Looking forward long-term:

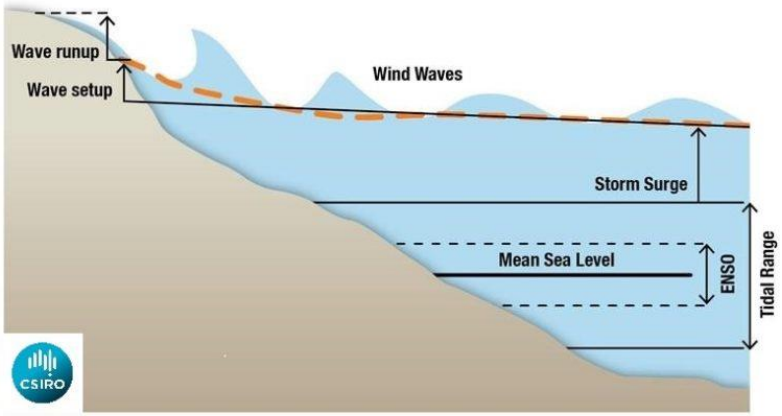
Ice sheet tipping points and sea level rise

Michael Grose and Leanne Webb, CSIRO

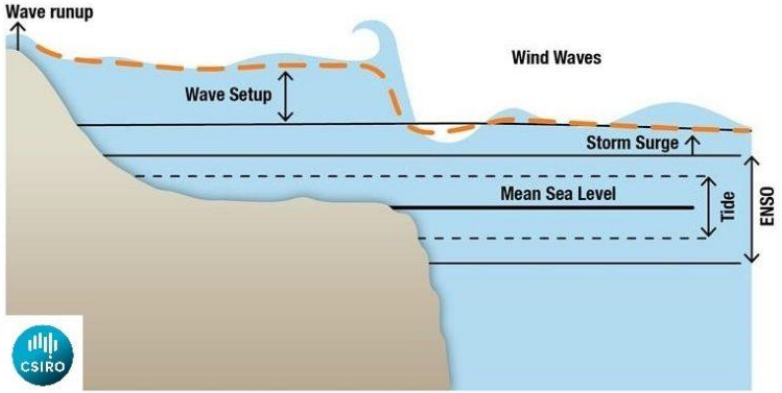
Sea level rise

- Sea level rise is one of the clearest consequences of climate change
- As well as the effect like ‘filling up a bathtub’, higher sea level means more events of extreme high sea level:
  - Seasonal drivers – El Niño Southern Oscillation
  - Storm surges
  - Waves
- Coastal flooding, saltwater entering freshwater supplies, coastal erosion and many other impacts!

On a continental shelf

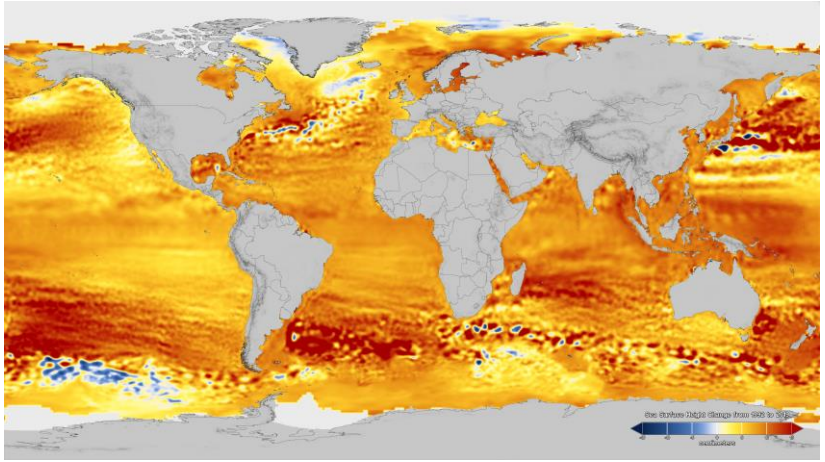


On a reef atoll



Well understood components of sea level rise

- Some processes very well understood and measured:
  - A big one is warmer water = higher seas
  - Changes to land water storage (dams, ground water)
  - The movement and redistribution of water and changes to ocean currents with higher sea level
  - Changes to the land and the Earth's crust, e.g. 'subsidence' or 'uplift' at the coast



Sea level change 1992-2019

Measured by satellite (credit: NASA)

What about ice?

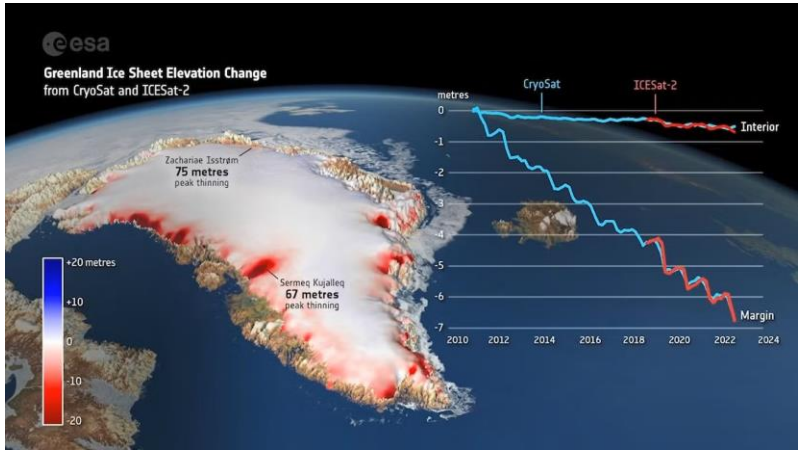
- **Temperate glaciers are receding**

Contributing a little to sea level, will continue

- **Loss of ice from Greenland ice sheet**

Losing ice, mainly at the margins,

Whole thing = about +7.4 m sea level!



Ice loss estimated 2013-2024
ESA Satellite data

What about ice?

- **Loss of ice from West Antarctica**

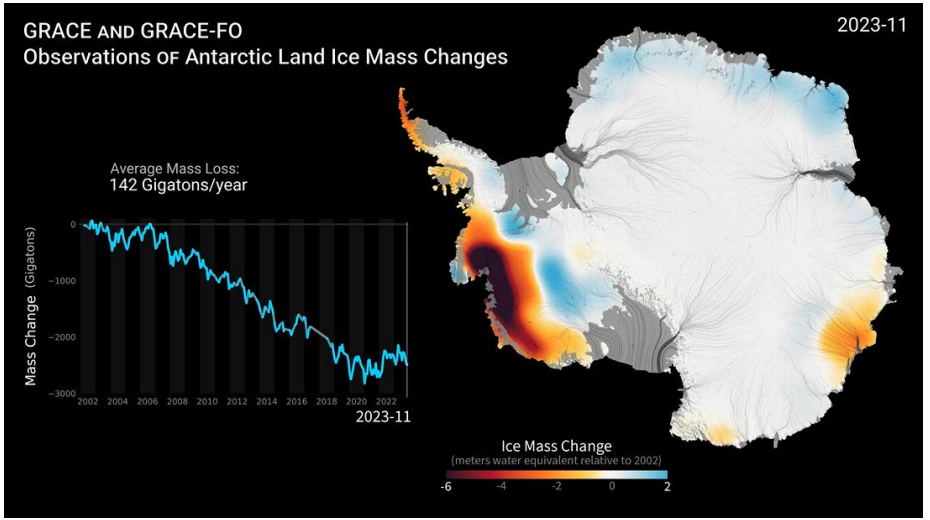
The side losing ice first, a big concern

Whole thing = about 4.3 m sea level

- **Loss of ice from East Antarctica**

Expected later, but much bigger!

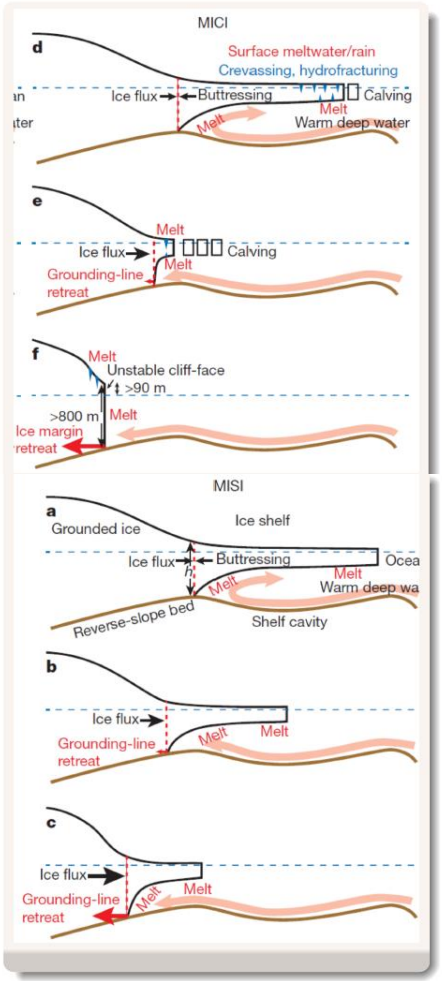
Whole thing = 52 metres!



Ice loss estimated 2002-2024
NASA Satellite data

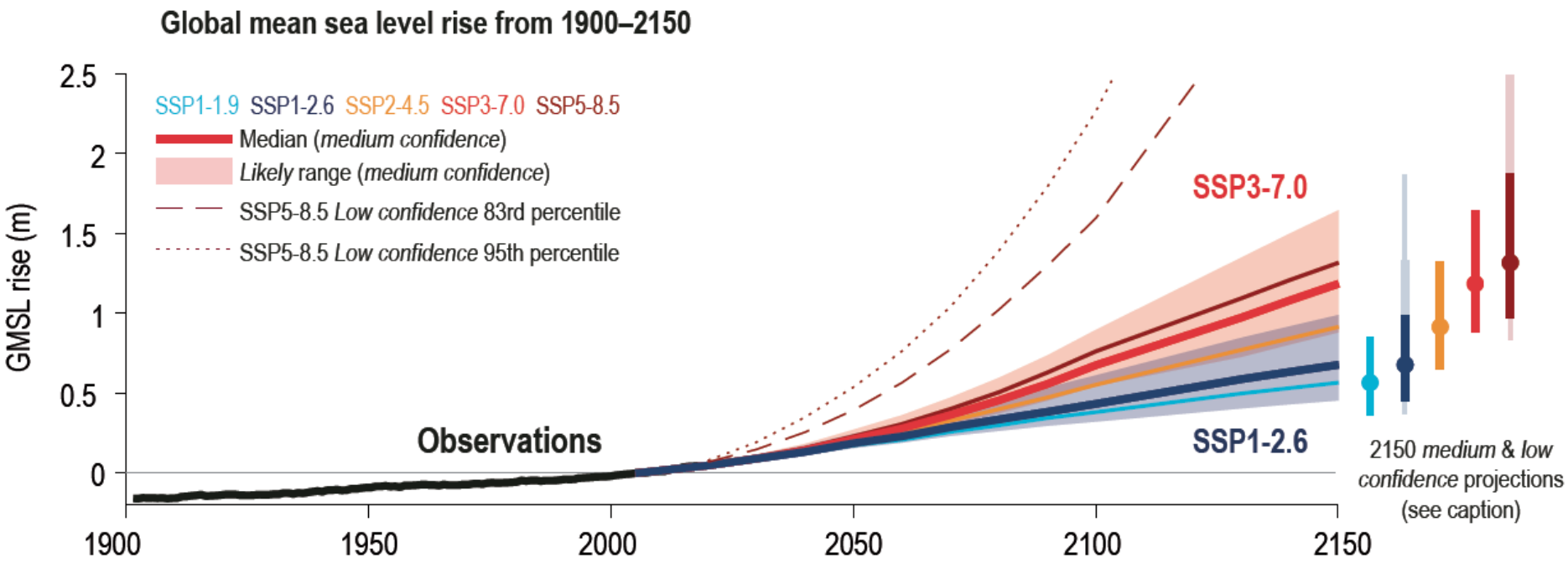
‘Tipping points’ in the ice

- Ice processes can be slow – these are huge masses of ice. But there is the possibility of rapid changes over just years or decades – they have happened in the distant past
- We may see a point where the ***ice cliffs*** and ***ice shelves*** become very unstable, and collapse – through different processes like cracking, moving fast over underlying water
- Change could become ***self-sustaining*** (through a ‘feedback’), ***abrupt*** and ***irreversible*** on long timescales – sometimes called a ‘tipping point’
- Once started, the change can be 'committed'



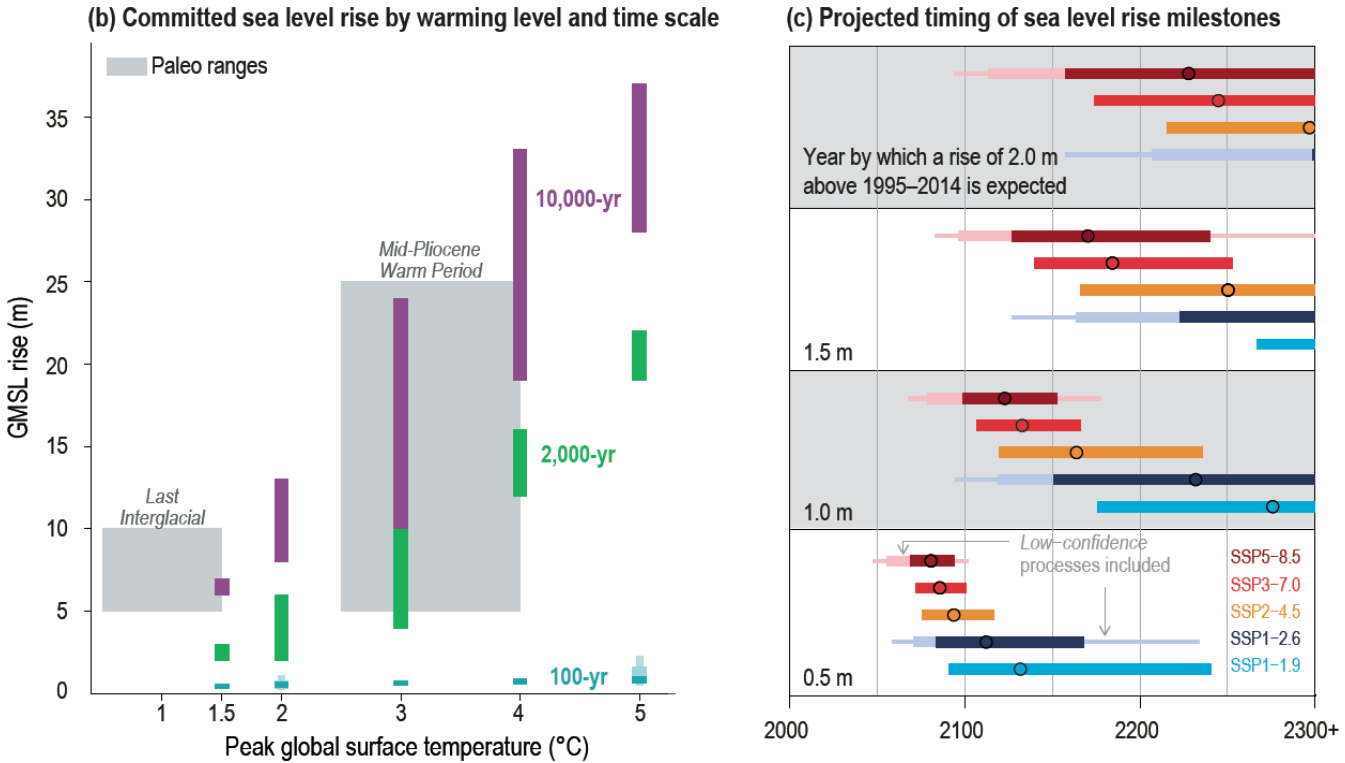
DeConto and Pollard 2016

Our best guess of what this means



IPCC Sixth Assessment Report 2021– Technical Summary

Long-term outlook

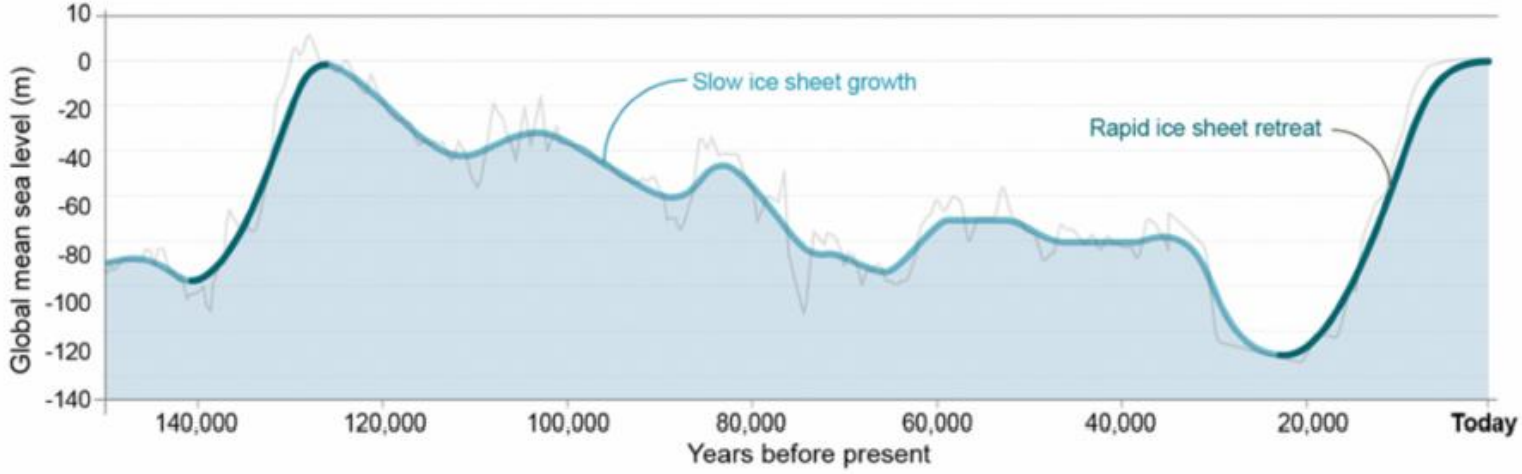


IPCC Sixth Assessment Report – Technical Summary

Reversibility timescale

FAQ 9.1: **Can melting of the ice sheets be reversed?**

Once ice sheets are **destabilised**, it takes them tens of thousands of years to re-grow.
These changes strongly affect **sea level**.



IPCC Sixth Assessment Report – Technical Summary

These are scary scenarios…

- There are a lot of ***unknowns*** – not just a reasonable guess with a range, some truly unknown aspects – makes it hard to plan for!

- The threshold for 'tipping' may be hard to see, or it may not strictly be a ‘tipping element' - a lot of debate and discussion about these words - but abrupt changes can happen regardless of if it is strictly a 'tipping point'

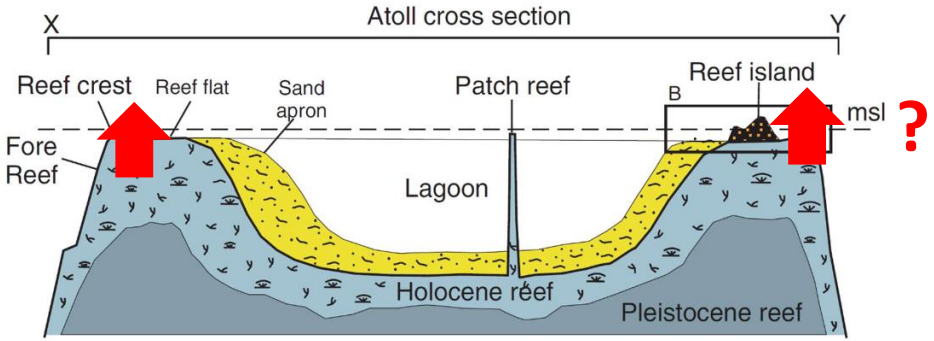
- And we can’t ignore the possibility – just like during good times we can’t say that another pandemic worse than COVID isn’t possible!

New Scientist magazine

What are the defences?

Natural

- Coral atolls may have some natural defence – **some evidence** that reefs build up, offsetting the effect of sea level rise
- *But this is poorly understood, we need to know more, and…*
- *Is there a limit to how much this can keep pace with more rapid sea level rise? Unknown!*



McLean and Kench, 2015

What are the defences?

Human responses

- Arifical reefs, coastal defences, sea walls and more
- House and building design
- *Harder to implement the faster and higher the sea level rise*

Last resort – retreat and relocation

New sea wall in Tuvalu
(photo: ABC News Australia & Newswire Fiji)

Houses in Solomon Islands
(photo Rob Maccoll/DFAT)

How should we respond?

Prevention is better than cure!

- High confidence that lower emissions and meeting the Paris Agreement means slower sea level rise… and less chance of the abrupt changes from ‘tipping points’

- *The possibility of abrupt and irreversible changes is yet another reason for reaching net zero and minimising further global warming*

Part of the delegation at COP28 (photo: SPREP)