



Title	Clarify causes and magnitude of sea level rise
Author(s)	Ikeda, M.
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# G8 Summit Symposium

## **Drastic Change in the Earth System during Global Warming**

### **Five hot issues (presenters, moderators)**

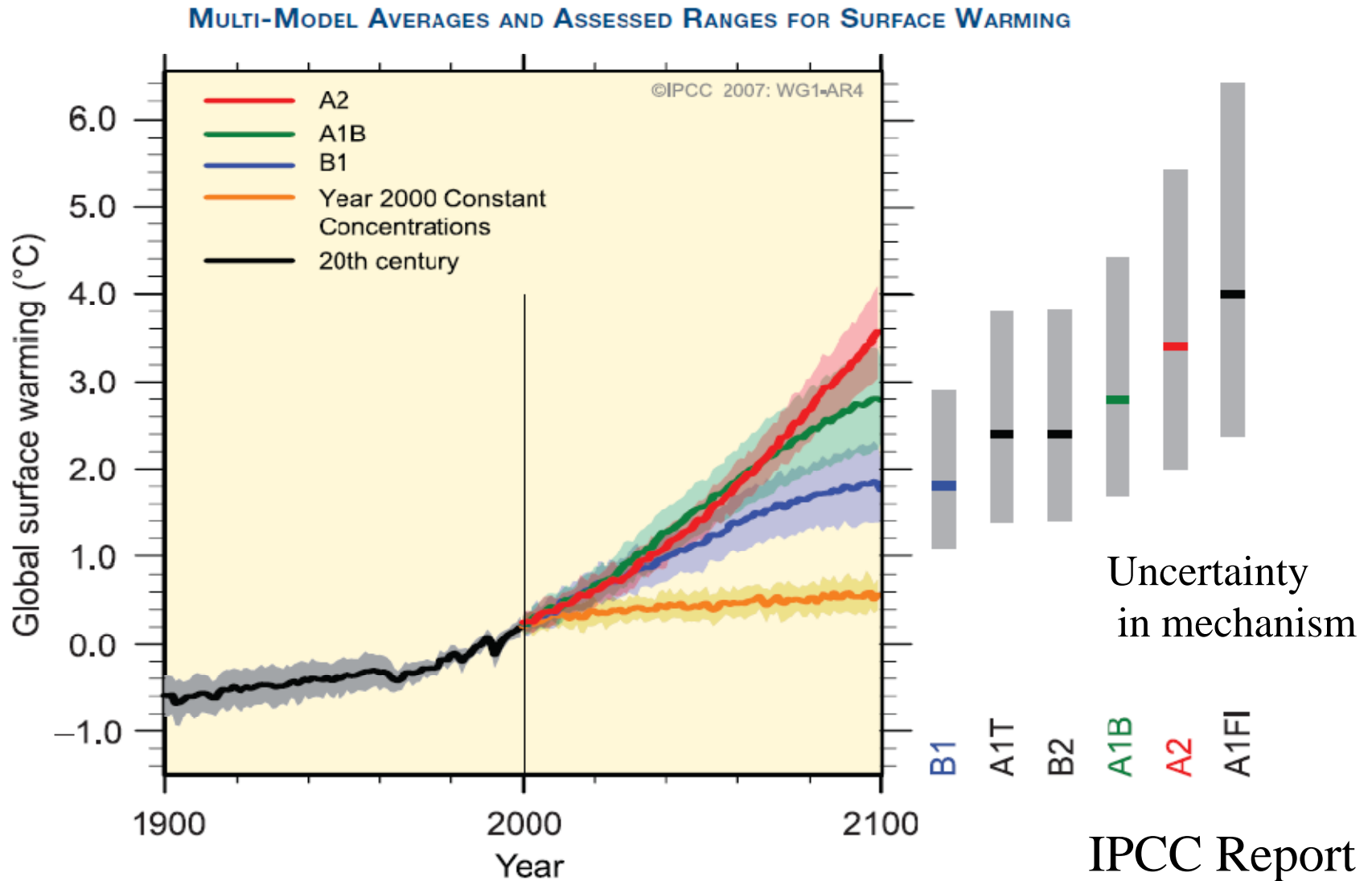
1. Clarify causes and magnitude of sea level rise  
([J. Church](#), M. Ikeda)
2. Decay of glaciers and Greenland and Antarctic ice sheets  
([A. Ohmura](#), R. Greve)
3. When will summer Arctic sea ice disappear?  
([W. Maslowski](#), M. Ikeda)
4. Carbon uptake or emission by terrestrial ecosystem  
([T. Maximov](#), [A. Itoh](#), T. Hara)
5. Marine ecosystem change resulting in carbon emission  
([M. Kawamiya](#), Y. Watanabe)

# Agenda

- ⊗ Global warming is a real and crucial phenomenon.  
(Nobel Peace Prize awarded to IPCC and Al Gore)
- ⊗ Do we well know about global warming?
- ⊗ Uncertainty larger than 50% on the warming rate
- ⊗ Scientific clarification is required on some issues and mechanisms which yield positive feedback in the earth system.
- ⊗ Reliable projection on distinct indicators is crucial for scientists to establish credibility.
- ⊗ Summarize the outcome of extensive discussion on the hot issues for non-scientists

# 0. General Introduction

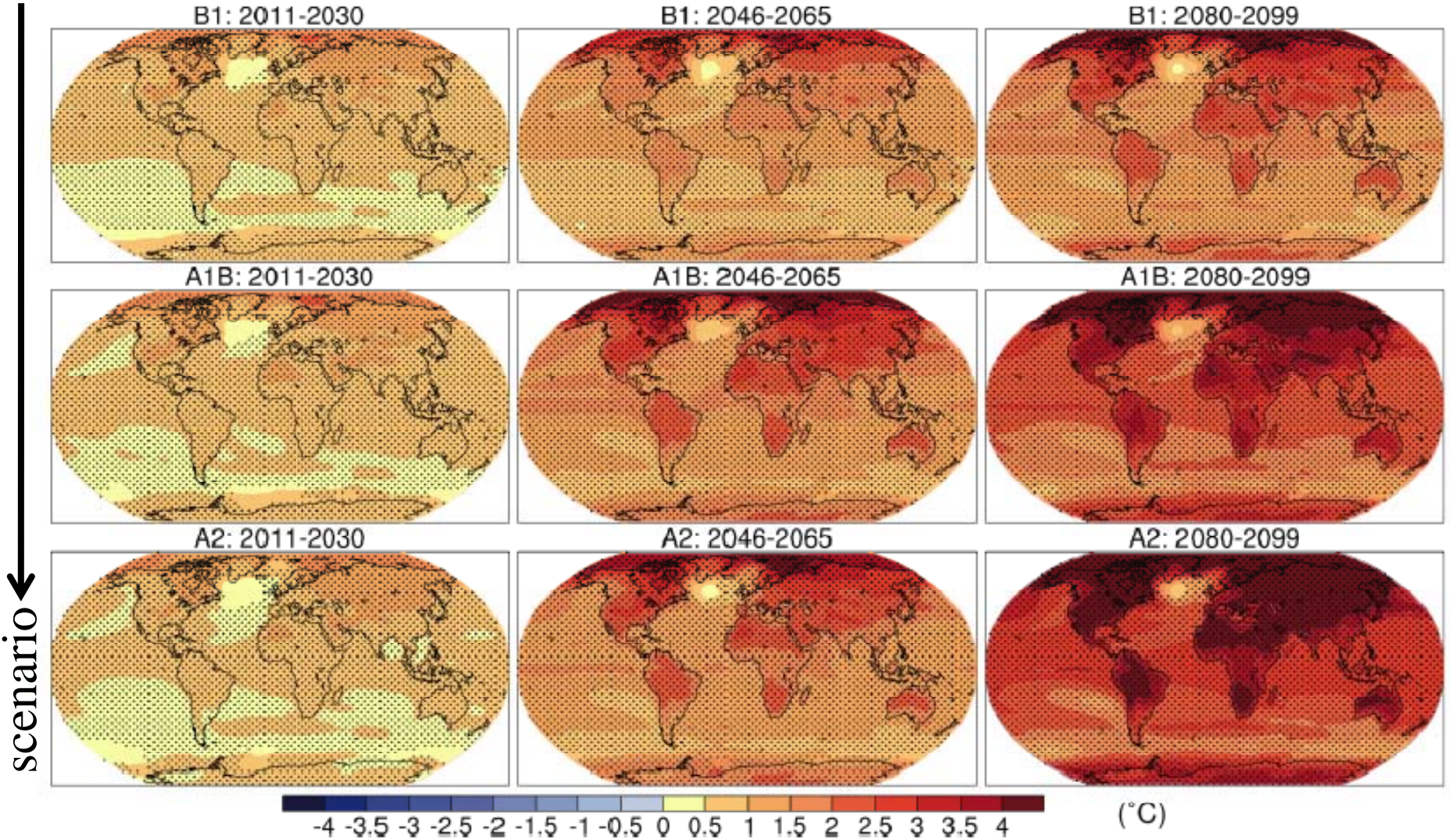
# Global warming in the 21st Century could be 1°C to 6°C



Uncertainty is large due to both scenarios and models.

# Warming predicted by models (IPCC)

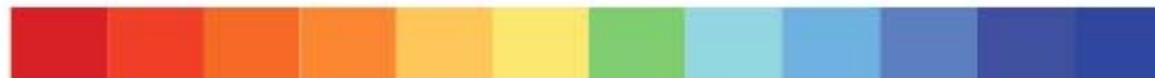
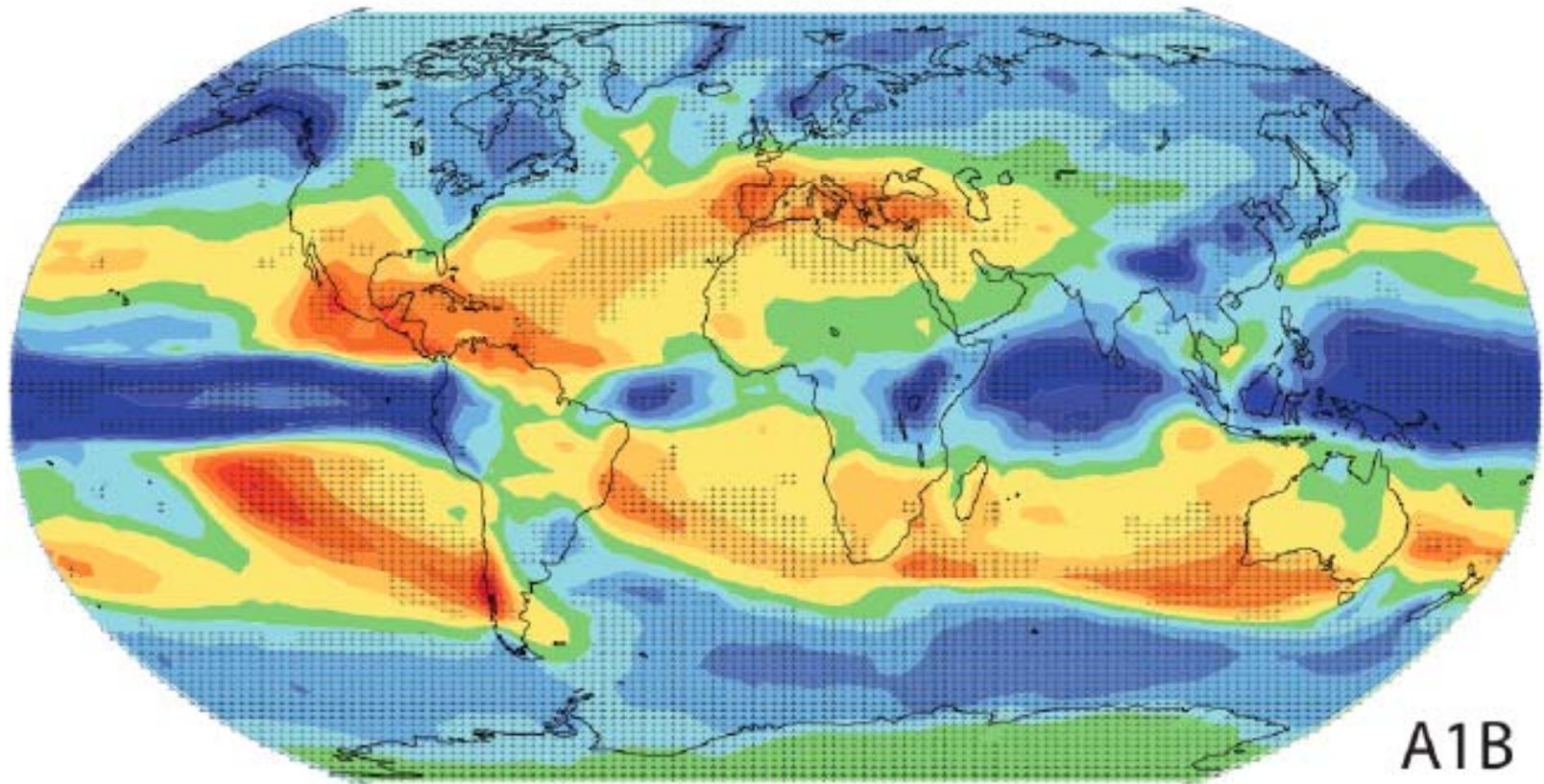
→ year



Temperature projection is important for decision making.

# More rain or less rain? (IPCC Report)

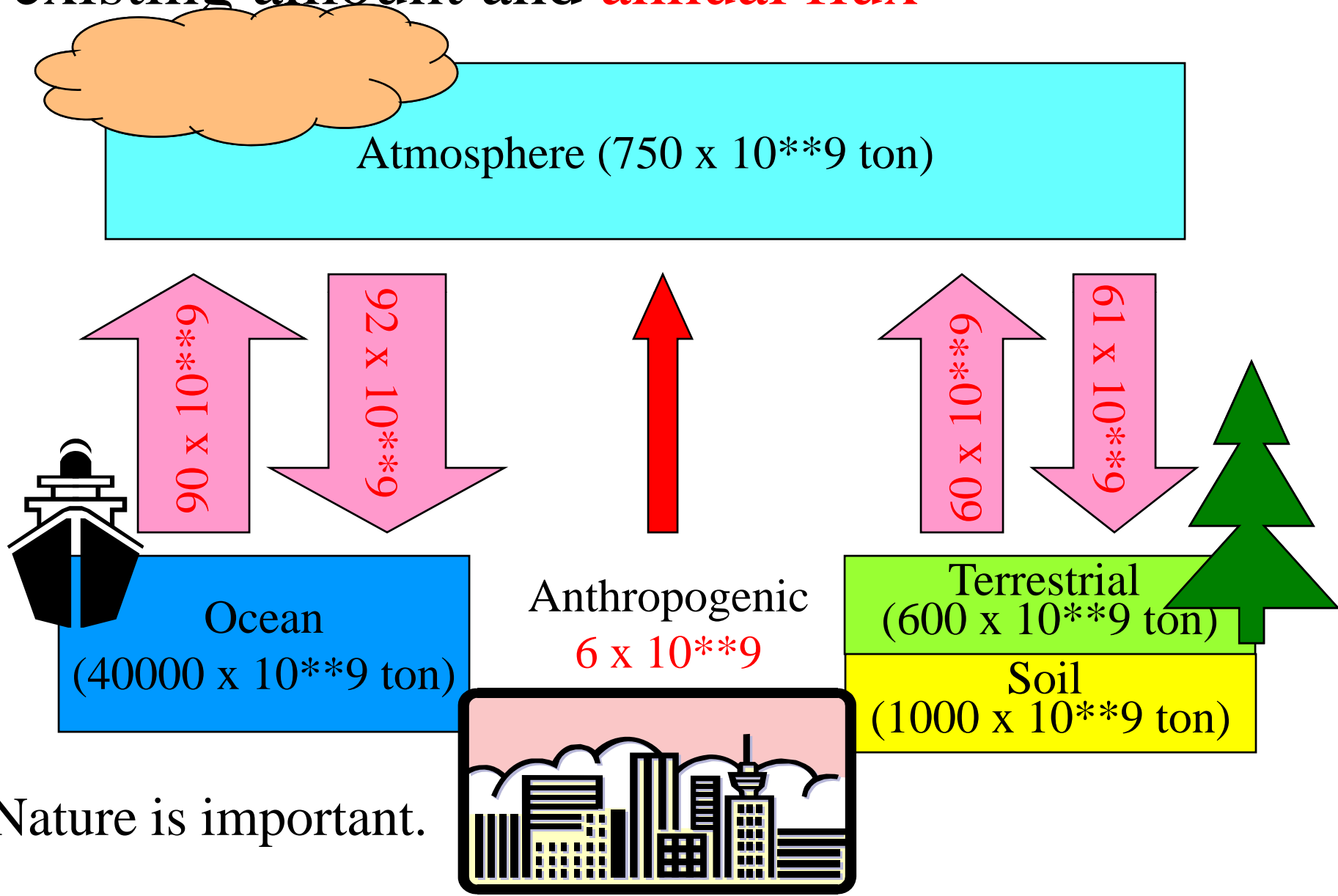
2080-2099



-0.5 -0.4 -0.3 -0.2 -0.1 0 0.1 0.2 0.3 0.4 0.5  
Annual Mean Precipitation Change (mm/day)

Rain changes are now qualitatively better projected. Quantitatively?

# Global Carbon (Dioxide) Cycle existing amount and **annual flux**



Nature is important.



# Attempts through discussion

Scientists should

- try to give more information beyond the non-regret policy,
- pursue to clarify mechanisms of positive feedbacks in the earth system,
- not be too conservative, but not make a false alarm,
- not try to oversell their own research areas/projects,
- give uncertainty in risk assessment,
- keep objective discussion.

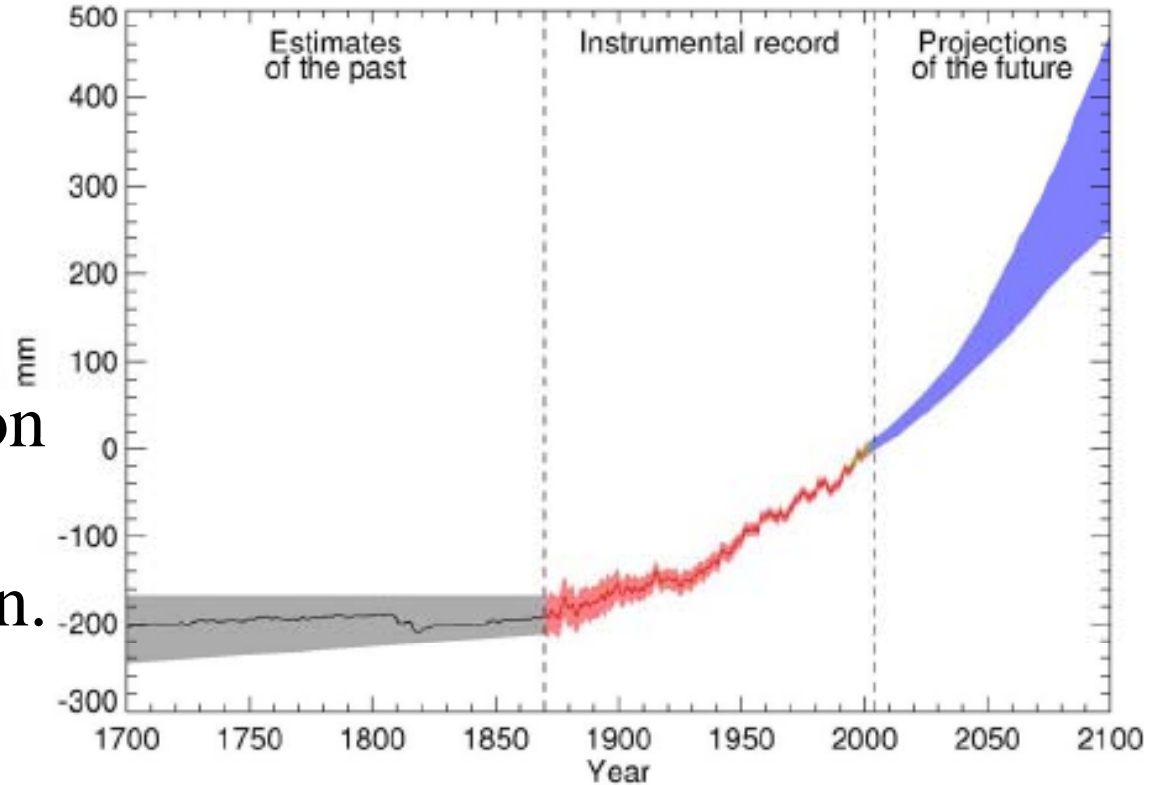
# 1. Sea Level Rise

# Clarify causes and magnitude of sea level rise

- Most scenarios: only 30-50cm rise in the 21st century
- Oceanic thermal expansion near surface is major in the recent 10-year period and the future projection, but minor in last 50 years.
- Mountain glaciers: comparable with the thermal expansion in last 50 years
- What is missing in last 50 years? Deep ocean warming, or ice sheets in Greenland and Antarctica?
- Is the future projection correct? Will the sea level rise 100cm, 150cm or more?

# Future sea level rise

Sea level rise will be mainly related to thermal expansion of sea water in the future projection. Only 30 – 50 cm?



**Question 5.1, Figure 1.** Time-series of global mean sea level in the past and future, relative to zero in 2001. For the period before 1870, we do not have global measurements of sea level. The solid line here is a climate model calculation (Gregory et al., 2006) of sea level change due to natural factors (volcanic and solar variability) and anthropogenic factors; the rather sudden fall early in the 19th century is mainly due to the eruption of Tambora in 1815. The grey shading shows the uncertainty on the estimated long-term rate of sea level change (see Chapter 6, Section 6.4.3). We show a reconstruction of global mean sea-level from tide gauges (Church and White, 2006, Section 5.5.2.1) for 1870–2001, with uncertainties shown by shading, and from satellite altimetry (Cazenave and Nerem, 2004, Section 5.5.2.2) for 1993–2004, both as annual means. For the future we indicate the range of uncertainty due to different choices of emission scenario (see Chapter 10, Section 10.6.5). Beyond 2100 the projections are increasingly dependent on the scenario. Over many centuries or millennia, sea level could rise by several metres (see Chapter 10, Section 10.7.3).

# Sea level rise in last 13 years Thermal expansion

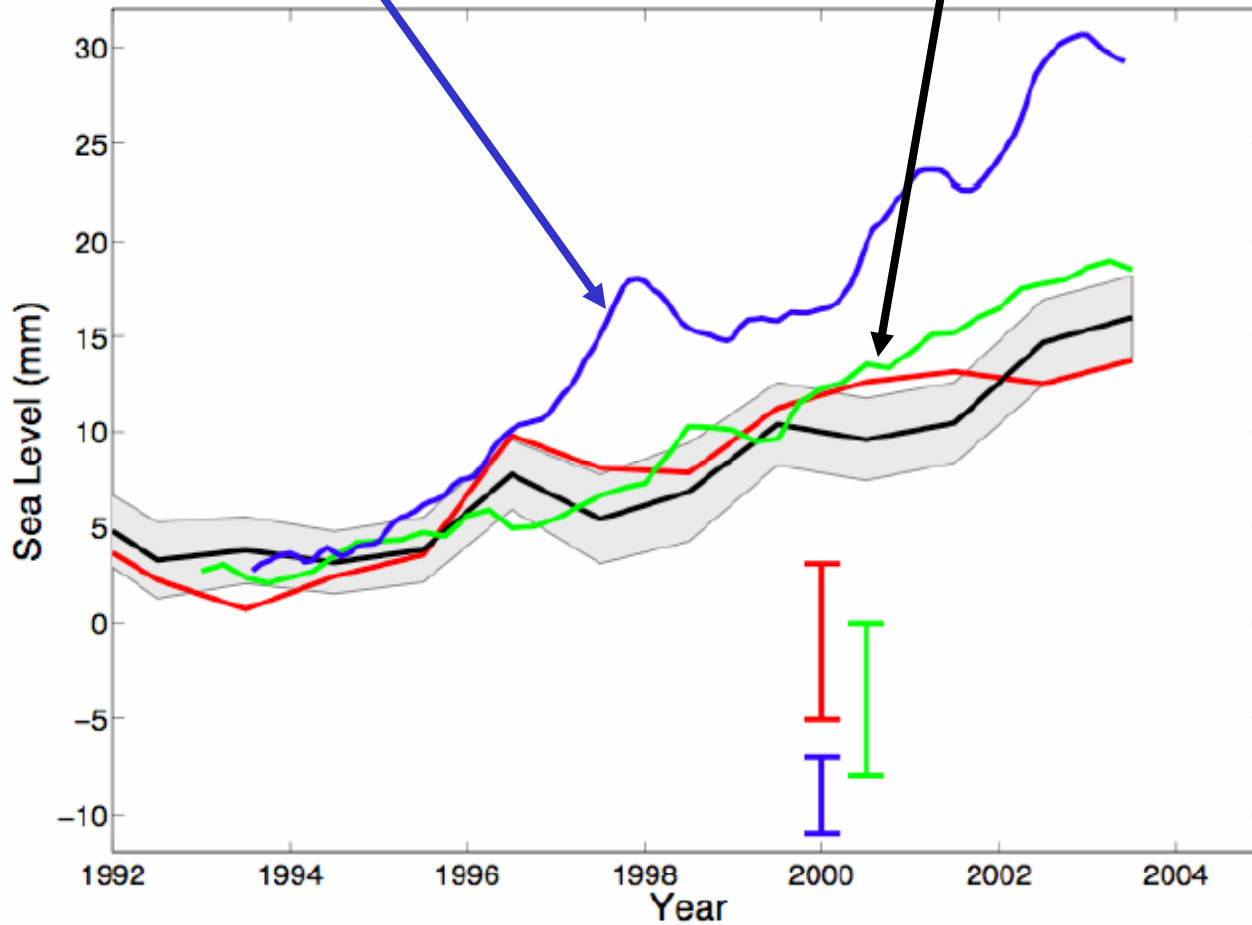
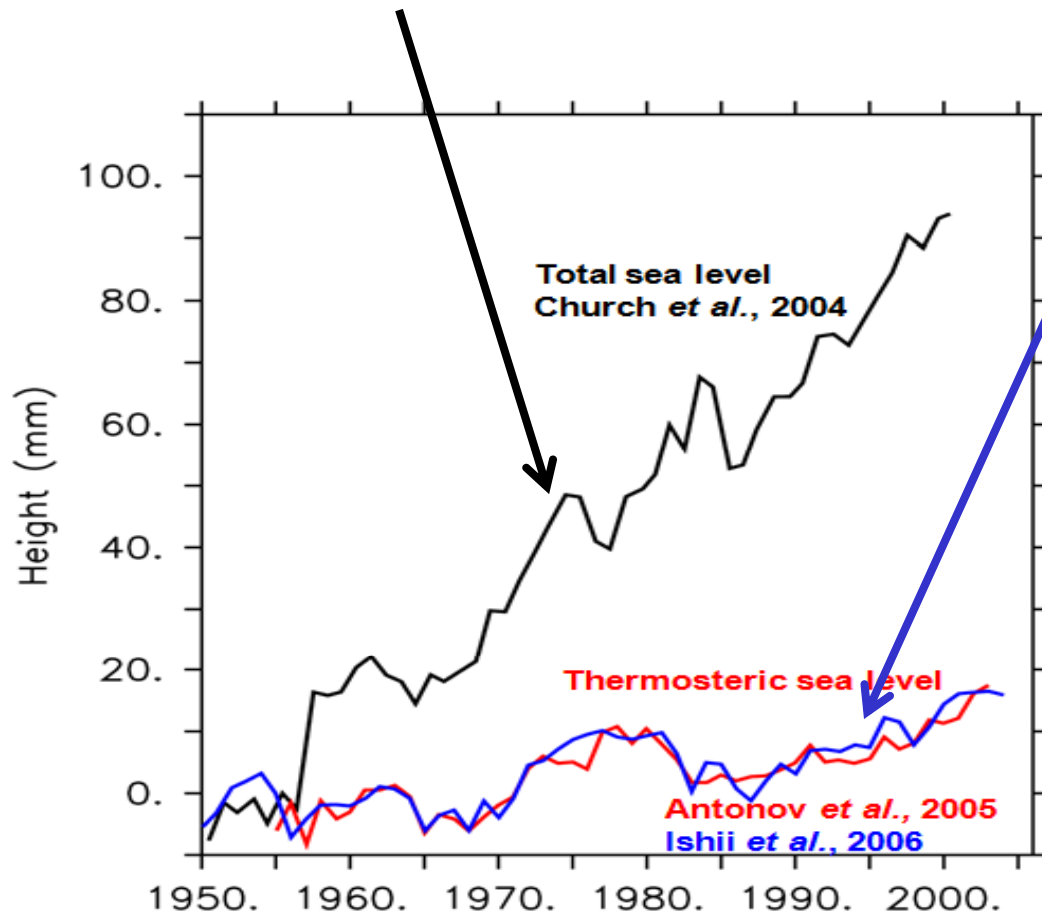


Figure 5.5.7. Thermal expansion curves for 1993–2003, average over 60°S–60°N, based on Levitus et al. (2005a) temperature data (in black; 0–700 m layer), Ishii et al. (2006) (in red; 0–700 m layer) and Willis et al. (2004) (in green; 0–750 m layer). Shaded area and vertical red and green bars represent the 95% errors of the black, red and green curves respectively. The blue curve is the observed global mean sea level by satellite altimetry (yearly-mean, averaged over 65°S–65°N).

The thermal expansion is a major component.

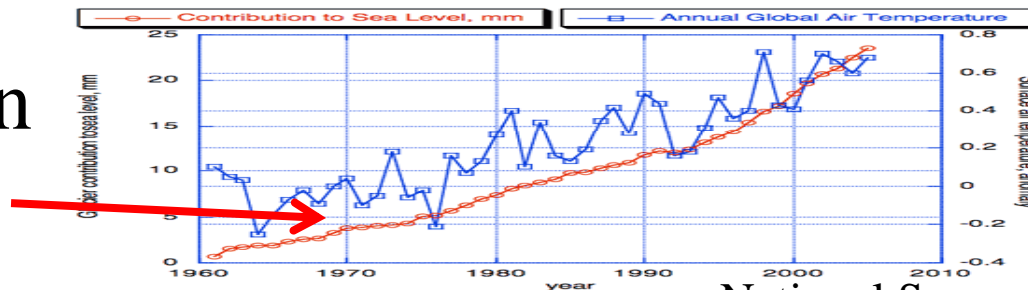
# Sea level rise in last 50 years

# Thermal expansion



What about inaccurate deep ocean data?  
How about melting of Greenland and Antarctic ice sheets?  
Then, sea level rise can be much faster!

Mountain glaciers



# Questions collected by web and moderator

- How accurate are the sea level data in last 50 years?
- How fast will warming take place in the ocean below 2000m? How important is it?
- Do you think ice sheet melting crucial?
- What is your projection on the sea level rise in this century? Is there any disagreement among the scientists?
- What is the most crucial component but missing now?