



Australian
National
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Changing nature of frost risk – a climate surprise?



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What is a Climate Surprise?

Abrupt and/or steady changes in climate that can trigger abrupt changes in other physical, biological, and human systems.

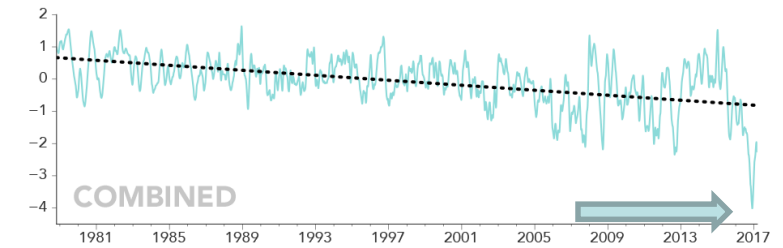
These climate "surprises," can include things like:

- Unprecedented rate of sea-ice decline
- Possible high-latitude Methane and Carbon Cycle feedbacks ("runaway CC")

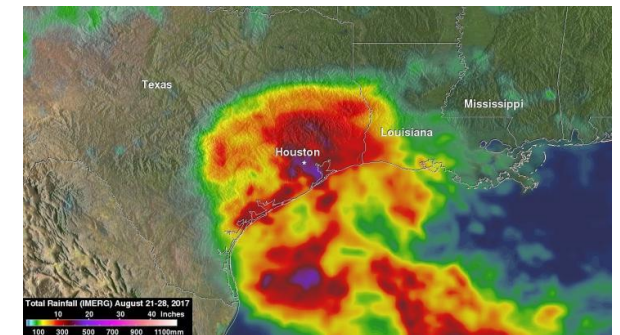
But can also includes:

- Large increases in rainfall intensity from extreme events e.g. Harvey 1-in-1,000 year event (peak of 96mm/hr).
- Three Category 4 cyclones in the Pacific at one time.
- Unprecedented cold temperature extremes along the North American east coast.

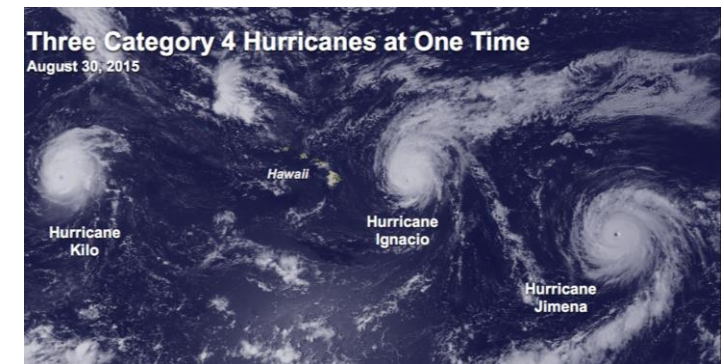
Deviation in Sea Ice Extent (x 1 million km²)



Source: NASA (Satellite data only)

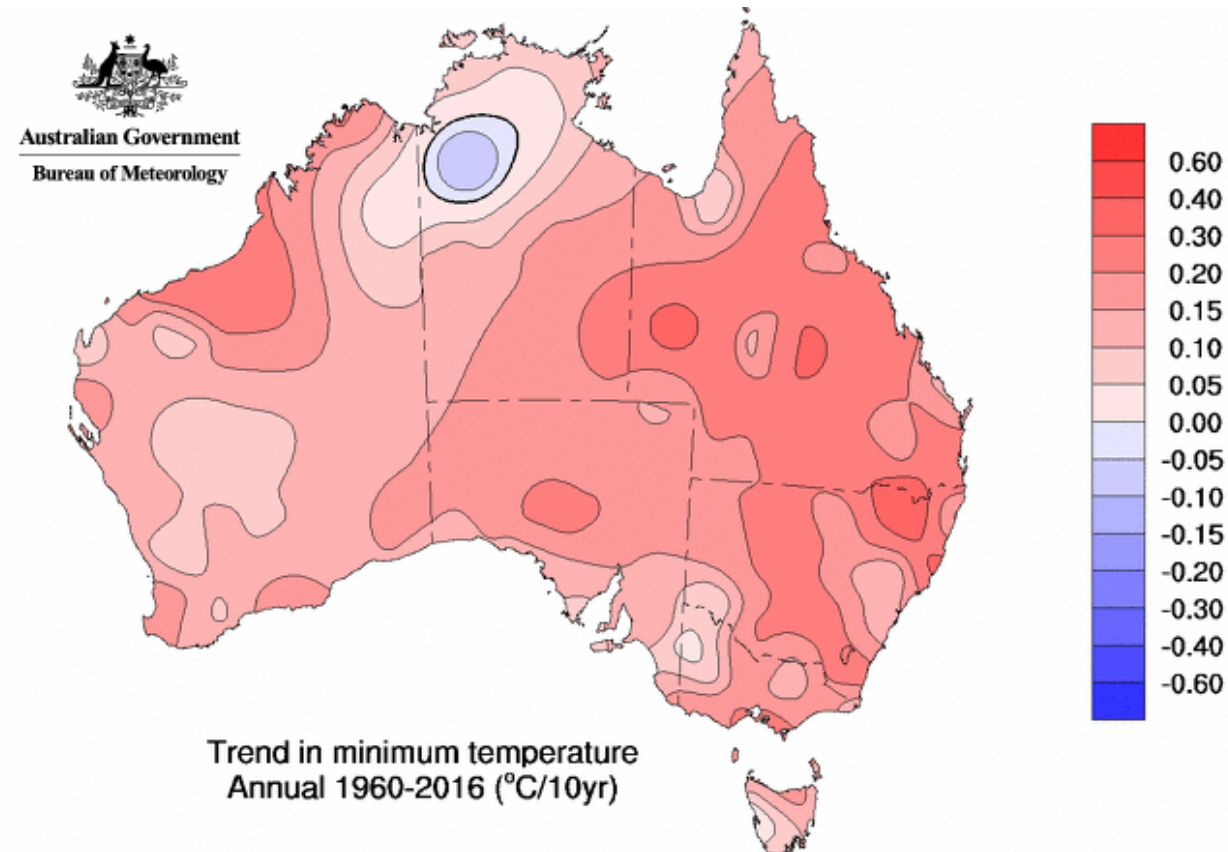


Source: NASA



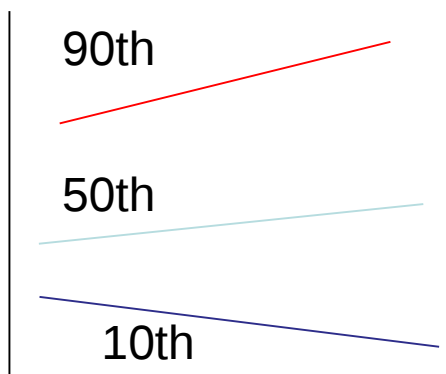
Source: NOAA

Minimum temperatures are warming

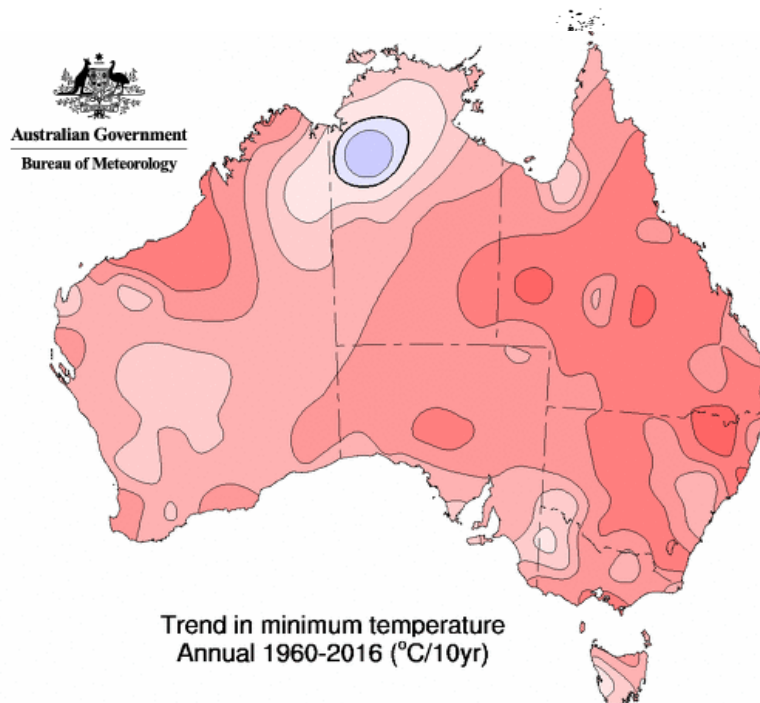
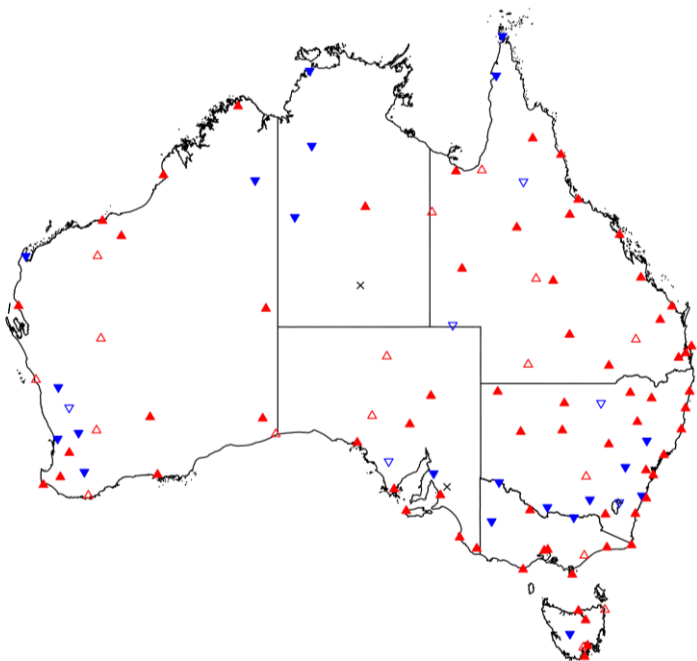


- Mean minimum temperature trends appear to show a consistent warming trend across Australia, except in the northern parts of NT.
- Mean warming of approximately 1.1°C since 1910.
- More complex regional trends.

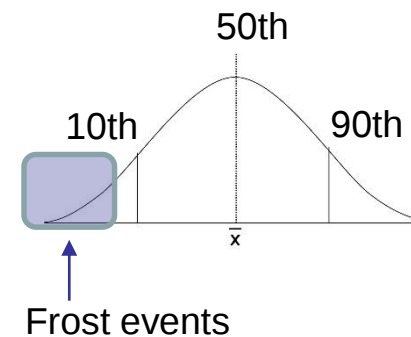
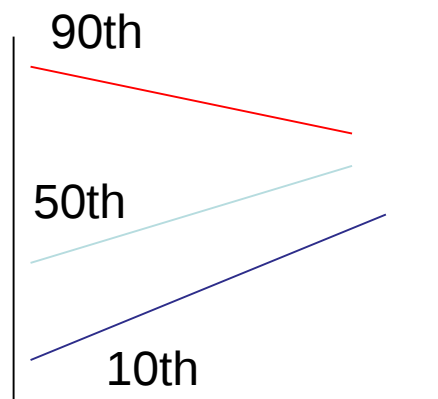
More complex spatial trends



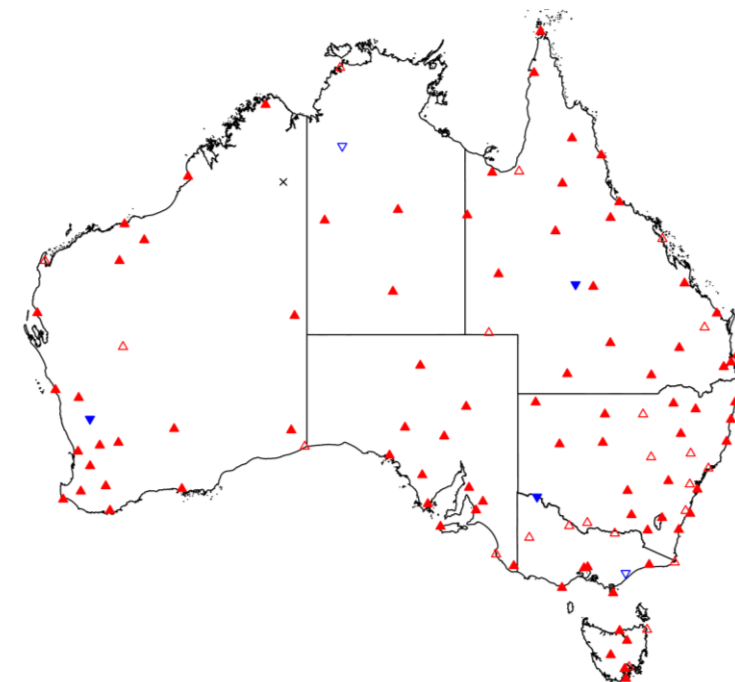
10th % Min T trends



Trend in minimum temperature
Annual 1960-2016 (°C/10yr)

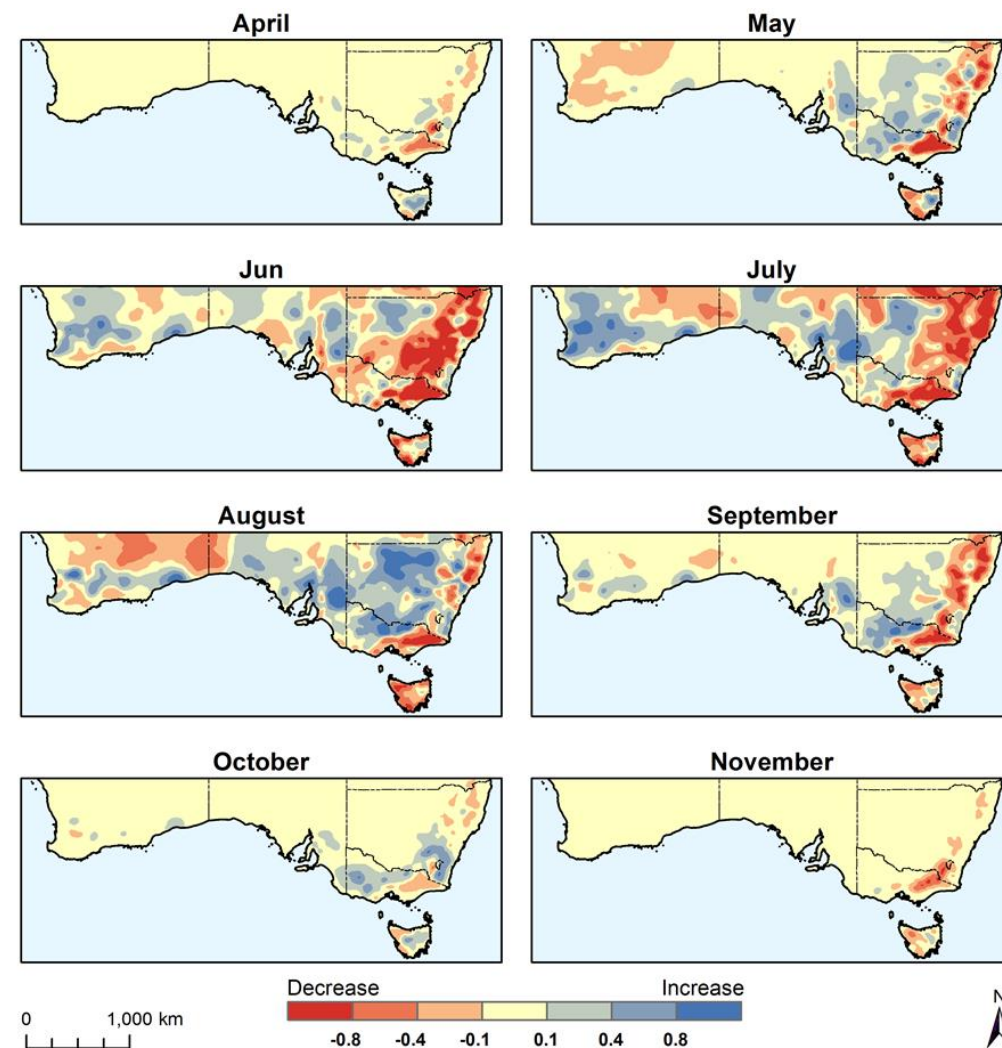


90th % Min T trends



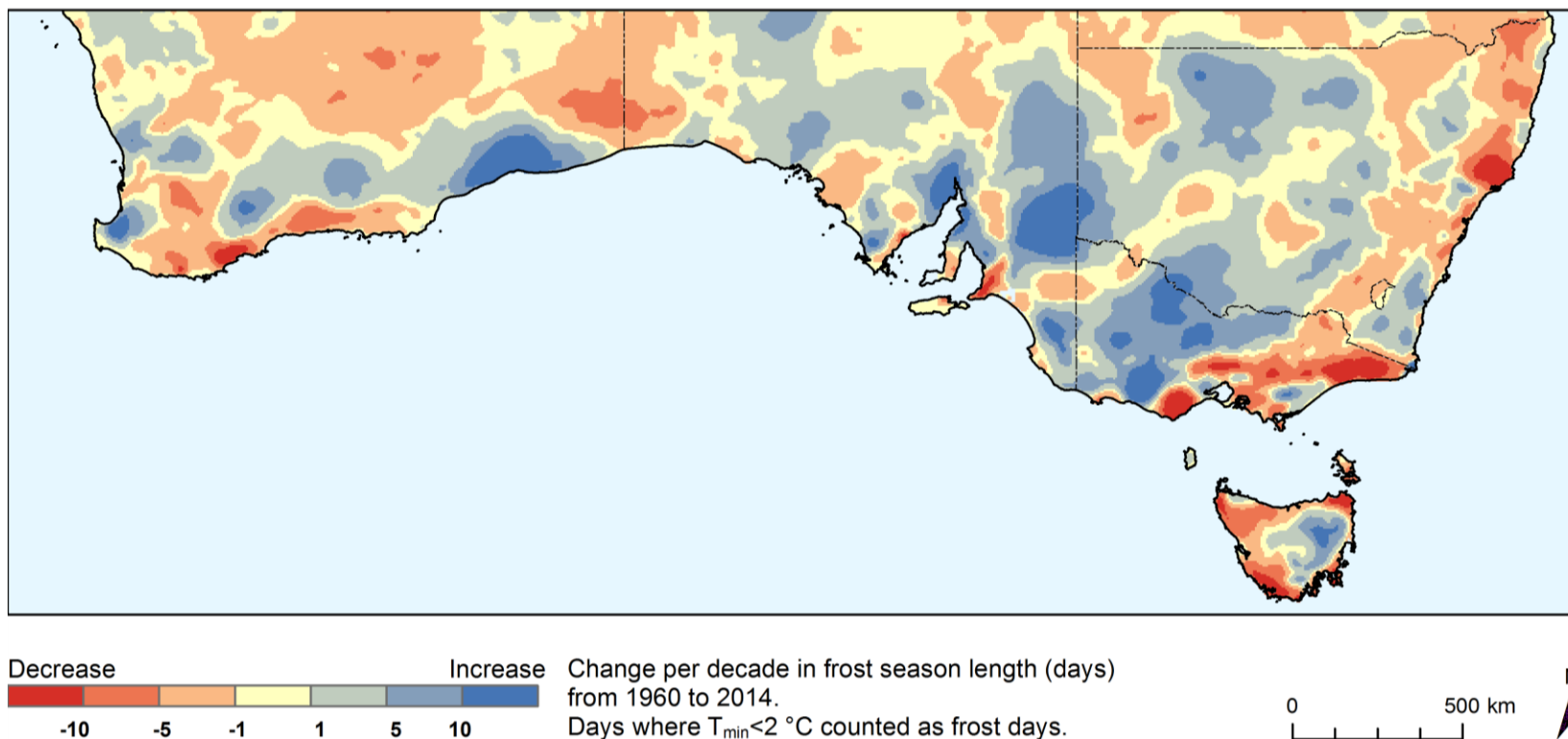
Some increases in frost frequency

- Regional increases in the number of frost days most apparent in August (up to 5 more events on average).
- Some regional increases in September and October (Late frosts).



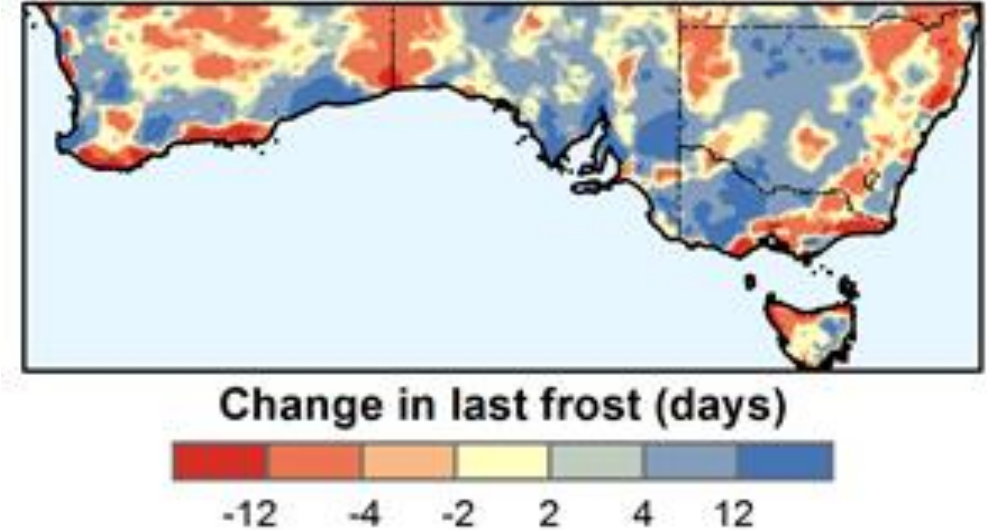
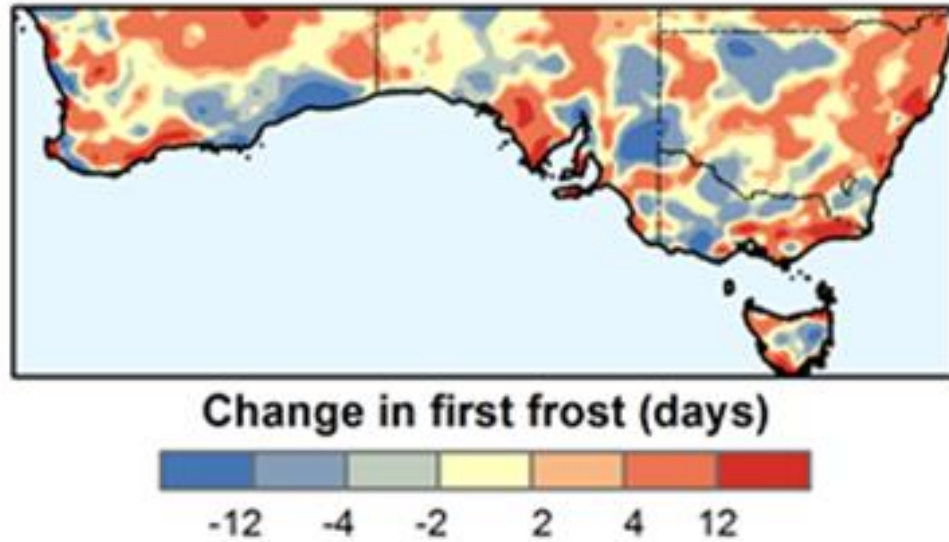
Trend in the number of frost days per decade, April to November 1960 to 2014. Days where $T_{\min} < 2^{\circ}\text{C}$ counted as frost days.

The “Frost Window” now broader



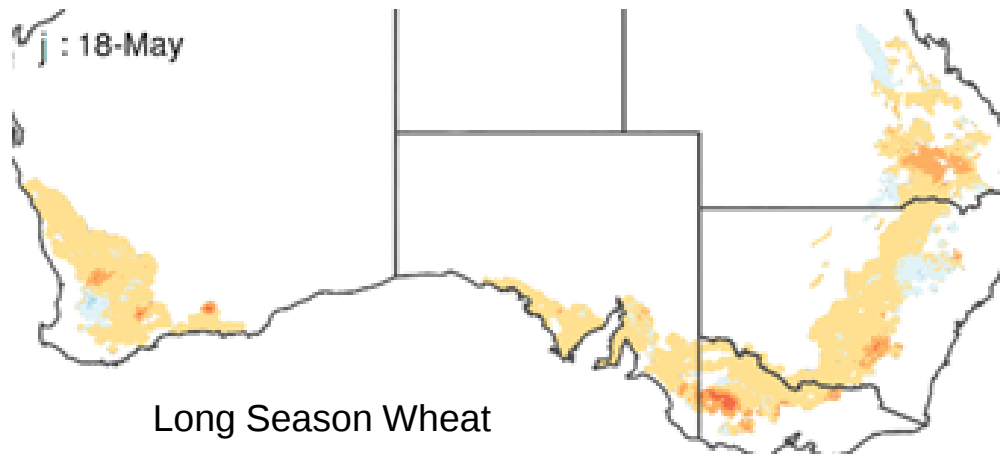
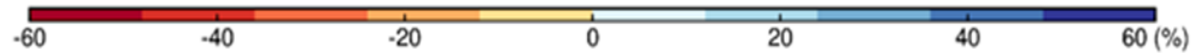
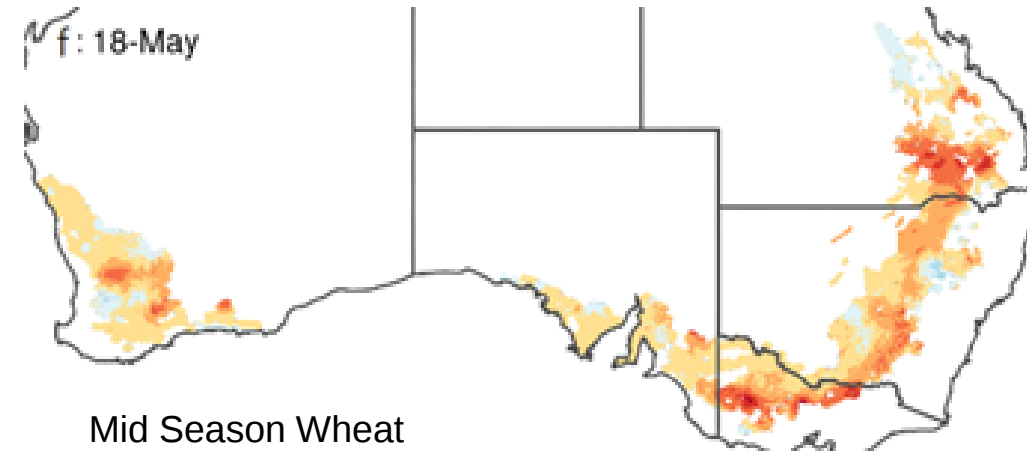
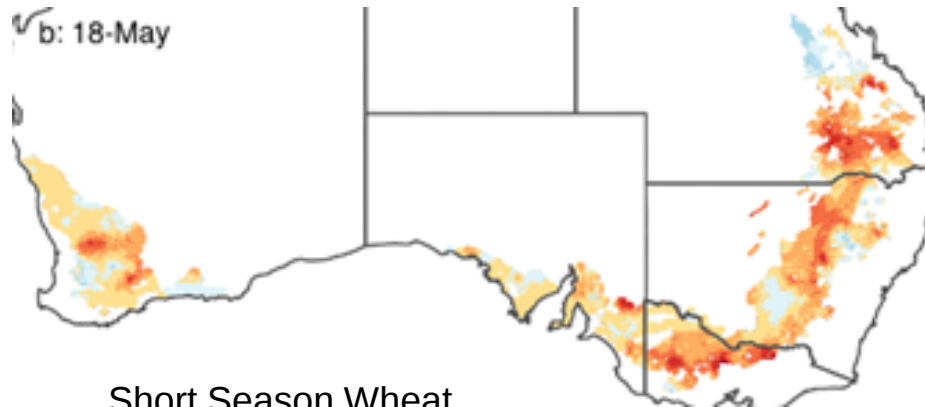
- A broadening of the frost window by up to four weeks in some locations.
- Driven by both earlier and later occurrence of events.

Later frost events more common



- The broadening of the frost widow driven more strongly by the extension of the period of the last frost.
- In 2017 frosts on 4 November resulted in damage to vineyards and cereal crops in Victoria and South Australia.
- In 2017 Canberra experienced 109 nights below 2°C (16 more than average), with -8.7°C recorded on 1 July (coldest temperature in almost 50 years).

Implications for wheat production



- Using the APSIM crop model we were able to estimate the potential production losses related to this change in frost risk.
- The simulations show increased losses of as much as 40% for short season varieties, 23% for mid season and 8% for long season varieties.

Frost will remain a production risk



- Regional analysis (75 sites and 10 GCMs) show that despite continued anthropogenic warming, frost frequencies over the August to November period will remain comparable to current levels until the early 2030s.
- The ongoing warming versus regionalised increases in frost frequency and more extensive broadening of the frost window, represents a climate surprise.

Whether this is:

- a Known Known
- a Known Unknown
- or an Unknown Unknown

I'll leave that up to you!!!

Source: https://www.brainyquote.com/quotes/donald_rumsfeld_148142



Source: AppleWhite AP



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Thank you

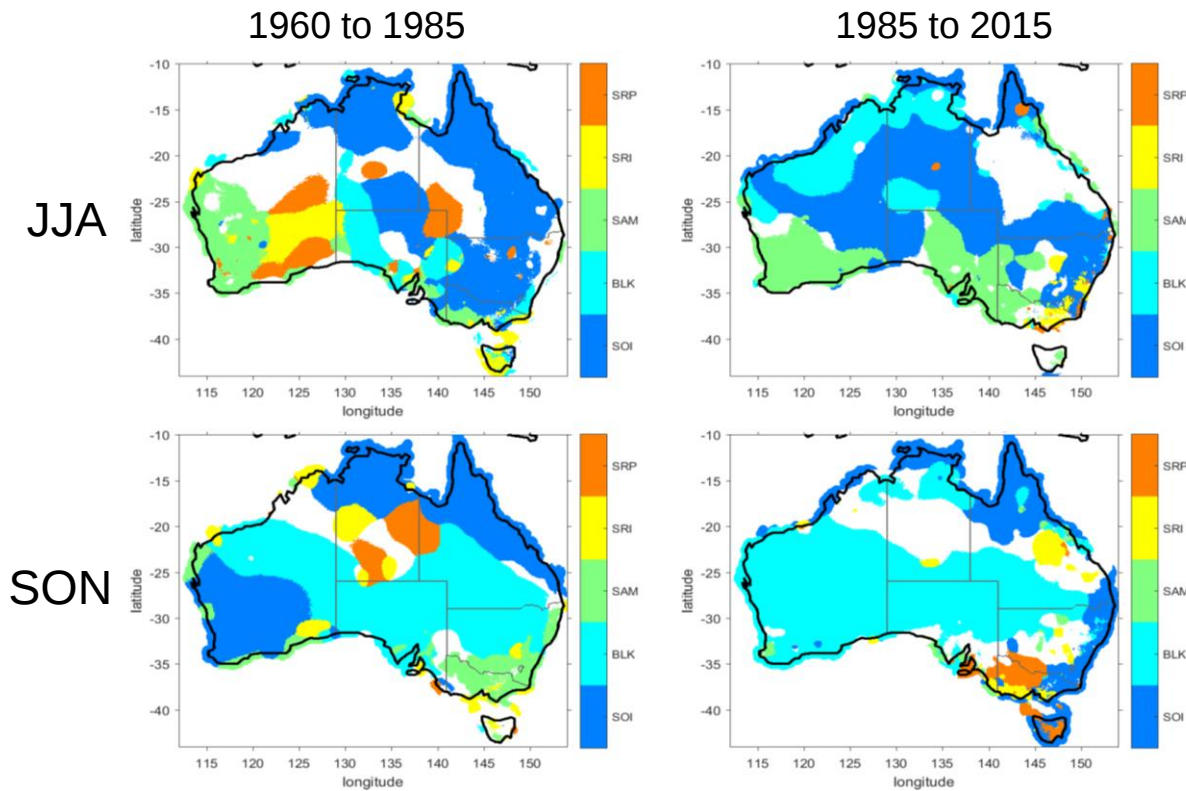
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Dominant Synoptic drivers changing



- ENSO less important as a driver of minimum temperature variability.
- The sub-tropical ridge (position and Intensity) growing in importance particularly in SON.