Past and Future Climate – Present Weather

Week 8

Holocene

Terry Hart

Dates

Term 2

4 June	**Climate – The Holocene (“Recent” Past)**
11 June	Geology
18 June	**Climate – El Niño/La Niña**

WA storm leaves thousands without power as wild weekend weather continues

By Callum Liddelow | Storms

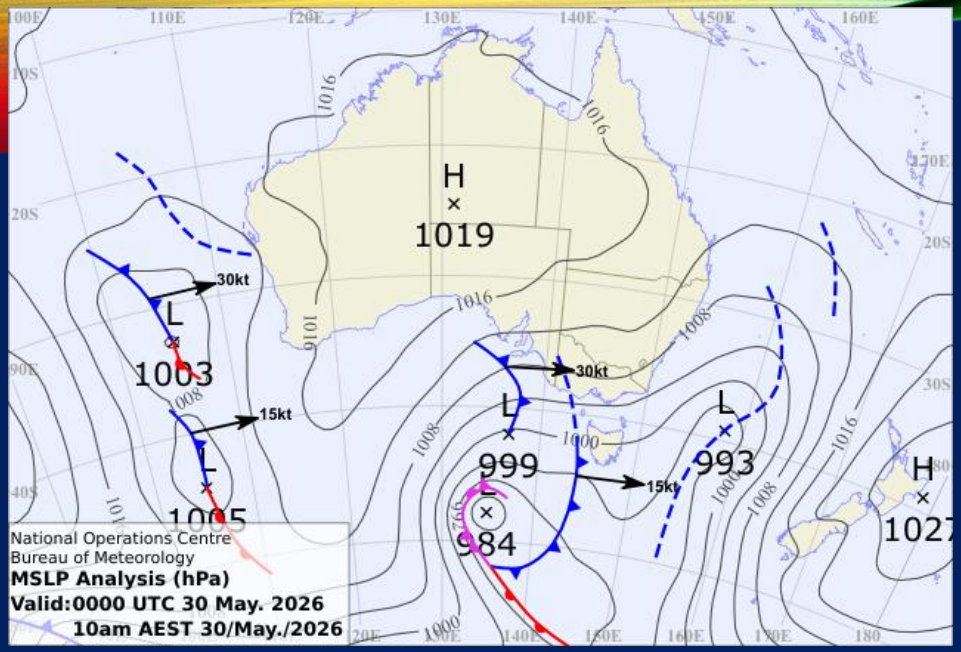
1h ago

Quindalup boat ramp in WA's South West was left inundated as sea levels rose in the severe weather. *(ABC News: Madigan Landry)*

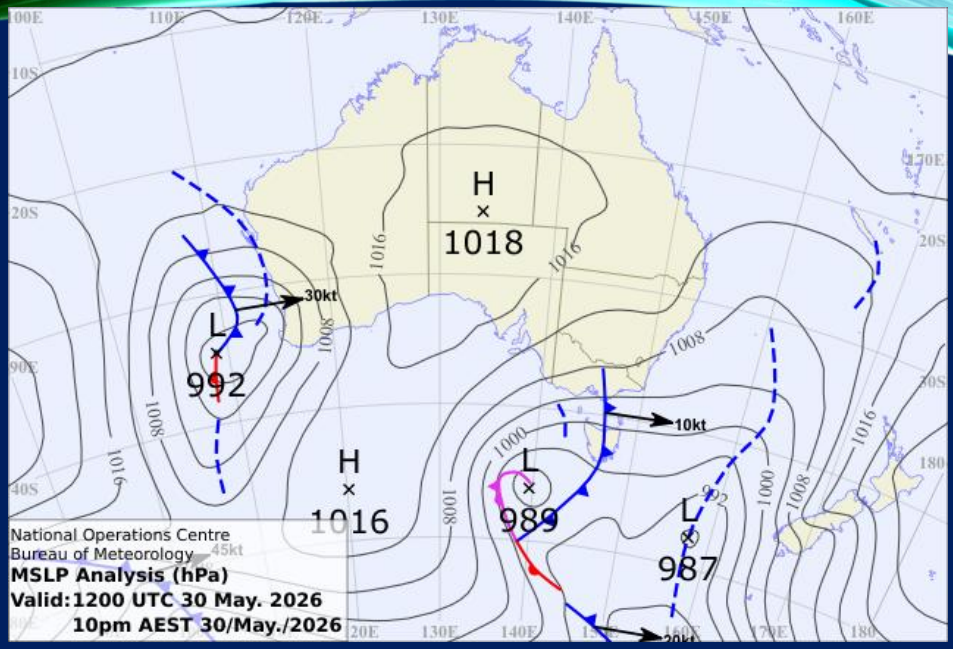
In short:

More severe weather has battered southern WA, with trees and power lines brought down by strong winds and emergency crews dealing with hundreds of calls for help.

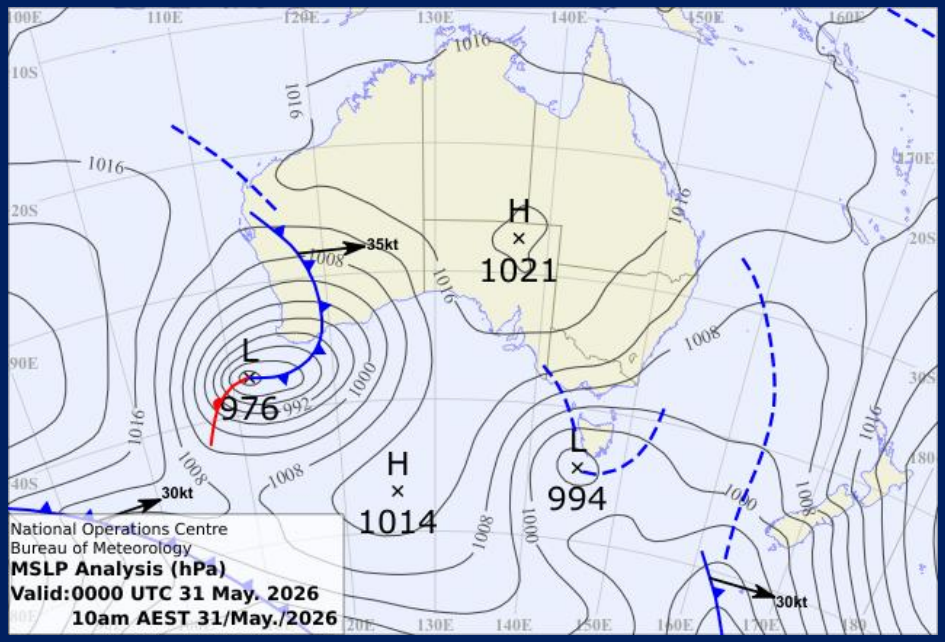
Almost 70,000 Western Power customers have been hit by outages, with more than 250 storm-related outages in the South West.



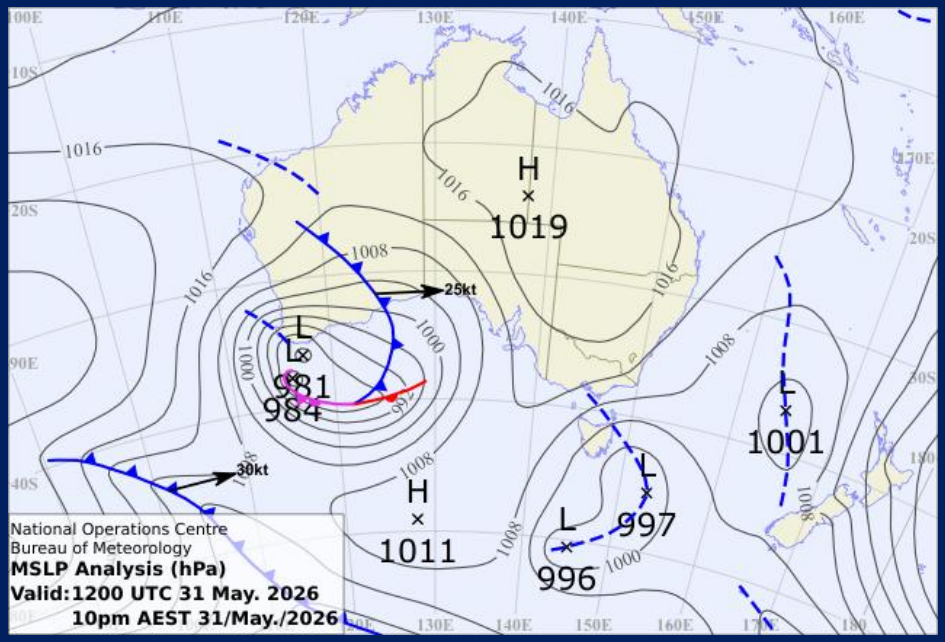
Saturday morning



Saturday evening



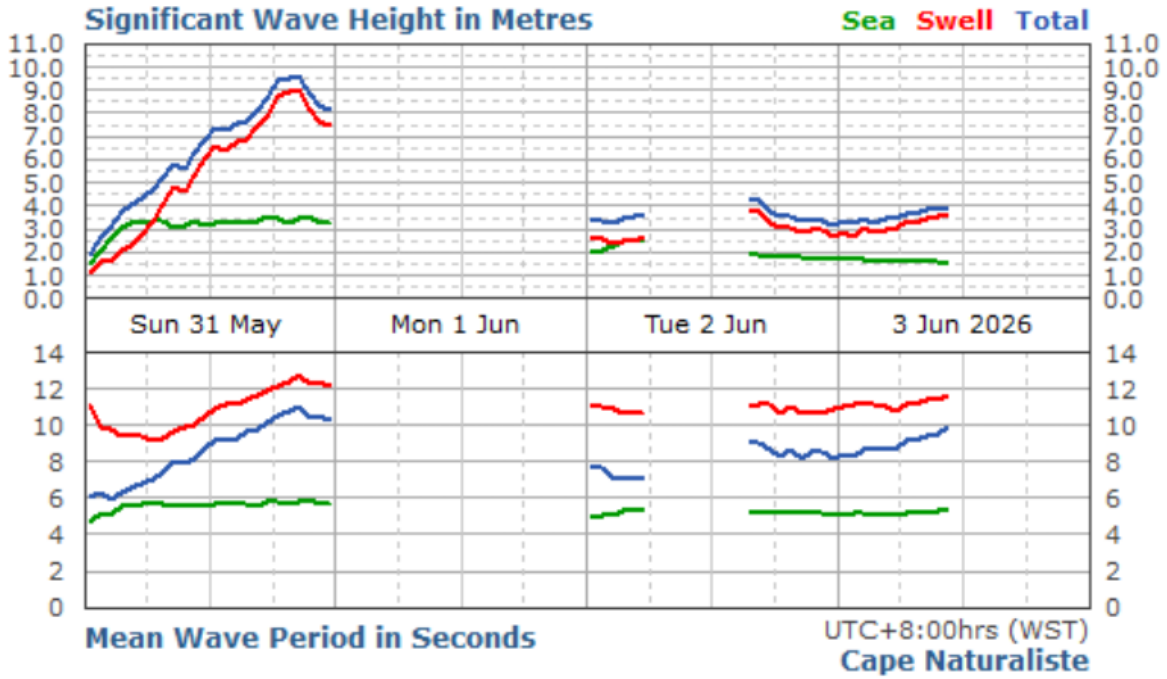
Sunday morning



Sunday evening

Cape Naturaliste significant wave height graph

The significant wave height is the average height of the highest one third of waves recorded. It is often the wave height reported by an experienced observer.



https://www.transport.wa.gov.au/marine/charts-warnings-current-conditions/coastal-data-charts/wave-data/cape-naturaliste

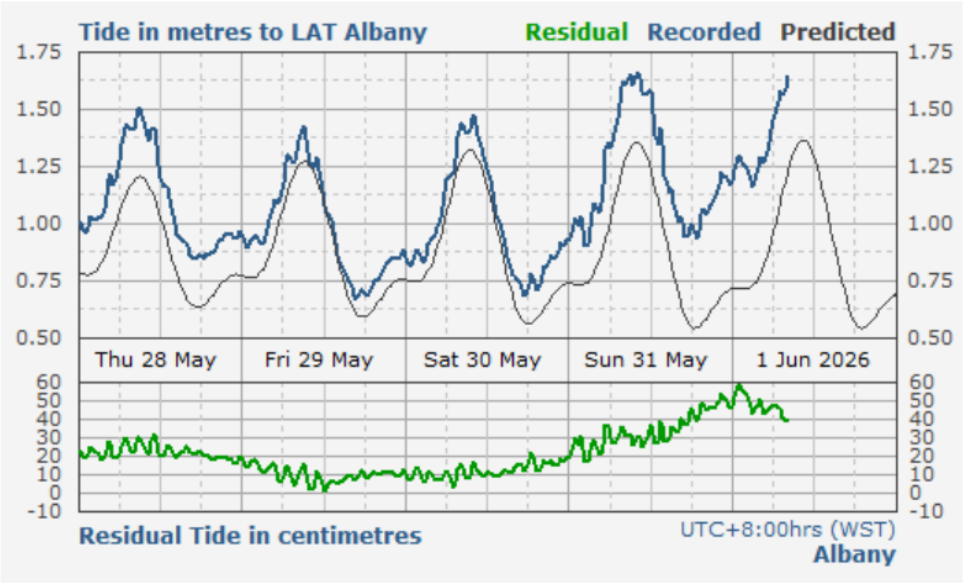
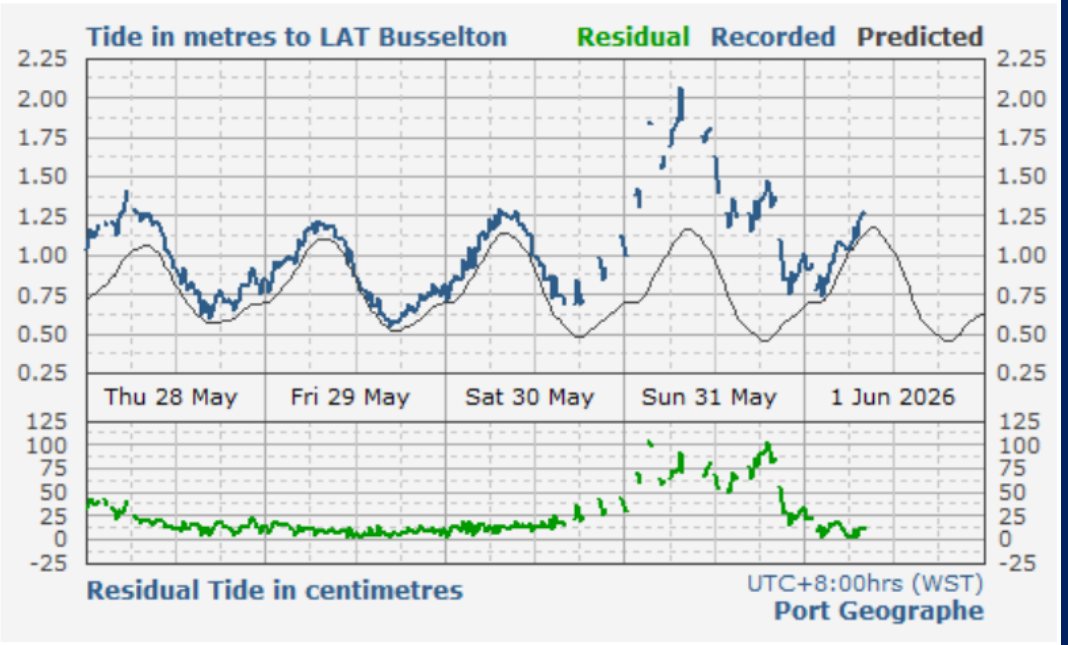
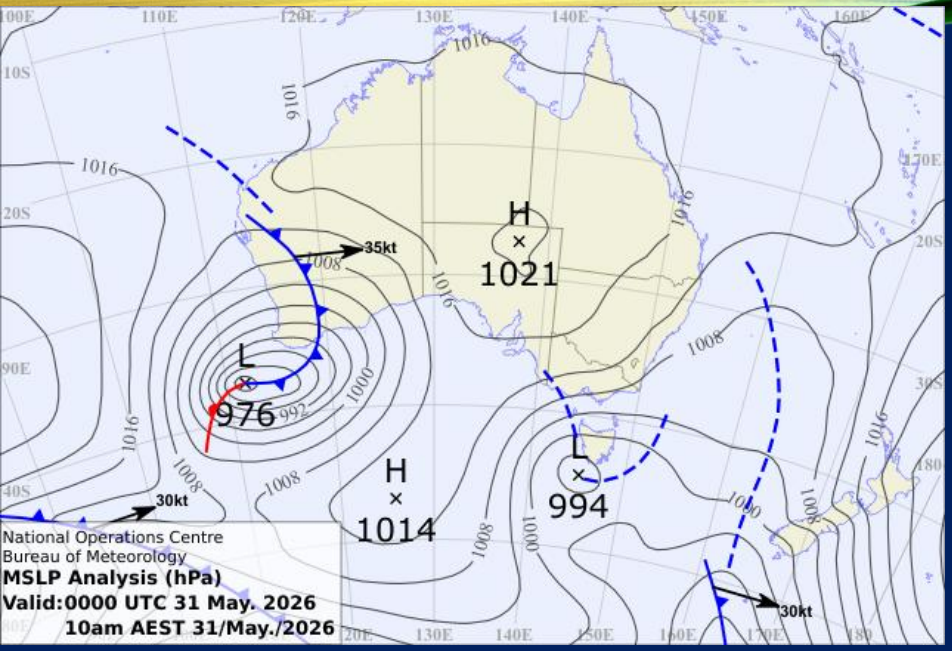


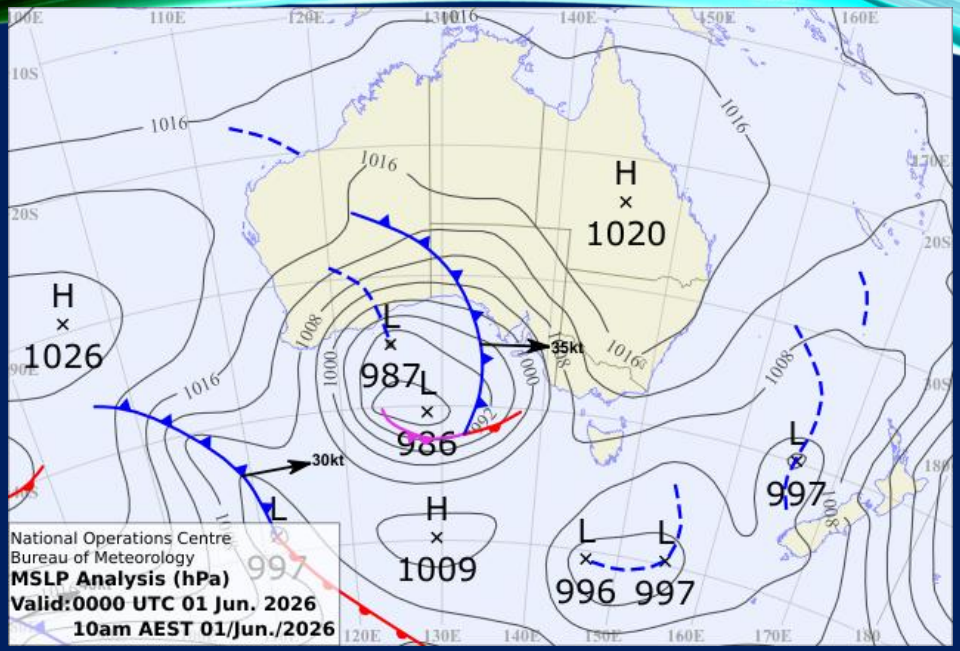
Chart modification date and time: 01/06/2026 8:15:00 am

https://www.transport.wa.gov.au/marine/charts-warnings-current-conditions/coastal-data-charts/tide-data/busselton-port-geographe

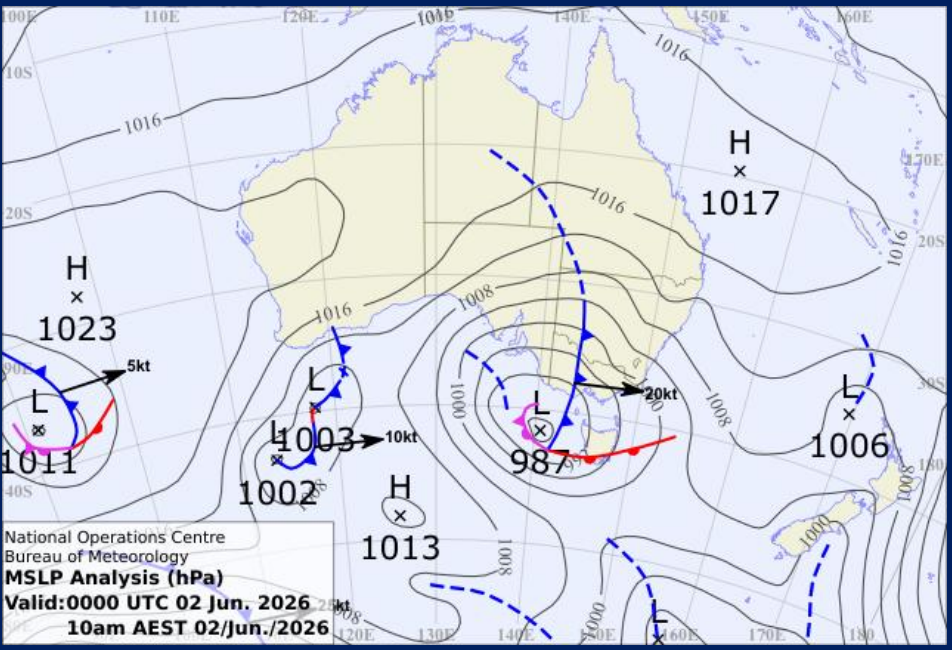




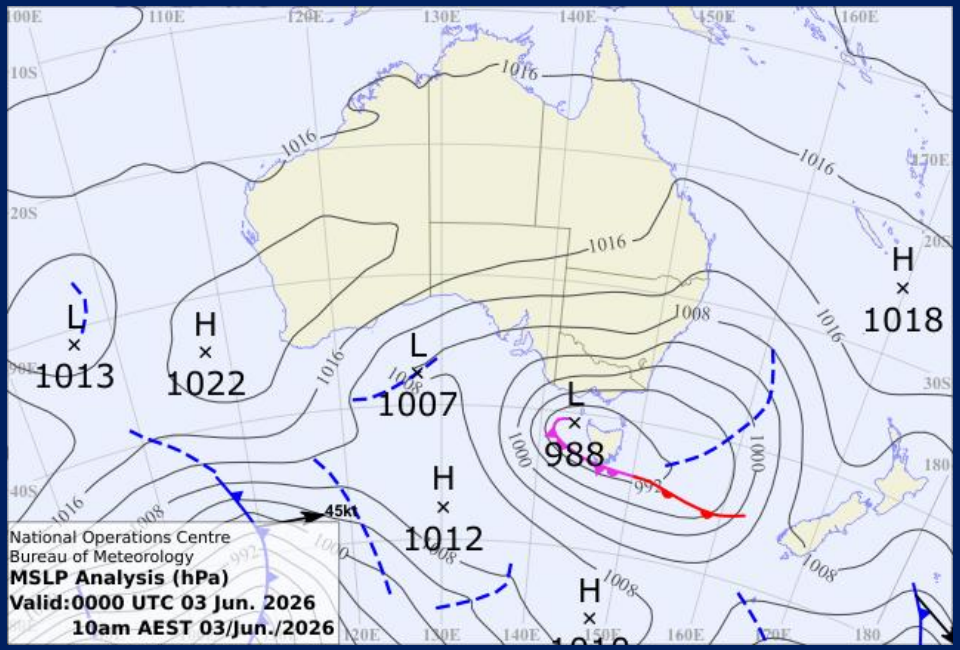
Sunday morning



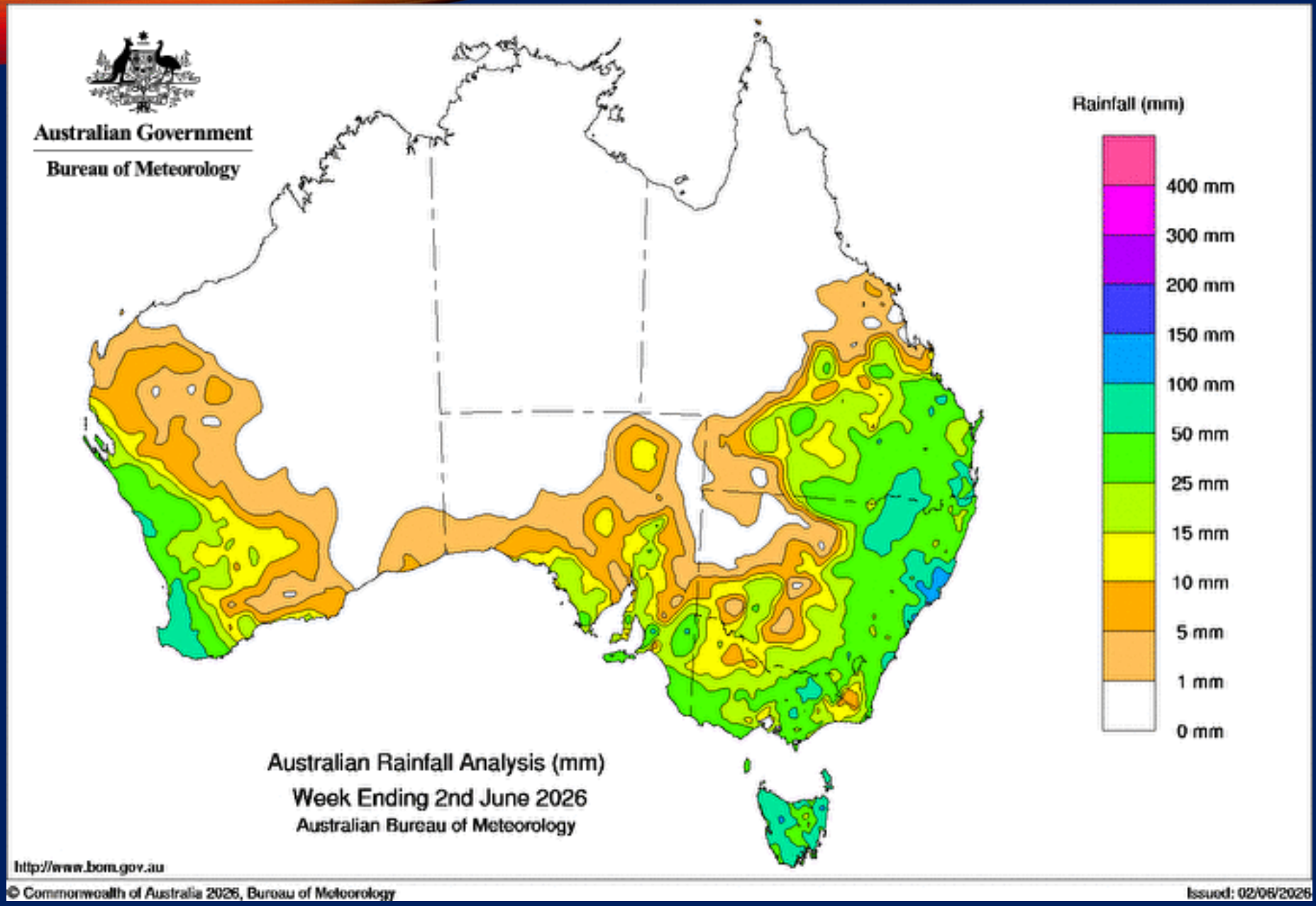
Monday morning



Tuesday morning



Wednesday morning



Issued: 02/06/2026

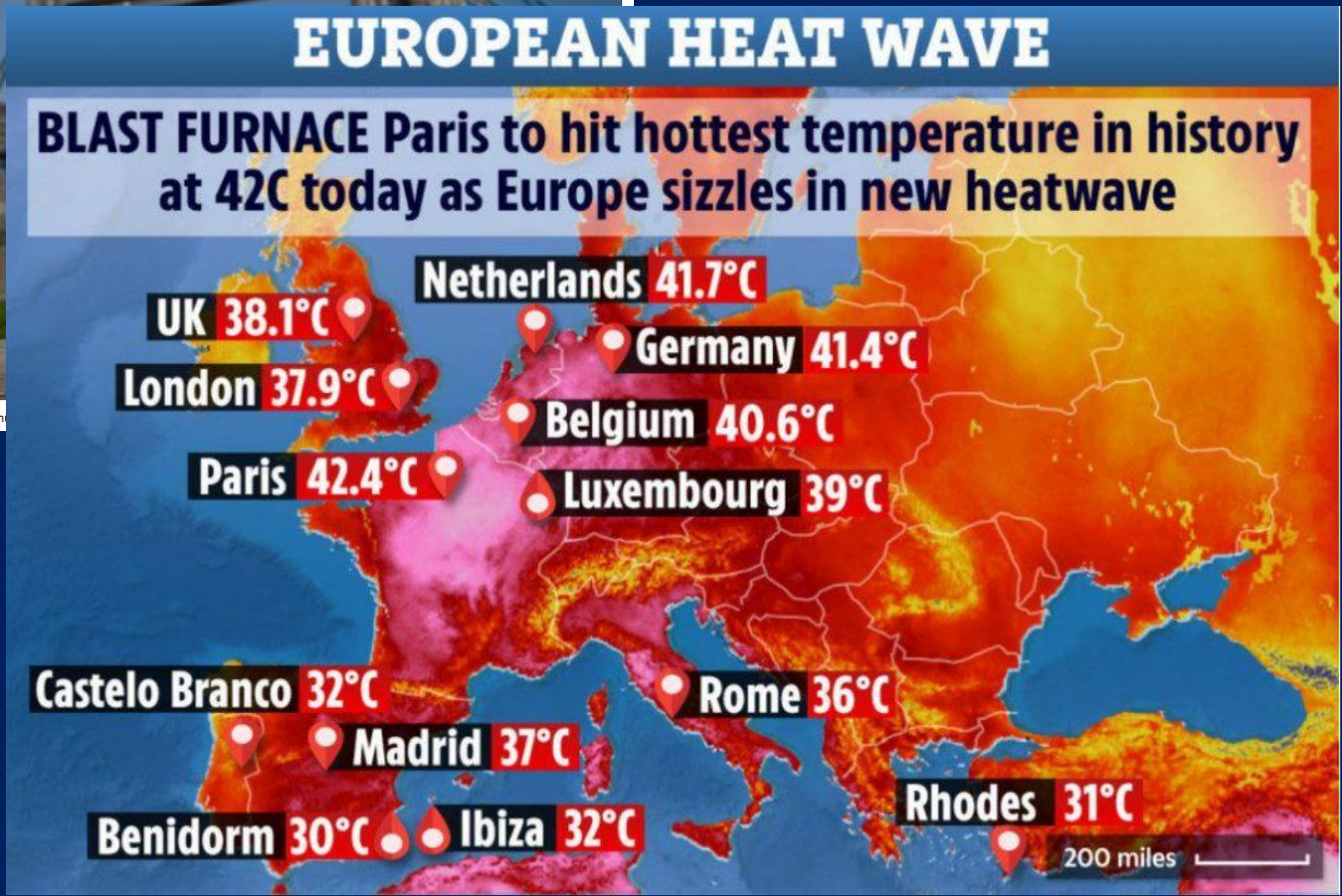
Warning issued as UK hits 35C in spring and records tumble

By Europe bureau chief **Mazoe Ford** in London

Climate Change

10h ago

London's spring heatwave was too m



Weather enthusiasts spot rare cloud feature in regional Victoria

By Laura Mayers and Stephen Martin

ABC Ballarat | Weather Phenomena

4h ago

The large funnel was spotted yesterday near Mount Hooghly in north-west Victoria. *(Supplied: Jenny Leech)*

ABC News 28 May 2025

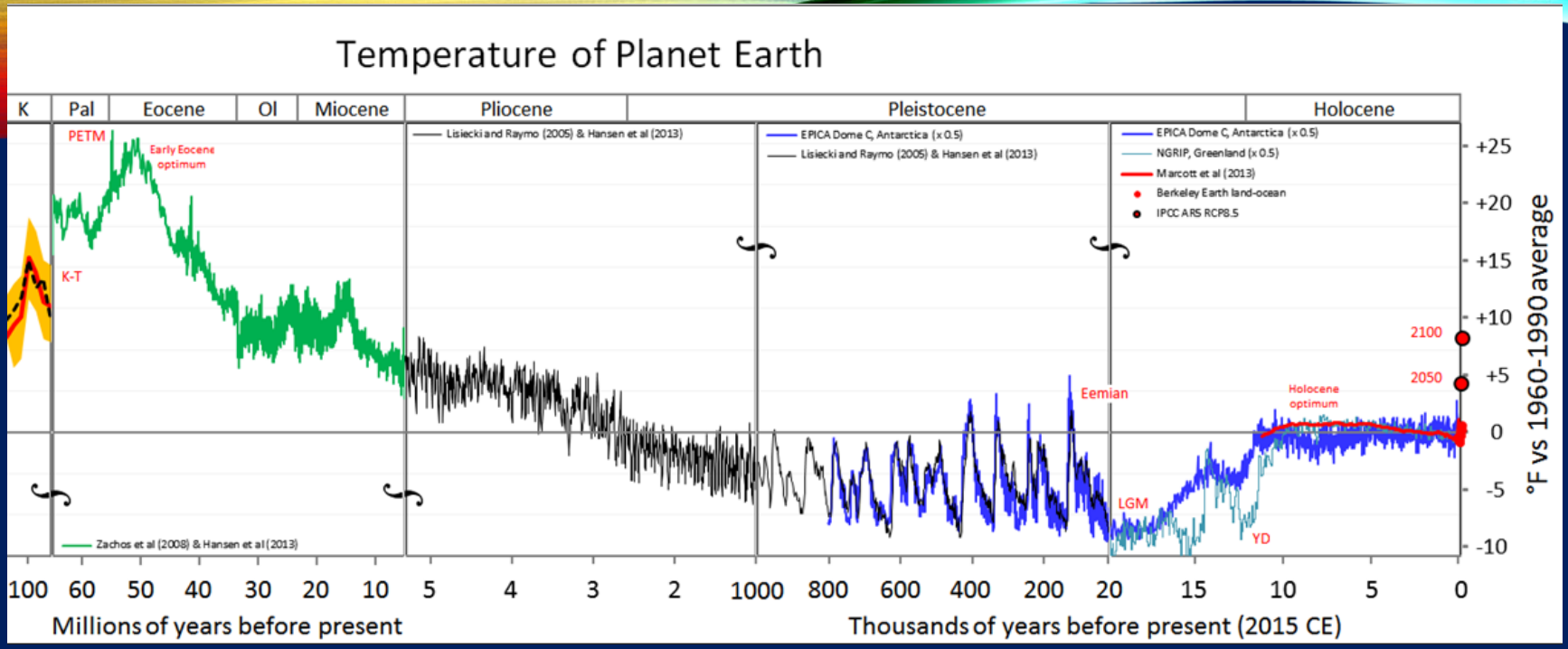
Near Avoca

Mr Leech said the cloud column lasted just a few minutes before dissipating.

Bureau of Meteorology forecaster Jonathan How said the photos of the funnel were "remarkable".

"You normally see them when you have a big cold front … It's not something you'd expect with a little bit of cloud or showers.

If it reached to the ground it would be a **tornado**.



- Cooling from around 4 Mya, faster after 3 Mya.

- Ice first appears in Greenland around 5 Mya and on America, Russia and Europe from 2.5 Mya, the start of the Ice Age. (There had been ice in Antarctica millions of years before that).

- Large variations related to variations in the earth's orbit (Croll-Milankovic cycles)
  - about every 40,000 years before 1 Mya
  - After 1 Mya even stronger and about every 100,000 years.

- Last Glacial Maximum (26,000 – 20,000 years ago) – then a general increase in temperature leading to a stable period since about 12,000 years ago.

Comments on the origins of intelligence.

- *Lewis Dartnell – Origins: How the Earth Shaped Human History. (2019)*

- The long swings in climate associated with the astronomical cycles (tens of thousands of years or more):
  - Can be met by evolution of physiology of the body

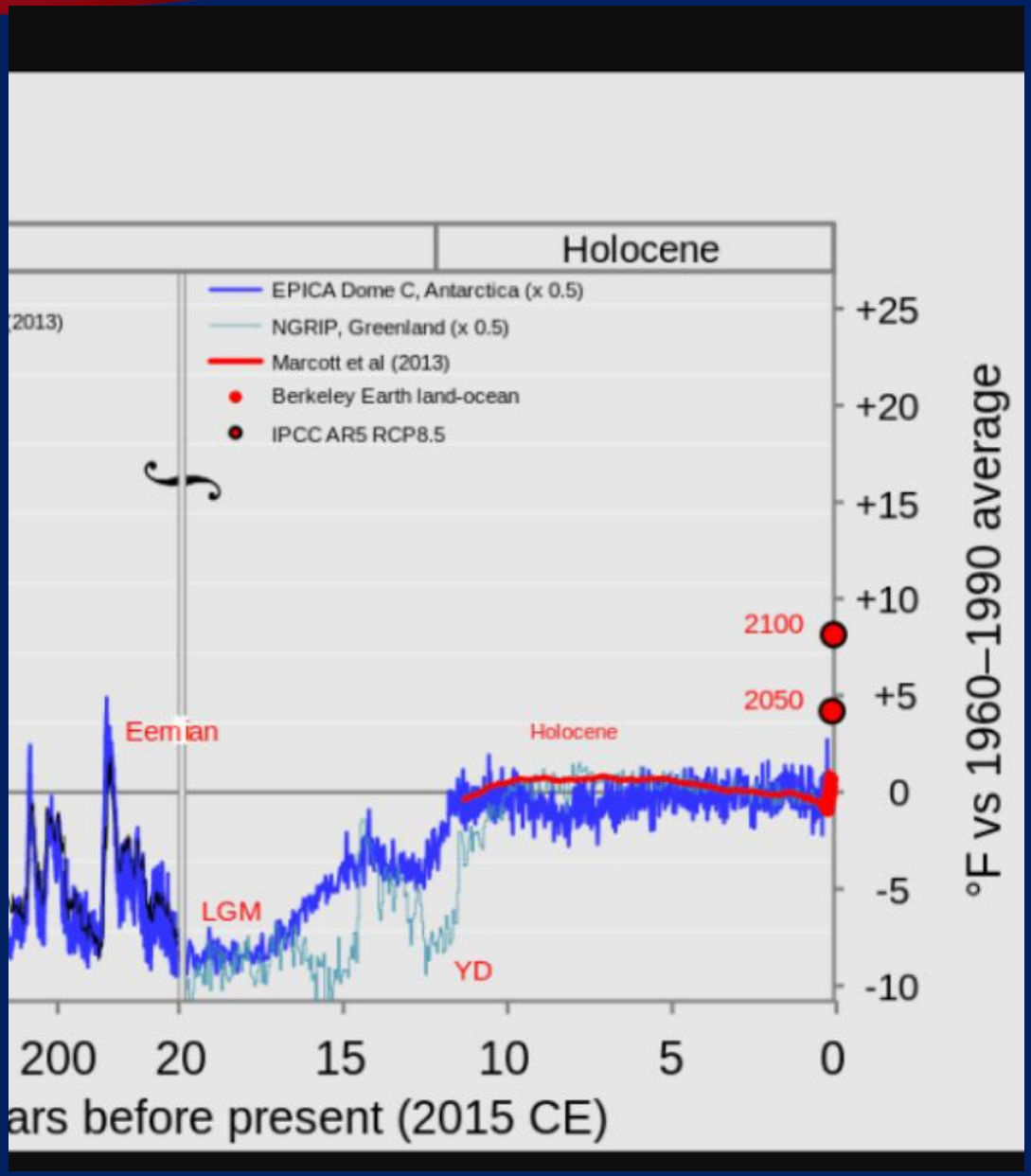
- **Intelligence** – an evolutionary solution to the problem of an environment that *shifts faster than natural selection can adapt the body*.

- This applies to places where changes were occurring on a short time-scale.

- Unique geology of the Rift Valley lends itself to rapid changes in the environment:

  - Sharp contrast in rainfall between high ground and the valley
  - Many diverse habitats within the region
  - Rain flows from the Rift walls into the hot valley forming lakes – evaporation is high.
  - Lakes very sensitive to slight changes in the rainfall, so there are times when they dry out - "amplifier lakes"
  - 1.9 – 1.7 million years ago (around the time of the appearance of *homo erectus*) – five of the seven lake basins repeatedly filled and emptied.

Holocene: "entirely new"



Three temperature lines:

- Greenland (Lighter blue)
- Antarctica (Dark Blue)
- Reconstruction of global temperature (Red)

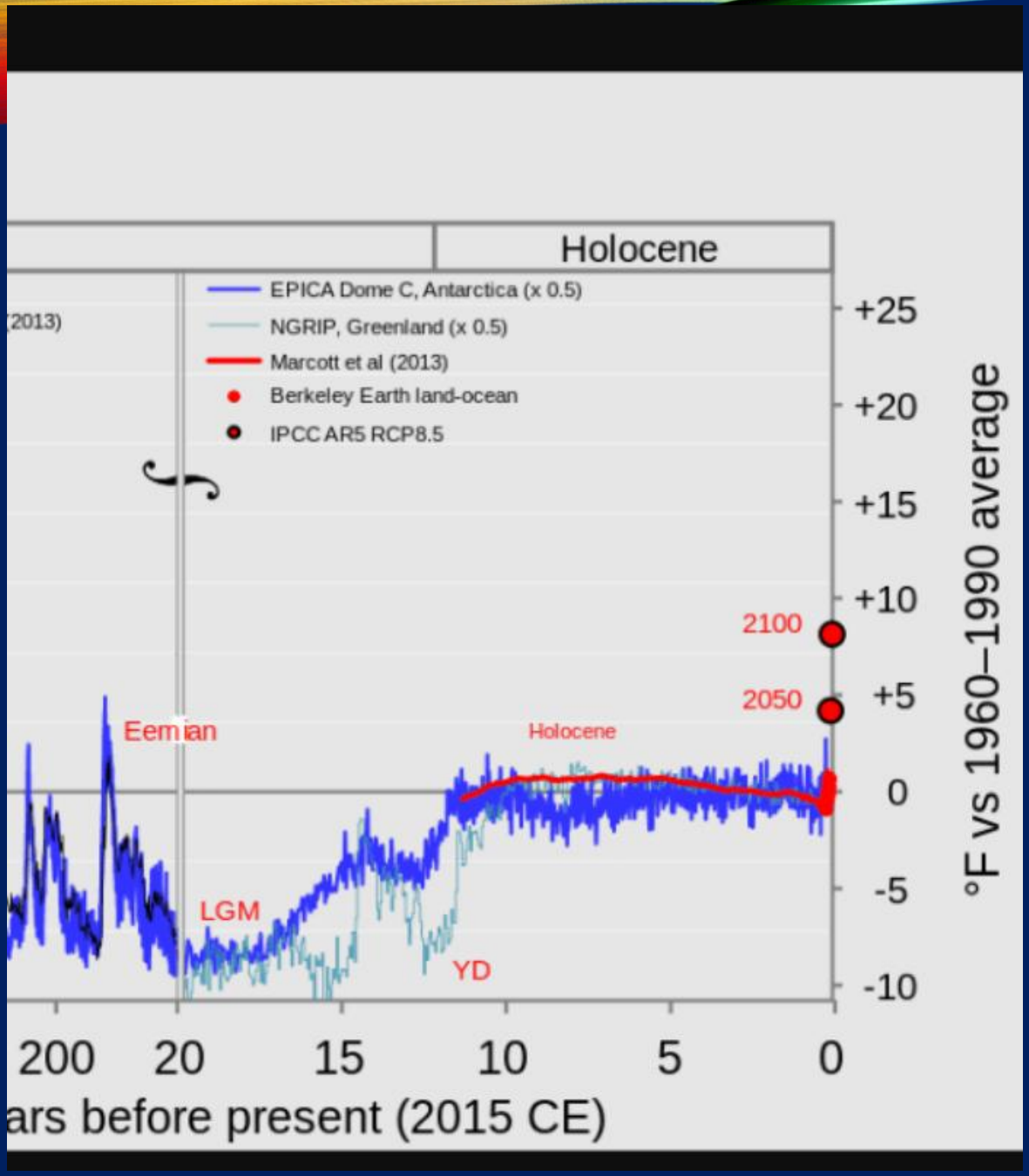
Last Glacial Maximum (LGM) was the period around 20,000 years ago

Antarctica:

- steady rise from about 18 kya
- slight decrease about 13 kya
- Increase again and then fairly steady from about 12 kya.

Greenland:

- stays cool until about 15 kya
- Rapid increase
- Another cool period 13 – 12 kya followed by rapid warming (Younger Dryas)
- Fairly constant since 12 kya.



Holocene: "entirely new"

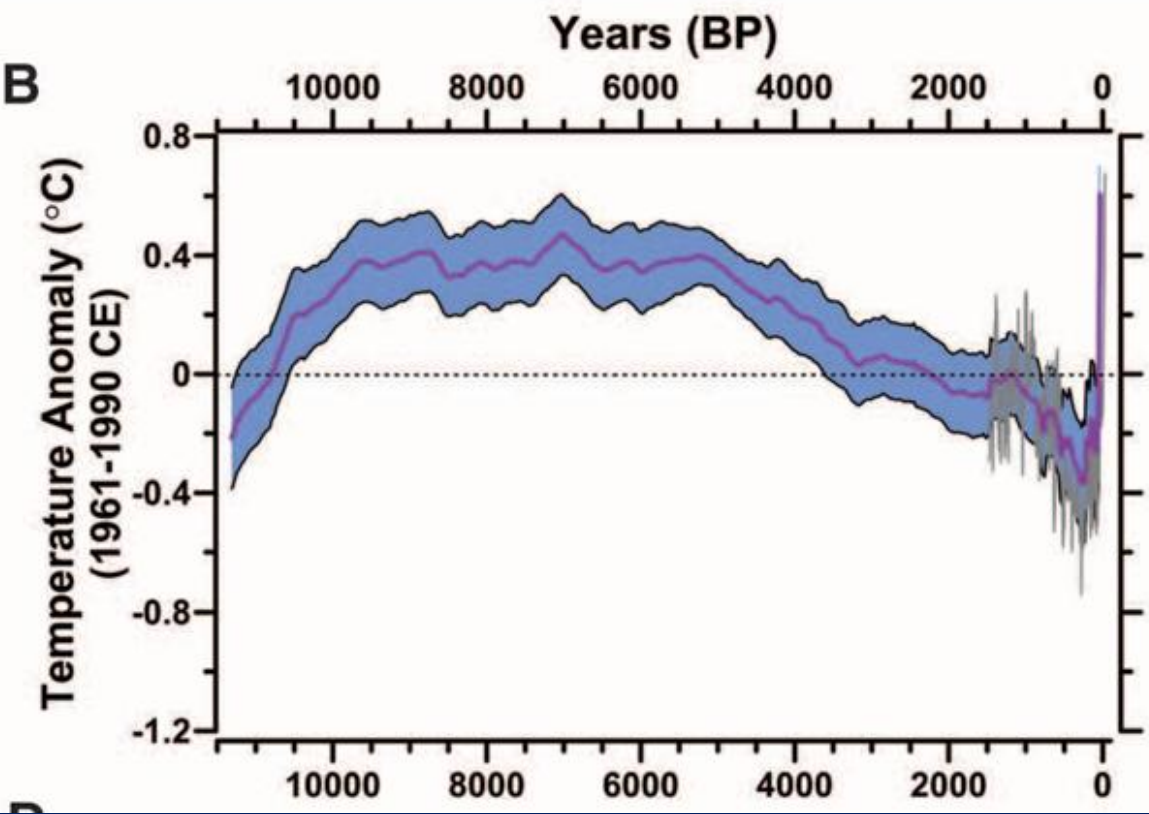
Although the graph looks quite flat there were some variations.

Note the difference in the temperature measurements from Antarctica (dark blue) and Greenland (teal).

9,000 -5,500 ya

Holocene Climatic Optimum

- Global temperatures about 0.7 °C warmer than typical for the Holocene
- polar regions about 4 °C warmer
- North America and Europe about 2 °C warmer.



A closer look at the global average temperatures of the past 11,000 years

(Marcott et al. (2013))

(red line in previous slide)

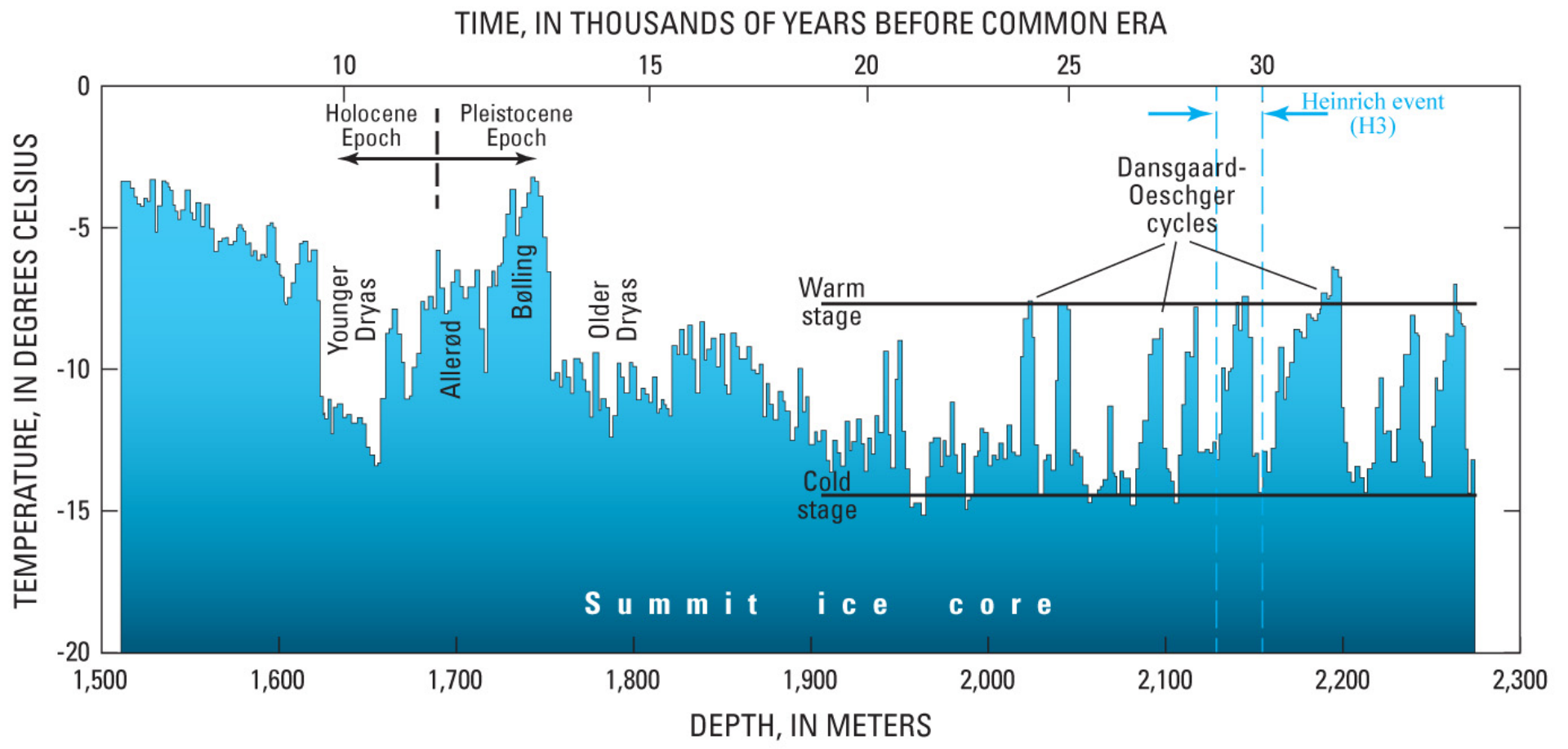
- About 0.6°C of warming from the early Holocene (11,300 yr B.P.)
- A plateau from 9500 to 5500 yr B.P.
- Long-term 0.7°C cooling reaching a minimum in the Little Ice Age (500 – 100 yr B.P.)

- The largest changes occurred in the North Atlantic region.
- After the early warming the tropics were quite constant.
- The Southern Hemisphere actually cooled slightly from 11,000 to 7,000 years ago and was fairly constant after that.

The Warming period

- Major environmental changes
- Sea level rise
- Spread of forests
- Retreating ice sheets – new areas for settlement
- Animals such as mammoth, woolly rhinoceros and steppe bison disappeared as temperatures increased.

Note: The peak of the Croll-Milankovich cycles occurred about 10,000 ya in high Northern Hemisphere latitudes but the temperature response is delayed as it takes time to melt the ice sheets.



There was a sudden cool period (12,900 – 11,700 ya) evident in the Greenland ice core. This is called the Younger Dryas and occurred about the same time as the development of agriculture – coincidence?.

Younger Dryas period – about 12,900 to 11,700 years ago

- named after the alpine–tundra wildflower *Dryas octopetala*, because its fossils appear in European (particularly Scandinavian) sediments dating to this time.
- Average temperatures decreased 3-6 ^{o}C over Europe and North America, and 10 ^{o}C in Greenland within a few years. In Greenland it began and ended in a decade or less.
- Southern hemisphere may have warmed, so there would have been movement of weather systems, especially in tropical regions.
- Rainfall decreased in the cooler regions leading to a shortened growing season.
- End of the Younger Dryas marks the start of the Holocene epoch – our current interglacial period.

- Reduction of population?

- Linked to the adoption of agriculture and cereal crops?

Brief cold events linked to fresh water flows off Greenland or North America disrupting currents in the Atlantic:

- Bond events – similar to the Dansgaard-Oeschger cycles during the Ice Age.
- Occur about every 1500 years
- Linked to droughts in the Middle East and disruption of South-east Asian monsoons
- The Younger Dryas may be related to the collapse of a gigantic lake over the North American continent – Lake Agassiz.

The most recent event - 8,200 years ago ("8.2 ka event")

- A final remaining ice dam in North America broke through and a large ice-dammed lake drained into N Atlantic through Hudson Strait.
- Lasted 150 years – several degrees cooling in Greenland, and on land around the North Atlantic.
- Reduced summer monsoon intensity in the Northern Hemisphere.
- Death throes of last ice age. Deglaciation complete around 6ka.

- These events relate to the **Atlantic Meridional Overturning Current (AMOC)**. There is some discussion these days about whether it is slowing and the potential climate effects.

- What is it?

What Happens If the Atlantic Ocean Stops Flowing? (AMOC Explained)

1K views · 6 months ago
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The Ocean System That Controls Earth's Climate is Slowing Down! Wh…

1.3K views · 1 month ago
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What is AMOC?

12.2K views · 2 months ago
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Atlantic Meridional Overturning Circulation (AMOC) Explained | UPS…

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Amoc Slowdown And Possible Collapse

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Atlantic Ocean Alert 2025 — Is AMOC Slowing or Collapsing?

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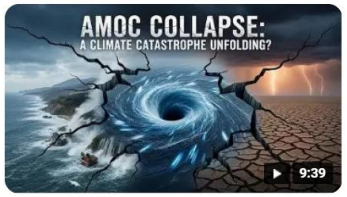

AMOC Collapse: A Climate Catastrophe Unfolding?

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Why Europe is About to Freeze (The AMOC Crisis) | The Science of AMO…

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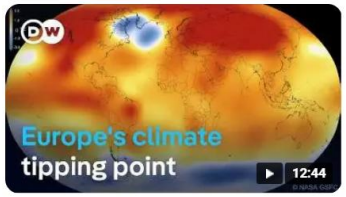

A key Atlantic current is weakening. Here's why it matters. | DW News

129.8K views · 3 weeks ago
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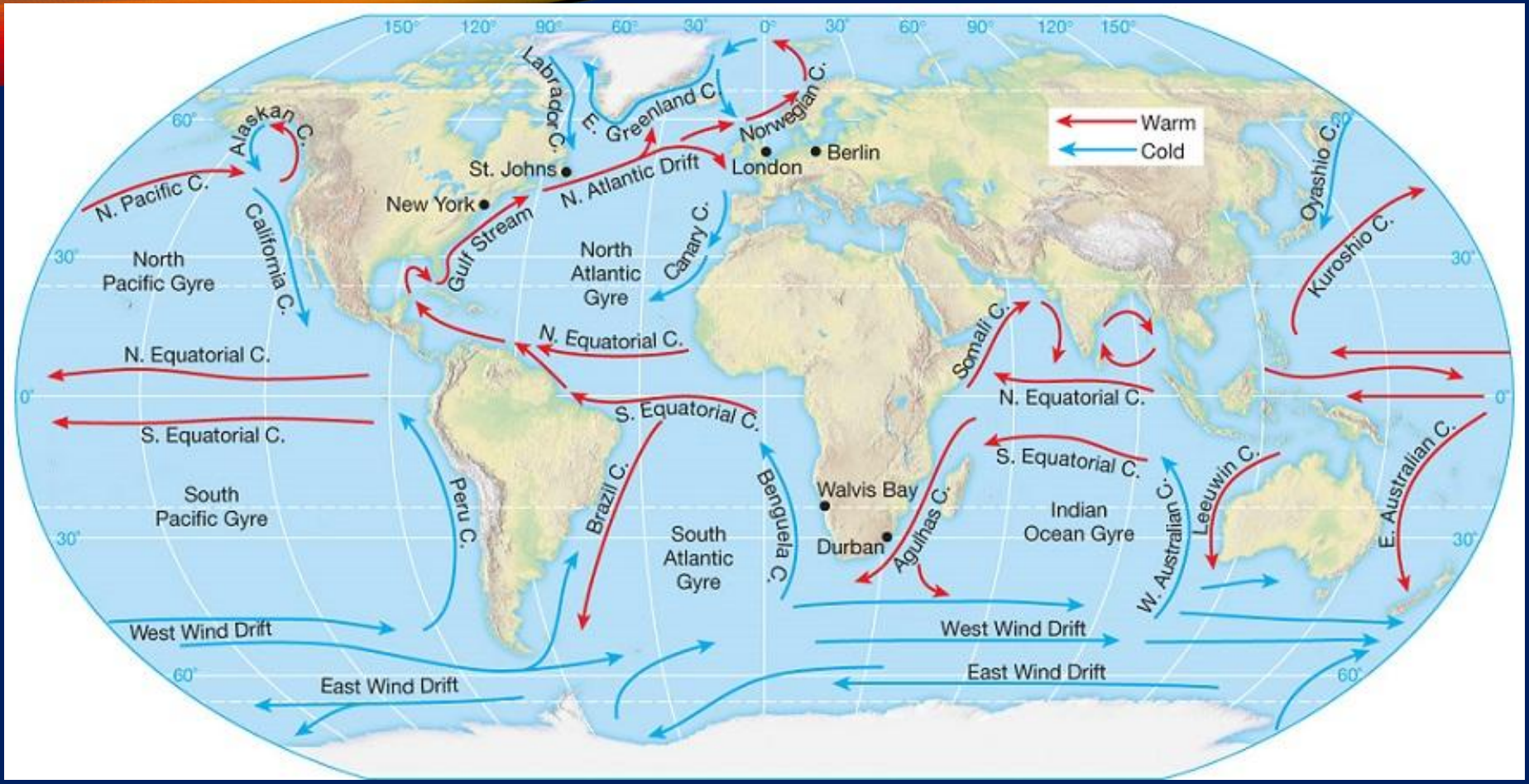
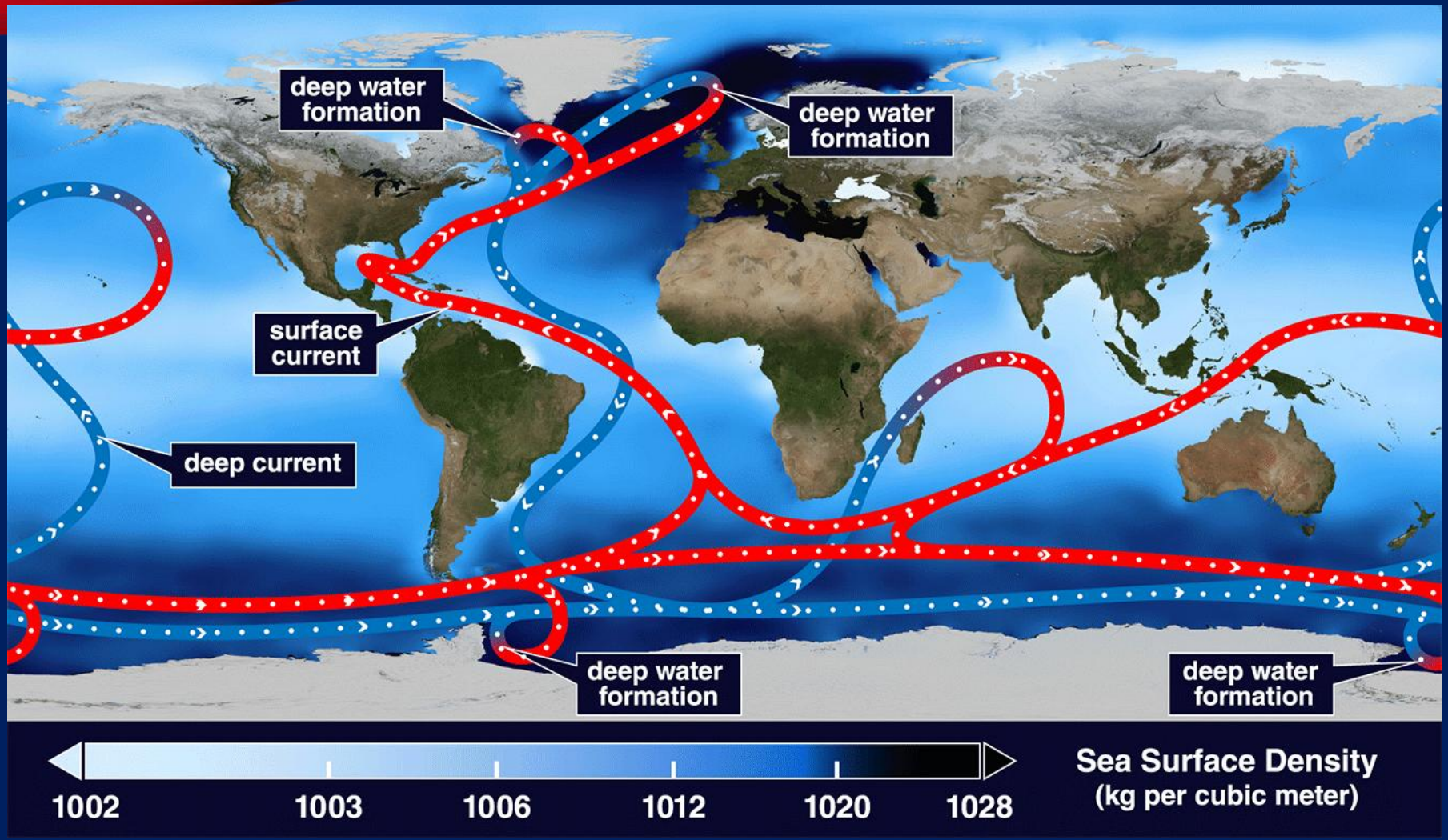


Wind-driven surface currents in the ocean.

Deep Ocean Conveyor Belt



The "great ocean conveyor belt" refers to the major ocean currents that move warm water around at the surface and cold water at depth. Water heats up from sunlight in the tropics and then cools as it travels toward the poles (red). Cold, salty water then sinks in the North Atlantic and some places off the coast of Antarctica. This water then travels in deep currents around the world before rising up to the surface again (blue). The background color shows sea-surface density. NASA/Goddard Space Flight Center Scientific Visualization Studio.

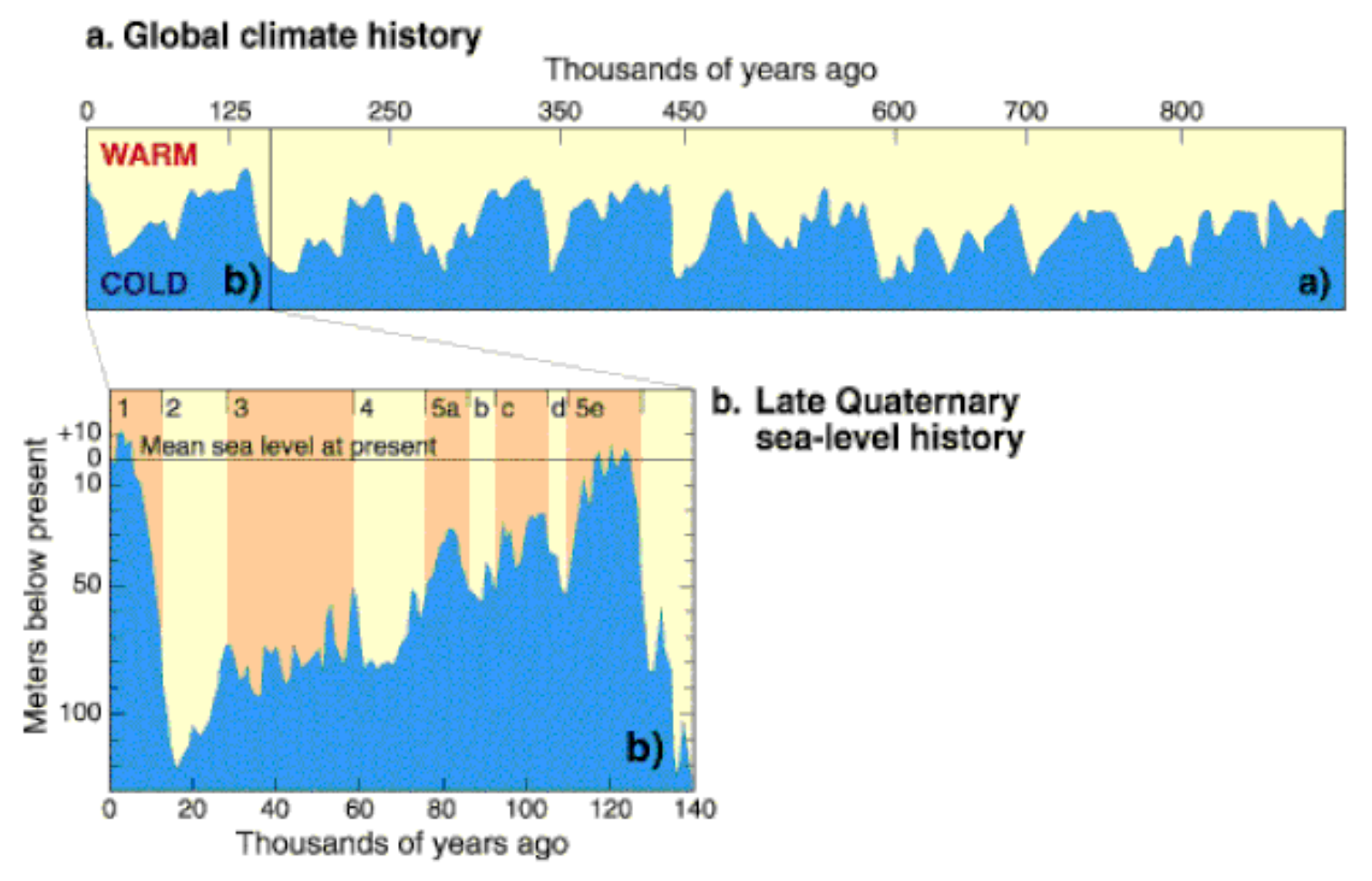
The Atlantic Meridional Overturning Circulation ...

YouTube · National Oceanogra...
58.7K views · Jul 17, 2024

Bing Videos

https://www.bing.com/videos/riverview/relatedvideo?q=amoc+explained&&mid=82DC794E10D6F2F5252A82DC794E10D6F2F5252A&churl=https%3a%2f%2fwww.youtube.com%2fchannel%2fUC9j-wx3nWXOY-Z9hNOcAJ5g&FORM=VCGVRP

An important feature of the Ice Ages was the impact on sea level.



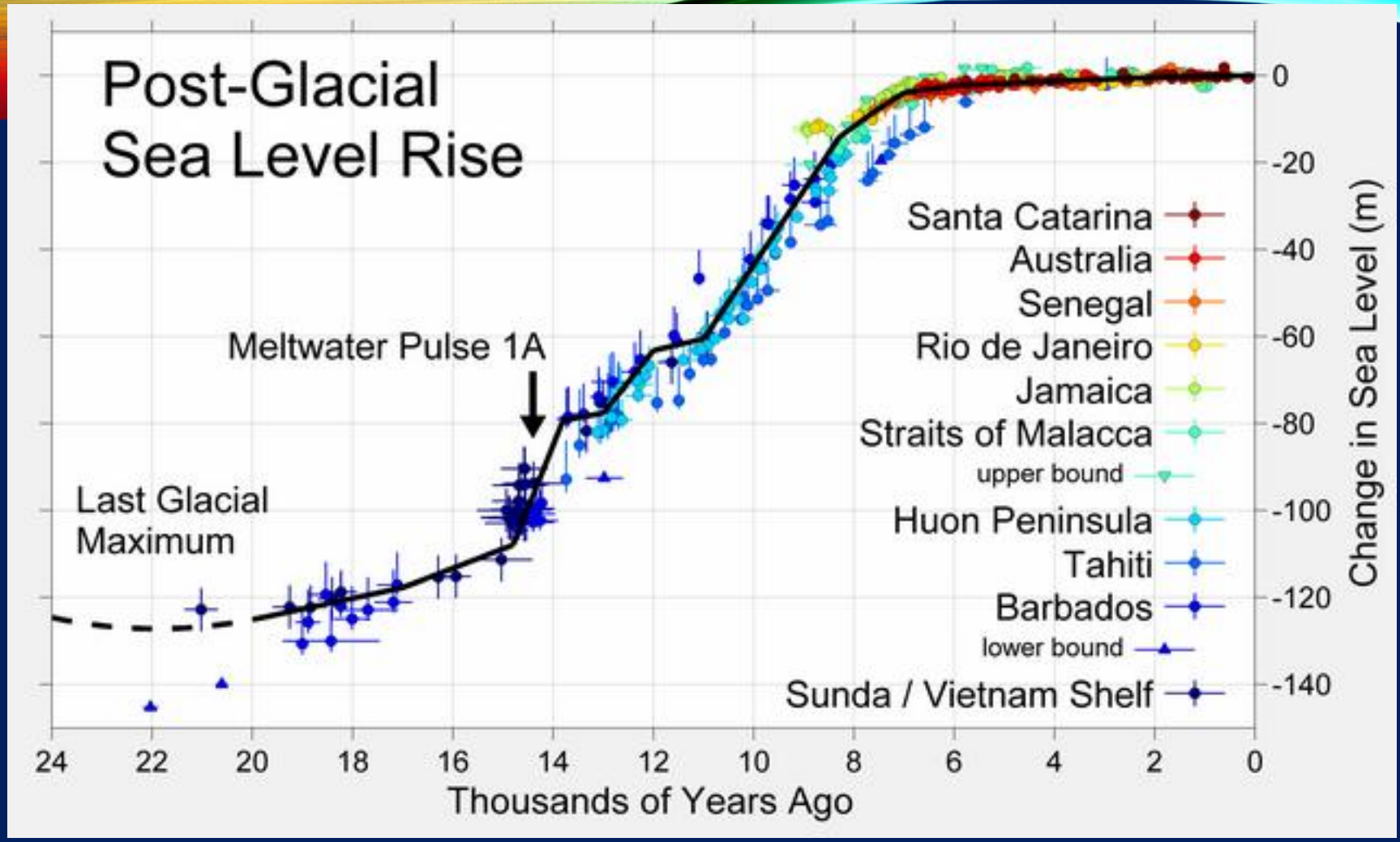
Creation of major land bridges due to lower sea level.

- Bering Strait – connecting Russia and Alaska
- North of Australia – and Bass Strait
- Persian Gulf - dry land.

UK and NW Europe at the end of the Ice Age.

English Channel formed in the early Holocene as sea levels rose.

Human artefacts and Mammoth skulls, tusks and bones found on the seabed in the English Channel.



- Sea level rise – 120 m in about 12 thousand years (i.e. about 1 metre/Century)
- Some faster rates based on analysis if coral reefs:
  - Meltwater Pulse 1A about 14.5 Ka – 13.5 m in 300 years years (4.5 m/century)
  - *A memory that triggered the various Great Flood stories?.*

Impacts of sea-level rise

- loss of continental shelf and land bridges cut
- Closing of English Channel (6,000 BCE) (dredging has found evidence of human habitation and mammoth bones)
- Bering Strait (9000 BCE)
- Bass Strait (6 – 12,000 ya)
- Flooding of Port Phillip (around 1,000 ya)

- Note: One complication with sea level is the isostatic rebound of the land once the ice cover melts. Different parts respond differently and explains why sea level changes vary round the world.

Some features of the Holocene Climate Optimum Period:

- Deserts of Central Asia and Sahara were wetter
- Ancient civilisations developed in this area
- The Sahara shows buried river valleys and lake beds
- There were a few interruptions especially in the North Atlantic such as the “8.2 ka event”.
- “Neoglacial” – last 5,500 years – cooler and drier.
- 1177 BCE - severe drought associated with the demise of some civilisations in the Eastern Mediterranean and adjacent areas?

Map of Southwest Asia showing the main archaeological sites of the Pre-Pottery Neolithic period about 9,500 years ago, in the "Fertile Crescent". Black squares indicate pre-agricultural sites. (Wikipedia)

One Earth
Review

CellPress

The Greening of the Sahara: Past Changes and Future Implications

Francesco S.R. Pausata,[1,*] Marco Gaetani,[2] Gabriele Messori,[3,4] Alexis Berg,[5] Danielle Maia de Souza,[6] Rowan F. Sage,[7] and Peter B. deMenocal[8]

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https://doi.org/10.1016/j.oneear.2020.03.002

https://www.sciencedirect.com/science/article/pii/S2590332220301007#fig2

https://www.youtube.com/watch?v=czwMl9jYGb8

Lakeside Cemeteries in the Sahara: 5000 Years of Holocene Population and Environmental Change - PMC https://pmc.ncbi.nlm.nih.gov/articles/PMC2515196/

"Approximately two hundred human burials were discovered on the edge of a paleolake in Niger that provide a uniquely preserved record of human occupation in the Sahara during the Holocene (~8000 BCE to the present). Called Gobero, this suite of closely spaced sites chronicles the rapid pace of biosocial change in the southern Sahara in response to severe climatic fluctuation."

"We are just beginning to understand the anatomical and cultural diversity that existed within the Sahara during the Holocene."

Note: Some speculation that over-grazing was a contributor to the Sahara region drying out and desertification.

The Sahara Desert used to be a green savannah – new research explains why

Published: December 15, 2023 8.07pm AEDT

Rock carving of an elephant at the Tassili N'Ajjer National Park, Tadrart Rouge, in Algeria. Eric Lafforgue/Getty Images

Algeria's Tassili N'Ajjer plateau is Africa's largest national park. Among its vast sandstone formations is perhaps the world's largest art museum. Over 15,000 etchings and paintings are exhibited there, some as much as 11,000 years old according to scientific dating techniques, representing a unique ethnological and climatological record of the region.

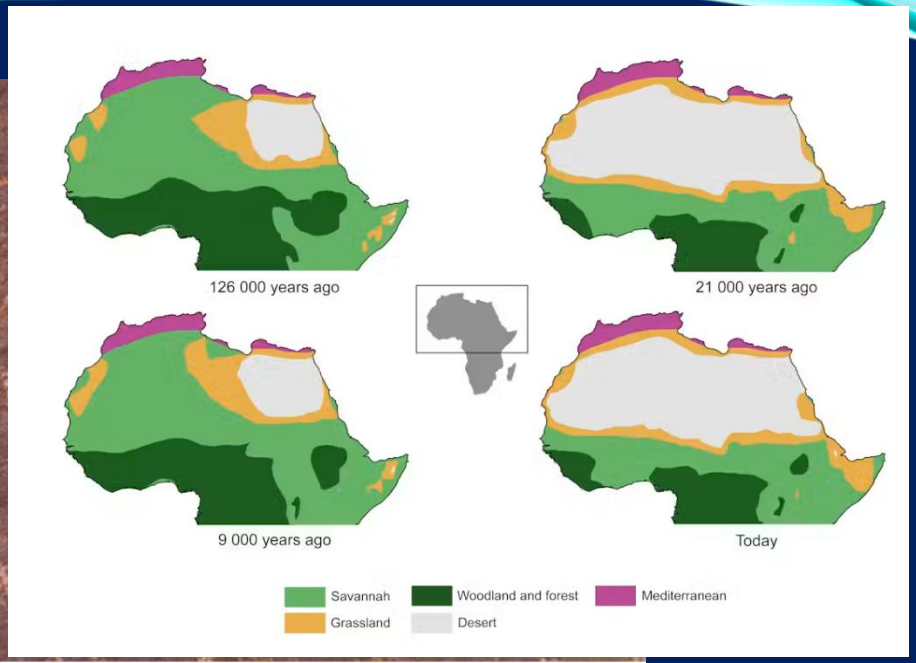
Curiously, however, these images do not depict the arid, barren landscape that is present in the Tassili N'Ajjer today. Instead, they portray a vibrant savannah inhabited by elephants, giraffes, rhinos and hippos. This rock art is an important

Author

Edward Armstrong
Postdoctoral research fellow, University of Helsinki

Disclosure statement

Edward Armstrong does not work for, consult, own shares in or receive funding from any company or organisation that would benefit from this article, and has disclosed no relevant affiliations beyond their academic appointment.



https://theconversation.com/the-sahara-desert-used-to-be-a-green-savannah-new-research-explains-why-216555

"We identified why north Africa greened approximately every 21,000 years over the past eight million years. It was caused by changes in the Earth's orbital precession - the slight wobbling of the planet while rotating. This moves the Northern Hemisphere closer to the sun during the summer months."

Arts + Culture | Books + Ideas | Business + Economy | Education | Environment + Energy | Health | Politics + Society | Science + Tech

https://theconversation.com/
12 May 2026

We found hundreds of huge ancient mass graves hidden in the Sahara desert

Published: May 12, 2026 6.07am AEST

Authors

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PhD Candidate, Ancient History, Université Lumière Lyon 2

- Satellite aerial imagery
- Atbai Desert of Eastern Sudan, a small part of the much larger Sahara.

4000 – 3000 BCE, nearing the end of a period when the once-greener Sahara was drying, a phase scientists call the "African Humid Period".

The summer monsoon gradually retreated, reducing rainfall and shrinking pastures. This led nomads to abandon thirsty cattle, increase the mobility of their herds, migrate to the south or flee to the Nile.