Climate change: a new context for food security?

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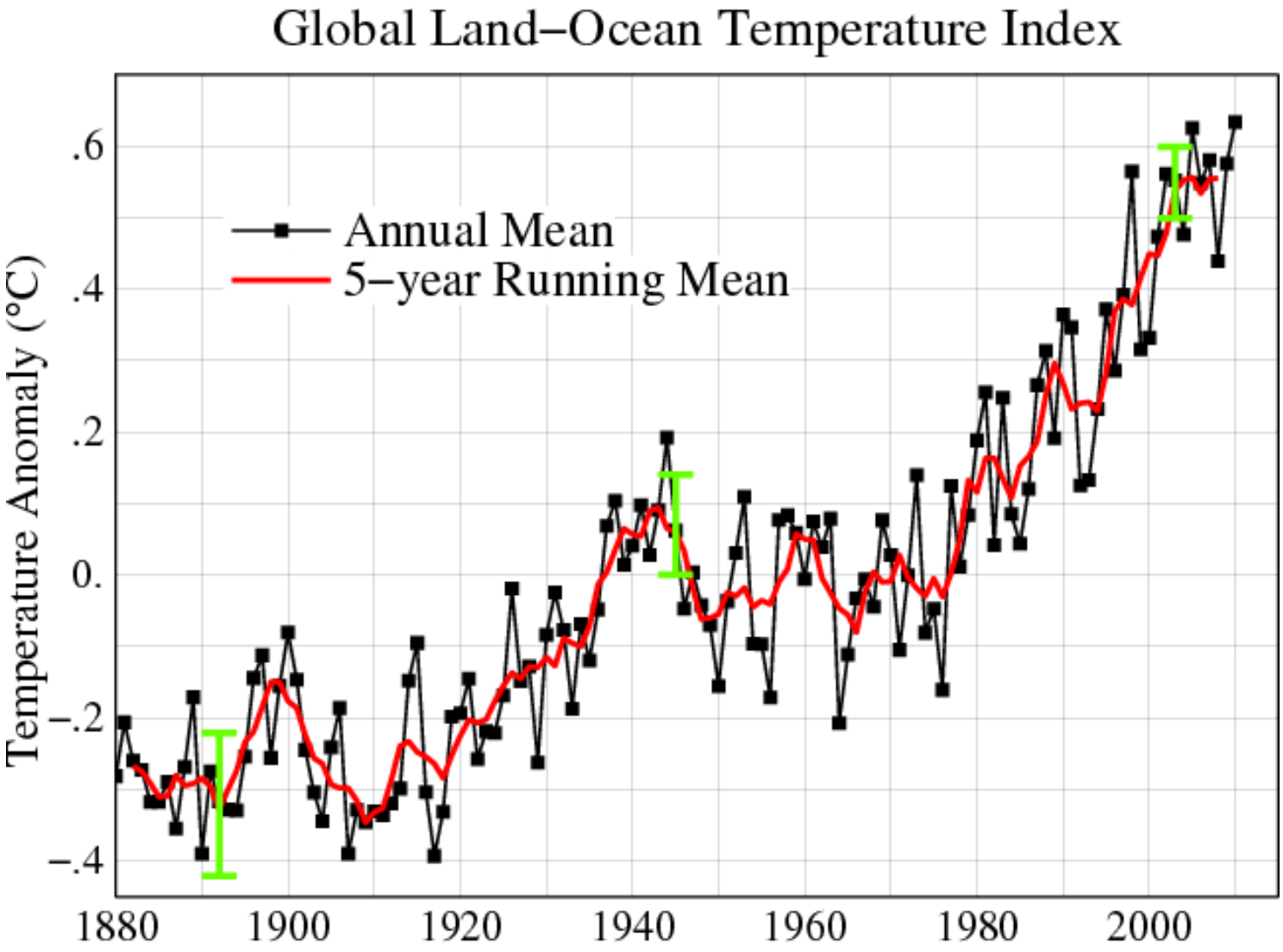
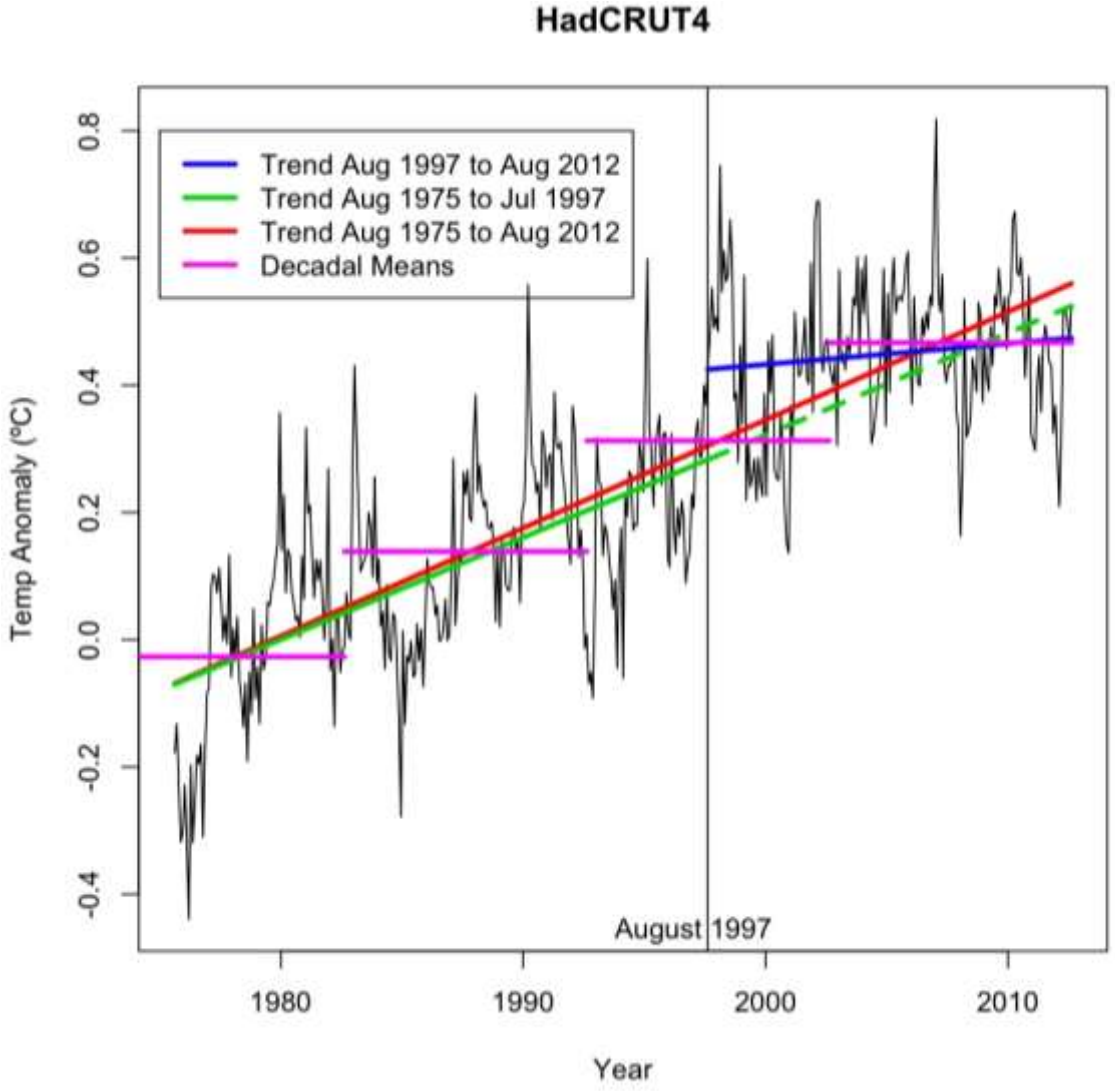
NB: The support of Belgian Science Policy Office are gratefully acknowledged.

Warming has not « stopped »: Global (land & ocean) mean surface temperature change from NASA GISS until 2010



Source: NASA GISS

Warming has not « stopped »: Global (land & ocean) mean surface temperature change



http://www.realclimate.org/index.php/archives/2012/11/short-term-trends-another-proxy-fight/

The human contribution to climate warming

Removing fast-varying natural effects (volcanic, solar, El Niño/La Niña), what is left is the human contribution +0.15˚ C/decade).

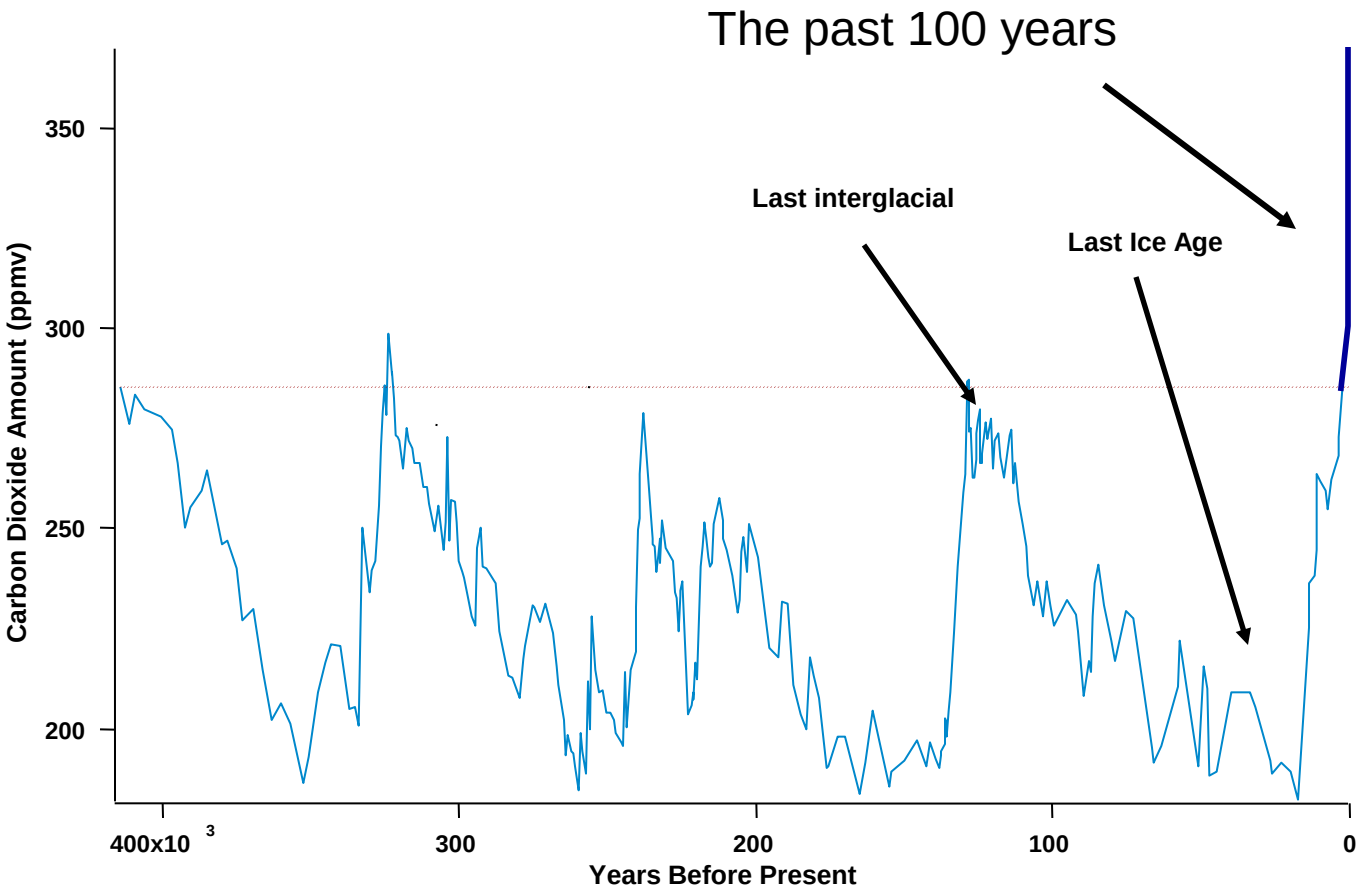
An excellent video demonstration by

www.skepticalscience.com

Or:

http://sks.to/16years

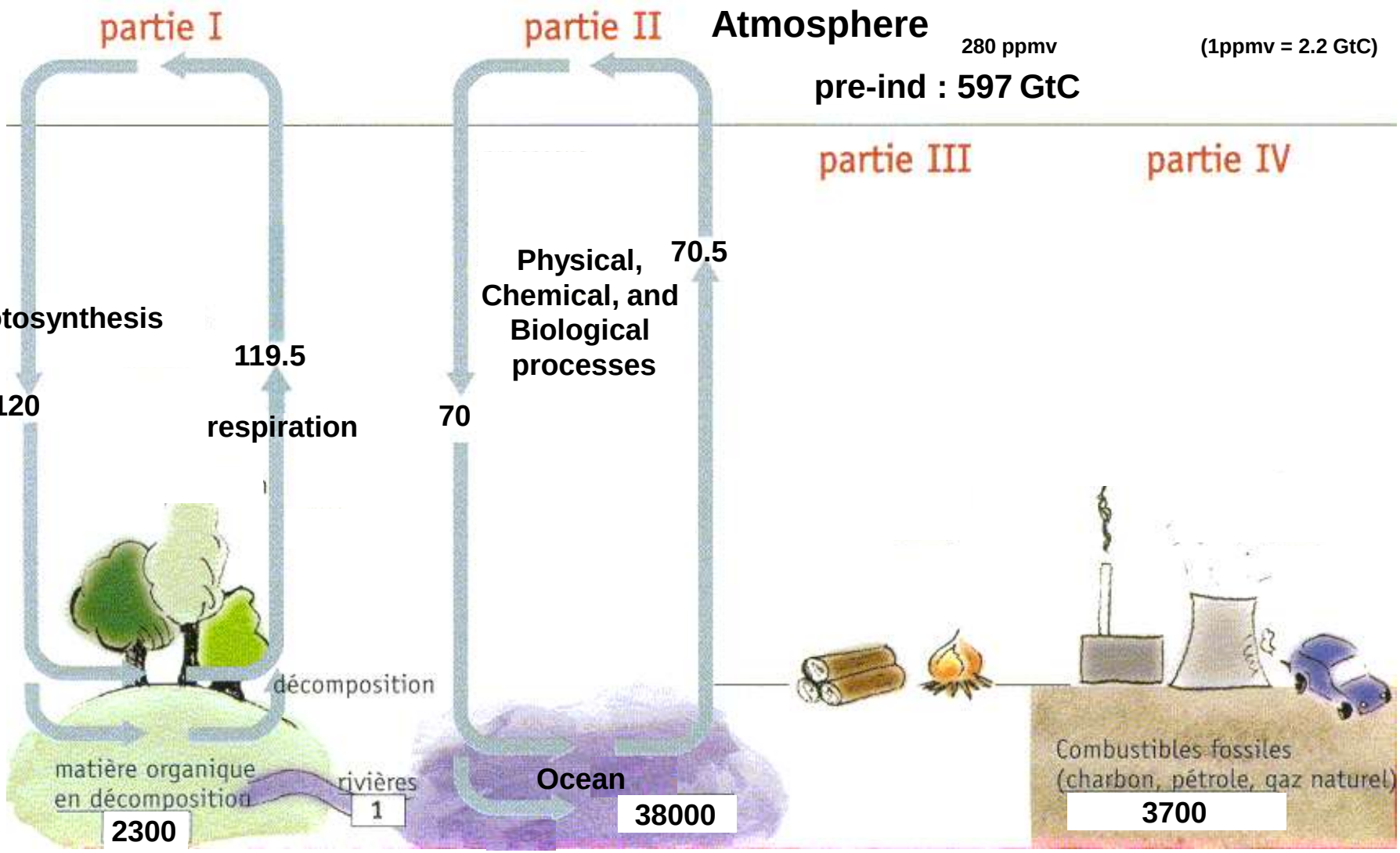
Some information about carbon dioxide changes through four past ice ages (from ice cores), and in the modern era (from global data)



Ice ages are 'forced' by earth's orbital clock….

It is well established that there is more carbon dioxide in the atmosphere today than there has been in at least 650,000 years. **(Figure by S. Solomon)**

Carbon cycle: unperturbed fluxes



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

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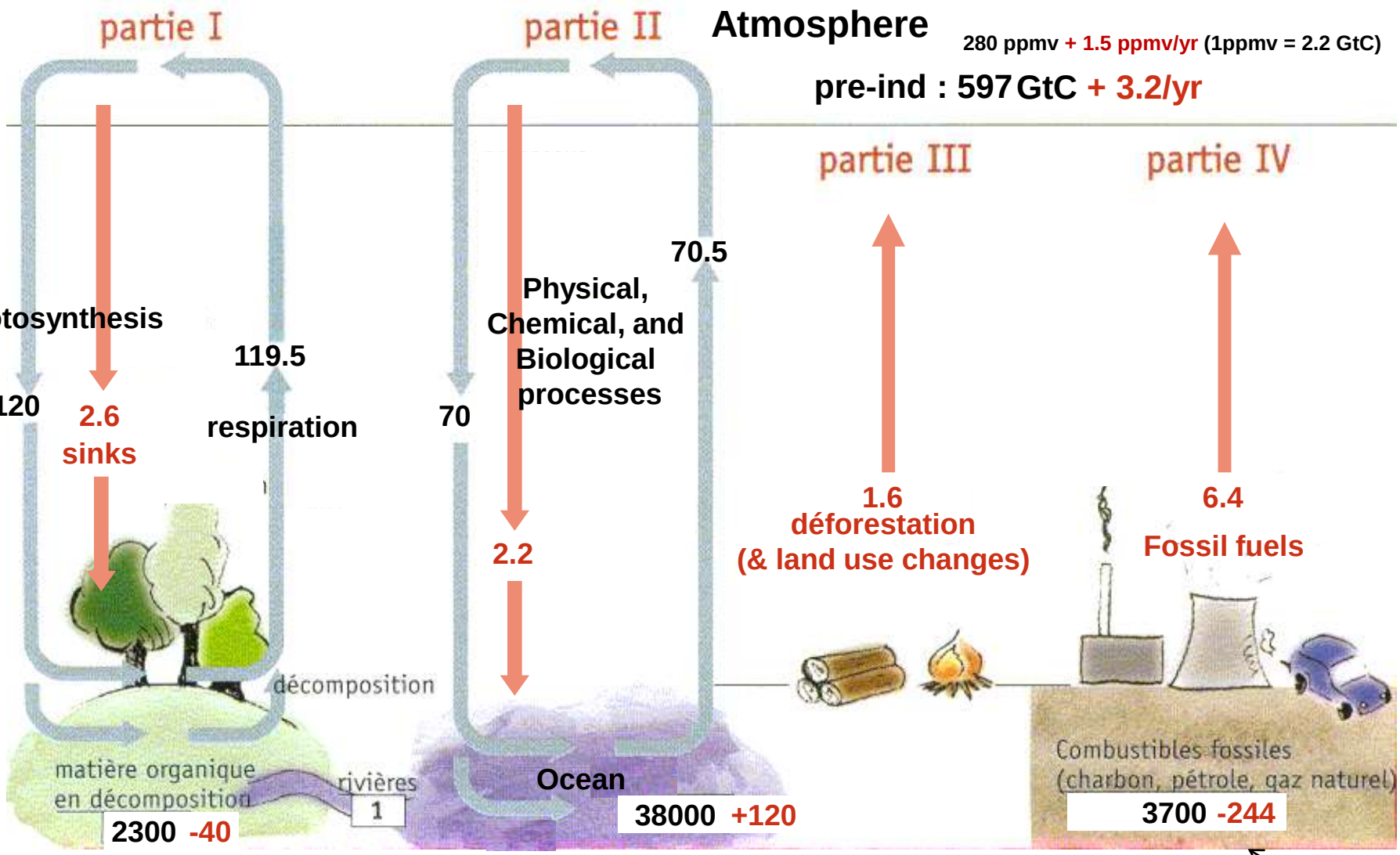
Carbon cycle: perturbed by human activities

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



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

Stocks!

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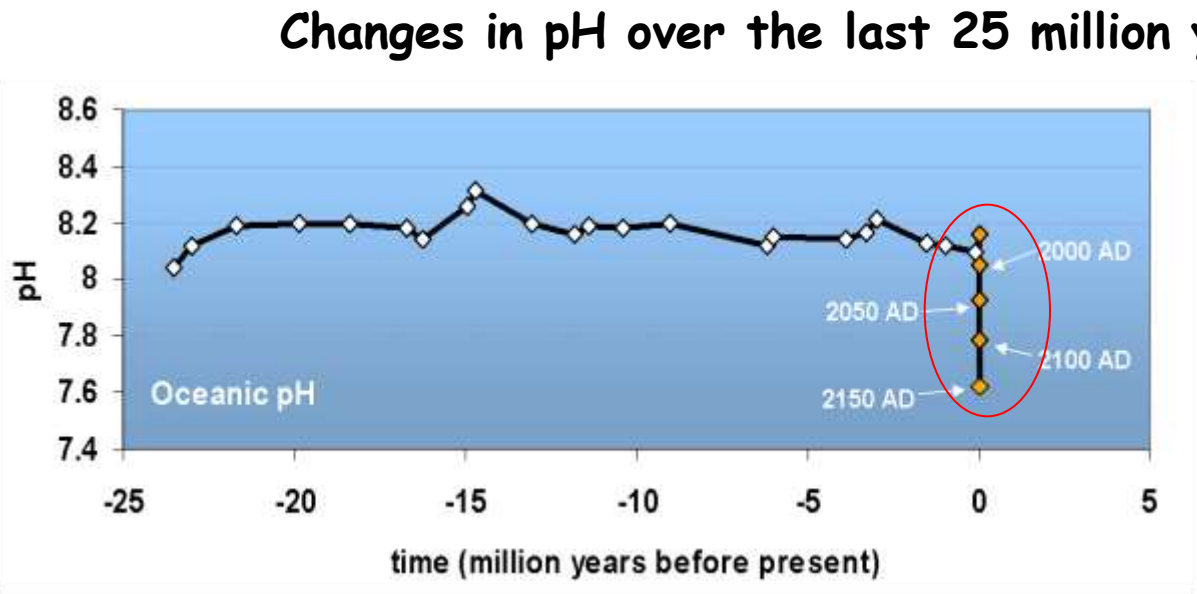
Oceans are Acidifying Fast …….



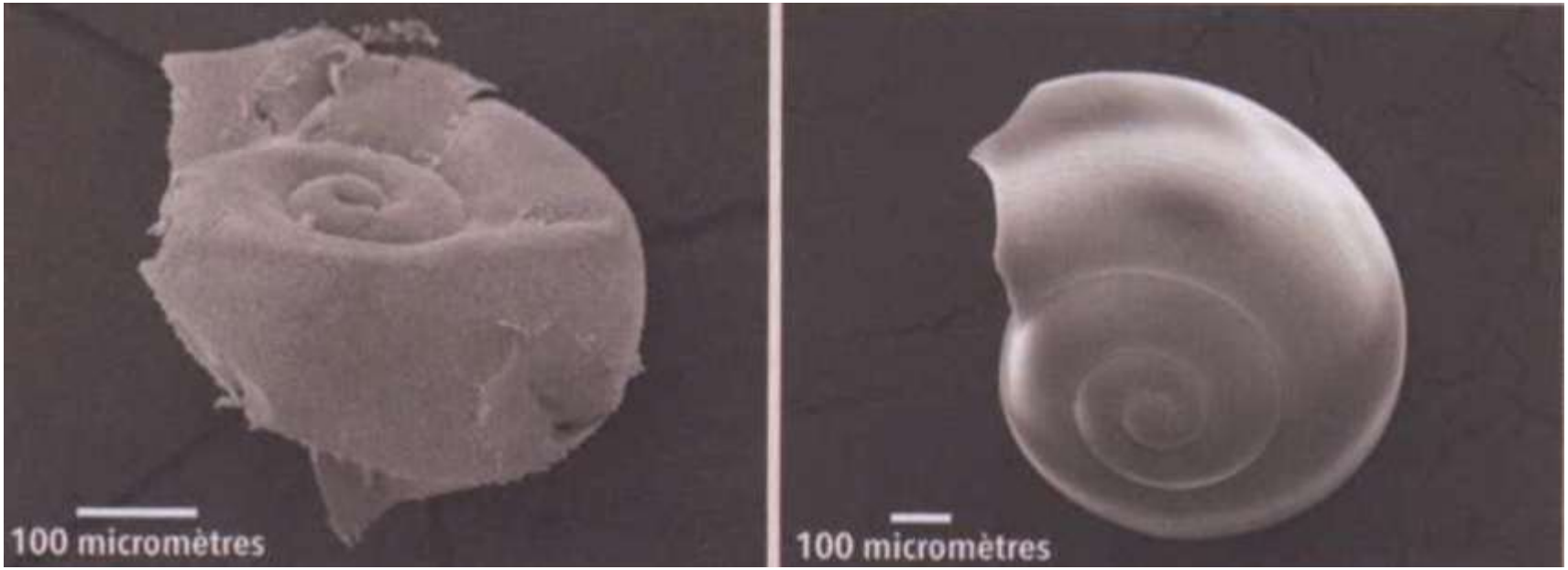
"Today is a rare event in the history of the World"

- **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

First visible effects of acidification on calcarous shells: a threat to ocean life ?

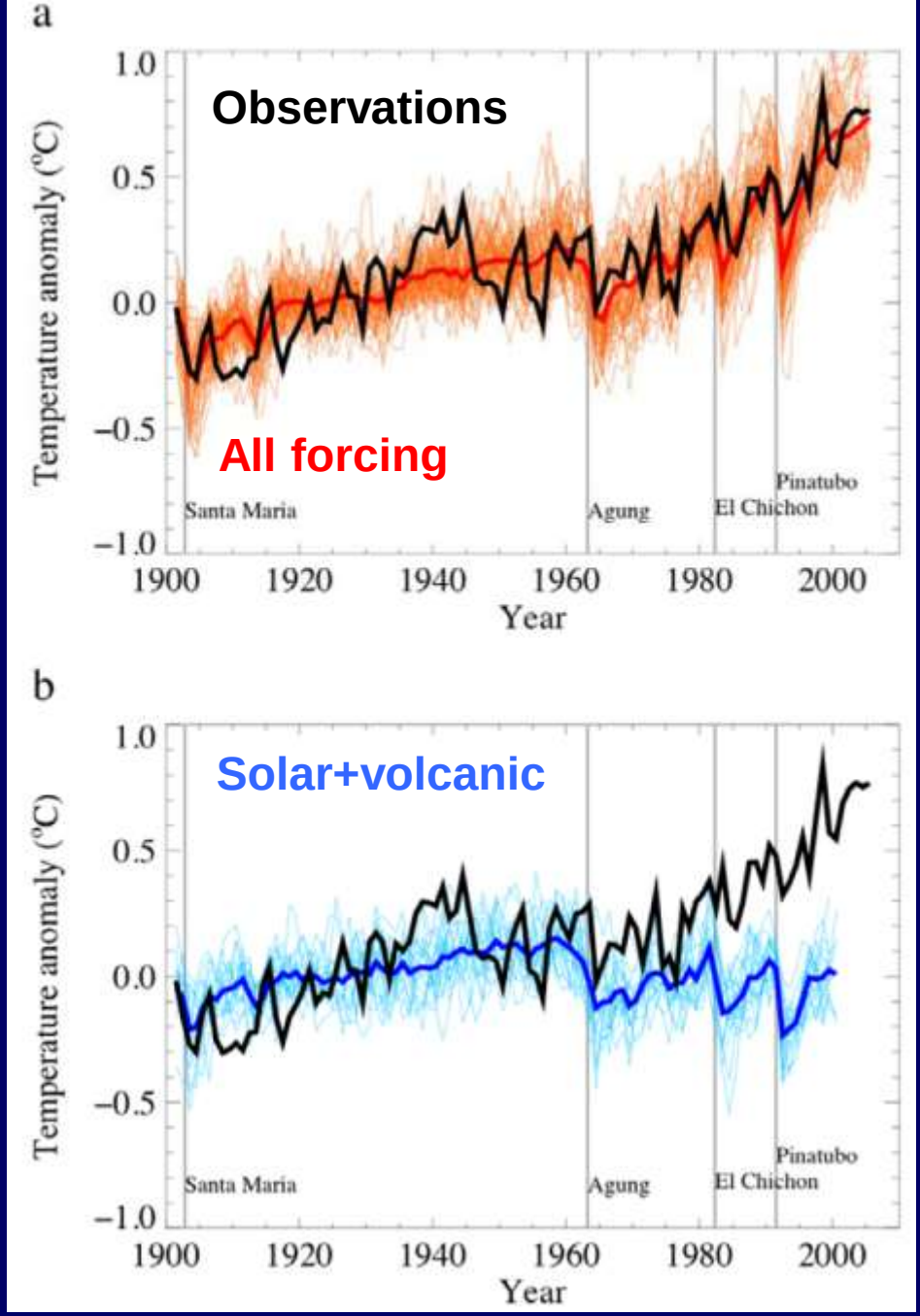


Bednarsek et al. (2012), Ngeo, doi:10.1038/ngeo1635

Attribution

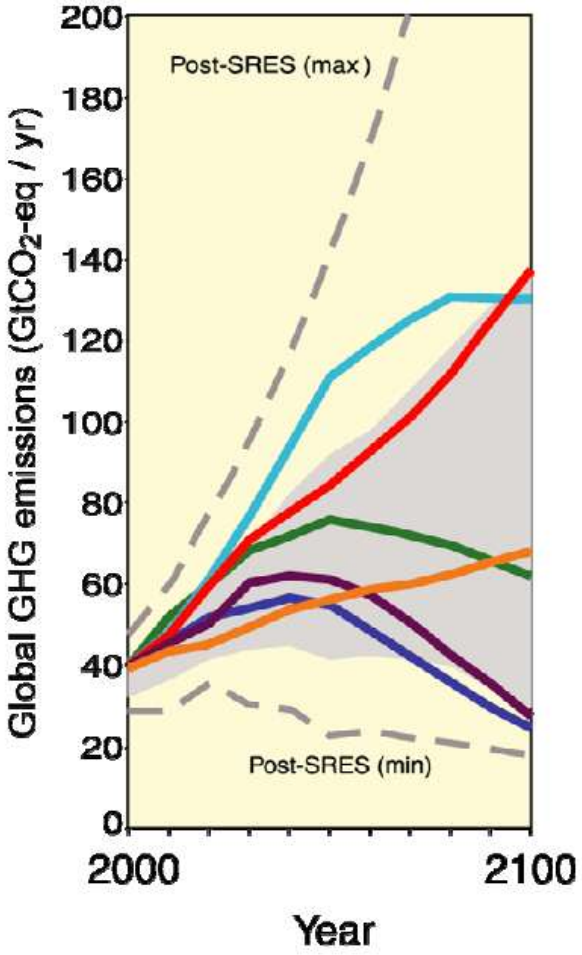
Are observed changes consistent with expected responses to natural forcings?

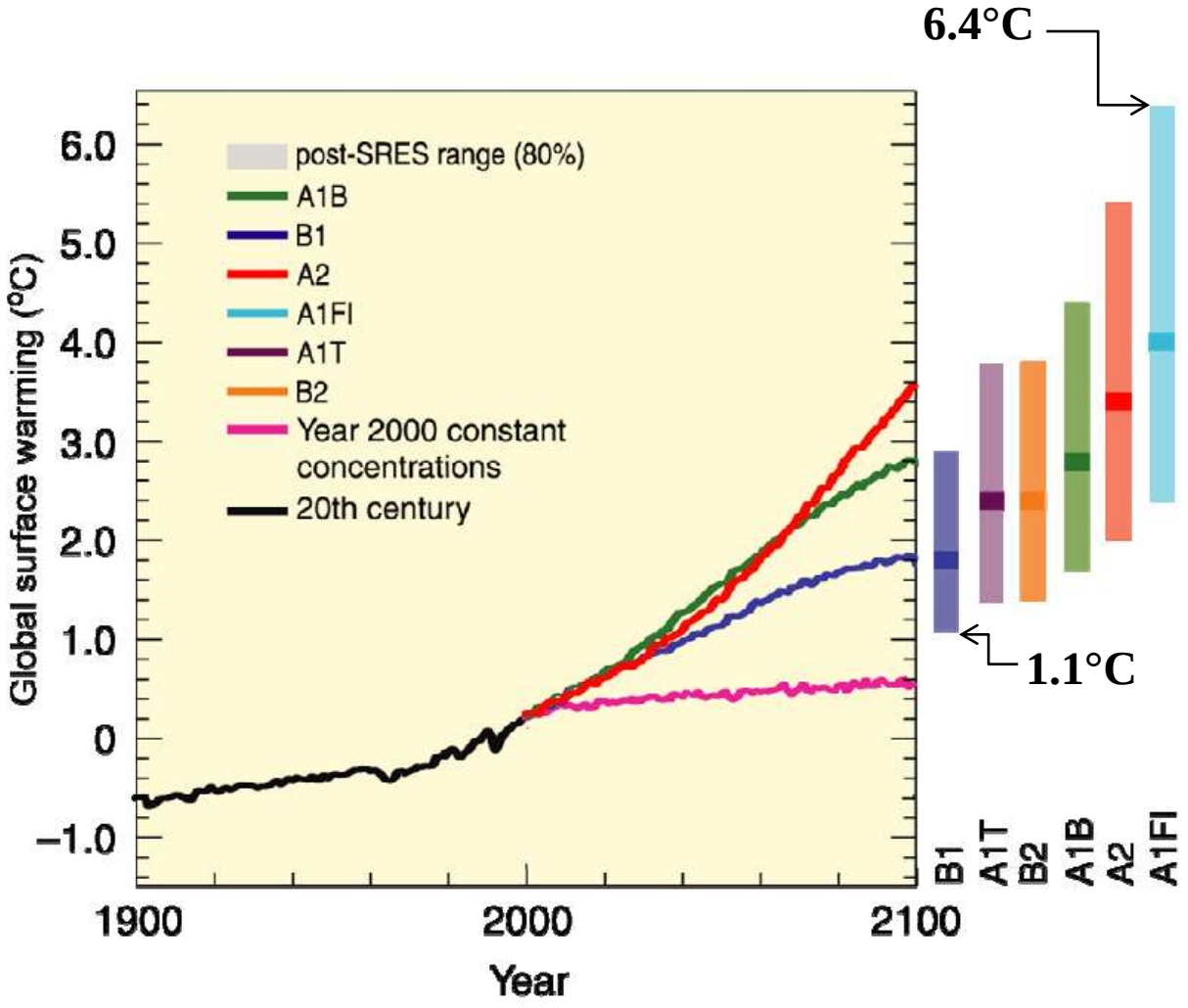
IPCC (2007):
"Warming is unequivocal, and most of the warming of the past 50 years is very likely (90%) due to increases in greenhouse gases."



Source: IPCC, AR4 (2007)

Climate projections without mitigation





NB: departure from the 1980-1999 average

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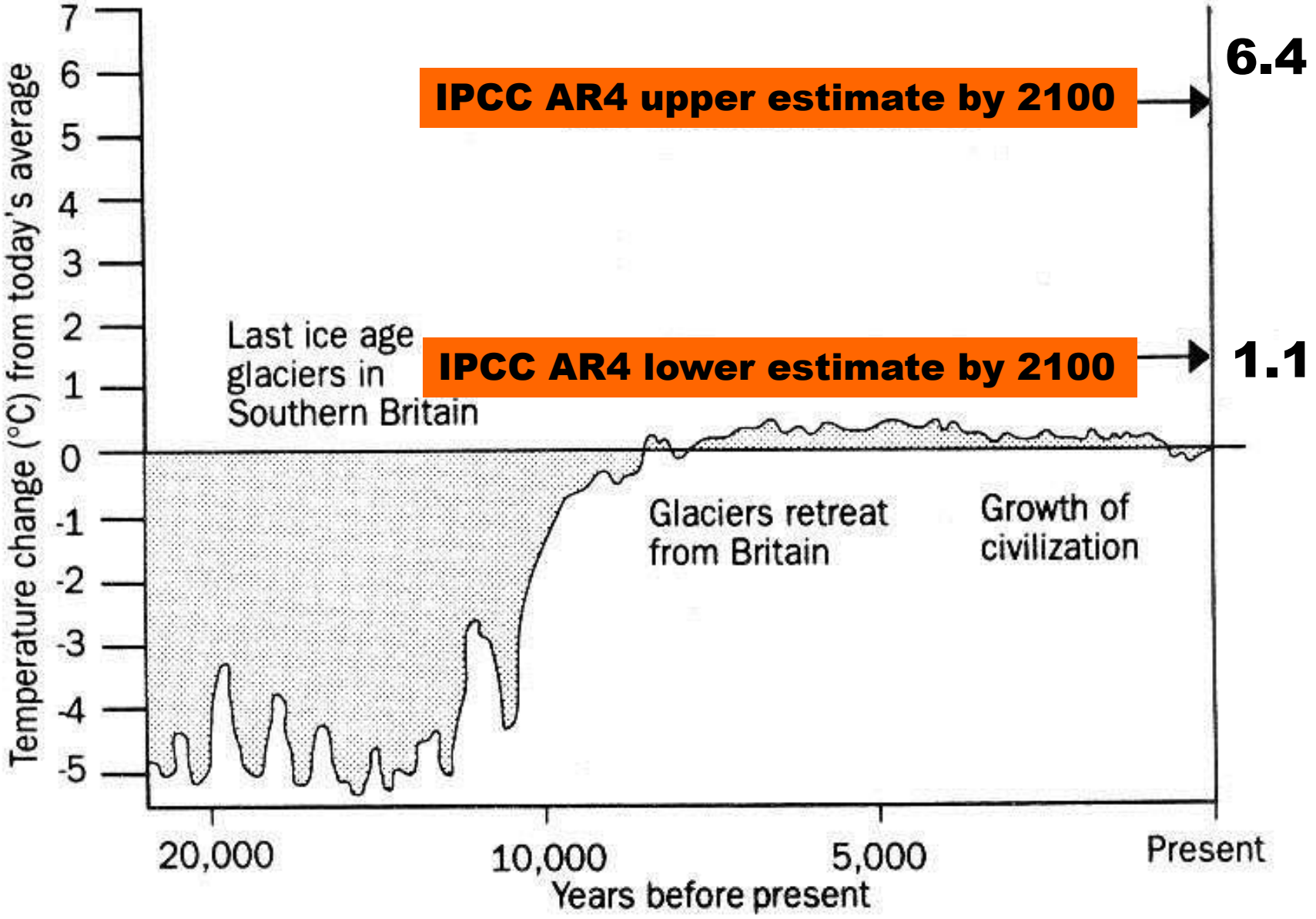
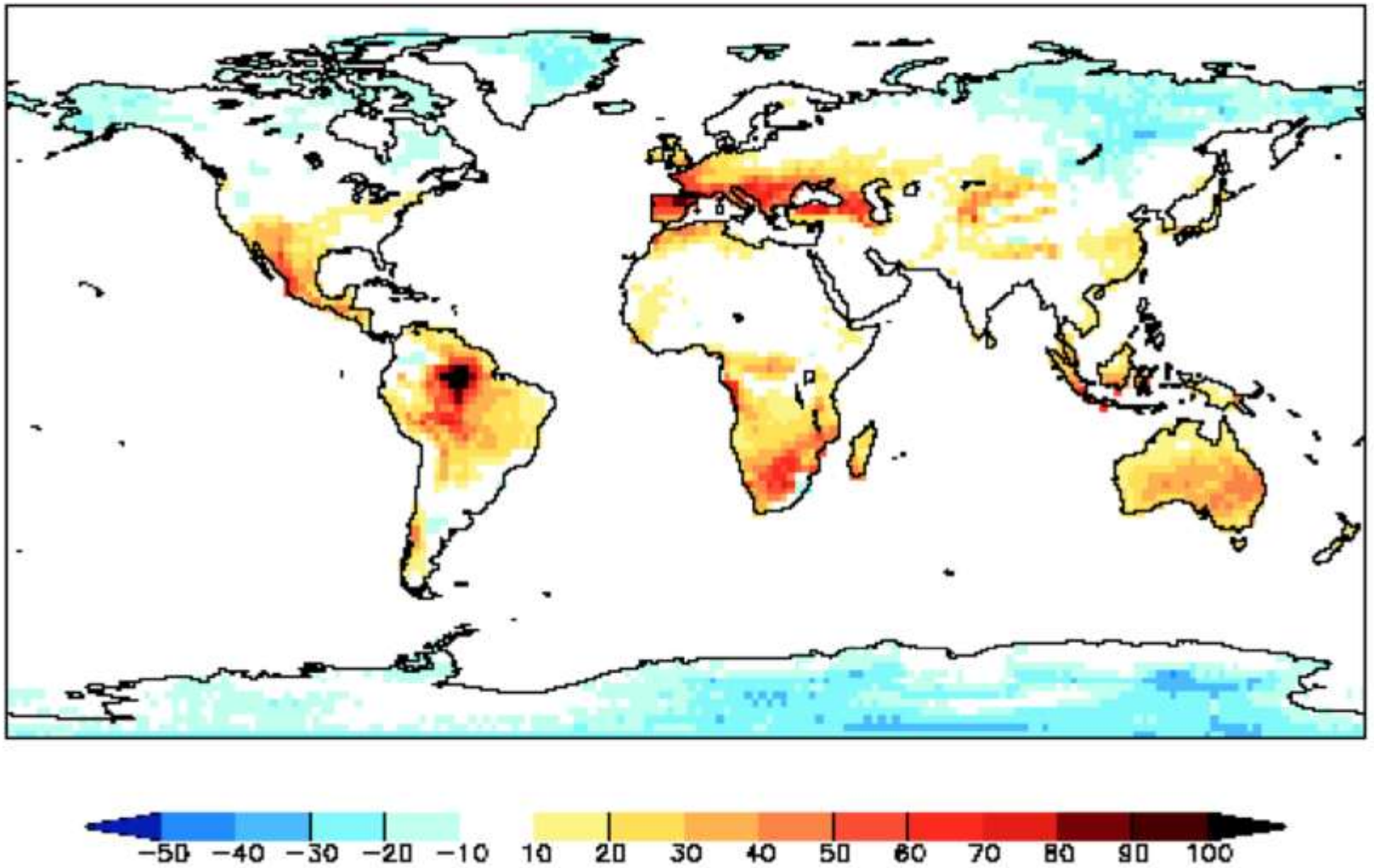


Adapted from: International Geosphere Biosphere Programme Report no.6, Global Changes of the Past, July1988

What's expected: worse droughts

Drought projections for IPCC's A1B scenario



Percentage change in average duration of longest dry period, 30-year average for 2071-2100 compared to that for 1961-1990.

AR4: 20% - 30% of plants and animals species likely at "increased risk of extinction"

if ΔT 2°C - 3°C (above pre-industrial temperature)

WMO

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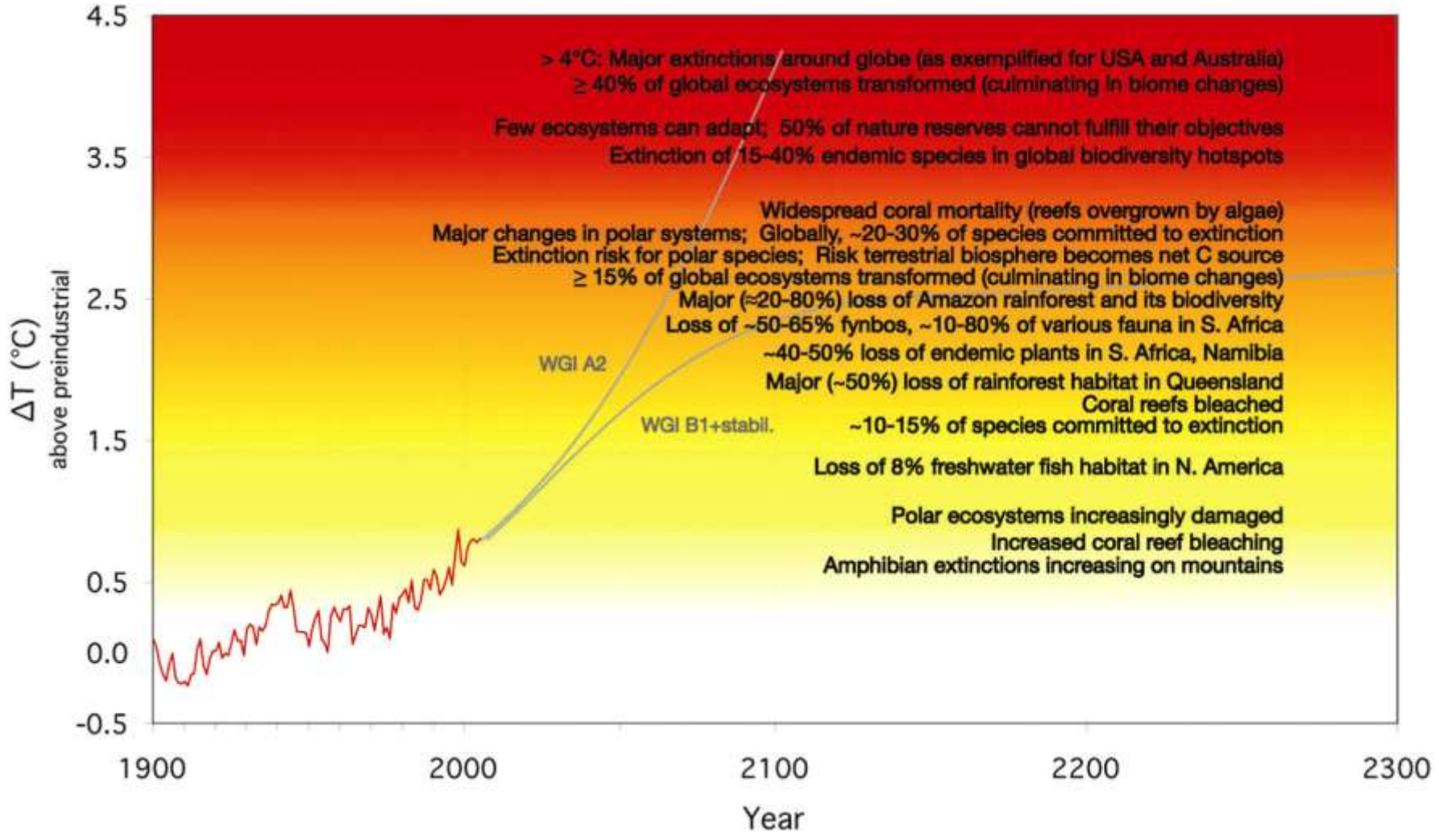
AR4 WGII: Figure TS.6. Projected risks due to critical climate change impacts on ecosystems



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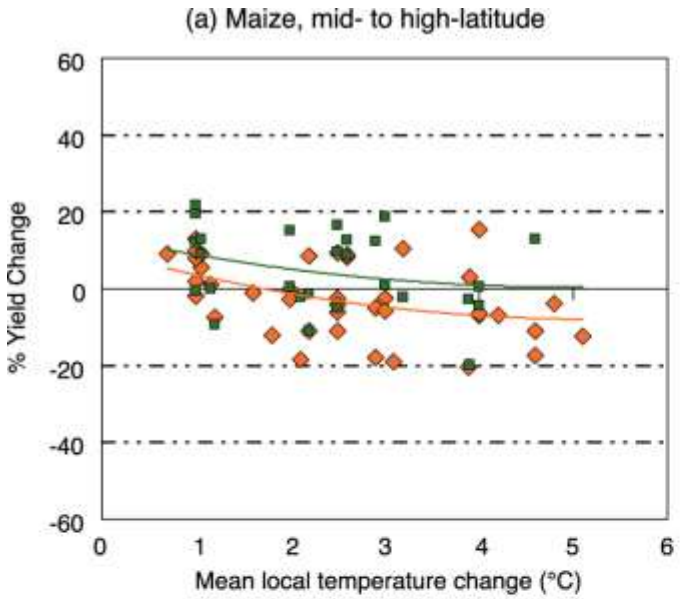
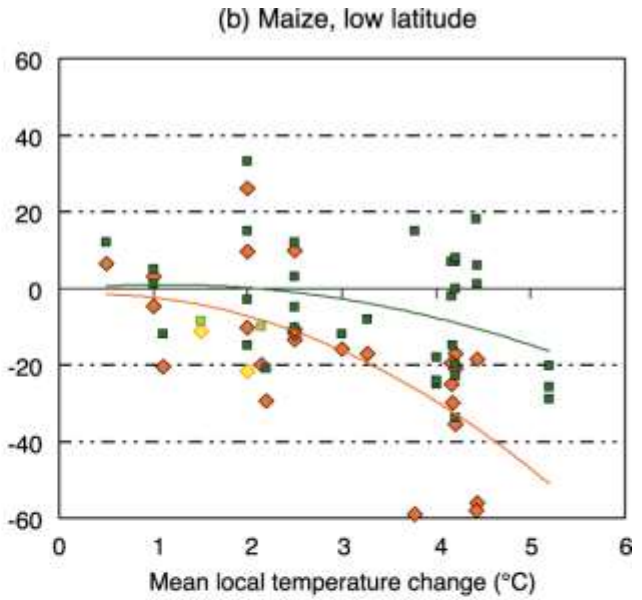
AR4 WGII Figure TS.7. Sensibilité des rendements céréaliers à la température

Maïs





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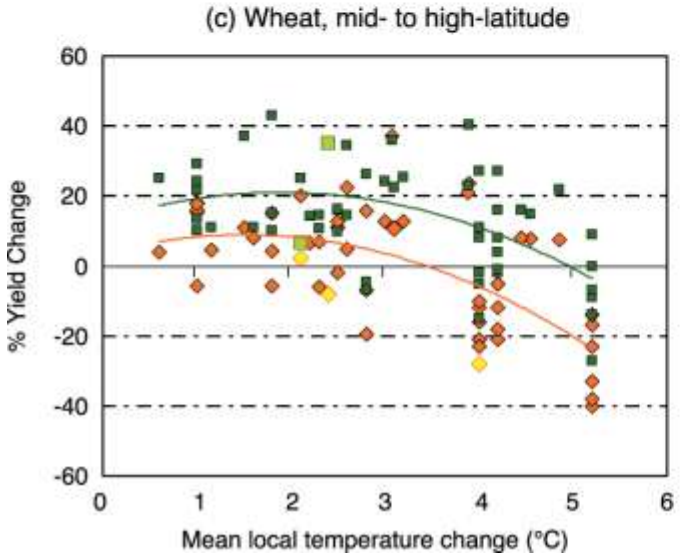

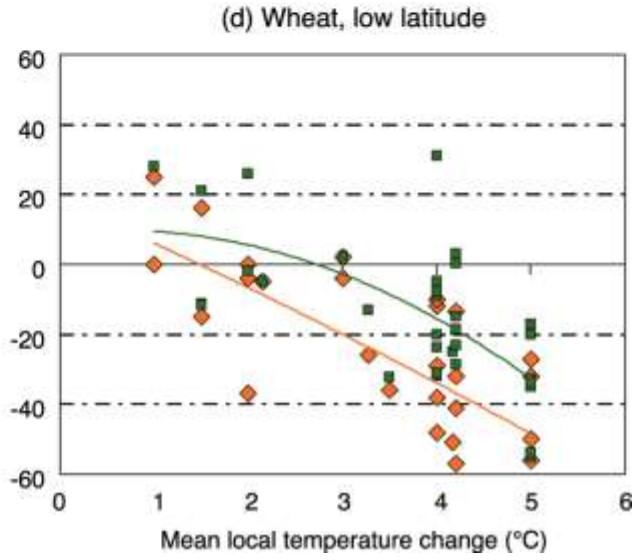

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Régions côtières

(Time 2001)

Excerpts from IPCC AR4 WG2 (Chapter Africa)

- **Africa is one of the most vulnerable continents to climate change and climate variability, a situation aggravated by the interaction of 'multiple stresses', occurring at various levels, and low adaptive capacity (high confidence).**
- (…) and this vulnerability is exacerbated by existing developmental challenges (…) These in turn have contributed to Africa's weak adaptive capacity, increasing the continent's vulnerability to projected climate change.

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Excerpts from IPCC AR4 WG2 (Chapter Africa)

- **African farmers have developed several adaptation options to cope with current climate variability, but such adaptations may not be sufficient for future changes of climate (high confidence).**
- Human or societal adaptive capacity, identified as being low for Africa in the TAR, is now better understood (…) However, such advances in the science of adaptation to climate change and variability (…), show that these adaptations may be insufficient to cope with future changes of climate.

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Excerpts from IPCC AR4 WG2 (Chapter Africa)

- **Agricultural production and food security (including access to food) in many African countries and regions are likely to be severely compromised by climate change and climate variability (high confidence).**
- A number of countries in Africa already face semi-arid conditions that make agriculture challenging, and climate change will be likely to reduce the length of growing season as well as force large regions of marginal agriculture out of production. Projected reductions in yield in some countries could be as much as 50% by 2020, and crop net revenues could fall by as much as 90% by 2100, with small-scale farmers being the most affected. This would adversely affect food security in the continent.

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Excerpts from IPCC AR4 WG2 (Chapter Africa)

- **Climate change will aggravate the water stress currently faced by some countries, while some countries that currently do not experience water stress will become at risk of water stress (very high confidence).**
- Climate change and variability are likely to impose additional pressures on water availability, water accessibility and water demand in Africa.

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Excerpts from IPCC AR4 WG2 (Chapter Africa)

- **Climate variability and change could result in low-lying lands being inundated, with resultant impacts on coastal settlements (high confidence).**
- Climate variability and change, coupled with human-induced changes, may also affect ecosystems e.g., mangroves and coral reefs, with additional consequences for fisheries and tourism.

Excerpts from IPCC AR4 WG2 (Chapter Africa)

- **Human health, already compromised by a range of factors, could be further negatively impacted by climate change and climate variability, e.g., malaria in southern Africa and the East African highlands (high confidence).**
- It is likely that climate change will alter the ecology of some disease vectors in Africa, and consequently the spatial and temporal transmission of such diseases. Most assessments of health have concentrated on malaria and there are still debates on the attribution of malaria resurgence in some African areas.

Managing the risks: drought in the context of food security in West Africa

Risk Factors

- more variable rain
- population growth
- ecosystem degradation
- poor health and education systems

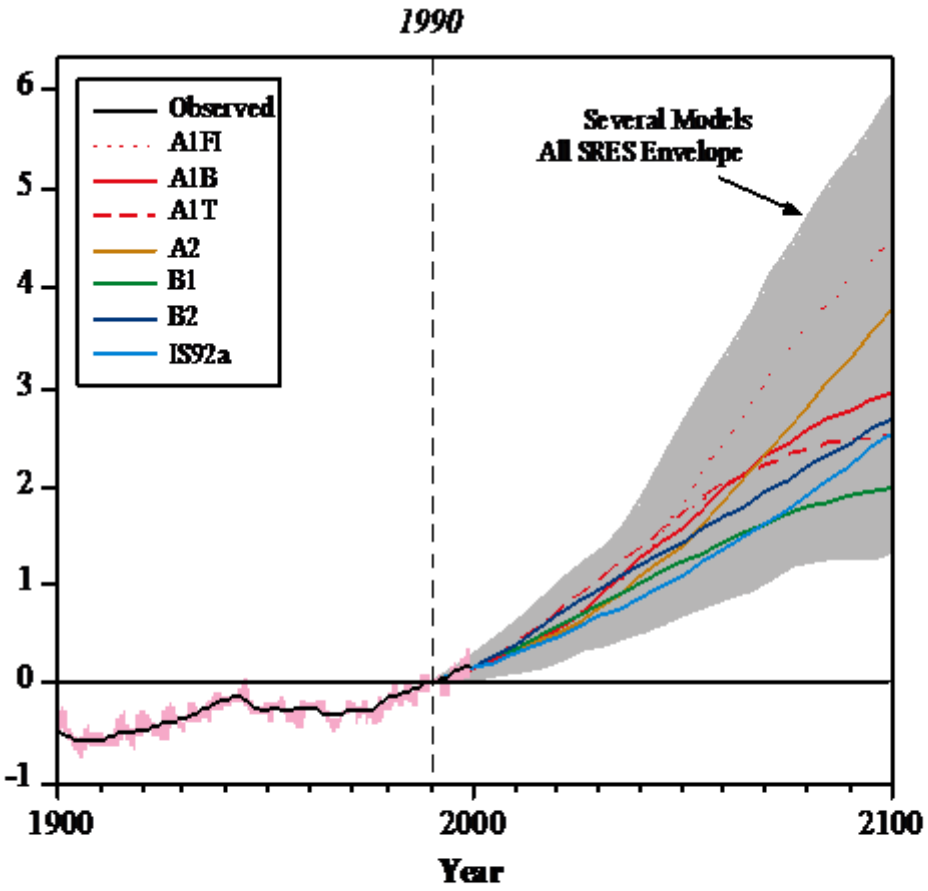
Risk Management/ Adaptation

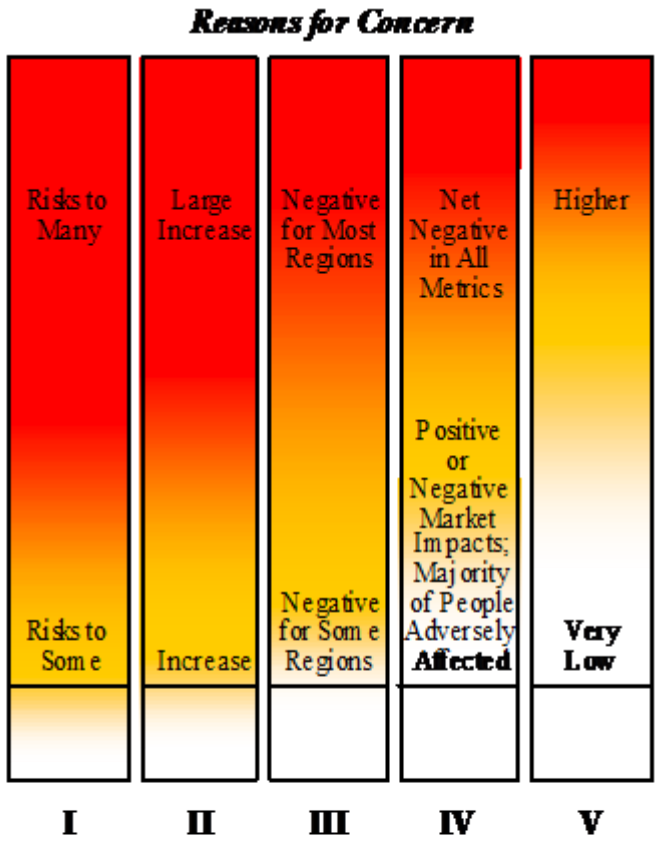
- improved water management
- sustainable farming practice
- drought-resistant crops
- drought forecasting

Projected: *low confidence* in drought projections for West Africa

Based on IPCC SREX report (2011)

Reasons for Concern

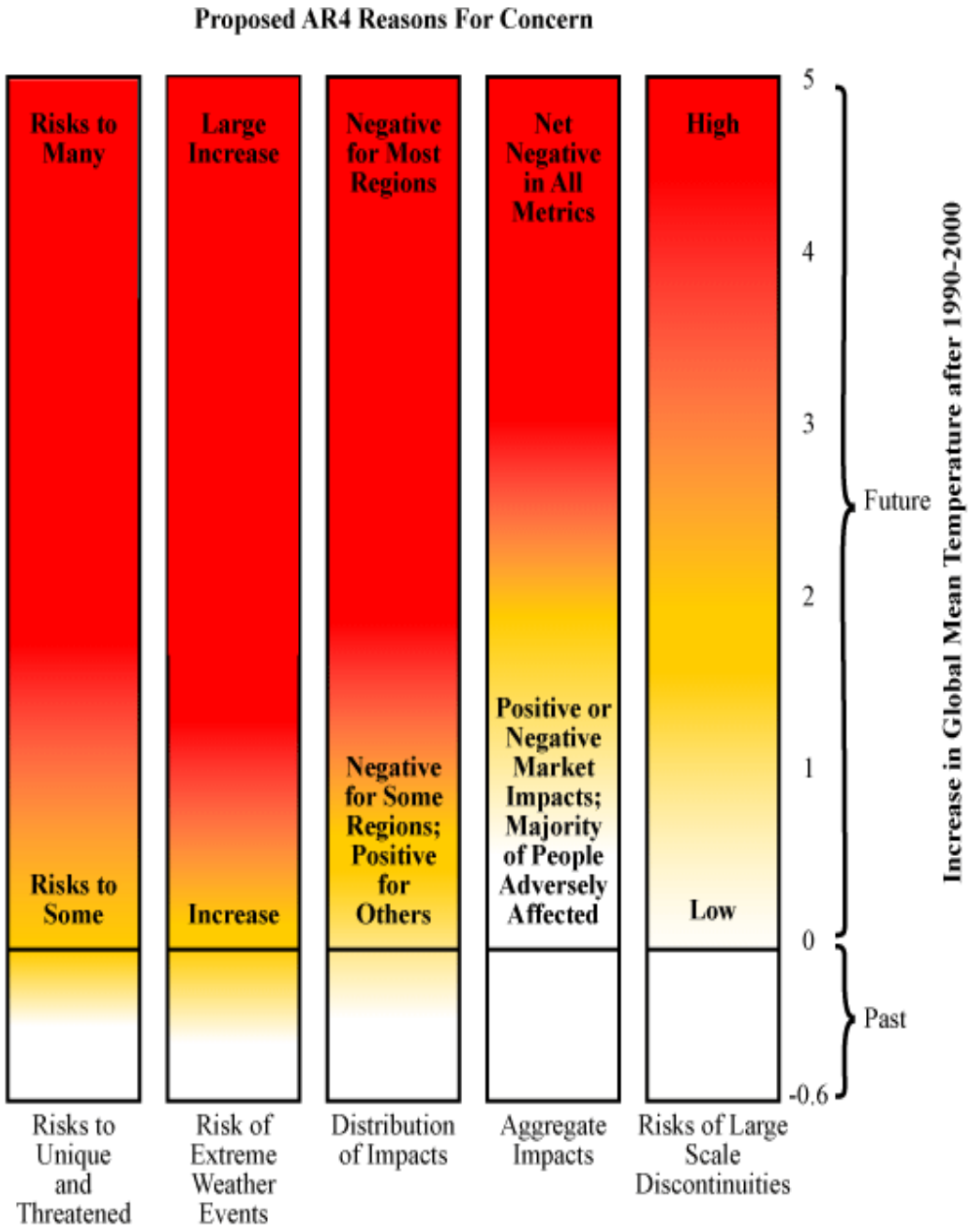




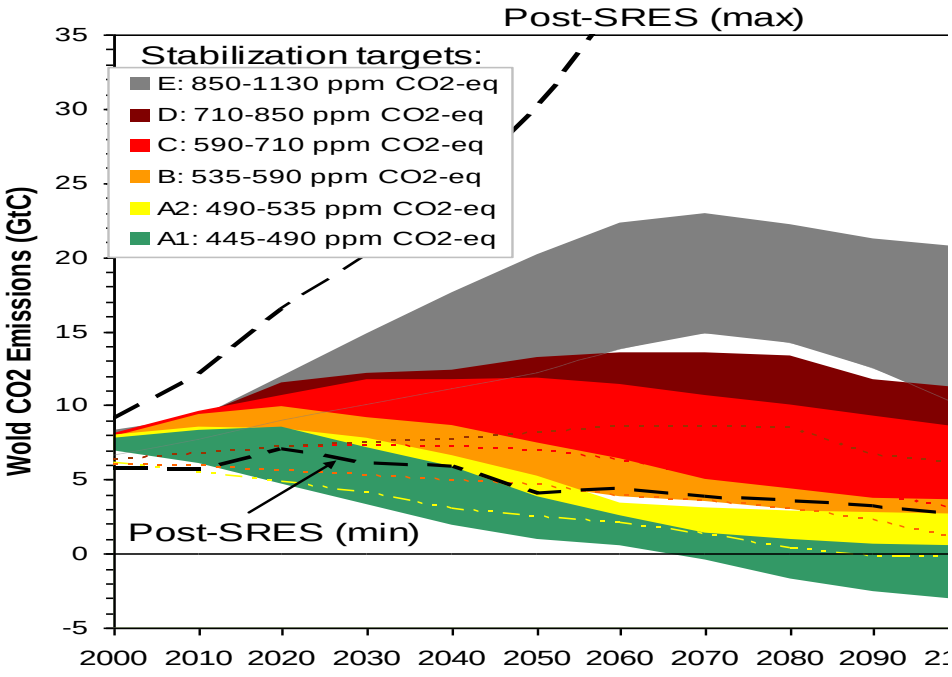
I Risks to unique and threatened systems
II Risks from extreme climate events
III Distribution of Impacts
IV Aggregate Impacts
V Risks from large-scale discontinuities

Source: IPCC TAR WG2 (2001)

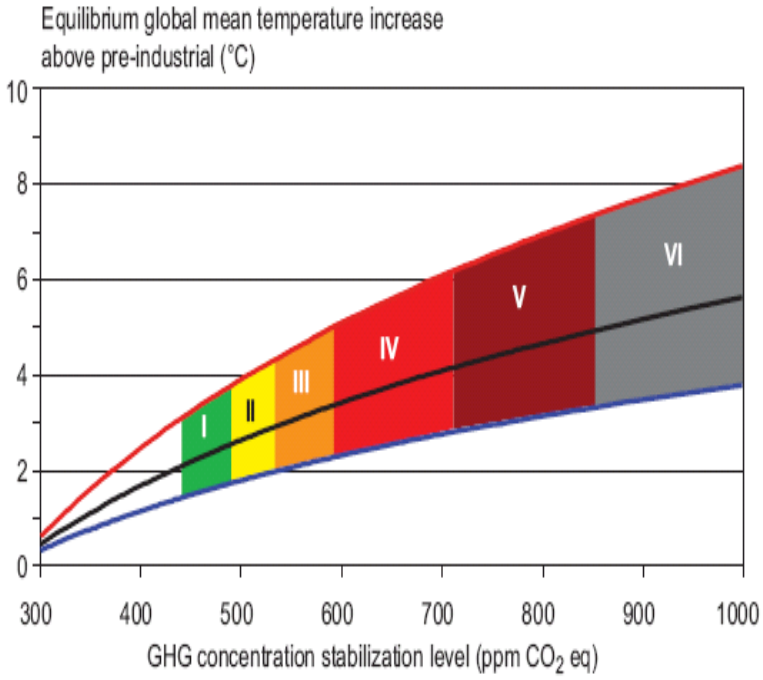
Smith et al, 2009, PNAS, based on IPCC AR4, 2007



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



Multigas and CO2 only studies combined



IPCC AR4 (2007)

Long term mitigation (after 2030)

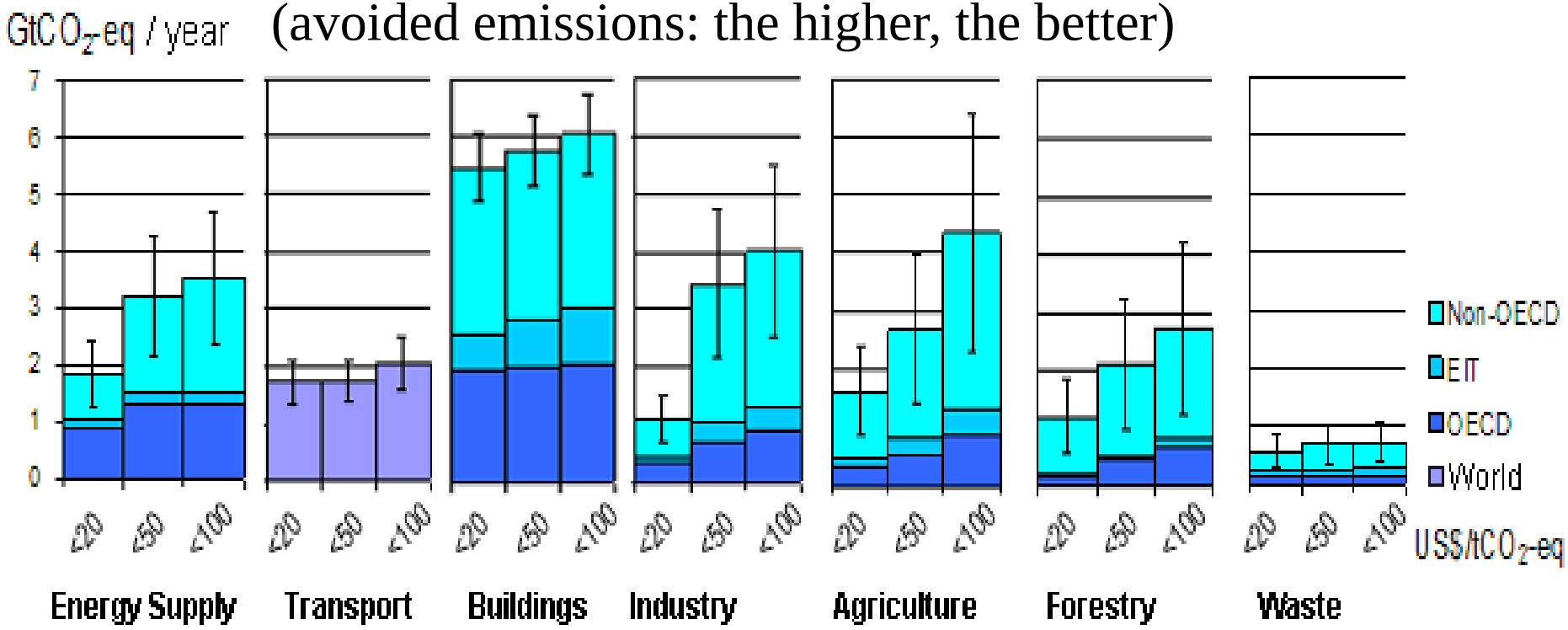
- The lower the stabilization level, the more quickly emissions would need to peak and to decline thereafter
- Mitigation efforts over the next two to three decades will have a large impact on opportunities to achieve lower stabilization levels

IPCC AR4 (2007)

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

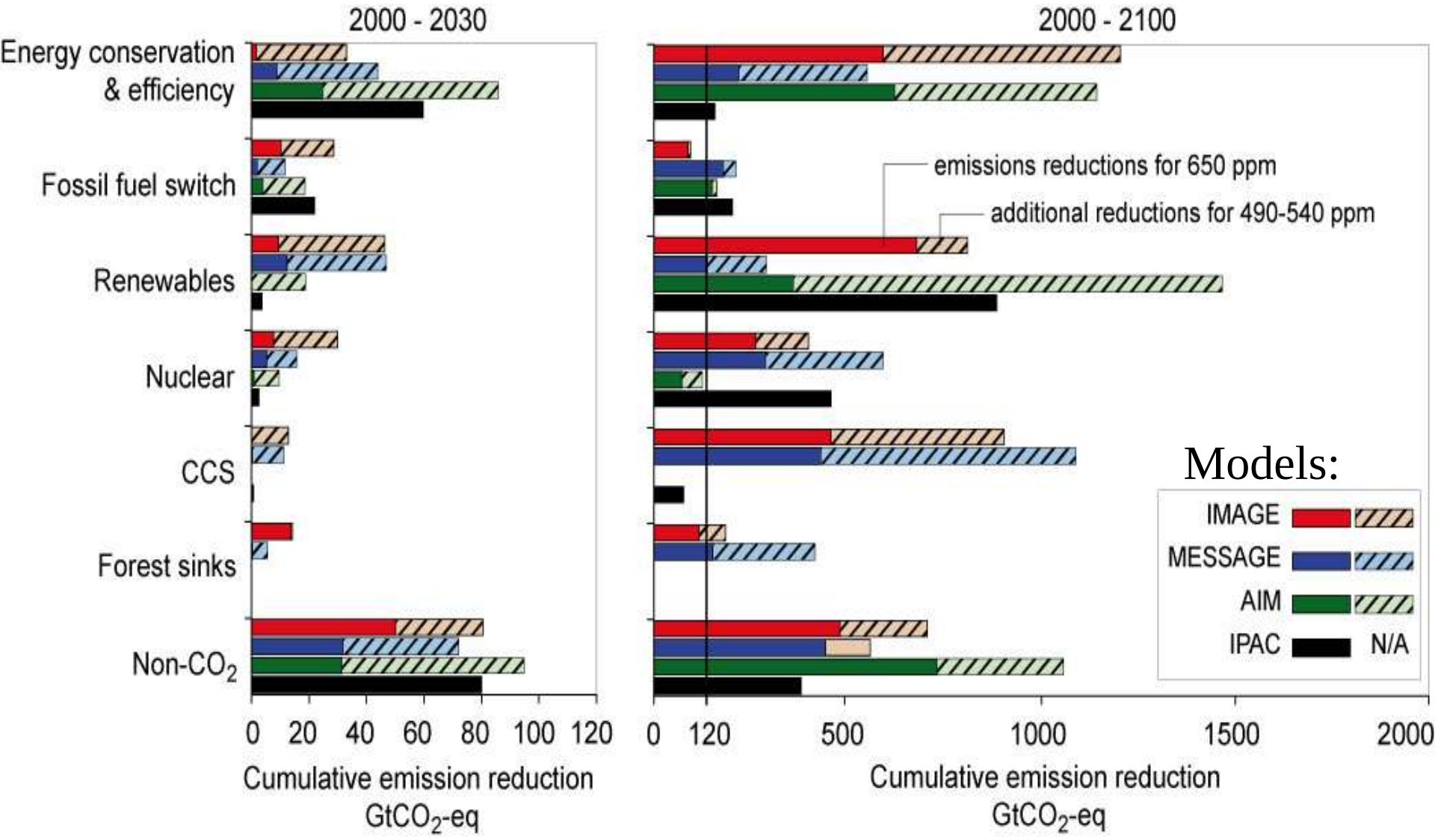
(avoided emissions: the higher, the better)



IPCC AR4 (2007)

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

Role of Technology, following IPCC AR4



What should we do?

There are only three options:

- Mitigation, meaning measures to reduce the pace & magnitude of the changes in global climate being caused by human activities.
- Adaptation, meaning measures to reduce the adverse impacts on human well-being resulting from the changes in climate that do occur.
- Suffering the adverse impacts that are not avoided by either mitigation or adaptation.

Concerning the three options…

- We're already doing some of each.
- What's up for grabs is the future mix.
- Minimizing the amount of suffering in that mix can only be achieved by doing a lot of mitigation and a lot of adaptation.
  - Mitigation alone won't work because climate change is already occurring & can't be stopped quickly.
  - Adaptation alone won't work because adaptation gets costlier & less effective as climate change grows.
  - We need enough mitigation to avoid the unmanage-able, enough adaptation to manage the unavoidable.

Adaptation possibilities include…

- Changing cropping patterns
- Developing heat-, drought-, and salt-resistant crop varieties
- Strengthening public-health & environmental-engineering defenses against tropical diseases
- Building new water projects for flood control & drought management
- Building dikes and storm-surge barriers against sea-level rise
- Avoiding further development on flood plains & near sea level

Many are "win-win": They'd make sense in any case.

Mitigation possibilities include…

(CERTAINLY)

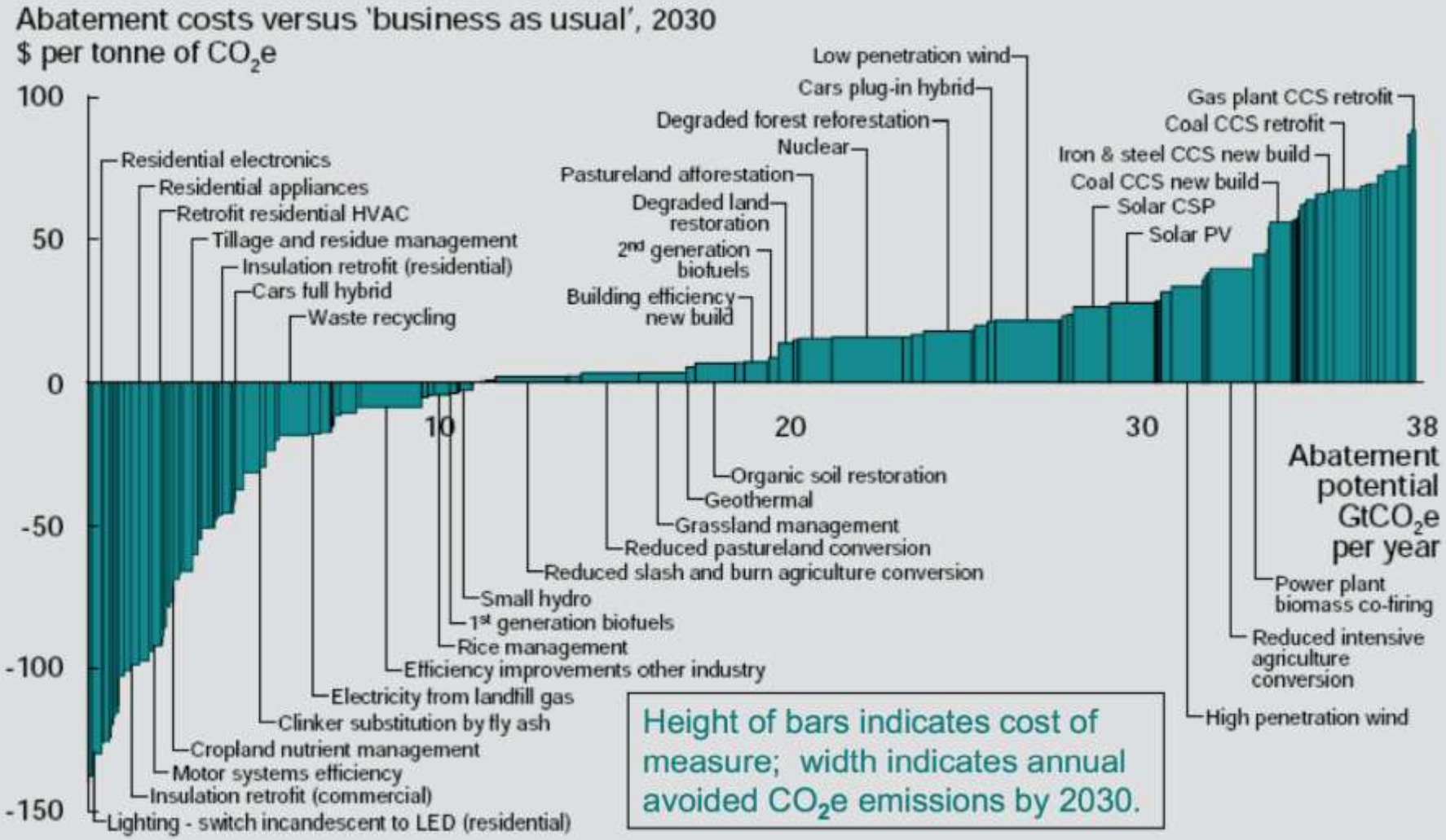
- Reduce emissions of greenhouse gases & soot from the energy sector
- Reduce deforestation; increase reforestation & afforestation
- Modify agricultural practices to reduce emissions of greenhouse gases & build up soil carbon

(CONCEIVABLY)

- "Scrub" greenhouse gases from the atmosphere technologically
- "Geo-engineering" to create cooling effects offsetting greenhouse heating

Mitigation supply curve for 2030: aiming for 450 ppm CO_2e

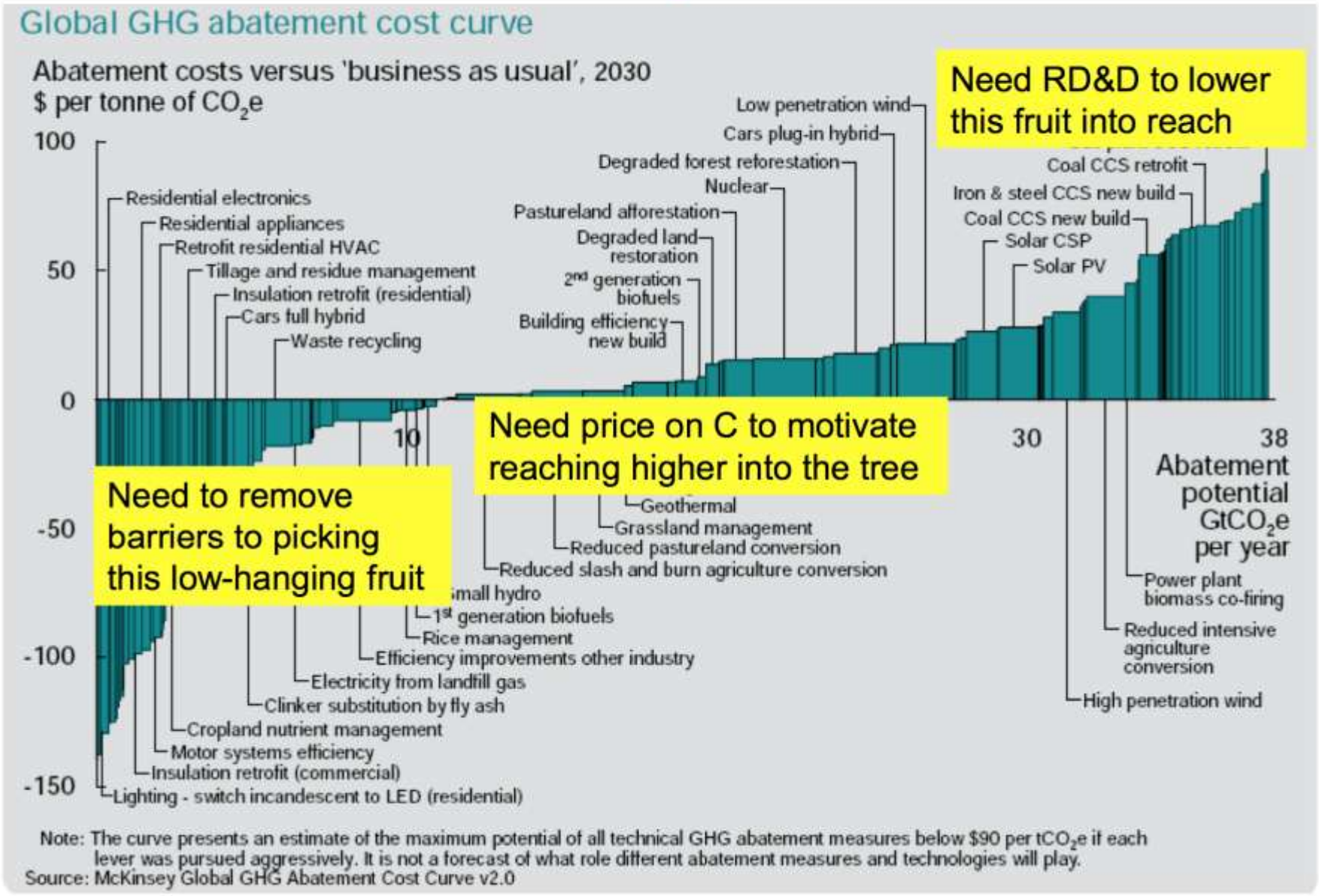
Global GHG abatement cost curve



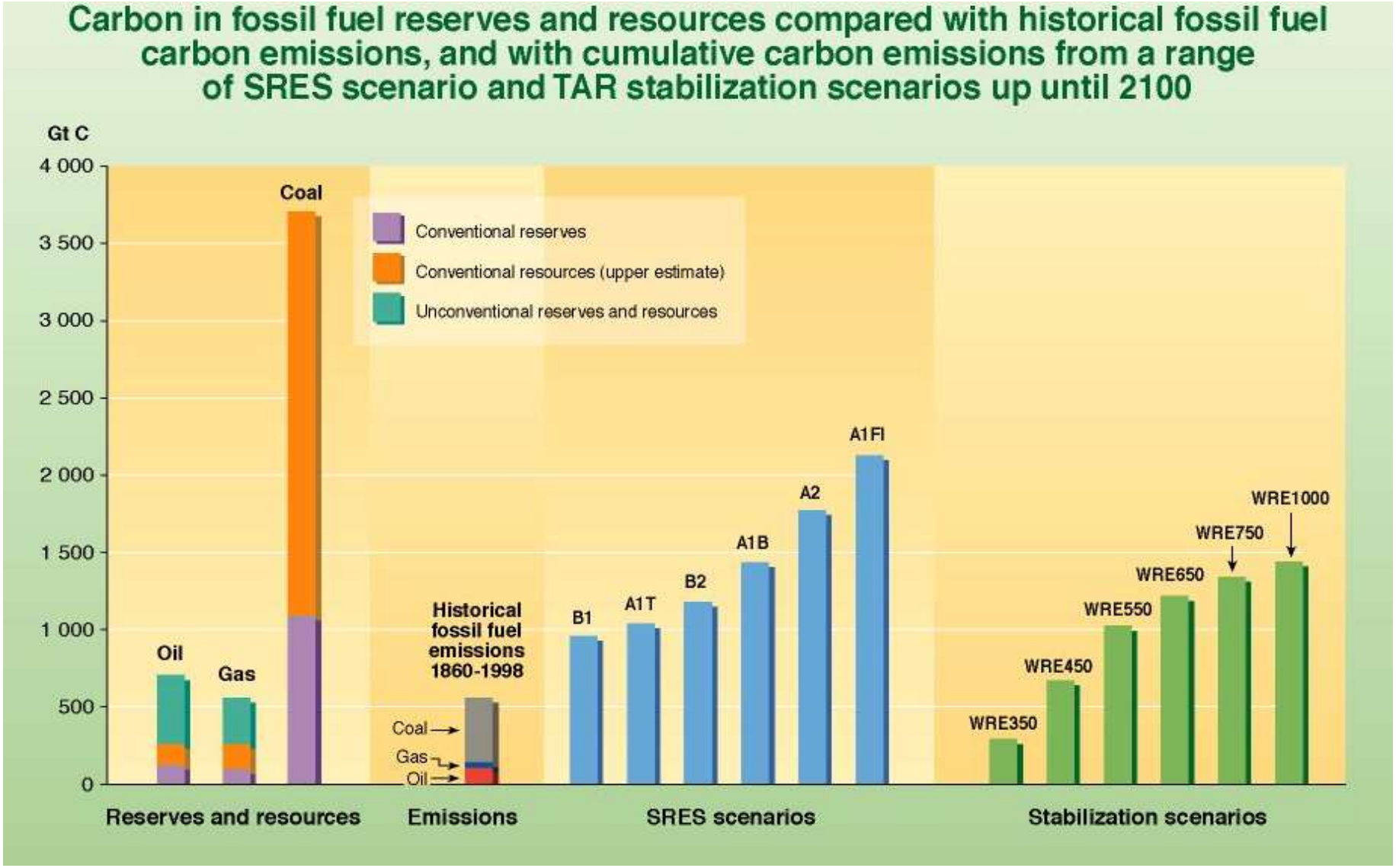
Note: The curve presents an estimate of the maximum potential of all technical GHG abatement measures below $90 per tCO_2e if each lever was pursued aggressively. It is not a forecast of what role different abatement measures and technologies will play.

Source: McKinsey Global GHG Abatement Cost Curve v2.0

Policies needed if 450 ppm CO_2e is the global goal

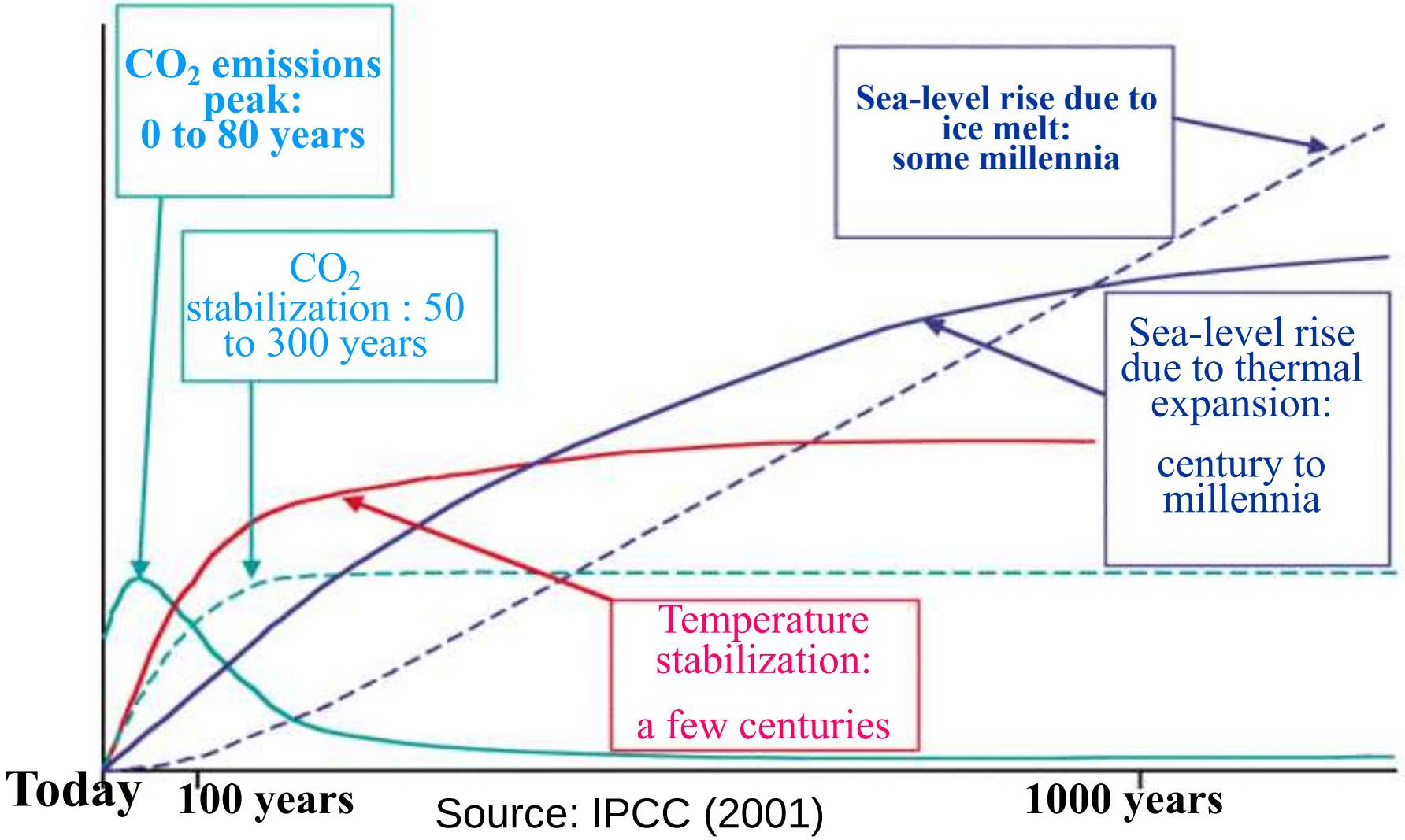


Fossil fuel depletion will not suffice to limit warming at low levels



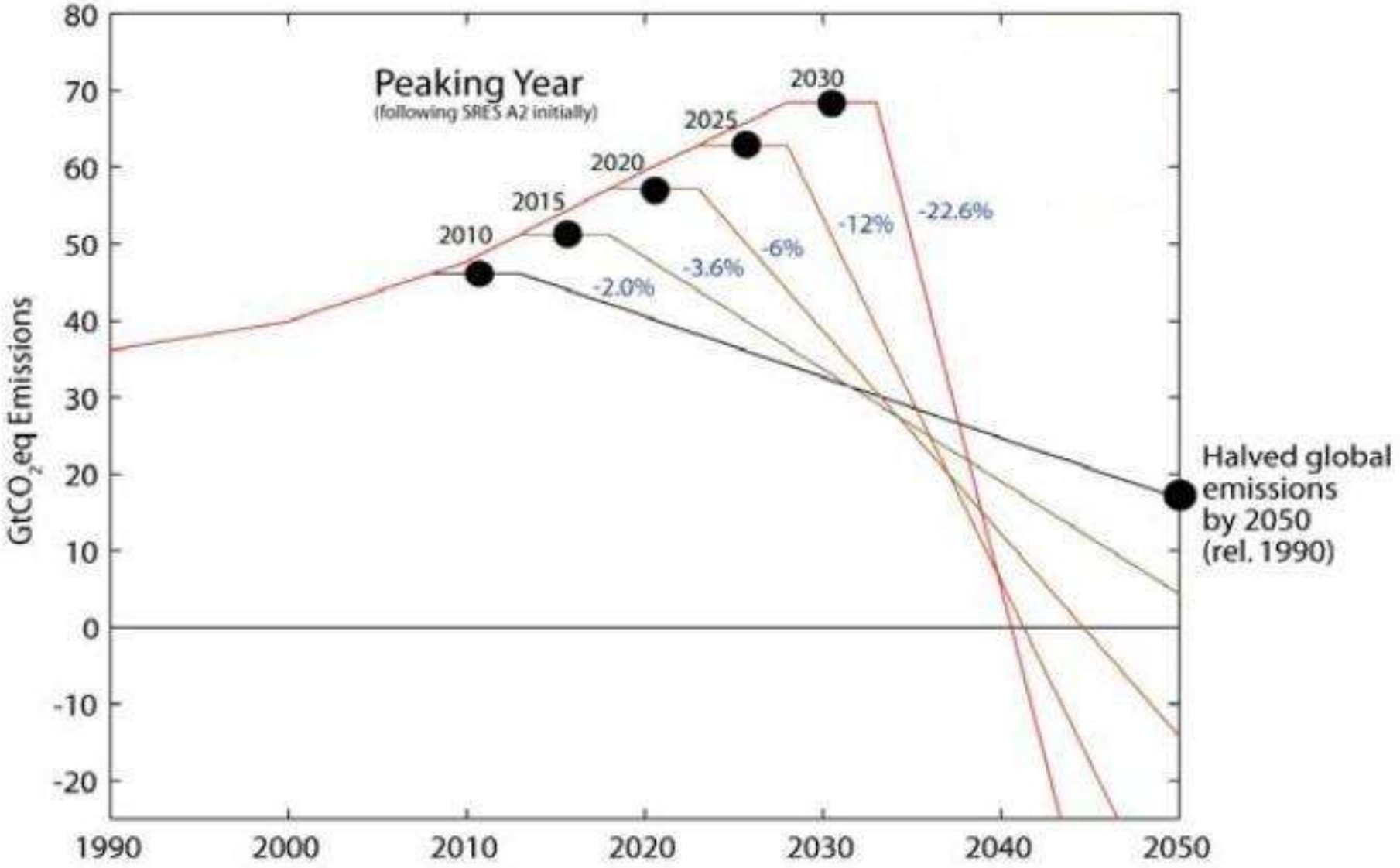
Source: IPCC (2001)

Significant inertia exists in the climate system



Source: IPCC (2001)

The more we wait, the more difficult it will be



Source: Meinshausen et al. - Nature, 30th April 2009

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
- www.skepticalscience.com: excellent responses to contrarians arguments
- www.uclouvain.be/conferenceplanete : video of UCL lecture on climate, food, and oceans, with HSH Prince Albert II of Monaco, O. De Schutter, and JP van Ypersele

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