The Challenge of Climate Change: Also an Opportunity

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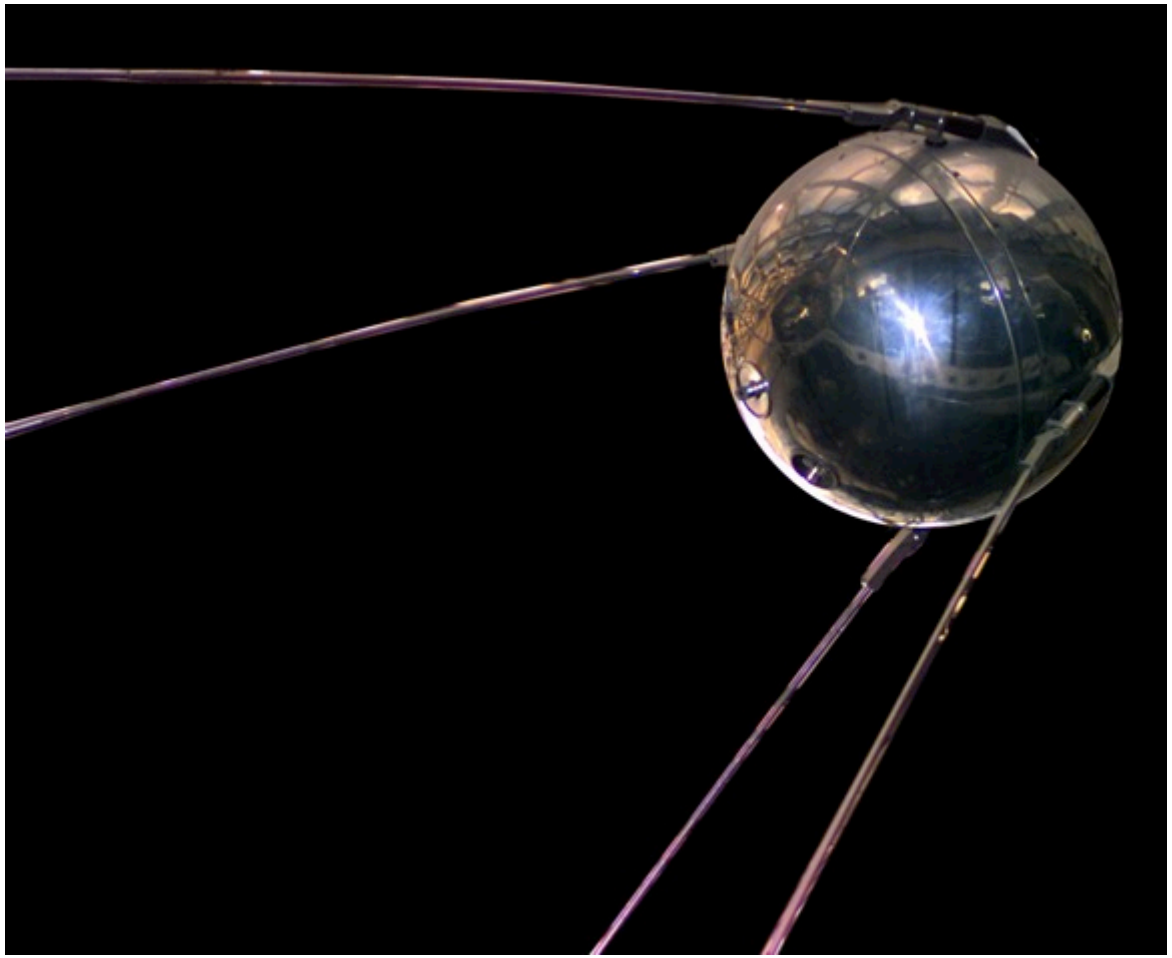
SDEWES-12(*), Dubrovnik, 5 October 2017

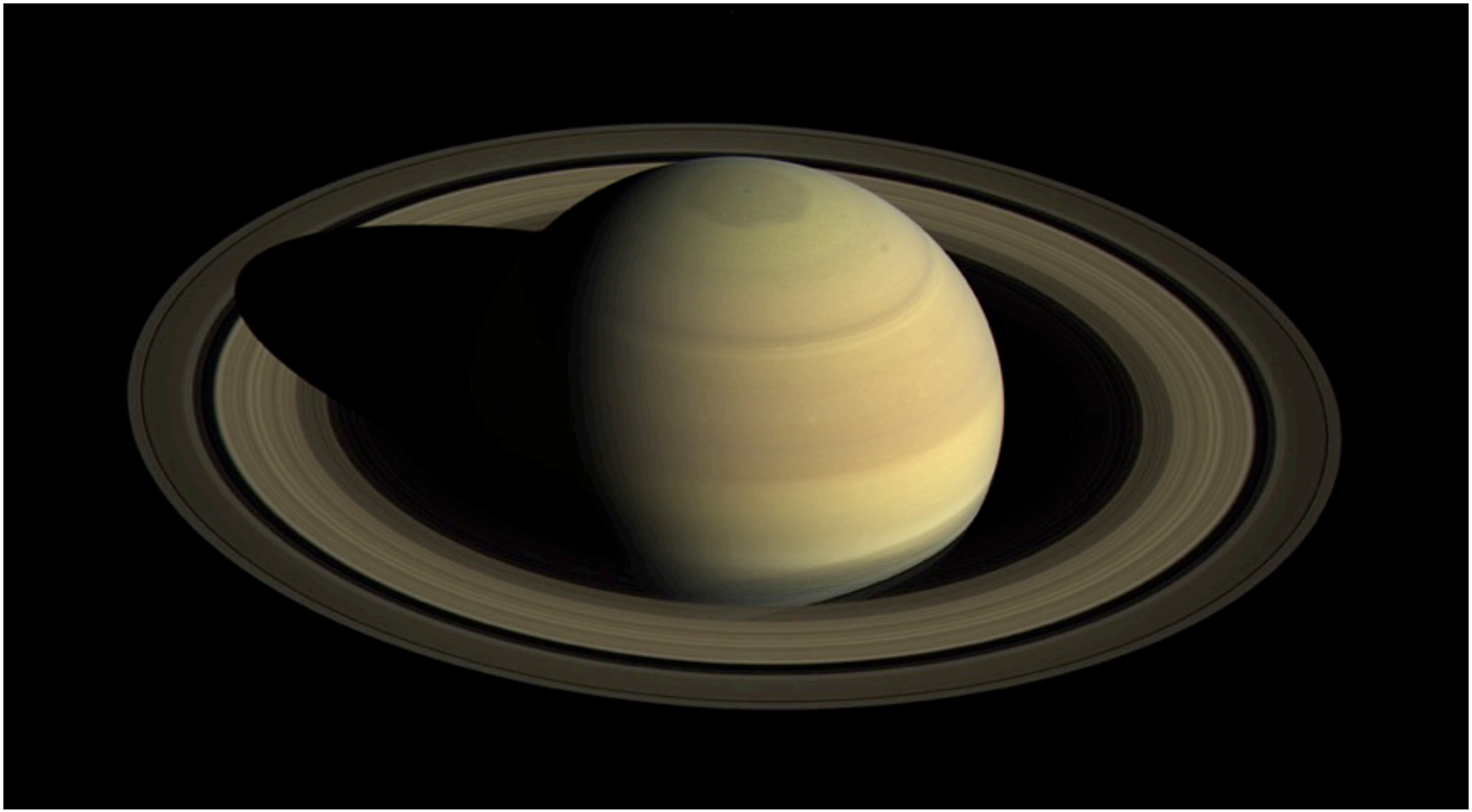
Thanks to the Walloon Government (funding the Walloon Platform for IPCC) and to my team at the Université catholique de Louvain for their support

(*) SDEWES-12 = 12th Conference on Sustainable Development of Energy, Water, and Environment Systems

Yesterday, 4 October, was the 60th anniversary of the Sputnik-1 launch in 1957



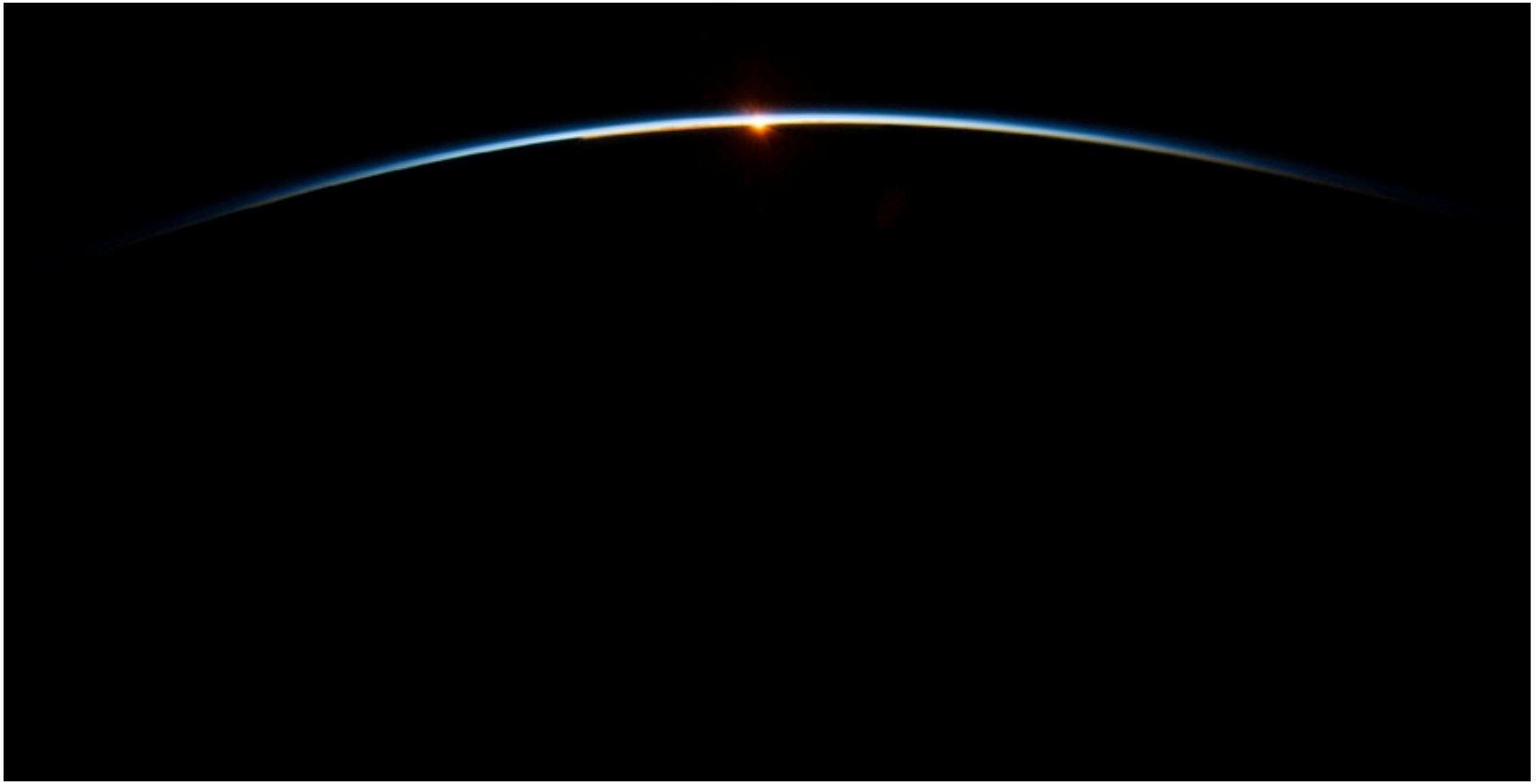
Saturn, as seen on 25-4-2016 from a 3 million km distance by the Cassini satellite launched in October 1997, 40 years after Sputnik



That small blue dot is the Earth, a seen from Cassini, orbiting Saturn, 1.44 billion km from us, on 19-7-2013

Apollo 17,
7 Dec. 1972

Our atmosphere is thin and fragile (as seen by ISS crew on 31 July 2013)



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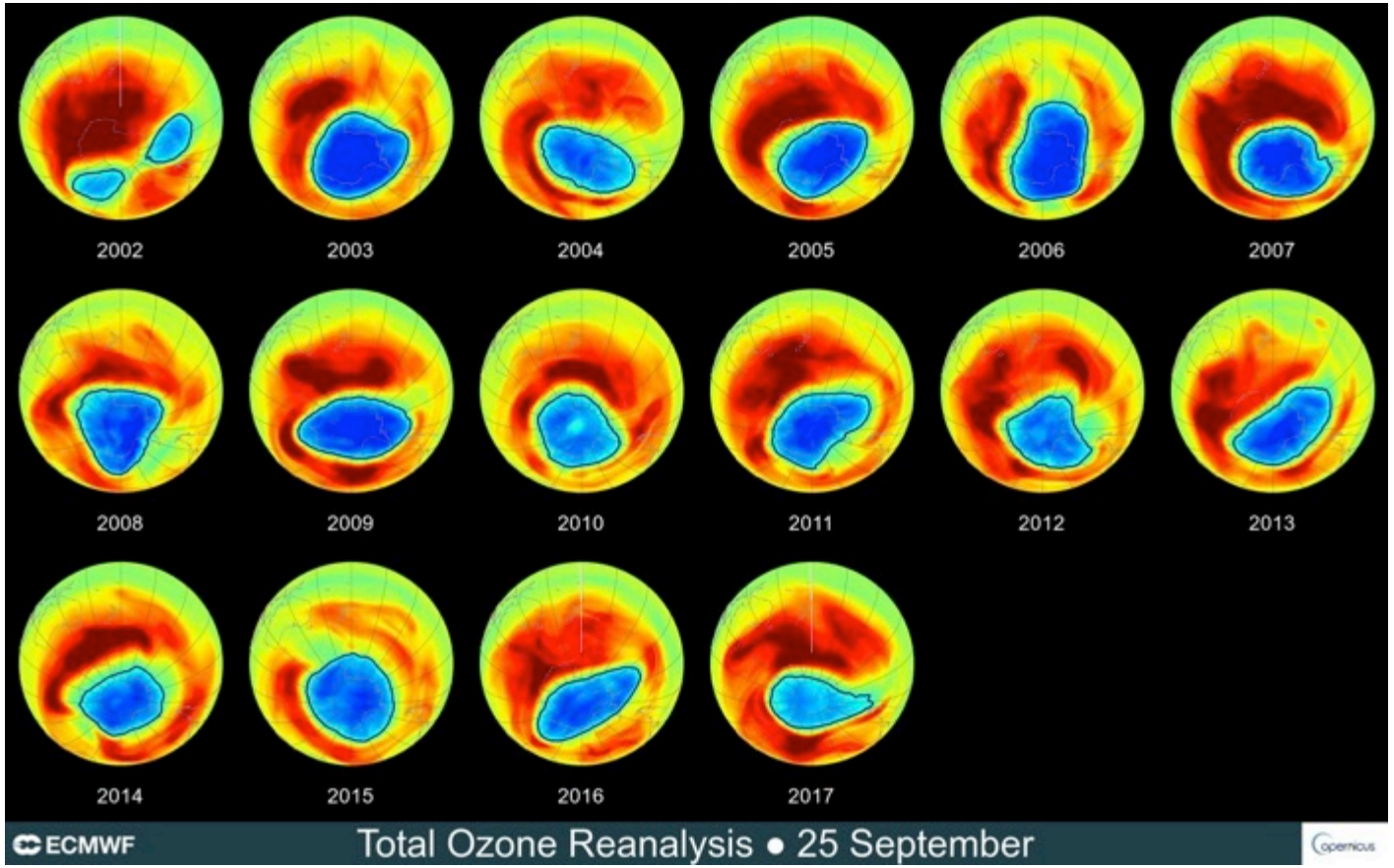
(vanyp@climate.be)

Recovering Stratospheric Ozone Layer (our anti-UV shield), thanks to Montreal Protocol, according to Copernicus (EU Earth Observation Programme) 25-9-2017



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(vanyp@climate.be)

Lessons from the ozone hole recovery

- The Earth's atmosphere is fragile
- Understanding it is crucial
- Human influence can threaten global habitability
- Determined human action can reverse the degradation of our environment and climate and put us on a sustainable development pathway
- There are many opportunities associated

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Let us think about the future of these children from Machakos (Kenya) in a warming climate

JPvY, April 2015

In Germany, many residents weren't prepared for the mass flooding as the rain pelted down (May 2016)

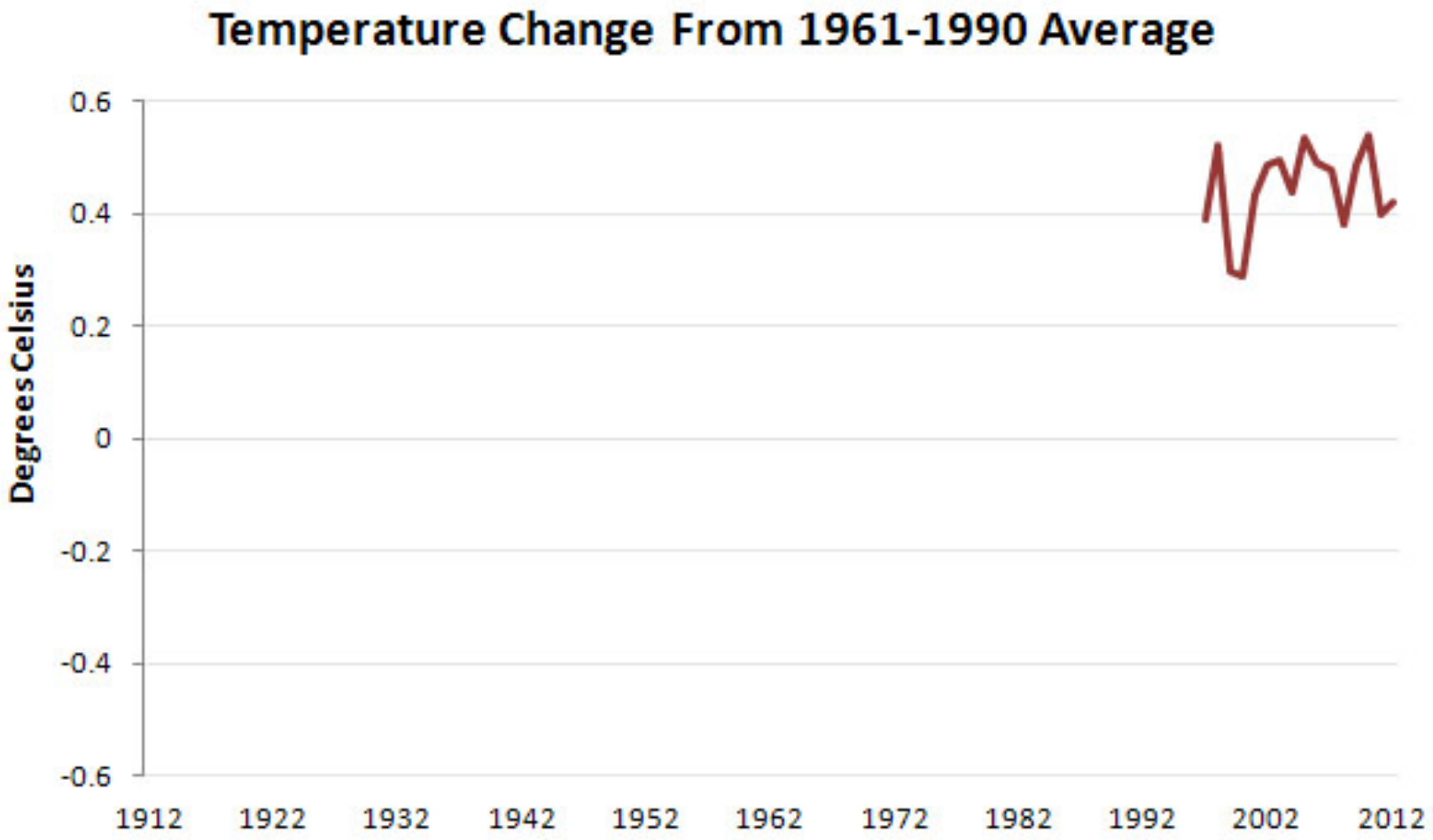
Matthias Schrader / AP

In Puerto Rico, Hurricane Maria created in 2017 the worst humanitarian crisis in the US for decades

Source: FEMA, 24-9-2017

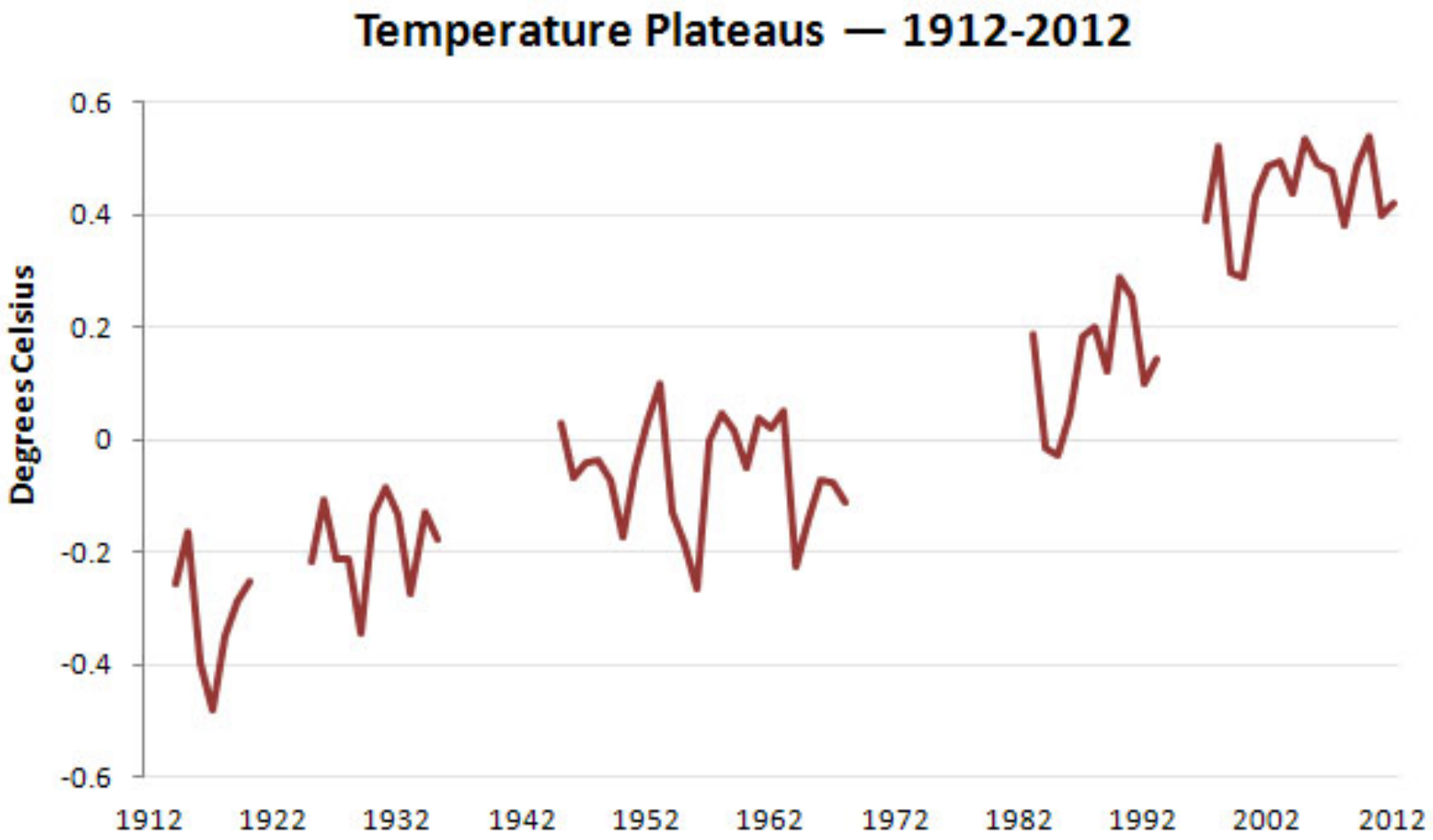
Closer to here: 11 September 2017 , Dubrovnik, after torrential rains (more frequent in a warming climate)

Source: The Dubrovnik Times

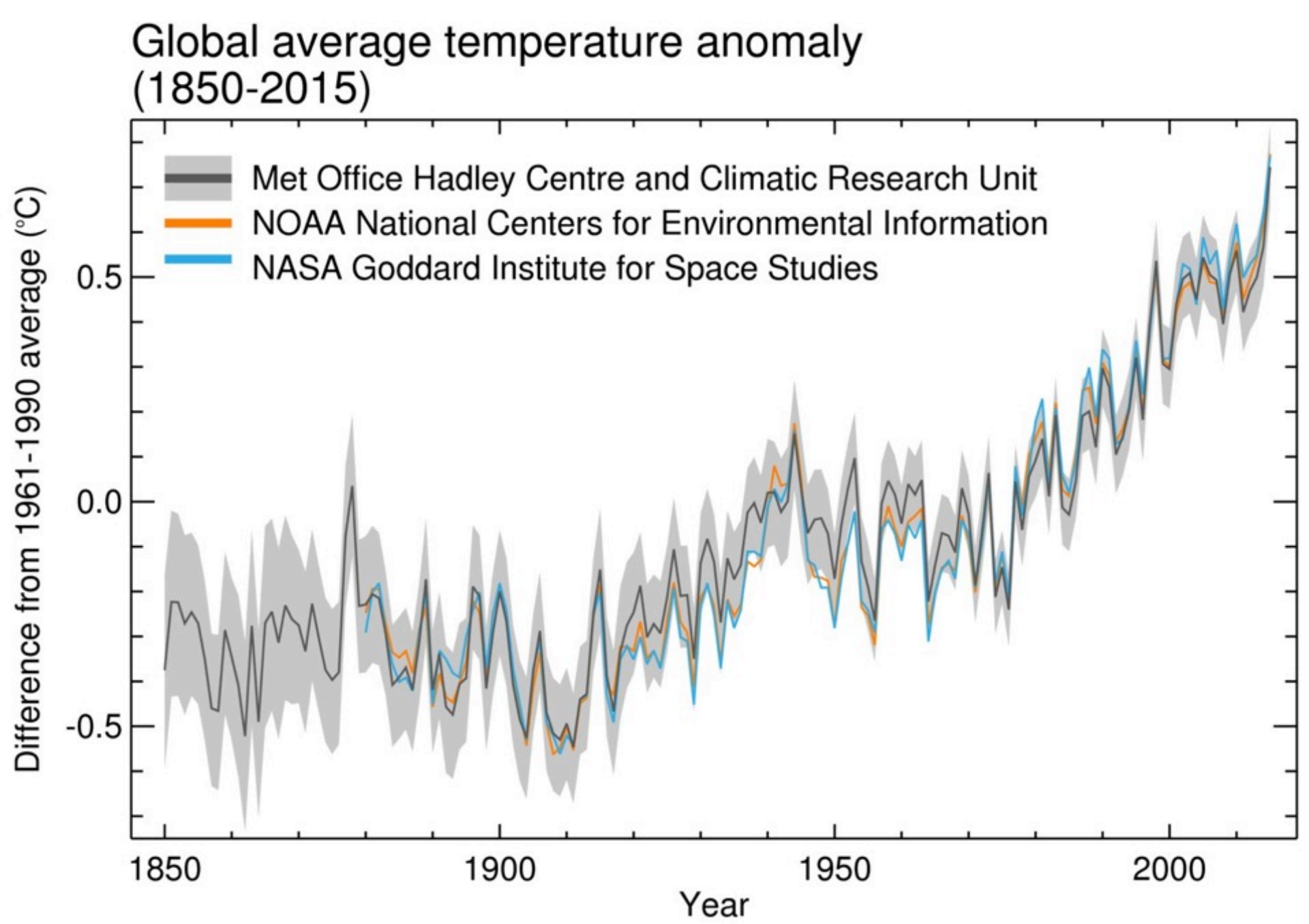


http://www.motherjones.com/kevin-drum/2012/10/lying-statistics-global-warming-edition

Lying With Statistics, Global Warming Edition



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



Source: NASA GISS

Why the IPCC ?

Established by WMO and UNEP in 1988

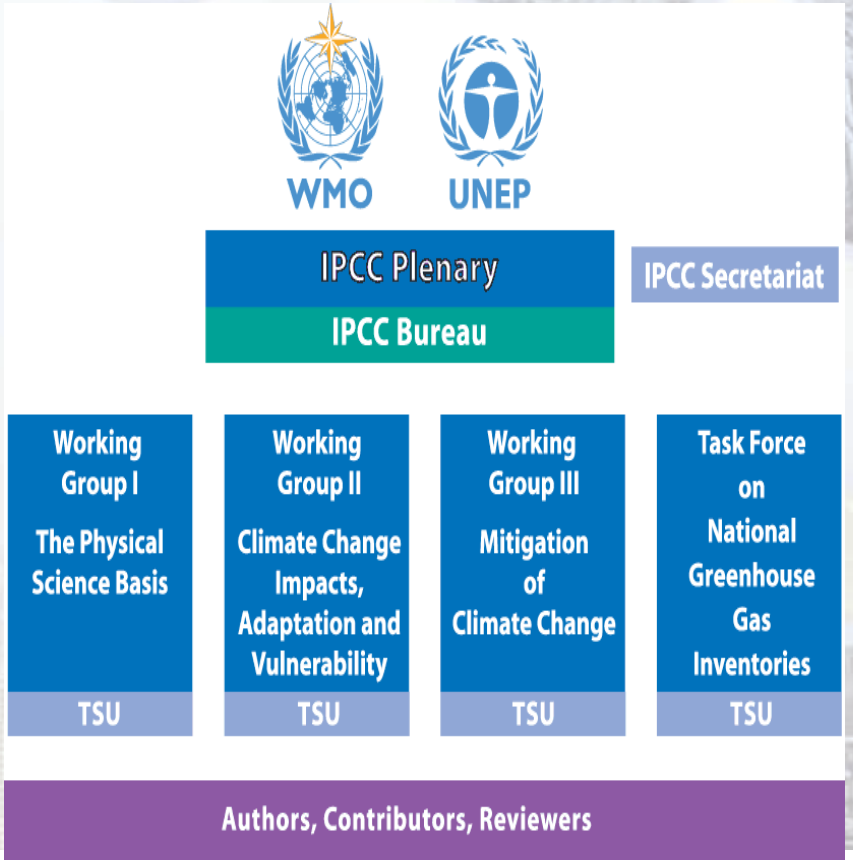
to provide **policy-makers** with an **objective source of information** about

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

WMO=World Meteorological Organizatior

UNEP= United Nations Environment Programme

Inter-governmental Panel on Climate Change (IPCC): Organization Structure



- IPCC plenary comprises of all countries in the world
- IPCC Bureau comprises of 34 elected members; IPCC elects its Bureau every 6-7 years
- 3 Working Groups & a Task Force on National Greenhouse Gas Inventories
- Authors, Contributors, Reviewers, Review Editors

IPCC writing cycle (4 years, 831 Lead authors for AR5)

- **Plenary decides table of content of reports**
- **Bureau appoints world-class scientists as authors, based on publication record**
- **Authors assess all scientific literature**
- ***Draft* – Expert review (+ Review editors)**
- ***Draft 2 (+ Draft 1 Summary for Policy Makers (SPM)* – Combined expert/government review**
- ***Draft 3 (+ Draft 2 SPM)*– Government review of SPM**
- **Approval Plenary (interaction authors – governments) – *SPM and full report***
- ***NB: The scientists have the last word on what is in!***

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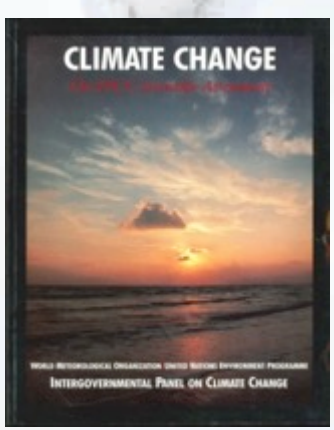
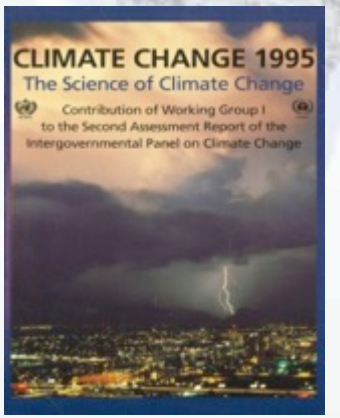
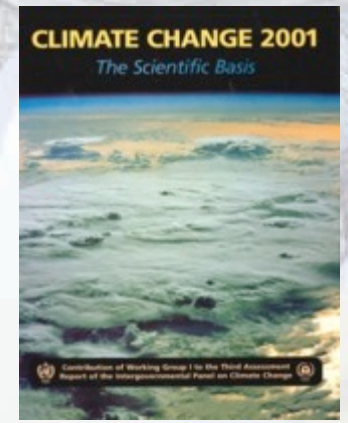
IPCC Assessment Reports



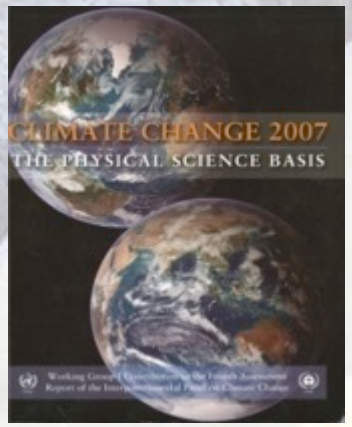
FAR 1990



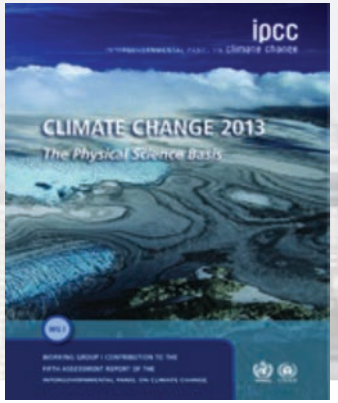
SAR 1995



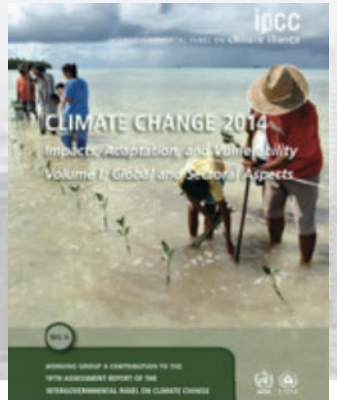
TAR 2001



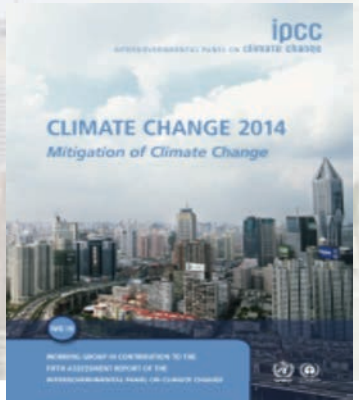
AR4 2007



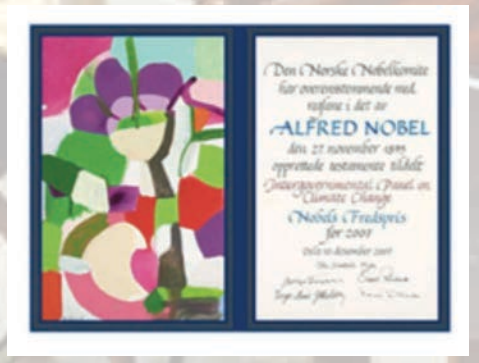
AR5 WGI 2013



AR5 WGII 2014



AR5 WGIII 2014



IPCC AR5 Synthesis Report

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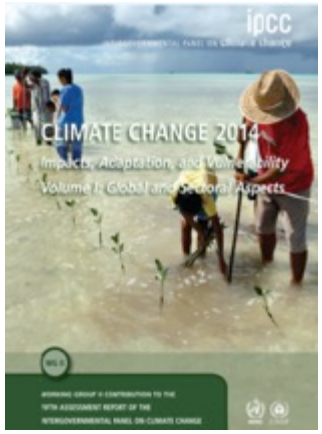
INTERGOVERNMENTAL PANEL ON climate change

WMO UNEP



What is happening in the climate system?

What are the risks?

What can be done?

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INTERGOVERNMENTAL PANEL ON climate change

WMO UNEP

Key messages from IPCC AR5

- → **Human influence on the climate system is clear**
- → **Continued emissions of greenhouse gases will increase the likelihood of severe, pervasive and irreversible impacts for people and ecosystems**
- → **While climate change is a threat to sustainable development, there are many opportunities to integrate mitigation, adaptation, and the pursuit of other societal objectives**
- → **Humanity *has* the means to limit climate change and build a more sustainable and resilient future**

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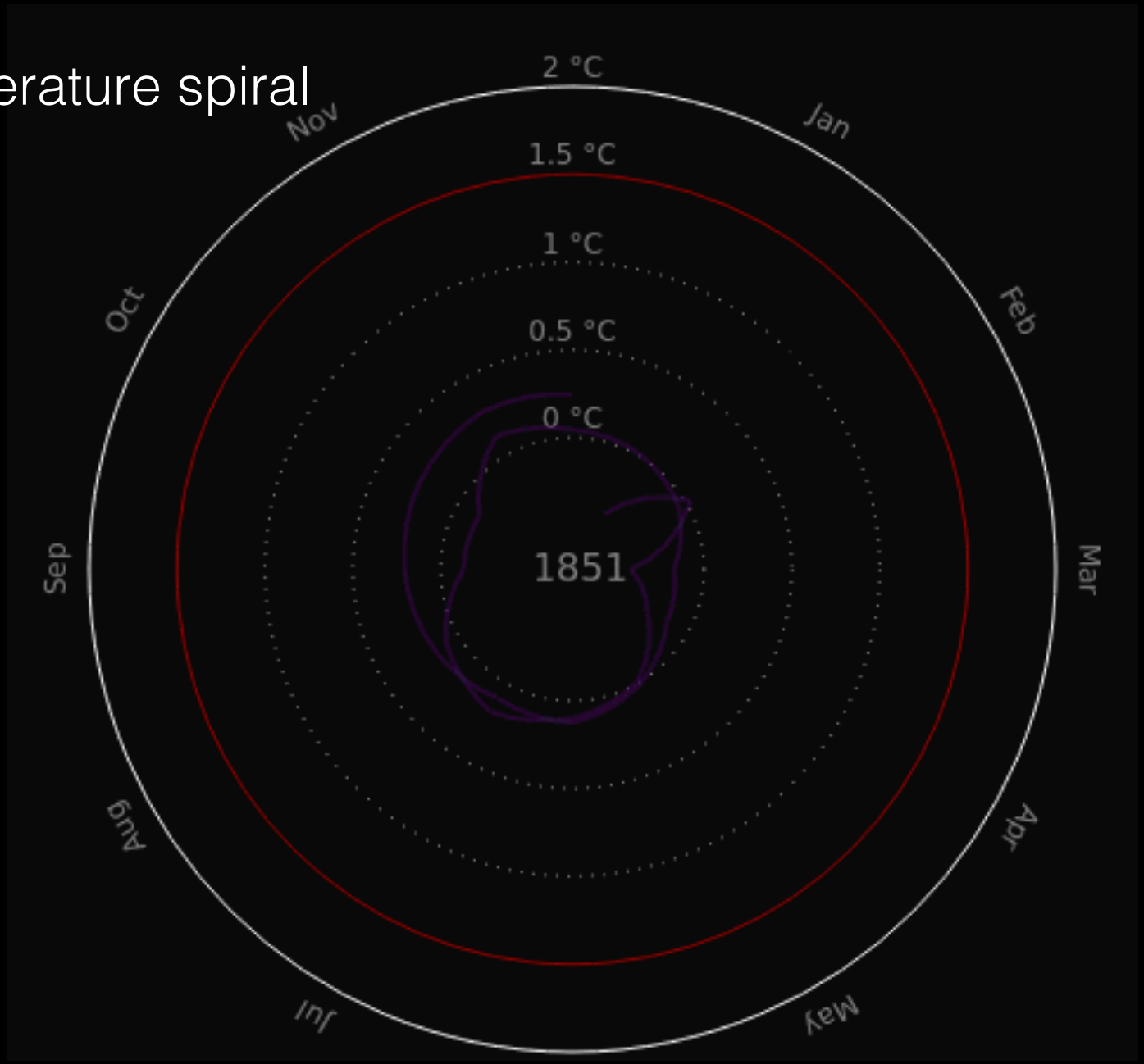
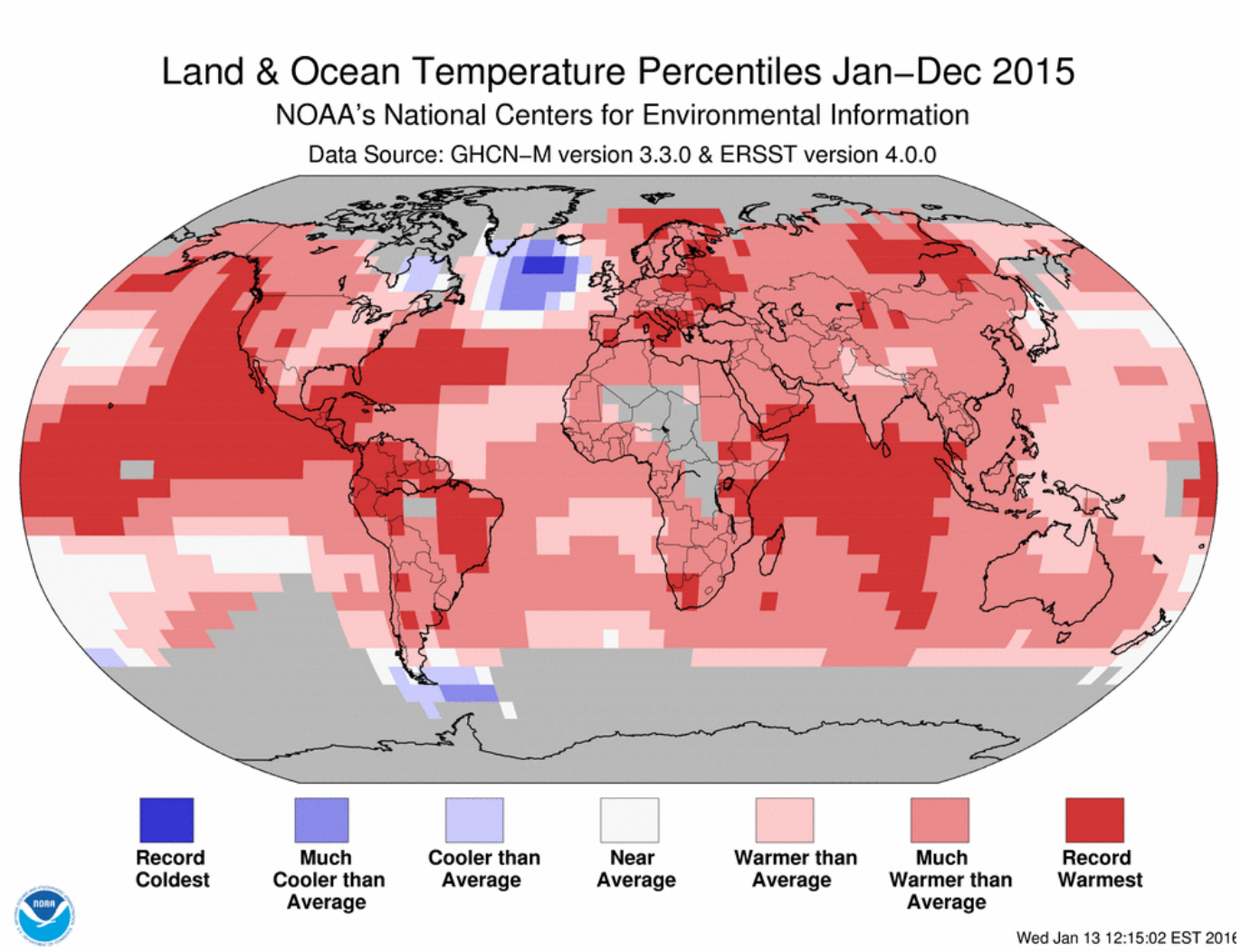
INTERGOVERNMENTAL PANEL ON climate change
WMO UNEP

Temperature spiral

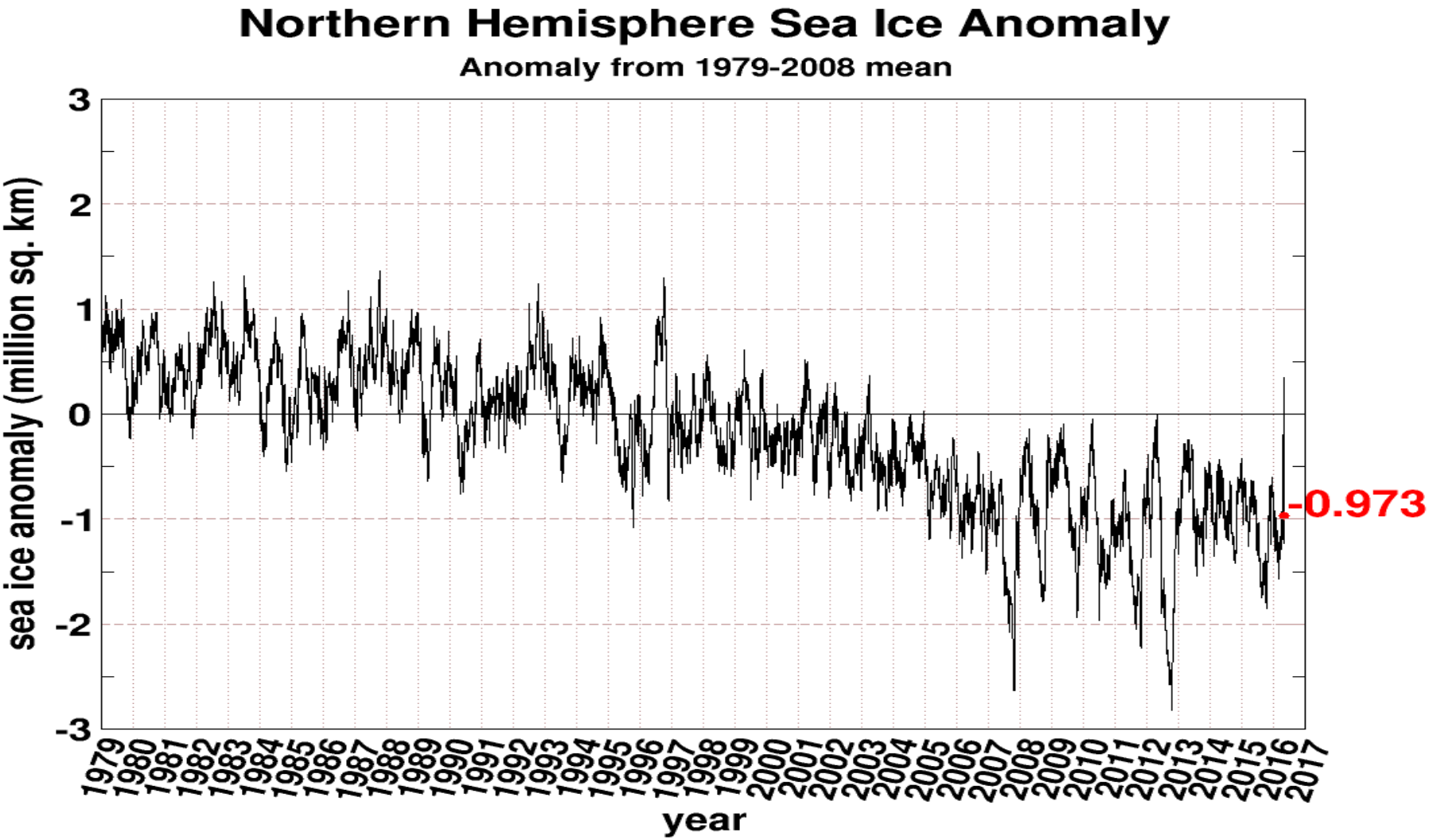


Global Mean Temperature in °C relative to 1850 – 1900
Graph: Ed Hawkins (Climate Lab Book) – Data: HadCRUT4 global temperature dataset
Available on http://openclimatedata.net/climate-spirals/temperature

2014, 2015, 2016= warmest years since 1880



Arctic Sea Ice Cover (1979-2016)



Plateau Glacier (1961)
(Alaska)

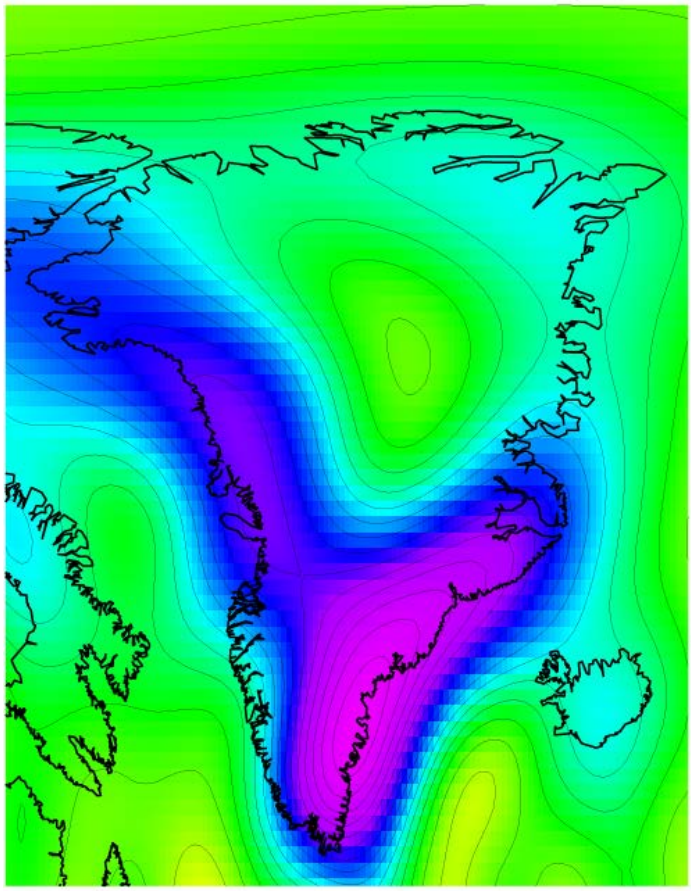
http://www.weather.com/news/science/environment/alaskas-glaciers-capturing-earth-changing-our-eyes-20131125?cm_ven=Email&cm_cat=ENVIRONMENT_us_share

Plateau Glacier (2003)
(Alaska)

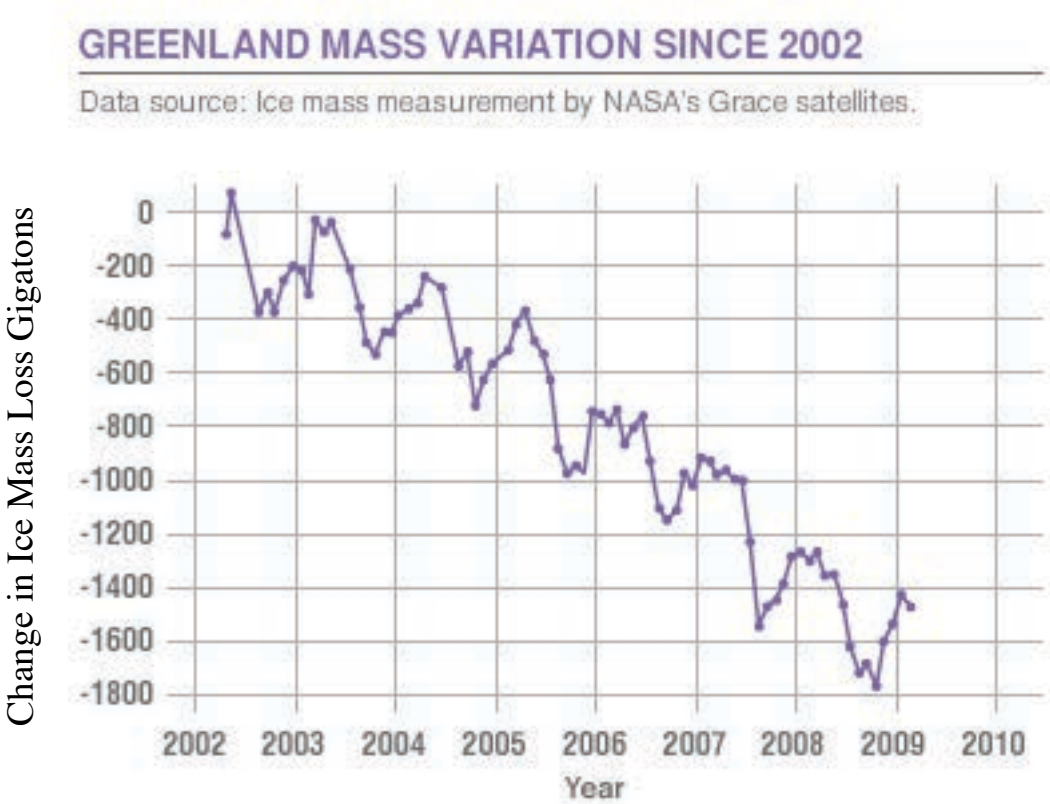
http://www.weather.com/news/science/environment/alaskas-glaciers-capturing-earth-changing-our-eyes-20131125?cm_ven=Email&cm_cat=ENVIRONMENT_us_share

Greenland Ice Mass Loss 2002-2009 Derived From NASA GRACE Gravity Mission

Greenland



J. Wahr, U. Colorado

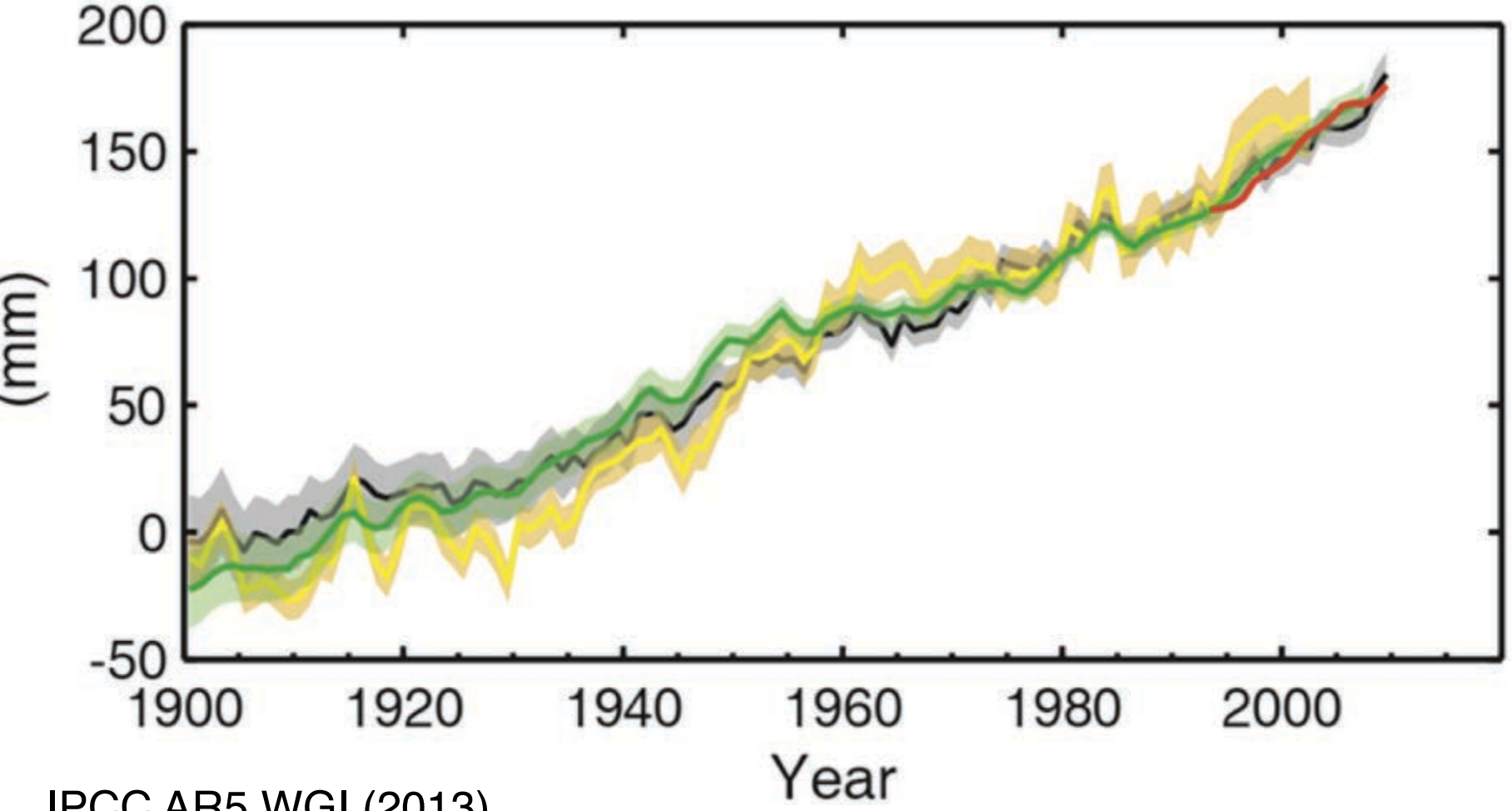


Velicogna, Geophysical Research Letters, 2009

•Contributes to sea level rise

B. Holt - JPL

Change in average sea-level change

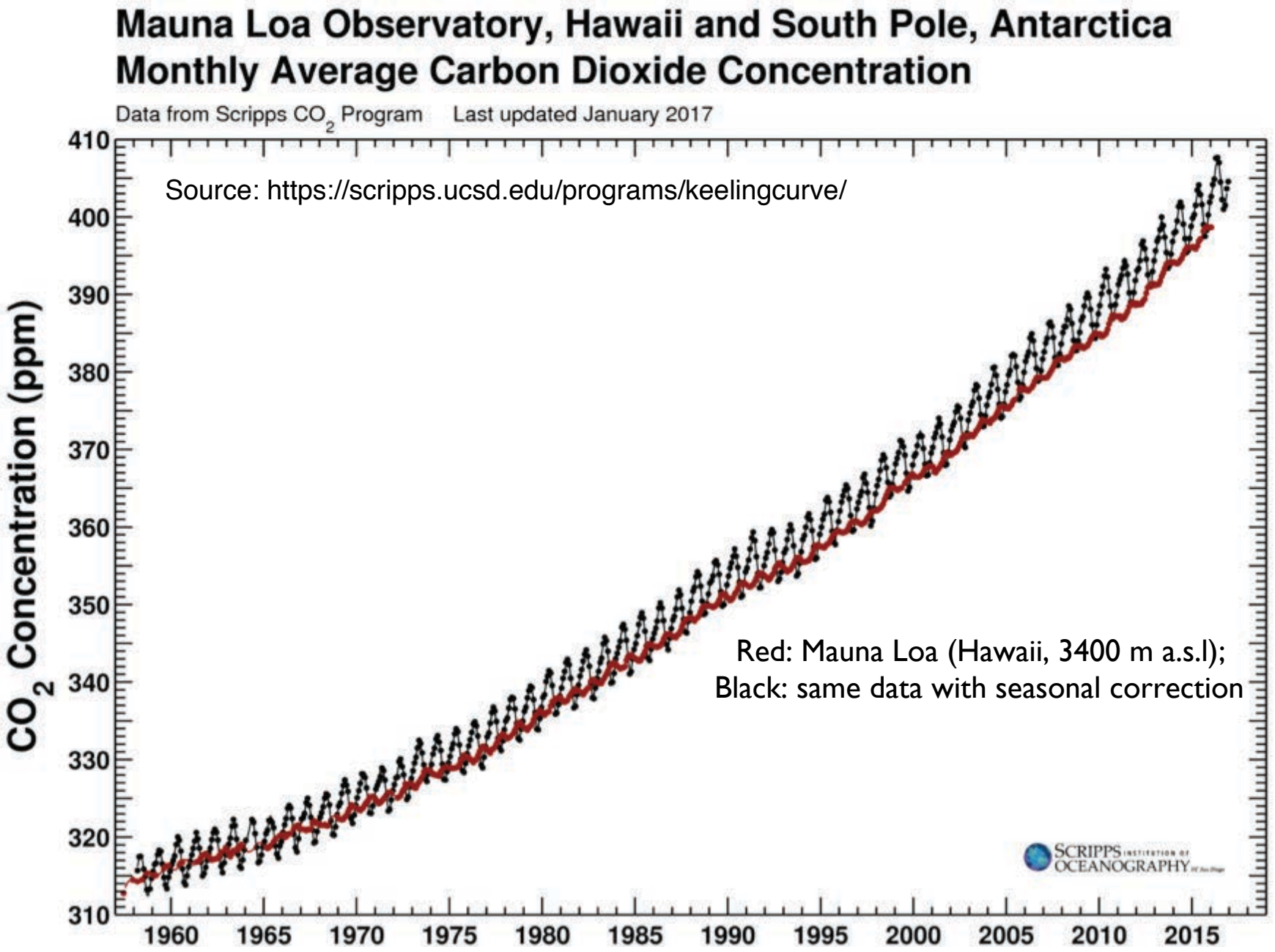


IPCC AR5 WGI (2013)

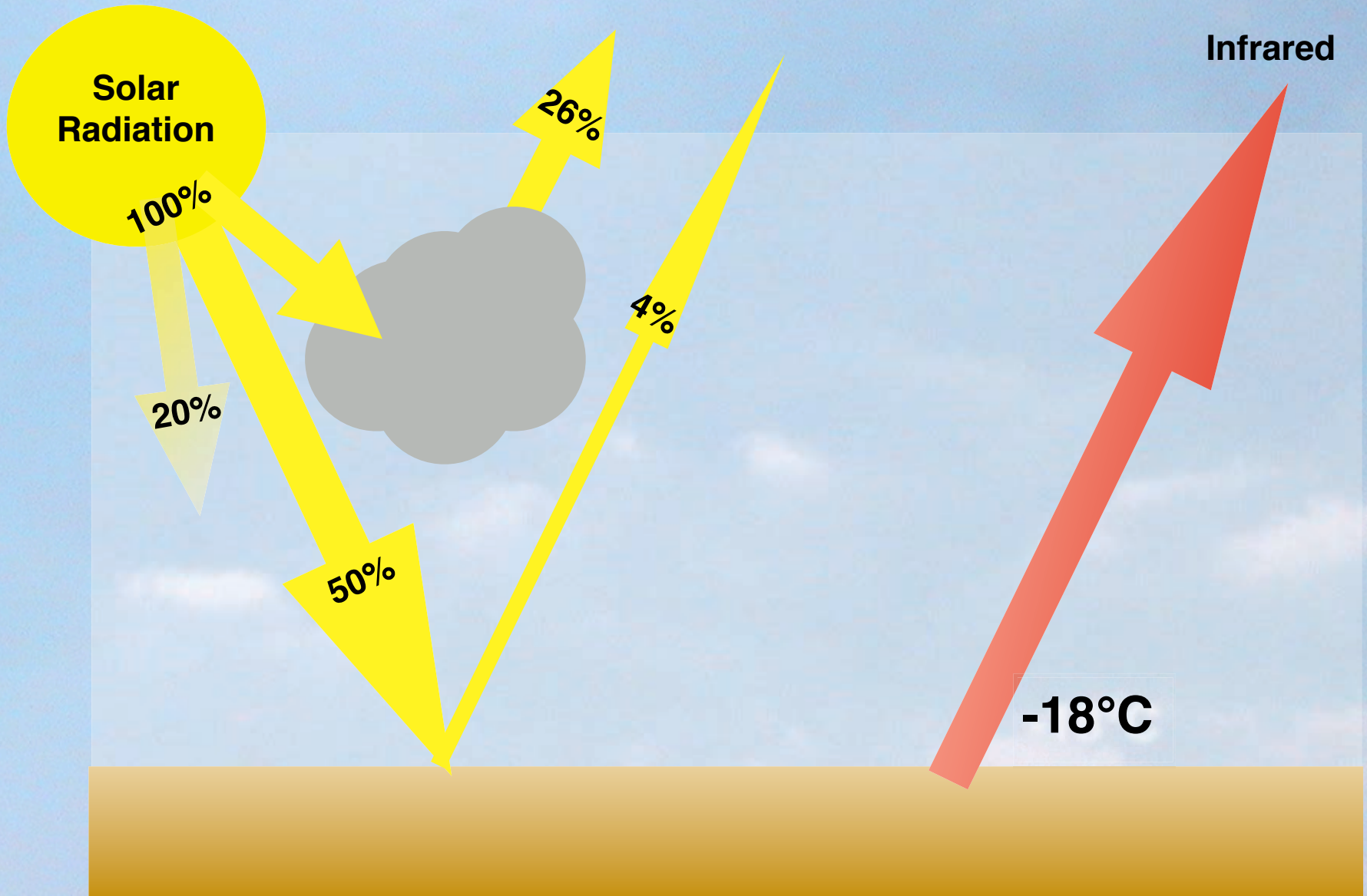
Coral reefs are dying

American Samoa (from www.globalcoralbleaching.org)

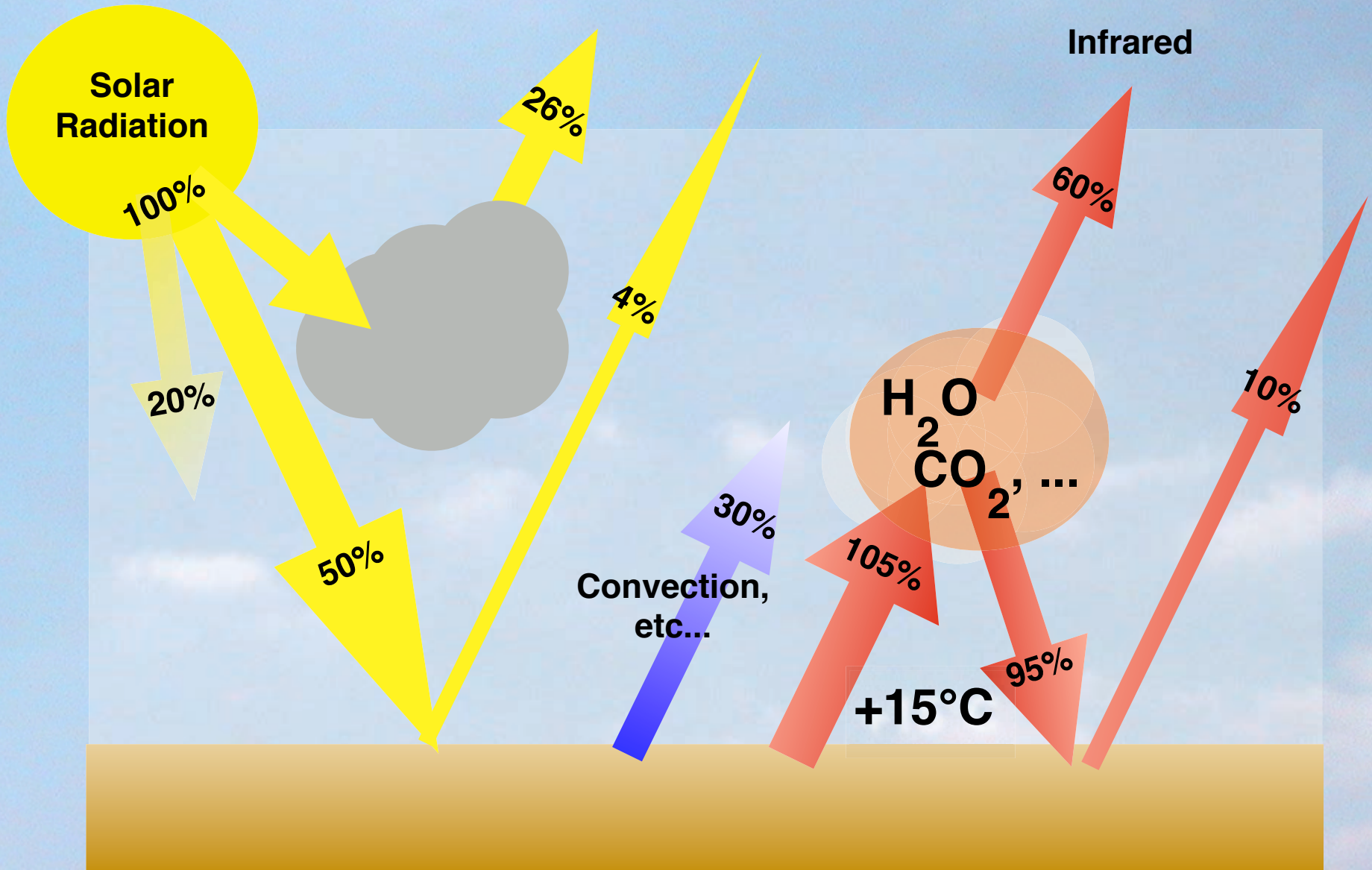
Atmospheric CO_2 concentration: the Keeling curve



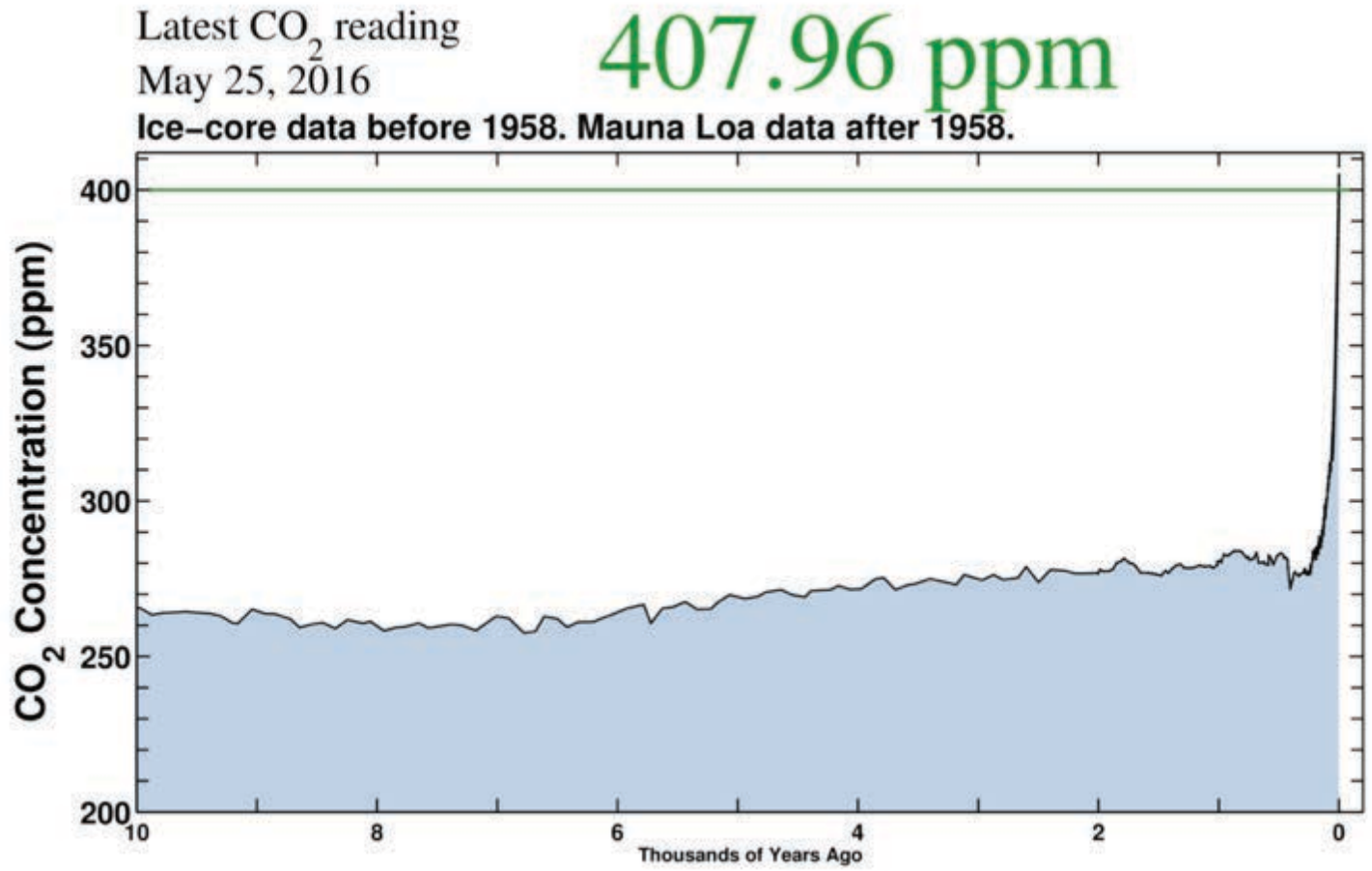
Energy Cycle Without Greenhouse Gases



Energy Cycle with Greenhouse Gases



CO_2 Concentration, 25 May 2016 (Keeling curve)



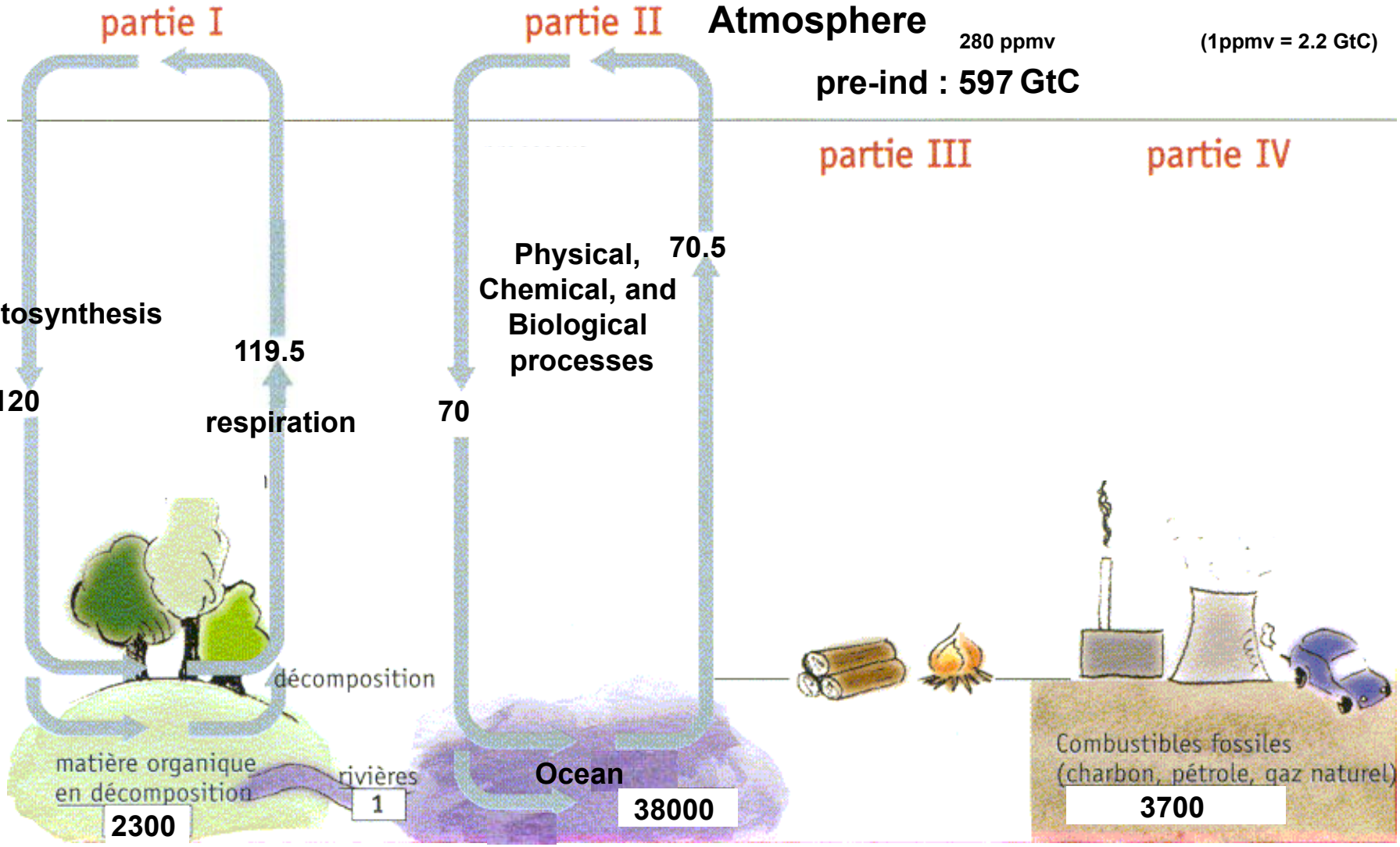
Source: scripps.ucsd.edu/programs/keelingcurve/

Atmospheric concentrations of CO_2

(Lüthi et al.,2008, NOAA)

The concentrations of CO_2 have increased to levels unprecedented in at least the last 800,000 years.

Carbon cycle: unperturbed fluxes

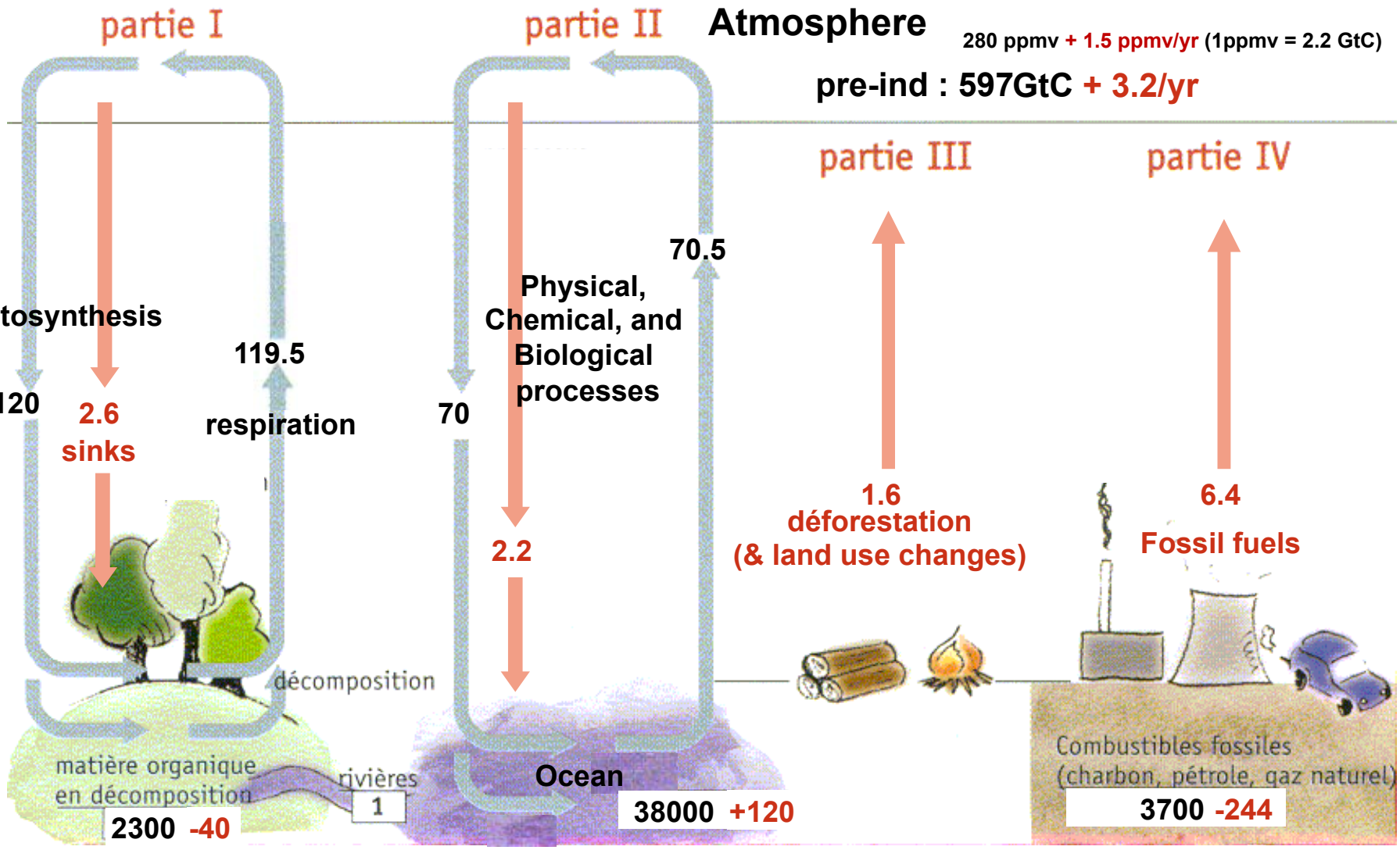


Units: GtC (billions tons of carbon) or GtC/year (multiply by 3.7 to get $GtCO_2$)

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

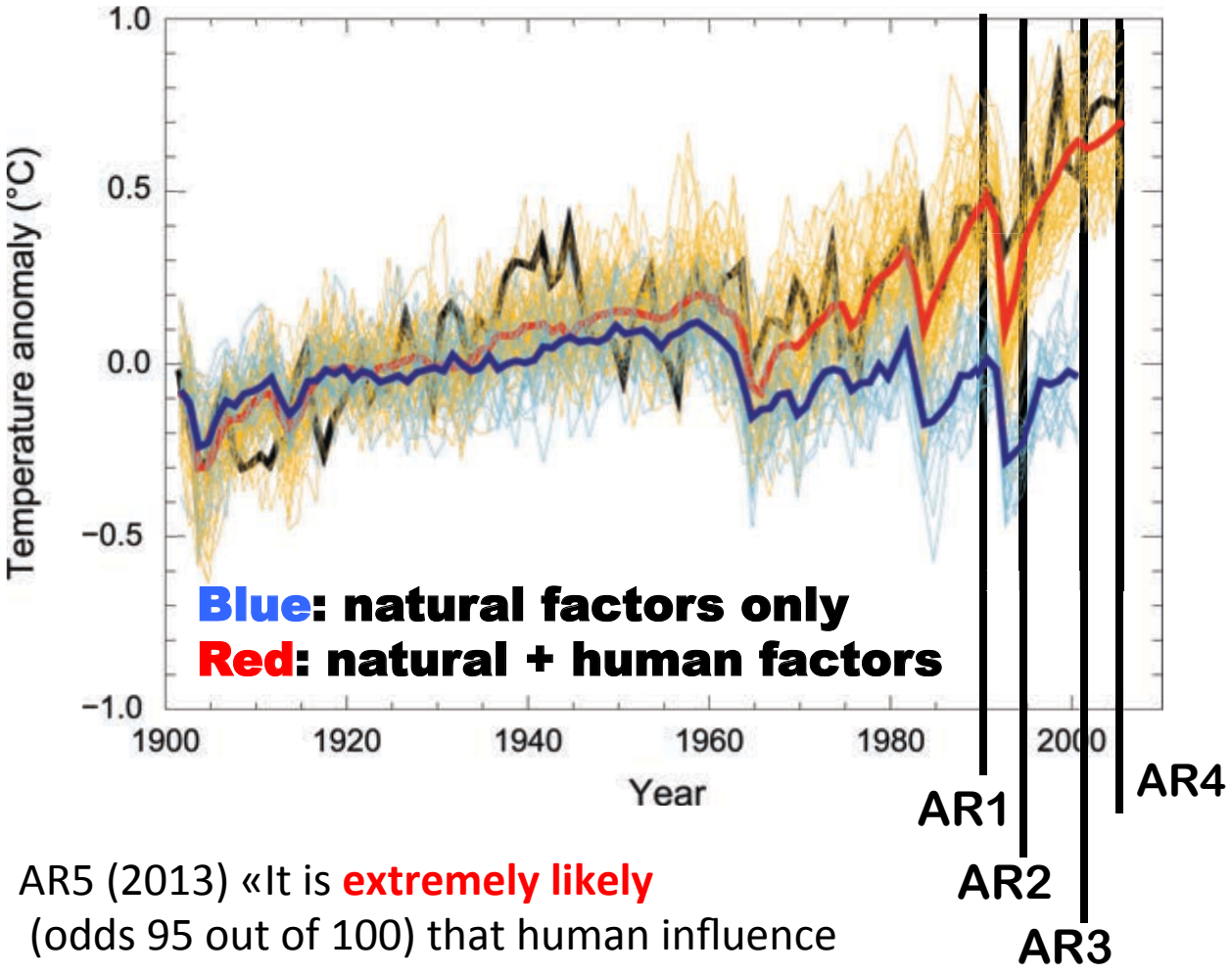
A Progression of Understanding: Greater and Greater Certainty in Attribution

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

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

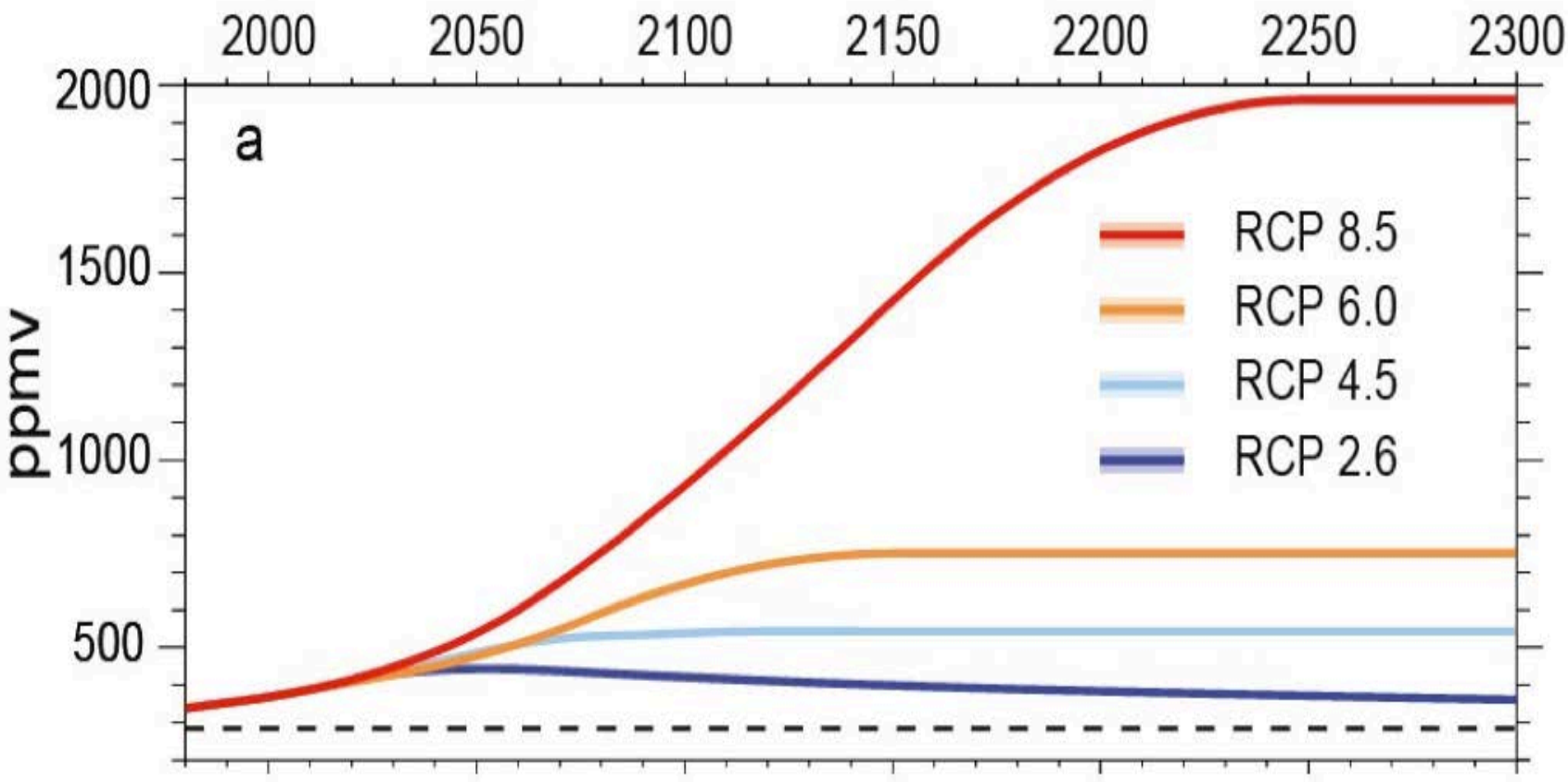
AR3 (2001): "most of the warming of the past 50 years is **likely** (odds 2 out of 3) due to human activities"

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



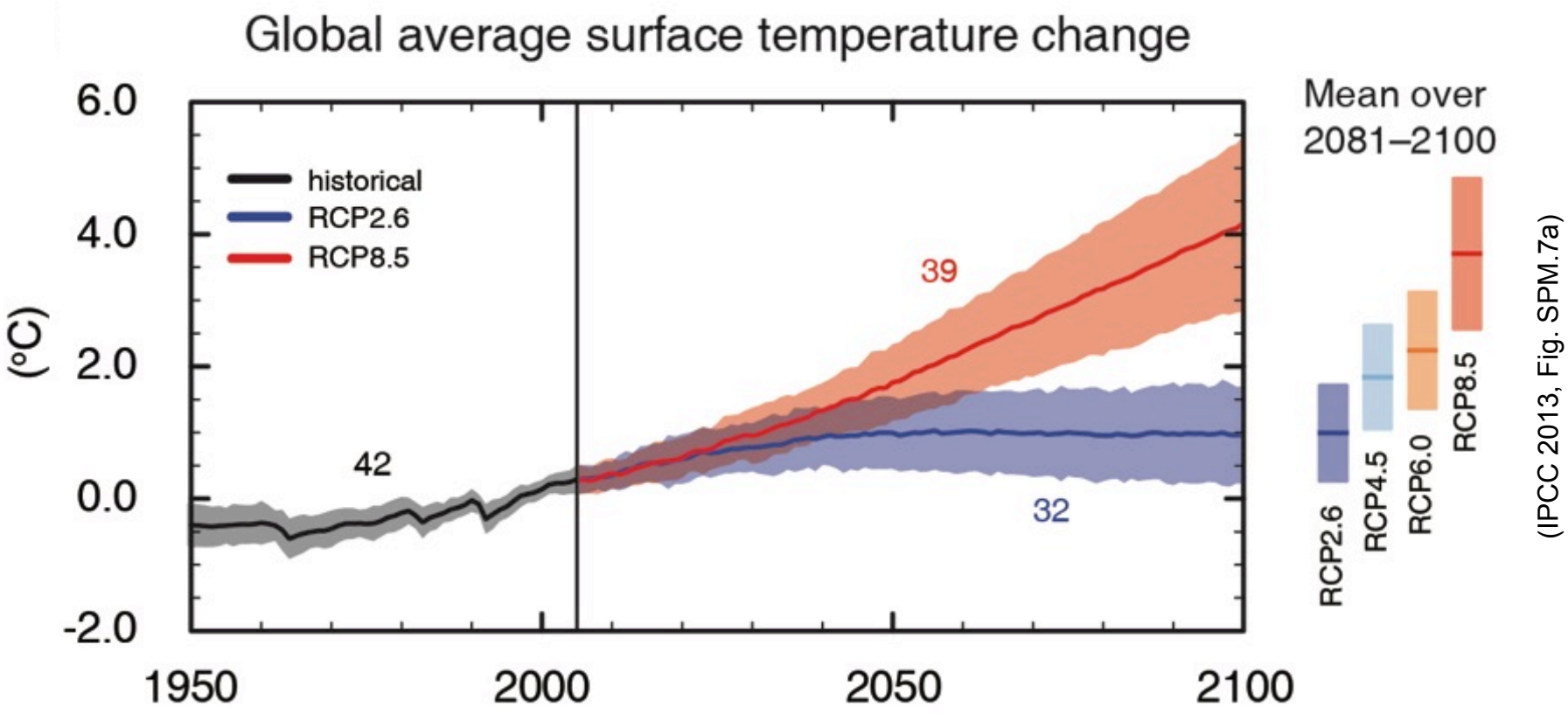
AR5 (2013) «It is **extremely likely** (odds 95 out of 100) that human influence has been the dominant cause… »

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)

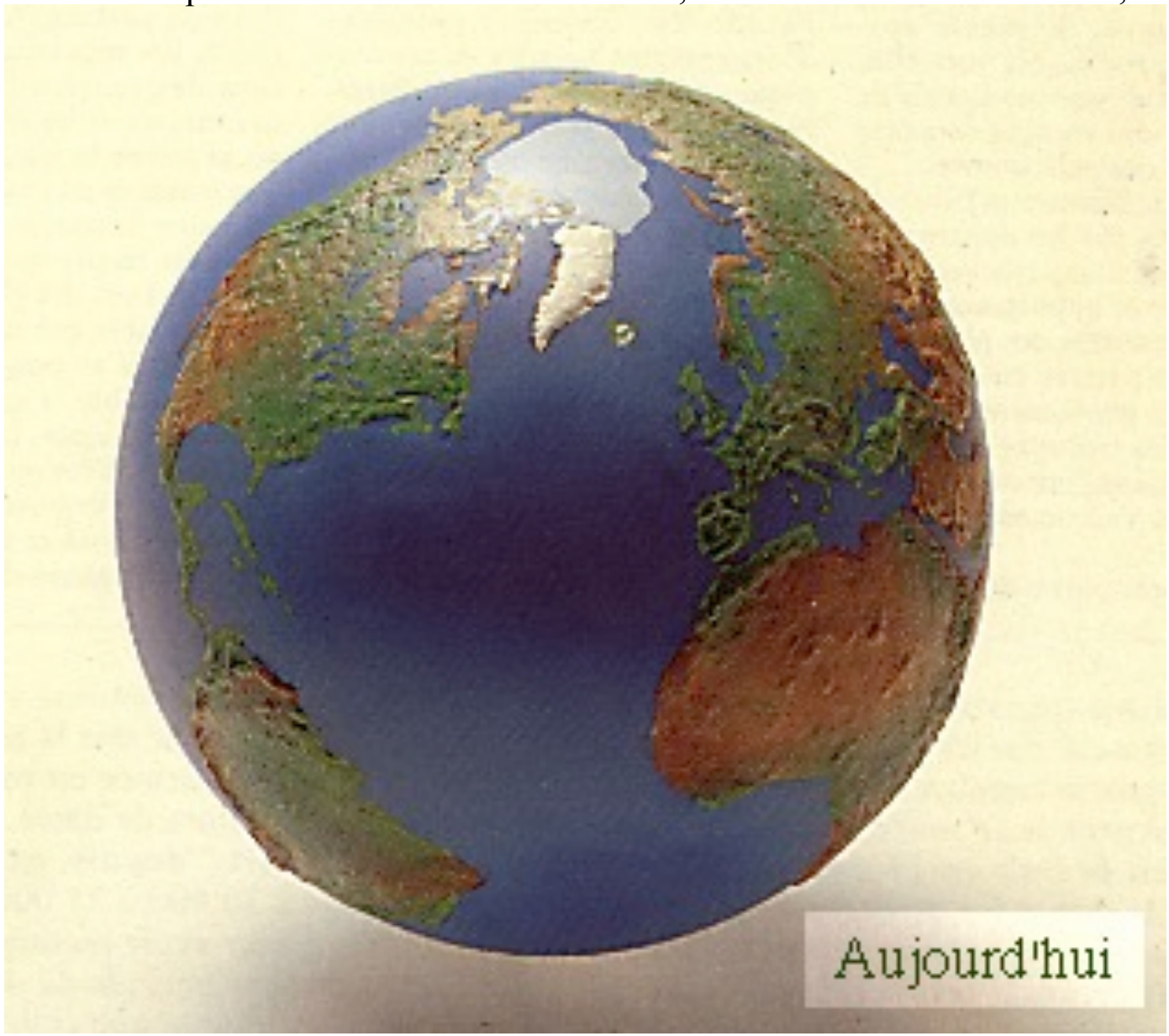
Only the lowest (RCP2.6) scenario maintains the global surface temperature increase above the pre-industrial level to less than 2°C with at least 66% probability

18-20000 years ago (Last Glacial Maximum)

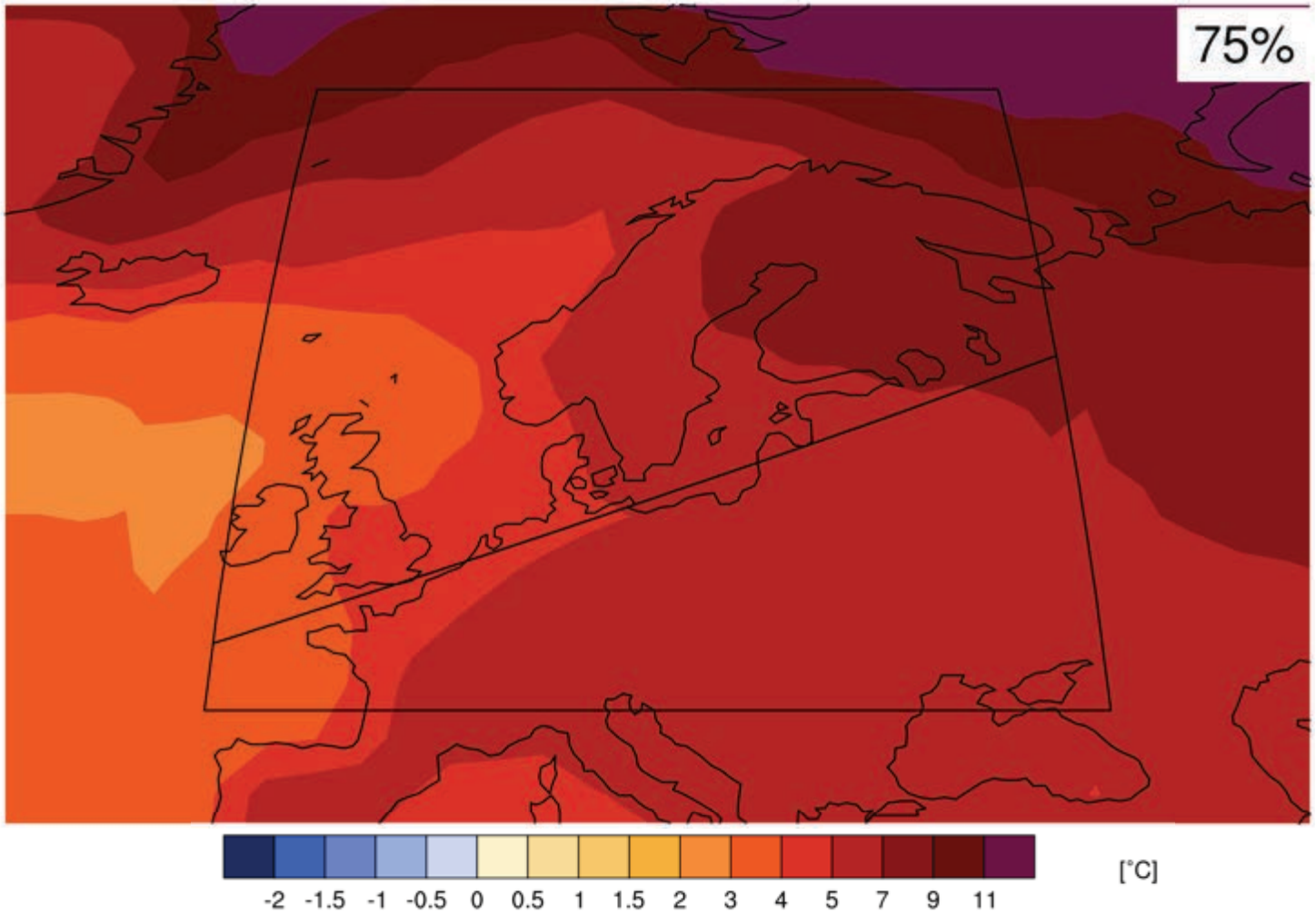
With permission from Dr. S. Joussaume, in « Climat d'hier à demain », CNRS éditions.

Today, with +4-5°C globally

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

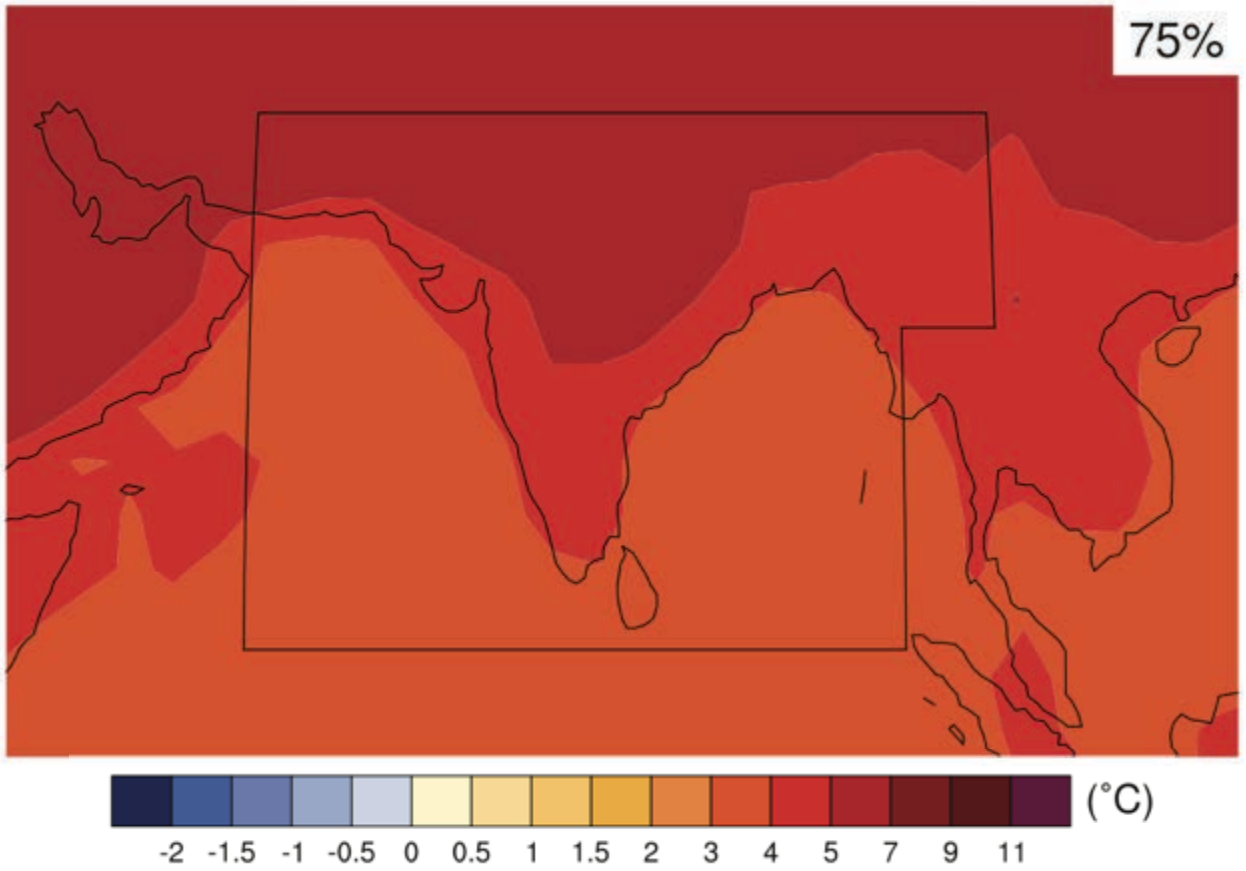


North Europe - Map of temperature changes: 2081–2100 with respect to 1986–2005 in the RCP8.5 scenario (annual)



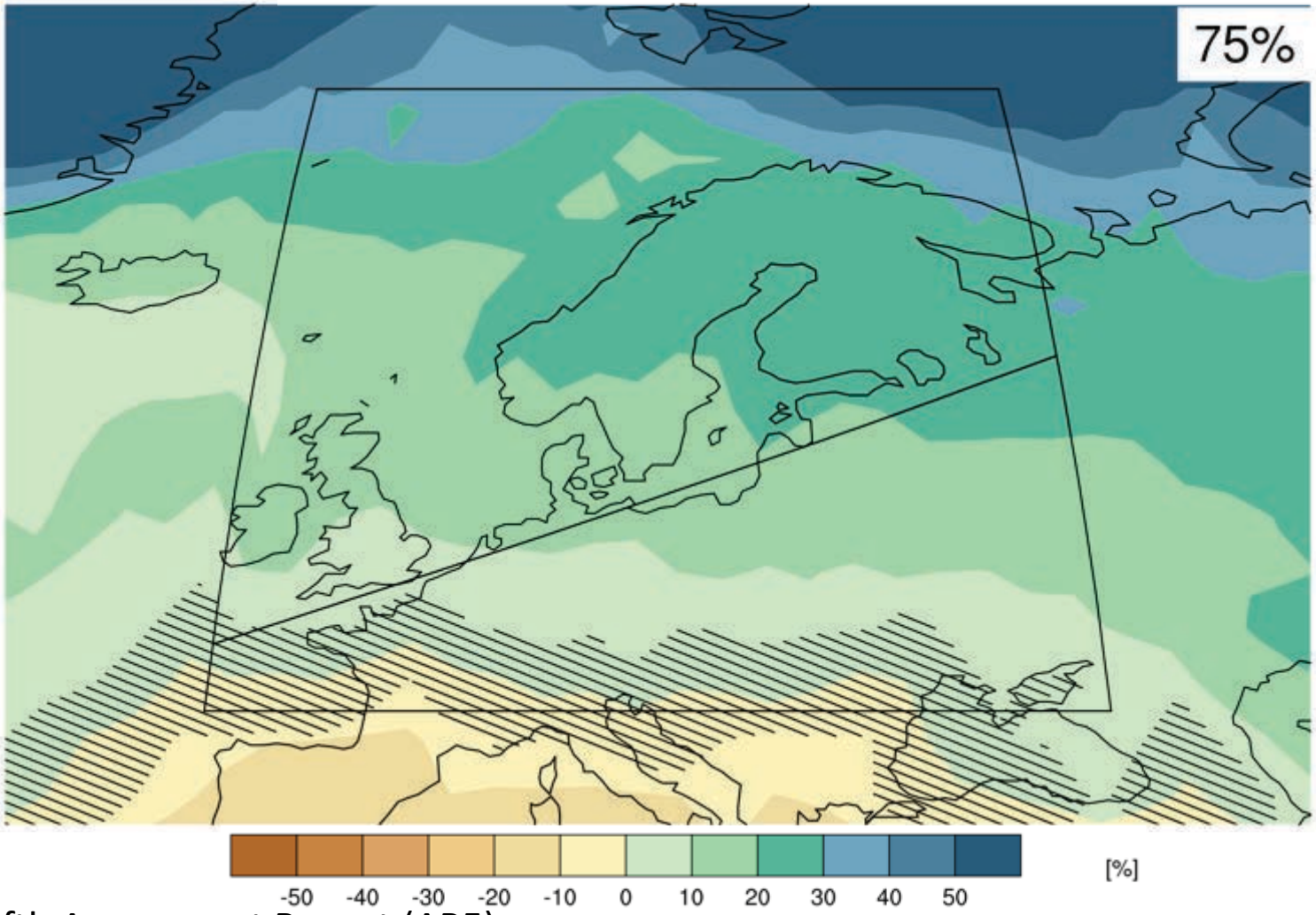
IPCC WG1 Fifth Assessment Report (AR5)

Maps of temperature changes in 2081–2100 with respect to 1986–2005 in the RCP8.5 scenario



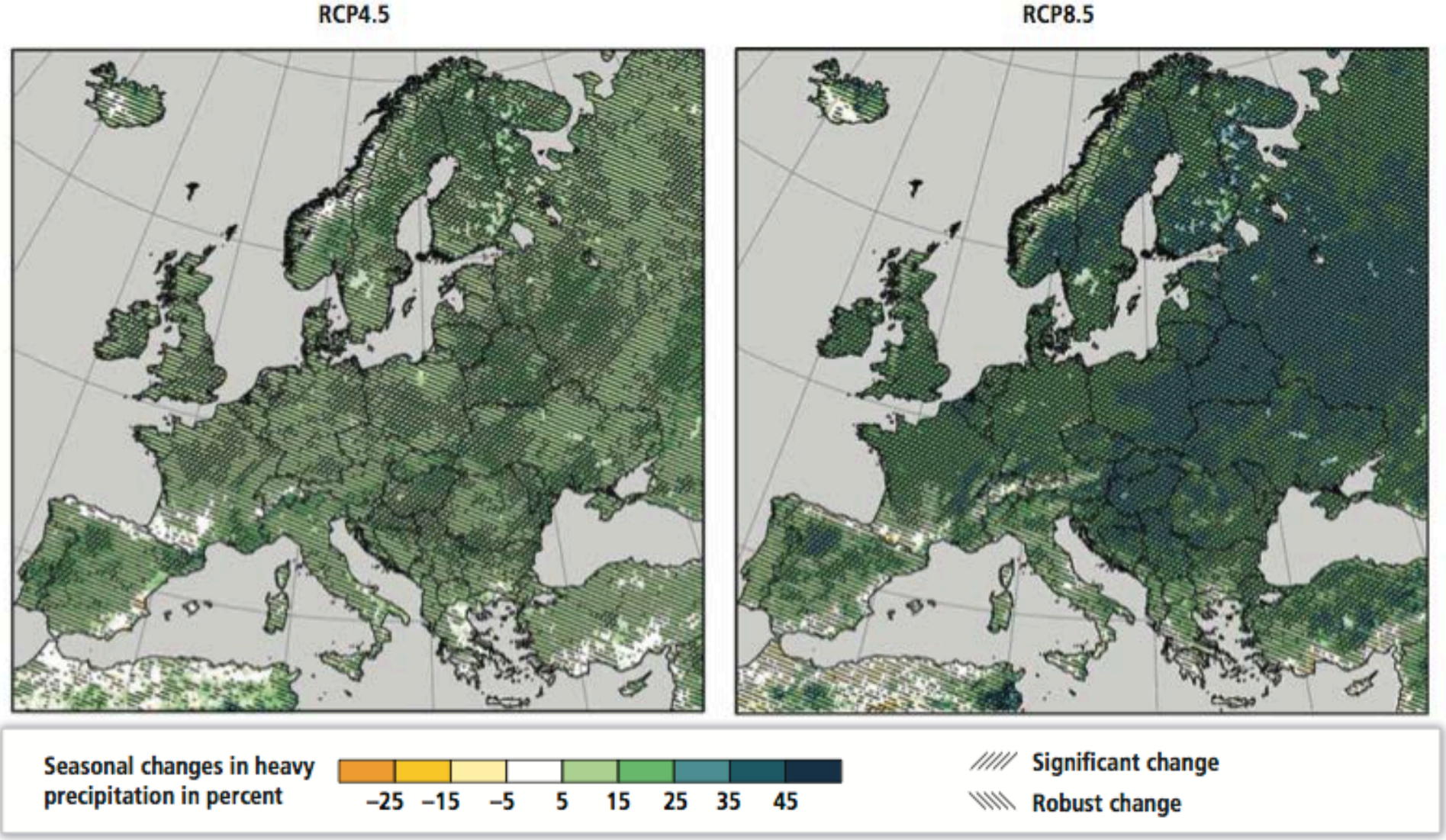
IPCC, WGI, Annex I: Atlas of Global and Regional Climate Projections Supplementary Material RCP8.5

North Europe - Map of precipitation changes in 2081–2100 with respect to 1986–2005 in the RCP8.5 scenario (annual)

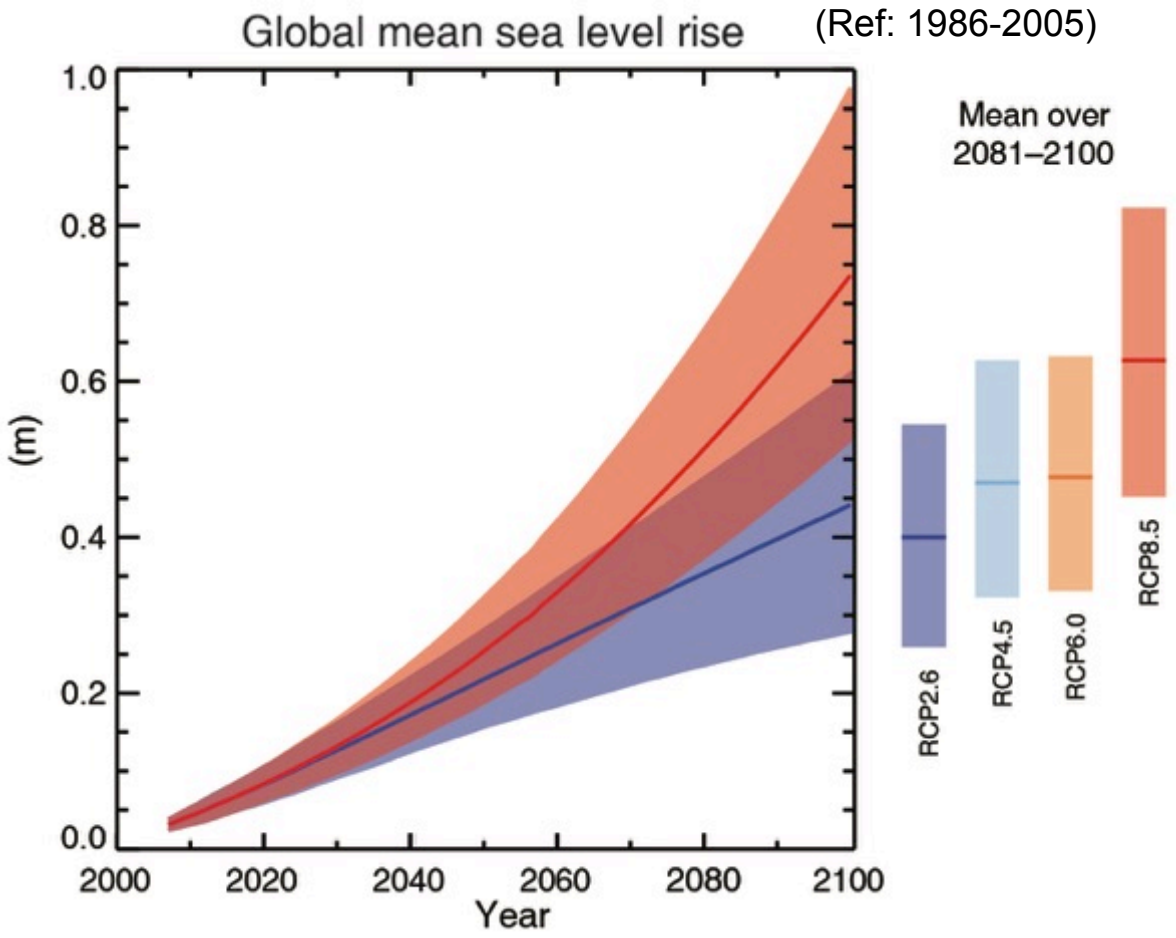


IPCC WG1 Fifth Assessment Report (AR5)

Winter (DJF) seasonal changes in heavy precipitation (%), 2071-2100 compared to 1971-2000



IPCC, AR5, WG II, Chap. 23, p. 1277



(IPCC 2013, Fig. SPM.9)

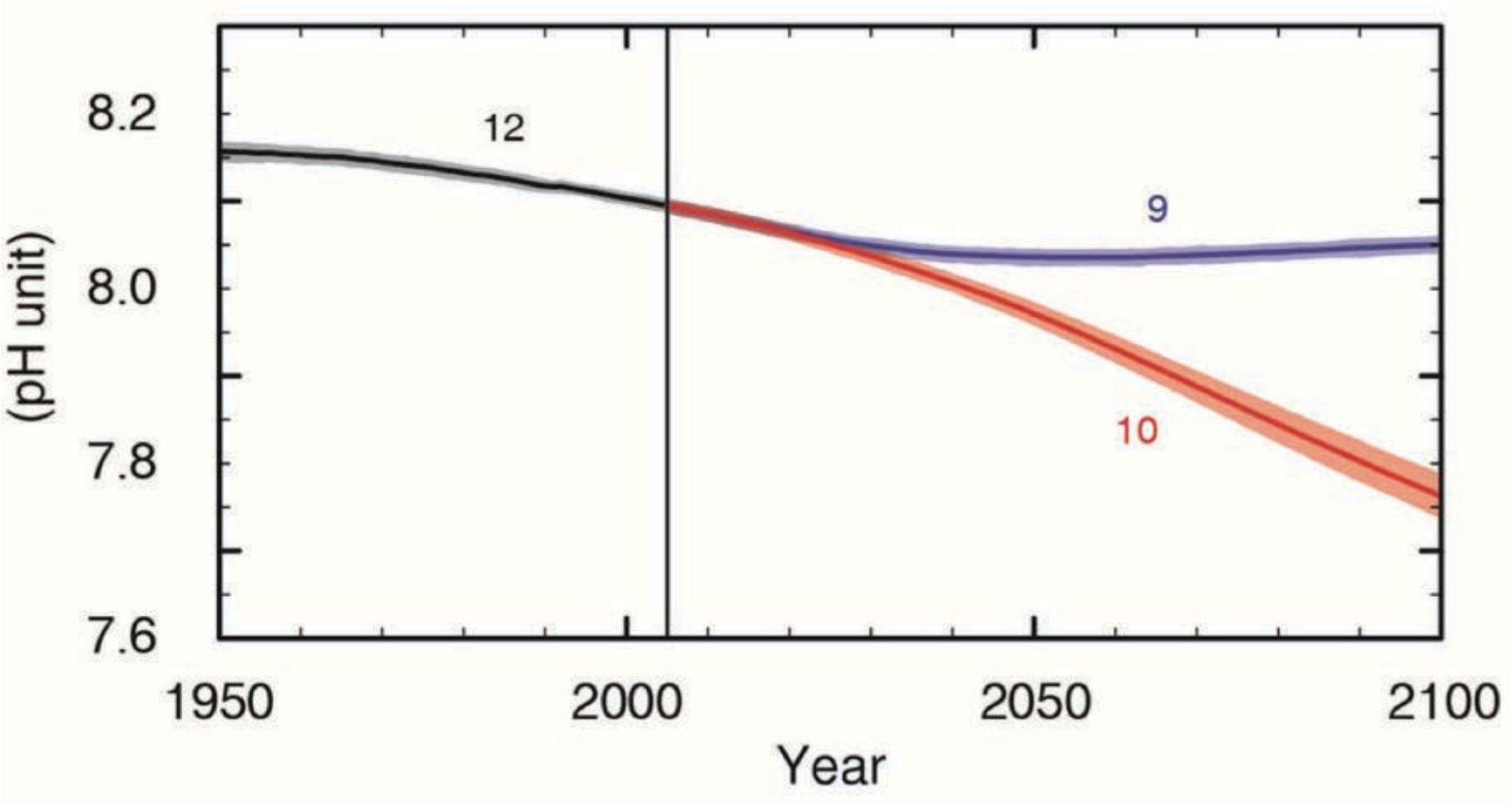
Sea level due to continue to increase

Effects on the Nile Delta, where more than 10 million people live less than 1 m above sea level

(Time 2001)

Global ocean surface pH (projections)

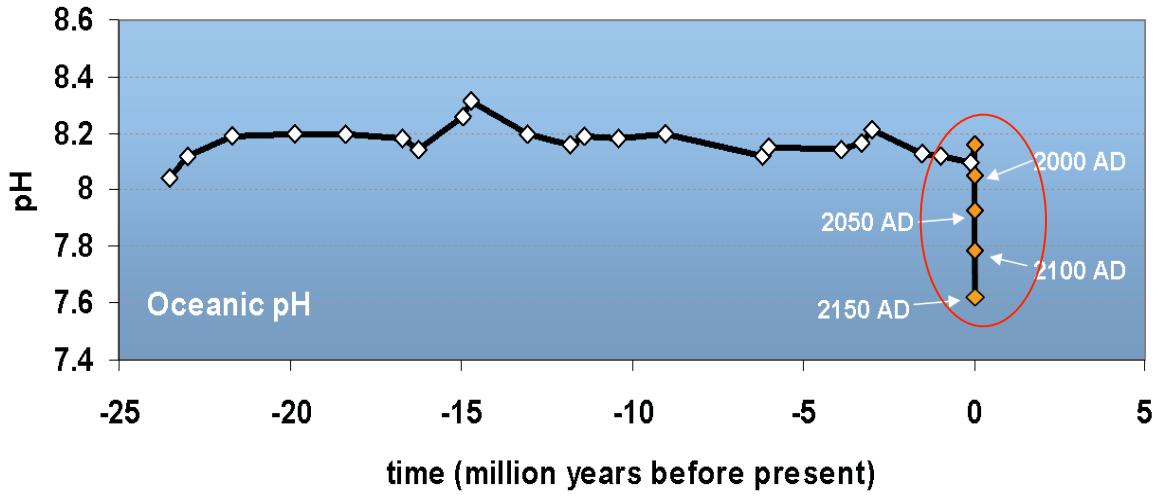
Ocean Acidification, for RCP 8.5 (orange) & RCP2.6 (blue)



IPCC AR5 WGI, Fig SPM 07

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

Climate change impacts are already underway

- Tropics to the poles
- On all continents and in the ocean
- Affecting rich and poor countries (but the poor are more vulnerable everywhere)




AR5 WGII SPM

Potential Impacts of Climate Change

Food and water shortages

Increased displacement of people

Increased poverty

Coastal flooding

AR5 WGII SPM

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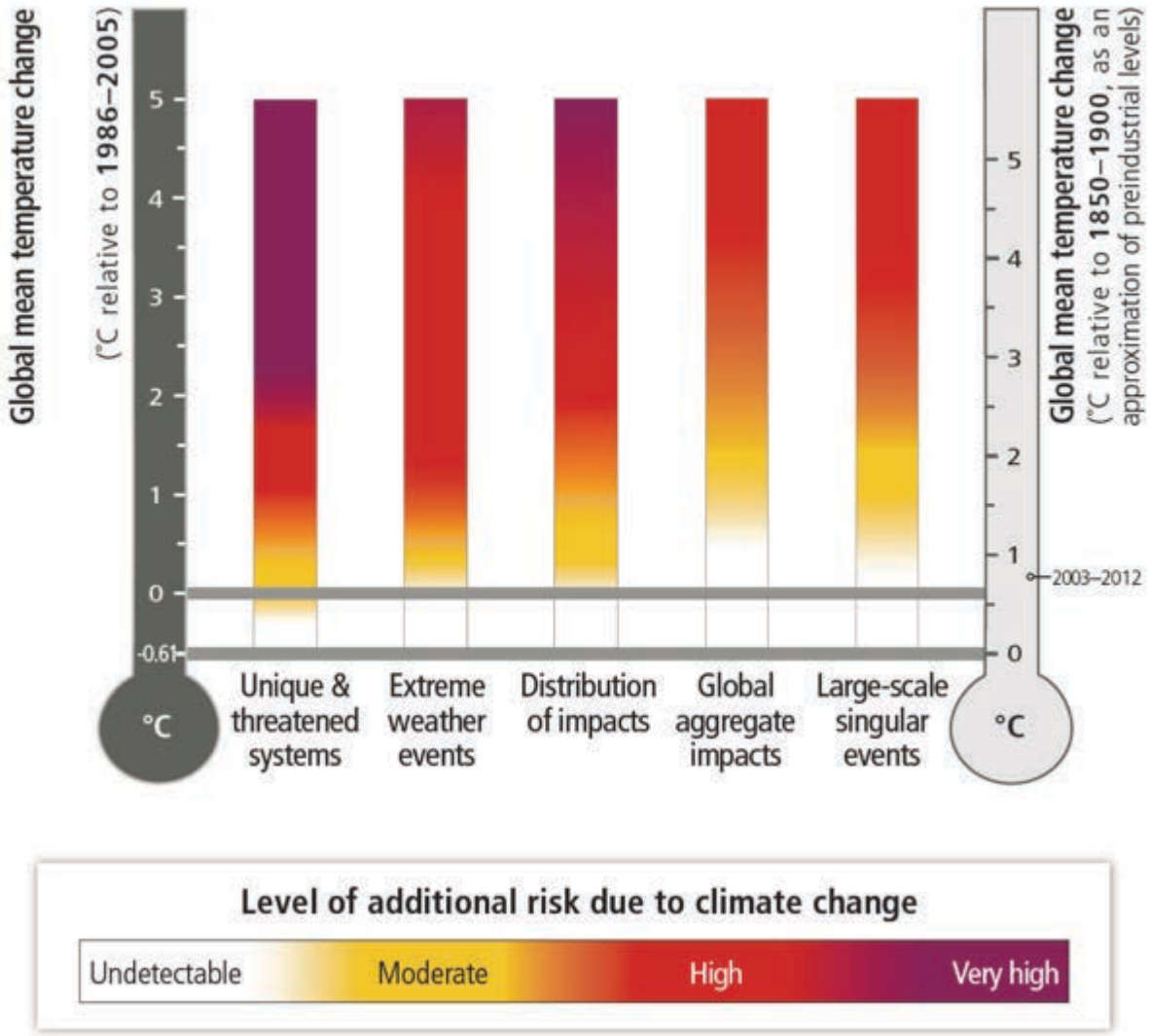
Risk = Hazard x Vulnerability x Exposure (Katrina flood victim, New Orleans, 2005)

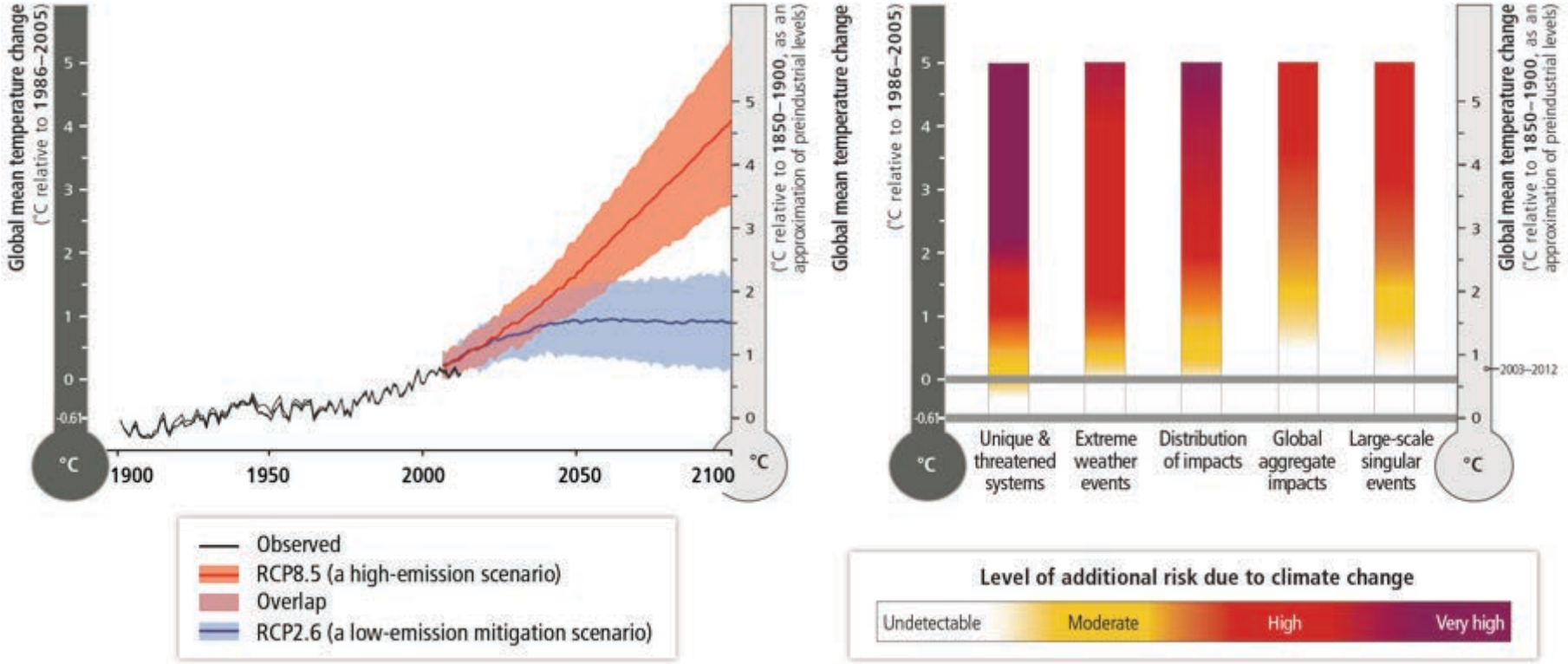
AP Photo - Lisa Krantz (http://lisakrantz.com/hurricane-katrina/zspbn1k4cn17phidupe4f9x5t1mzdr)

Synthesis: 5 key Reasons For Concern



AR5, WGII, Box SPM.1 Figure 1

Only scenario RCP2.6 allows avoidance of the red (high additional) risk zone



IPCC AR5

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INTERGOVERNMENTAL PANEL ON climate change

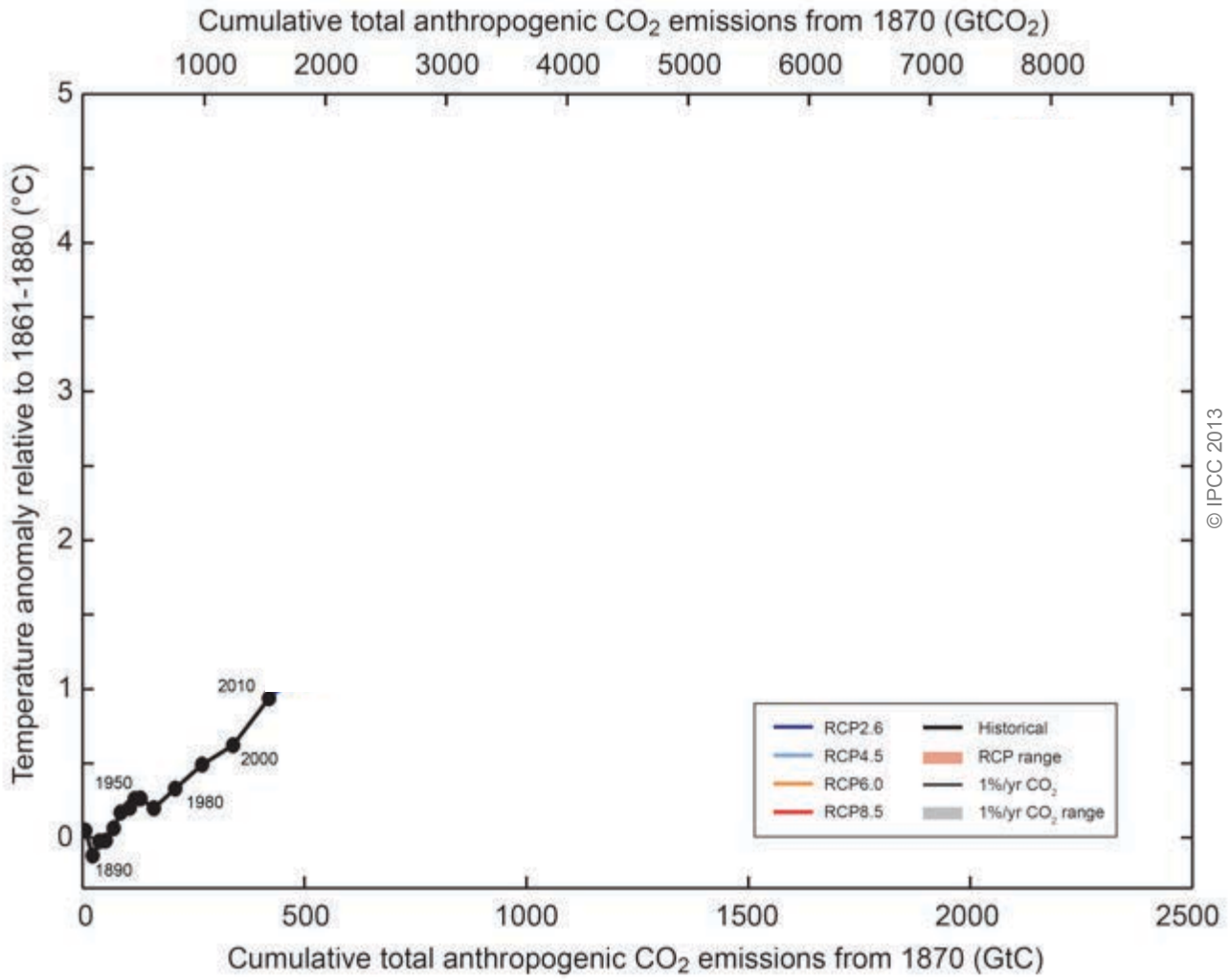


Fig. SPM.10

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

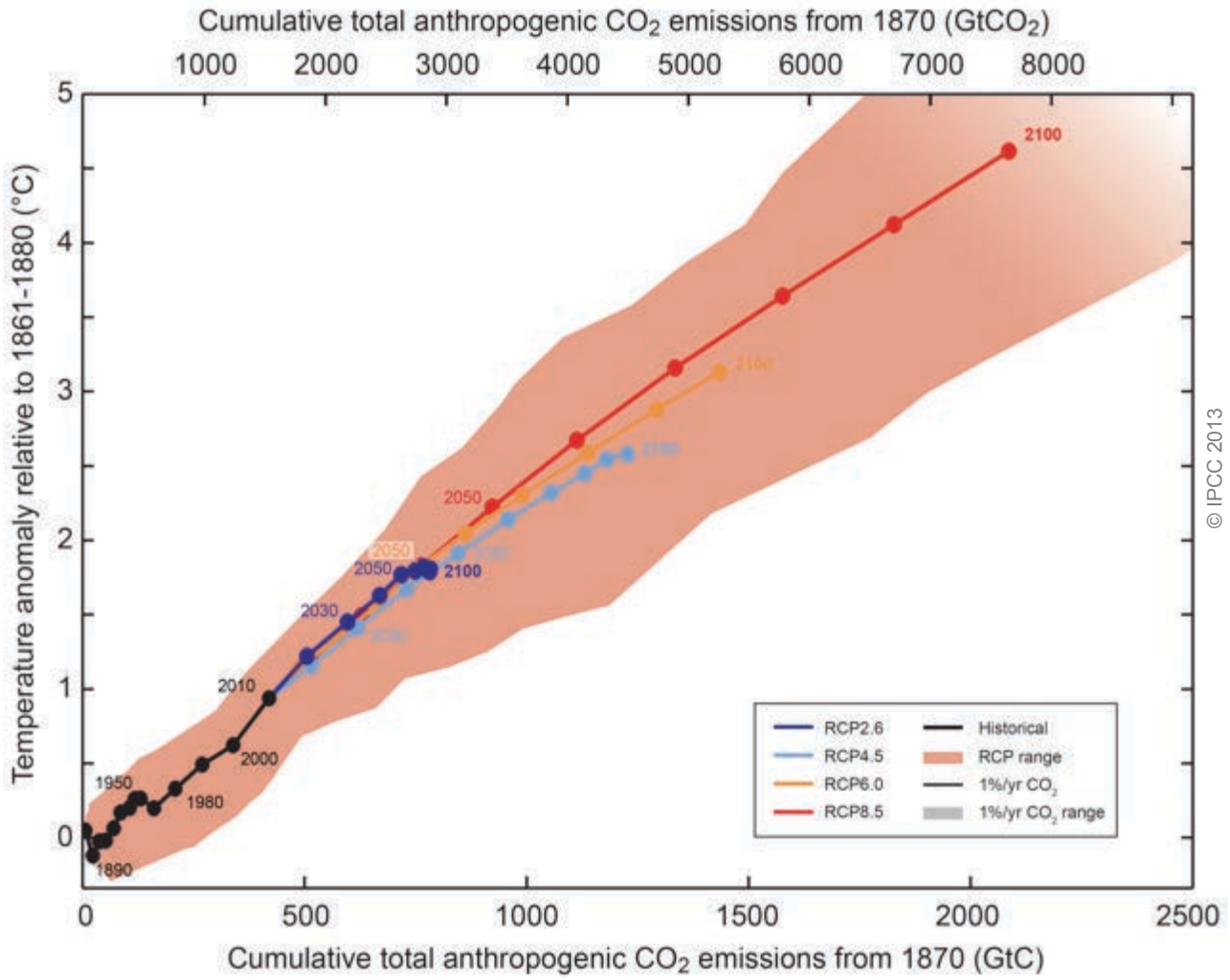
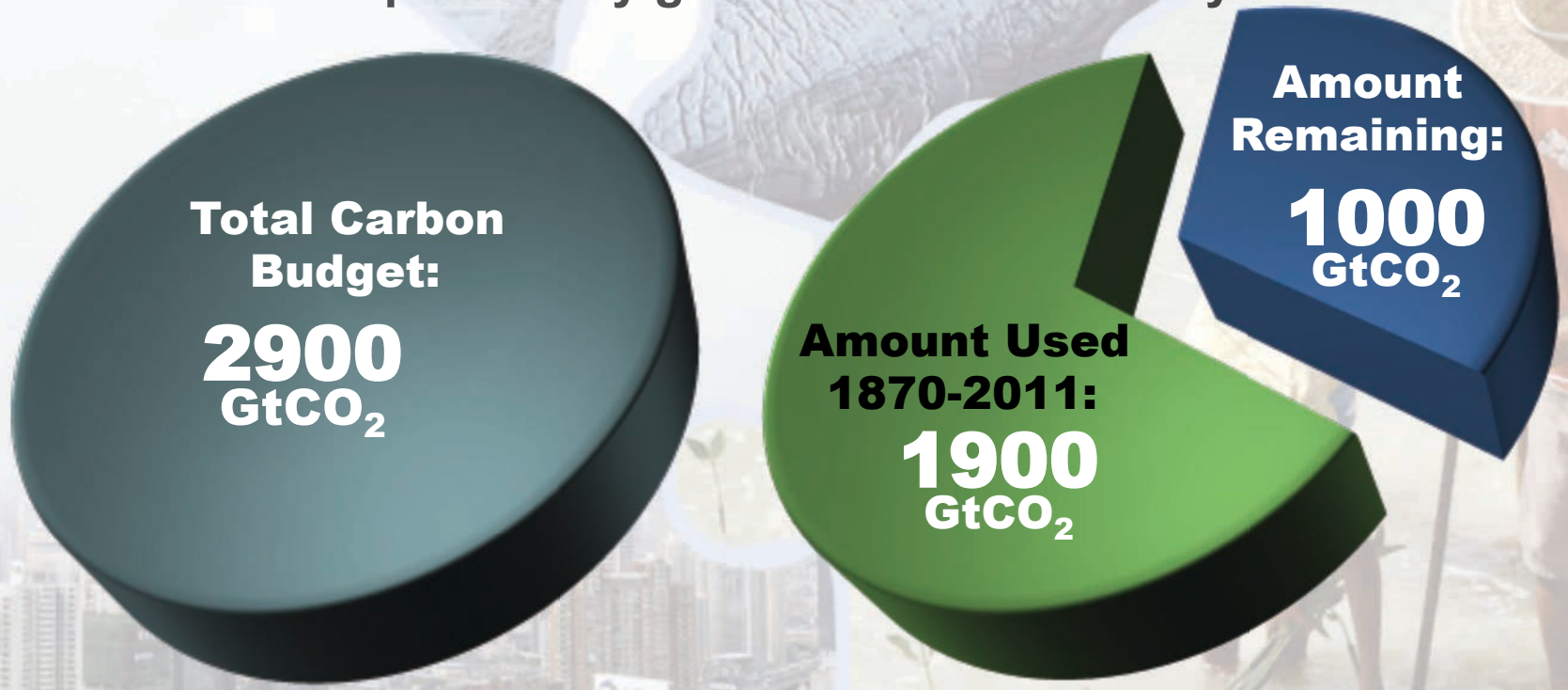


Fig. SPM.10

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

The window for action is rapidly closing

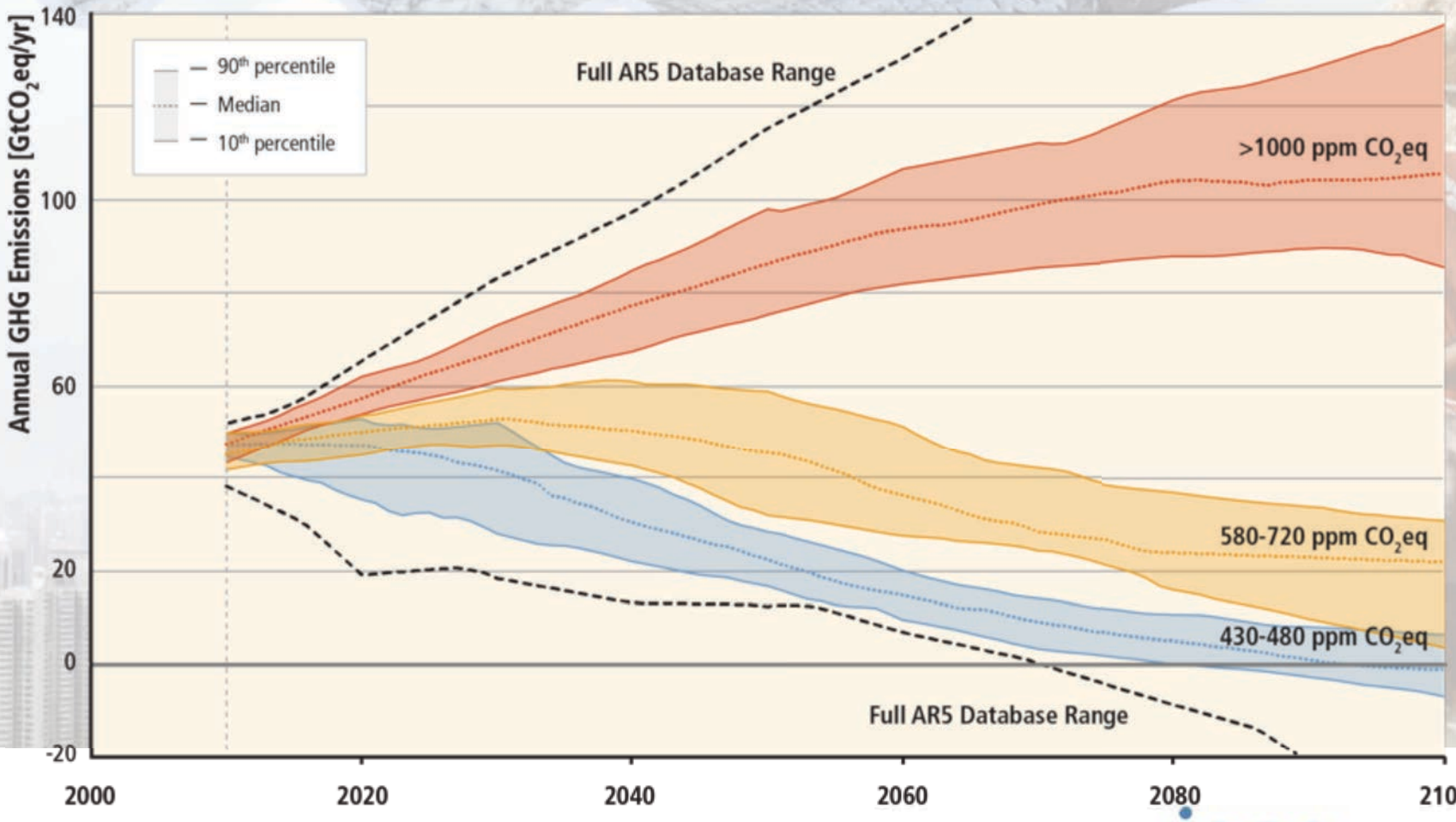
65% of the carbon budget compatible with a 2°C goal is already used
NB: this is with a probability greater than 66% to stay below 2°C



NB: Emissions in 2011: 38 GtCO2/yr

AR5 WGI SPM

Stabilization of atmospheric concentrations requires moving away from the baseline – regardless of the mitigation goal.



Based on Figure 6.7

AR5 WGIII SPM

IPCC AR5 Synthesis Report

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INTERGOVERNMENTAL PANEL ON climate change

WMO UNEP

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.**

Mitigation Measures

More efficient use of energy

Greater use of low-carbon and no-carbon energy

- Many of these technologies exist today
- But worldwide investment in **research** in support of GHG mitigation is small…

Improved carbon sinks

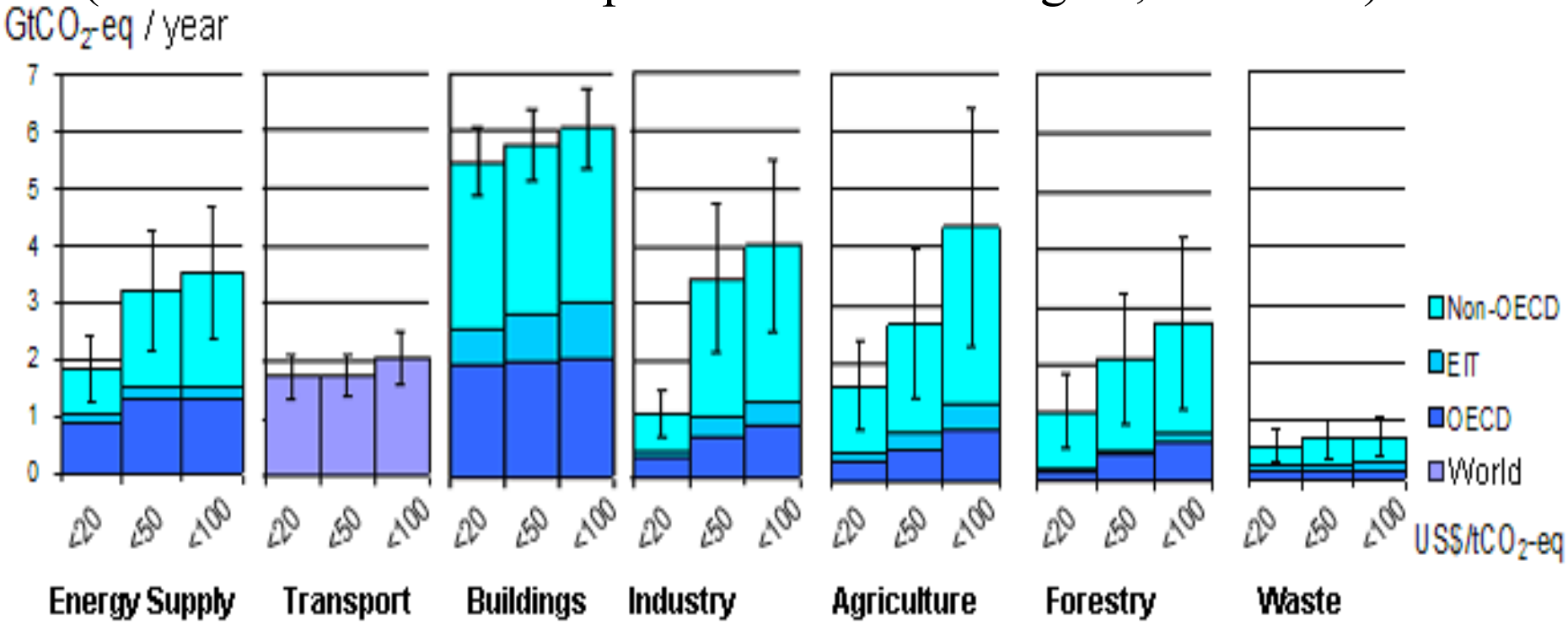
- **Reduced deforestation** and improved forest management and planting of new forests
- **Bio-energy with carbon capture and storage**

Lifestyle and behavioural changes

AR5 WGIII SPM

All sectors and regions have the potential to contribute by 2030

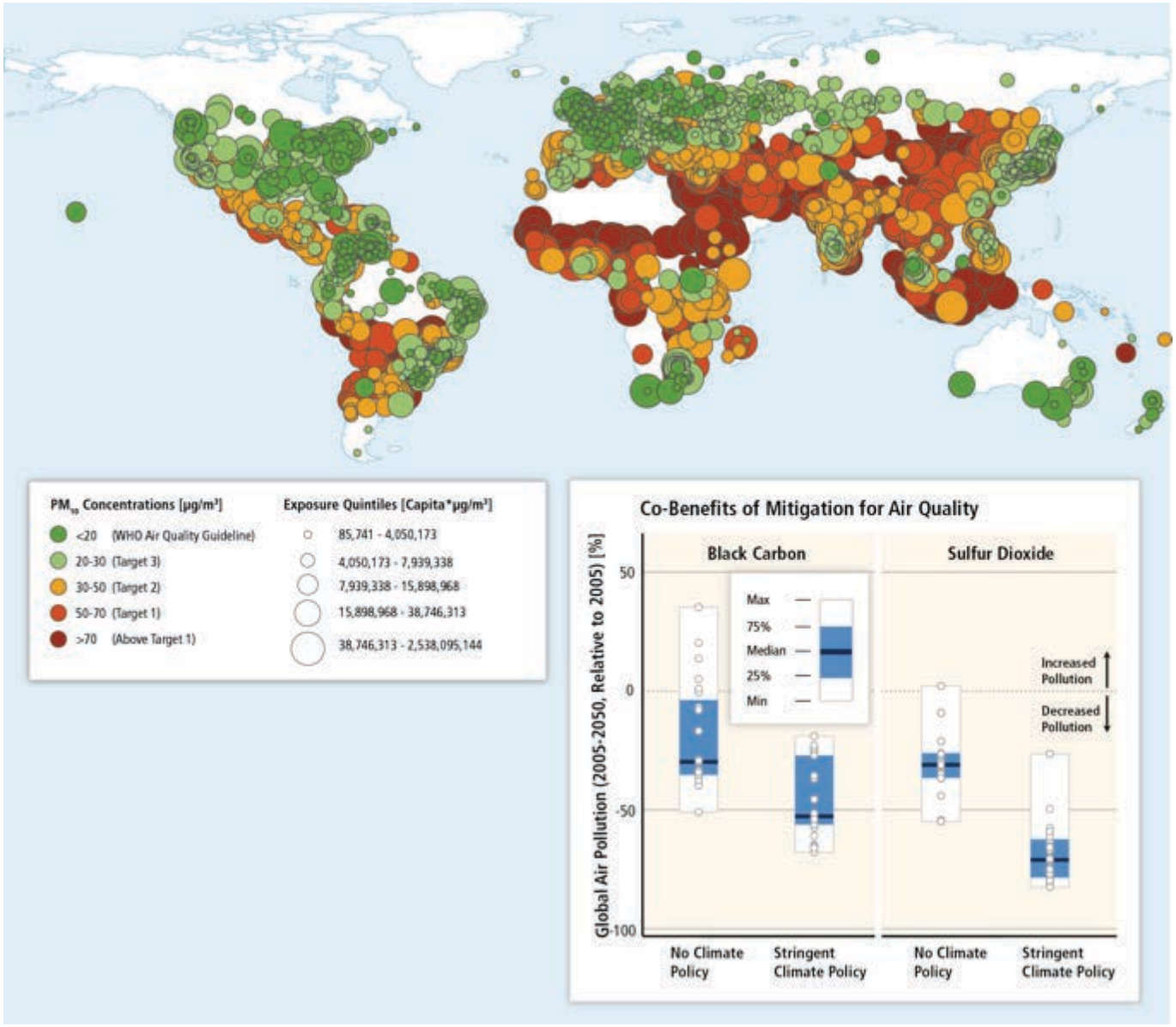
(avoided emissions compared to BaU: the higher, the better)



IPCC AR4 (2007)

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

- **Substantial reductions in emissions would require large changes in investment patterns e.g., from 2010 to 2029, in billions US dollars/year:**
  (mean numbers rounded, IPCC AR5 WGIII Fig SPM 9)
- **energy efficiency: +330**
- **renewables: + 90**
- **power plants w/ CCS: + 40**
- **nuclear: + 40**
- **power plants w/o CCS: - 60**
- **fossil fuel extraction: - 120**



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

IPCC AR5

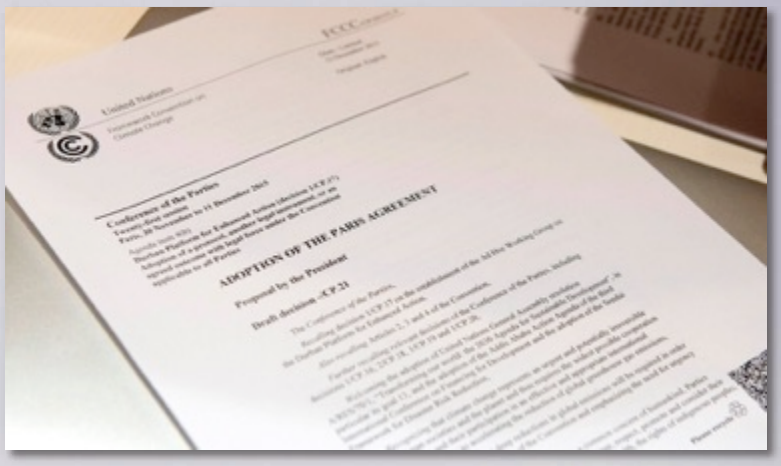
If well designed, measures to prevent climate change could offer so many opportunities:

- Co-benefits in reduced pollution, health improvement, employment, gender equality, food security, reduced poverty, energy independence…
- Opportunities to shift the tax burden away from labour and implement sustainable development
- Opportunities to integrate research results in a useful, policy-relevant way, accross disciplines (including social sciences)

ur les Changements Climatiques 2015

COP21/CMP11

Paris, France



Paris Agreement

- Article 2:
  - (…) to strengthen the global response to the threat of climate change, in the context of sustainable development and efforts to eradicate poverty, including by:
    - Holding the increase in the global average temperature to **well below 2 °C** above pre-industrial levels and to **pursue efforts** to limit the temperature increase to **1.5 °C** above pre-industrial levels, recognizing that this would significantly reduce the risks and impacts of climate change;
    - **Increasing the ability to adapt** (…) and foster climate resilience and low greenhouse gas emissions development, in a manner that does not threaten food production;
    - Making **finance flows consistent** with a pathway towards low greenhouse gas emissions and climate-resilient development

Paris Agreement

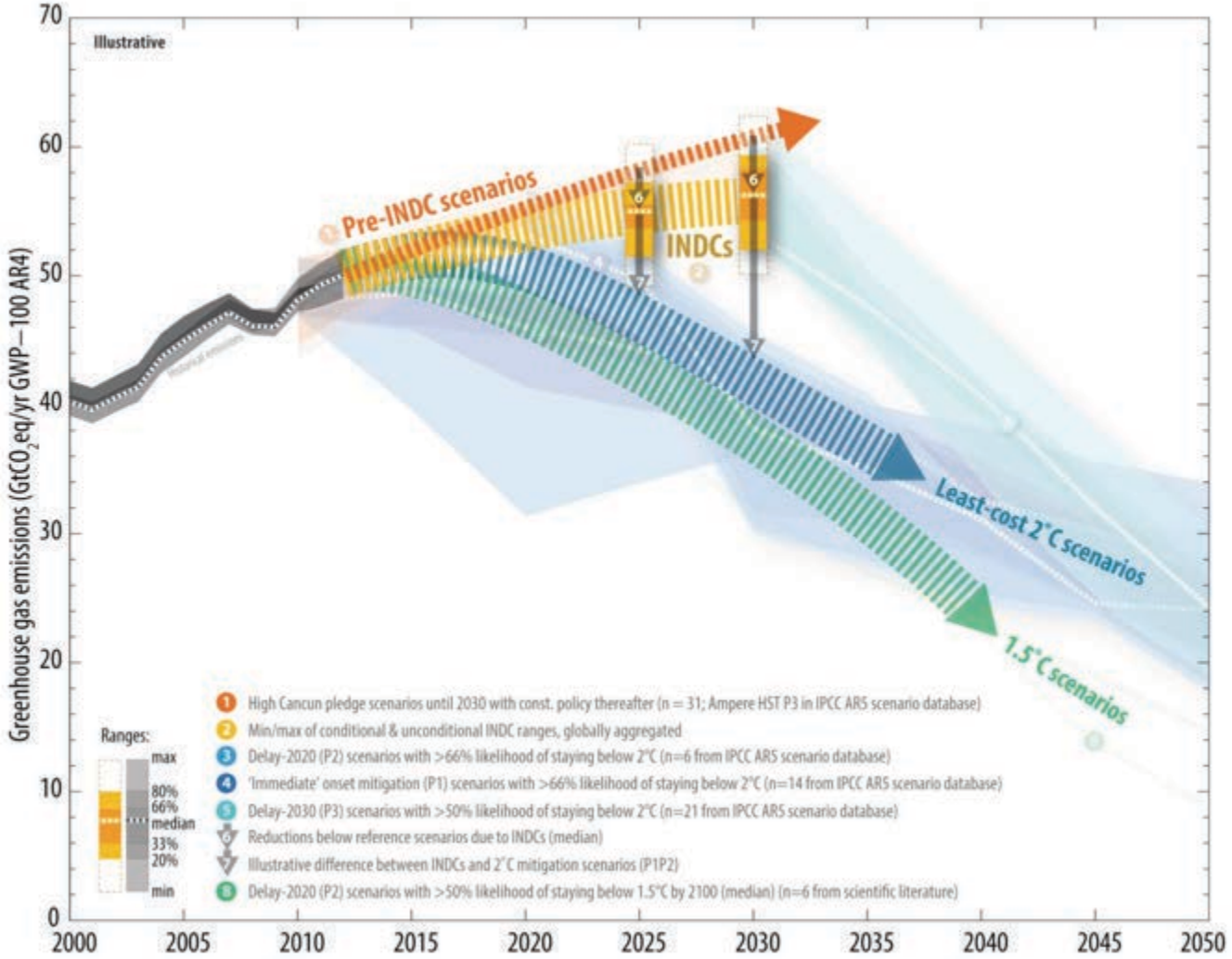
- Article 4:
  - 1. (…) Parties aim to reach **global peaking** of greenhouse gas emissions **as soon as possible**, recognizing that **peaking will take longer for developing country Parties**,
  - and to undertake **rapid reductions thereafter in accordance with best available science**,
  - so as to achieve a **balance between anthropogenic emissions by sources and removals by sinks of greenhouse gases in the second half of this century**, on the basis of equity, and in the context of sustainable development and efforts to eradicate poverty
  - 3. **Each Party's successive nationally determined contribution will represent a progression**(…)

"Getting 196 Countries To Agree On Climate Change Was The Easy Part. Now comes the real work."

(C. Figueres, World Economic Forum 2016, Davos)


Delaying additional mitigation to 2030 will substantially increase the challenges associated with limiting warming over the 21st century to below 2°C relative to pre-industrial levels.

Comparison of global emission levels in 2025 and 2030 resulting from the implementation of the intended nationally determined contributions



UNFCCC, Aggregate effect of the intended nationally determined contributions: an update
http://unfccc.int/resource/docs/2016/cop22/eng/02.pdf

SUSTAINABLE DEVELOPMENT GOALS

Walking the talk…

- Energy audit of our home
- Strong external insulation (wood fibre)
- Ultra-efficient windows
- Airtightness inspecting + heat-recovery mechanical ventilation
- Oil furnace replaced by geothermal heat pump principally fed with PV pannels
- Non-tropical wood
- Small, used electric car
- Electric bicycles

Trying to be coherent (external insulation)

J’essaye d’être cohérent…

Please go and see the latest movie with Al Gore

An Inconvenient Sequel:

Truth to Power

Last Advice

Explore how you could contribute to IPCC activities:

- **Nominations to become AR6 author are open until 27 October 2017 (check www.ipcc.ch)**
- **Regular opportunities to contribute as expert reviewer (check www.ipcc.ch)**
- **Publish literature relevant to the IPCC work, and bring it to the attention of IPCC authors**

Conclusions (1/2)

The challenge is huge: transform the world in a few decades so that the whole world activities are decarbonized, while poverty and hunger are eliminated;

Addressing it open so many opportunities, for research in all disciplines and accross disciplines and for integrating results of this research in meaningful actions by all: governments, cities, businesses, NGOs, and citizens;

It opens also economic opportunities, and opportunities to address in a synergistic manner other societal goals, such as the 17 Sustainable Development Goals discussed by Prof. Slaus this morning, including the modesty and compassion he pleaded for;

Conclusions (2/2)

Last but not least, addressing this challenge, together, will allow us to look our children and grand children into their eyes when they will ask us how we contributed to avoiding the announced environmental collapse.

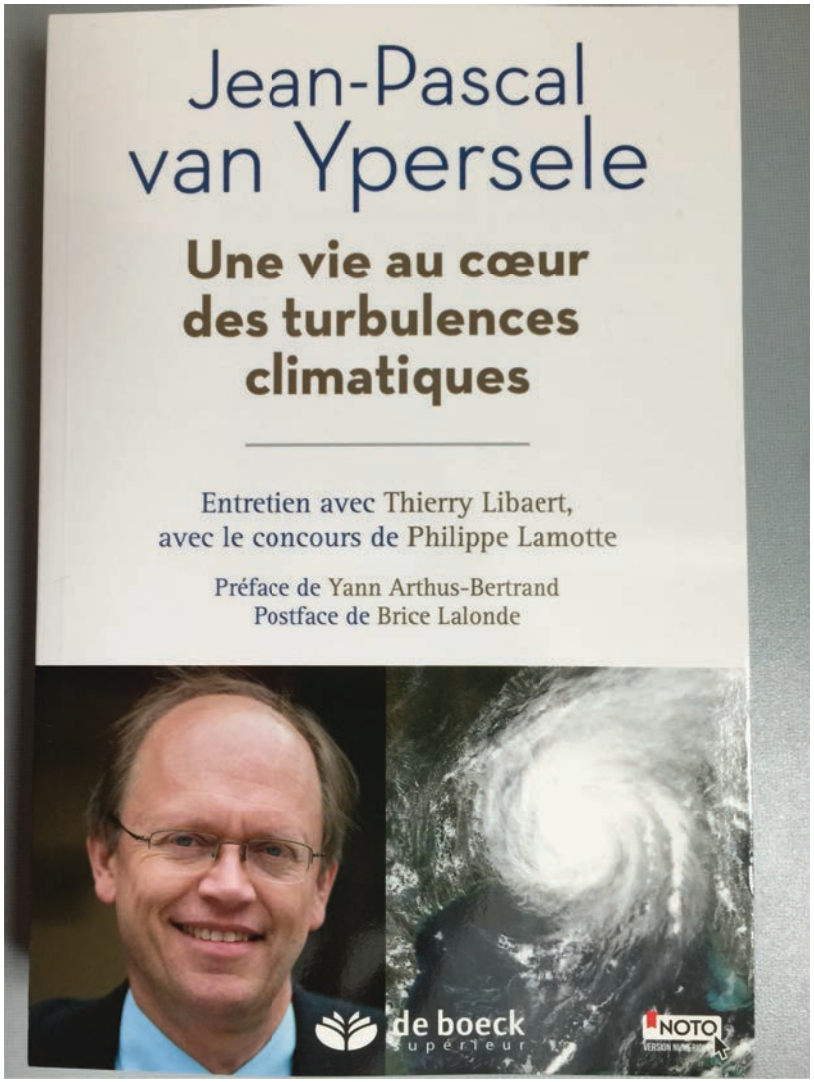
Buddhist saying: Courage is the gateway to happiness

In a nutshell: Yes we can !

Only together…

Source: UNICEF

My book (in French)
De Boeck supérieur, (2015)
Broché: 16 euros
E-book: 13 euros



Useful links:

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