An introduction to climate change

An Overview Based on the IPCC Reports (AR5 & SR15)

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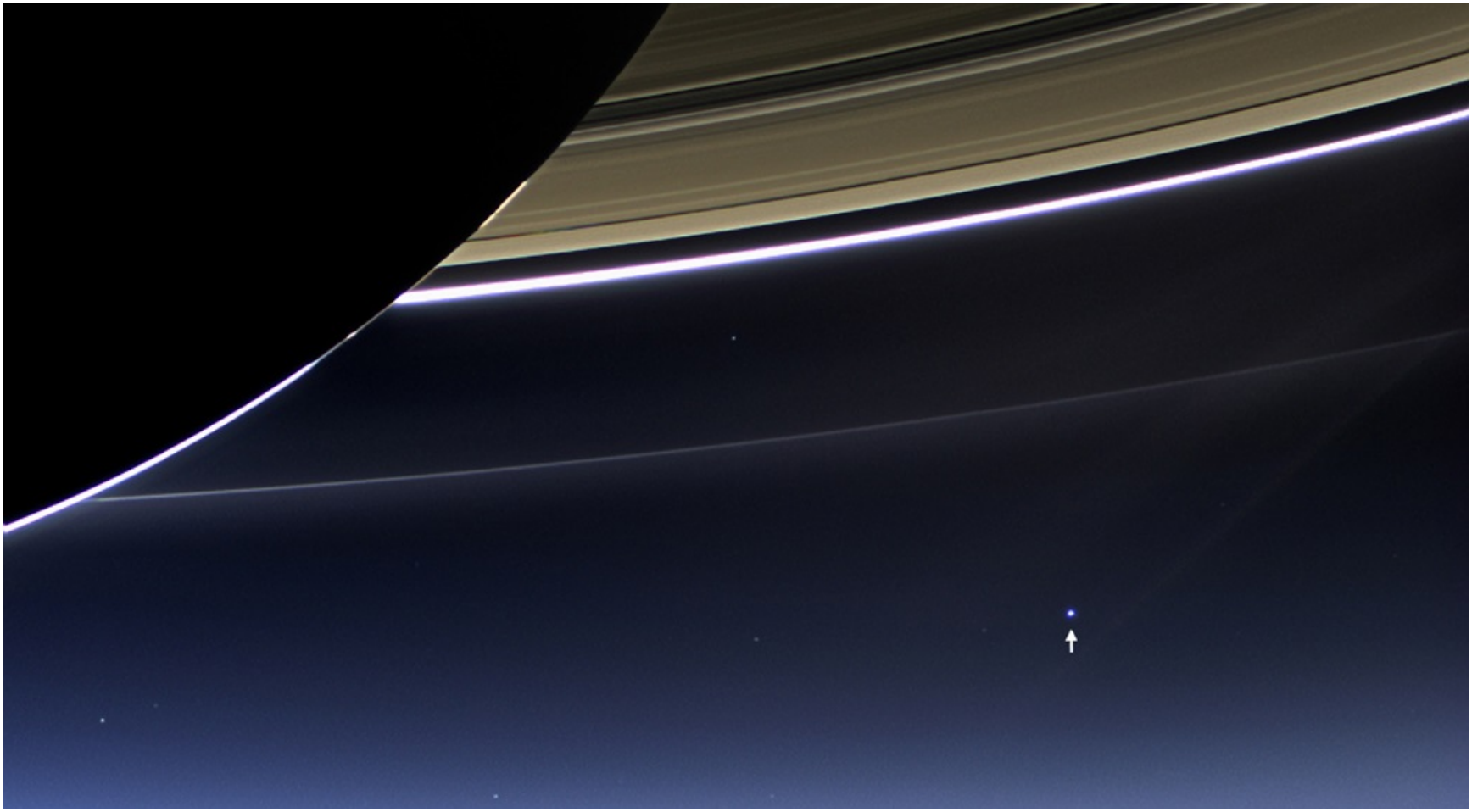
Former IPCC Vice-Chair (2008-2015)

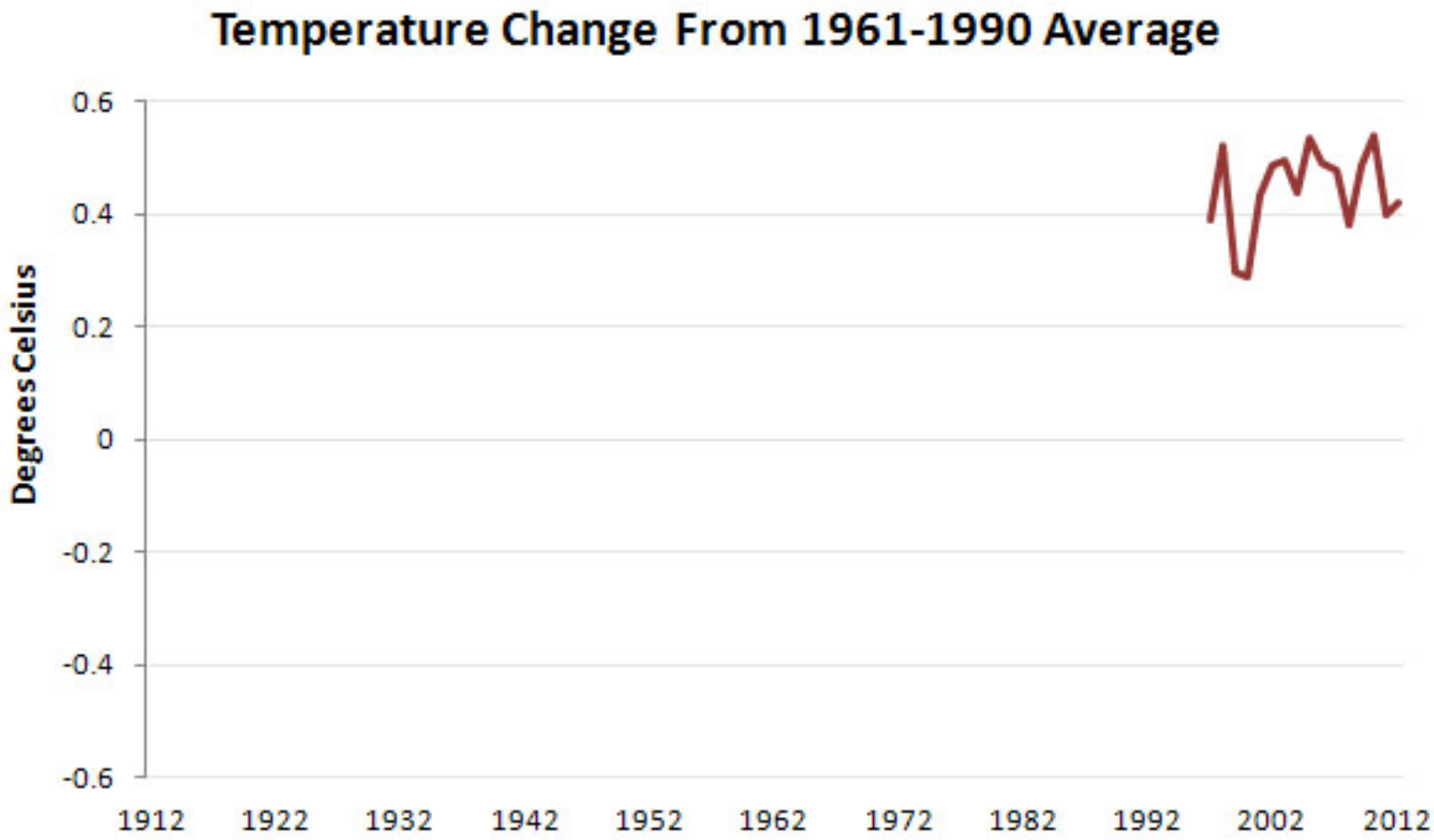
Twitter: @JPvanYpersele

Training on « The role of the judiciary in enforcing environmental law and combatting climate change »,
Belgian Judicial Training Institute (IGO/IFJ), Brussels, 15 February 2019

Thanks to the Walloon Government, funding the www.plateforme-wallonne-giec.be, and to my team at the Université catholique de Louvain for their support

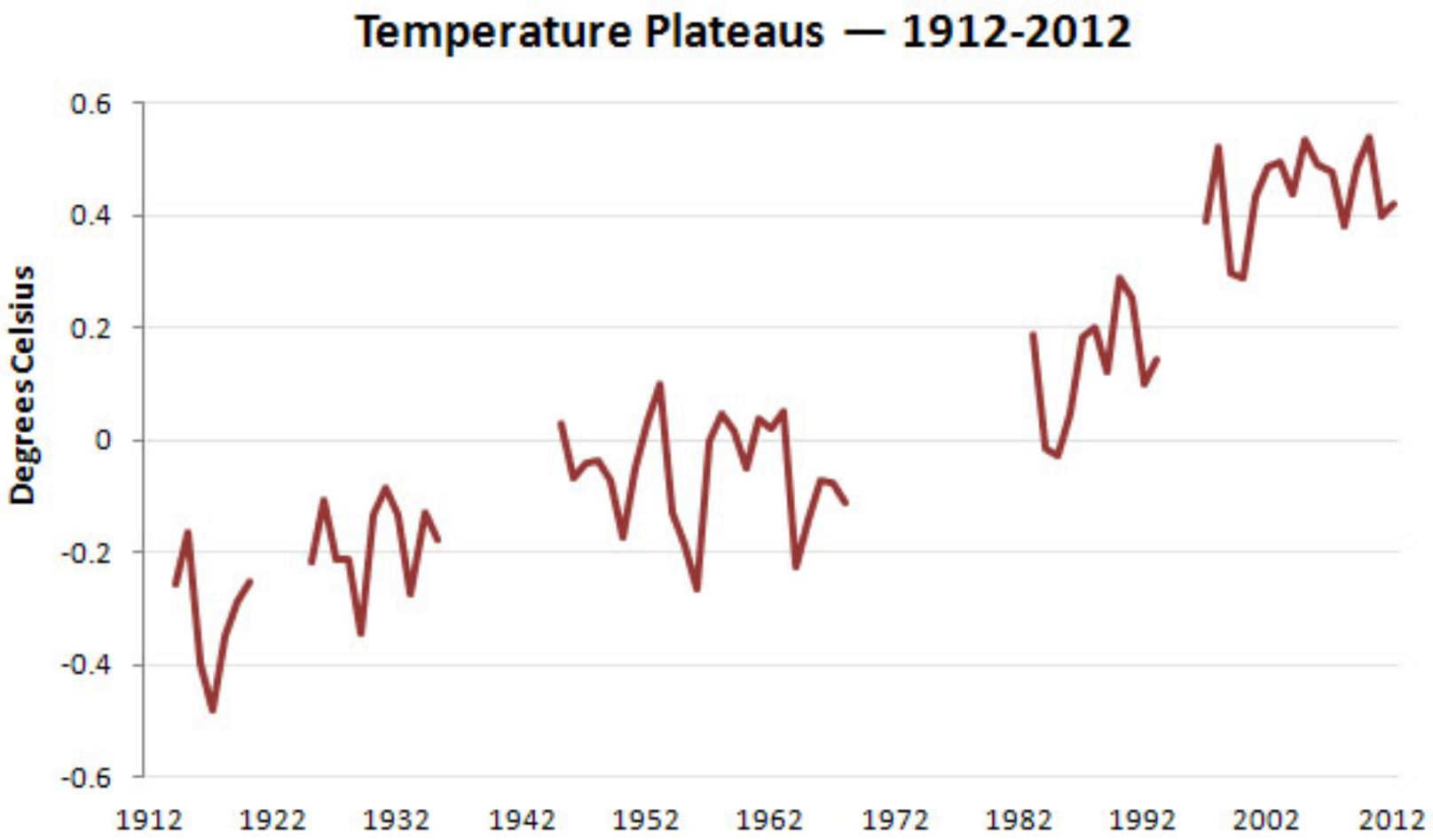
That small blue dot is the Earth, a seen from Cassini, orbiting Saturn, 1.44 billion km from us, on 19-7-2013





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

Lying With Statistics, Global Warming Edition



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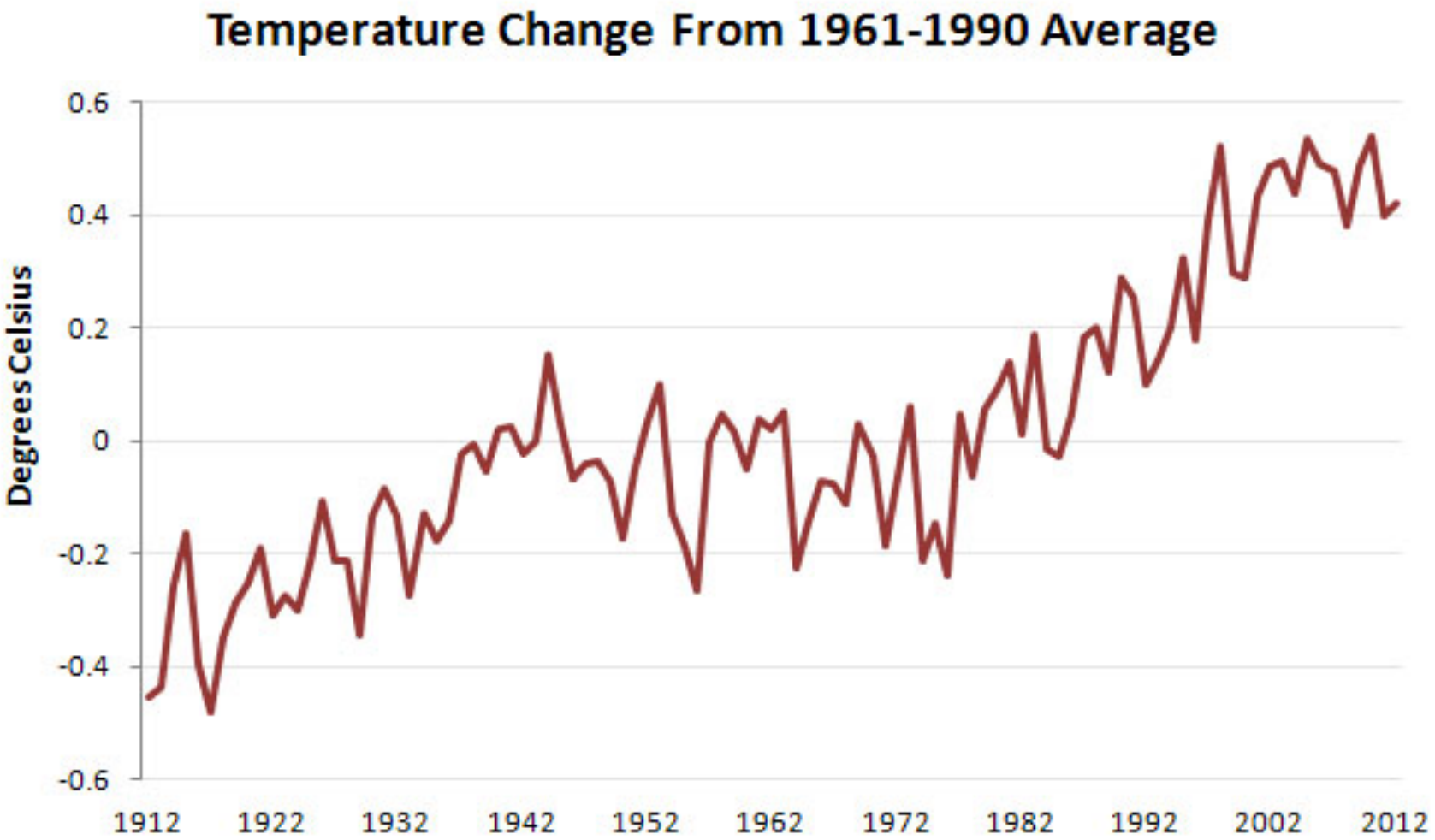

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In the USA alone, organizations which sow doubt about climate change spend almost a billion dollars/year! (Brulle 2014, average numbers for 2003-2010)

The European Union fares a little better, but many Brussels lobbyists try to dilute the EU environmental efforts (see the car industry…)

The « merchants of doubt » have evolved in their arguments:

- Existence of global warming
- Human responsability in the warming
- Cost of decarbonization
- Drawbacks from alternatives

(recent example: so-called enormous needs of cobalt for electric mobility reported on CNN; see critical analysis on https://www.desmogblog.com/2018/05/02/cnn-wrongly-blames-electric-cars-unethical-cobalt-mining)

Dear President Obama & The United States Congress,

Tomorrow
leaders from 192 countries
will gather at
The UN Climate Change Conference in Copenhagen
to determine
the fate of our planet.

As business leaders we are optimistic that President Obama is attending Copenhagen with emissions targets. Additionally, we urge you, our government, to strengthen and pass United States legislation, and lead the world by example. We support your effort to ensure meaningful and effective measures to control climate change, an immediate challenge facing the United States and the world today. Please don't postpone the earth. If we fail to act now, it is scientifically irrefutable that there will be catastrophic and irreversible consequences for humanity and our planet.

We recognize the key role that American innovation and leadership play in stimulating the worldwide economy. Investing in a Clean Energy Economy will drive state-of-the-art technologies that will spur economic growth, create new energy jobs, and increase our energy security all while reducing the harmful emissions that are putting our planet at risk. We have the ability and the know-how to lead the world in clean energy technology to thrive in a global market and economy. But we must embrace the challenge today to ensure that future generations are left with a safe planet and a strong economy.

Please allow us, the United States of America, to serve in modeling the change necessary to protect humanity and our planet.

In partnership,

Chris Anderson, Curator, TED Richard Baker, Chairman, Lord & Taylor Dan, David & Laureen Barber, Blue Hill Chris Blackwell, Founder, Island Records, Island Outpost Graydon Carter, Editor, Vanity Fair Deepak Chopra, Adjunct Professor, Kellogg School of Business and Management Yvon Chouinard, Founder, Patagonia Ben Cohen, Jerry Greenfield, Co-founders, Ben & Jerry's Gregory Colbert, Creator, Ashes & Snow Kenneth Cole, Chairman, Kenneth Cole Paulette Cole, CEO & Creative Director, ABC Home, ABC Carpet & Home Tom Colicchio, Chef & Owner, Craft Restaurants Kit Crawford, Gary Erickson, Co-Owners & Co-CEOs, Clif Bar & Company Steve Ells, Founder, Chairman & Co-CEO, Chipotle Mexican Grill, Inc. Eileen Fisher, CEO, Eileen Fisher Walt Freese, CEO, Ben & Jerry's Homemade Mitchell Gold, Chairman, Bob Williams, President, Co-Founders, Mitchell Gold + Bob Williams Matt Goldman, Co-Founder & CEO, Blue Man Group Seth Goldman, CEO, Honest Tea Robert Greibler, Founder, Pokonobe Associates, Jenga Licensor Adrian Grenier, Reckless Productions Alan Hassenfeld, former Chairman, Hasbro, Inc. Don Hazen, Executive Editor, AlterNet Gary Hirshberg, CEO, Stonyfield Yogurt Jeffrey Hollender, CEO, Seventh Generation Kate Hudson, David Babaii, Co-Founders, David Babaii for WildAid Mike Keplan, CEO, Aspen Skiing Company Michael Kieschnick, President, Credo Mobile Sheryl Leach, Creator & Founder of Barney Sven-Olof Lindblad, Founder, Lindblad Expeditions Danny Meyer, CEO, Union Square Hospitality Group Laura Michalchyshyn, President & GM, Planet Green, Discovery Communications Will Raap, Chairman & Founder, Gardener's Supply Company Horst Rechelbacher, Founder, Aveda, Founder & CEO, Intelligent Nutrients David Rockwell, Founder & Owner, Rockwell Group Maury Rubin, Founder, Chef & CEO, City Bakery, Birdbath Green Bakery Michael Rupp, CEO & President, The Rockport Company Gordon Segal, Chairman, Crate & Barrel Jeff Skoll, Founder, Participant Media and Skoll Foundation Harvey Spevak, CEO, Equinox Greg Steltenpohl, Founder, Odwalla Michelle Stein, President, Aveda USA Martha Stewart, Founder, Martha Stewart Living Omnimedia, Inc. Jeffrey Swartz, CEO, Timberland Tom Szaky, CEO, TerraCycle Donald J. Trump, Chairman and President, Donald J. Trump Jr., EVP, Eric F. Trump, EVP, Ivanka M. Trump, EVP, The Trump Organization Jean-Georges Vongerichten, Executive Chef & Owner, Jean-Georges Management LLC

if you want to go quickly, go alone. if you want to go far, go together. *african proverb*

Business leaders, sign onto this initiative: *businessleaders4environmentalchange.us*

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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 Organization

UNEP= United Nations Environment Programme

Mandate of the IPCC

- To **assess** on a **comprehensive, objective, open and transparent** basis the scientific, technical and socio-economic information relevant to understanding the **scientific basis of risk of human-induced climate change, its potential impacts and options for adaptation and mitigation.**
- IPCC reports should be **neutral with respect to policy,** although they may need to deal objectively with **scientific, technical and socio-economic factors relevant** to the application of particular policies

Source : http://www.ipcc.ch/organization/organization_procedures.shtml (last update 2013)

IPCC Reports are policy-relevant, NOT policy-prescriptive

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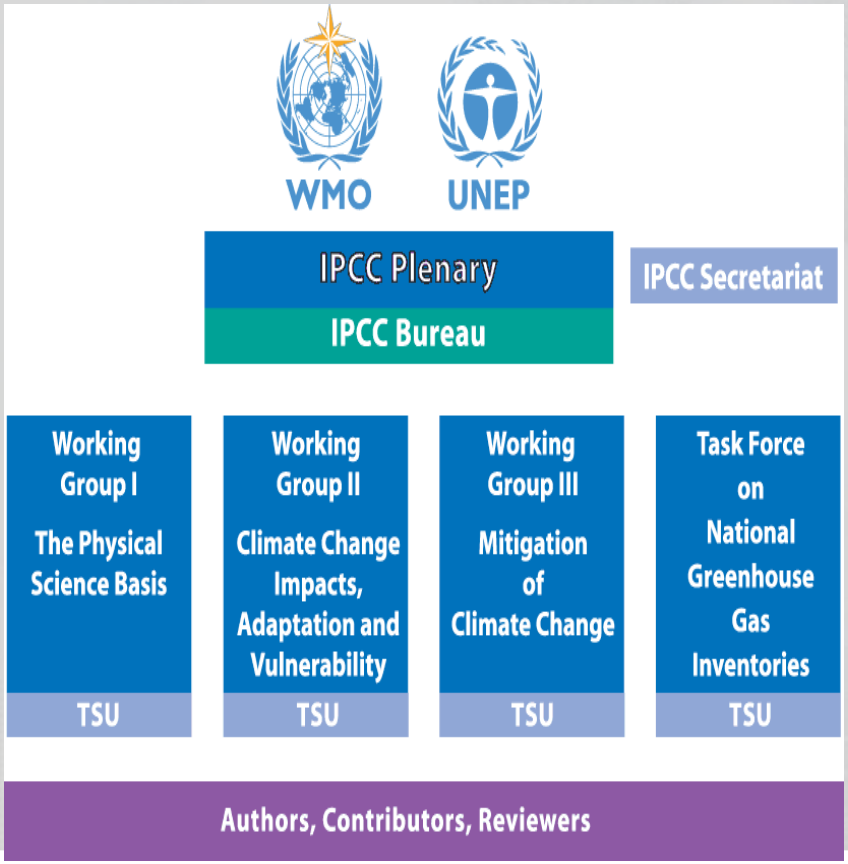
Inter-governmental Panel on Climate Change (IPCC): Organization Structure



- 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!***

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Previous schedules

	Special Reports			AR4		
	LULUCF	SROC	SRCCS	WGI	WGII	WGIII
LA1	11-13/01/99	Aug 03	2-4/07/03	26-29/09/04	20-23/09/04	19-21/10/04
writing	8 weeks g	9 weeks	12 weeks	19 weeks	12 weeks	19 weeks
informal review	4 weeks	8 weeks	8 weeks	8 weeks	7 weeks	8 weeks
consideration of comments	3 weeks	4 weeks	3 weeks	4 weeks	5 weeks	5 weeks
LA2	28-30/04/99	Jan 04	16-18/12/03	10-12/05/05	14-17/03/05	6-9/06/05
preparation of 1st draft	8 weeks	11 weeks	21 weeks	18 weeks	25 weeks	25 weeks
Expert review	~ 5 weeks	8 weeks	8 weeks	8 weeks	8 weeks	9 weeks
consideration of comments	~ 2 weeks	4 weeks	6 weeks	5 weeks	10 weeks	3 weeks
LA3	23-25/08/99	June 04	17-19/08/04	11-16/12/05	16-19/01/06	14-18/02/06
preparation of 2nd draft	8 weeks	10 weeks	20 weeks	17 weeks	18 weeks	22 weeks
Exp/gov review	~ 7 weeks	8 weeks	8 weeks	8 weeks	8 weeks	8 weeks
consideration of comments	5 weeks	3 weeks	7 weeks	3 weeks	6 weeks	3 weeks
LA4	11-13/01/00	Dec 04	25-29/04/05	26-28/06/06	10-15/09/06	10-13/10/06
preparation of final draft	~ 6 weeks	9 weeks	11 weeks	18 weeks	14 weeks	18 weeks
final gov. distribution	4/8 weeks	8 weeks	7 weeks	9 weeks	8 weeks	7 weeks
consideration SPM comments			2 weeks	6 weeks	6 weeks	3 weeks
Approval/acceptance	May-00	April 05	Sept 05	Feb.07	Apr. 07	May.07

How are IPCC report chapters prepared:

- By teams consisting of **Coordinating Lead Authors (CLA)**, **Lead Authors (LA), Contributing Authors (CA),** and **Review Editors (RE)**.
- **Coordinating Lead Authors** and **Lead Authors** have collective responsibility for the contents of a chapter.
- **Contributing Authors** assist the work of the author teams by providing specific knowledge or expertise in a given area.
- The **Review Editors** ensure that all substantive comments received during review are given appropriate consideration by the author teams, ensure that genuine diversity in perspectives in the literature is reflected adequately in the report, and advise Lead Authors on how to handle contentious or controversial issues.

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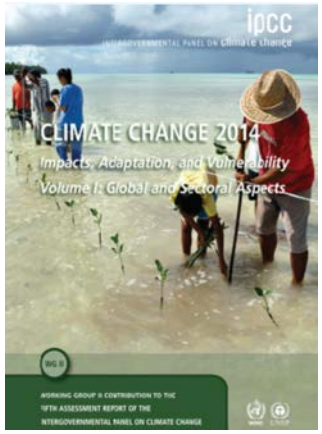
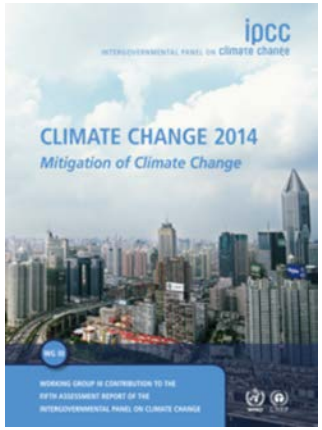




What is happening in the climate system?

What are the risks?

What can be done?

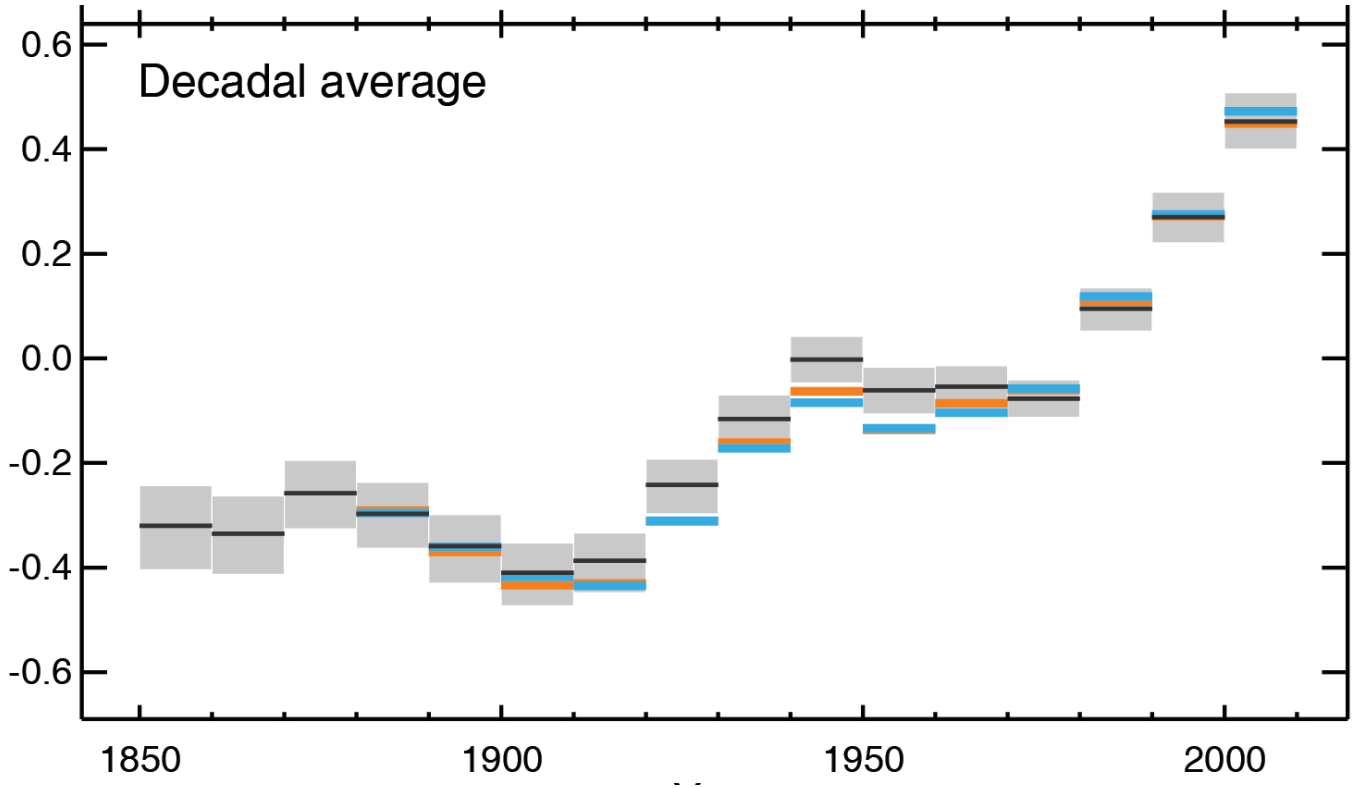
ipcc
INTERGOVERNMENTAL PANEL ON climate change

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

ipcc INTERGOVERNMENTAL PANEL ON climate change
WMO UNEP

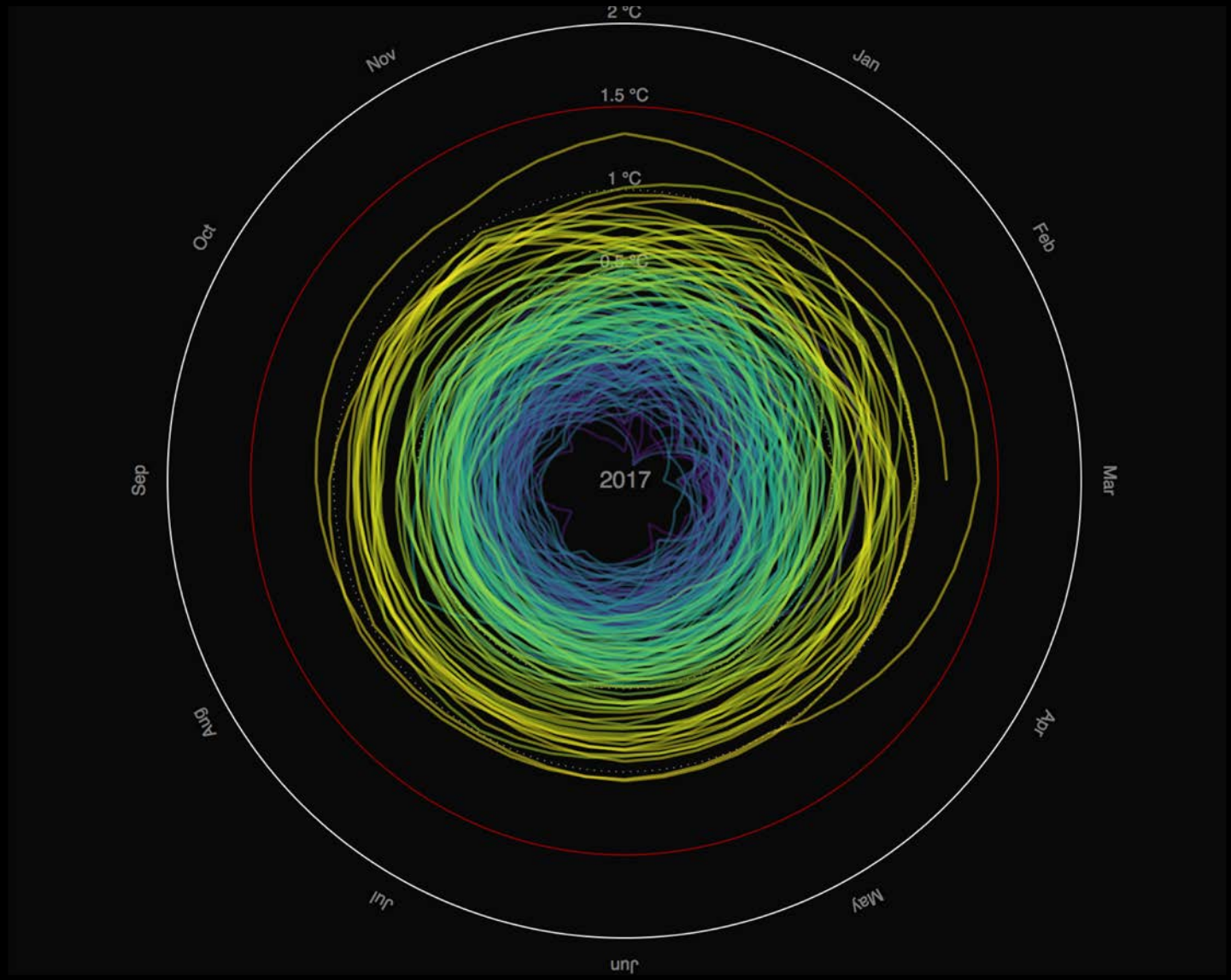


(IPCC 2013, Fig. SPM.1a)

Each of the last three decades has been successively warmer at the Earth's surface than any preceding decade since 1850.

In the Northern Hemisphere, 1983–2012 was *likely* the **warmest 30-year period of the last 1400 years** (*medium confidence*).

Temperature spiral

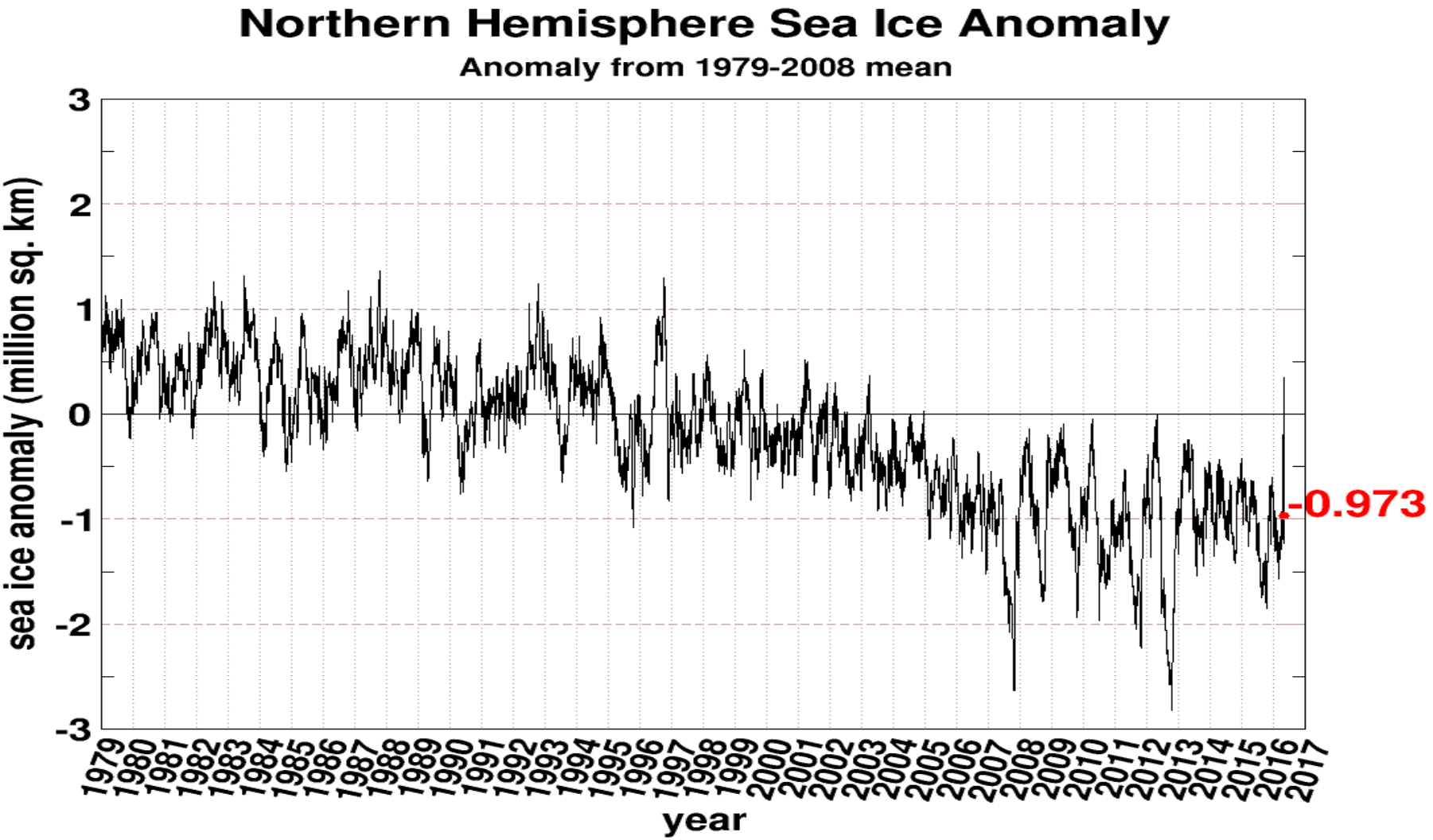


Global Mean Temperature in °C relative to 1850 – 1900
Graph: Ed Hawkins (Climate Lab Book) – Data: HadCRUT4 global temperature dataset
Animated version available on http://openclimatedata.net/climate-spirals/temperature

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

Arctic Sea Ice Cover (1979-2016)



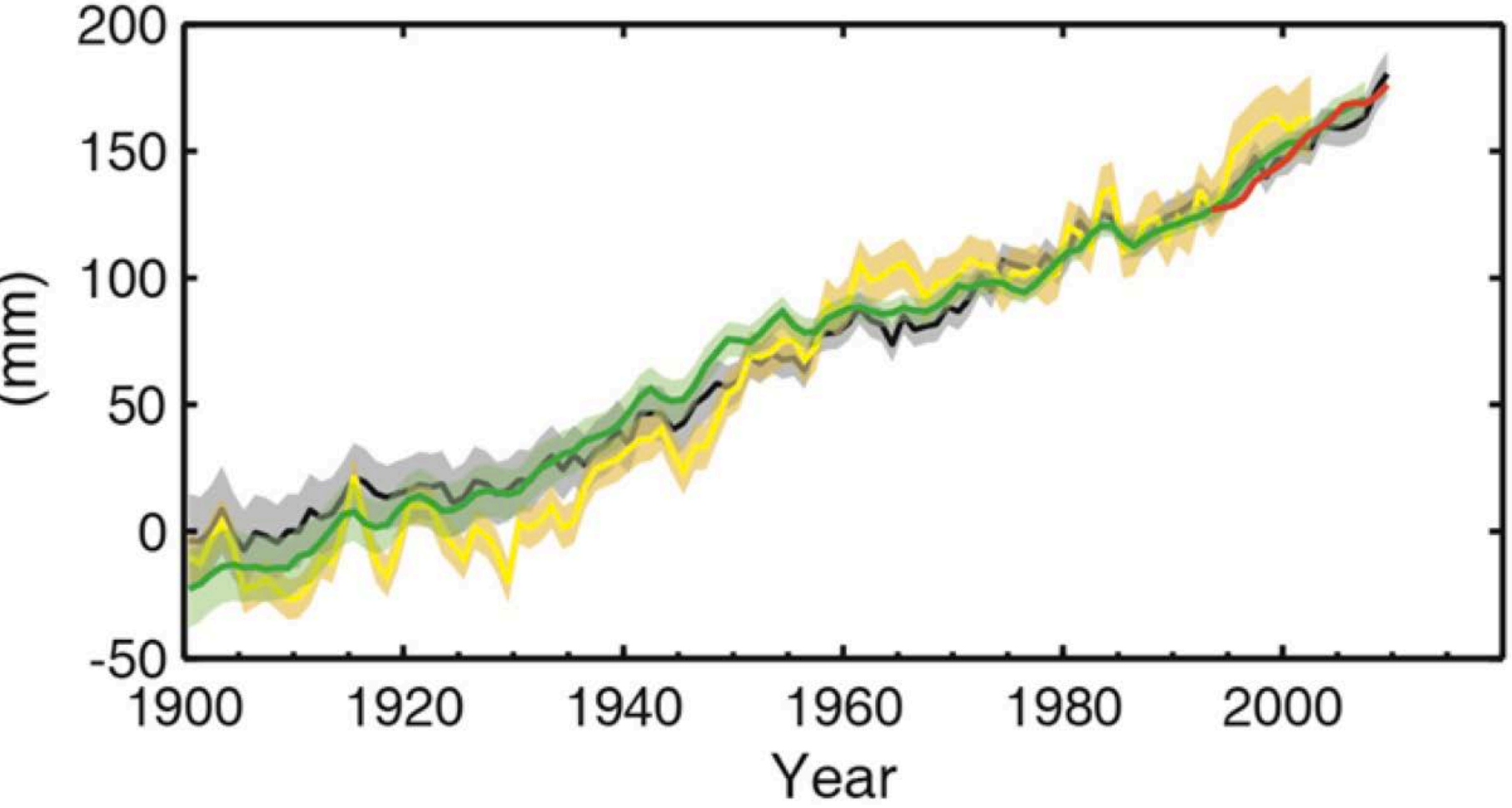
Plateau Glacier (1961)
(Alaska)

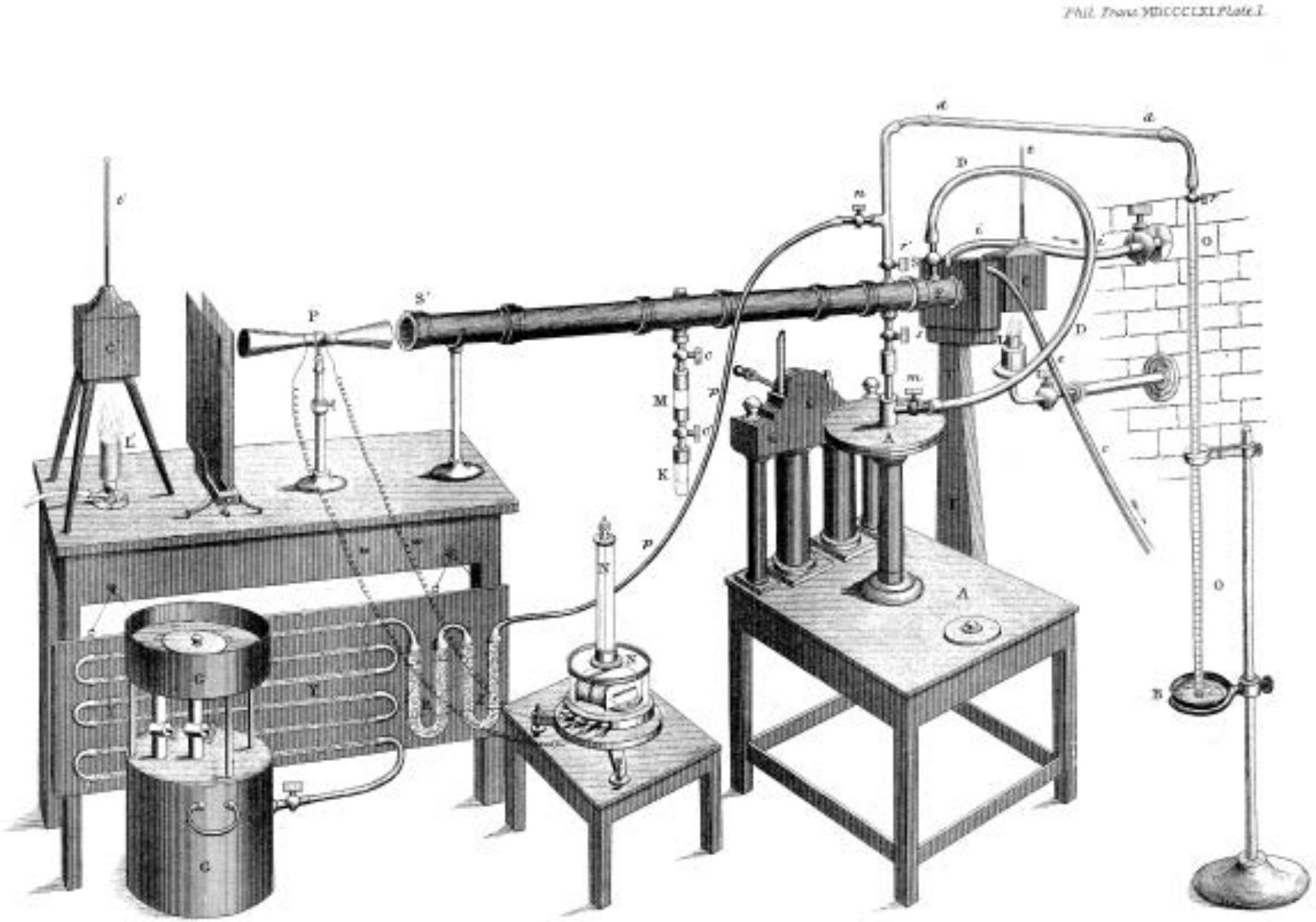
http://www.weather.com/news/science/environment/alaskas-glaciers-capturing-earth-changing-our-eyes-20131125?cm_ven=Email&cm_cat=ENVIRONMENT_us_share

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

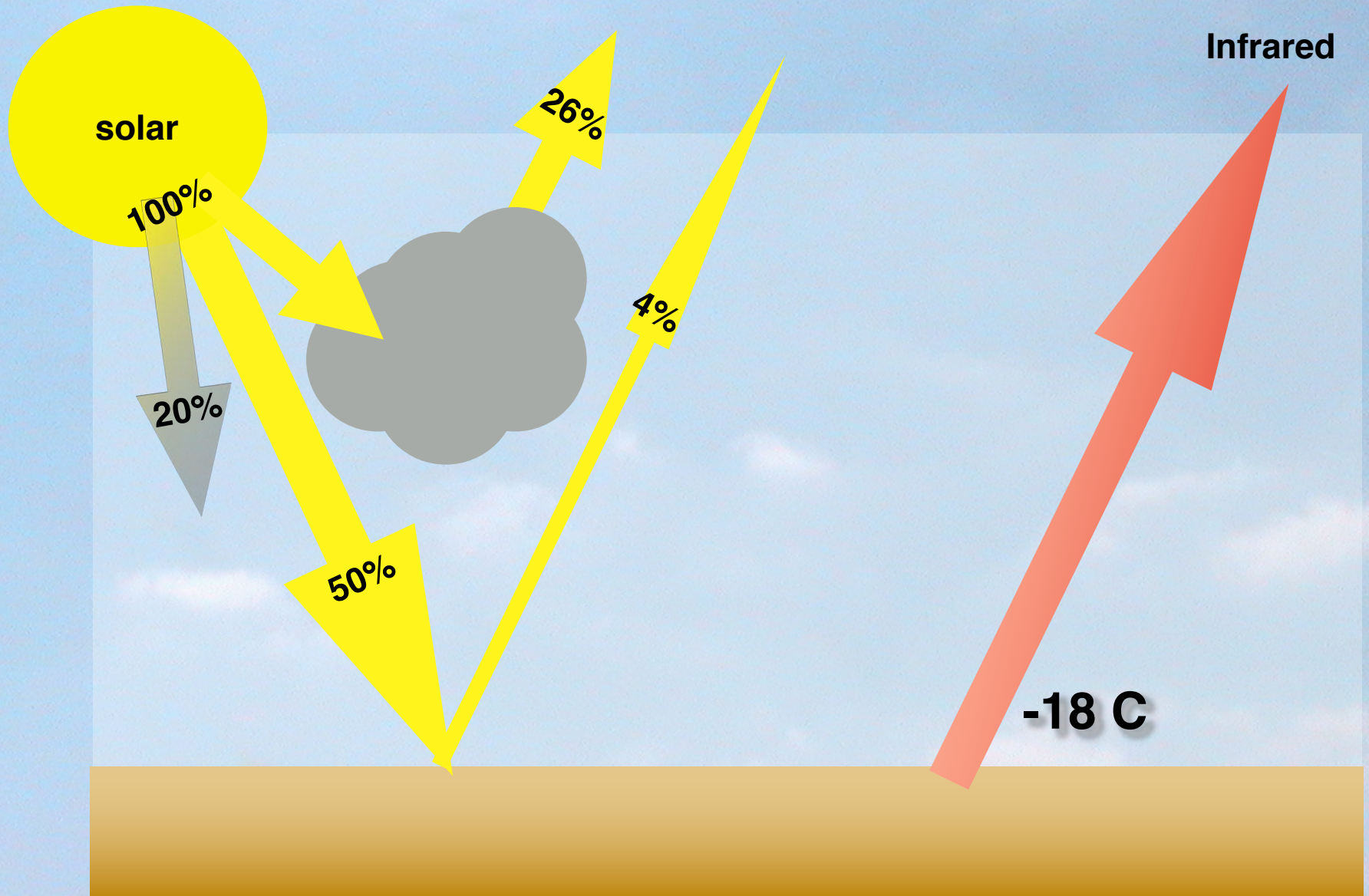
Change in average sea-level change





Tyndall (1861) mesure l'absorption du rayonnement par les gaz

Without Greenhouse Effect



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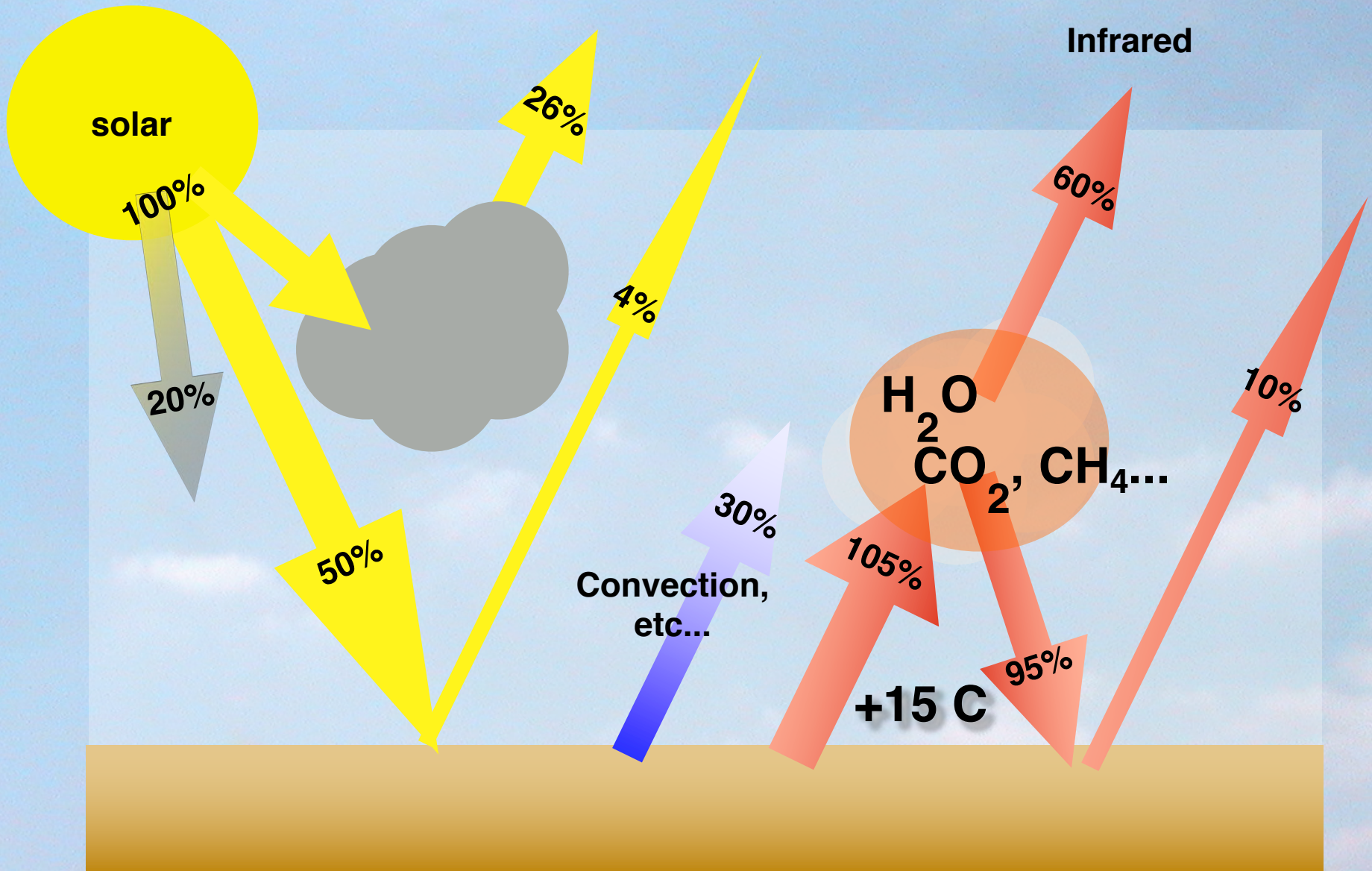
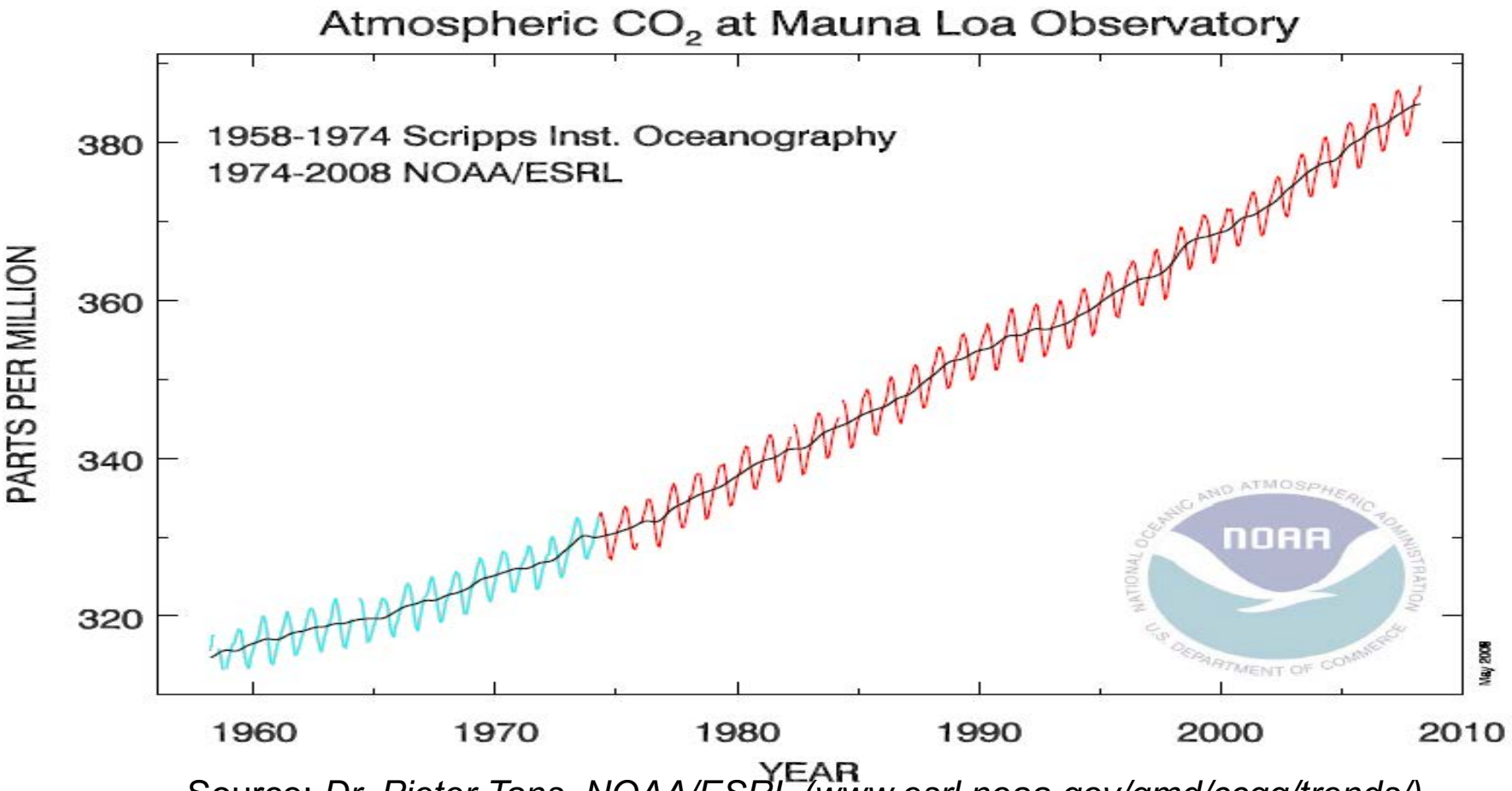


Because we use the atmosphere as a dustbin for our greenhouse gases, we thicken the insulation layer around the planet

That is why we must cut emissions to ZERO as soon as possible

@JPvanYpersele

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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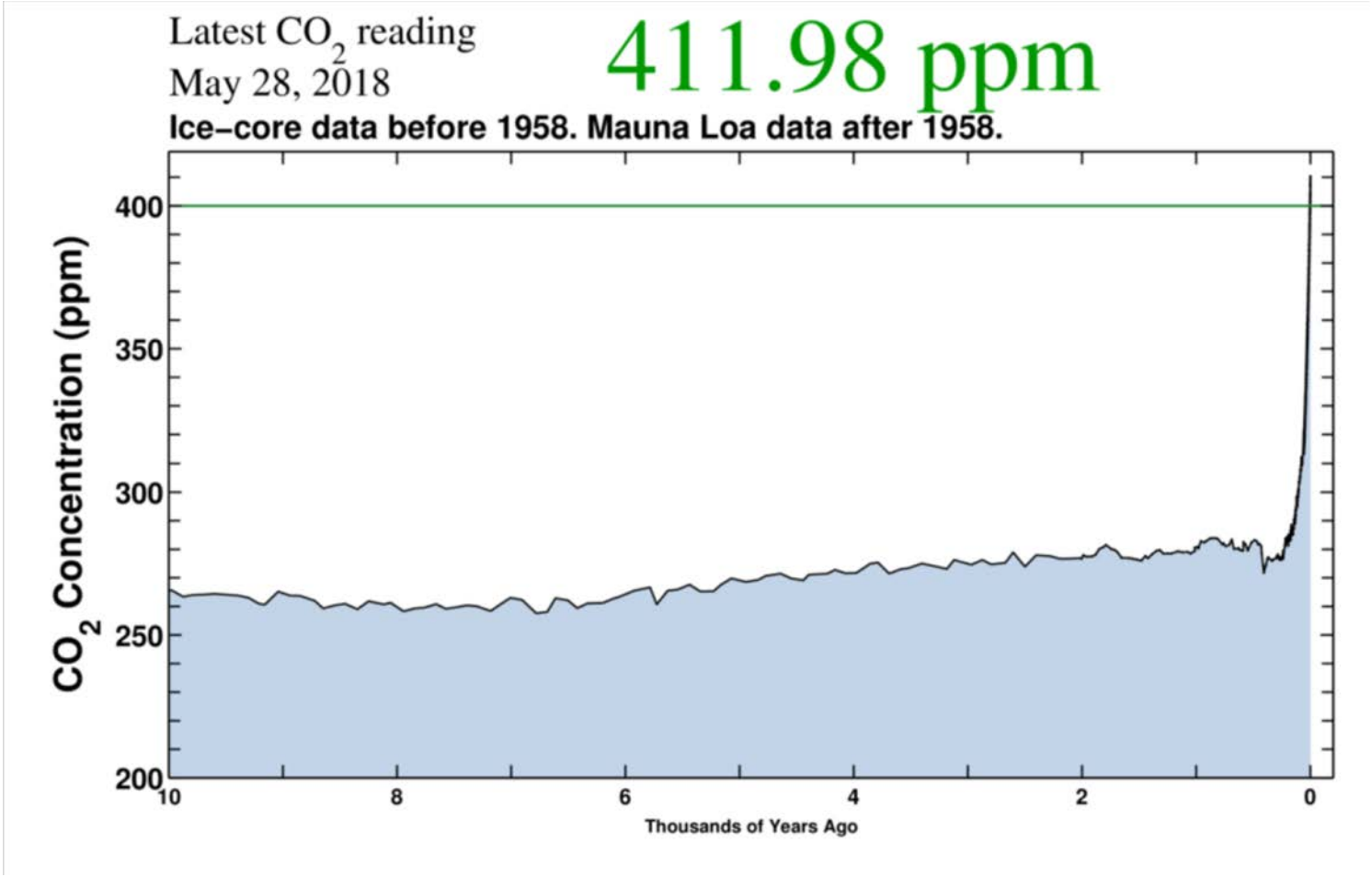
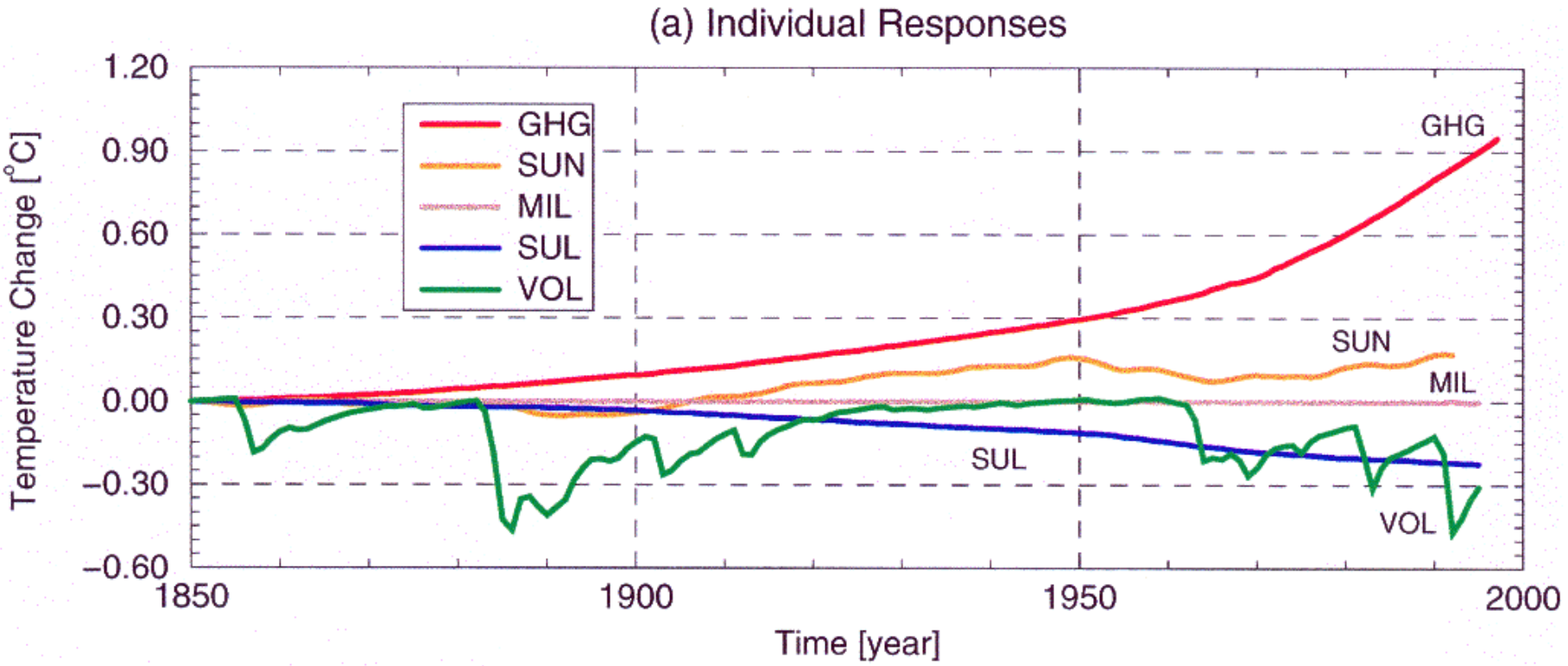
CO_2 Concentration, 28 May 2018 (Keeling curve)



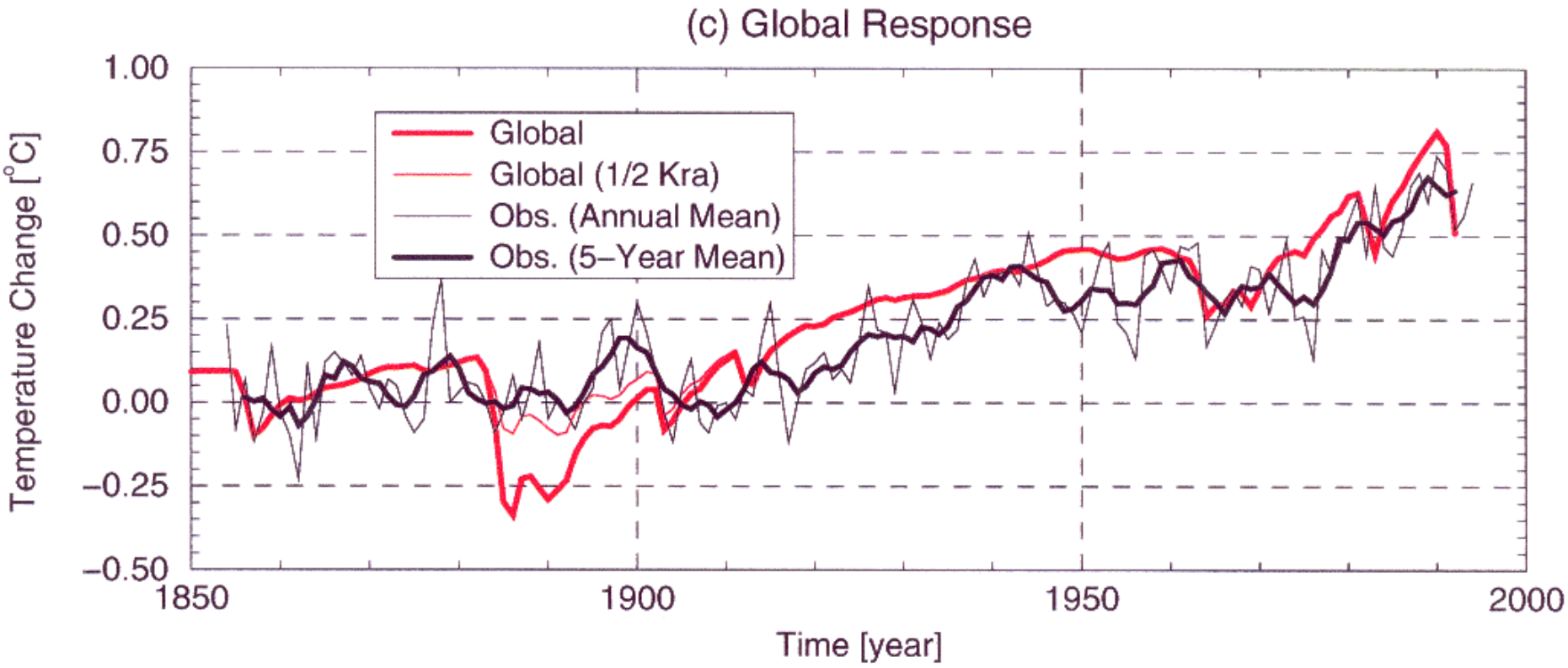
Source: scripps.ucsd.edu/programs/keelingcurve/

Separate effect of different factors in the 2-dimensional climate model at UCLouvain



Bertrand et al. 2001

Combined effect of all factors in the 2-dimensional climate model at UCLouvain



Bertrand et al. 2001

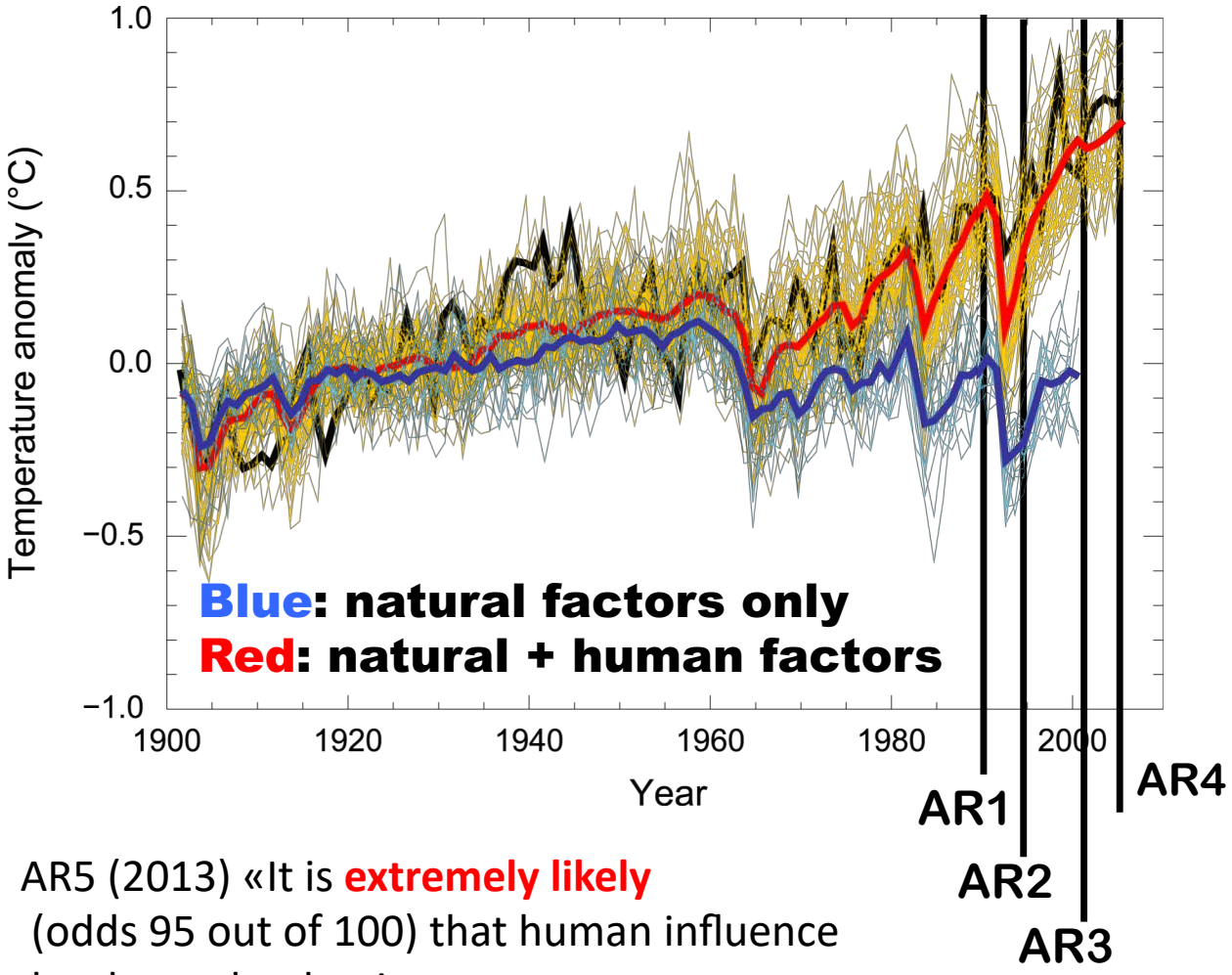
A Progression of Understanding: Greater and Greater Certainty in Attribution

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"



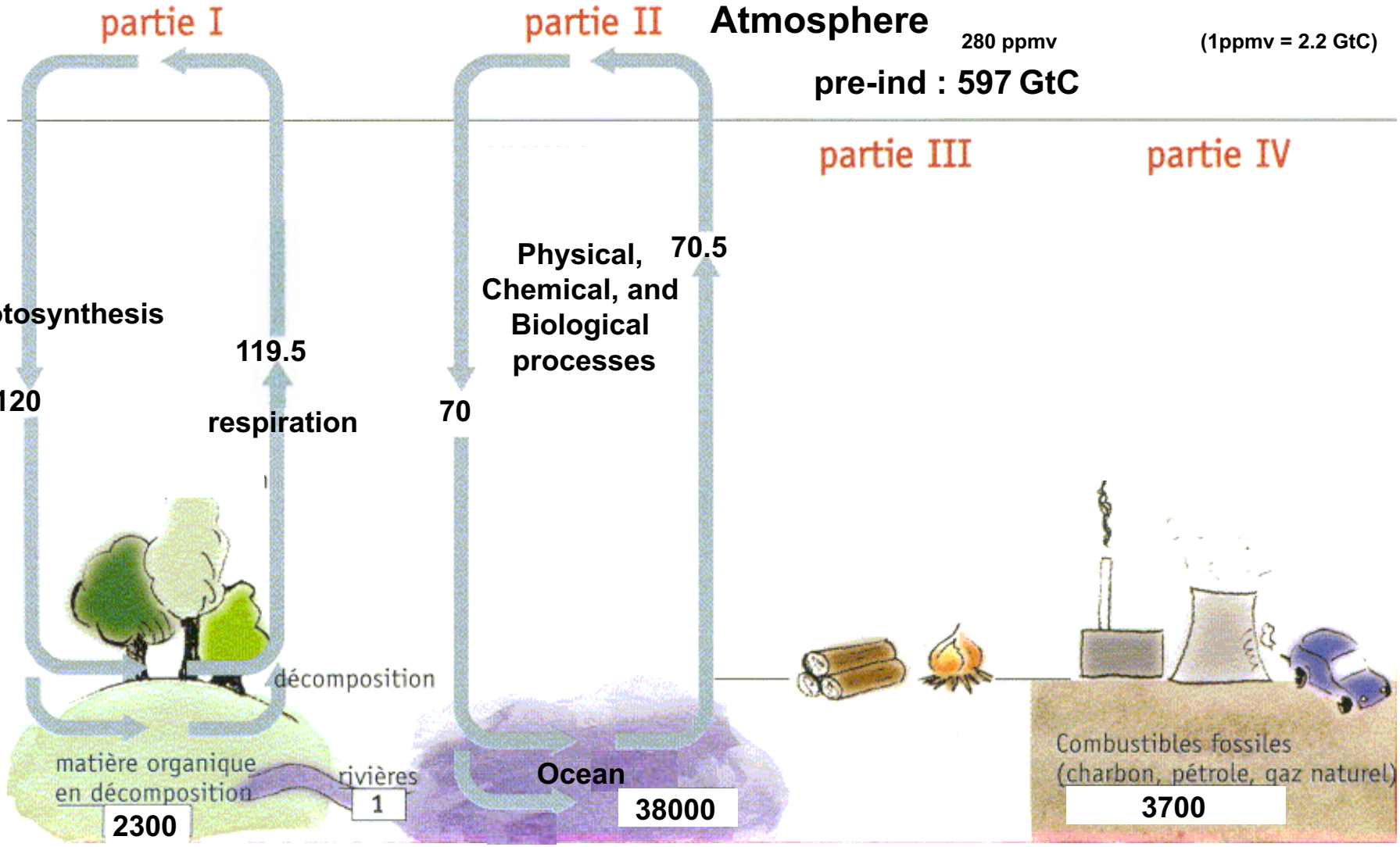
AR5 (2013) «It is **extremely likely** (odds 95 out of 100) that human influence has been the dominant cause… »

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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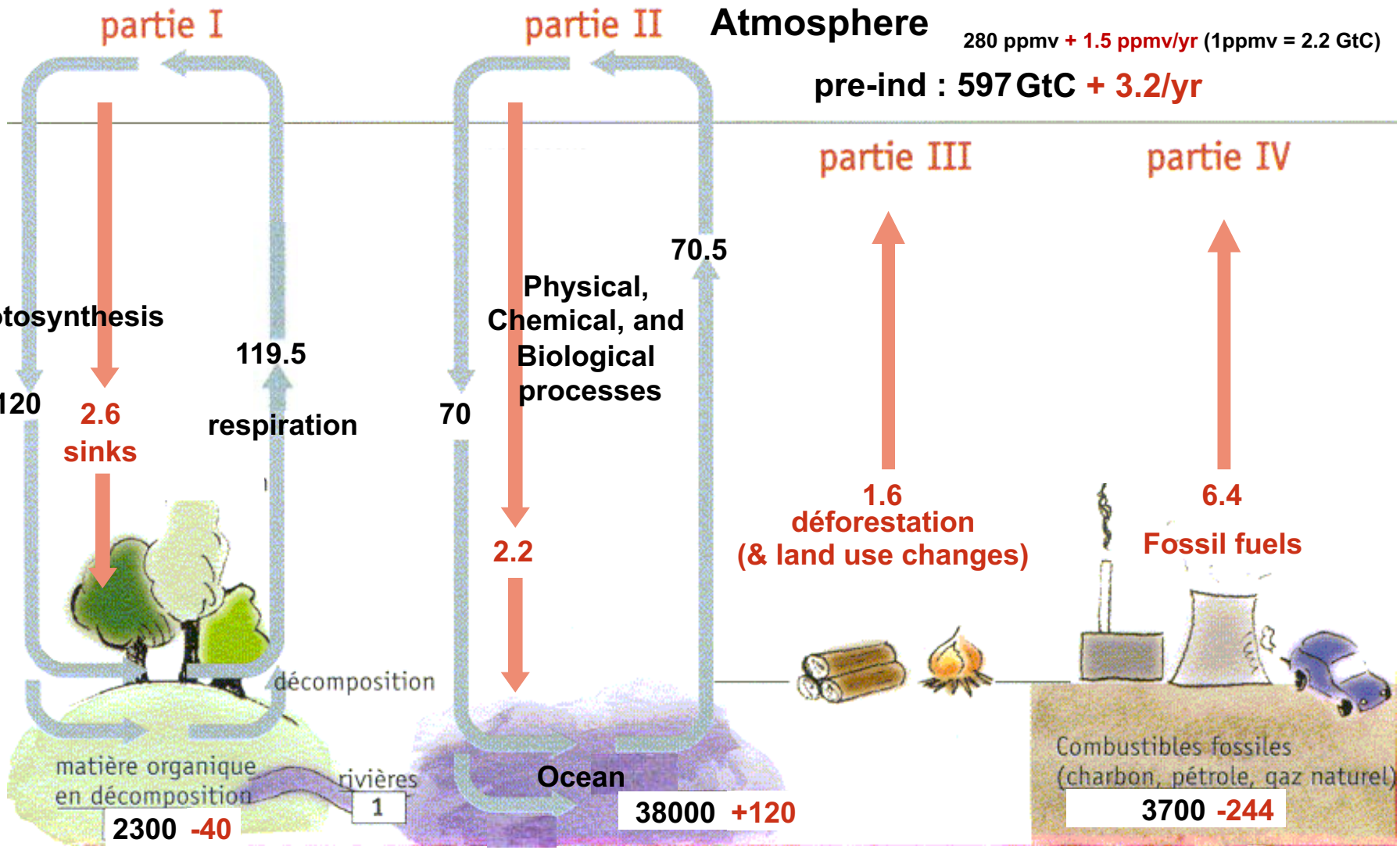
Carbon cycle: perturbed by human activities

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



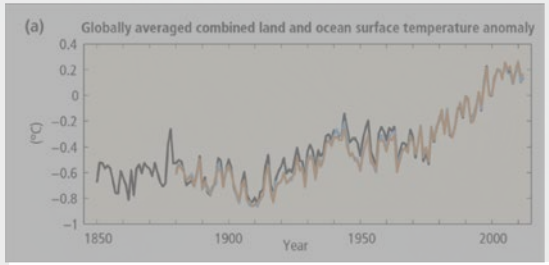
Units: GtC (billions tons of carbon) or GtC/year

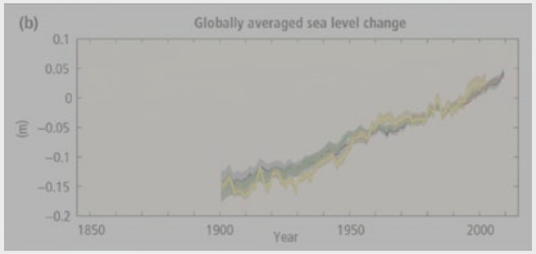
Stocks!

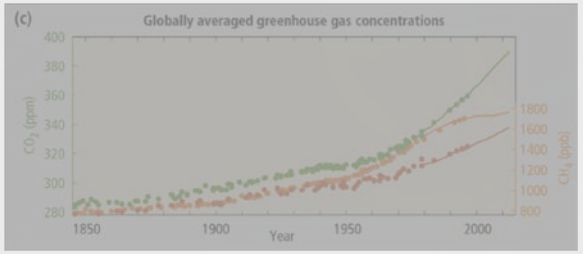
vanyp@climate.be

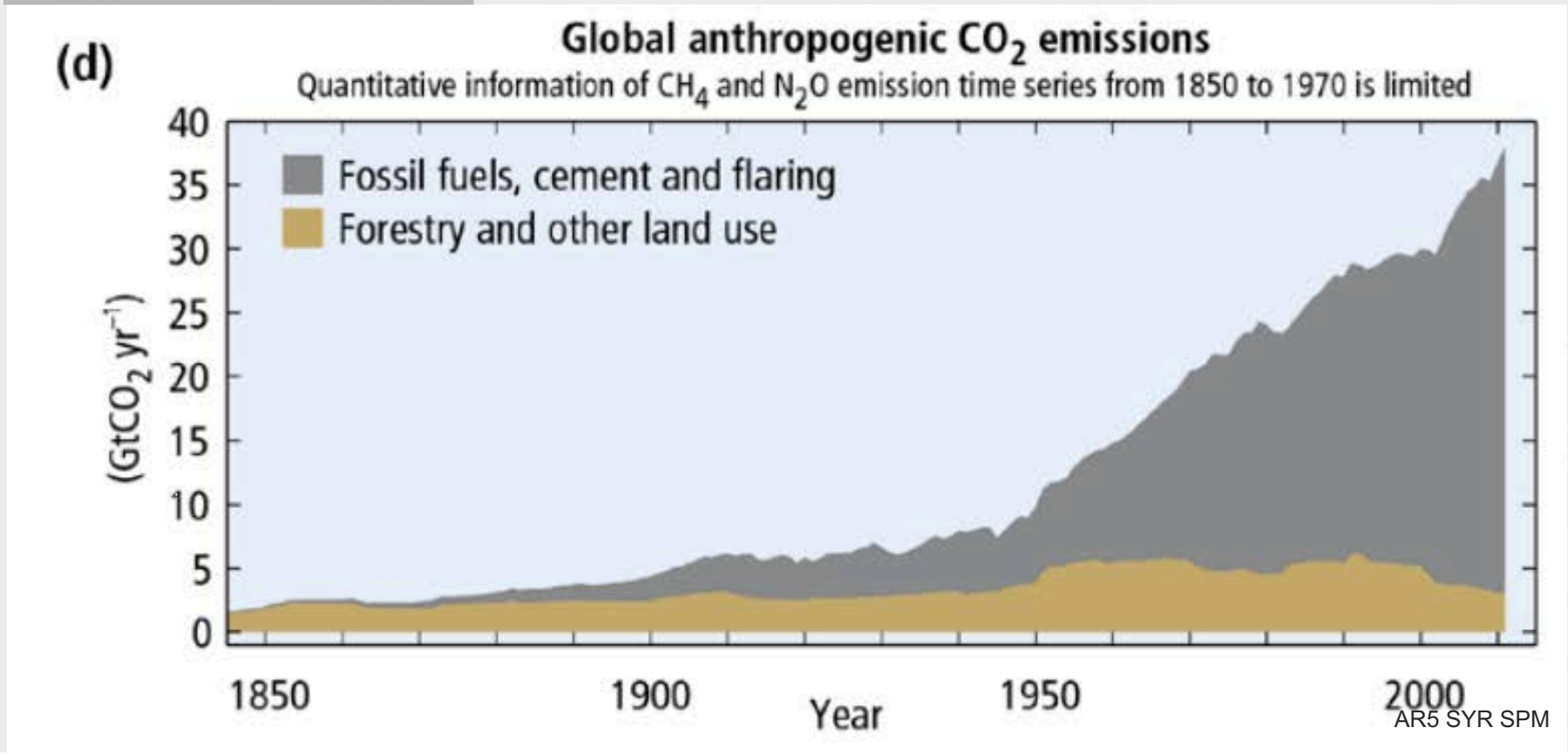
The carbon cycle is policy-relevant

- **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)**


(a)
Globally averaged combined land and ocean surface temperature anomaly
(°C)
Year


(b)
Globally averaged sea level change
(m)
Year

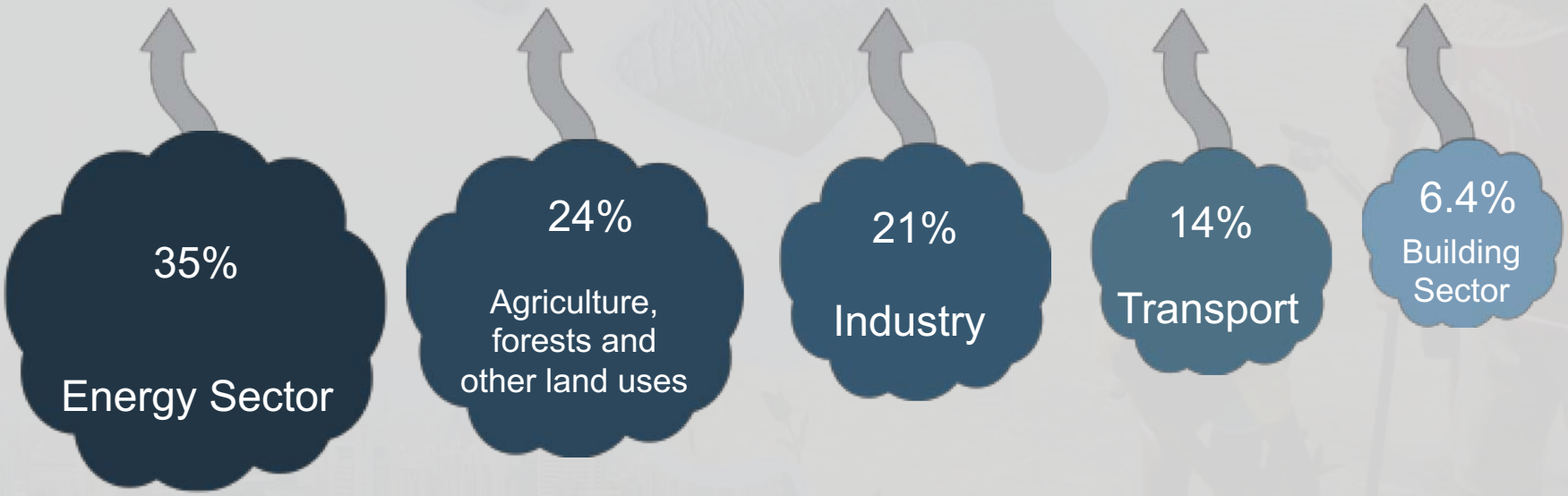

(c)
Globally averaged greenhouse gas concentrations
Year


(d)
Global anthropogenic CO_2 emissions
Quantitative information of CH_4 and N_2O emission time series from 1850 to 1970 is limited
Fossil fuels, cement and flaring
Forestry and other land use
$(GtCO_2\ yr^{-1})$
Year

AR5 SYR SPM

Sources of emissions

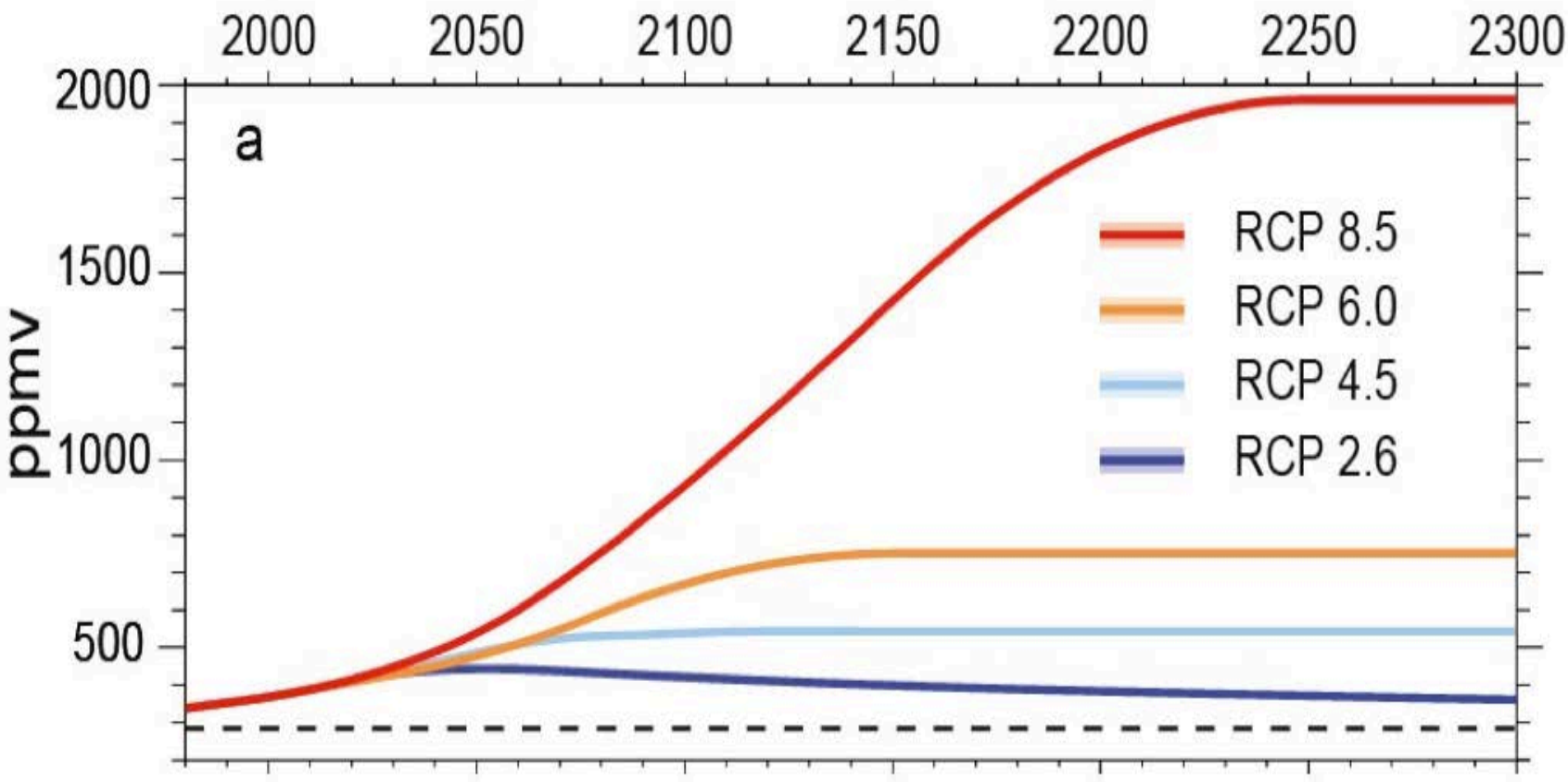
Energy production remains the primary driver of GHG emissions



2010 GHG emissions

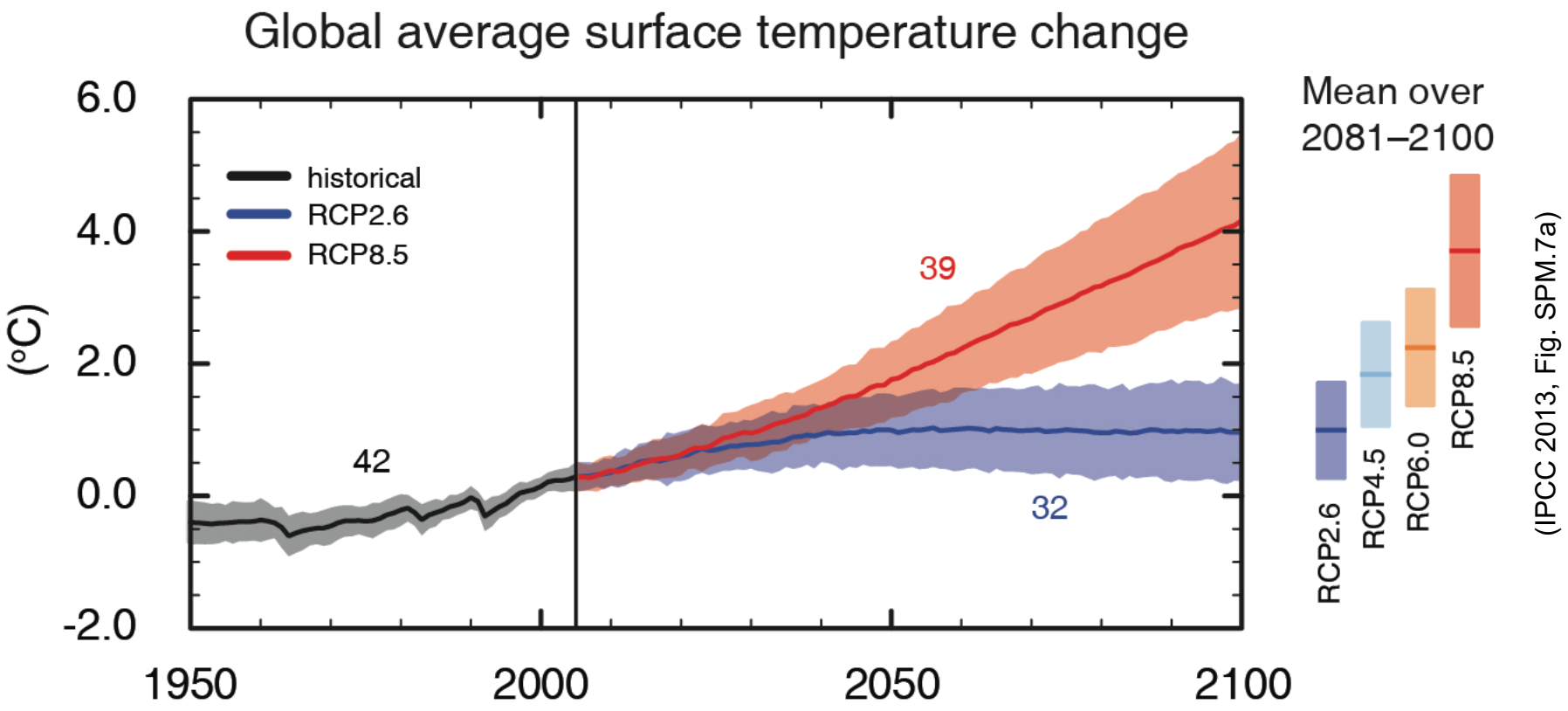
AR5 WGIII SPM

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



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

Average temperature is probably on its way to exceed the « conservation temperature » for the Greenland and (some of the) Antarctic ice sheet

There is therefore a very high risk that average sea level would increase by several metres over the next century or two

@JPvanYpersele

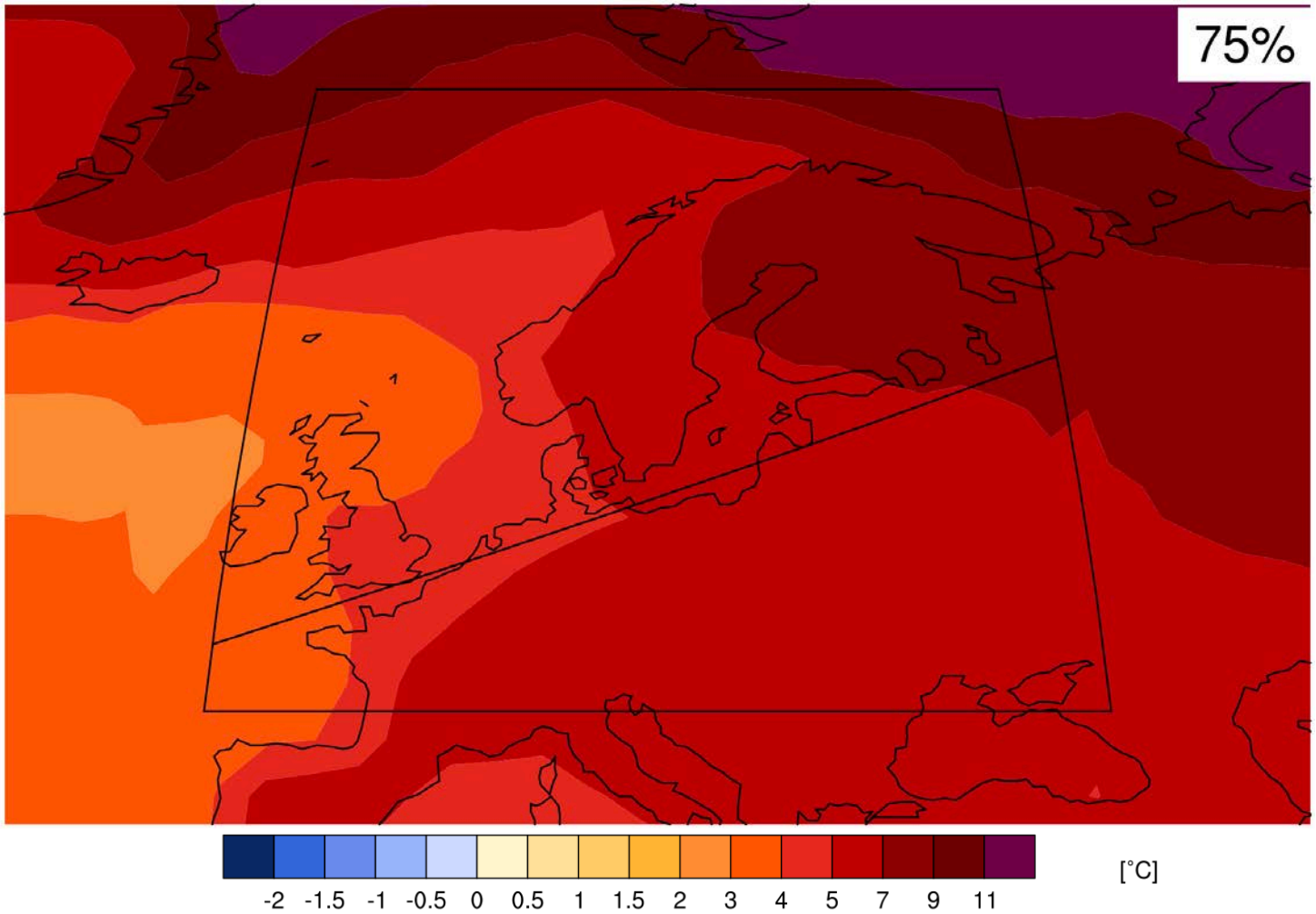
18-20000 years ago (Last Glacial Maximum)

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

Today, with +4-5° C globally

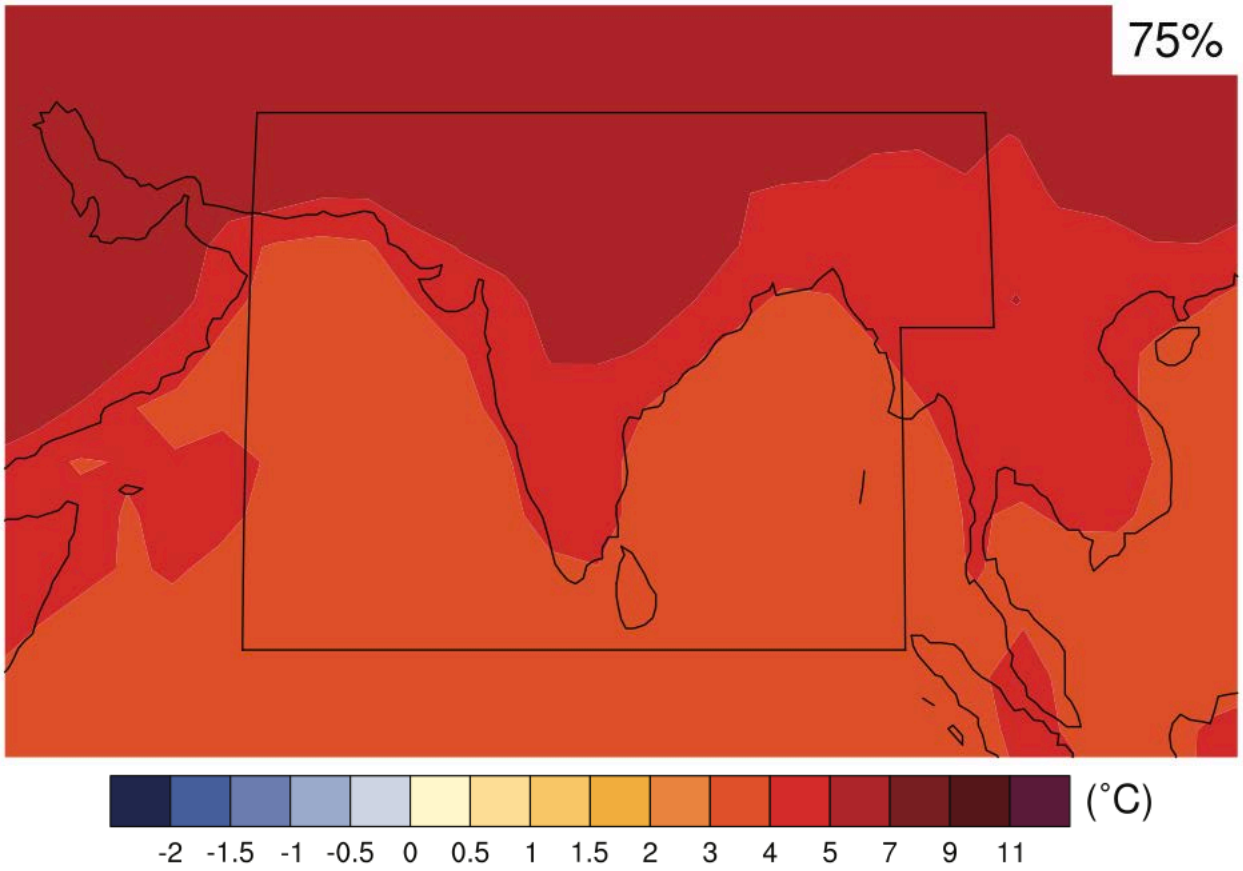
With permission from Dr. S. Joussaume, in « Climat d'hier à demain », CNRS éditions.

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



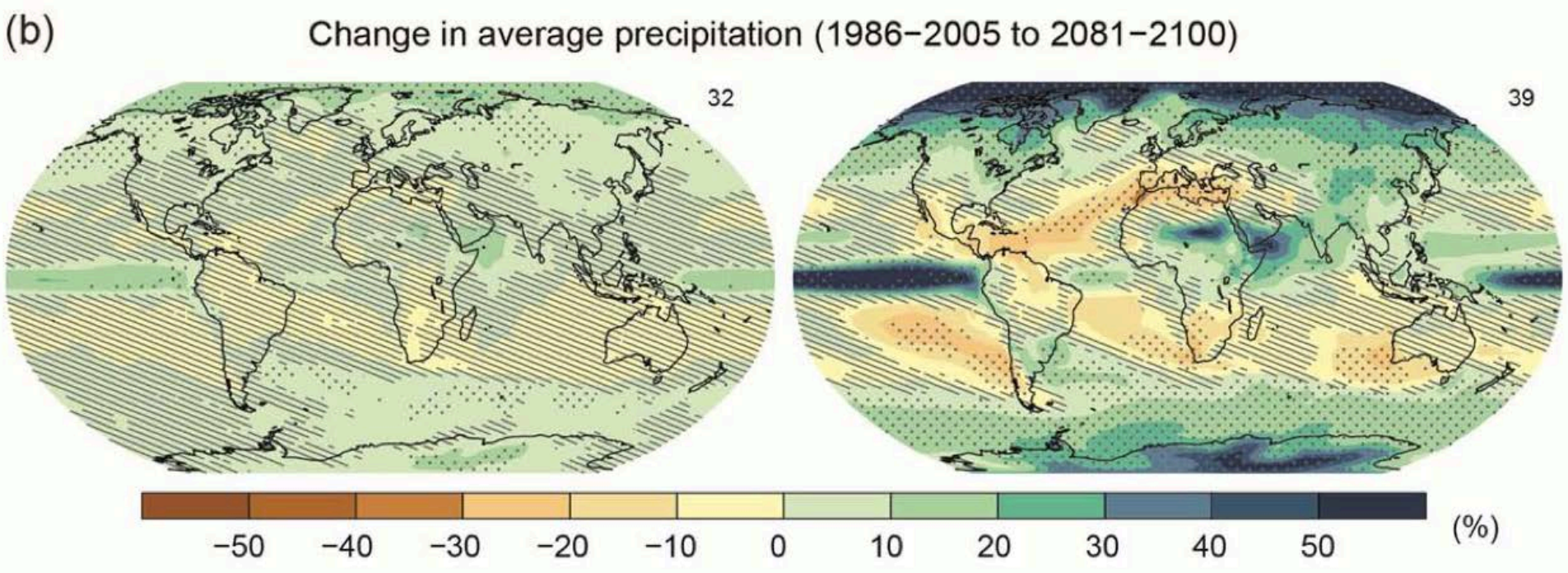
IPCC WG1 Fifth Assessment Report (Final Draft)

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

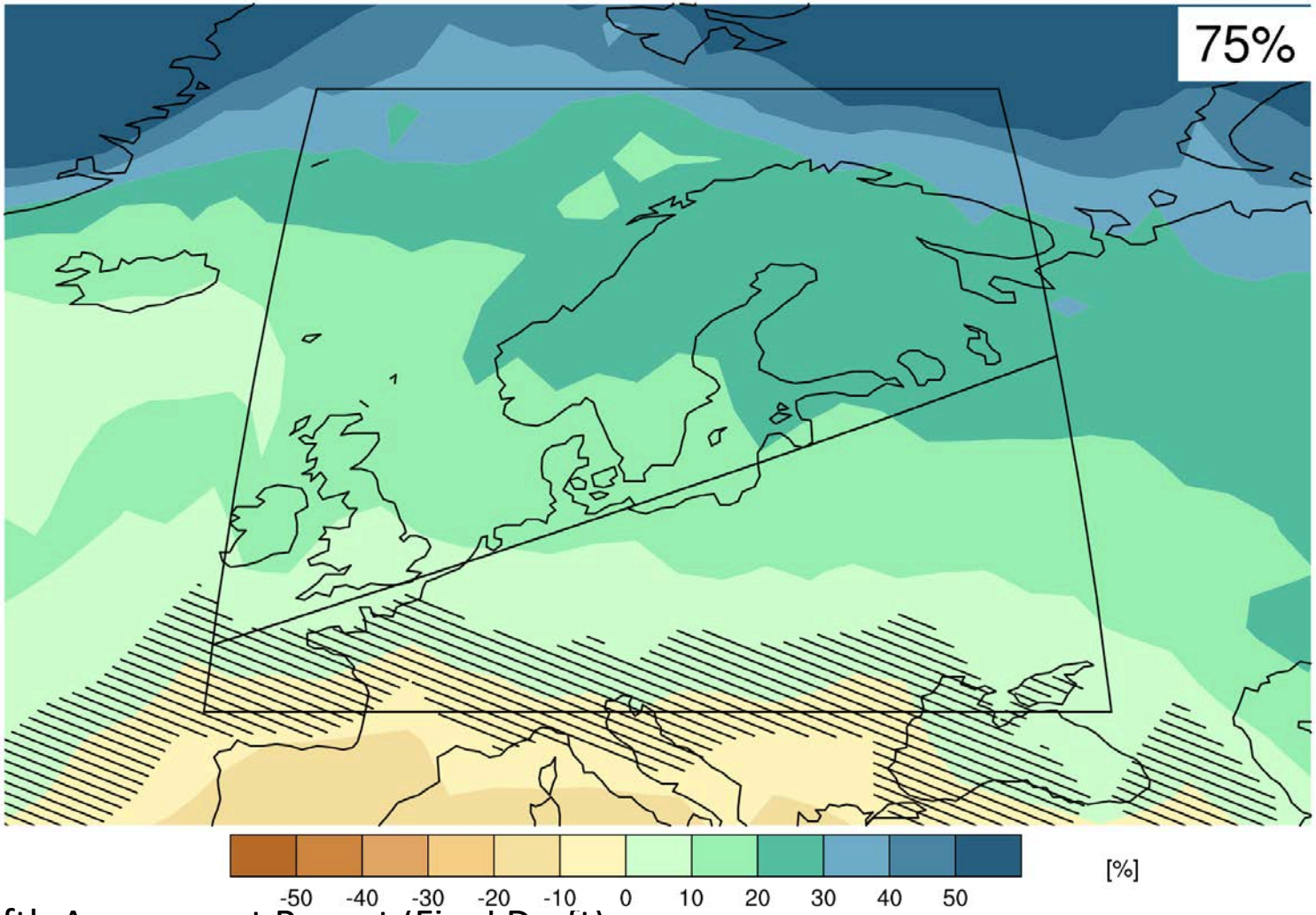


IPCC, WGI, Annex I: Atlas of Global and Regional Climate Projections Supplementary Material RCP8.5

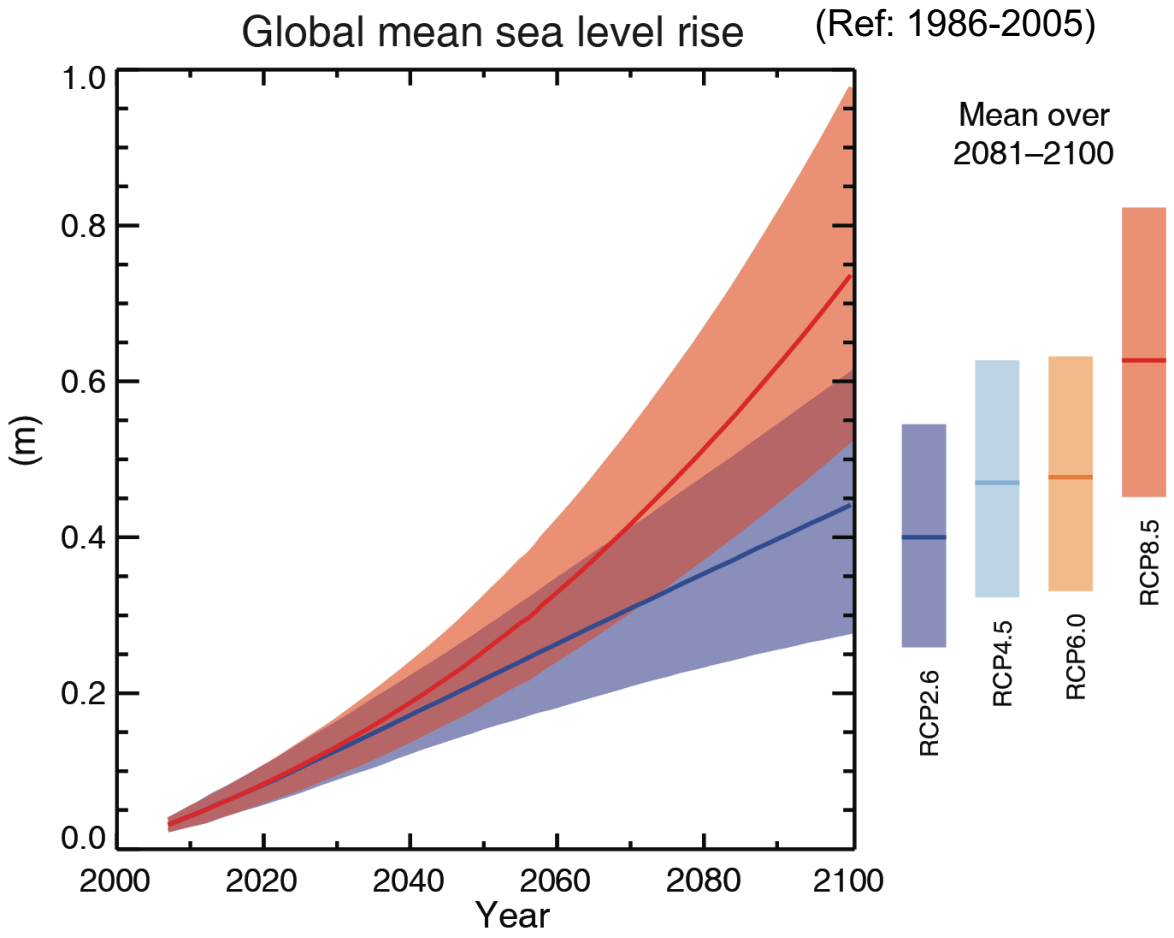
Annual rainfall projections



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 (Final Draft)



(IPCC 2013, Fig. SPM.9)

Sea level due to continue to increase

With 1 metre sea-level rise: 63000 ha below sea-level in Belgium (likely in 22nd century, not impossible in 21st century) (NB: flooded area depends on protection)

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

Effets sur le Delta du Nil, où vivent plus de 10 millions de personnes à moins d'1 m d'altitude

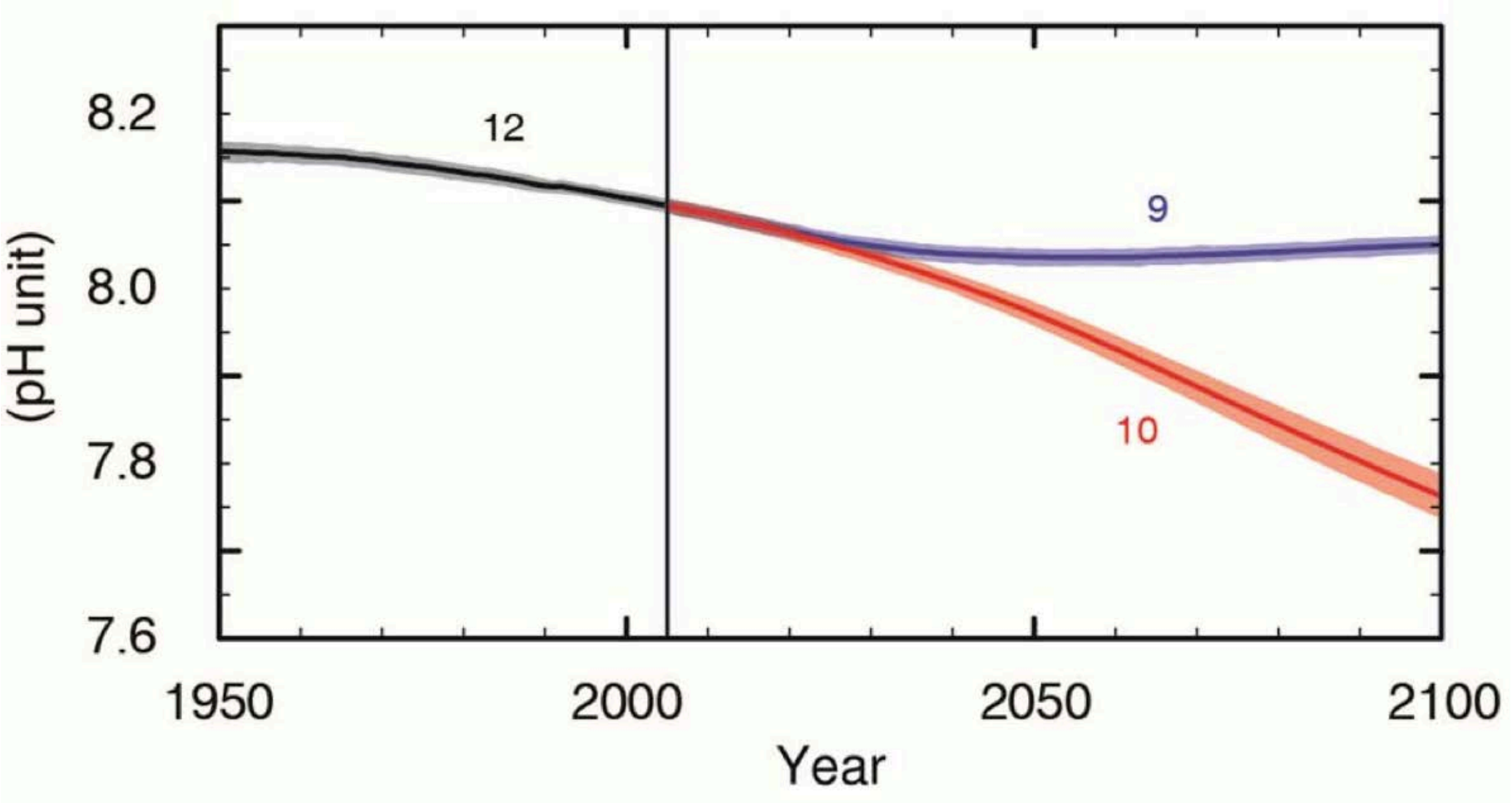
(Time 2001)

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

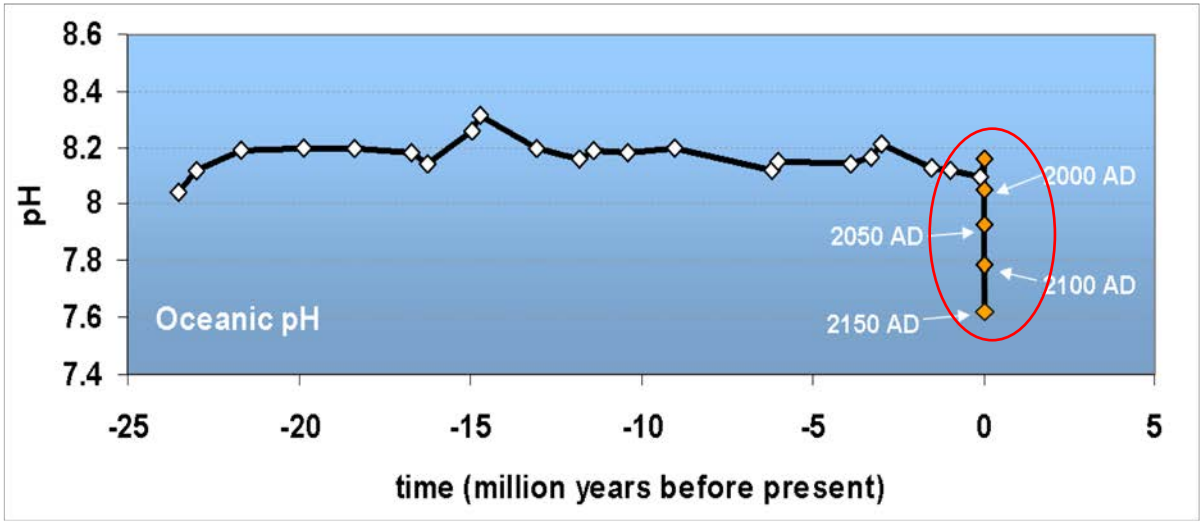
Global ocean surface pH (projections)

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**

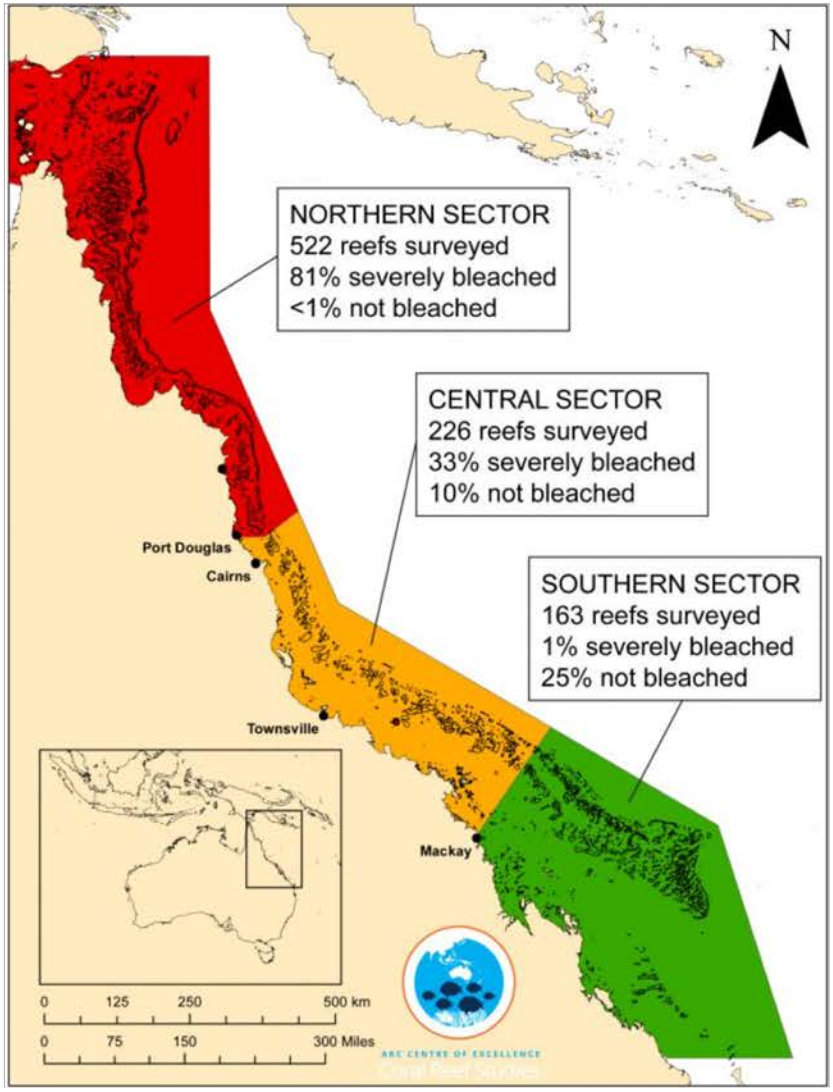
- **Mass extinctions linked to previous ocean acidification events**

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

Turley et al. 2006

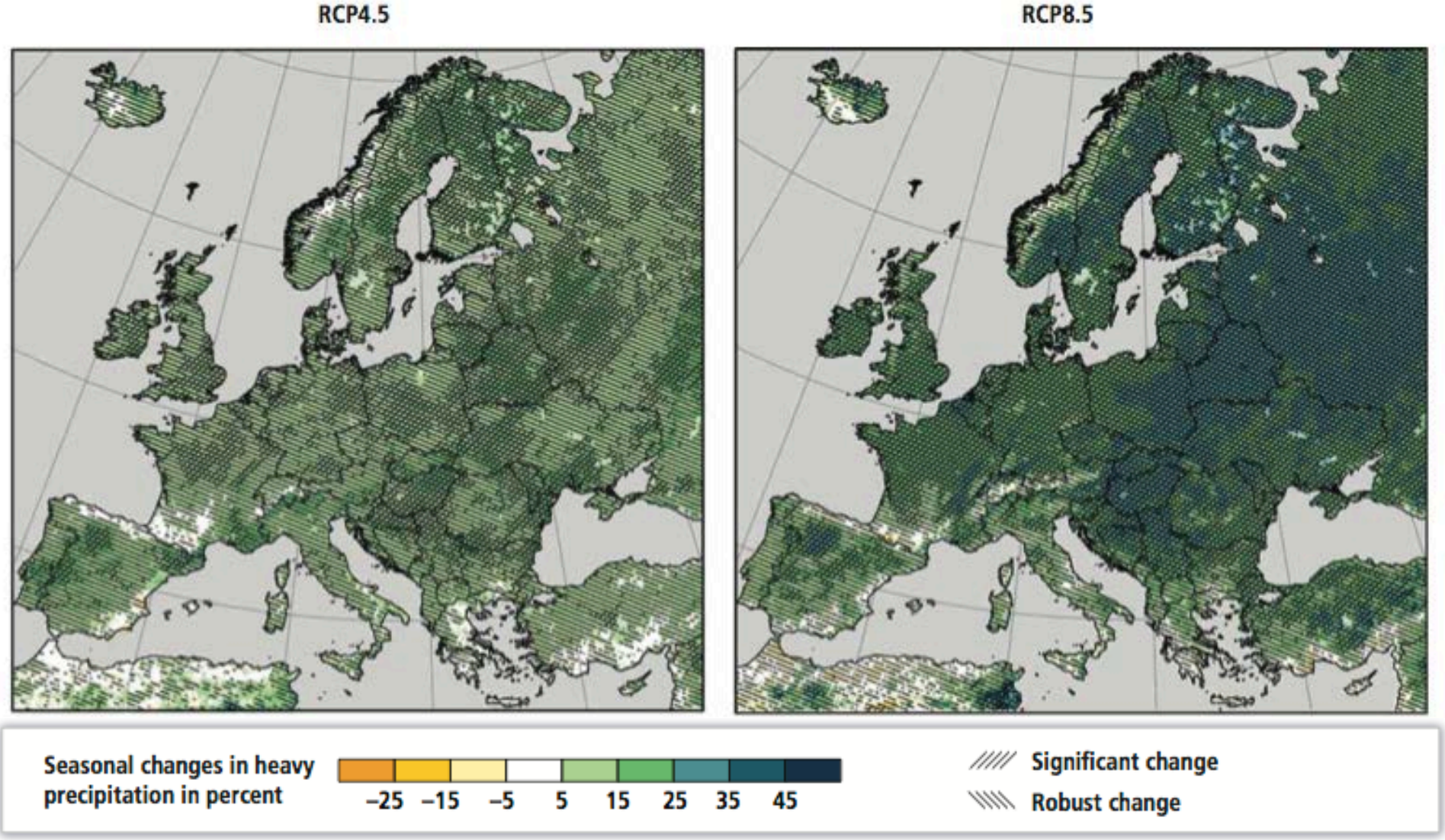
Slide courtesy of Carol Turley, PML

Only 7% of the Great Barrier Reef has avoided coral bleaching (May 2016)



JCU Australia - ARC Centre of Excellence for Coral Reef Studies / Tom Bridge and James Kerry

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



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

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

Climate change impacts poor people first, but we are all on the same spaceship

Belgian Prime Minister Charles Michel (RTBF, 4 May 2018): « when there is a geopolitical instability, we pay the cost as well »

@JPvanYpersele

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

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

Potential Impacts of Climate Change

Food and water shortages

Increased displacement of people

Increased poverty

Coastal flooding

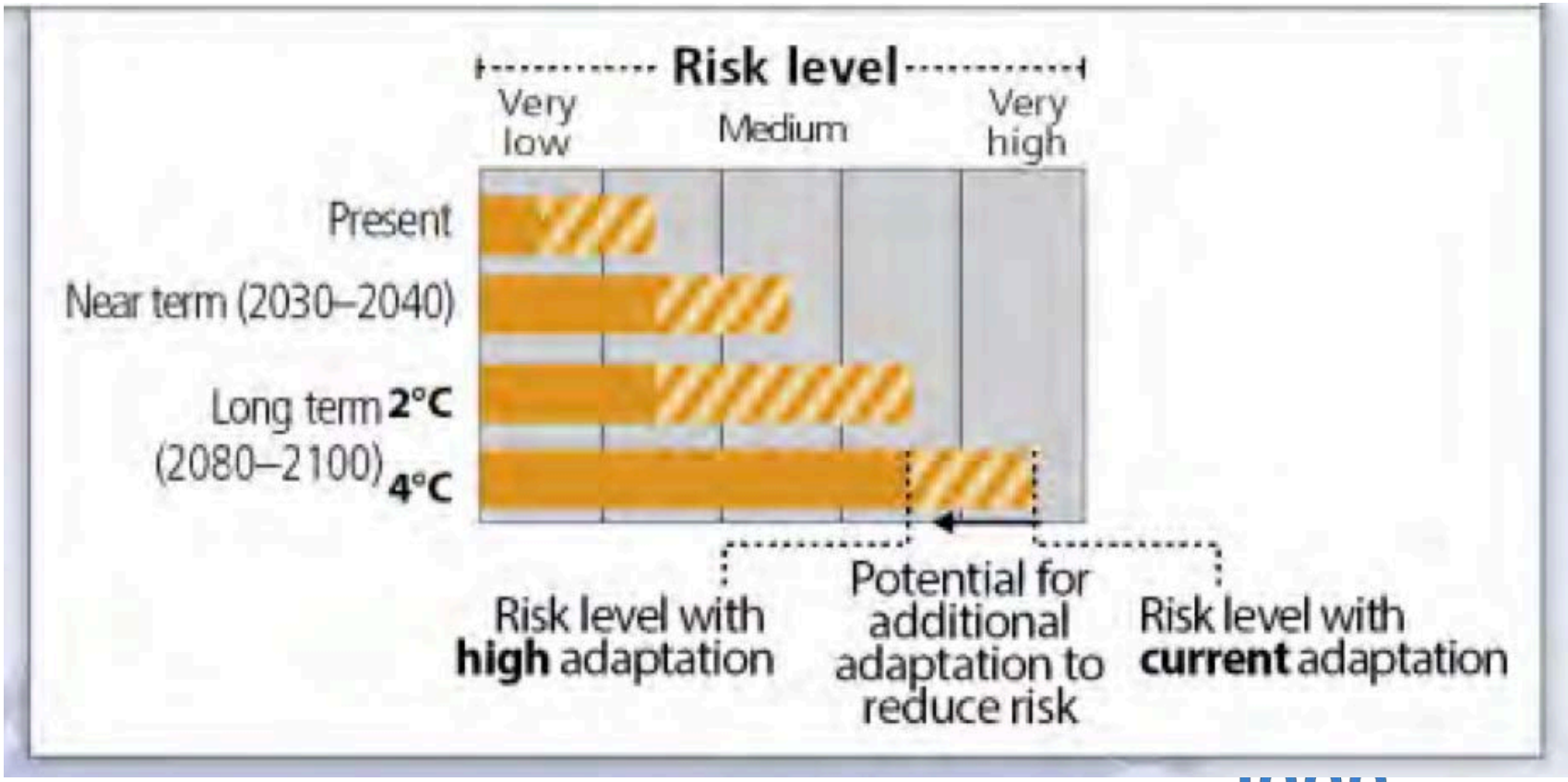
AR5 WGII SPM


ADAPTATION IS
ALREADY OCCURRING
ipcc
INTERGOVERNMENTAL PANEL ON climate change

Flood risk adaptation in Bangladesh (example): cyclone shelters, awareness raising, forecasting and warning

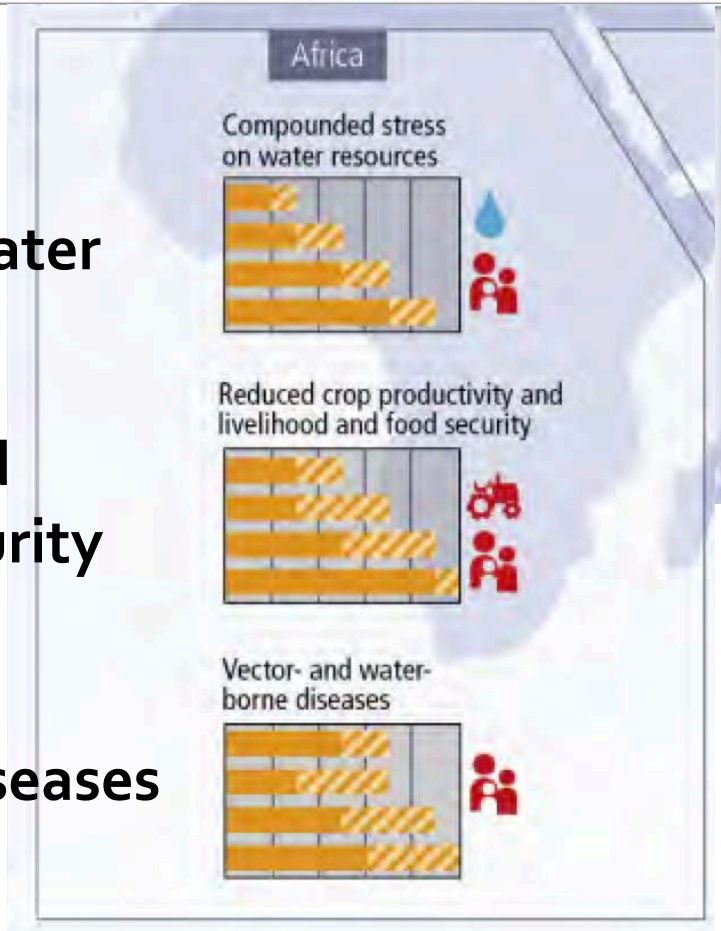
photo: Dr Thorsten Klose/German Red Cross (2010), evaluation of the Community Based Disaster Preparedness Programme run by the Red Cross in1996-2002

Regional key risks and potential for risk reduction through adaptation



IPCC, AR5, SPM, Figure SPM.8

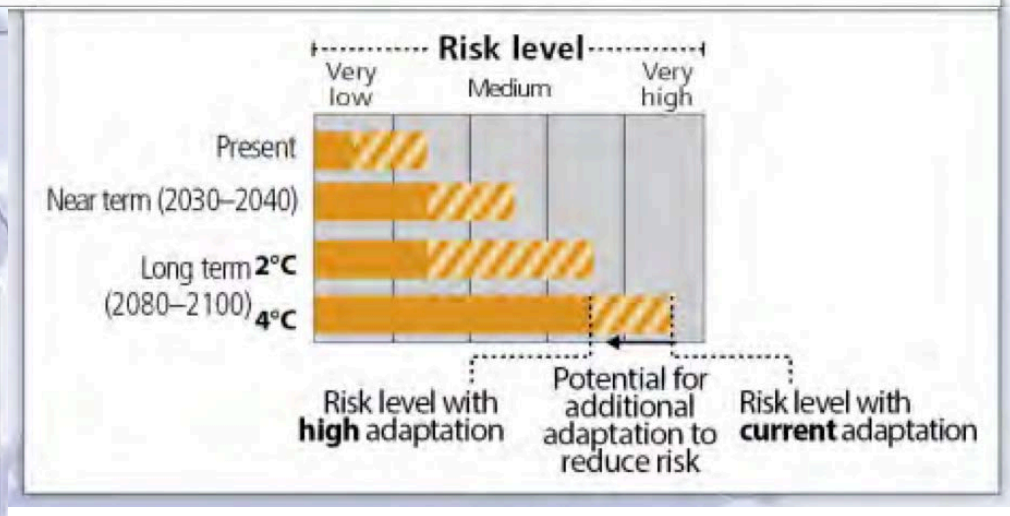
Regional key risks and risk reduction through adaptation



Water

Food security

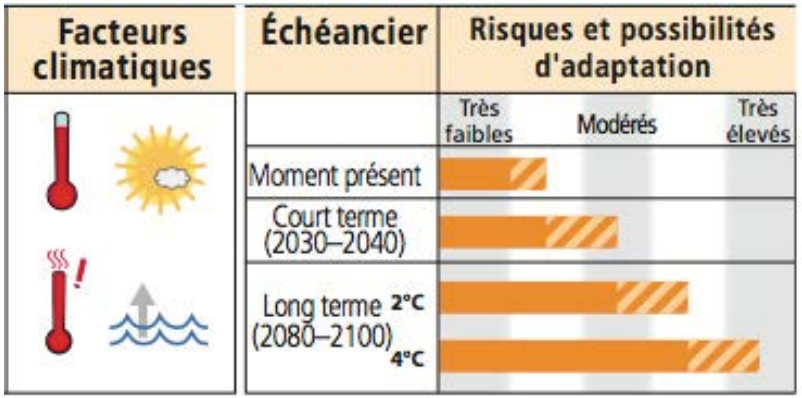
Diseases

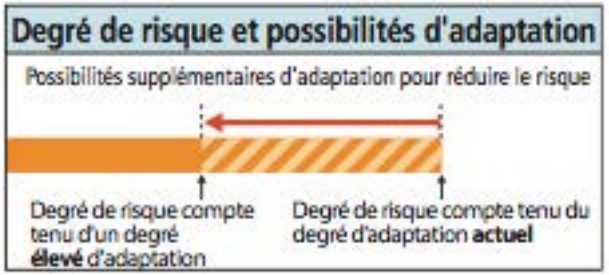


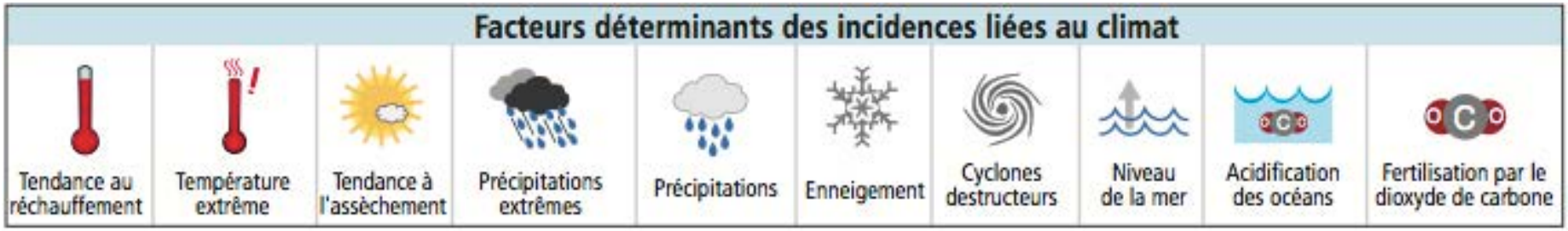
IPCC, AR5, SPM, Figure SPM.8

Risque majeur pour l'Afrique: eau

Aggravation des pressions exercées sur les ressources hydriques déjà lourdement sollicitées par la surexploitation et la dégradation, et qui feront face à l'avenir à une demande accrue. Stress dû à la sécheresse exacerbé dans les régions africaines déjà exposées à ce fléau (degré *de confiance élevé).*



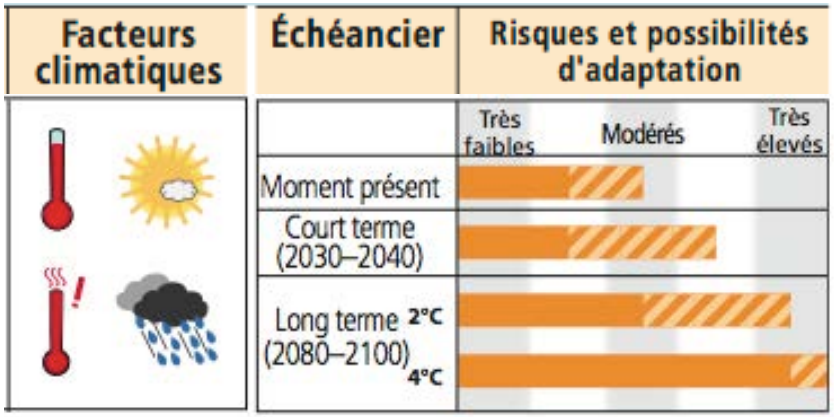


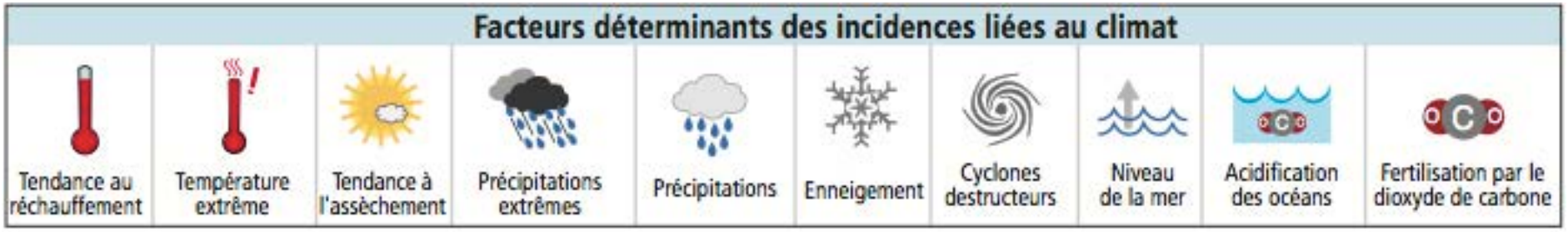


IPCC, AR5, GT II, RID, p. 21

Risque majeur pour l'Afrique: agriculture

Baisse de la productivité des cultures due à la chaleur et à la sécheresse — dont les conséquences sur les moyens de subsistance et la sécurité alimentaire des pays, des régions et des ménages pourraient être graves — ainsi qu'aux dommages causés par les ravageurs, les maladies et les inondations sur l'infrastructure des systèmes alimentaires (degré *de confiance élevé)*

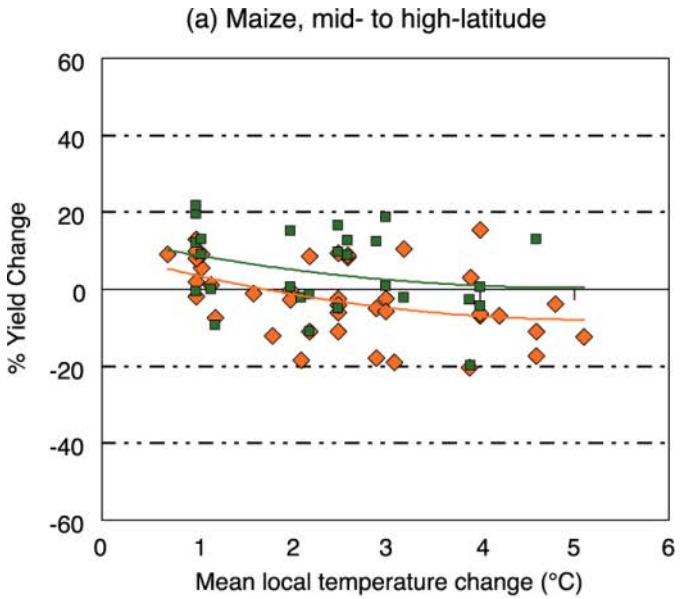


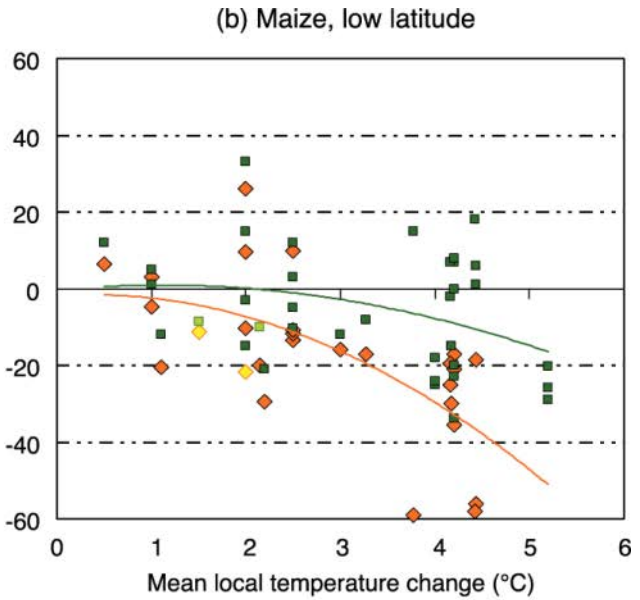


IPCC, AR5, GT II, RID, p. 21

Figure TS.7. Sensitivity of cereal yield to climate change

Maïs





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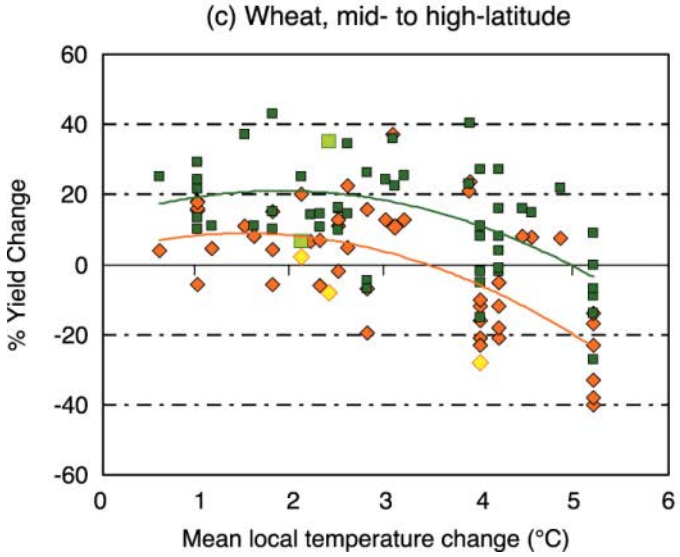
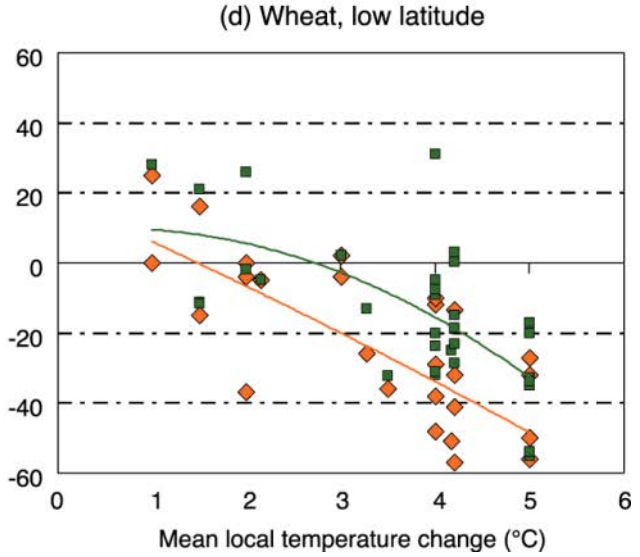


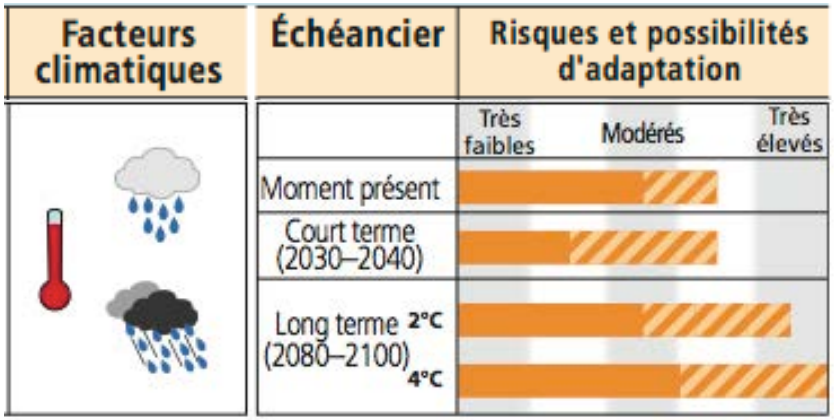


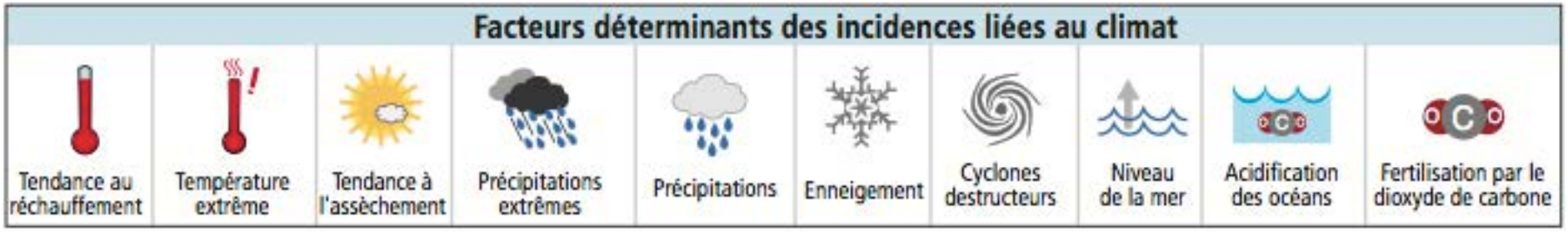
WMO

UNEP

Risque majeur pour l'Afrique: santé

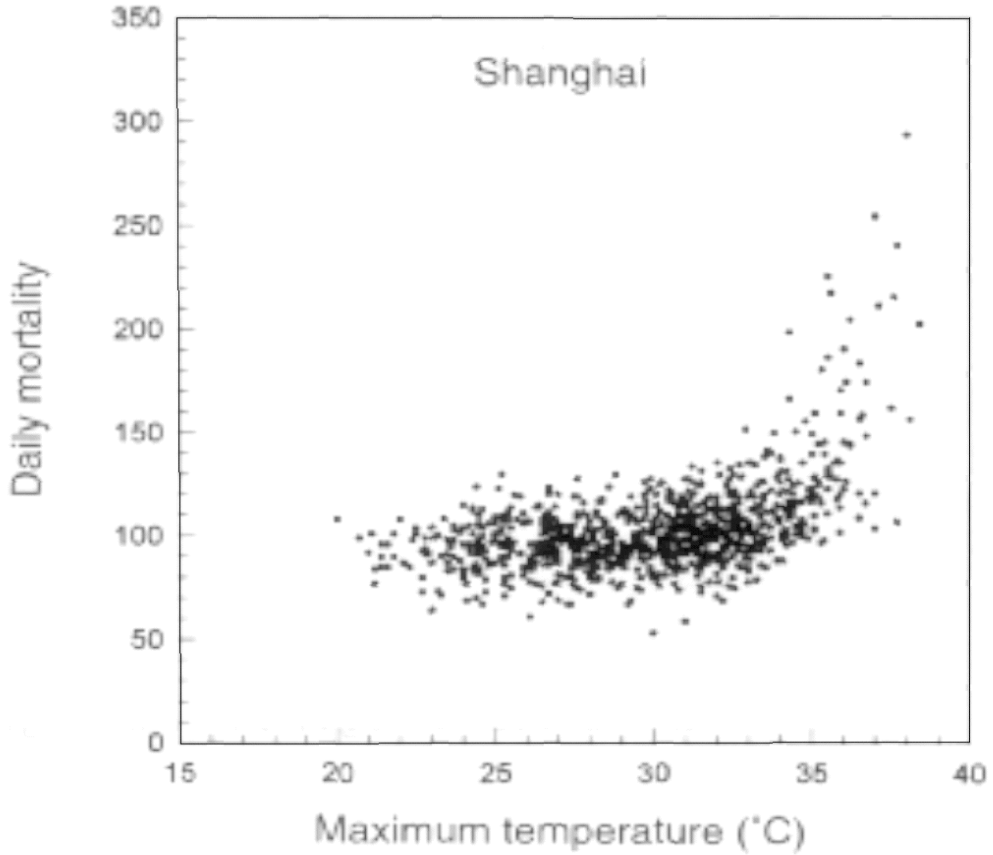
Variations de l'incidence et de l'extension géographique des maladies à transmission vectorielle ou d'origine hydrique dues à l'évolution des températures et des précipitations moyennes et de leur variabilité, en particulier aux limites de leurs aires de répartition (degré *de confiance moyen)*





IPCC, AR5, GT II, RID, p. 21

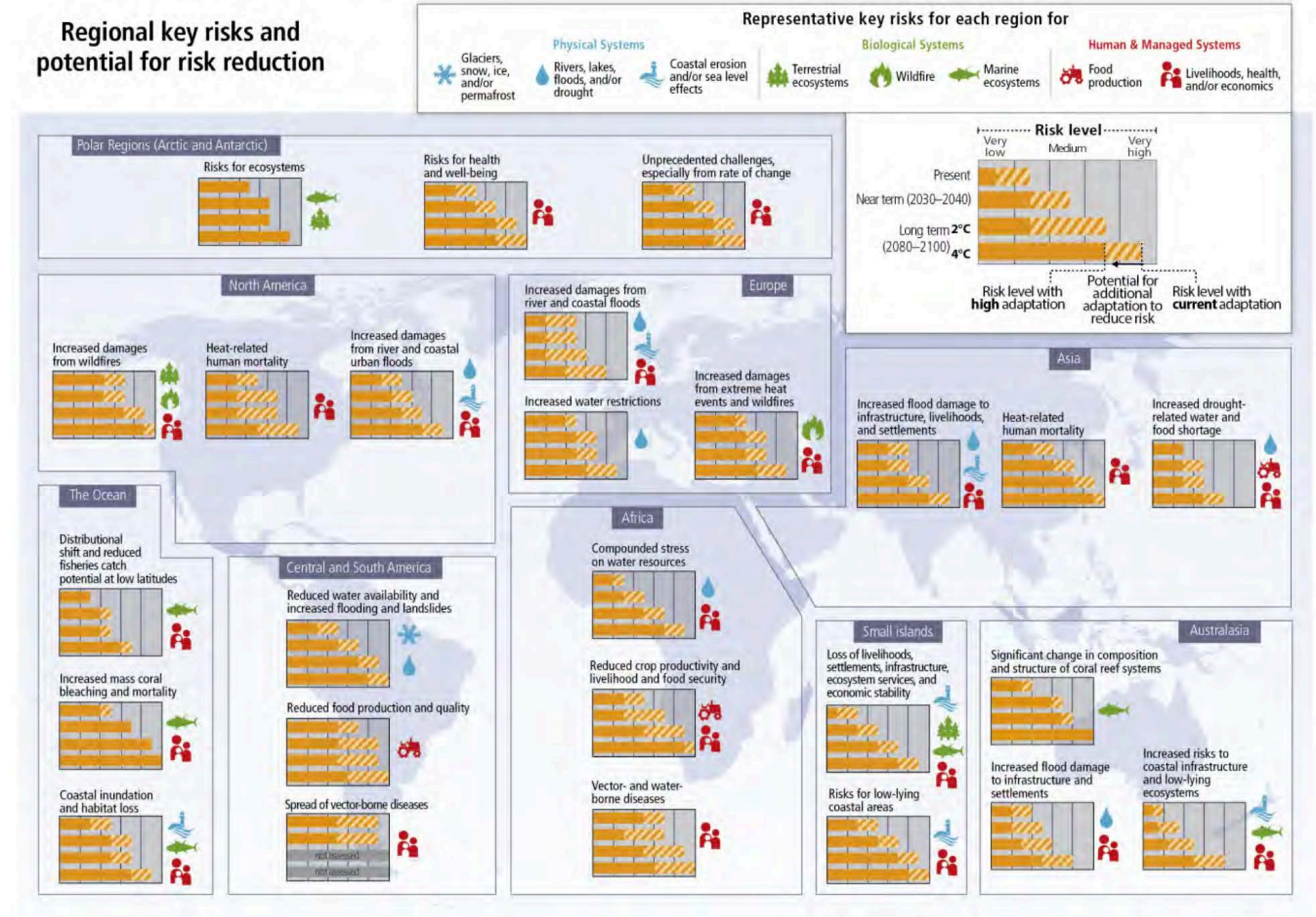
Relationship between maximum temperature and mortality in Shanghai, China, 1980-89



Référence : CILIMATE CHANGE AND HUMAN HEALTH, 1996

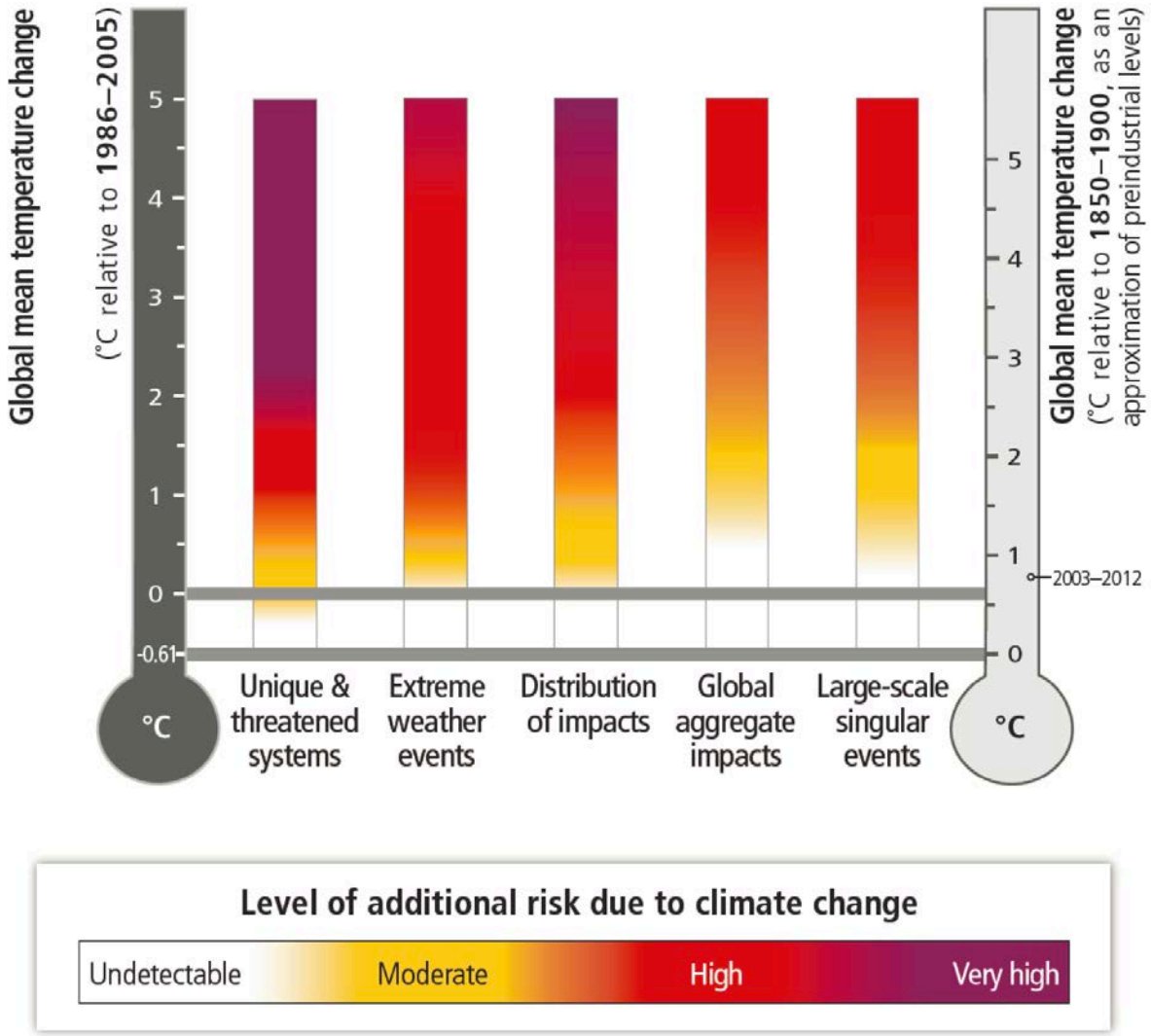
Jean-Pascal van Ypersele
(vanypersele@astr.ucl.ac.be)

Regional key risks and potential for risk reduction



IPCC, AR5, SPM, Figure SPM.8


RISKS OF
CLIMATE CHANGE
INCREASE
WITH CONTINUED
HIGH EMISSIONS
ipcc
INTERGOVERNMENTAL PANEL ON climate change

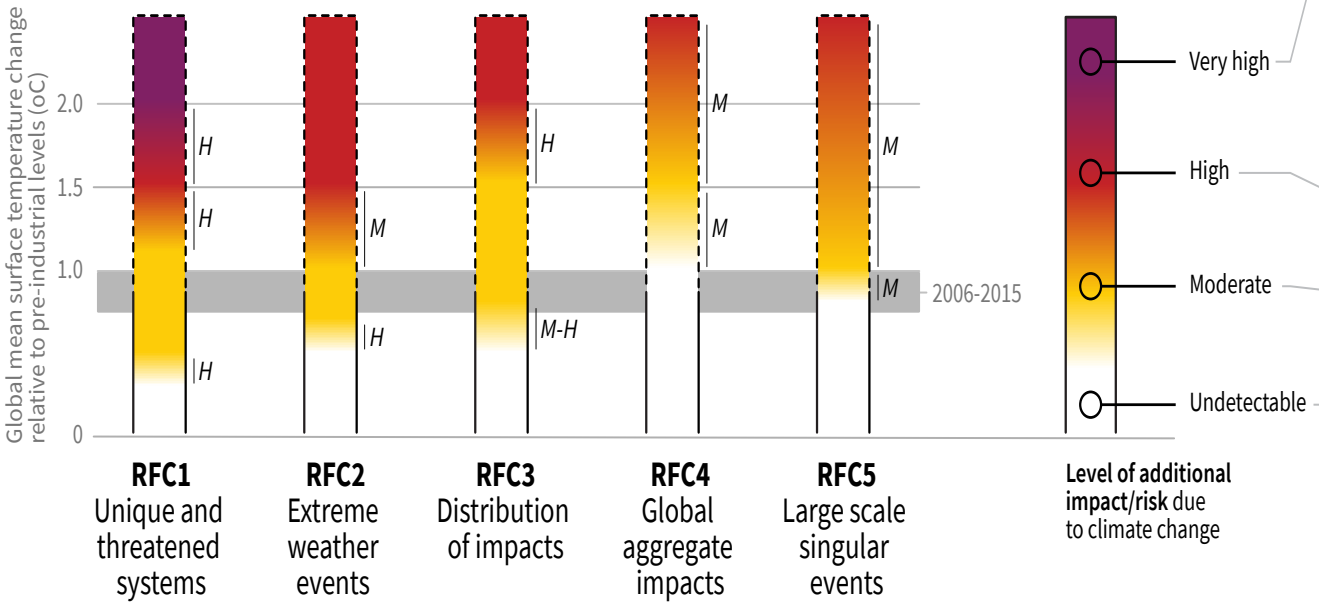


AR5, WGII, Box SPM.1 Figure 1

How the level of global warming affects impacts and/or risks associated with the Reasons for Concern (RFCs) and selected natural, managed and human systems

Five Reasons For Concern (RFCs) illustrate the impacts and risks of different levels of global warming for people, economies and ecosystems across sectors and regions.

Impacts and risks associated with the Reasons for Concern (RFCs)



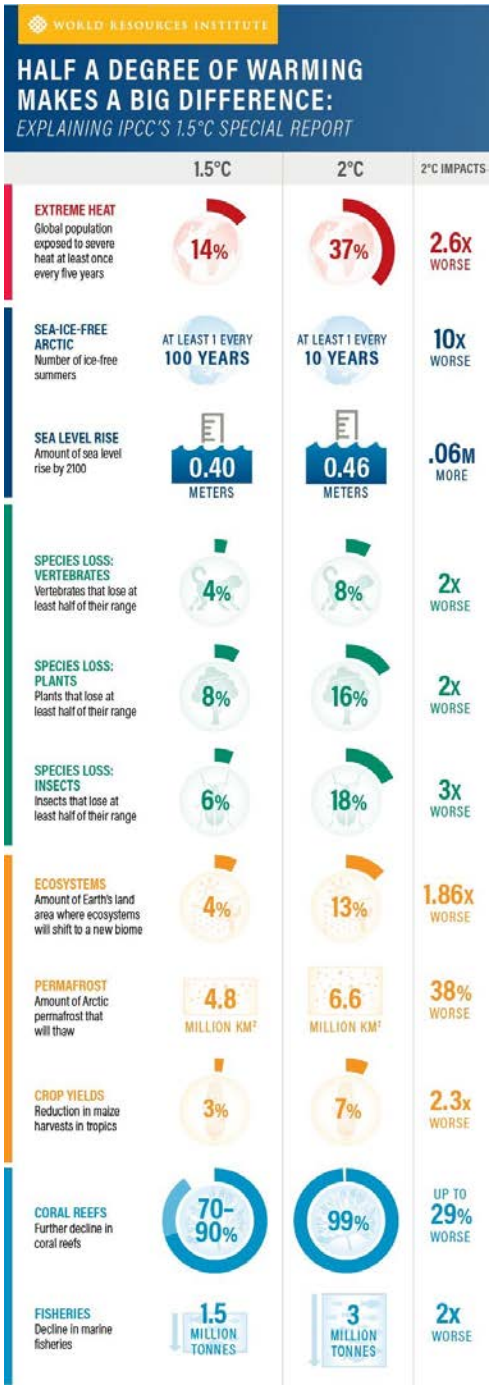
Purple indicates very high risks of severe impacts/risks and the presence of significant irreversibility or the persistence of climate-related hazards, combined with limited ability to adapt due to the nature of the hazard or impacts/risks.

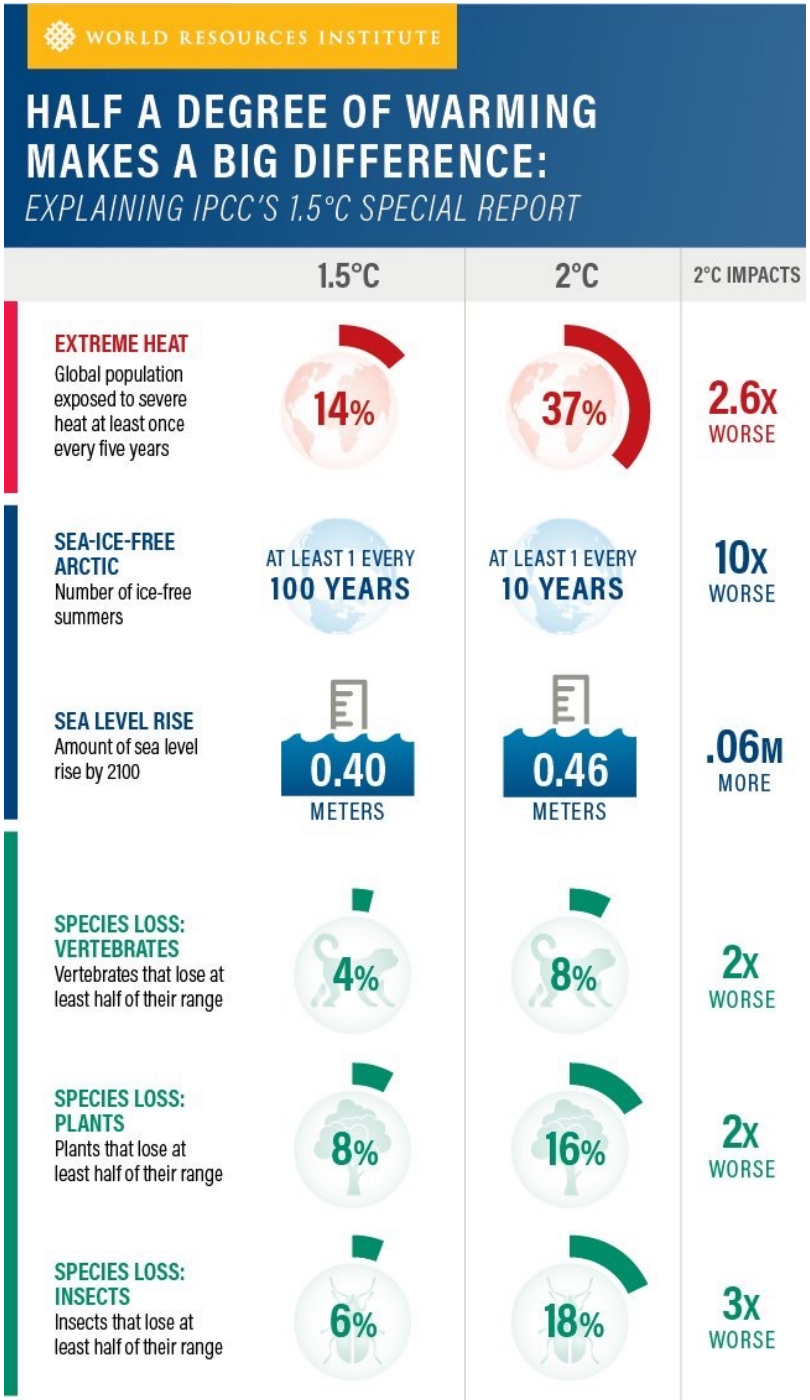
Red indicates severe and widespread impacts/risks.

Yellow indicates that impacts/risks are detectable and attributable to climate change with at least medium confidence.

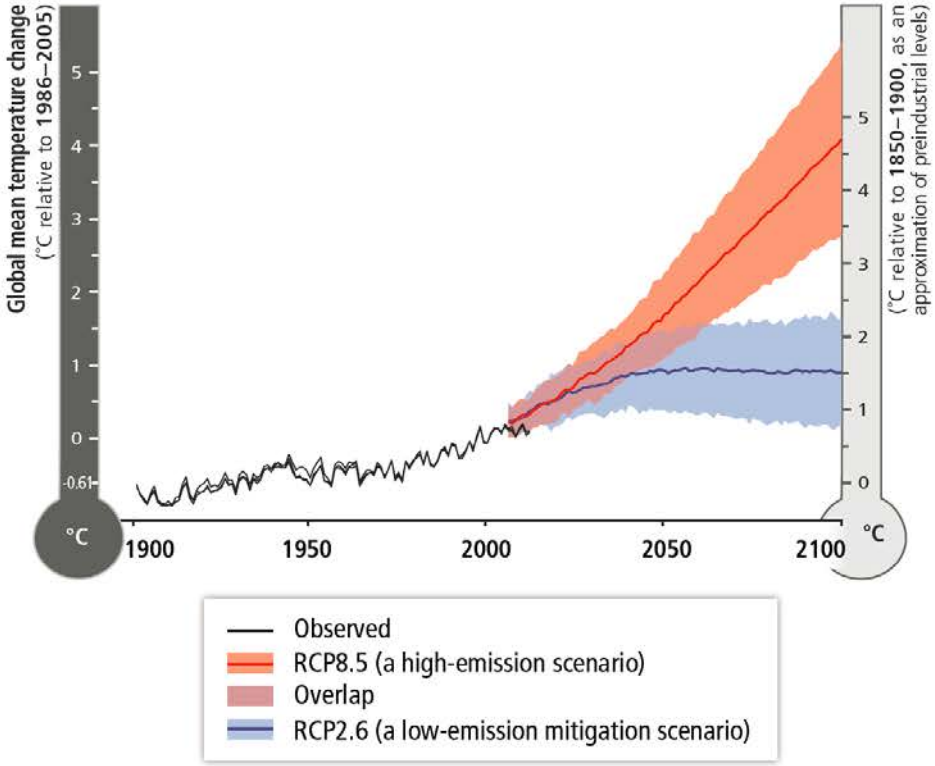
White indicates that no impacts are detectable and attributable to climate change.

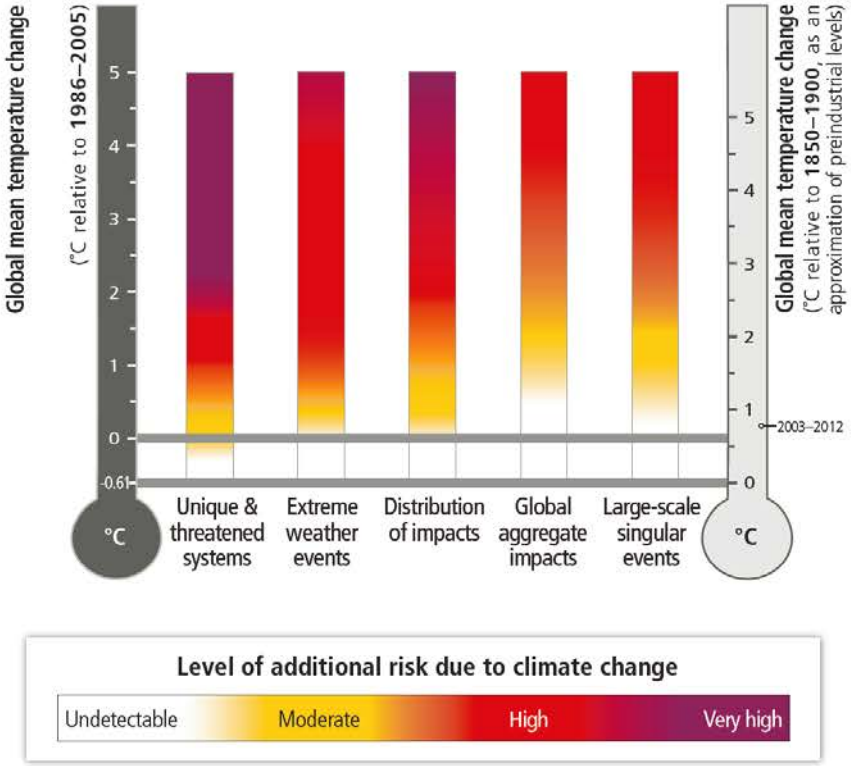
Responsibility for content: WRI





Responsibility for content: WRI





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INTERGOVERNMENTAL PANEL ON climate change

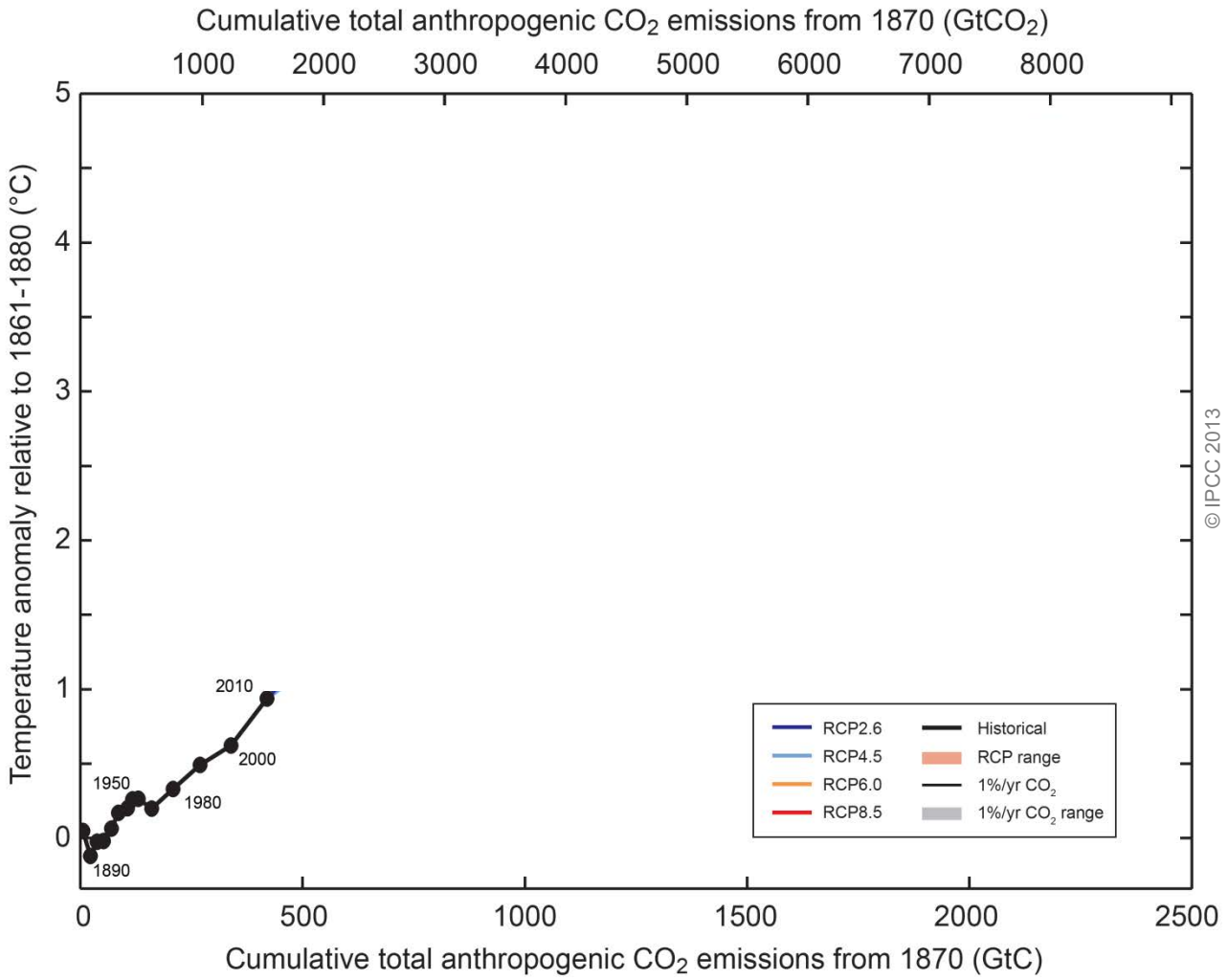


Fig. SPM.10

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

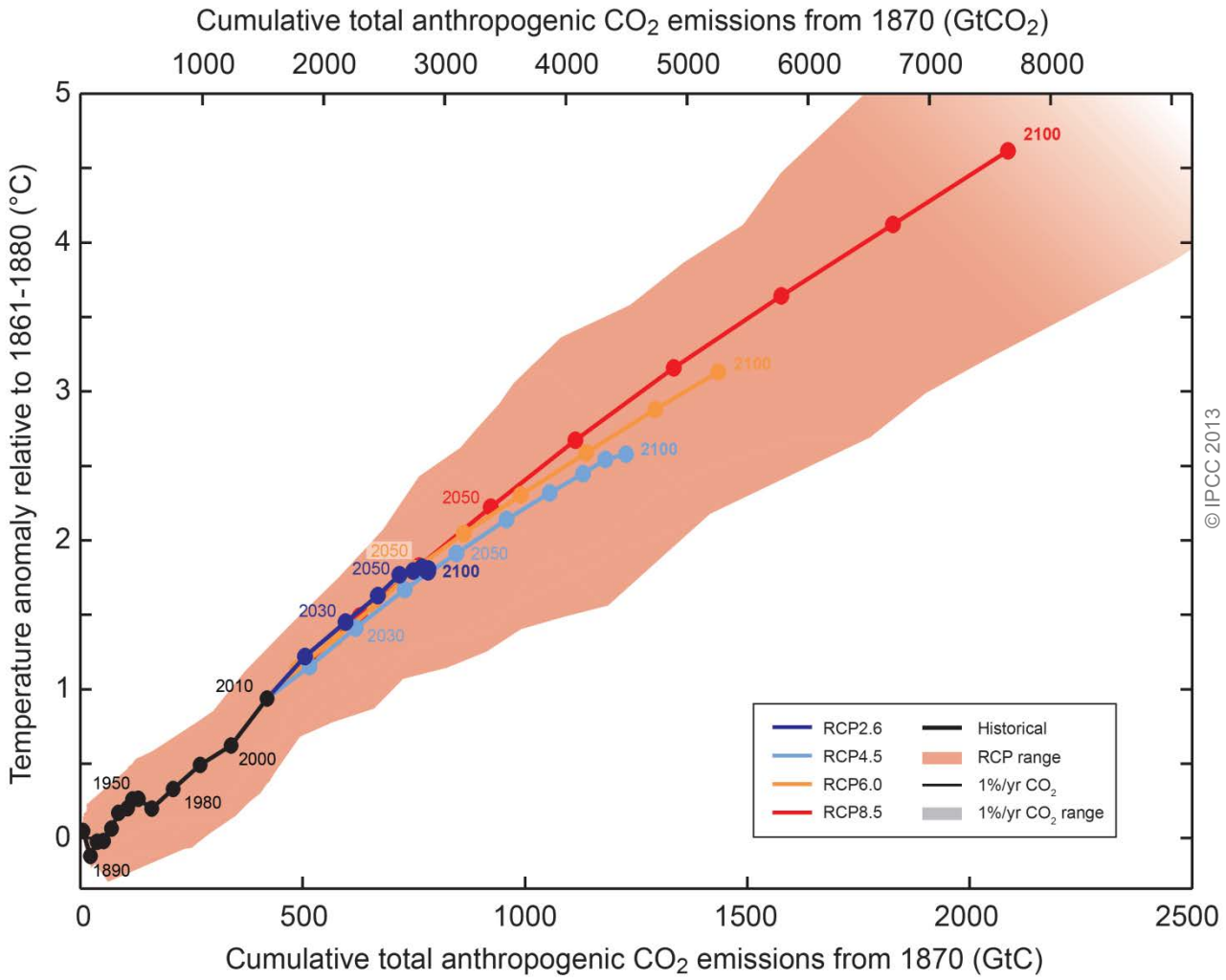
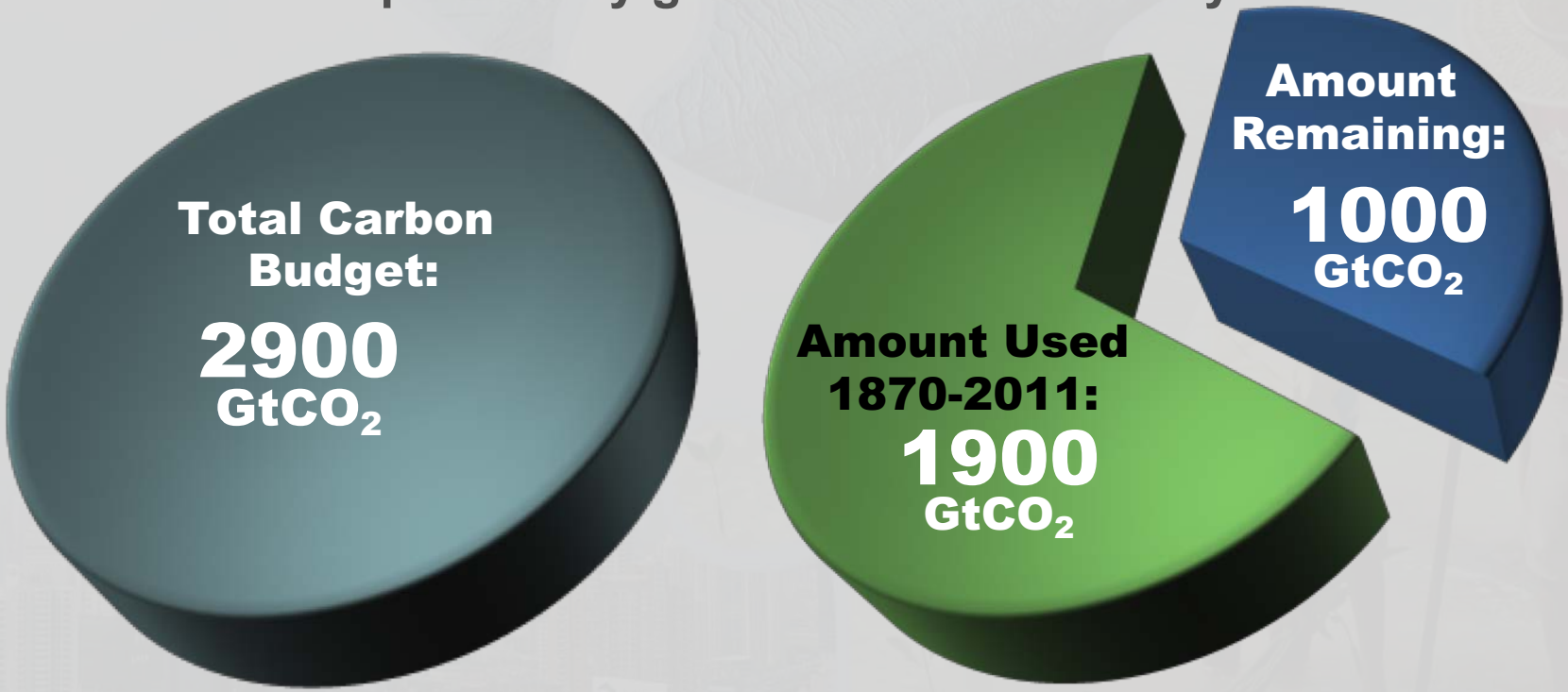


Fig. SPM.10

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

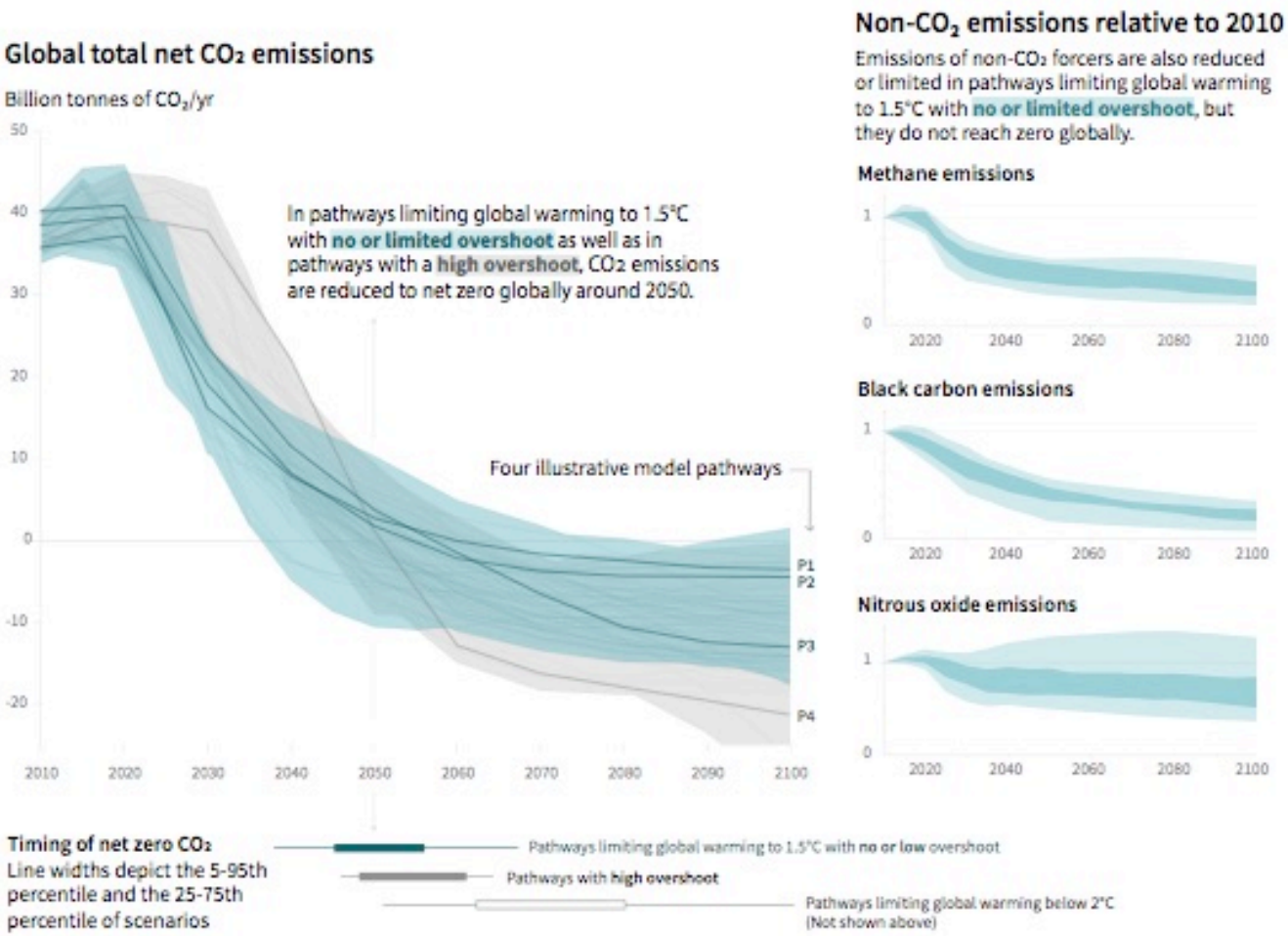
Emission Pathways and System Transitions Consistent with 1.5°C Global Warming

Greenhouse gas emissions pathways

- To limit warming to 1.5° C, CO_2 emissions fall by about 45% by 2030 (from 2010 levels)
  - Compared to 20% for 2° C
- To limit warming to 1.5° C, CO_2 emissions would need to reach 'net zero' around 2050
  - Compared to around 2075 for 2° C
- Reducing non-CO_2 emissions would have direct and immediate health benefits

Global emissions pathway characteristics

General characteristics of the evolution of anthropogenic net emissions of CO_2, and total emissions of methane, black carbon, and nitrous oxide in model pathways that limit global warming to 1.5°C with no or limited overshoot. Net emissions are defined as anthropogenic emissions reduced by anthropogenic removals. Reductions in net emissions can be achieved through different portfolios of mitigation measures illustrated in Figure SPM3B.



Source: IPCC Special Report on Global Warming of 1.5°C

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

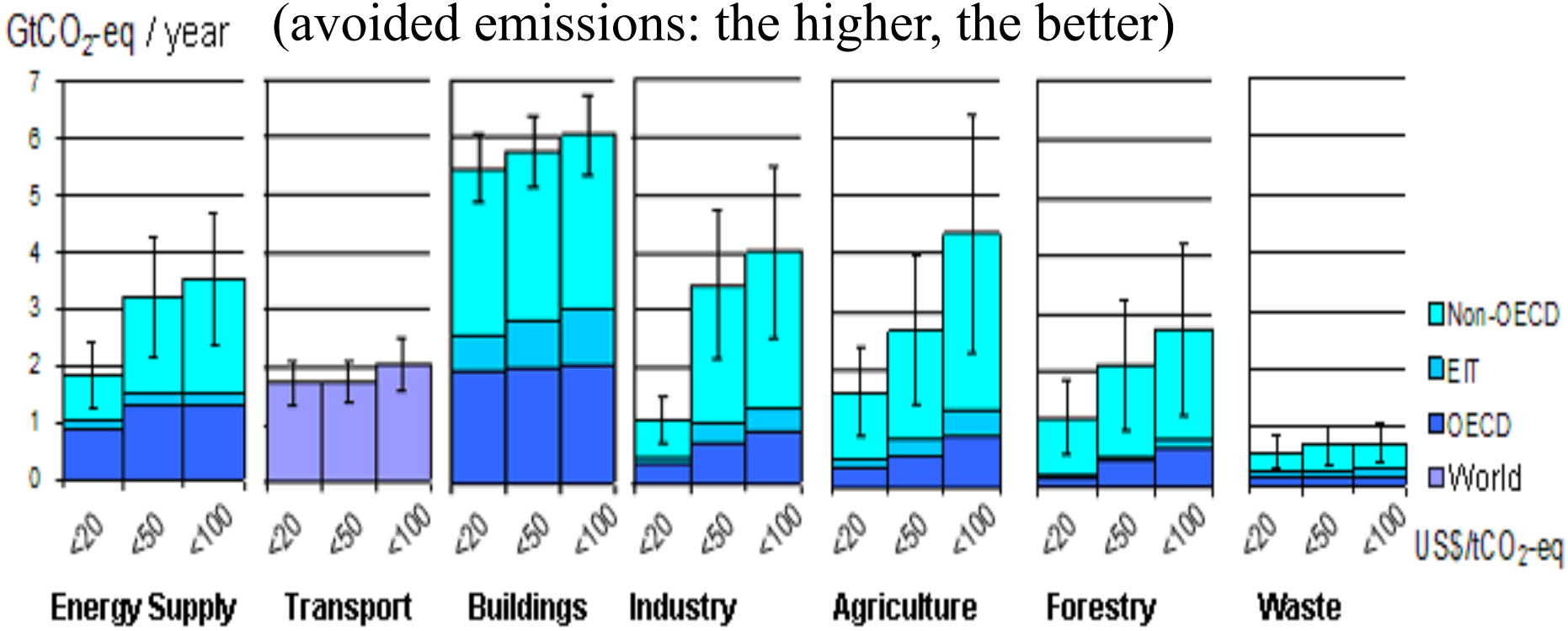
- **Reduced deforestation** and improved forest management and planting of new forests
- **Bio-energy with carbon capture and storage**

Lifestyle and behavioural changes

AR5 WGIII SPM

All sectors and regions have the potential to contribute by 2030

(avoided emissions: the higher, the better)



IPCC AR4 (2007)

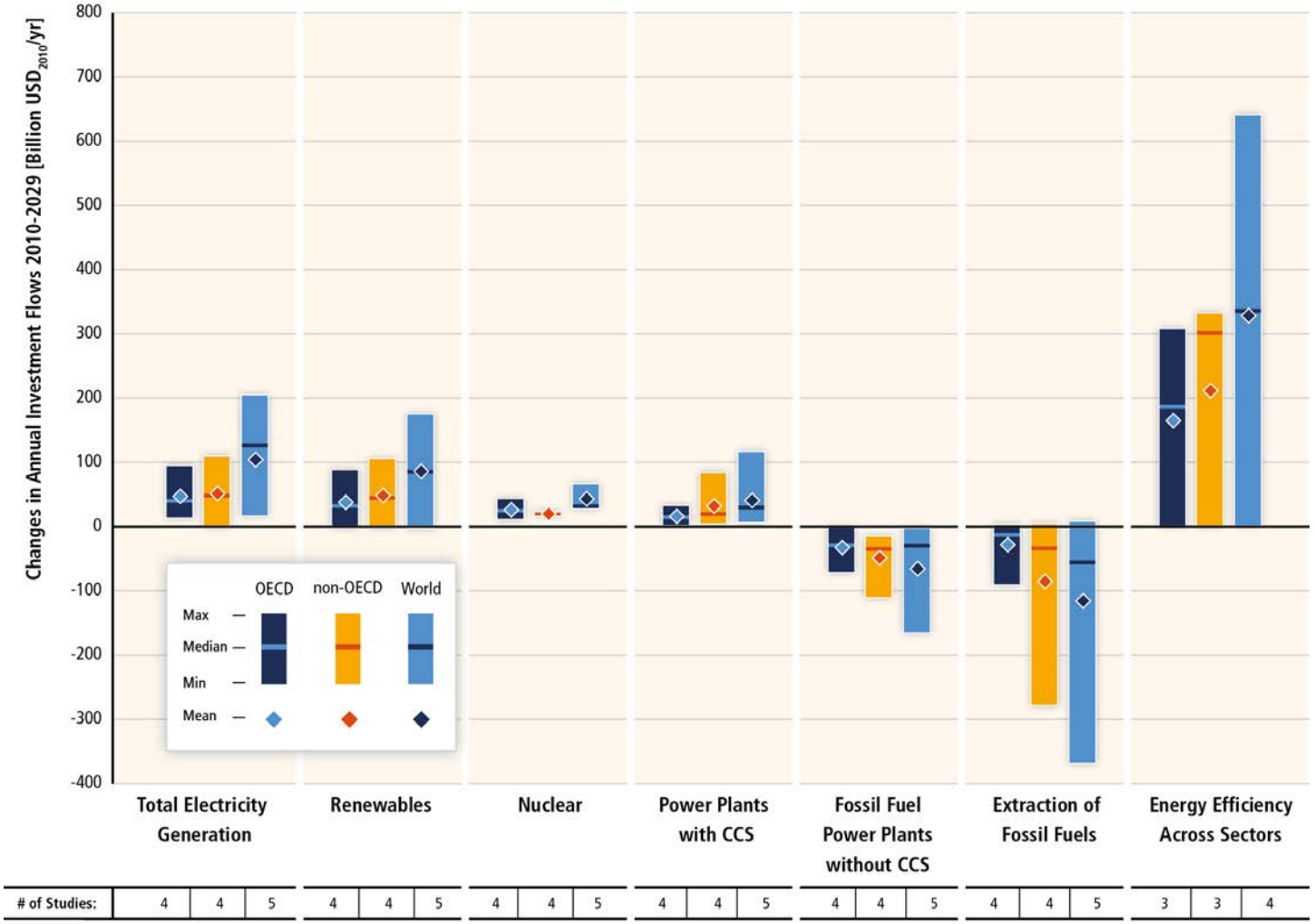
Note: estimates do not include non-technical options, such as lifestyle changes.

- **Mitigation requires major technological and institutional changes including the upscaling of low- and zero carbon energy (quadrupling from 2010 to 2050 for the scenario limiting warming below 2° C)**

Greenhouse gas emissions pathways

- Limiting warming to 1.5° C would require changes on an unprecedented scale
    - Deep emissions cuts in all sectors
    - A range of technologies
    - Behavioural changes
    - Increase investment in low carbon options

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



- **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**

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.

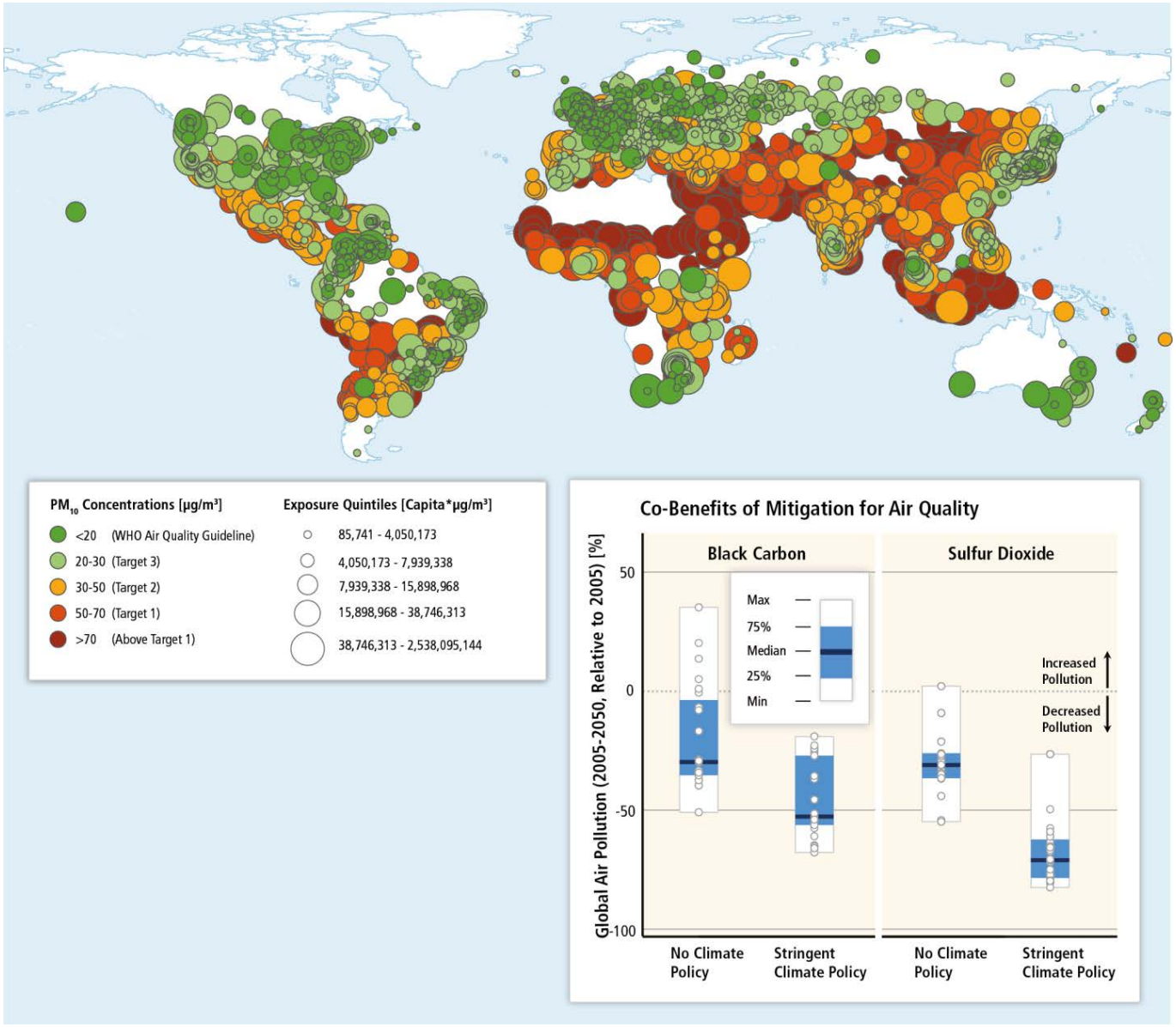
- Existing and proposed **international climate change cooperation** arrangements vary in their focus and degree of centralization and coordination.
- Issues of **equity, justice, and fairness** arise with respect to mitigation and adaptation.
- Climate policy may be informed by a consideration of a 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.

Ambitious Mitigation Is Affordable

- → Economic growth reduced by ~ 0.06%
  (BAU growth 1.6 - 3%/year)
- → This translates into delayed and not forgone growth
- → Estimated cost does not account for the benefits of reduced climate change
- → Unmitigated climate change would create increasing risks to economic growth and efforts to eradicate poverty

AR5 WGI SPM, AR5 WGII SPM


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.



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

World Health Organization (2018): Air pollution kills 7 million people per year (including 500 000 in Europe)

Sources of air pollution are broadly the same as those affecting climate: fossil fuels, wood and biomass combustion

Children are particularly sensitive to air pollution

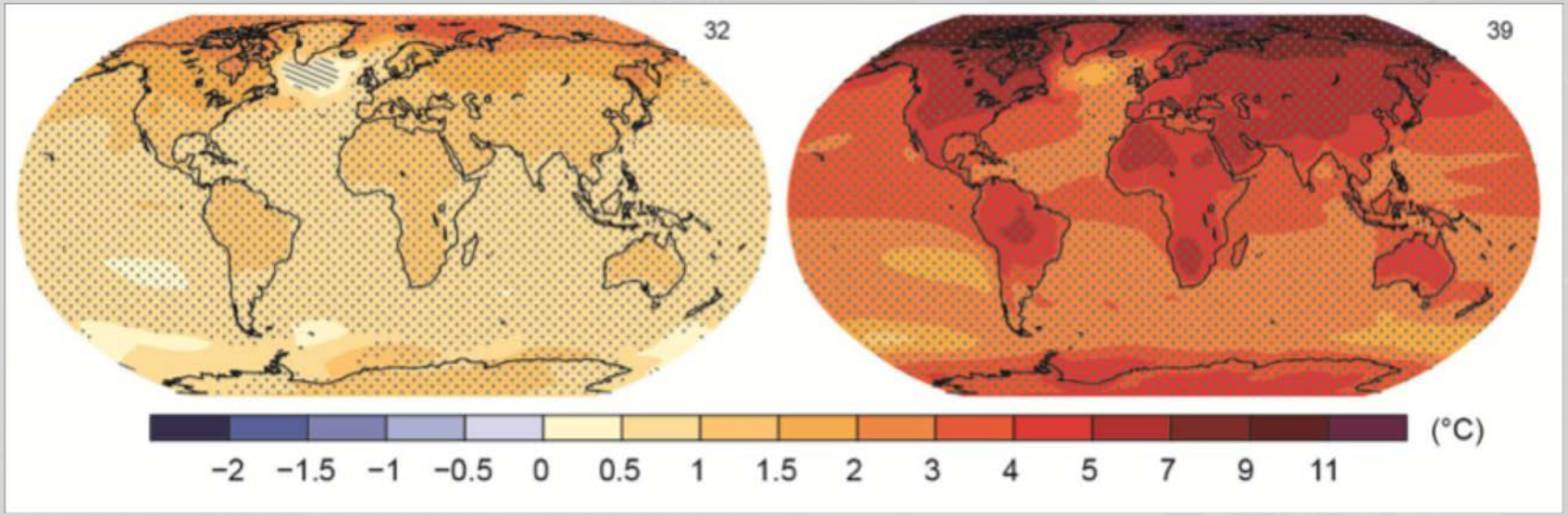
Photo: Indiatoday.in, 6-12-2017

SUSTAINABLE DEVELOPMENT GOALS

The Choices Humanity Makes Will Create Different Outcomes (and affect prospects for effective adaptation)

With substantial mitigation

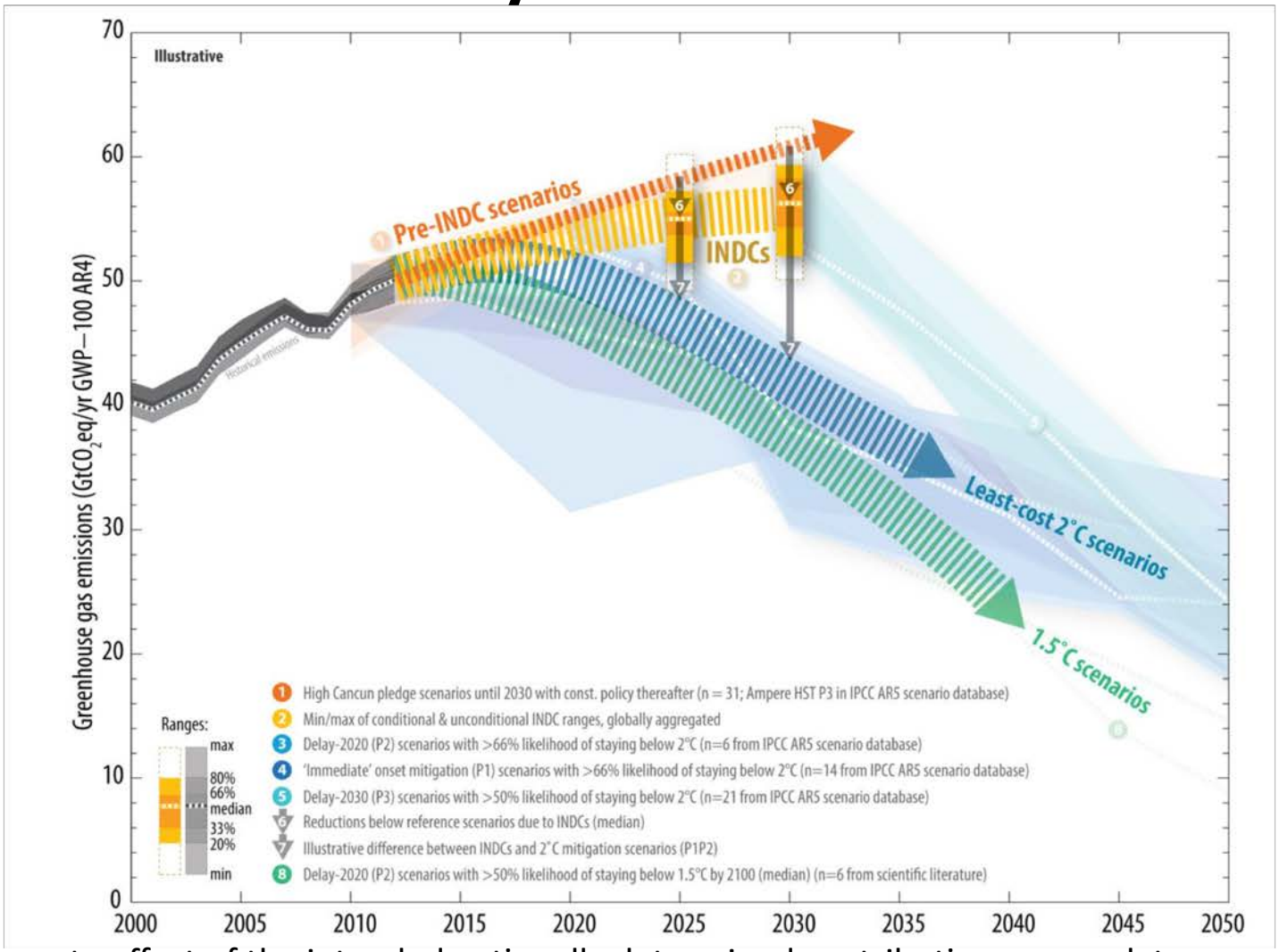
Without additional mitigation



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

AR5 WGI SPM

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

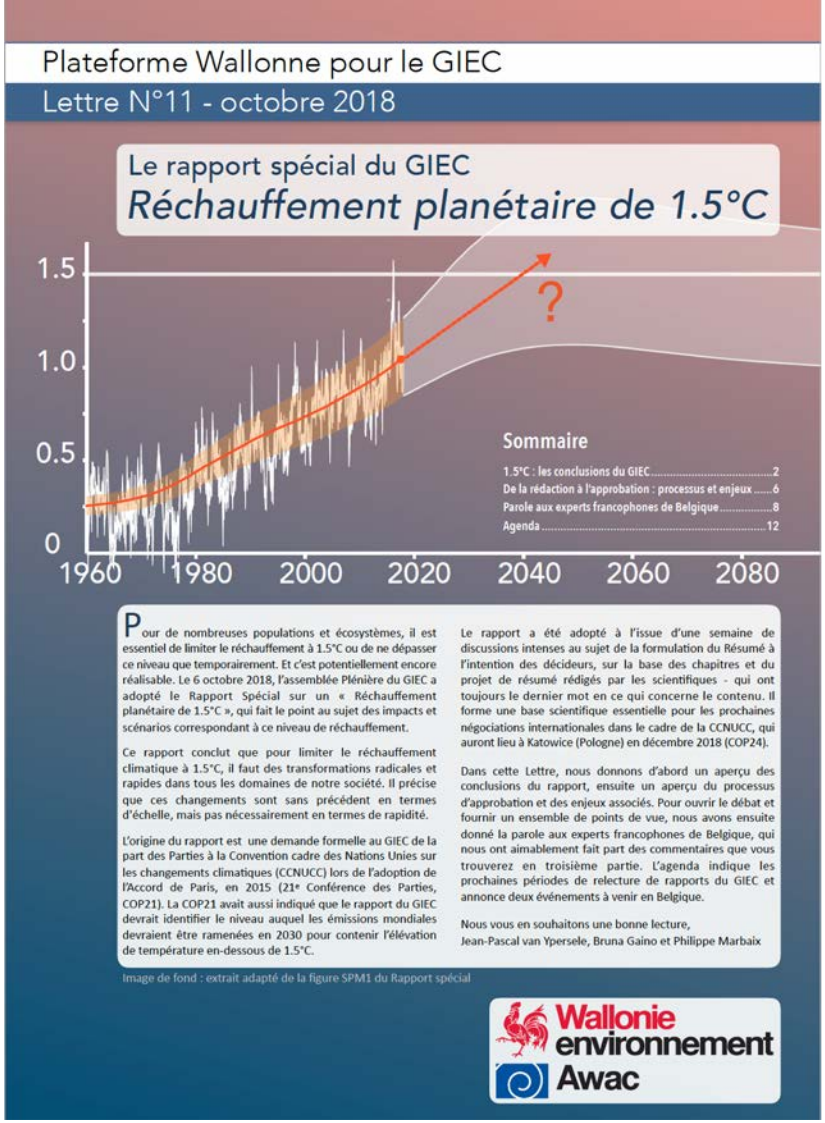
The Hidden IPCC Message:

- **If it's possible and not enough happens, what is lacking?**
- ***Political will, at the appropriate scale***

This gives me hope:

Well-informed young people speaking truth to power

With @GretaThunberg at COP24



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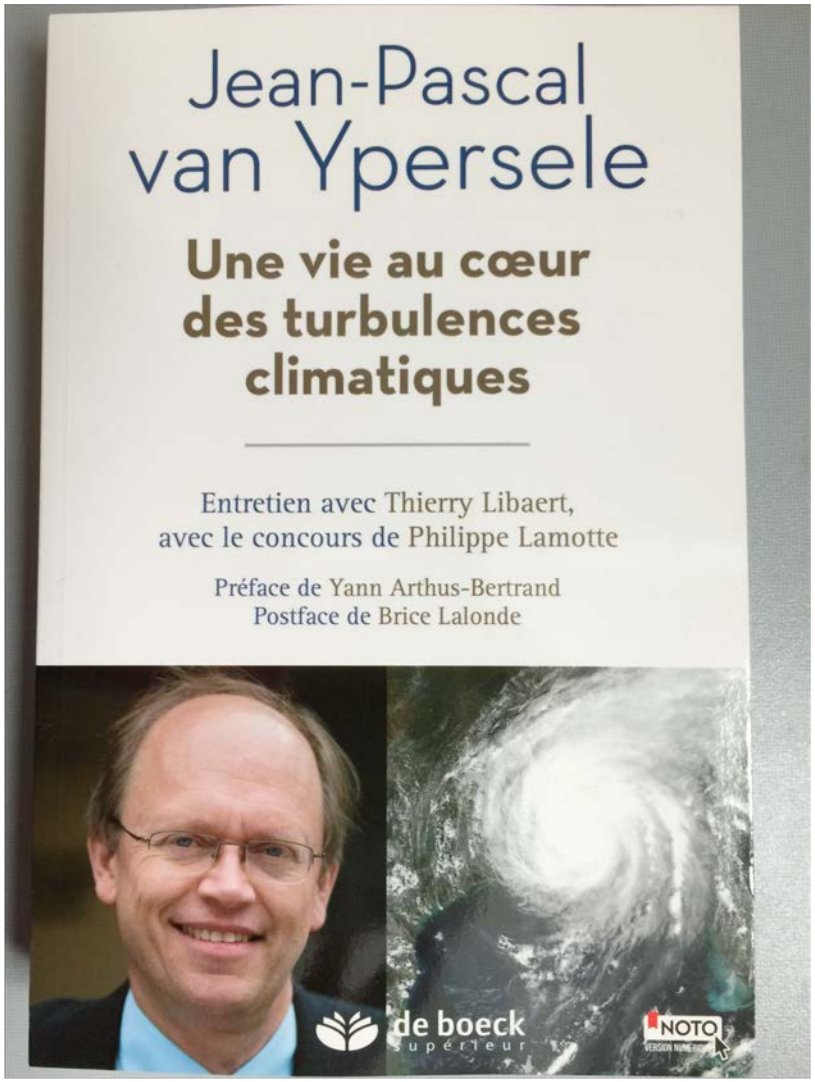

Om meer te weten:

Bij EPO (2018)

Voorwoord:
Jill Peeters

To go further :

- www.climate.be/vanyp : my slides (under « conferences)
- www.ipcc.ch : IPCC
- www.realclimate.org : answers to the merchants of doubt arguments
- www.skepticalscience.com : same
- www.plateforme-wallonne-giec.be : IPCC-related in French, Newsletter, latest on SR15 & COP24
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