Climate Change 2013: The Physical Science Basis

Working Group I contribution to the IPCC Fifth Assessment Report

Chapter 13: Sea Level Change

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What is IPCC? The Process.

- Intergovernmental Panel, Role is to produce Assessments that are policy relevant but not policy prescriptive
- Small Secretariat plus three Working Groups and Synthesis Report teams, IPCC selects scientists to review science
- robust findings, multiple lines of evidence, weight of evidence, clarity of communication
- Scoping Meeting (July 2009), Sea level workshop, Four Lead Author meetings
- Zeroth Draft, First Draft (scientific review), Second Draft (government and scientific review), Final Draft.
- Final Plenary (October 2013 for WGI) – Government Approval on line by line basis of summary for policy makers, and acceptance of full report

Key SPM Messages

19 Headlines

on less than 2 Pages

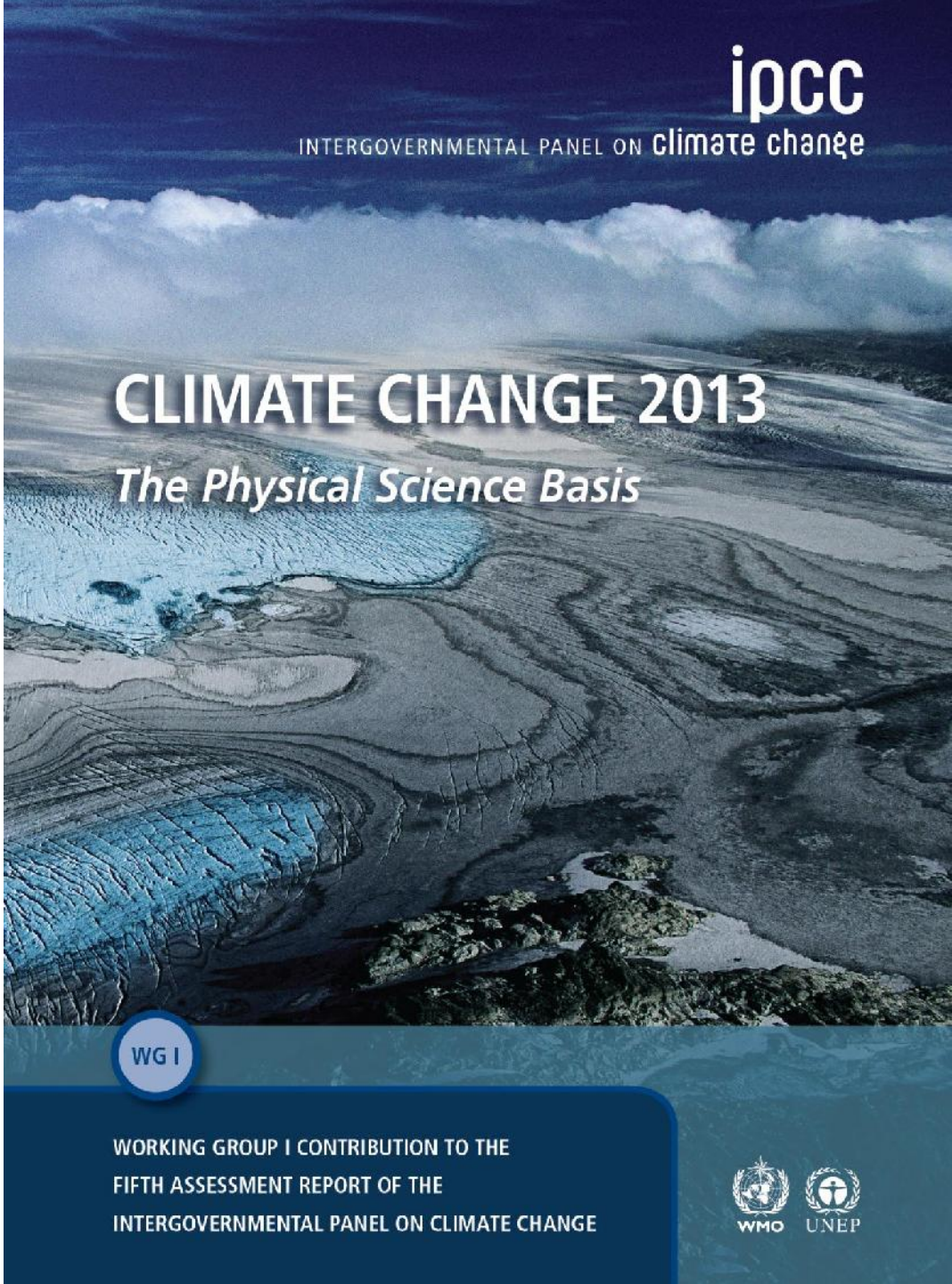
Summary for Policymakers
~14,000 Words

14 Chapters
Atlas of Regional Projections

54,677 Review Comments
by 1089 Experts

2010: 259 Authors Selected

2009: WGI Outline Approved



Key messages

- In warmer climates, sea level was higher
- The rate of sea level rise has increased over the last 200 years
- Sea level rose by 0.19 [0.17 to 0.21] m over 1901-2010
- The rate of rise will increase under all scenarios.

- Collapse of marine-based sectors of the Antarctic Ice Sheet, if initiated, would add no more than several tenths of a meter by 2100.
- Increase in the occurrence of sea level extremes.
- Sea level rise will continue for many centuries, with the amount of rise dependent on future emissions.

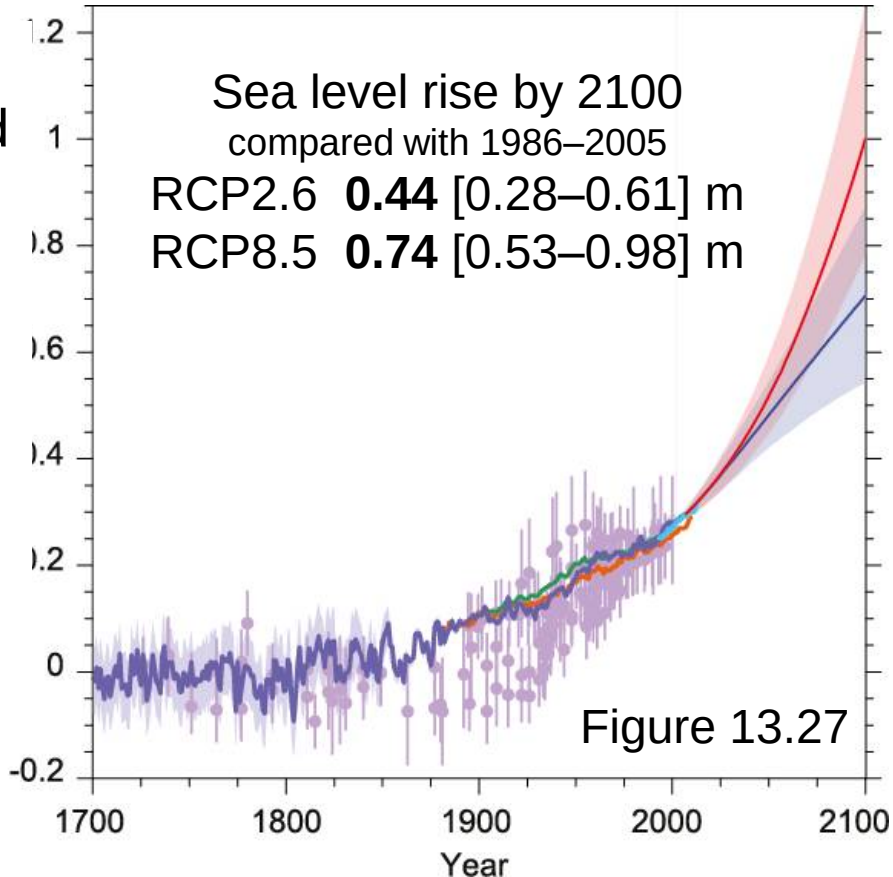
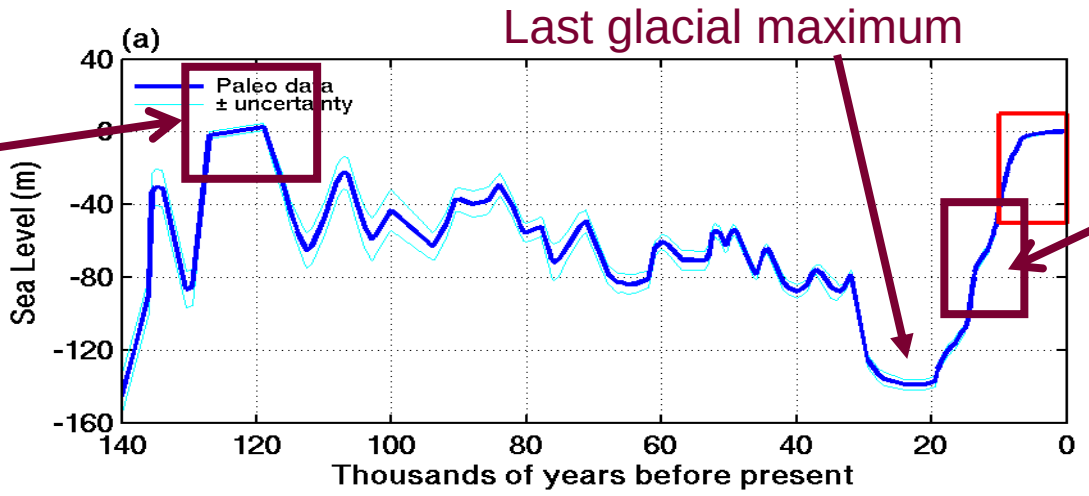


Figure 13.27

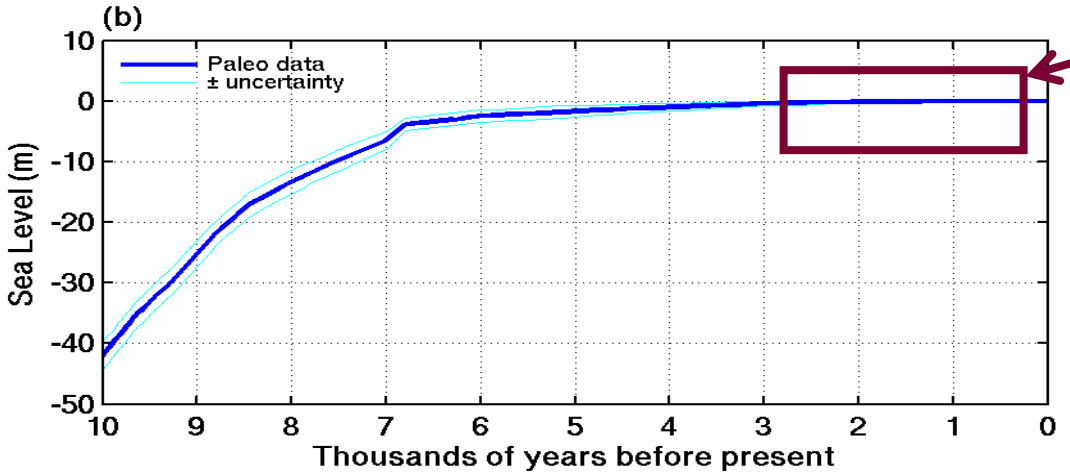
Sea level has changed over Earth's history

Sea level during the last interglacial was >5 to <10 m higher than present. The Greenland ice sheet contributed between 1.4 and 4.3 m; high latitude temperatures >2°C than present.

- Sea level higher than today,
- At temperature similar to what we expect by 2100



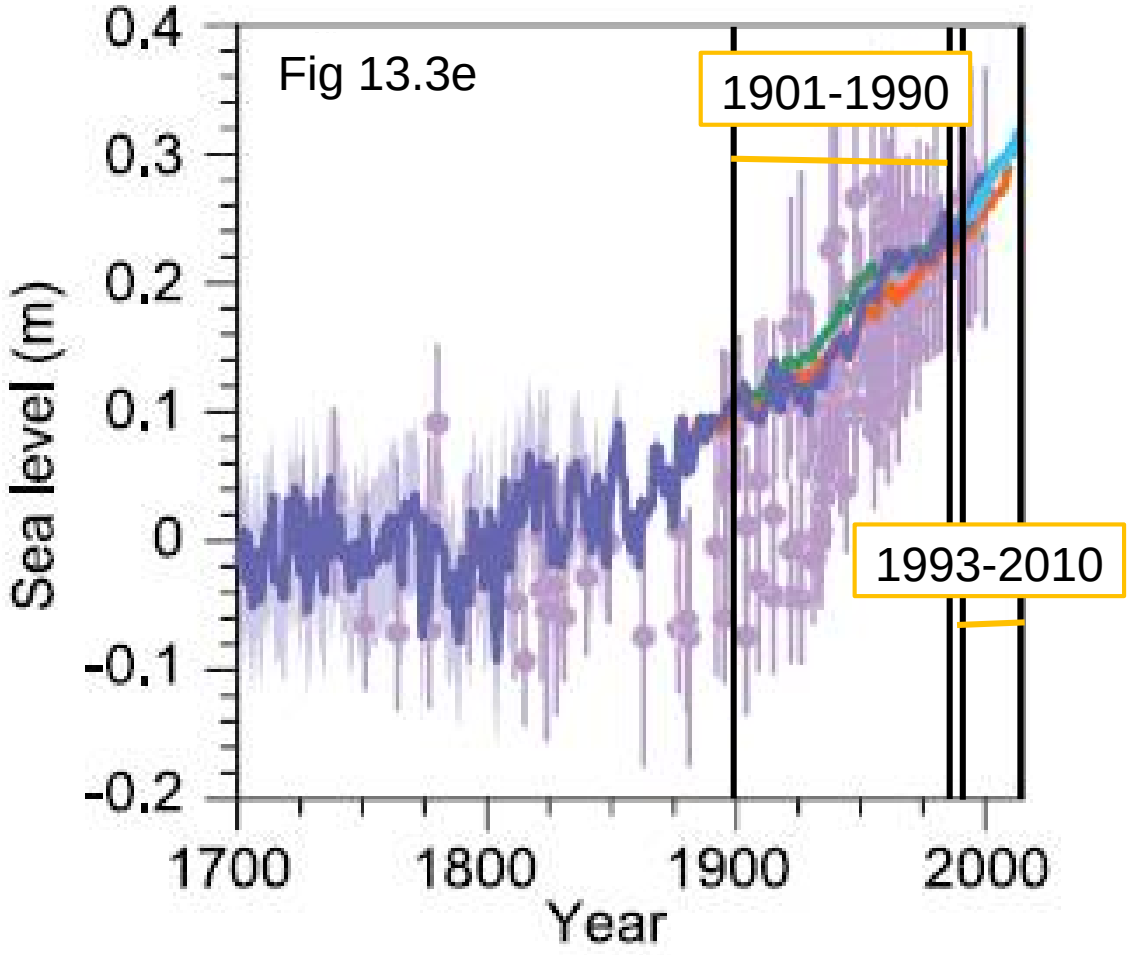
- Rates of rise up to 4 m/century



- Our coastal society developed in a time of stable sea level

Rate of GMSLR has been greater since the mid-19th century

Rate during the last two millennia was of order a few tenths of mm yr^{-1}.



Rate during 1901-1990 was 1.5 [1.3 to 1.7] mm yr^{-1}.

Likely that the rate has increased since the early 1900s

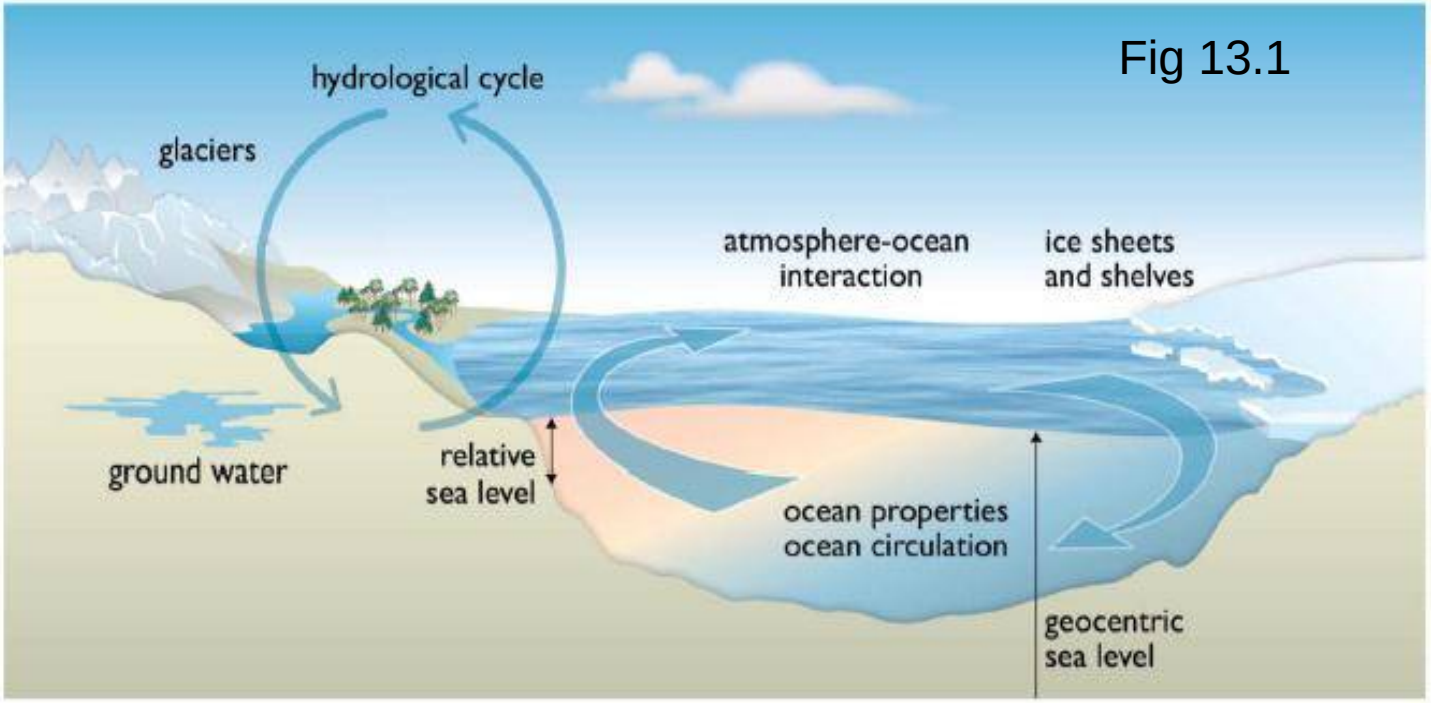
Rate during 1993-2010 was 3.2 [2.8 to 3.6] mm yr^{-1}, but also high rates in 1920-1950

Understand the causes of global mean sea level (GMSL) change during the 20th century

Warming (cooling) of the ocean (thermal expansion/contraction)

Change in mass of glaciers and ice sheets

Changes in liquid water storage on land



Relative sea level is also affected by ocean density and circulation, land movement, and distribution of mass on the Earth

Improved understanding and modelling of 20th century sea level change

Observed contributions explain observed GMSLR 1993-2010

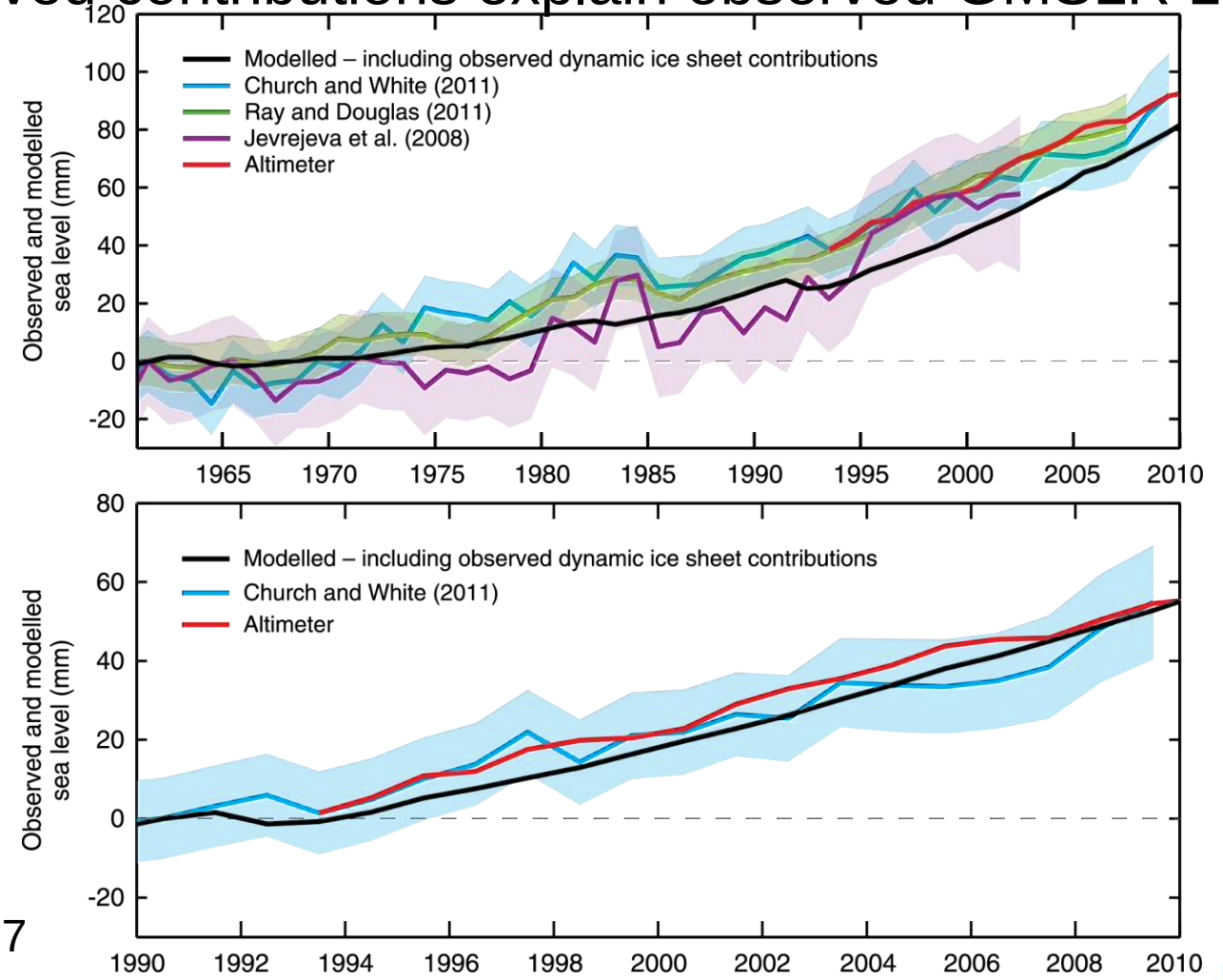
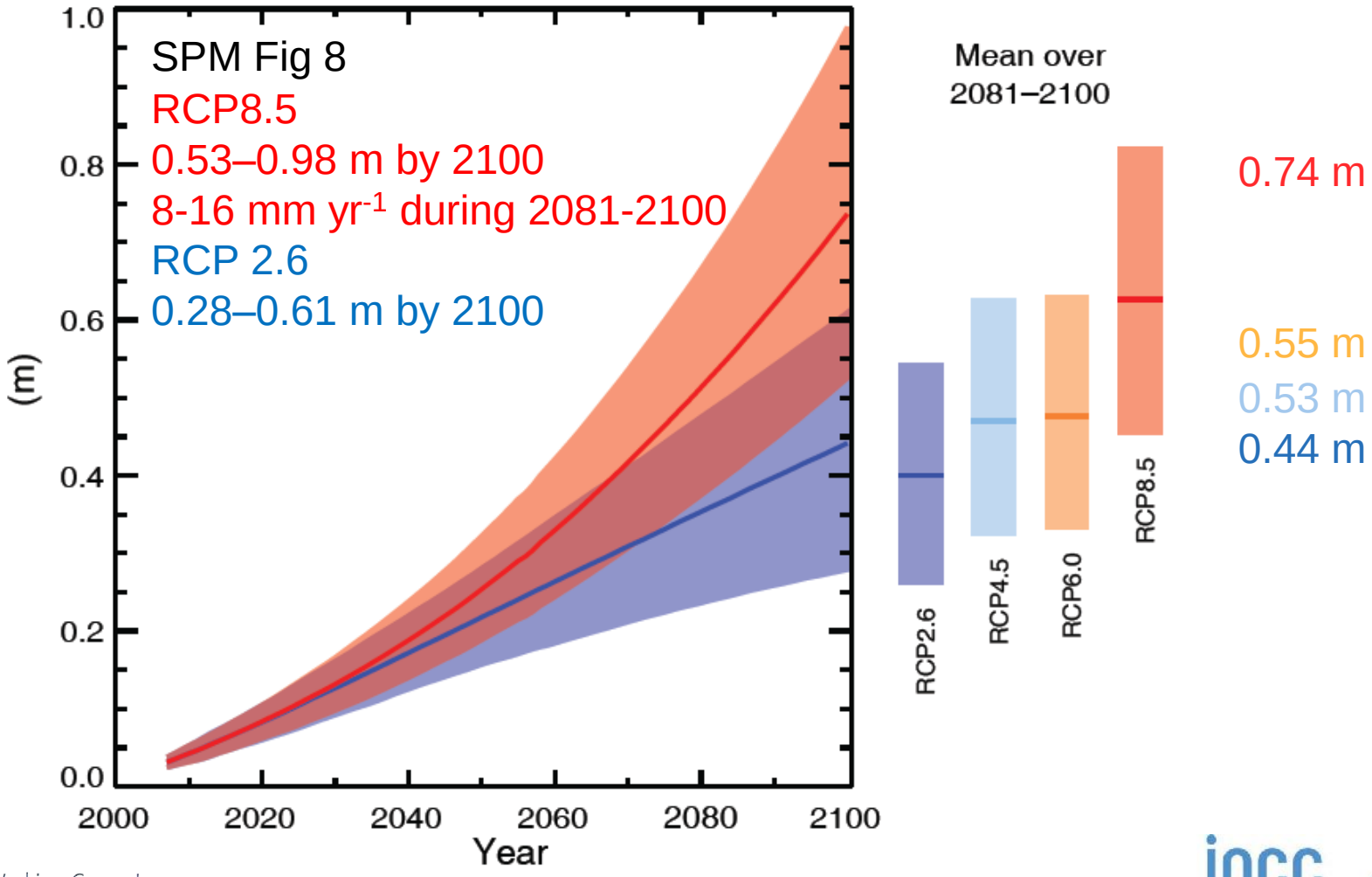


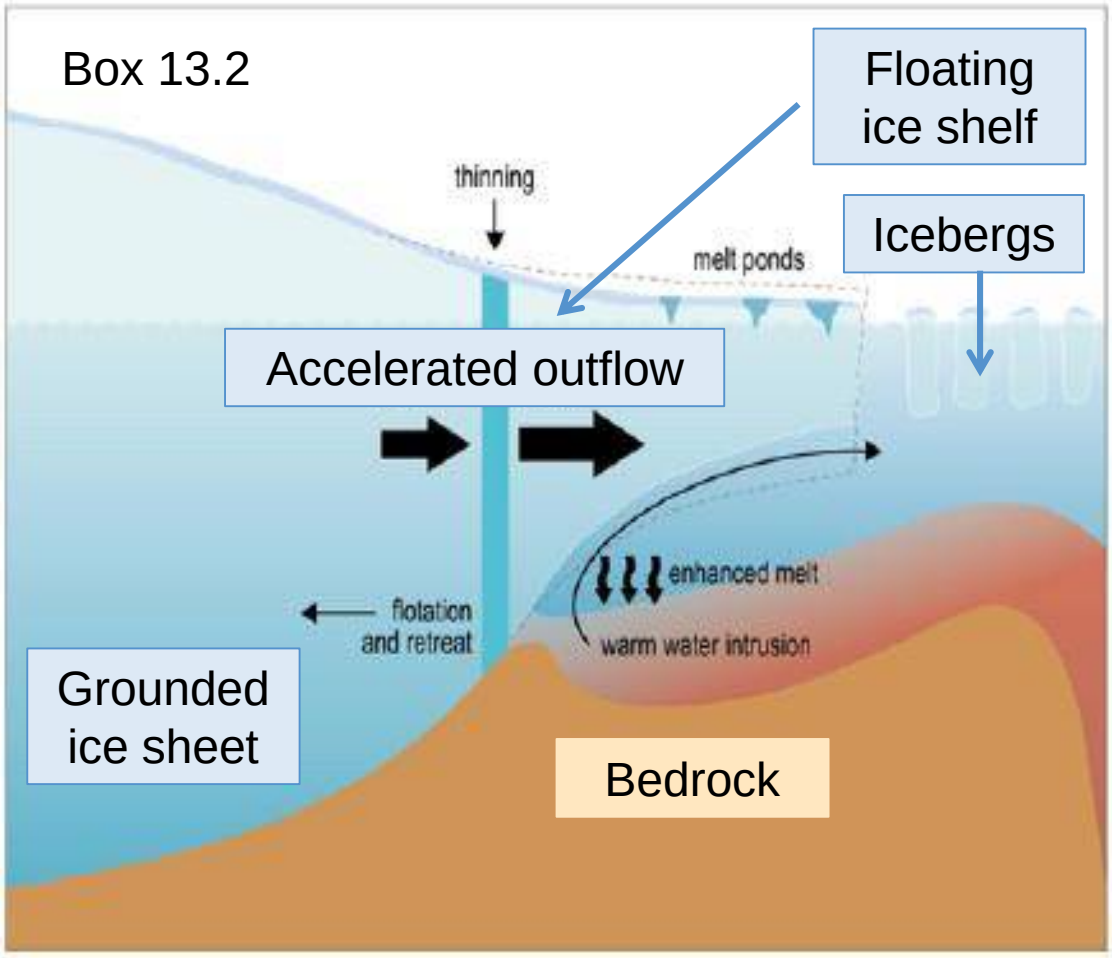
Figure 13.7

Projections of 21st-century GMSLR

Medium confidence in *likely* ranges. *Very likely* that the 21st-century mean rate of GMSLR will exceed that of 1971-2010 under all RCPs.



Potential rapid increase in ice sheet outflow

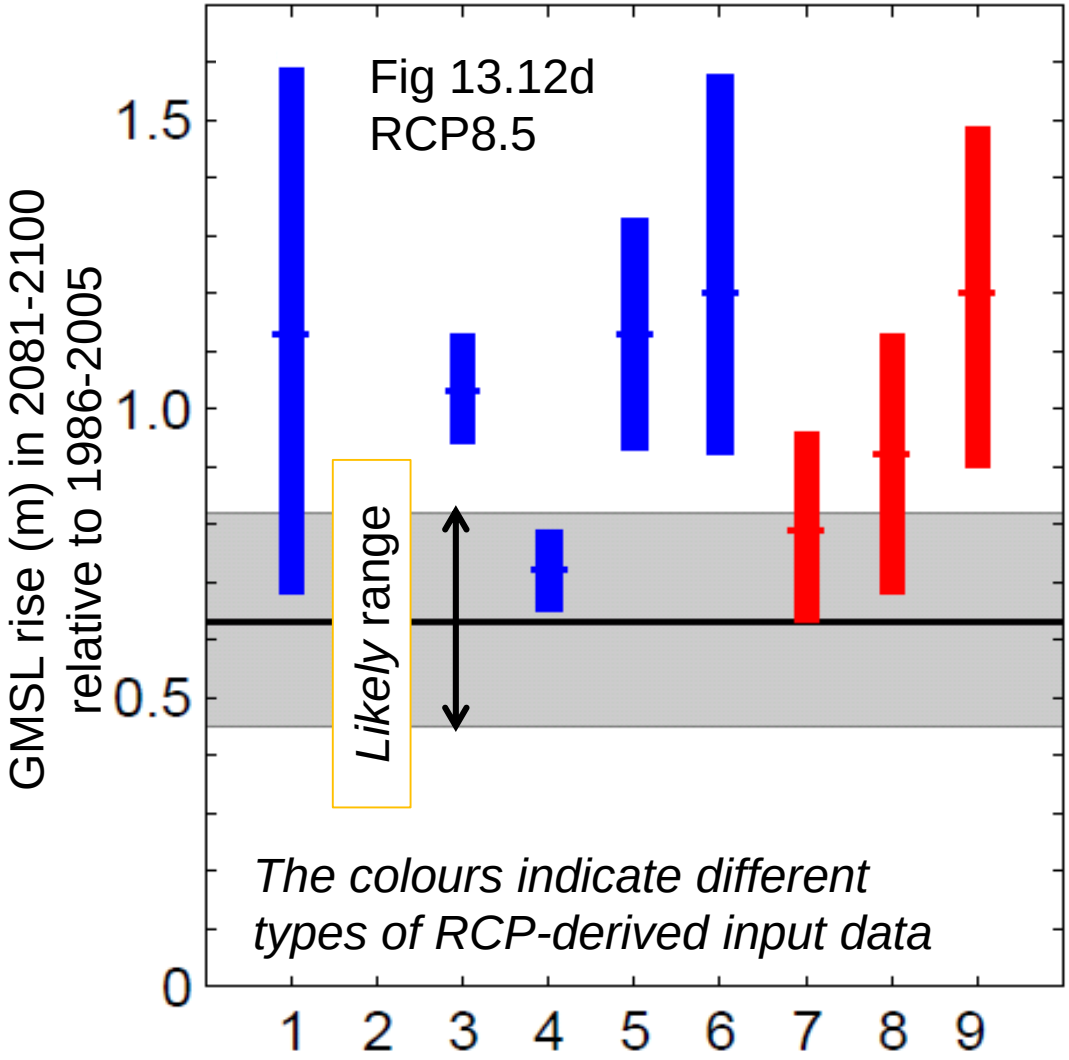


Only the collapse of marine-based sectors of the Antarctic ice sheet, if initiated, could cause GMSL to rise substantially above the *likely* range during the 21st century.

Medium confidence that this additional contribution would not exceed several tenths of a metre during the 21st century.

Current evidence and understanding do not allow a quantification of either the timing of its onset or of the magnitude of its multi-century contribution.

Low confidence in projections of a larger rise from semi-empirical models



In nearly every case, the semi-empirical model 95-percentile is higher than the process-based *likely* range.

There is no consensus in the scientific community about the reliability of semi-empirical model projections.

There is no evidence that ice-sheet dynamical change is the explanation for the higher projections.

It is *virtually certain that global mean sea level rise will continue beyond 2100, with sea level* rise due to thermal expansion to continue for many centuries

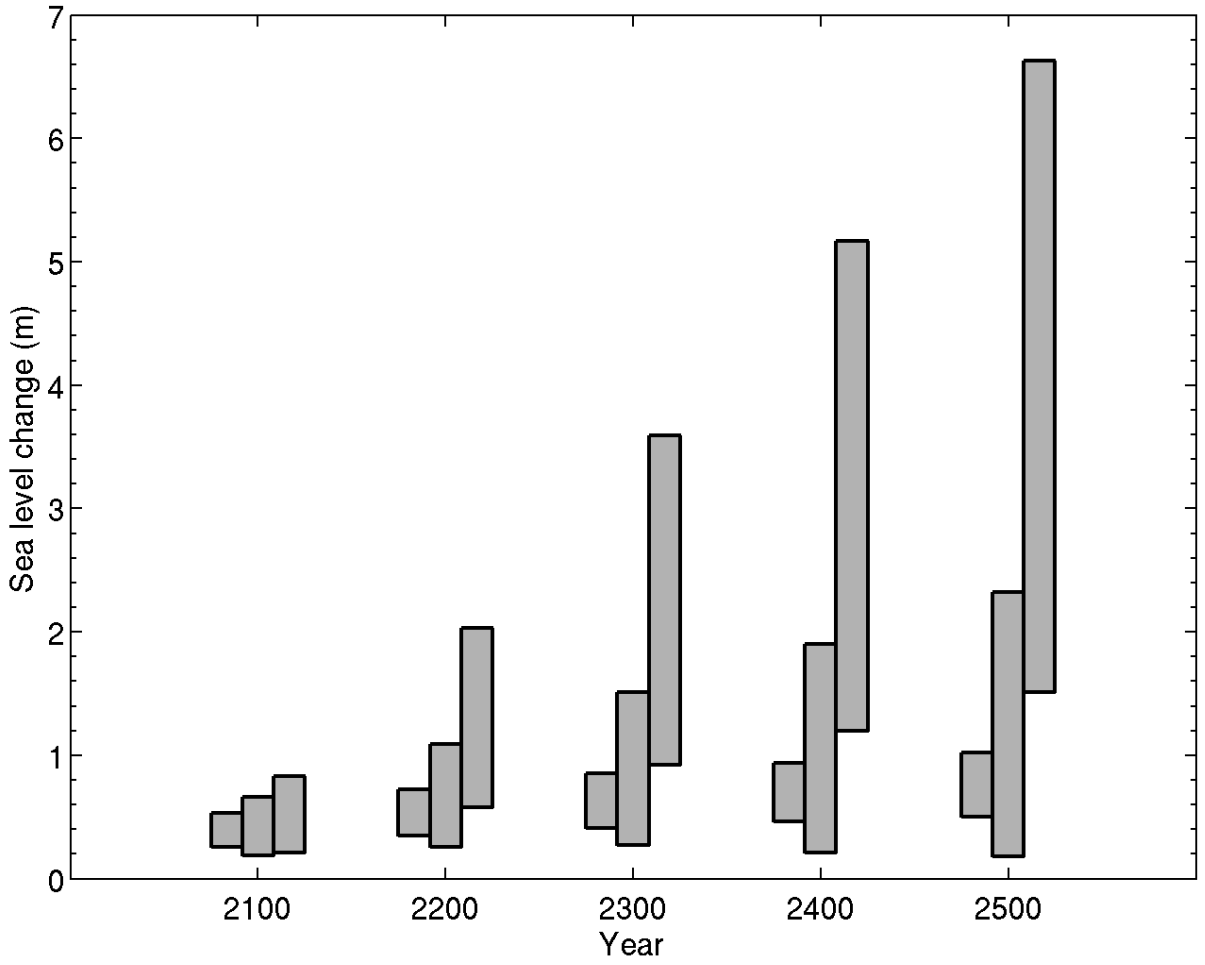
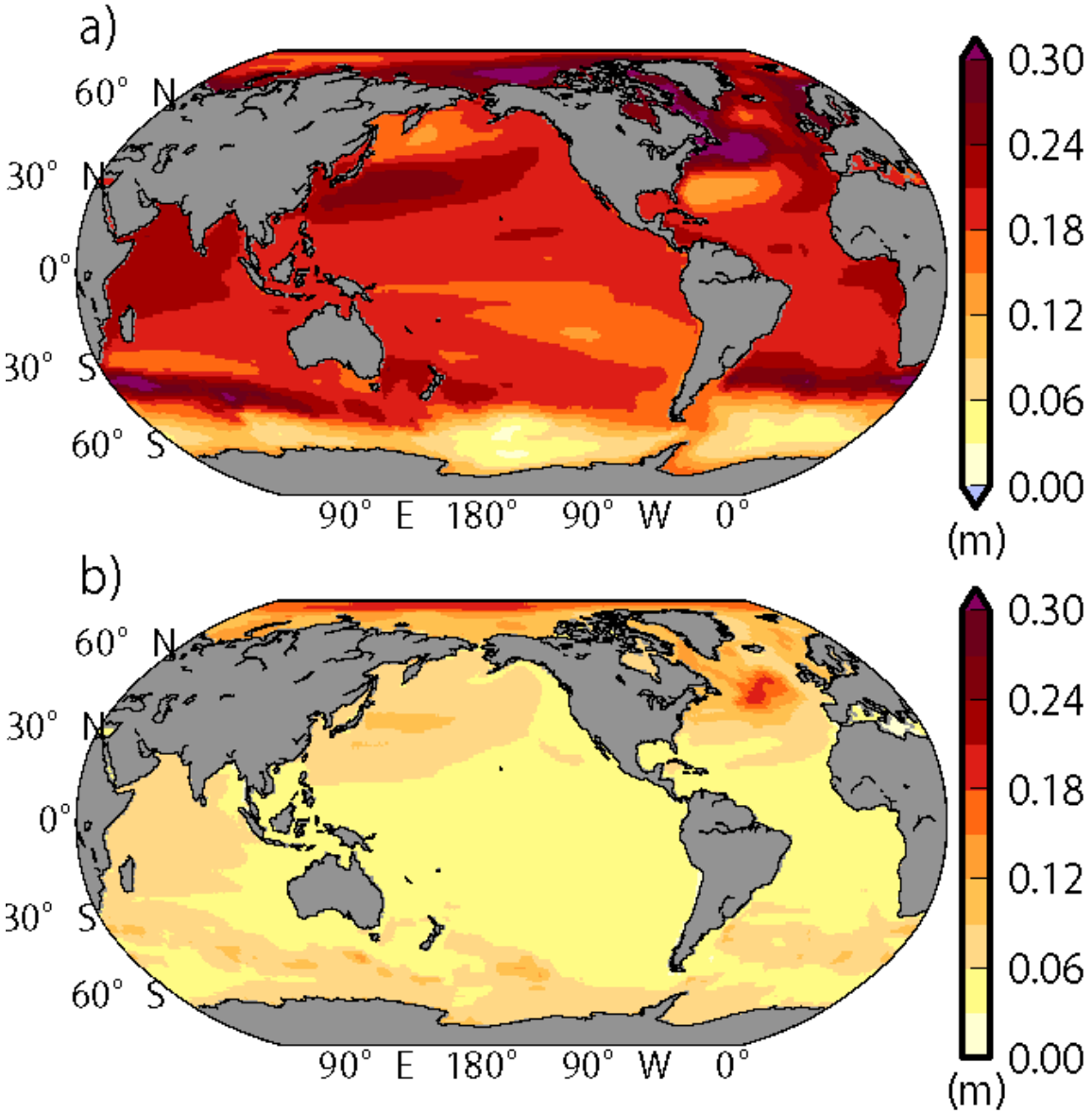


Figure 13.13

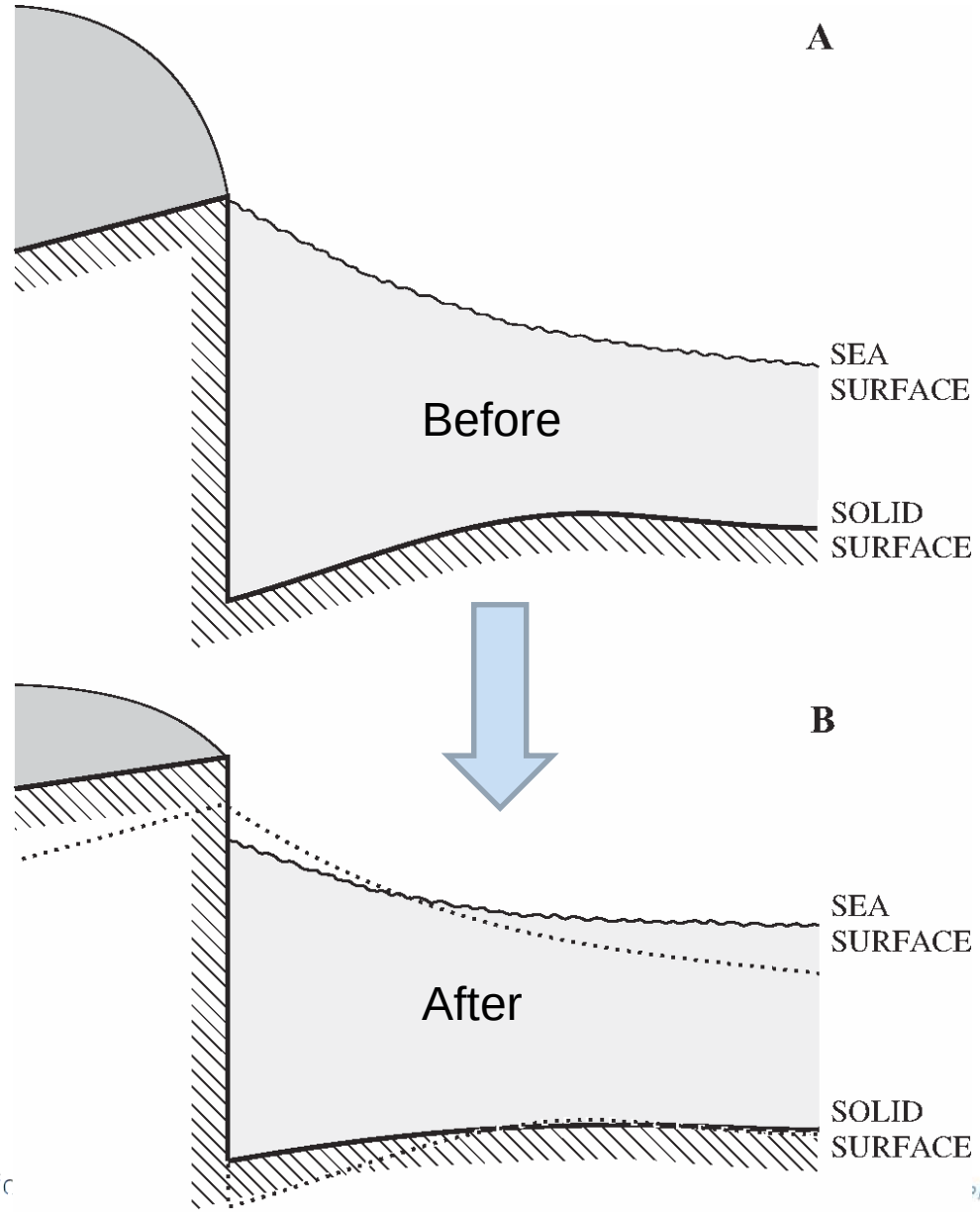
A number of processes lead to a non-uniform sea-level rise



Dynamical Ocean Response

Figure 13.16

The earth changes as ice sheets change



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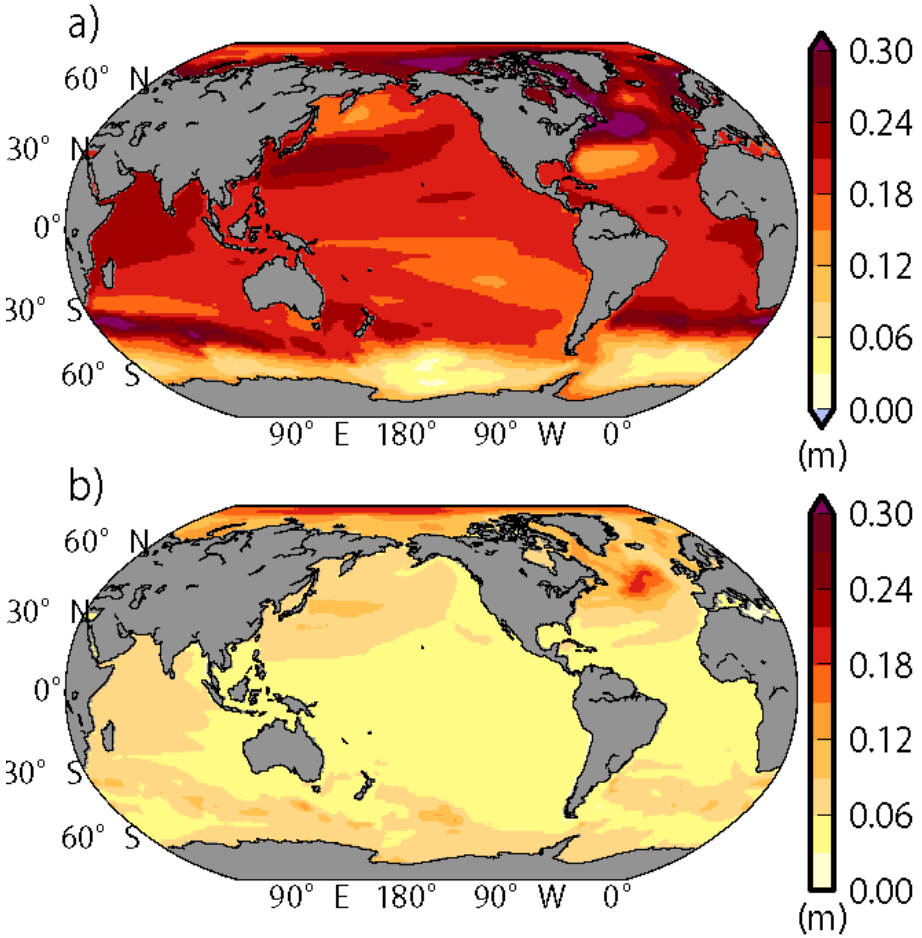


Figure 13.16

Glacial isostatic adjustment

Glacier mass loss

Ice sheet mass loss

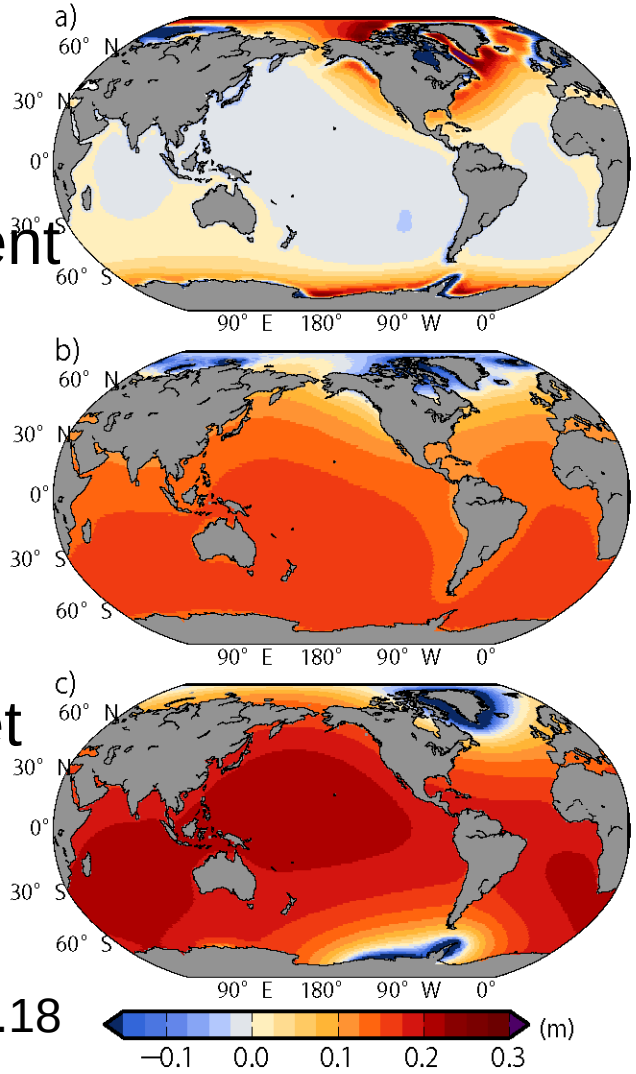


Figure 13.18

It is *very likely* that sea level will rise in more than about 95% of the ocean area.

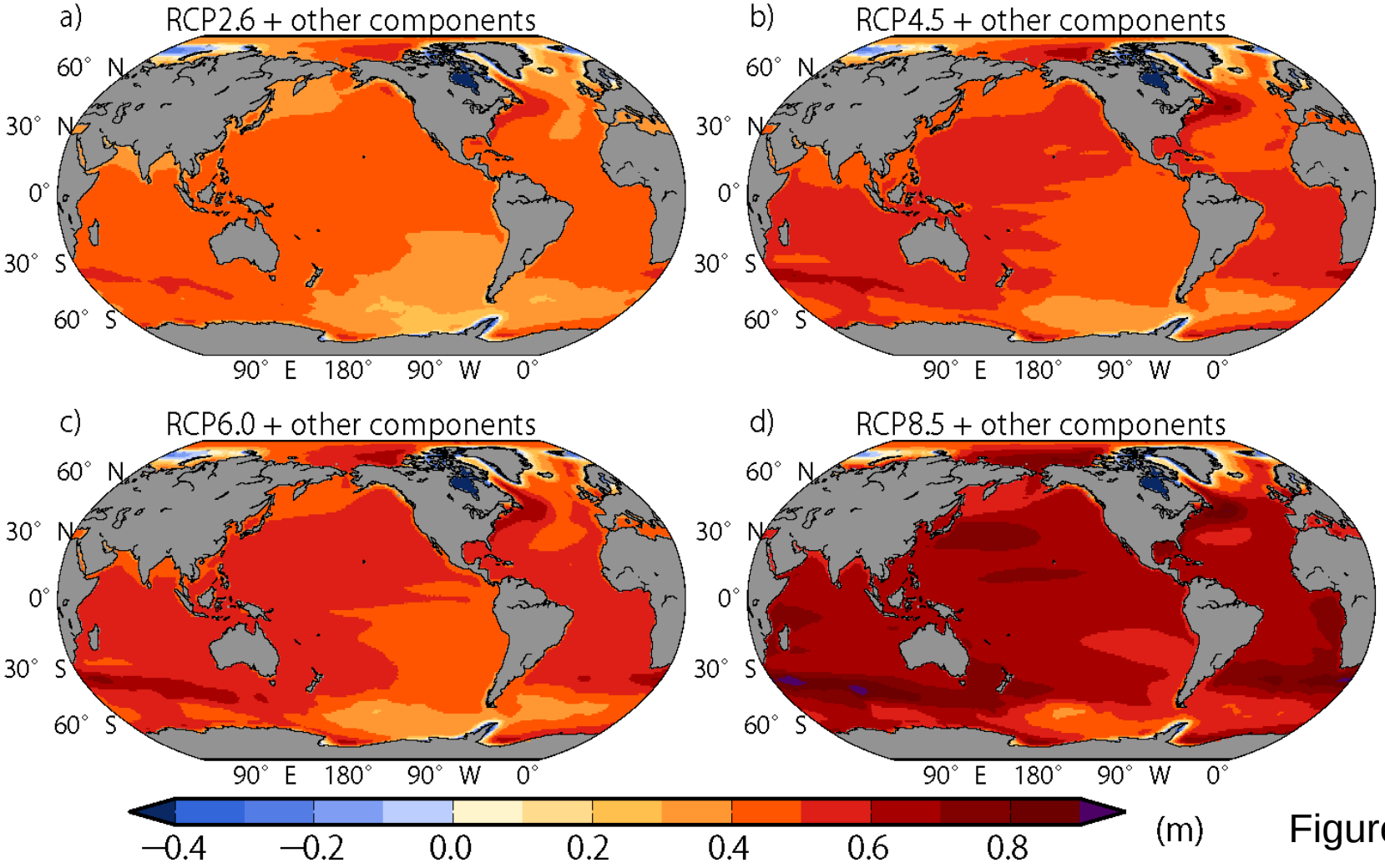
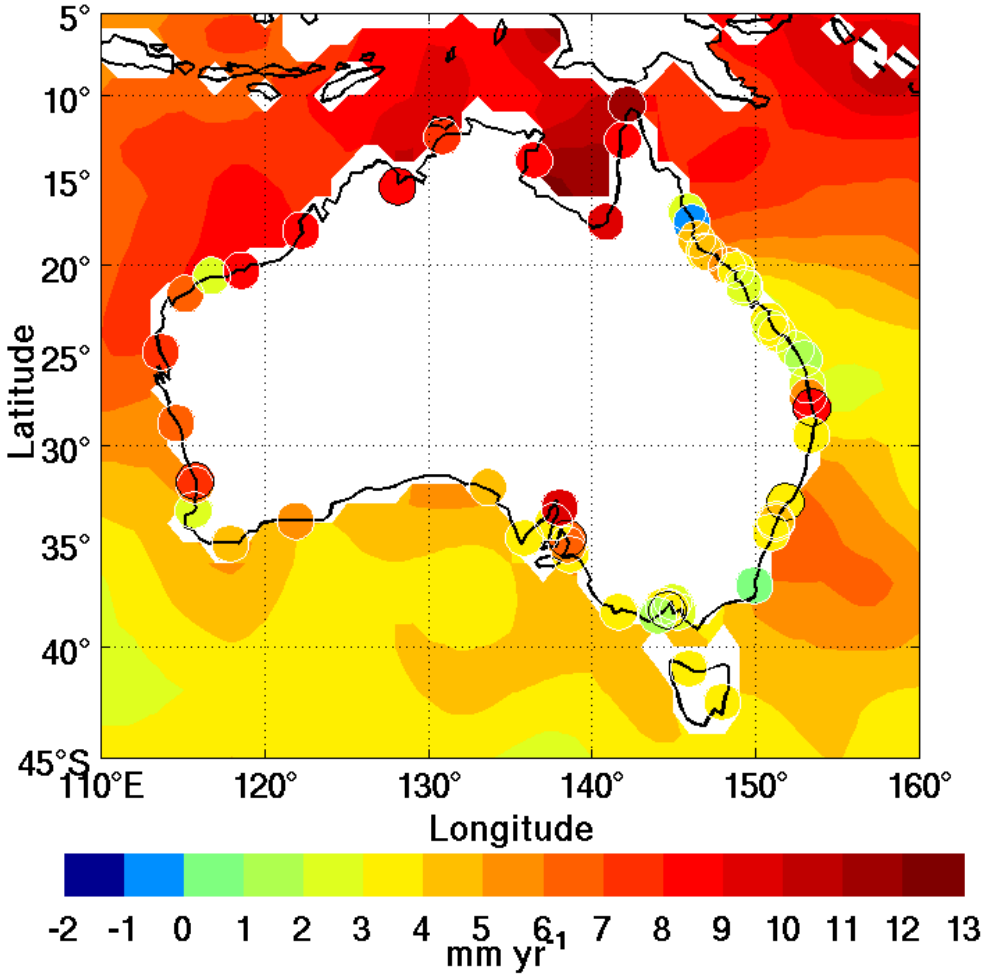
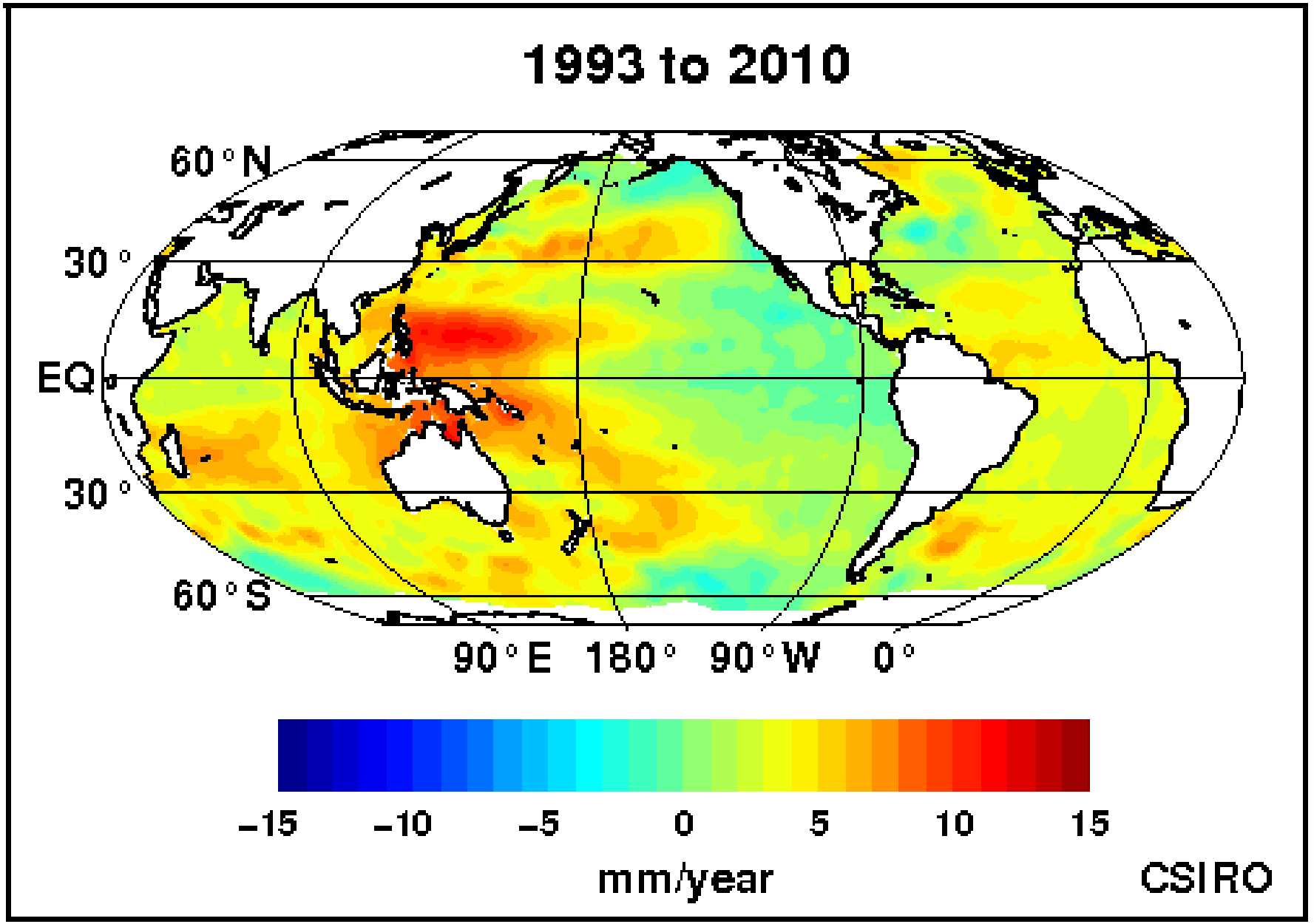


Figure 13.20

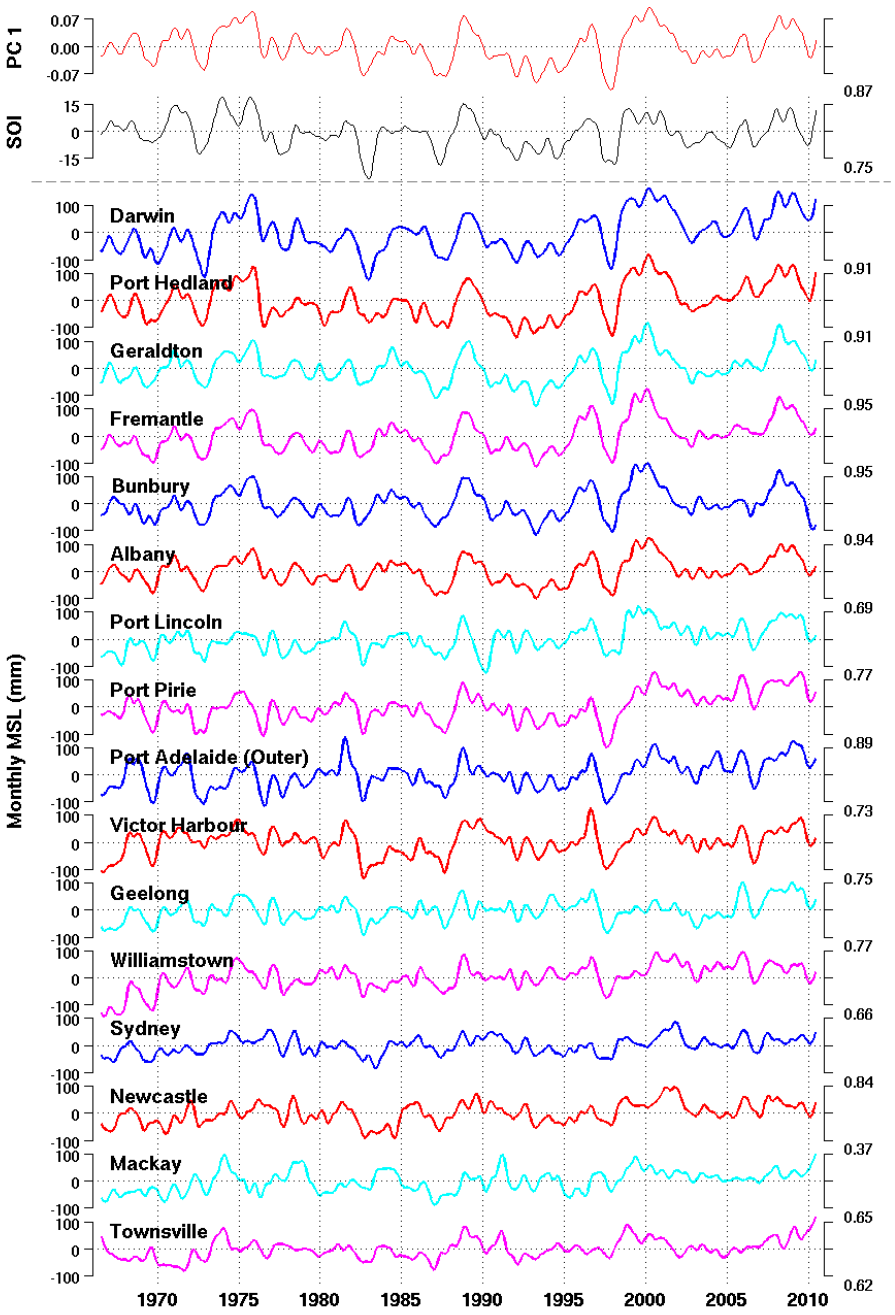
Australian sea levels since 1993 rising faster than the global average



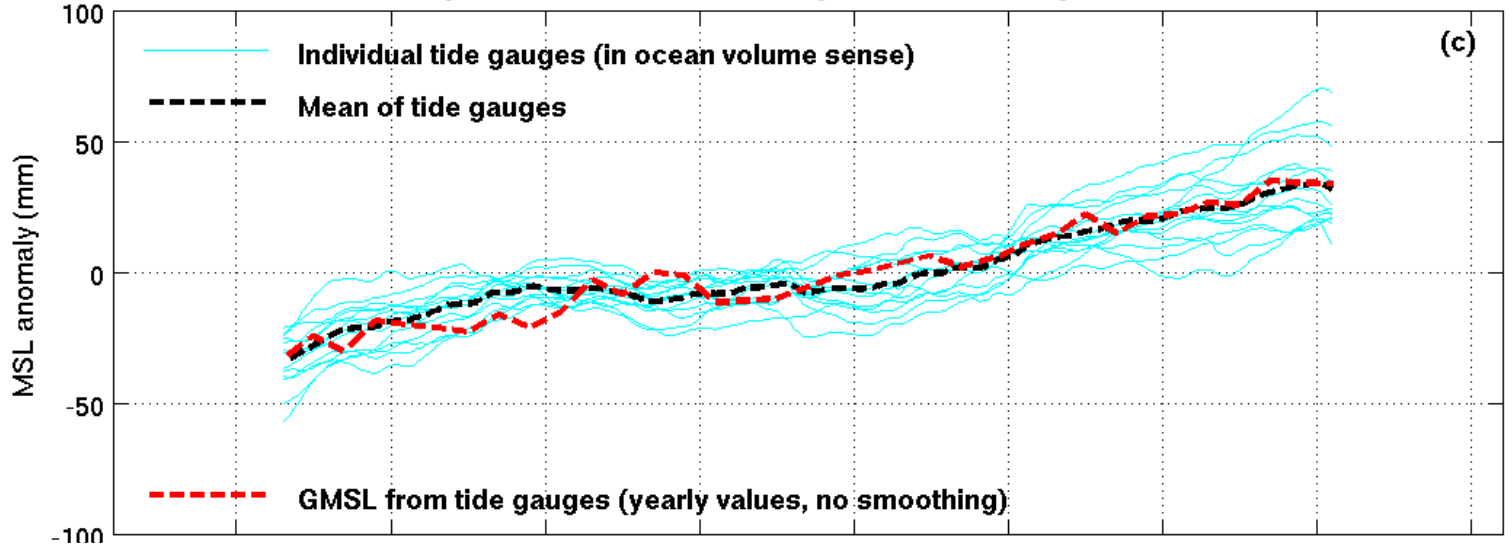
Observed sea-level rise is not uniform



Variability in sea level is coherent around much of the Australian coastline



The average of Australian sea level trends similar to the global average change

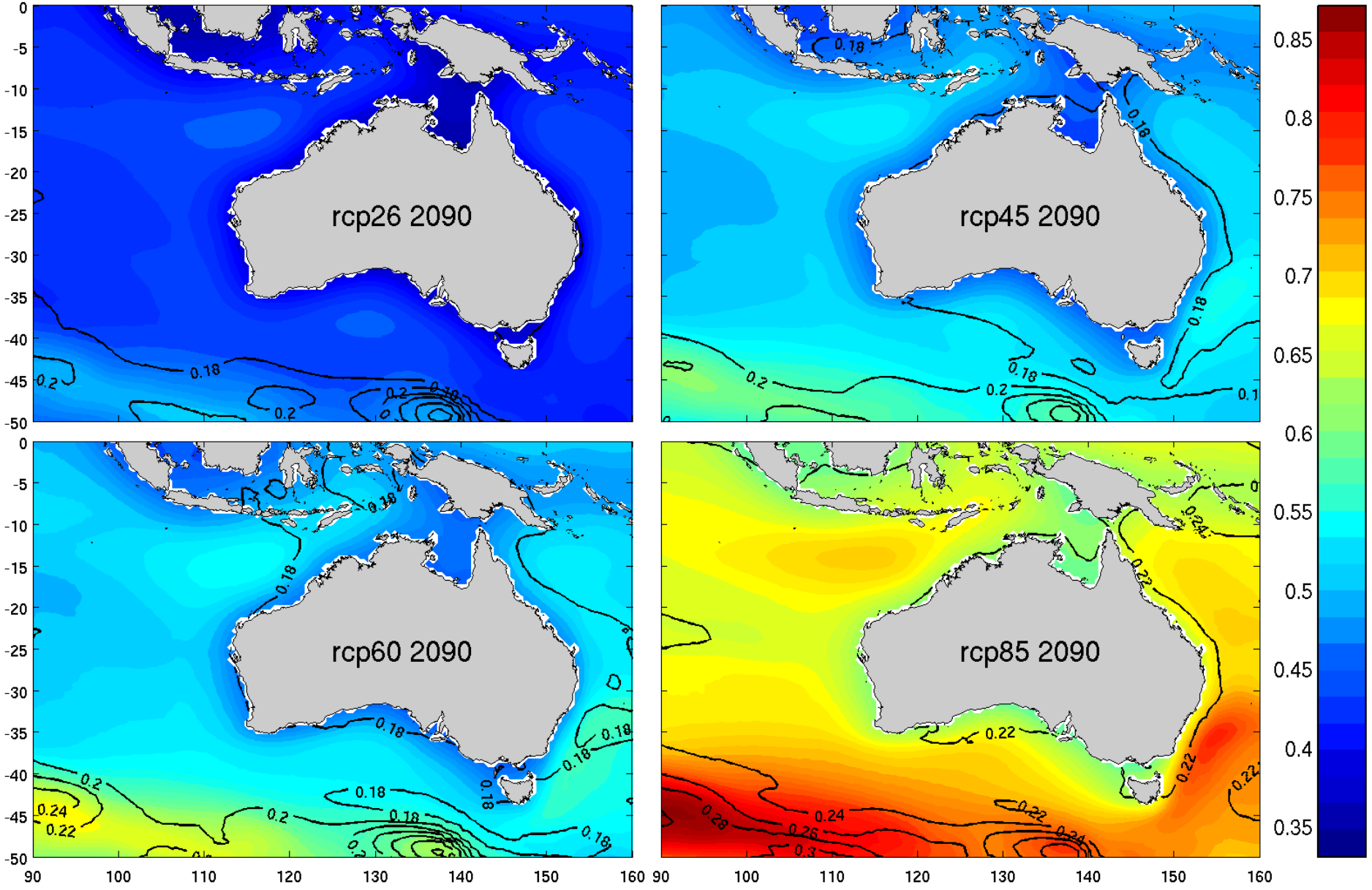


1.4 ± 0.3 mm yr^{-1} and 4.5 ± 1.3 mm yr^{-1}, for 1965-2009 and 1993-2009

after removal of ENSO, correcting for GIA and changes in atmospheric pressure,

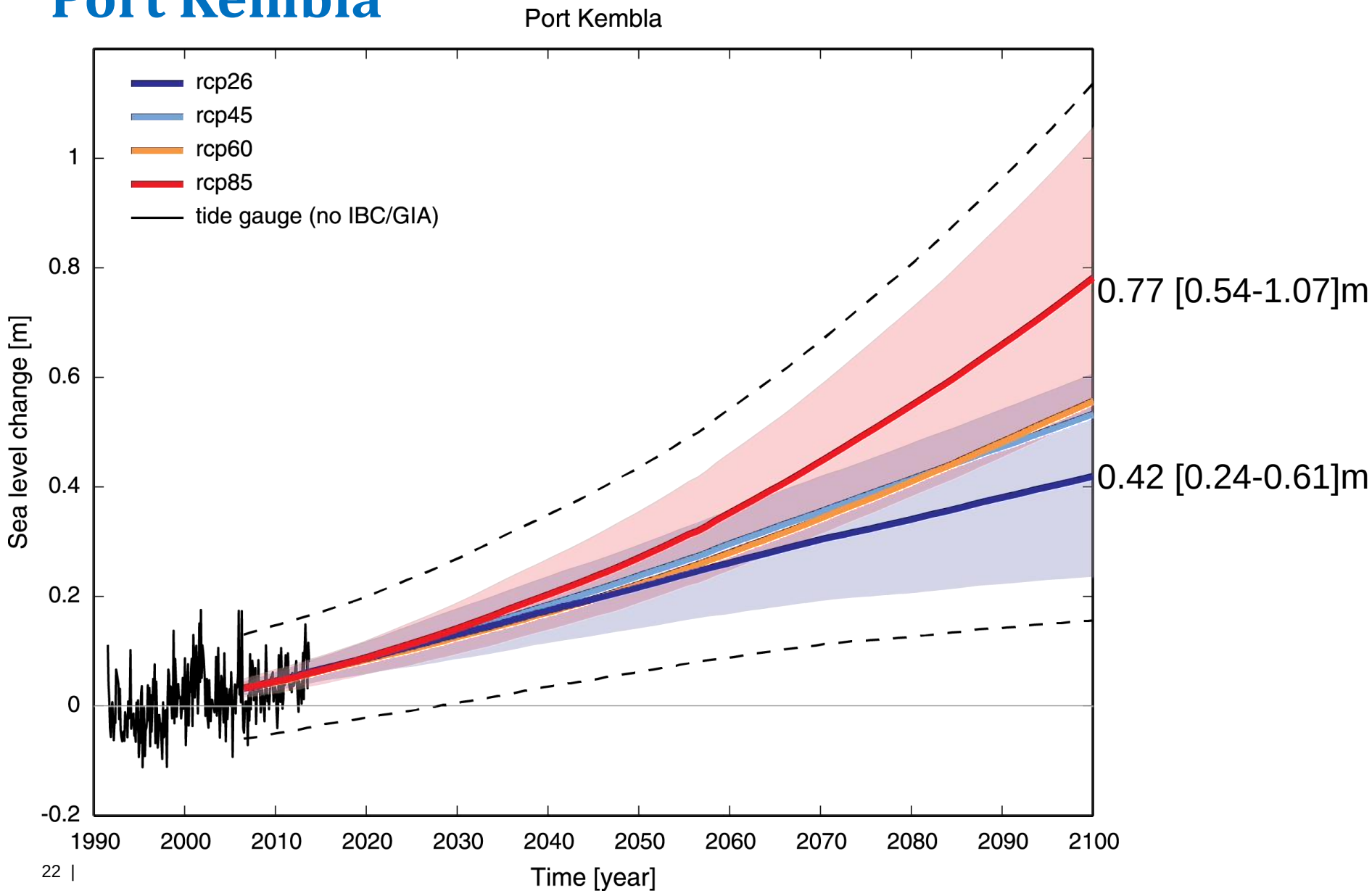
the trends are 2.1 ± 0.2 mm yr^{-1} and 3.1 ± 0.6 mm yr^{-1}

Projections of relative sea level rise around Australia



0.42 [0.24-0.61]

Projections of 21st century sea level change for Port Kembla



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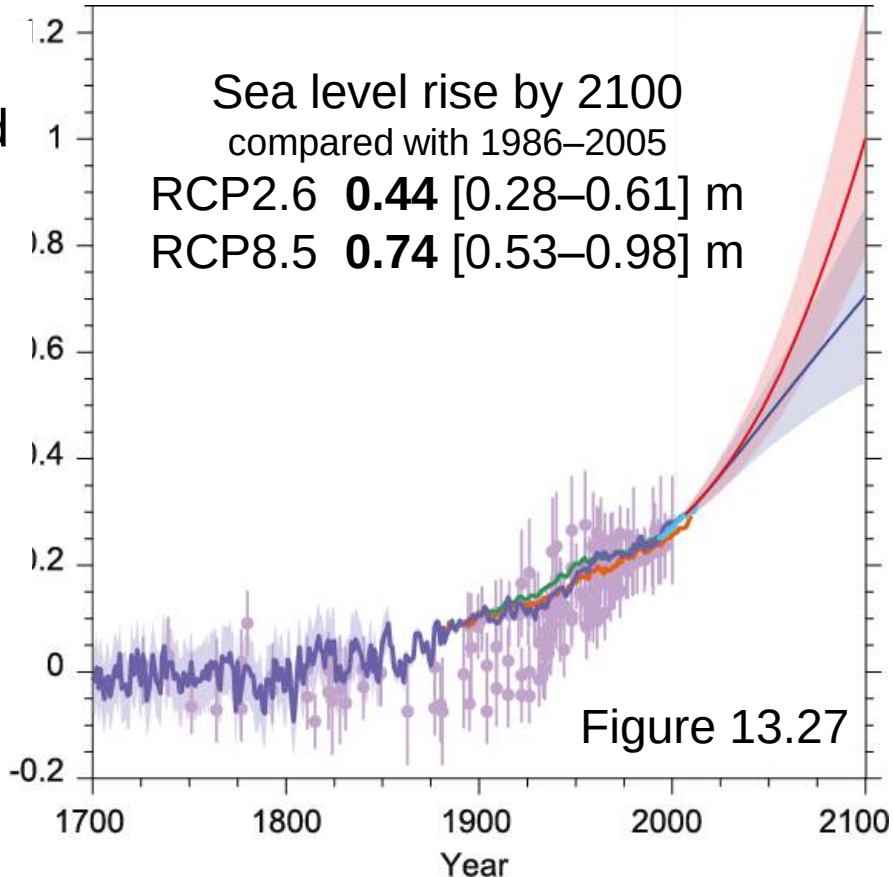
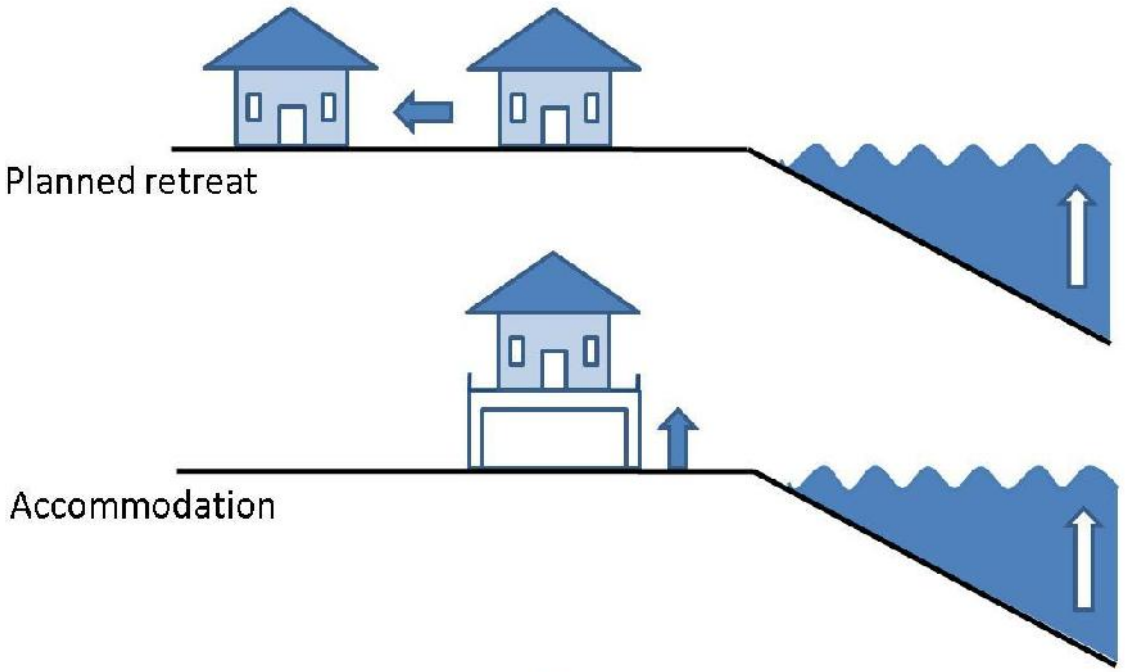


Figure 13.27

Will need to Adapt - Options



Method for estimating an allowance for sea level rise so that risks are not increased

Climate Change 2013: The Physical Science Basis

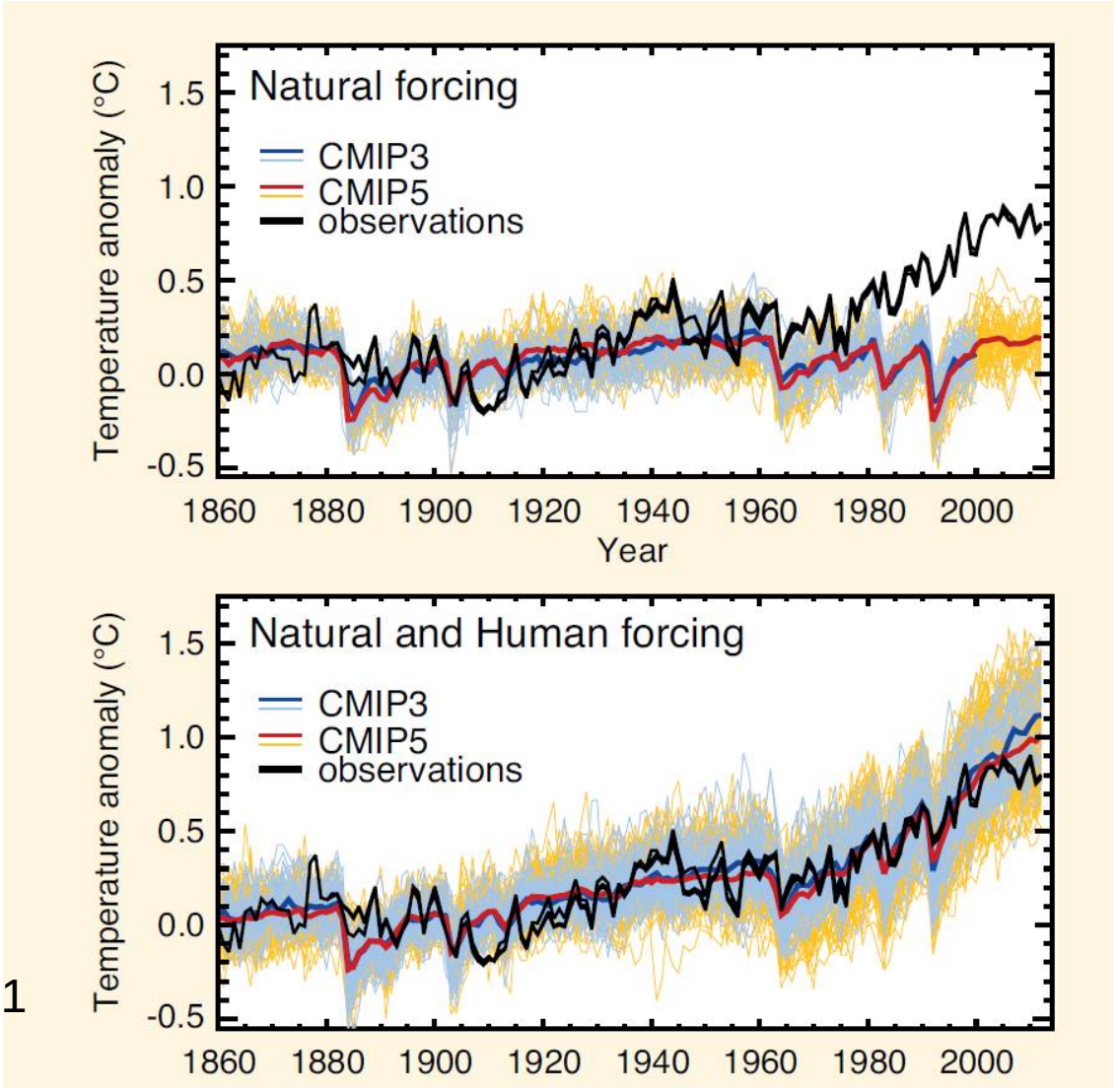
Working Group I contribution to the IPCC Fifth Assessment Report

Further Information

www.climatechange2013.org

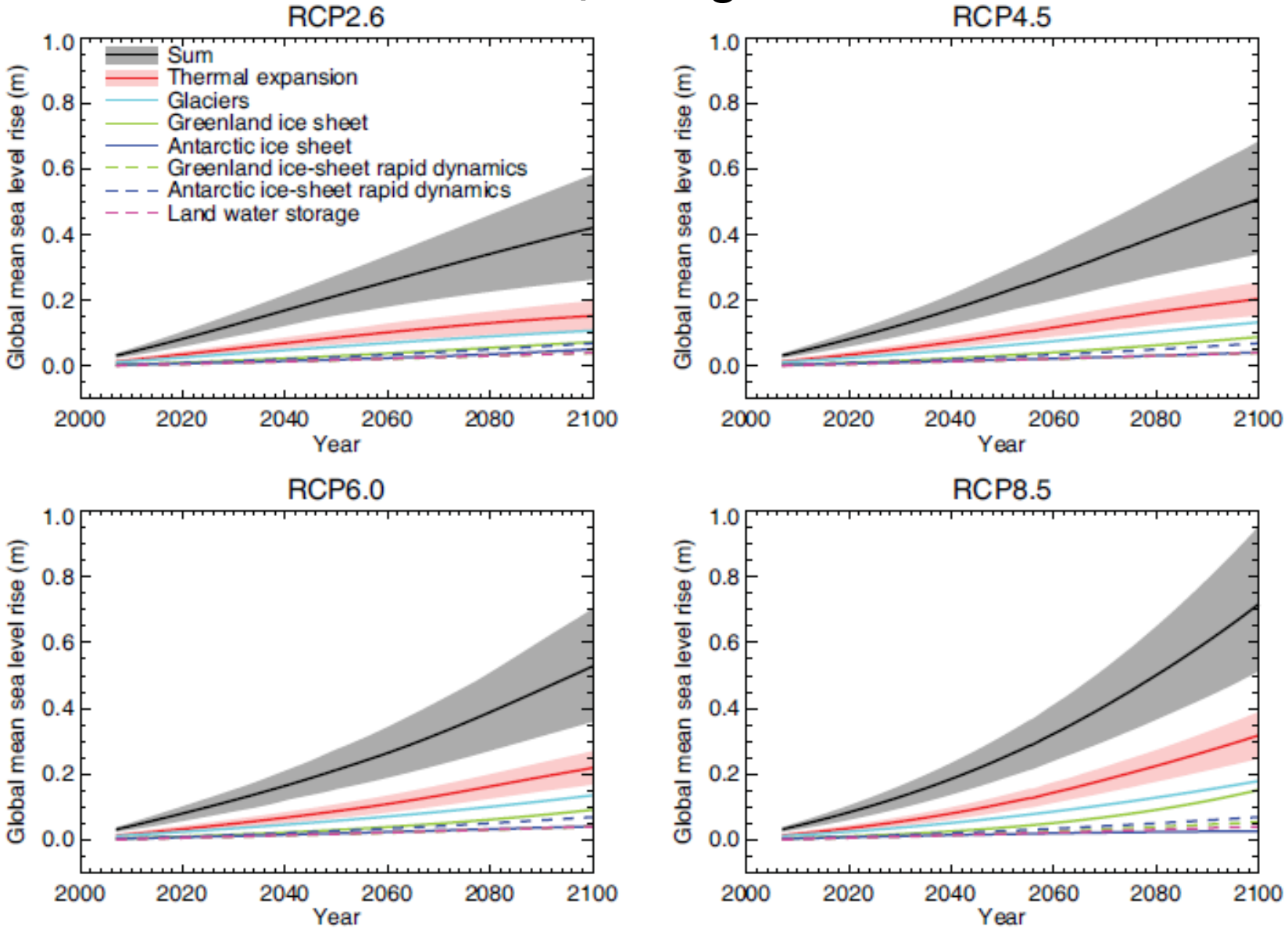
ipcc
INTERGOVERNMENTAL PANEL ON climate change
WMO UNEP

Human forcing of climate change necessary to explain observed changes



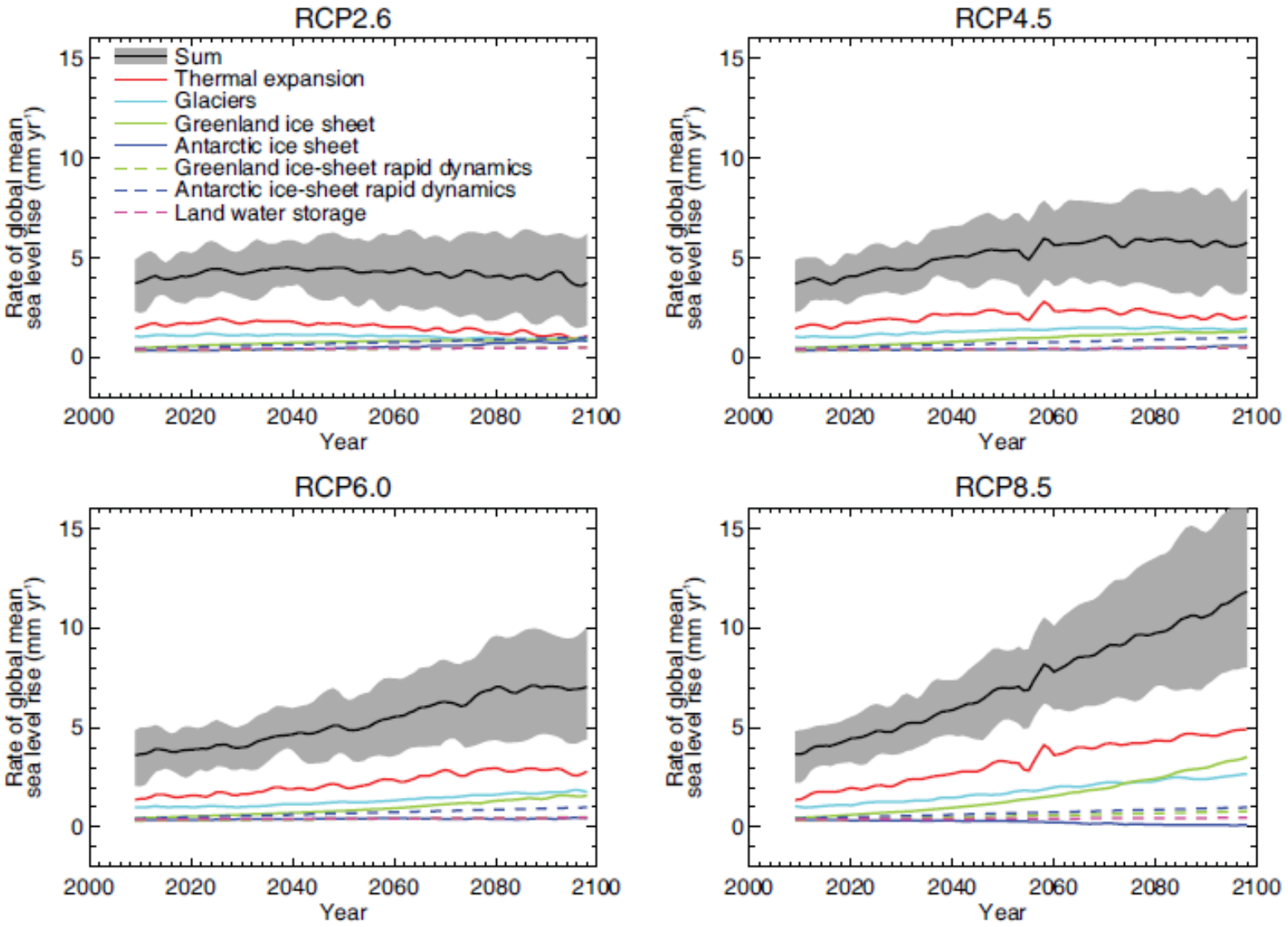
FAQ 10.1, Figure 1

Thermal expansion accounts for 30 to 55% of 21st century global mean sea level rise, and glaciers for 15 to 35%.

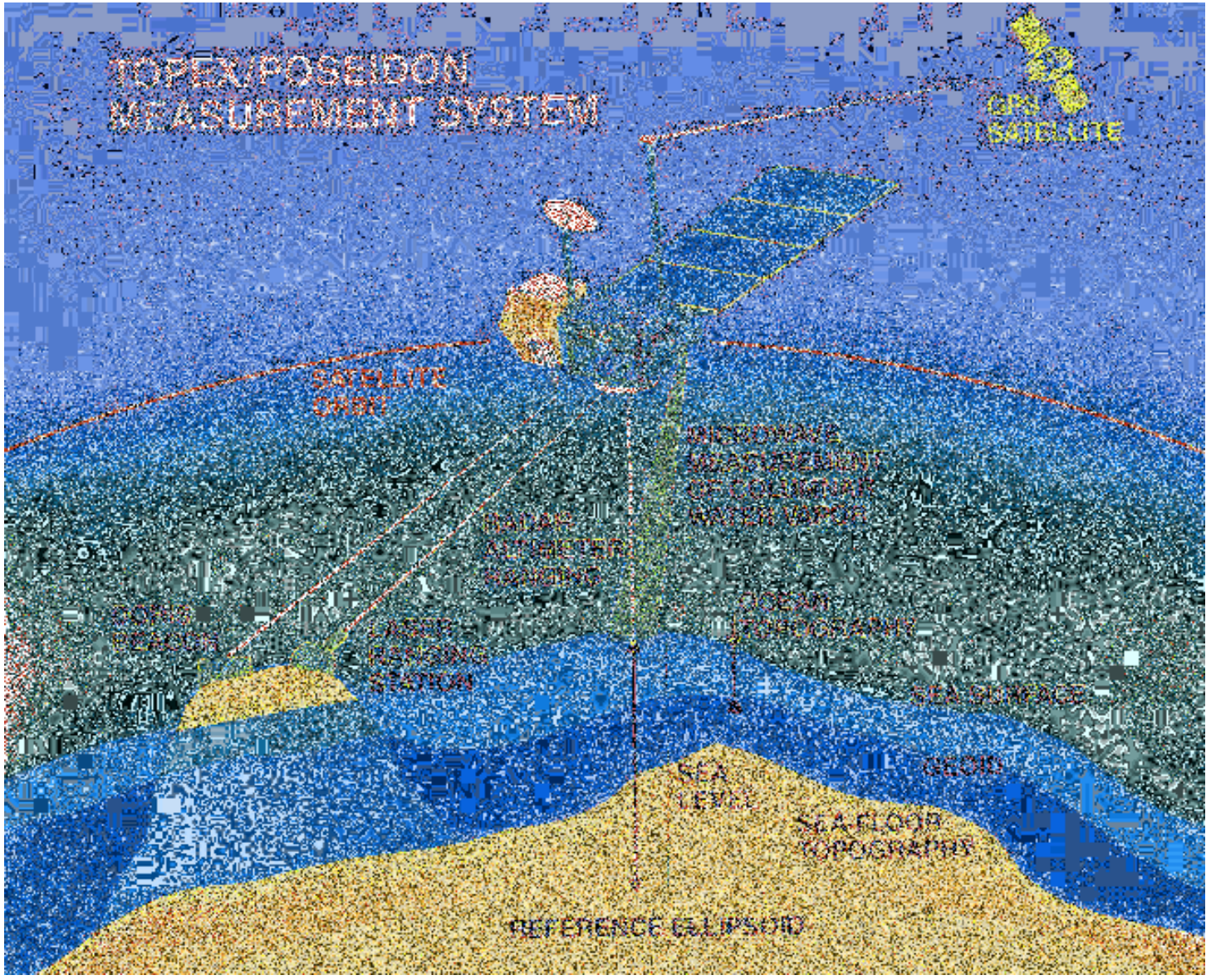


For RCP8.5, the rate of rise during 2081–2100 is 8 to 16 mm yr^{-1} (*medium confidence)*

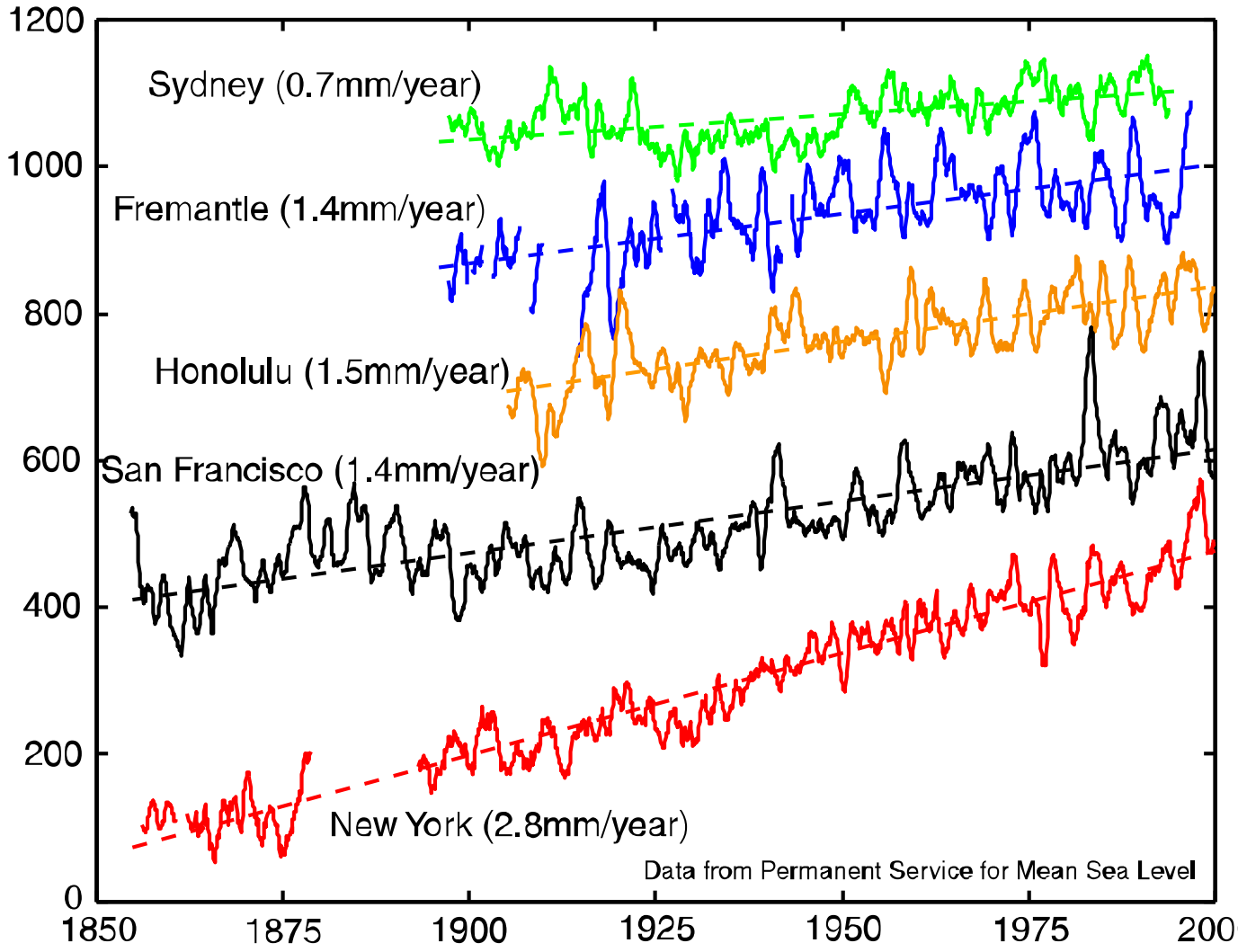
Figure 13.11



Satellite altimeters measure global sea levels



Without vertical land motion corrections there are regional differences in the rate of rise



With vertical land motion corrections the regional differences are reduced