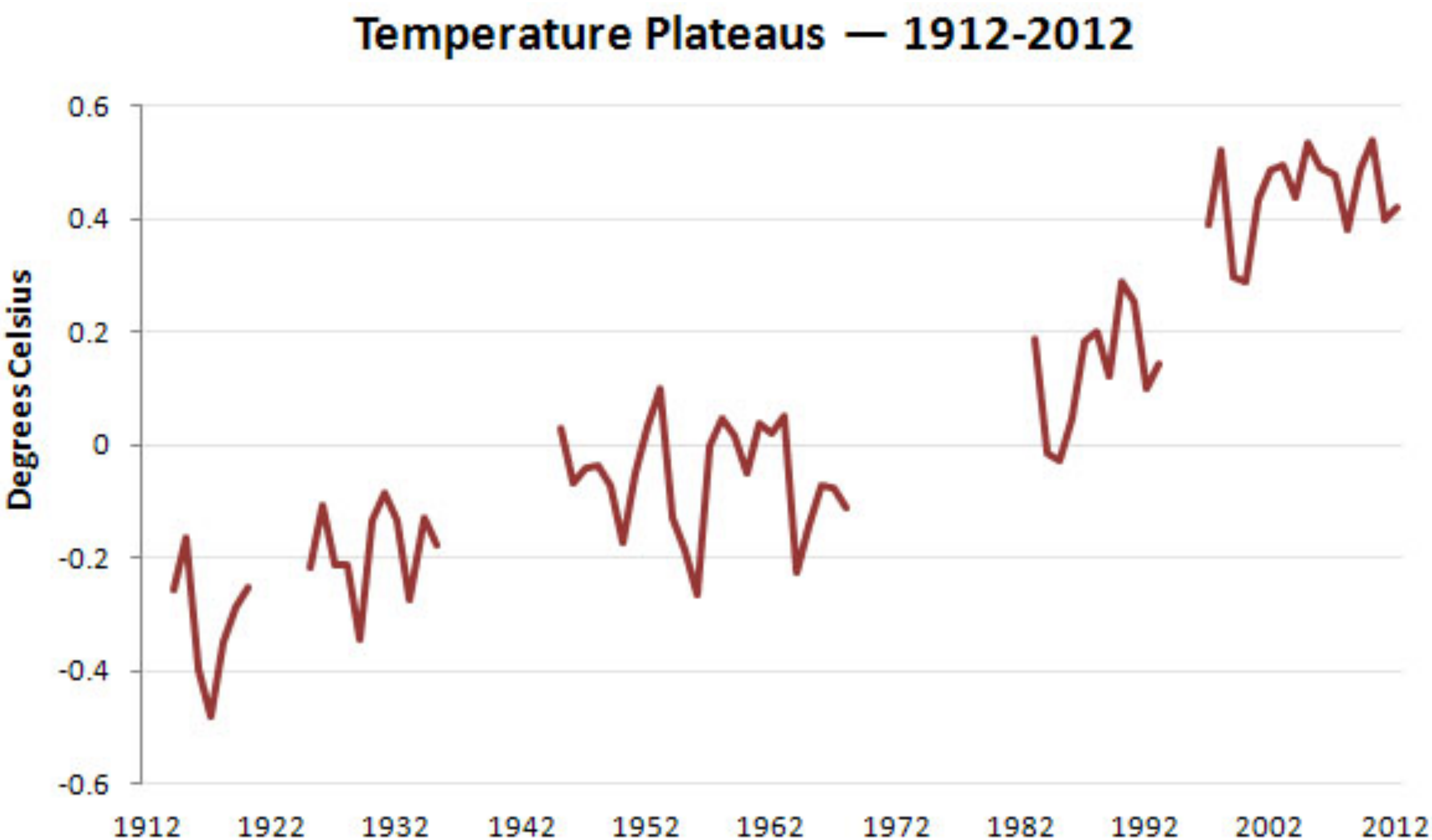
« The parallels between the political decisions regarding climate change we have made and the decisions that led Europe to World War One are striking – and sobering. The decisions made in 1914 reflected political policies pursued for short-term gains and benefits, coupled with institutional hubris, and a failure to imagine and understand the risks or to learn from recent history. »

http://www.slate.com/articles/technology/future_tense/2014/04/david_titley_climate_change_war_an_interview_with_the_retired_rear_admiral.html



http://www.motherjones.com/kevin-drum/2012/10/lying-statistics-global-warming-edition

Lying With Statistics, Global Warming Edition



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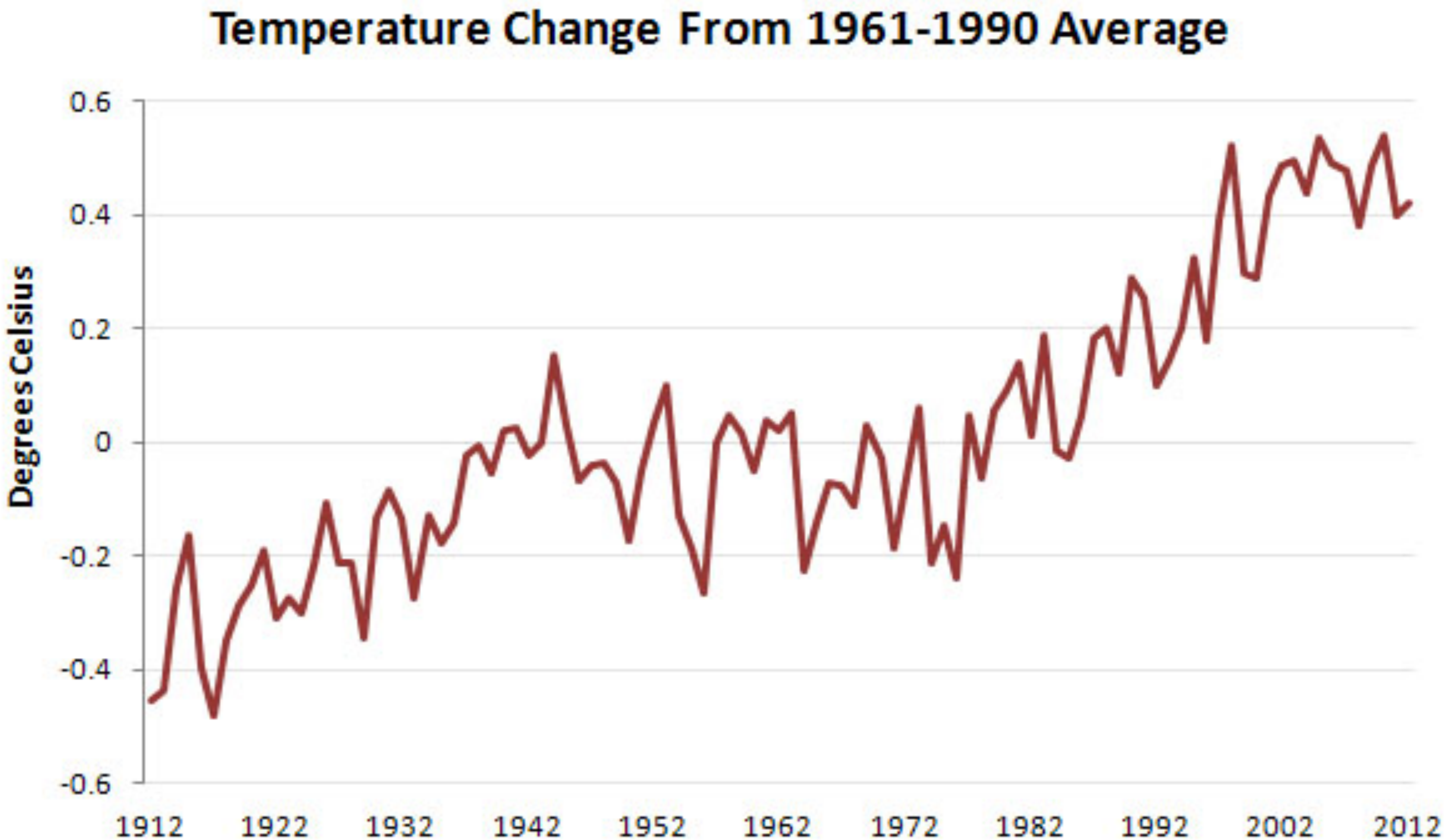
Lying With Statistics, Global Warming Edition



http://www.motherjones.com/kevin-drum/2012/10/lying-statistics-global-warming-edition

Why the IPCC ?

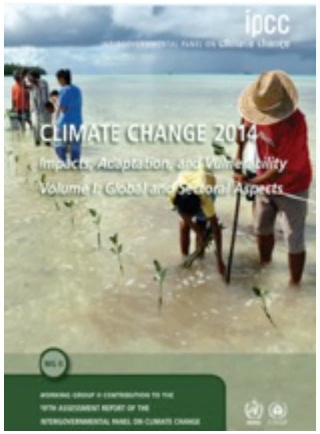
Established by WMO and UNEP in 1988

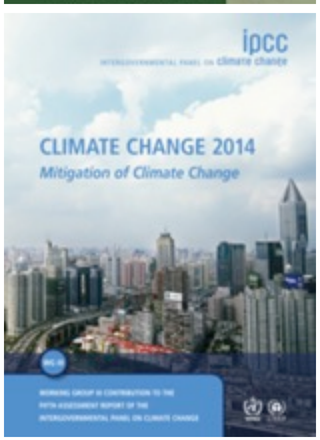
to provide policy-makers with an objective source of information about

- causes of climate change,
- potential environmental and socio-economic impacts,
- possible response options (adaptation & mitigation).

WMO=World Meteorological Organization

UNEP= United Nations Environment Programme





What is happening in the climate system?

What are the risks?

What can be done?

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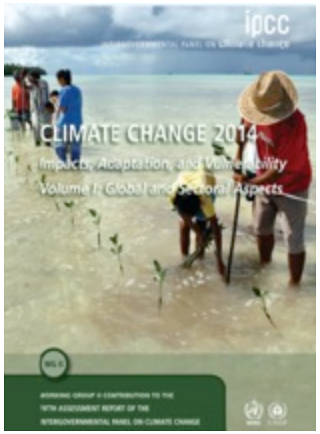
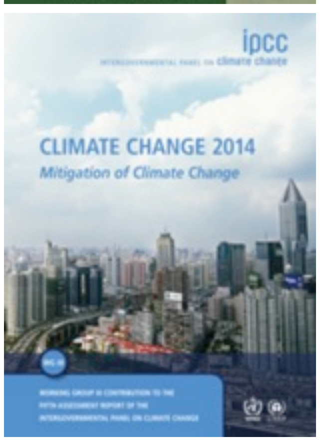
WG I (Physical science basis): 209 lead authors, 2014 pages, 54.677 review comments



WG II (Impacts, Adaptation, and Vulnerability): 243 lead authors, 2500 pages, 50.492 review comments



WG III (Mitigation of Climate Change): 235 coordinating and lead authors, 2000 pages, 38.315 review comments

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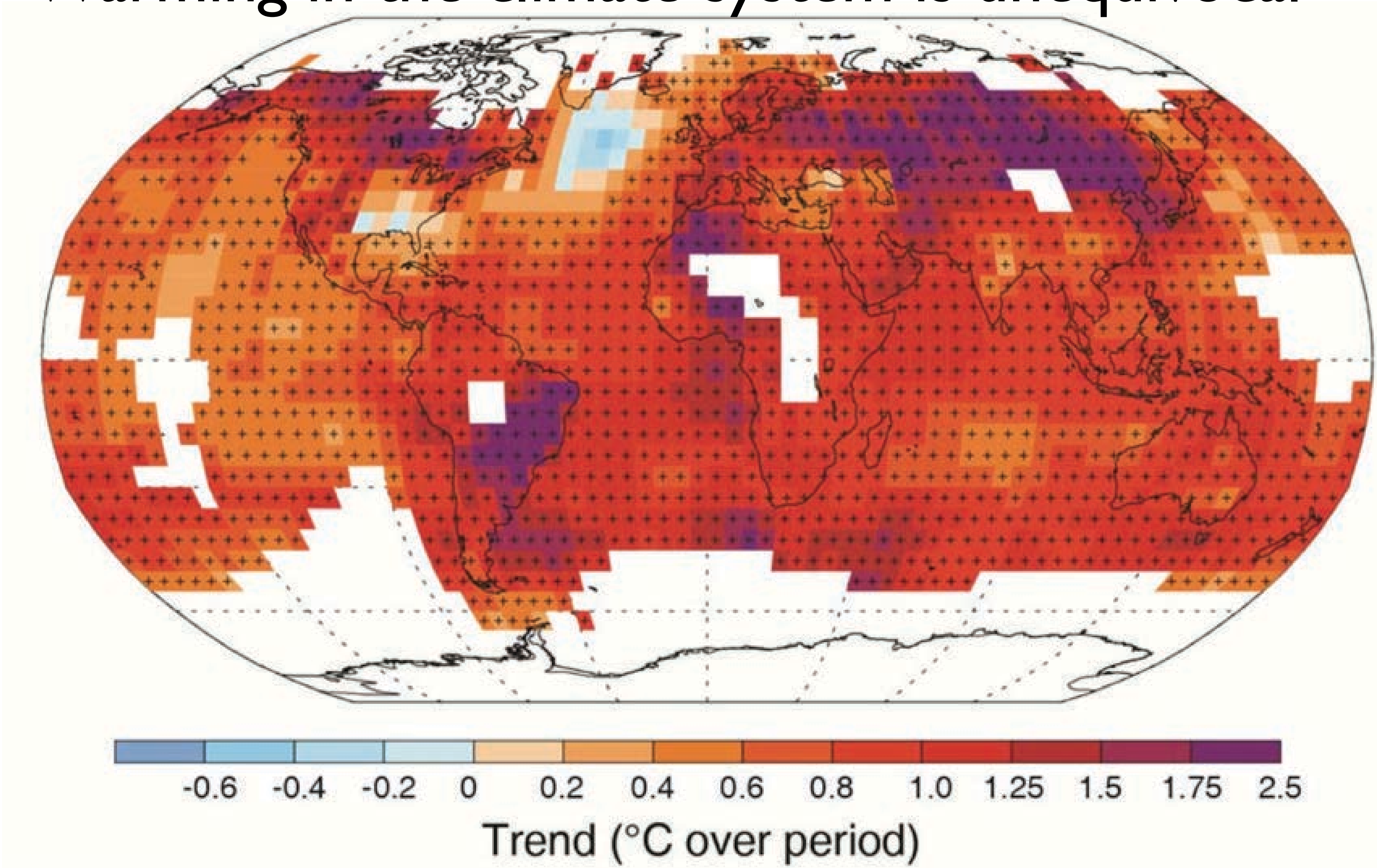
What is happening in the climate system?

Change in average surface temperature 1901-2012

Warming in the climate system is unequivocal



IPCC AR5 WGI Fig. SPM 1b

Plateau Glacier (1961)
(Alaska)

http://www.weather.com/news/science/environment/alaskas-glaciers-capturing-earth-changing-our-eyes-20131125?cm_ven=Email&cm_cat=ENVIRONMENT_us_share

Plateau Glacier (2003)
(Alaska)

http://www.weather.com/news/science/environment/alaskas-glaciers-capturing-earth-changing-our-eyes-20131125?cm_ven=Email&cm_cat=ENVIRONMENT_us_share

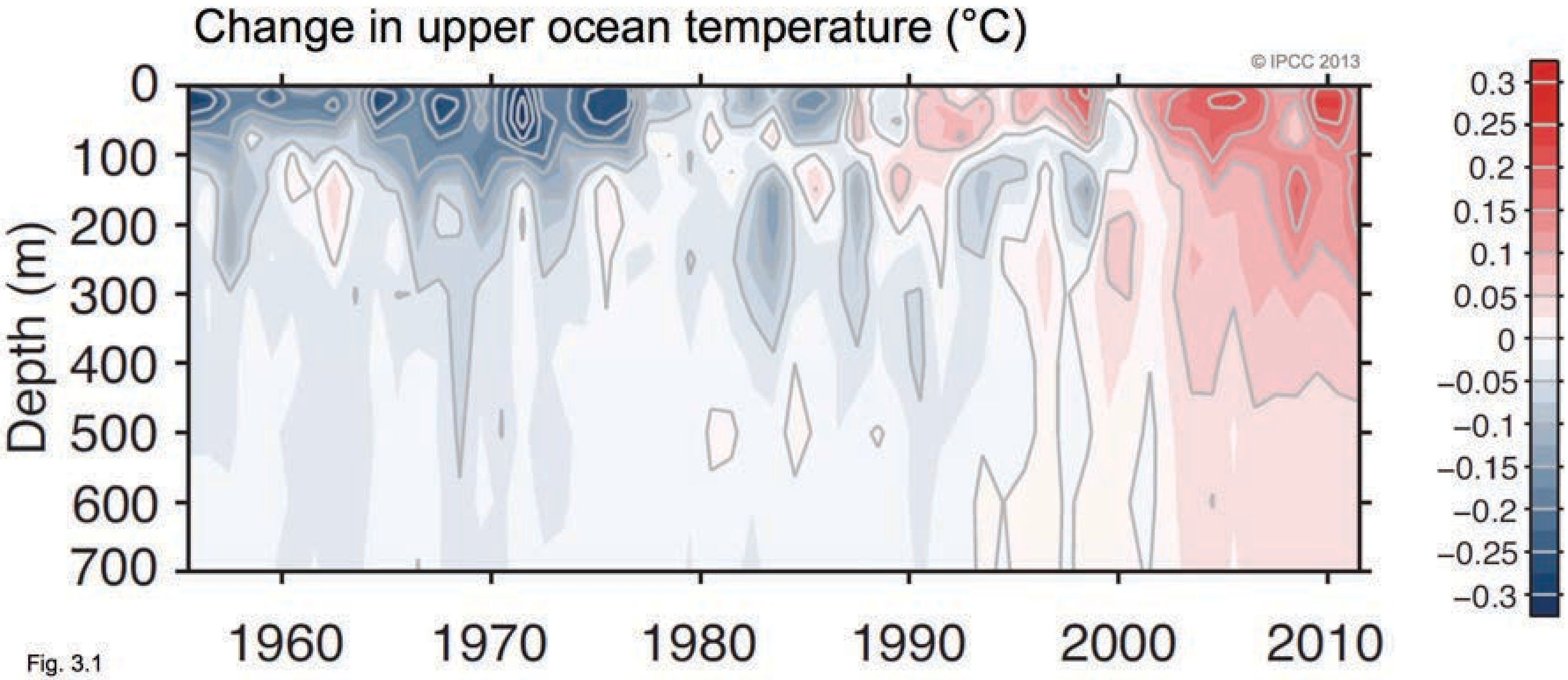


Fig. 3.1

It is *virtually certain* that the upper ocean (0-700 m) warmed from 1971 to 2010, [...]. It is *likely* that the ocean warmed between 700 and 2000 m from 1957 to 2009.

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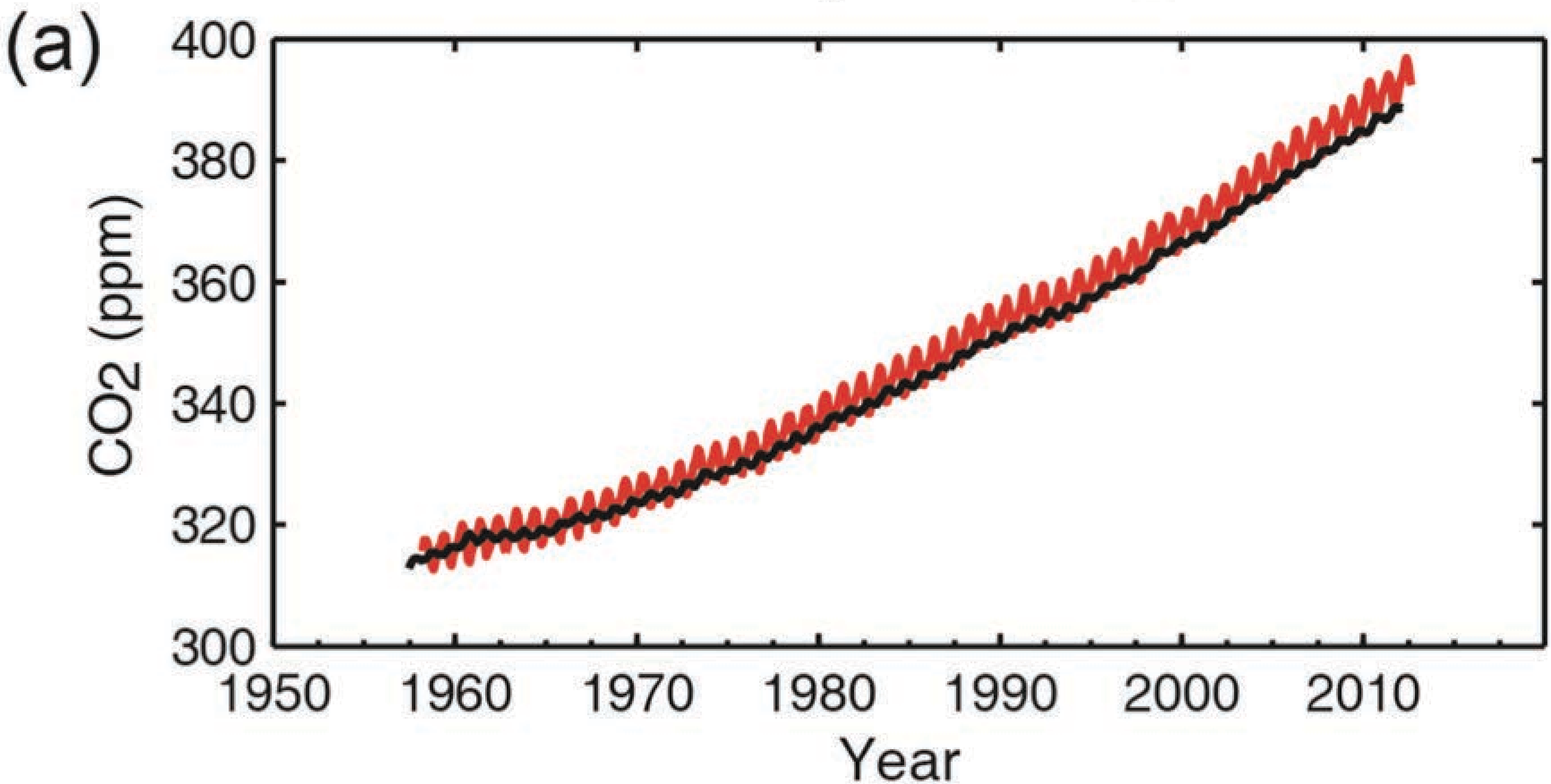
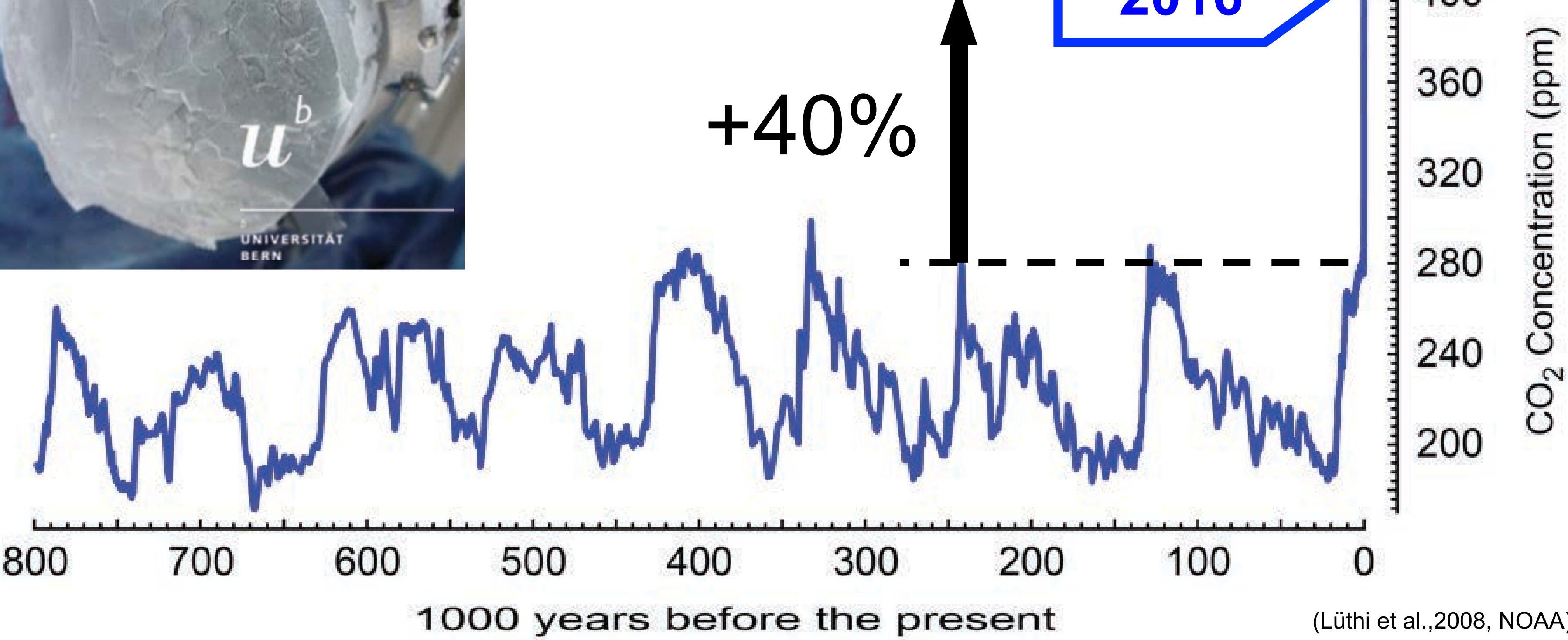
Atmospheric CO_2 concentration



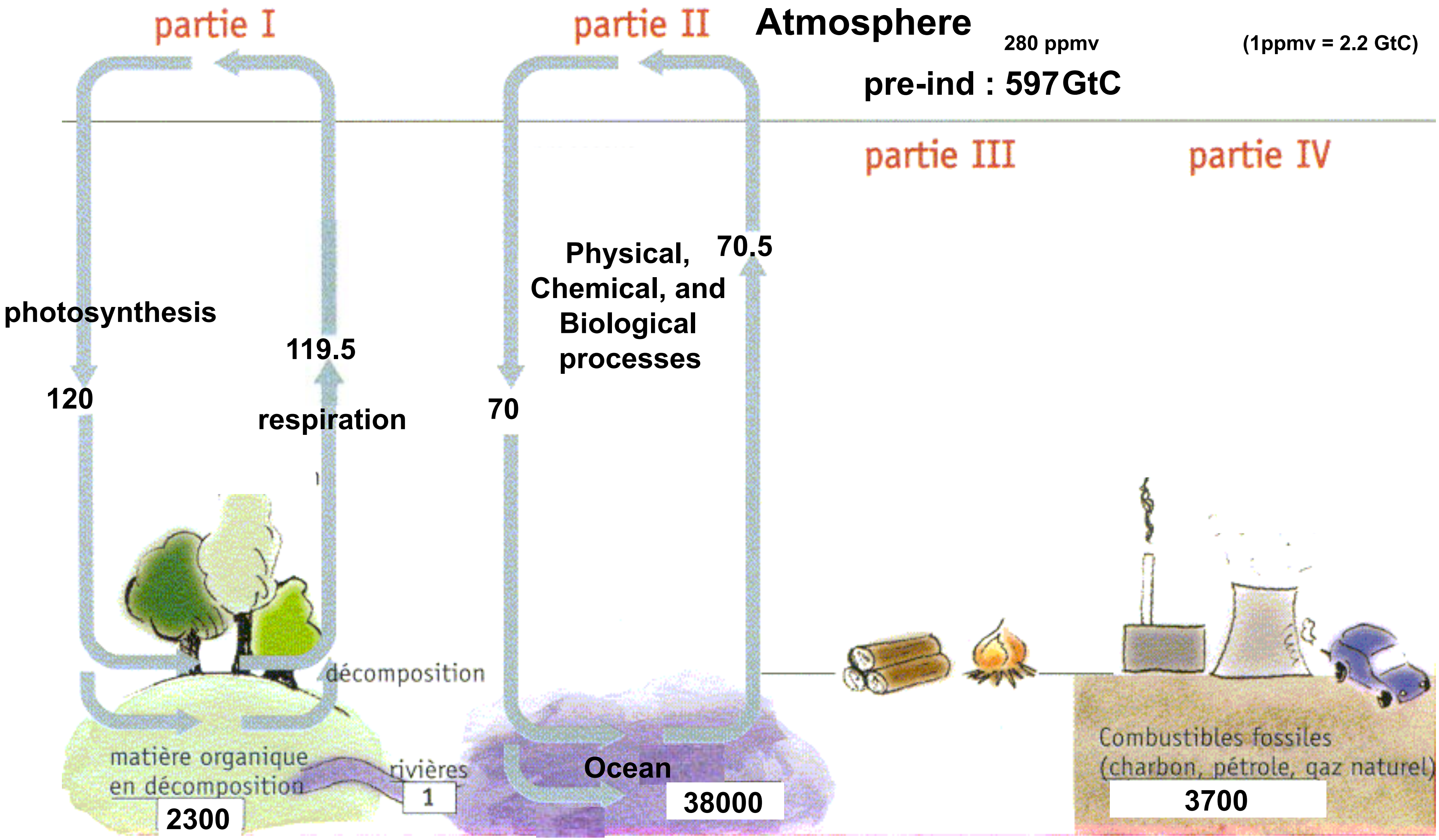
AR5 WGI SPM - Approved version / subject to final copyedit



(Lüthi et al.,2008, NOAA)

The atmospheric concentrations of carbon dioxide, methane, and nitrous oxide have increased to levels unprecedented in at least the last 800,000 years.

Carbon cycle: unperturbed fluxes

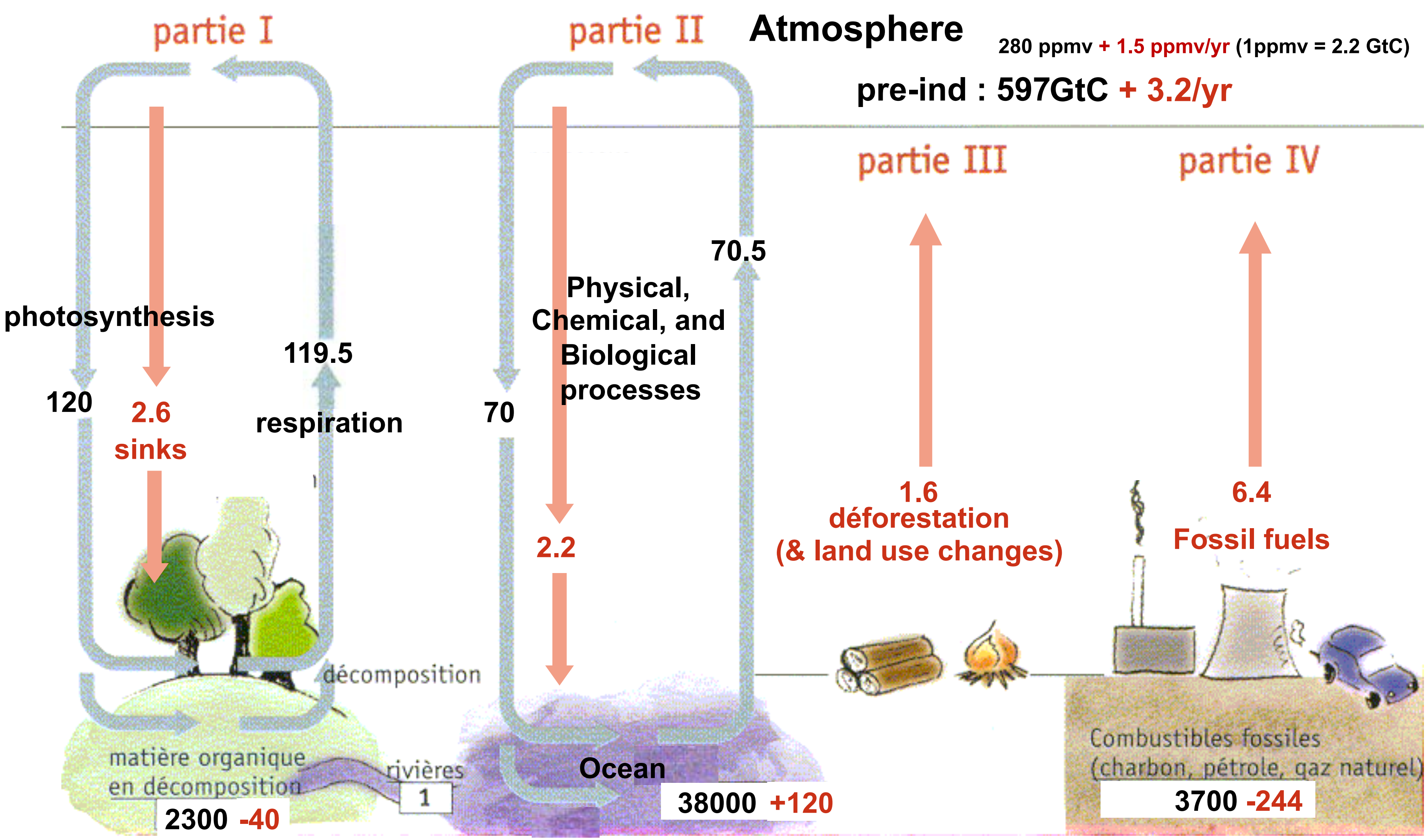


Units: GtC (billions tons of carbon) or GtC/year (multiply by 3.7 to get $GtCO_2$)

vanyp@climate.be

Carbon cycle: perturbed by human activities

(numbers for the decade 1990-1999s, based on IPCC AR4)



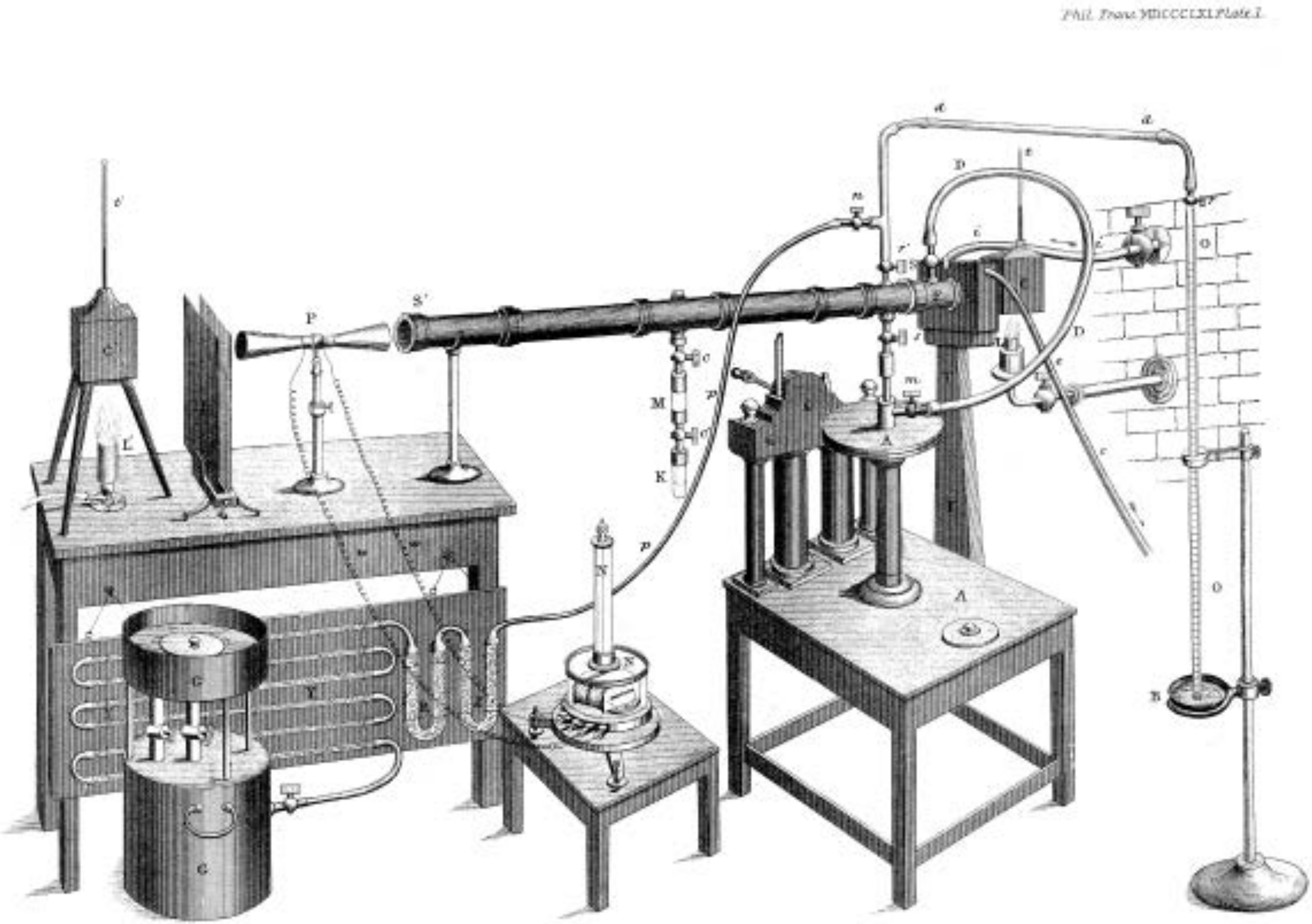
Units: GtC (billions tons of carbon) or GtC/year

Stocks!

vanyp@climate.be

The carbon cycle is policy-relevant

- CO_2 accumulates in the atmosphere as long as human emissions are larger than the natural absorption capacity
- Historical emissions from developed countries therefore matter for a long time
- As warming is function of cumulated emissions, the carbon « space » is narrowing fast (to stay under 1.5 or 2°C warming)



Tyndall (1861) measures gas absorption of radiation as a function of wavelength

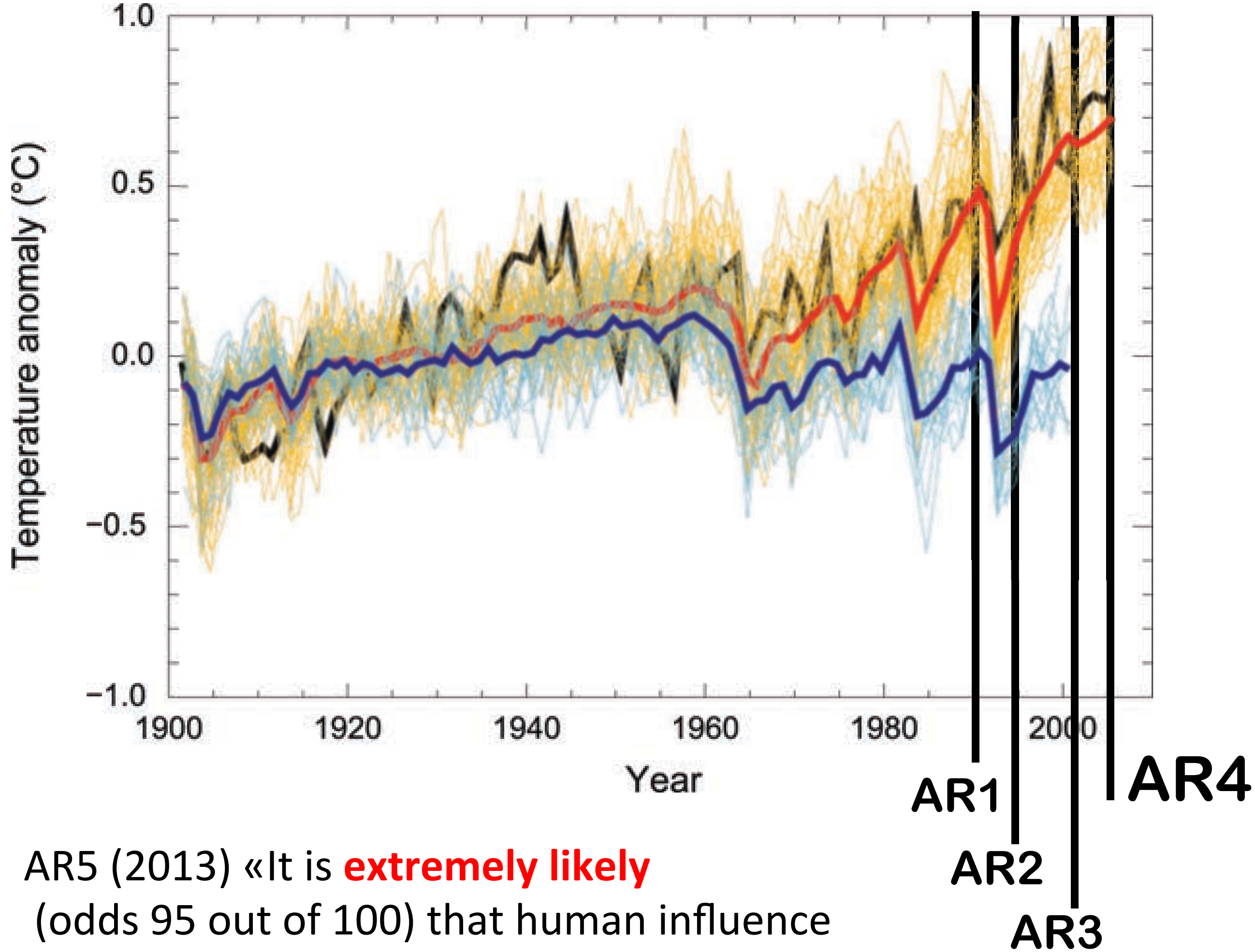
A Progression of Understanding: Greater and Greater Certainty in Attribution

AR1 (1990): "unequivocal detection not likely for a decade"

AR2 (1995): "balance of evidence suggests **discernible** human influence"

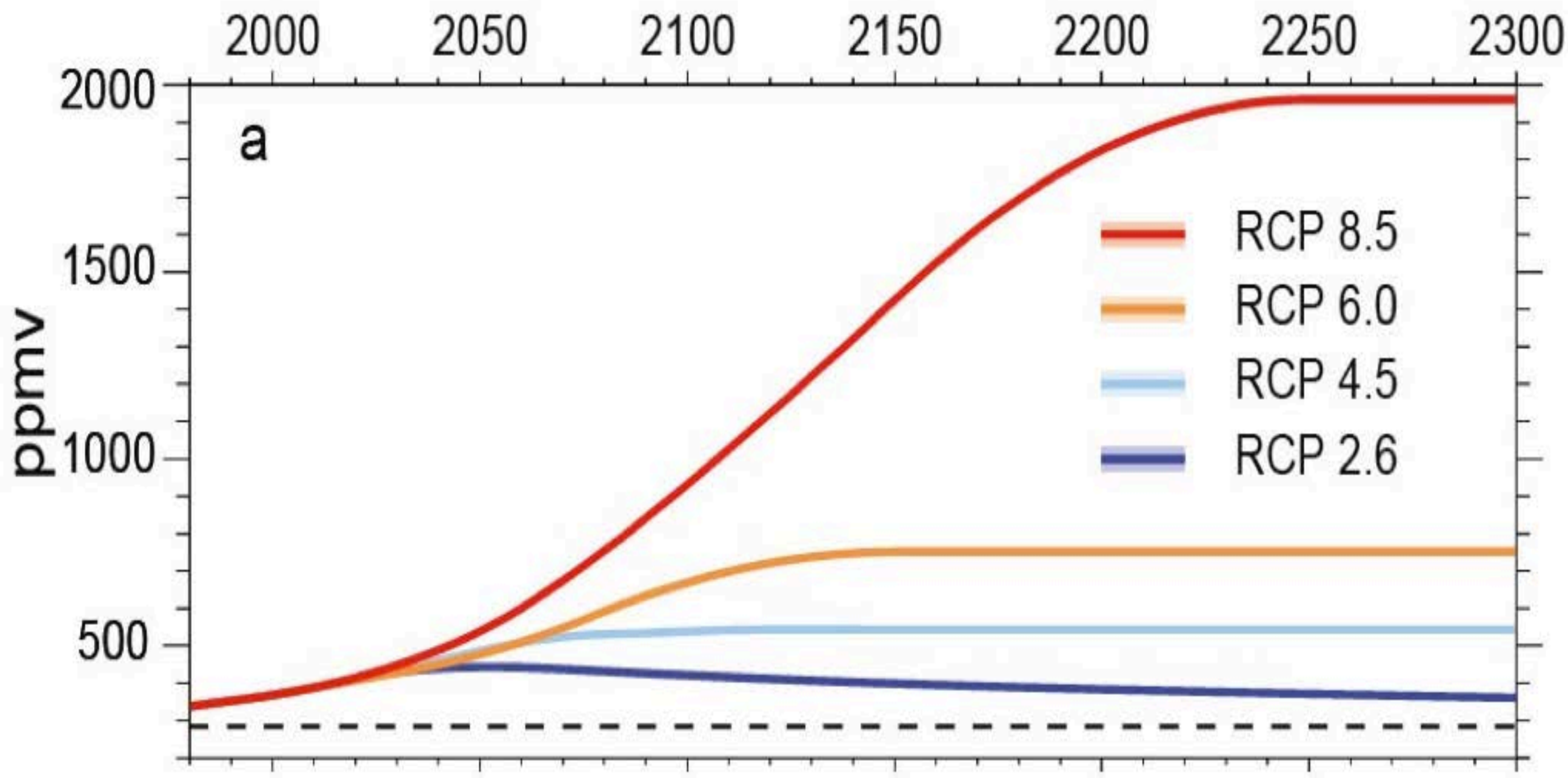
AR3 (2001): "most of the warming of the past 50 years is **likely** (odds 2 out of 3) due to human activities"

AR4 (2007): "most of the warming is **very likely** (odds 9 out of 10) due to greenhouse gases"



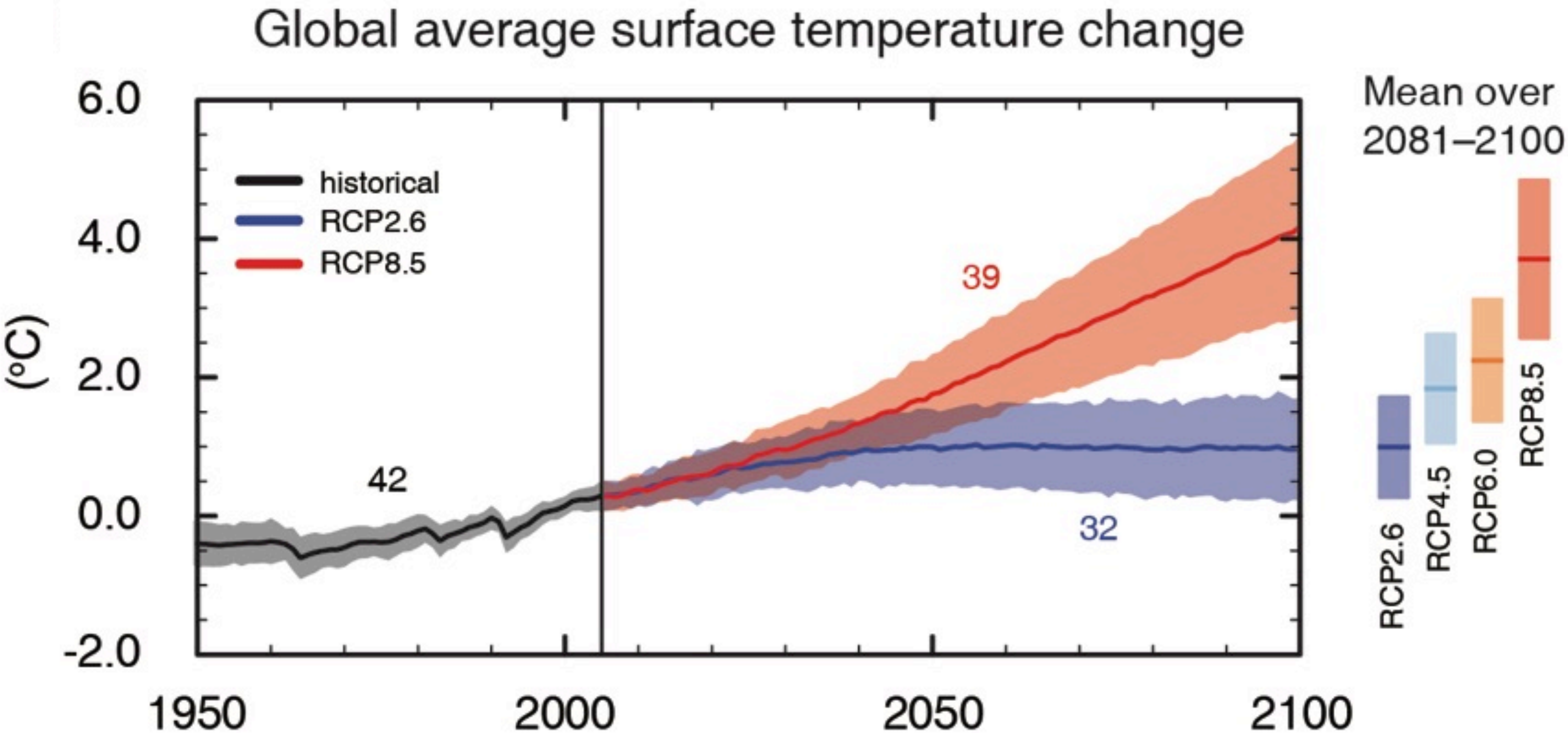
AR5 (2013) «It is **extremely likely** (odds 95 out of 100) that human influence has been the dominant cause… »

RCP Scenarios: Atmospheric CO_2 concentration



Three stabilisation scenarios: RCP 2.6 to 6
One Business-as-usual scenario: RCP 8.5

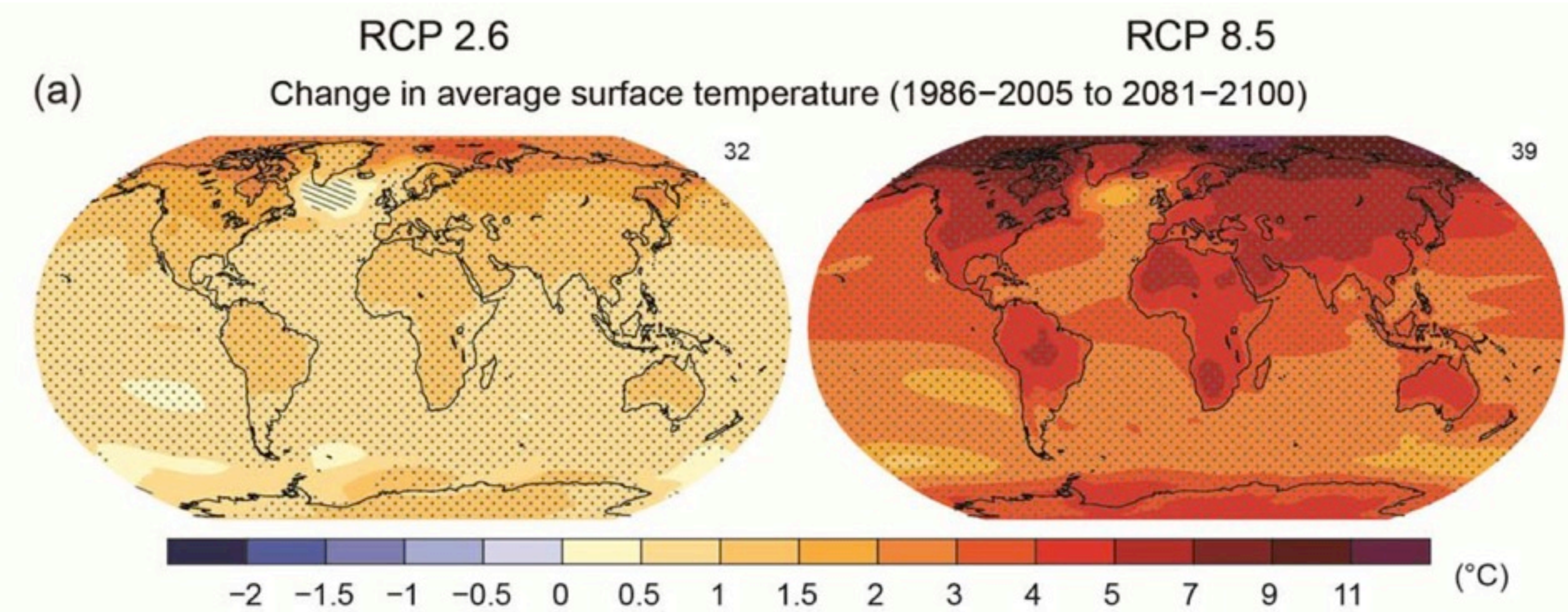
AR5, chapter 12. WGI- Adopted version / subject to final copyedit



(IPCC 2013, Fig. SPM.7a)

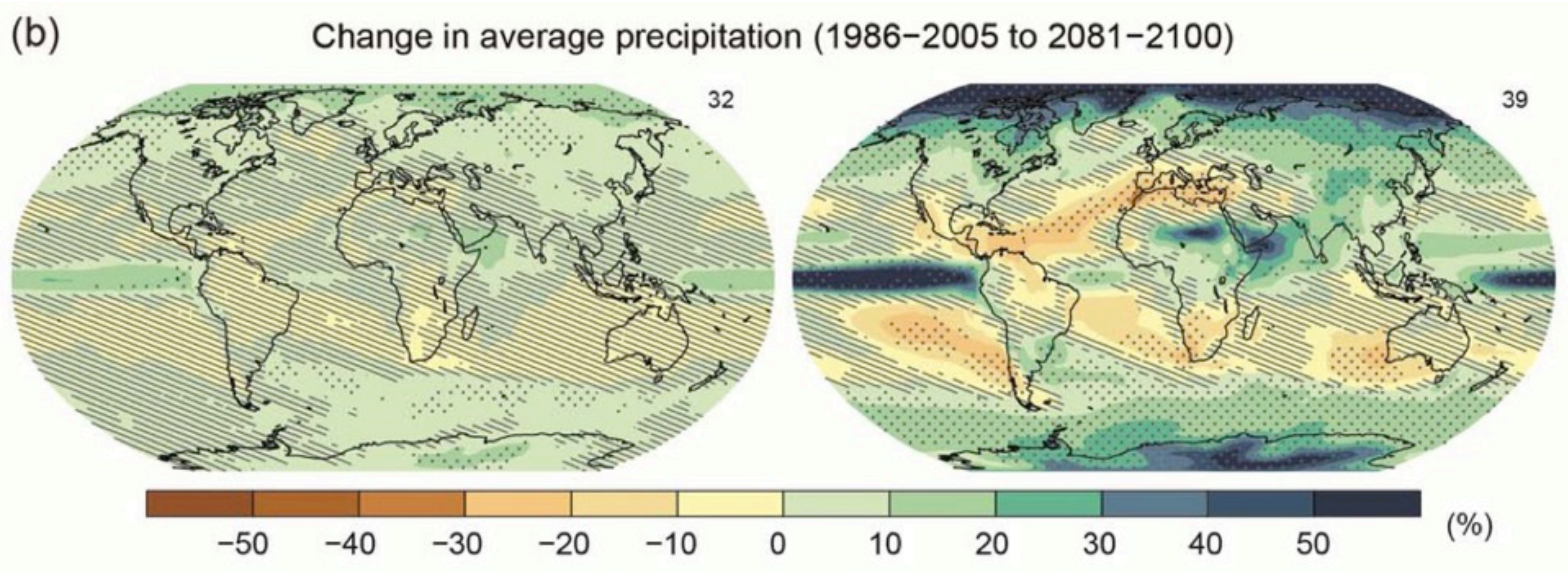
Only the lowest (RCP2.6) scenario maintains the global surface temperature increase above the pre-industrial level to less than 2°C with at least 66% probability

Surface temperature projections



AR5 WGI SPM - Approved version / subject to final copyedit

Precipitation projections



AR5 WGI SPM - Approved version / subject to final copyedit

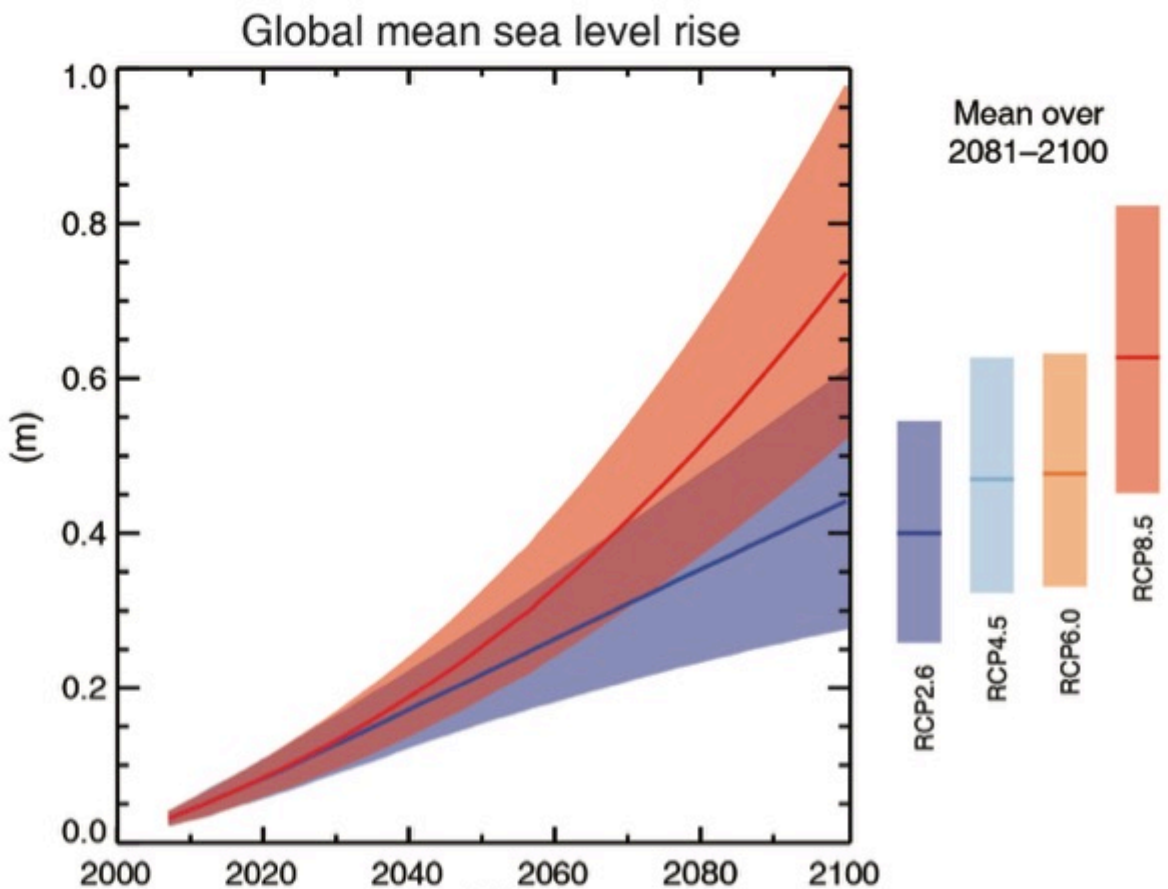


Fig. SPM.9

RCP2.6 (2081-2100), *likely* range: **26 to 55 cm**

RCP8.5 (in 2100), *likely* range: **52 to 98 cm**

(Reference level: 1986-2005)

Since 1950, extreme hot days and heavy precipitation have become more common

There is evidence that anthropogenic influences, including increasing atmospheric greenhouse gas concentrations, have changed these extremes

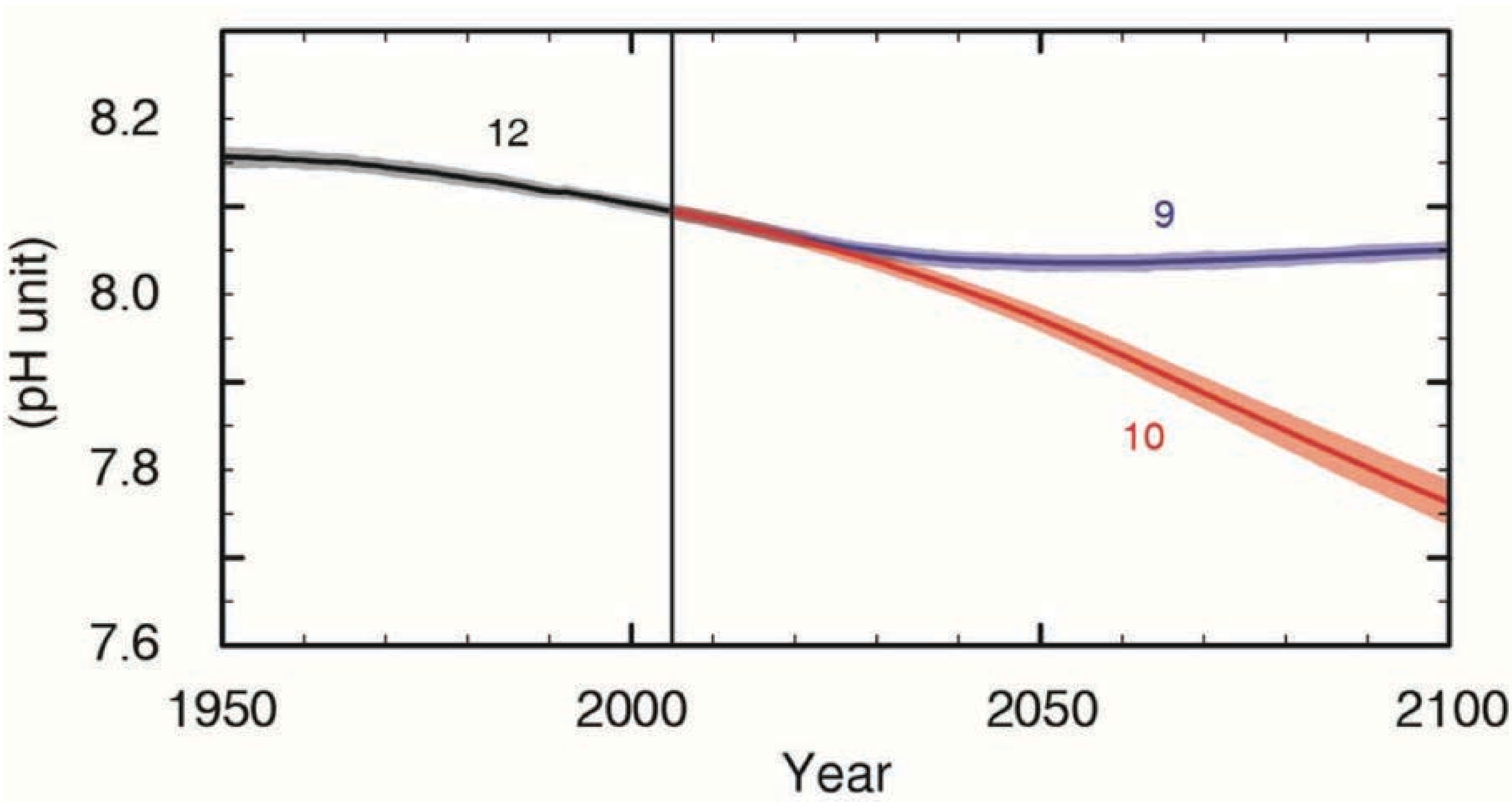
Extreme weather and climate events

Phenomenon and direction of trend	Assessment that changes occurred (typically since 1950 unless otherwise indicated)	Assessment of a human contribution to observed changes	Likelihood of further changes	
			Early 21st century	Late 21st century
Warmer and/or fewer cold days and nights over most land areas	*Very likely*	***Very likely***	*Likely*	***Virtually certain***
Warmer and/or more frequent hot days and nights over most land areas	*Very likely*	***Very likely***	*Likely*	***Virtually certain***
Warm spells/heat waves. Frequency and/or duration increases over most land areas	***Medium confidence*** on a global scale Likely in large parts of Europe, Asia and Australia	***Likely***	Not formally assessed	***Very likely***
Heavy precipitation events. Increase in the frequency, intensity, and/or amount of heavy precipitation	*Likely more land areas with increases than decreases*	***Medium confidence***	*Likely* over many land areas	***Very likely*** over most of the mid-latitude land masses and over wet tropical regions
Increases in intensity and/or duration of drought	***Low confidence*** on a global scale Likely changes in some regions	***Low confidence***	*Low confidence*	***Likely*** *(medium confidence)* on a regional to global scale
Increases in intense tropical cyclone activity	***Low confidence*** in long term (centennial) changes Virtually certain in North Atlantic since 1970	***Low confidence***	*Low confidence*	***More likely than not*** in the Western North Pacific and North Atlantic
Increased incidence and/or magnitude of extreme high sea level	*Likely* (since 1970)	***Likely***	*Likely*	***Very likely***

IPCC, AR5, Table SPM.1

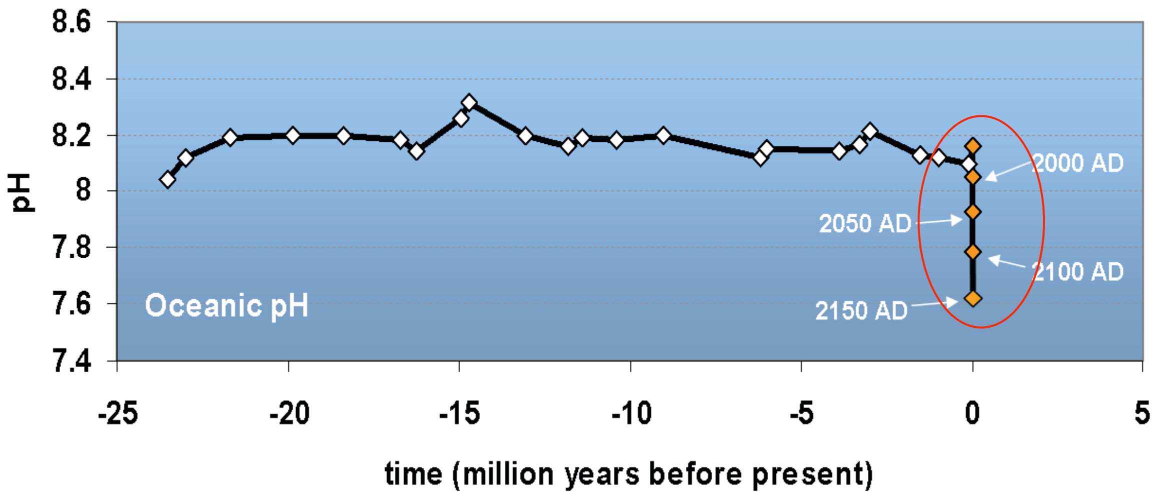
Global ocean surface pH (projections)

Ocean Acidification, for RCP 8.5 (orange) & RCP2.6 (blue)



Oceans are Acidifying Fast…

Changes in pH over the last 25 million years



“Today is a rare event in the history of the World”

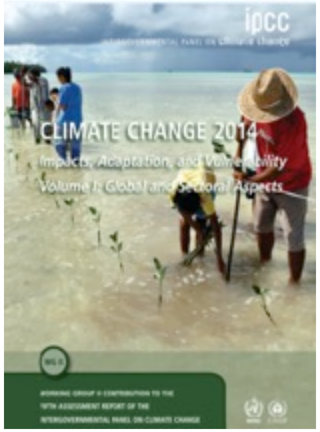
- **It is happening now, at a speed and to a level not experienced by marine organisms for about 60 million years**

- **Mass extinctions linked to previous ocean acidification events**

- **Takes 10,000’s of years to recover**

Turley et al. 2006

Slide courtesy of Carol Turley, PML



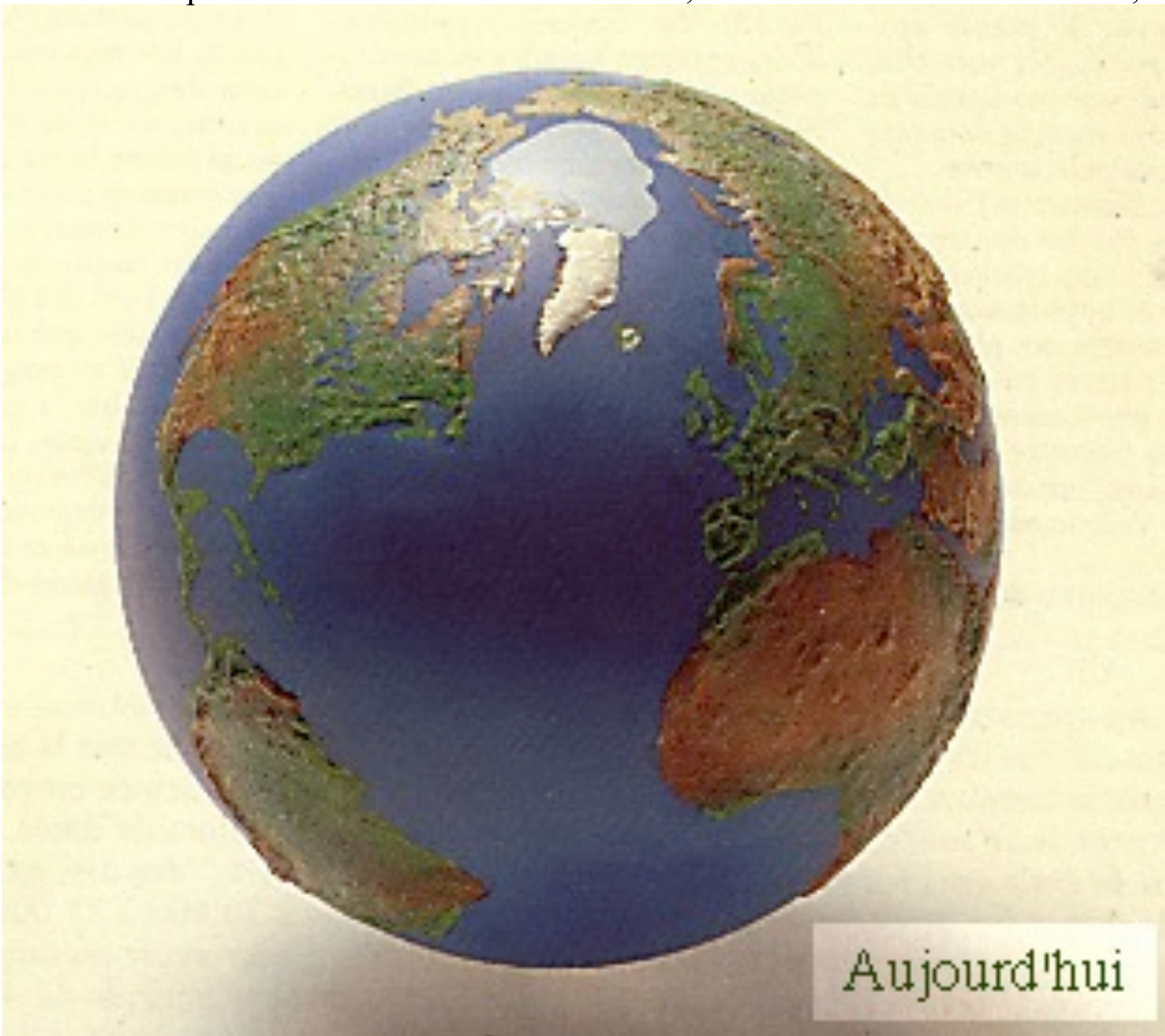
What are the risks?

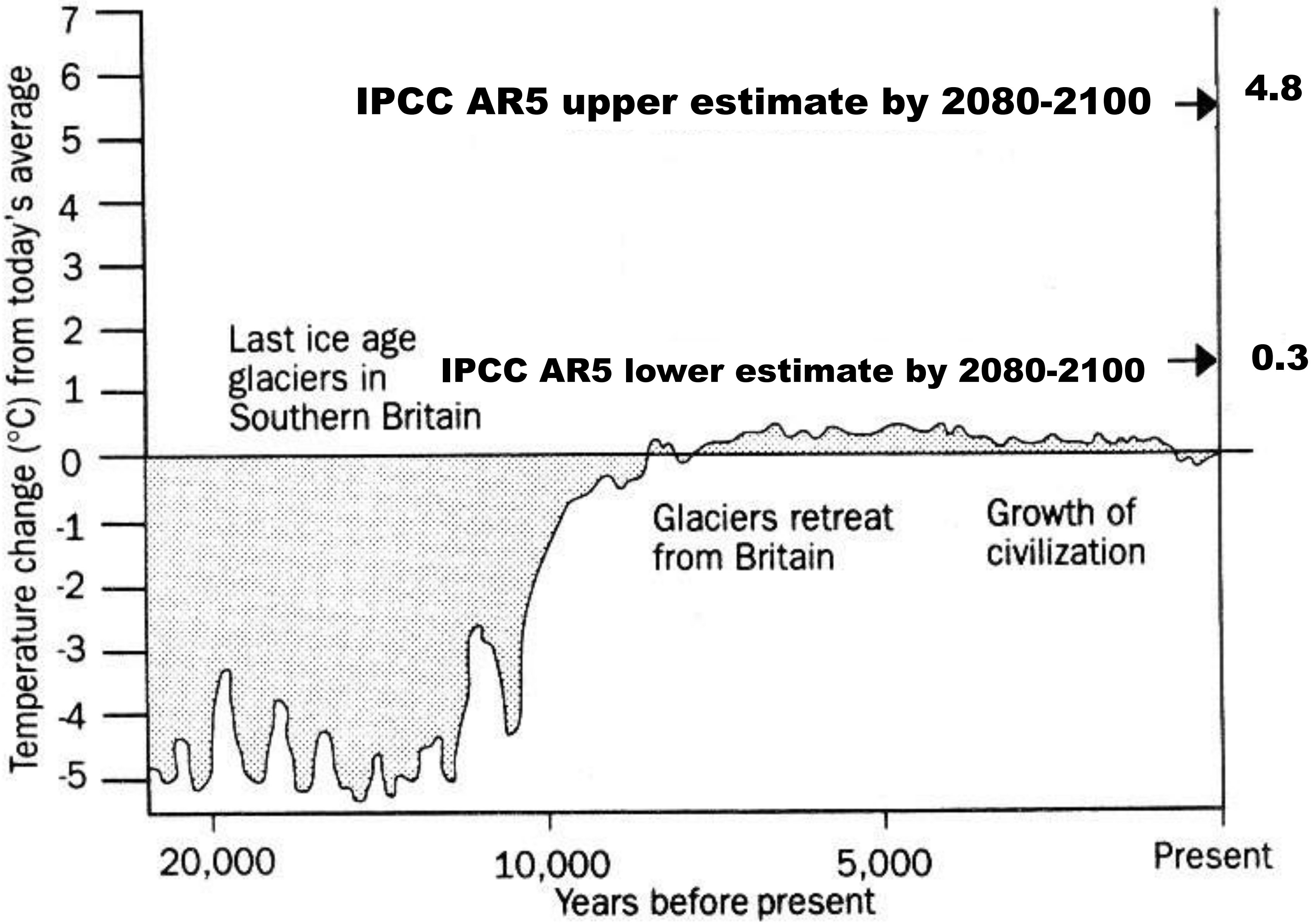
18-20000 years ago (Last Glacial Maximum)

With permission from Dr. S. Joussaume, in « Climat d'hier à demain », CNRS éditions.

Today, with +4-5°C globally

With permission from Dr. S. Joussaume, in « Climat d'hier à demain », CNRS éditions.





Adapted from: International Geosphere Biosphere Programme Report no.6, Global Changes of the Past, July1988


WIDESPREAD
OBSERVED IMPACTS
A CHANGING WORLD
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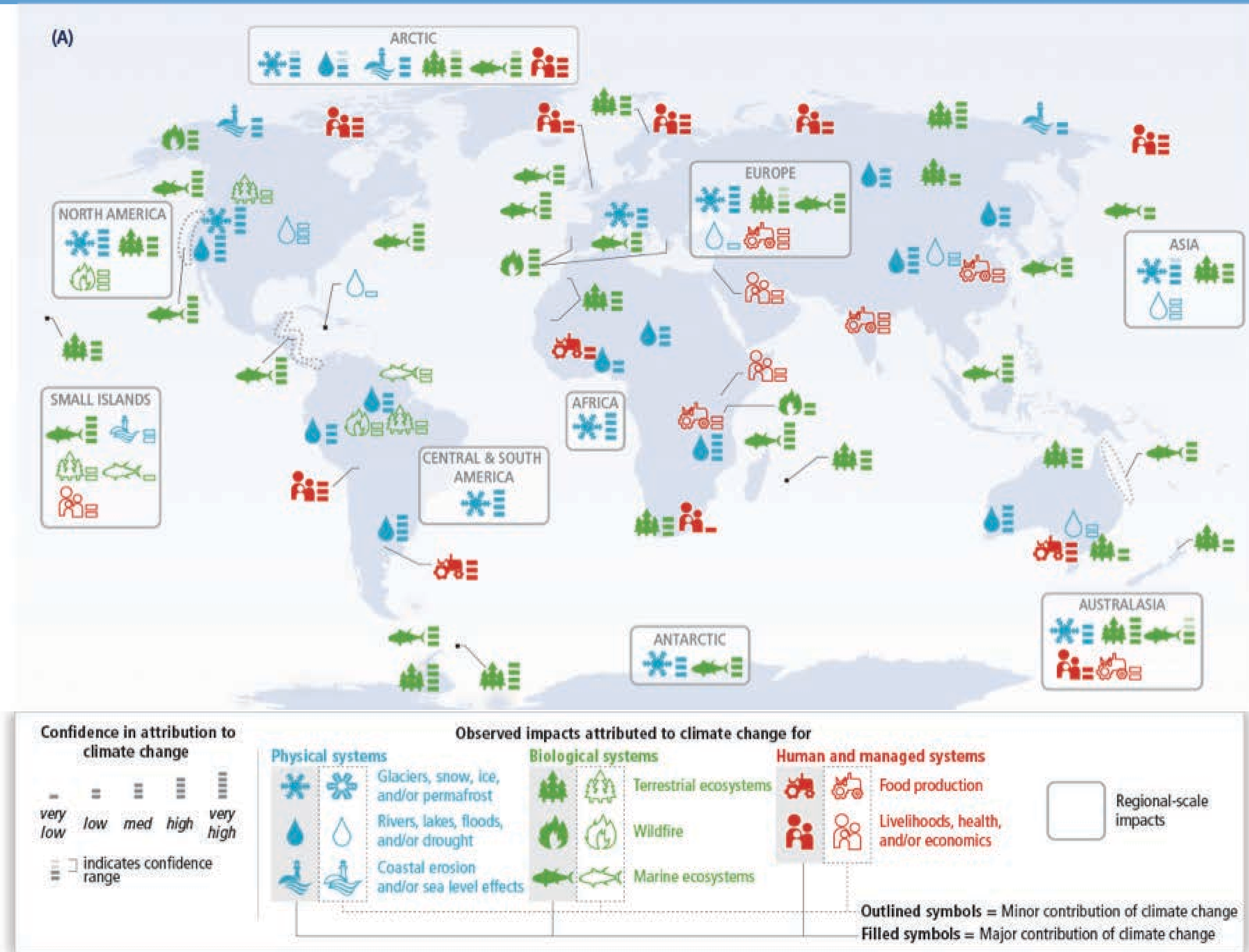
(A)
ARCTIC
EUROPE
NORTH AMERICA
ASIA
SMALL ISLANDS
AFRICA
CENTRAL & SOUTH AMERICA
AUSTRALASIA
ANTARCTIC
Confidence in attribution to climate change
very low
low
med
high
very high
indicates confidence range
Observed impacts attributed to climate change for
Physical systems
Glaciers, snow, ice, and/or 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

Effects on Nile delta: 10 M people above 1m

(Time 2001)

With 8 metre sea-level rise: 3700 km^2 below sea-level in Belgium (very possible in year 3000) (NB: flooded area depends on protection)

Source: J.P. van Ypersele et P. Marbaix (2004) See www.climate.be/impacts

Risk = Hazard x Vulnerability x Exposure (Katrina flood victim)

AP Photo - Lisa Krantz (http://lisakrantz.com/hurricane-katrina/zspbn1k4cn17phidupe4f9x5t1mzdr)

More heavy precipitation <u>and</u> more droughts….

ADAPTATION IS
ALREADY OCCURRING
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RISKS OF
CLIMATE CHANGE
INCREASE
WITH CONTINUED
HIGH EMISSIONS
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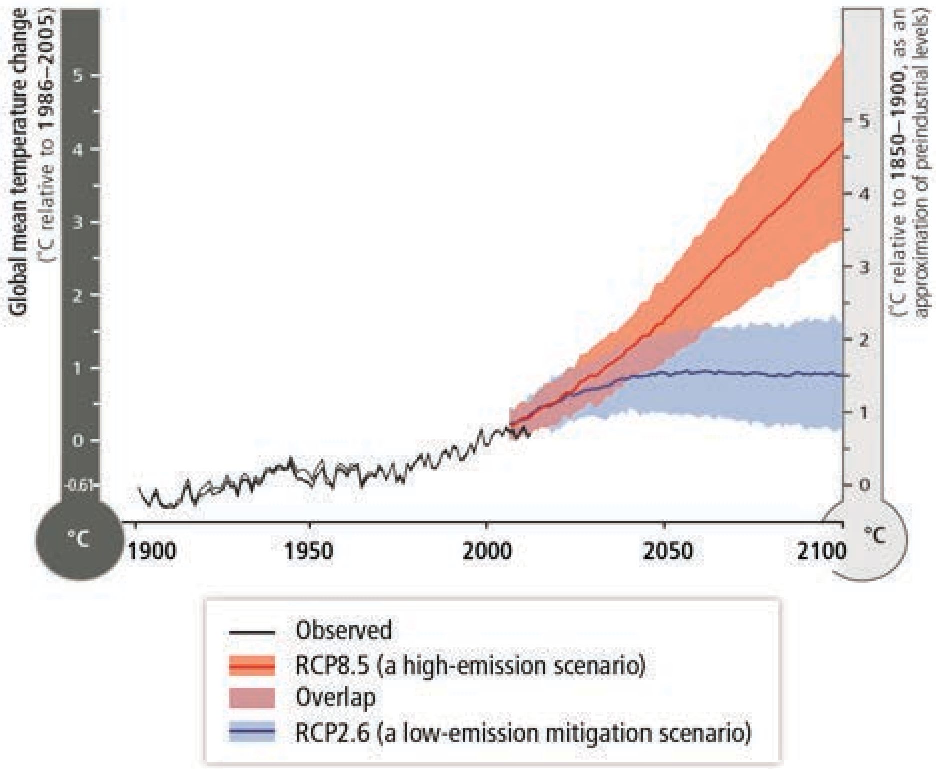

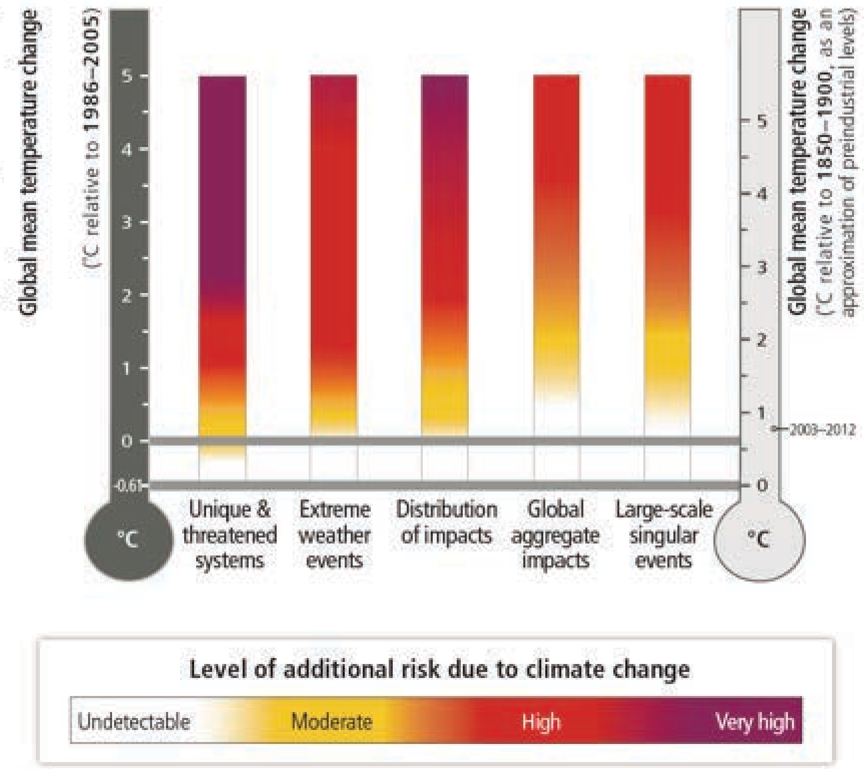

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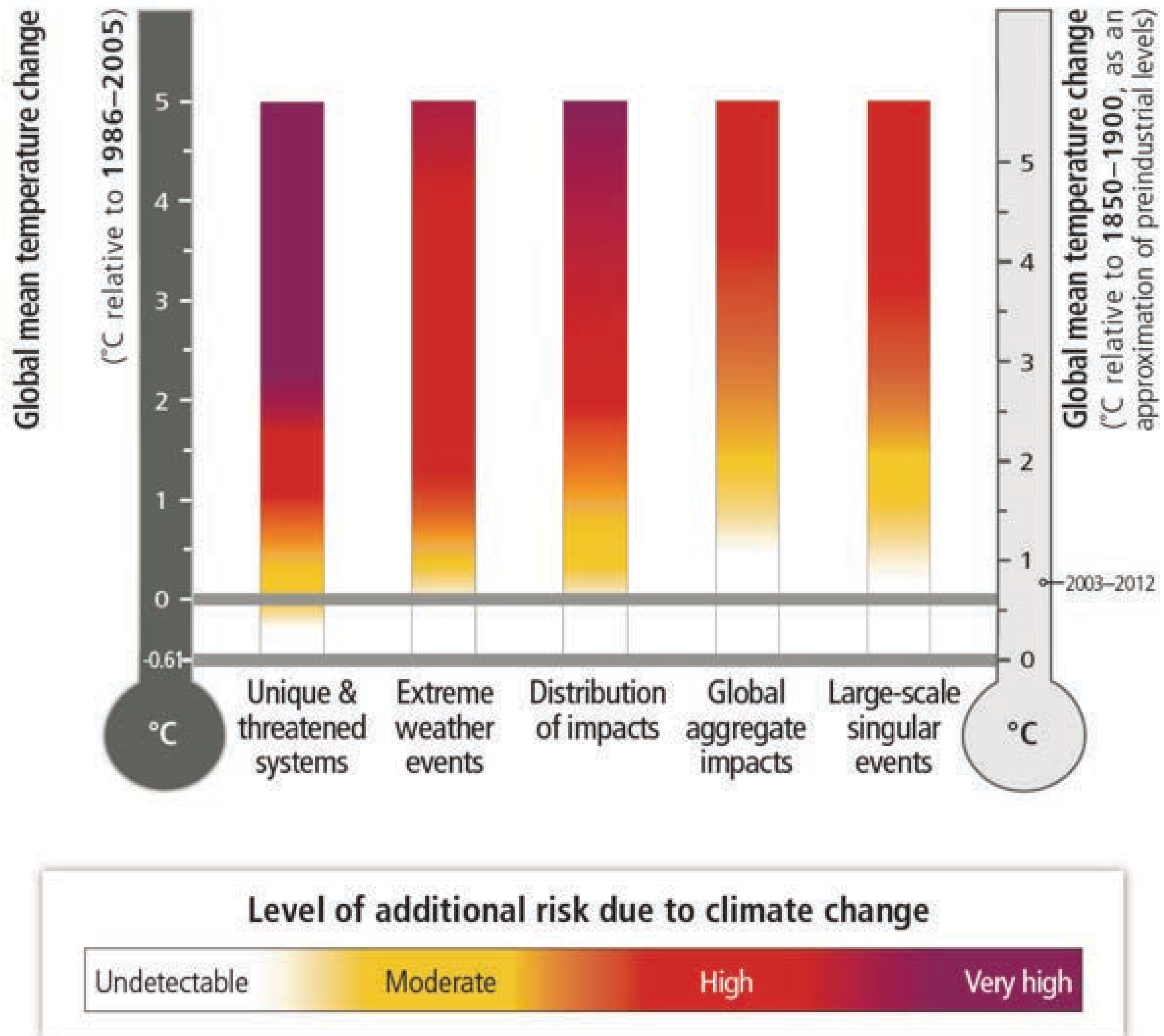

AR5, WGII, Box SPM.1 Figure 1

What can be done?

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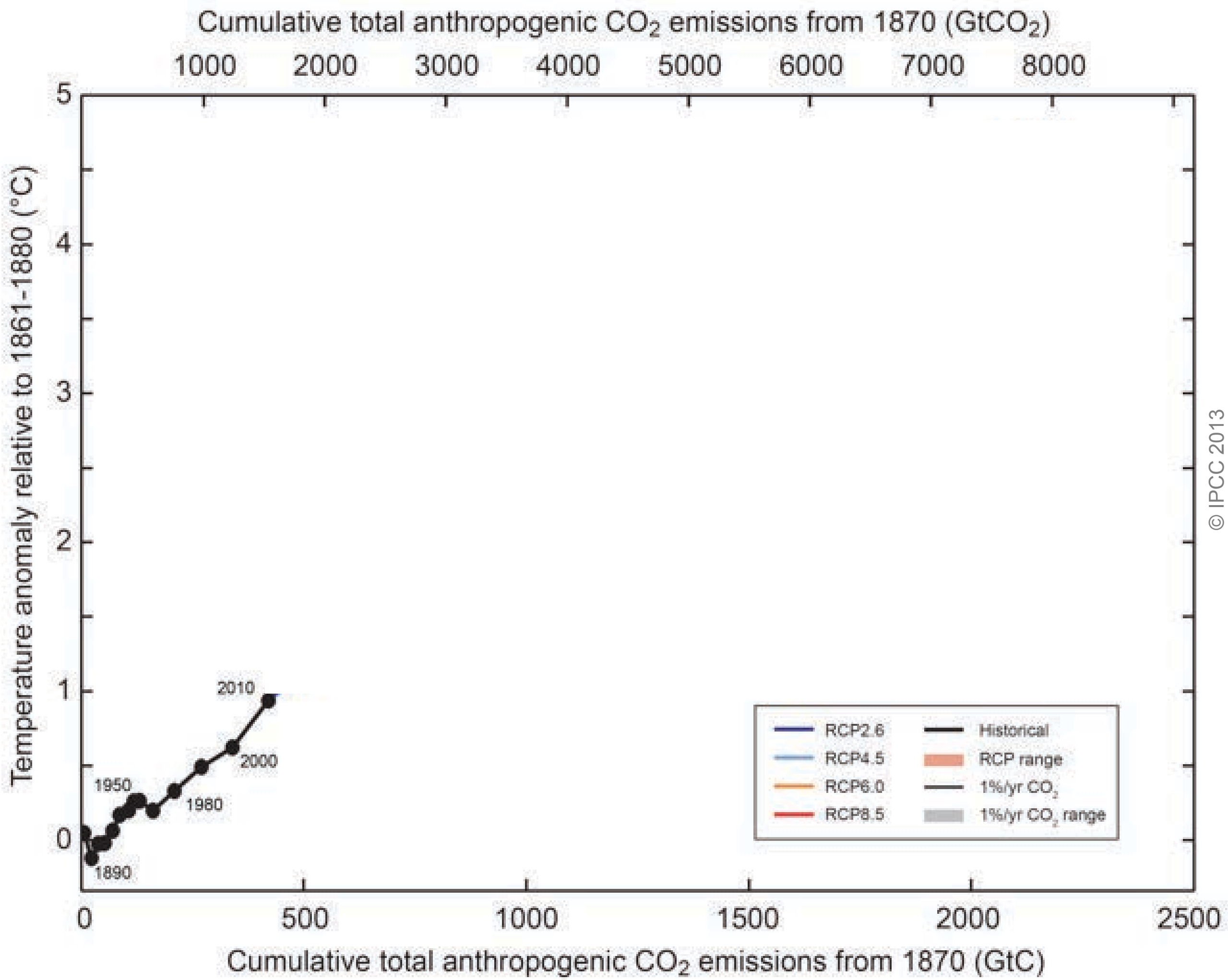


Fig. SPM.10

Cumulative emissions of CO_2 largely determine global mean surface warming by the late 21st century and beyond.

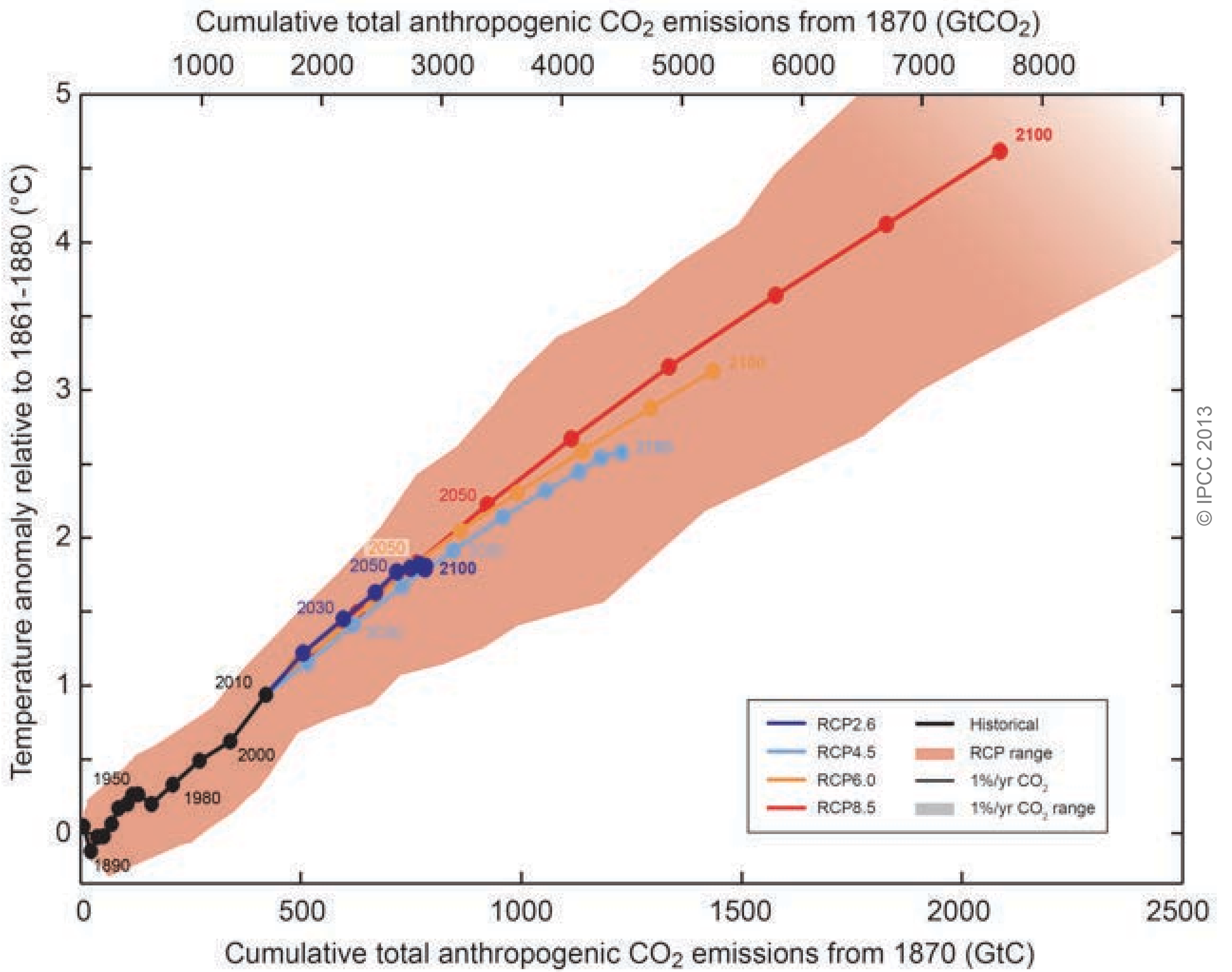
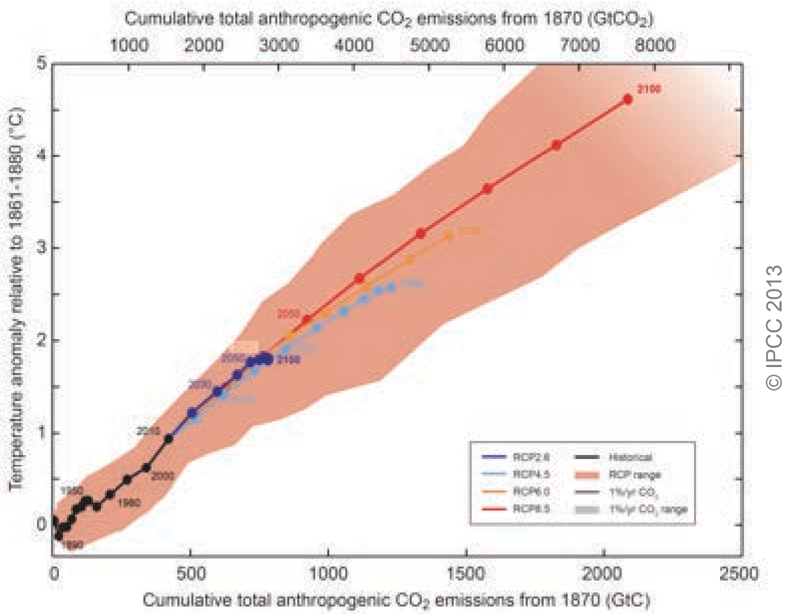


Fig. SPM.10

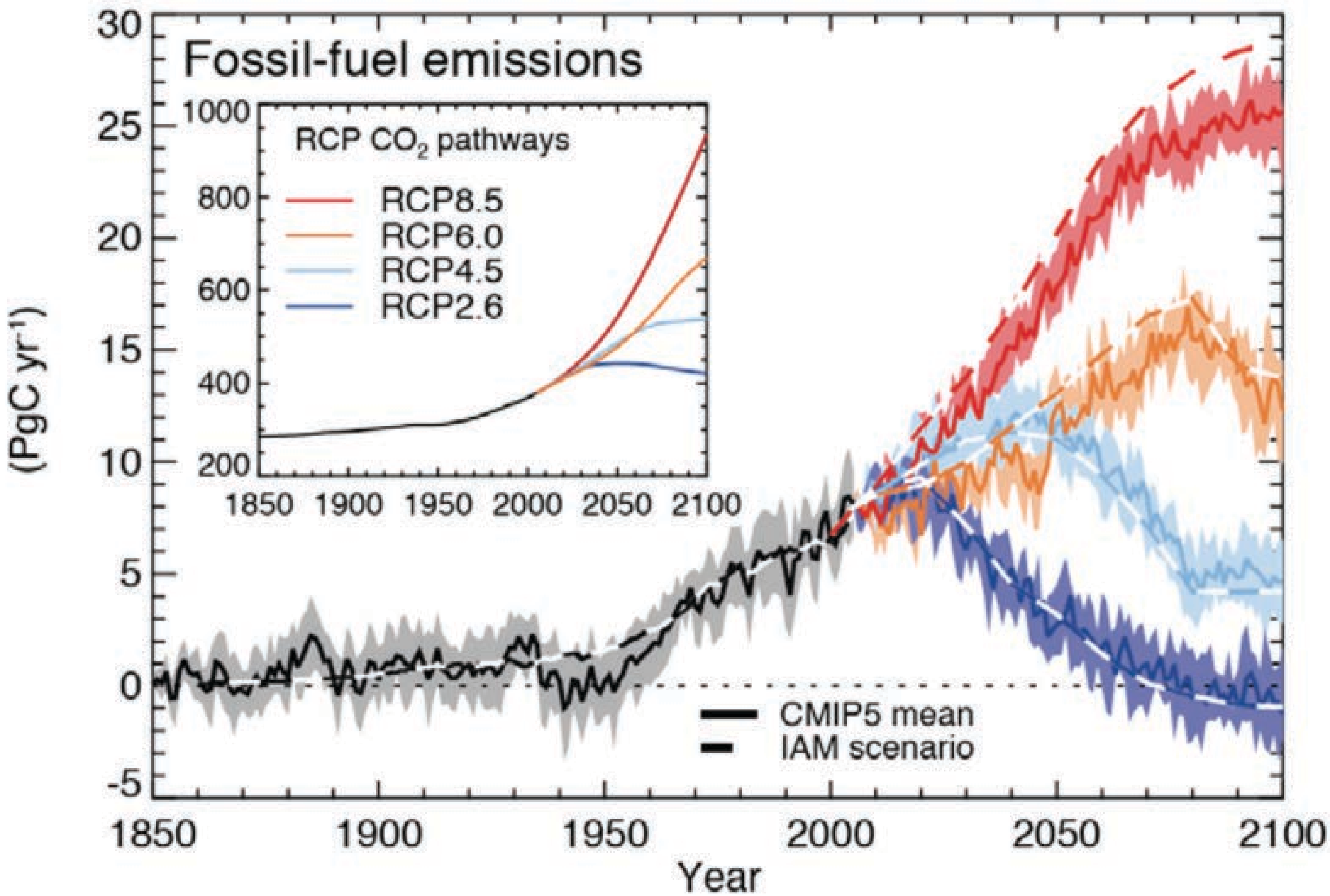
Limiting climate change will require substantial and sustained reductions of greenhouse gas emissions.



Limiting warming to *likely* less than 2°C since 1861-1880 requires cumulative CO_2 emissions to stay below 1000 GtC. Until 2011, over 50% of this amount has been emitted.

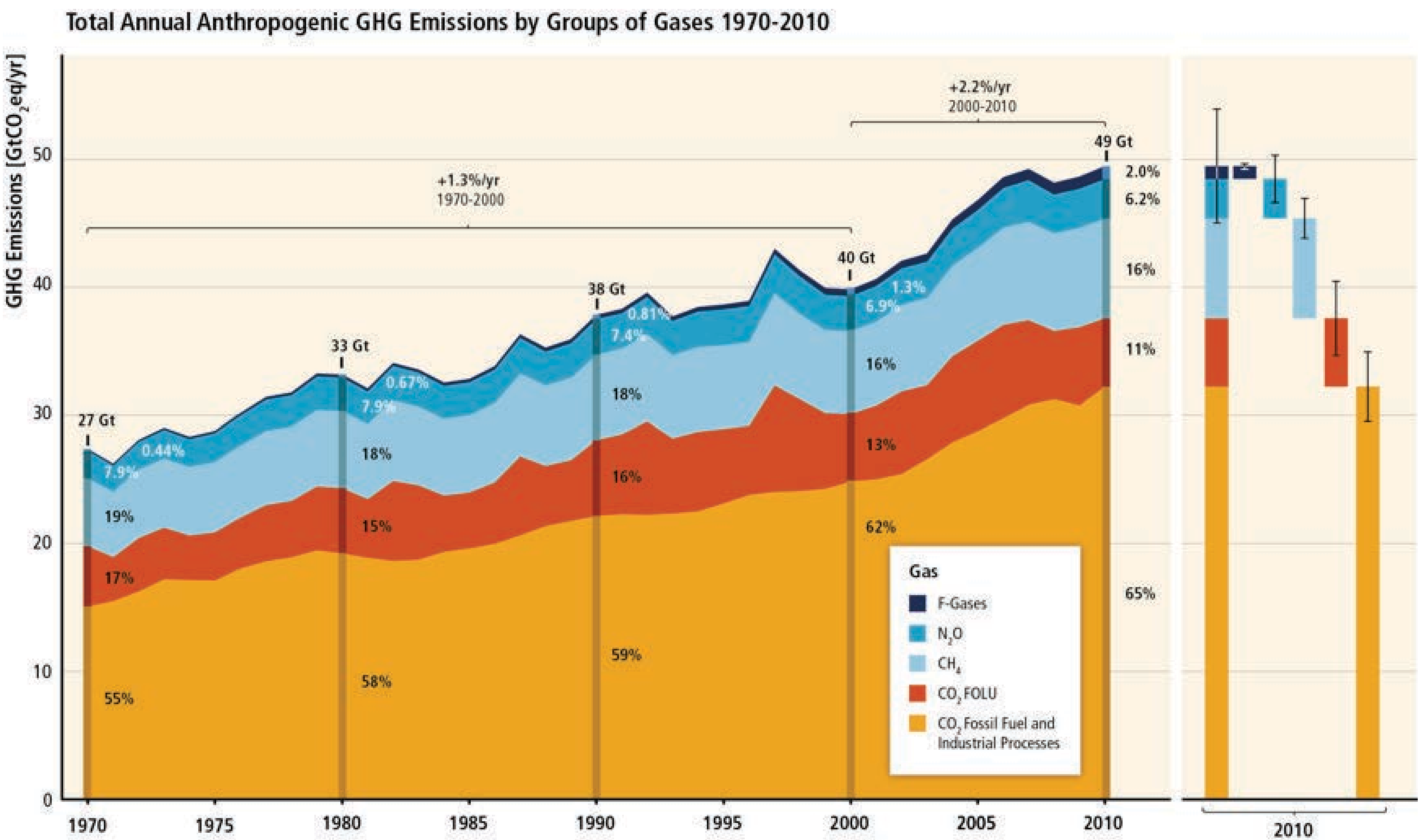
Accounting for other forcings, the upper amount of cumulative CO_2 emissions is 800 GtC; over 60% have been emitted by 2011.

Compatible fossil fuel emissions simulated by the CMIP5 models for the four RCP scenarios



AR5 WGI TS – Fig TS 19

GHG emissions accelerate despite reduction efforts. Most emission growth is CO_2 from fossil fuel combustion and industrial processes.



Working Group III contribution to the
IPCC Fifth Assessment Report

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Can temperature rise still be kept below 1.5 or 2°C (over the 21st century) compared to pre-industrial ?

- **Estimated global GHG emissions levels in 2020 based on the Cancún Pledges are not consistent** with cost-effective long-term mitigation trajectories that have at least 50% chance to limit global temperature change to 2°C relative to pre-industrial levels.
- **Meeting this goal would require further substantial reductions beyond 2020.**
- **The Cancún Pledges are broadly consistent with cost-effective scenarios that are** likely **to keep temperature change below 3°C relative to preindustrial levels.**

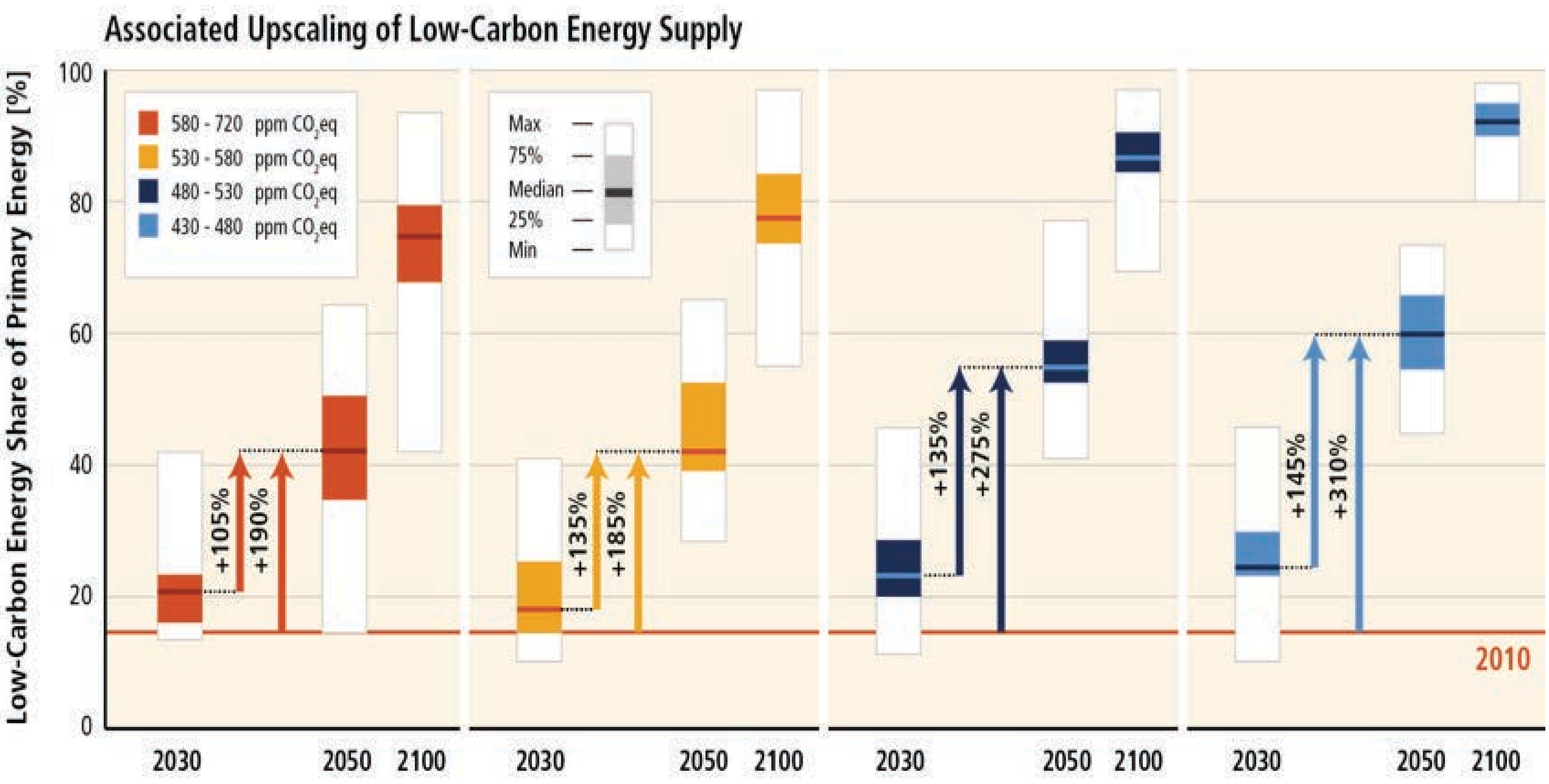
Can temperature rise still be kept below 1.5 or 2°C (over the 21st century) compared to pre-industrial ?

- **Many scenario studies confirm that it is technically and economically feasible to keep the warming below 2°C, with more than 66% probability ("likely chance").** This would imply limiting atmospheric concentrations to 450 ppm CO_2-eq by 2100.
- **Such scenarios** for an above 66% chance of staying below 2°C **imply reducing by 40 to 70% global GHG emissions compared to 2010 by mid-century, and reach zero or negative emissions by 2100.**

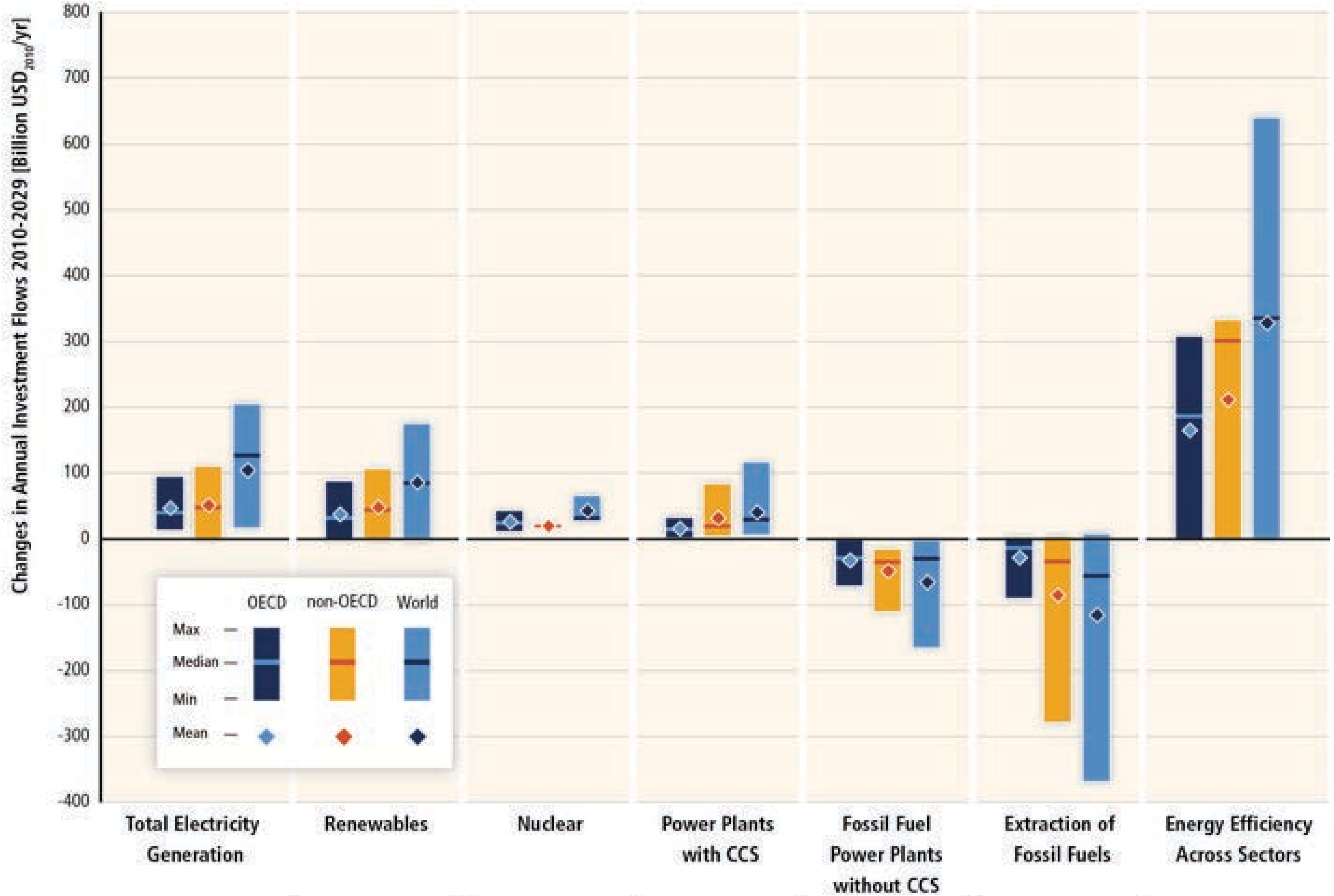
Can temperature rise still be kept below 1.5 or 2°C (over the 21st century) compared to pre-industrial ?

- **These scenarios are characterized by rapid improvements of energy efficiency and a near quadrupling of the share of low-carbon energy supply (renewables, nuclear, fossil and bioenergy with CCS), so that it reaches 60% by 2050.**
- **Keeping global temperature increase below 1.5°C would require even lower atmospheric concentrations (<430 ppm CO_2eq) to have a little more than 50% chance.** There are not many scenario studies available that can deliver such results, **requiring even faster reductions** in the medium term, indicating how difficult this is.

Mitigation requires major technological and institutional changes including the upscaling of low- and zero carbon energy



Substantial reductions in emissions would require large changes in investment patterns.



# of Studies:	4	4	5	4	4	5	4	4	5	4	4	5	4	4	5	4	4	5	3	3	4

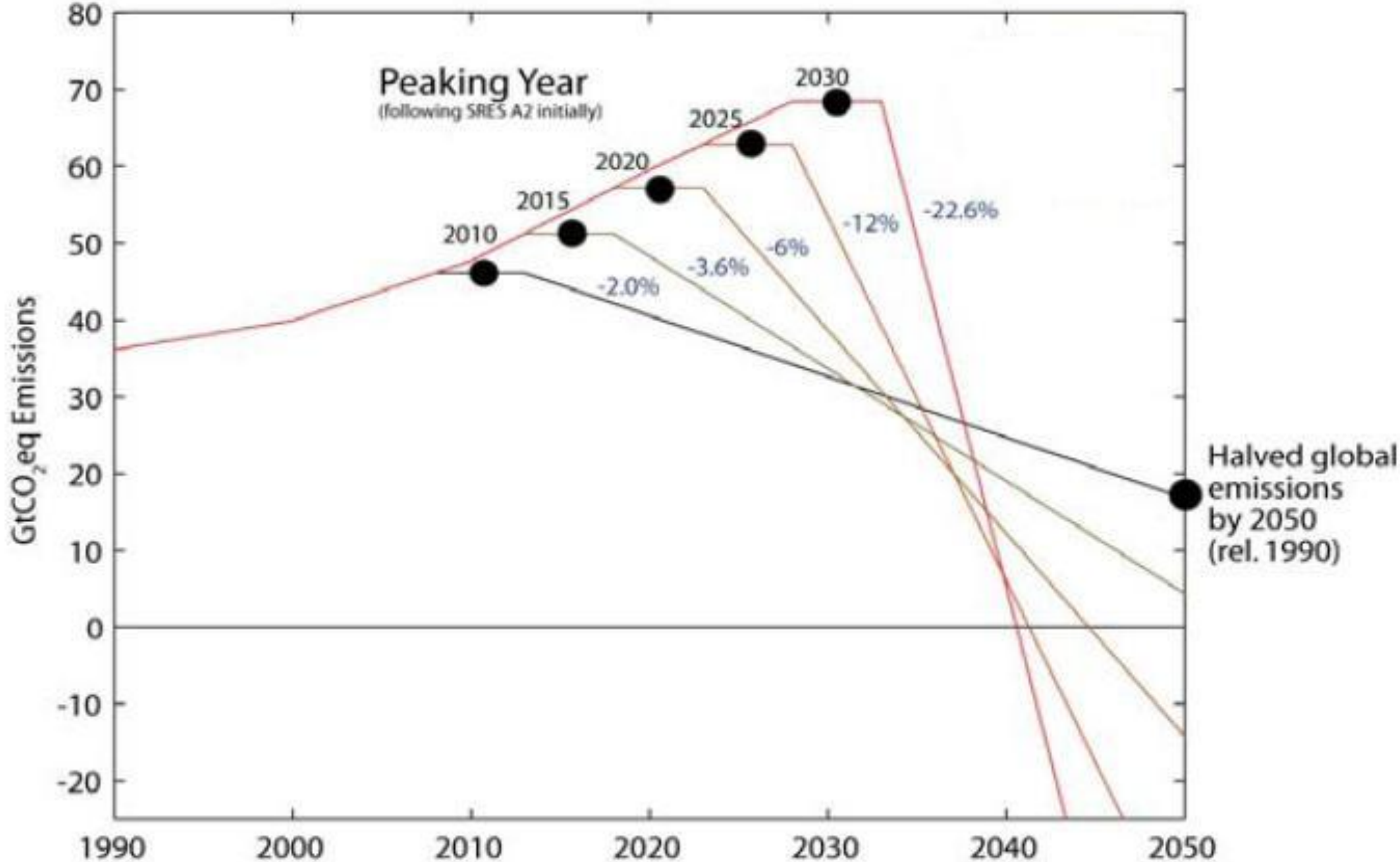
Since AR4, there has been an increased focus on policies designed to integrate multiple objectives, increase co-benefits and reduce adverse side-effects.

- **Sector-specific policies** have been more widely used than economy-wide policies.
- **Regulatory approaches and information** measures are widely used, and are often environmentally effective.
- Since AR4, **cap and trade** systems for GHGs have been established in a number of countries and regions.
- In some countries, **tax-based policies** specifically aimed at reducing GHG emissions–alongside technology and other policies–have helped to weaken the link between GHG emissions and GDP
- The **reduction of subsidies** for GHG-related activities in various sectors can achieve emission reductions, depending on the social and economic context.

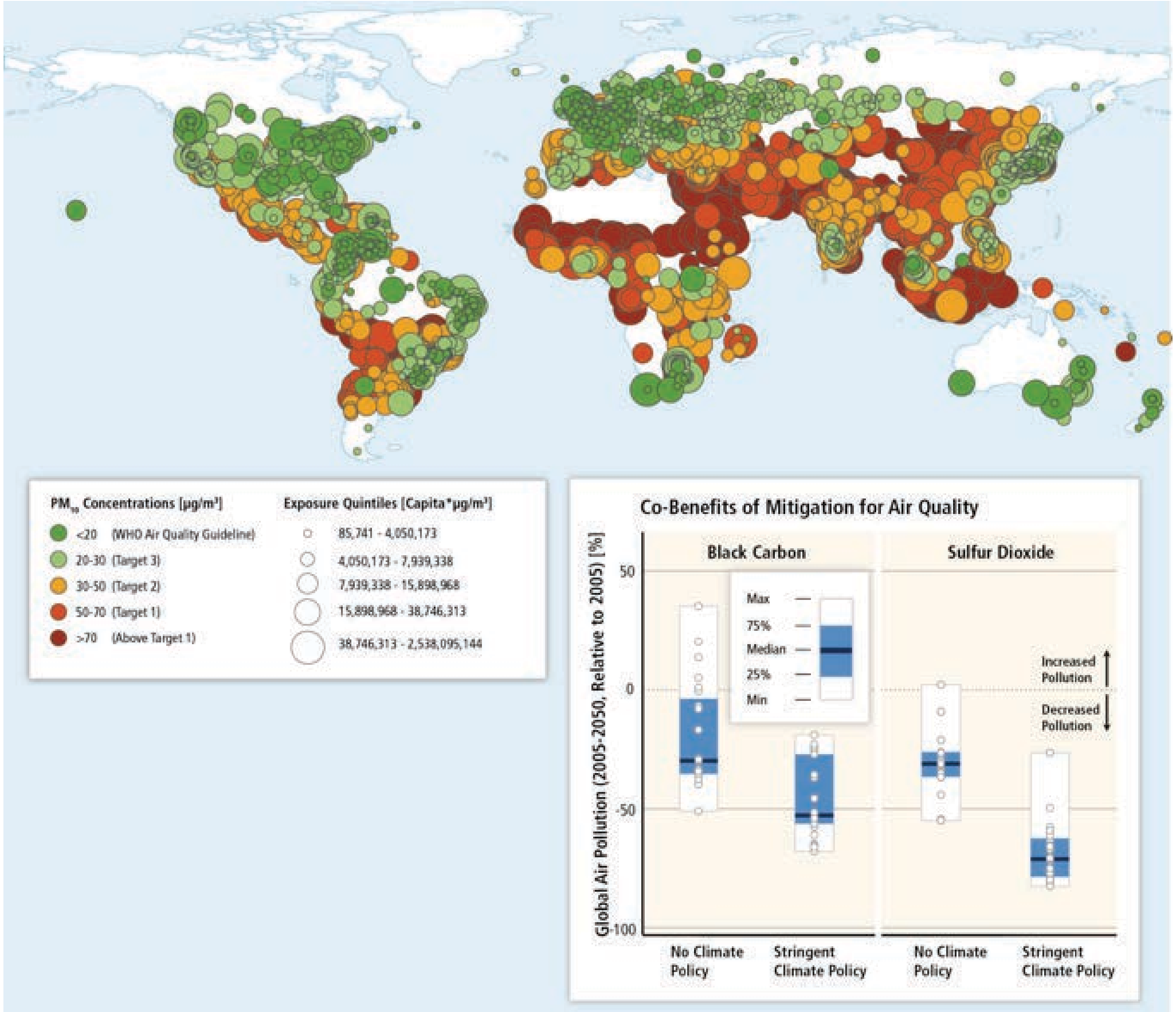
Effective mitigation will not be achieved if individual agents advance their own interests independently.

- Existing and proposed **international climate change cooperation** arrangements vary in their focus and degree of centralization and coordination.
- Issues of **equity, justice, and fairness** arise with respect to mitigation and adaptation.
- Climate policy may be informed by a consideration of a diverse array of **risks and uncertainties**, some of which are difficult to measure, notably events that are of **low probability but** which would have a **significant impact** if they occur.

The more we wait, the more difficult it will be



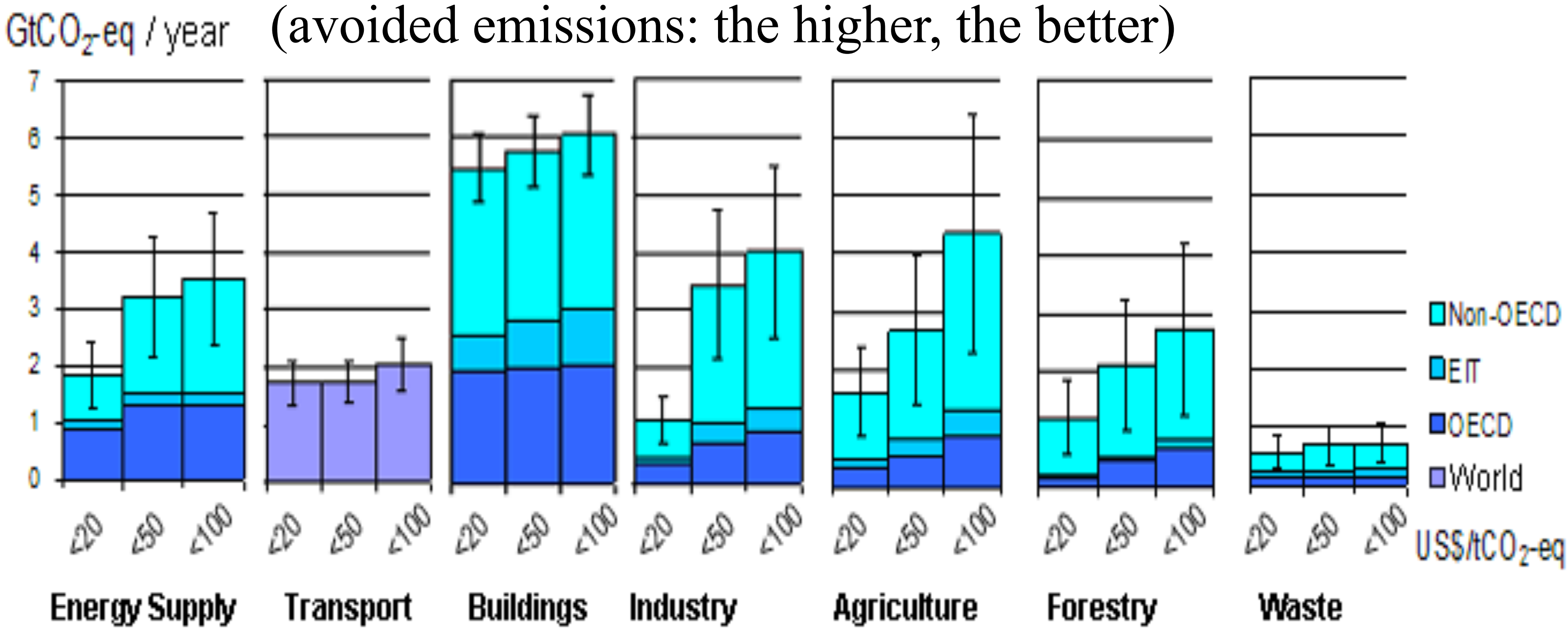
Source: Meinshausen et al. - Nature, 30th April 2009



Mitigation can result in large co-benefits for human health and other societal goals.

All sectors and regions have the potential to contribute by 2030

(avoided emissions: the higher, the better)



IPCC AR4 (2007)

Note: estimates do not include non-technical options, such as lifestyle changes.

Climate change and conflicts: summary (IPCC AR5 WGII)

- Climate change [and climate variability] can indirectly increase risks of violent conflicts in the form of civil war and inter-group violence by amplifying well-documented drivers of these conflicts such as poverty and economic shocks (medium confidence)

- Violent conflict increases vulnerability to climate change Large-scale conflicts harms assets that facilitate adaptation, including infrastructure, institutions, natural resources, social capital and livelihood opportunities

Does climate change cause violent conflicts?

- Some factors that increase risks from violent conflicts and civil wars are sensitive to climate change
  - For example […] factors like low per capita income, economic contraction, and inconsistent state institutions are associated with the incidence of civil wars, and also seem to be sensitive to climate change.
- Climate-change policies, particularly those associated with changing rights to resources, can also increase risks from violent conflict.
- While statistical studies document a relationship between climate variability and conflict, there remains much disagreement about whether climate change directly causes violent conflicts

AR5 WGII (TS) FAQ.9

Will climate change cause war between countries?

- Climate change has the potential to increase rivalry between countries over shared resources
  - For example, (…) rivalry over changing access to the resources in the Arctic and in transboundary river basins.
- Climate changes represent a challenge to the effectiveness of the diverse institutions that already exist to manage relations over these resources.
- However, there is high scientific agreement that this increased rivalry is **unlikely** to lead **directly** to **warfare between states**.
  - The evidence to date shows that the nature of resources such as transboundary water and a range of conflict resolution institutions have been able to resolve rivalries in ways that avoid violent conflict.

(AR5 WGII FAQ.12.5)

Climate change - conflict: insights from the past ?

- Some studies show that the Little Ice Age in the mid-17th century was associated with more cases of political upheaval and warfare than in any other period, but (…) findings from historical antecedents are not directly transferable to the contemporary globalized world.

- collectively the research **does not conclude** that there is a **strong positive relationship** between warming and armed conflict

- There is some agreement that either increased rainfall or decreased **rainfall** in **resource-dependent economies enhances the risk of localized violent conflict**, particularly in pastoral societies in Africa (…)
  Institutions able to peacefully manage conflict are highlighted as the critical factor in mediating such risks

(AR5 section 12.5.1)

Example:

- Climate and the multiple causes of conflict in Darfur (AR5 Box 12-5):
    - Most authors identify government practices as being far more influential drivers than climate variability, noting also that similar changes in climate did not stimulate conflicts of the same magnitude in neighboring regions, and that in the past people in Darfur were able to cope with climate variability in ways that avoided large-scale violence.

Conflict and Insecurity associated with Climate Policy Responses

- where property rights and conflict management institutions are ineffective or illegitimate, efforts to mitigate or adapt to climate change that change the distribution of access to resources have the potential to create and aggravate conflict.
  For example:
  - Maladaptation or greenhouse gas mitigation efforts at odds with local priorities and property rights may increase the risk of conflict in populations
  - Research on the rapid expansion of biofuels production connects land grabbing, land dispossession, and social conflict
  - Provision of financial resources in payment for ecosystem services projects (such as REDD), has the potential to stimulate conflict over resources and property rights
  - Forced resettlement related to e.g. hydropower, other issues related to low-carbon energy

Violent Conflict and Vulnerability to Climate Change

- development studies and political science show that violent conflict undermines capacity to cope with changes
- conflict creates poverty and constrains livelihoods that, in turn, increases vulnerability to the impacts of climate change; violent conflict is a major cause of hunger and famines.
- armed conflict can decrease the capacity of governments to function effectively as well as the capacity for collective action, which also impedes adaptation

(AR5 section 12.5.3)

State Integrity and Geopolitical Rivalry

- Examples
  - sea-level rise and other changes compromise human security, in particular in countries made up entirely of low-lying atolls
  - Productive ocean fisheries are already directly affected by climate change (…) the movement of fish stocks has been suggested to increase transboundary rivalry
  - The **impacts of climate-induced water variability on transboundary water basins** generates geopolitical concerns (…) particularly where challenges stemming from rising consumption and growing populations are already present.
  - Uncertainty and high likelihood of differential geographic impacts of **geoengineering** are anticipated sources of tension or conflict between states. These include regional effects of solar radiation management on reduced precipitation in specific areas in Asia or in the Sahel with negative food production implications

(AR5 section 12.6)

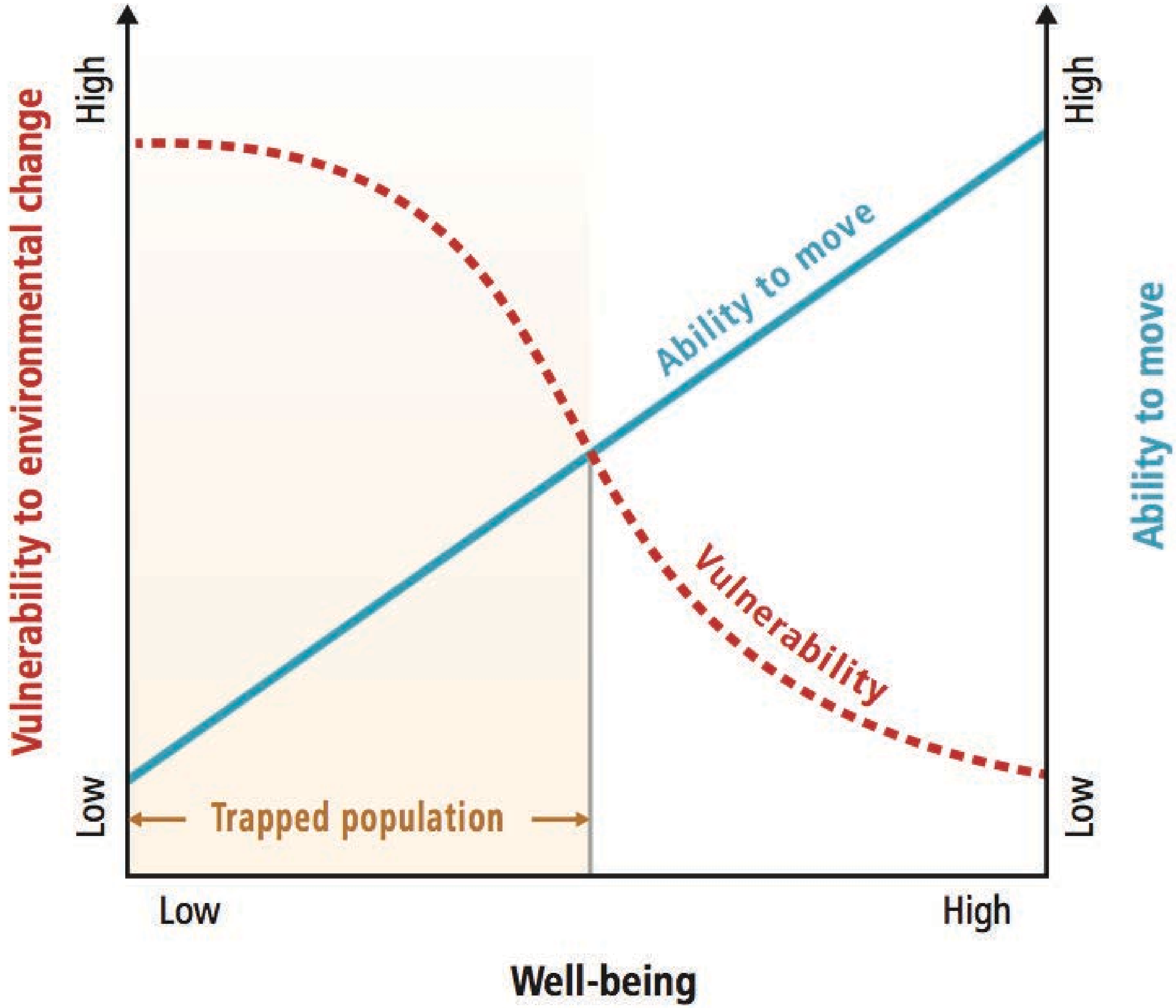
Geopolitical Dimensions of Climate Change Impacts in the Arctic

- The Arctic has been warming at about twice the global rate since 1980, resulting in unprecedented loss in sea ice
- These changes have implications for land-based infrastructure, shipping, resource extraction, coastal communities, and transport
- There is medium evidence that changes will create or revive terrestrial and maritime boundary disputes among Arctic countries. There is little evidence the changing Arctic will become a site for violent conflict between states
- At present, political institutions are providing forums for managing resource competition, new transportation practices, and boundary disputes, but anticipated increased stresses will test these institutions in the future

(AR5 Box 12-6)

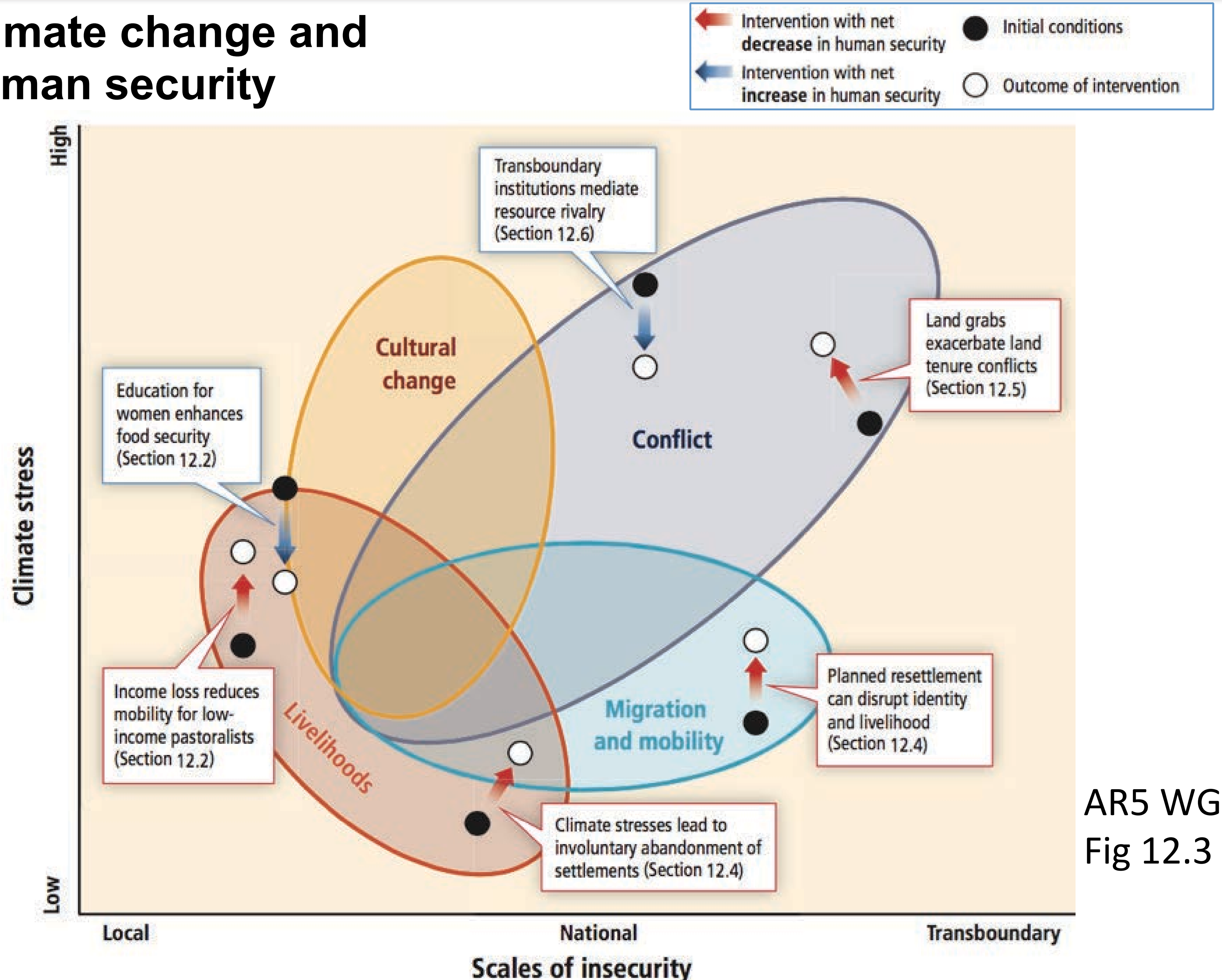
Climate change and migrations

- populations most exposed and vulnerable to the impacts of climate change may have least ability to migrate

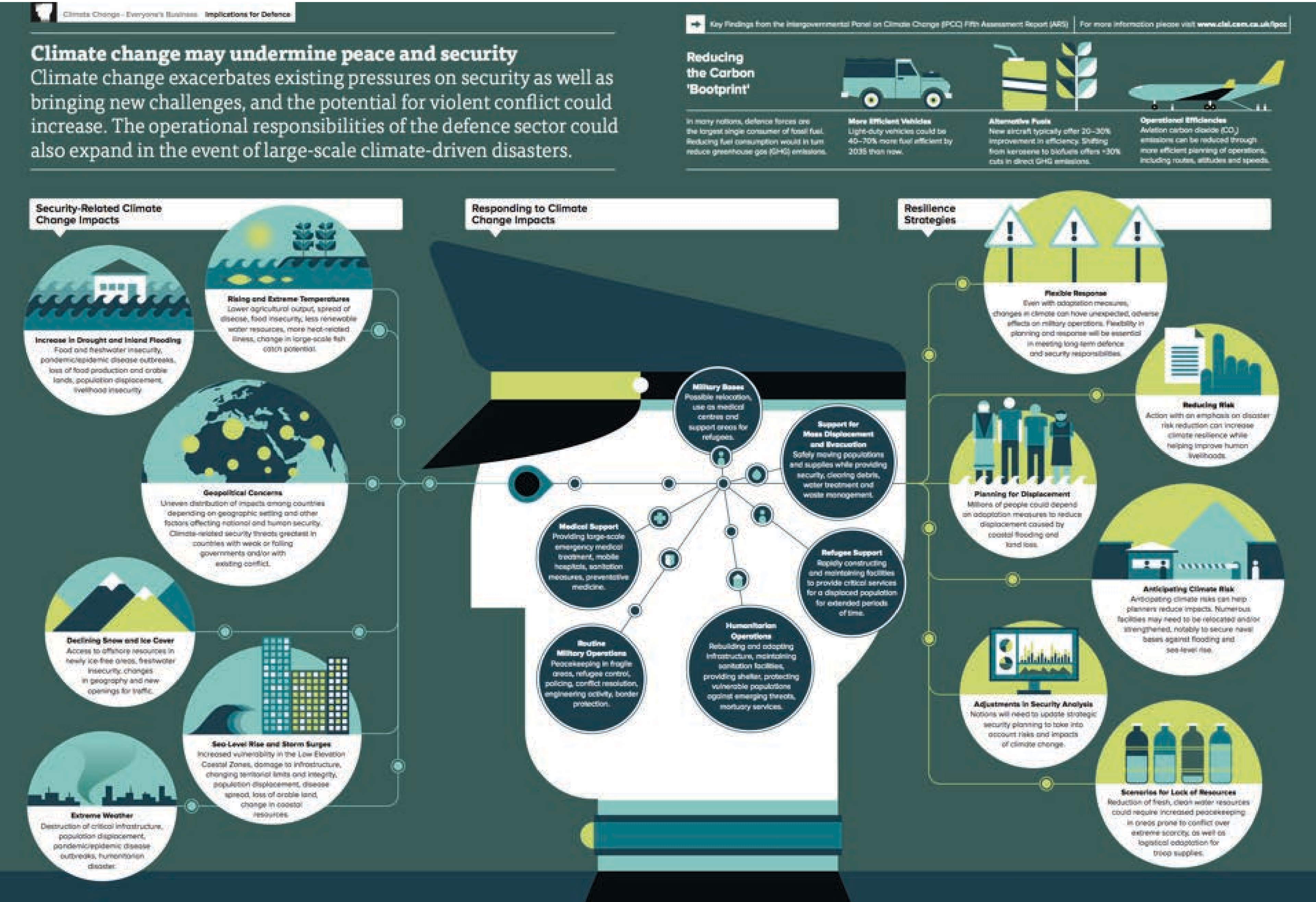


AR5 WGII
Fig 12.1

Climate change and human security



AR5 WGII Fig 12.3



http://www.cisl.cam.ac.uk/Resources/Climate-and-Energy/Climate-Change-Implications-for-Defence.aspx

Climate change may undermine peace and security

Climate change exacerbates existing pressures on security as well as bringing new challenges, and the potential for violent conflict could increase. The operational responsibilities of the defence sector could also expand in the event of large-scale climate-driven disasters.

Key Findings from the Intergovernmental Panel on Climate Change (IPCC) Fifth Assessment Report (AR5) | For more information please visit **www.cisl.cam.ca.uk/ipcc**

Reducing the Carbon 'Bootprint'

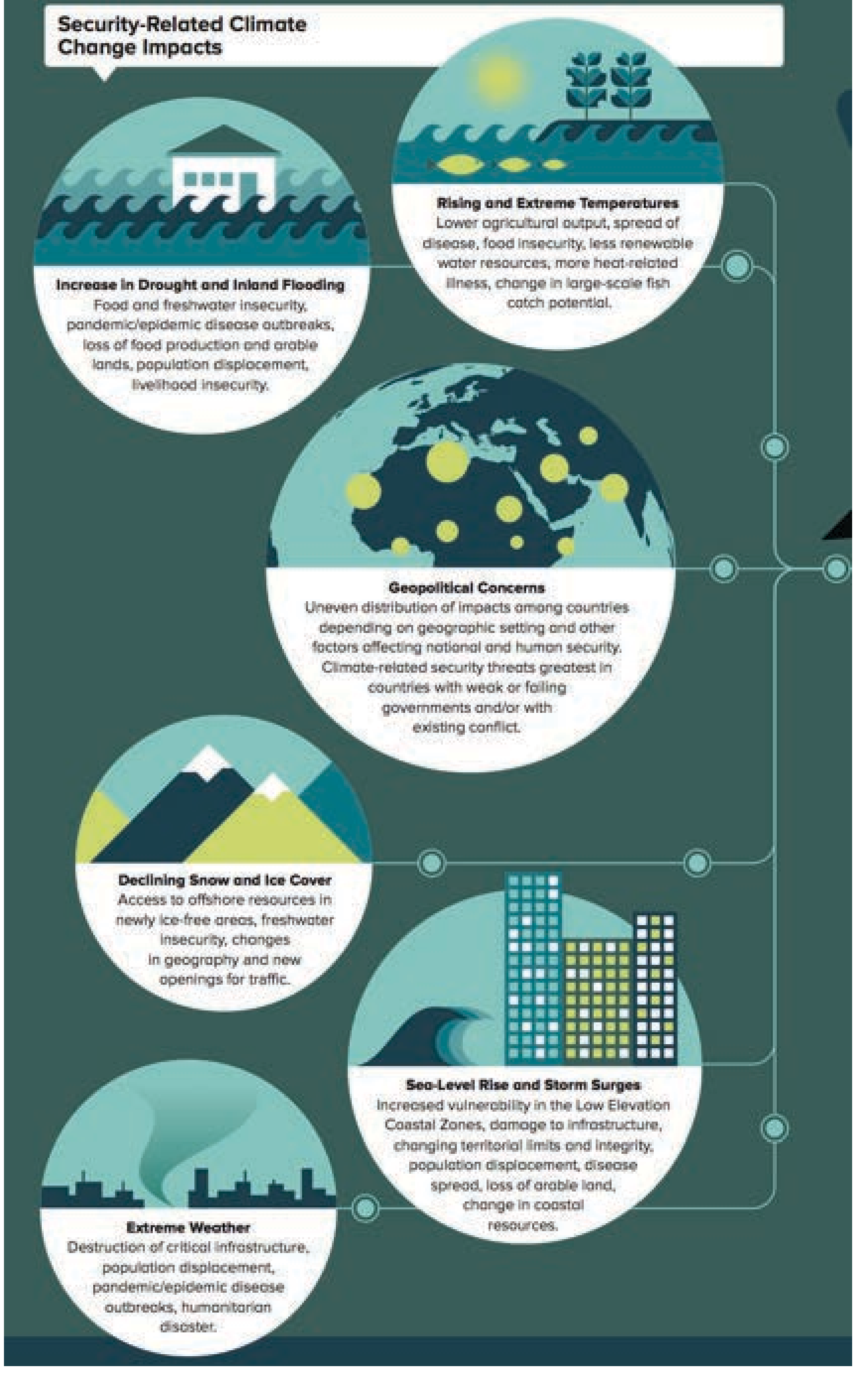
In many nations, defence forces are the largest single consumer of fossil fuel. Reducing fuel consumption would in turn reduce greenhouse gas (GHG) emissions.

More Efficient Vehicles
Light-duty vehicles could be 40–70% more fuel efficient by 2035 than now.

Alternative Fuels
New aircraft typically offer 20–30% improvement in efficiency. Shifting from kerosene to biofuels offers +30% cuts in direct GHG emissions.

Operational Efficiencies
Aviation carbon dioxide (CO_2) emissions can be reduced through more efficient planning of operations, including routes, altitudes and speeds.

http://www.cisl.cam.ac.uk/Resources/Climate-and-Energy/Climate-Change-Implications-for-Defence.aspx



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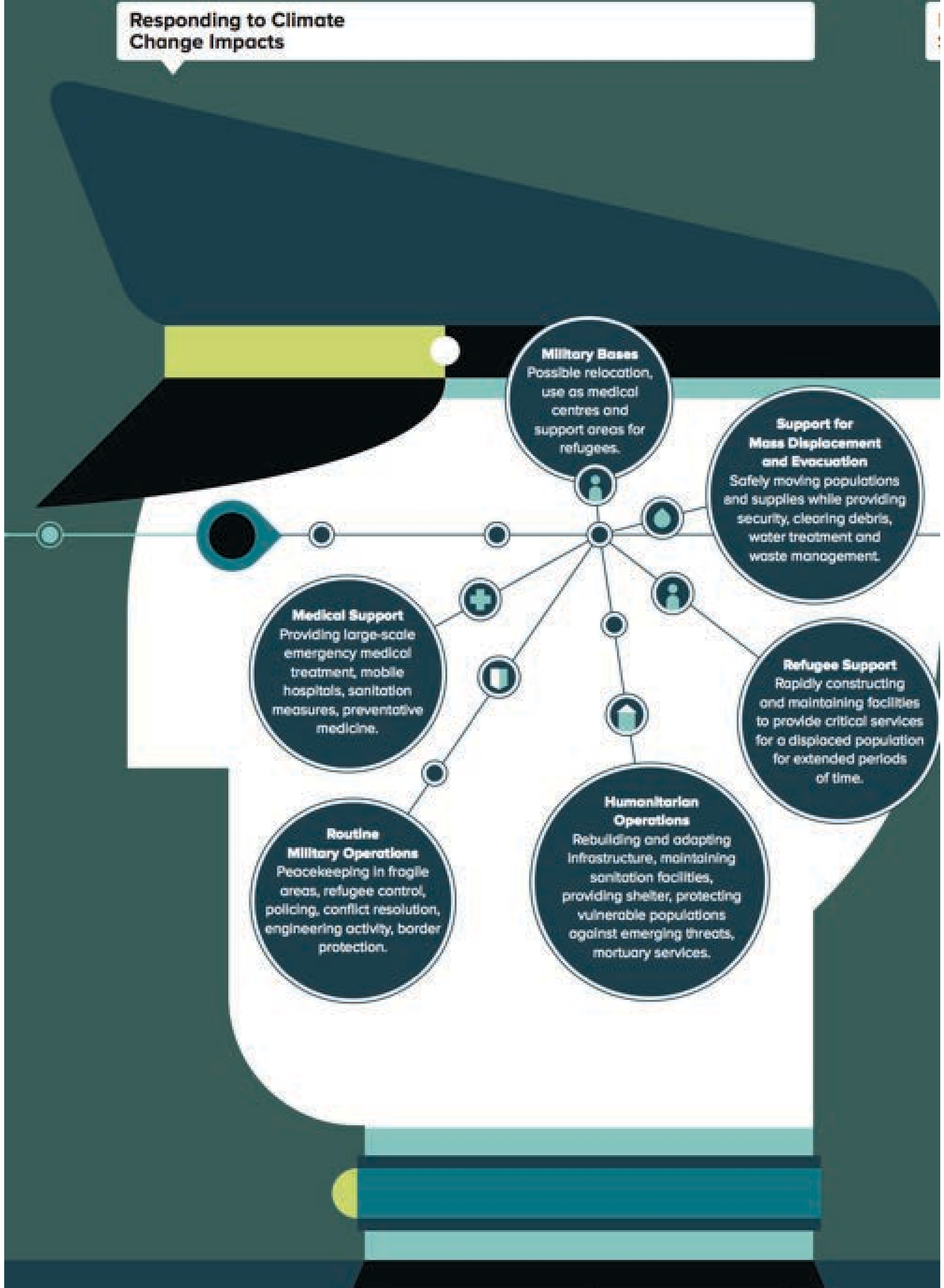

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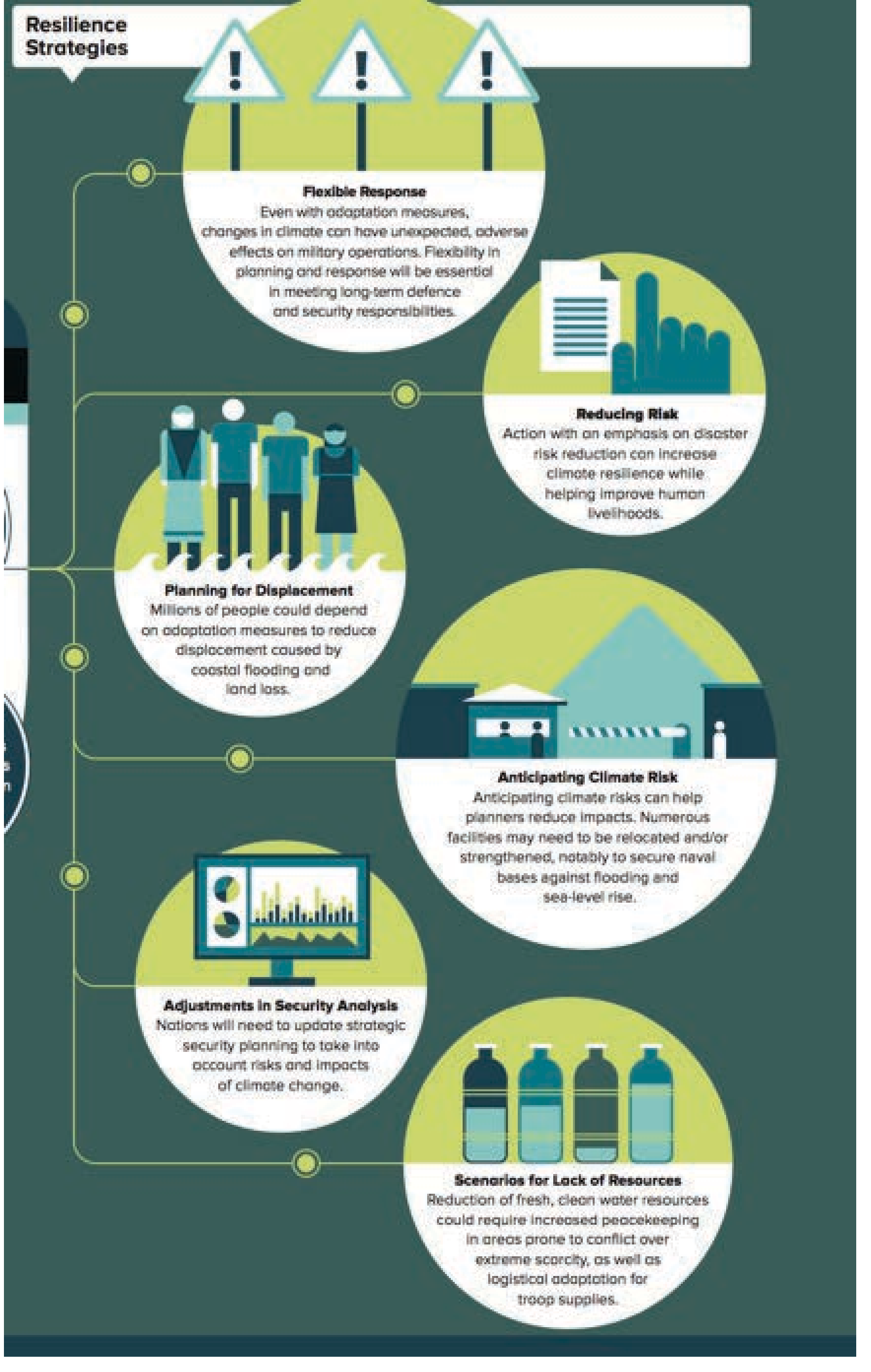

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Resilience

Many **adaptations to climate change that involve the military can result in significant co-benefits**, such as alleviating poverty and enhancing development, especially in developing countries:

- **Flood preparedness**
- **Relocating military installations and bases**
- **Preparing for water insecurity**
- **Increasing resilience**

Mitigation Potential

The **global military complex is an energy-intensive industry** and in many nations, defence forces are the largest single consumer of fossil fuels.

- **More efficient vehicles**
- **Alternative fuels**
- **Operational improvements**
- **NB: Note risk of unintended consequences of mitigation and adaptation**

Conclusion

Climate change has the potential to increase the risk of conflict and insecurity because factors such as poverty and economic hardship, associated with a higher risk of violent conflict, are especially sensitive to climate change.

Although many climate risks warrant further investigation and there is a need for more comprehensive evidence across multiple locations and over long durations, **it is likely that climate change over the 21st century** will lead to new challenges to states and **will increasingly shape national security policies**.

Useful links:

- www.ipcc.ch : IPCC
- www.cisl.cam.ca.uk/ipcc : AR5 summary sheet on security
- www.climate.be/vanyp : my slides and other documents
- www.skepticalscience.com: excellent responses to contrarians arguments
- **On Twitter: @JPvanYpersele**

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