

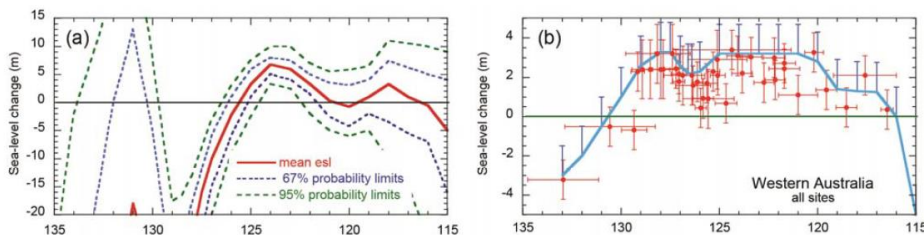
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Sea level was higher during warm periods

Sea level was above present (up to 20 m) during the mid-Pliocene (3.3 to 3.0 million years ago – *high confidence*).

Sea level during the last interglacial (129,000 to 116,000 ka) was >5 to <10 m higher than present (*very high* and *high confidence*). The Greenland ice sheet *very likely* contributed between 1.4 and 4.3 m, when high latitude temperatures 2°C warmer than present.



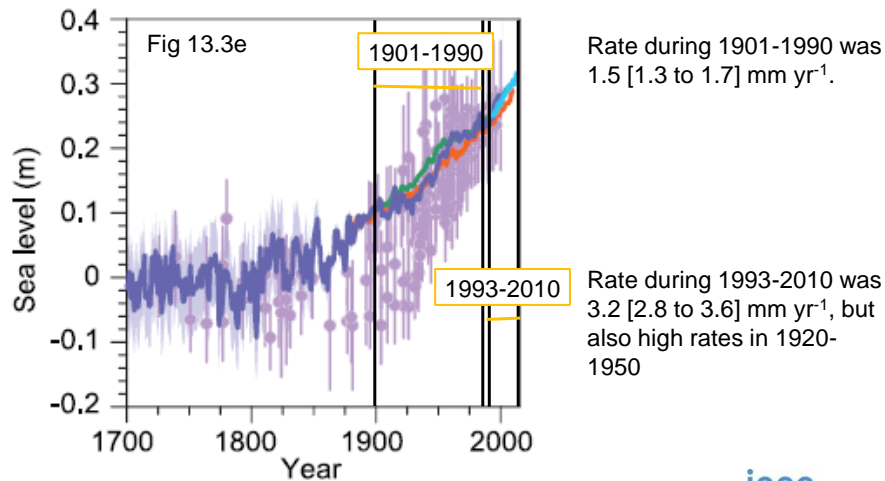
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Figure 5.15

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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} .



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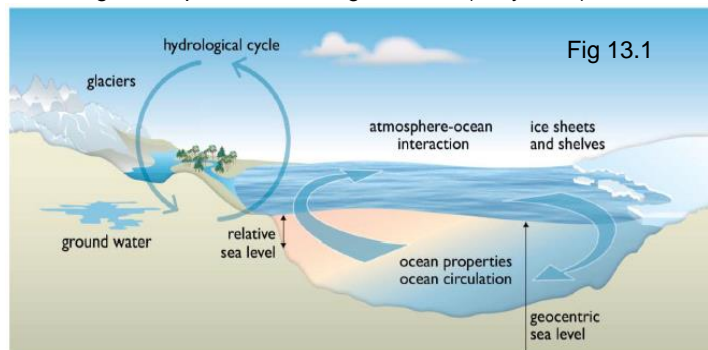
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Causes of global mean sea level (GMSL) change

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

Change in mass of glaciers and ice sheets (Barystatic)

Changes in liquid water storage on land (Barystatic)



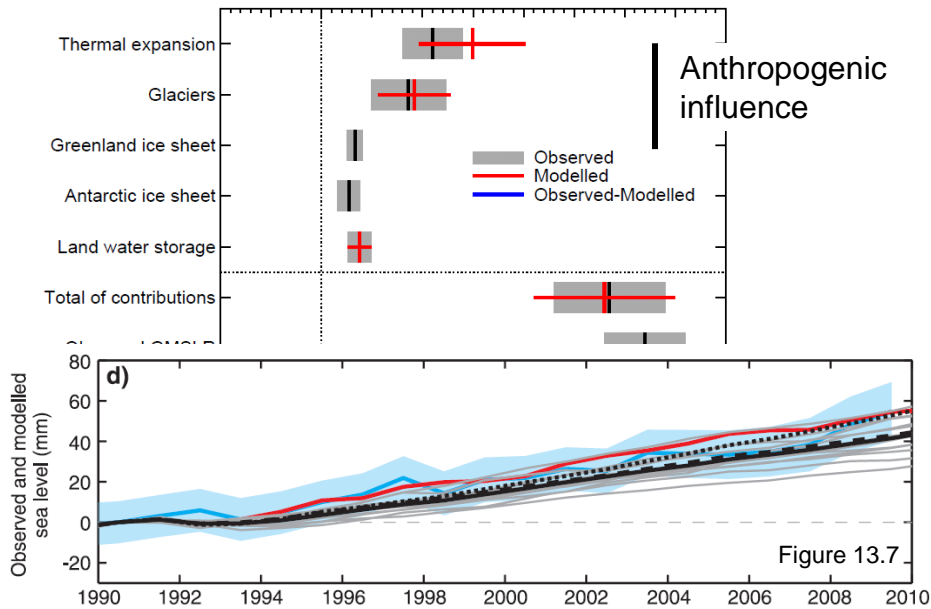
Relative sea level is also affected by ocean density and circulation, land movement, and distribution of mass on the Earth

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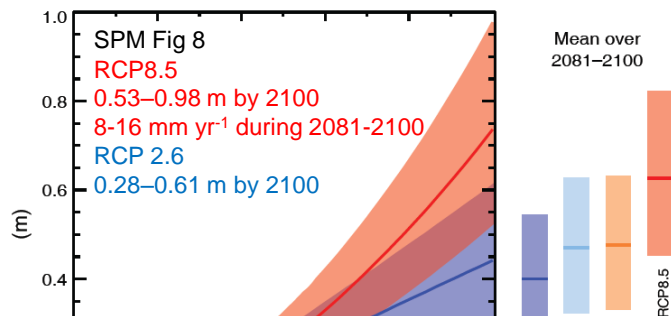
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Improved understanding of 20th century sea level change Observed contributions explain observed GMSLR 1993-2010



Projections of 21st-century GMSLR under RCPs

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



Earlier emissions lead to larger sea-level rise

Largest contributions: expansion, glaciers

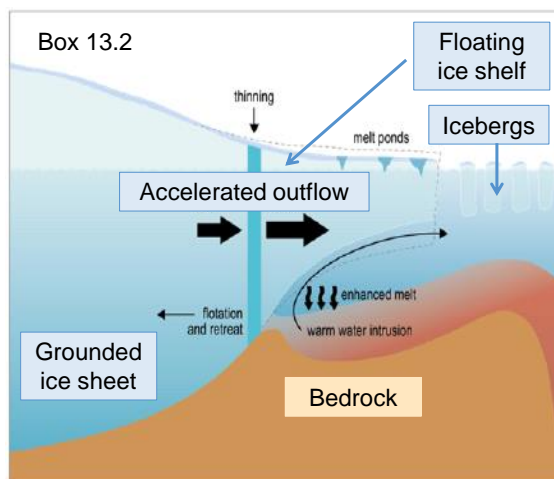
Then Greenland SMB, Antarctic and Greenland dynamics

Antarctic dynamics and land water storage scenario

independent

Post AR5 dynamical estimates consistent with likely range

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.

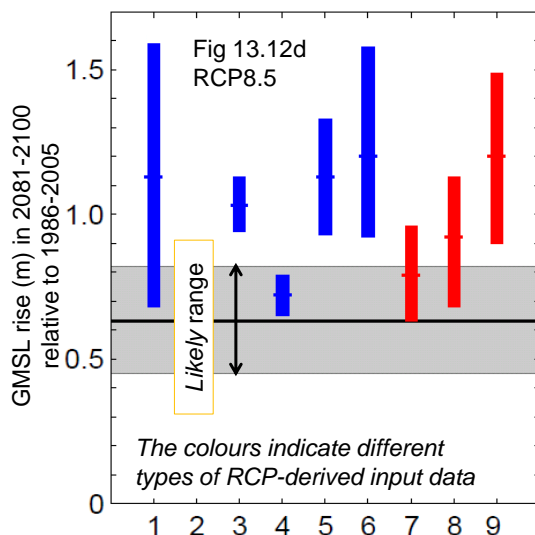
Medium confidence that this additional contribution would not exceed several tenths of a metre during the 21st century.

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.

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Low confidence in the projections of 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.

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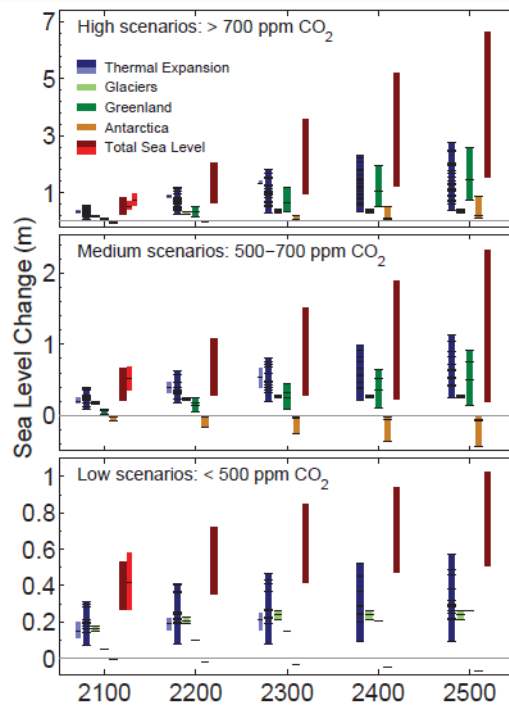
It is *virtually certain* that global mean sea level rise will continue beyond 2100.

Ranges from few available models, not a *likely* range.

Current models are *likely* to systematically underestimate Antarctica's contribution

Figure 13.13

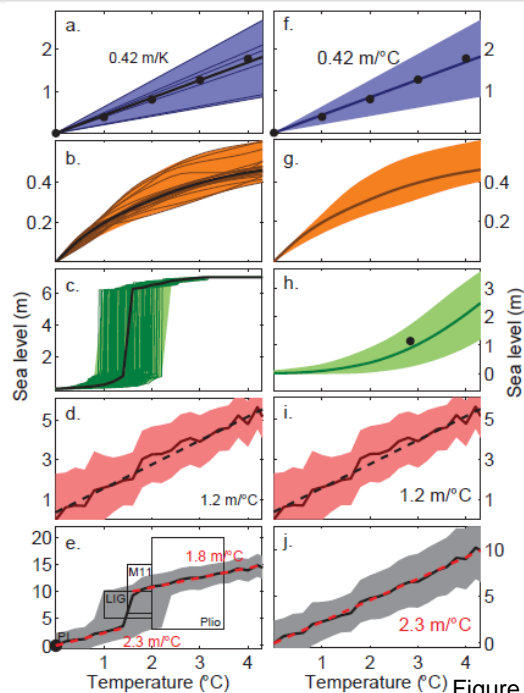
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Ocean thermal expansion to continue for centuries

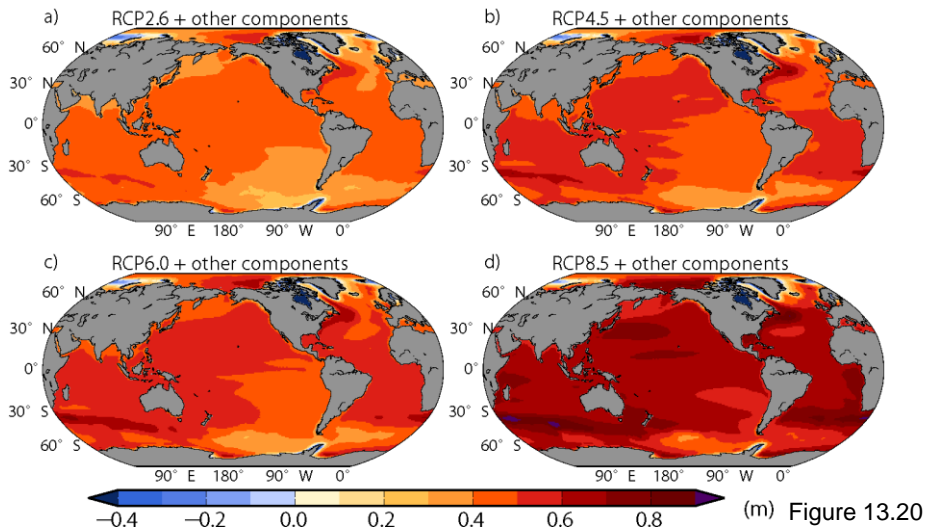
GMSL rise of several meters could result from long-term mass loss by ice sheets (consistent with paleo data).

Sustained warming greater than some threshold would lead to the near-complete loss of the Greenland ice sheet over a millennium or more, causing a global mean sea level rise of up to 7 m.



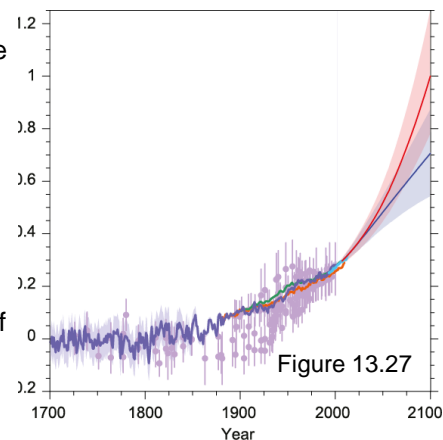
Figure

Very likely sea level will rise in more than 95% of the ocean.
About 70% of the coastlines projected to experience sea level change within 20% of the global mean change.



Key messages

- In warmer climates, sea level was higher. The rate of rise has increased.
- Sea level rose by 0.19 [0.17 to 0.21] m over 1901–2010. 20th Century GMSL change can be accounted for.
- It is *very likely* that the rate of rise will increase under all scenarios. Sea level rise by 2100 compared with 1986–2005: *likely* 0.44 [0.28–0.61] m for RCP2.6, 0.74 [0.53–0.98] m for RCP8.5.
- Collapse of marine-based sectors of the Antarctic IS, if initiated, would add no more than several tenths of a meter by 2100.
- 70% of the coastline to experience sea level change within 20% of global mean
- *Very likely* increase in the occurrence of sea level extremes.
- *Virtually certain* that sea level rise will continue for many centuries; the amount of rise dependent on future emissions.
- Significant uncertainties remain.



Post IPCC AR5 Research for Antarctica

Widespread rapid retreat PIG, Thwaites, Smith and Kohler glaciers (Rignot et al. GRL 2014)

Simulations of the WAIS

PIG – 34 mm by 2100 (Favier et al. NCC 2014)

Thwaites – 21 mm by 2100 (Joughin et al. Science 2014)

Total – 55 mm by 2100

The AR5 upper limit of the *likely* range for rapid AIS dynamics from these two drainage basins was 80 mm (Little et al., 2013). Additional contribution from MISI limited to the large ice shelves (Ross and Ronne/Filchner).

Post IPCC AR5 Research for Antarctica

Levermann et al. Earth Sys Dyn 2014

Likely Range

RCP2.6: 0.07 m [0.02 - 0.14 m]

RCP8.5: 0.09 m [0.04 - 0.21 m]

AR5: -0.01 m to 0.16 m

Very Likely range

RCP2.6: 0.0 - 0.23 m

RCP8.5: 0.01 - 0.37 m

AR5: -0.01 m to 0.16 m plus several tenths of a metre



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

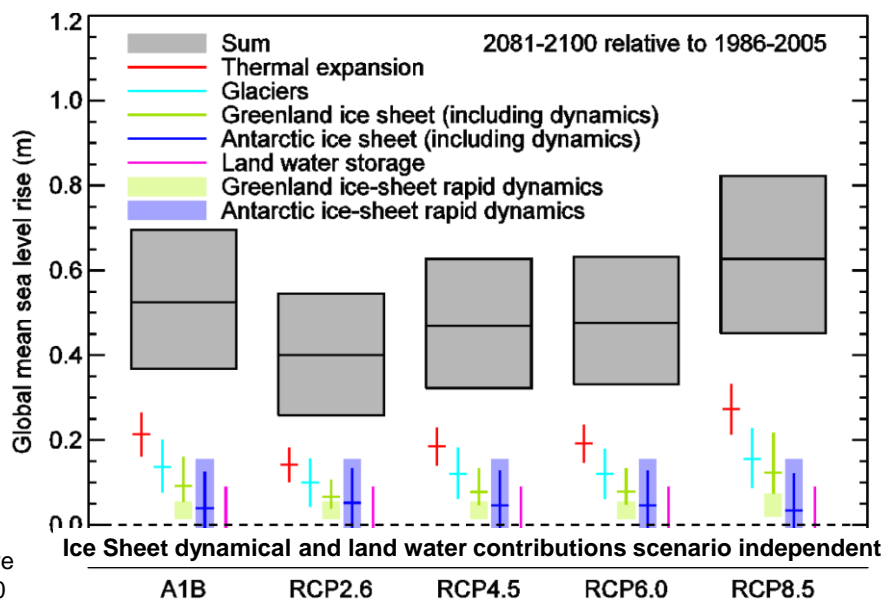


Figure
13.10

It is very likely that sea level will rise in more than about 95% of the ocean area by the end of the 21st century

About 70% of the coastlines worldwide are projected to experience sea level change within 20% of the global mean sea level change.

Figure 13.22

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