

SEA ICE



what it is and why it is important

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Important because.....as global temperature increases.....

1. Antarctic (and Arctic) *ecosystems* will become disrupted
2. there will be an acceleration of global warming through *albedo*
3. there will be a slowing of worldwide *oceanic circulation*

Davis Station 2001 seen from the sea ice



In autumn the sea starts to freeze, initially as loose frazil or grease ice, which then clumps into pancake ice



Eventually the ice consolidates into sheets, often breaking up and blowing out to sea before refreezing



As it thickens it may still be liable to crack under the influence of tides and waves



Eventually the winter sea ice is finally thick enough (up to 2m) to drive on in any vehicle



Winter sea ice is also useful for meeting visitors, playing golf, or going fishing!



.. or even a (very) quick
midwinter swim!



In summer the sea ice breaks up as it melts from below, drifts out and fully melts; a white ice surface is replaced by dark ocean. Loose sea ice is called pack ice.



An ice edge progressively advances towards the coast



Ships can approach the station, where vehicles can drive up for unloading.



Boating becomes possible, going out to see the grounded icebergs



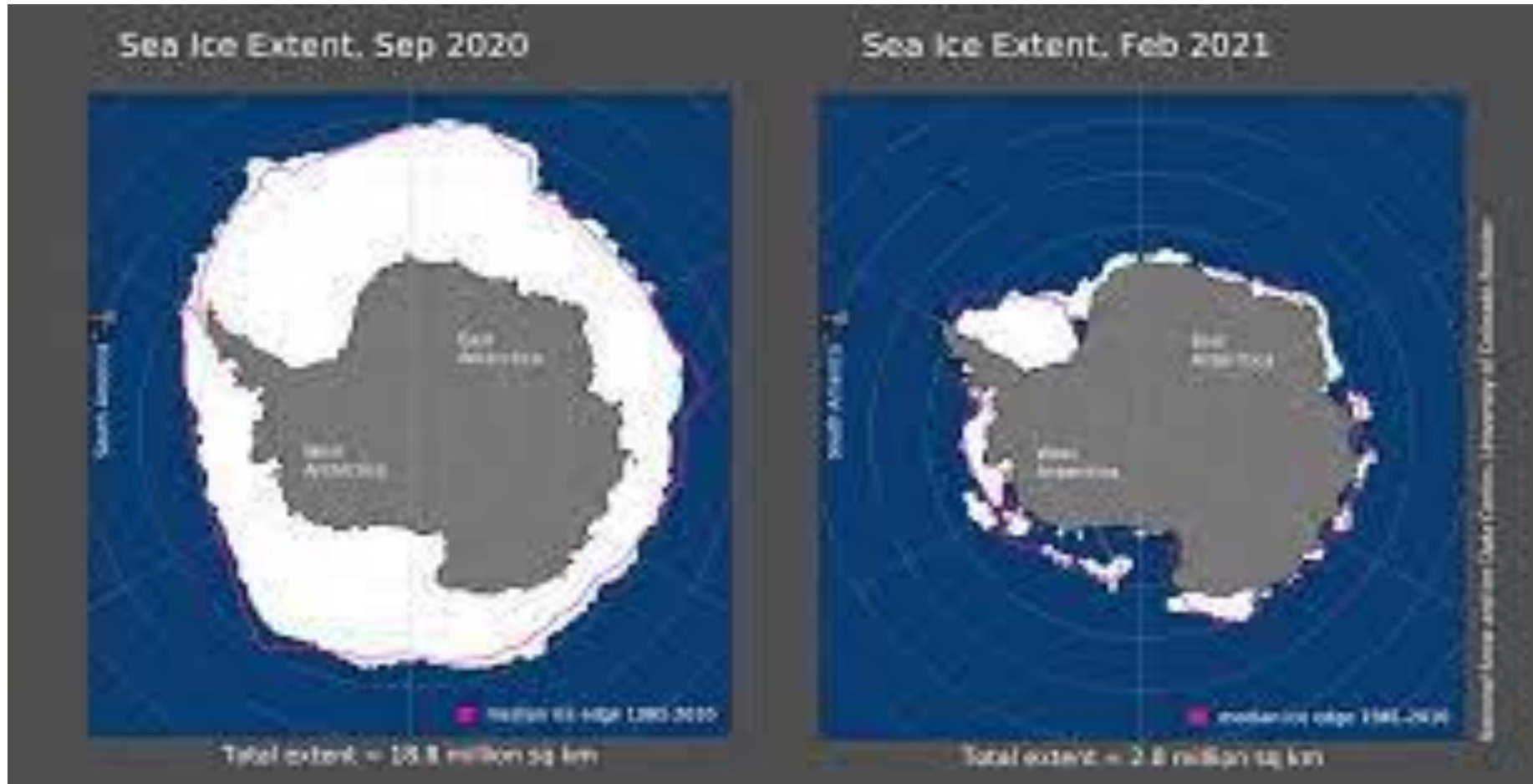
Sea ice remaining attached to land is called **fast ice**. If it stays in place for many years it is termed **multi-year ice**, and may be many metres thick.



Some sea ice close to the continent never breaks out - this American airfield is on multi-year sea-ice 3m thick.

So much for the local importance of sea-ice : what about the bigger picture? Every winter Antarctica effectively more than doubles in size! Late winter sea-ice covers an area 2.5 times the area of Australia!

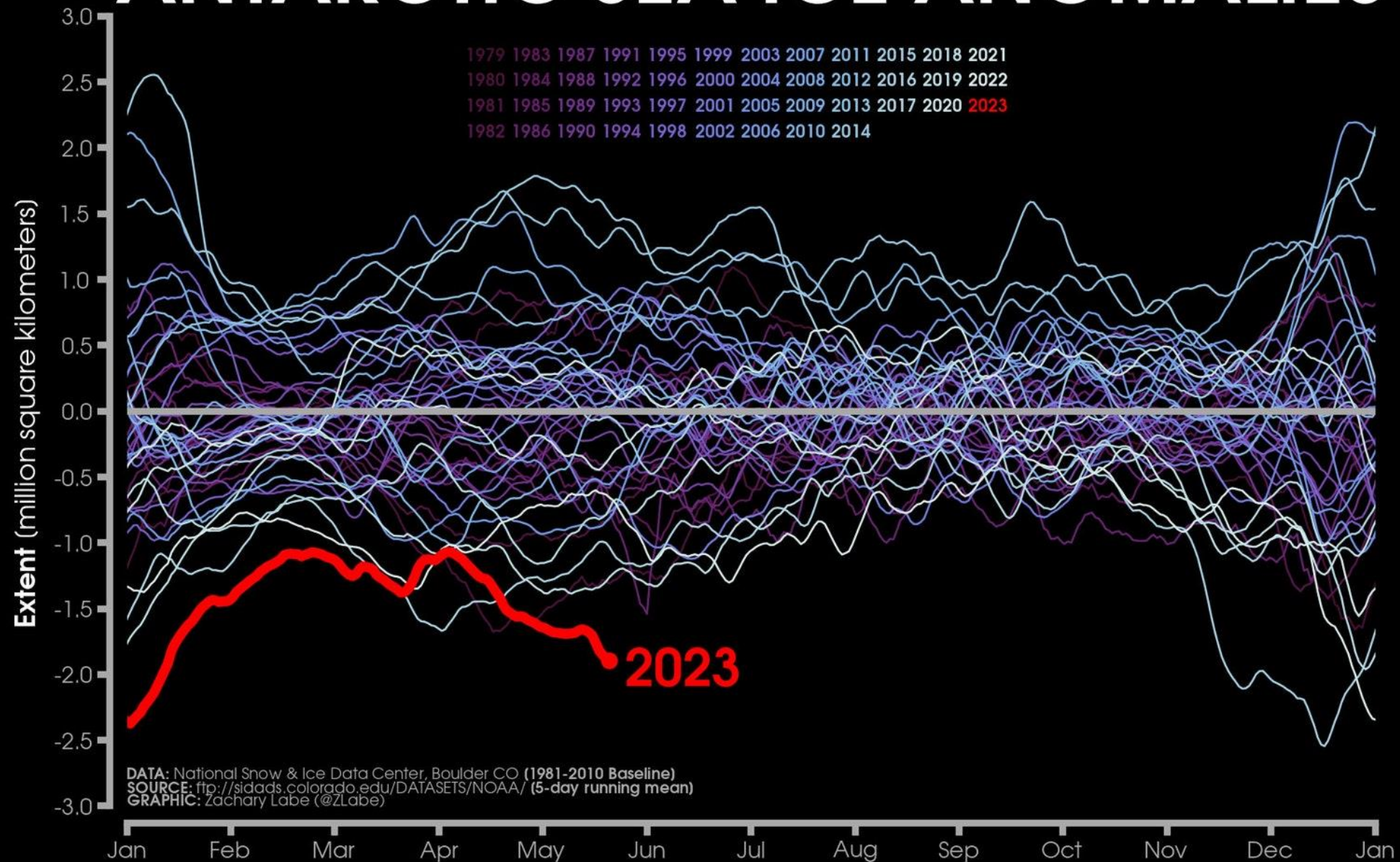
Late
Winter



Late
Summer

- The maximum area of winter sea-ice is usually up to **20 million square kilometres**. That's nearly 4% of the surface of the planet, 6% of the global ocean
- The summer sea-ice minimum is **2 million square kilometres**
- In each of the last three years its winter extent has diminished sharply. In 2023 Antarctic sea-ice extent reached its maximum for the year at less than **17 million square kilometres**

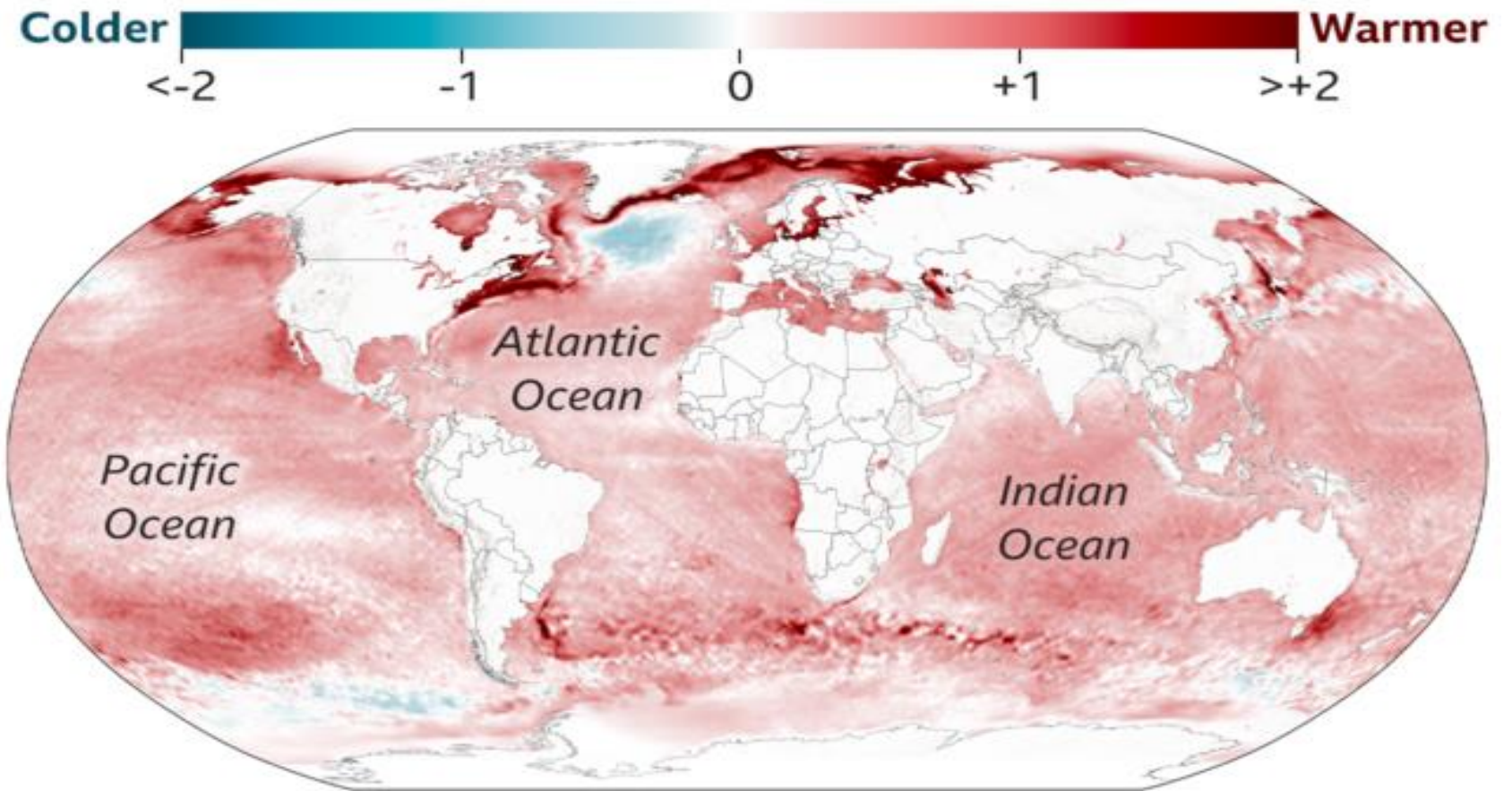
ANTARCTIC SEA ICE ANOMALIES



Sea-ice extent is related to the warming of the ocean as energy stored over recent decades is progressively released.

Rising temperatures in the world's oceans

Average sea surface temperature in 2011-2020 (degrees C), compared to 1951-1980



Source: ECMWF ERA5

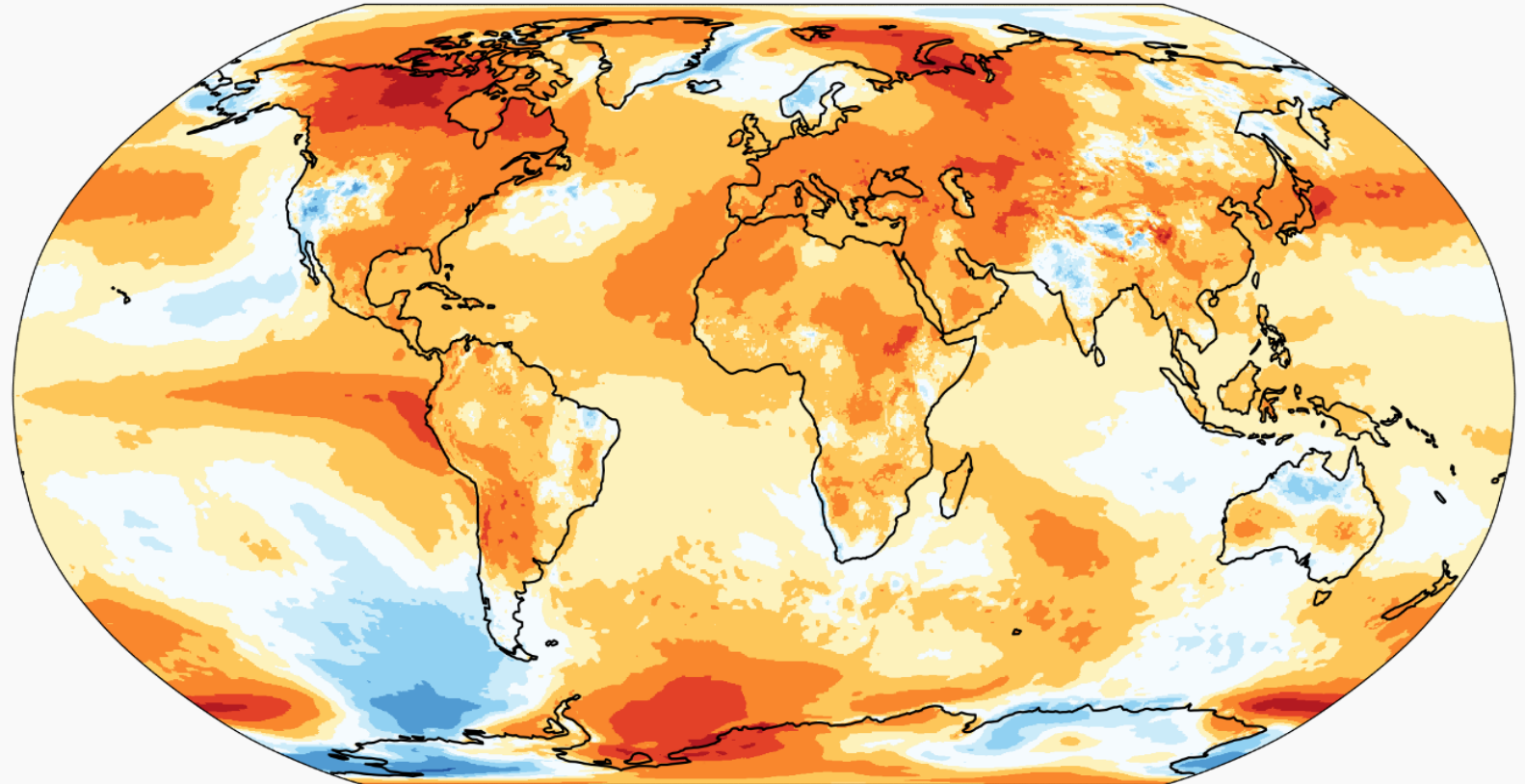
BBC

It's part of global warming.

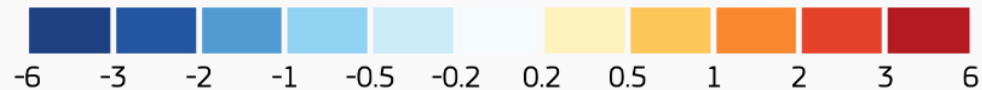
2023 was the hottest year on record; now 2024 has beaten it.

SURFACE AIR TEMPERATURE ANOMALY • 2023

Reference period: 1991–2020 • Data: ERA5 • Credit: C3S/ECMWF



Temperature anomaly (°C)



PROGRAMME OF
THE EUROPEAN UNION



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So what? Why is Sea-Ice important?

Beyond local impacts near Antarctic stations, there are three major implications of substantial, sustained loss of Antarctic sea-ice.

1. Antarctic **ecosystem** impacts
2. Acceleration of global warming through **albedo**
3. Slowing of **oceanic water circulation**

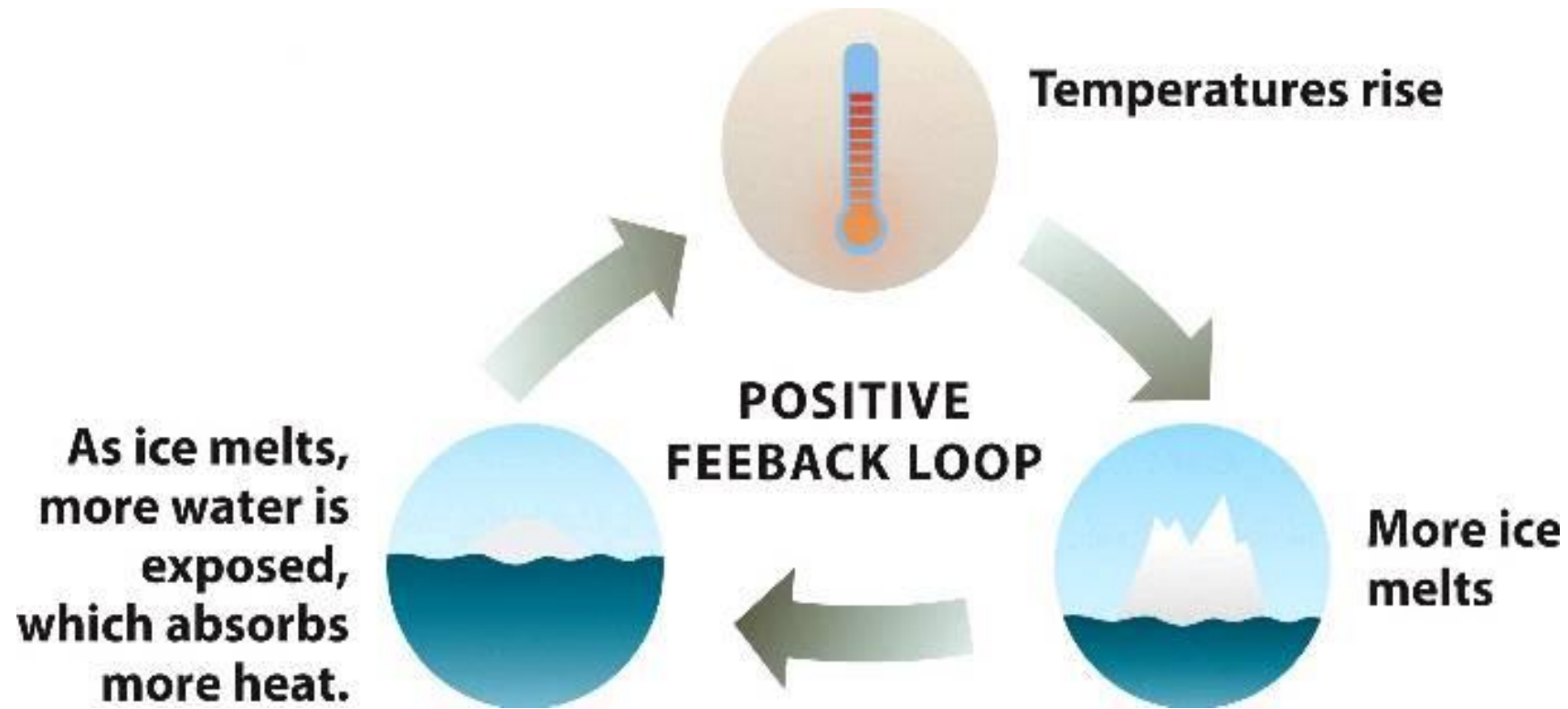
1. Loss of sea ice has major implications for Antarctic marine **ecosystems** - krill, fish, penguins, whales.



There was a marine extinction event 2.5 million years ago (mya) when **36%** of marine megafauna, eg sharks, rays and whales, went extinct globally. This event coincided with a drop in global temperature at the onset of the most recent ice age.

There has been a **70%** decrease in sharks and rays since the 1970's

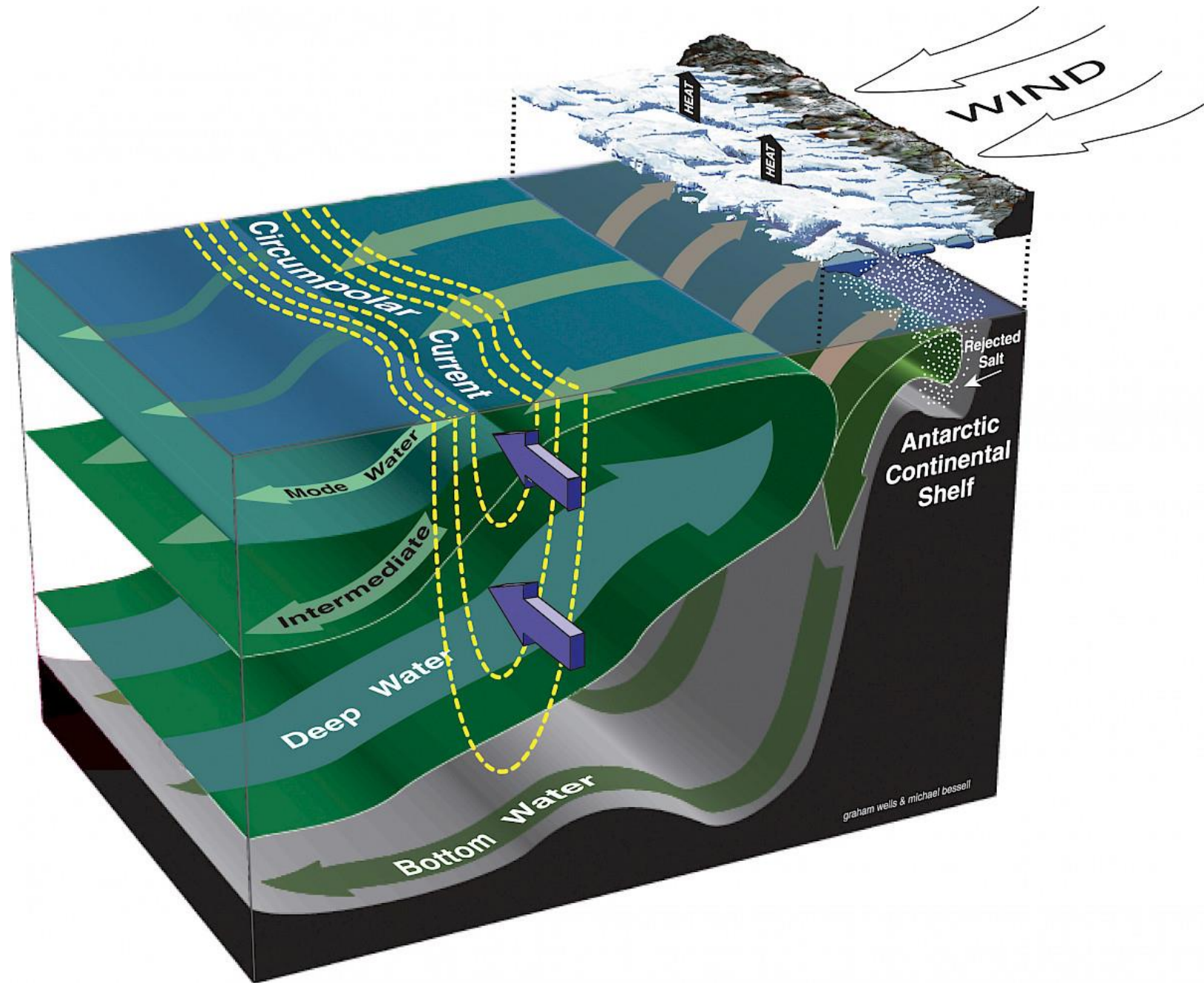
2. Loss of sea ice cover leads to ocean warming through **albedo** effects



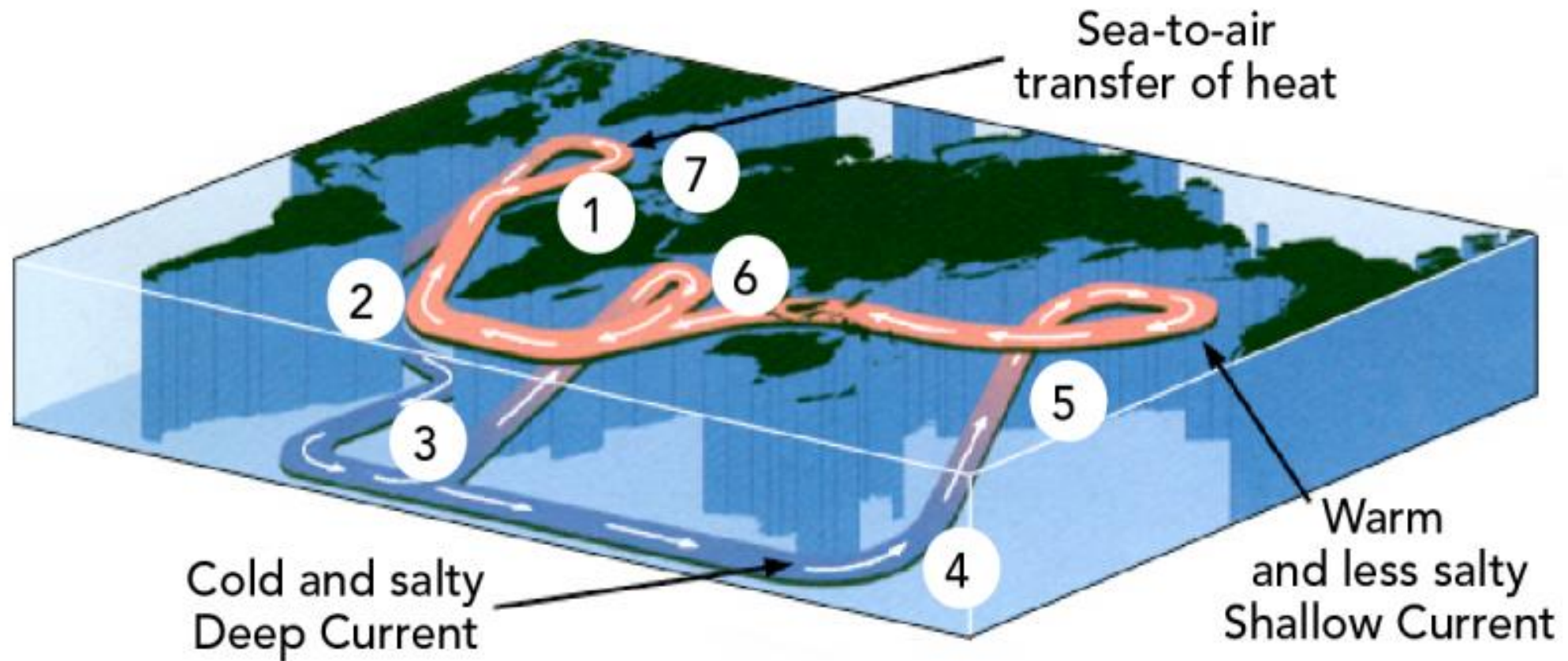
Sea ice reflects **85%** of solar radiation, ocean reflects only **9%**

- Loss of sea-ice is both a result and a driver of global warming
- The more an ocean warms, the greater the loss of (white) sea-ice and its replacement by (dark) open water
- This increases the warming of the ocean
- This then leads to more melting of the sea ice, and so on a positive feedback loop
- This may become irreversible, leading to runaway warming
- Sea ice reflects 85% of solar radiation, ocean reflects only 9%

3. In another effect of global significance, as sea water freezes each winter its salt is squeezed out producing cold, hyper-saline water that sinks:



This sinking water generates the bottom currents in all major oceans which in turn propel upwelling of nutrients and generation of surface currents



Without the cold bottom current, the pattern of surface warm currents around the world will alter and reduce. Note here, for example, the warm currents maintaining (for now) comfortably temperate conditions in two island nations – Britain and Japan.



- In conclusion.....

Loss of Antarctic sea ice affects far more than just the area around Antarctica. It is part of major global change:

- Because the thermal mass of the ocean is so vast, even if we could rapidly reduce atmospheric pollution (and we seem incapable of this) it would take centuries to cool again to 'normal' levels
- I think it is inevitable that the world of our grandchildren will be vastly different from the one we have experienced in our own lifetime
- Apologies for the dismal message. But it is best to keep our eyes open to what is happening to and around us - and anyway, I (...my brother) find it all quite fascinating!

