MJO-Impact on Australian Temperature Extremes during Austral Spring

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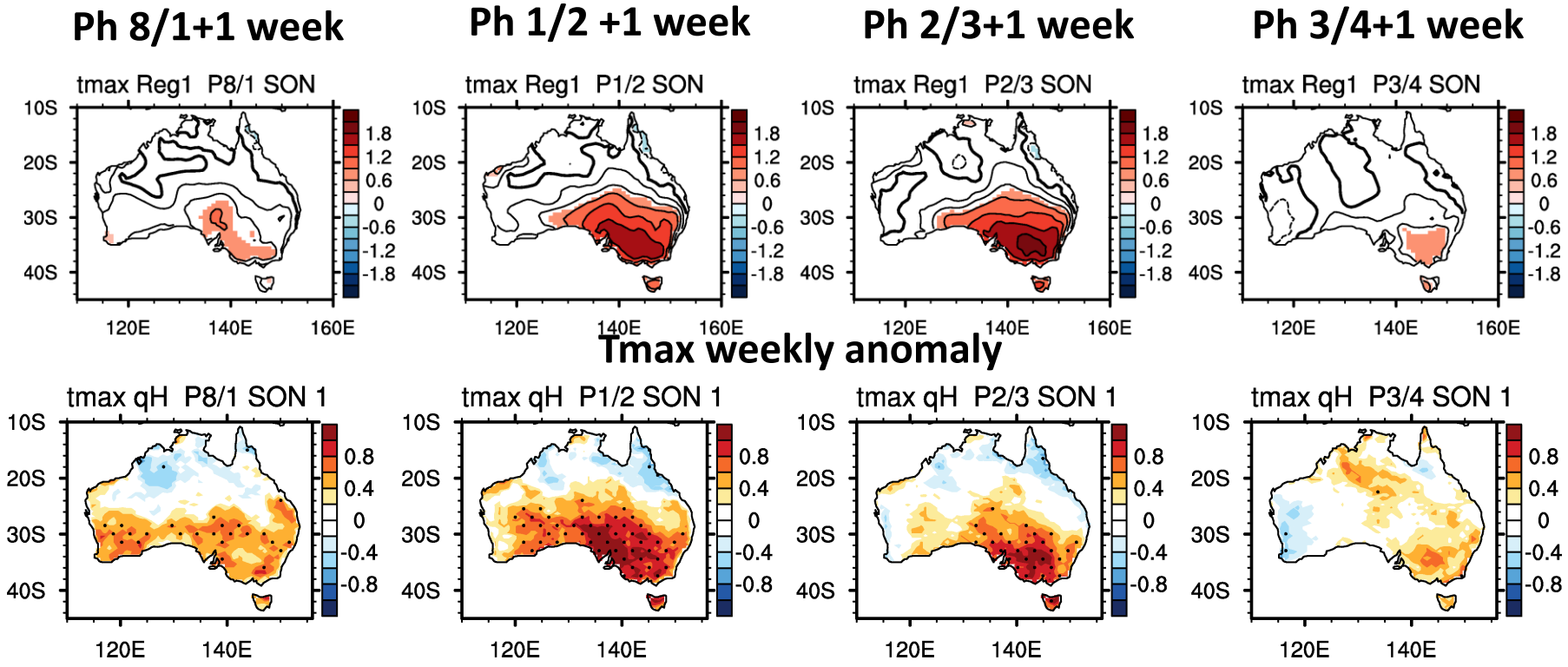
- Observed relationship between MJO and weekly Tmax/Tmin
- Mechanism of MJO teleconnection into Southern Hemisphere
- Predictability with ACCESS-S1 (new S2S prediction system at BoM)

MJO Tmax weekly anomalies SON 1990-2012 (compatible with hindcast record)

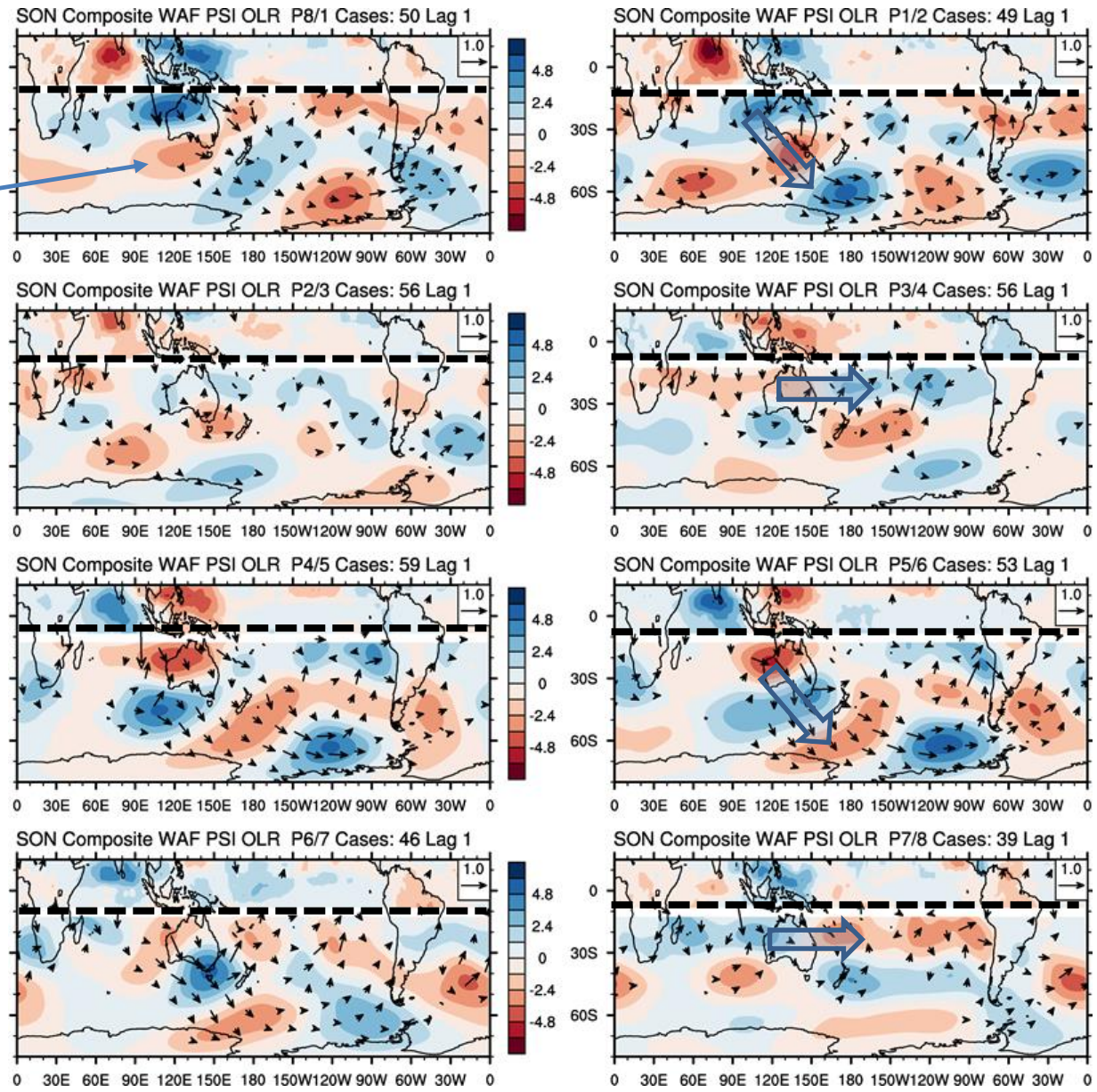


- The other 4 phases look the opposite
- Impact on Tmin is similar
- **Little indication of any W-E progression**

MJO Composite Ψ_{200}, Wave activity flux, equatorial OLR during SON

OLR'

ψ_{200}, Wave activity flux



Ph8/1

Ph1/2

Ph2/3

Ph3/4

Ph4/5

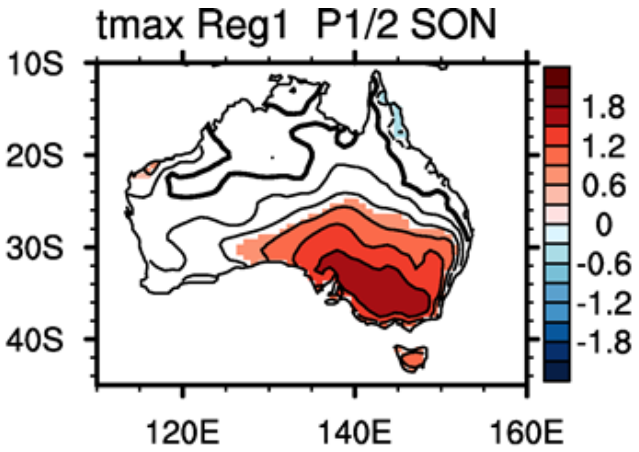
Ph5/6

Ph6/7

Ph7/8

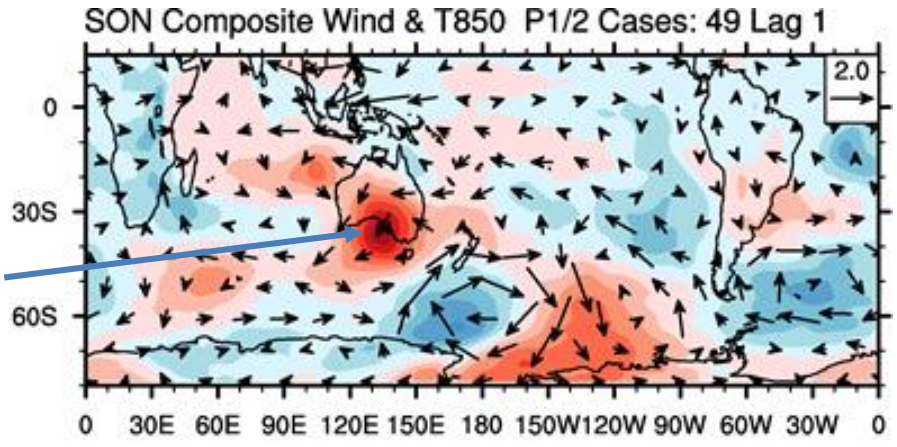
Ph1/2

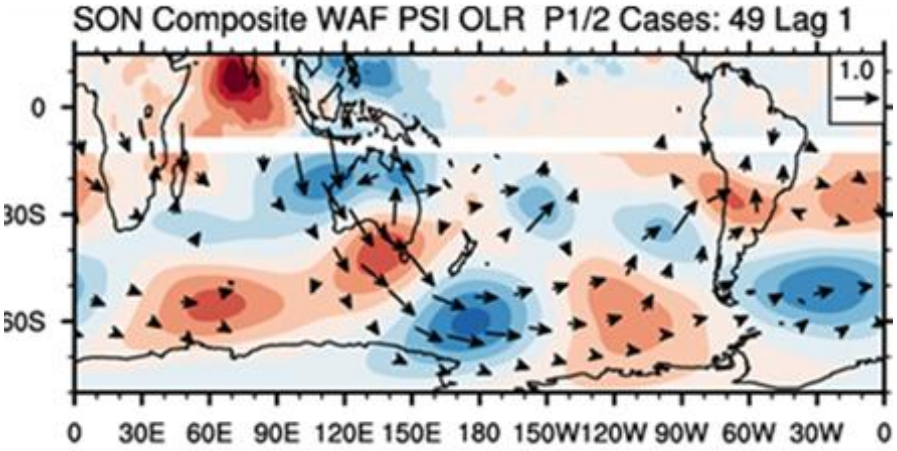
Tmax weekly anom



T (u,v) 850hPa

Hot in southeast under influence of anticyclonic northeasterlies



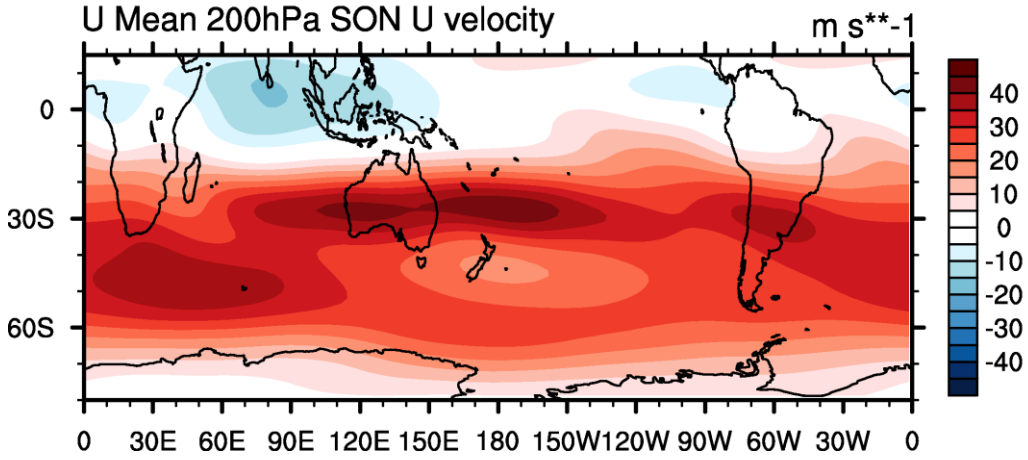


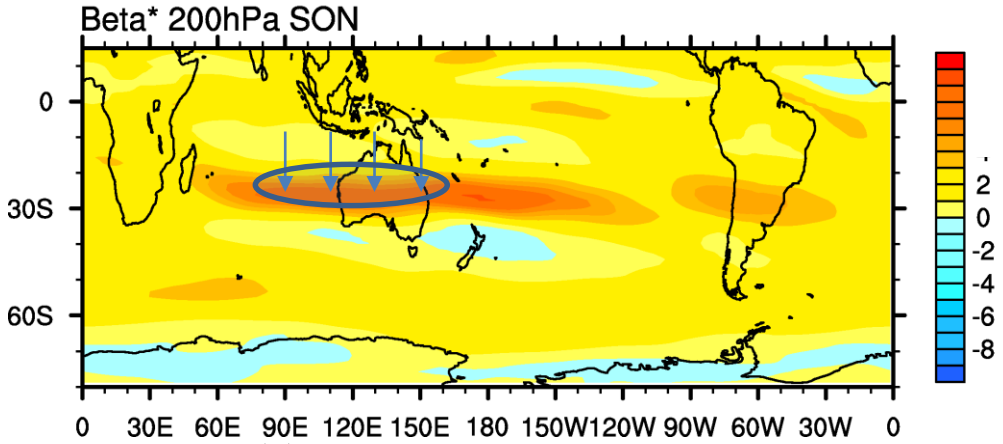
Why is the teleconnection apparently fixed in space, despite continuous west-east propagation of convective anomaly?

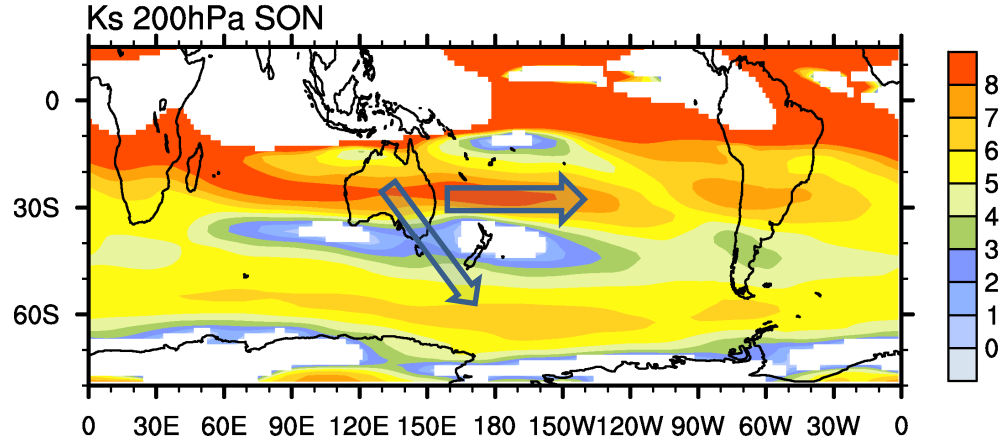
1) MJO is exciting some sort of internal mode (like PNA) X (possible but not supported by evidence yet)

2) Rossby wave source produced by MJO convection is localized in space X (Rossby wave source exhibits W-E propagation from 60-180E)

3) Mean state supports Rossby wave propagation from tropics to extratropics in limited longitudinal domain ✓







Impacts of mean flow on Rossby Waves:

- Localization of **R**ossby **w**ave **s**ource
- Preferential Rossby wave propagation (K_s)

$$\beta^* = \beta - \frac{\partial^2 \bar{U}}{\partial y^2}$$

$$\mathrm{RWS} = -\mathbf{v}_\chi \cdot \nabla\zeta - \zeta D \approx -\mathbf{v}_\chi' \cdot \nabla\bar{\zeta} - \bar{\zeta} D'$$

$$\approx -v'_d \beta^*$$

Convective outflow 60E-180E expected to make localized RWS along ~25S (max B)*

$$K_s = \left(\frac{\beta^*}{\bar{U}}\right)^{1/2}$$

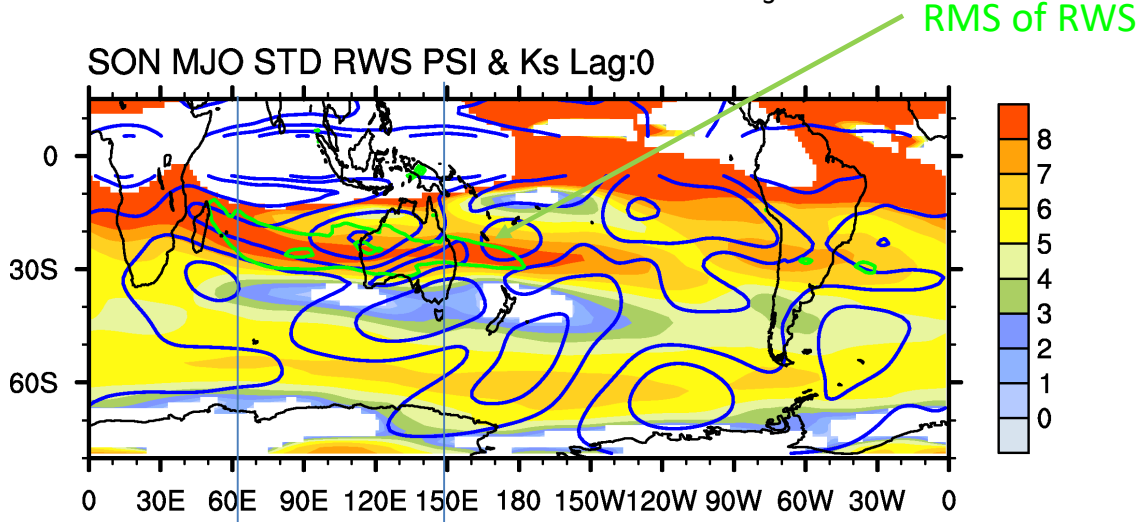
Propagate only where Ks>0

Refracted toward high Ks

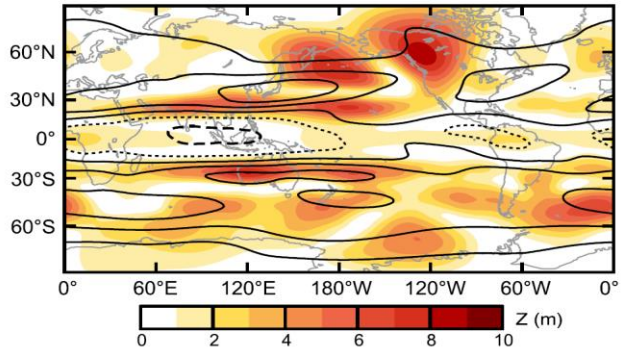
Localized max acts as waveguide

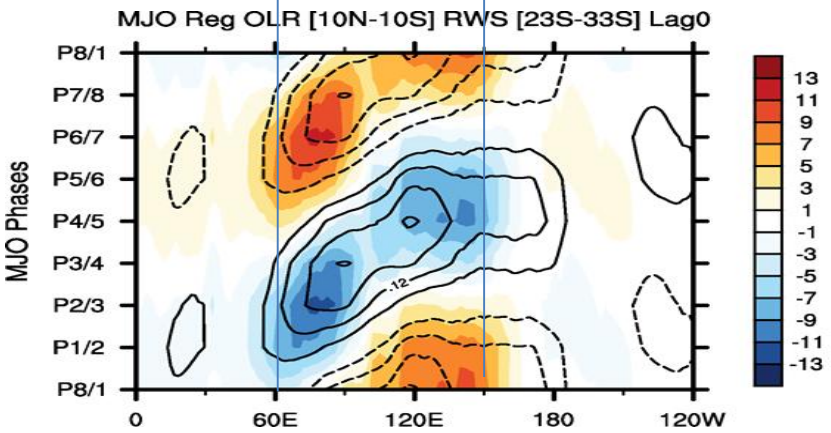
RMS amplitude of ψ200 (blue contours) and RWS (green contours) anomalies across all MJO phases

Background field is K_s



Adames and Wallace 2014 but using all months (Z' and ubar)





OLR along 0-10S (shaded)

Rossby wave source along 23-33S (contoured)

RWS is continuous ~60E-180E

Composite OLR and RWS for each MJO phase

ACCESS-S1 coupled model prediction system

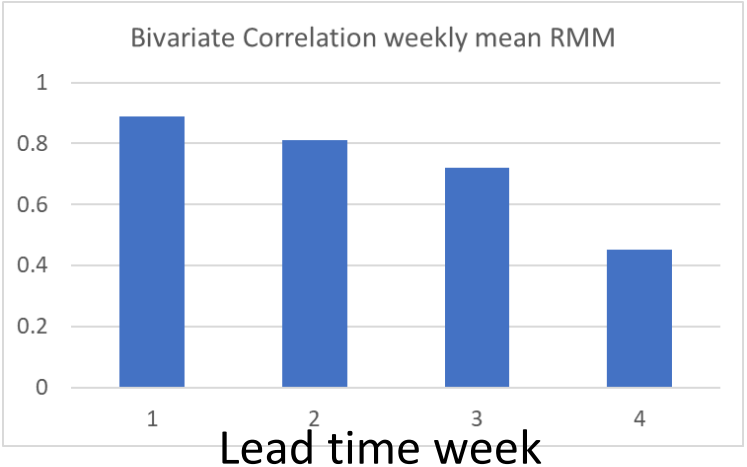
Based on UKMO GC2 (same as GloSea5)
60 km atmos with 85 levels (UM8.6 GA6)
Nemo ocean (ORCA25 25 km with 70 levels)

Hindcasts initialized 4 times per month 1990-2012
Atmos IC from ERA-Interim
Ocean/sea ice from UKMO assimilation

11 member ensemble by perturbing atmos IC plus SKEB2 stochastic physics

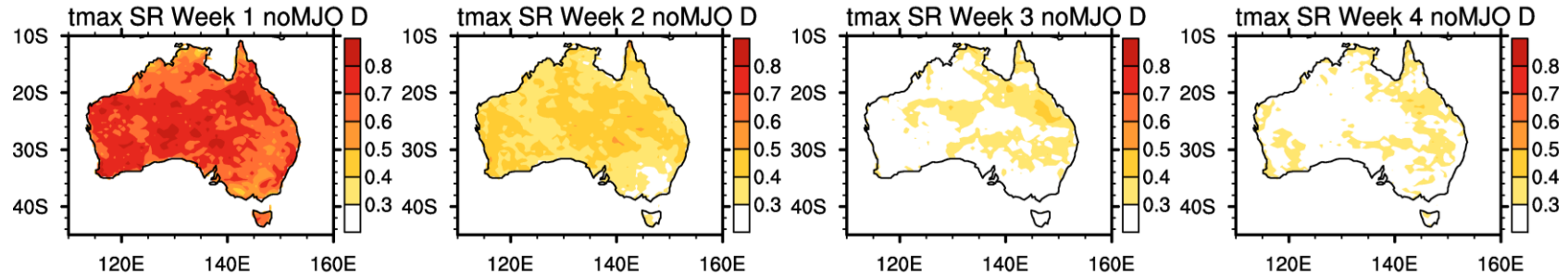
Real time: 33 members everyday

Good skill for predicting weekly mean MJO

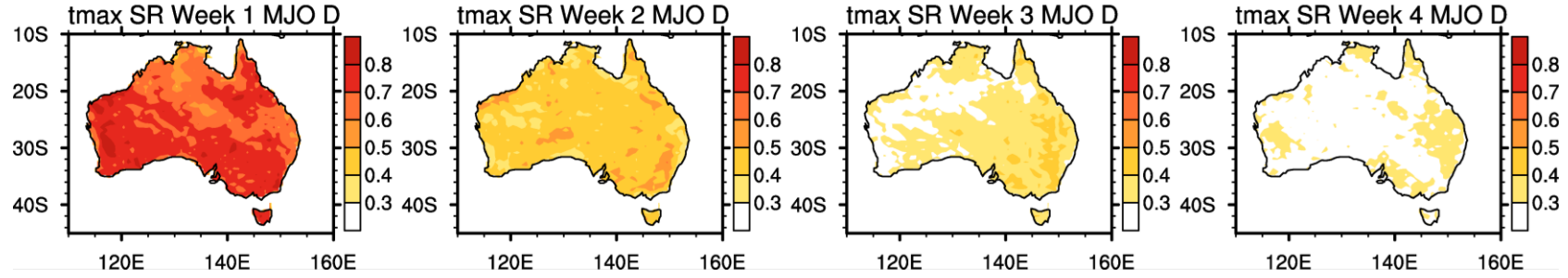


Success Ratio =hits/(hits+false alarms) for Tmax in upper quintile SON 1990-2012

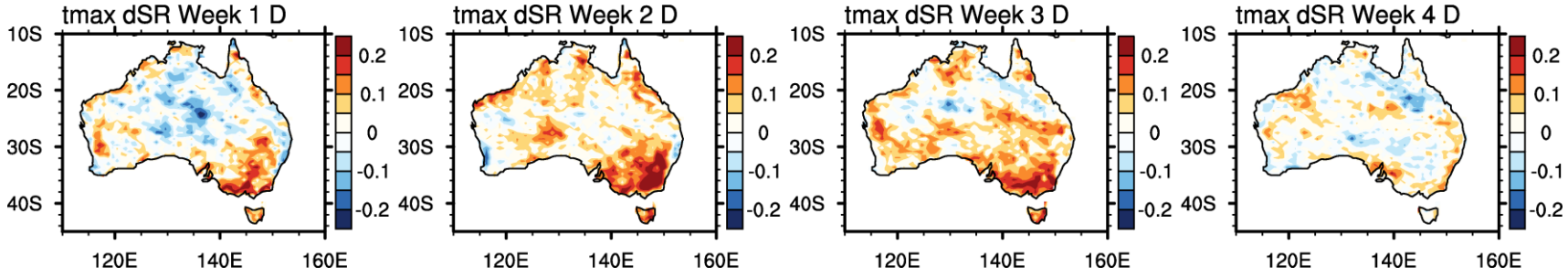
Week 1 | Week 2 | Week 3 | Week 4



Weak MJO at t=0



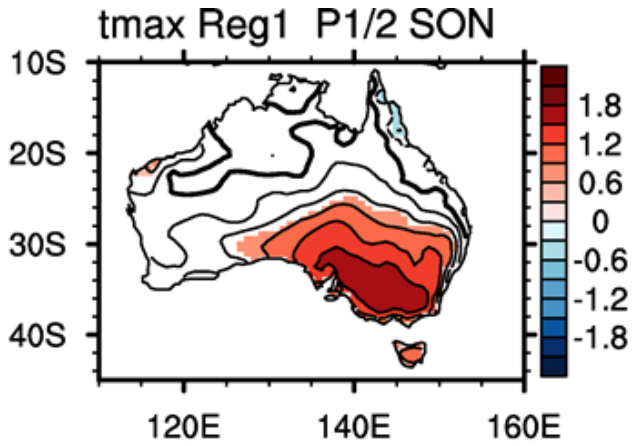
Observed MJO strong at start of each week



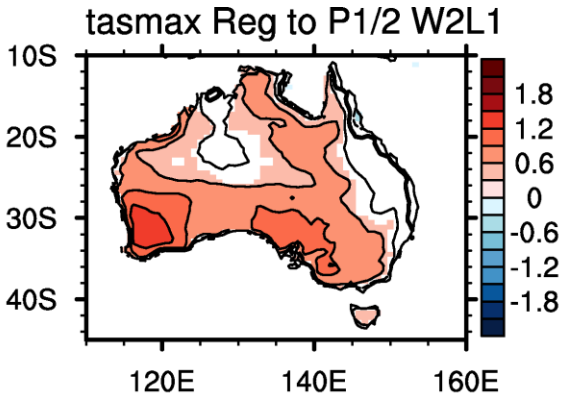
Difference MJO S-W

How well does ACCESS simulate MJO teleconnection?

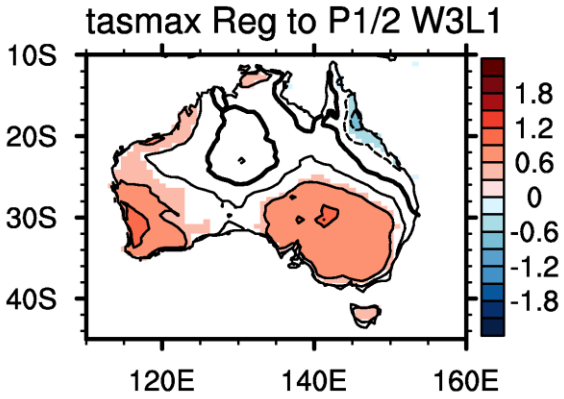
Observed Tmax anomaly Ph1/2



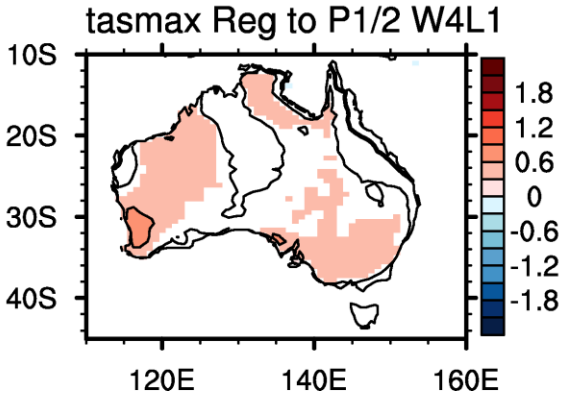
Model MJO composite Ph1/2 using individual members



Week 2



Week 3



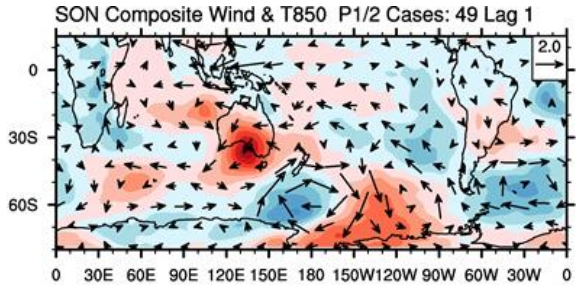
Week 4

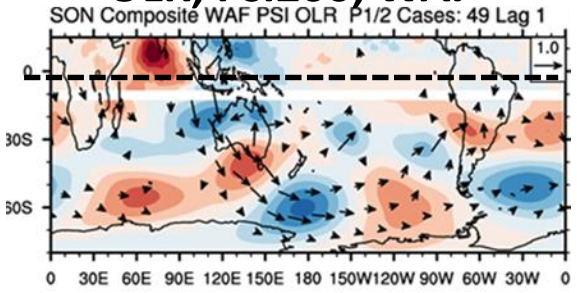
Model signal too far west and weakens with lead time

T, (u.v) 850hPa

OLR, Psi200, WAF

Obs Ph1/2





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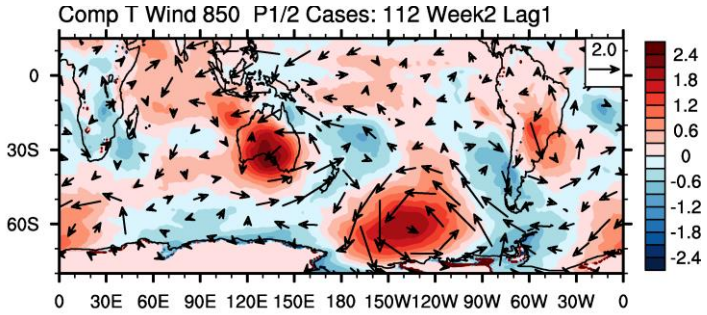

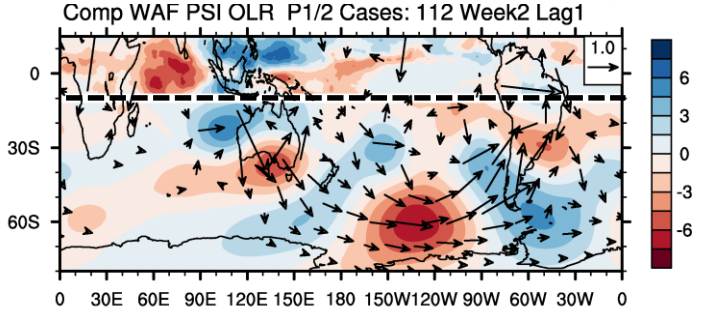

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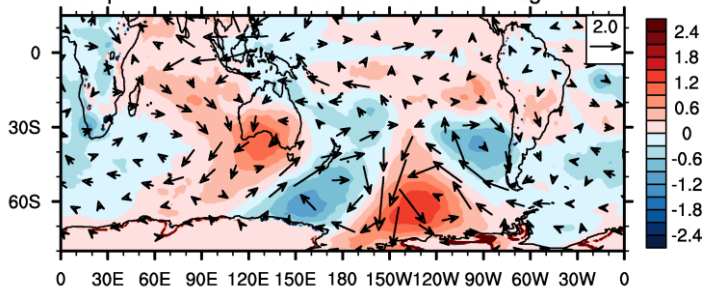

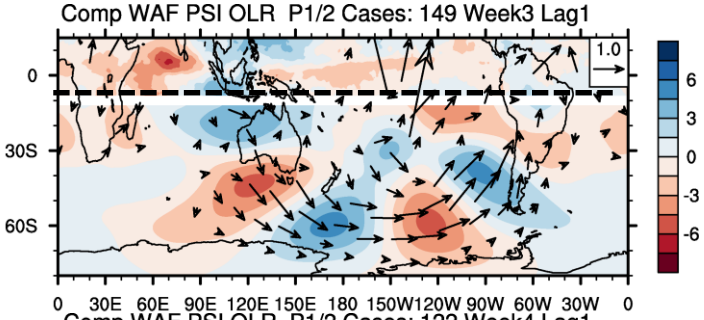

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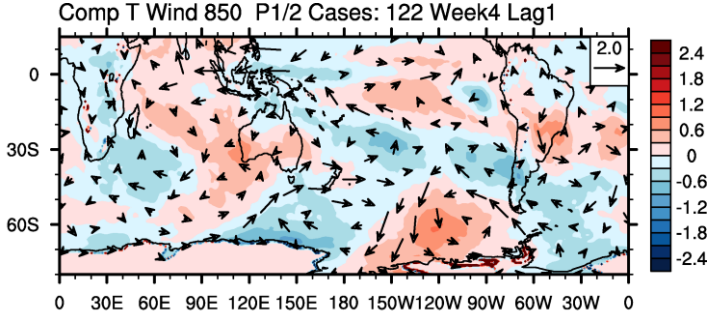
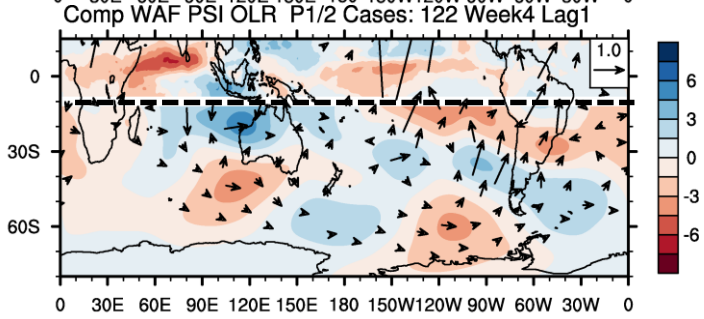
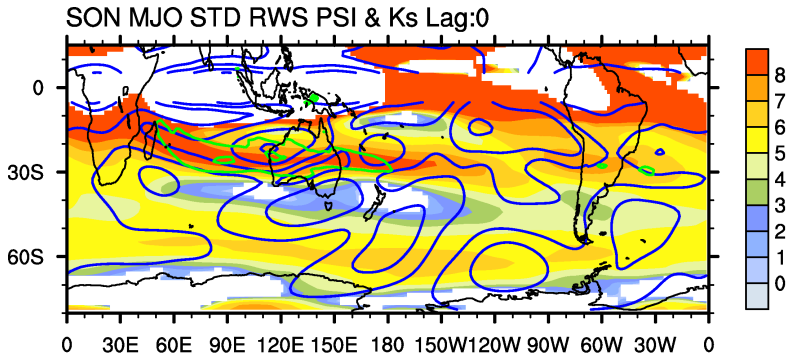
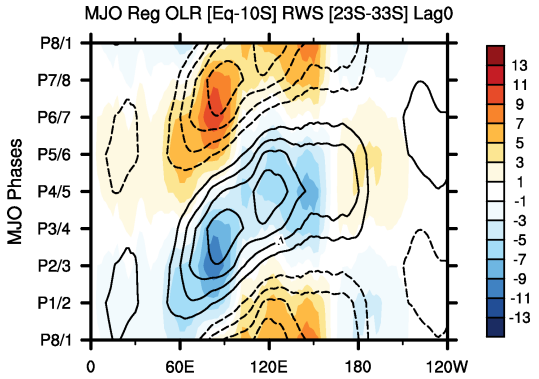




Obs



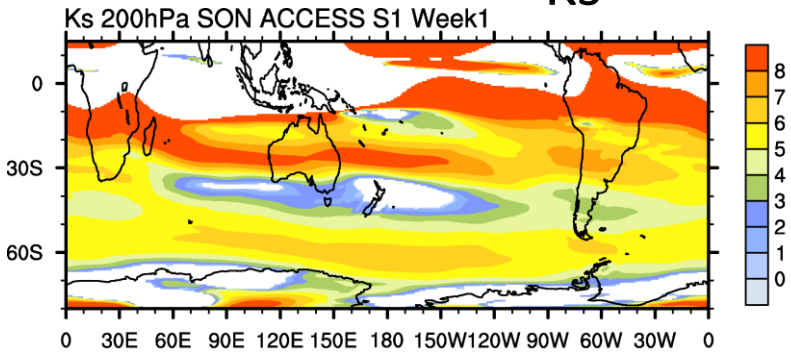


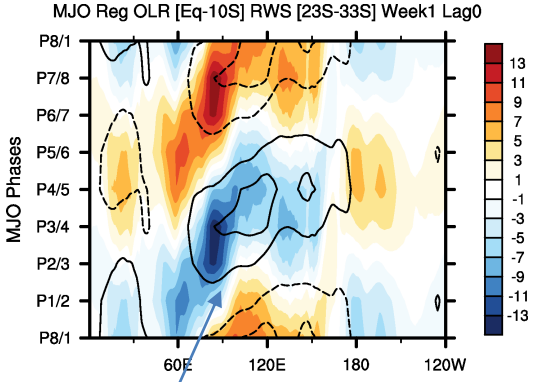
OLR (0-10S)

RWS (23-33S)

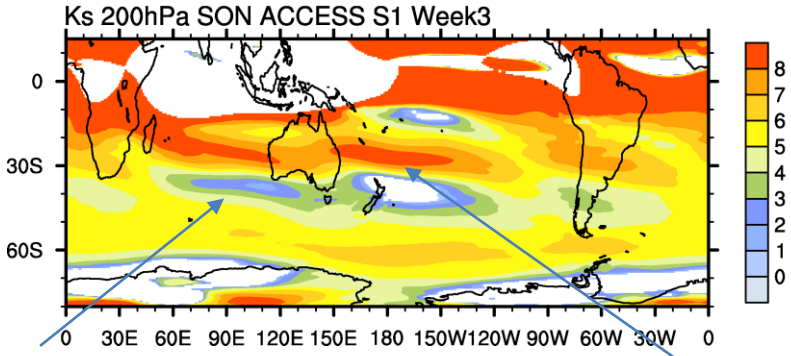
Ks

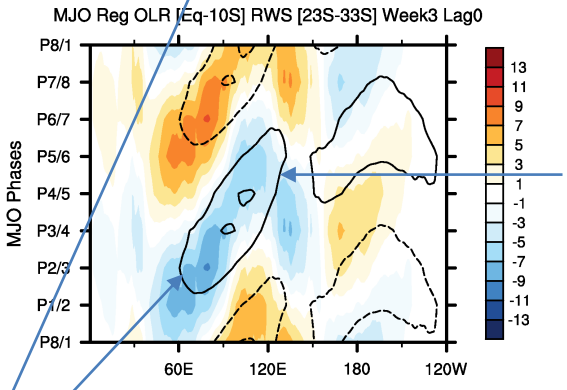
Week 1





Week 3





Weakened OLR and not extending far enough east

Less inhibition to propagation: teleconnection smeared out to west

Weaker B*

Weaker RWS

Conclusions

- MJO teleconnection into SH during spring strongly regulated by mean state flow
  Results in non-translating (fixed in space) wave train
- MJO is source of predictability of temperature extremes across southern Australia
- MJO well predicted by ACCESS-S1 to at ~week 3
- Impacts on Australian T well captured in first ~2 weeks of forecast but model biases in both MJO (too weak to north of Australia and into W Pacific) and mean flow (entrance to STJ weakens and merges into high latitude EDJ) act to weaken predictable impacts in weeks 3-4
- Could be explored in S2S archive to see how pervasive are these biases