Past and Future Climate – Present Weather

Week 11

The Little Ice Age and Beyond

Terry Hart

Dates

Term 3

6 August	**The Little Ice Age and Beyond**
20 August	**Carbon dioxide and climate**
3 September	Away
17 September	Away

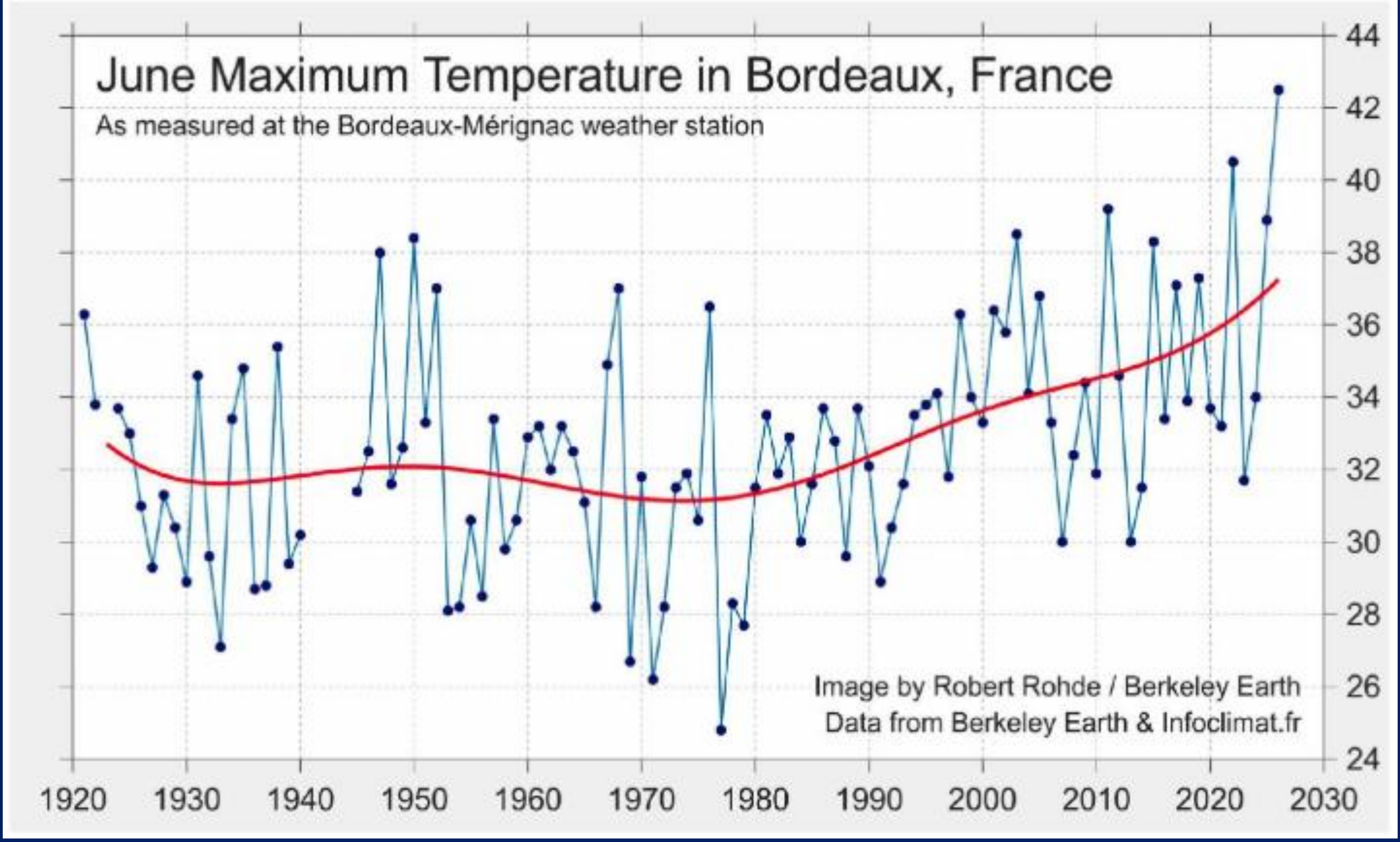
Term 4

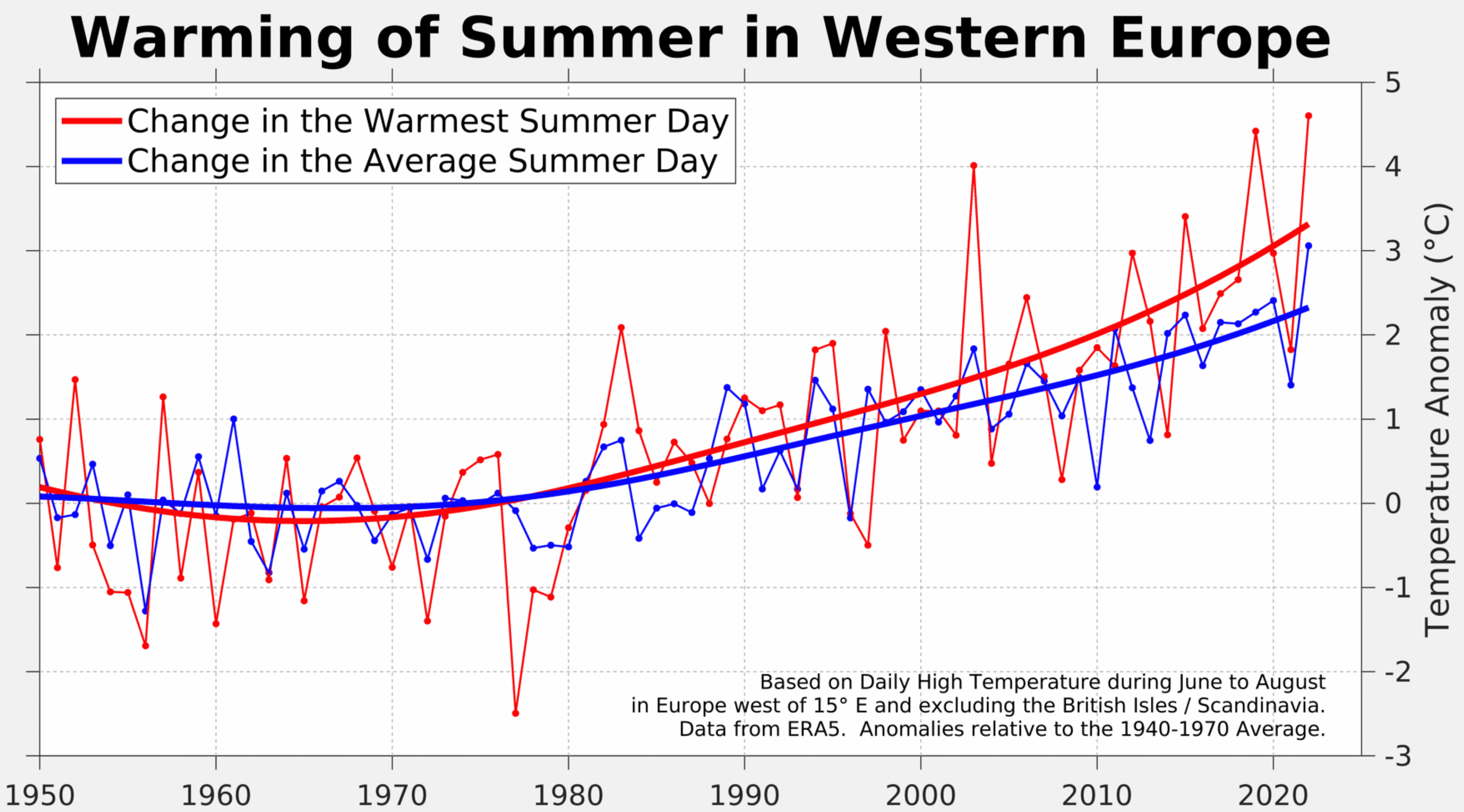
15 October	**Computer modelling of the Climate**
29 October	**Where are we now? The current and future state of the Climate.**
12 or 19 November?	**Royal Institution Christmas Lecture 2020** **Engine Earth**

Suggestions for 2027?

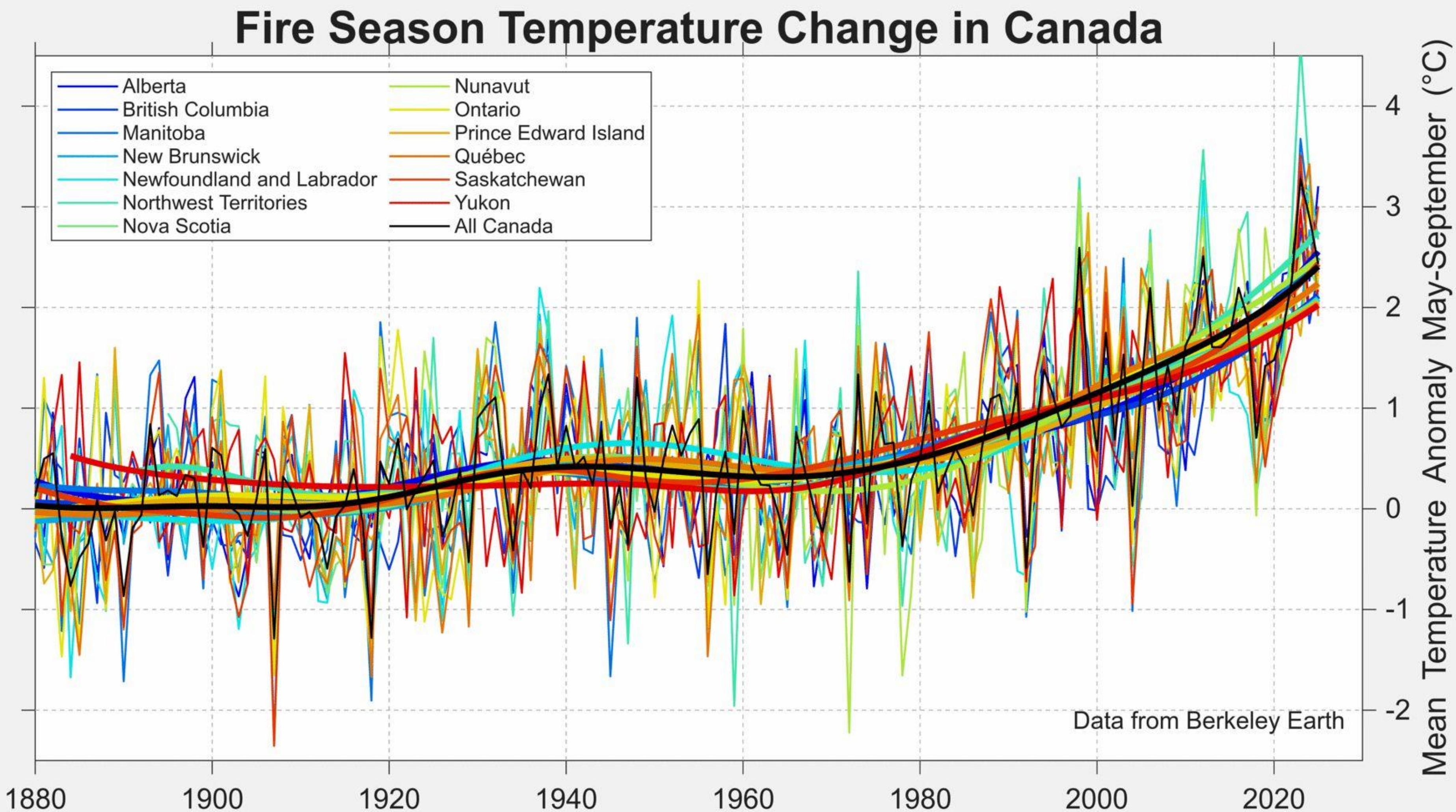

Over Malaysia 23 July 2026
Mark Sneddon

https://berkeleyearth.org/a-summer-of-extremes-in-context/

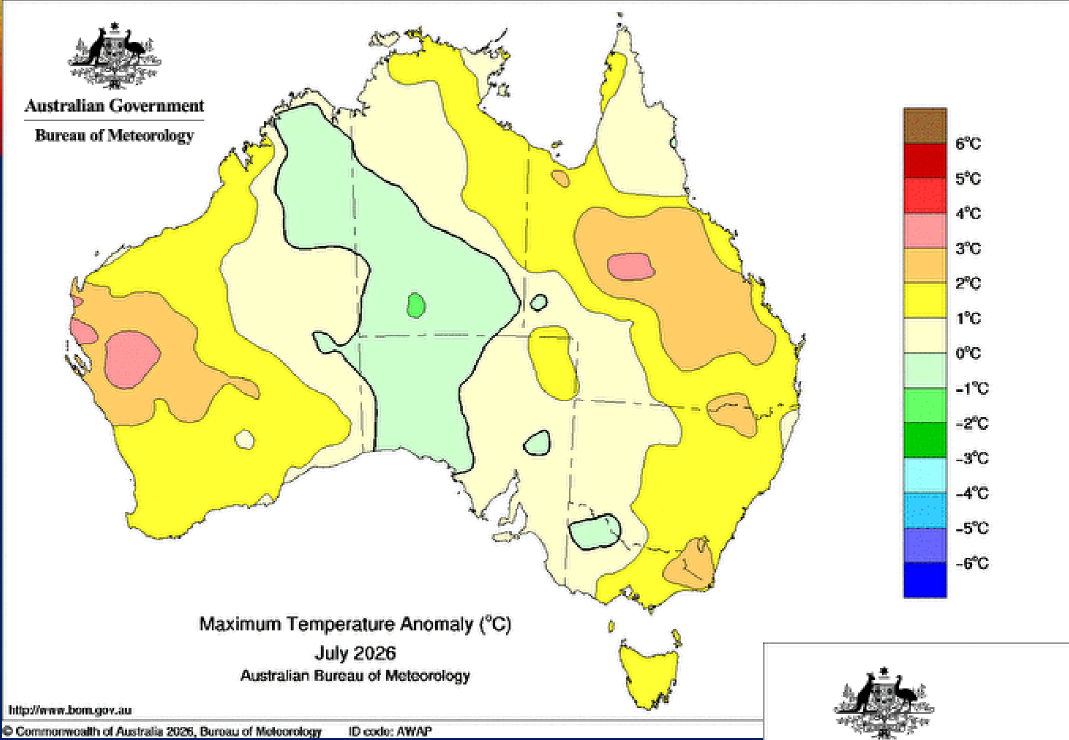


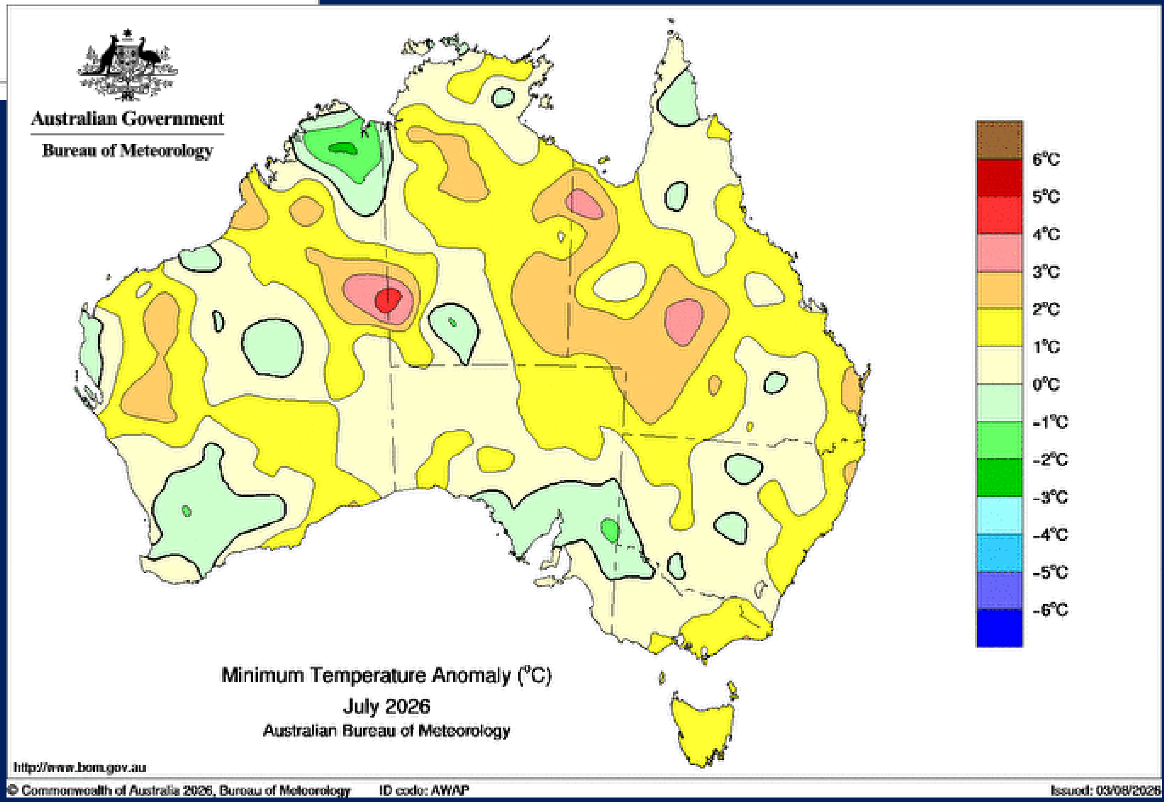


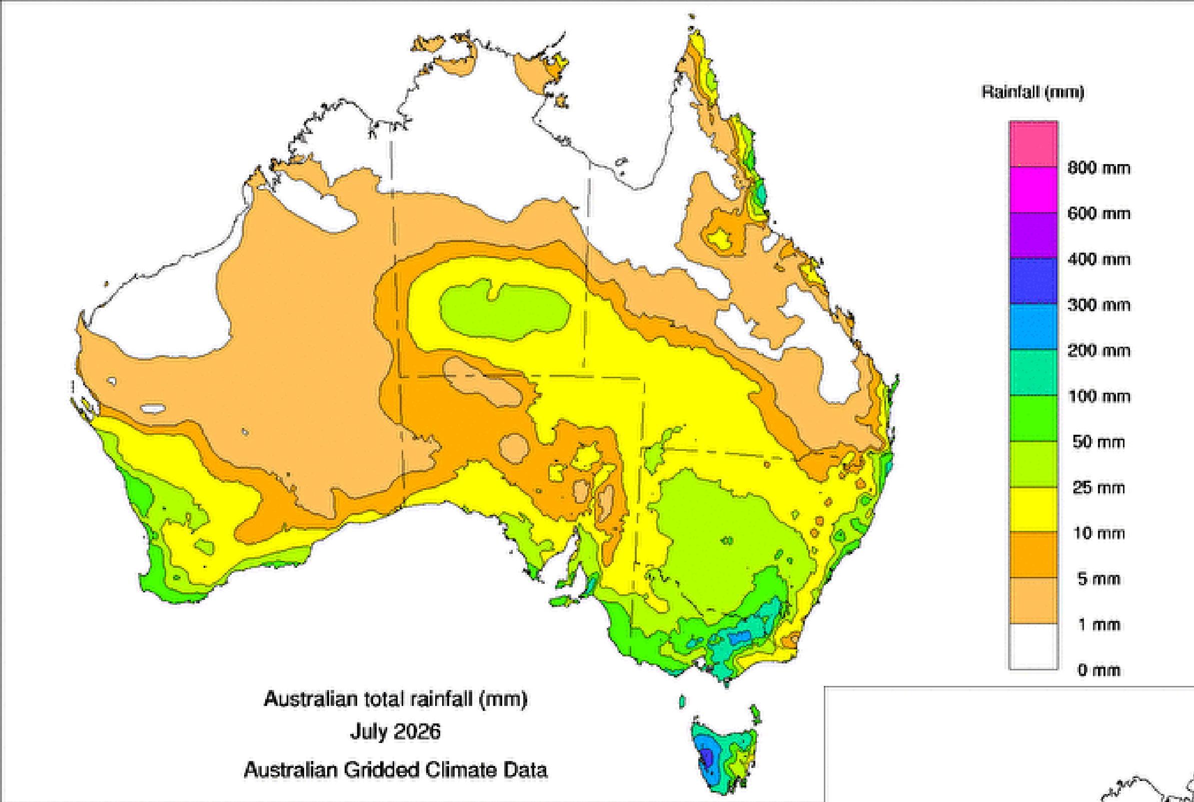
Warming of Summer in Western Europe
Change in the Warmest Summer Day
Change in the Average Summer Day
Temperature Anomaly (°C)
5
4
3
2
1
0
-1
-2
-3
1950
1960
1970
1980
1990
2000
2010
2020
Based on Daily High Temperature during June to August
in Europe west of 15° E and excluding the British Isles / Scandinavia.
Data from ERA5. Anomalies relative to the 1940-1970 Average.

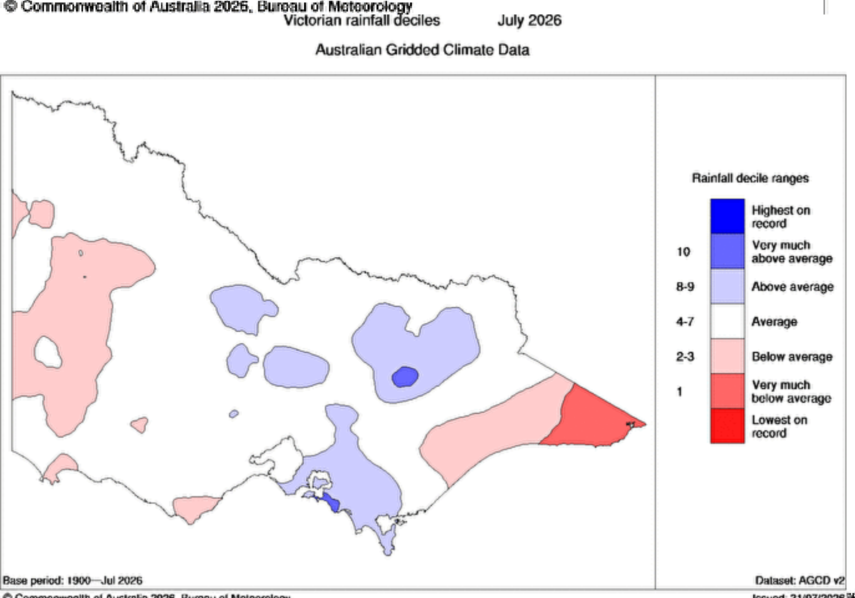

Fire Season Temperature Change in Canada
Alberta
British Columbia
Manitoba
New Brunswick
Newfoundland and Labrador
Northwest Territories
Nova Scotia
Nunavut
Ontario
Prince Edward Island
Québec
Saskatchewan
Yukon
All Canada
Data from Berkeley Earth
Mean Temperature Anomaly May-September (°C)
4
3
2
1
0
-1
-2
1880
1900
1920
1940
1960
1980
2000
2020

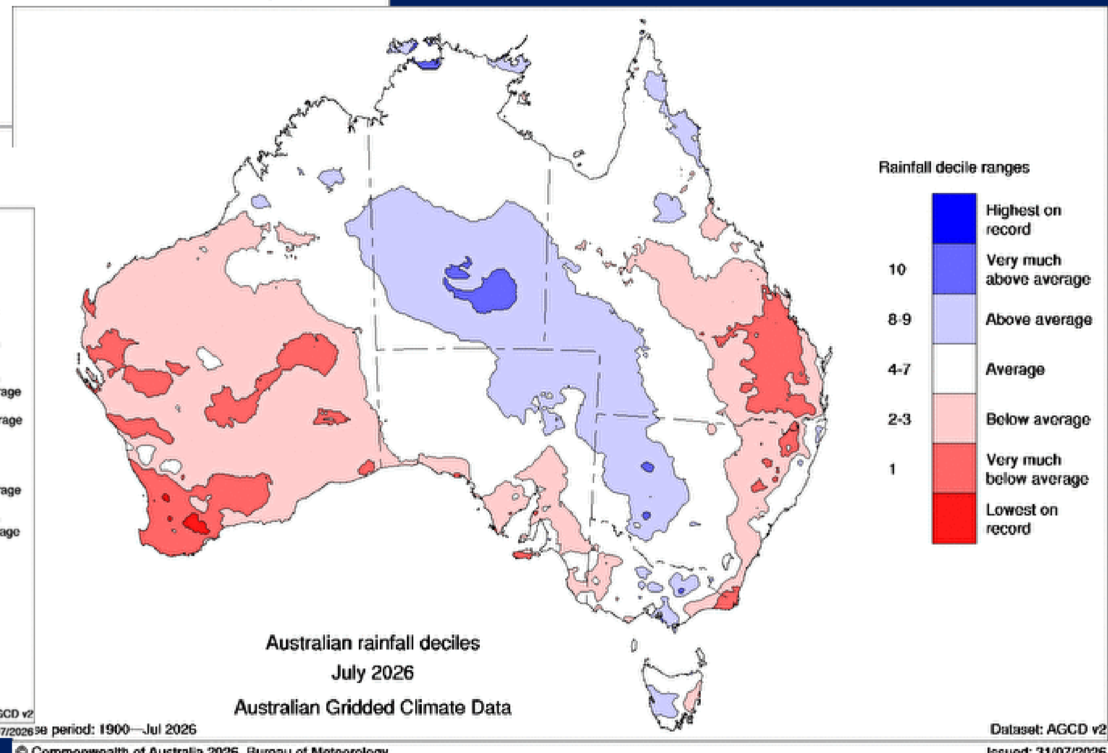
July’s weather

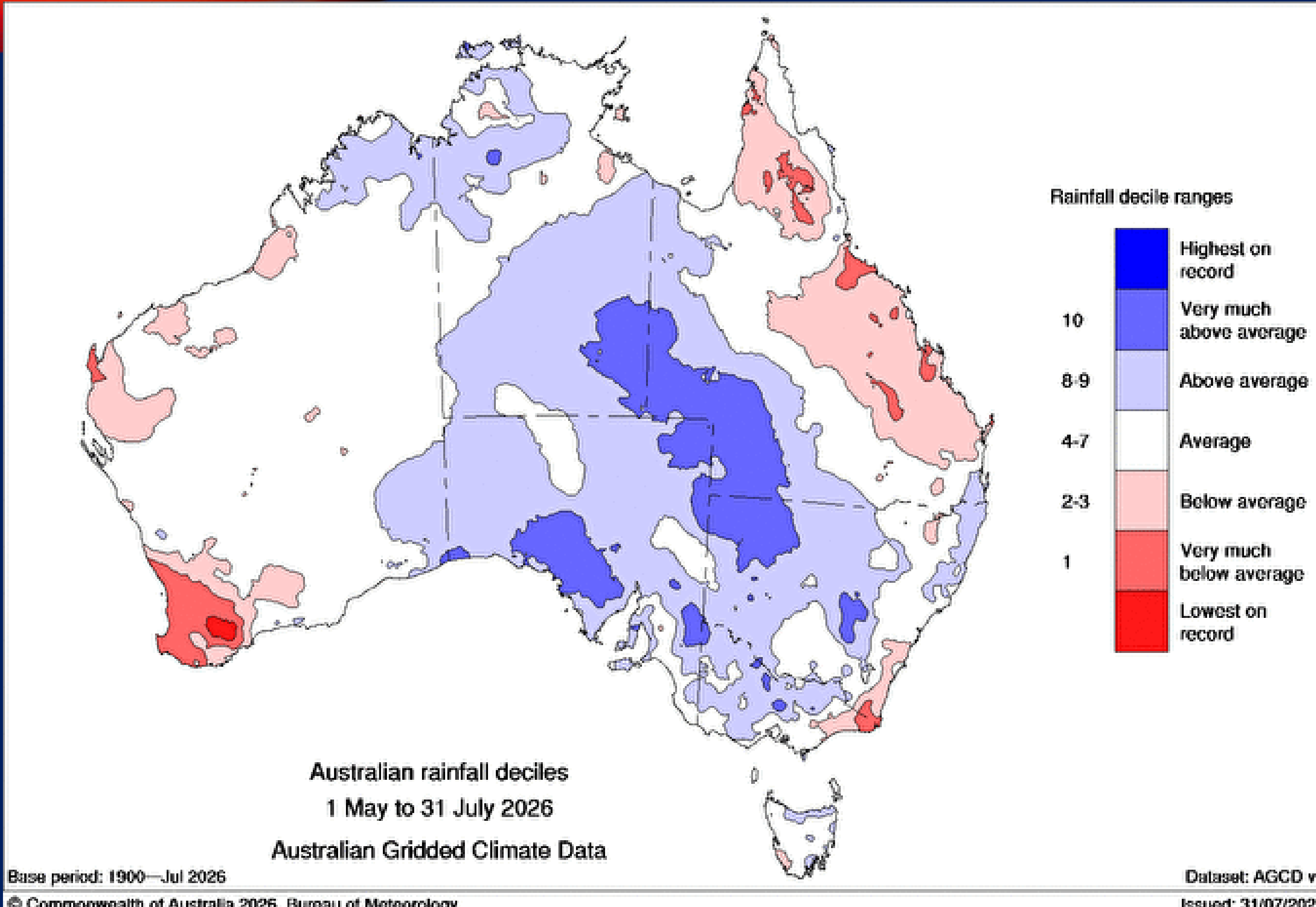


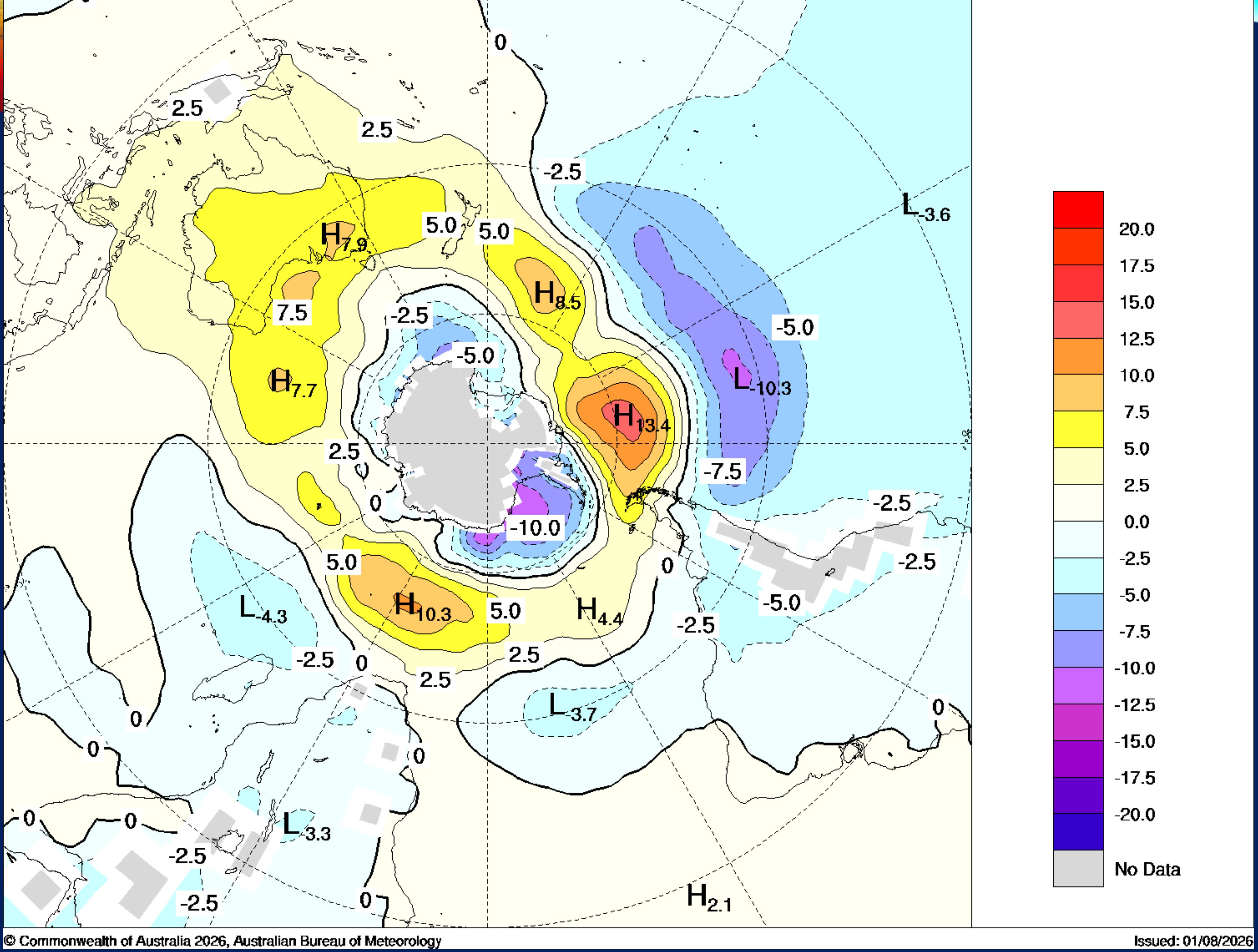



Rainfall (mm)
800 mm
600 mm
400 mm
300 mm
200 mm
100 mm
50 mm
25 mm
10 mm
5 mm
1 mm
0 mm
Australian total rainfall (mm)
July 2026
Australian Gridded Climate Data


Victorian rainfall deciles July 2026
Australian Gridded Climate Data
Rainfall decile ranges
Highest on record
10
Very much above average
8-9
Above average
4-7
Average
2-3
Below average
1
Very much below average
Lowest on record
Base period: 1900—Jul 2026
Dataset: AGCD v2
© Commonwealth of Australia 2026, Bureau of Meteorology
Issued: 31/07/2026


Rainfall decile ranges
Highest on record
10
Very much above average
8-9
Above average
4-7
Average
2-3
Below average
1
Very much below average
Lowest on record
Australian rainfall deciles
July 2026
Australian Gridded Climate Data
Base period: 1900—Jul 2026
Dataset: AGCD v2
© Commonwealth of Australia 2026, Bureau of Meteorology
Issued: 31/07/2026


Rainfall decile ranges
Highest on record
10
Very much above average
8-9
Above average
4-7
Average
2-3
Below average
1
Very much below average
Lowest on record
Australian rainfall deciles
1 May to 31 July 2026
Australian Gridded Climate Data
Base period: 1900—Jul 2026
Dataset: AGCD v2
© Commonwealth of Australia 2026, Bureau of Meteorology
Issued: 31/07/2026

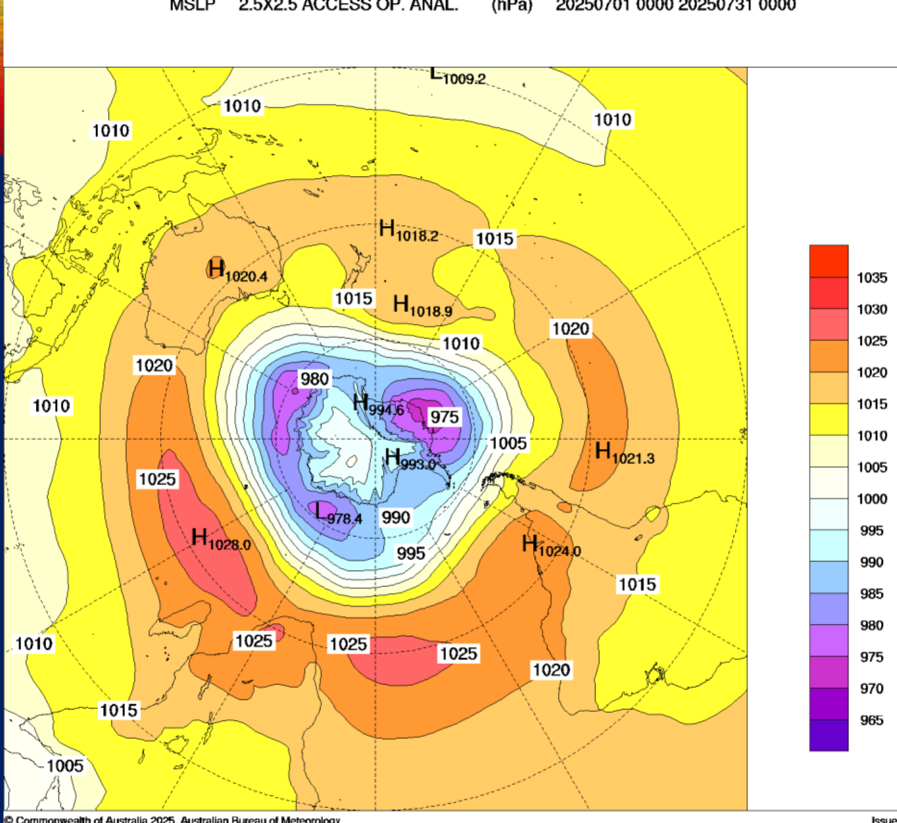


Difference from Average Mean Sea Level Pressure (MSLP) for July 2026

Southern Oscillation Index:
Tahiti (Papa'ete): 17°40' S 149° 25' W
Darwin: 12° 28' S 130° 51' W

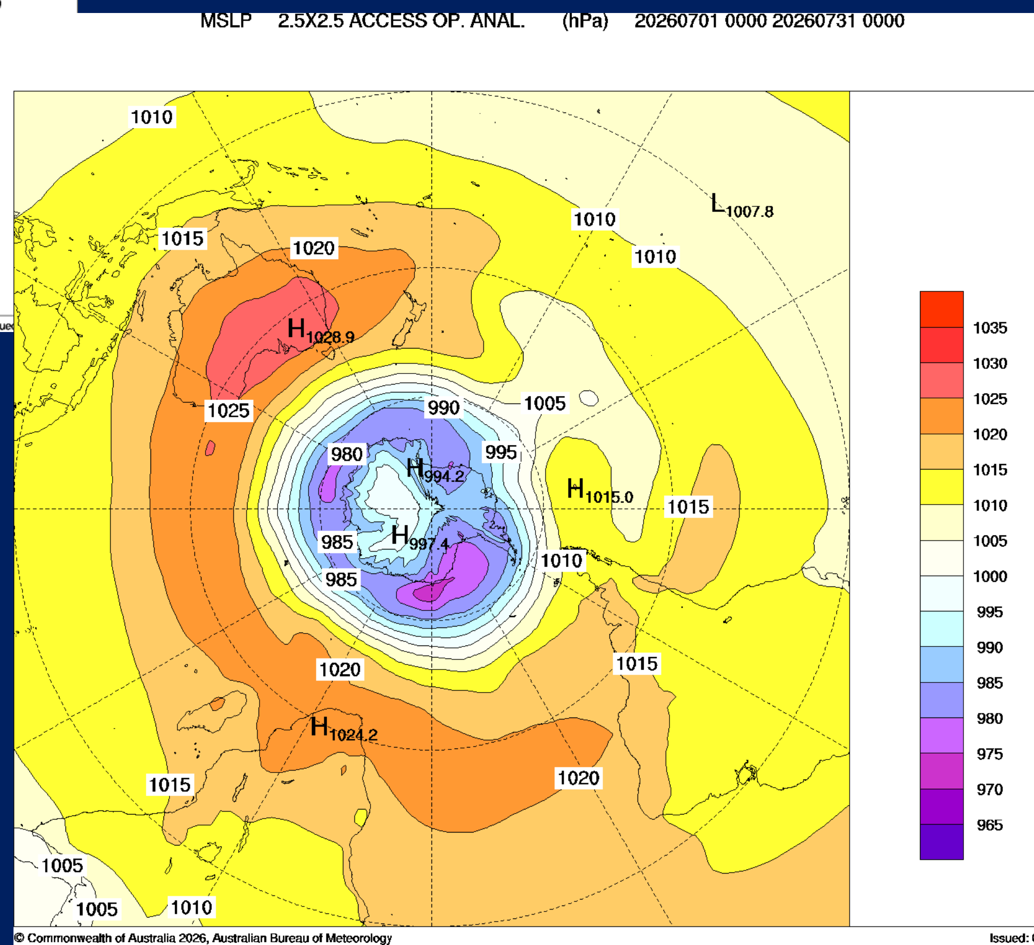
Sea Surface Temperature Indices:
The Bureau cites sustained monthly Niño3 or Niño3.4 values above +0.8 °C as being associated with El Niño, and values below −0.8 °C being associated with La Niña.

Average Mean Sea Level Pressure (MSLP)



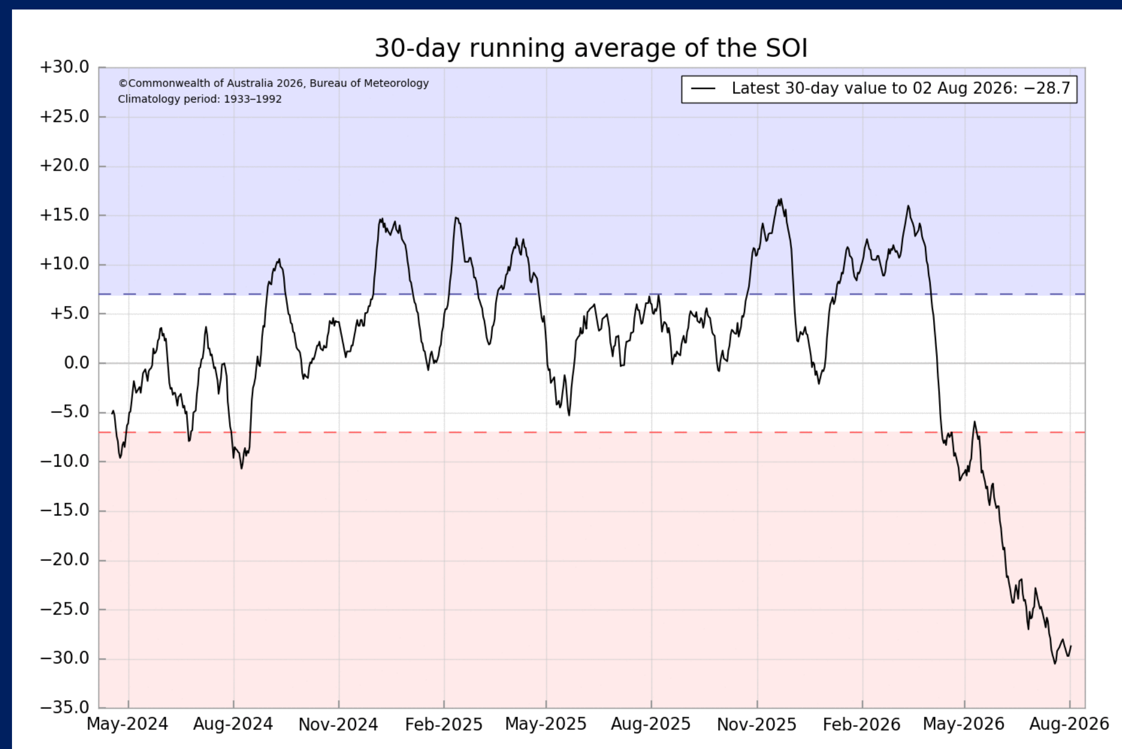
July 2025

July 2026



Sea Surface Temperature
Pacific Ocean Niño 3.4 area

Southern Oscillation Index



Livestock and animals | Crops and horticulture | Biosecurity | Climate and weather | Farm management | Export | Support and resources | About

Home / Support and resources / Newsletters / The Break newsletters

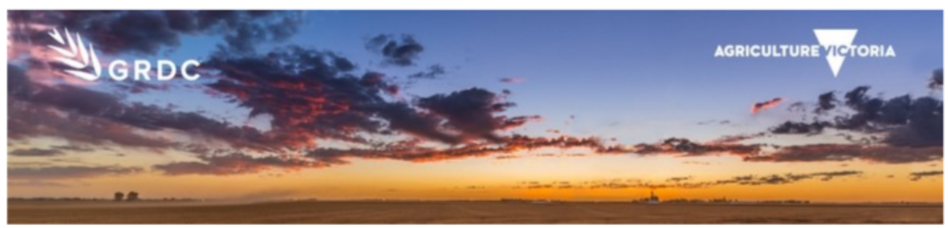
Support and resources

- Agriculture Victoria Connect
- Case studies
- Education
- eLearning
- Events
- Funds, grants and programs
- Networks
- Newsletters
  - Backyard Biosecurity
  - Biosecurity Matters
  - Chemical industry news
  - Milking the weather
  - Newsflash newsletter
  - Sheep Notes newsletter
  - Soil moisture monitoring in cropping regions
  - Soil moisture monitoring of pastures

The Break newsletters

On this page

- The Fast Break newsletter
- The Very Fast Break videos
- Ten years of making The Break
- We value your feedback



The Fast Break newsletter

The Fast Break details oceanic and atmospheric climate driver activity over the last month and summarises three month model predictions for the Pacific and Indian Oceans, rainfall and temperature for Victoria.

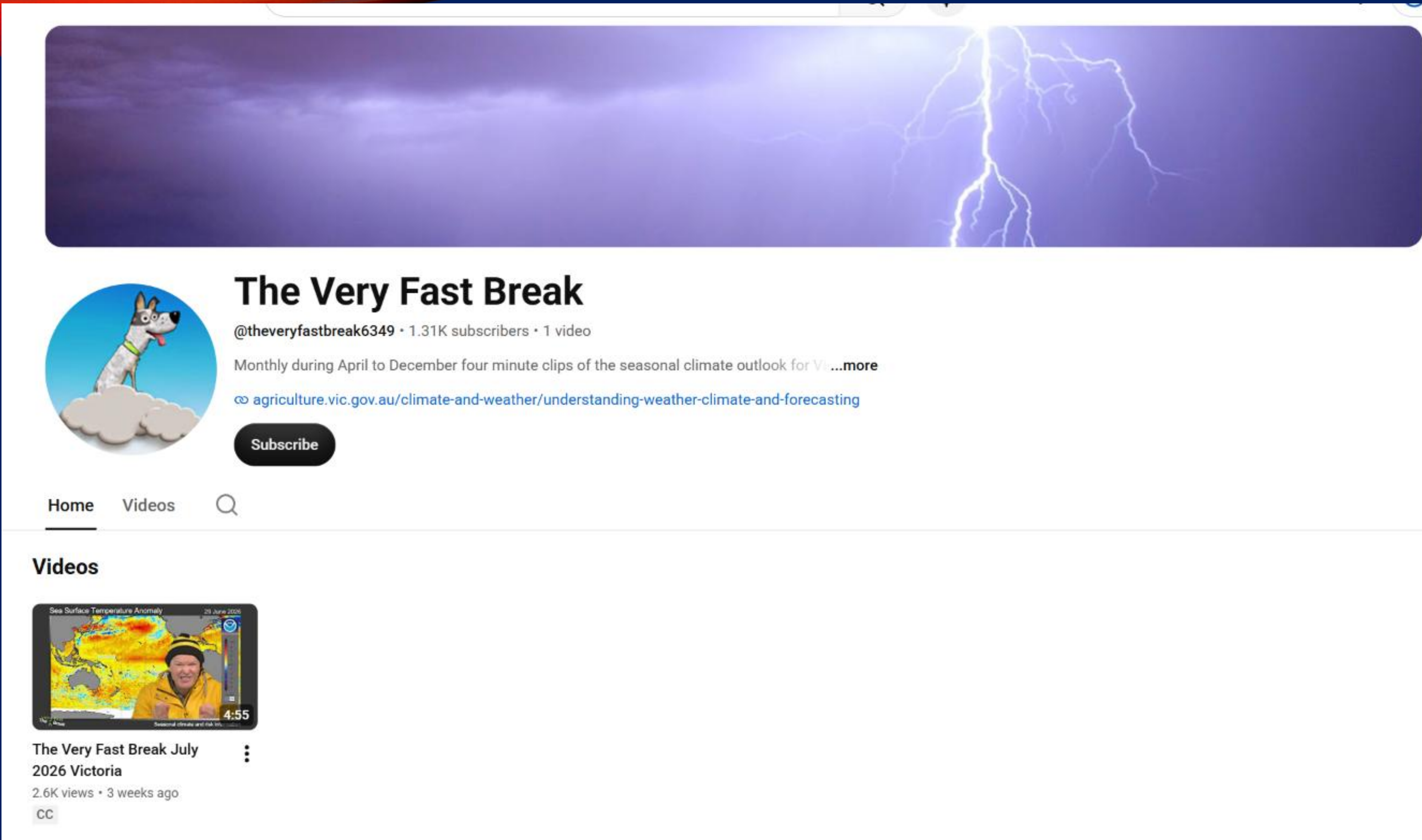
https://agriculture.vic.gov.au/support-and-resources/newsletters/the-break

The Fast Break – Victoria

On this page

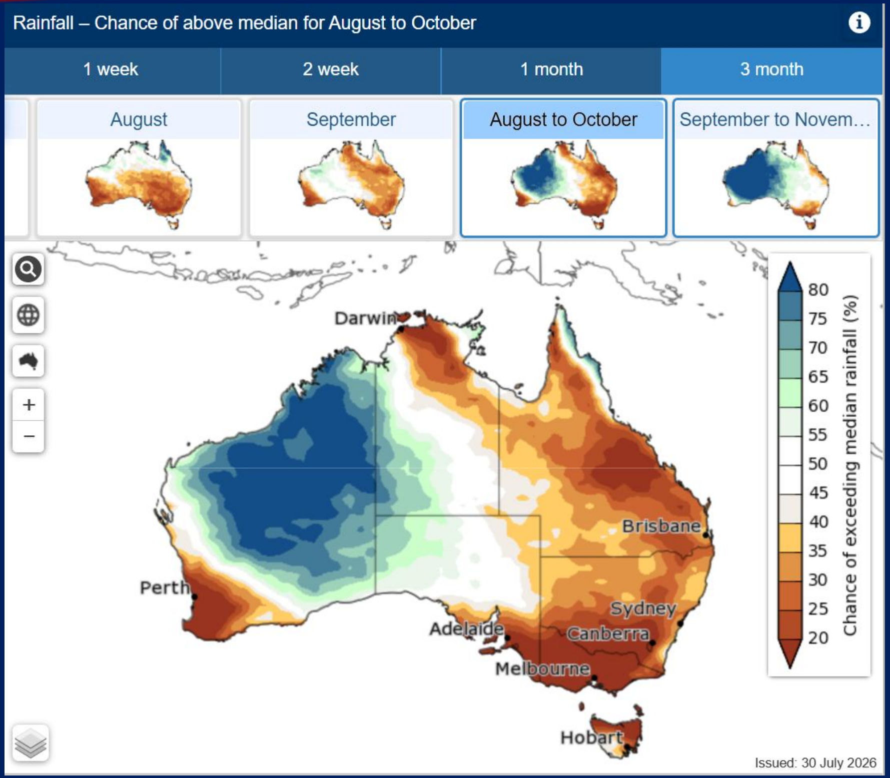
Seasonal climate risk information for Victoria

Volume 21 | Issue 7 | 29 July 2026

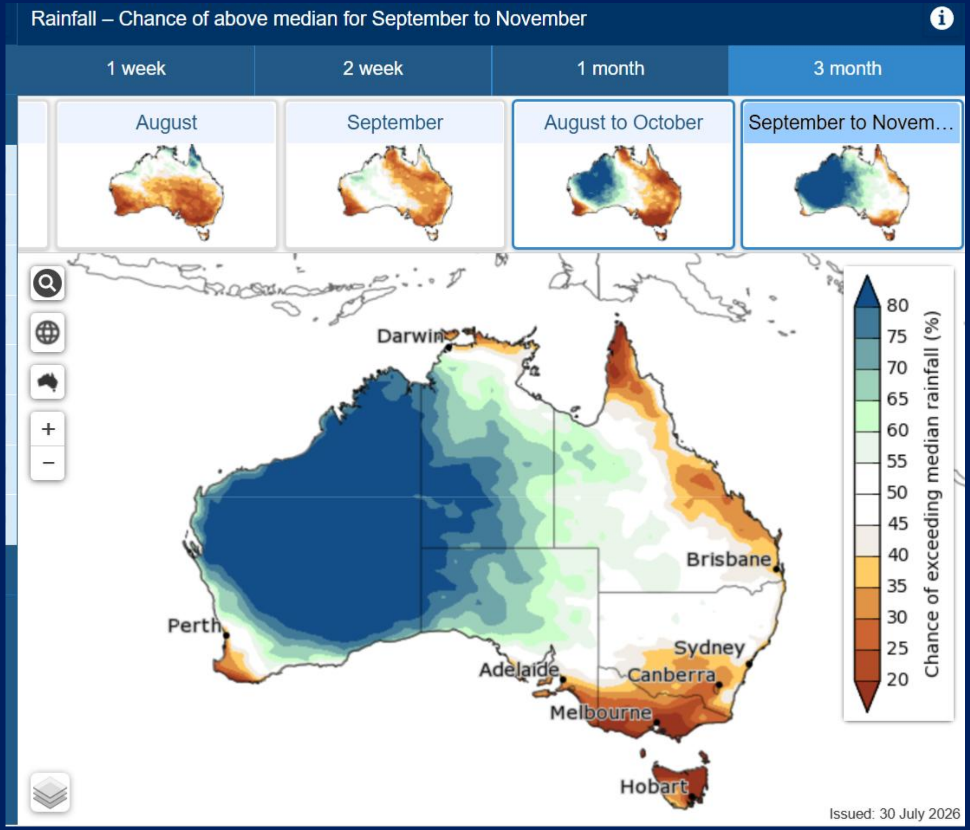


https://www.youtube.com/channel/UClDCIlI7gRZhUs03opGqH1g

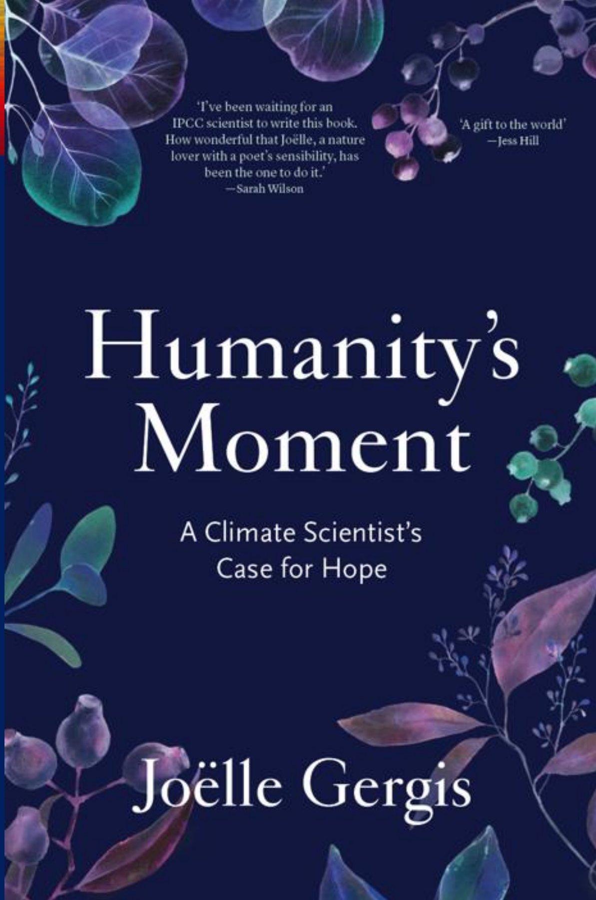
ENSO and long-range forecast - latest



Rainfall – Chance of above median August to October



Rainfall – Chance of above median September to November



The Saturday Paper

ENT

Nº 611 August 1 – 7, 2026

Joëlle Gergis

The threat El Niño poses to climate science

Hours into my research on the state of the climate, a siren on my phone jolts me out of my concentration. At first I don't know what's going on, then I recall it's just a test of AusAlert. Developed in response to the findings of the 2020 Royal Commission into National Natural Disaster Arrangements, this

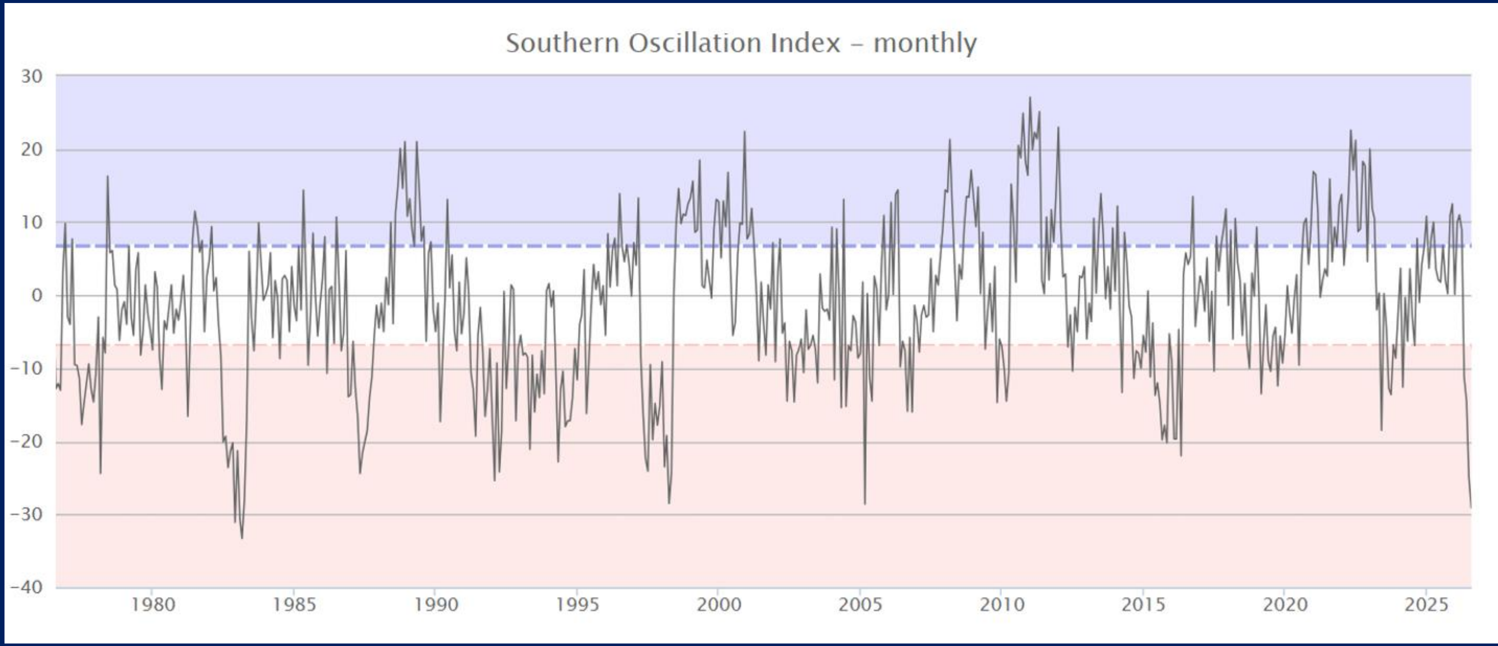
Joëlle Gergis is an award-winning climate scientist and author.

Importantly though, the science is nuanced. Journalistic hyperbole warning of a "super El Niño" doesn't help an already baffled public understand what's going on. When the media gets ahead of what the science says, scientists are the ones who cop the blame when the reality that plays out is more complex than simple headlines or sensationalist clickbait suggest.

When a headline promises a "super El Niño" and the season turns out to be bad rather than biblical, climate change deniers are ready to pounce, claiming scientists are crying wolf.

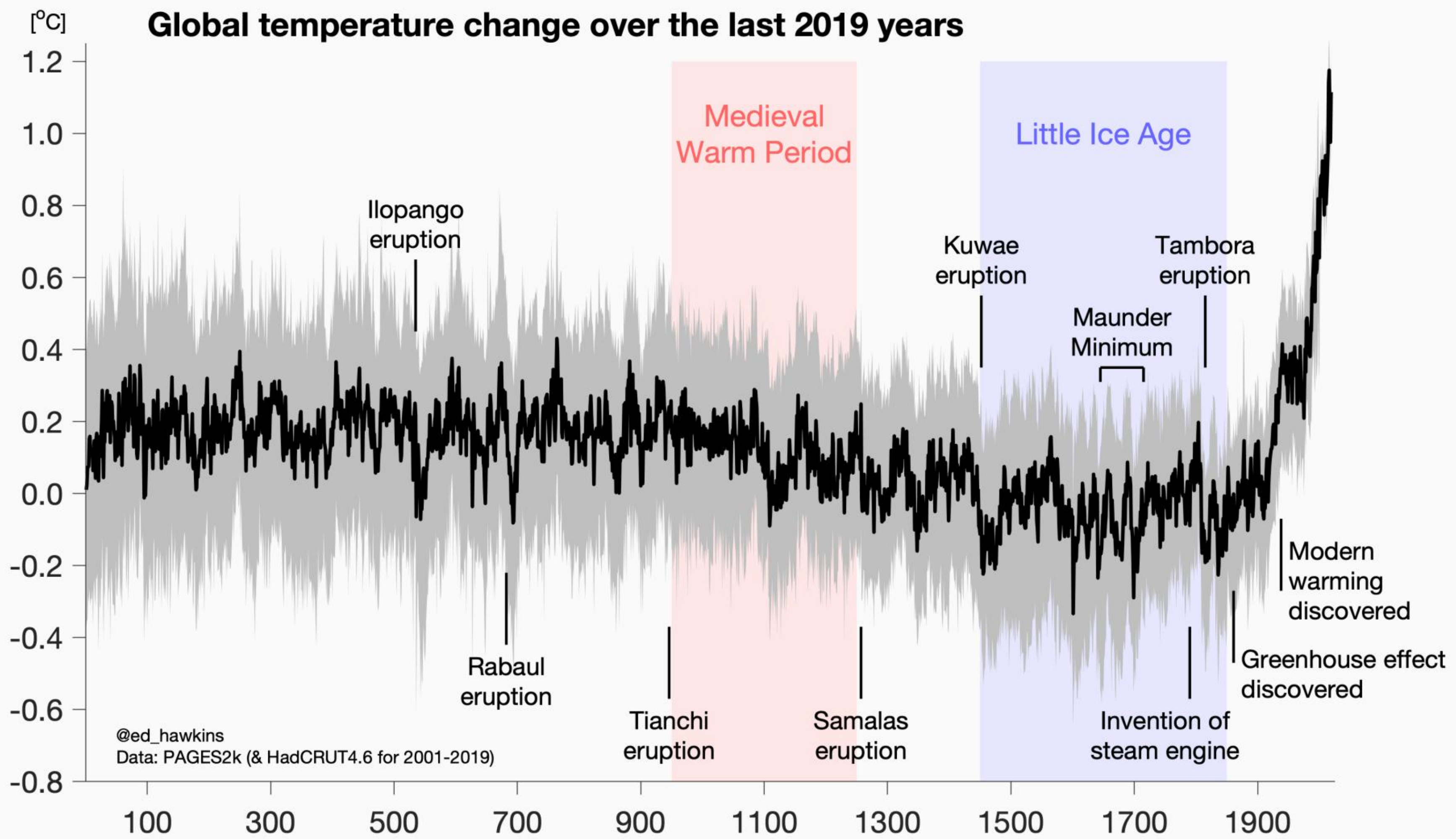
"The general perception that El Niño brings drought and La Niña brings flooding rain glosses over just how different each event can be. El Niño's influence is typically felt most strongly across eastern and Central Australia, while western Tasmania, the eastern seaboard and much of Western Australia are barely touched."

“Although history tells us El Niño events have had huge consequences for Australian society, the forecast strength of an event in the tropical Pacific isn’t always the best guide to the effects in our region. For example, the extreme El Niño of 1997-98 passed over Australia with near-normal rainfall, while the far more modest event of 2002-03 pushed two-thirds of eastern Australia into severe drought.



“While the last very strong El Niño in 2015-16 drove severe mass coral bleaching on the Great Barrier Reef, its impact on the mainland was subdued by a warmer than average Indian Ocean, sparing much of the country the worst of the forecast drought.

“Advances in the science now show it is the complex interactions of conditions in the Pacific, Indian and Southern oceans that collectively determine the severity of the impacts we experience.”



Reconstruction of **global temperature** going back to the year 1 CE thanks to the work of the PAGES2k team from a wide variety of proxy records such as tree rings, cave deposits, corals, etc.

https://web.archive.org/web/20200202220240/https://www.climate-lab-book.ac.uk/2020/2019-years/

Medieval Warm Period (950 – 1250 CE)
(Medieval Climate Anomaly)

- Most consistent signal in North Atlantic and Europe
  - Summers generally warm, crops good and few serious famines
  - Vineyards in England as far north as York (54^0N)
  - area under agriculture expanded, landowners prospered, including to higher altitudes.

- Sea-ice retreated
  - Vikings travelled further north and west
  - settlements in southern Greenland and Iceland, and North America

- Consequence: Money for Crusades and cathedrals!

- Causes:
  - Few significant volcanic eruptions
  - North Atlantic Ocean circulation.

- **Note:**
  - the warming seems to have been confined to the North Atlantic
  - Global average cooled, rather than warmed.

Little Ice Age (LIA)

- Not universally cold but over the period much of the world was cooler.

    - variations across the world
    - not a single uninterrupted cold period; there were warmer intervals.

- Two stages:
    - Early LIA: 1250-1550
    - Main LIA: 1550 – 1850 with peak cooling 1700 – 1800.

- A slight perturbation within the current Interglacial period, but significant societal impacts – due to changes in precipitation and frequency of storms rather than merely temperature.

- Coldest temperatures: (Summerhayes p. 454)
    - 15th century: Central and Eastern Pacific Ocean
    - 17th century: NW Europe and SE North America
    - Mid-19th century: diverse regions.

- Over Europe winters seem to have been affected more than summer.
    - Thames froze 4 times in 1500s, 8 times 1600s, 6 times in 1700s. (*Frost fairs*)

- Sea ice returned to Greenland, settlements abandoned, ice sheets expanded.
- Coastal areas in Germany, Denmark and the Netherlands lost to agriculture due to storms.
- Glaciers in the Alps advanced.
- Cod as a proxy indicator? (*Frozen Earth.* D. McDougall. pp. 222-3)
- Swings in climate:
  - Central England had one of its coldest winters in 1683-4 and one of its warmest in 1685-6.
- Impact on society? How much can be attributed to the climate?
  - Perhaps there had been a population increase during the MWP, leading to pressures as the climate changed – famine, unrest and disease (e.g. Black Death) and plant disease in cold , wet periods.
  - Did it contribute to the end of feudal system in parts of England and Europe in the 14^{th} century?
  - Innovations?
    - dykes and land reclamation in Holland
    - Glass for windows?
    - More specialized crops – growing food for cities.

Causes?

Volcanoes:

- More active during the time of the Little Ice Age with some big eruptions:
  - Samalas (Lombok, Indonesia) 1257
  - Kuwae (Vanuatu) 1458
  - Tambora (Sumbawa, Indonesia) 1815 leading to “the year without summer” in 1816
- On the other hand, effects of volcanoes are generally short-lived.

Solar input associated with the Croll-Milankovich cycle:

- Accounts for the slow decrease of global temperature over the past 10,000 years but its time-scale is too long for the MWP and LIA.

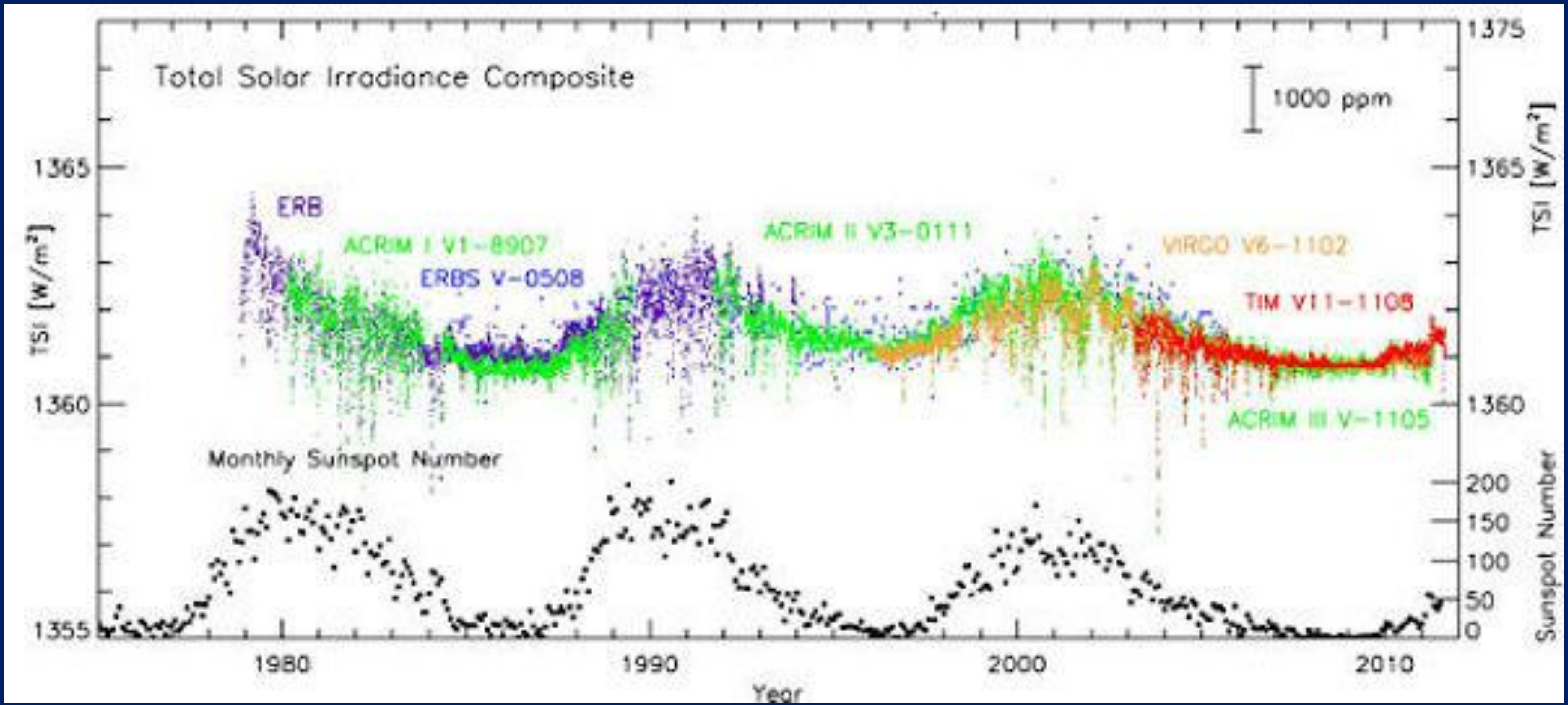
Solar activity:

- Sunspots are linked to solar activity
- Small effect on energy from the sun (0.1%) but significant on magnetic field
- Maunder Minimum of sunspots (1650 – 1800 CE)
- Questions on how this affects climate; the 11-year cycle does not appear to.

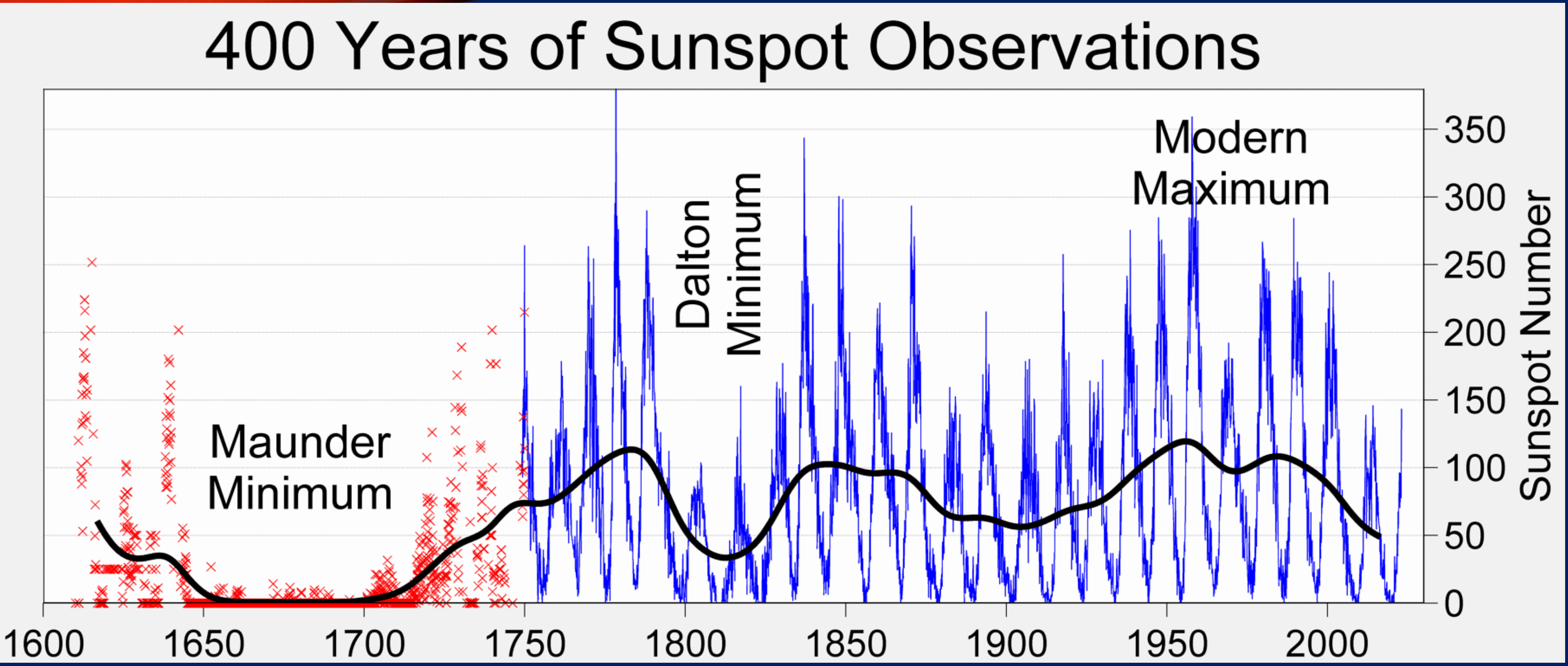
Changes in the oceans:

- changes in the average phase of the North Atlantic Oscillation (NAO) – related to position of high- and low-pressure systems.

How can the energy from the sun before the satellite era be determined?

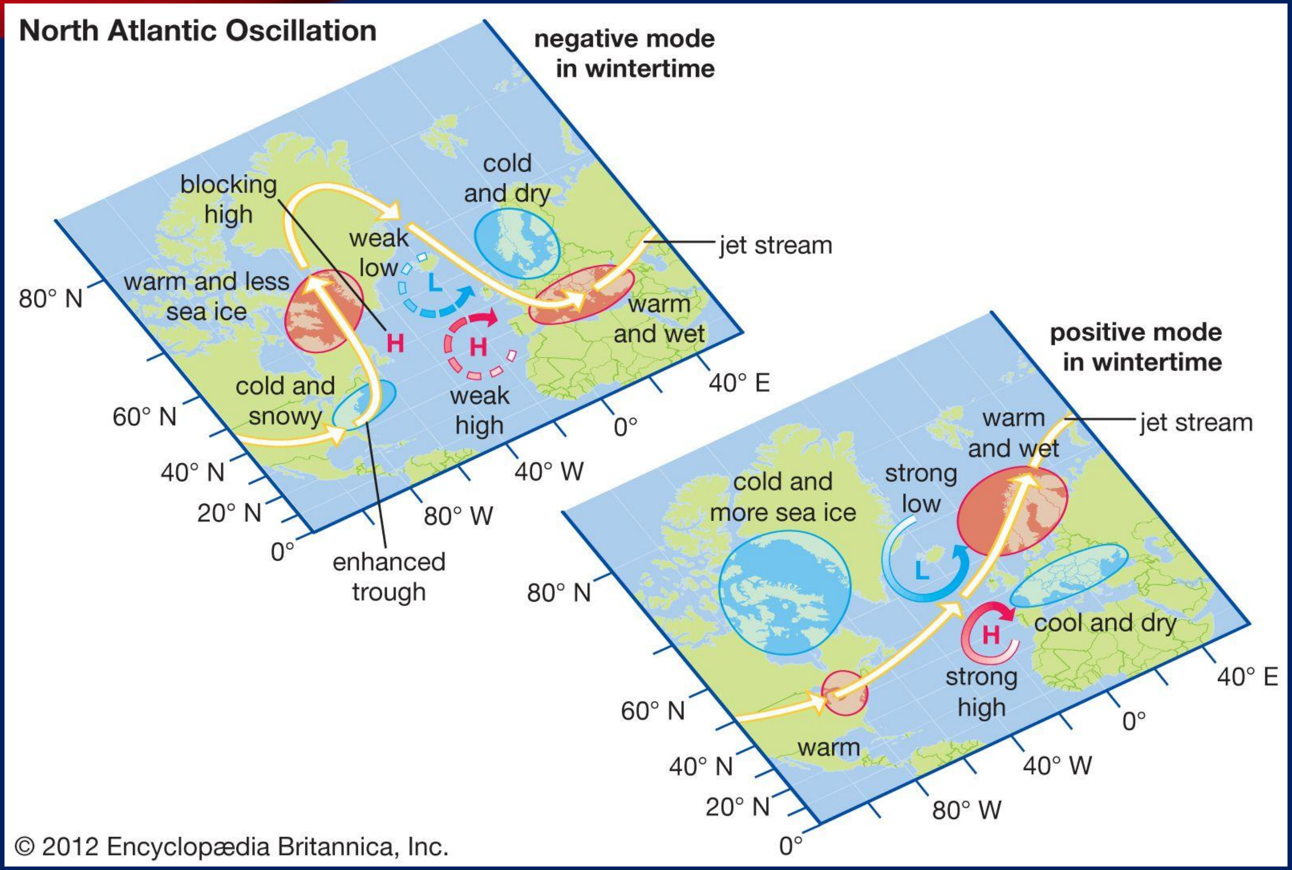


Satellite Measurements of solar energy compared with sunspot numbers.
Sunspot numbers are correlated with the variations in the total energy coming in from the sun. Chinese astronomers began regular records of sunspot numbers in 28 BCE. Observations through telescopes go back to 1601 with monthly averages starting in 1749. Sunspot numbers can be used as a **proxy** measurement to extend the record of the incoming solar energy further back in time.



The big spikes are the 11-year cycle.

North Atlantic Oscillation (NAO)



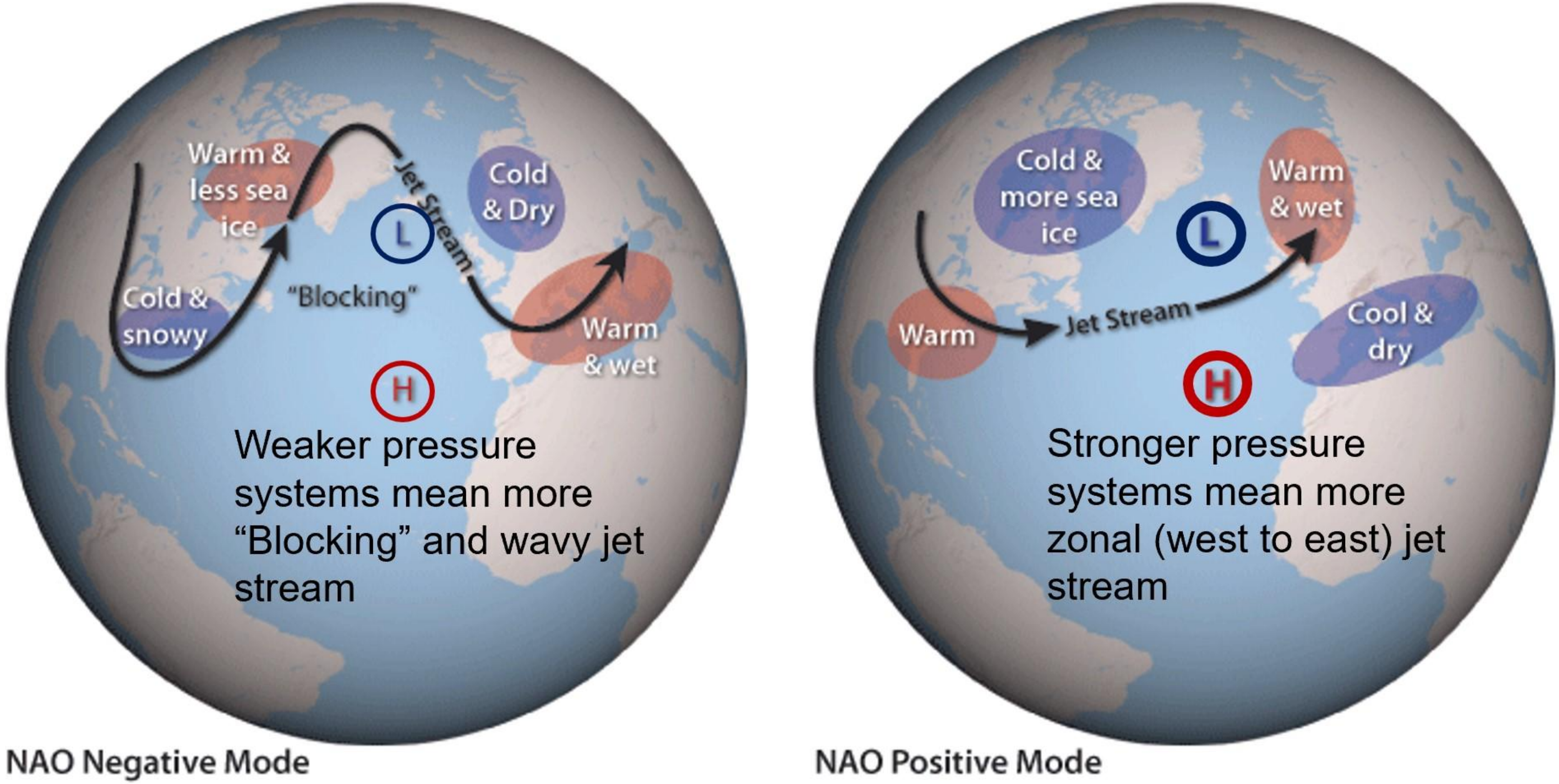
Two common synoptic features are the Azores High and the Icelandic Low.

The NAO measures the pressure difference between these two areas.

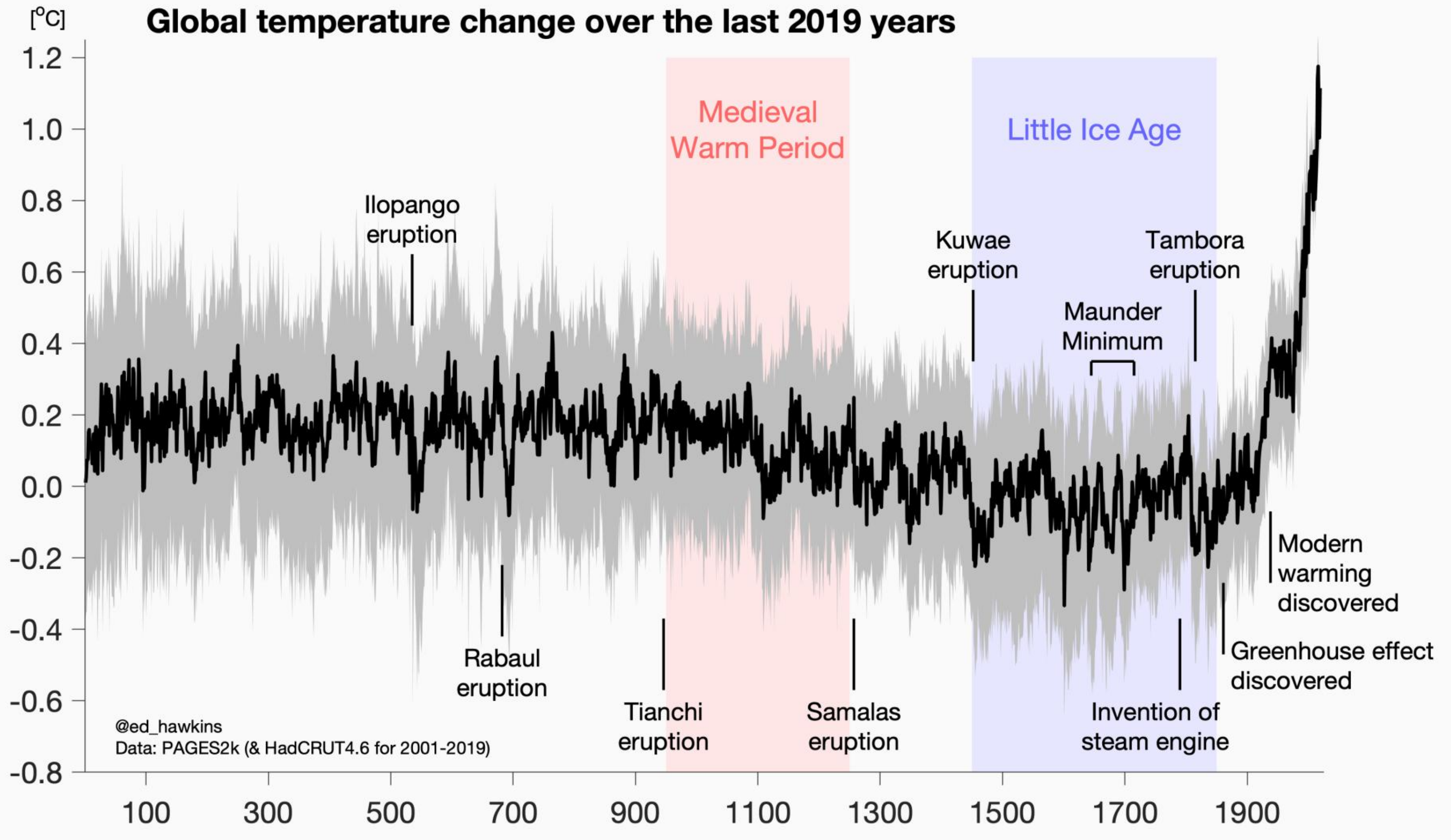
Positive mode: increased westerlies and, consequently, cool summers, mild and wet winters in northern Europe and UK.

Negative mode: westerlies are suppressed, more extreme temperatures in northern Europe - cold dry winters and heat waves in summer.

Storms track southwards to southern Europe and northern Africa – higher rainfall.

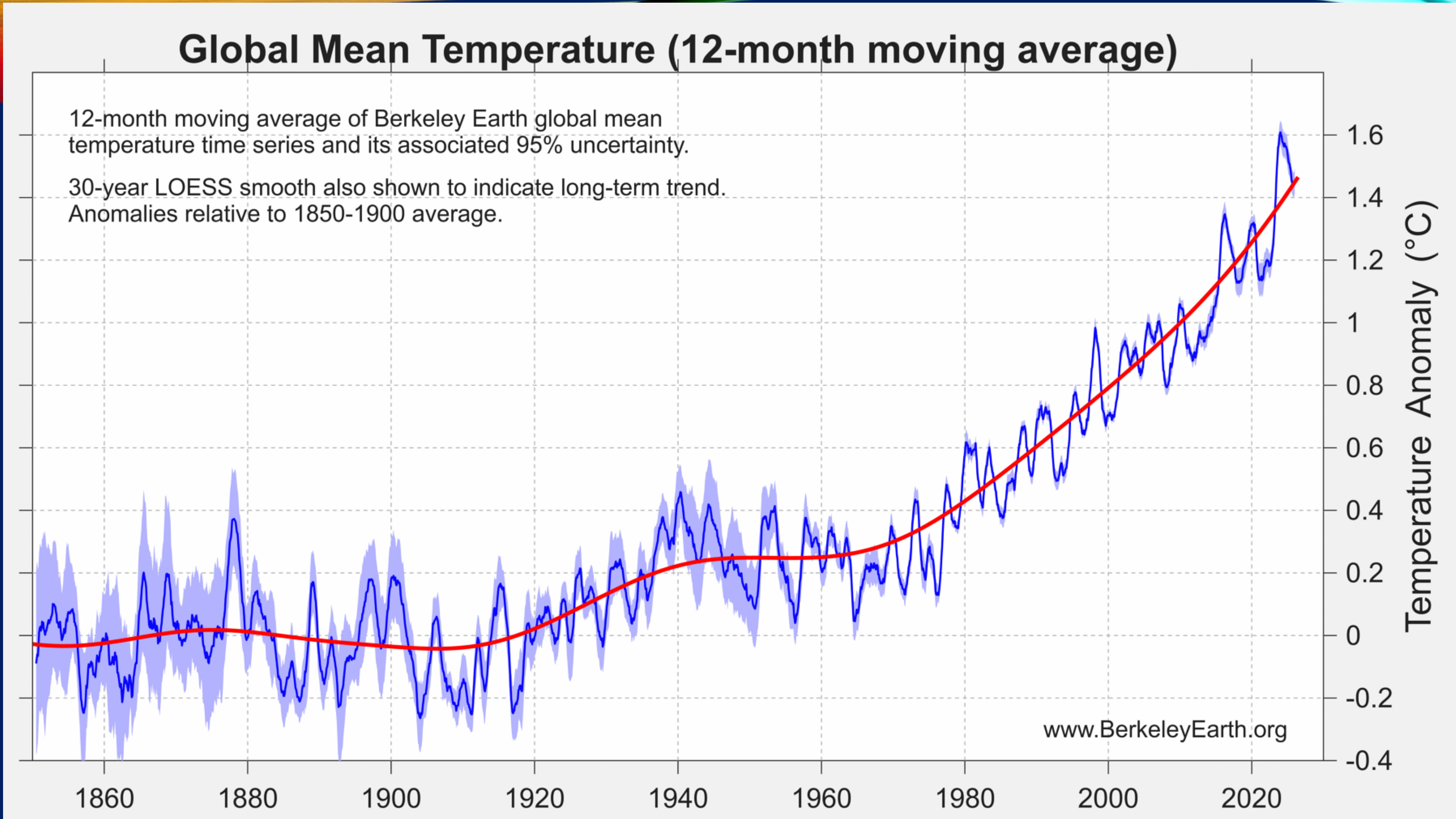


Met Office video: https://www.youtube.com/watch?v=KOYJG7j4Iy8



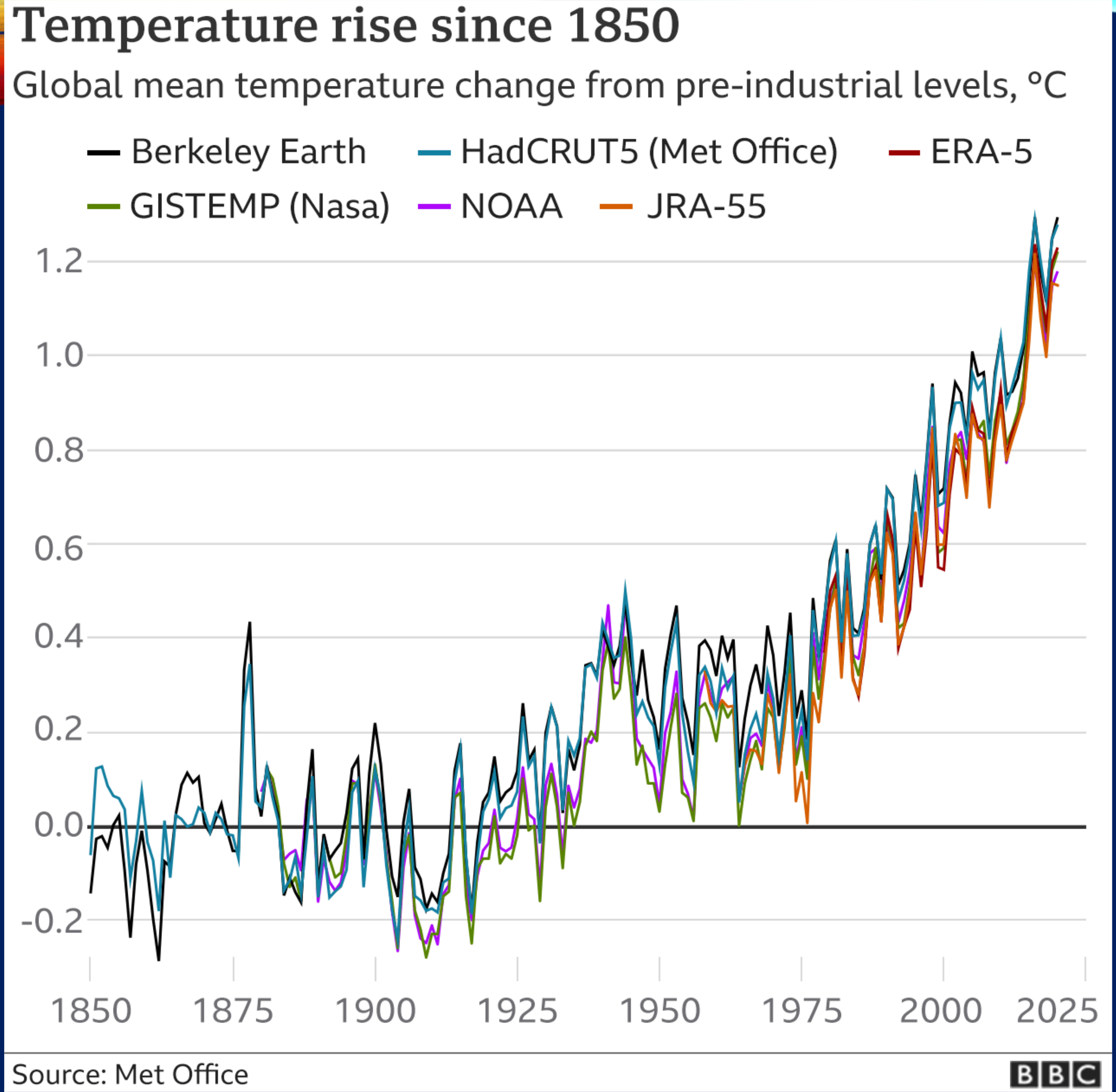
Reconstruction of **global temperature** going back to the year 1 CE thanks to the work of the PAGES2k team from a wide variety of proxy records such as tree rings, cave deposits, corals, etc.

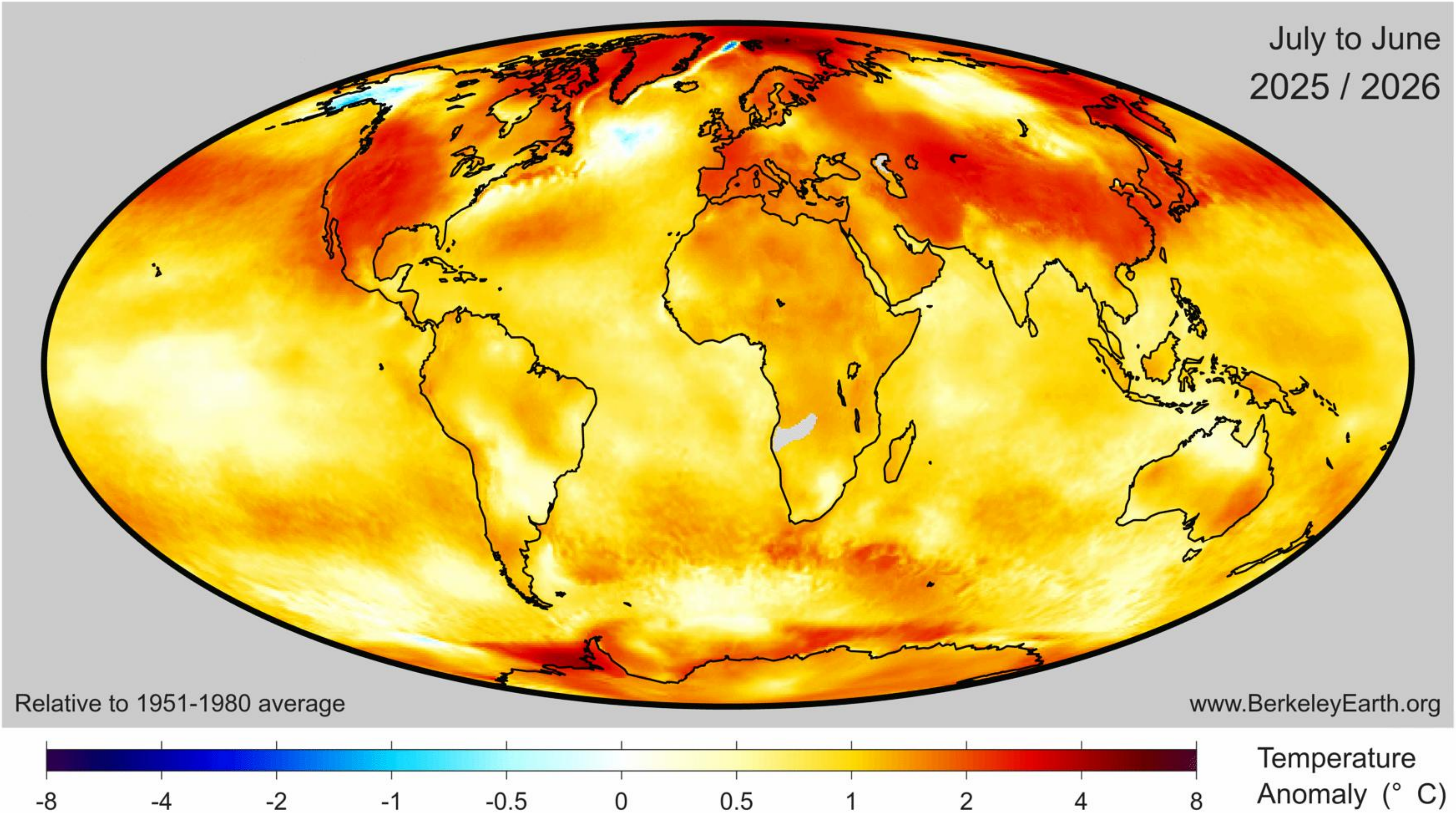
https://web.archive.org/web/20200202220240/https://www.climate-lab-book.ac.uk/2020/2019-years/



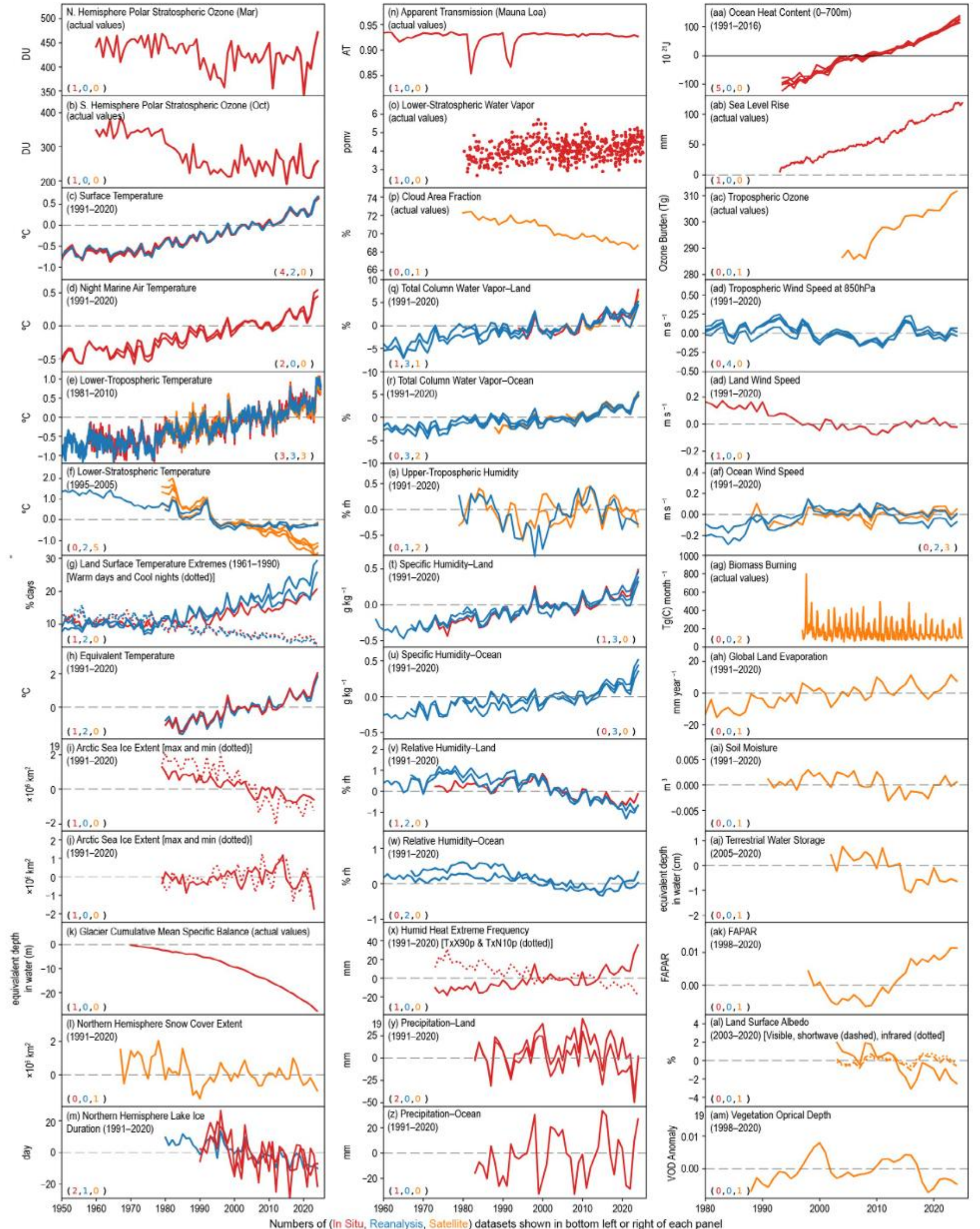
https://berkeleyearth.org/june-2026-temperature-update/

Why the concentration on temperature?
Other variables? – next term when the latest AMS State of Climate published.


Temperature rise since 1850
Global mean temperature change from pre-industrial levels, °C
Berkeley Earth
HadCRUT5 (Met Office)
ERA-5
GISTEMP (Nasa)
NOAA
JRA-55
1.2
1.0
0.8
0.6
0.4
0.2
0.0
-0.2
1850
1875
1900
1925
1950
1975
2000
2025
Source: Met Office



The 12-month anomaly map continues to show the strongest warmth across the Arctic and the northern high latitudes of Canada, Russia, and Siberia, with no regions of significant relative cooling.

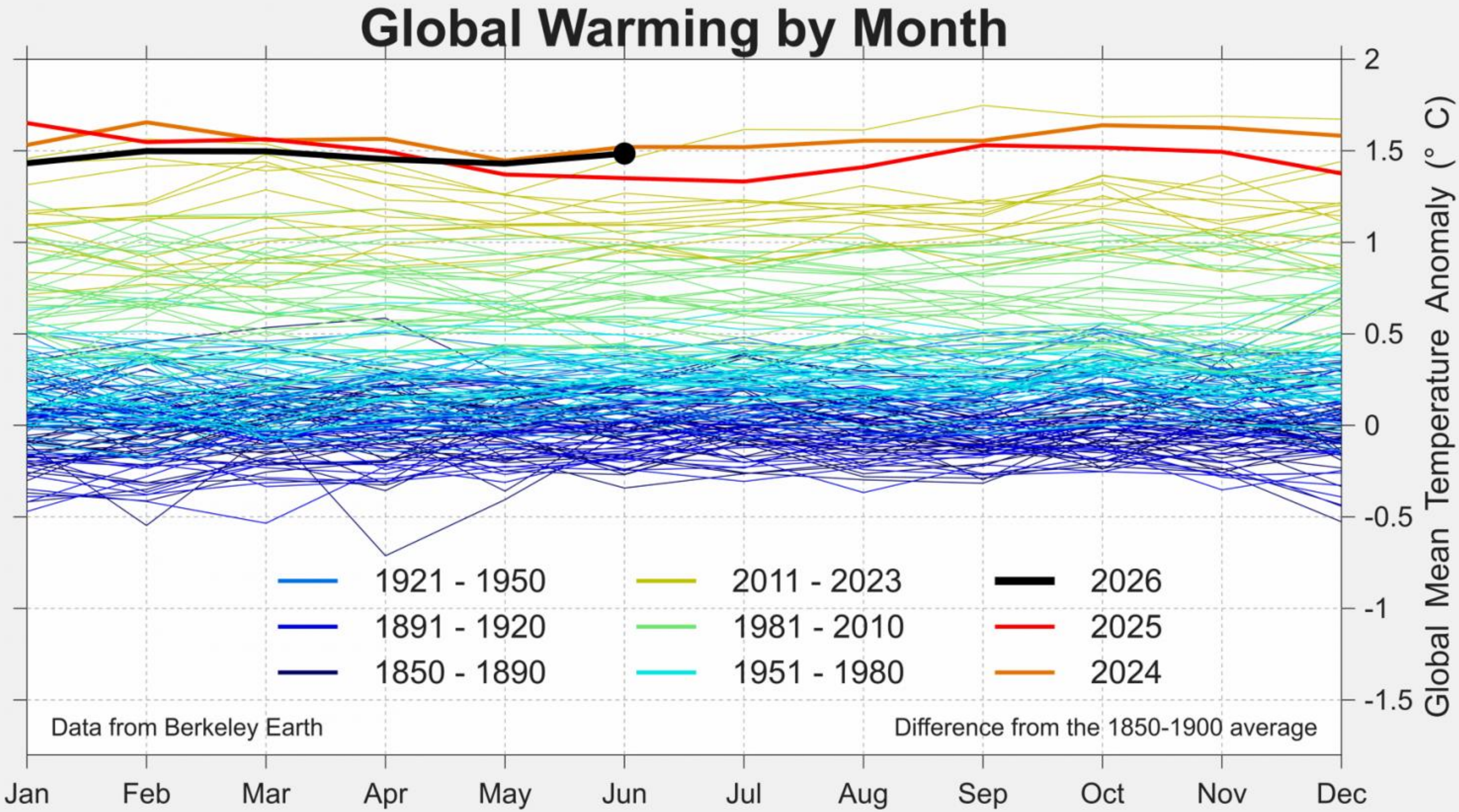


Global (or representative) average time series for essential climate variables through 2024.

STATE OF THE CLIMATE IN 2024

Table of Contents

513 pages



Global temperature anomaly by calendar month for every year since 1850.