# Northern Queensland Floods of February 2019: Drivers and predictability


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Tropical Variability Meeting (20 August 2019)

Photo credit: Dan Gresham, Cloncurry Mustering Company

11th February 2019

Townsville

Burdekin river outflow

Flinders-Norman rivers catchment

Mount Isa

Cloncurry

Julia Creek

Richmond

Burdekin river catchment

Dalrymple Lake

50 km

Diamantina-Georgina rivers catchment

# Impacts of the flood and extreme conditions

**Northwest QLD**

- Livestock losses: 625,000 cattle and 48,000 sheep
- Infrastructure damage: 10,000 km fencing; 16,000 km of farm roads, 1000 km of water pipes
- **Total cost: livestock + infrastructure damage = over $1 billion.**

(source: Queensland Country Life, 29/5/2019)

**Townsville**

- Fatalities: 6 people
- House damage: approximately 8000 homes with some damage (10% of stock); over 1400 homes still uninhabitable (as of 31 July)
- Health: Build up post-flood mould implicated in lung infections.

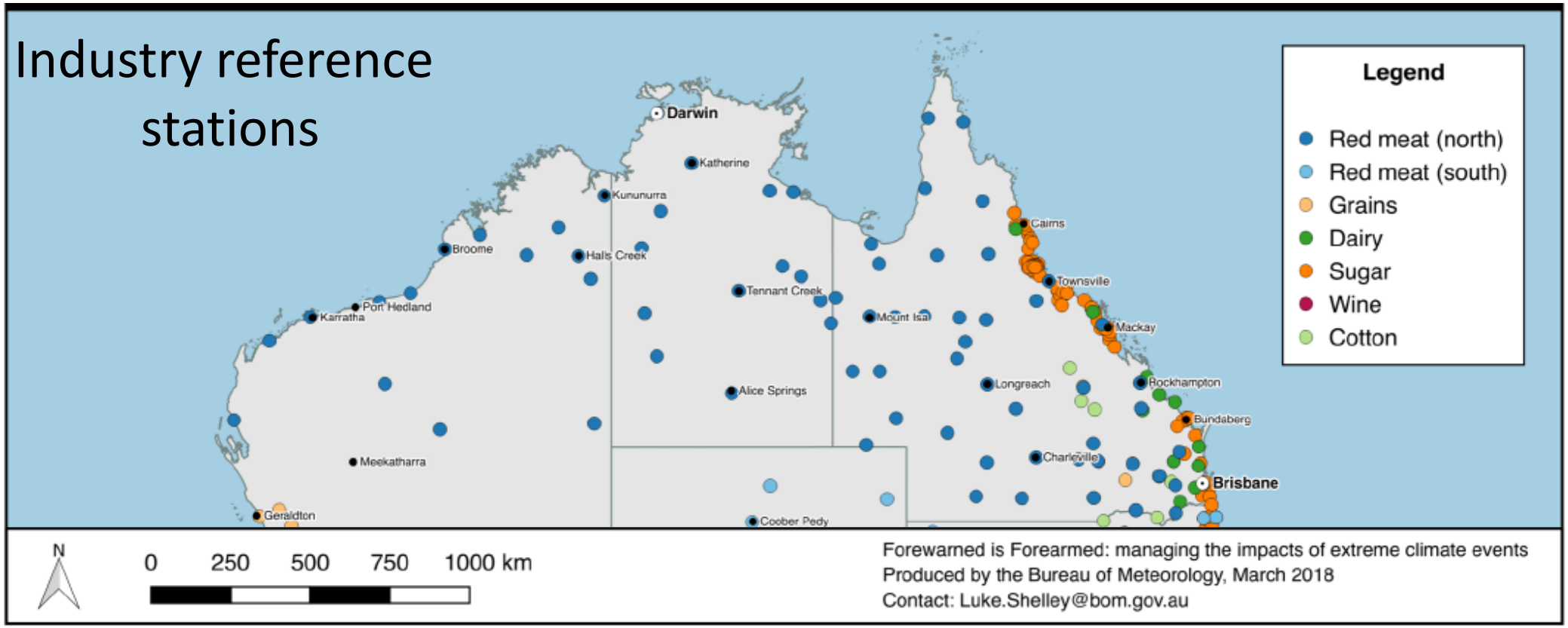
(source: abc.net.au, 9/8/2019)

*Bos Indicus*

*Bos Taurus*

Megan Munchenberg, Gregory Downs Station (USQ ClimateMate): *"Anecdotal information is that Bos Taurus cattle had a higher survival rate than Bos Indicus cattle…(which) are typically carried in the north for their tolerance of extreme heat."*

# Northern Australia and the production of red meat




Major purpose of our Northern Australian Climate Program (NACP) is to improve the: "*operational skill of seasonal, sub-seasonal (multi-week) and multi-year climate forecasting systems of direct relevance to the northern Australia red meat industry*".

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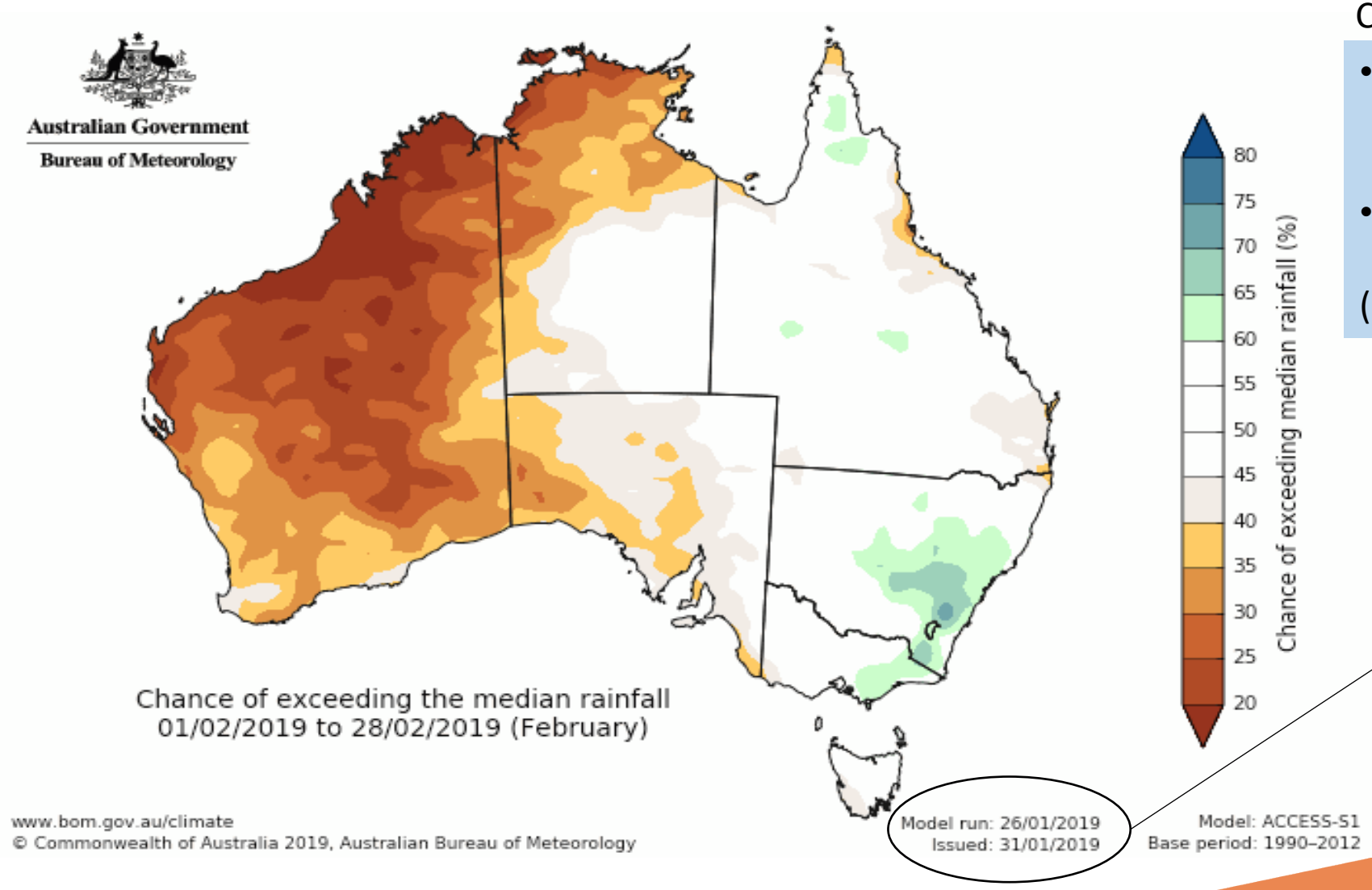
# Monthly rainfall outlook for February 2019




Chance of…

- at least 300 mm for inland Gulf region for all of Feb: < 15%
- at least 200 mm: < 35%

(higher chances over Townsville)

Outlook issued on the 31st January, based on model forecasts from 9 successive days from the 18th-26th of Jan. (99 members total)

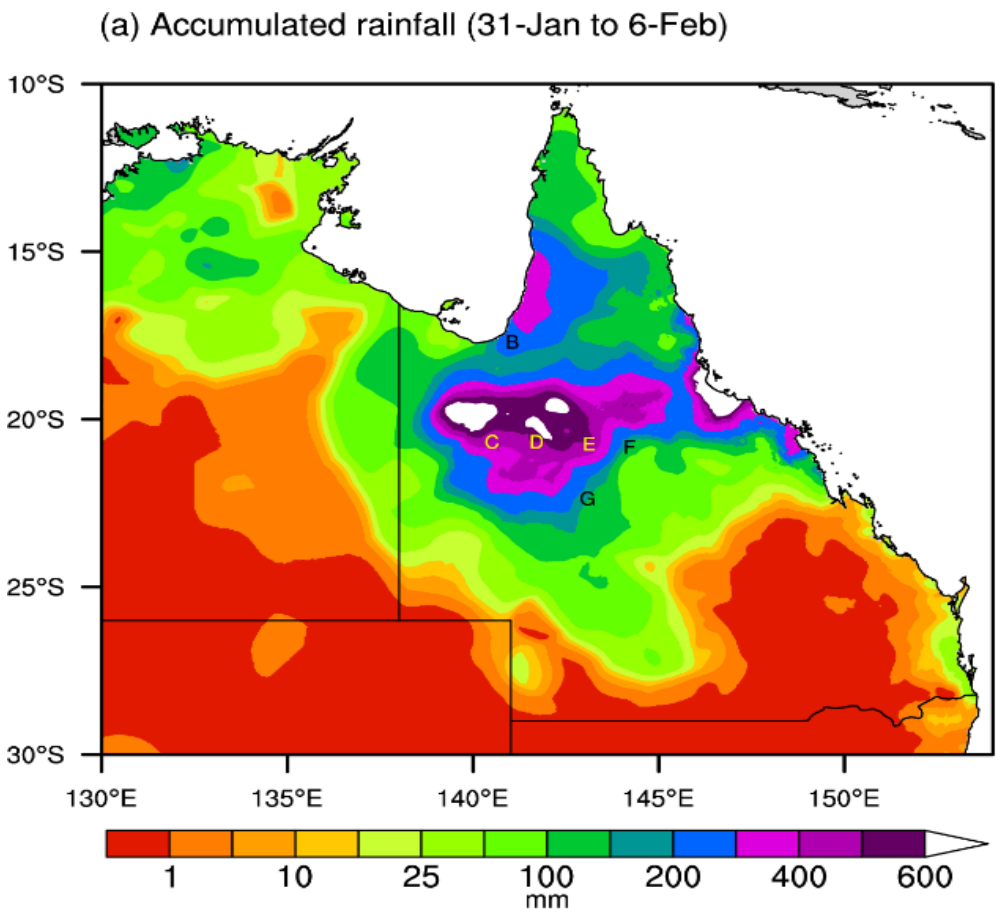
# Three Main Questions

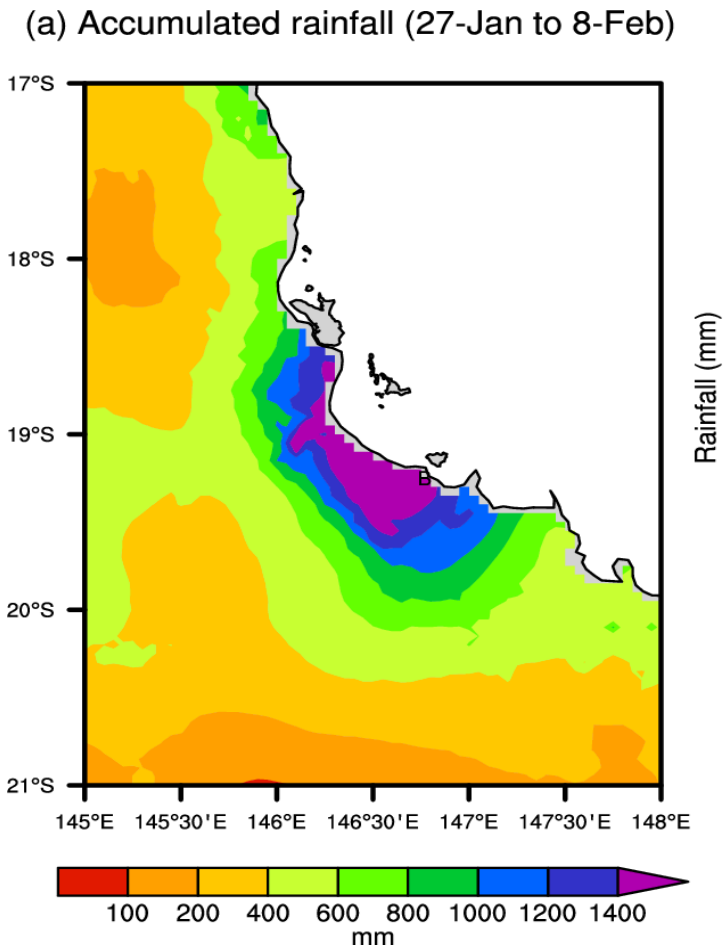
1) What were the large-scale climate conditions associated with this extreme event?

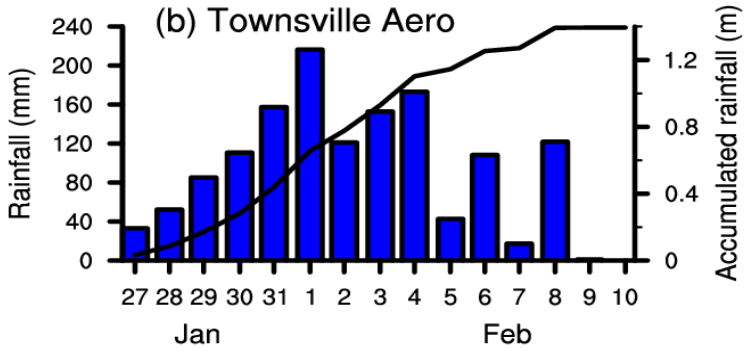
2) Why did the BoM's monthly forecast for February apparently 'miss' the event?

3) Would a multi-week forecast product, issued within a day of being generated, have provided greater benefit?

# Extreme wet conditions




Top 10-day BOM station totals:
East coast: Paluma Ivy Cottage = **2014 mm** (29-Jan to 7-Feb)
Northwest Qld: Millungera Station = **782 mm** (29-Jan to 7-Feb)

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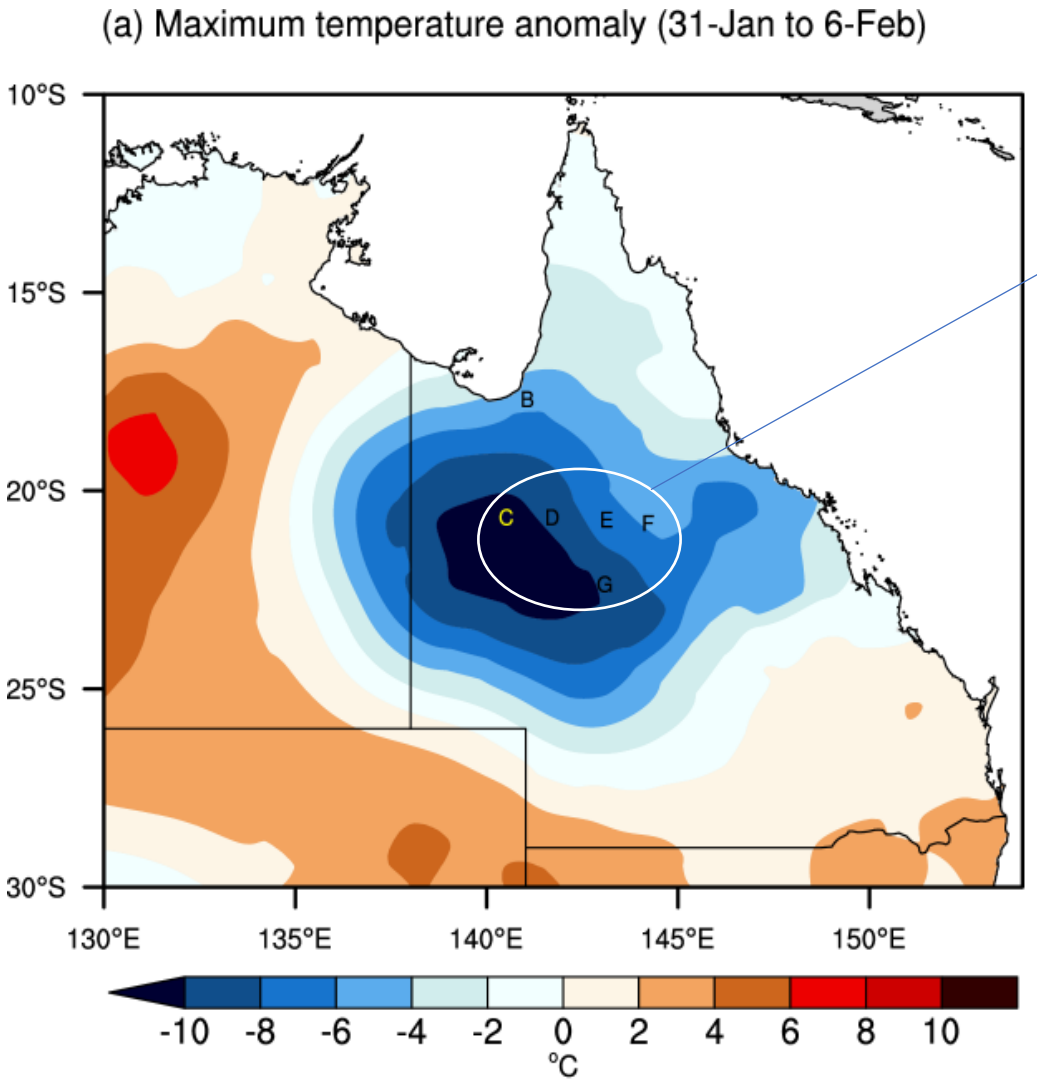
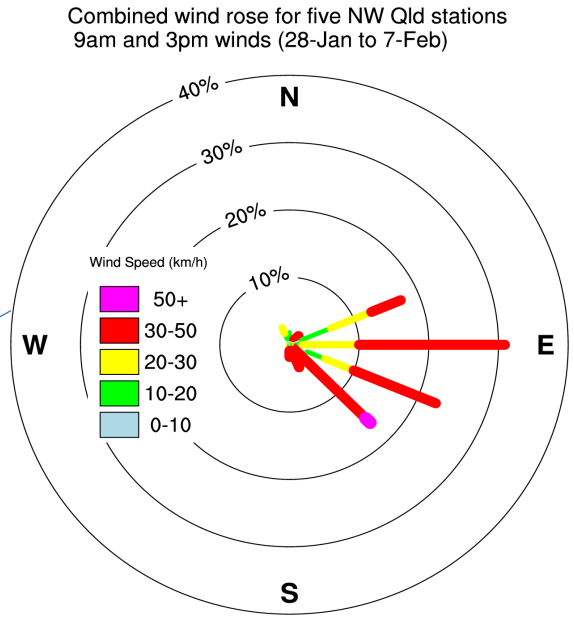
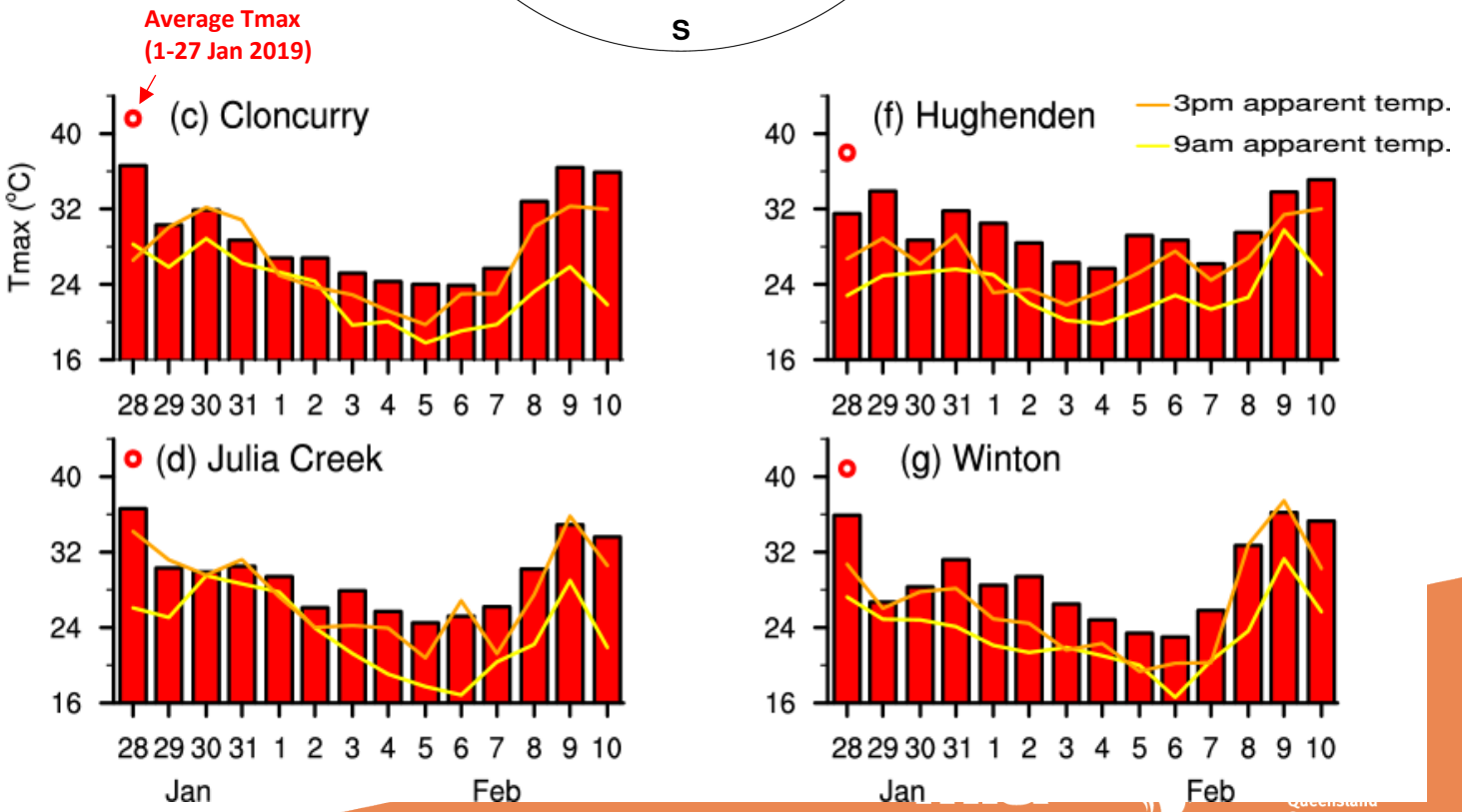
# Extreme cold conditions



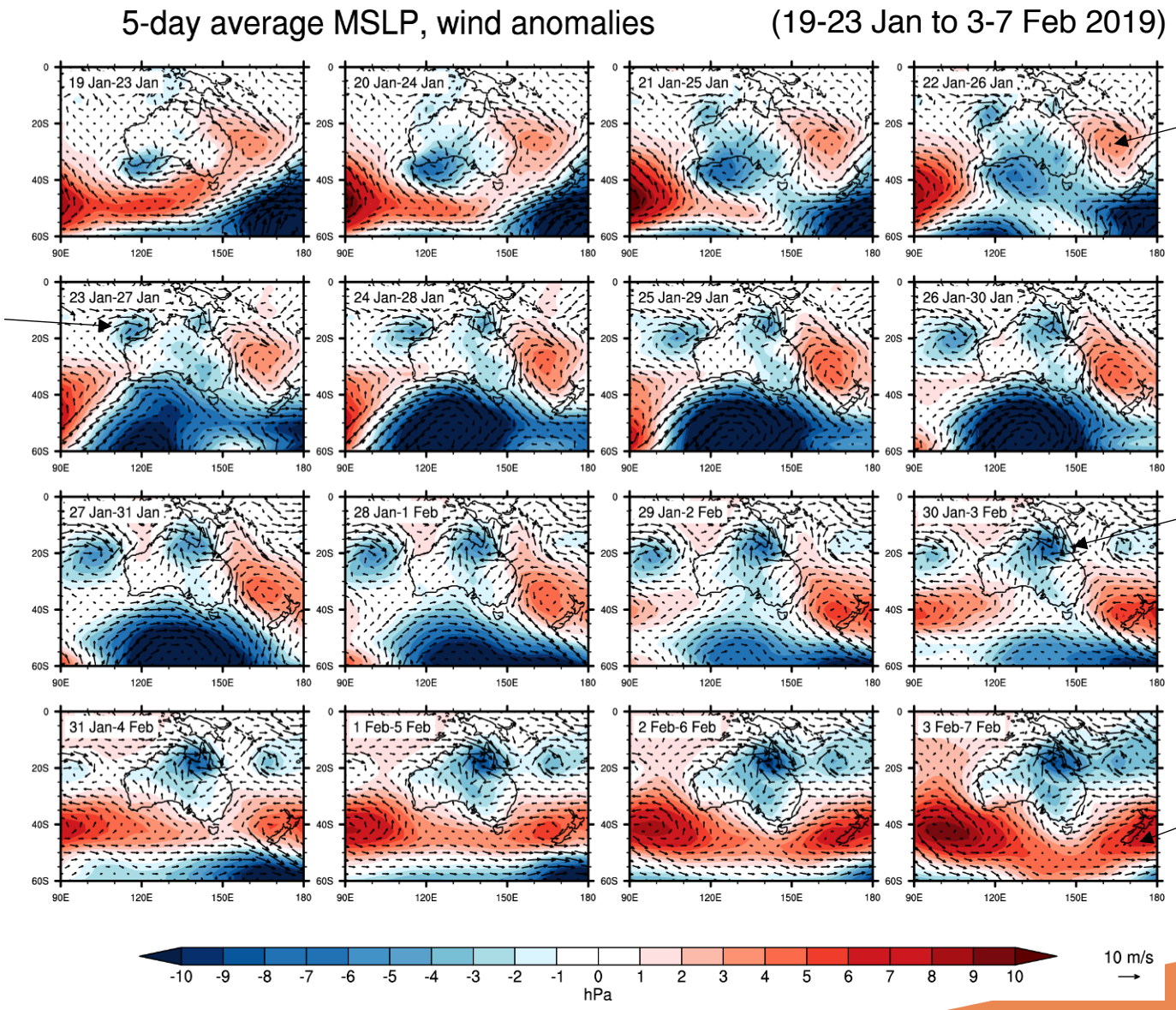




Dudley Harrington,
grazier from Julia Creek:

*"(the rain) didn't really stop and the cold winds came and it was just relentless for about 11 days…we had very low temperatures and winds up to 65kph which just made it really tough on the cattle"*
(7.30 Report, ABC, 11 Feb 2019)



# Large-scale atmospheric conditions




Tropical Cyclone Riley

Blocking anticyclone

Monsoon depression

Subtropical (High) pressure ridge

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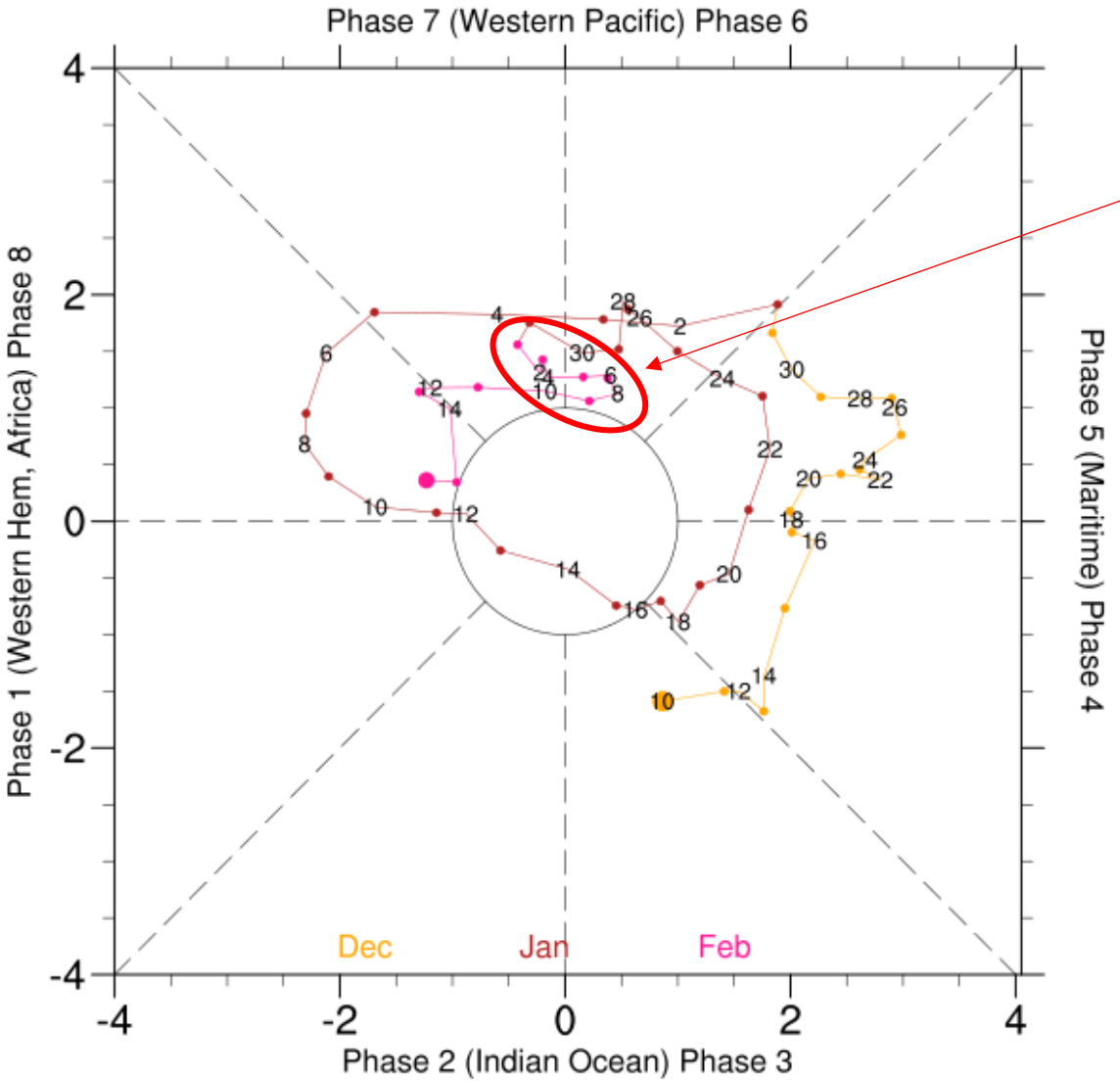
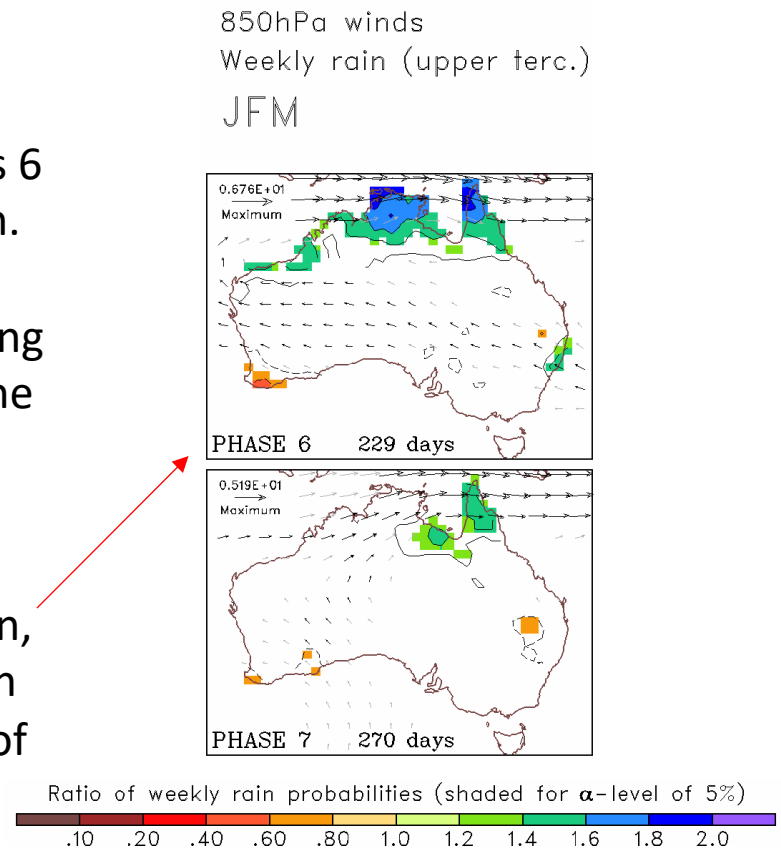
# Madden-Julian Oscillation (MJO)




The MJO was in Phases 6 and 7 from the 25th Jan. to the 11th Feb., and stalled likely contributing to the stationarity of the event.

Based on the historical MJO-rainfall association, the MJO cannot explain the southward extent of the event.




(from Wheeler & Hendon 2007)

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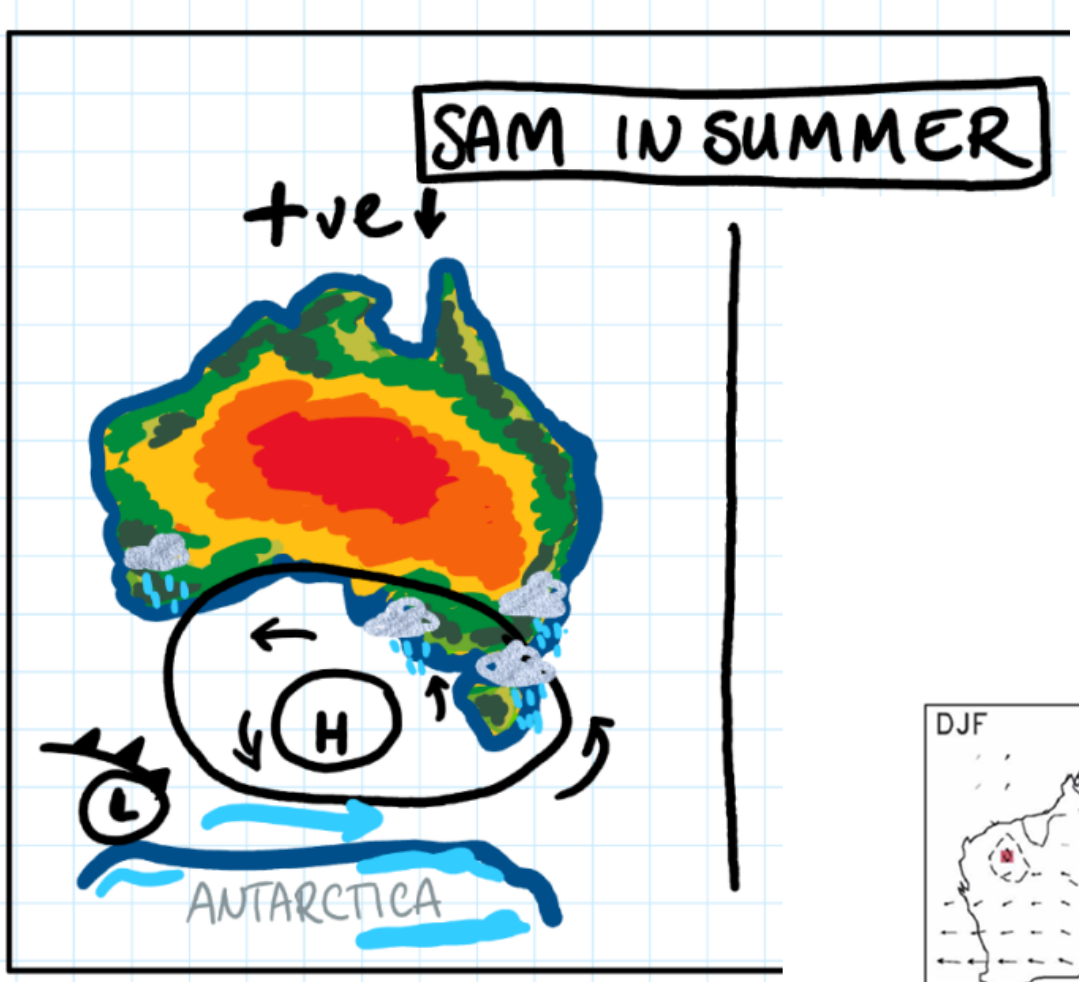
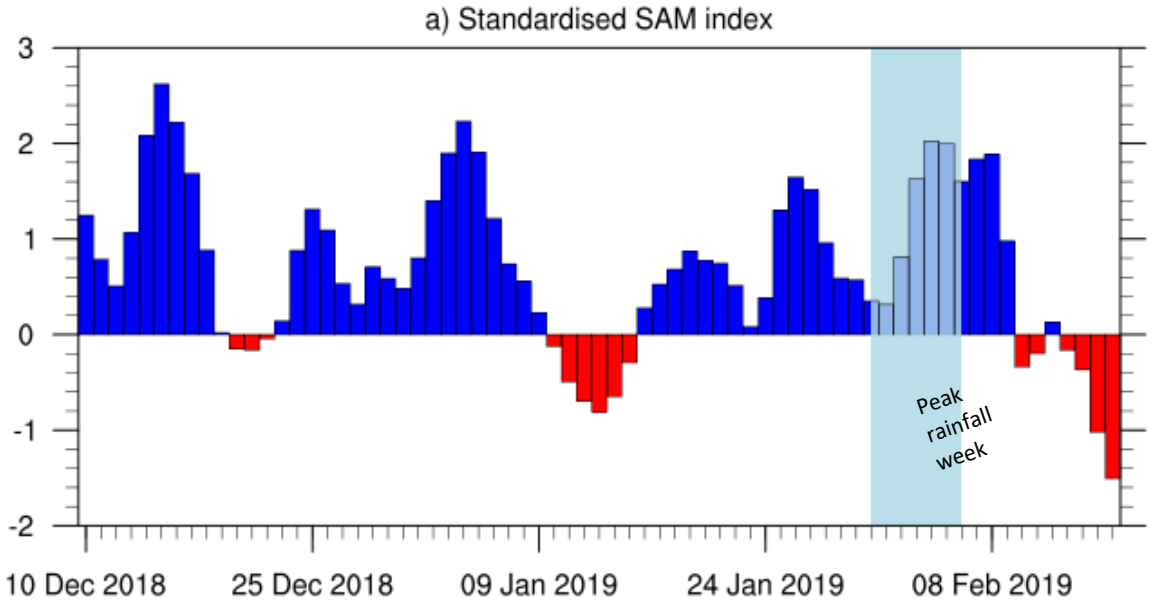
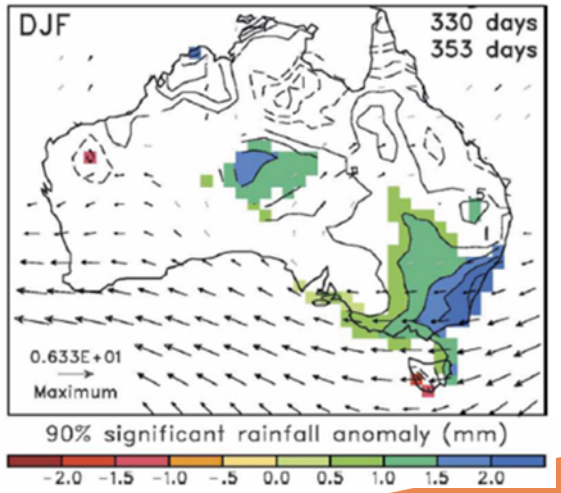
# Southern Annular Mode (SAM)




Source: Kate Doyle, ABC online

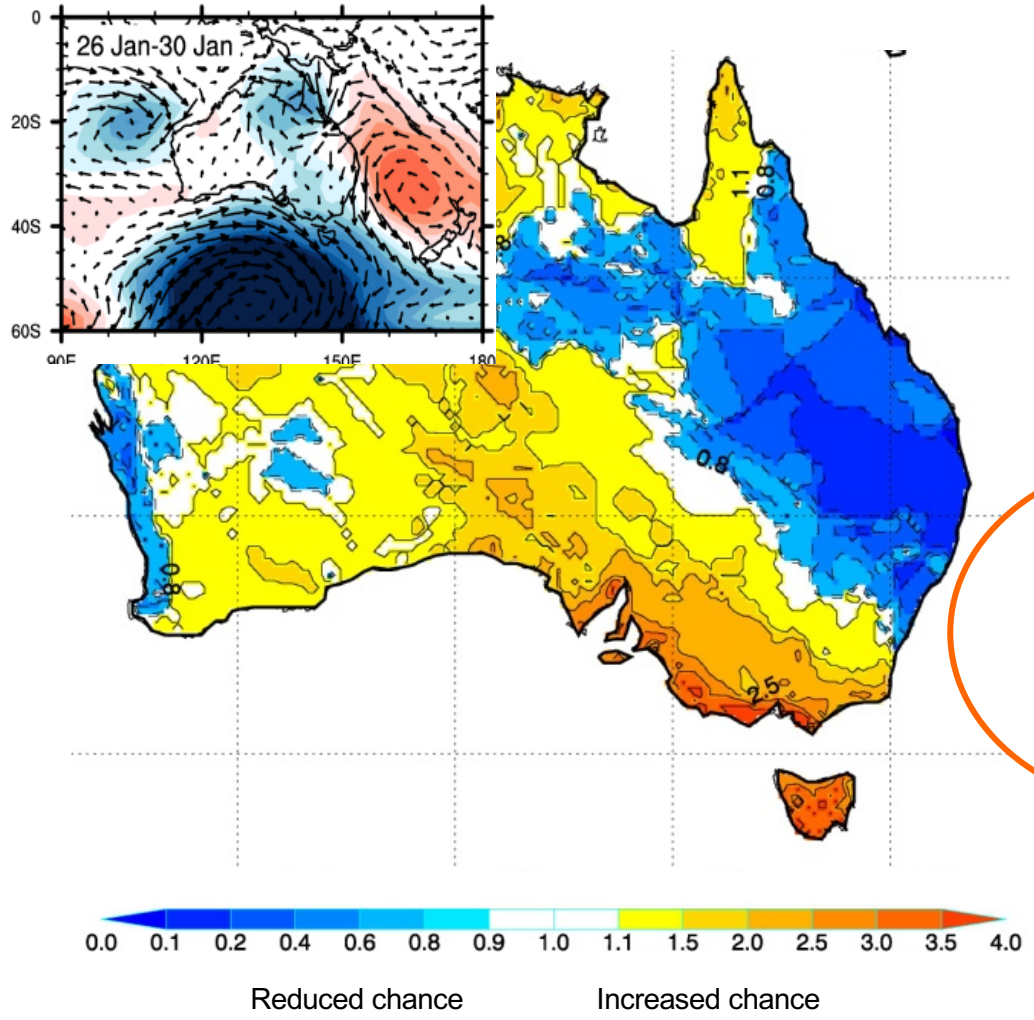



SAM rainfall composite using daily rainfall, 1979-2005 (Hendon et al. 2007)

# Impacts of blocking in the Tasman Sea

Extreme heat (Tmax decile 10)

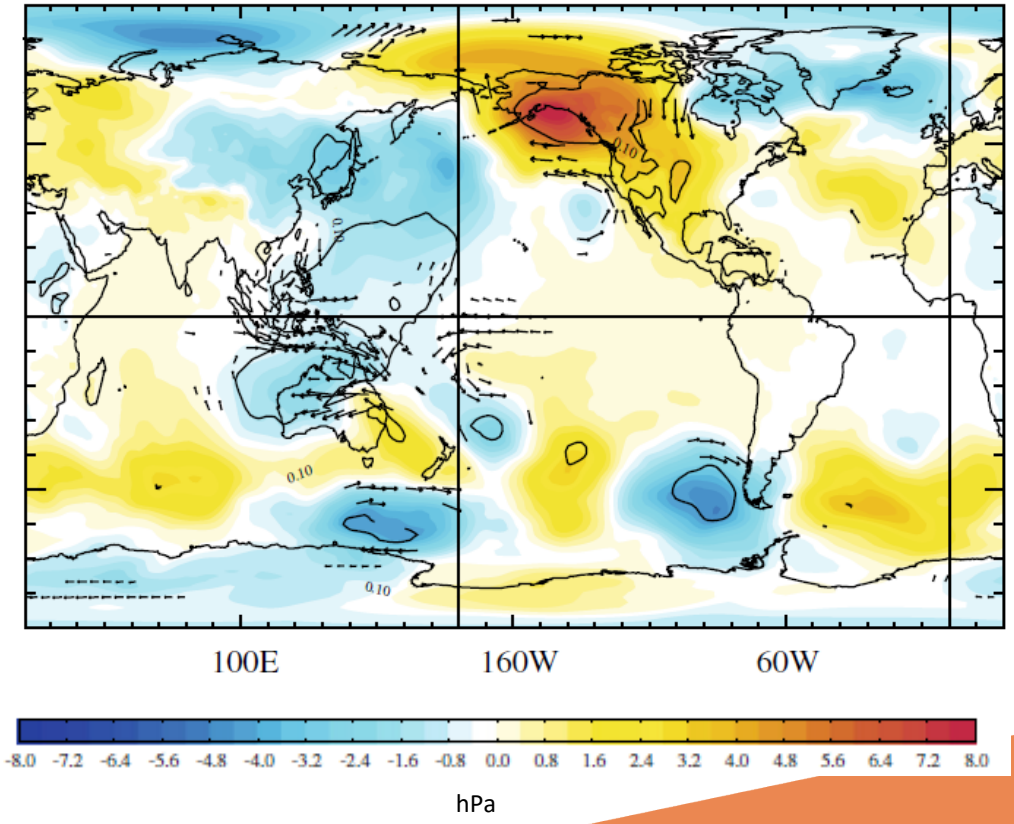



**STR high**

**H**

**(Tasman)**

Composite daily MSLP anomaly pattern
for 14 extreme rainfall weeks over northern Qld



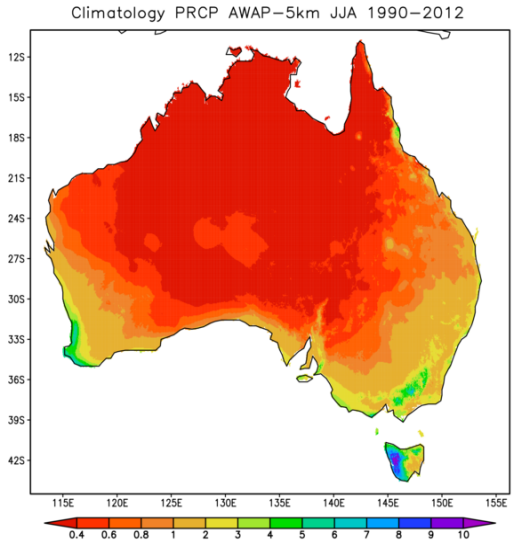

Boschat et al. 2014

Courtesy of Andrew Marshall

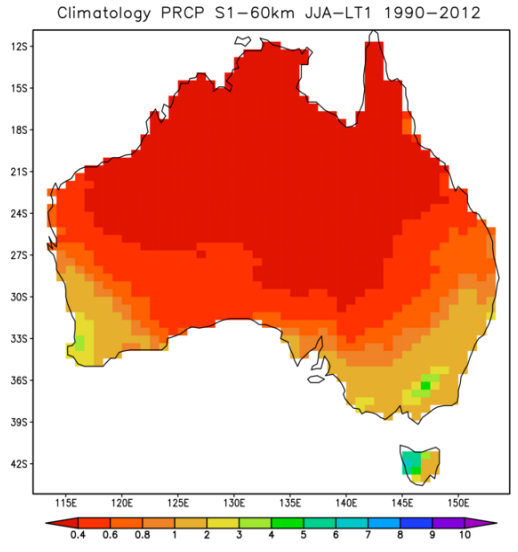
# ACCESS-S1 prediction system

- **Ensembles:** 11 real-time members per day (run out to 6 months), another 22 members per day (run out to 6 weeks), lagged ensemble = 99 members
- Raw output on a ~60 km grid
  - Calibrate output to 5 km resolution, using quantile-quantile matching (corrects for biases)
- Monthly outlooks issued bimonthly (operationally), so seemingly missed event due to the timing of forecast and the inclusion of longer lead time forecasts.

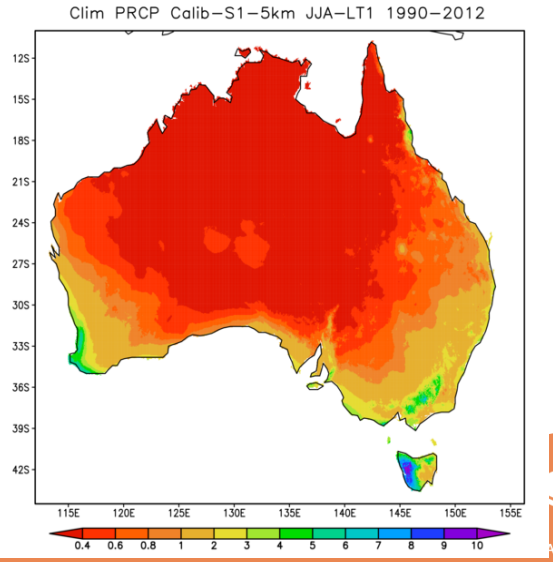
Observations




Raw model output



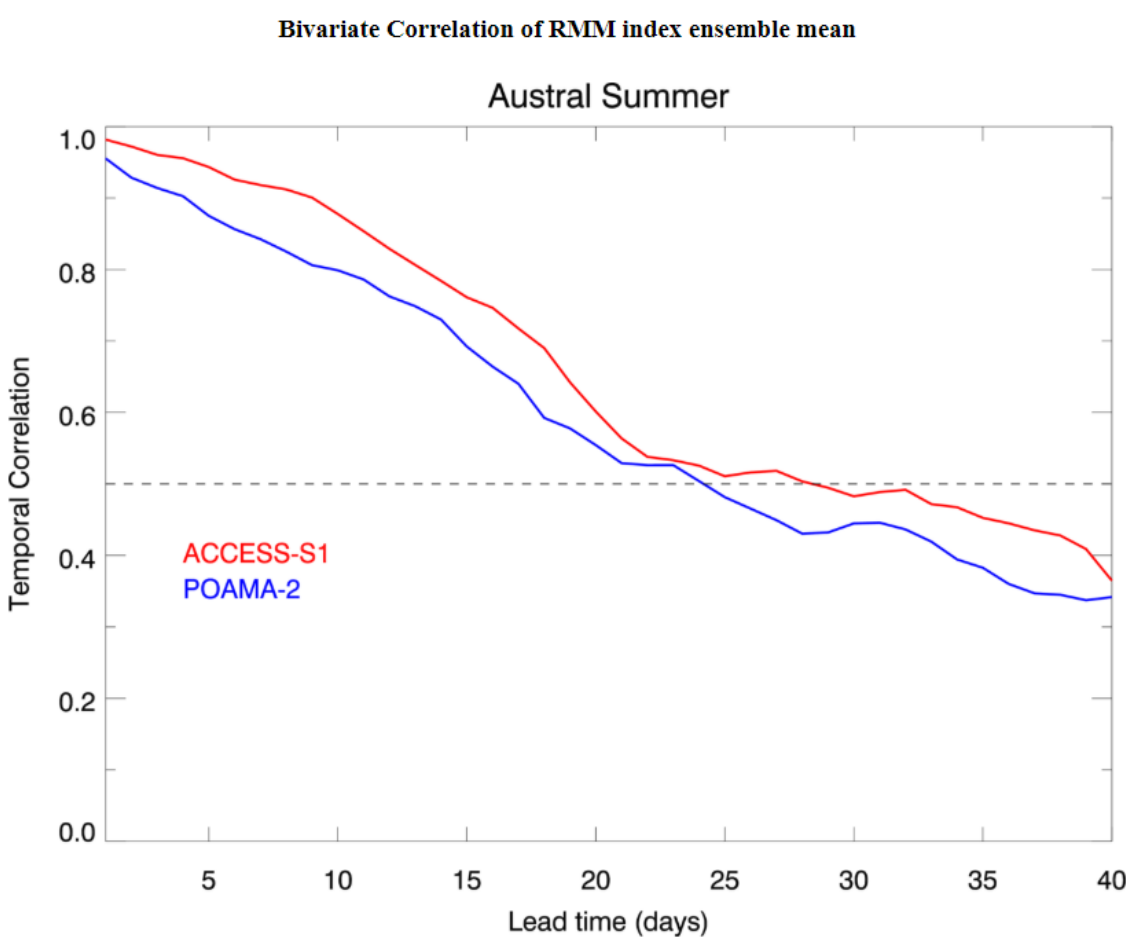

Calibrated model output



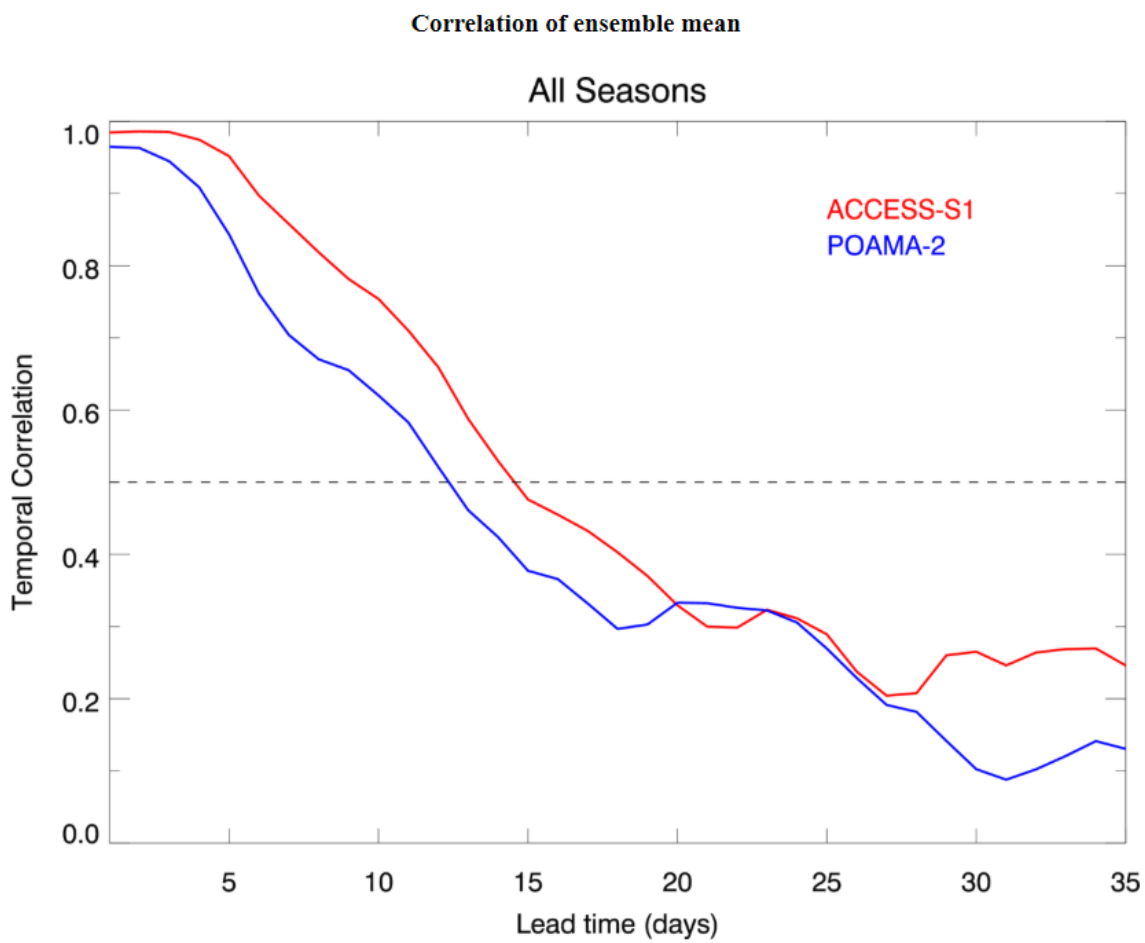
# ACCESS-S1 hindcast skill

(Start dates: 25 Jan, 1 Feb, 25 Apr, 1 May, 25 Jul, 1 Aug, 25 Oct, 1 Nov)

## MJO Verification




## Daily SAM Verification

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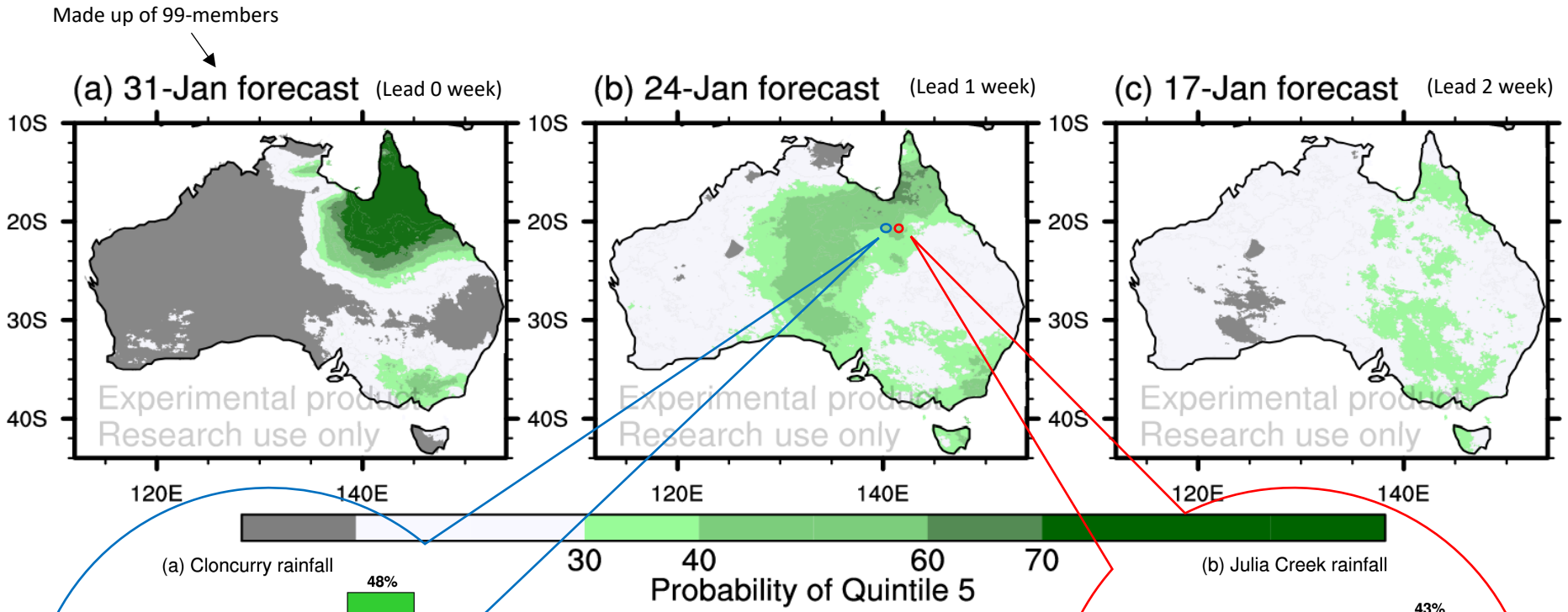
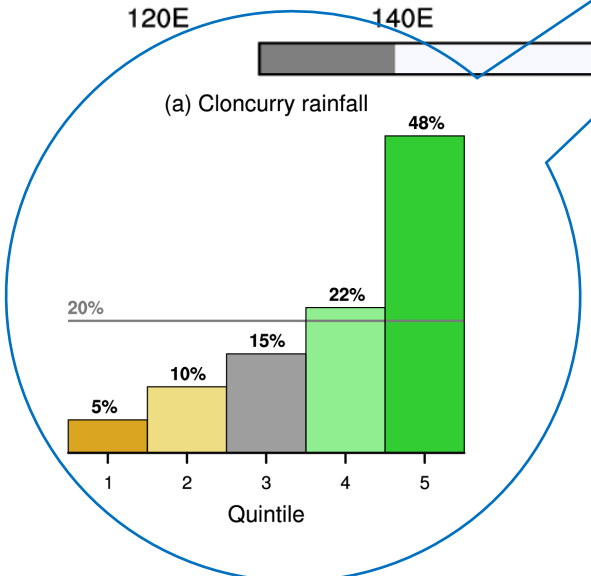
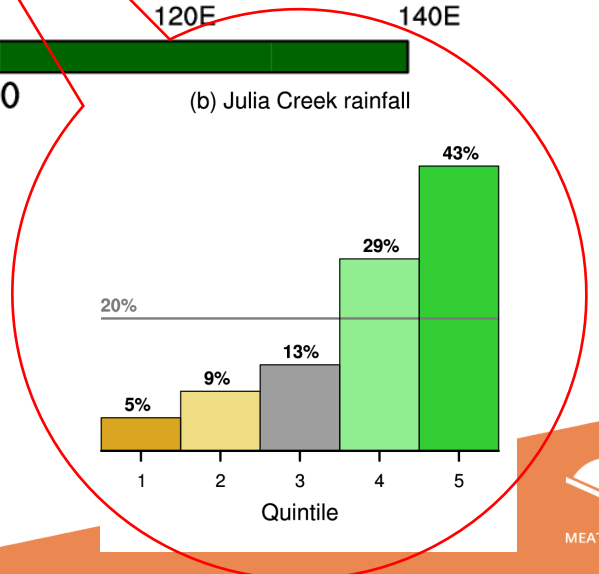
# Multi-week rainfall forecast (31st Jan. to 6th Feb.)

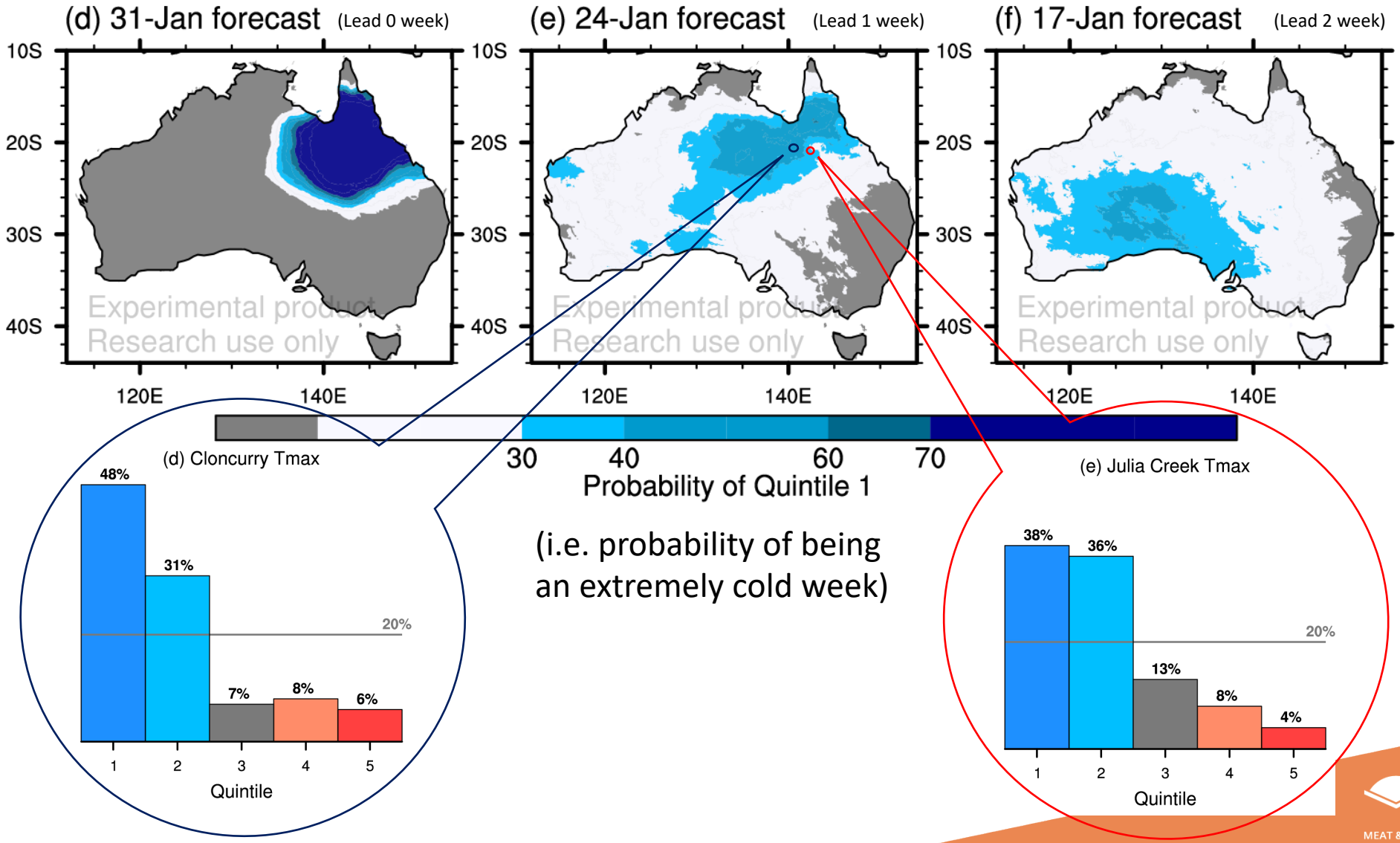



(i.e. probability of being an extremely wet week)



# Multi-week Tmax forecast (31st Jan. to 6th Feb.)

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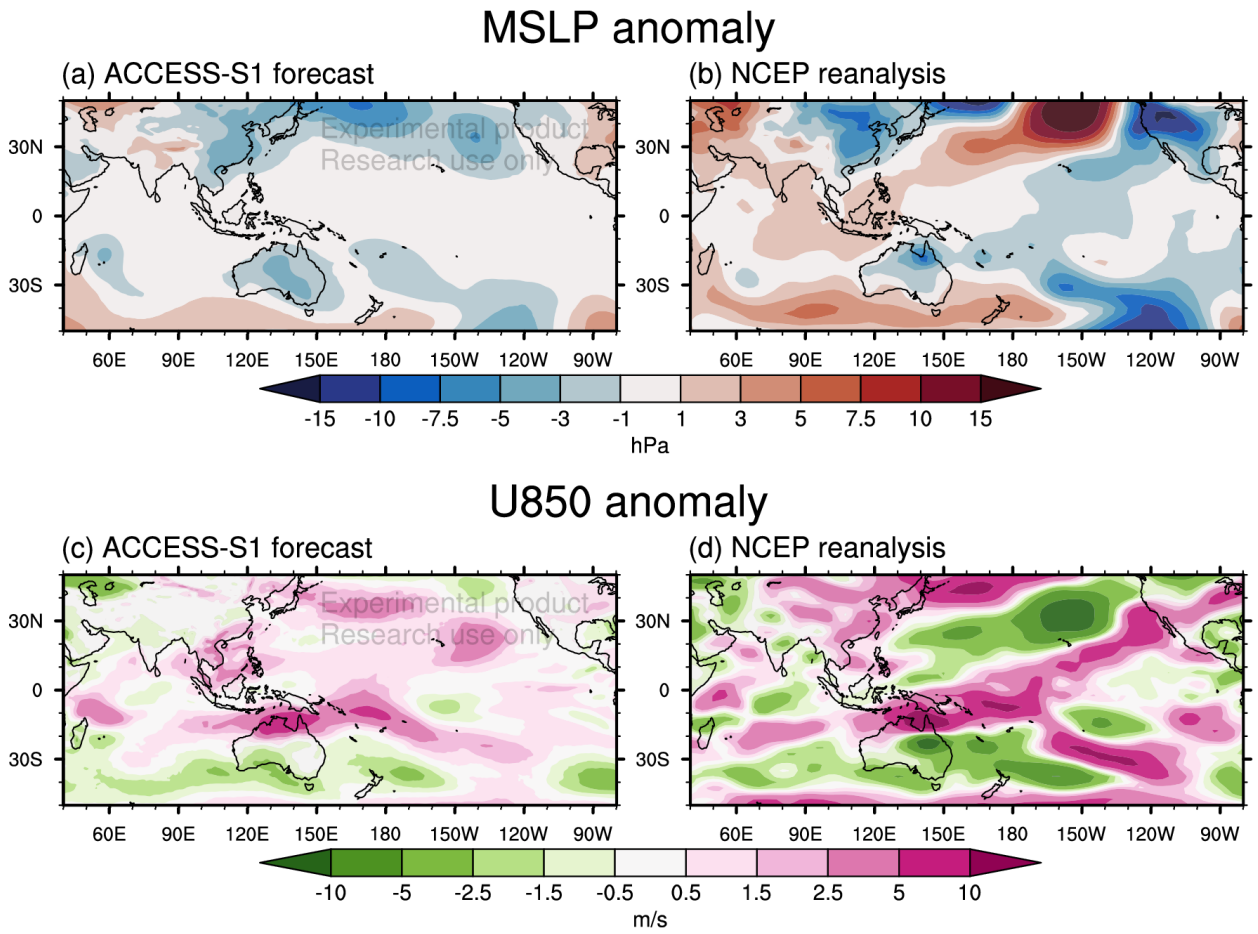
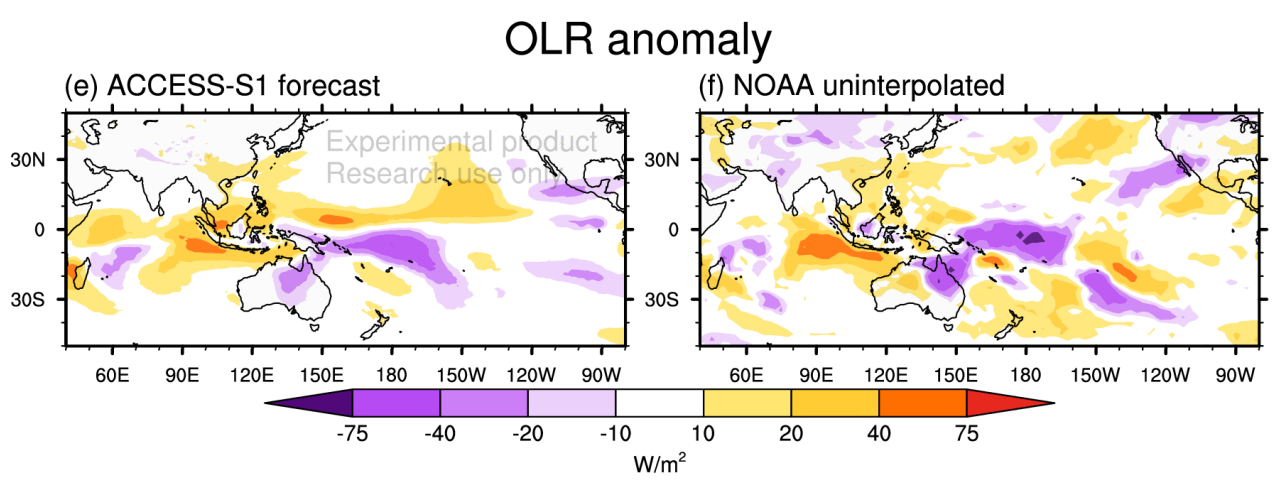
# ACCESS-S1 forecast of the large-scale atmosphere (lead time 1 week; 24th Jan. initialisation)




Week of 31st Jan. to 6th Feb.

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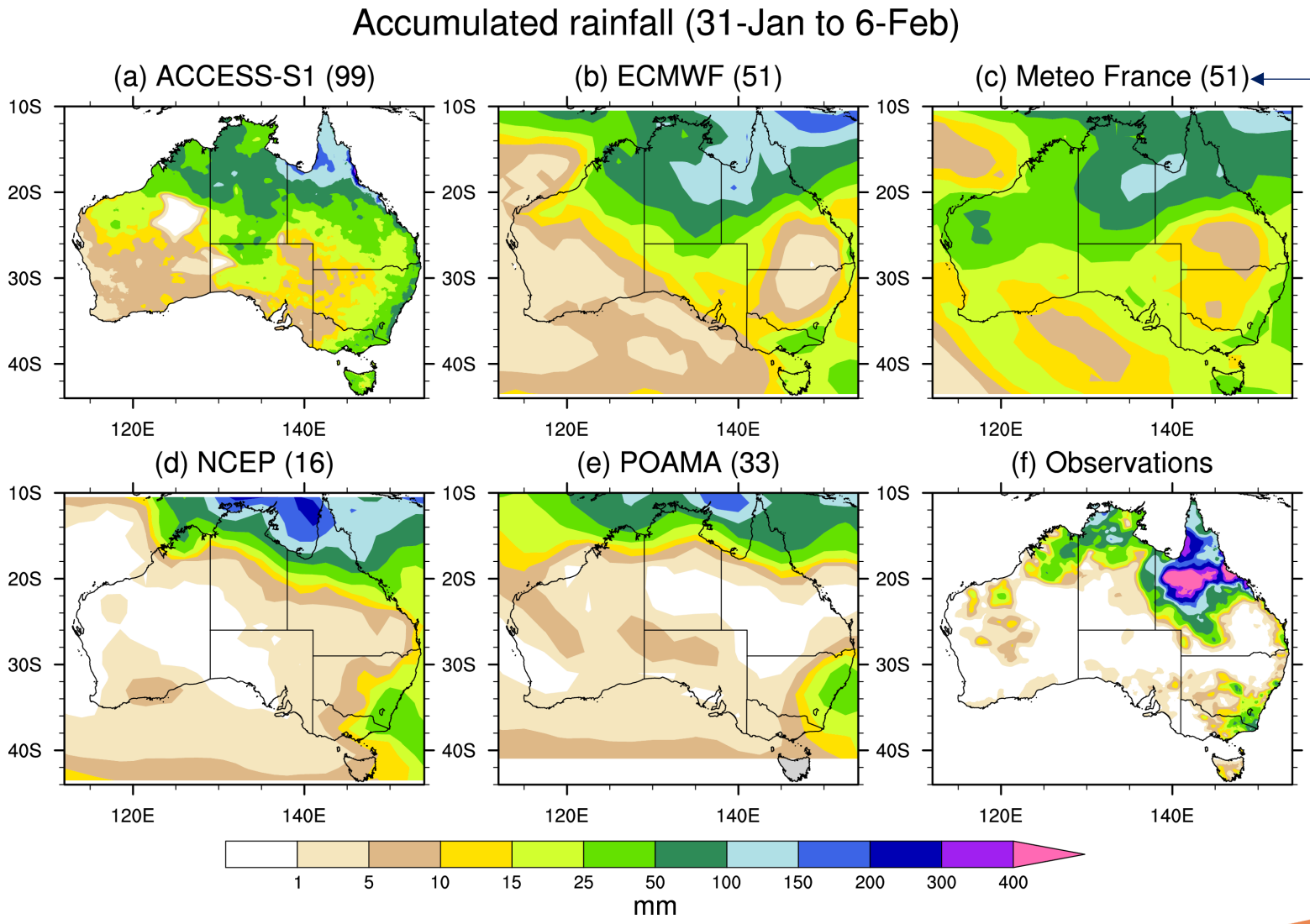
# Prediction of the rainfall magnitude (ensembles)



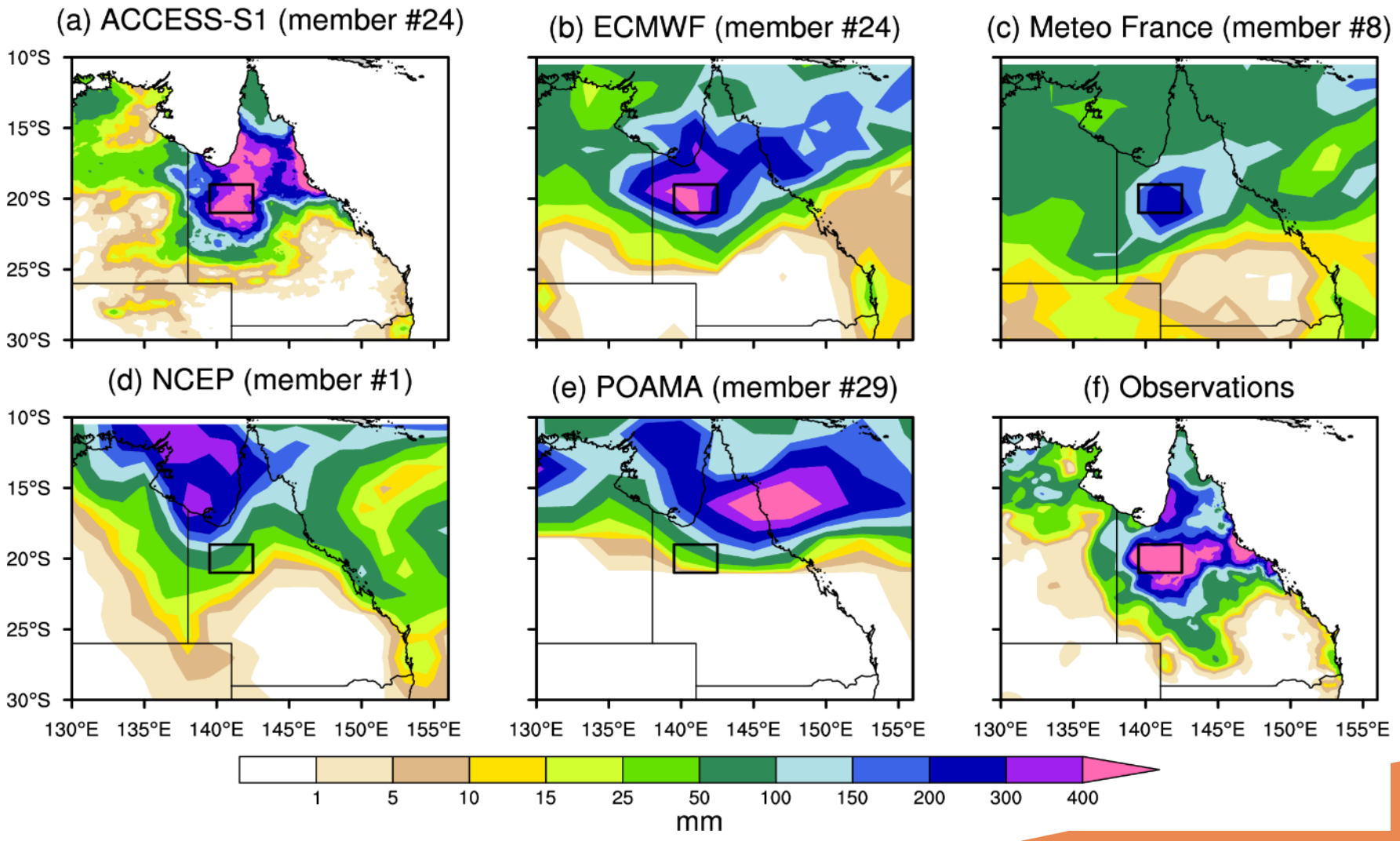

# of members

The S2S (and ACCESS-S1) prediction system ensemble:

- Underestimate the magnitude;
- Fail to capture the southward extent and localised nature of the rainfall (northwest QLD);

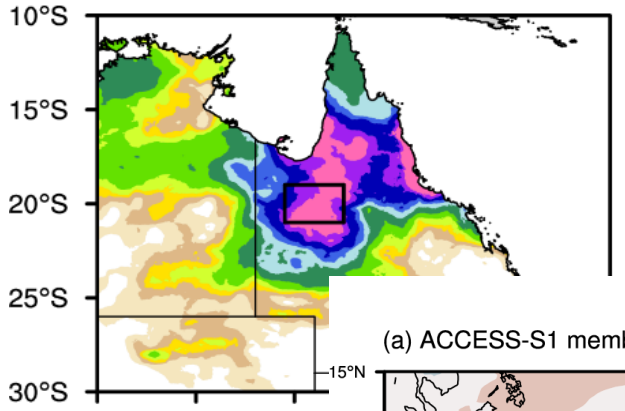
NCEP and POAMA are also too zonally oriented, with rainfall totals tailing off quite substantially away from the Gulf of Carpentaria.

# Individual S2S prediction system members (24th Jan. initialisation)



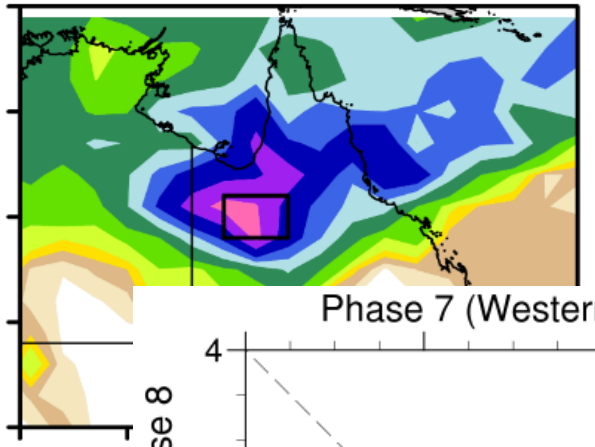
# Predicting extreme precipitation for the right reasons?

(a) ACCESS-S1 (member #24)

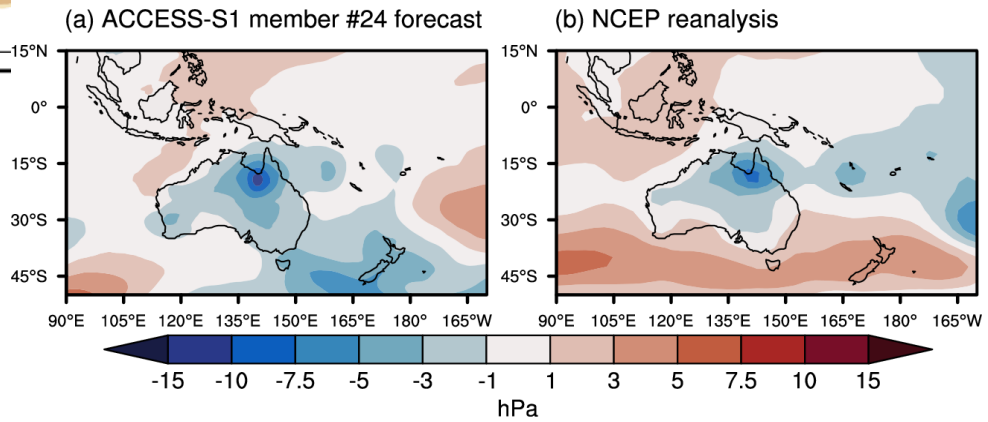



24th Jan forecast

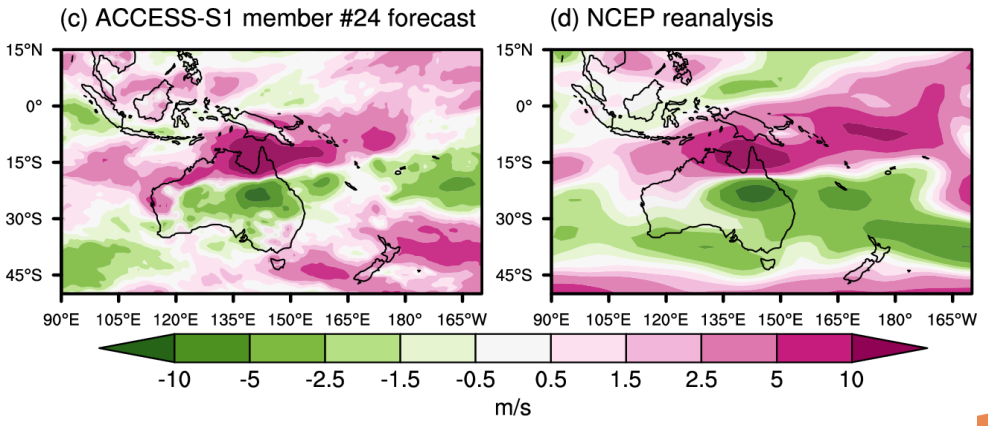
(b) ECMWF (member #24)

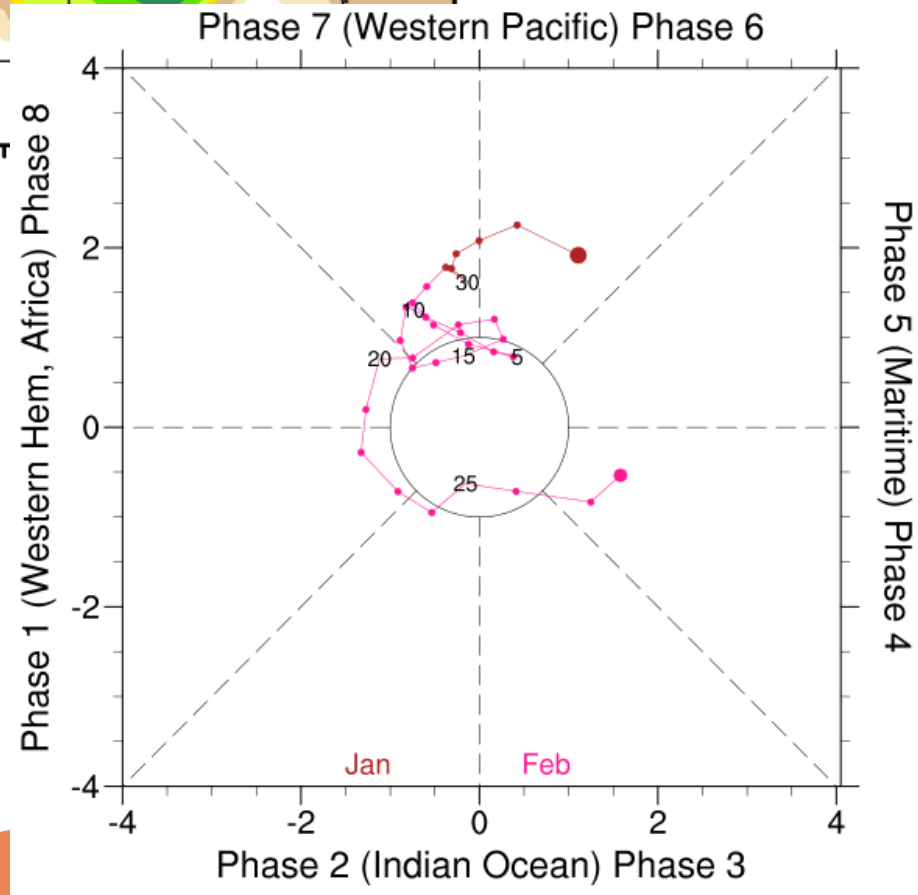


MSLP anomaly




U850 anomaly



# Answers to Questions

1) What were the large-scale climate conditions associated with this extreme event?

- **A MJO pulse which stalled in the Western Pacific (phases 6 & 7)→ typically associated with increased rainfall over northern Qld.**
- **Positive SAM may have partly contributed, but usually its impacts are further south.**
- **Atmospheric blocking likely contributed, but further study warranted.**

2) Why did the BoM's issued monthly forecast for February apparently 'miss' the event?

- **Possibly due to timing, and the fact that it contained forecasts from as far back as the 18th January (beyond predictability). Also, 5-day gap between model and issuing forecast could have been important. Will be reduced in 3-days in the future.**

3) Would a multi-week forecast product, issued within a day of being generated, have provided greater benefit?

- **Forecasts from the 24th January showed a 40-60% probability of extreme conditions over northwest Qld, so this information could have been useful...**
- **However, the magnitude of the precipitation was underestimated, and so it is an open question whether any producer would have acted on the multi-week prediction.**

Roger Hill – Queensland Country Life