Knowledge of Limits and Limitations of Knowledge:

Dealing with the Earth's Limited Life-sustaining Capacity

Jean-Pascal van Ypersele

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Former IPCC Vice-Chair

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Swiss Sustainable University Day,

Université de Lausanne, 21 April 2016

Thanks to the Belgian Federal Science Policy Office (BELSPO) and to my team at the Université catholique de Louvain for their support

A poem to start:

« In the end, we conserve only what we love.
We will love only what we understand.
We will understand only what we are taught.»

(*Baba Dioum*, Senegalese poet)

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Plan

- Where do I speak from?
- The Earth's limited life sustaining capacity
- Knowledge of limits
- Limitation of knowledge
- Conclusions

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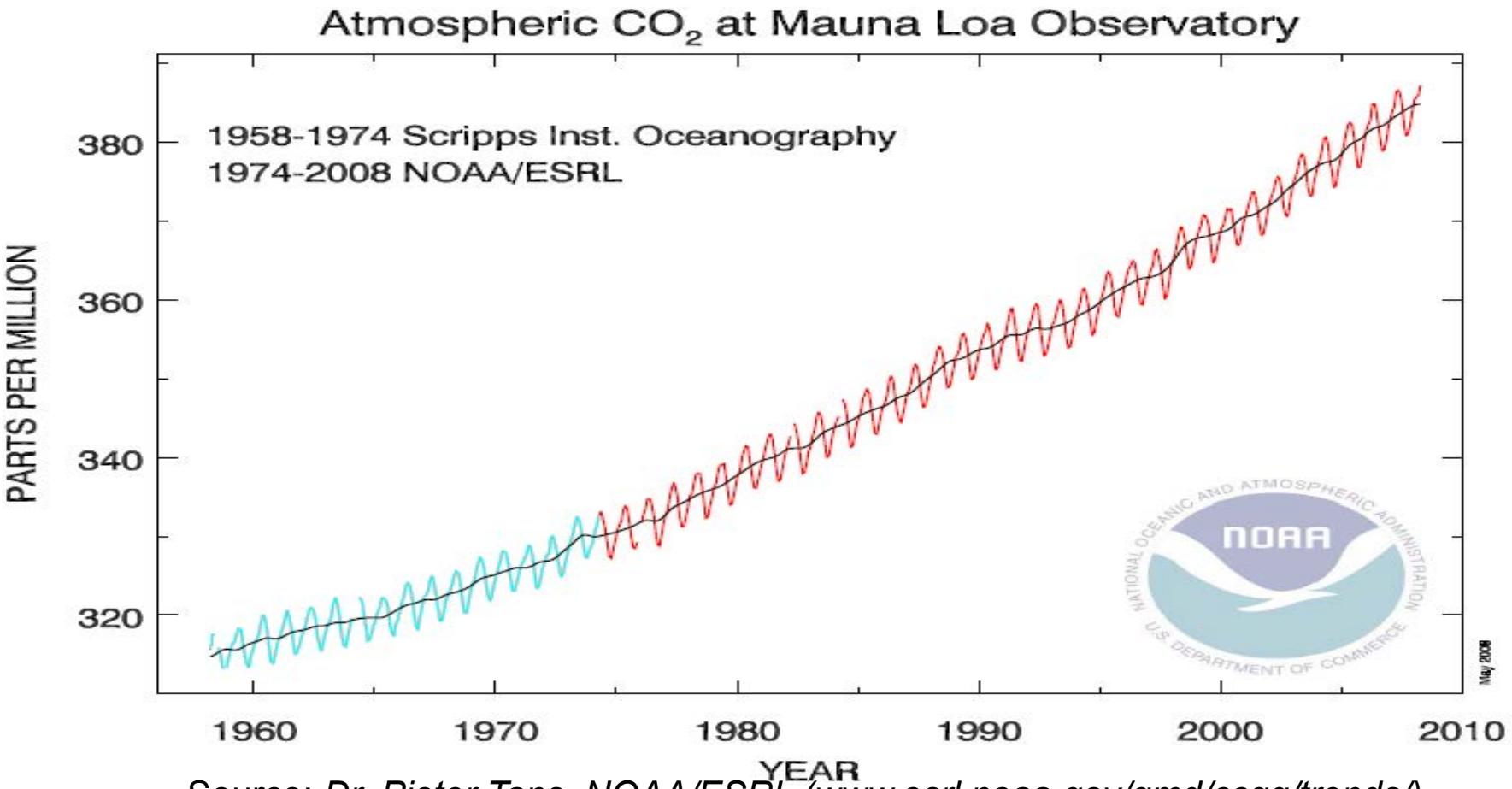
CO_2 concentration measured at Mauna Loa (3400 m)



Source: *Dr. Pieter Tans, NOAA/ESRL (www.esrl.noaa.gov/gmd/ccgg/trends/)*

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Where do I speak from?

- 1957 : Born: IGY, Sputnik, Keeling curve CO2 Mauna Loa
- 1972 : Astronomy / Environment : Limits to Growth at school, Earth Day (COP21 signing tomorrow in NYC, 44th Earth Day), UNEP
- 1973 : Total solar eclipse in Kenya : astronomy, but drought as well
- 1979 : First World Climate Conference in Geneva : Science and Policy

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Where do I speak from?

- 1980 : Physics Master, EBM and CO2 (Apartheid, development, UNEP, desertification)
- 1982 : I meet Steve Schneider, NCAR : science-policy interface, nuclear winter, climate science communication
- 1986 : Tchernobyl : the day I came back from NCAR after Ph.D.!
- 1992 : Rio Summit, UN Conf on Env & Development, Council on Sustainable Development

Where do I speak from?

- 1995 : IPCC WGI Final Plenary in Madrid ; Famous sentence « The balance of evidence suggests a discernible influence of human activities on climate »
- 1997 : Kyoto
- 1998 : IPCC author with Steve
- 2002 : IPCC Bureau (for 13 years) (and UCL prof, Interdisciplinary Master in Science & Management of the Environment, until now)

Where do I speak from?

- 2008 : IPCC Vice-Chair (until 2015),
- 2010 Copenhagen, Himalaya error, IPCC-bashing/ reform
- 2013 : First Interdisciplinary Symposium on Sustainable development in Belgium
- 2015 : Candidate IPCC Chair (56 countries voted for me) / book about my turbulent experiences / COP21
- 2016 : Lubricating the climate-science policy interface/ decarbonizing my way of life /IPCC back to basics

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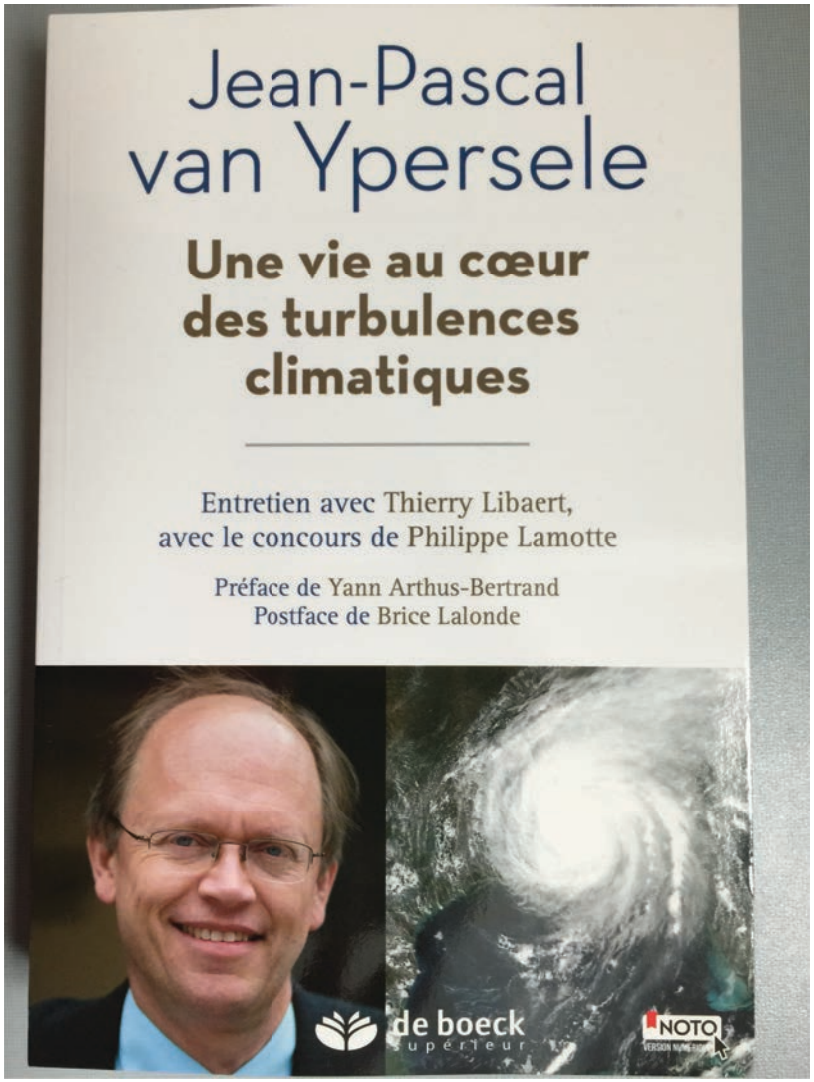
Publié chez De Boeck supérieur, octobre 2015



Horace-Bénédict de Saussure (1740-1799)

Chamonix

The Earth's limited life sustaining capacity

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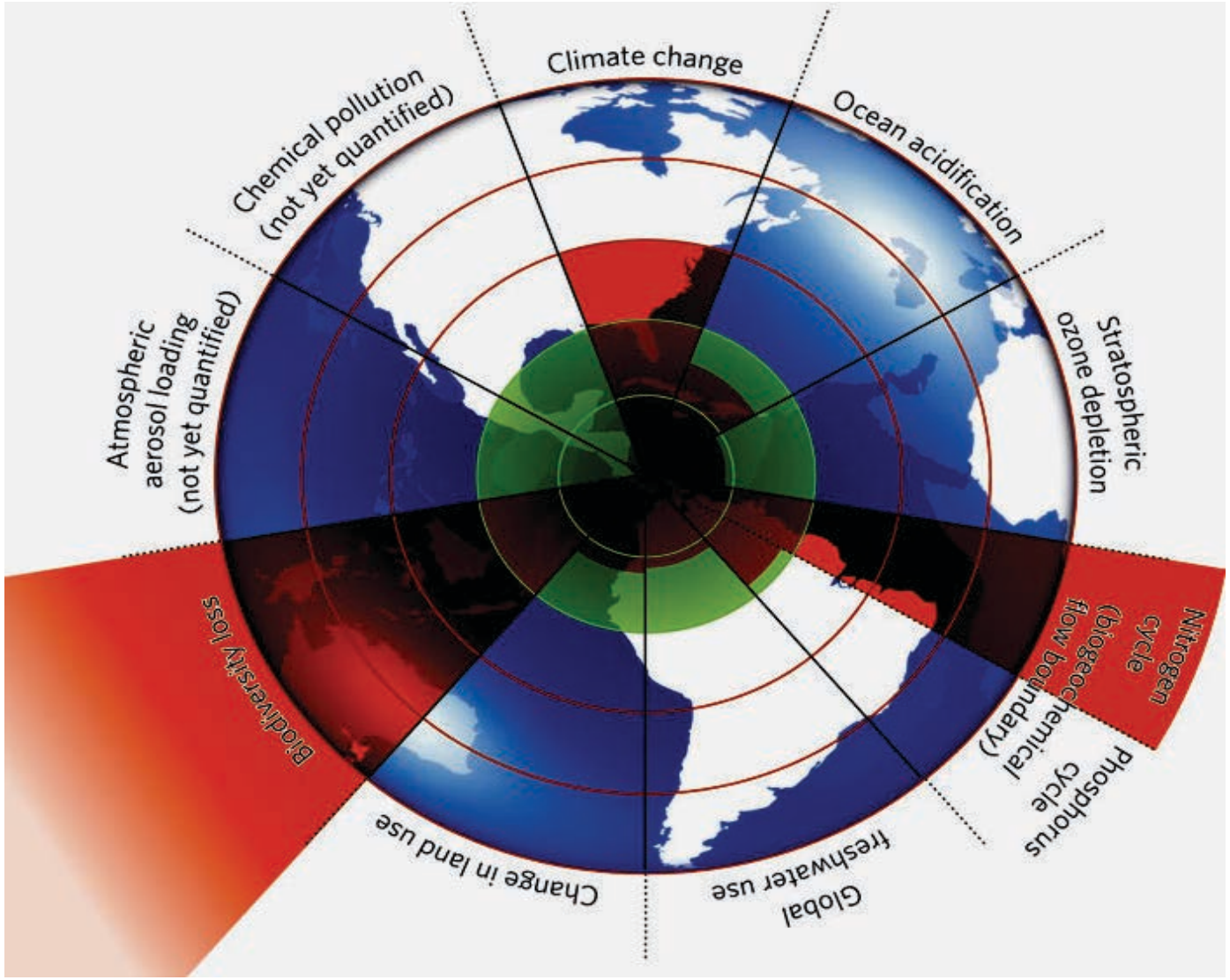
Children from Machakos (Kenya), April 2015

9 Planetary Boundaries; 3 crossed already



Source: Rockström et al 2009

Knowledge of limits

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Why the IPCC ?

Established by WMO and UNEP in 1988

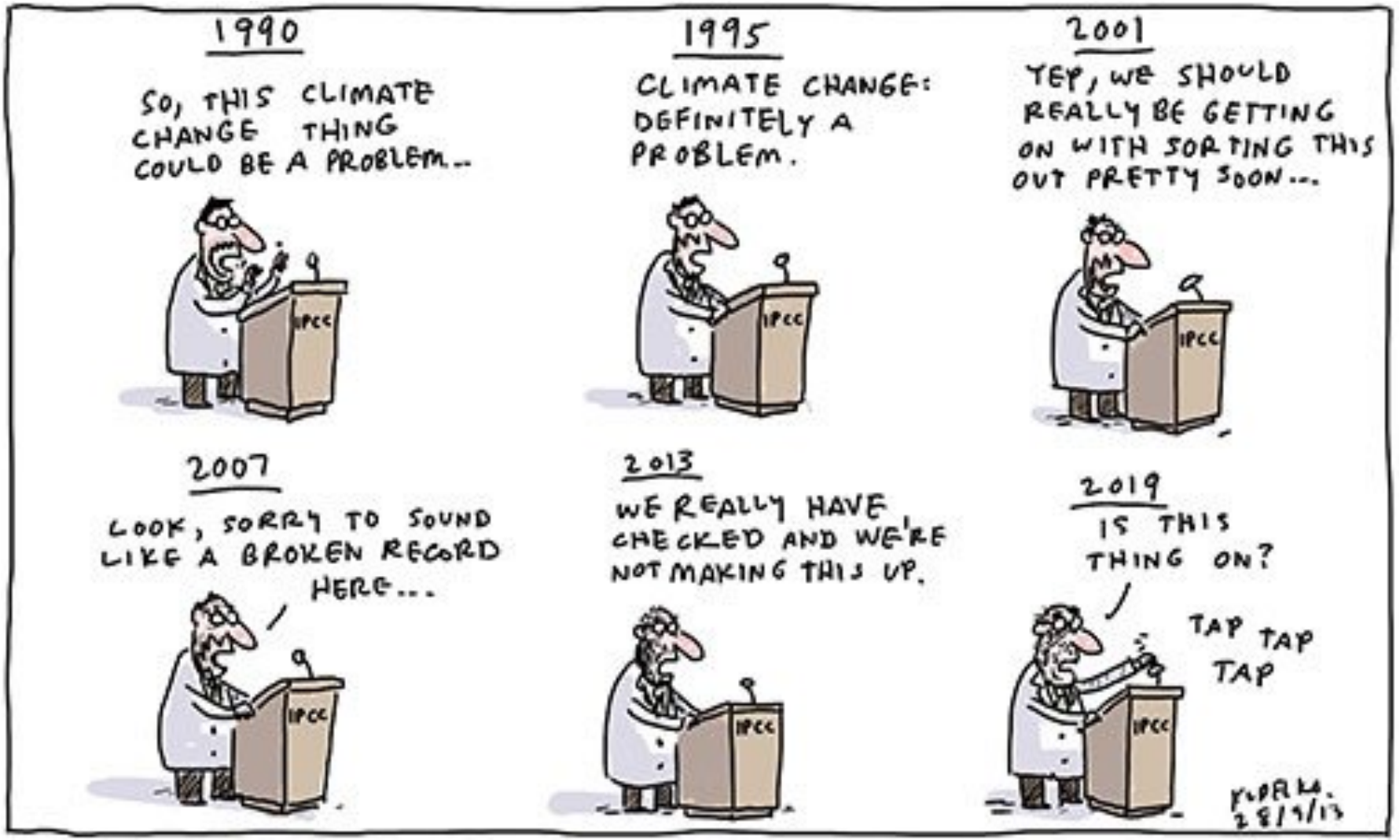
to provide **policy-makers** with an **objective source of information** about

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

WMO=World Meteorological Organizatior

UNEP= United Nations Environment Programme

None So Deaf



http://www.kudelka.com.au/2013/09/none-so-deaf/

26 years old: IPCC first report warning of global warming induced climate change

Auteur: @JohnKudelka

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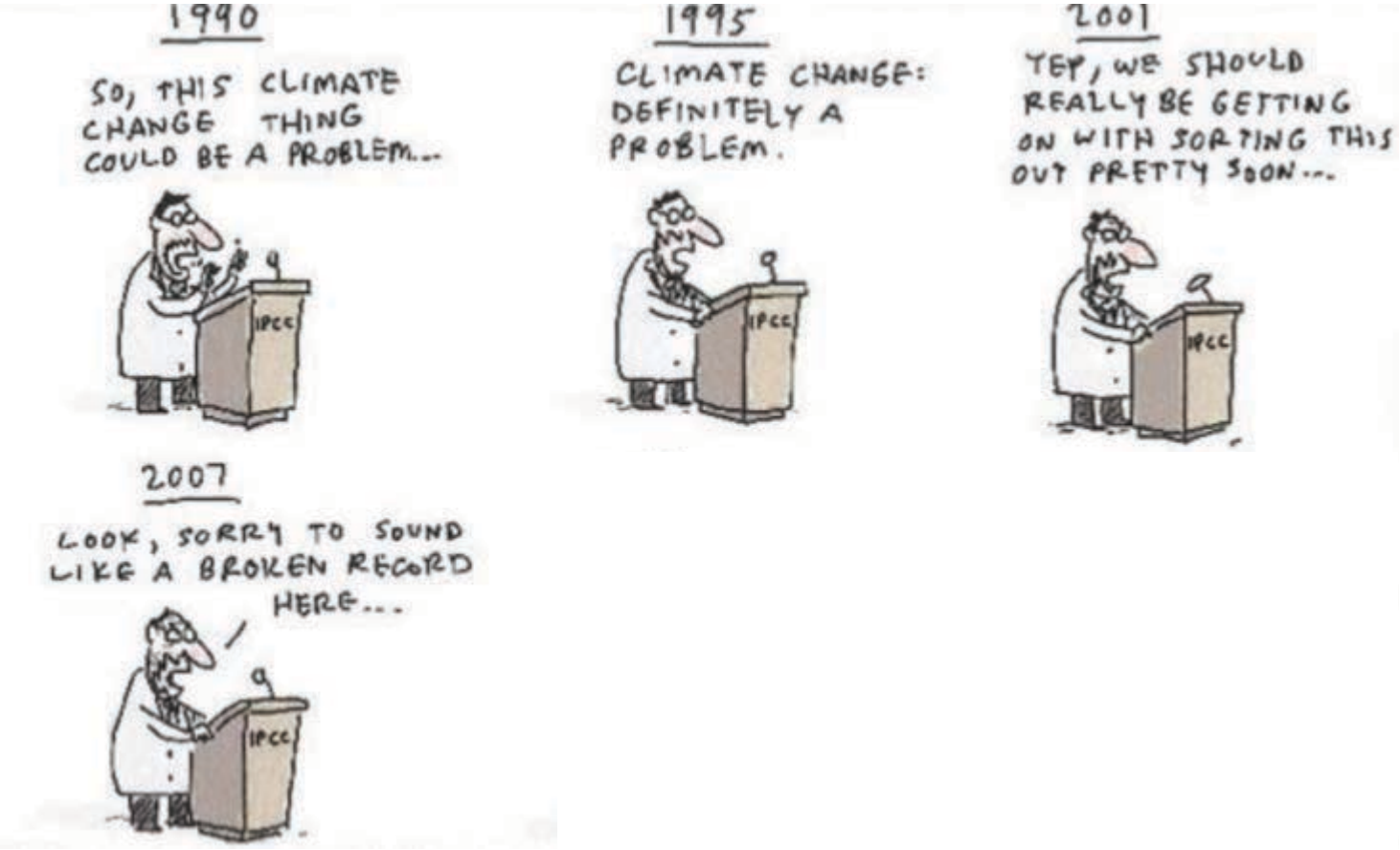

Auteur: @JohnKudelka

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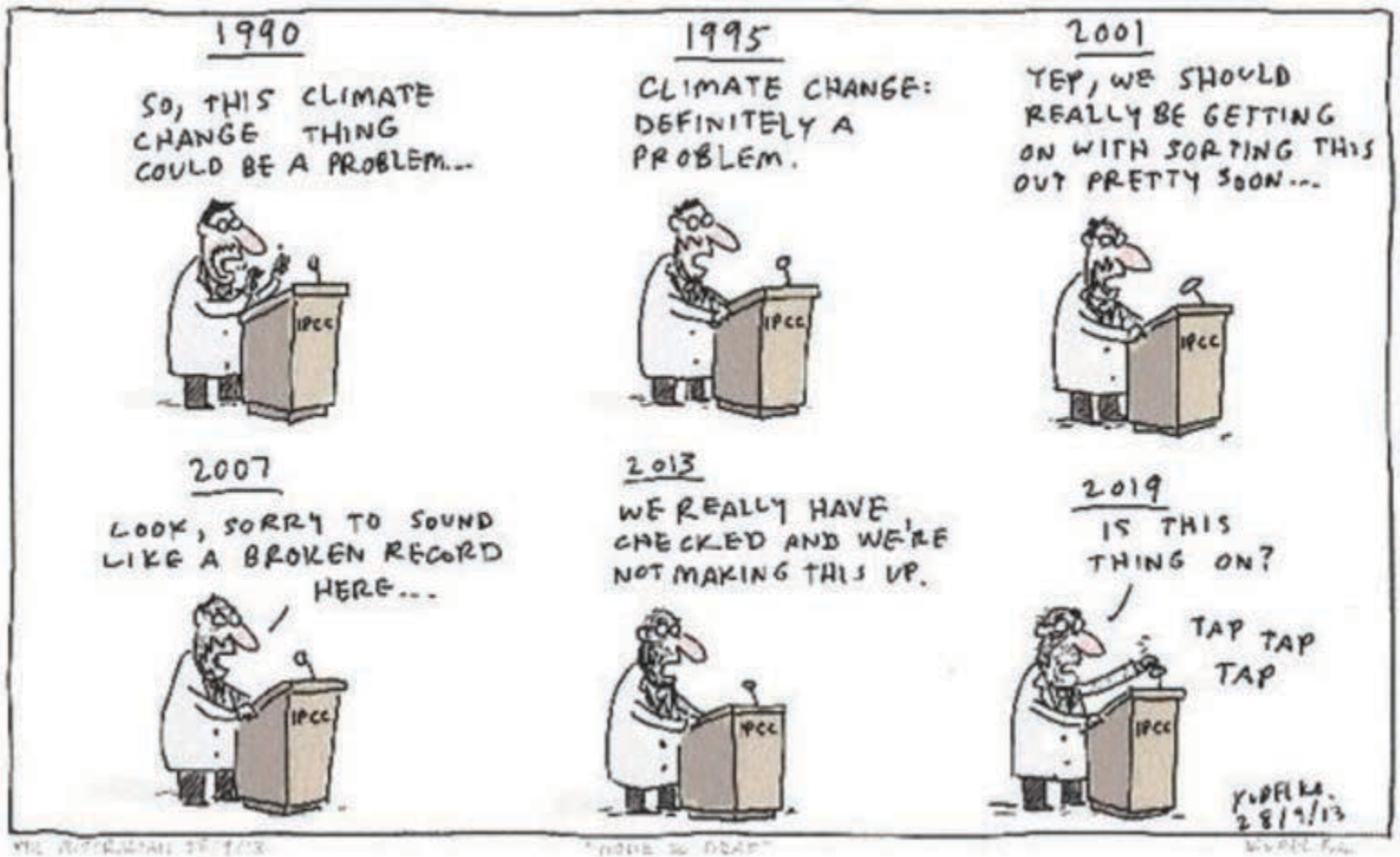
None So Deaf



Auteur: @JohnKudelka

Key messages from the IPCC WG1 Report (1)

- **Certain:**
  - Emissions resulting from **human activities are substantially increasing** the atmospheric concentrations of the **greenhouse gases**: CO2, CH4, CFC, and N2O
- Calculated **with confidence**:
  - Under the business as usual scenario, **temperature will increase by about 3°C by 2100** (uncertainty range: **2 to 5°C**), and **sea level will increase by 60 cm** (uncertainty range: **30 to 100 cm**)

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Key messages from the IPCC WG1 Report (2)

- With an increase in the mean temperature, **episodes of high temperature** will most likely become **more frequent**
- Rapid changes in climate will change the composition of ecosystems; **some species** will be unable to adapt fast enough and **will become extinct**.
- Long-lived gases (**CO2**, N2O and CFCs) **would require immediate reduction** in emissions from human activities **of over 60% to stabilise their concentration at today's levels**.

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Oops…

- … this was from the IPCC **first** assessment report, published 26 years ago (1990)

- Was anybody really listening?

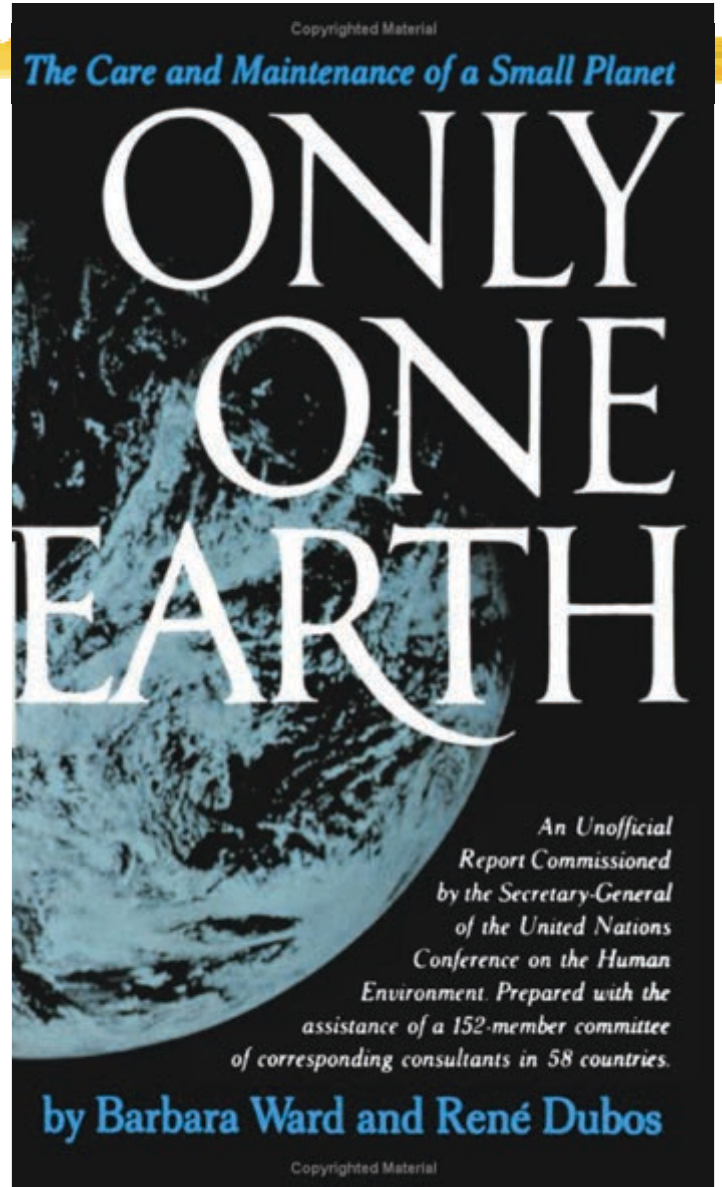
When does this quote date from?

"It may require only a very small percentage of change in the planet's balance of energy to modify average temperatures by 2°C. Downward, this is another ice age; upward, a return to an ice-free age. In either case, the effects are global and catastrophic. "

When does this quote date from?

"... The sum of all likely fossil-fuel demands in the early decades of the [21st] century might … greatly increase the emission of carbon dioxide into the atmosphere and by doing so bring up average surface temperature uncomfortably close to that rise of 2°C which might set in motion the long-term warming up of the planet."

B. Ward & R. Dubos, 1972



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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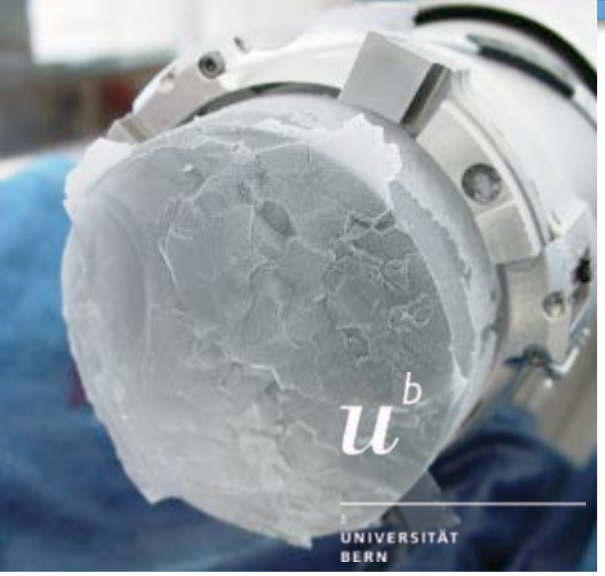
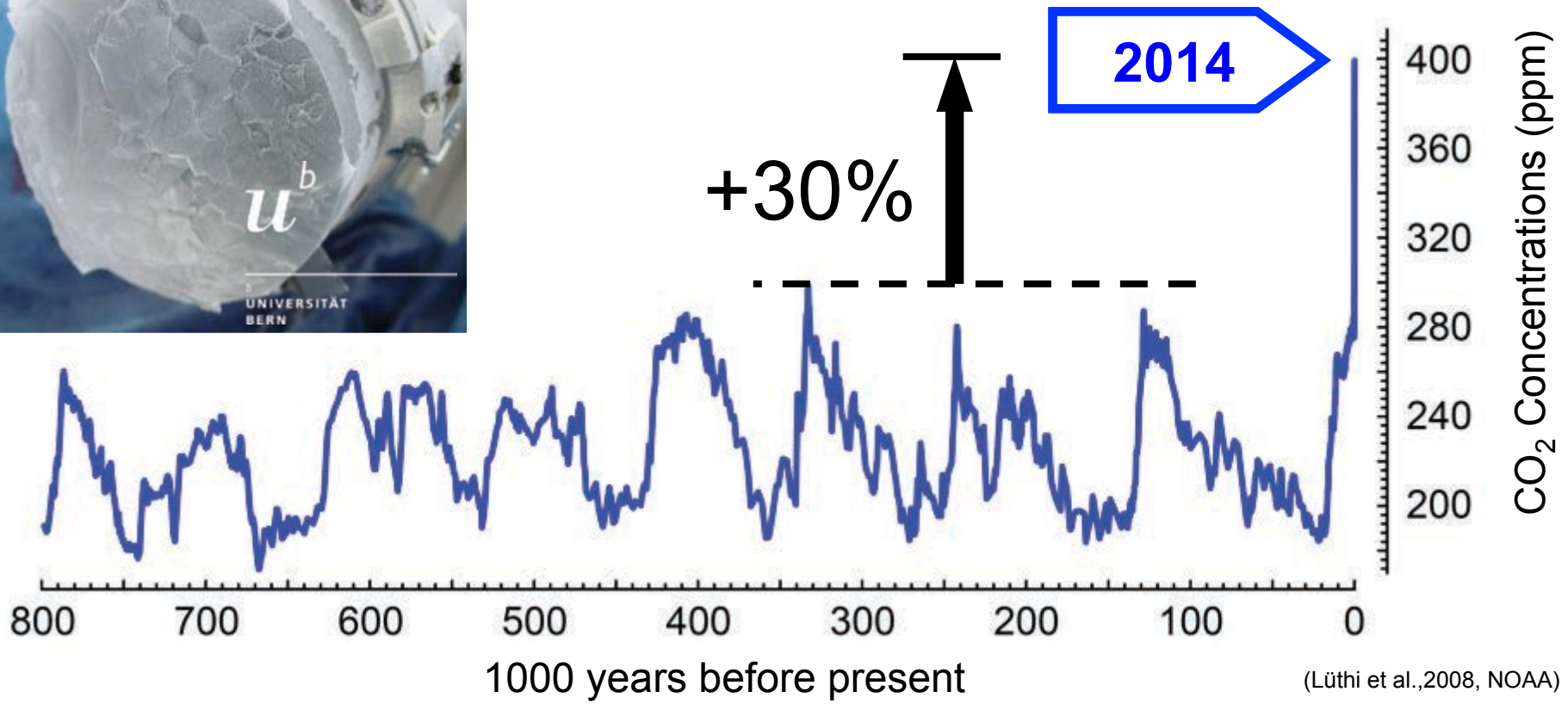


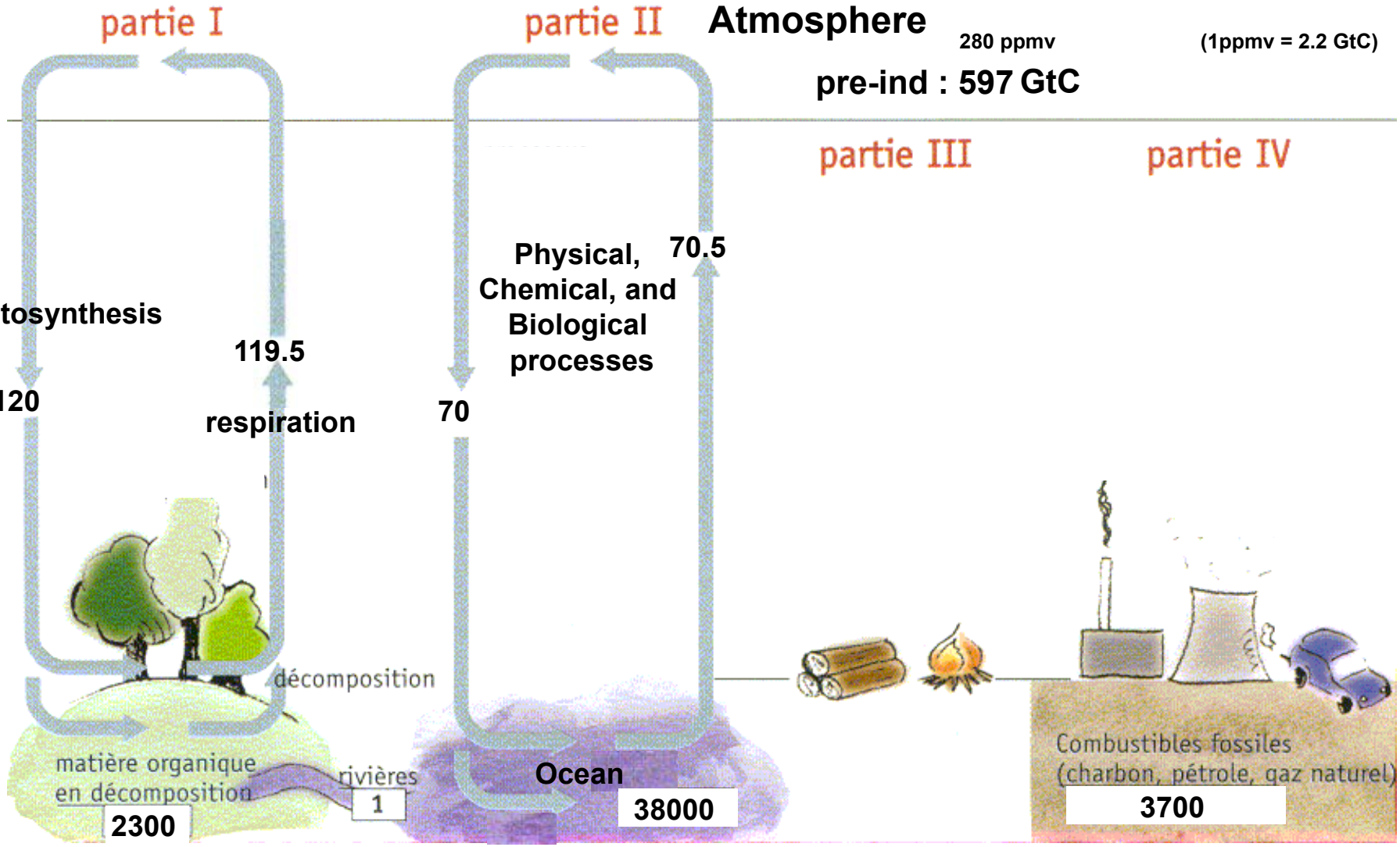
Atmospheric concentrations of CO_2



(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 $GtCO_2$)

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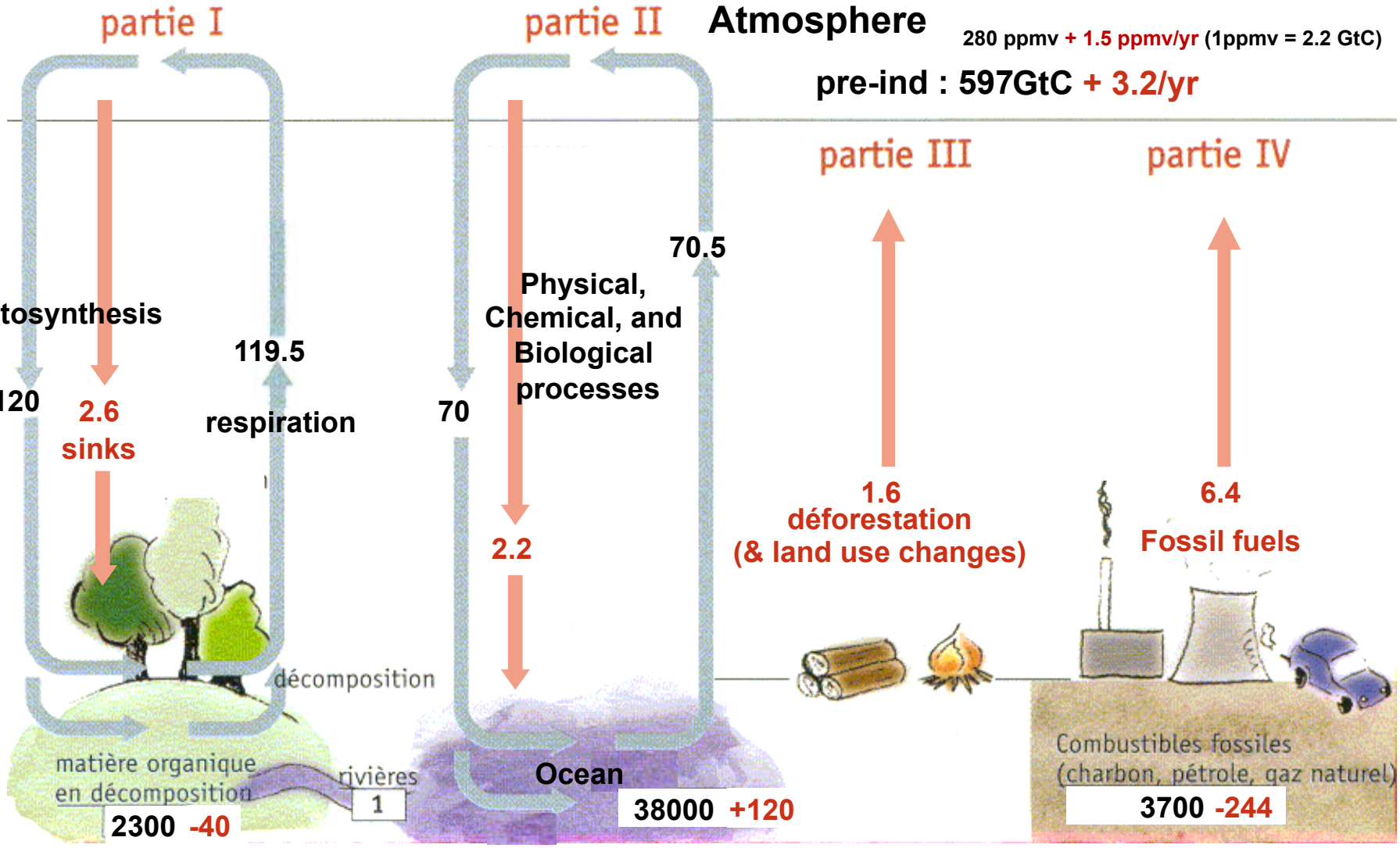
Carbon cycle: perturbed by human activities

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



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

Stocks!

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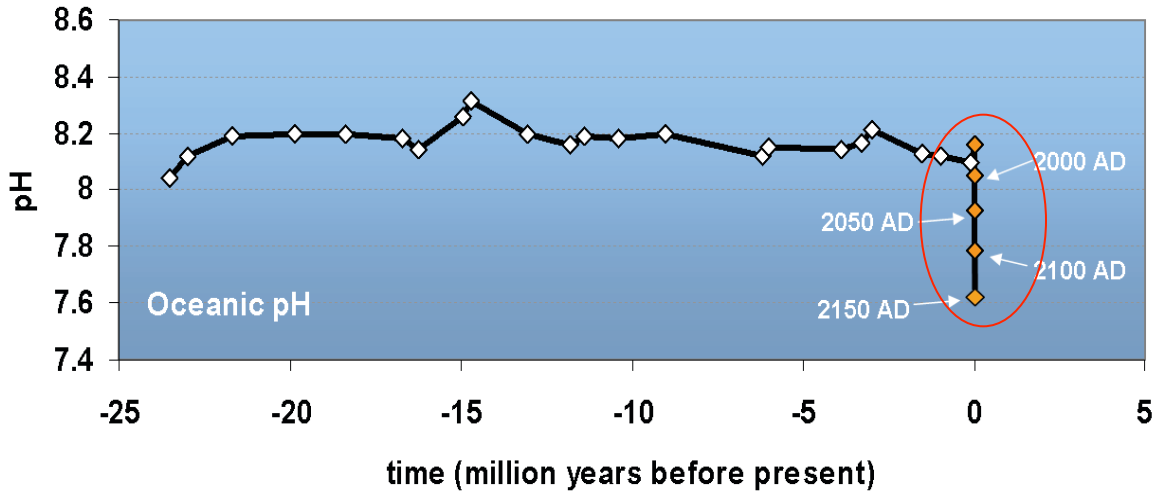
Oceans are Acidifying Fast ……..

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

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)**

Once upon a time, a US climatologist said this in Belgium (1):

- **Net accumulation of carbon as CO_2 in the atmosphere is about 3 gigatons per year. There is no quantitative explanation why the annual accumulation is 3 GtC when emissions are 8 GtC.**
- **There is no reason to expect that existing trends between emissions and atmospheric buildup will continue in the future.**

Once upon a time, a US climatologist said this in Belgium (2):

- **Projections are based on unverified models of natural and social science.**
- **Results from climate models are known to be wrong.**
- **It is impossible today to project future impacts of climate change.**
- **Progress to advance the science will require major effort and many years of study.**

After his talk, an European climatologist declared:

- What I heard today is the most biased “science talk” I have ever heard in my life; I am sorry to say.
- I only want to warn the audience: don’t think that what we heard is a honest presentation of the science of climate change. It is just one side of the coin.

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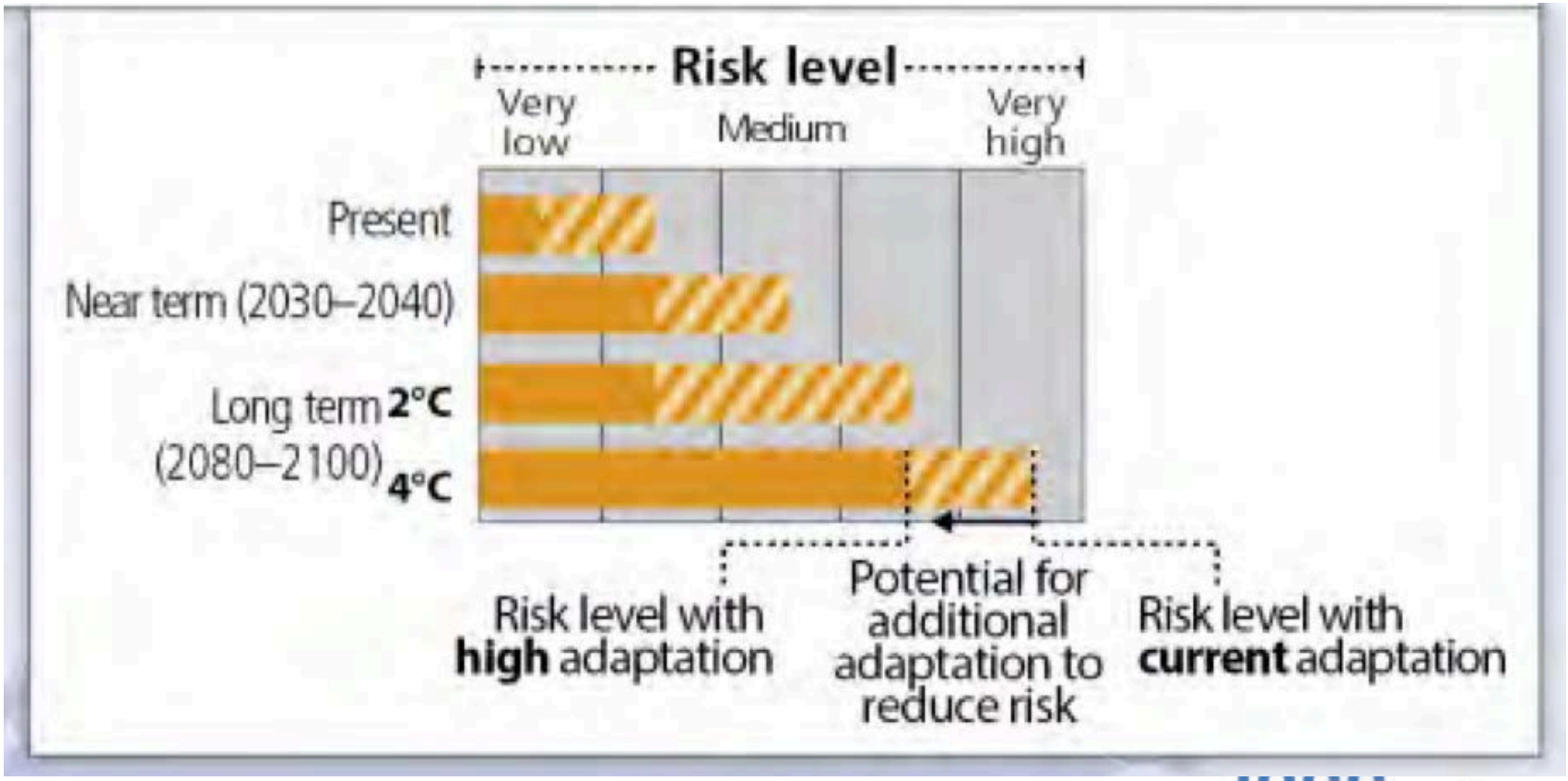
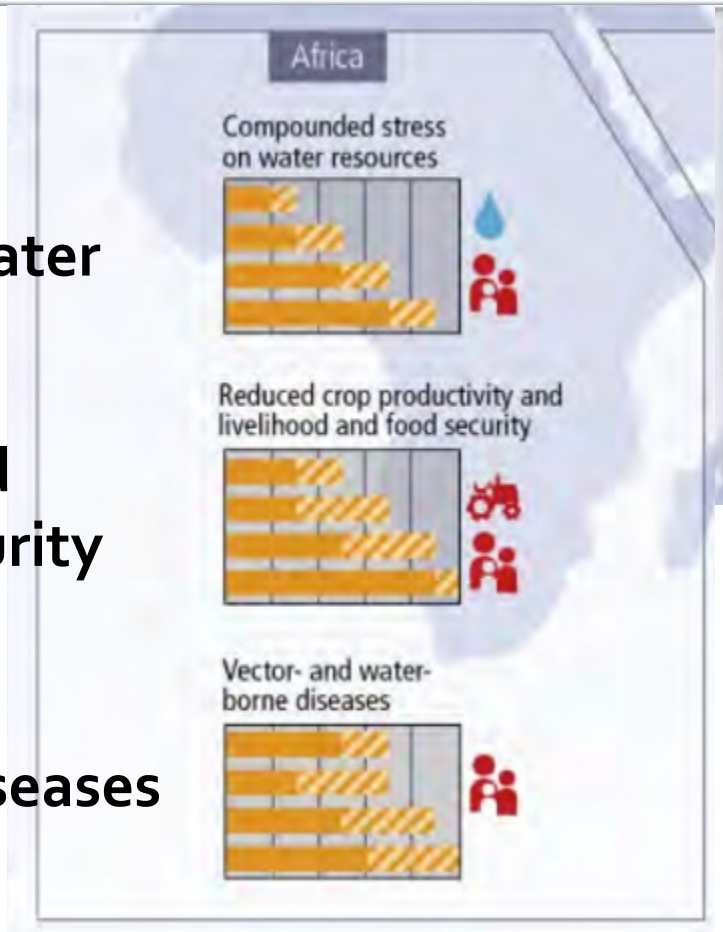
Regional key risks and potential for risk reduction through adaptation



IPCC, AR5, SPM, Figure SPM.8

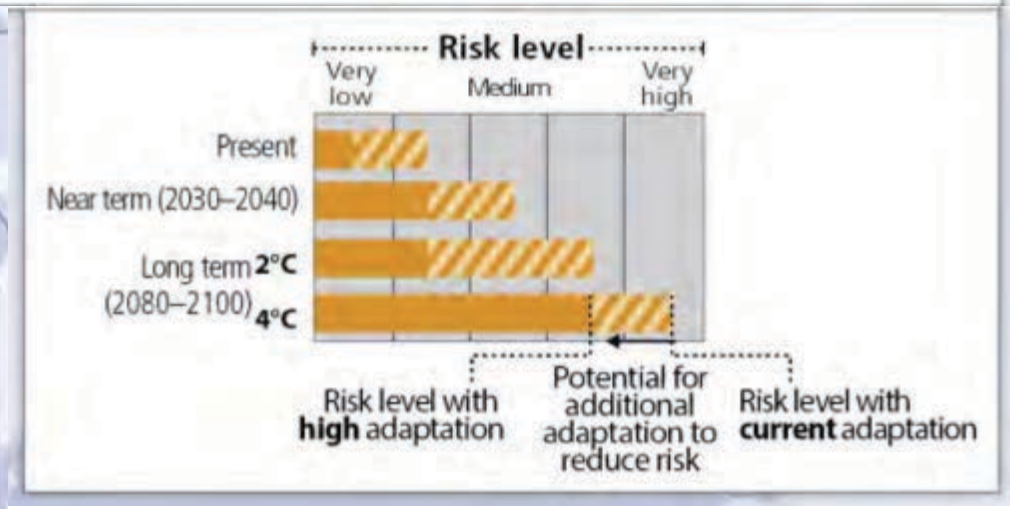
Regional key risks and risk reduction through adaptation



Water

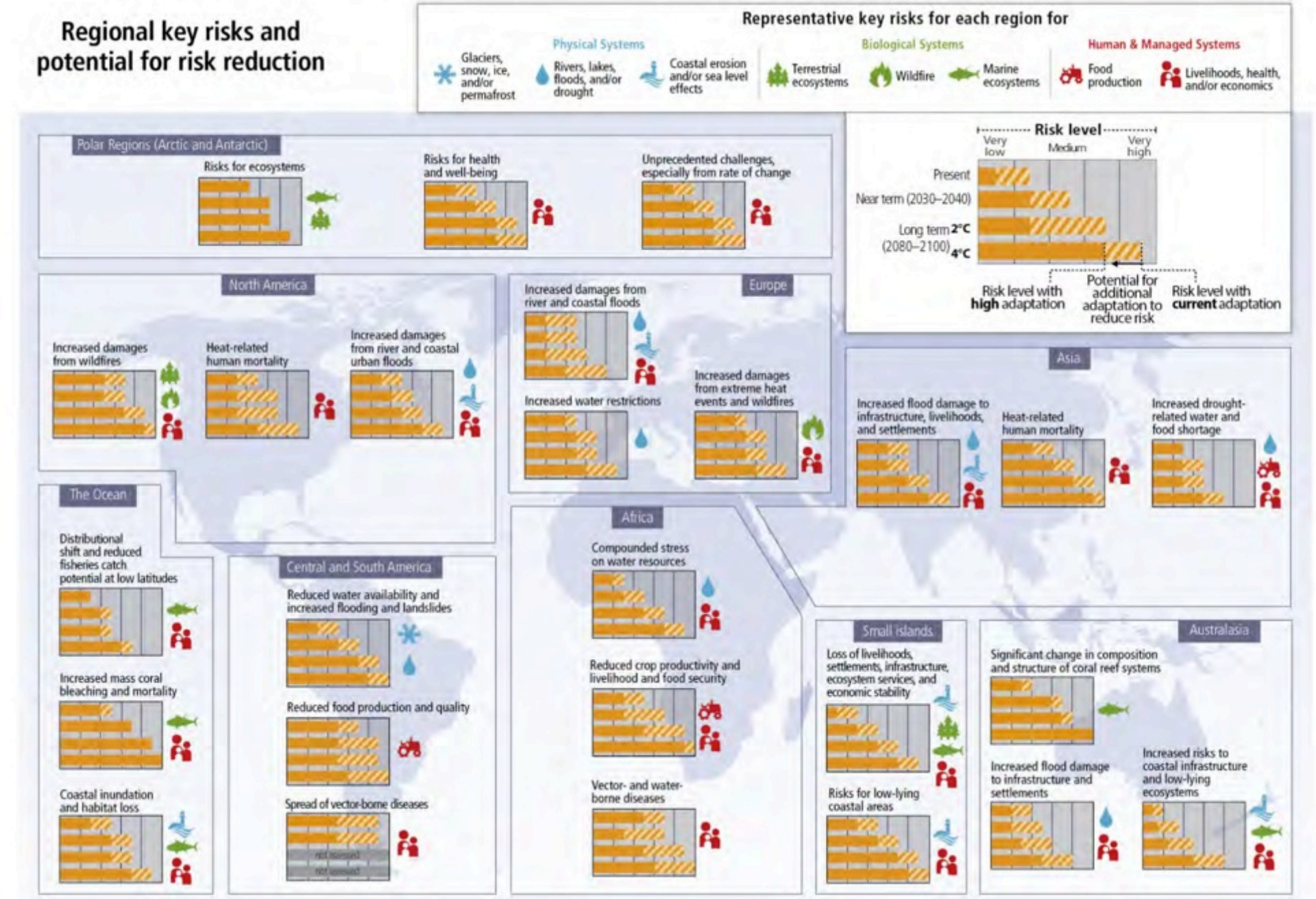
Food security

Diseases



IPCC, AR5, SPM, Figure SPM.8

Regional key risks and potential for risk reduction



IPCC, AR5, SPM, Figure SPM.8

Limitation of knowledge

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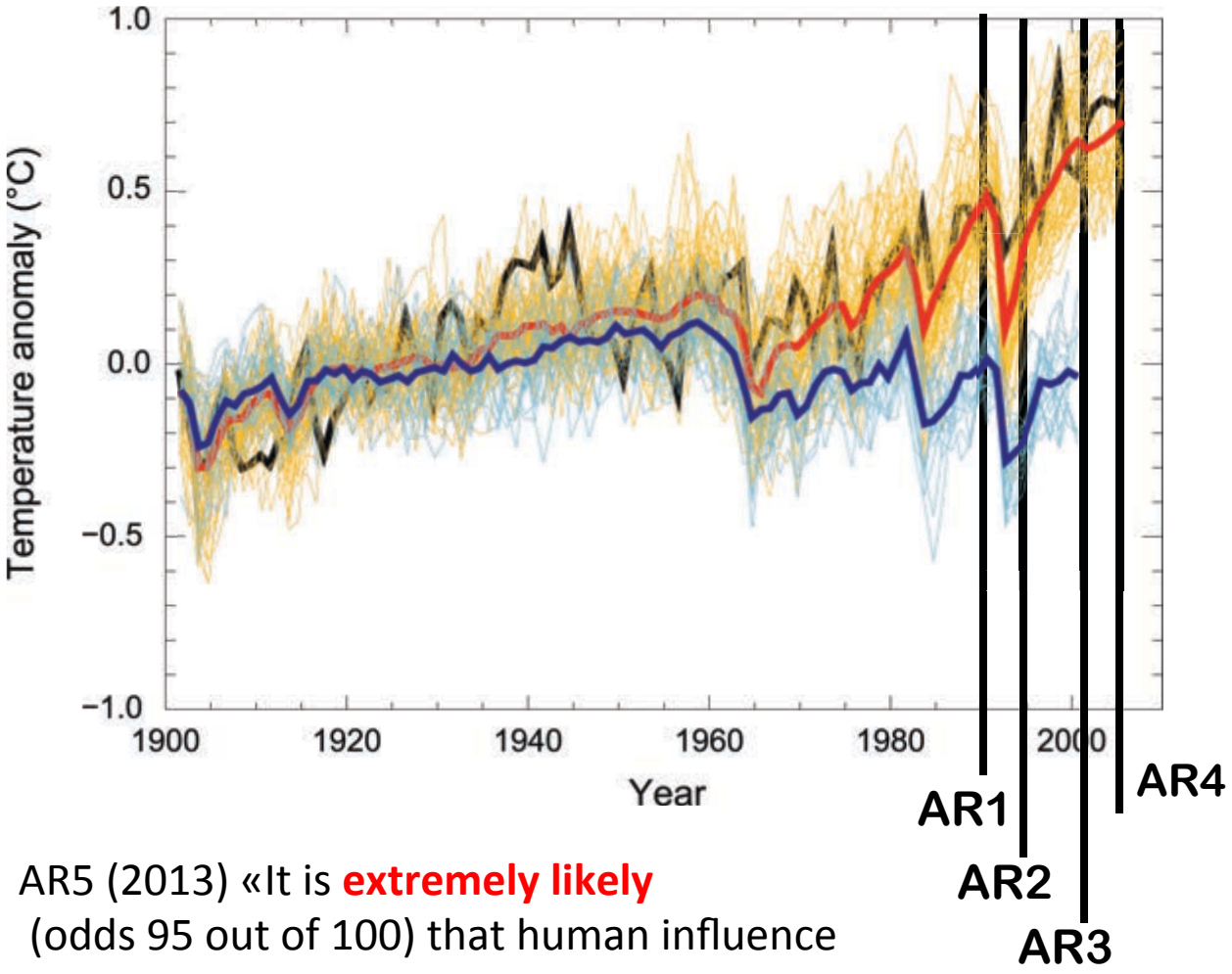
A Progression of Understanding: Greater and Greater Certainty in Attribution

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

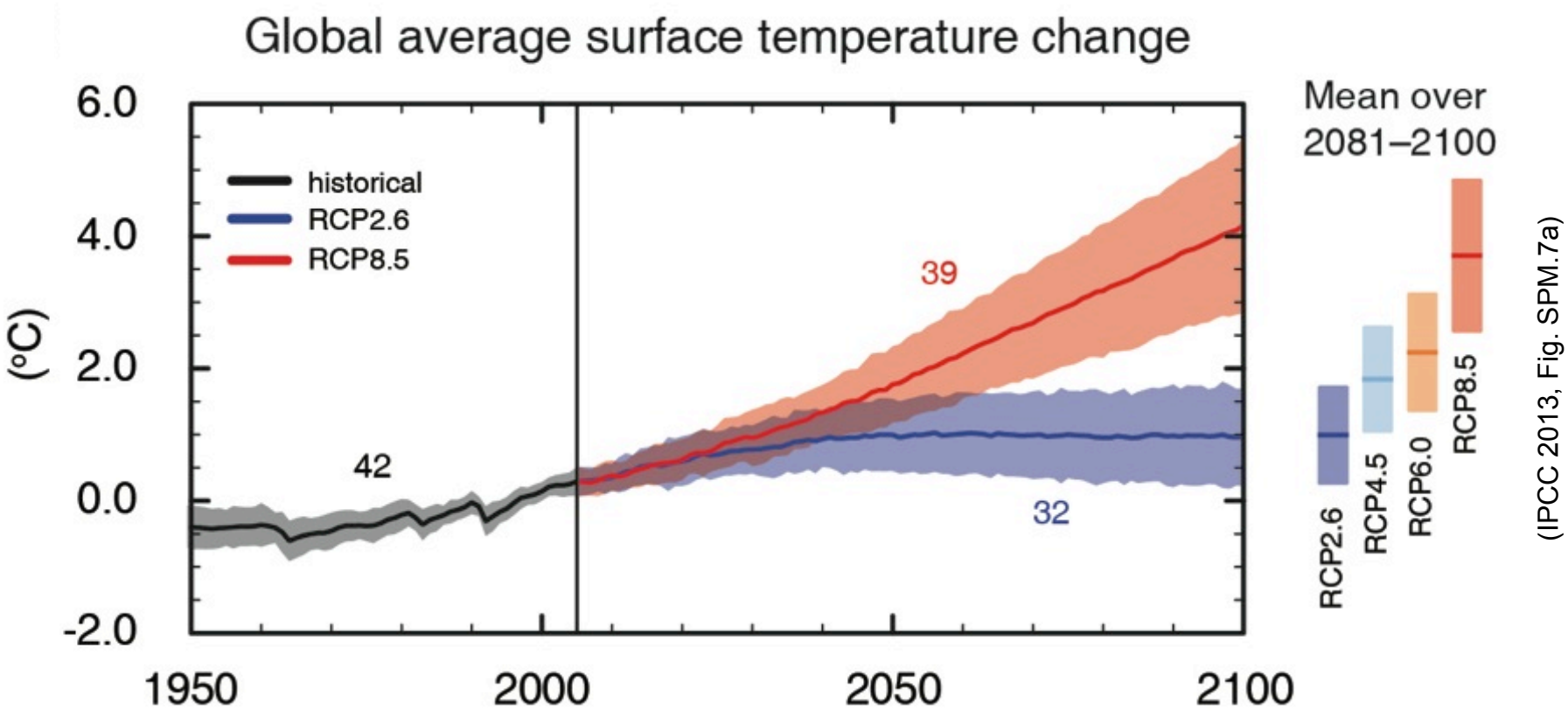
AR2 (1995): "balance of evidence suggests **discernible** human influence"

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"

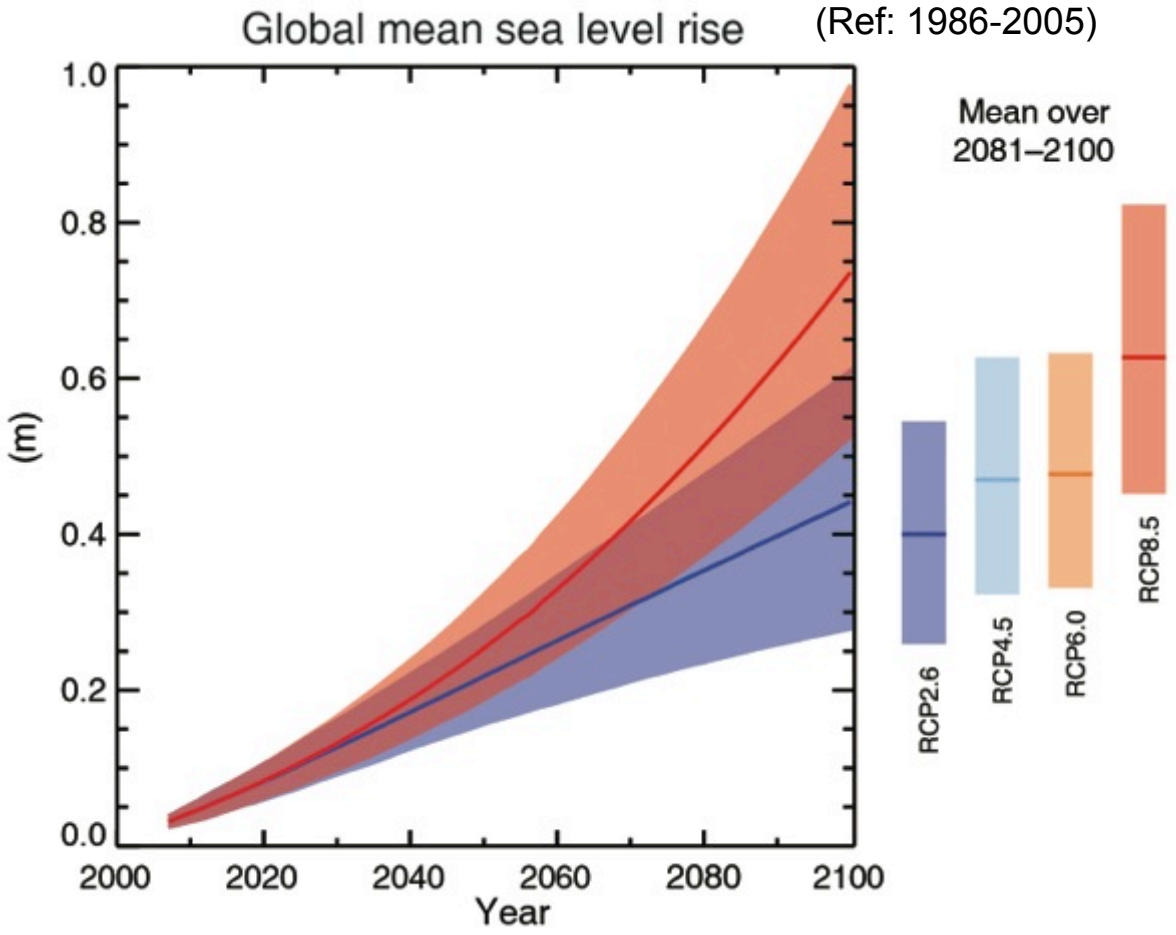


AR5 (2013) «It is **extremely likely** (odds 95 out of 100) that human influence has been the dominant cause… »



(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



(IPCC 2013, Fig. SPM.9)

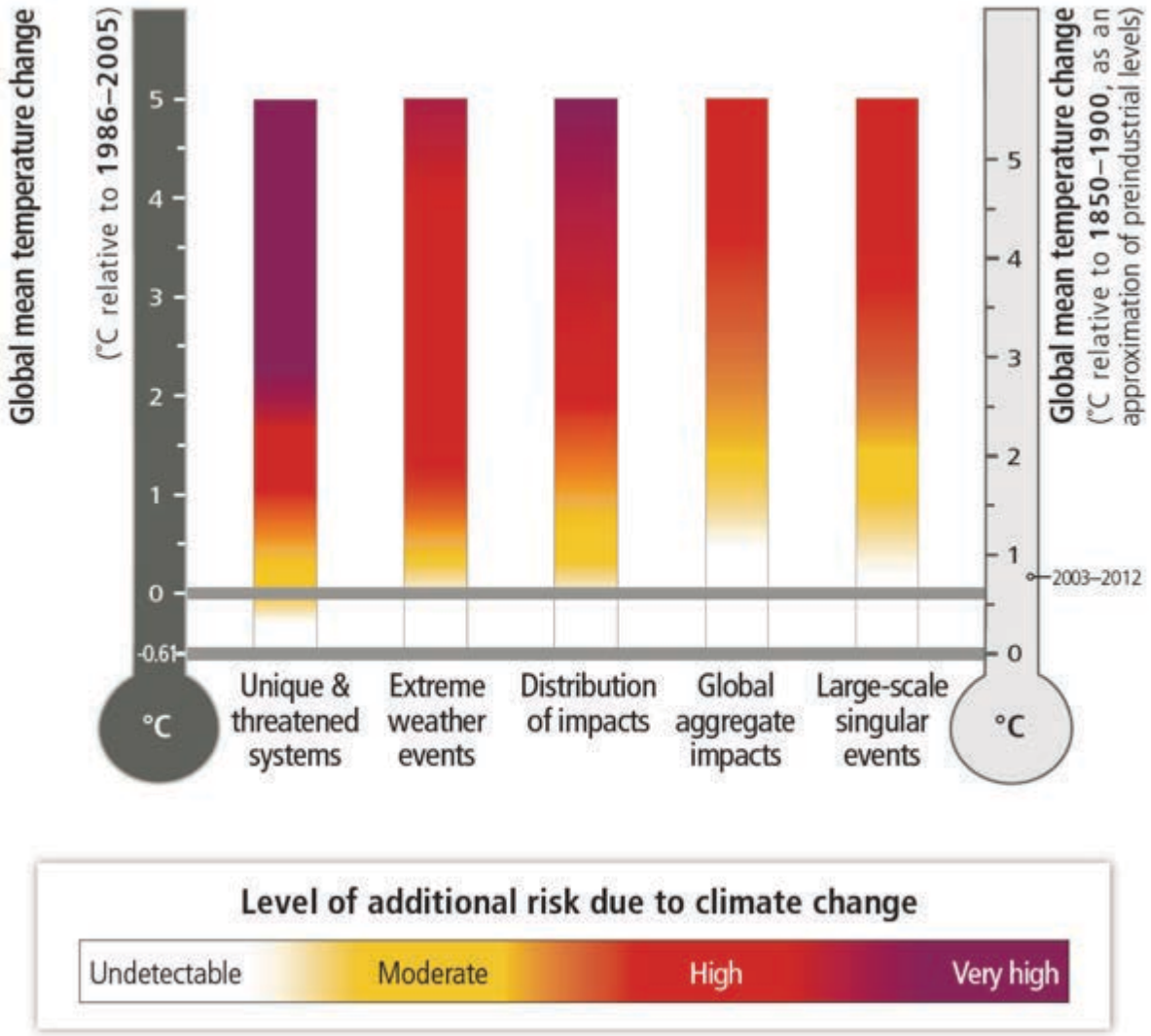
Sea level due to continue to increase

Effects of a 1 m Sea-Level Rise in the Nile Delta (>10 million people live at less than 1 m a.s.l.)

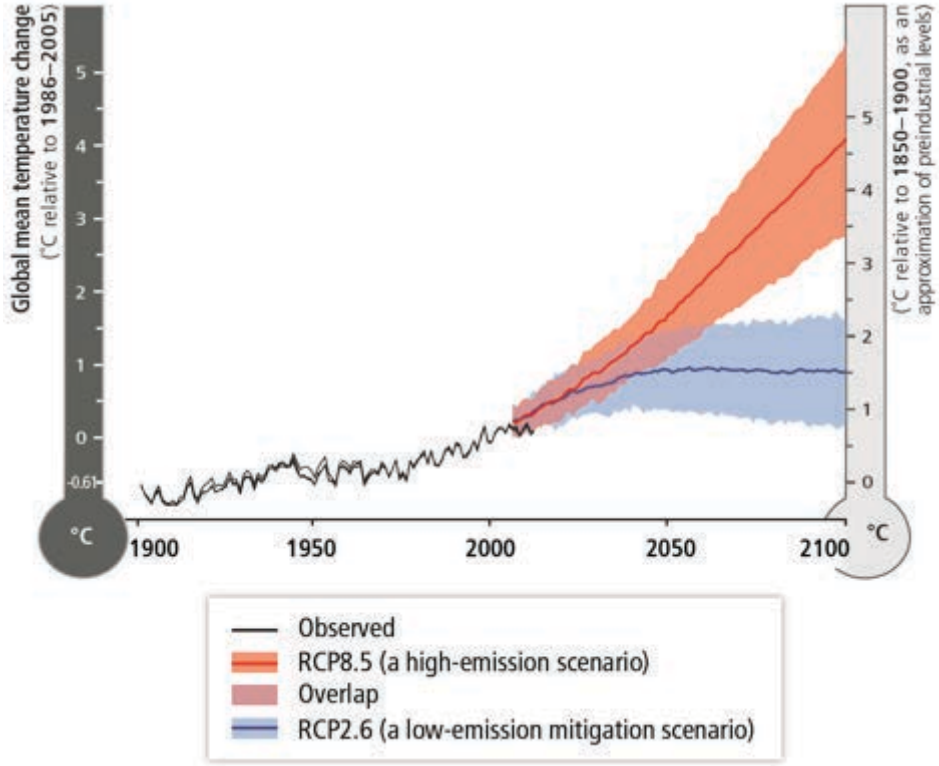
(Time 2001)

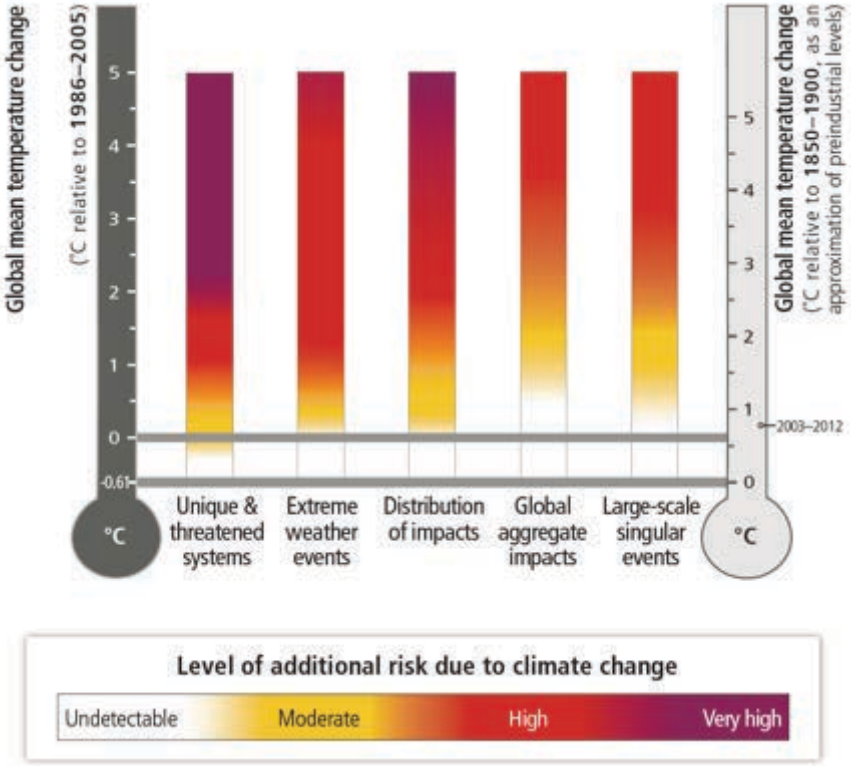
Risk = Hazard x Vulnerability x Exposure (Katrina flood victim)

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



AR5, WGII, Box SPM.1 Figure 1





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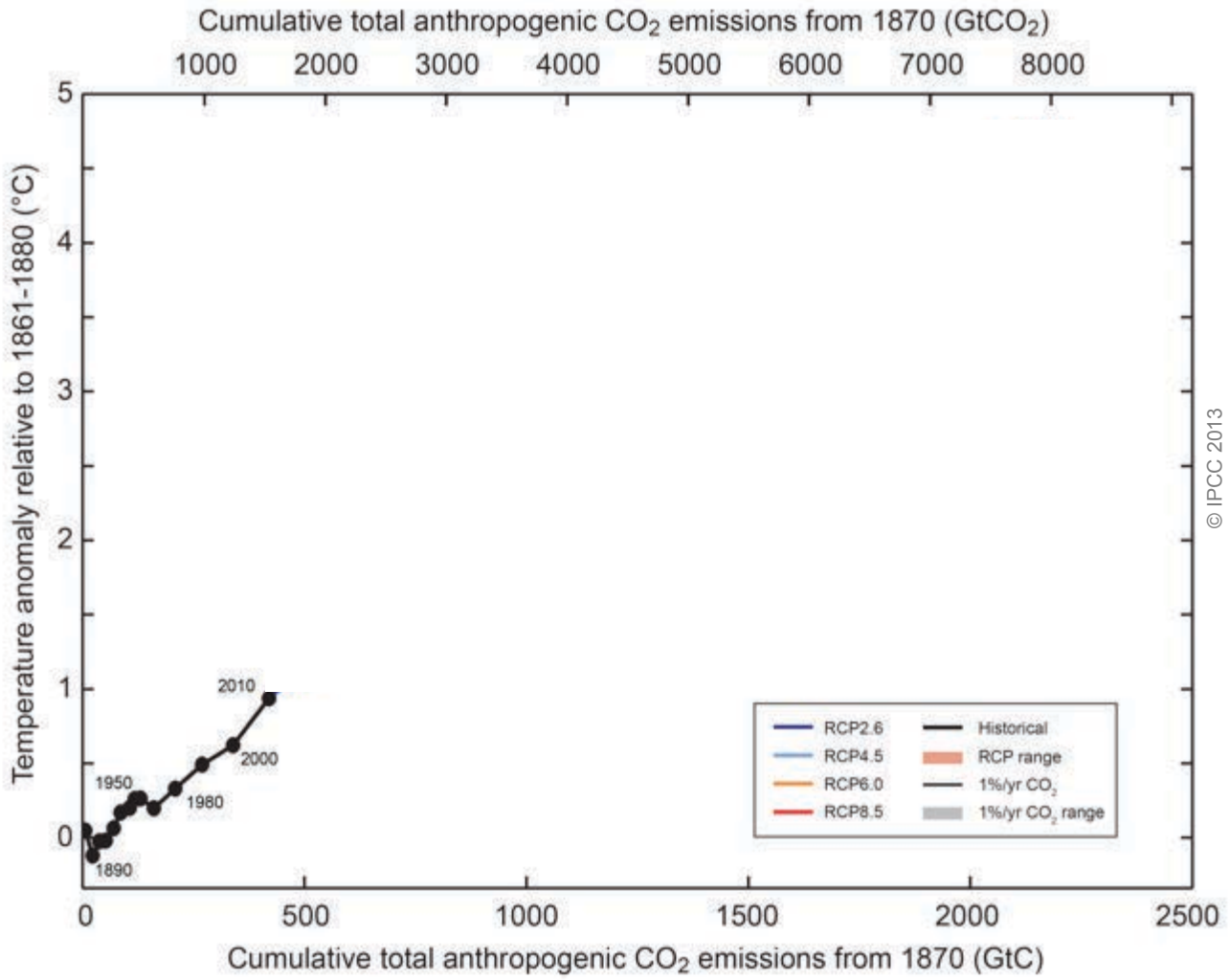


Fig. SPM.10

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

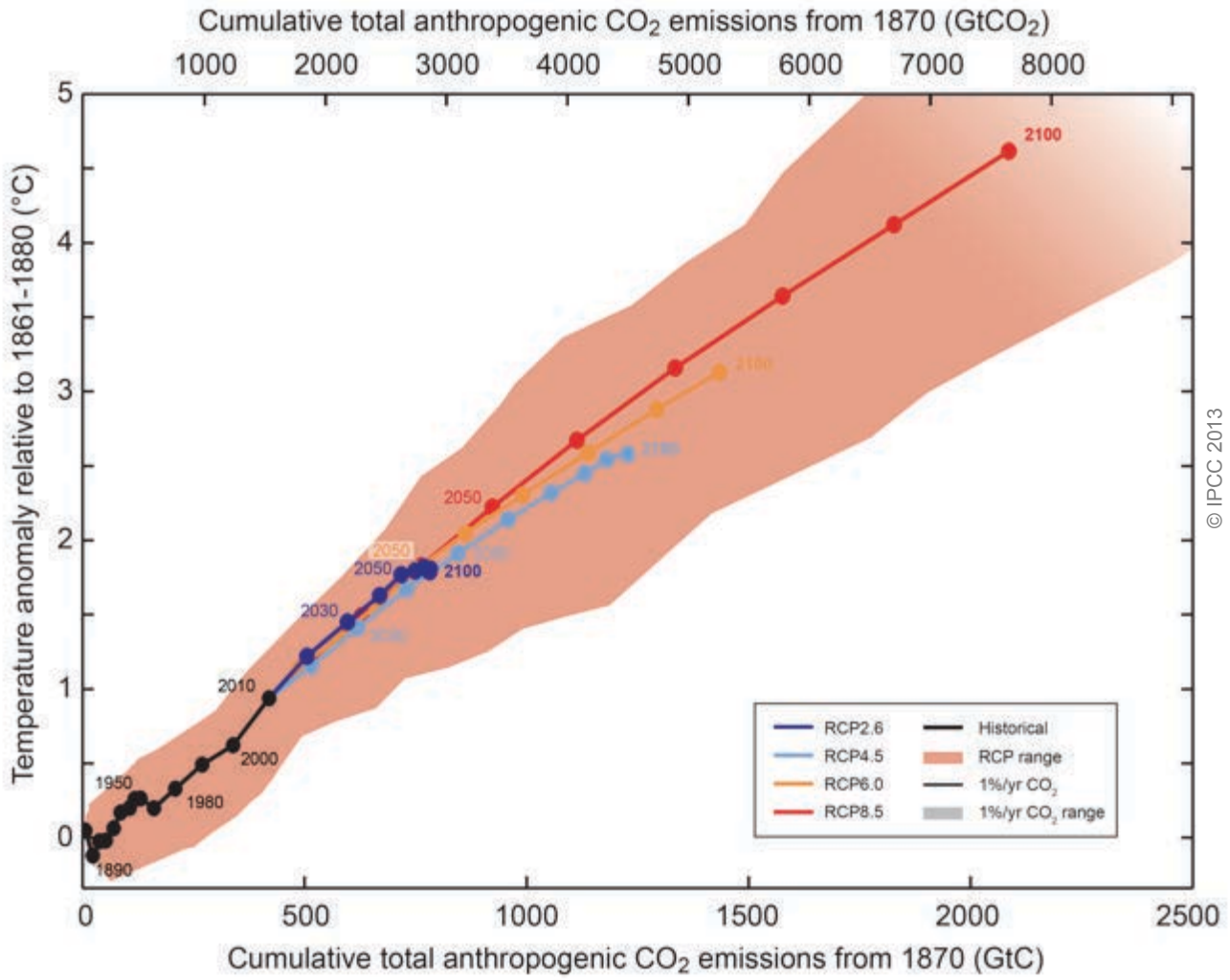
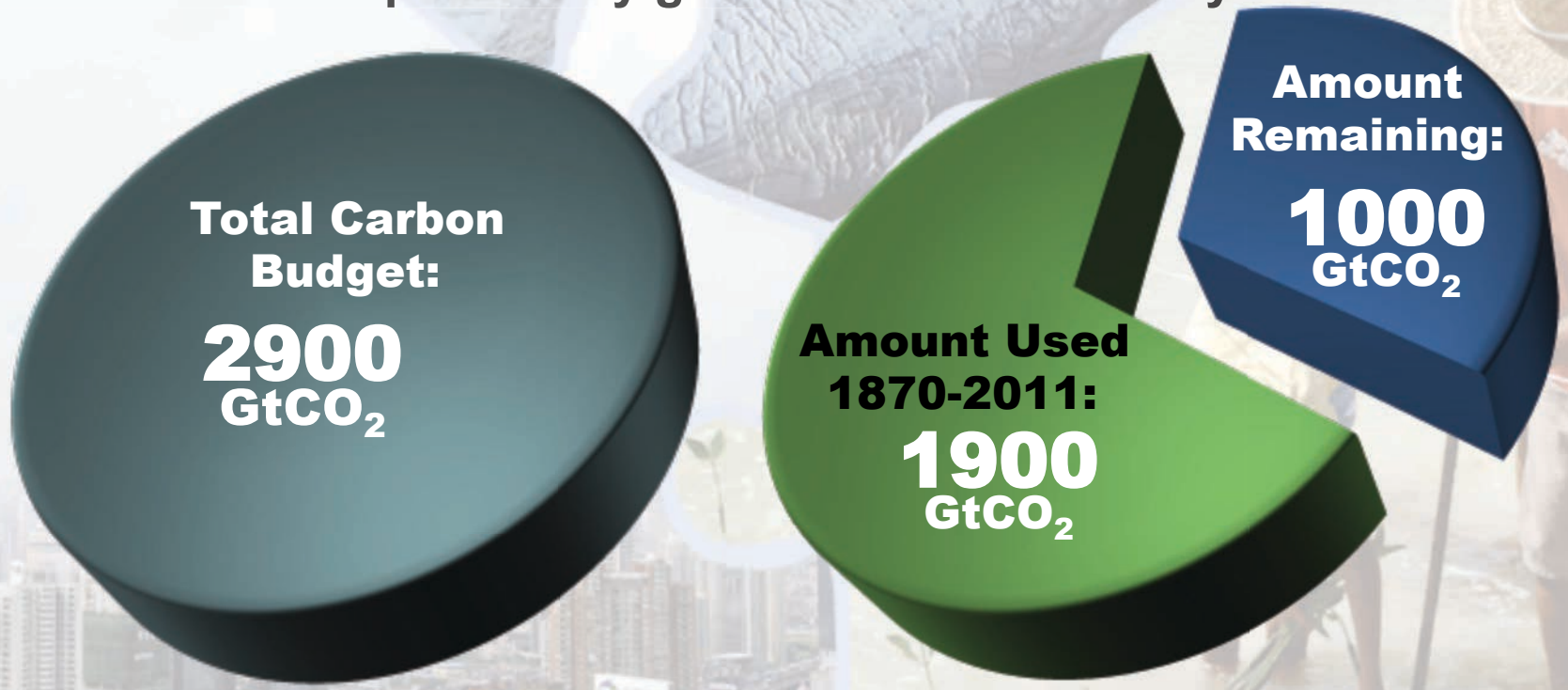


Fig. SPM.10

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

The window for action is rapidly closing

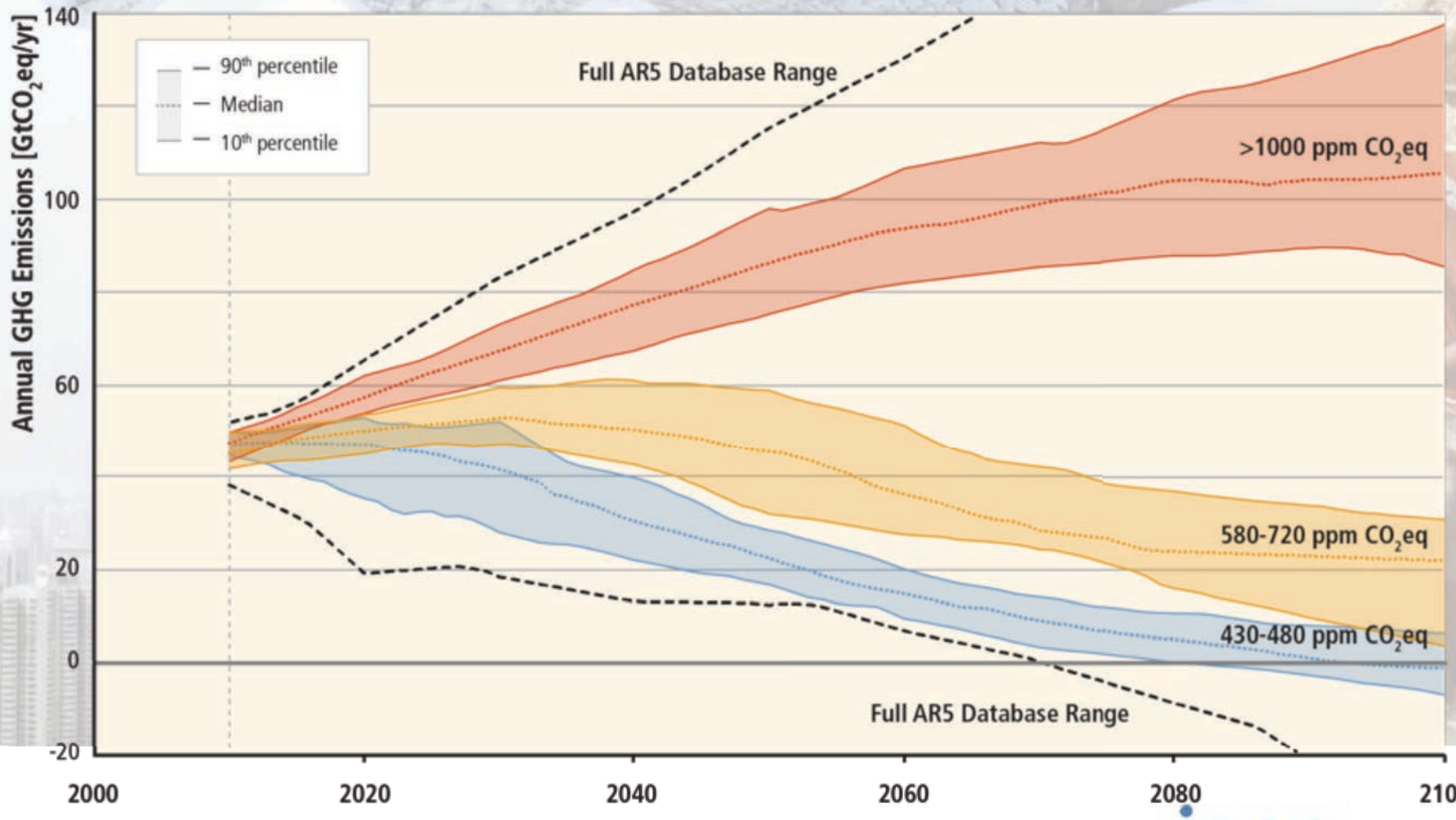
65% of the carbon budget compatible with a 2°C goal is already used
NB: this is with a probability greater than 66% to stay below 2°C



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

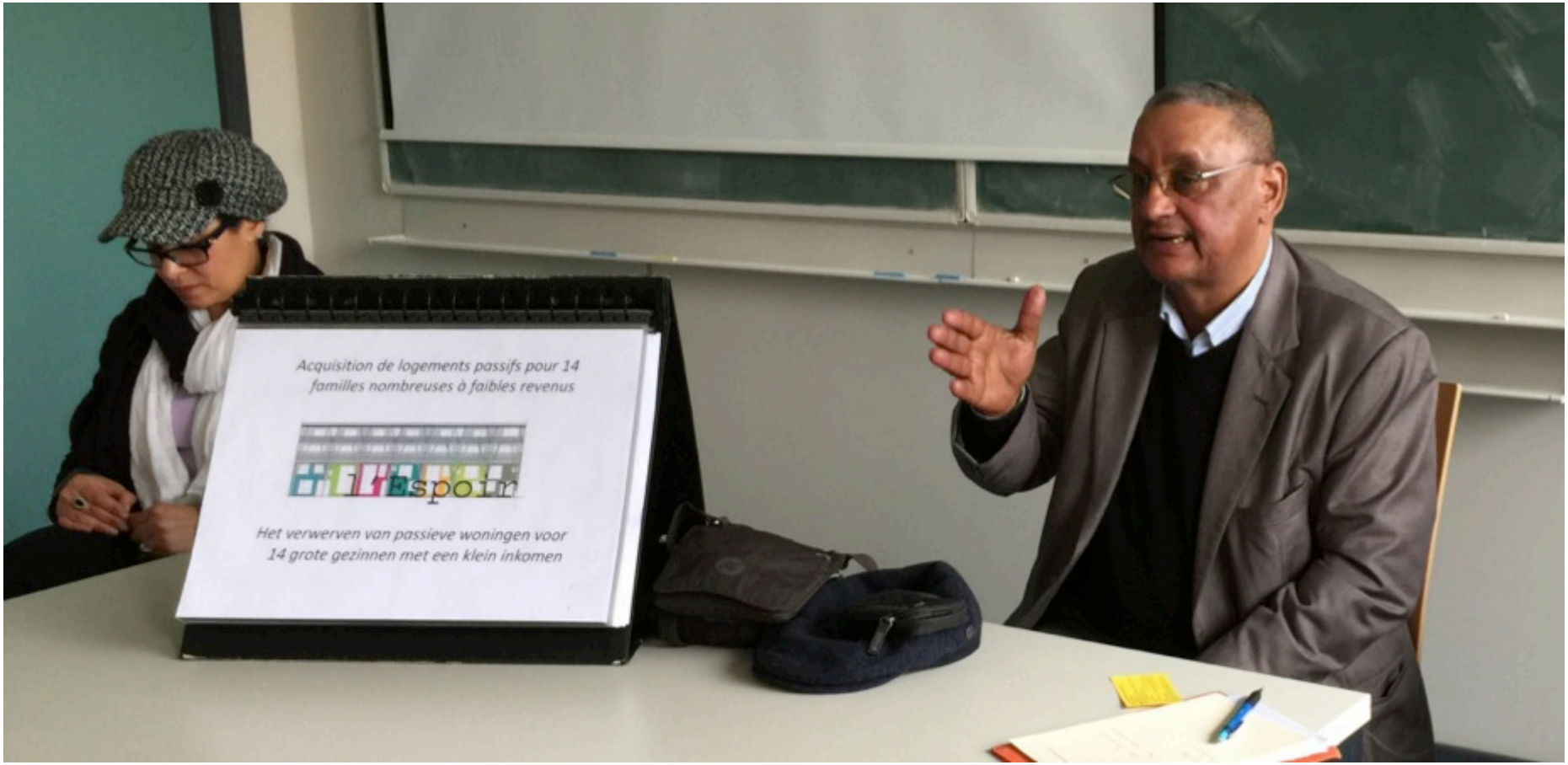
- **Many scenario studies confirm that *it is technically and economically feasible to keep the warming below 2°C*, with more than 66% probability ("likely chance").** This would imply limiting atmospheric concentrations to 450 ppm CO_2-eq by 2100.
- **Such scenarios** for an above 66% chance of staying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

- **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**

Passive houses for poor people in Molenbeek



Experts from Molenbeek in my course on climate change At UCLouvain this Monday 18-4-2016

Conclusions

- **Knowledge about the limits is more than sufficient to act**
- **Limitations to knowledge still needs to be addressed: in both natural and social sciences**
- **Interdisciplinarity, policy-relevance, science communication are essential**

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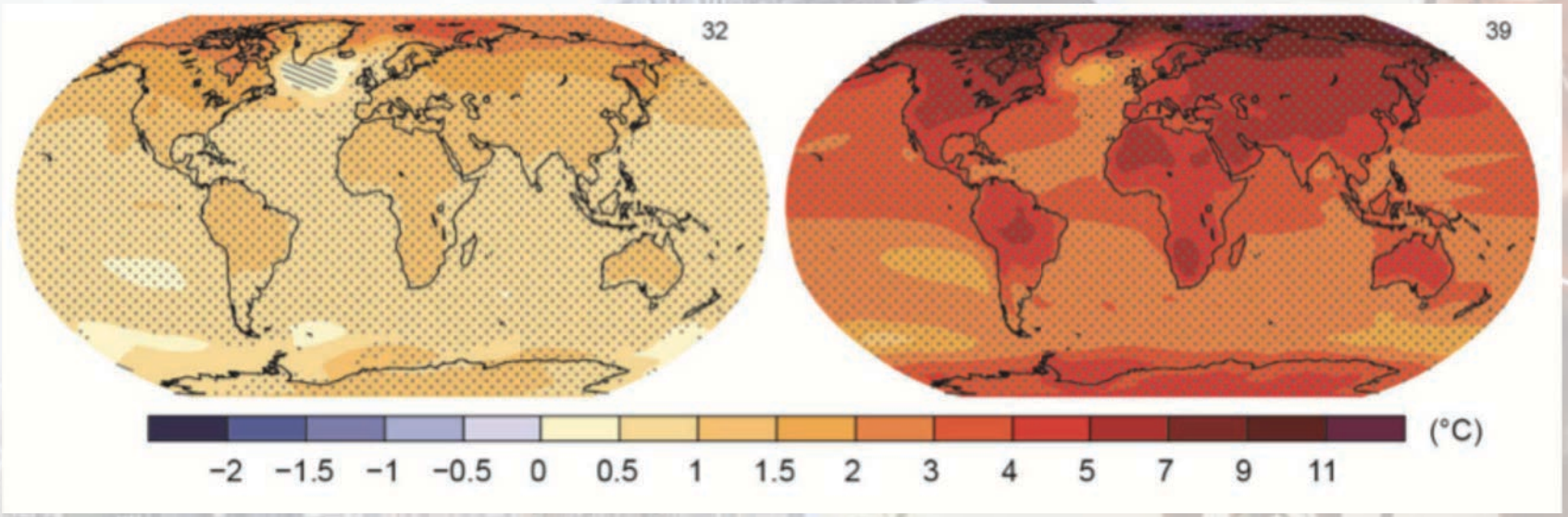
Humanity still has the choice

With substantial mitigation

Without additional mitigation



Change in average surface temperature (1986–2005 to 2081–2100)

AR5 WGI SPM

Trying to be coherent…

Please…

- Participate to the next IPCC Assessment (as authors or expert reviewers)(Tip: meet your IPCC Focal point, José Romero is here!)
- Think about the children and their future in a warm climate

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

Useful links:

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