Climatic change: Bridging the Gap between Science and Policy Making with IPCC

(Intergovernmental Panel on Climate Change)

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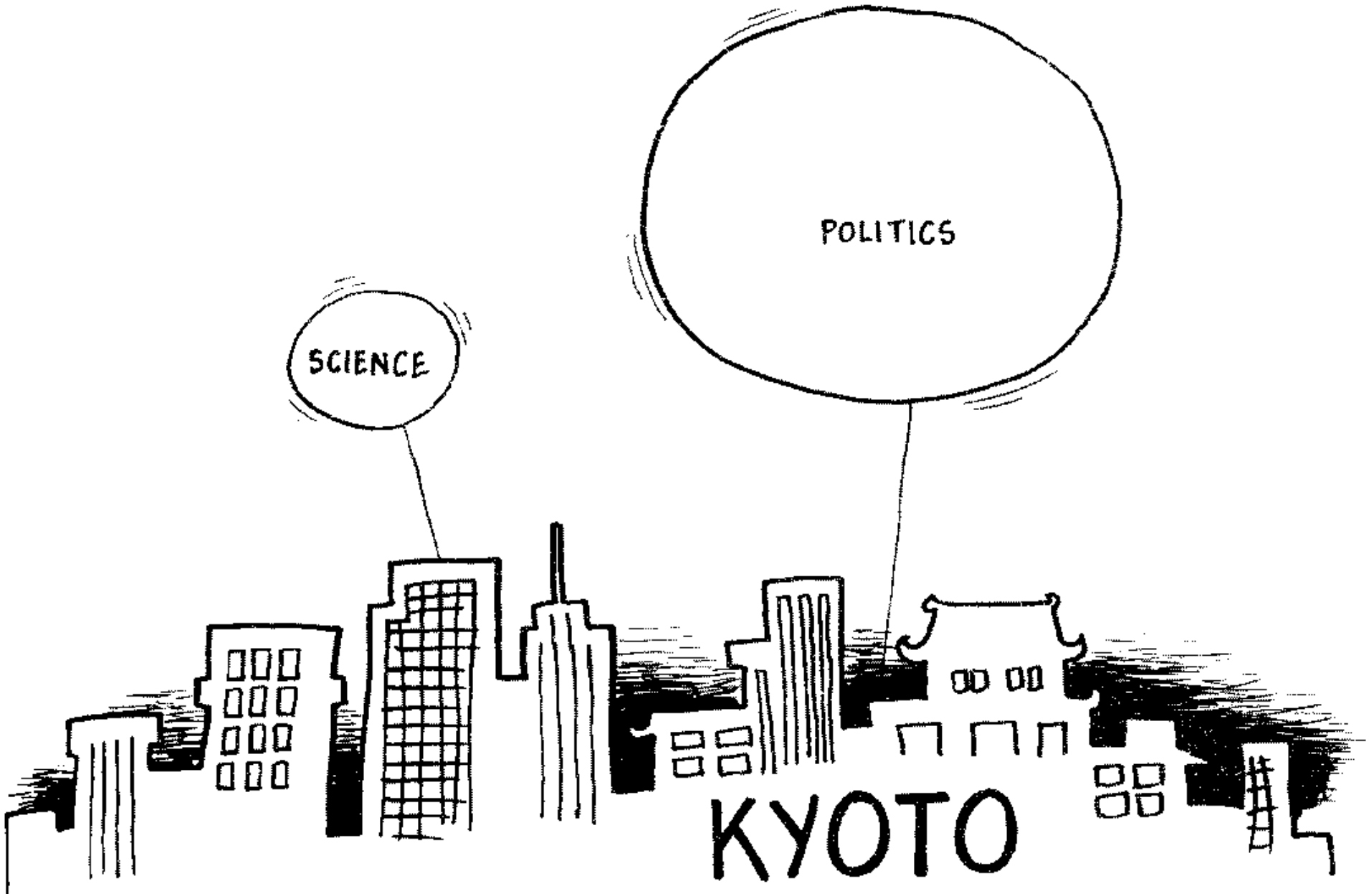
Credits: many slides borrowed with gratitude from IPCC colleagues: R. Christ, RK Pachauri, S. Solomon, J. Palutikof, J. Stone…

Training session for The Climate Project (Al Gore), Amsterdam, 15-10-2008



Agarwal et al., 1999

⌘The IPCC

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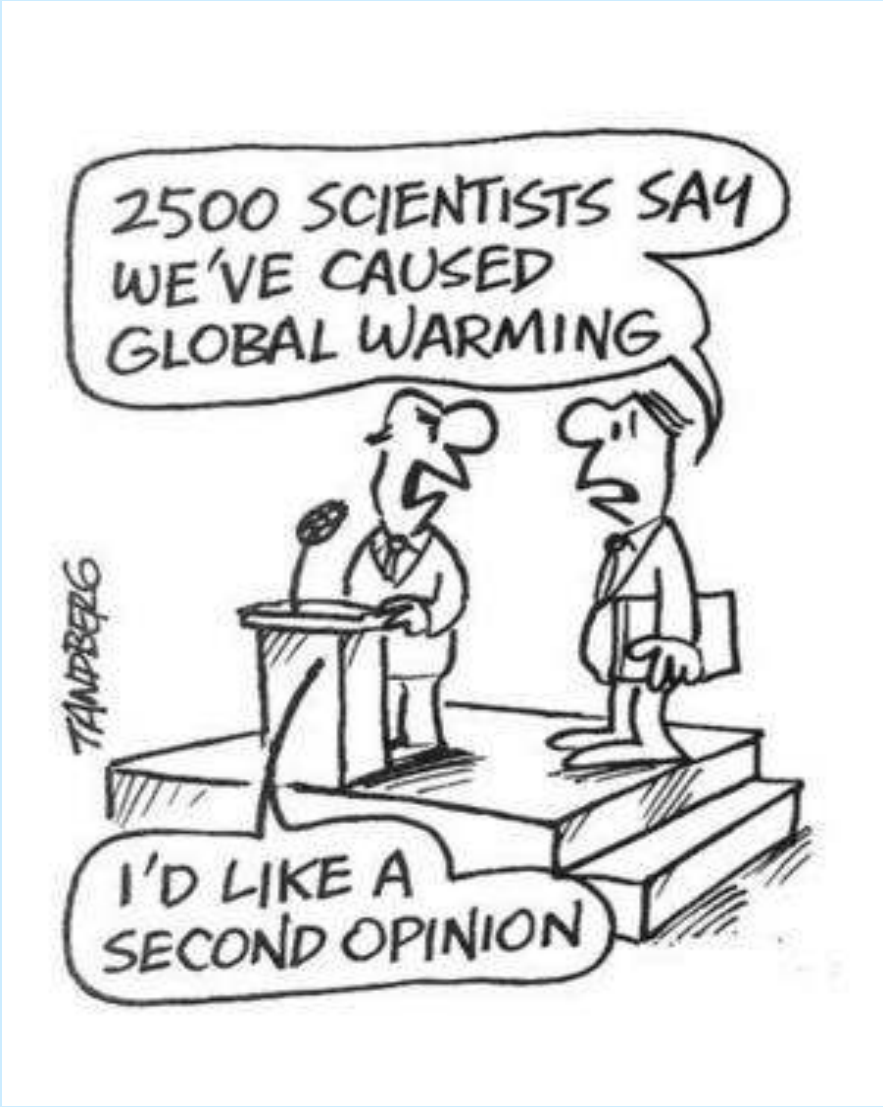
Why the IPCC ?

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.



The IPCC (Intergovernmental Panel on Climate Change)

The work of the IPCC is guided by the mandate given to it in 1988 by its parent organisations: the World Meteorological Organisation (**WMO**) and the United Nations Environment Programme (**UNEP**)

Its role is to assess on a comprehensive, objective, open and transparent basis the **scientific, technical and socio-economic** information relevant to understanding the scientific basis of climate change, its potential impacts and options for adaptation and mitigation

Role of IPCC

"The IPCC does not carry out research nor does it monitor climate related data or other relevant parameters. It bases its assessment mainly on peer reviewed and published scientific/technical literature."

(source: www.ipcc.ch)

IPCC Reports are policy-relevant, NOT policy-prescriptive

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 writing cycle (4 years, 2500 scientists)

- **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***

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2500+ SCIENTIFIC EXPERT REVIEWERS
800+ CONTRIBUTING AUTHORS AND
450+ LEAD AUTHORS FROM
130+ COUNTRIES
6 YEARS WORK
1 REPORT

2007

The assessments carried out by the IPCC have influenced global action on an unprecedented scale

1. First Assessment Report (1990) had a major impact in defining the content of the **UNFCCC**

2. The Second Assessment Report (1996) was largely influential in defining the provisions of the **Kyoto Protocol**

3. The Third Assessment Report (2001) focused attention on the **impacts** of climate change and the need for **adaptation**

4. The Fourth Assessment Report (2007) is creating a strong basis for a **post Kyoto Protocol** agreement

Upcoming IPCC activities

- Special Report on Renewable energy sources - 2010
- Possible Special Report on Extreme Events
- Methodology work as required by UNFCCC
- **5th Assessment Report – 2013/14**
  - Future changes in climate, impacts and socio economic conditions based on new scenarios currently prepared by the scientific community
  - Focus on response measures in an integrated manner
  - Economics of vulnerability and adaptation
  - Regional changes in climate and its impacts

Timing of AR5

- Working Group I to report in early 2013
- Working Group II and III, and Synthesis Report, to appear as early as possible in 2014
- Taking into account the timings of the UNFCCC negotiations (COP 2014)

⌘Latest science

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Changes in global mean surface temperature for three scenarios (reference: pre-industrial)(page 420 of report)

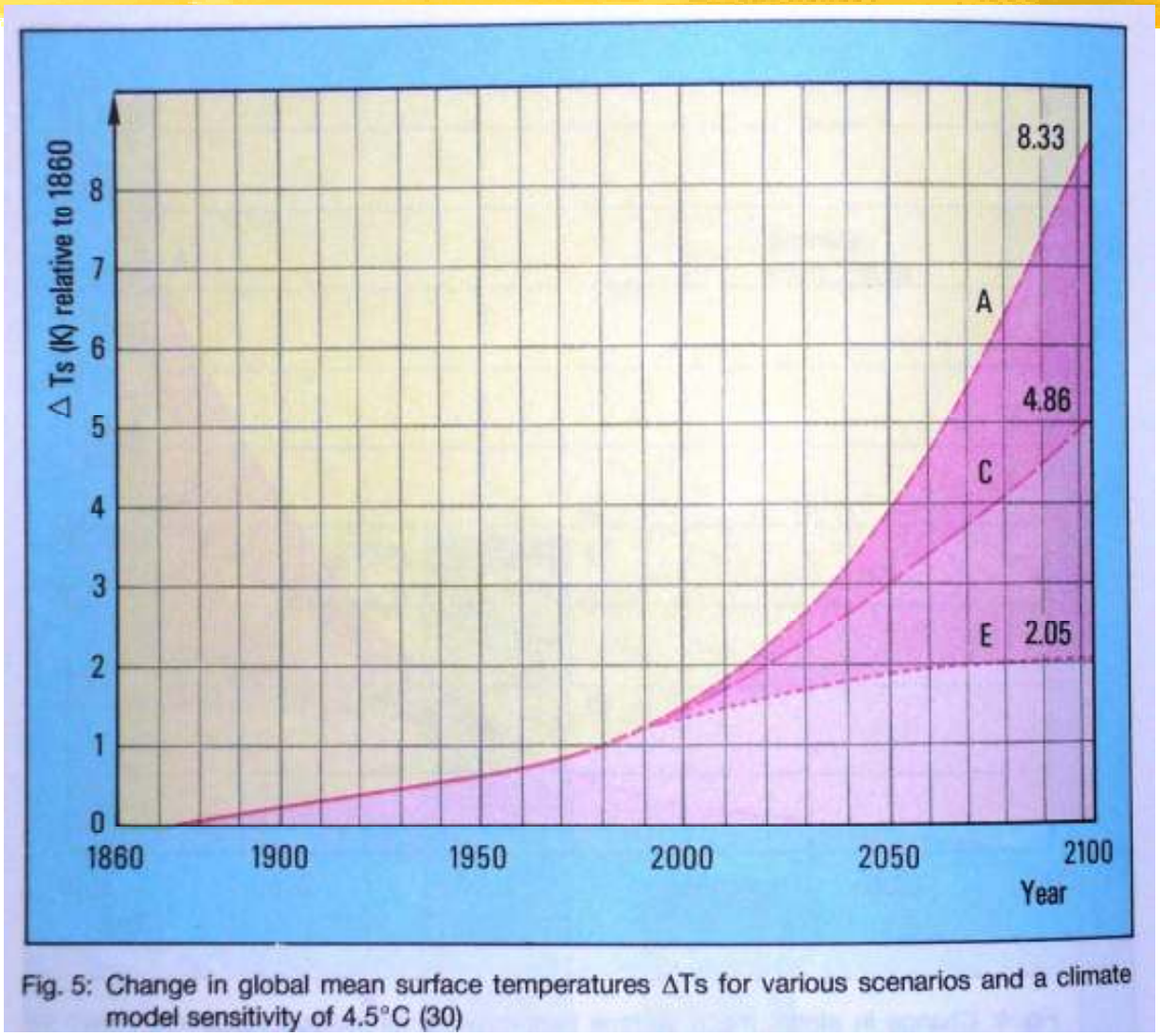

Fig. 5: Change in global mean surface temperatures ΔTs for various scenarios and a climate model sensitivity of 4.5°C (30)

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Quotation from the report (p 43):

- There is growing evidence suggesting that the expected changes in the Earth's atmosphere and in the climate will have **serious consequences** for human living conditions and for the biosphere as a whole.
- There is an **extraordinary need for action**, and detailed and long-term action strategies should be developed at (…) international level.

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Oops…

- … this was from the German Bundestag report on « Protecting the Earth's atmosphere », published 19 years ago (1989)

- Was anybody really listening?

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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 18 years ago (1990)

- Was anybody really listening?

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⌘Basic science and skeptics

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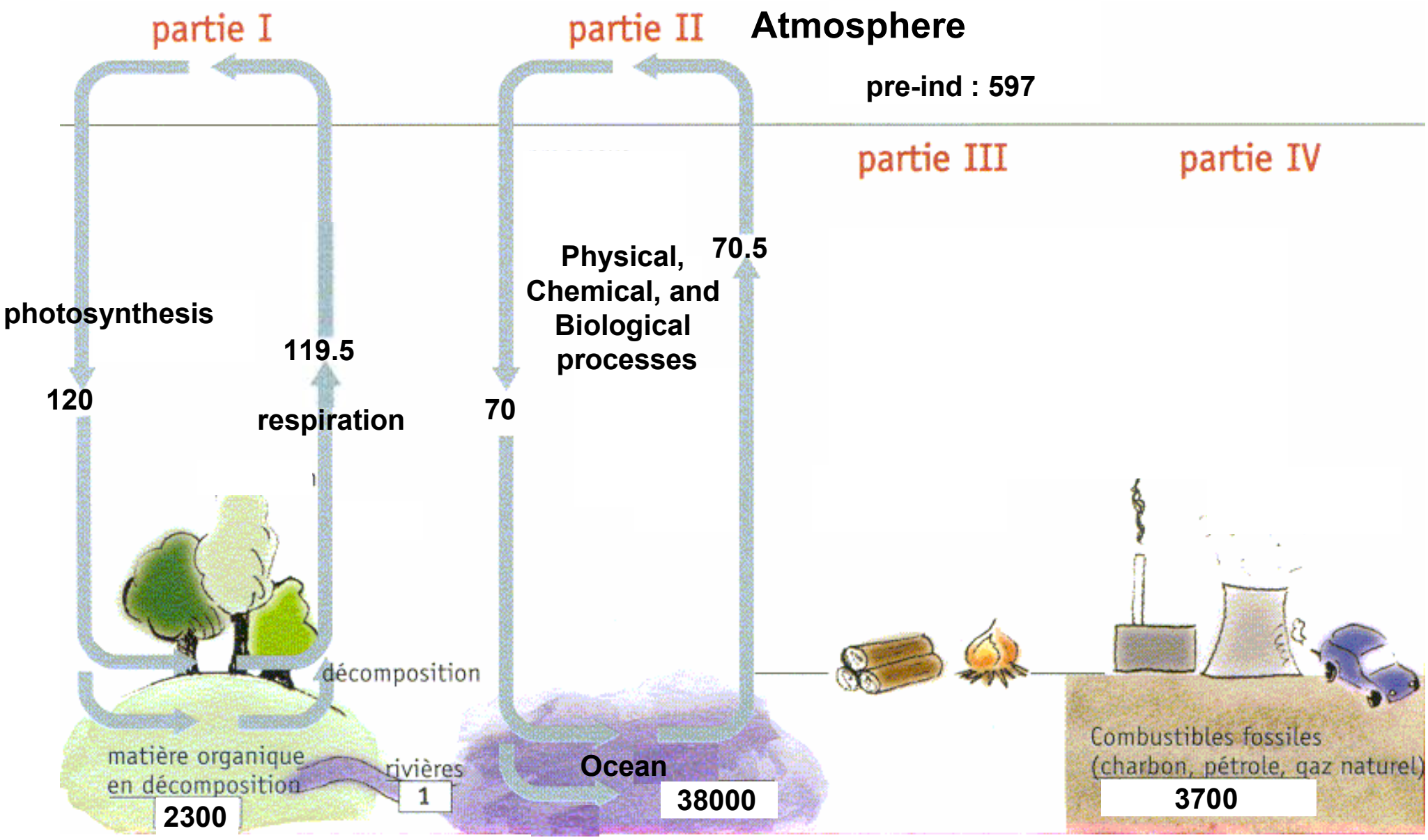
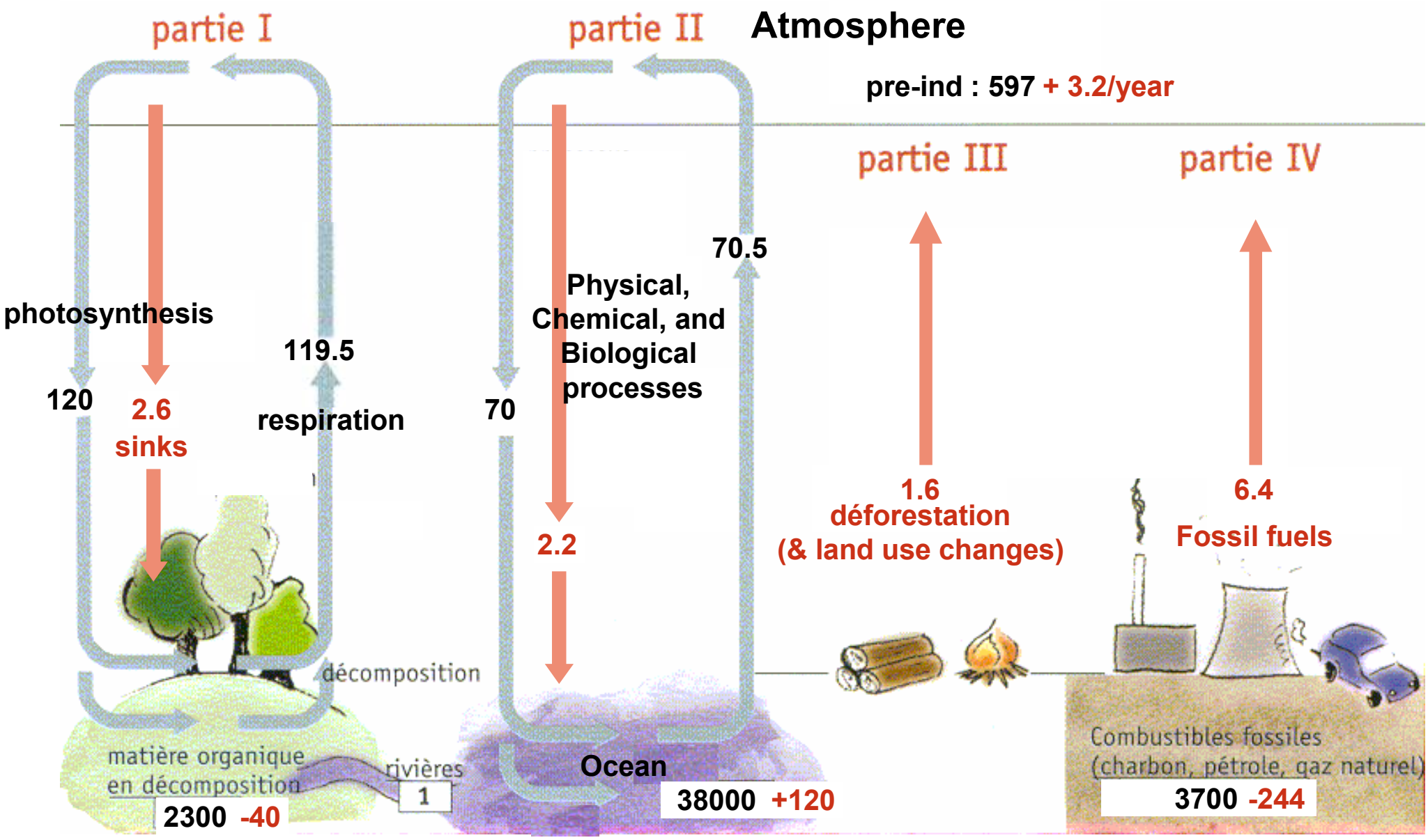
Carbon cycle



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

Source: vanyp@climate.be

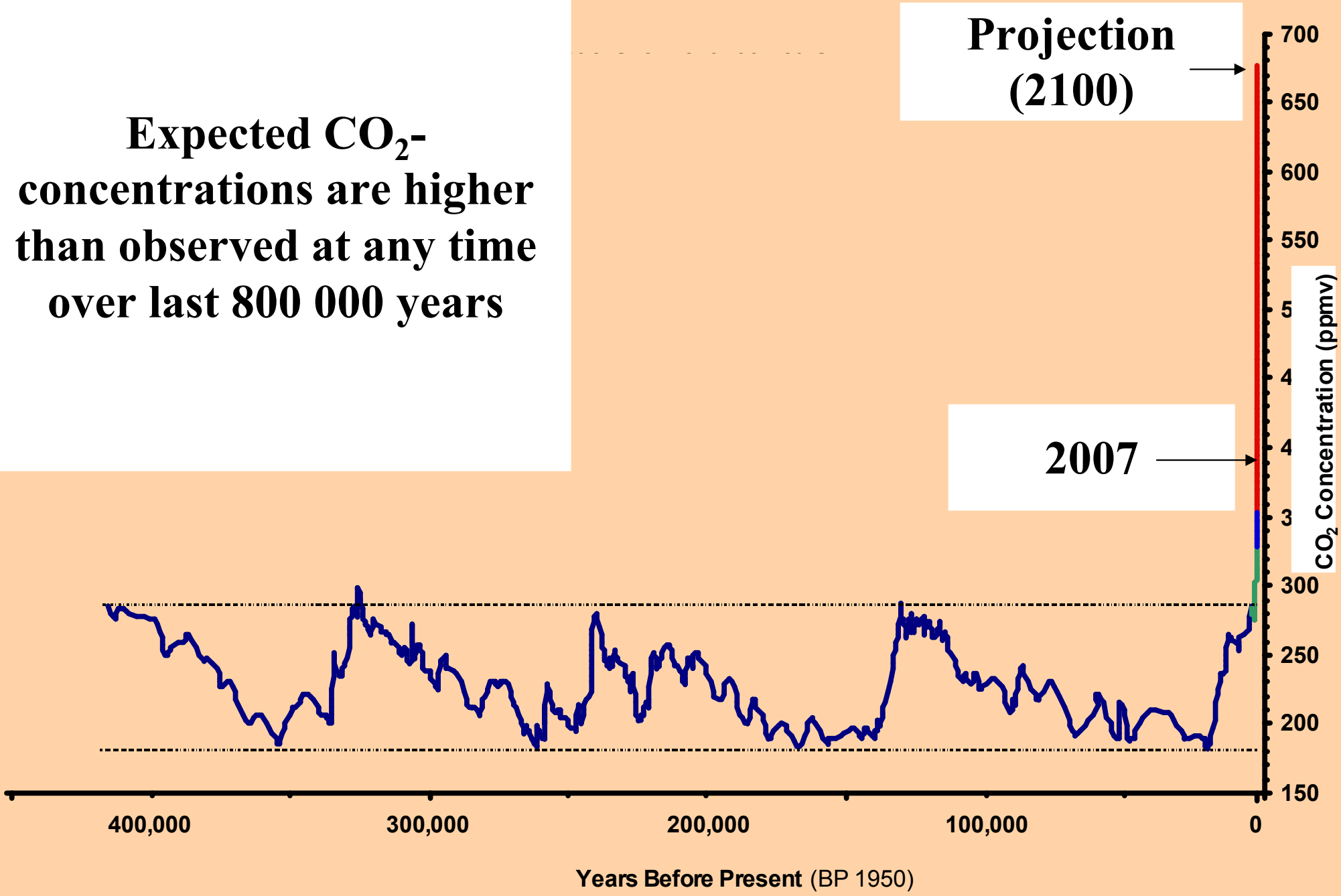
Carbon cycle



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

Source: vanyp@climate.be

Expected CO_2-concentrations are higher than observed at any time over last 800 000 years



Test yourself effect of different scenarios and uncertainties with the Java Climate Model:

- www.climate.be/JCM: interactive climate model developed by Dr. Ben Matthews (UCL)

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⌘Some IPCC conclusions

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The IPCC WG1 Sequence……

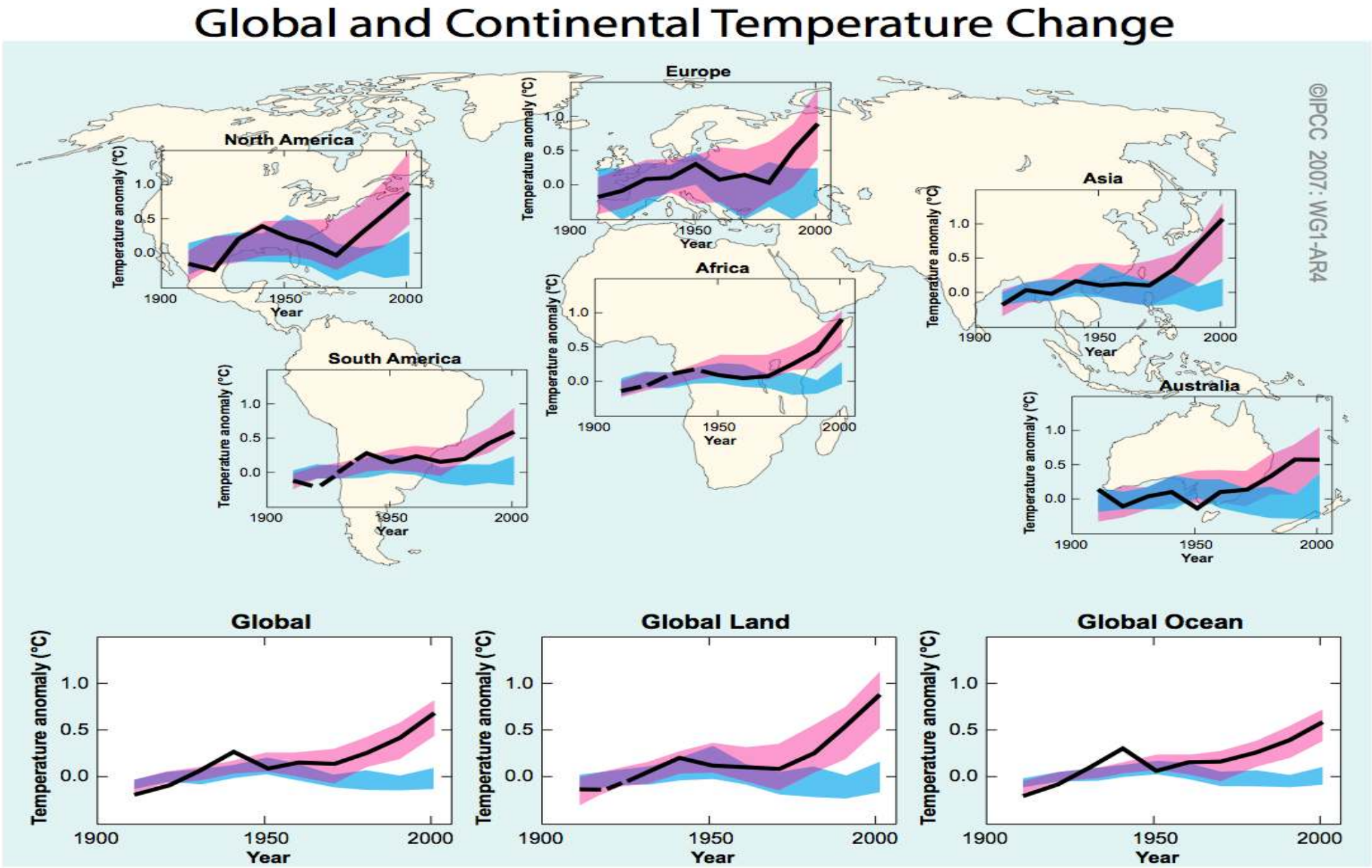
IPCC (1990) Broad overview of climate change science, discussion of uncertainties and evidence for warming.

IPCC (1995) "The balance of evidence suggests a discernible human influence on global climate."

IPCC (2001) "Most of the warming of the past 50 years is likely (>66%) to be attributable to human activities."

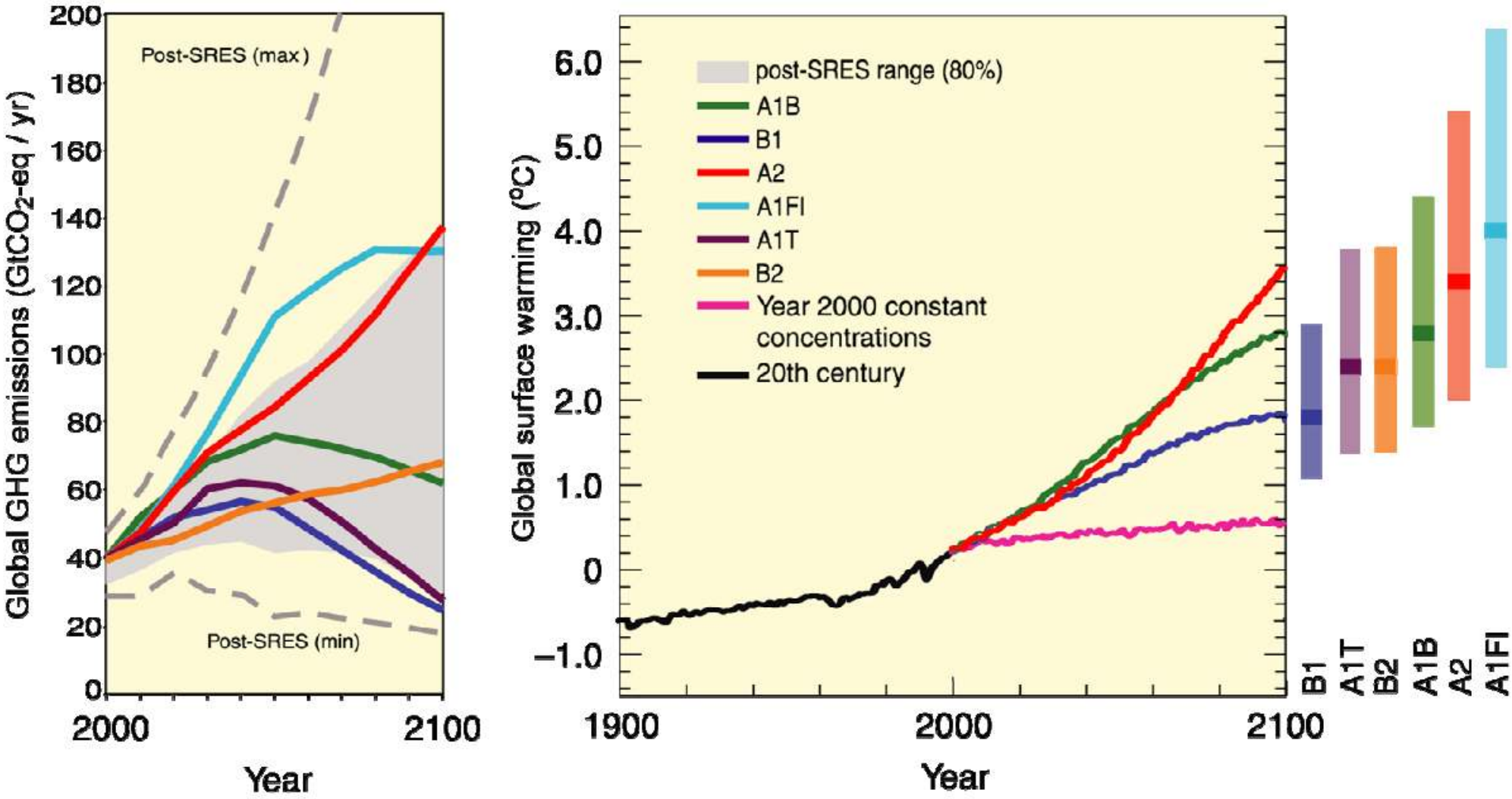
IPCC (2007) "Warming is unequivocal, and most of the warming of the past 50 years is very likely (90%) due to increases in greenhouse gases."

Understanding and Attributing Climate Change



Source: IPCC, AR4 (2007)

Climate projections without mitigation



NB: Reference: 1980-1999 average

Projected globally averaged surface warming and sea level rise at the end of the 21st century (IPCC WG1 AR4)

	Temperature Change (°C at 2090-2099 relative to 1980-1999) [a]		Sea Level Rise (m at 2090-2099 relative to 1980-1999)
Case	Best estimate	*Likely* range	Model-based range excluding future rapid dynamical changes in ice flow
Constant Year 2000 concentrations [c]	0.6	0.3 – 0.9	NA
B1 scenario	1.8	1.1 – 2.9	0.18 – 0.38
A1T scenario	2.4	1.4 – 3.8	0.20 – 0.45
B2 scenario	2.4	1.4 – 3.8	0.20 – 0.43
A1B scenario	2.8	1.7 – 4.4	0.21 – 0.48
A2 scenario	3.4	2.0 – 5.4	0.23 – 0.51
A1FI scenario	4.0	2.4 – 6.4	0.26 – 0.59

NB: add 0.5°C to get pre-industrial reference

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A personal word of caution on the « Best estimate » range [+1.8 to 4°C]

- The « likely » range spans 1.1 to 6.4°C (for 2095 // 1990)
- Add 0.5°C if ref=pre-industrial:
  - Best estimates: +2.3 to 4.5°C
  - Likely range: 1.6 to 6.9°C

- These global values translate into higher values over continents (~+0.2-0.4°C) ➔ Likely range: 1.8 to 7.3°C

- Seasonal effects (« Prudence » EU project):
  - N. Europe: larger warming in winter than in summer
  - S. and Central Europe: larger warming in summer than in winter

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A personal word of caution on the « Best estimate » range [+1.8 to 4°C]

- « Likely » means over 66% assessed likelihood. You still have a 34% likelihood of being out of the range. A first guess is **17% probability of being above 7.3°C** (annual value), and still higher seasonally.

- Using the « best estimates » values is misleading for policy purposes!!

- Good news: all this is *without* specific climate mitigation

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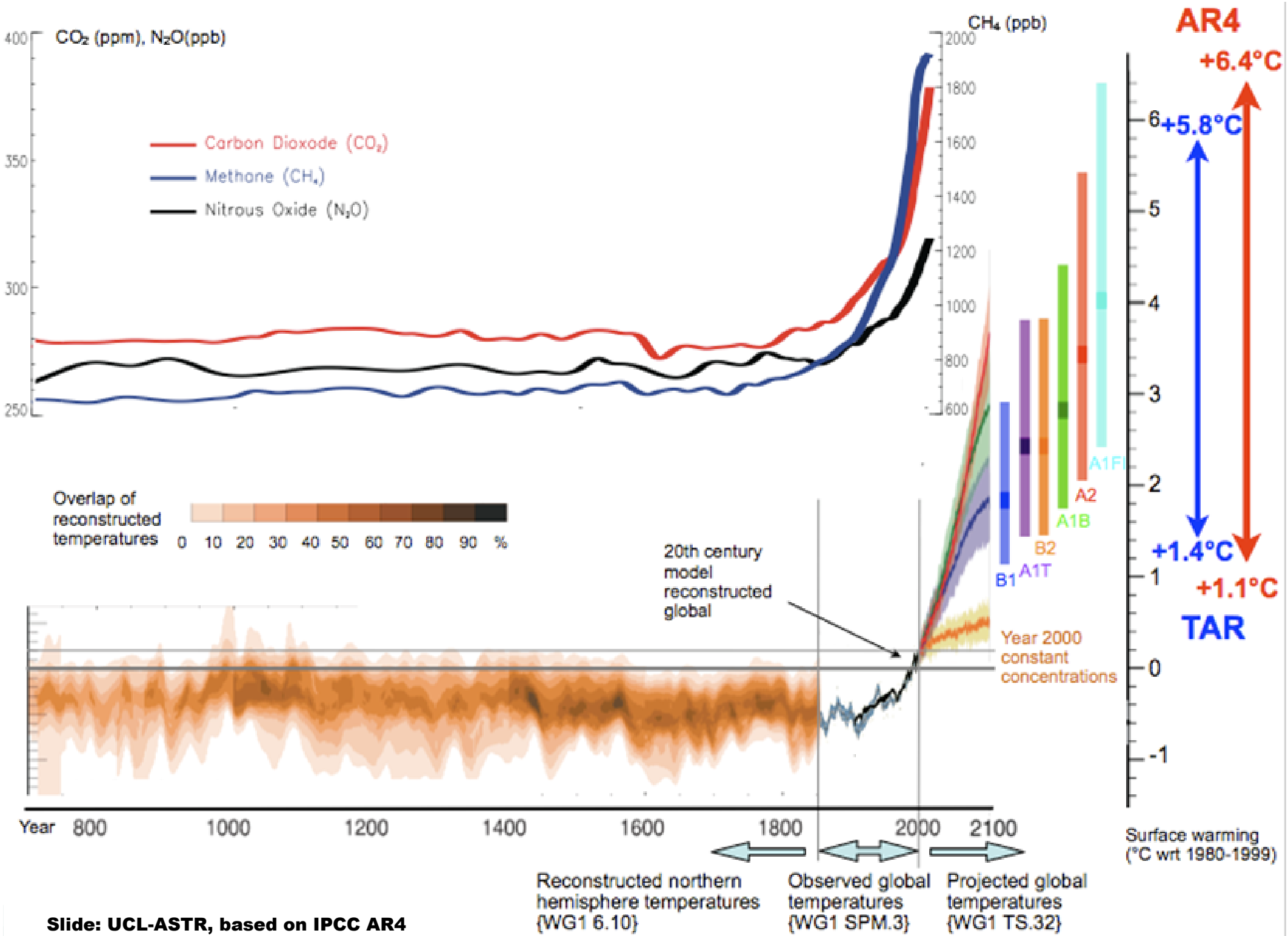
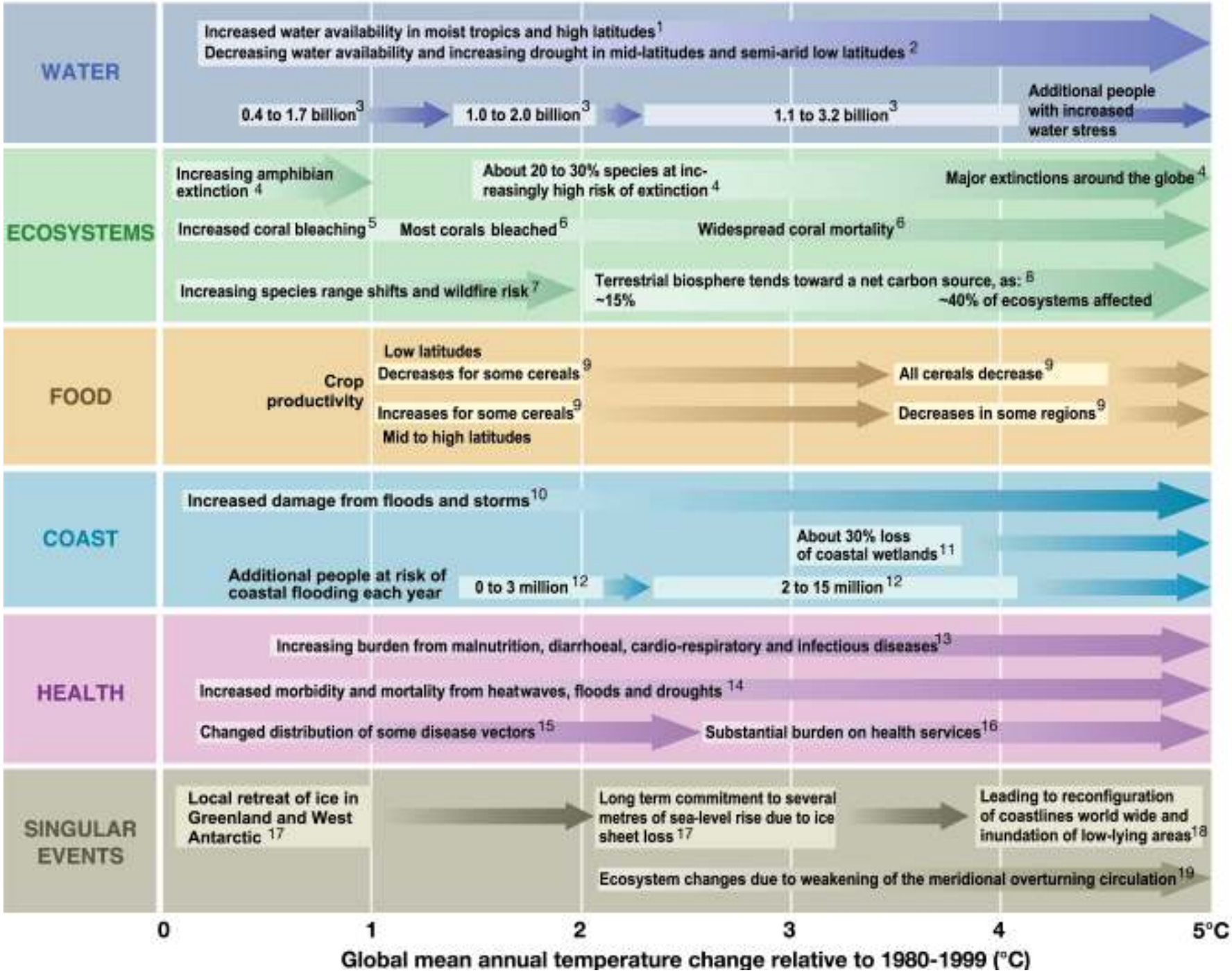


Slide: UCL-ASTR, based on IPCC AR4

Ice sheet melting

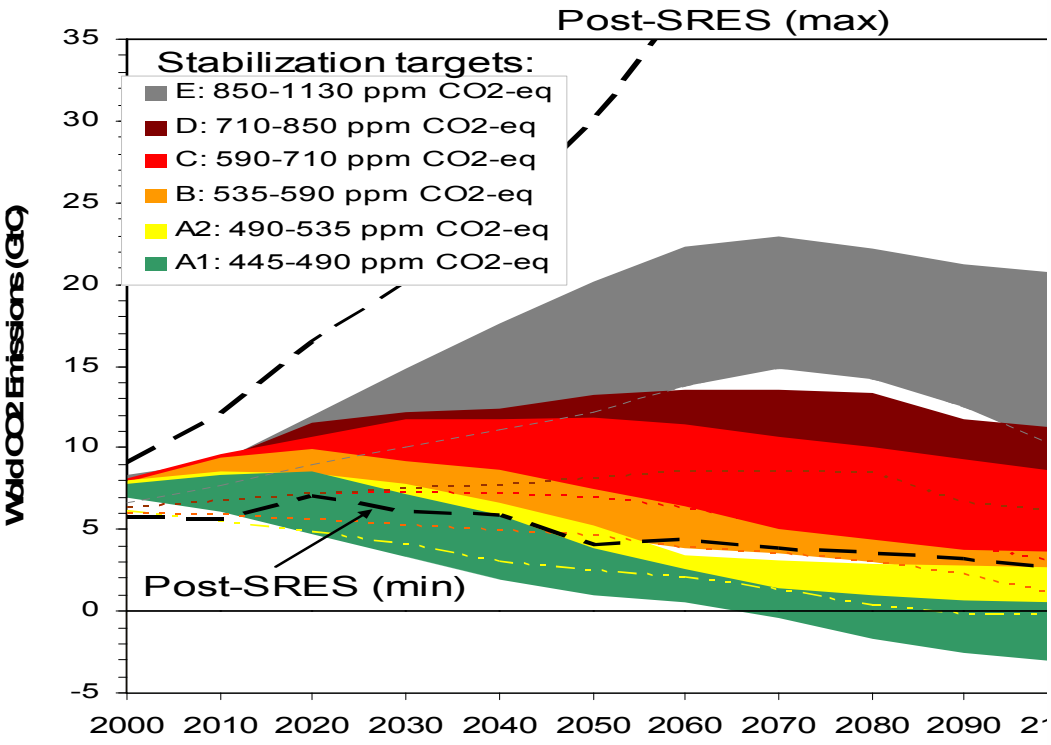
- Melting of the Greenland ice sheet
  - Total melting would cause 7 m SLR contribution
- Melting of the West Antarctic Ice Sheet
  - Total melting would cause 5 m SLR contribution
- Warming of 1 – 4^{o}C over present-day temperatures would lead to partial melting over centuries to millennia

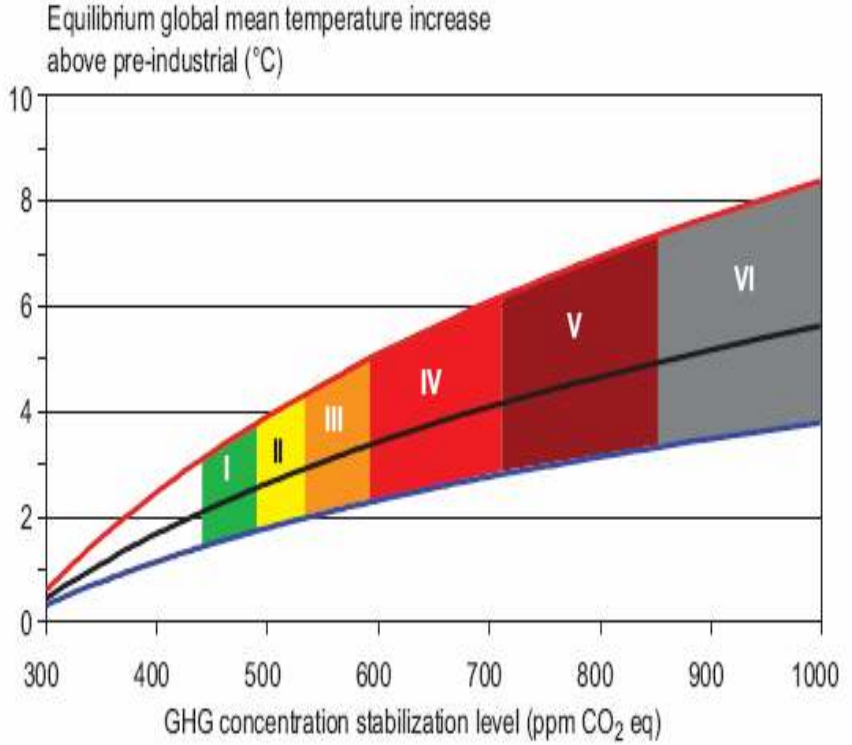
Table TS.3. (lower) Examples of global impacts projected for changes in climate (and sea level and atmospheric CO_2 where relevant)



Source: IPCC WGII AR4

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





Multigas and CO2 only studies combined

WMO

UNEP

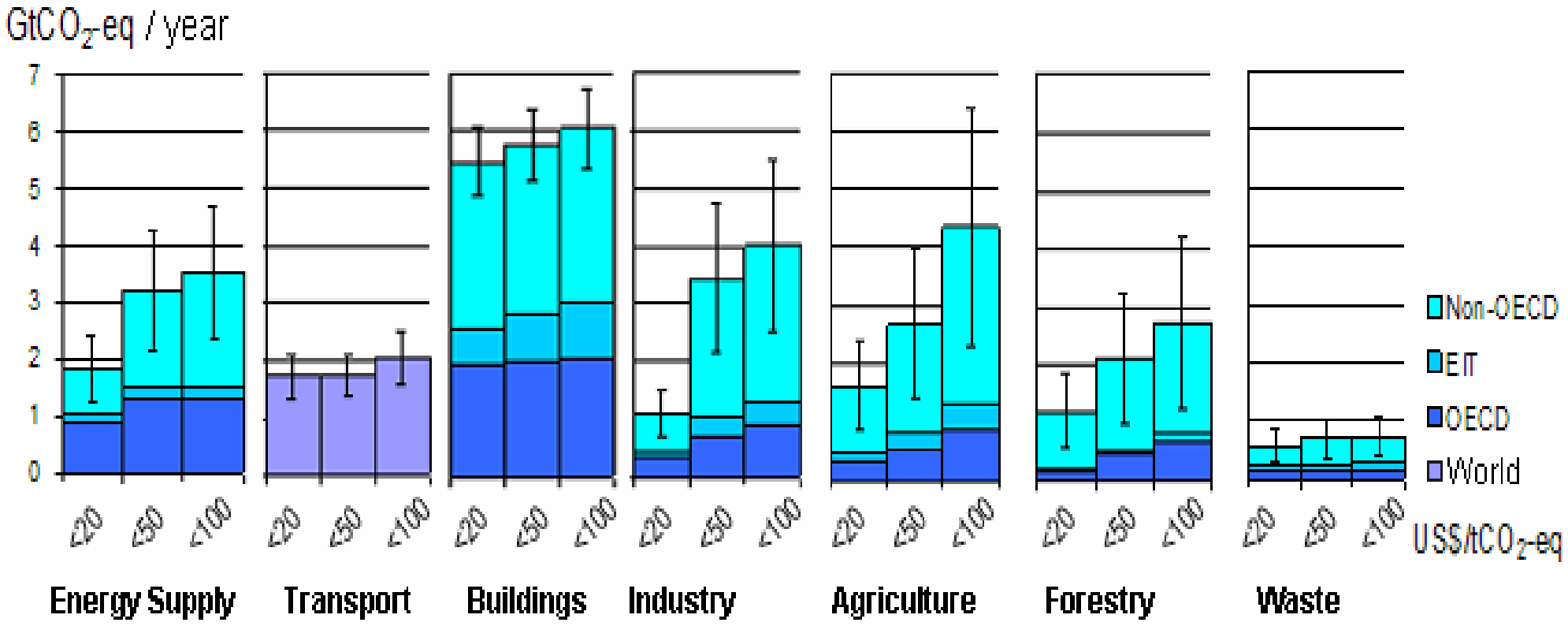
Long term mitigation (after 2030)

Source: IPCC WGIII AR4

- The lower the stabilization level, the more quickly emissions would need to peak and to decline thereafter
- Mitigation efforts over the next two to three decades will have a large impact on opportunities to achieve lower stabilization levels

Stab level (ppm CO2-eq)	Global Mean temp. increase at equilibrium (°C)	Year CO2 needs to peak	Reduction in 2050 compared to 2000
445 – 490	2.0 – 2.4	2000 - 2015	-85 to -50
490 – 535	2.4 – 2.8	2000 - 2020	-60 to -30
535 – 590	2.8 – 3.2	2010 - 2030	-30 to +5
590 – 710	3.2 – 4.0	2020 - 2060	+10 to +60
710 – 855	4.0 – 4.9	2050 - 2080	+25 to +85
855 – 1130	4.9 – 6.1	2060 - 2090	+90 to +140

All sectors and regions have the potential to contribute by 2030



Source: IPCC WGIII AR4

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

⌘Does policy listen to IPCC ?

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Bali: COP Decision about IPCC AR4 (Decision 5/CP.13)

- The Conference of the Parties,
- 1. Welcomes the Fourth Assessment Report of the Intergovernmental Panel on ClimateChange;
- 2. Expresses its appreciation and gratitude to all those involved in the preparation of the Fourth Assessment Report of the Intergovernmental Panel on Climate Change for their excellent work;
- 3. Recognizes that the Fourth Assessment Report represents the most comprehensive and authoritative assessment of climate change to date, providing an integrated scientific, technical and socio-economic perspective on relevant issues;

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Bali action plan (december 2007)

- ***The Conference of the Parties*,**
- ***(…) Responding* to the findings of the Fourth Assessment Report of the Intergovernmental Panel on Climate Change that warming of the climate system is unequivocal, and that delay in reducing emissions significantly constrains opportunities to achieve lower stabilization levels and increases the risk of more severe climate change impacts,**
- ***Recognizing* that deep cuts in global emissions will be required to achieve the ultimate objective of the Convention and emphasizing the urgency *(NOTE 1)* to address climate change as indicated in the Fourth Assessment Report of the IPCC,**
- **1. *Decides* to launch a comprehensive process to enable the full, effective and sustained implementation of the Convention through long-term cooperative action, now, up to and beyond 2012, in order to reach an agreed outcome and adopt a decision at its fifteenth session, by addressing, inter alia: …**
- ***Note 1: Contribution of Working Group III to the Fourth Assessment Report of the IPCC, Technical Summary, pages 39 and 90, and Chapter 13, page 776.***

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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,

- **WGIII Chapter 13, page 776, referred to by Bali action plan**

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).

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⌘Some post-IPCC AR4 science

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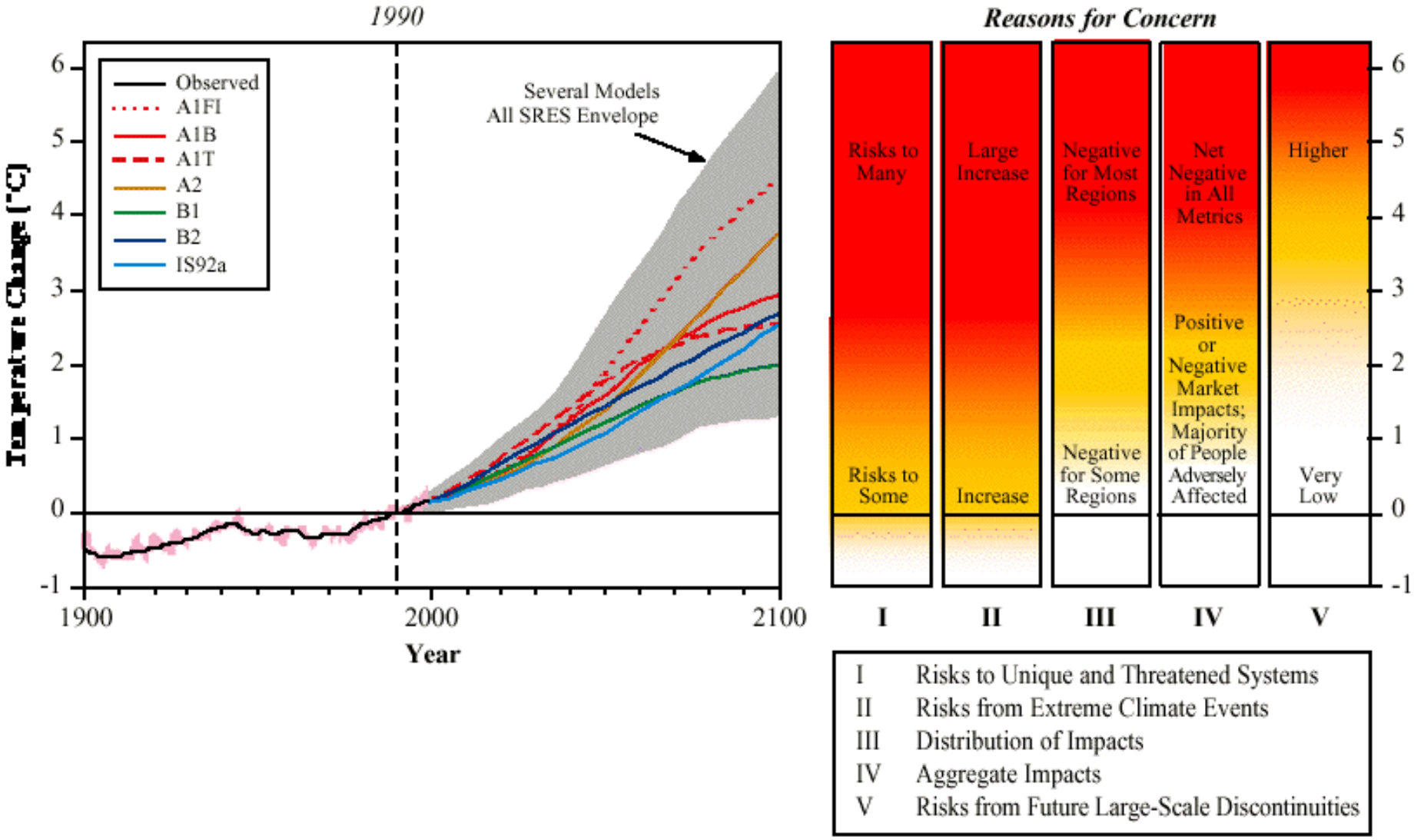
IPCC 2001: Burning ember diagram



Were there an AR4 Burning ember diagram the red zones would migrate downward. The Reasons For Concern are, likewise, higher at same temperature levels

Emission reduction trade-offs for meeting concentration targets

Michel den Elzen (Contributing Author IPCC WG III AR4)
Niklas Höhne (Lead Author IPCC WG III AR4)

Box 13.7: Reductions Annex I and non-Annex I countries *as a group* for concentration targets

Scenario category	Region	2020	2050
A-450 ppm CO_2-eq[2]	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, Middle East, and East Asia

Back-ground

- AWG-KP recognised that Annex I countries need to reduce their emissions within a range of 25% to 40% below 1990 levels, in order to reach the lowest stabilisation levels.
- Bali action plan:
  - Box 13.7 much attention, but it called for “deep cuts in global emissions” and a reference was included in a footnote
  - comparable mitigation commitments by all developed countries
  - “measurable, reportable and verifiable nationally appropriate mitigation commitments or actions … by all developed country Parties…”
  - appropriate mitigation actions by developing countries by the end of 2009.

Netherlands Environmental Assessment Agency

Two questions

1. How were the reduction ranges derived and whether new allocation studies would change the results?
2. What is termed as “substantial deviation from the baseline” for non-Annex I countries and what are the important determinants?

Netherlands Environmental Assessment Agency

Conclusions

- New allocation studies confirm the reductions in Box 13.7.
- For non-Annex I (NA1) countries as a group “substantial deviation from baseline” is now specified: 15-30% for 450 ppm CO_2-eq, 0-20% for 550 ppm CO_2-eq and from 10% above to 10% below baseline for 650 ppm CO_2-eq, in 2020. Roughly the first 10% can be “no-regret options”
- If Annex I countries as a group reduces with 30% below 1990 level, non-Annex I need to reduce about 10-25% below baseline for meeting 450 ppm CO_2-equivalent
- For baseline that assume ongoing rapid growth in non-Annex I emissions (higher than IPCC SRES range), the reductions will be higher.
- Avoiding deforestation relaxes the reductions for Annex I and non-Annex I

Netherlands Environmental Assessment Agency

⌘Some focus on Europe

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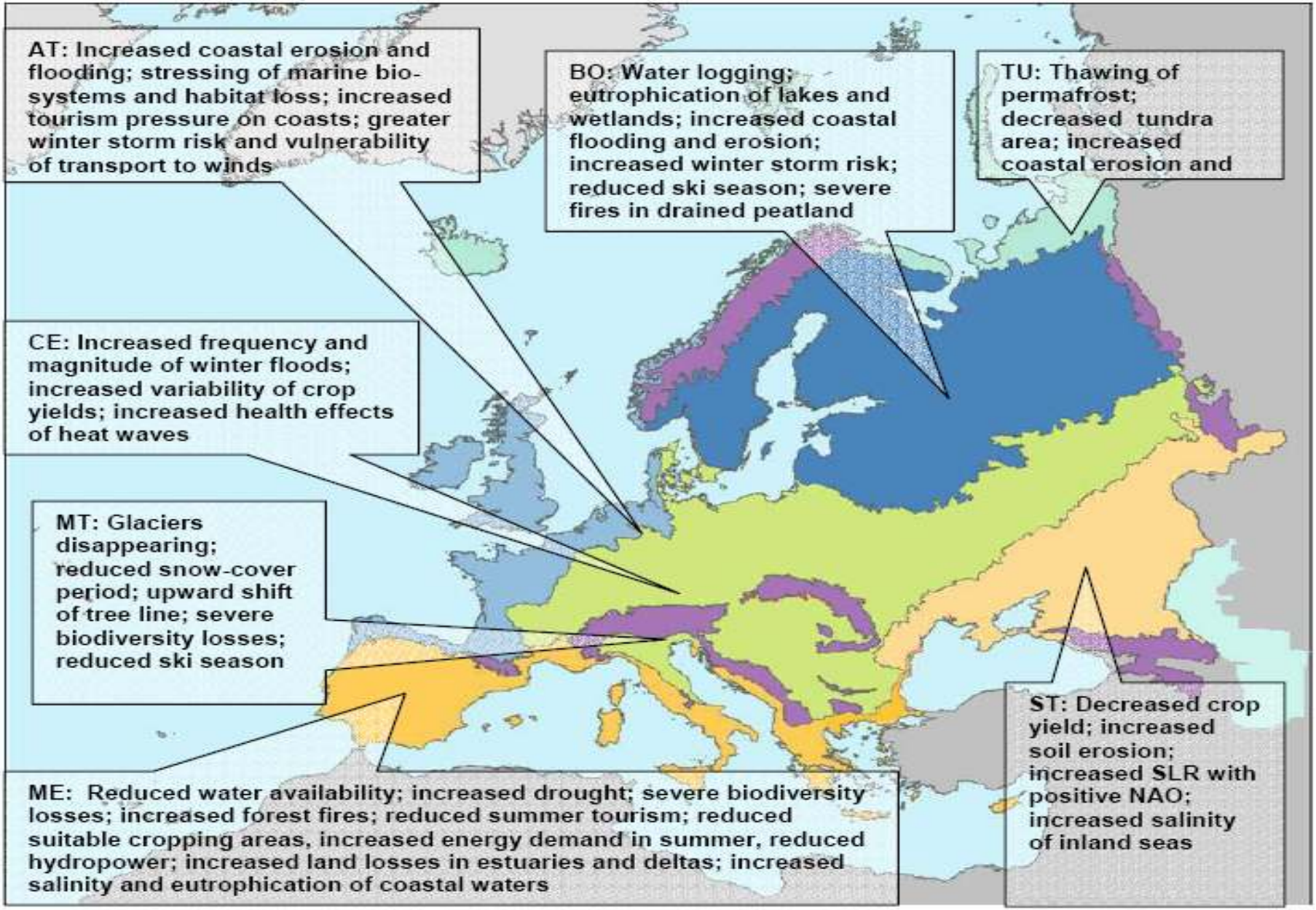


Figure 12.3: *Key vulnerabilities of European systems and sectors to climate change during the 21st century for the main biogeographic regions of Europe (EEA 2004a): TU (Tundra, pale turquoise); BO (Boreal, dark blue); AT (Atlantic, light blue); CE (Central, green [includes the Pannonian Region]); MT (Mountains, purple); ME (Mediterranean, orange [includes the Black Sea region]); ST (Steppe, cream); SLR (sea-level raise); NAO (North Atlantic Oscillation).*

Excerpts from IPCC AR4 WG2 (Chapter Europe)

- **For the first time, wide ranging impacts of changes in current climate have been documented in Europe**
  - retreat of glaciers, lengthening of growing season, shift of species, heat wave in 2003, …
- **Climate-related hazards will mostly increase, although changes will vary geographically**
  - More winter floods in maritime regions, snowmelt-related floods in Central and E. Europe, flash floods throughout Europe.
  - Coastal flooding related to increasing storminess and sea level rise is likely to threaten up to 2.5 million additional people annually.
  - Some impacts may be positive, as in reduced risk of extreme cold events. However, on balance, health risks are very likely to increase.

WMO UNEP

Excerpts from IPCC AR4 WG2 (Chapter Europe)

- **Climate change is likely to magnify regional differences of Europe's natural resources and assets.**
- **Water stress will increase over Central and S. Europe, as well as the number of people living in river basins under high water stress.**

WMO UNEP

Excerpts from IPCC AR4 WG2 (Chapter Europe)

- **It is anticipated that Europe's natural (eco)systems and biodiversity will be substantially affected by climate change. The great majority of organisms and ecosystems are likely to have difficulty in adapting to climate change.**
  - **A large percentage of the European flora is likely to become vulnerable, endangered, or committed to extinction by the end of this century.**
  - **Options for adaptation are likely to be limited for many organisms and ecosystems.**
  - **Low-lying, geologically-subsiding coasts are likely to be unable to adapt to sea-level rise.**
  - **New sites for conservation may be needed.**

What if the Gulf Stream is affected?

- Based on current model simulations, it is *very likely* that the meridional overturning circulation (MOC) of the Atlantic Ocean will slow down during the 21st century.
  - **longer term changes not assessed with confidence**
- Temperatures in the Atlantic region are projected to increase despite such changes due to the much larger warming associated with projected increases of greenhouse gases.

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: N. Dendoncker (Dépt de Géographie, UCL), J.P. van Ypersele et P. Marbaix (Dépt de Physique, UCL) (www.climate.be/impact)

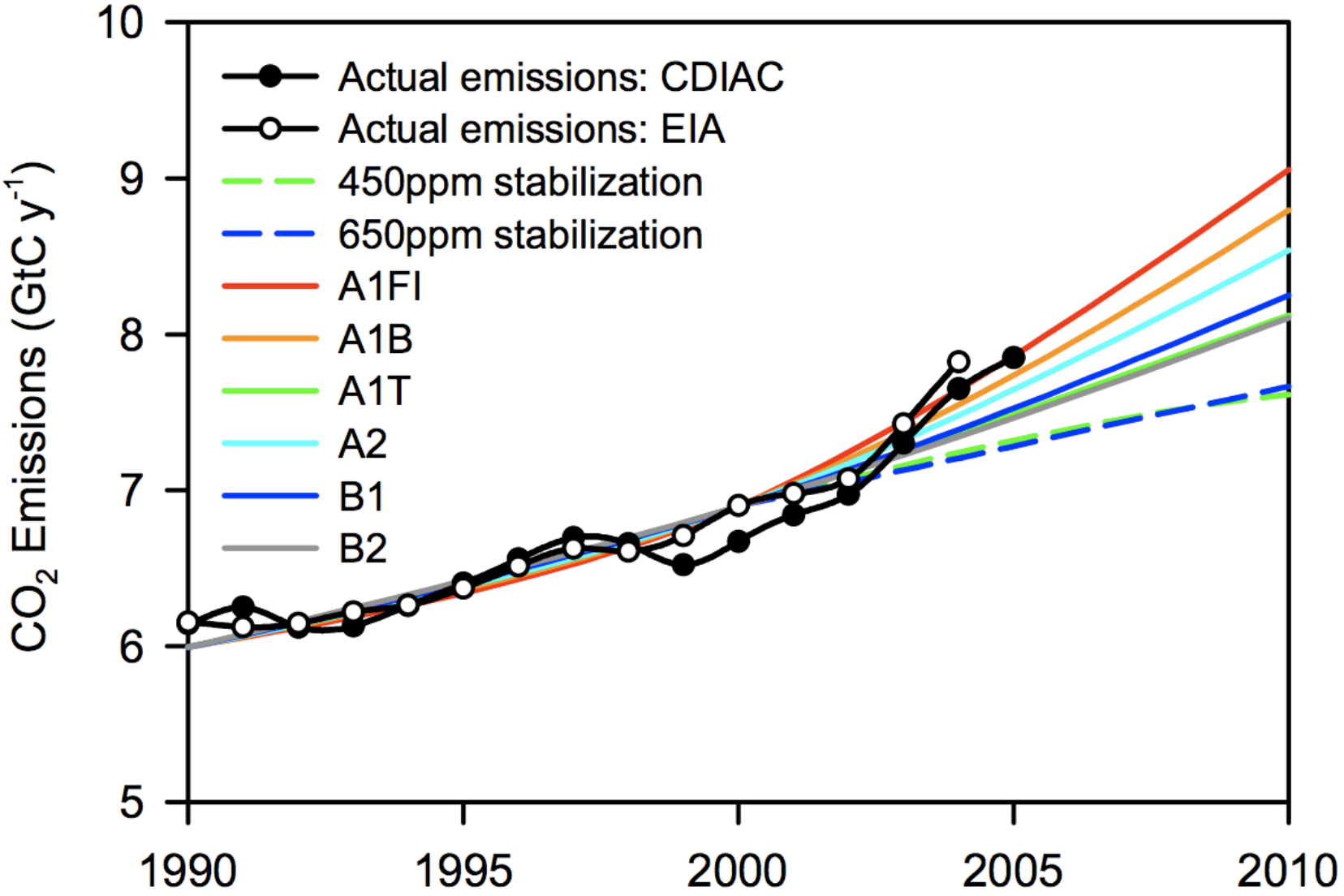
With 8 metre sea-level rise: 3700 km^2 below sea-level in Belgium

(very possible in year 3000)

(NB: flooded area depends on protection)

Source: N. Dendoncker (Dépt de Géographie, UCL), J.P. van Ypersele et P. Marbaix (Dépt de Physique, UCL) (www.climate.be/impact)

Urgent GHC reduction is needed to prevent greater climate risks and costs and help decouple economic growth from environmental pressure



Source: PNAS 2007, Raupach

Useful links:

- www.ipcc.ch : IPCC
- www.unfccc.int : Climate Convention
- www.climate.be/JCM: interactive climate model
- www.climate.be/vanyp : my slides and other documents

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