The Climate Change Challenge and the Role of Bioenergy

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World Bioenergy 2014, Jönköping, 3 June 2014

Thanks to the Belgian Federal Science Policy Office (BELSPO) for its support

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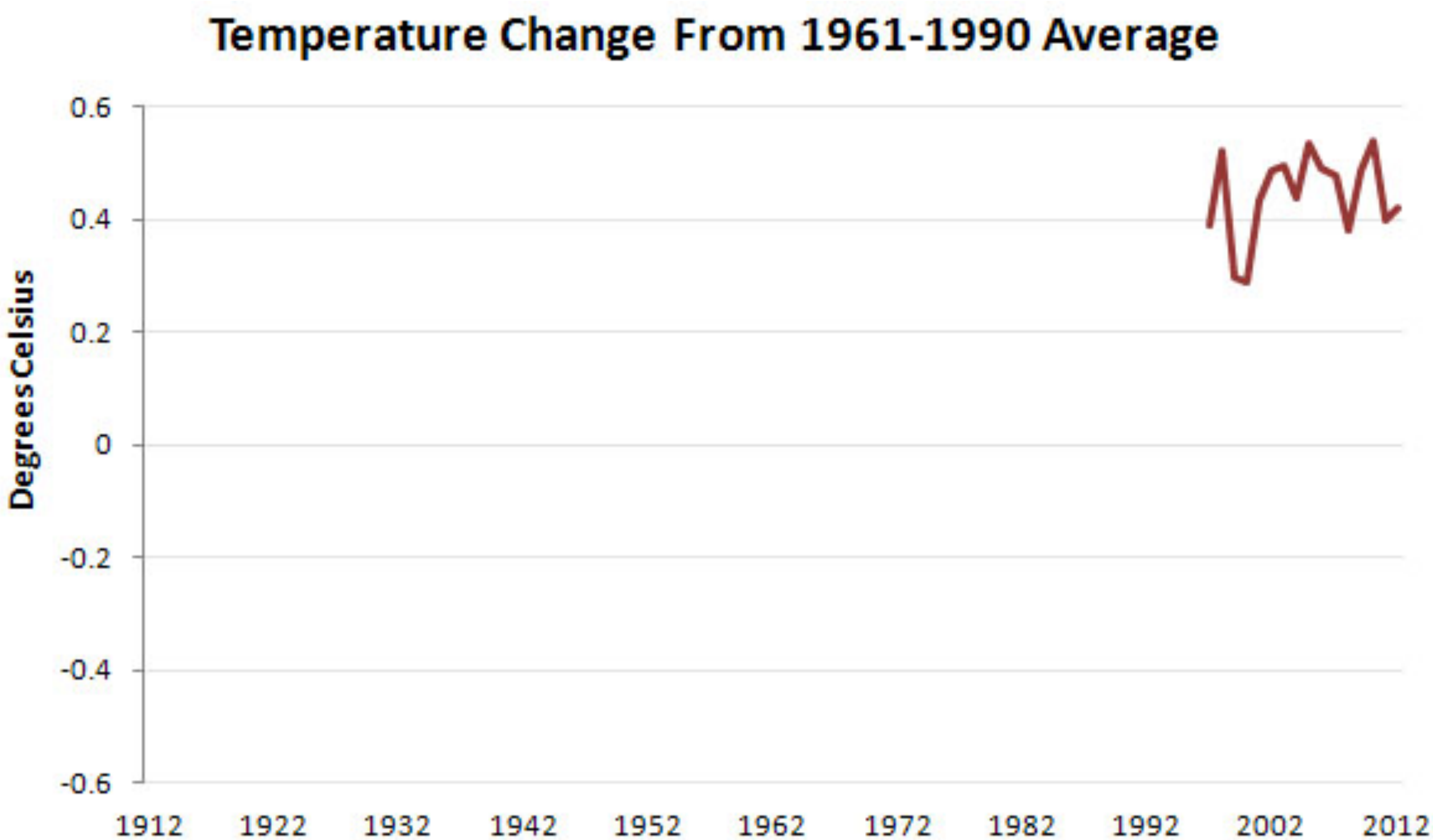
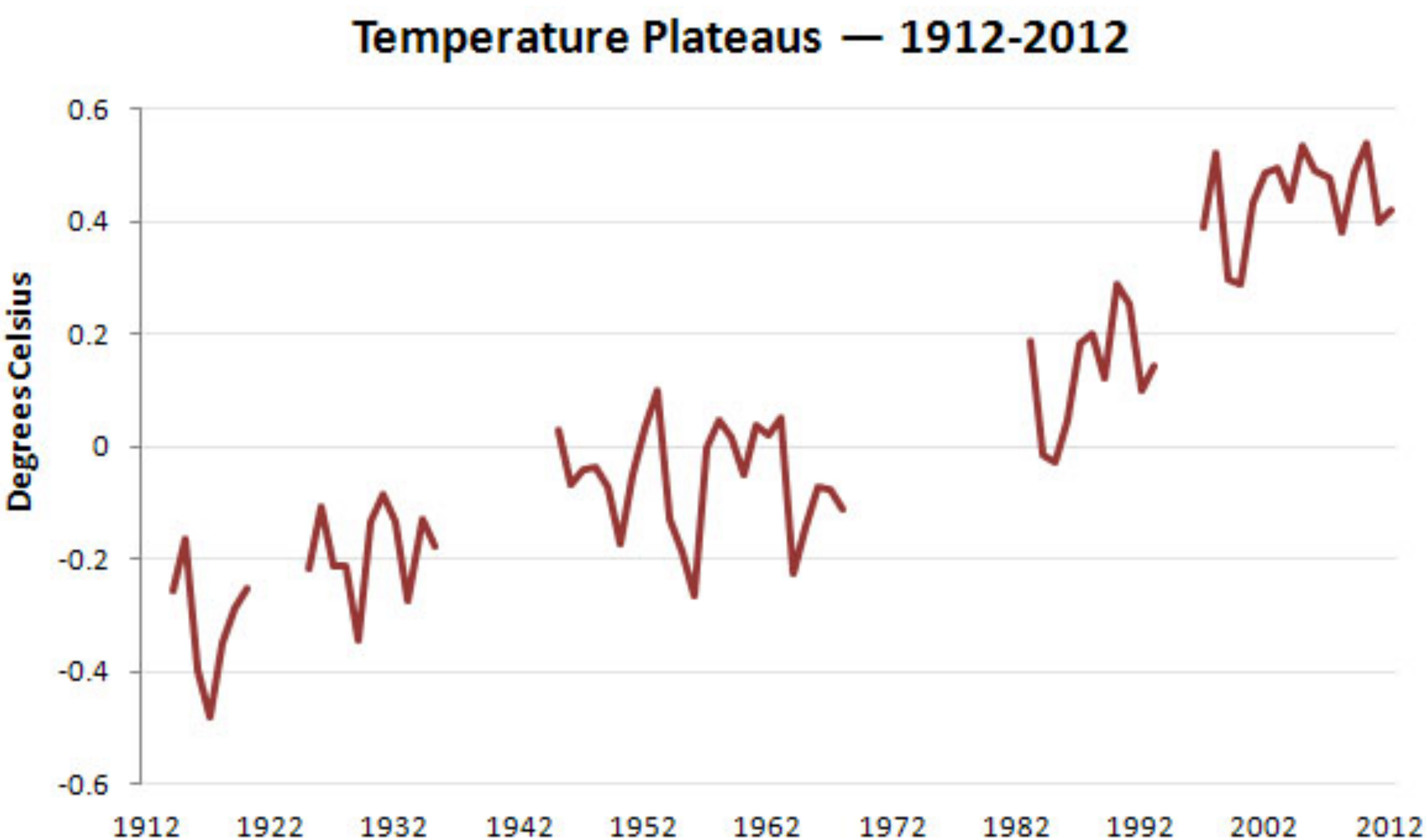


http://www.motherjones.com/kevin-drum/2012/10/lying-statistics-global-warming-edition

Lying With Statistics, Global Warming Edition



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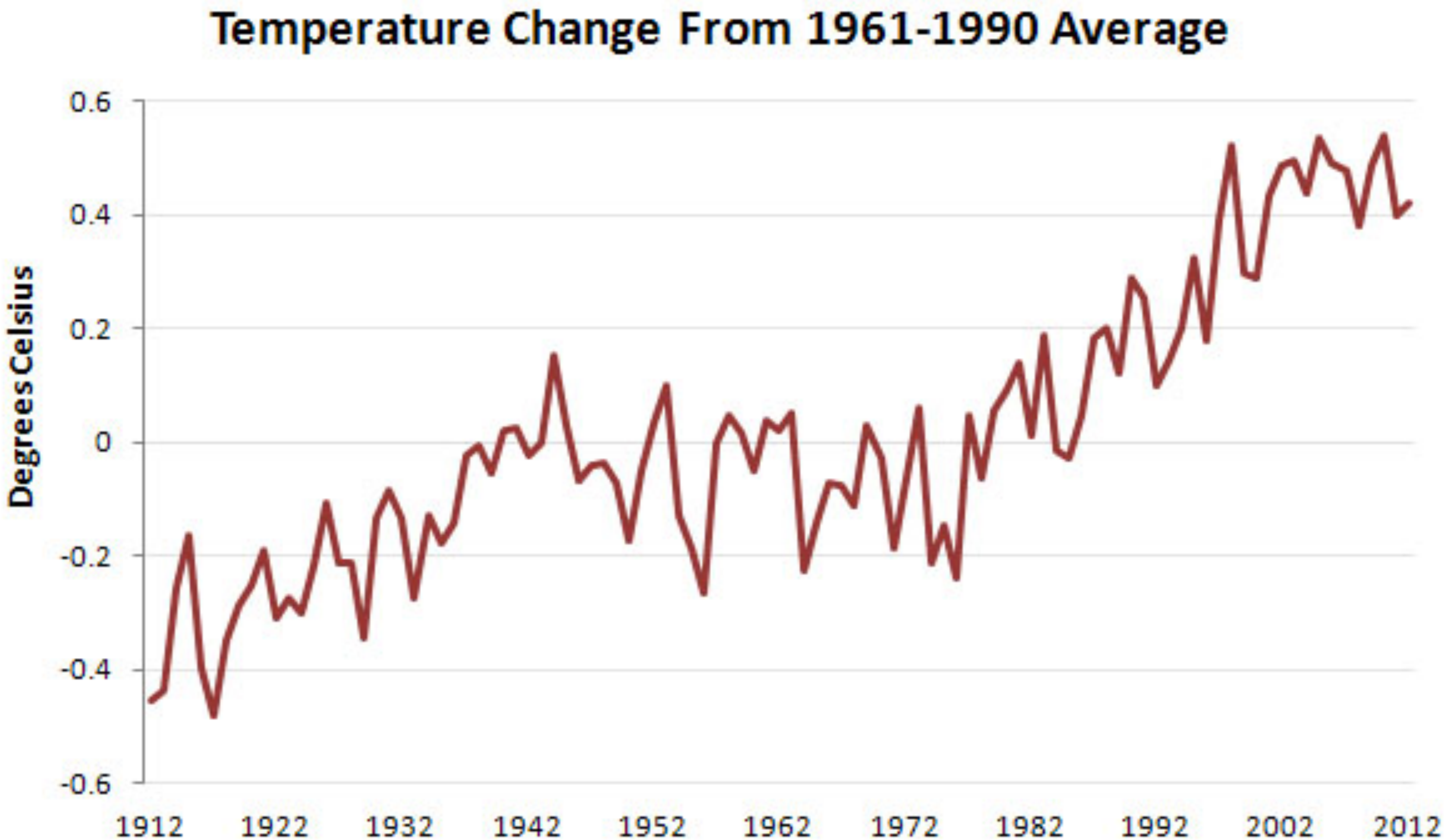


http://www.motherjones.com/kevin-drum/2012/10/lying-statistics-global-warming-edition

Why the IPCC ?

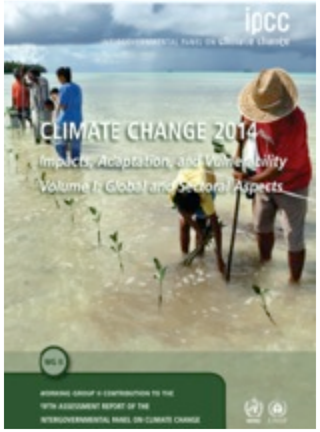
Established by WMO and UNEP in 1988

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 Organizatior

UNEP= United Nations Environment Programme



What is happening in the climate system?

What are the risks?

What can be done?

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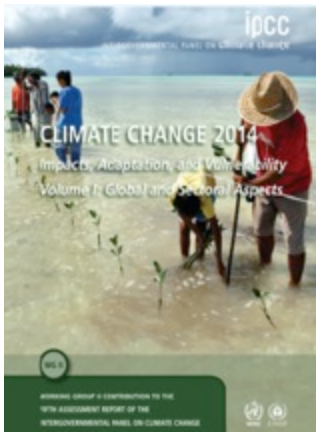

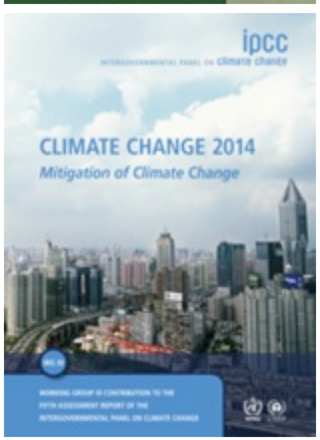

WG I (Physical science basis): 209 lead authors, 2014 pages, 54.677 review comments

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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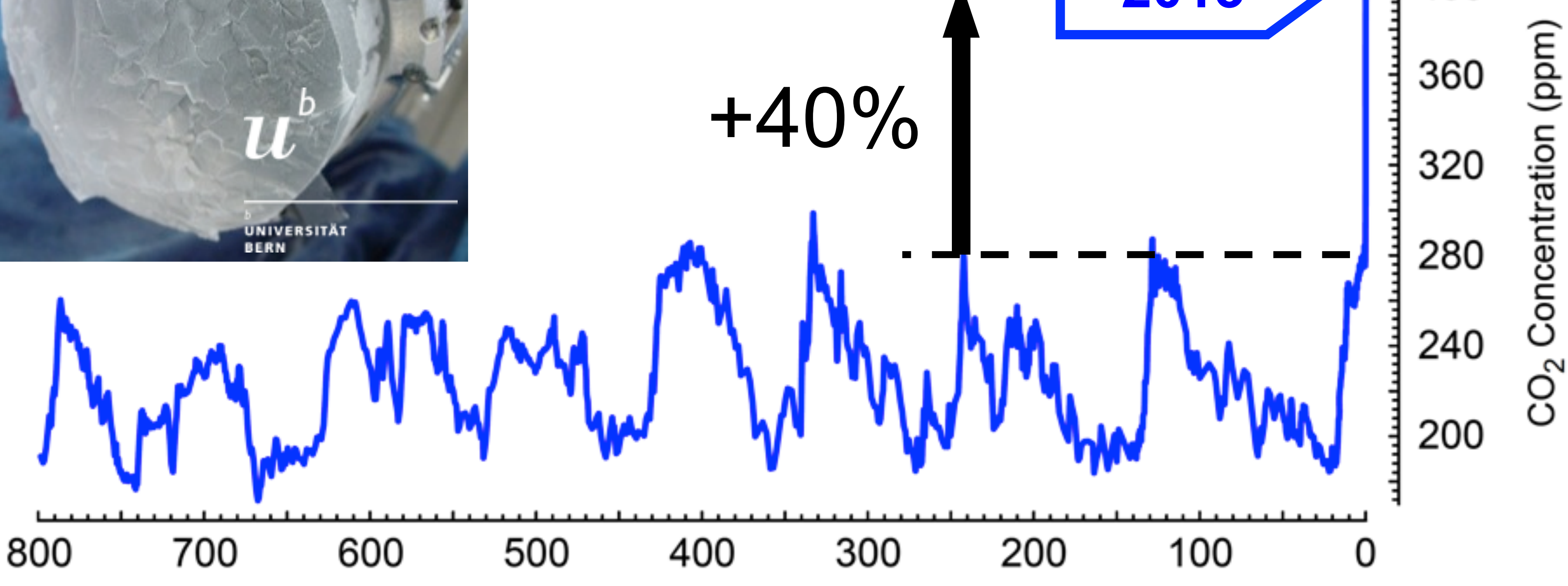
What is happening in the climate system?

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)

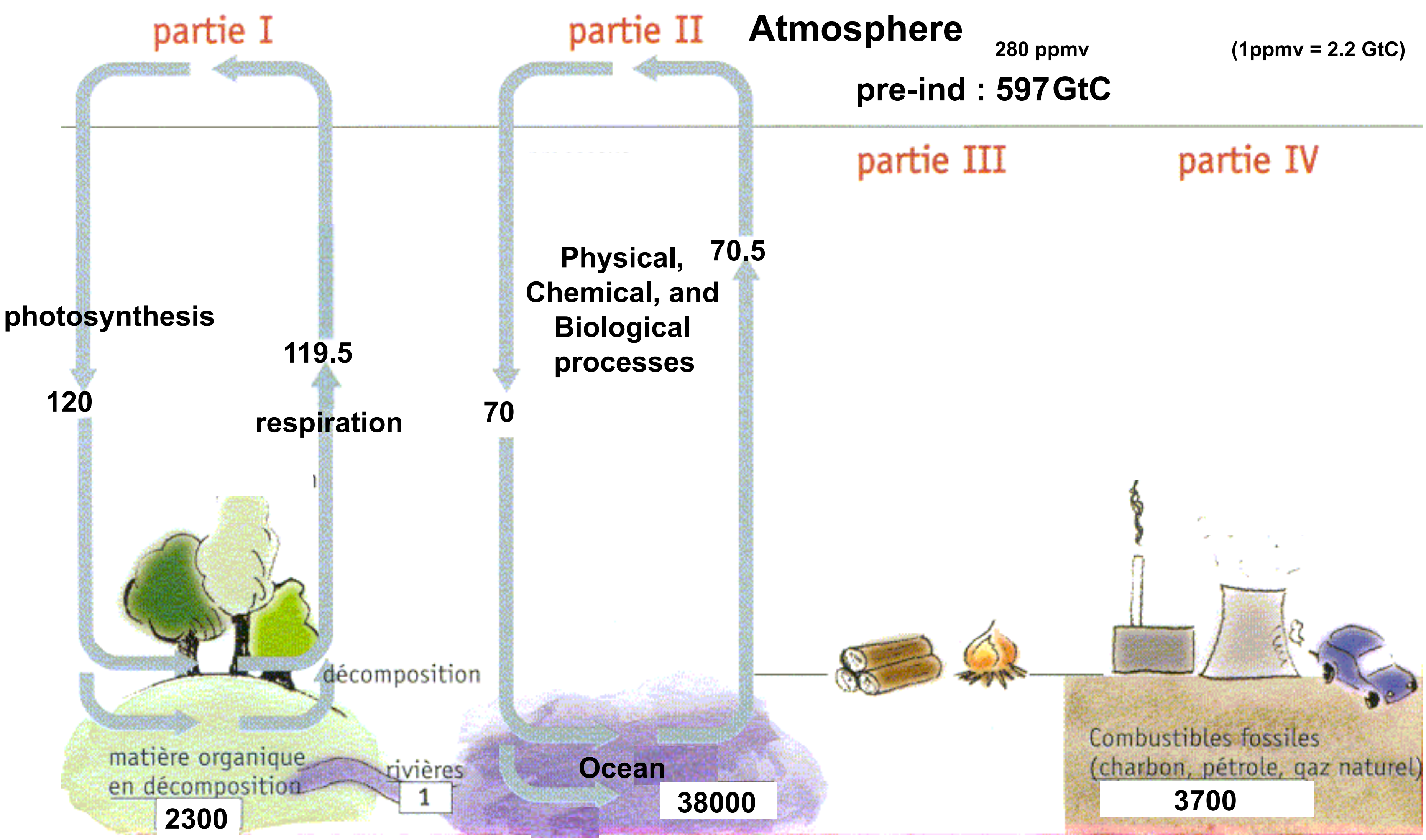
http://www.weather.com/news/science/environment/alaskas-glaciers-capturing-earth-changing-our-eyes-20131125?cm_ven=Email&cm_cat=ENVIRONMENT_us_share



(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

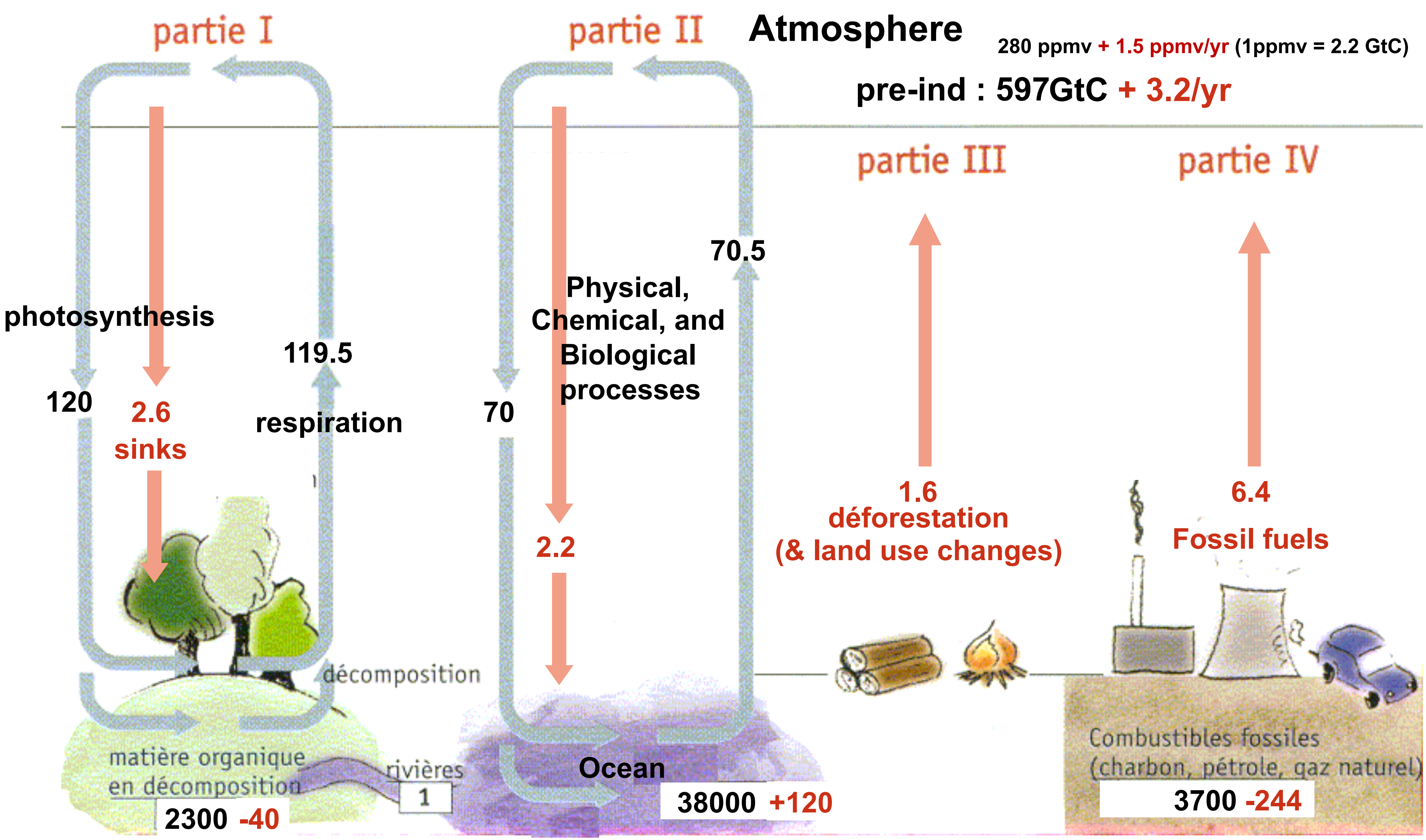


Units: GtC (billions tons of carbon) or GtC/year (multiply by 3.7 to get $GtCO_2$)

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!

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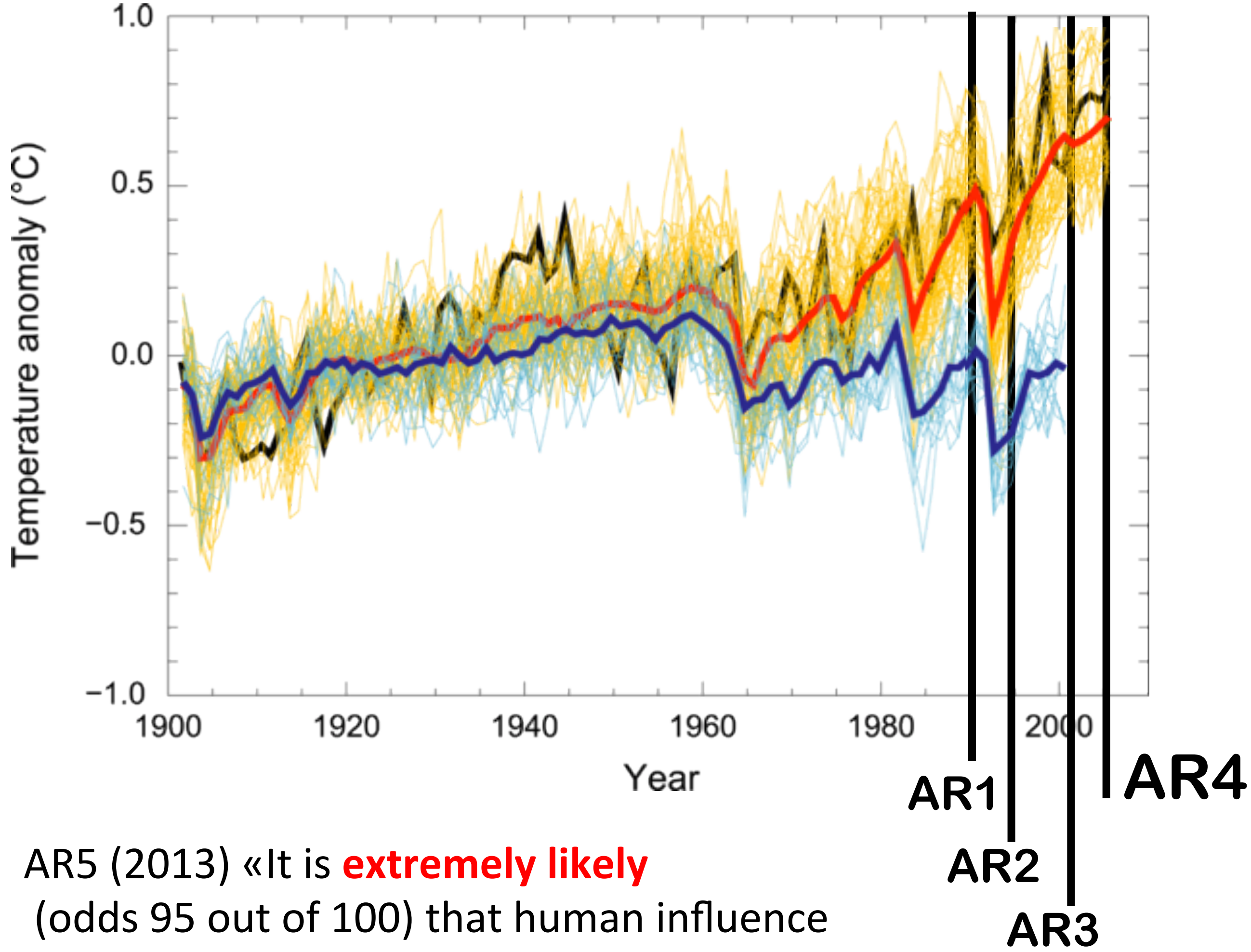
A Progression of Understanding: Greater and Greater Certainty in Attribution

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

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

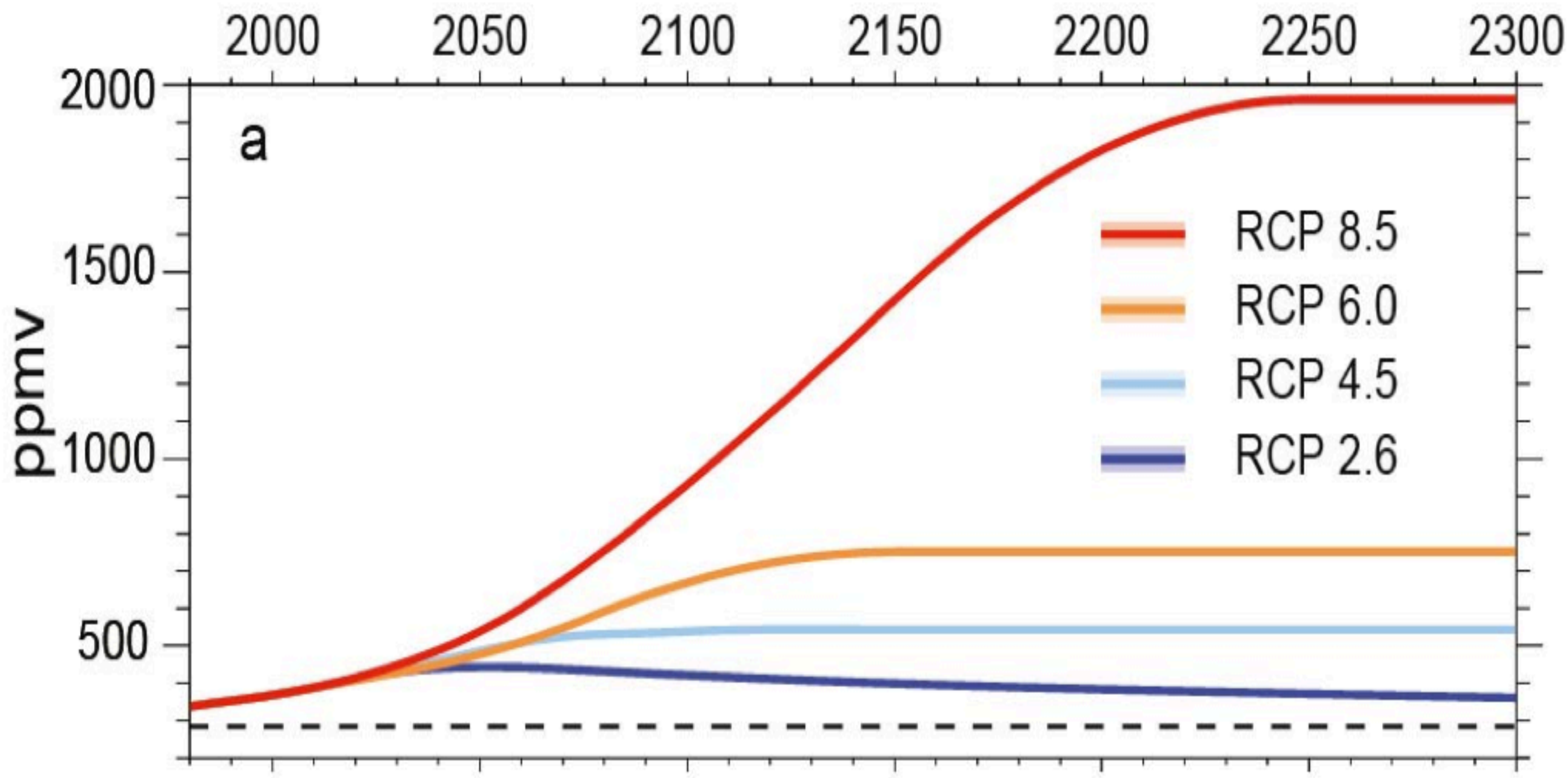
AR3 (2001): "most of the warming of the past 50 years is **likely** (odds 2 out of 3) due to human activities"

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



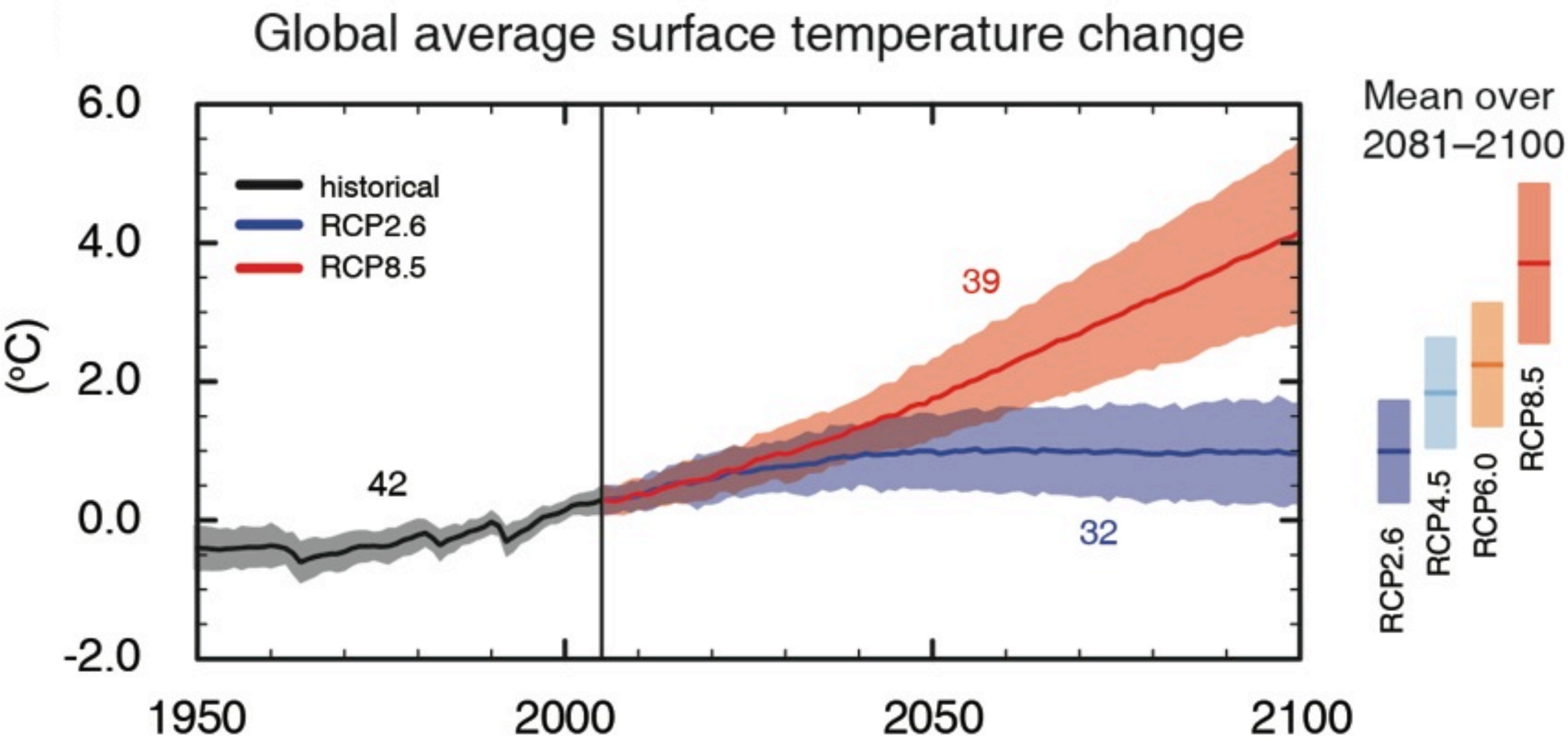
AR5 (2013) «It is **extremely likely** (odds 95 out of 100) that human influence has been the dominant cause… »

RCP Scenarios: Atmospheric CO_2 concentration



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

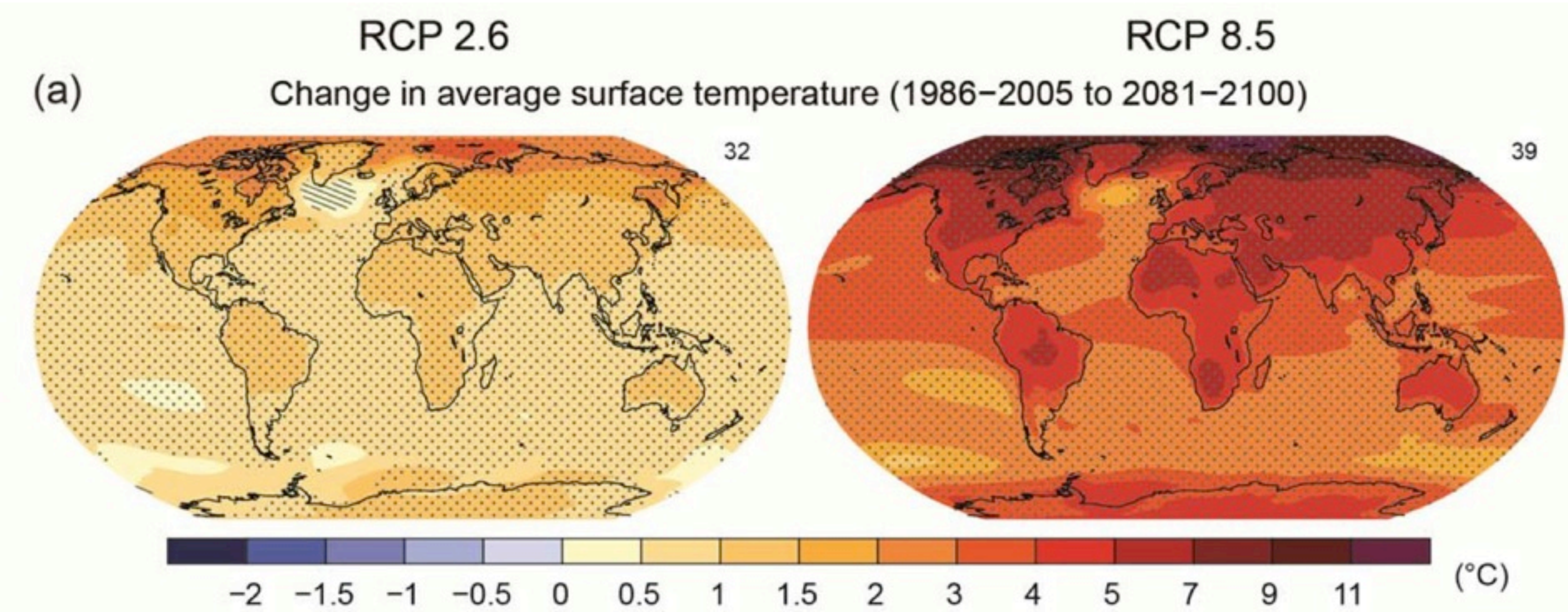
AR5, chapter 12. WGI- Adopted version / subject to final copyedit



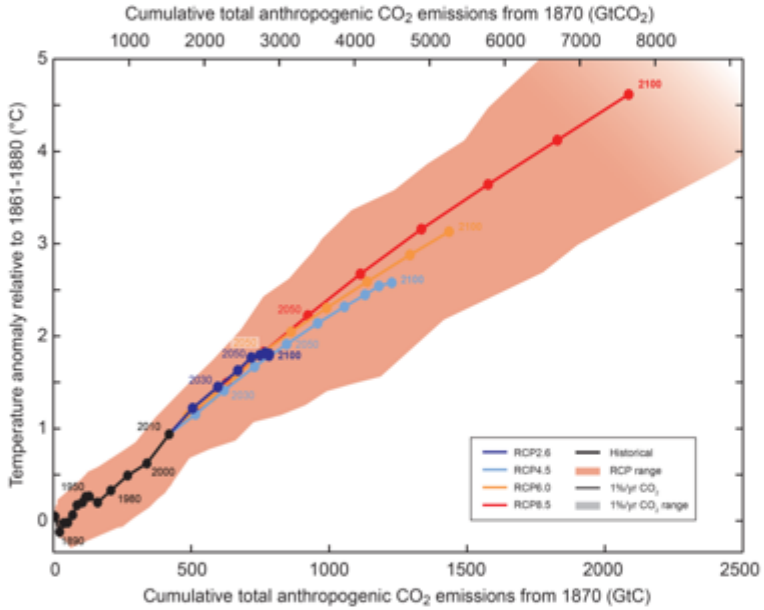
(IPCC 2013, Fig. SPM.7a)

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



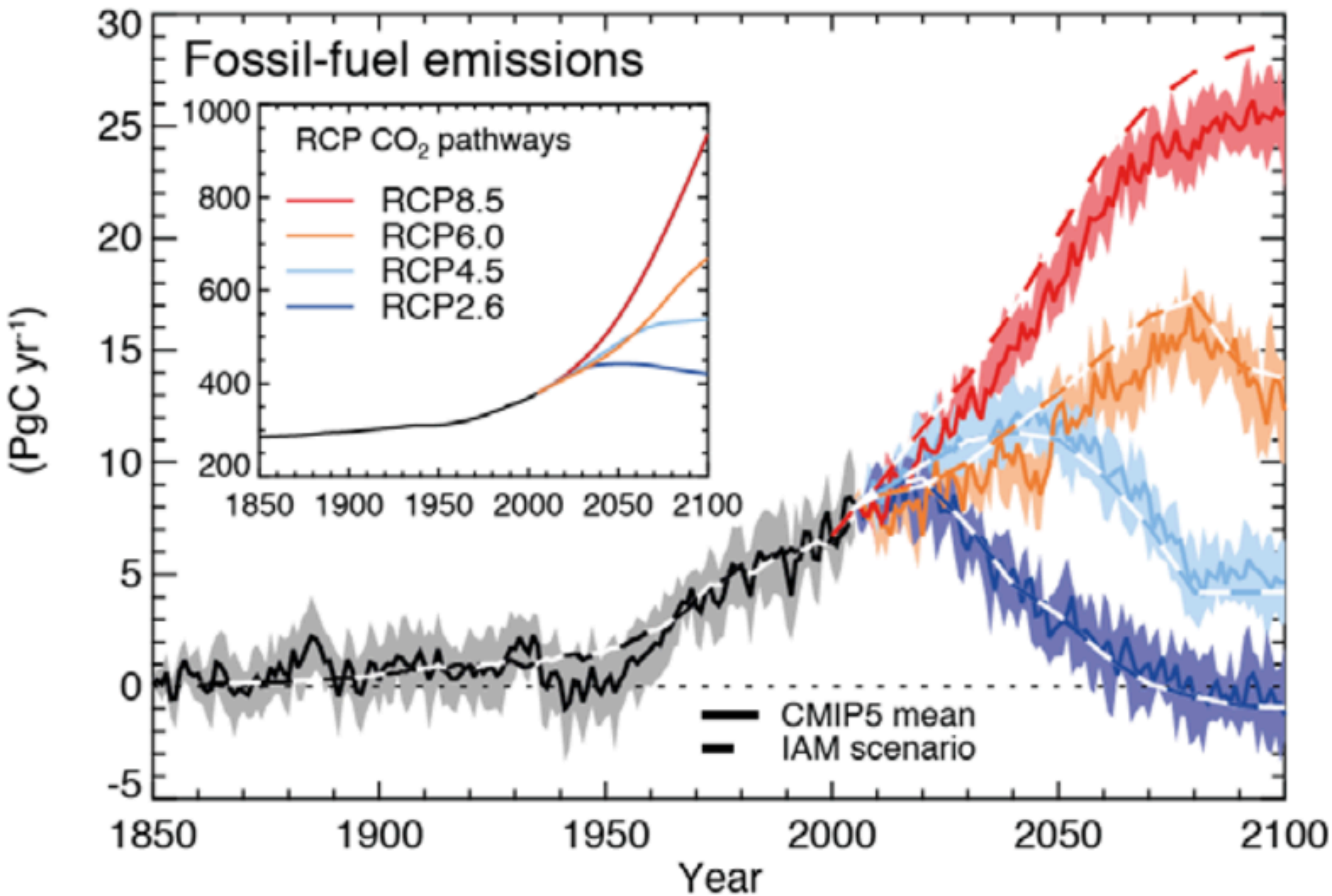
AR5 WGI SPM - Approved version / subject to final copyedit



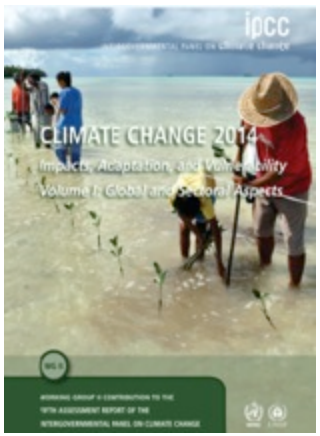
Limiting warming to *likely* less than 2°C since 1861-1880 requires cumulative CO_2 emissions to stay below 1000 GtC. Until 2011, over 50% of this amount has been emitted.

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

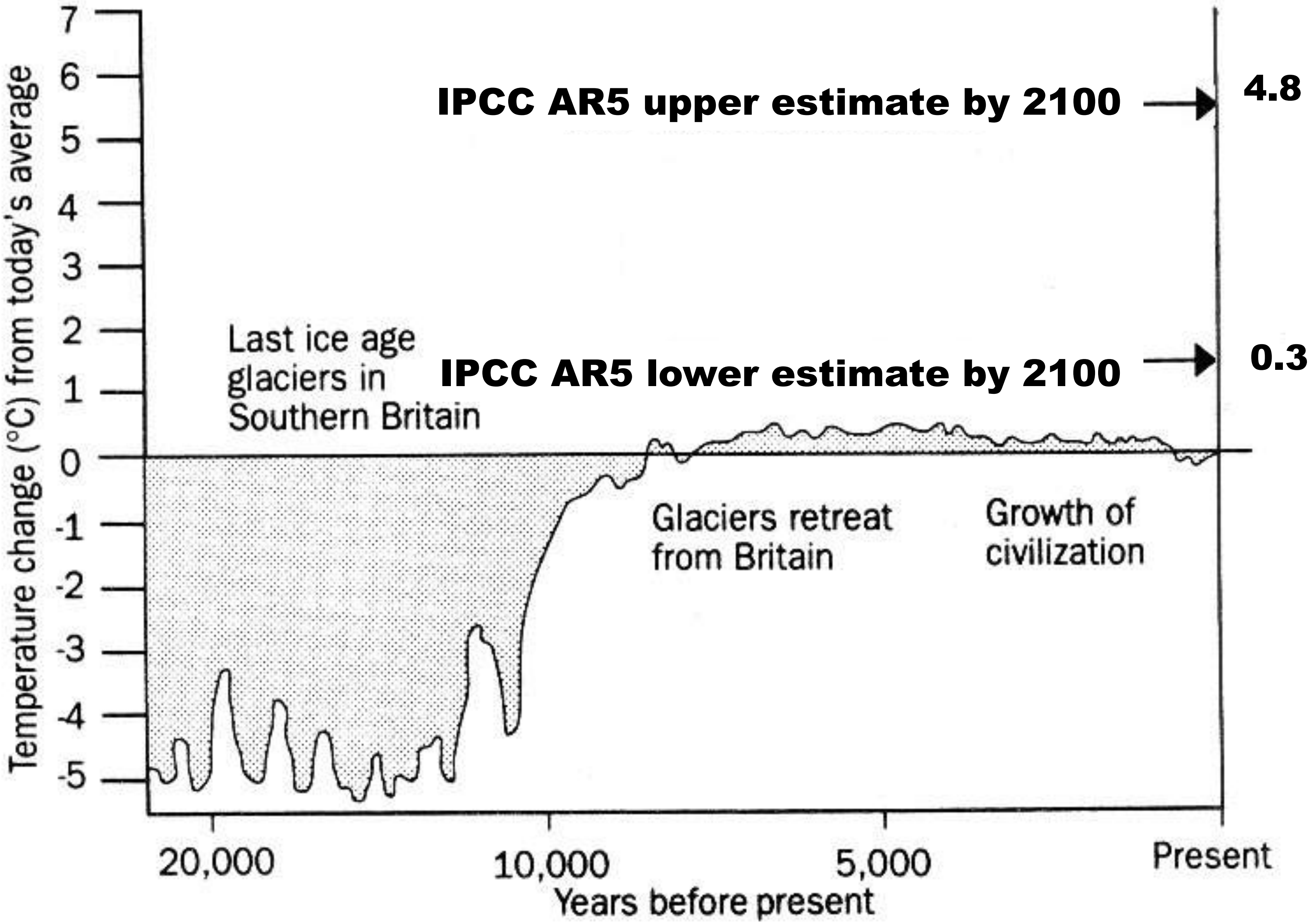
Compatible fossil fuel emissions simulated by the CMIP5 models for the four RCP scenarios



AR5 WGI TS – Fig TS 19



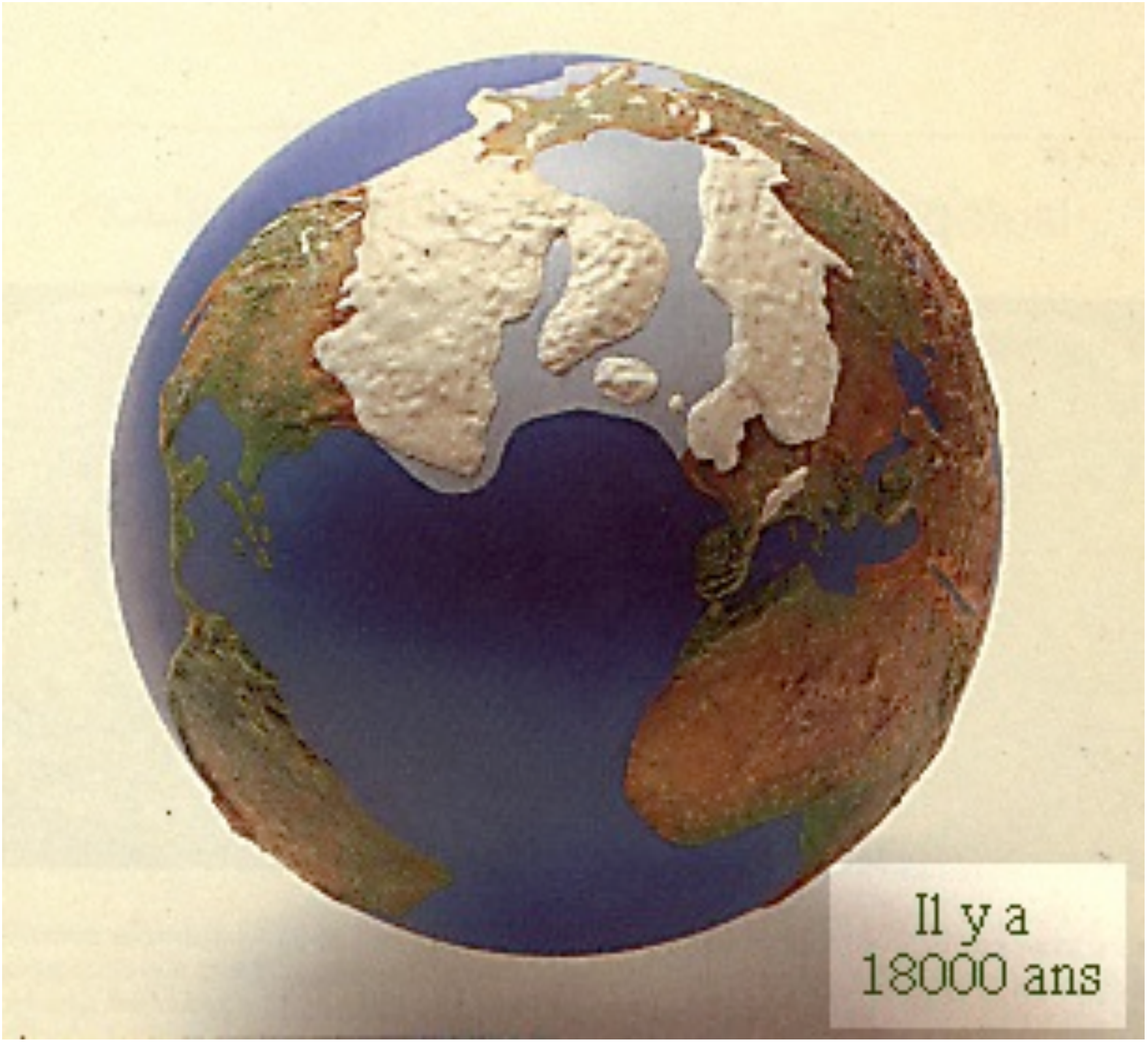
What are the risks?



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

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

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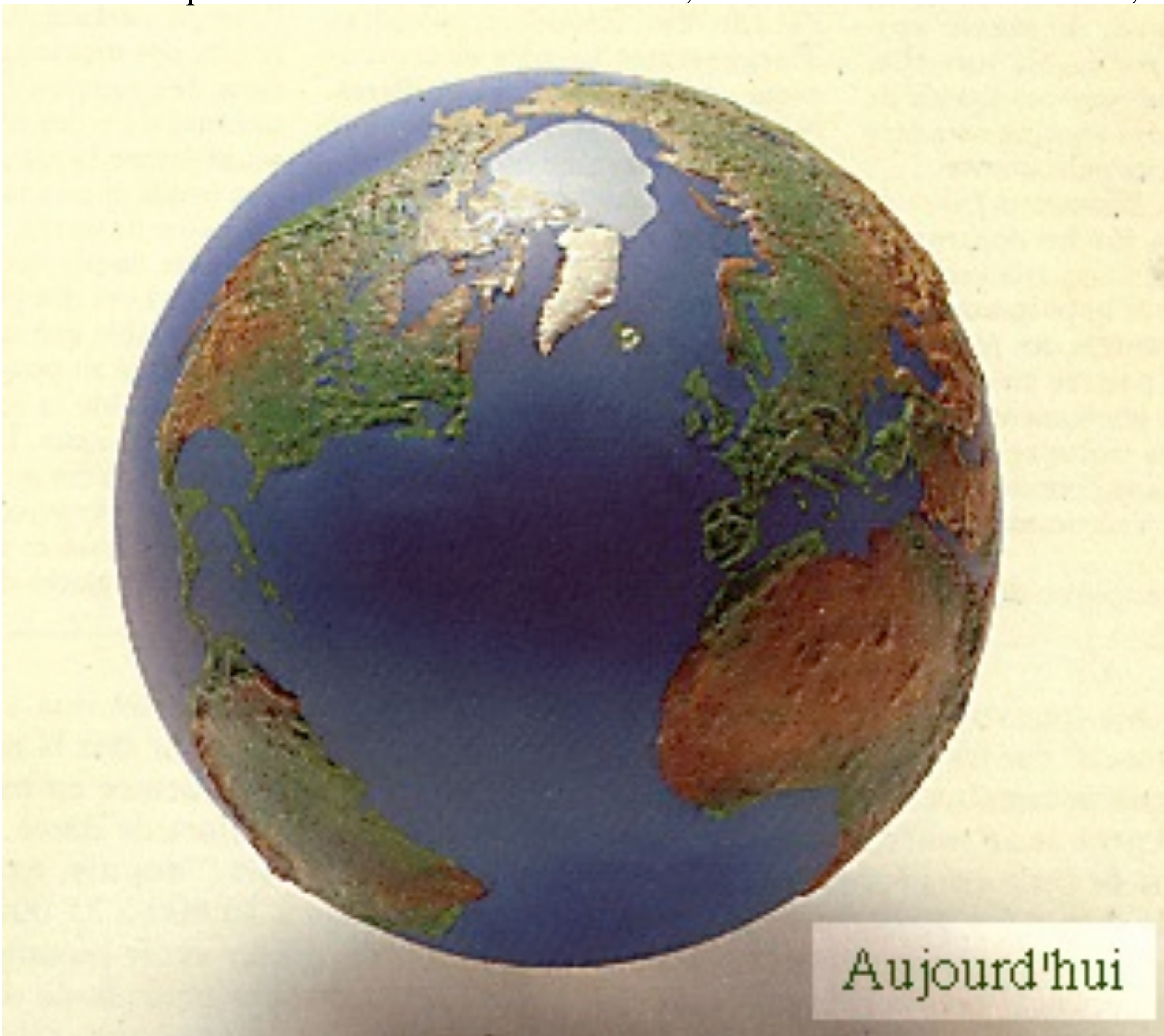


INCREASING MAGNITUDES OF WARMING INCREASE THE LIKELIHOOD OF
SEVERE AND PERVASIVE IMPACTS
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RISKS OF
CLIMATE CHANGE
INCREASE
WITH CONTINUED
HIGH EMISSIONS
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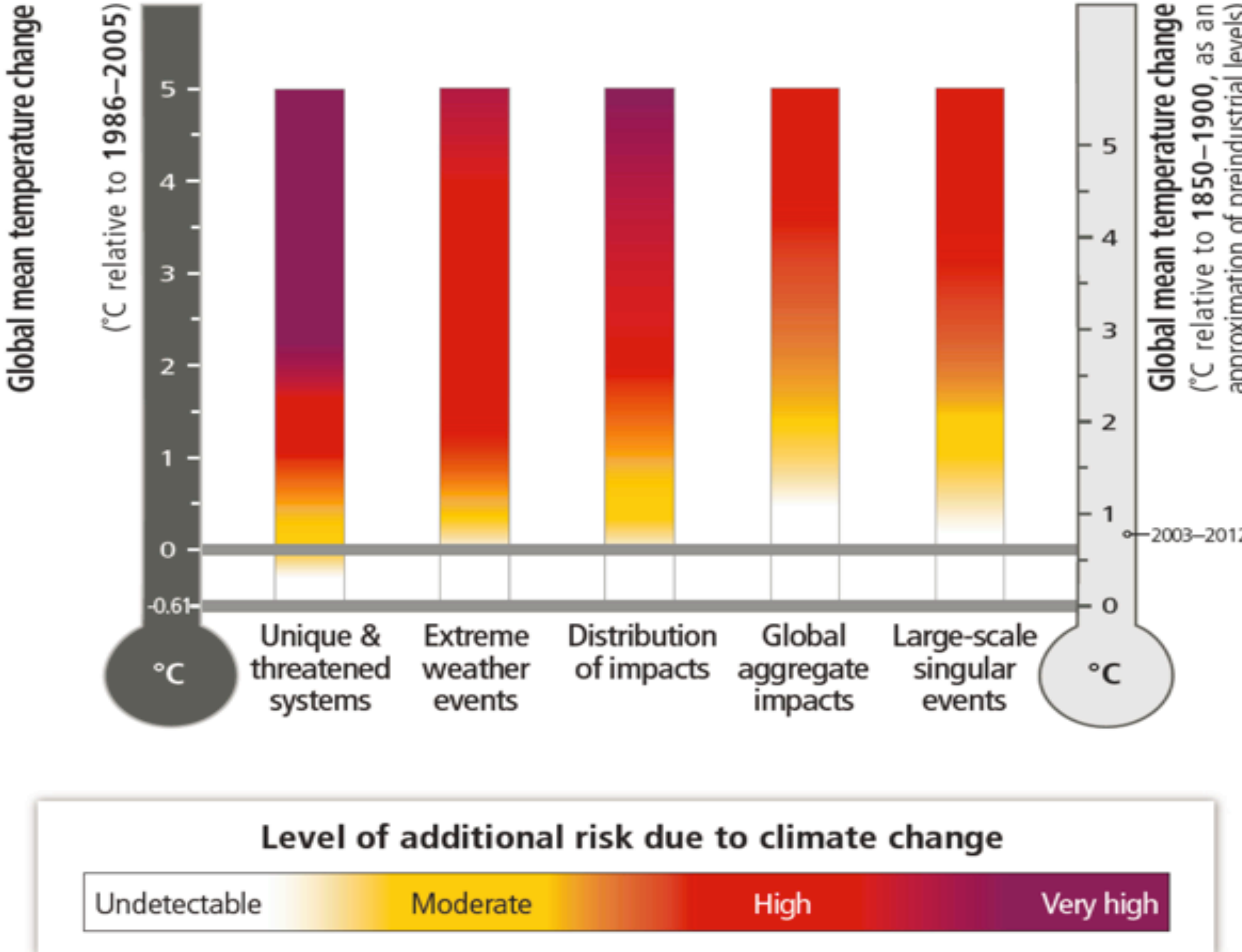
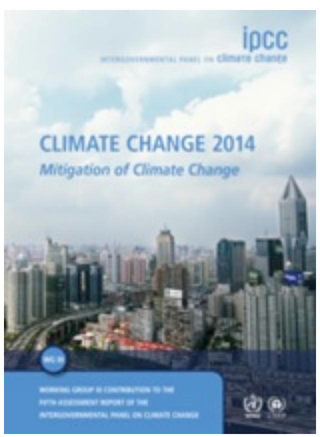
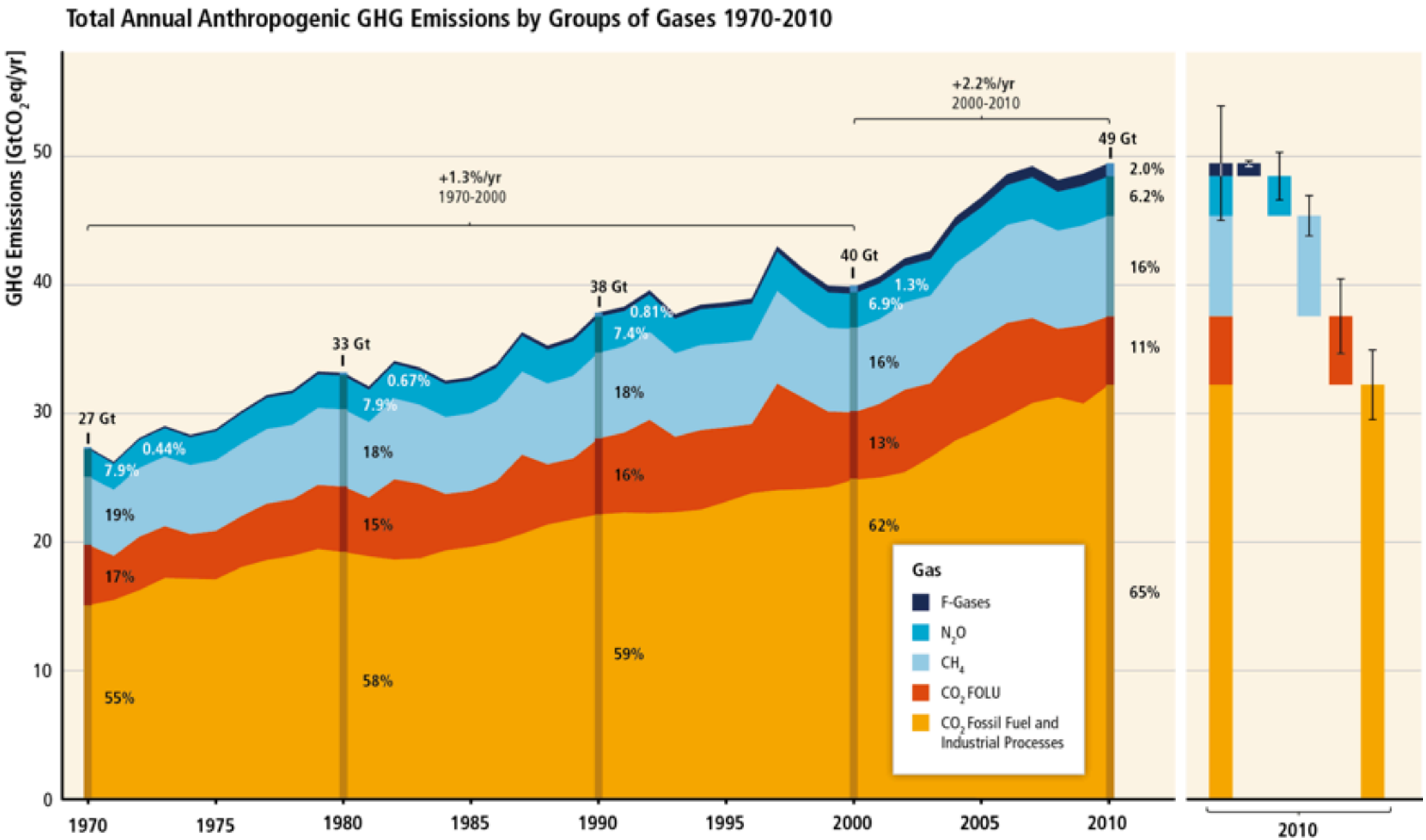


AR5, WGII, Box SPM.1 Figure 1

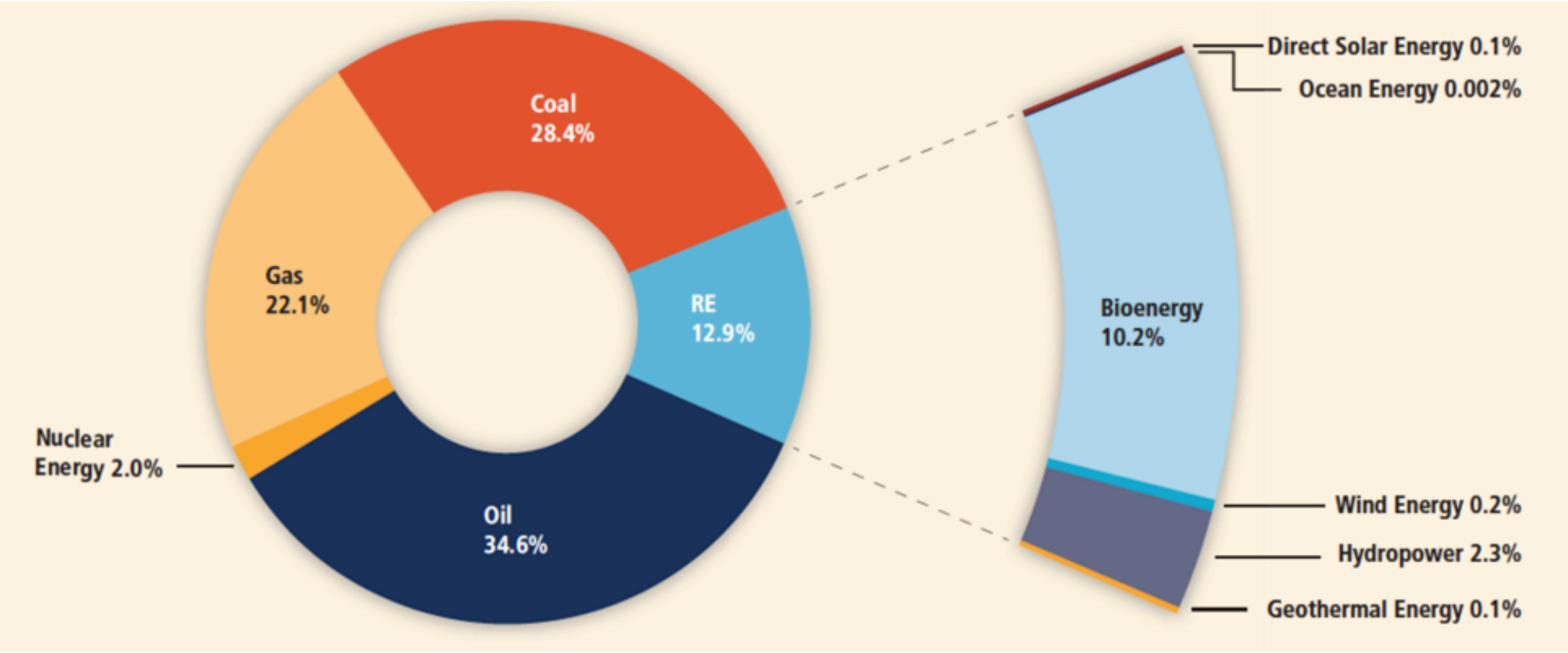


What can be done?

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



Shares of energy sources in total global primary energy supply in 2008



IPCC (2012), SRREN, SPM.2

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

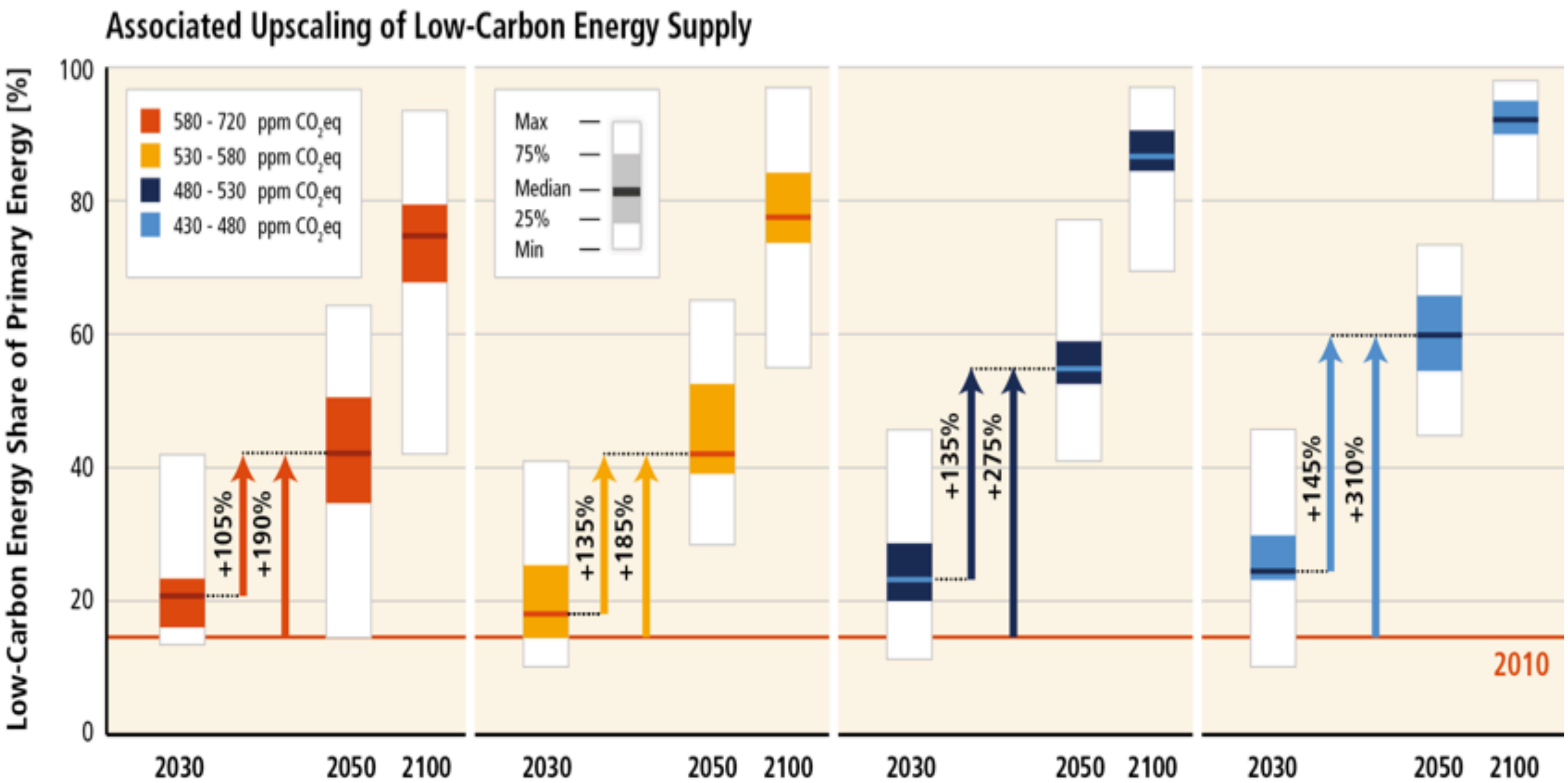
- **Many scenario studies confirm that it is technically and economically feasible to keep the warming below 2°C, with more than 66% probability ("likely chance").** This would imply limiting atmospheric concentrations to 450 ppm CO_2-eq by 2100.
- **Such scenarios** for an above 66% chance of staying 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 ?

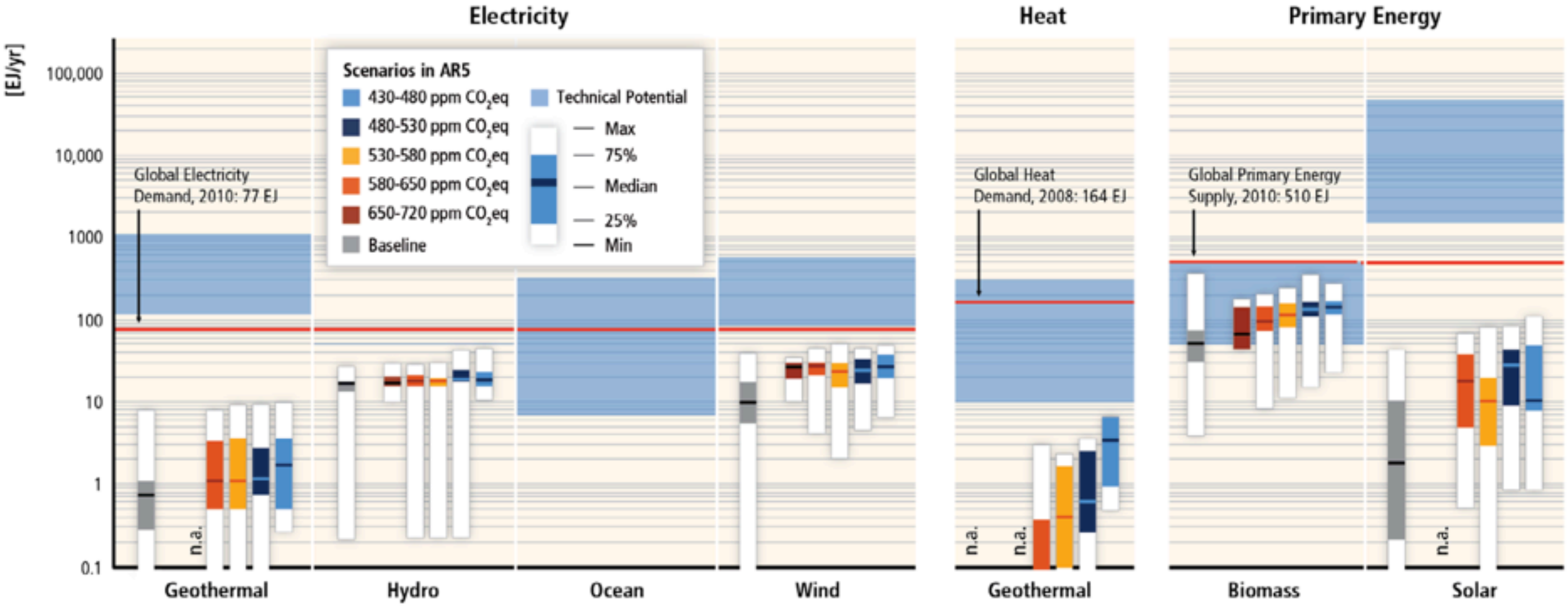
- **These scenarios are characterized by rapid improvements of energy efficiency and a near quadrupling of the share of low-carbon energy supply (renewables, nuclear, fossil and bioenergy with CCS), so that it reaches 60% by 2050.**

- **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



Comparison of global technical potentials of renewable energy sources in 2050



AR5 (2014), WGIII, Chap. 7, Fig. 7.12

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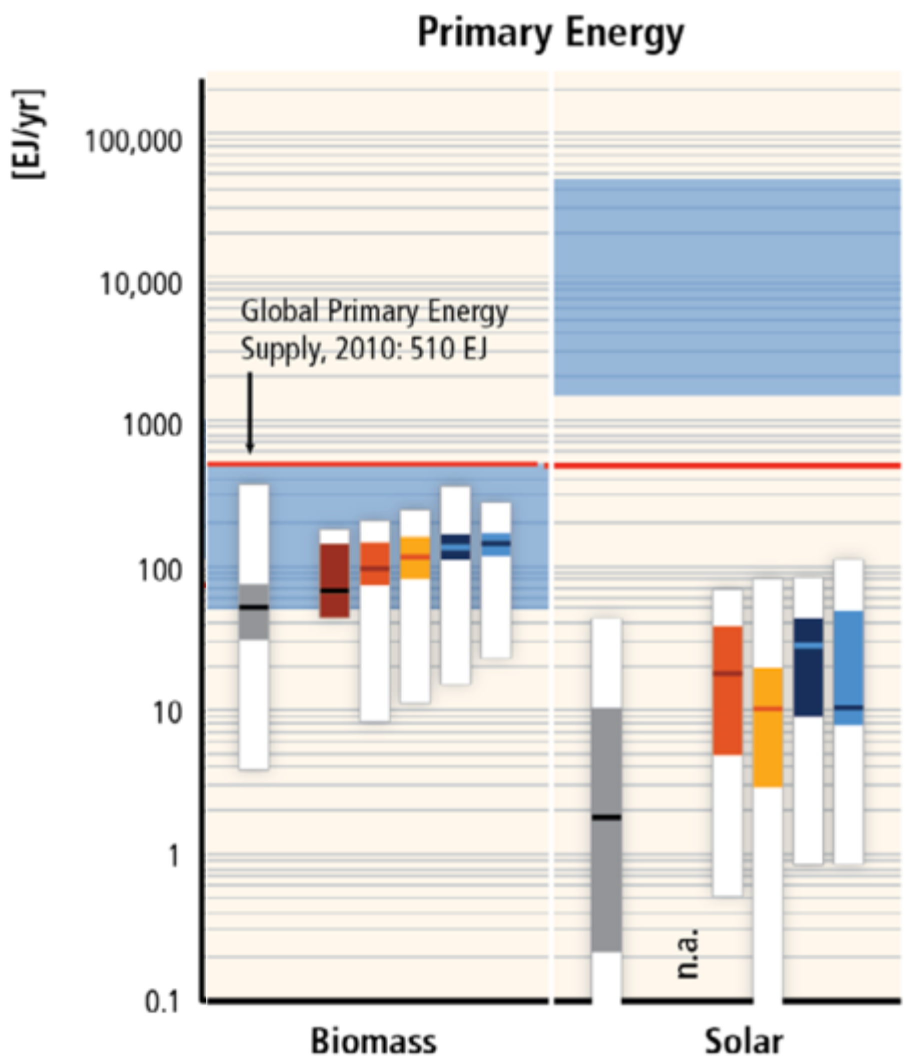
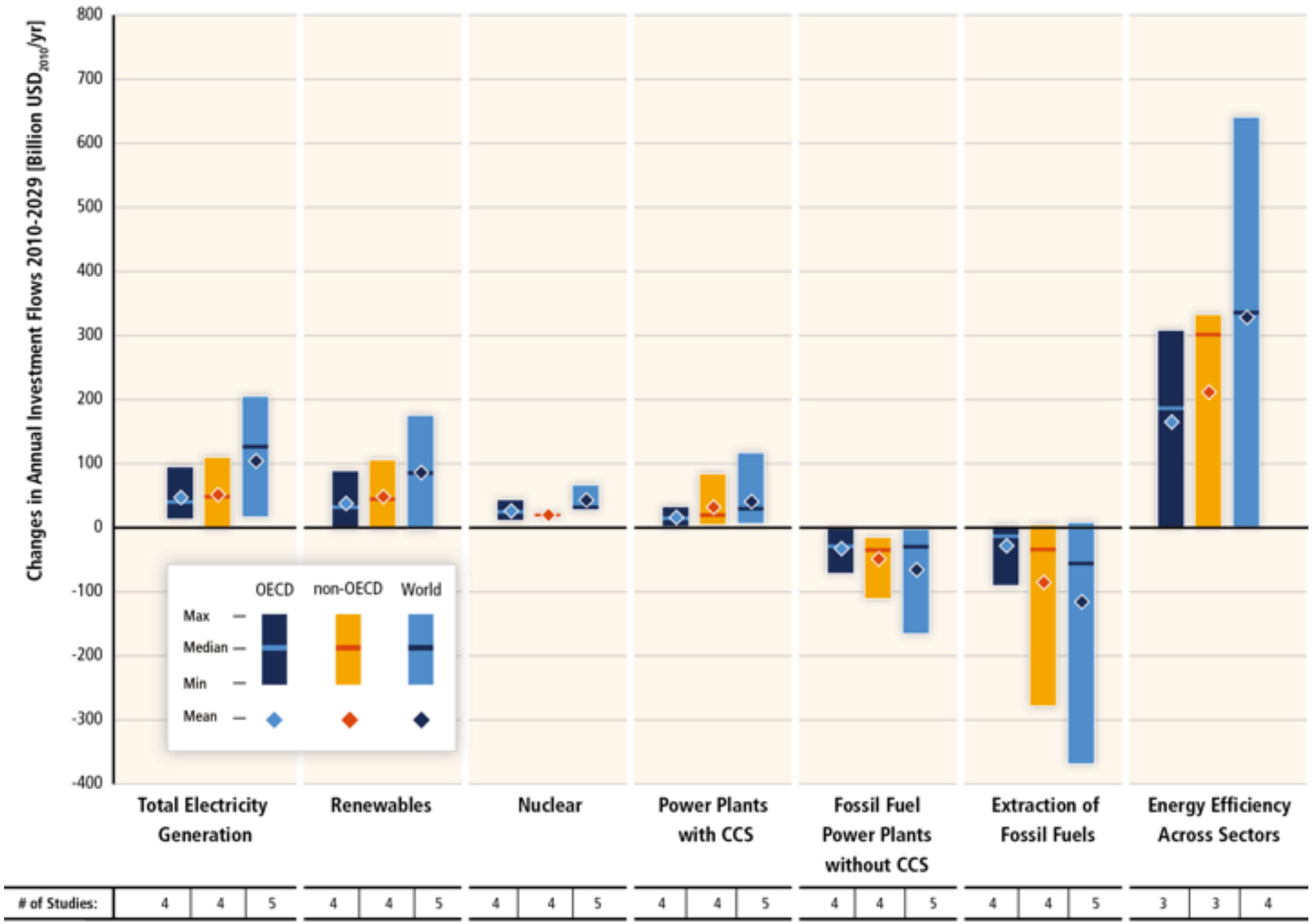
Comparison of global technical potentials (gray zone) and deployment of renewable energy sources in 2050



AR5 (2014), WGIII, Chap. 7, Fig. 7.12

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



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

- **Both categories of scenarios (< 1.5 and < 2°C) typically rely on the availability and widespread deployment of BECCS** (Bioenergy with Carbon dioxide Capture and Storage) and afforestation after 2050. There is only limited evidence for such a potential, and **BECCS entails challenges and risks** (including large-scale biomass provision, and the CCS technology itself).

Bioenergy coupled CCS (BECCS) has attracted particular attention since AR4 because it offers the prospect of energy supply with negative emissions (*limited evidence, medium agreement*)

Technological challenges and potential risks of BECCS include those associated with the upstream provision of the biomass that is used in the CCS facility as well as those originating from the capture, transport, and long-term underground storage of CO_2 that would otherwise be emitted.

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AR5 (2014), WGIII, Chap. 7, p.8

Any large-scale change in land use, for biomass for energy, or for sequestration in vegetation, will likely increase the *competition* for land, water, and other resources, and *conflicts may arise with important sustainability objectives* such as food security, soil and water conservation, *and the protection of* terrestrial and aquatic *biodiversity* (*medium evidence; medium agreement*)

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AR5 (2014), WGIII, Chap. 11, p.6-7

Bioenergy could play a critical role for climate change mitigation, *if* conversion of high carbon density ecosystems (forests, grasslands and peatlands) is avoided and best-practice land management is implemented (*robust evidence, medium agreement*). Integrated models suggest a wide range of between 10 and 245 EJ/yr primary energy from biomass by 2050.

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AR5 (2014), WGIII, Chap. 11, p.6

Mitigation challenges related to the bioenergy sector

Bioenergy has a significant mitigation potential, **provided that the resources are developed sustainably** and that bioenergy systems are **efficient**. Bioenergy production can be **integrated with food production in developing countries**, e.g., through suitable crop rotation schemes, or use of by-products and residues. If implemented sustainably this can result in higher food and energy outcomes and hence reduce land-use competition.

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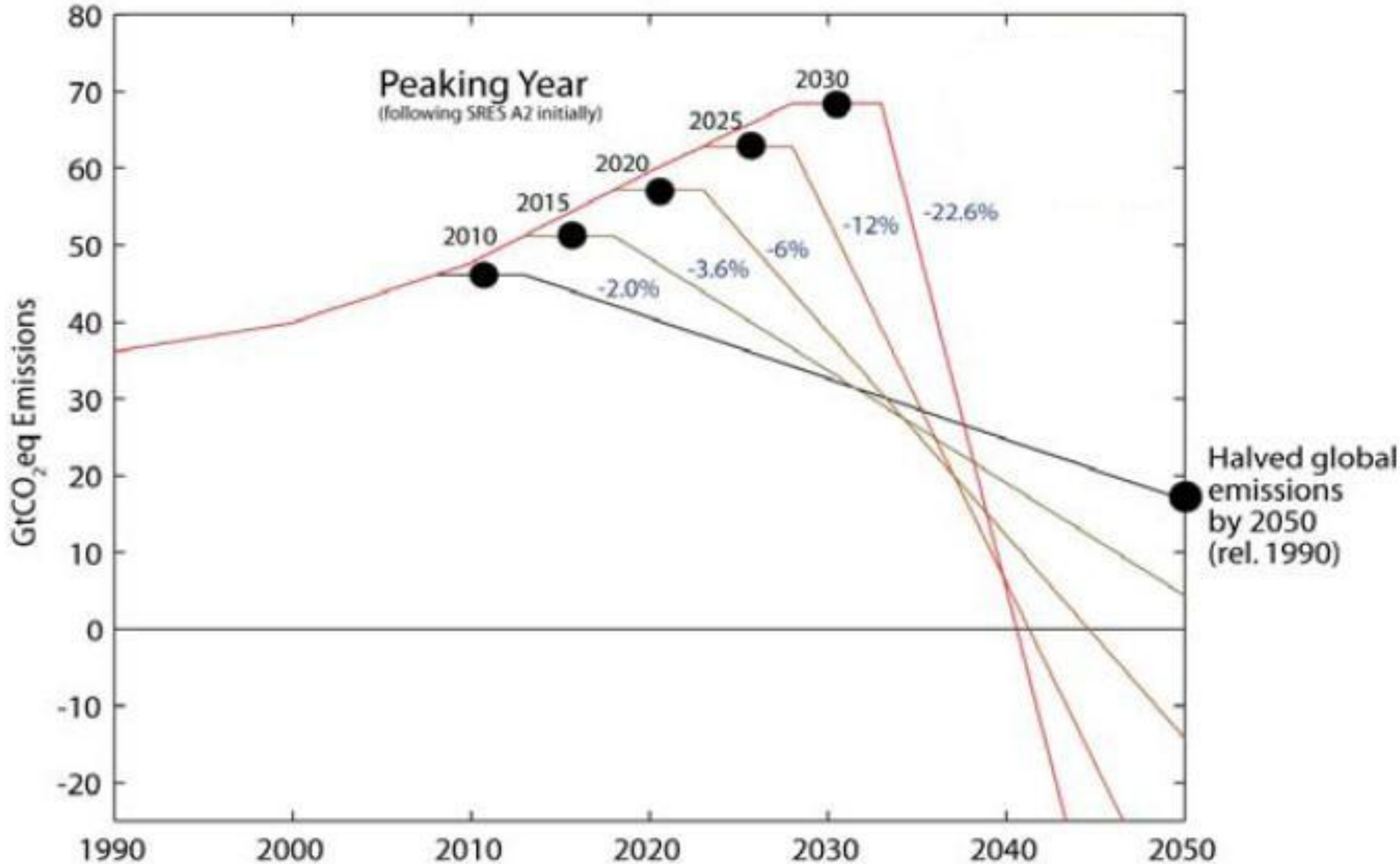
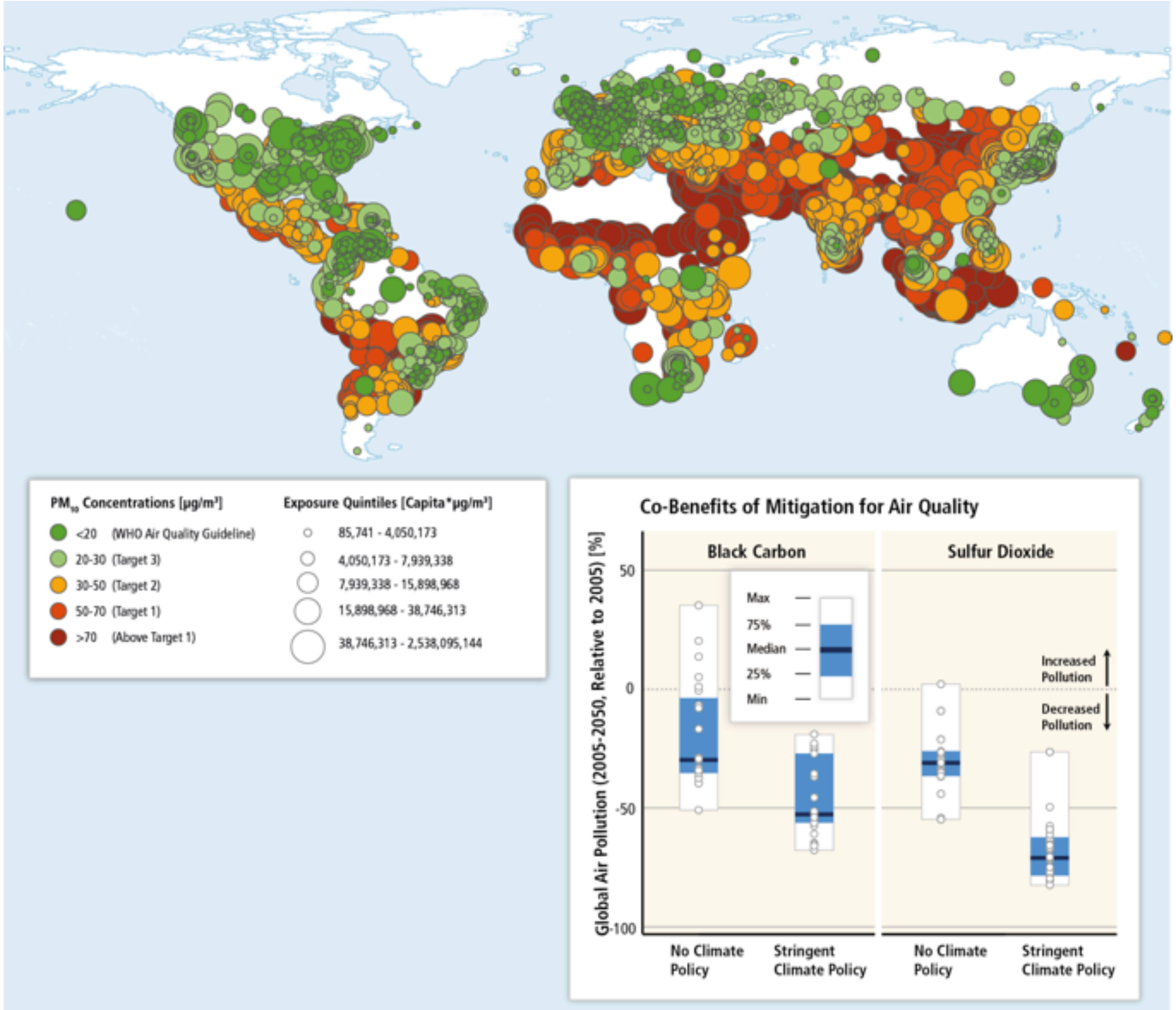
AR5 (2014), WGIII, Chap. 11, p.5

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.

Useful links:

- www.ipcc.ch : IPCC
- www.climate.be/vanyp : my slides and other documents
- www.skepticalscience.com: excellent responses to contrarians arguments
- **On Twitter: @JPvanYpersele**

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