Long Lead Prediction of the 2019 Climate Extremes

Harry Hendon and Eun-pa Lim
BoM

Focus on the climate extremes during austral spring/early summer 2019:

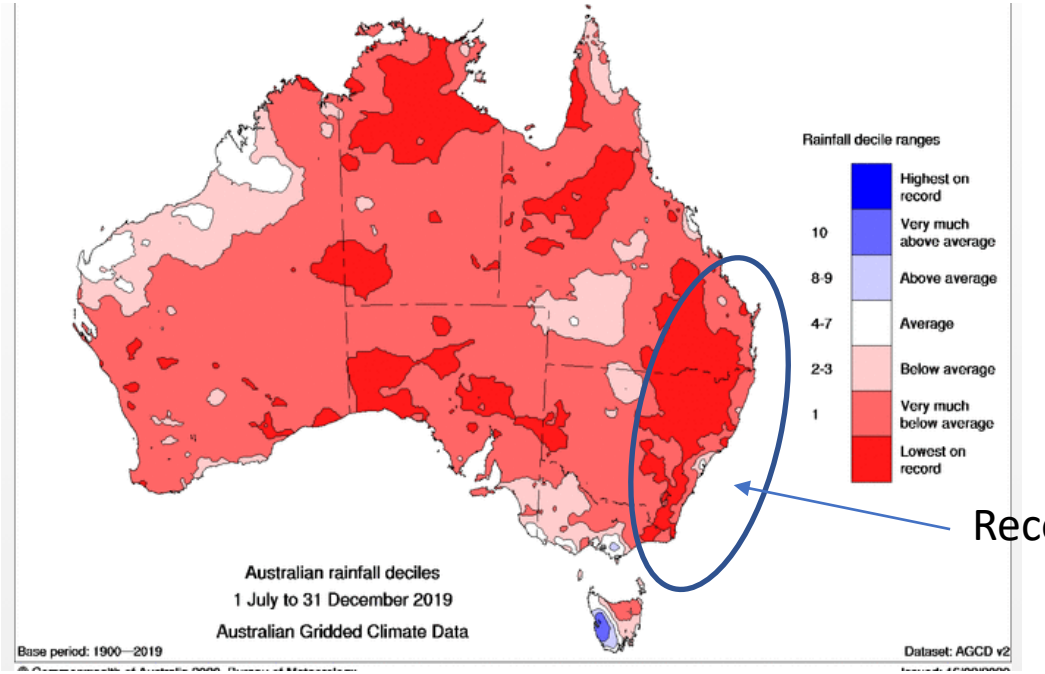
Manifestation of these climate extremes was the fires in NSW

Out of control fires in hot-dry-westerly conditions

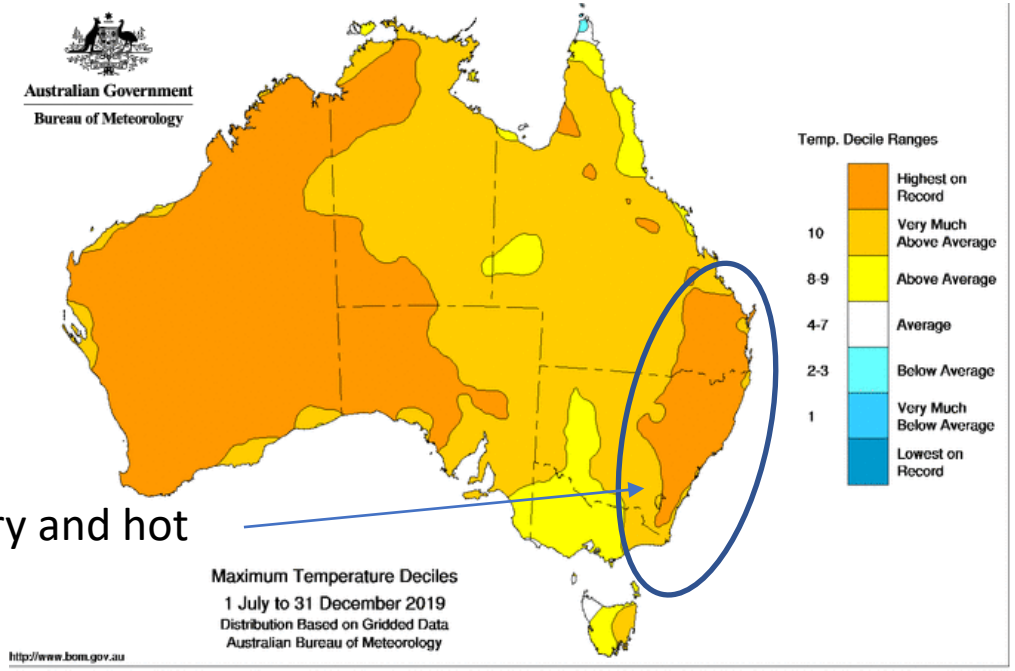
8 Nov 2019

July-December 2019 deciles

Rainfall



Max Temp

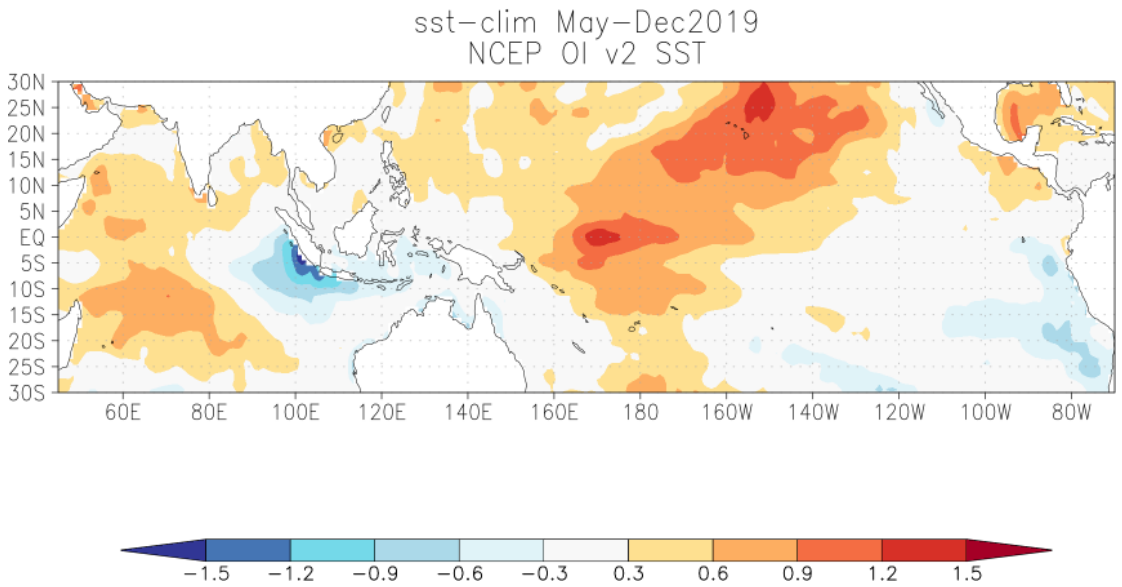


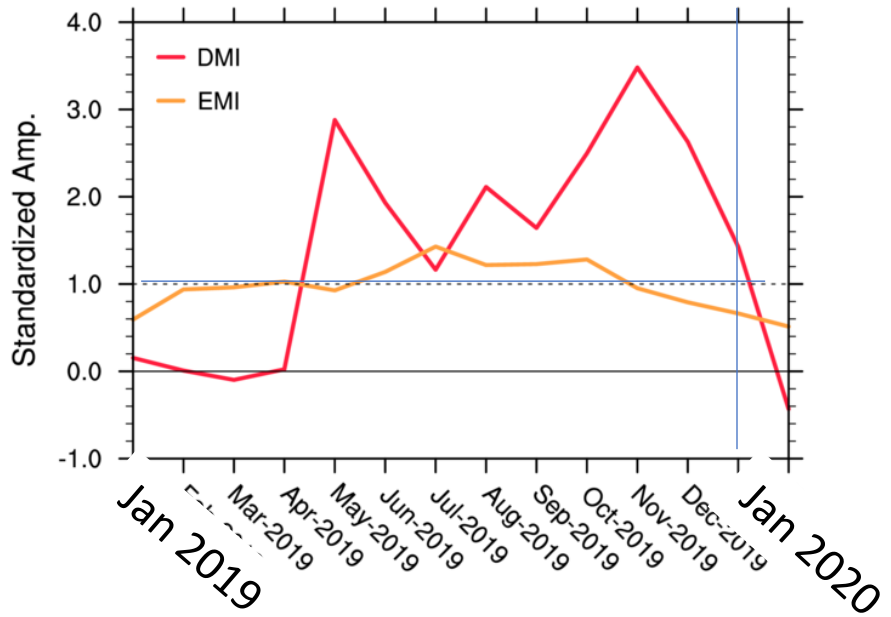
Record dry and hot

What was the cause(s)? How predictable were they?

Indian Ocean Dipole and El Nino Modoki

SST May-Dec 2019



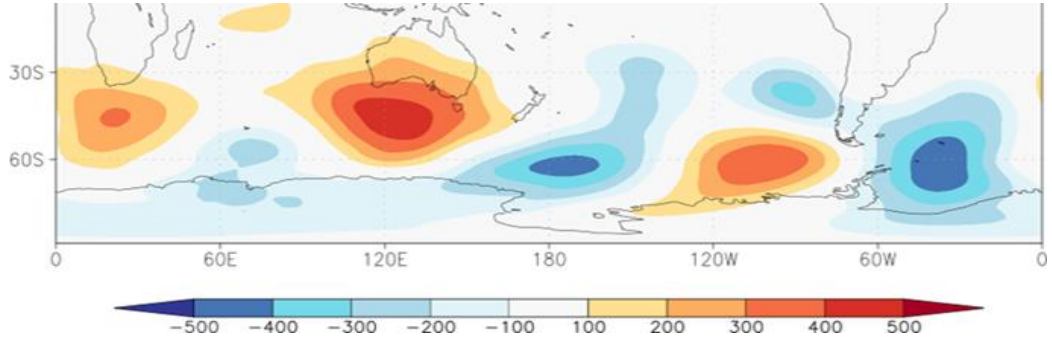


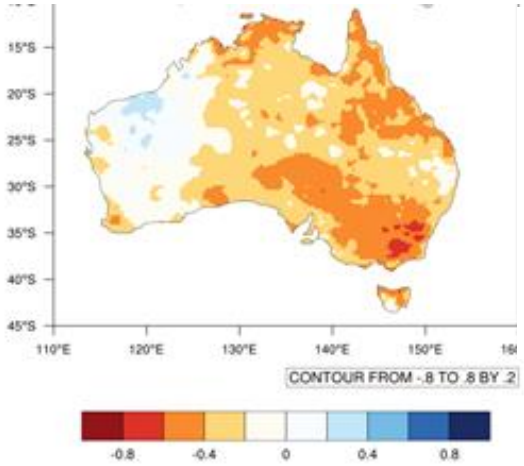
Record strong positive IOD developed in May 2019 and unusually lingered thru January 2020

Central Pacific (Modoki) El Nino persisting since 2018

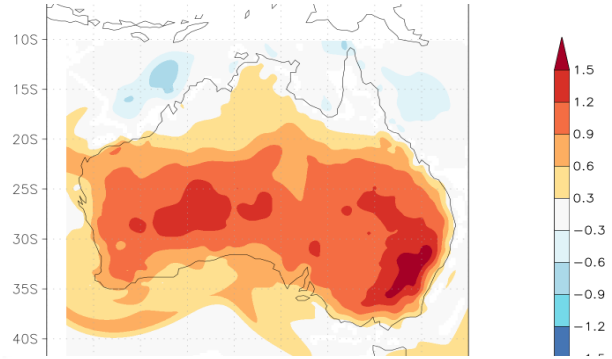
What do we expect from an IOD?

Regression onto DMI 1979-2018 SON





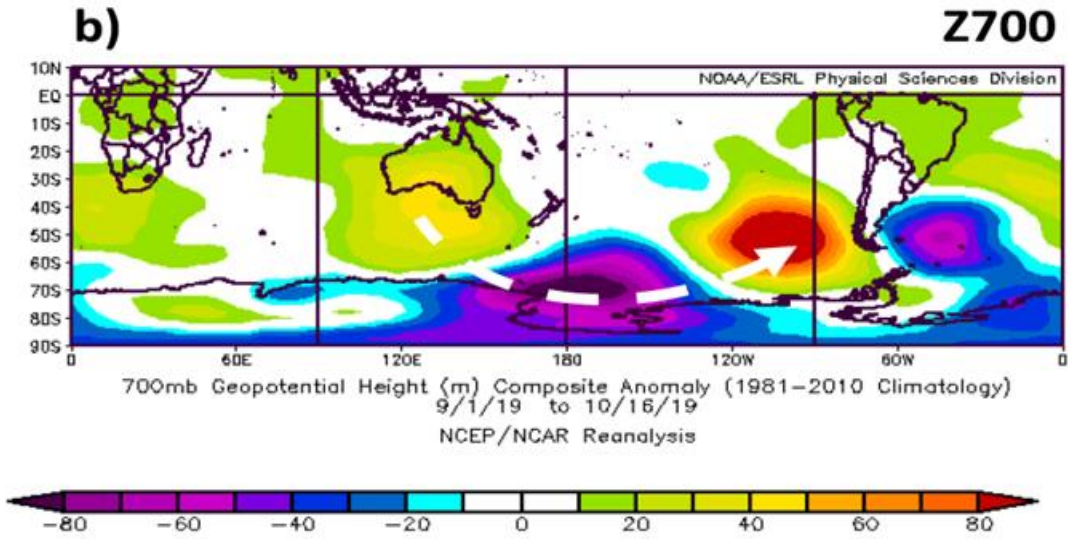
Rainfall anomaly

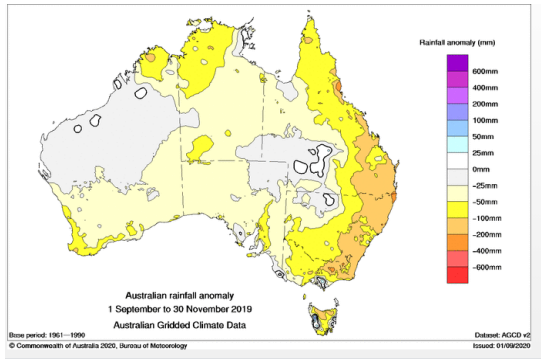


Tmax anomaly

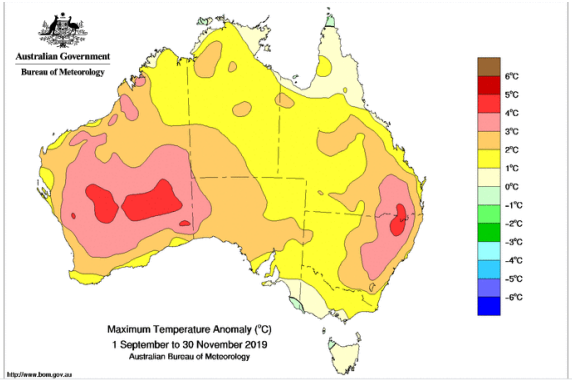
Observed SON anomalies 2019

Z700

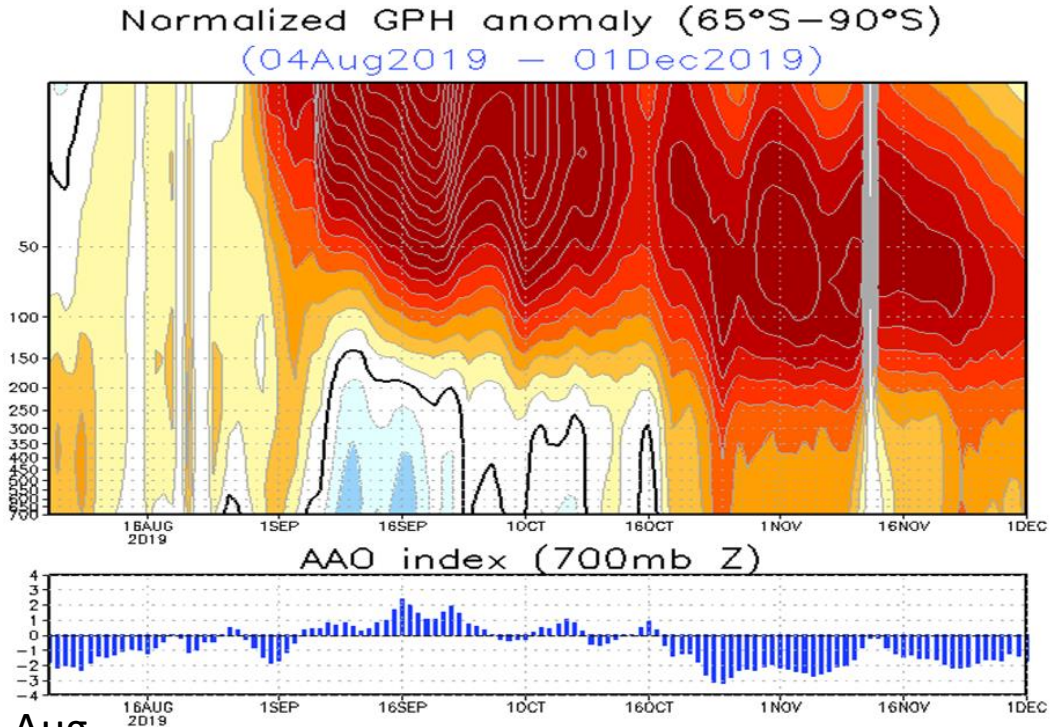




Rainall

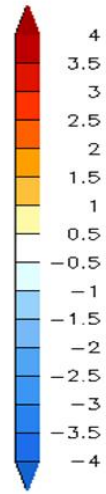


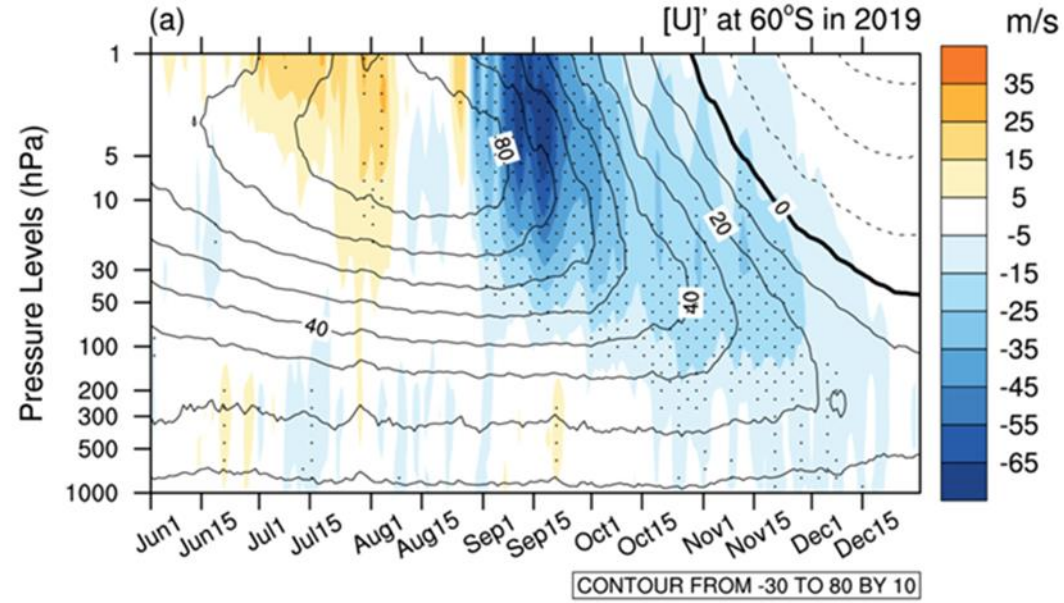
Tmax

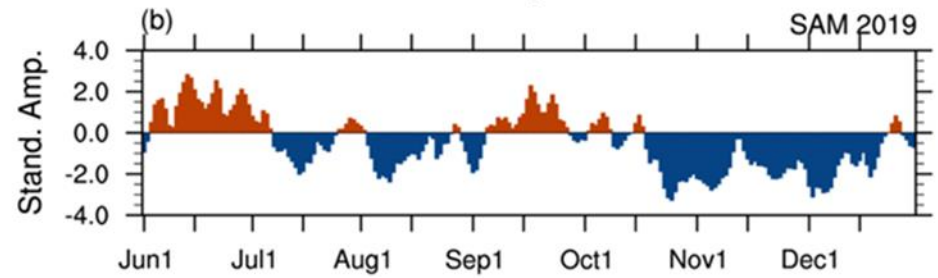


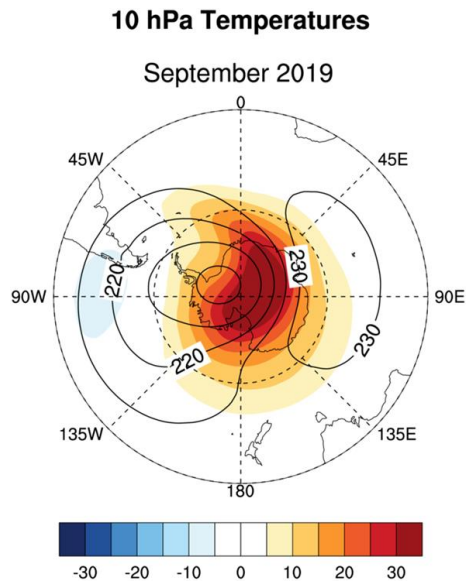
4 Aug

1 Dec





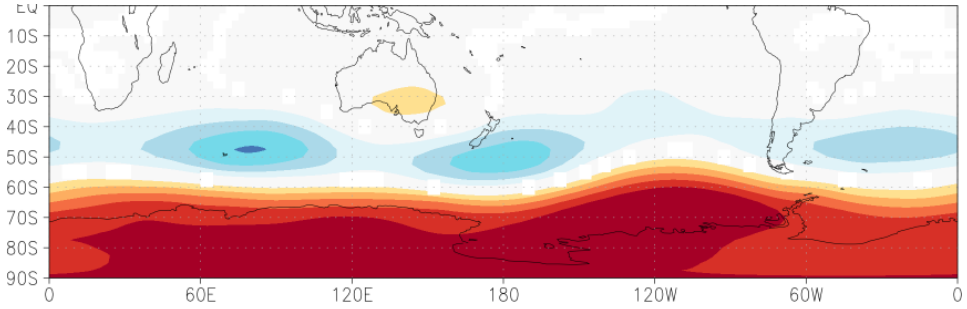




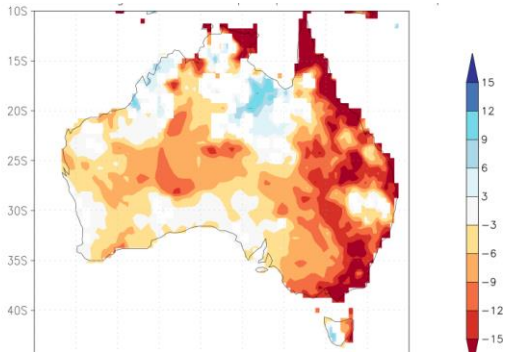
Our recent work has shown that the IOD (and EMI) played the key role for triggering the intensity of this SW by acting to increase the upward flux of planetary wave activity (poleward heat flux) from troposphere into stratosphere

Why does the SW matter > triggers low SAM in late spring

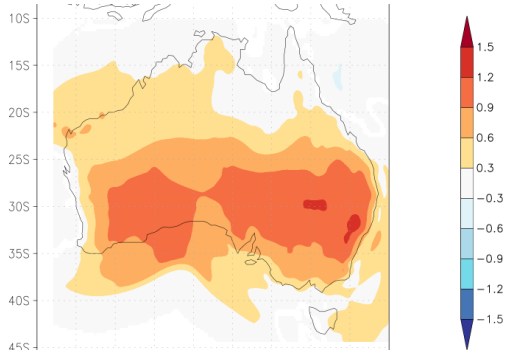
Regression onto negative SAM 1980-20198 Nov-Dec



Z700

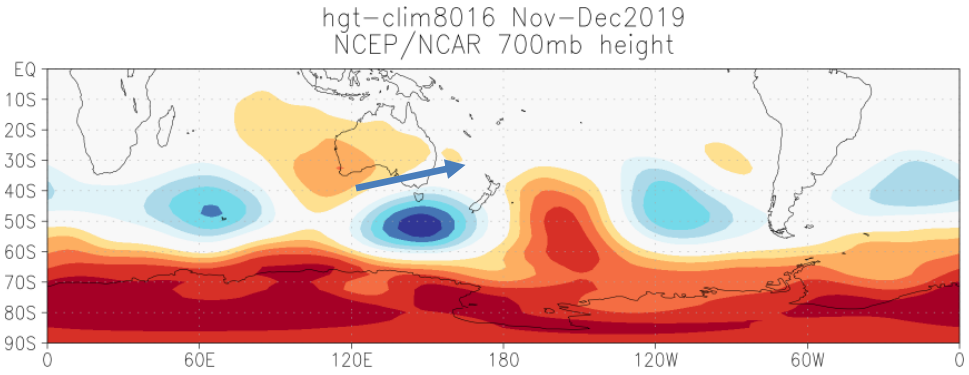


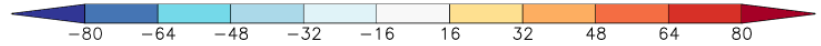
Rainfall

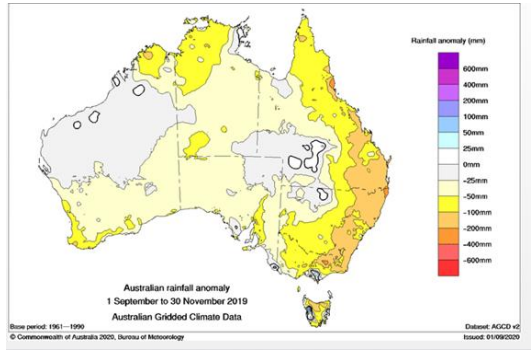


Tmax

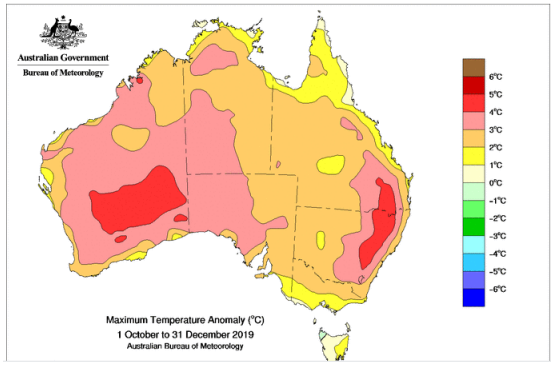
2019 Nov-Dec anomalies







Rainfall



Tmax

How well did we predict these climate extremes?

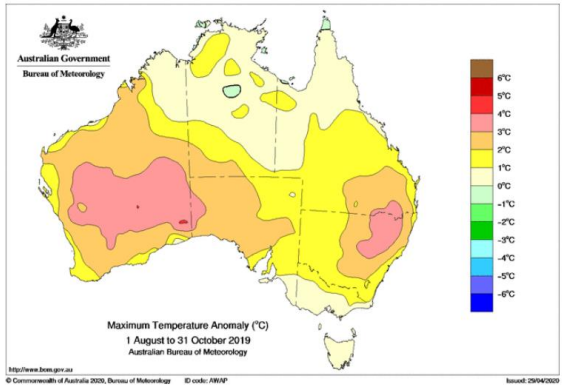
ACCESS-S1 Seasonal Forecast

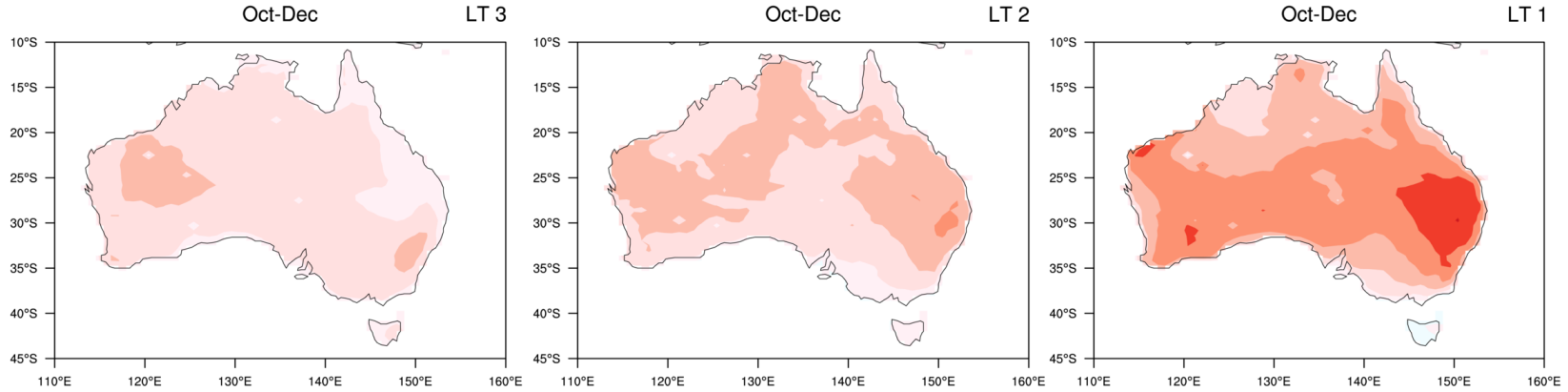
Ensemble mean of 22 members (11 from 25th and 11 from 1st of month)

Oct-Nov-Dec 2019

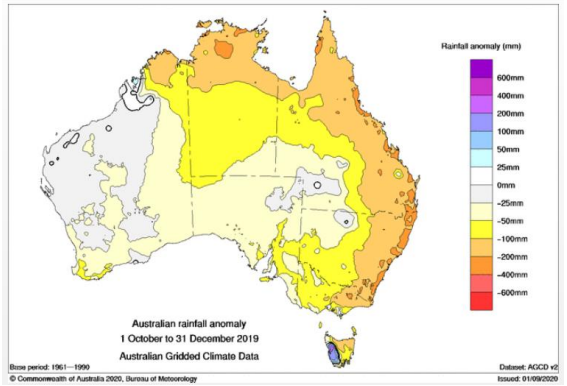
OBS OND | initialised on July 1 2019 | August 1 2019 | September 1 2019

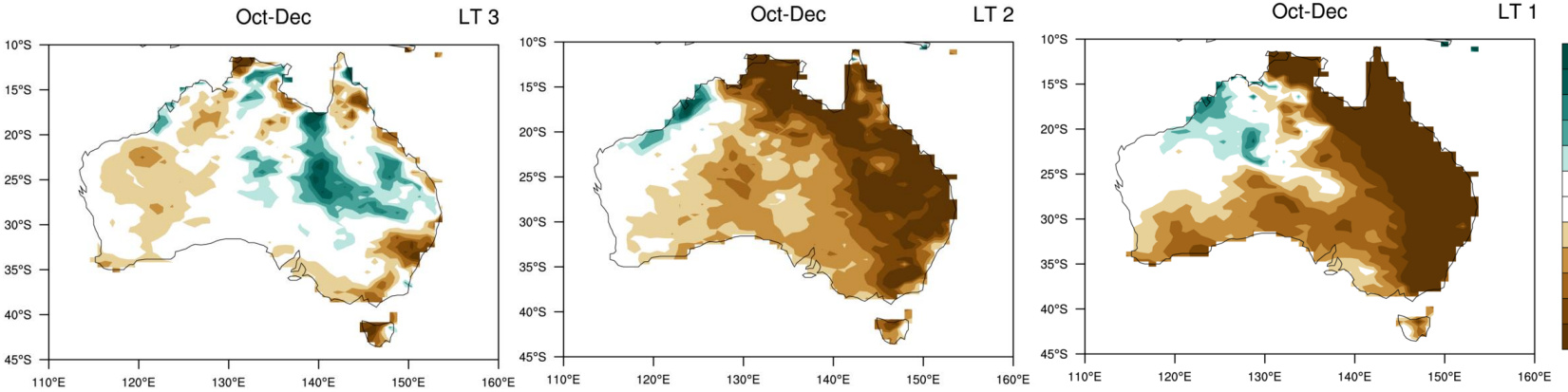
TMAX

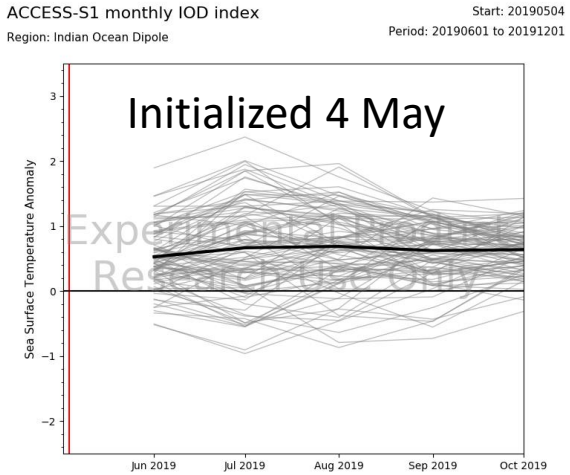


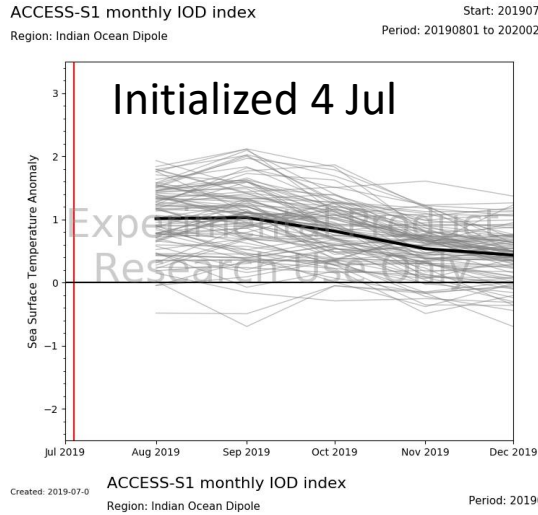


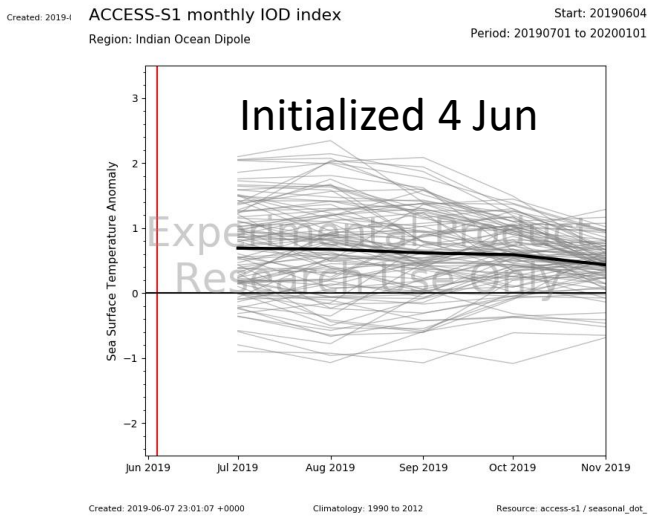
RAIN

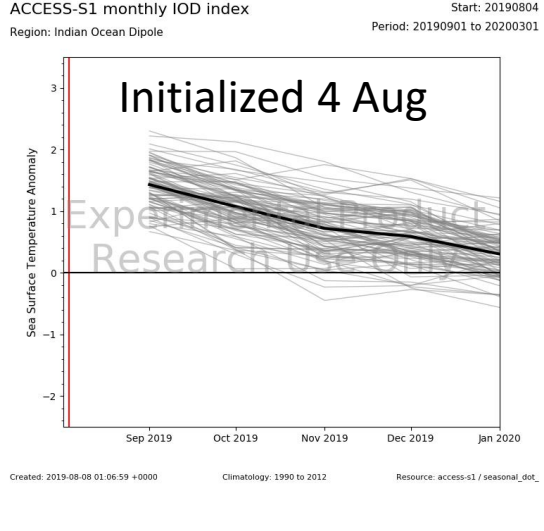




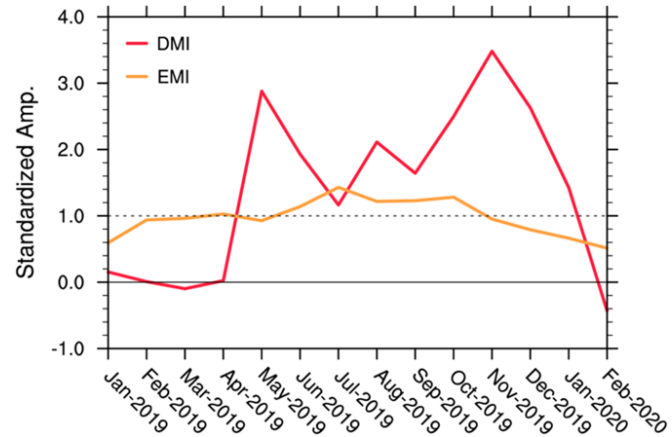




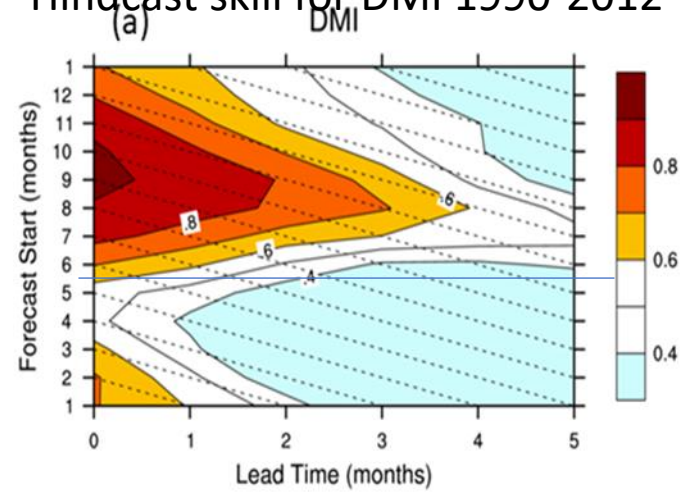




Prediction of the Dipole Mode Index with ACCESS-S1



ACCESS-S1
Hindcast skill for DMI 1990-2012

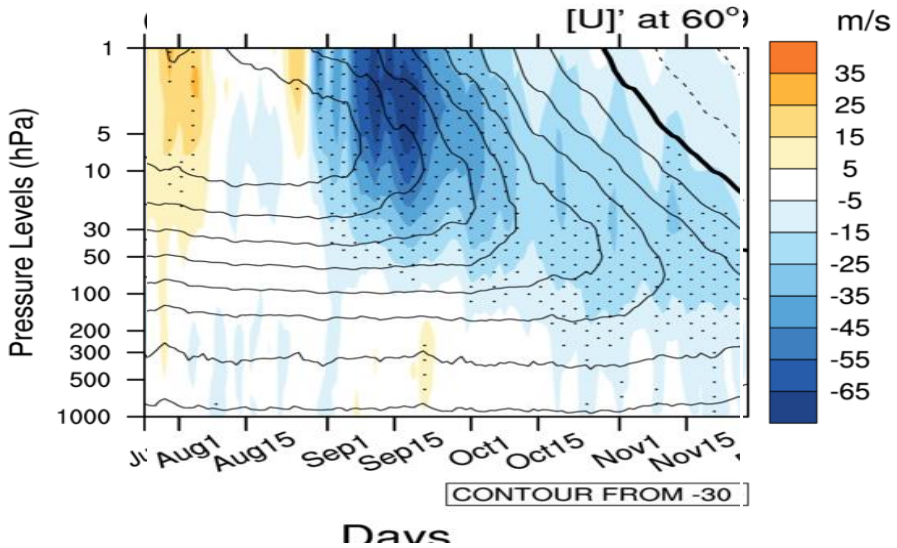


Typically no skill until after May

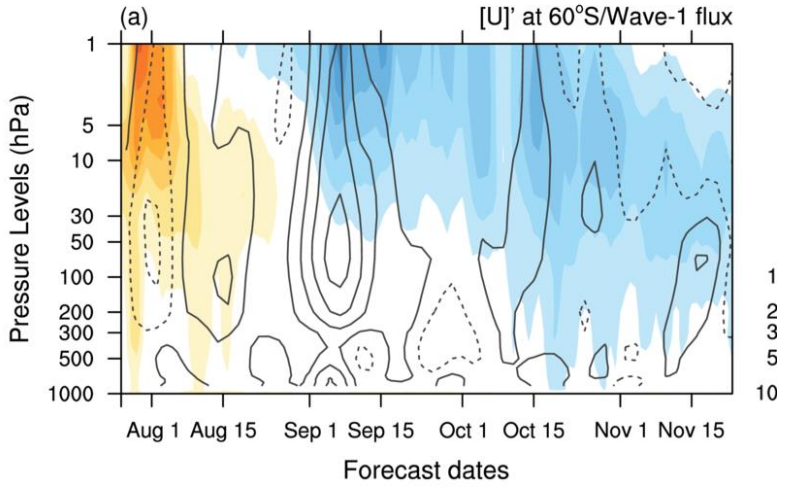
Strong IOD was being predicted from as early as May 2019 but we didn't have confidence until mid winter

Also systematically underestimated duration (event peaked in Nov)

Obs 2019 spring polar vortex [U] 60S

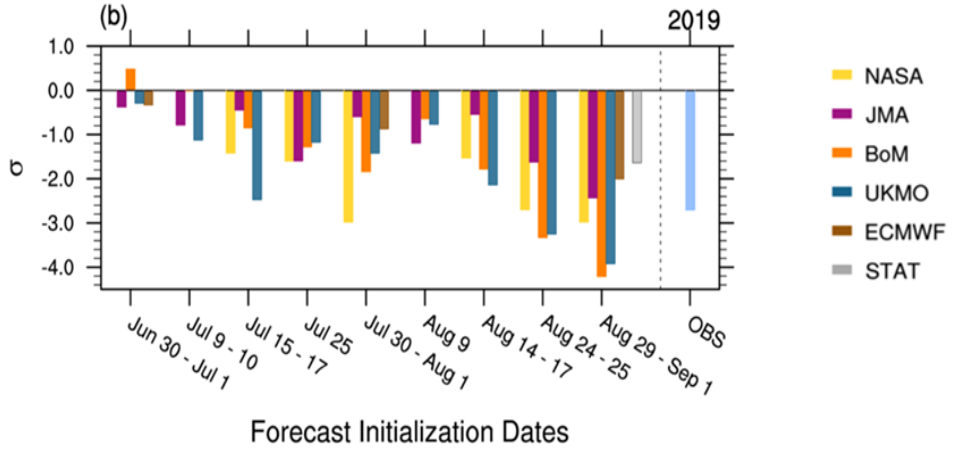


Ensemble mean forecast



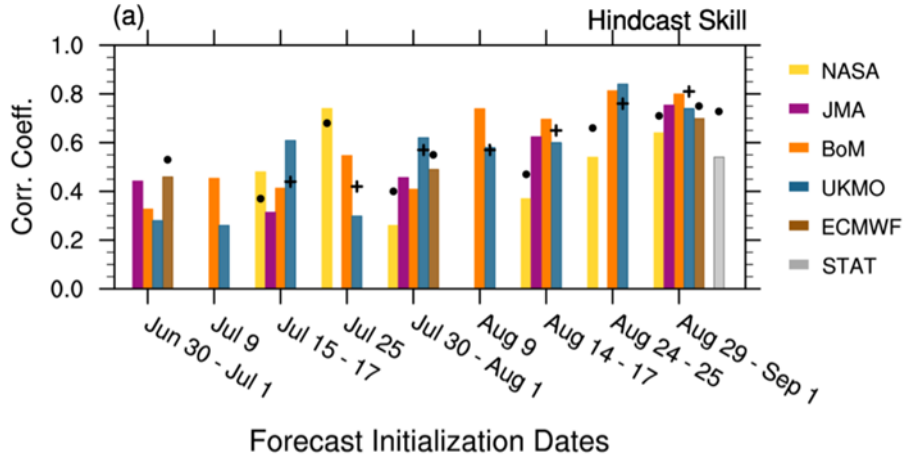
ACCESS-S1 from 1 Aug

Predicted magnitude OND [U] 10hPa at 60S



Weakening of the vortex and swing to negative SAM predictable from mid-winter

Hindcast skill for OND [U] 60S 10 hPa



Hindcasts (1990-2012) support notion that spring vortex predictable from mid winter

- **2019 eastern Australian climate anomalies resulted from a rare compound event that provided a 1-2 punch for dry and hot conditions in south eastern Australia**:

  IOD appears to have triggered the intensity of the SW

  previous major SSW in 2002 occurred in absence of IOD

- **Contribution of trends (not shown) to spring/early summer anomalies estimated to be minimal for rainfall (wrong sign from trend) and modest for temperature anomalies**

- **IOD and polar vortex weakening (SW) are predictable from mid winter**

  Numerous warnings and briefings about impending extreme heat/dry/wind during spring and early summer issued from late winter 2019

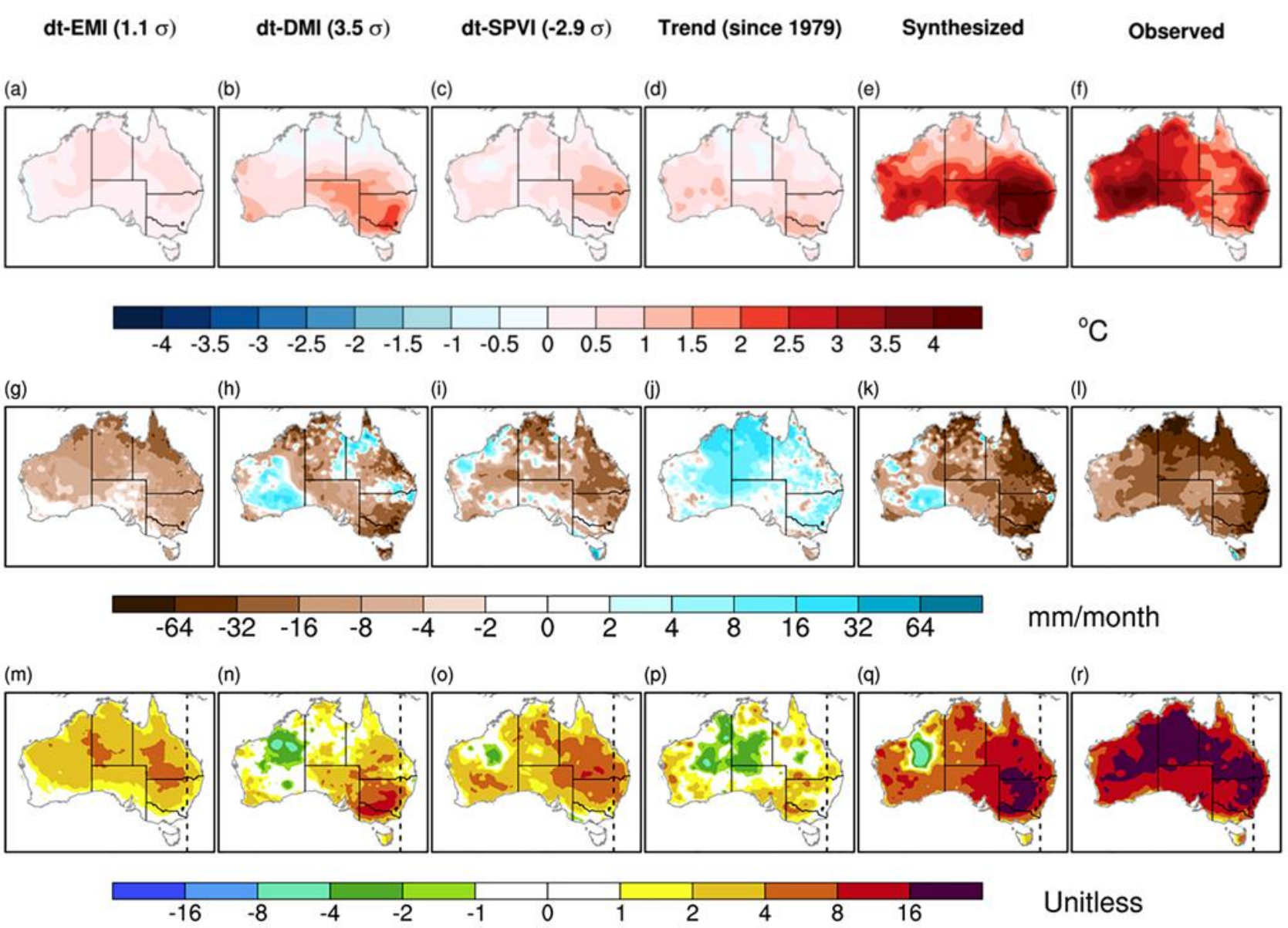
  Storyline approach to explaining the forecast proved useful for fostering trust in forecast

  Classic example of a window of opportunity

- **Untapped predictability from both the IOD (heard about the IOD biases/PEG from Oscar yesterday) and the polar stratosphere (better IC, include interactive ozone, Andy Brown: more vertical resolution)**

  Looking forward to the L137 version of ACCESS-S

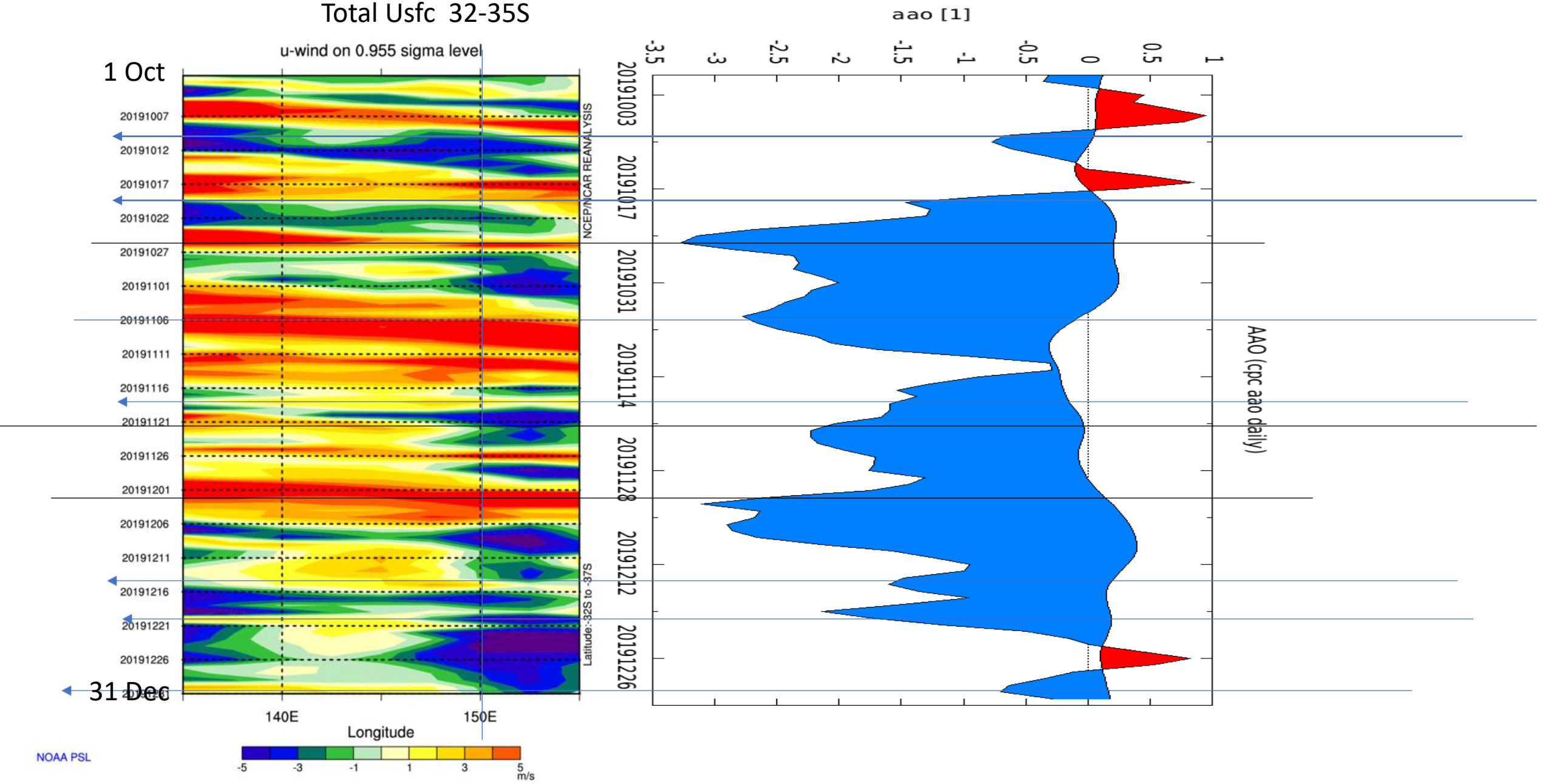
extras



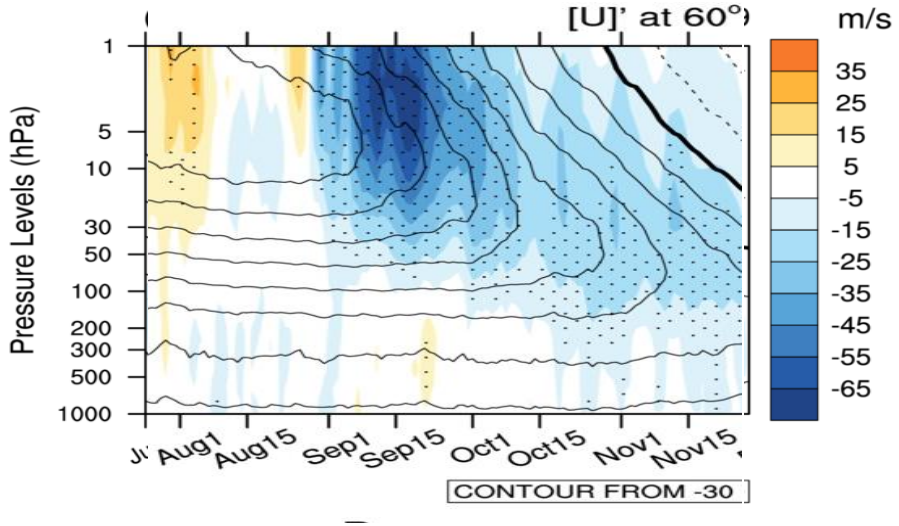
The anomalous large scale circulations acted together to force the pre-existing multi-year drought and on-going warming trend to its further extreme, which was conducive of the devastating bushfires especially in the east

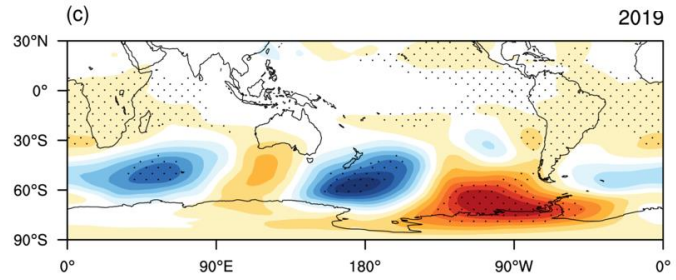
For instance,
For the far eastern seaboard where the bushfires were severe and persistent in Oct-Dec, SSW and related SAM explains ~30% of the observed bushfire dangerous weather conditions, and CP El Nino, DMI and a long term trend explained 14, 13 and 8% of the observed FFDI, respectively

Total Usfc 32-35S

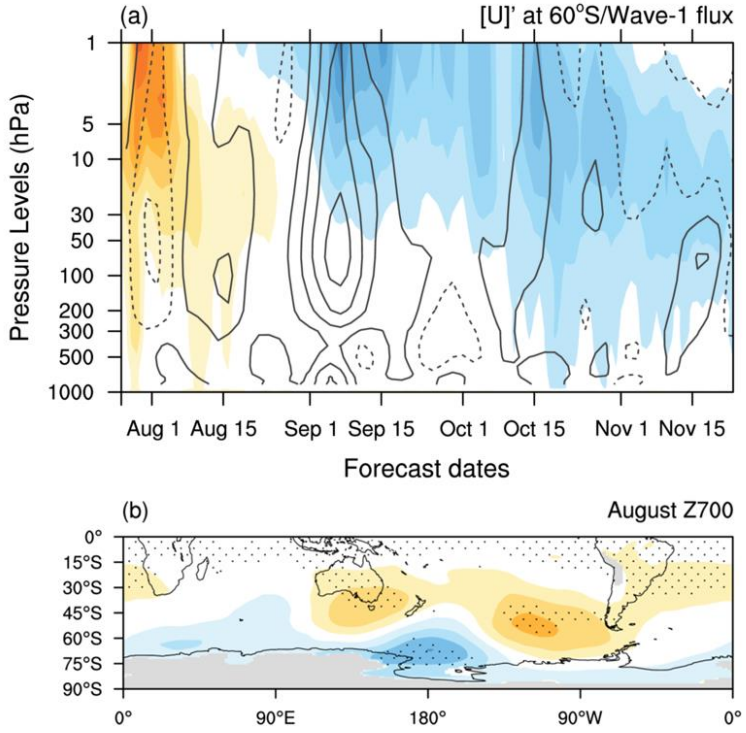


Obs 2019 spring polar vortex

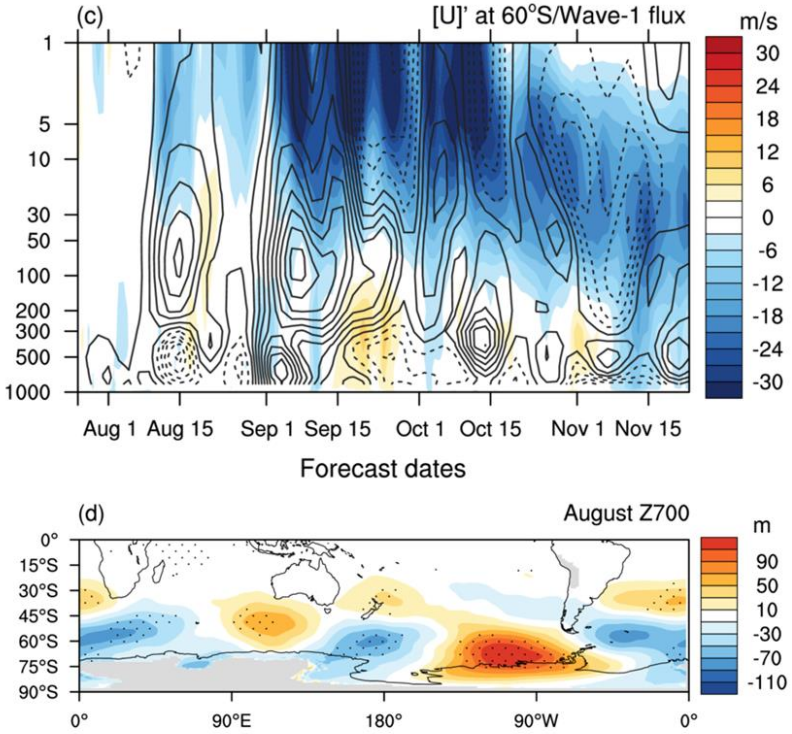


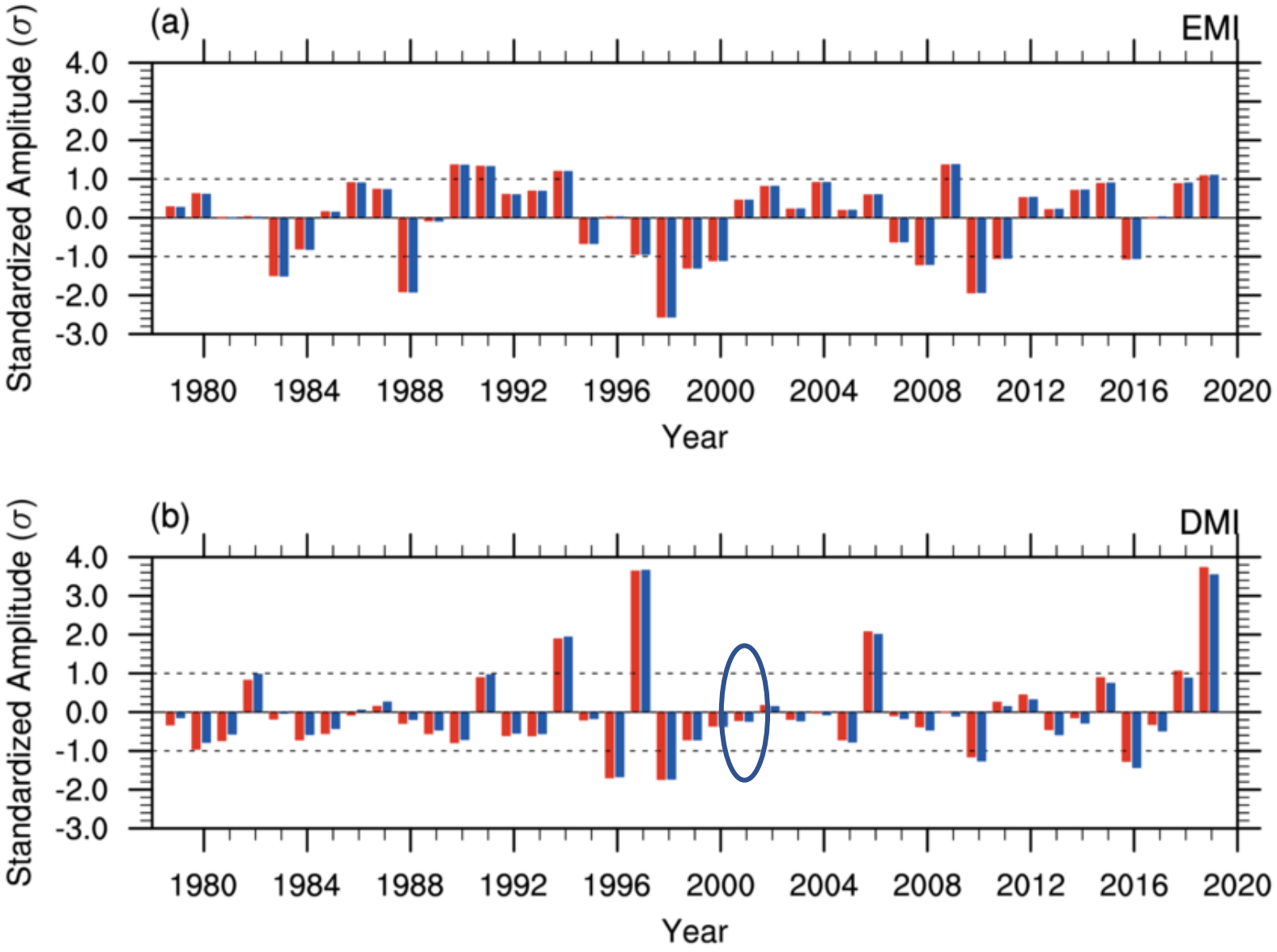


Ensemble mean forecast

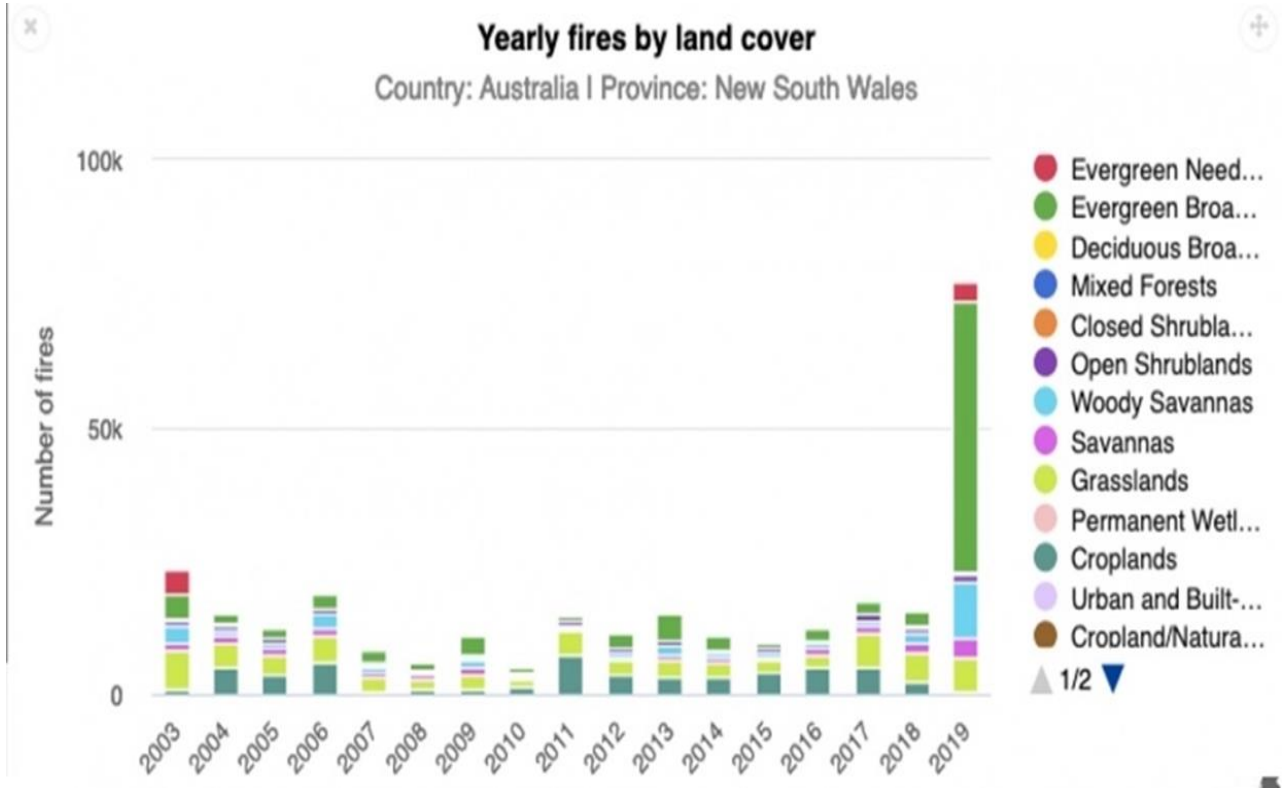


Forecast member difference

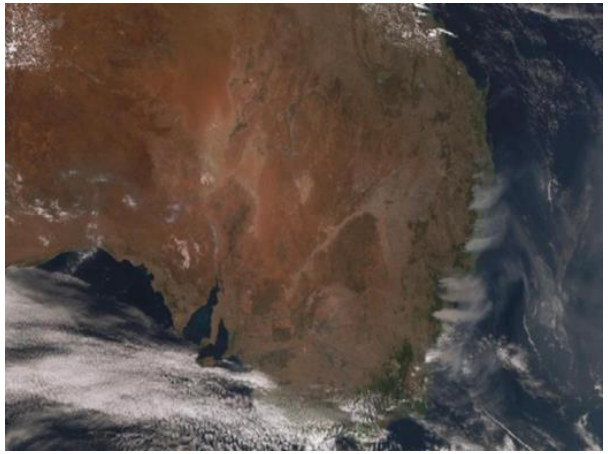




Note lack of IOD in 2002, when we also had a major SSW



8 Nov 2019



5 Dec 2019