The Evolving Forms of Circumnavigating, Successive MJOs

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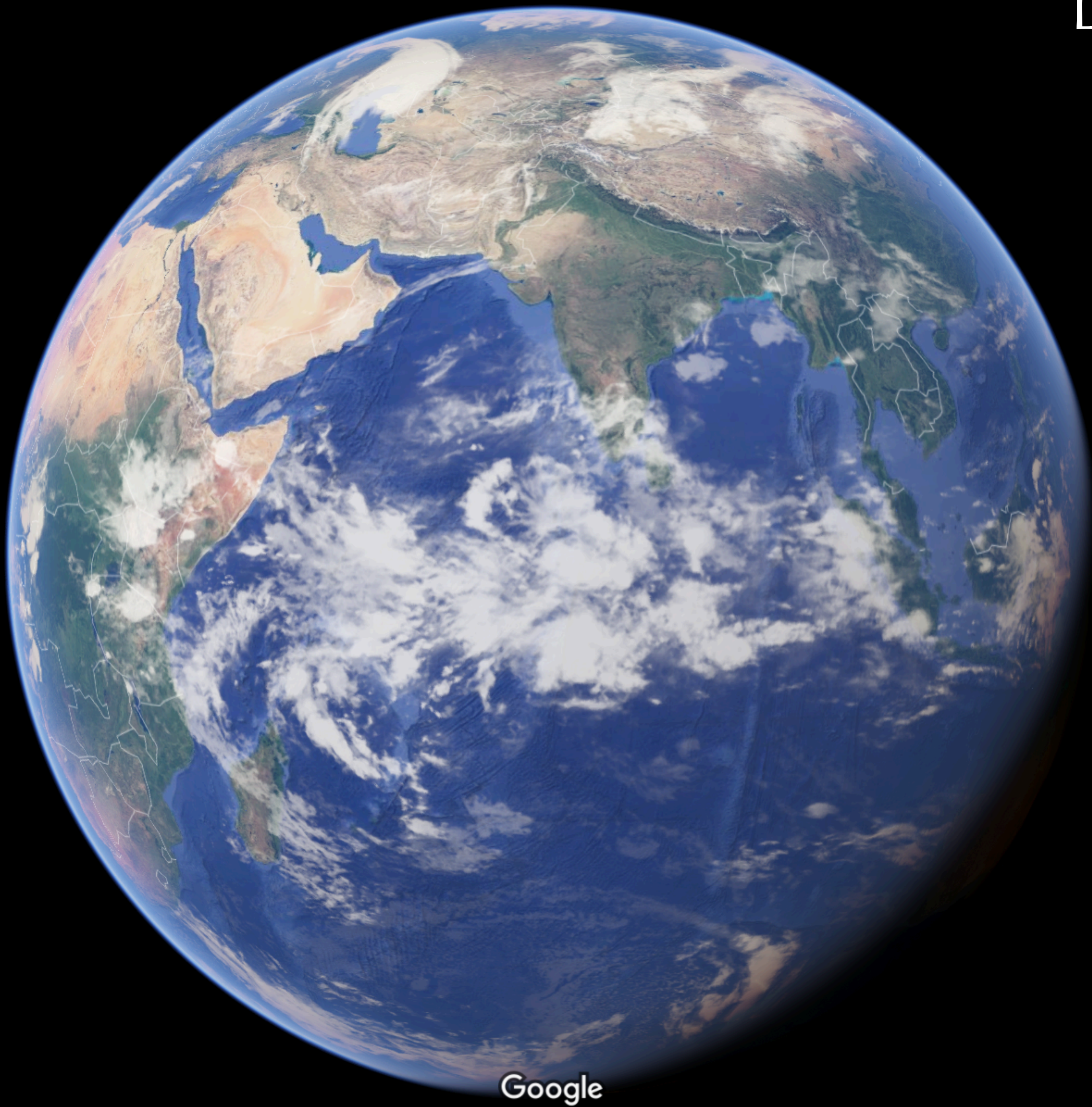
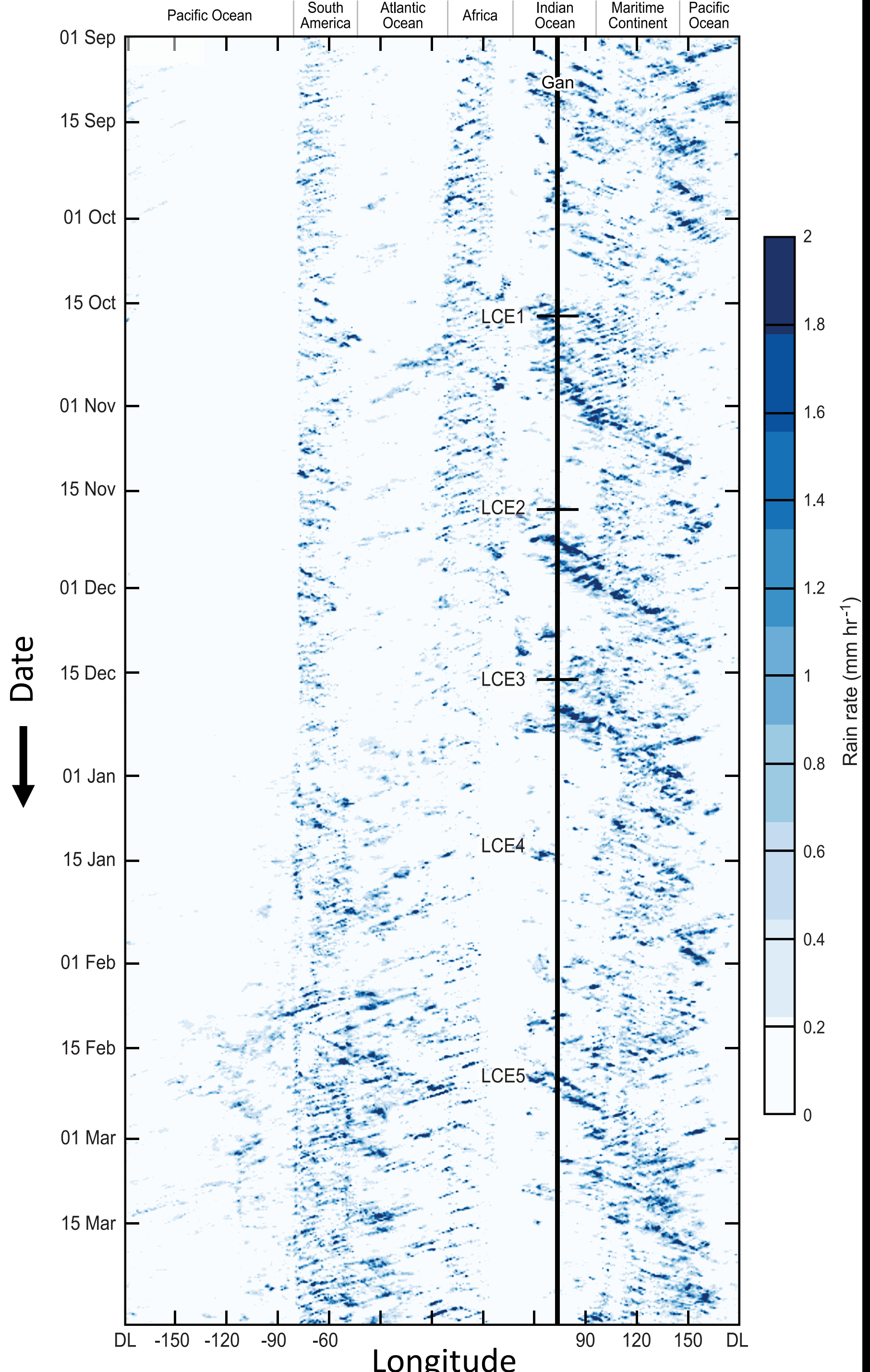
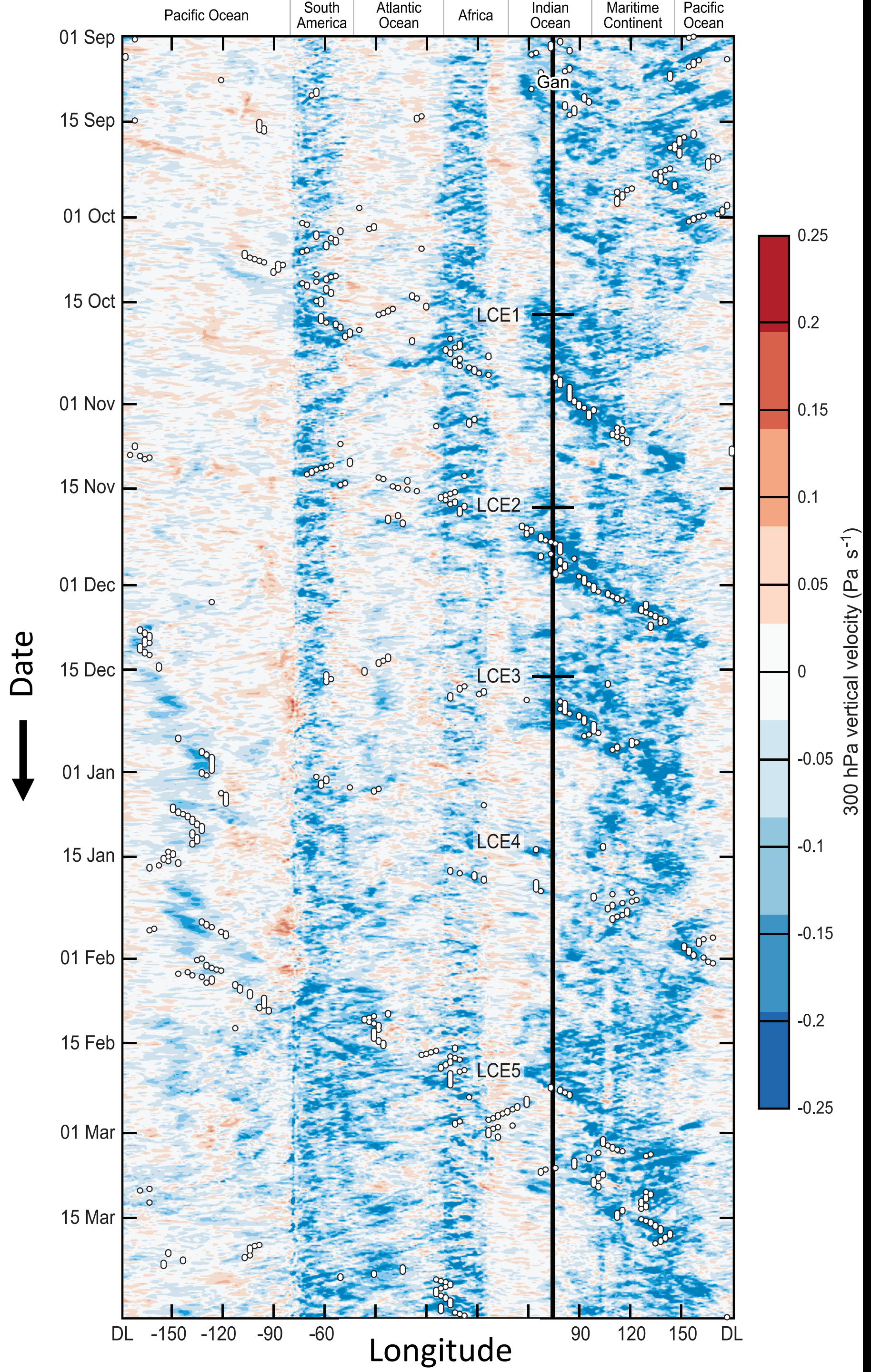
Last night



TRMM 3B42 Precipitation

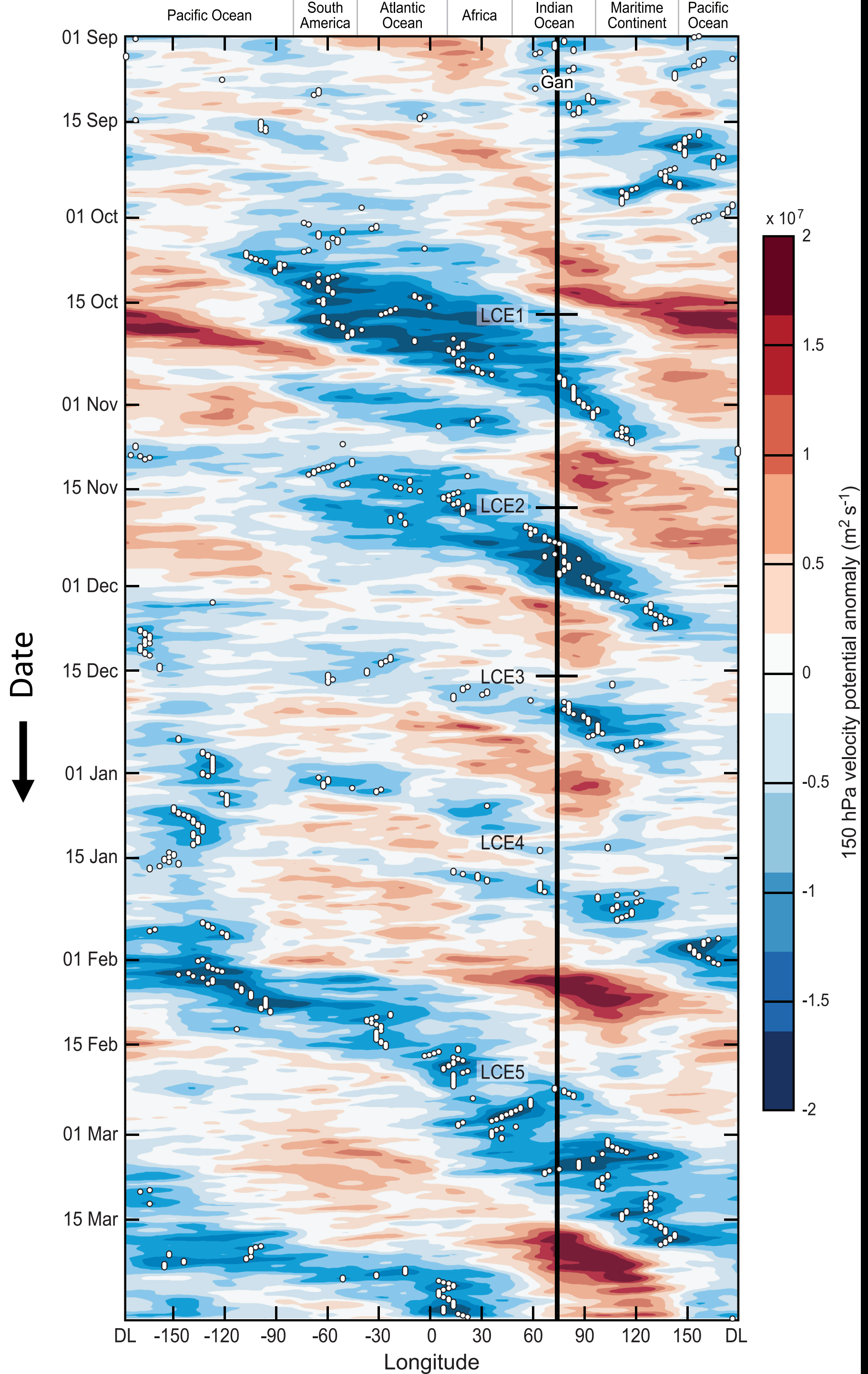


Powell and Houze (2015)



ERA-Interim Vertical Velocity

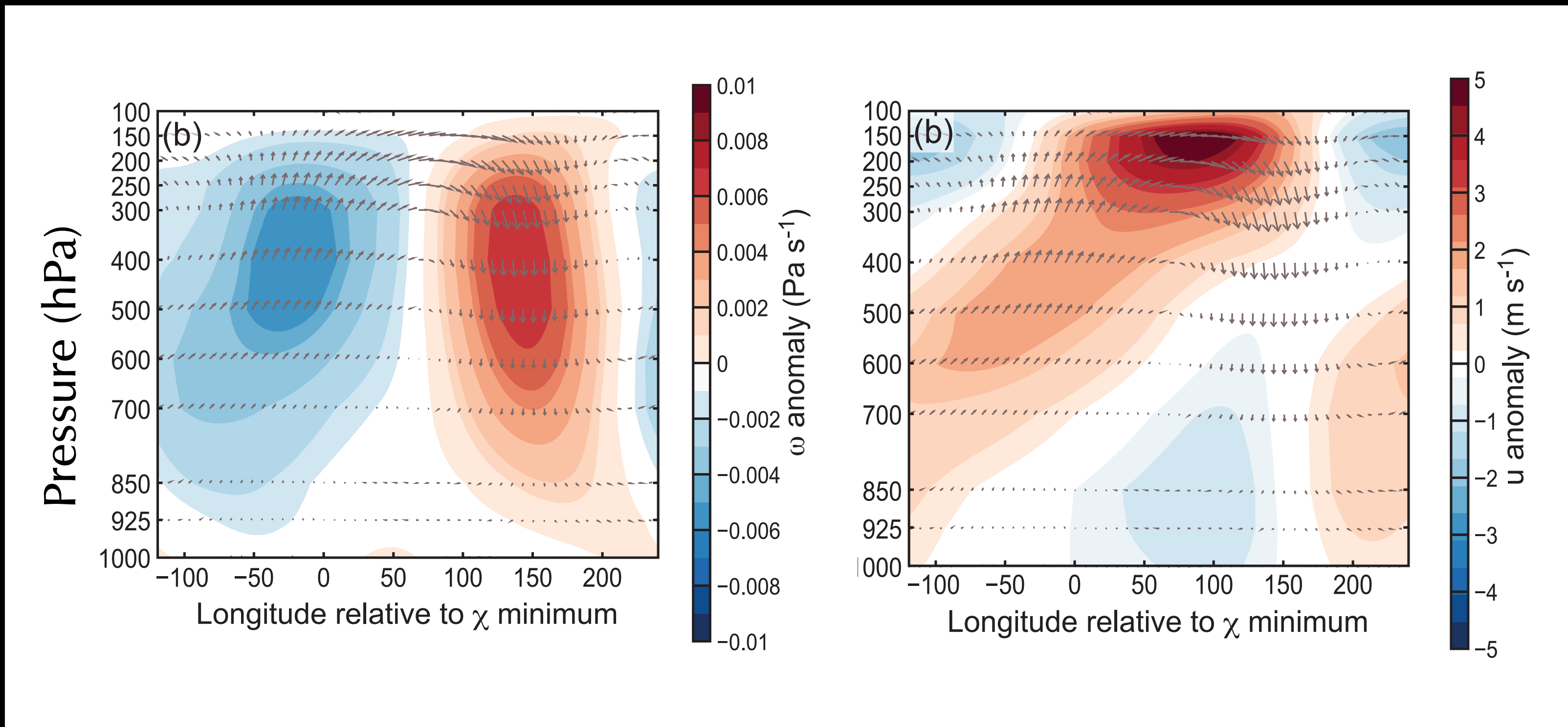
Powell and Houze (2015)



ERA-Interim 150 hPa Velocity Potential

Powell and Houze (2015)

ω' u'



Powell and Houze (2015)

Propagation of Coupled Equatorial Gravity Wave

$$\frac{\partial T}{\partial t} - S\omega = Q$$

Assert $Q \approx -\mu S\omega$ (Haertel et al. 2008)

$$\frac{\partial T}{\partial t} - (1-\mu)S\omega = 0$$

$c = \sqrt{gh_e}$ is the "dry" shallow water gravity wave speed.

$c_m = \sqrt{(1-\mu)gh_e} = \sqrt{\left(1 + \frac{Q}{S\omega}\right)gh_e}$ is theoretically reduced phase speed for first baroclinic mode (e.g. Neelin et al. 1987).

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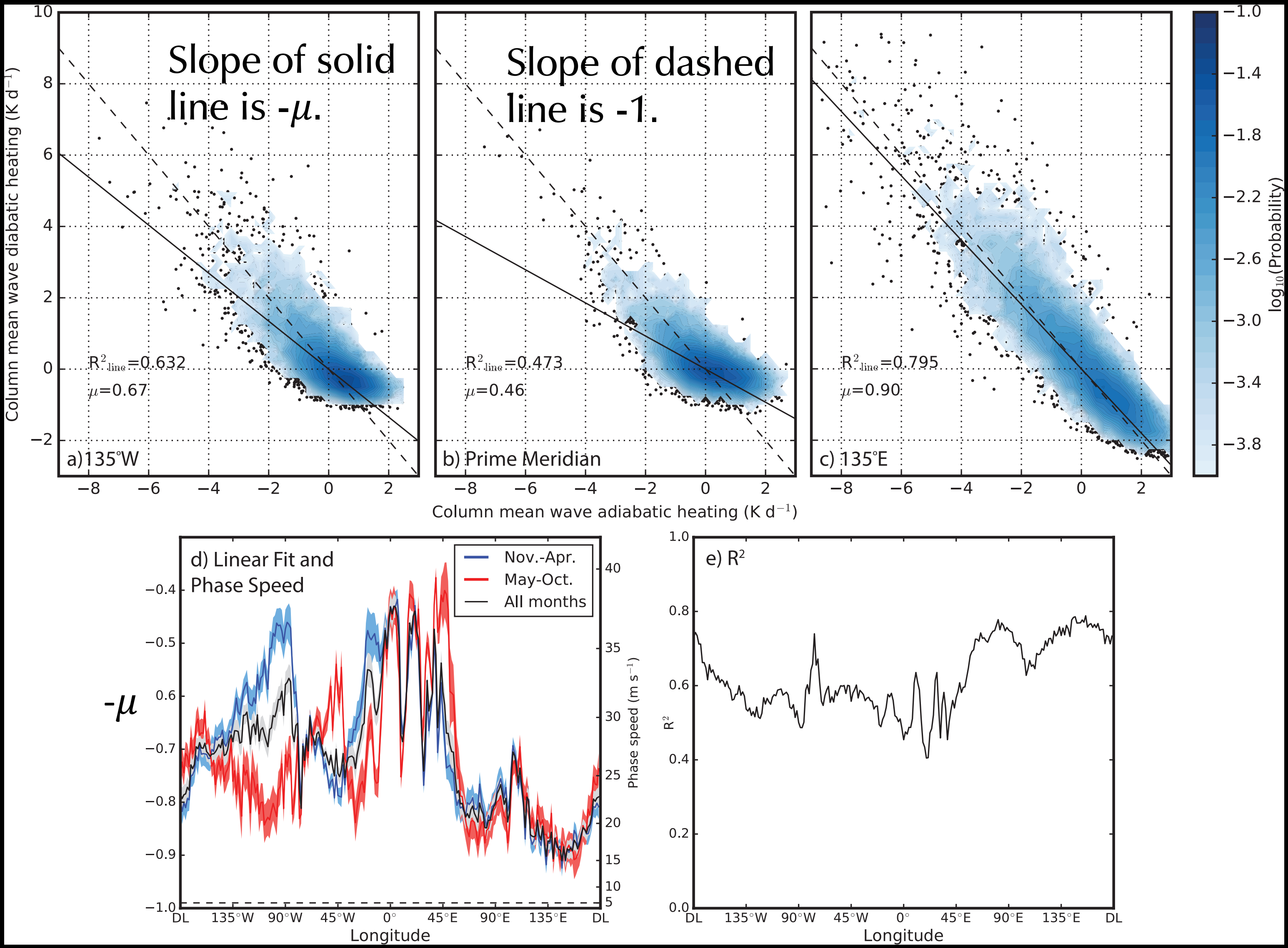
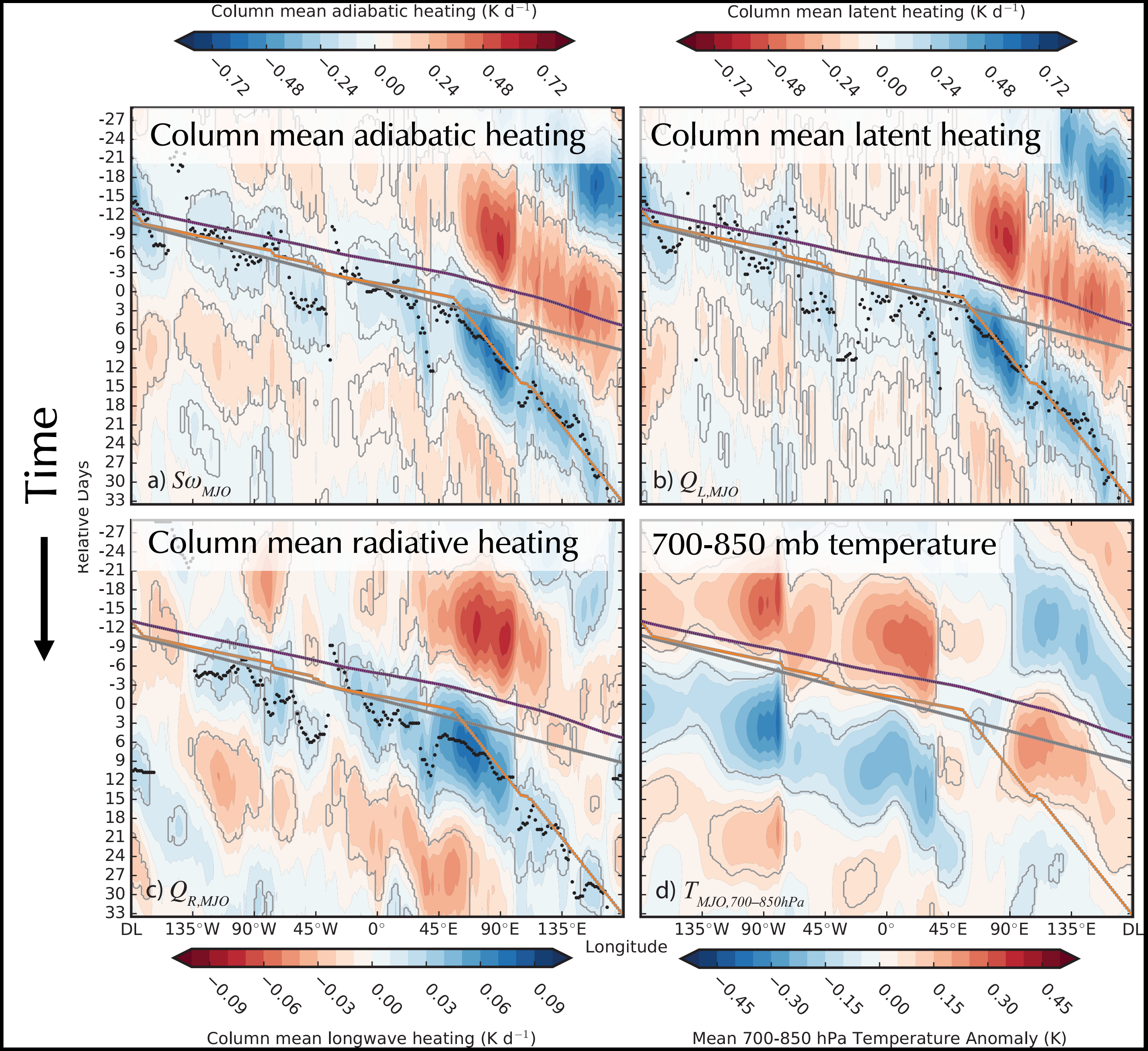
Powell (2017)



Slope of solid line is -μ.
Slope of dashed line is -1.
Column mean wave diabatic heating (K d⁻¹)
Column mean wave adiabatic heating (K d⁻¹)
R²line=0.632
μ=0.67
a) 135°W
R²line=0.473
μ=0.46
b) Prime Meridian
R²line=0.795
μ=0.90
c) 135°E
log10(Probability)
d) Linear Fit and Phase Speed
Nov.-Apr.
May-Oct.
All months
-μ
Phase speed (m s⁻¹)
Longitude
e) R²
R²
Longitude

Powell (2017)

Composited over 15N to 15S; filtered for 20–100 day signal



Purple: Phase speed of CCKW at all longitudes

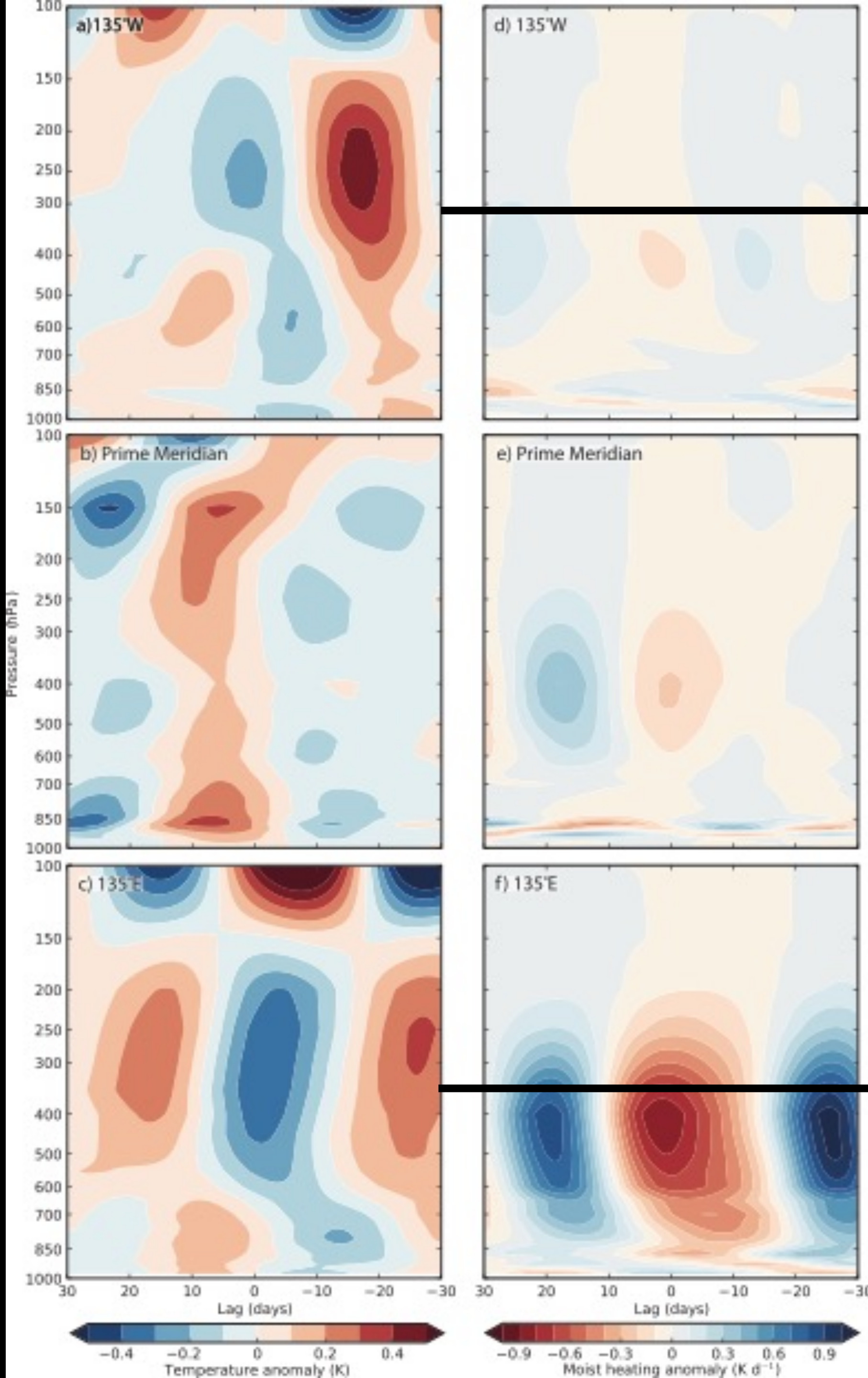
Orange: Phase speed of CCKW where $\mu \leq 0.75$; moisture wave speed elsewhere

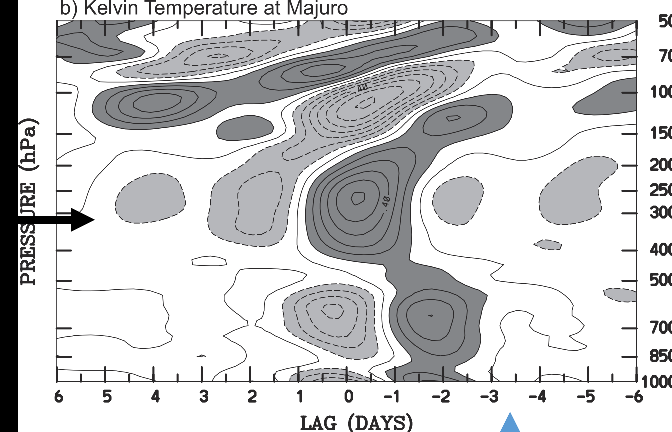
Gray: 23 ms^{-1}

East Pacific

East Atlantic

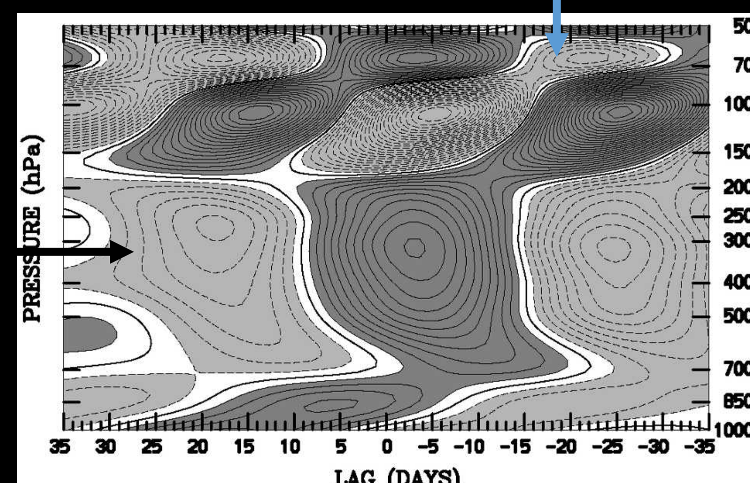
Warm Pool





Kiladis et al. (2009)

Kiladis et al. (2005)



Conclusions

- The MJO propagates at a speed consistent with a convectively coupled (not dry!) Kelvin wave (CCKW) outside of the warm pool.
- CCKW phase speed alone cannot explain propagation over warm pool. (Of course, we've known this for a long time!)
- A full MJO theory probably requires transition of a CCKW into "whatever the MJO is over the warm pool" and back to CCKW.

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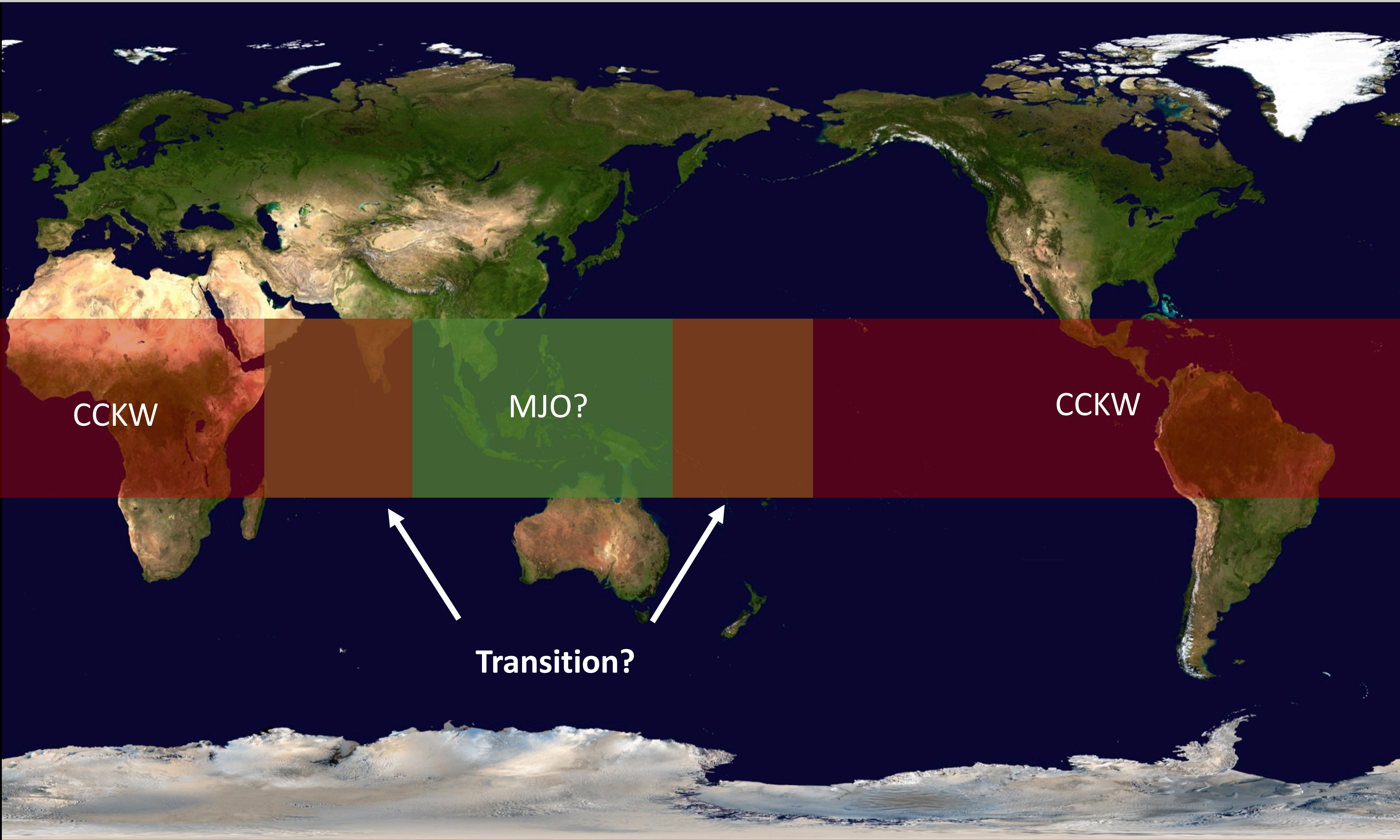
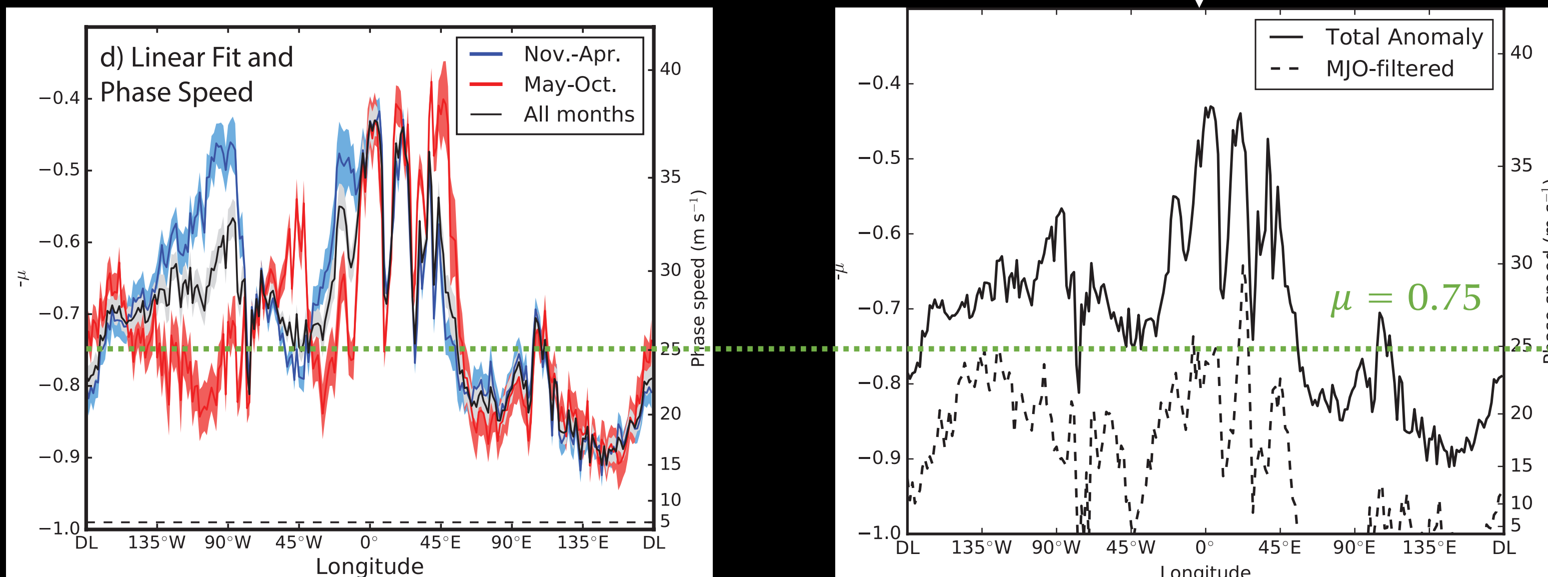


End

Black line from left panel is solid.
MJO filtered values are dashed.



Circumnavigation speed varies seasonally.

Boreal Summer (May-Oct.) Boreal Winter (Nov.-Apr.)