Climate Change: the IPCC view

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Credits: many slides borrowed with gratitude from IPCC colleagues: R. Christ, RK Pachauri, S. Solomon, J. Palutikof, J. Stone, or prepared by Ph. Marbaix & B. Gaino

UNFCCC training for media, Bonn, 7 June 2010

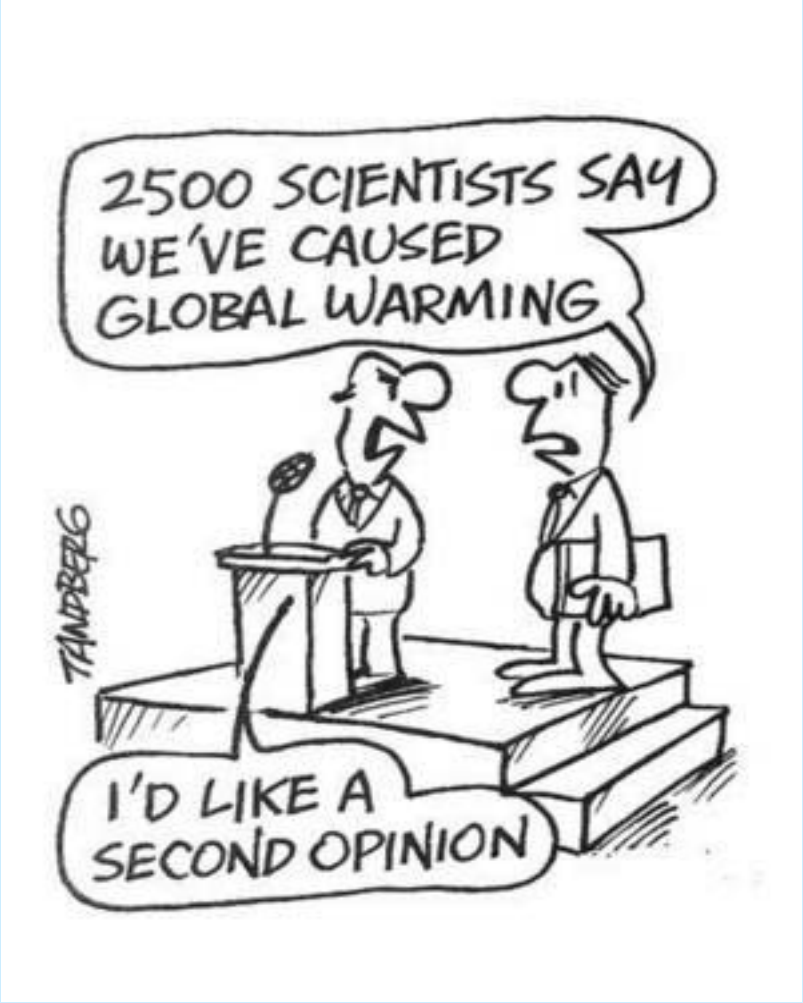
NB: The support of the Belgian Science Policy Office is gratefully acknowledged

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.



IPCC Working Groups & Task Force

Working Group I - "The Physical Science Basis"

Working Group II - "Impacts, Adaptation and Vulnerability"

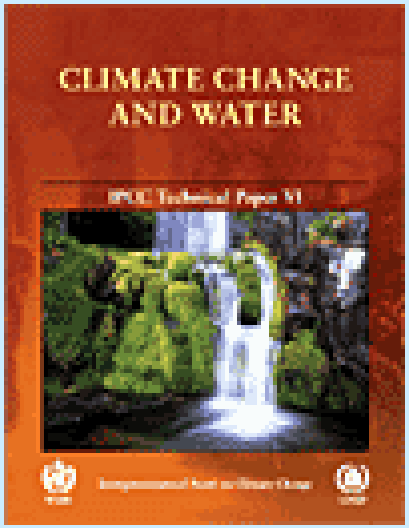
Working Group III - "Mitigation of Climate Change"

Task Force on National Greenhouse Gas Inventories

(source: www.ipcc.ch)

IPCC Products

- Assessment reports provide a comprehensive picture of the present state of understanding of climate change (1990 – 1995 – 2001 – 2007).
- Special reports address and assess a specific issue (e.g. Ozone layer, Land use, Technology transfer, Renewables, Adaptation & extreme events)
- Methodology reports provide guidelines for national greenhouse gas inventories and are used by Parties to the UNFCCC to prepare their national communications
- Technical papers focus on a specif topic drawing material from other IPCC reports



⌘Latest science

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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 20 years ago (1990)

- Was anybody really listening?

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⌘Some Highlights of the IPCC AR4 (2007) Working Group I, II, and III

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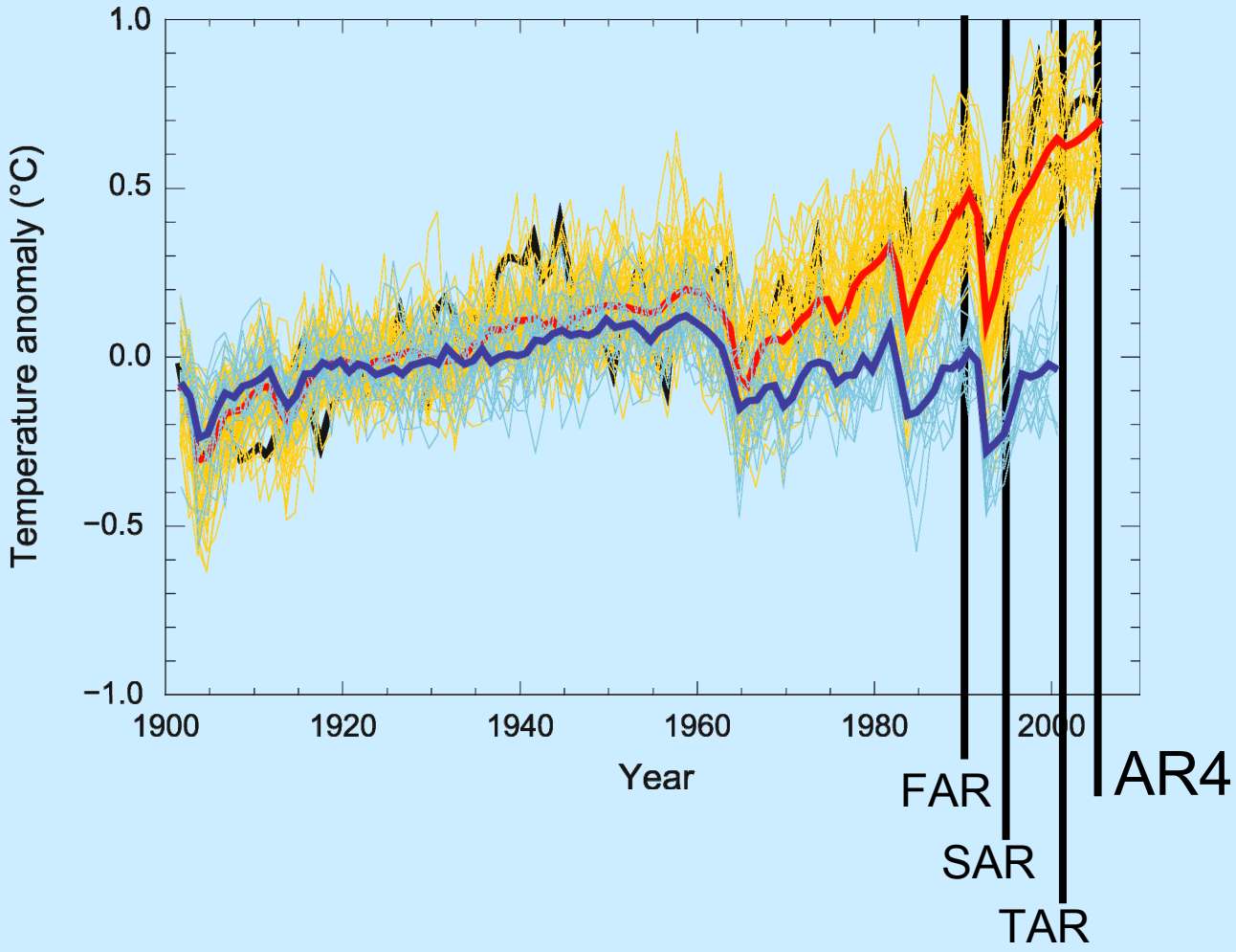
A Progression of Understanding: Greater and Greater Certainty in Attribution

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

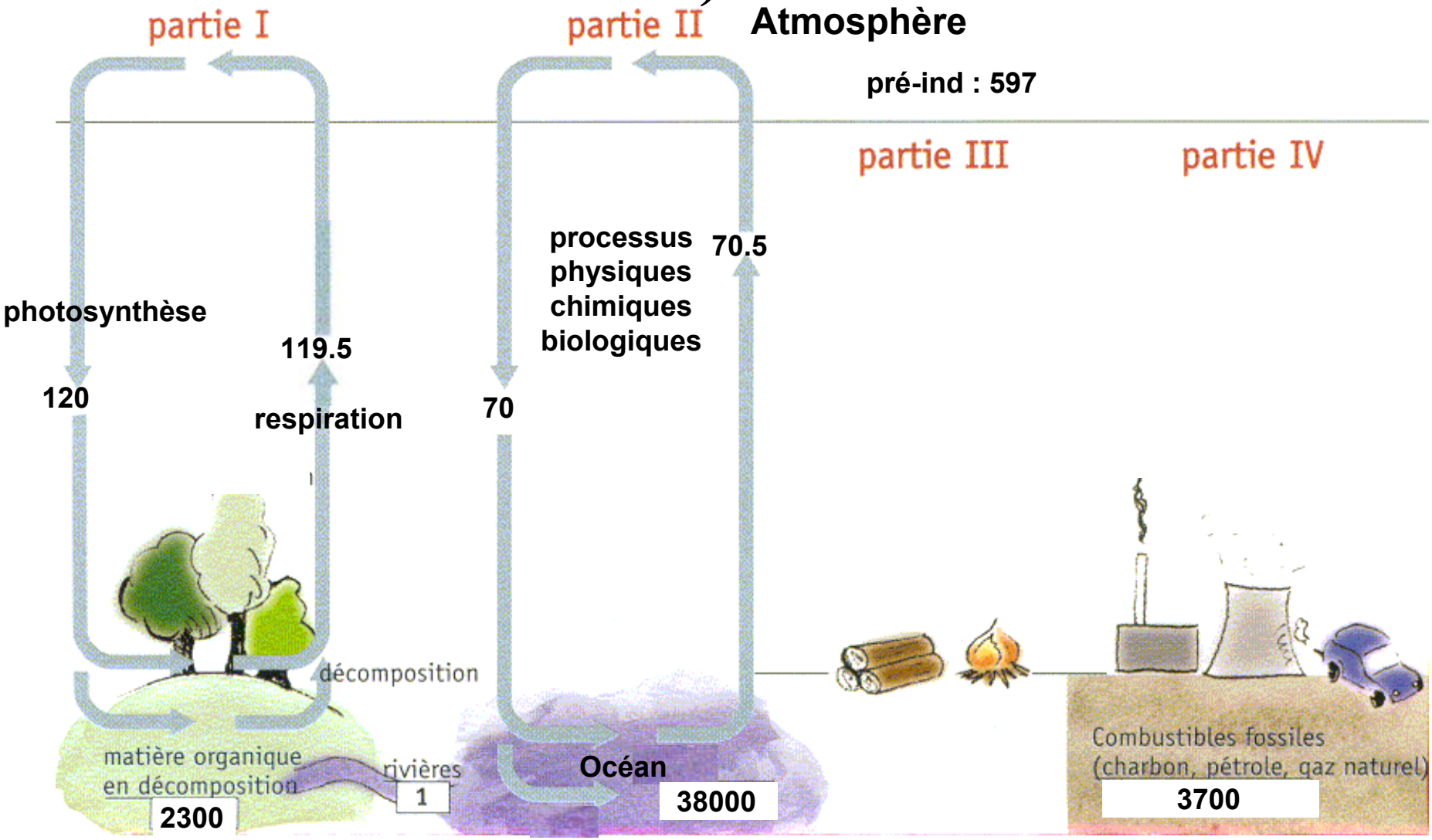
SAR (1995): "balance of evidence suggests discernible human influence"

TAR (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"



Carbon Cycle at end of 20th century (based on AR4)



Unités: GtC (milliards de tonnes de carbone) ou GtC/an

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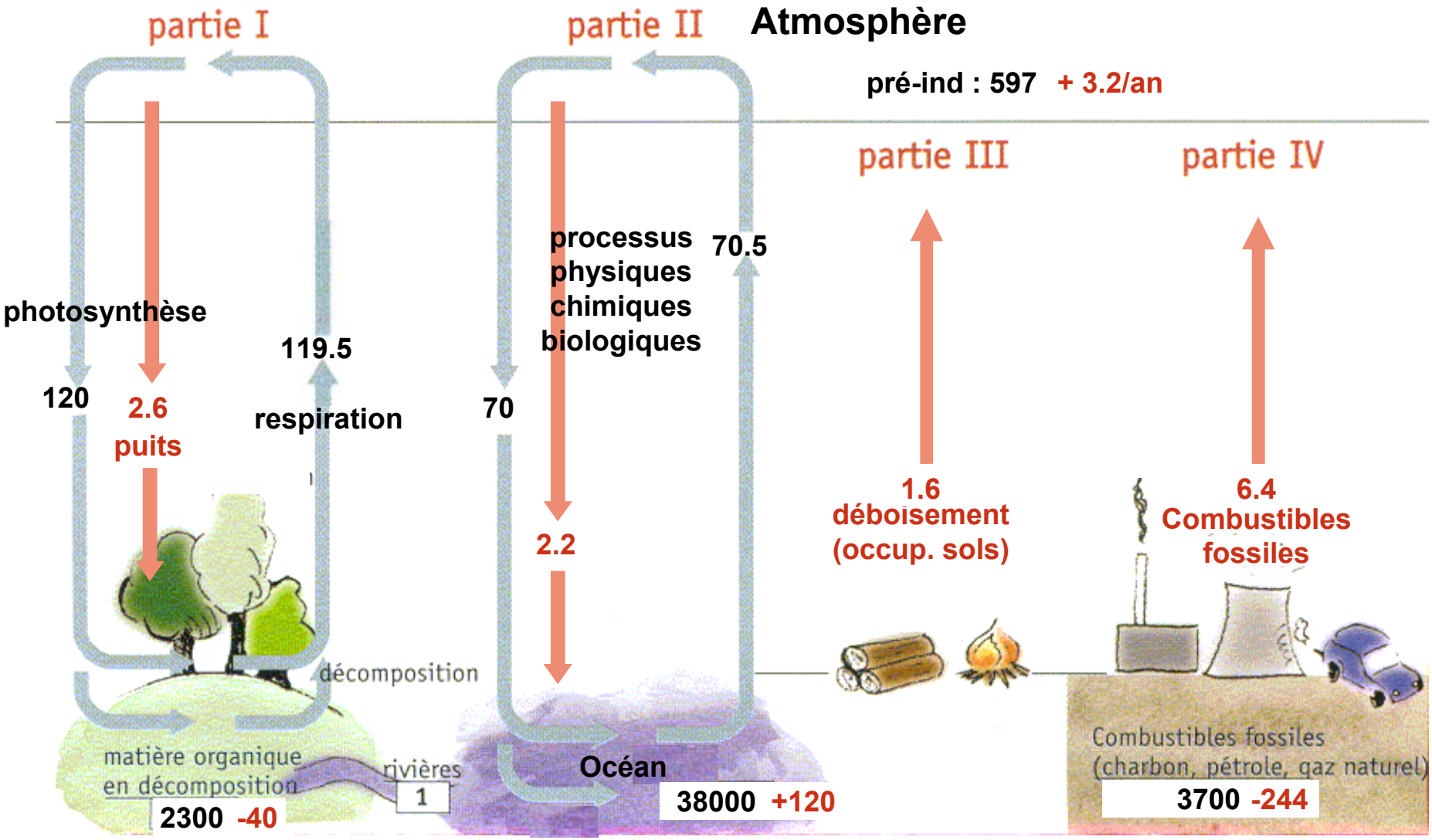
Carbon Cycle



Unités: GtC (milliards de tonnes de carbone) ou GtC/an

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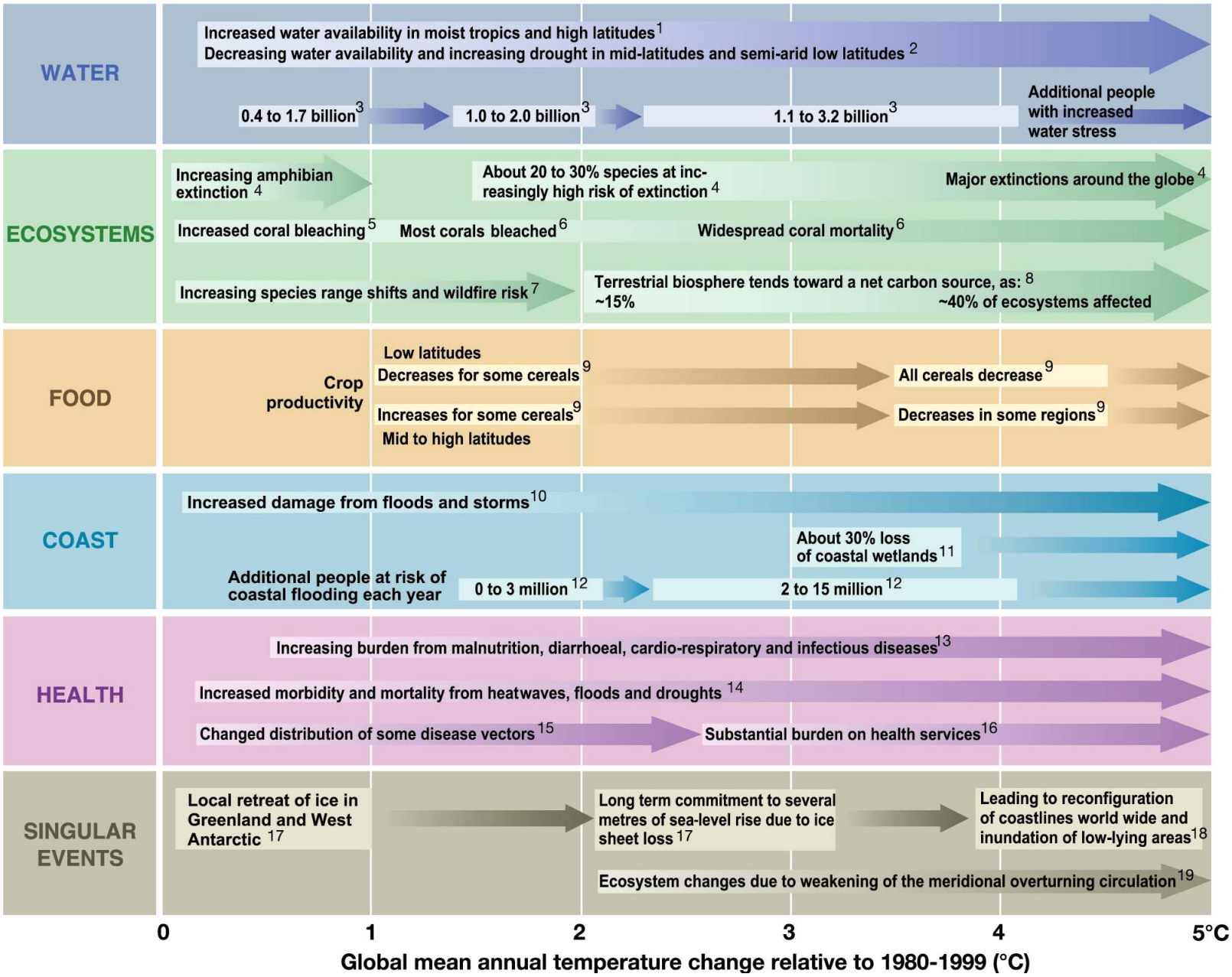
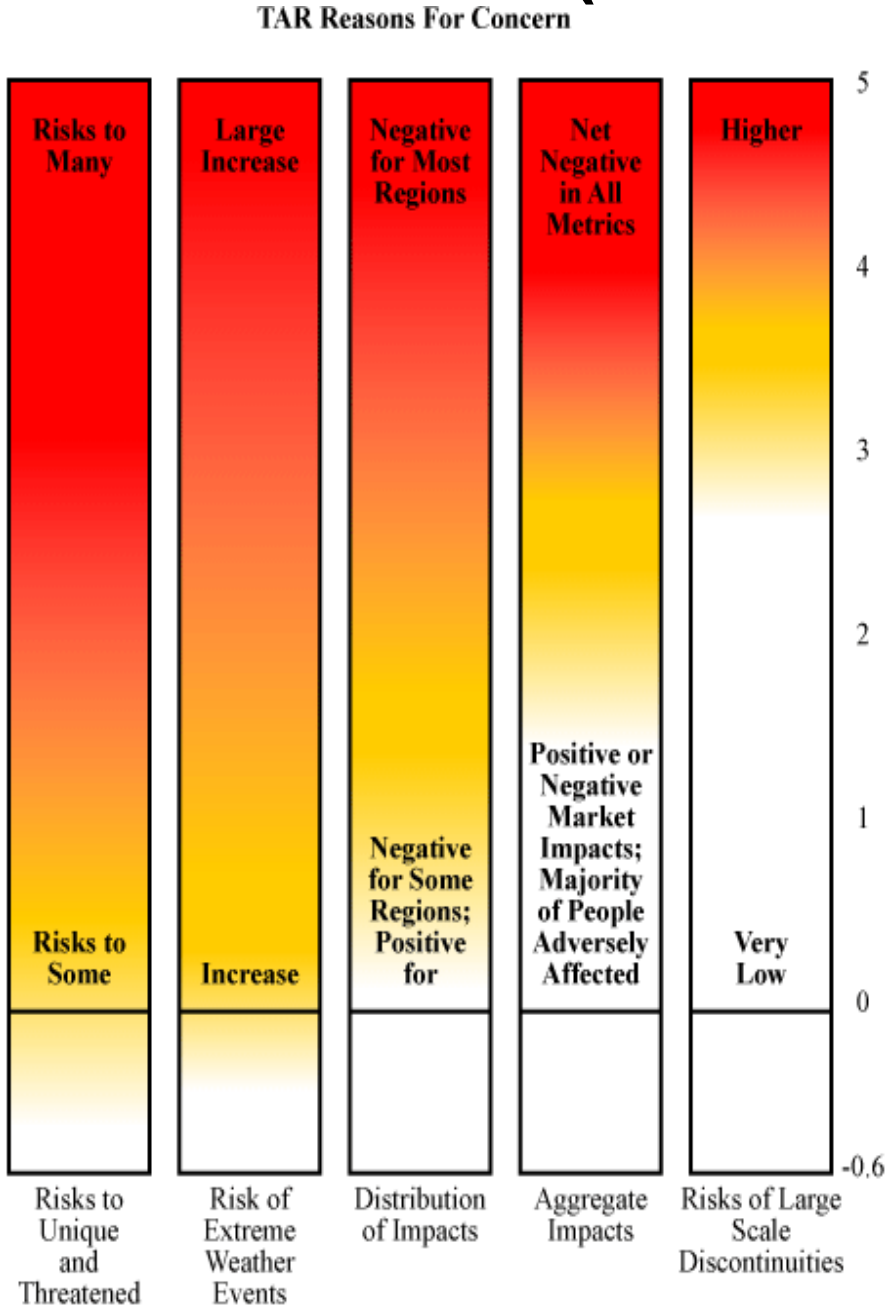
Table TS.3. (lower) Examples of global impacts projected for changes in climate (and sea level and atmospheric CO_2 where relevant)

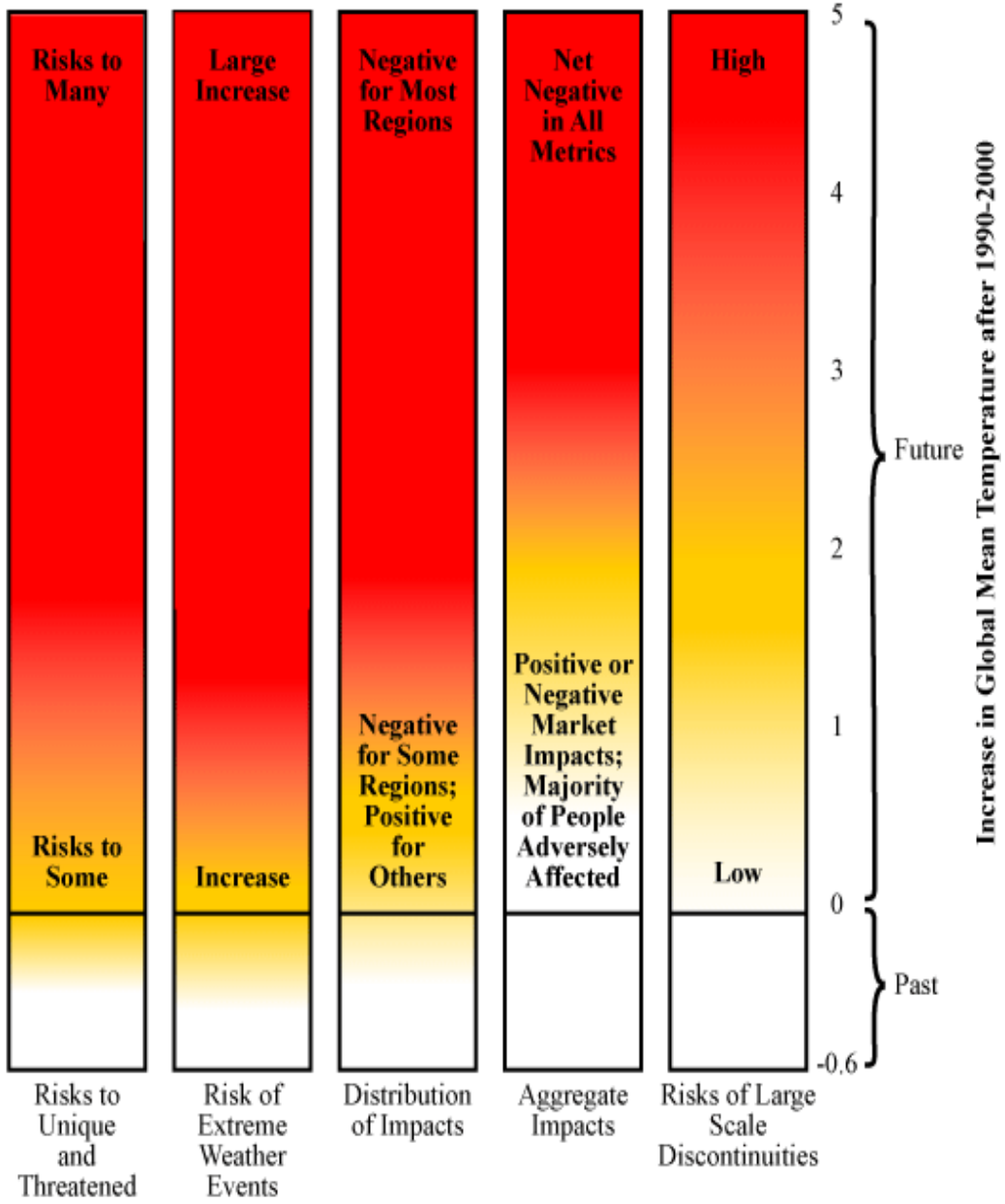


Source: IPCC WGII AR4

Reasons for concern (TAR-2001)



Reasons for concern (Smith et al, 2009, PNAS, based on AR4-2007)



Stabilisation levels and equilibrium global mean temperatures

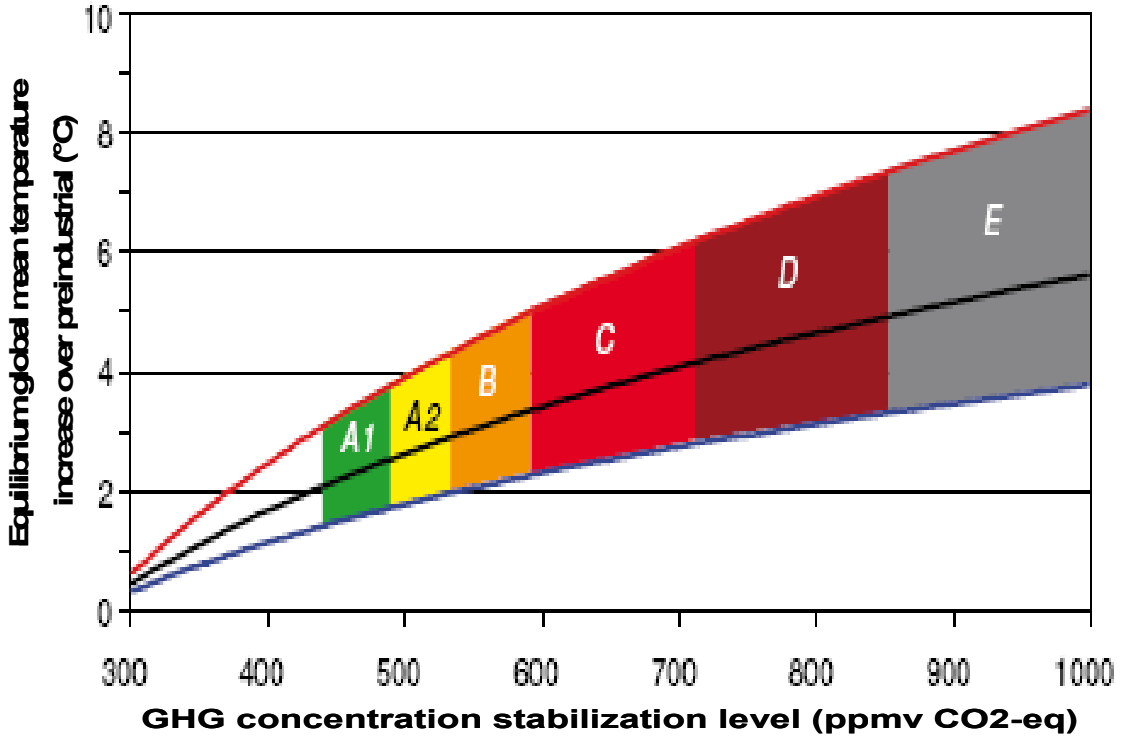
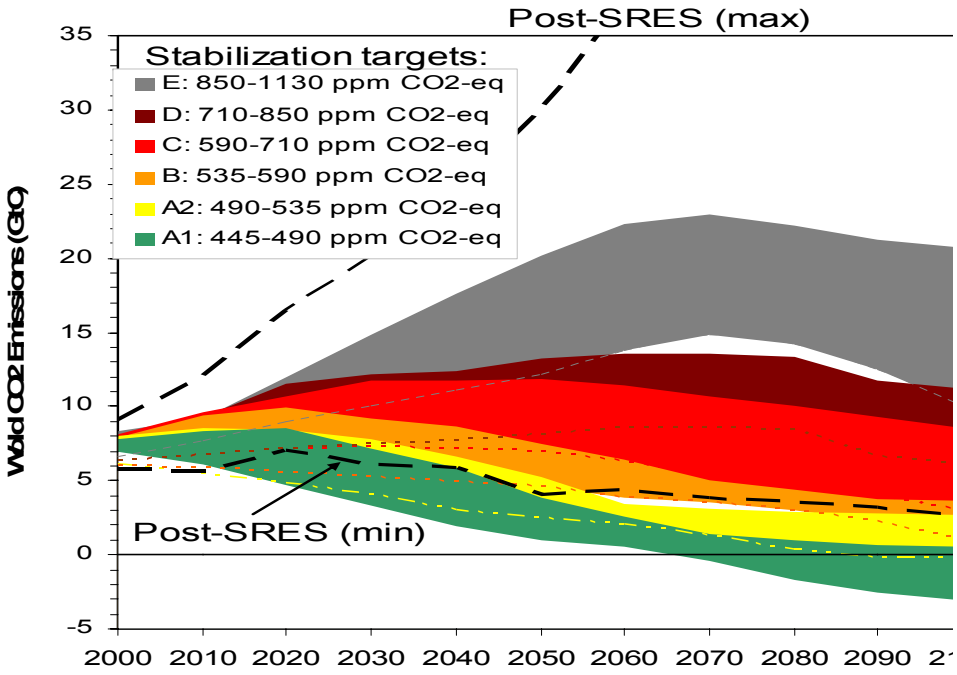
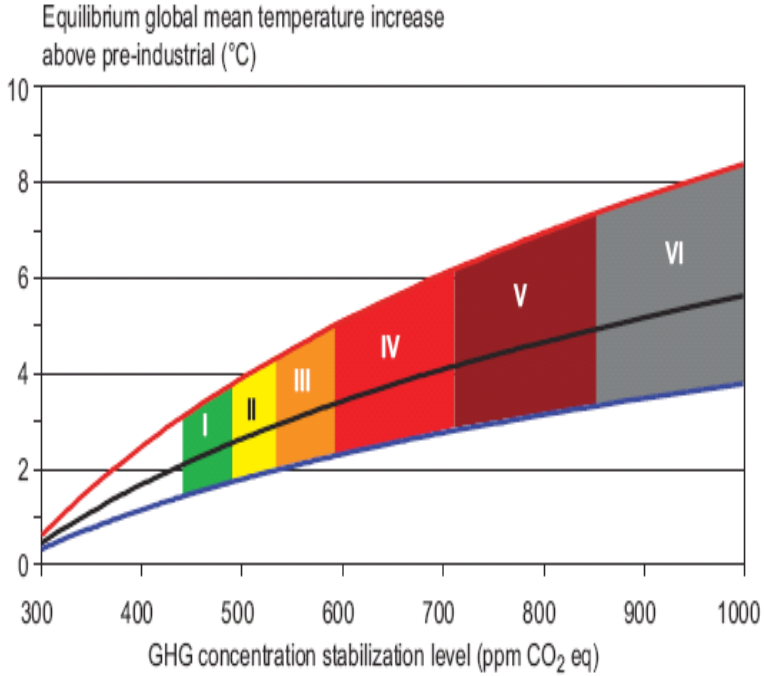


Figure SPM 8: *Stabilization scenario categories as reported in Figure SPM.7 (coloured bands) and their relationship to equilibrium global mean temperature change above pre-industrial, using (i) "best estimate" climate sensitivity of 3˚ C (black line in middle of shaded area), (ii) upper bound of likely range of climate sensitivity of 4.5˚ C (red line at top of shaded area) (iii) lower bound of likely range of climate sensitivity of 2˚ C (blue line at bottom of shaded area). Coloured shading shows the concentration bands for stabilization of greenhouse gases in the atmosphere corresponding to the stabilization scenario categories. The data are drawn from AR4 WGI, Chapter 10.8.*

The lower the stabilisation level the earlier global emissions have to go down



Multigas and CO2 only studies combined



Contribution of Working Group III to the Fourth Assessment Report of the IPCC,

- **Technical Summary, page 39:**

Table TS.2: *Classification of recent (Post-Third Assessment Report) stabilization scenarios according to different stabilization targets and alternative stabilization metrics [Table 3.5].*

Category	Additional radiative forcing (W/m^2)	CO_2 concentration (ppm)	CO_2-eq concentration (ppm)	Global mean temperature increase above pre-industrial at equilibrium, using "best estimate" climate sensitivity[a], [b] (°C)	Peaking year for CO_2 emissions[c]	Change in global CO_2 emissions in 2050 (% of 2000 emissions)[c]	No. of assessed scenarios
I	2.5-3.0	350-400	445-490	2.0-2.4	2000 - 2015	-85 to -50	6
II	3.0-3.5	400-440	490-535	2.4-2.8	2000 - 2020	-60 to -30	18
III	3.5-4.0	440-485	535-590	2.8-3.2	2010 - 2030	-30 to +5	21
IV	4.0-5.0	485-570	590-710	3.2-4.0	2020 - 2060	+10 to +60	118
V	5.0-6.0	570-660	710-855	4.0-4.9	2050 - 2080	+25 to +85	9
VI	6.0-7.5	660-790	855-1130	4.9-6.1	2060 - 2090	+90 to +140	5
						Total	177

Notes:

a) Note that global mean temperature at equilibrium is different from expected global mean temperatures in 2100 due to the inertia of the climate system.

b) The simple relationships $T_{eq} = T_{2\times CO2} \times \ln([CO_2]/278)/\ln(2)$ and $\Delta Q = 5.35 \times \ln([CO_2]/278)$ are used. Non-linearities in the feedbacks (including e.g., ice cover and carbon cycle) may cause time dependence of the effective climate sensitivity, as well as leading to larger uncertainties for greater warming levels. The best-estimate climate sensitivity (3 °C) refers to the most likely value, that is, the mode of the climate sensitivity PDF consistent with the WGI assessment of climate sensitivity and drawn from additional consideration of Box 10.2, Figure 2, in the WGI AR4.

c) Ranges correspond to the 15th to 85th percentile of the Post-Third Assessment Report (TAR) scenario distribution. CO_2emissions are shown, so multi-gas scenarios can be compared with CO_2-only scenarios.

Note that the classification needs to be used with care. Each category includes a range of studies going from the upper to the lower boundary. The classification of studies was done on the basis of the reported targets (thus including modelling uncertainties). In addition, the relationship that was used to relate different stabilization metrics is also subject to uncertainty (see Figure 3.16).

Contribution of Working Group III to the Fourth Assessment Report of the IPCC,

- **Chapter 13, page 776: (cité en note de bas de page dans la "feulle de route de Bali)**

Box 13.7 The range of the difference between emissions in 1990 and emission allowances in 2020/2050 for various GHG concentration levels for Annex I and non-Annex I countries as a group[a]

Scenario category	Region	2020	2050
A-450 ppm CO_2-eq[b]	Annex I	–25% to –40%	–80% to –95%
	Non-Annex I	Substantial deviation from baseline in Latin America, Middle East, East Asia and Centrally-Planned Asia	Substantial deviation from baseline in all regions
B-550 ppm CO_2-eq	Annex I	-10% to -30%	-40% to -90%
	Non-Annex I	Deviation from baseline in Latin America and Middle East, East Asia	Deviation from baseline in most regions, especially in Latin America and Middle East
C-650 ppm CO_2-eq	Annex I	0% to -25%	-30% to -80%
	Non-Annex I	Baseline	Deviation from baseline in Latin America and Middle East, East Asia

Notes:

[a] The aggregate range is based on multiple approaches to apportion emissions between regions (contraction and convergence, multistage, Triptych and intensity targets, among others). Each approach makes different assumptions about the pathway, specific national efforts and other variables. Additional extreme cases – in which Annex I undertakes all reductions, or non-Annex I undertakes all reductions – are not included. The ranges presented here do not imply political feasibility, nor do the results reflect cost variances.

[b] Only the studies aiming at stabilization at 450 ppm CO_2-eq assume a (temporary) overshoot of about 50 ppm (See Den Elzen and Meinshausen, 2006).

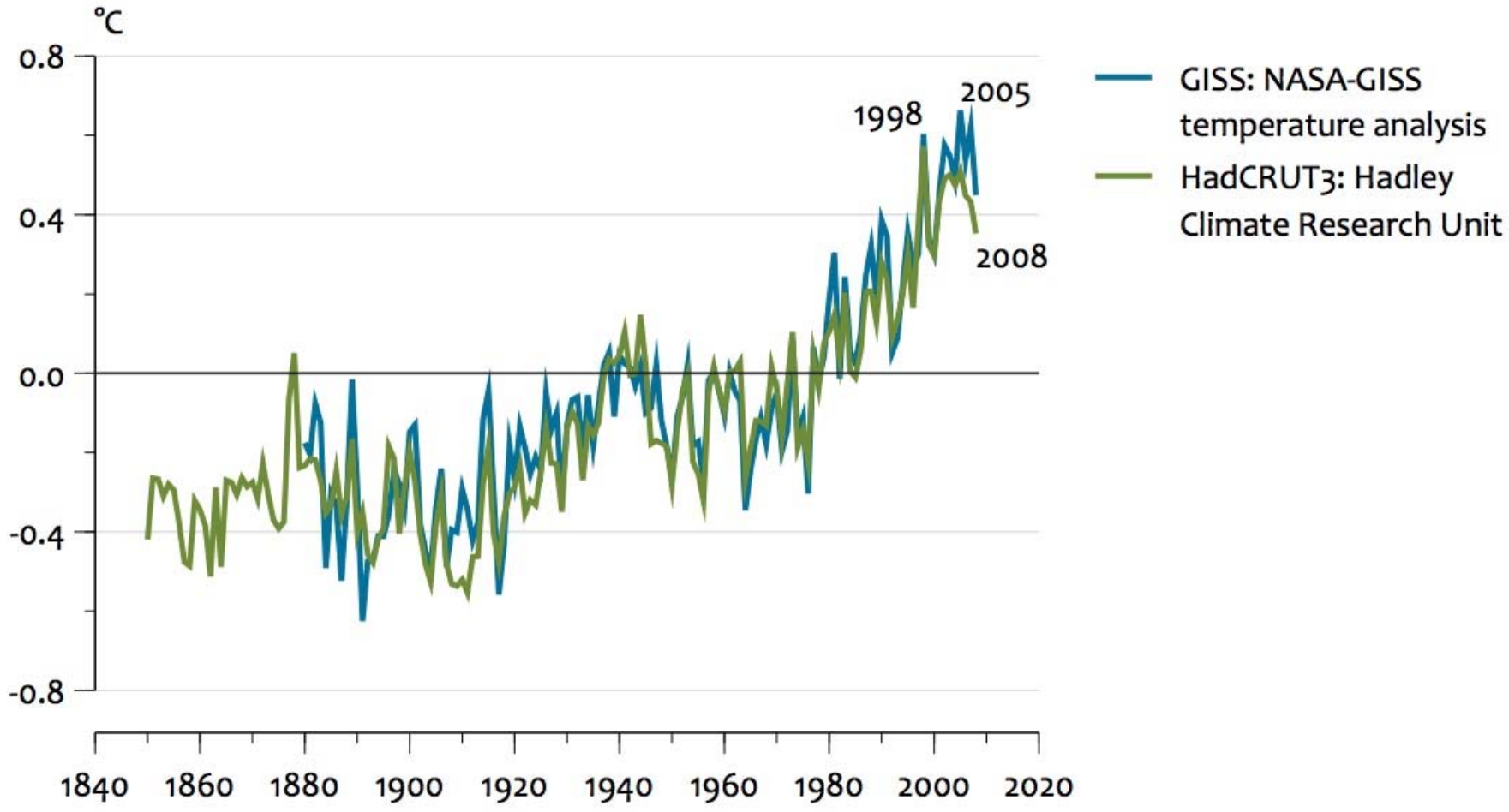
WG I Science Gaps and Questions for AR5

- Trends and rates of observed climate change
  Has climate change accelerated?
- Large ice sheets in polar regions
  Is the Greenland ice sheet stable?
- Irreversibilities and abrupt change in the climate system
  How robust and accurate is our understanding?
- Clouds and aerosols and their feedbacks
  What is the forcing uncertainty associated with cloud and aerosol processes?
- Carbon and other biogeochemical cycles
  Which carbon cycle feedbacks become relevant in the coming decades?
- Near-term and long-term climate projections
  How reliable is decadal prediction, what are the uncertainties beyond 2100?
- Climate phenomena across regions
  How do frequencies and amplitudes of monsoon, ENSO, and others change?

Some WGI-related news (NOT assessed by IPCC yet):

The Physical Science Basis

Temperature anomalies compared to 1961 to 1990 average



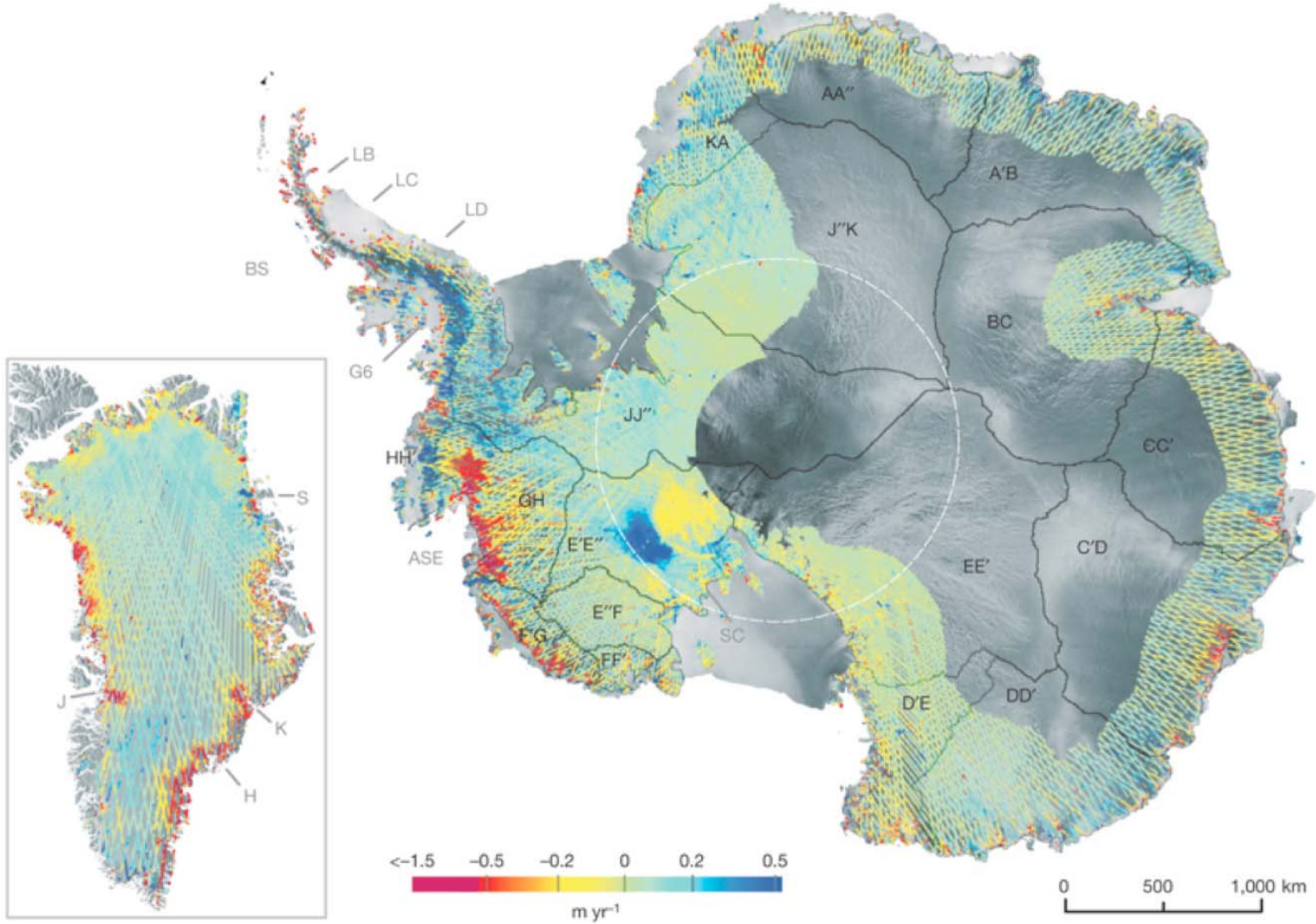
Source: Netherlands Environmental Assessment Agency, 2009

Sea Level :
a sea of uncertainty (Lowe, 2010)

Crucial question for sea level rise in the twenty-first century is how much ice will be lost from the Greenland and Antarctic ice sheets as a result of rapid accelerations in ice flow

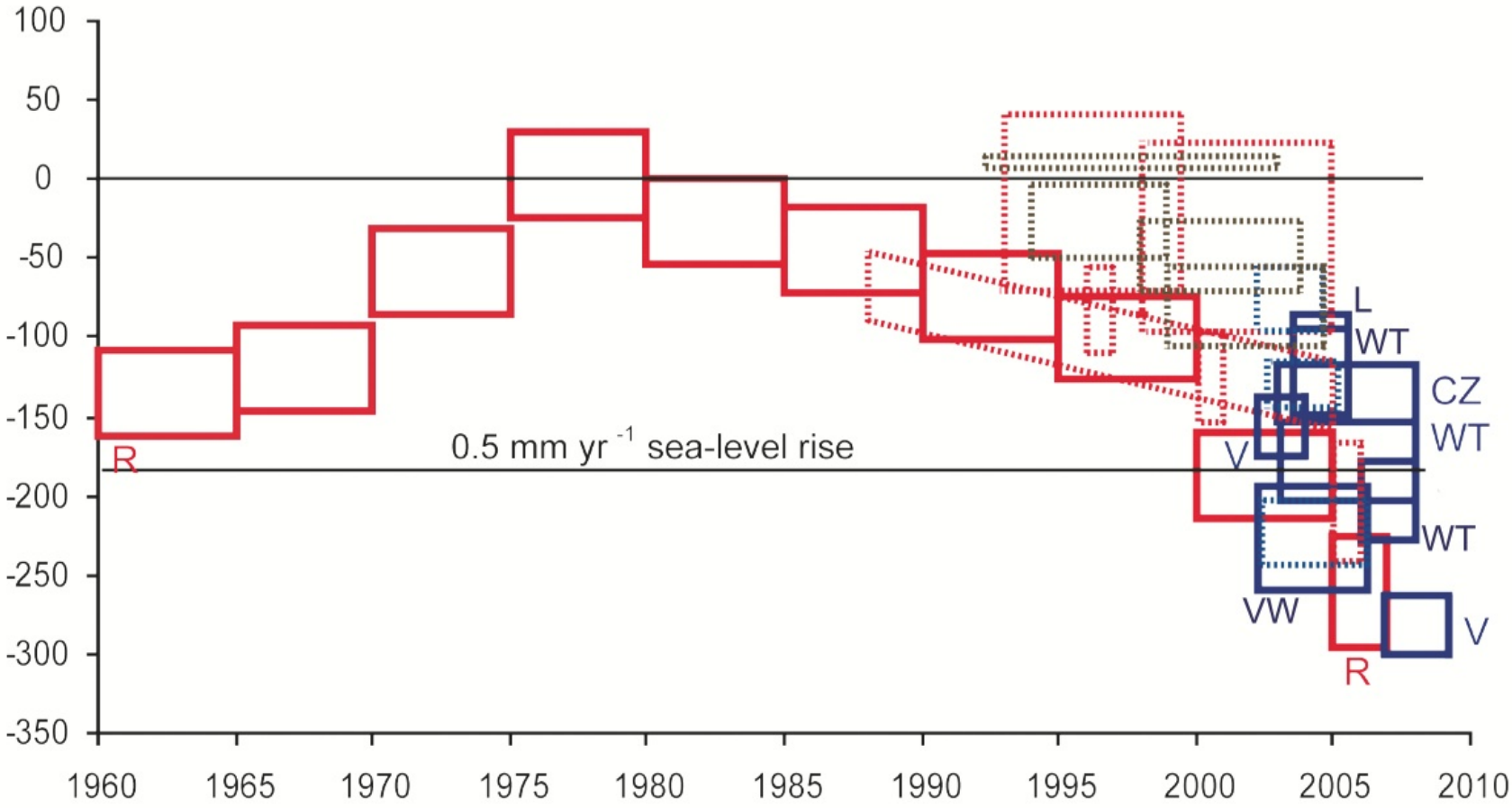
Source: Lowe and Gregory, Nature reports, 2010

Rate of change of surface elevation for Antarctica and Greenland, (2003-2007)



Source: Pritchard et al. 2009

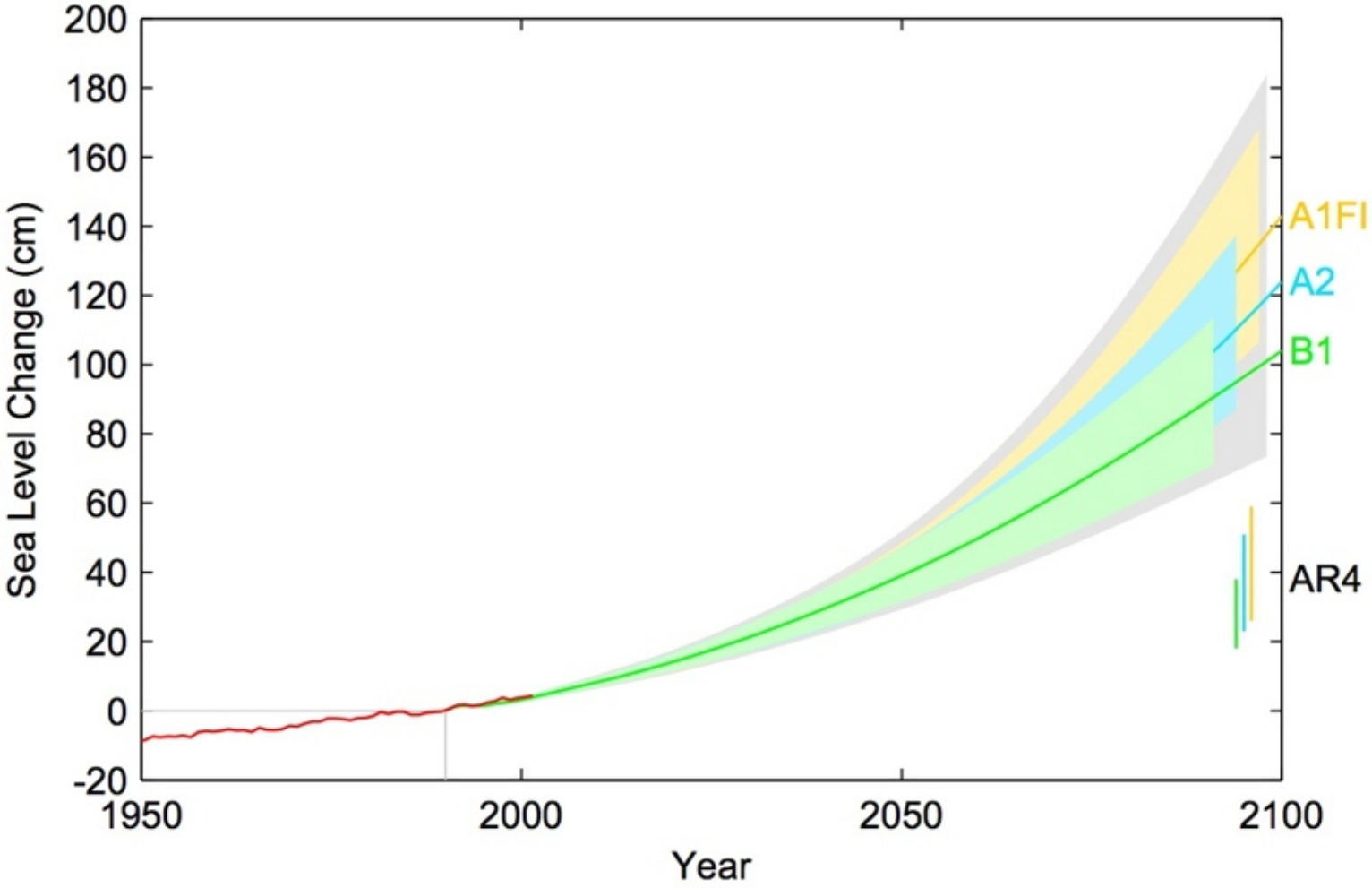
Estimates of the net mass budget of the Greenland Ice Sheet since 1960



Source: The Copenhagen Diagnosis, 2009, p.24

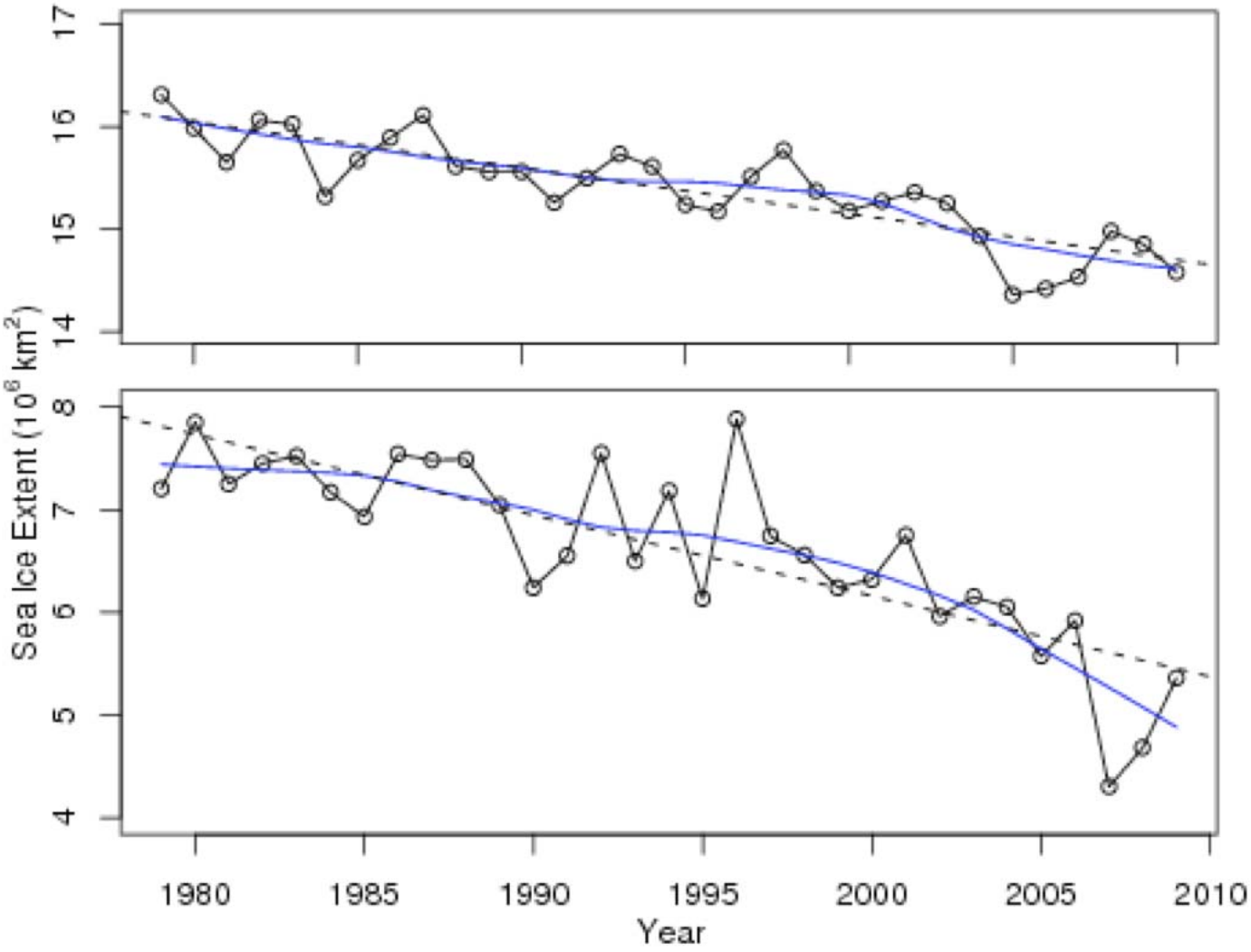
Projections of sea-level rise from 1990 to 2100

based on IPCC temperature projections for three different emission scenarios, and using a statistical model for sea-level



Source: M. Vermeer and S. Rahmstorf, PNAS, 2009

Changes in Arctic sea ice extent from 1979 to 2009



Feb

Sept.

Source: Physical Climate Science since IPCC AR4, A brief update

AR5 WG II Major Themes

- Framing to support good decisions, including information on risk
- Better integration of climate science with climate impacts
- Broader range of assessed impacts.
- Climate change in the context of other stresses
- Better treatment of extremes and disasters
- Expanded treatment of adaptation
- Better integration of adaptation, mitigation, and development at different regional scales
- Human settlements, industry, and infrastructure

AR5 Major Sections or "Superchapters"

- Part A: GLOBAL & SECTORAL ASPECTS
  - Context for the AR5
  - Natural and managed resources and systems, and their uses
  - Human settlements, industry, and infrastructure
  - Human health, well-being, and security
  - Adaptation
  - Multi-sector impacts, risks, vulnerabilities, and opportunities
- Part B: REGIONAL ASPECTS
  - With WG I and WG III input and collaboration

Some WGII-related news (NOT assessed by IPCC yet):

Impacts, Adaptation, and Vulnerability

Examples / Ecosystems: broader coverage

Picture : Nature, May 2010

- Erosion of Lizard Diversity by Climate Change and Altered Thermal Niches
  - *Since 1975, we estimate that 4% of local populations have gone extinct worldwide*
  - *by 2080 local extinctions are projected to reach 39% worldwide, and species extinctions may reach 20%.* (B Sinervo and 25 co-authors, Science, May 2010)

Examples / health

- *A study found that cold related mortality in England decreased much faster than heat related mortality increased (over 1976-2005); adaptation played a major role in preventing a larger increase*
  (Christidis et al, Climatic Change, 2009)
- *Projected health impacts of heat waves are significantly larger in the mediterranean area (Fischer and Schär, Nature Geoscience 2010)*

Other examples / impacts

- Reduced oxygenation of oceans, both due to warming and in connection with acidification, with implications for marine life
  (Keeling et al., Ann. Rev. of Marine Science, 2010; Hofman and Schellnhuber, PNAS, 2009)
- Carbon cycle & carbon content of soils :
  a study confirms that soil carbon fluxes will increase in a warming climate, but do not provide a conclusion on the net change in C content of soils
  (Bond-Lamberty and Thomson, Nature, 2010)

AR5 WG III Outline

I: Introduction	1. Introductory Chapter
II: Framing Issues	2. Integrated Risk and Uncertainty Assessment of Climate Change Response Policies 3. Social, Economic and Ethical Concepts and Methods 4. Sustainable Development and Equity
III: Pathways for Mitigating Climate Change	5. Drivers, Trends and Mitigation 6. Assessing Transformation Pathways 7. Energy Systems 8. Transport 9. Buildings 10. Industry 11. Agriculture, Forestry and Other Land Use (AFOLU) 12. Human Settlements, Infrastructure and Spatial Planning
IV: Assessment of Policies, Institutions and Finance	13. International Cooperation: Agreements and Instruments 14. Regional Development and Cooperation 15. National and Sub-national Policies and Institutions 16. Cross-cutting Investment and Finance Issues

The Research Challenge of WG III

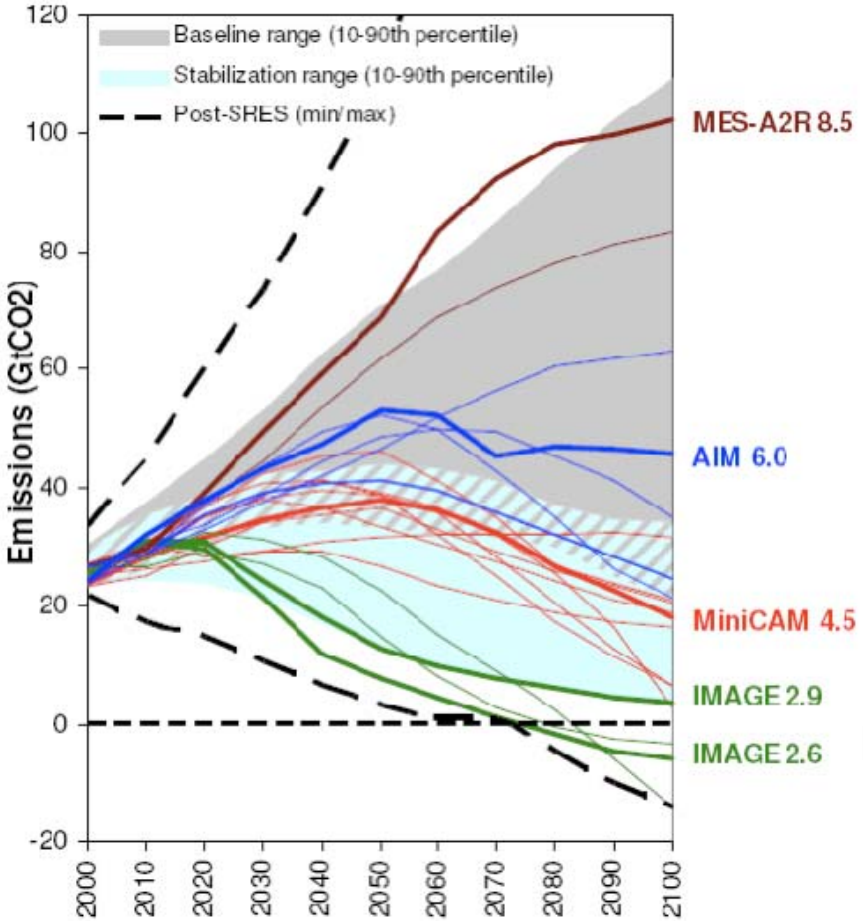
- Low Stabilisation Scenarios which identify the technical and institutional requirements.
- Exploring the costs, benefits and risks of all relevant mitigation options.
- Identifying differential impacts and develop a classification of risks comprising tipping points in the natural environment and also in society.

Some WGIII-related news (NOT assessed by IPCC yet): Mitigation

New scenarios: Representative concentration pathways

All selected from existing literature (but slightly updated)

Wide range of possible futures, including mitigation



RCP8.5 : 8.5 W/m^2 in 2100,
continue to increase
(proposed :
constant emissions until 2300)

RCP6 : 6 W/m^2 in 2100,
then stabilisation

RCP4.5 : 4.5 W/m^2 in 2100,
then stabilisation

RCP3-PD : peak in RF ~3 W/m^2,
then decline

SRREN: Special Report on Renewable Energy Sources and Climate Change Mitigation

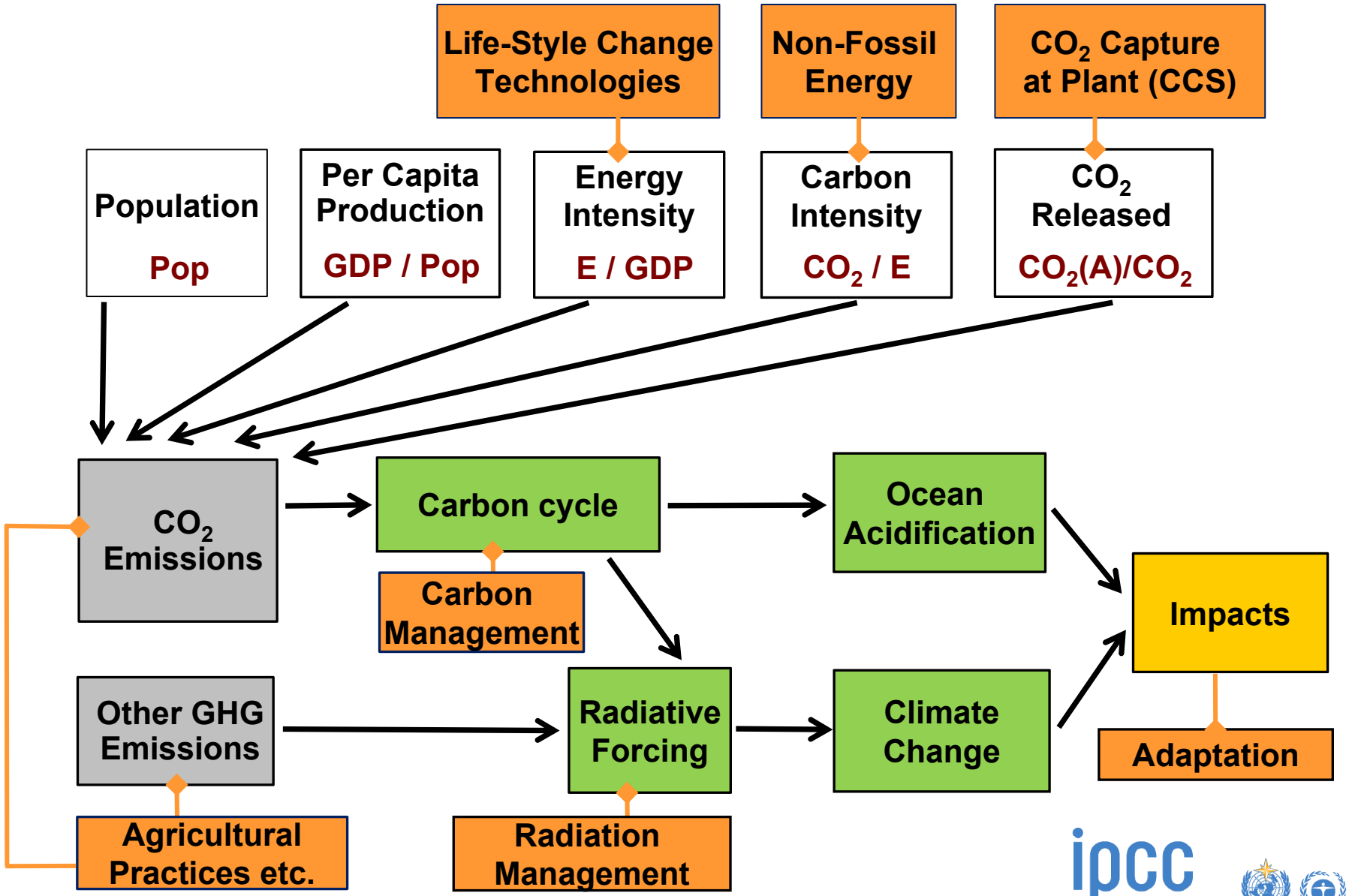
- 1. Renewable Energy and Climate Change
- 2. Bioenergy
- 3. Direct Solar Energy
- 4. Geothermal Energy
- 5. Hydropower
- 6. Ocean Energy
- 7. Wind Energy

Technology Chapters

- 8. Integration of Renewable Energy into Present and Future Energy Systems
- 9. Renewable Energy in the Context of Sustainable Development
- 10. Mitigation Potential and Costs
- 11. Policy, Financing and Implementation

Luderer et al. (2009)

Assessing the Solution Space



Some of the Challenges

- Restore confidence in climate science
- Improve policy-relevance, without becoming policy-prescriptive
- Innovate to allow easier « updating »
- Improve quality and readability
- Provide elements of answer to difficult/new questions
- Improve collaboration between WG
- Improve developing countries participation

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Jointly Organized Meetings/Workshops

- Joint WGI / WGII Expert Meeting on Detection and Attribution related to Anthropogenic Climate Change (09/09)
- Joint WGI / WGII Expert Meeting on Assessing and Combining Multi-Model Climate Projections (01/10)
- Joint WG II / WG III Expert Meeting on Human Settlement and Infrastructure (postponed to early 2011)
- Joint WG II / WG III Workshop on Socioeconomic Scenarios for Climate Change Impact and Response Assessments (11/10)
- Joint WGI / WGII Expert Meeting on Impacts of Ocean Acidification on Marine Biology and Ecosystems (01/11)
- Joint WGII / WGIII Expert Meeting on Economic Analysis, Costing Methods, and Ethics (03/11)

Independent Review: Set Up

- On the request of IPCC Chairman Rajendra Pachauri and UN Secretary-General Ban Ki-moon.
- Executed by InterAcademy Council (IAC).
- Review of IPCC principles, procedures, management structures and the IPCC scenario process ("honest broker" role).
- The report will be published Aug. 30 and considered by the IPCC Plenary in October 2010.

Coming IPCC Products

- ***2010: Special report on Renewable Energy Sources and Climate Change Mitigation***
- ***2011: Special Report on Managing the Risks of Extreme Events and Disasters to Advance Climate Change Adaptation***
- ***2013: AR5 WGI report (physical science)***
- ***2014: AR5 WGII (Impacts & Adaptation); WGIII (Mitigation), Synthesis Report***

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Useful links:

- www.ipcc.ch : IPCC
- www.climate.be/vanyp : my slides and other documents, including the PNAS paper)

- My e-mail: vanyp@climate.be