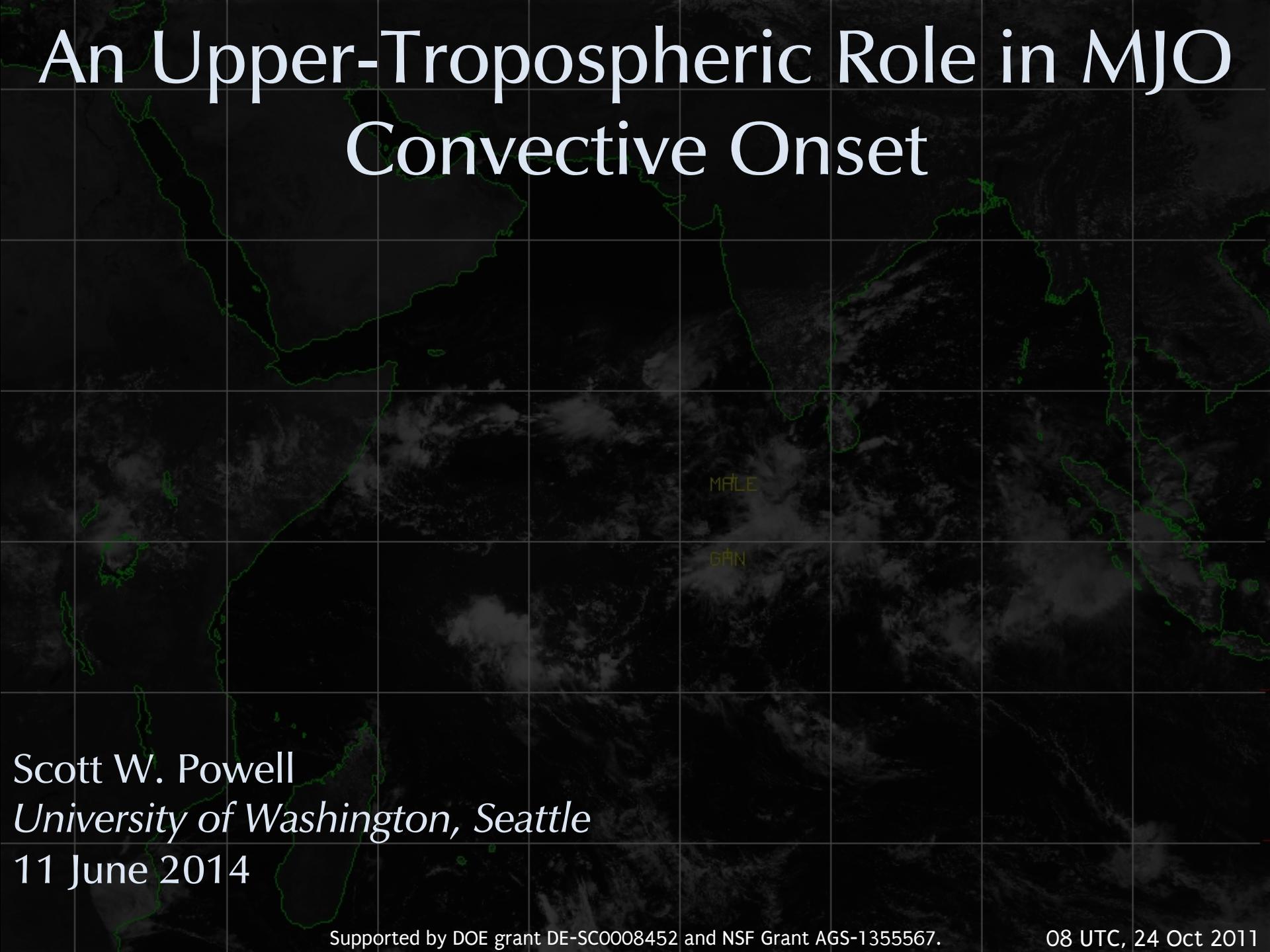


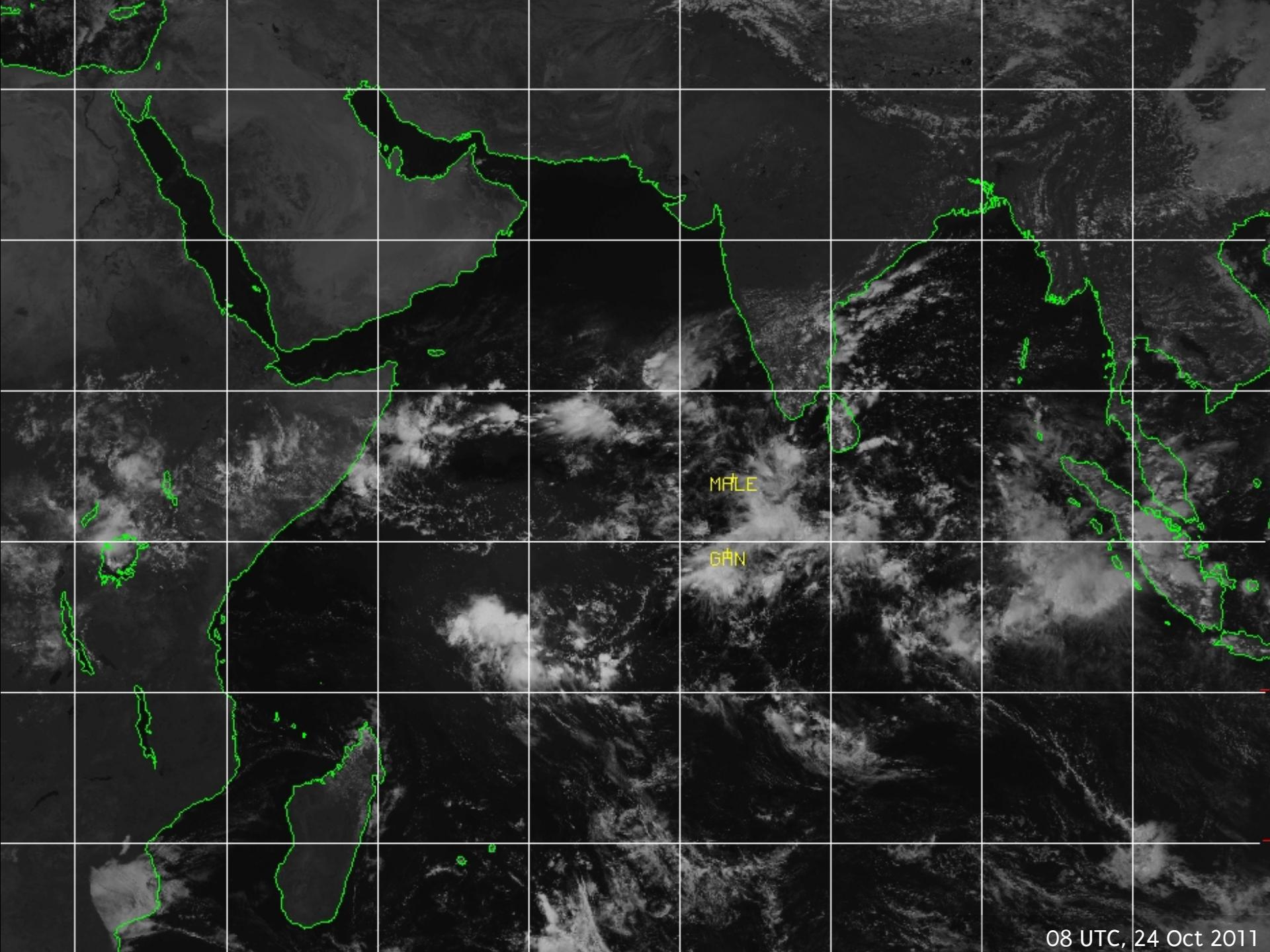
An Upper-Tropospheric Role in MJO Convective Onset



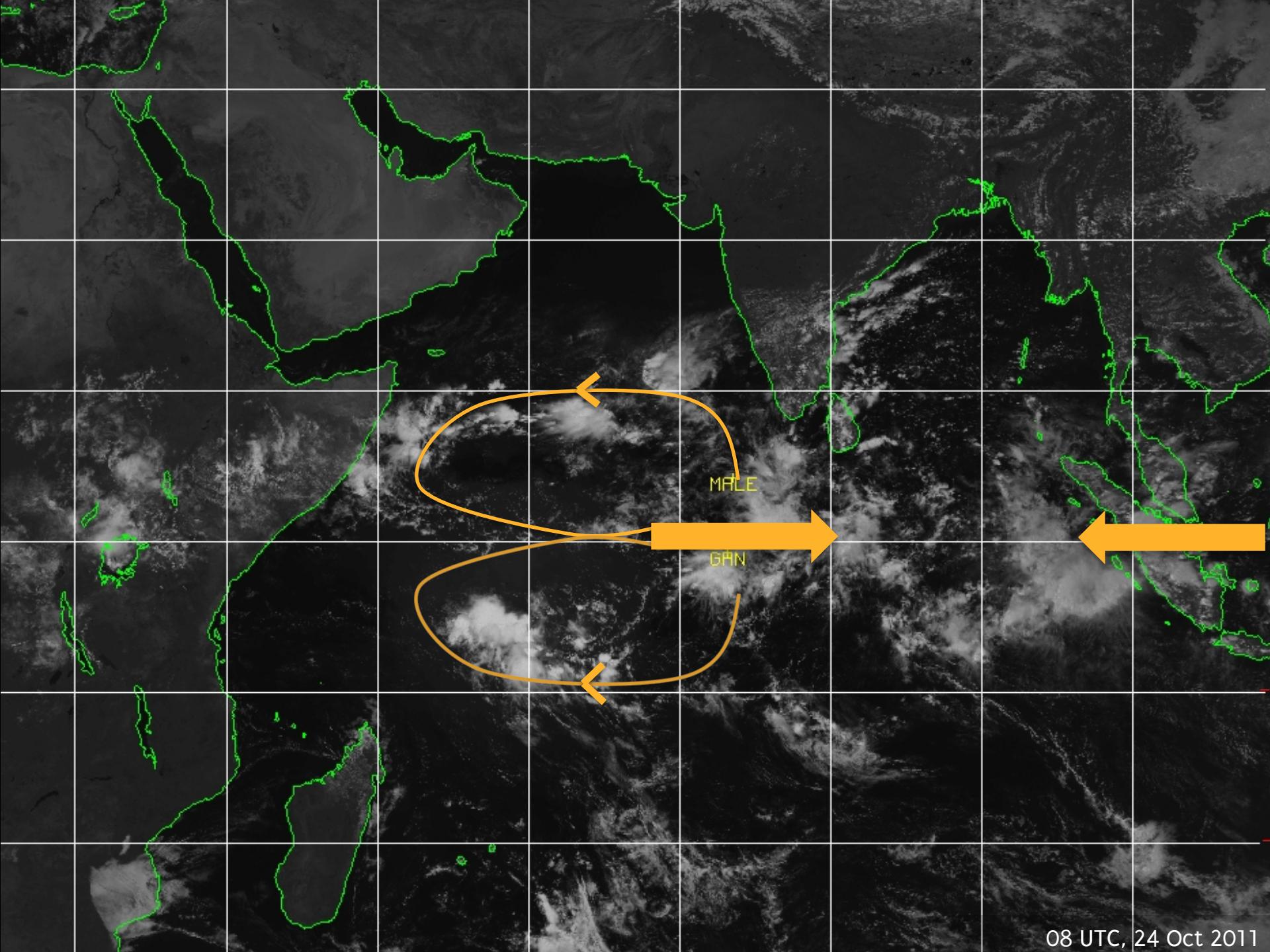
Scott W. Powell
University of Washington, Seattle
11 June 2014

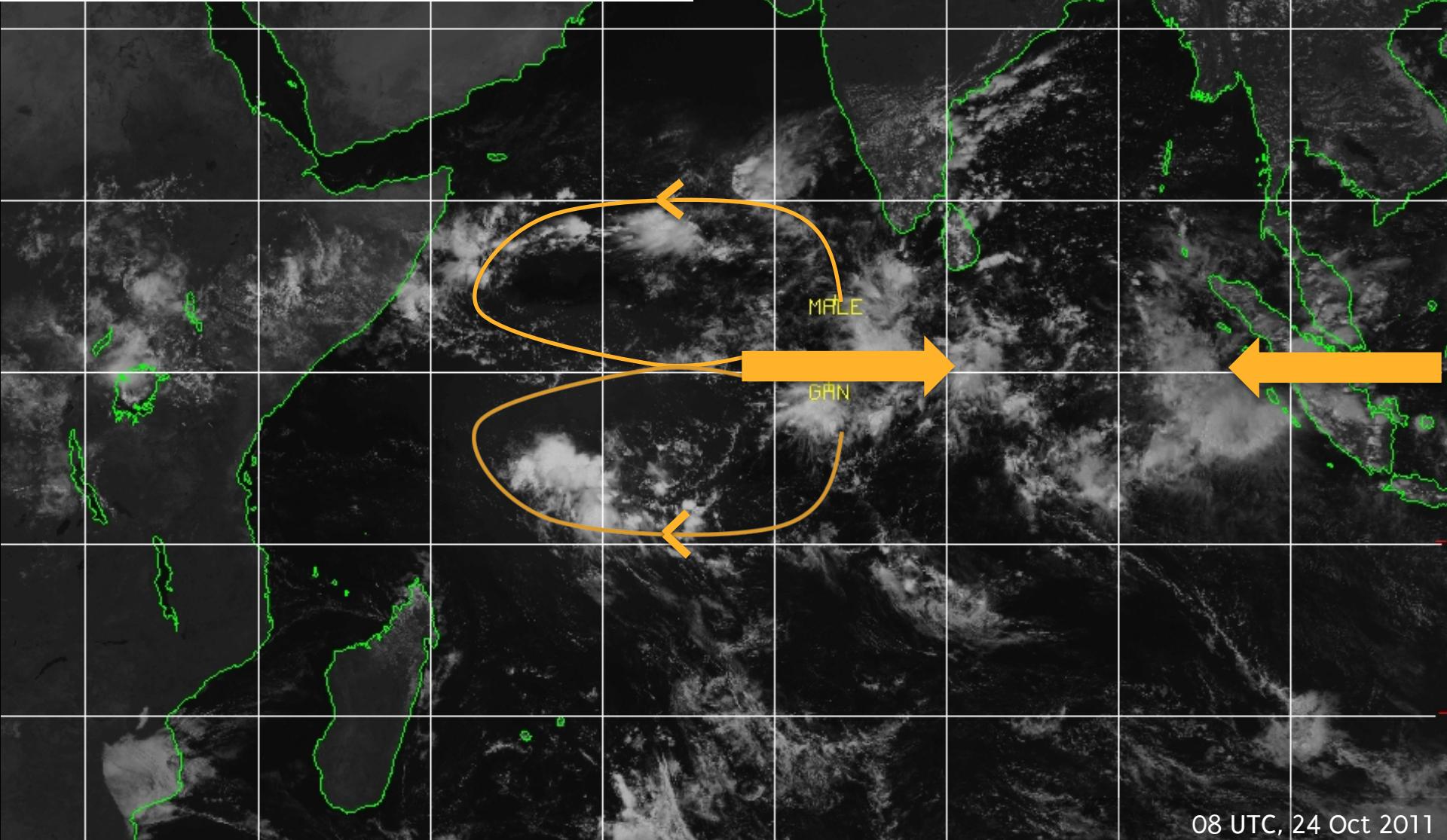
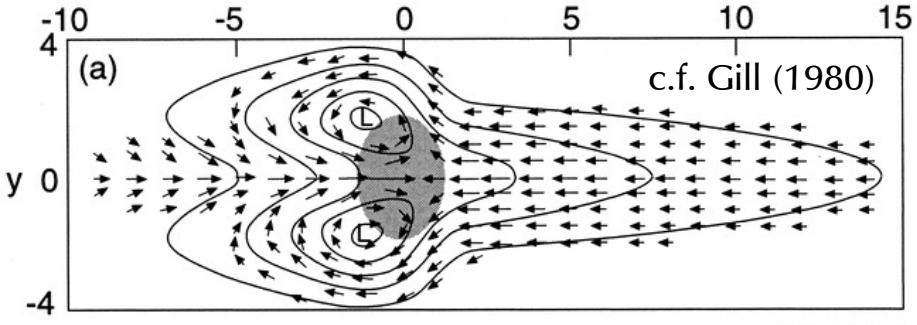
Supported by DOE grant DE-SC0008452 and NSF Grant AGS-1355567.

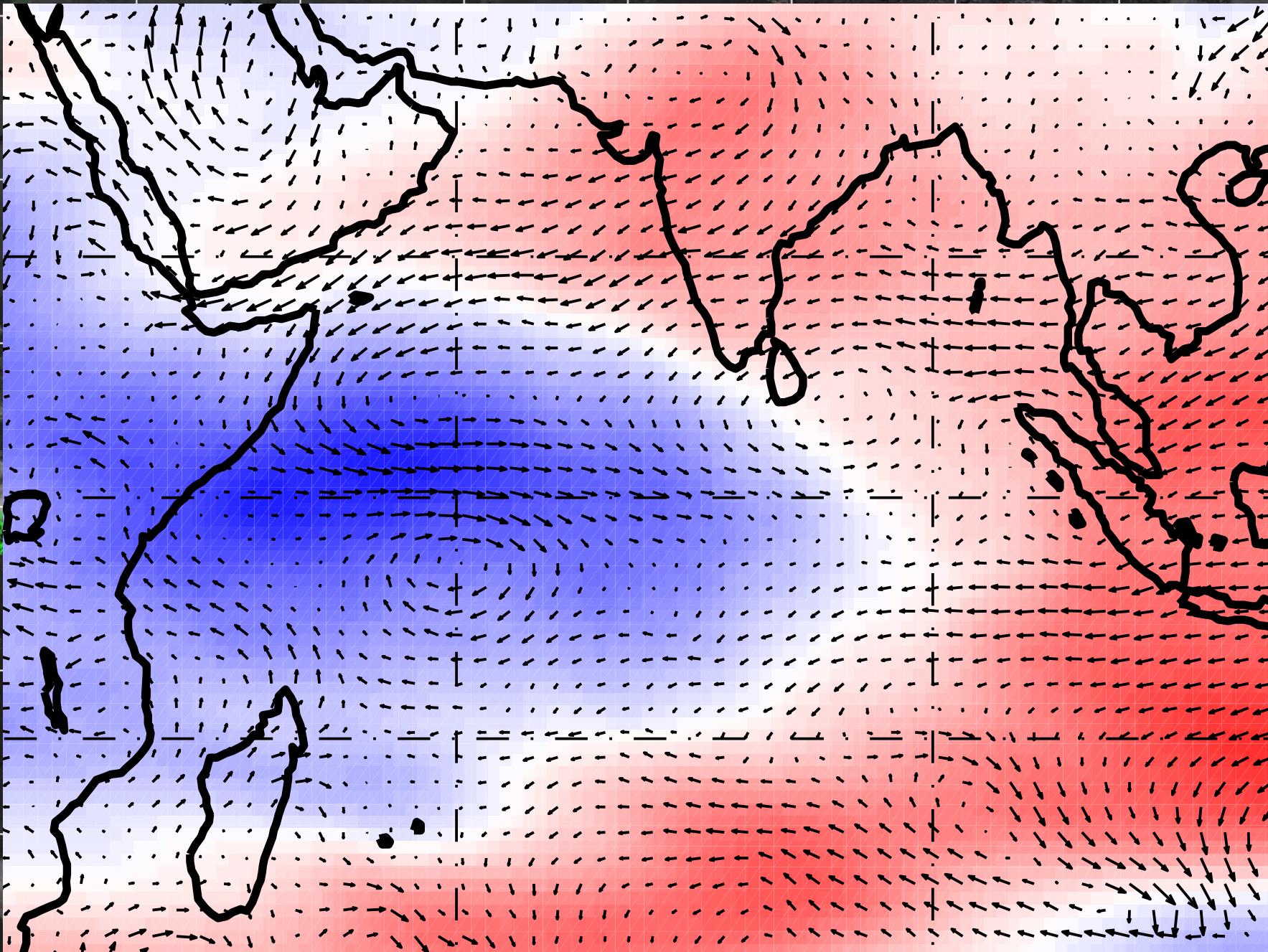
08 UTC, 24 Oct 2011

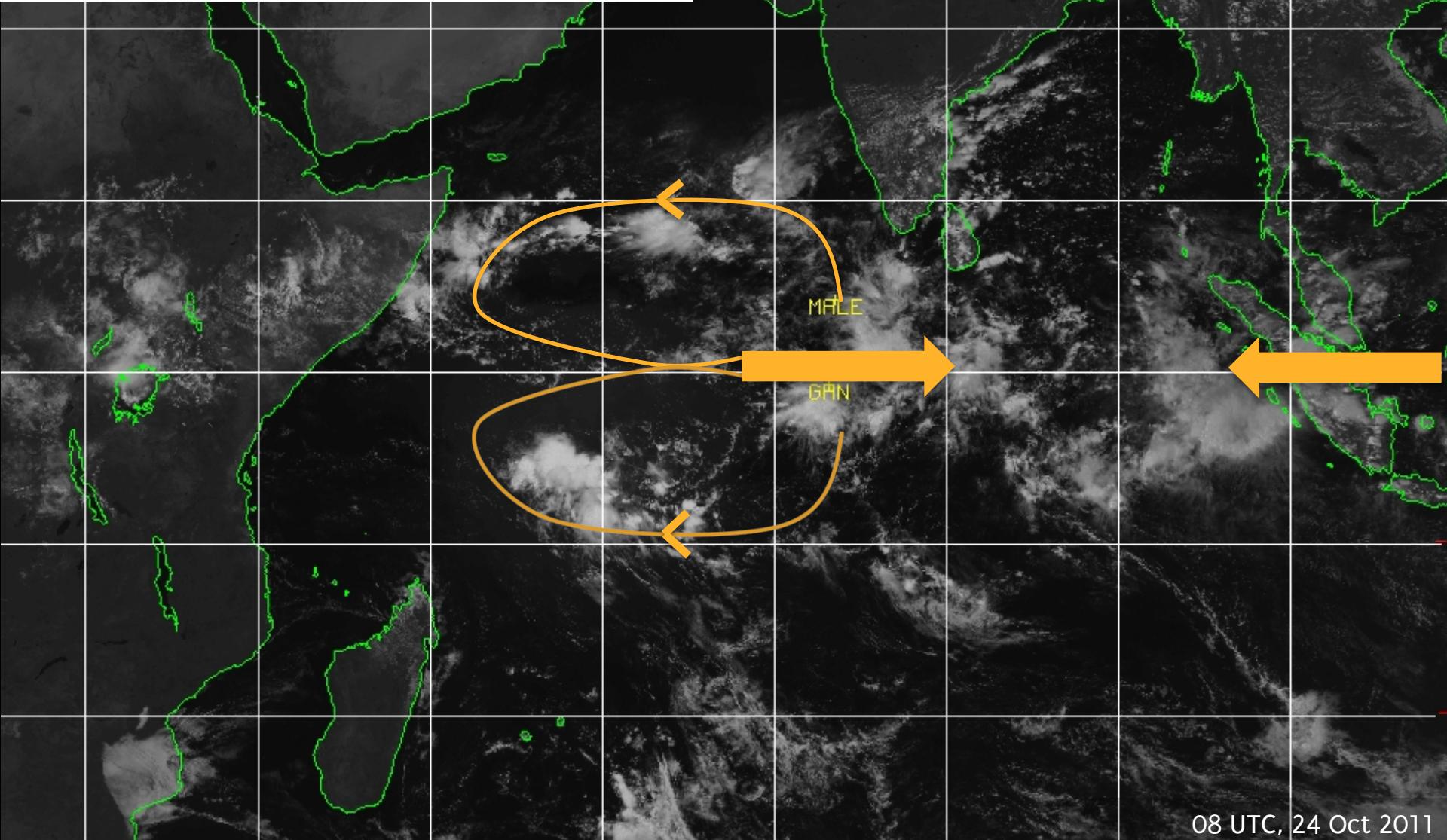
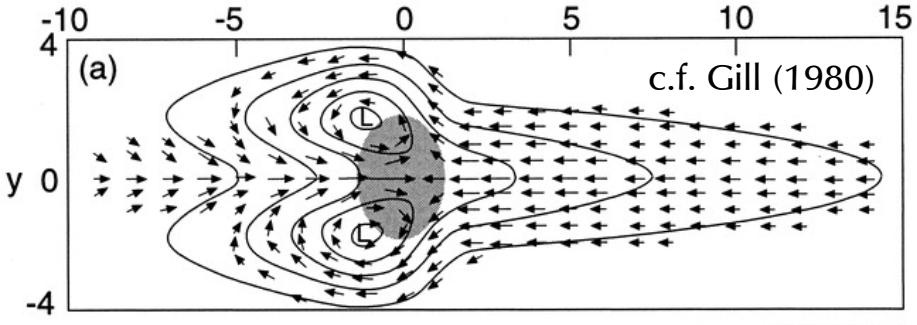


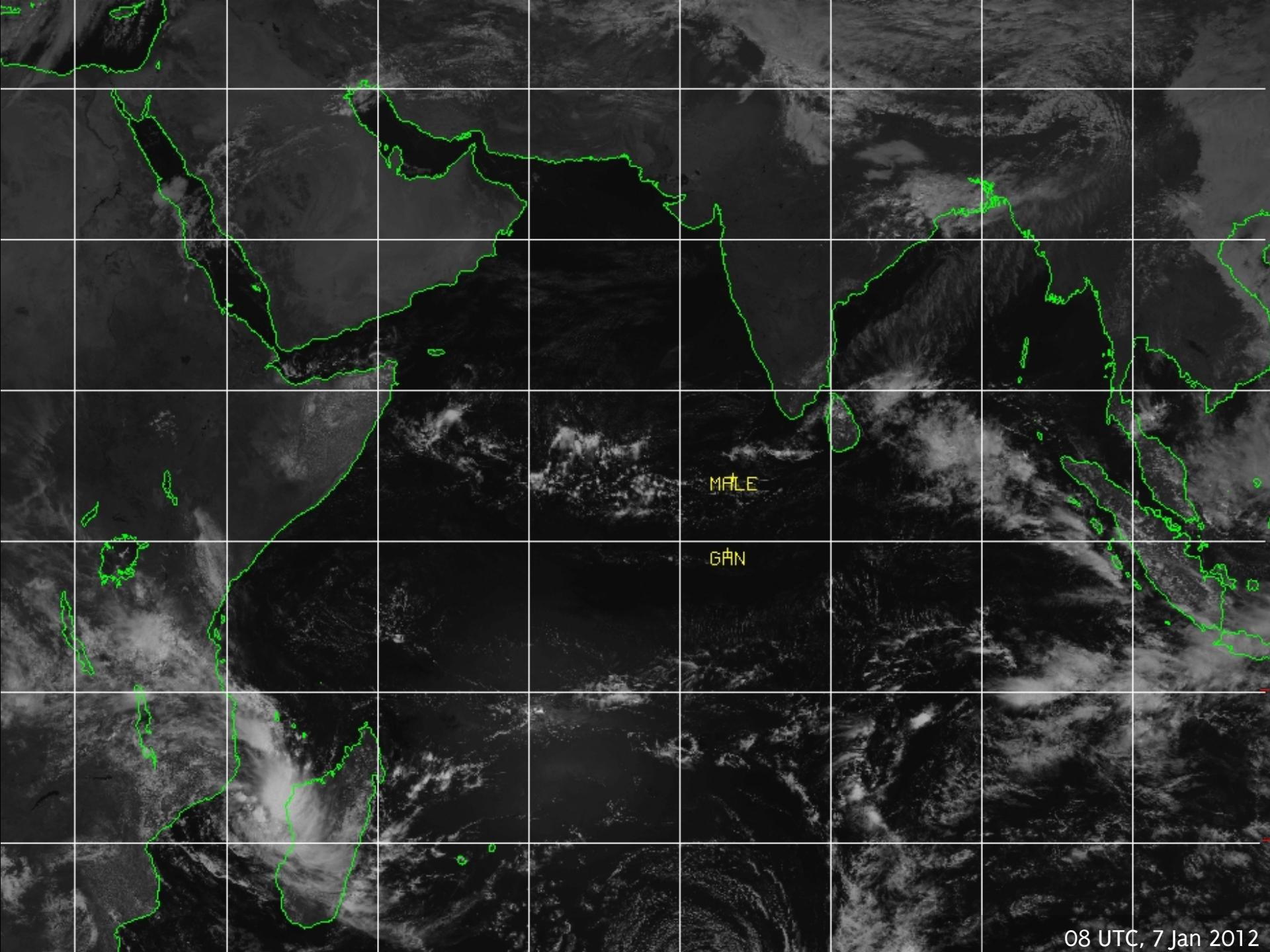
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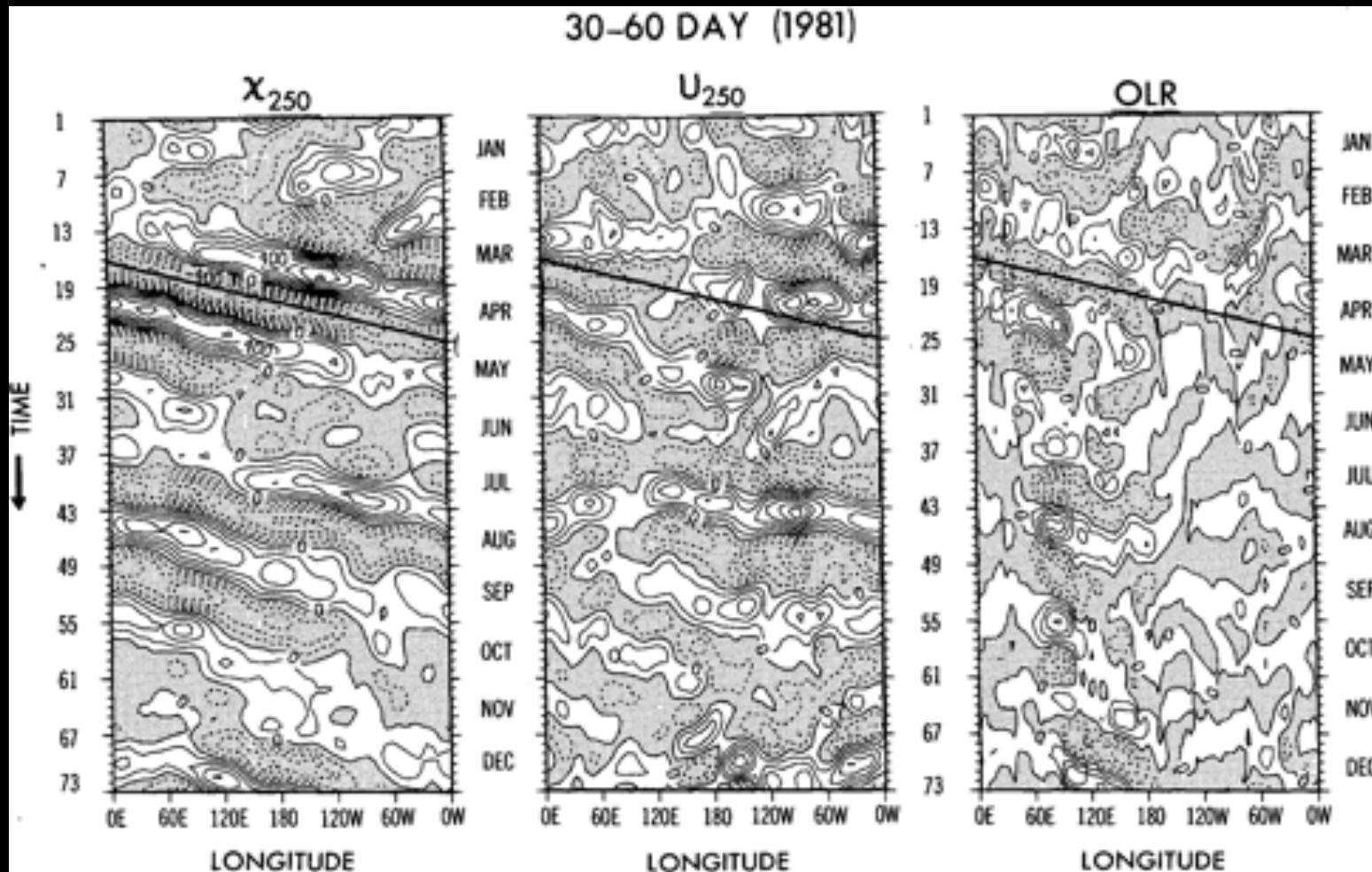




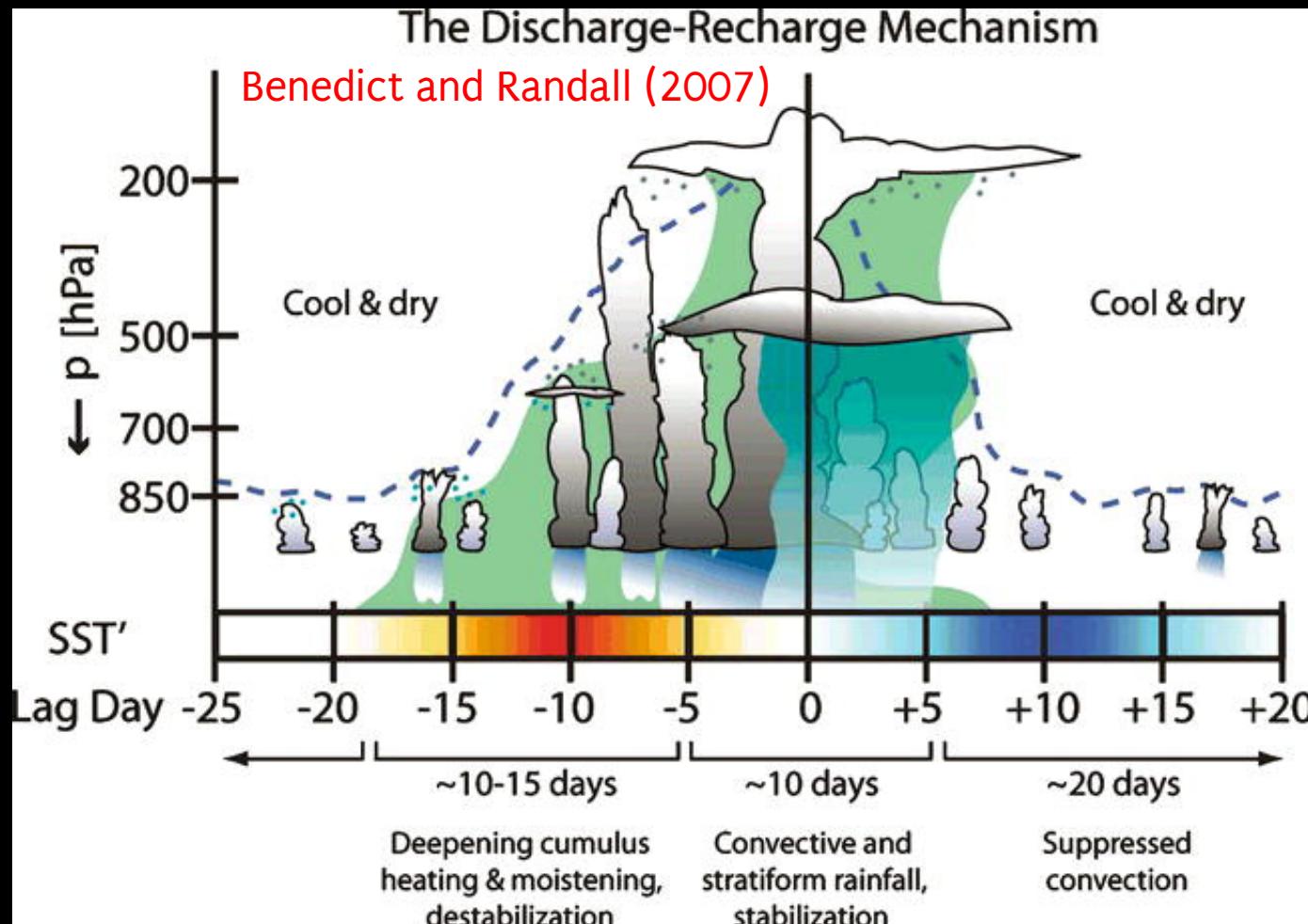


08 UTC, 7 Jan 2012

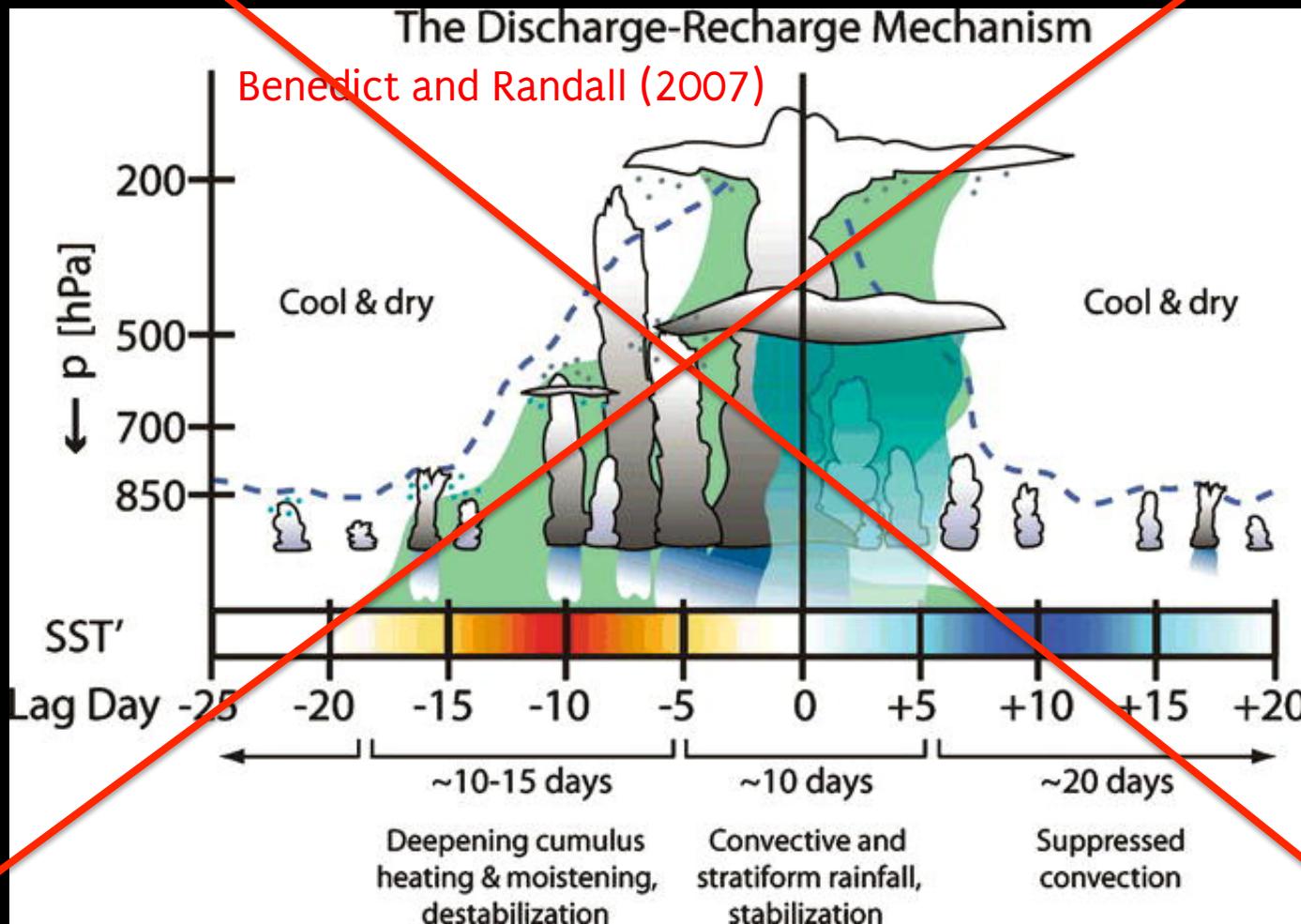
Knutson and Weickmann (1987)

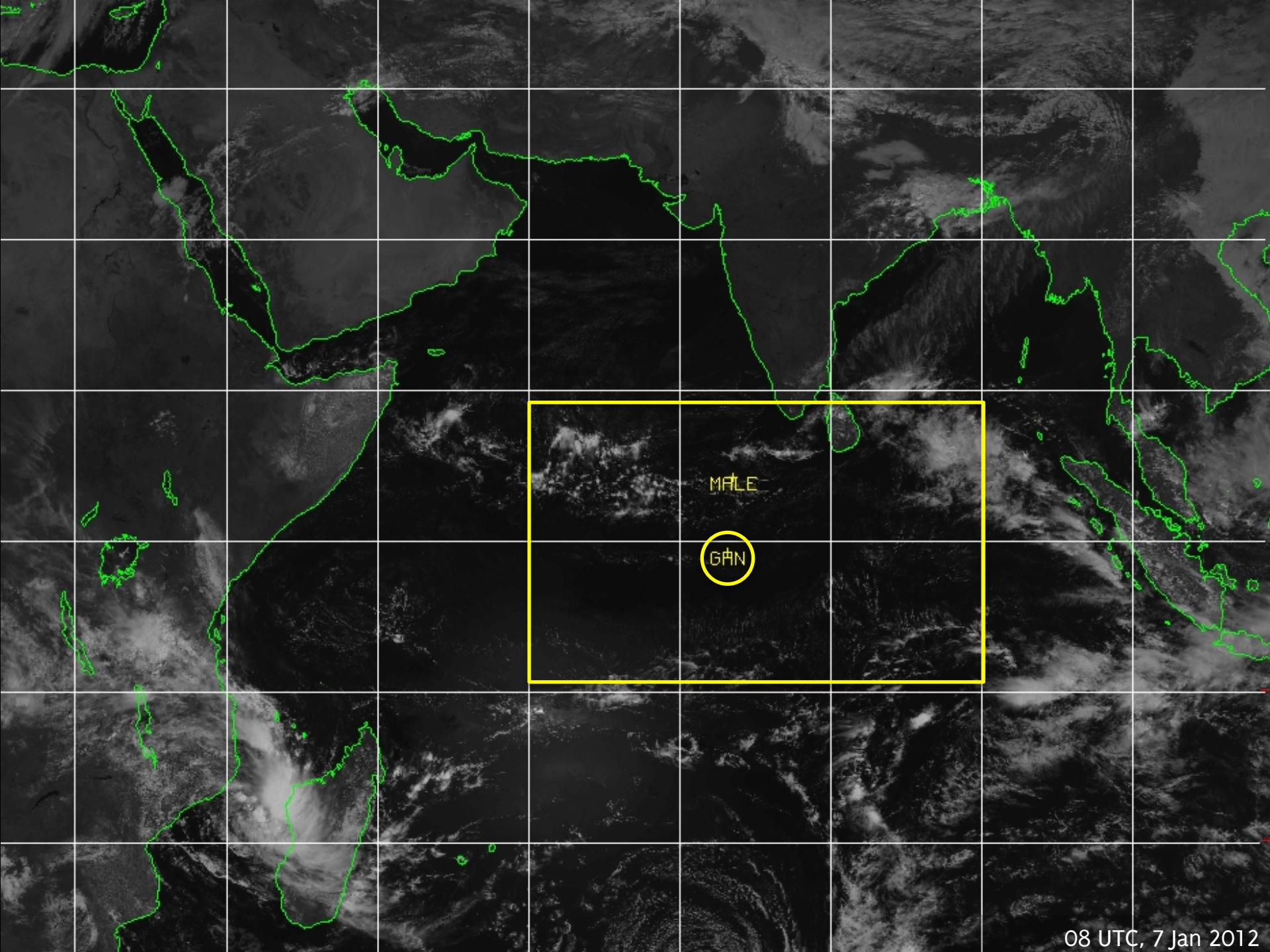


Hypothesis: Gradual moistening leads to systematic build-up of convection, ultimately resulting in MJO (“discharge-recharge”; Bladé and Hartmann (1993), Kemball-Cooke and Weare (2001), Benedict and Randall (2007), and others.)



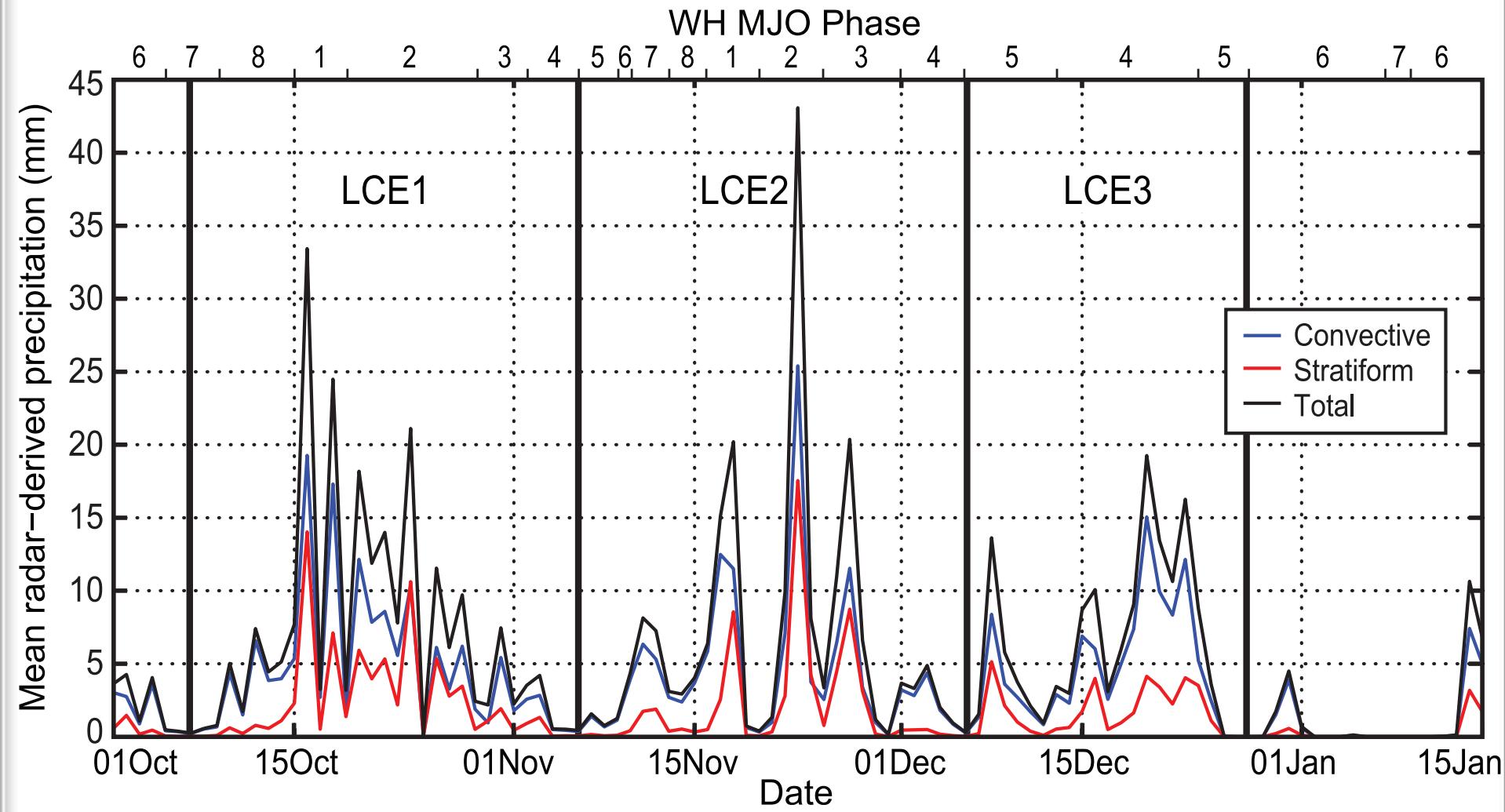
Hypothesis: Gradual moistening leads to systematic build-up of convection, ultimately resulting in MJO (“discharge-recharge”; Bladé and Hartmann (1993), Kemball-Cooke and Weare (2001), Benedict and Randall (2007), and others.)

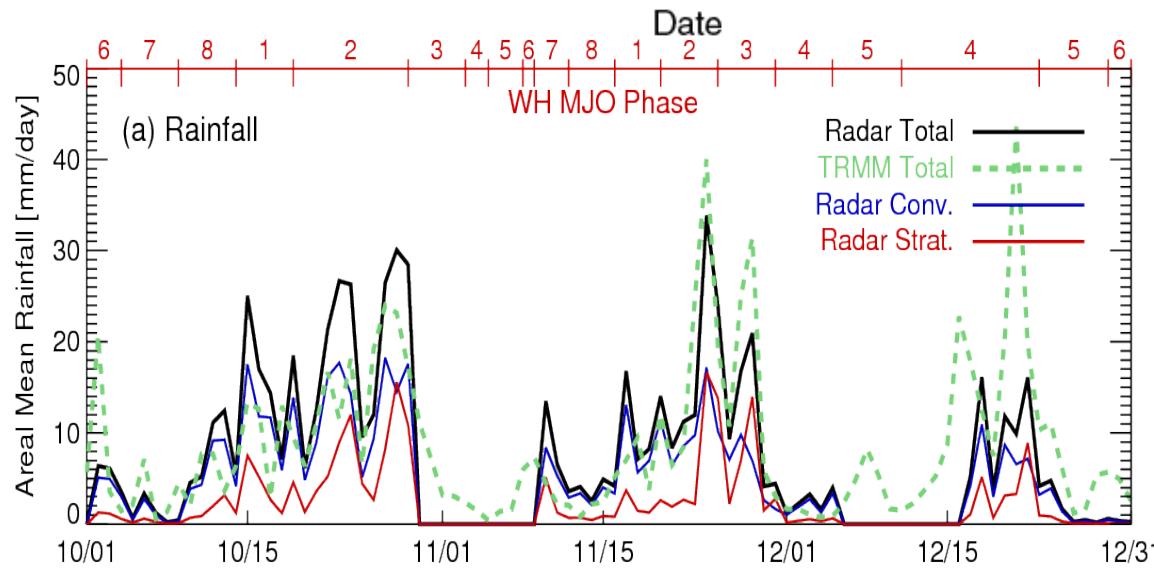
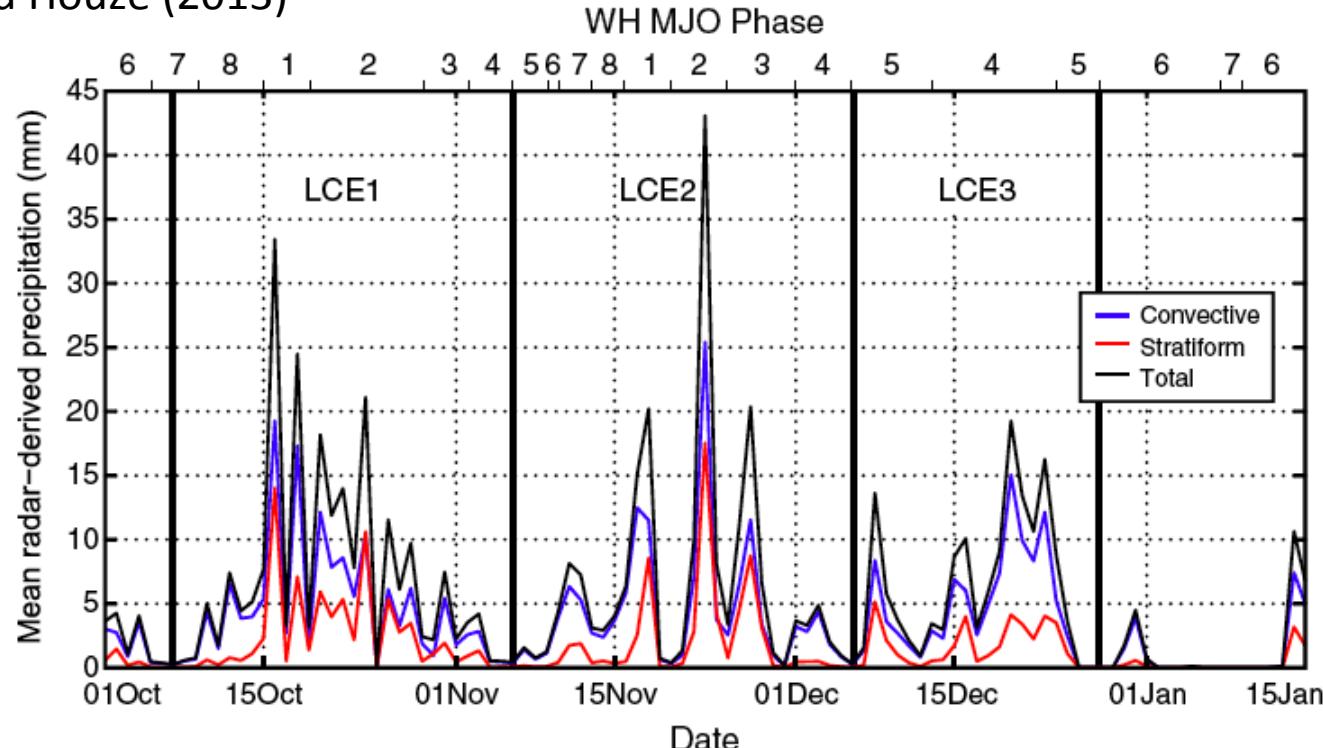




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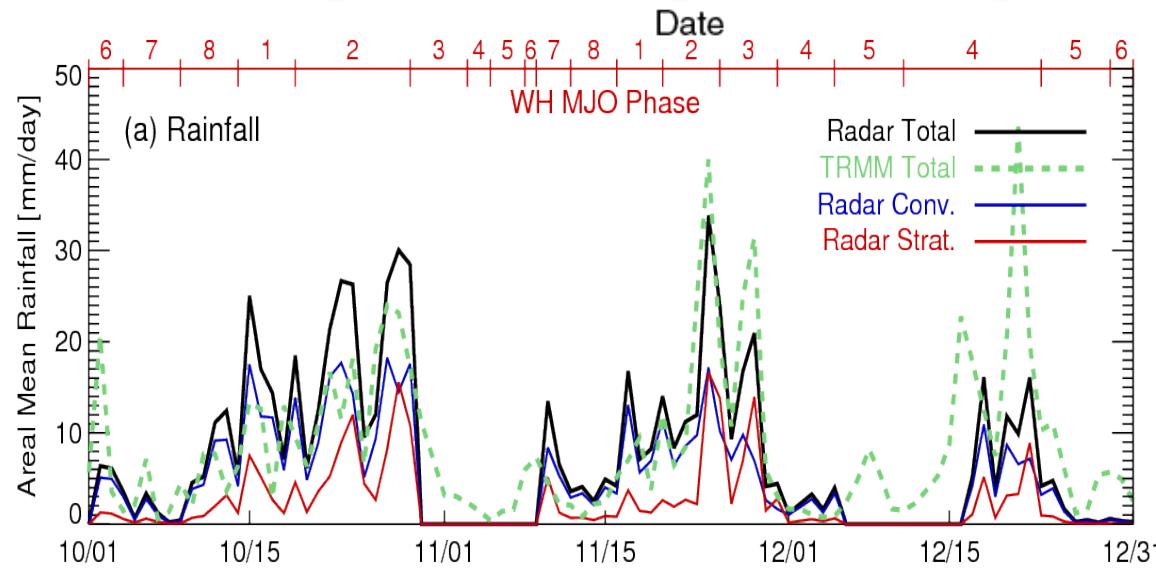
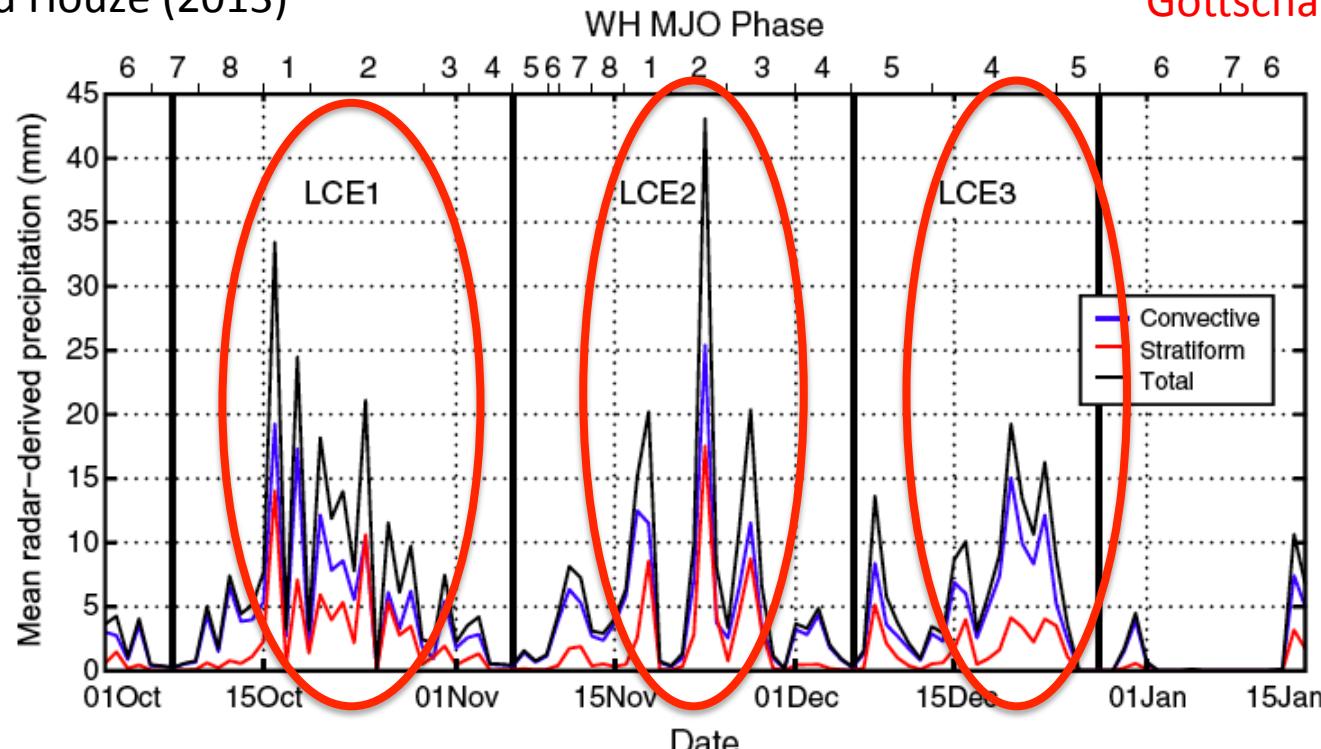
*Evolution of Cloud Population,
Precipitation, and Humidity
Fields*





Powell and Houze (2013)

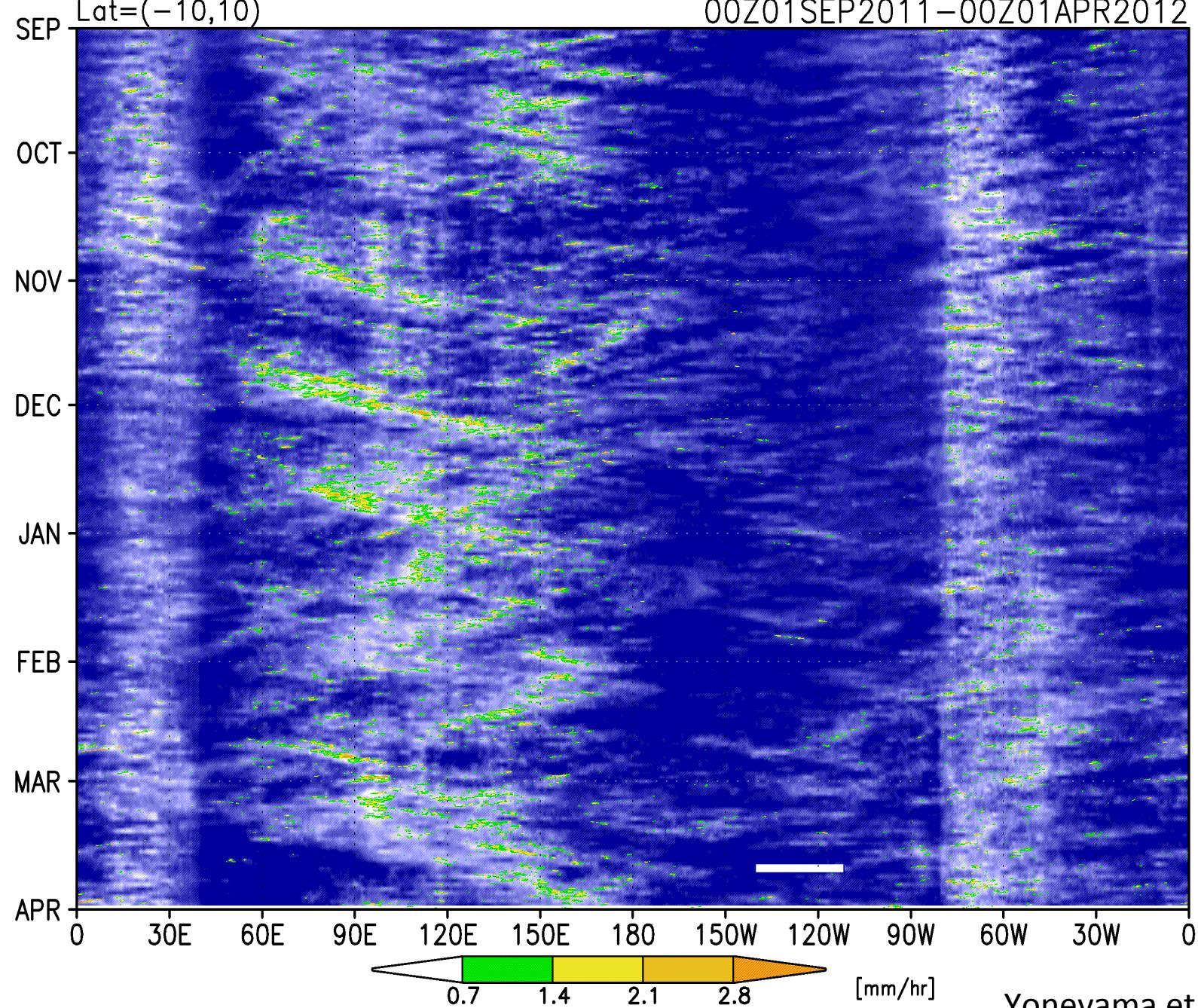
Gottschalck et al (2013)

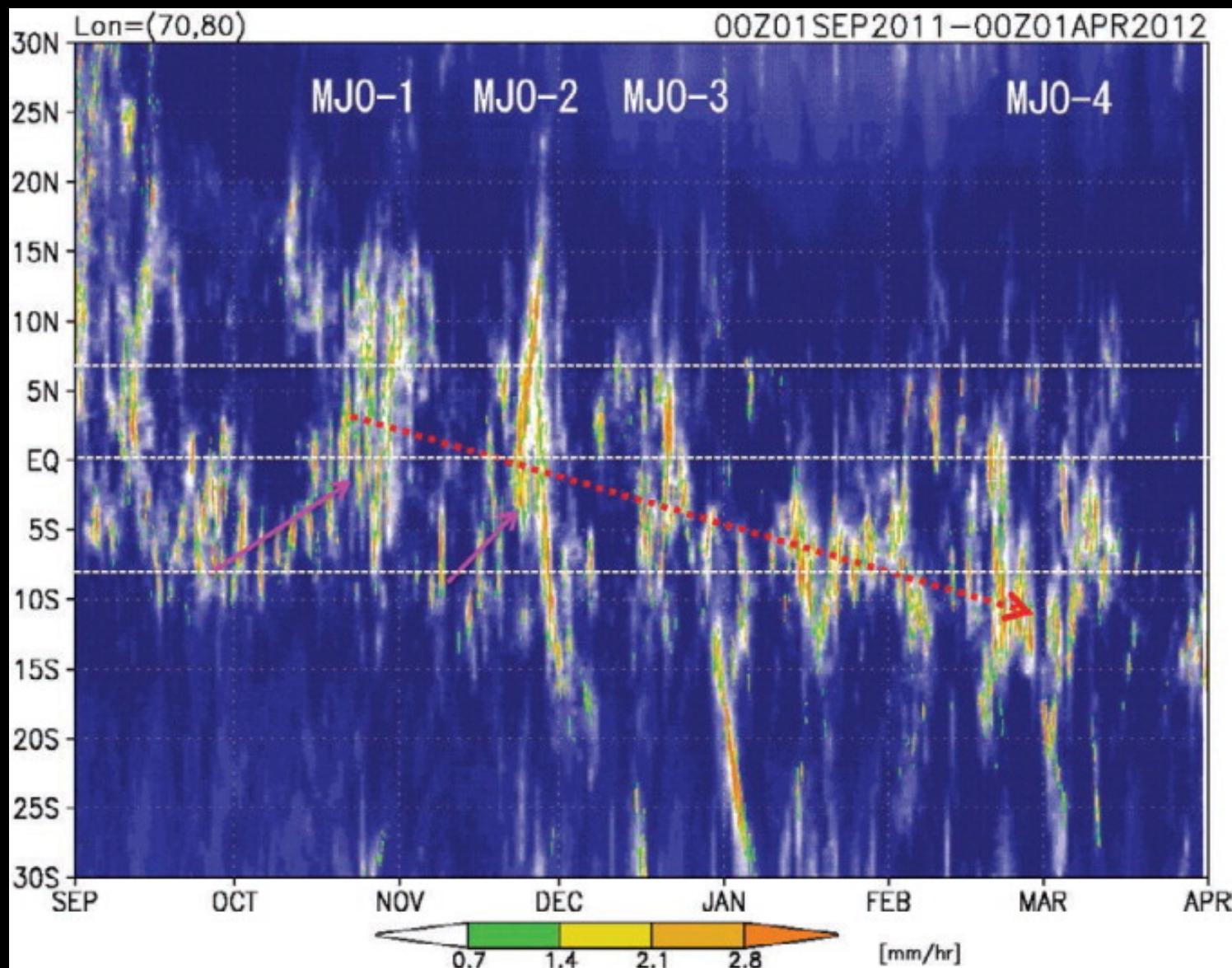


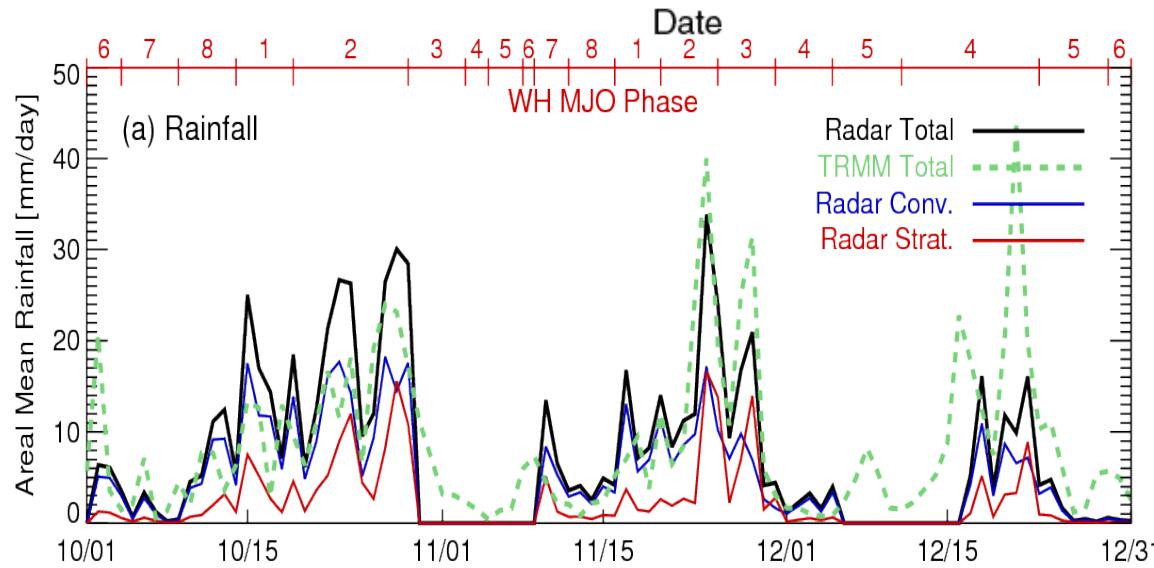
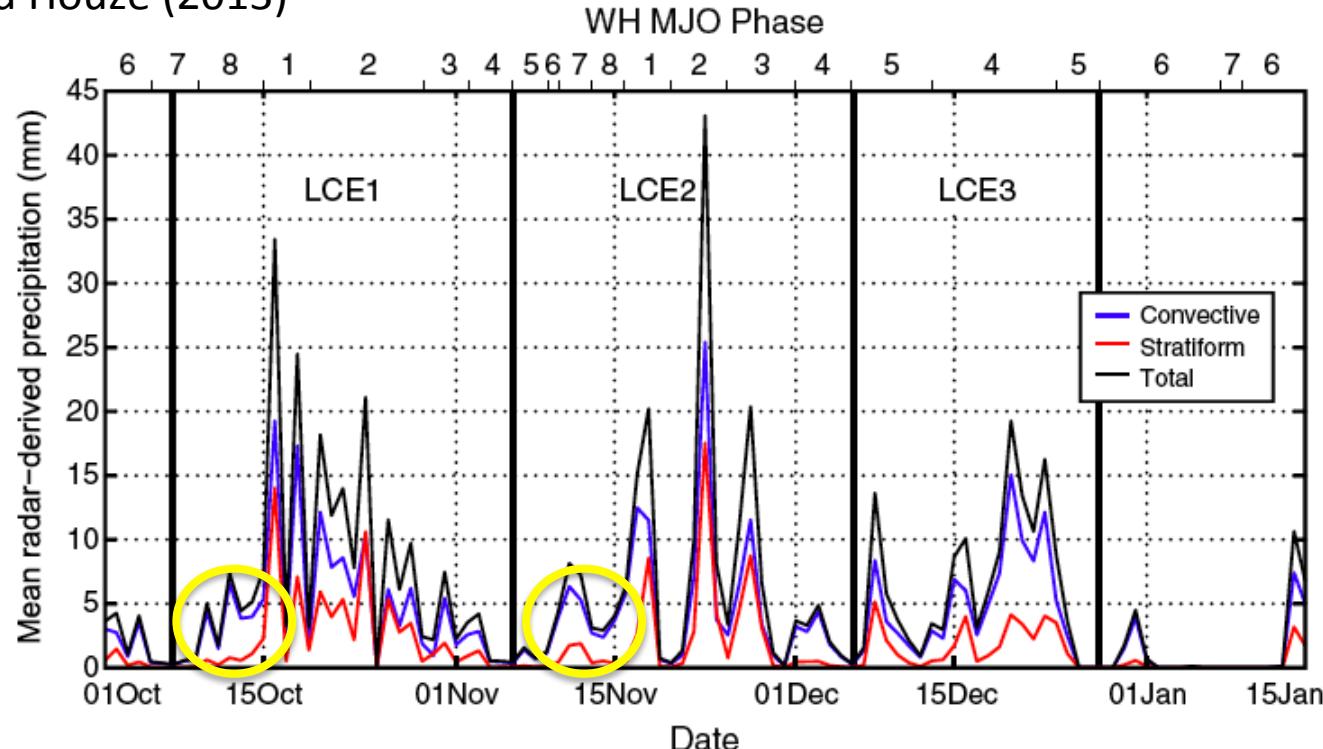
Xu and Rutledge (2014)

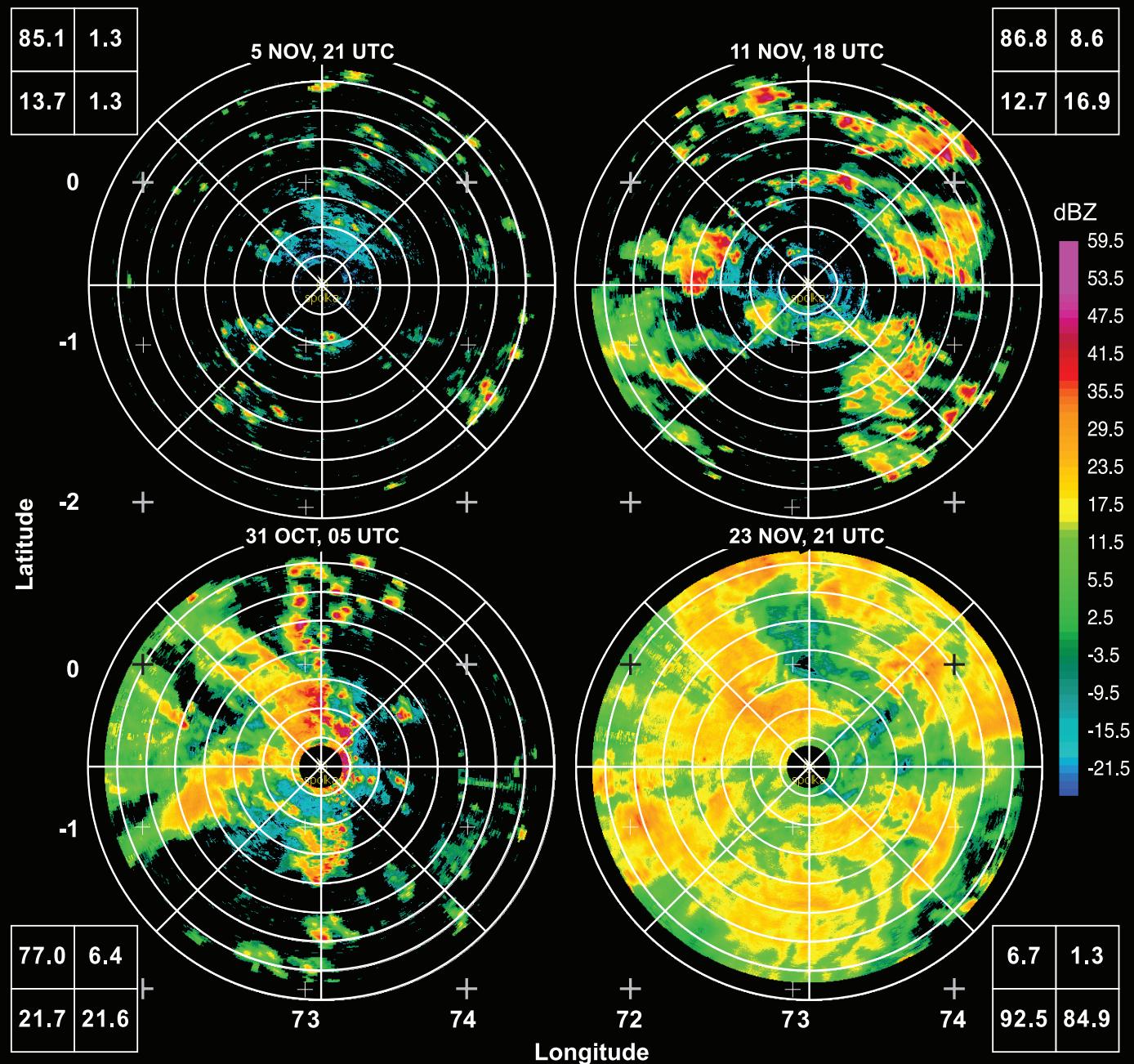
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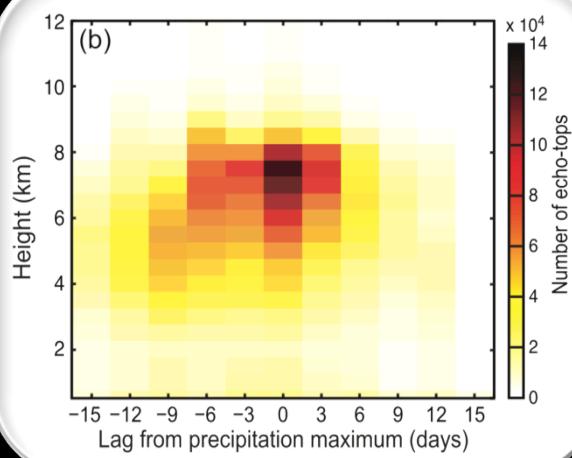
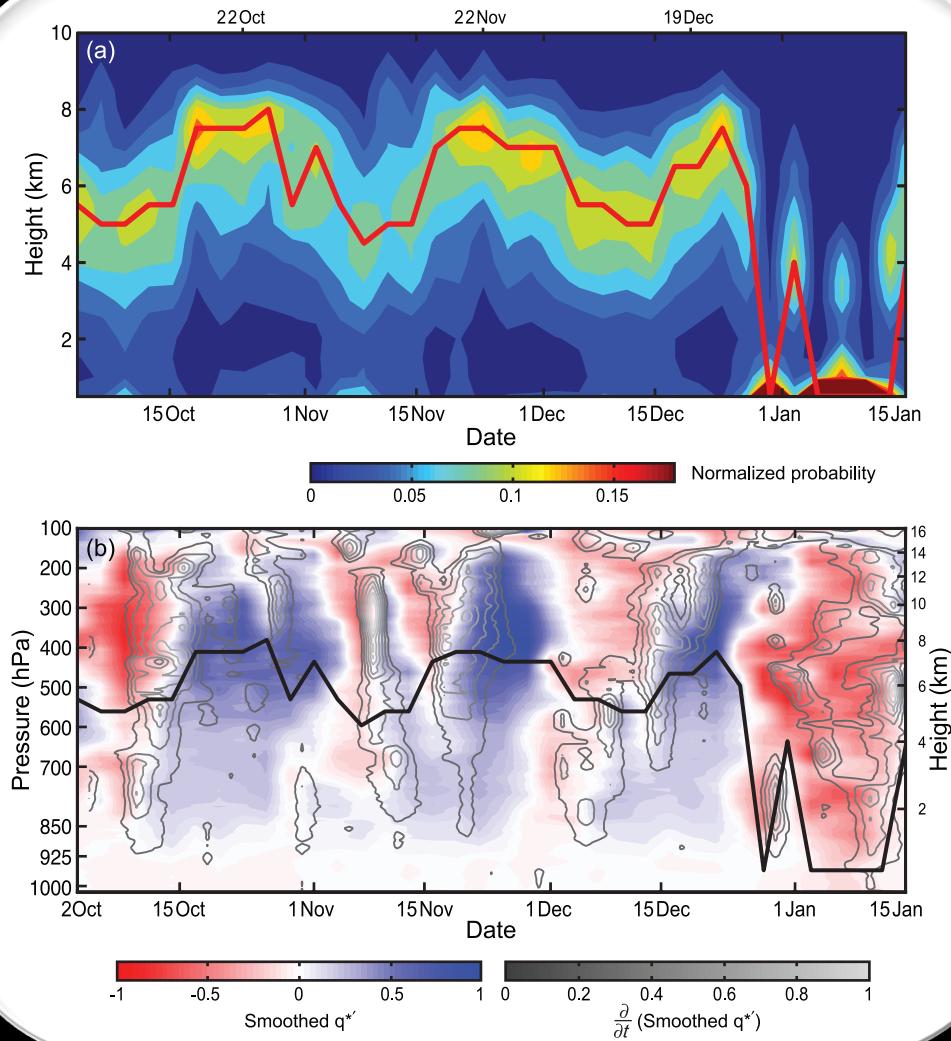
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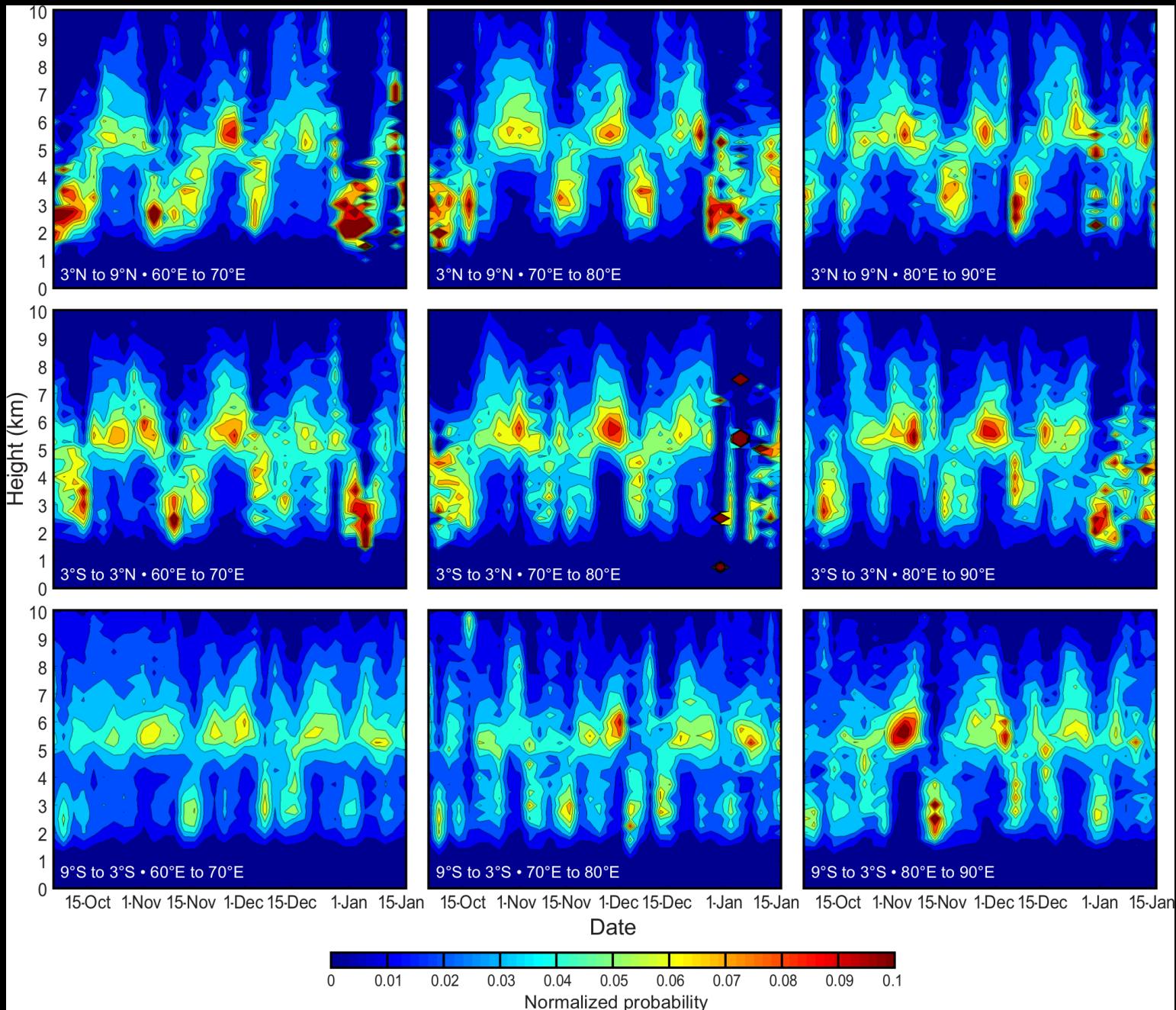


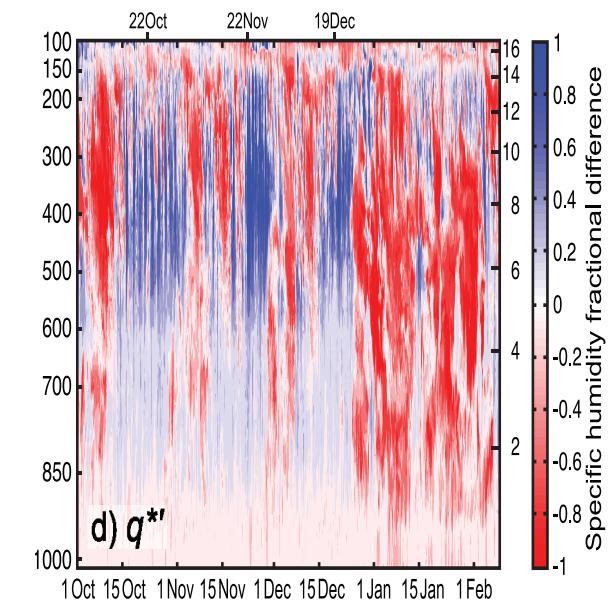
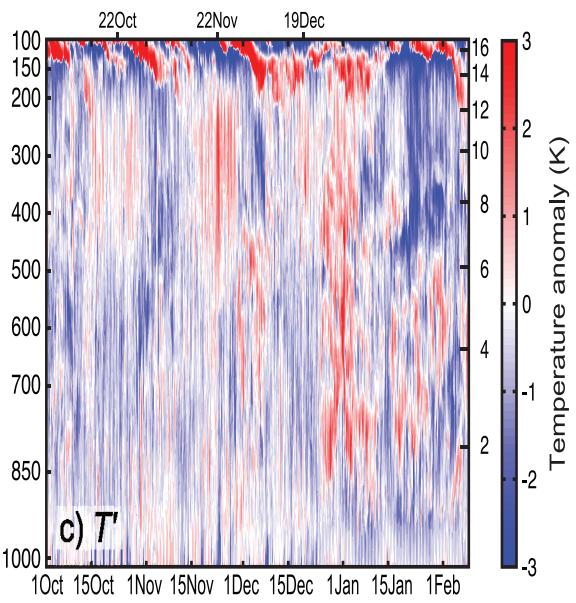
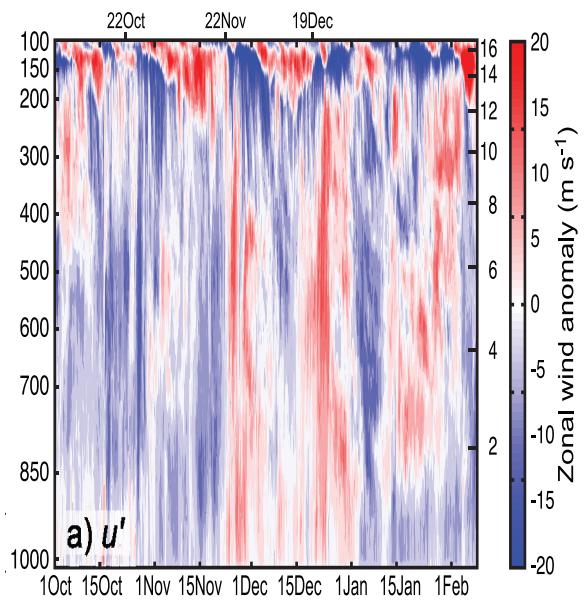






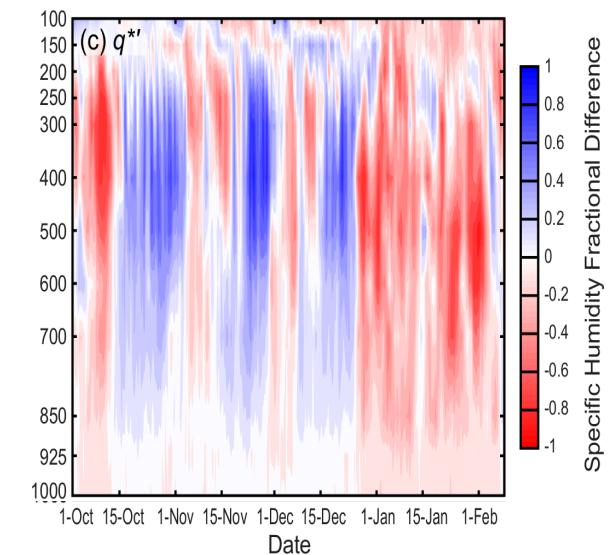
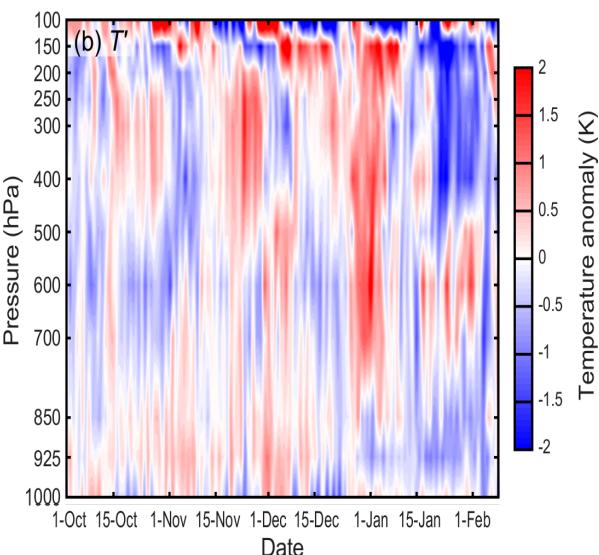
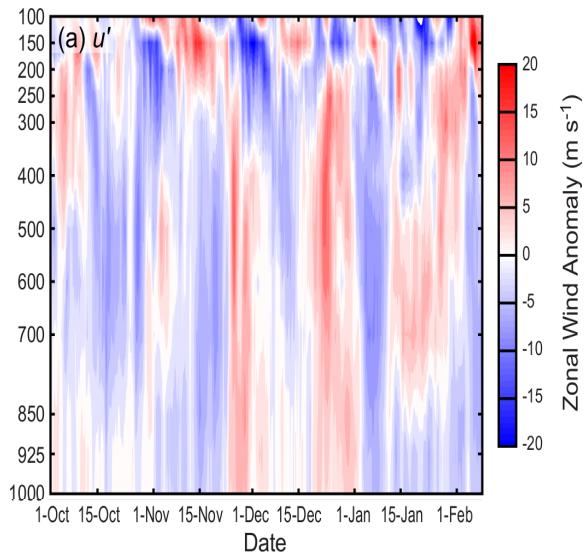






Top row: Gan rawinsonde data

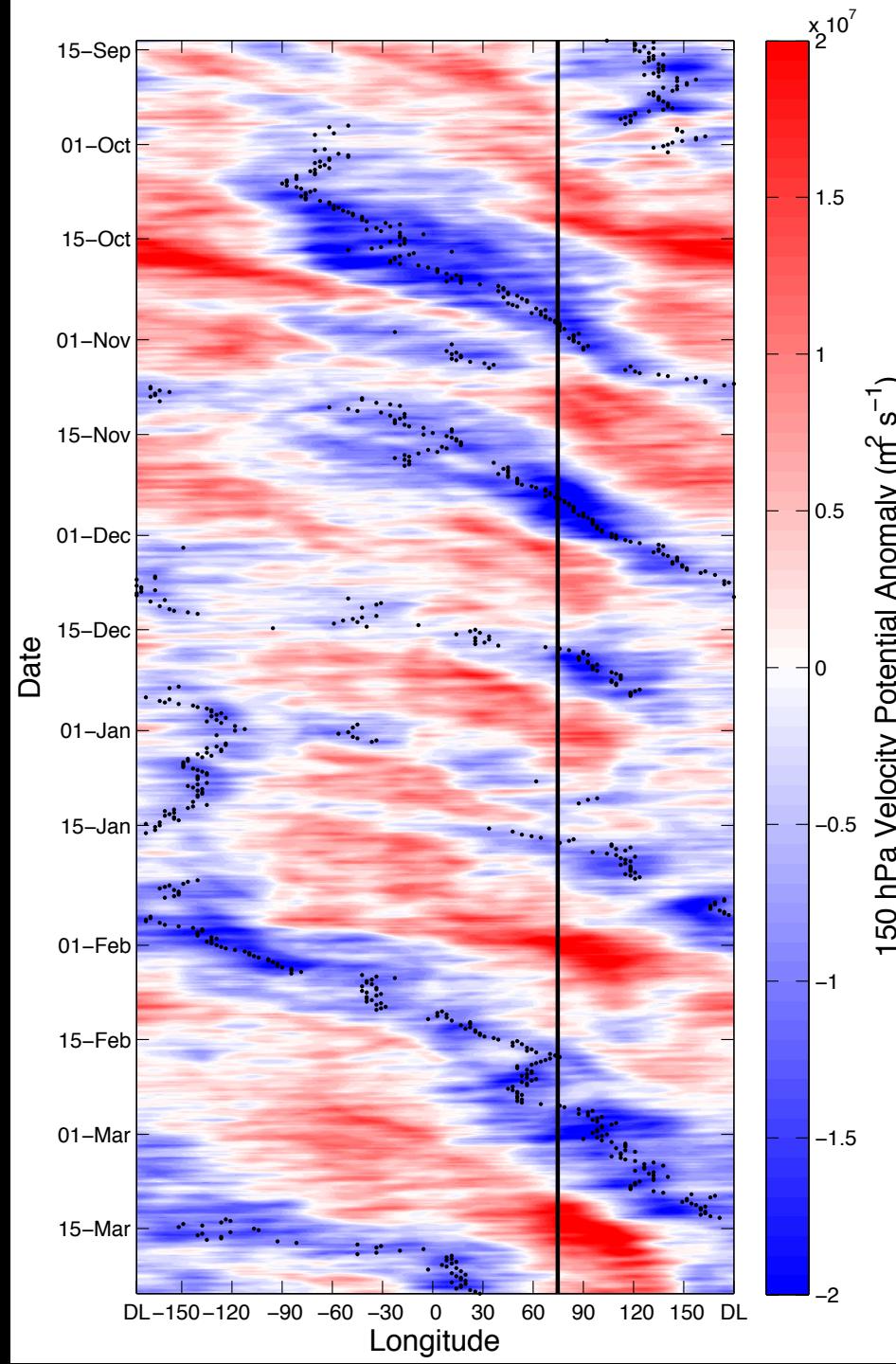
Bottom row: ERA-Interim ($3^{\circ}\text{N} - 3^{\circ}\text{S}$, $68^{\circ}\text{E} - 78^{\circ}\text{E}$)



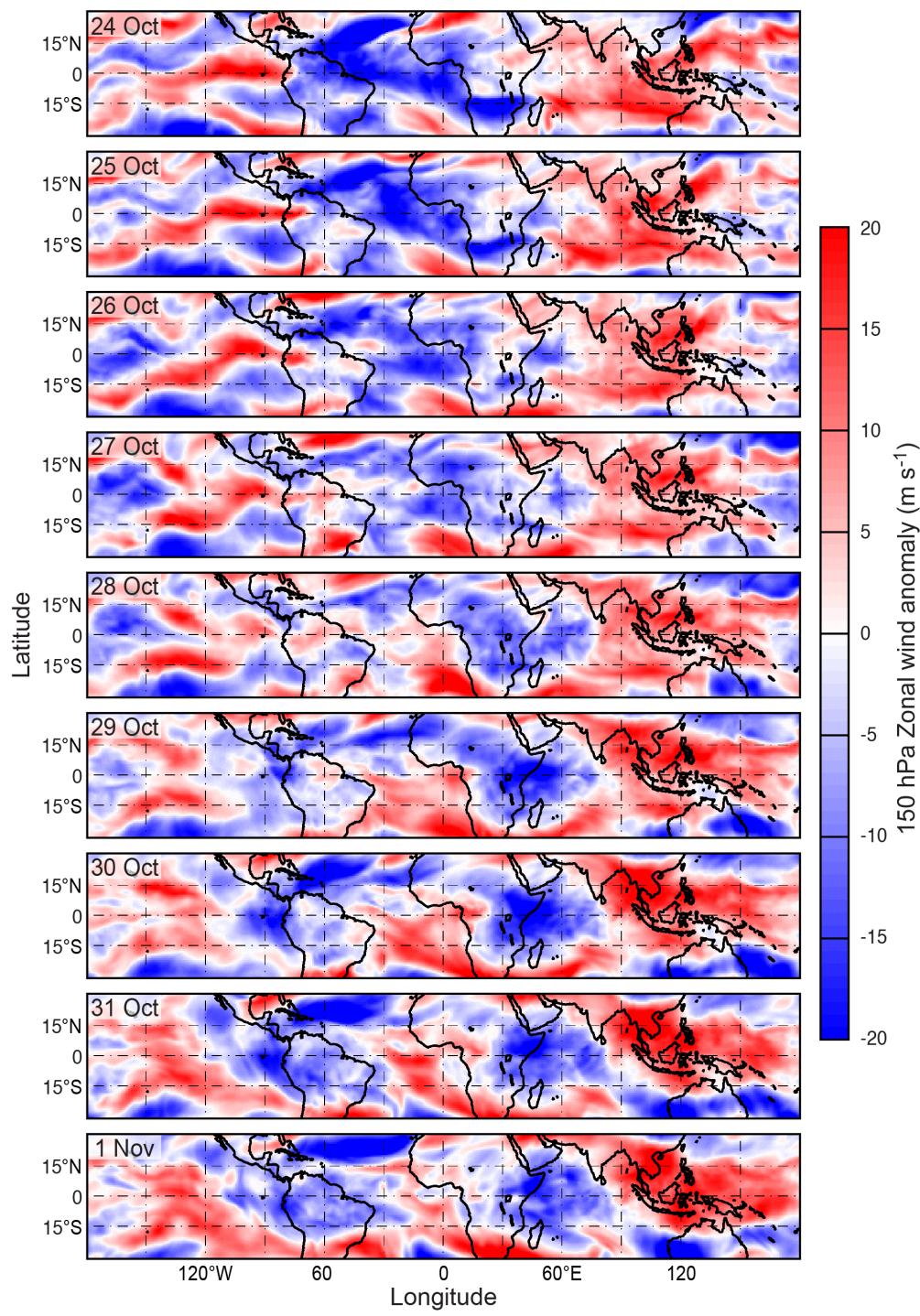
Upper-Tropospheric Dynamics

χ_{150}'

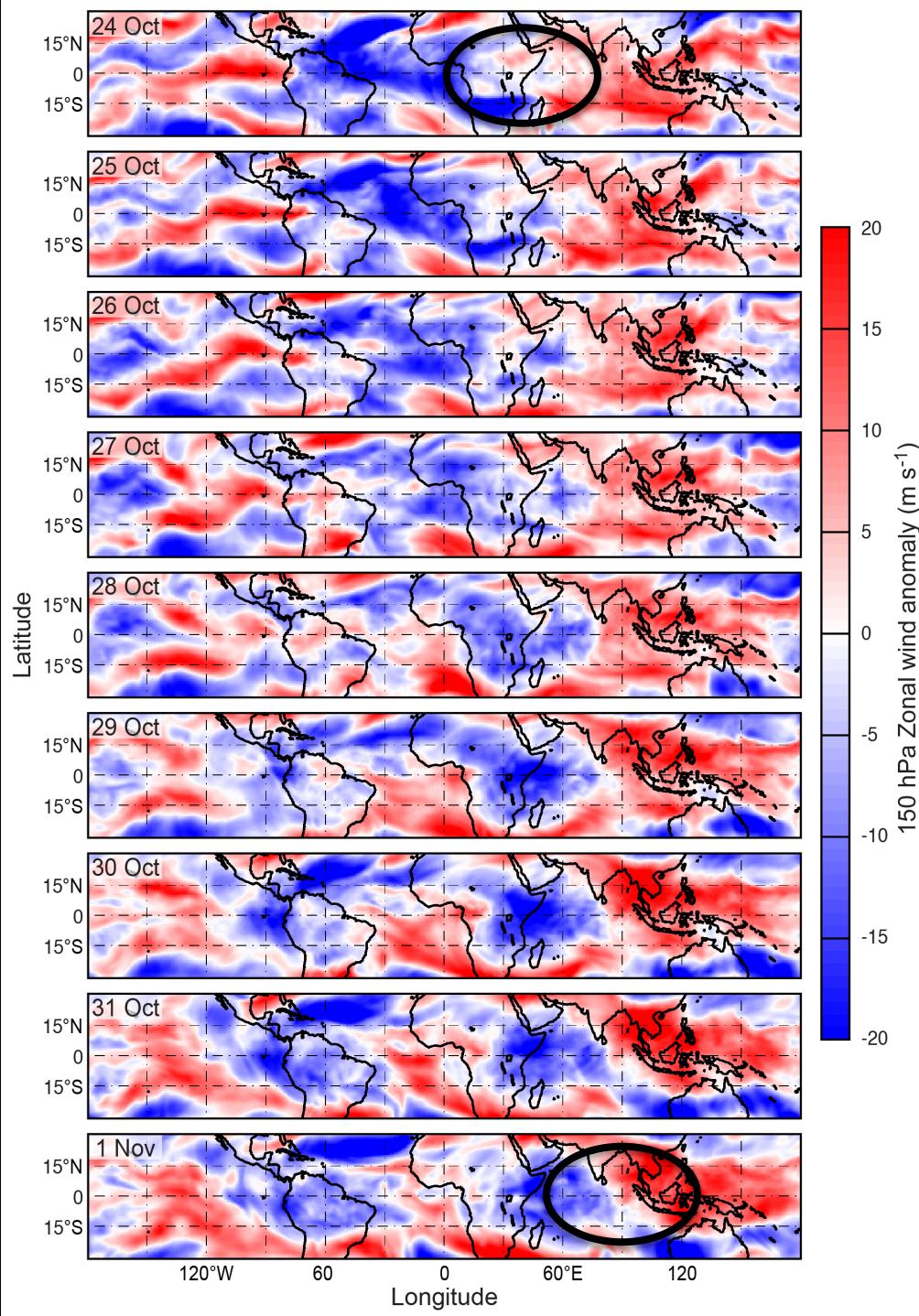
$$U = \nabla \chi$$



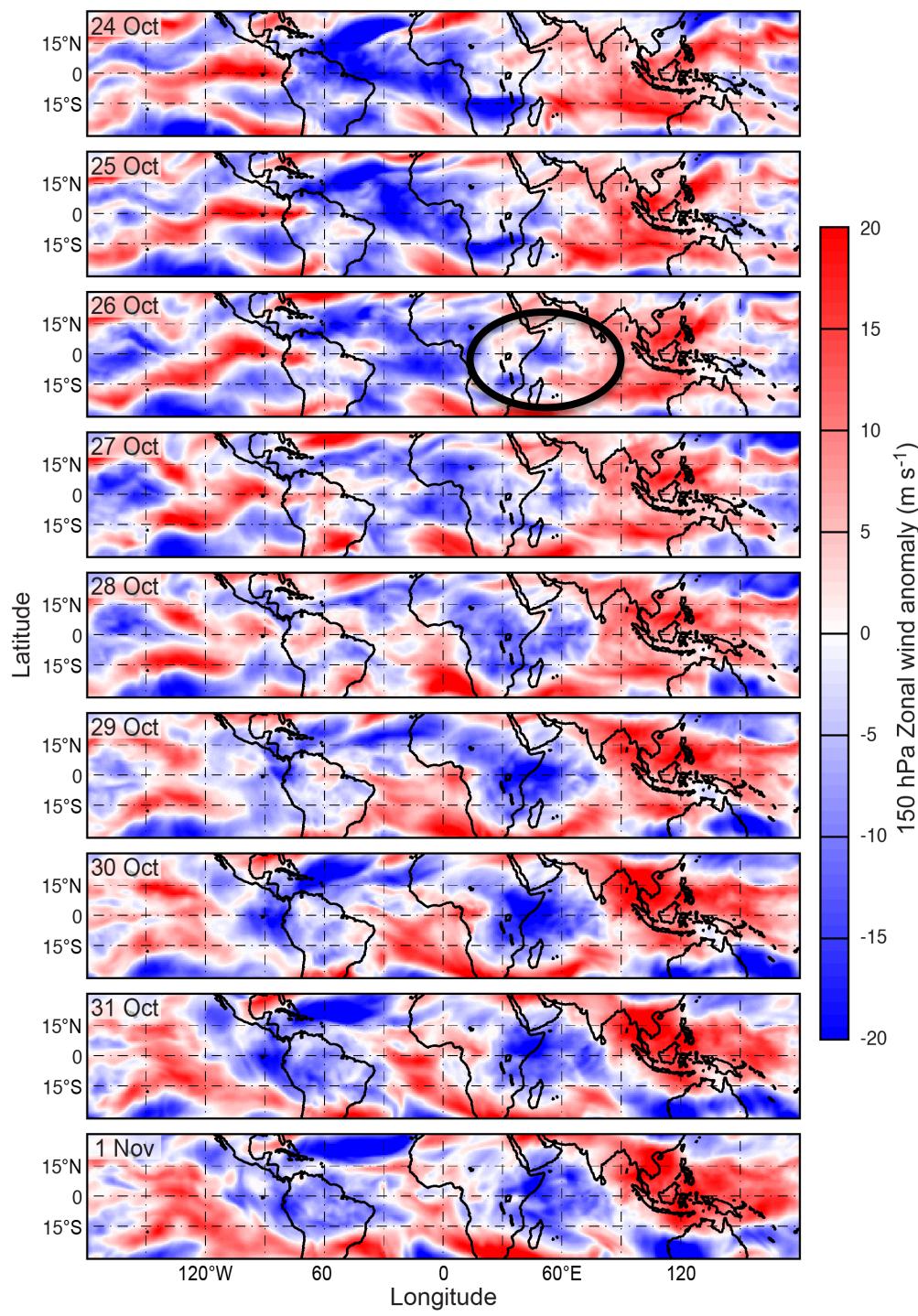
150 hPa u'
Blue: Easterly
Red: Westerly

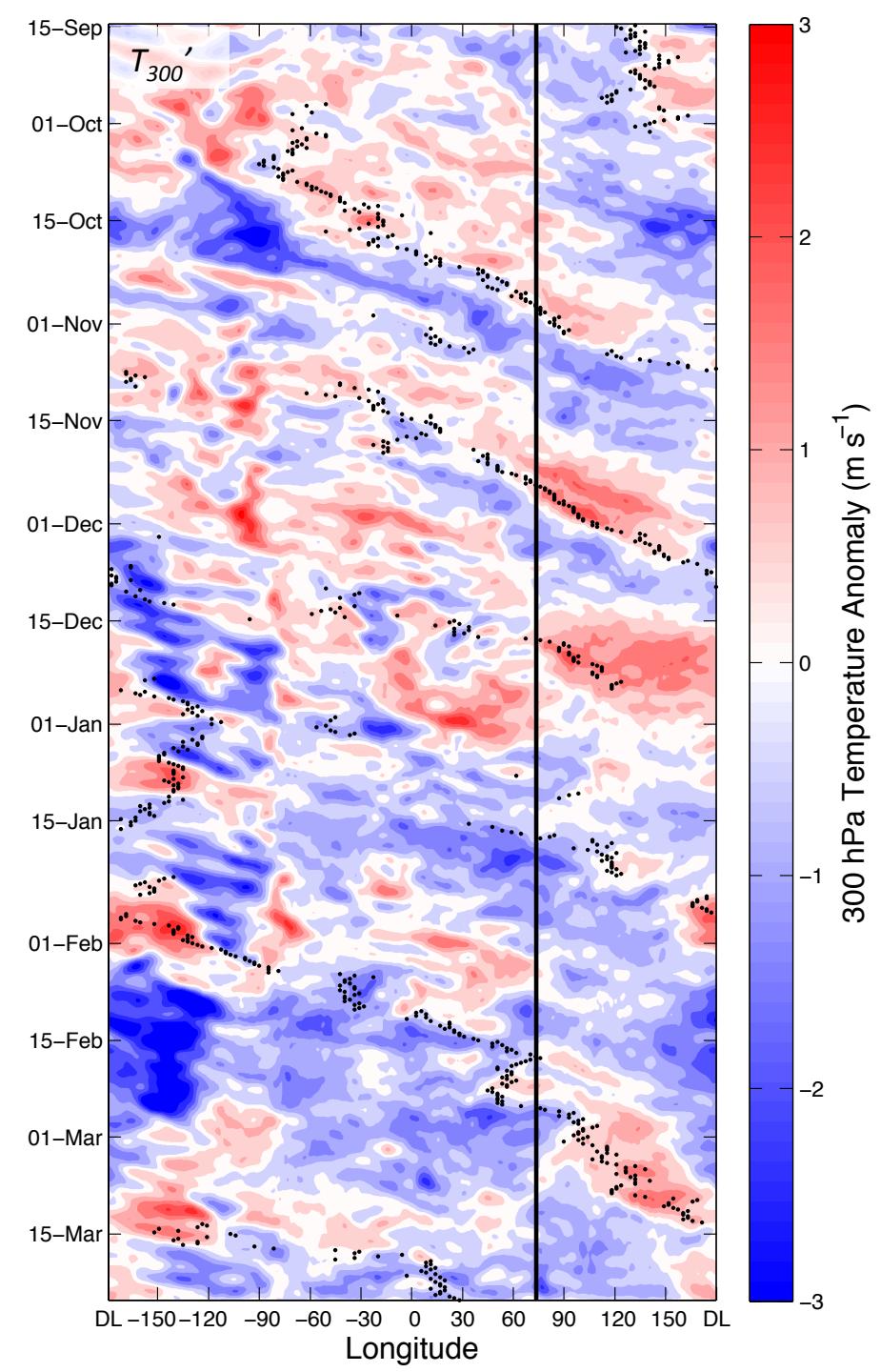
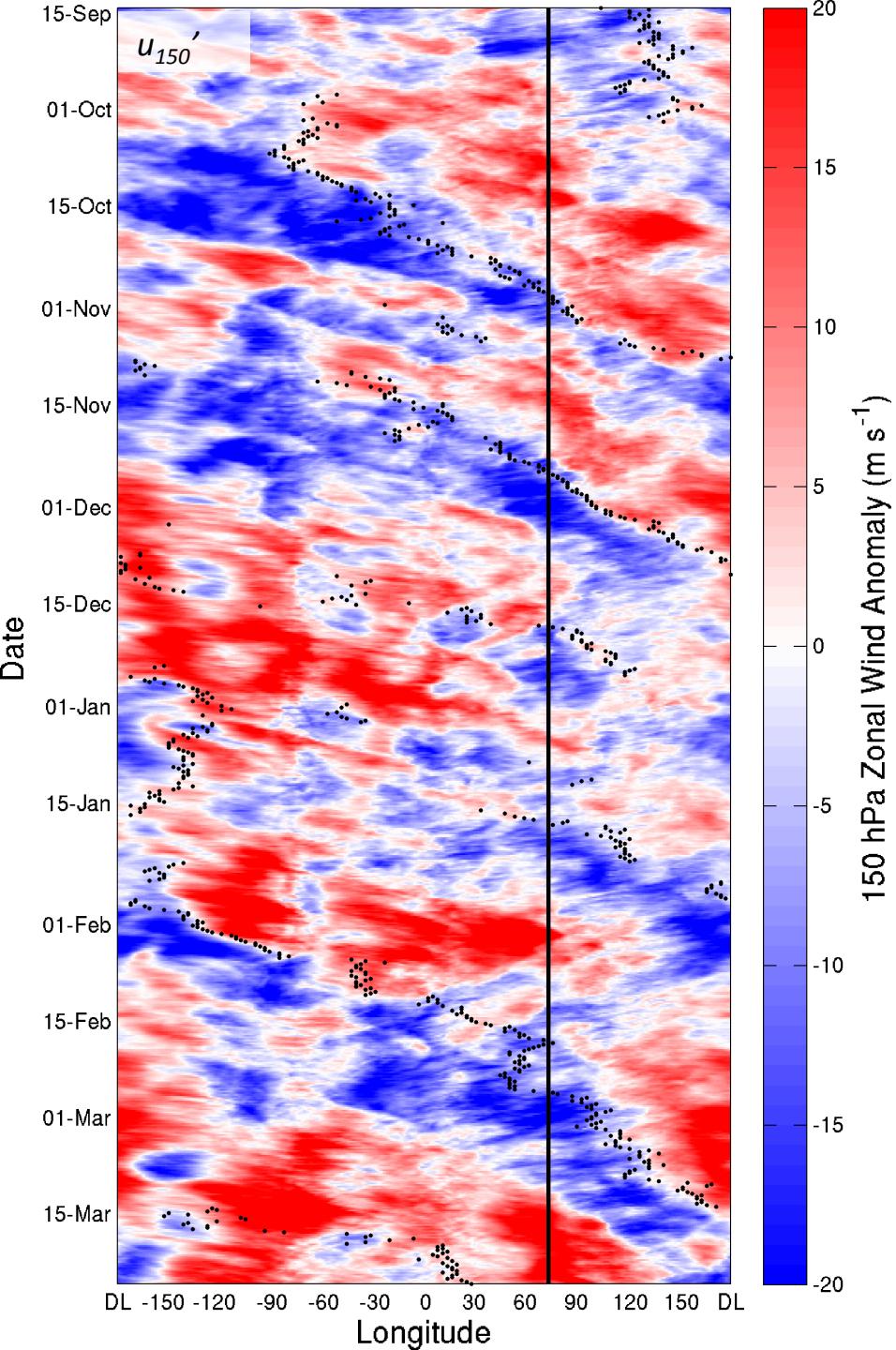


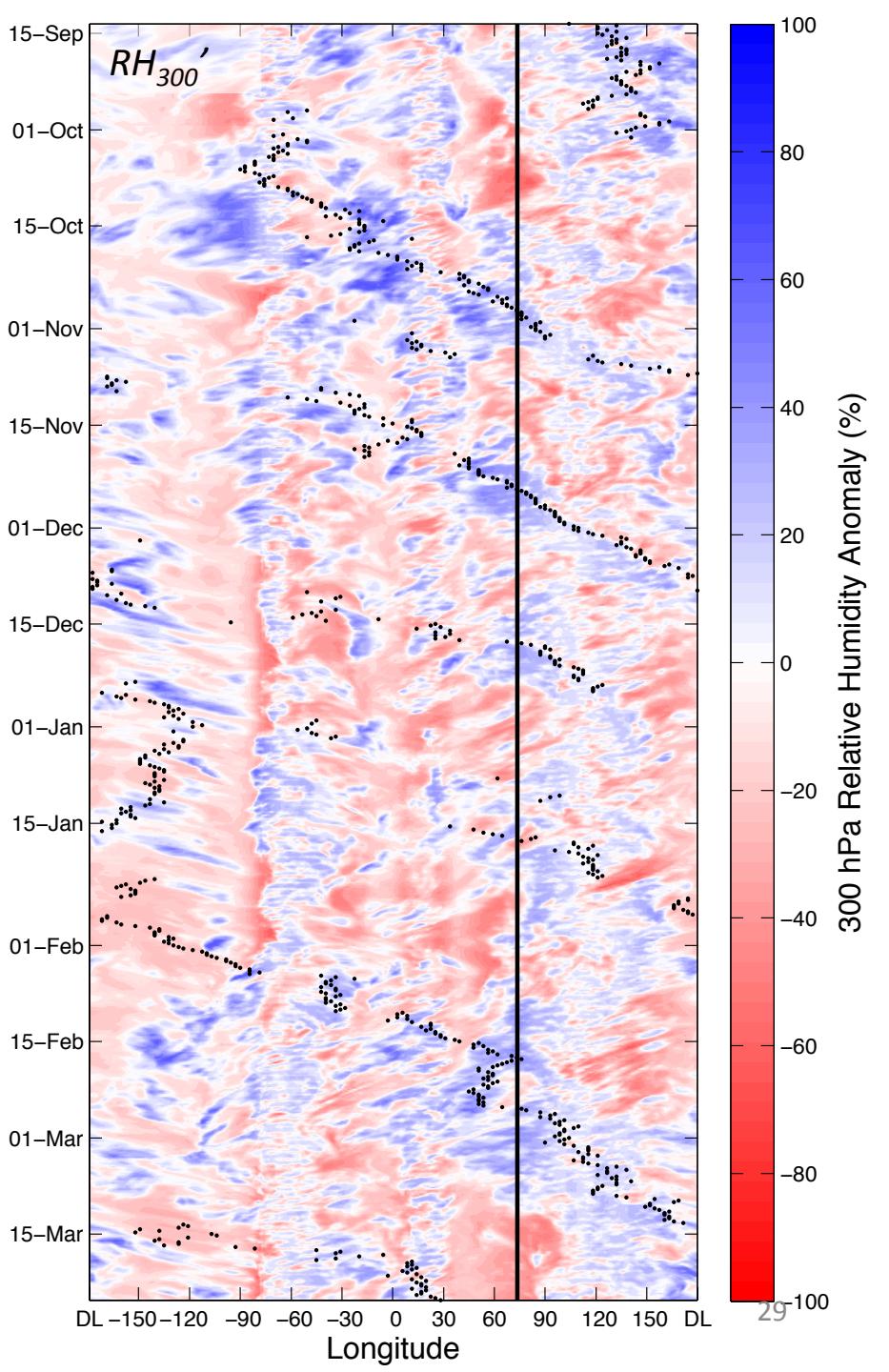
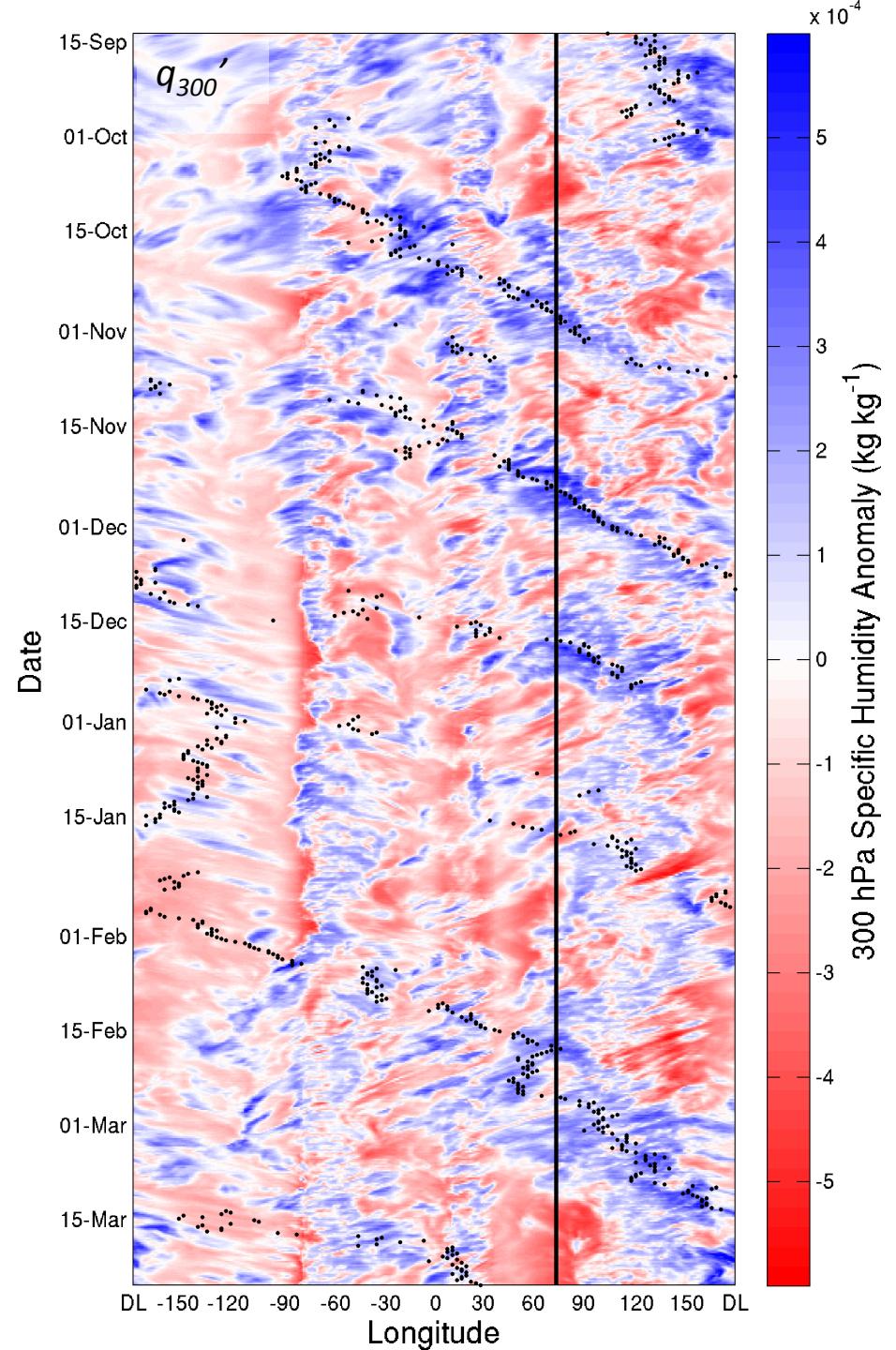
150 hPa u'
Blue: Easterly
Red: Westerly



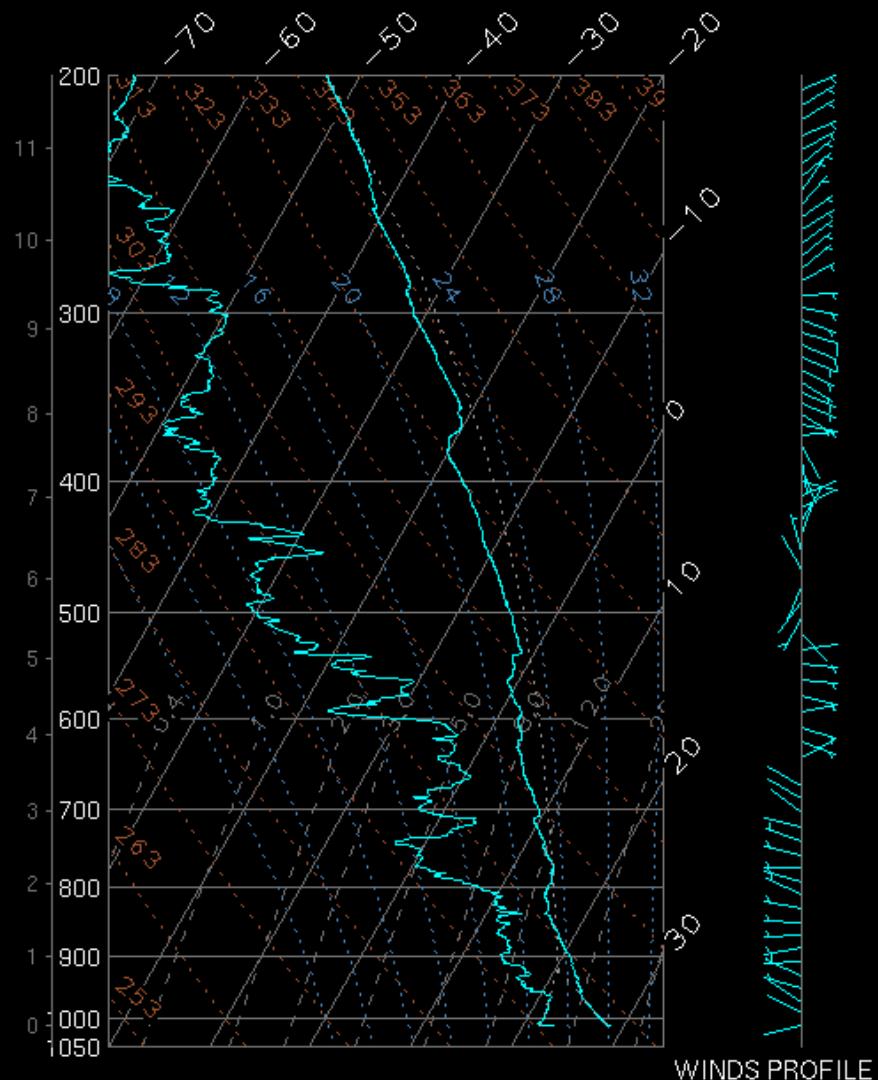
150 hPa u'
Blue: Easterly
Red: Westerly



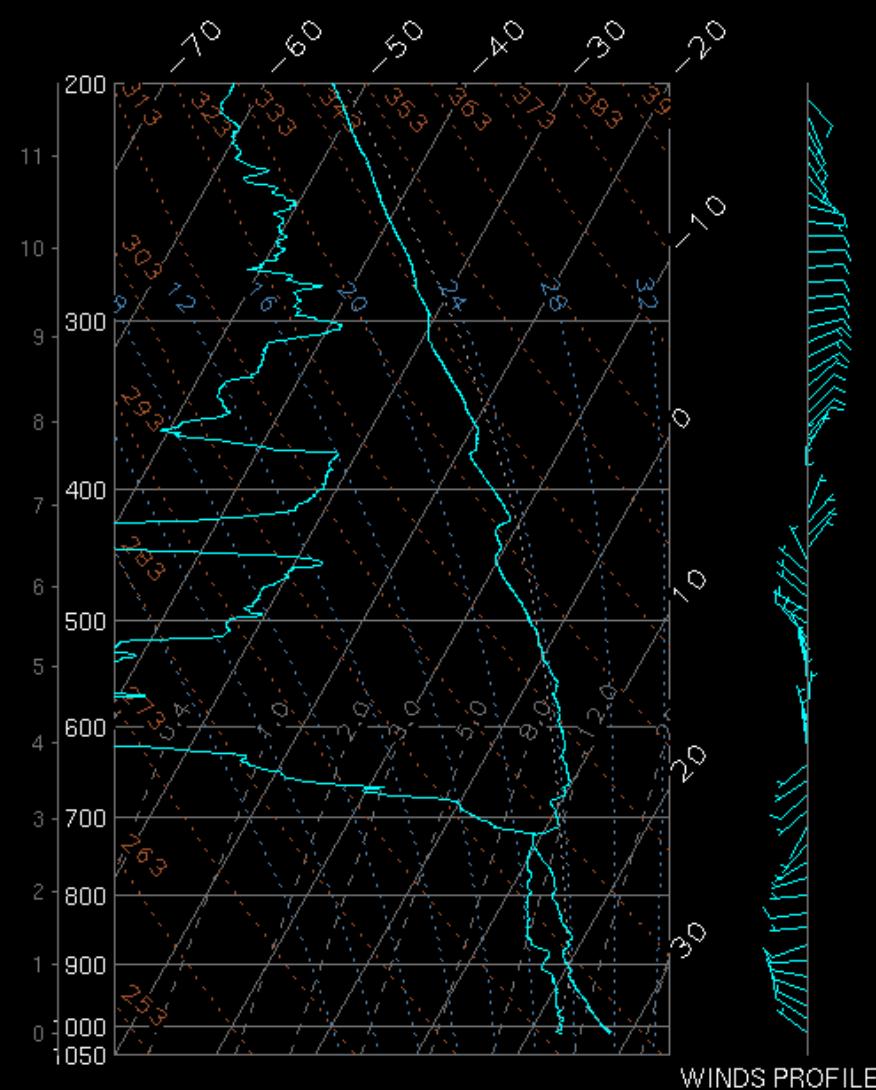


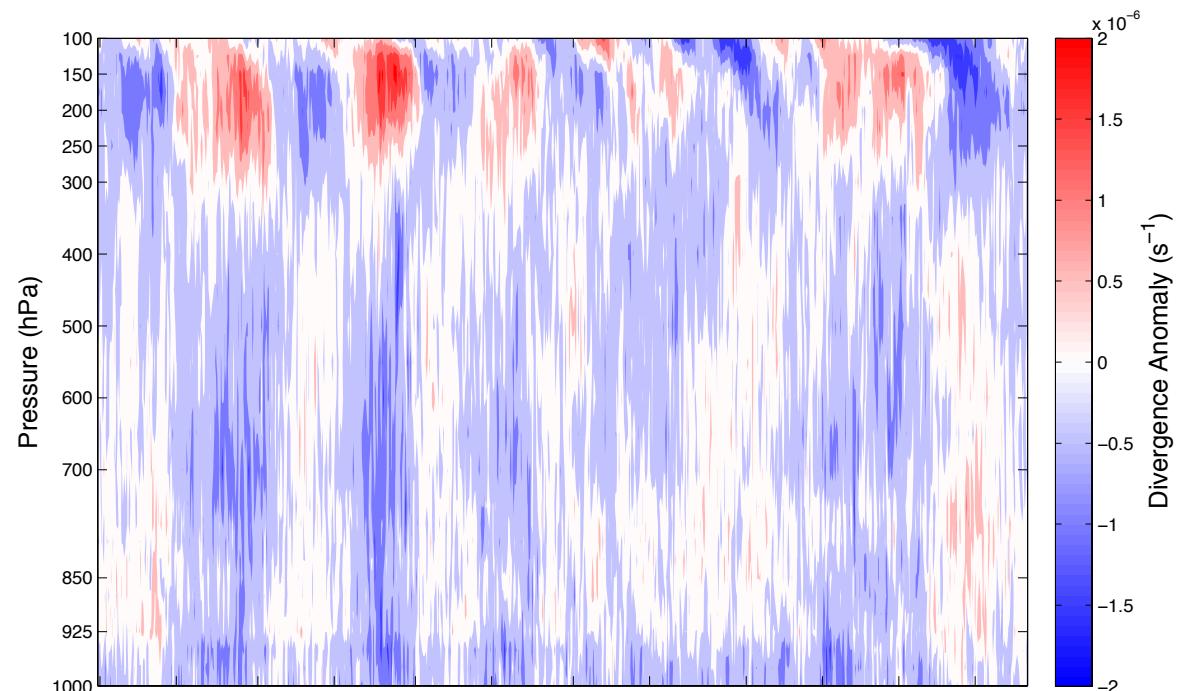
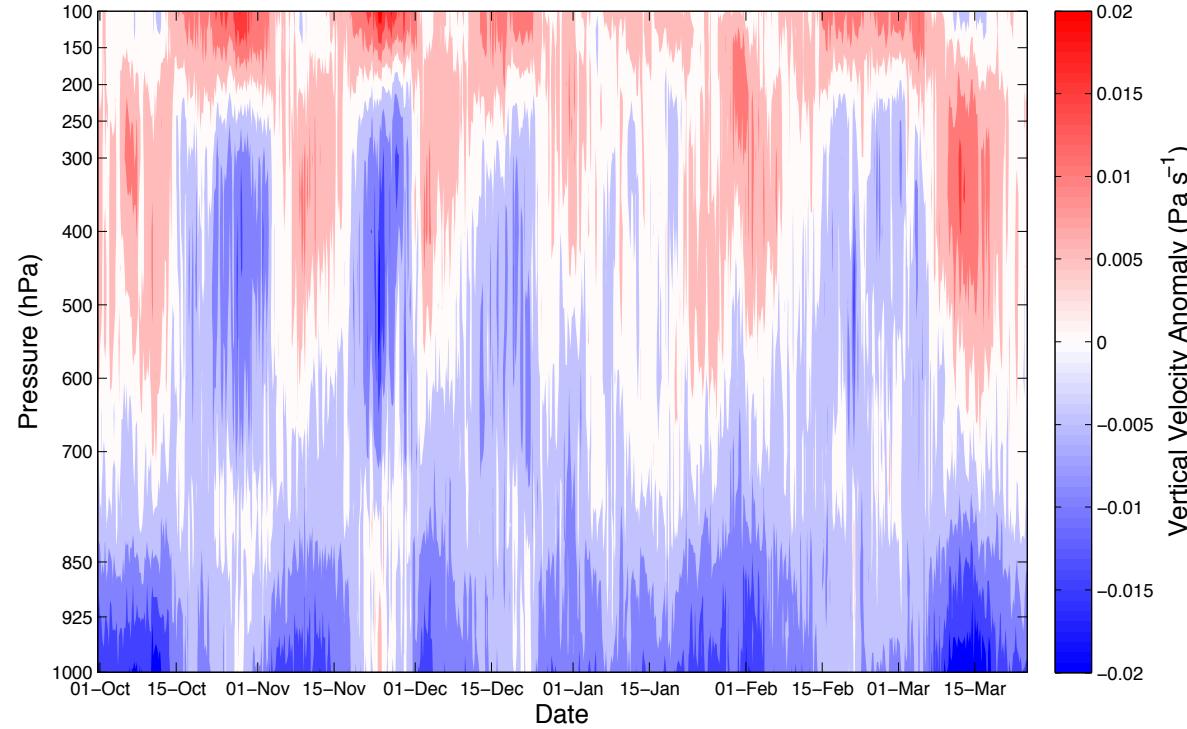


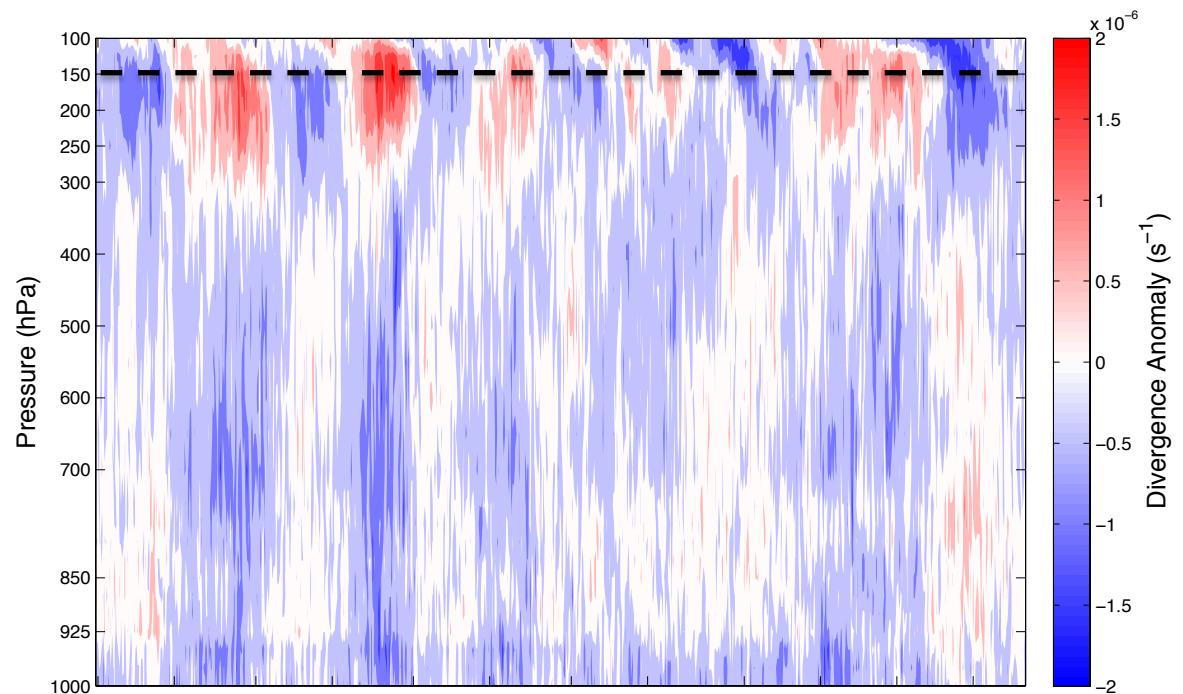
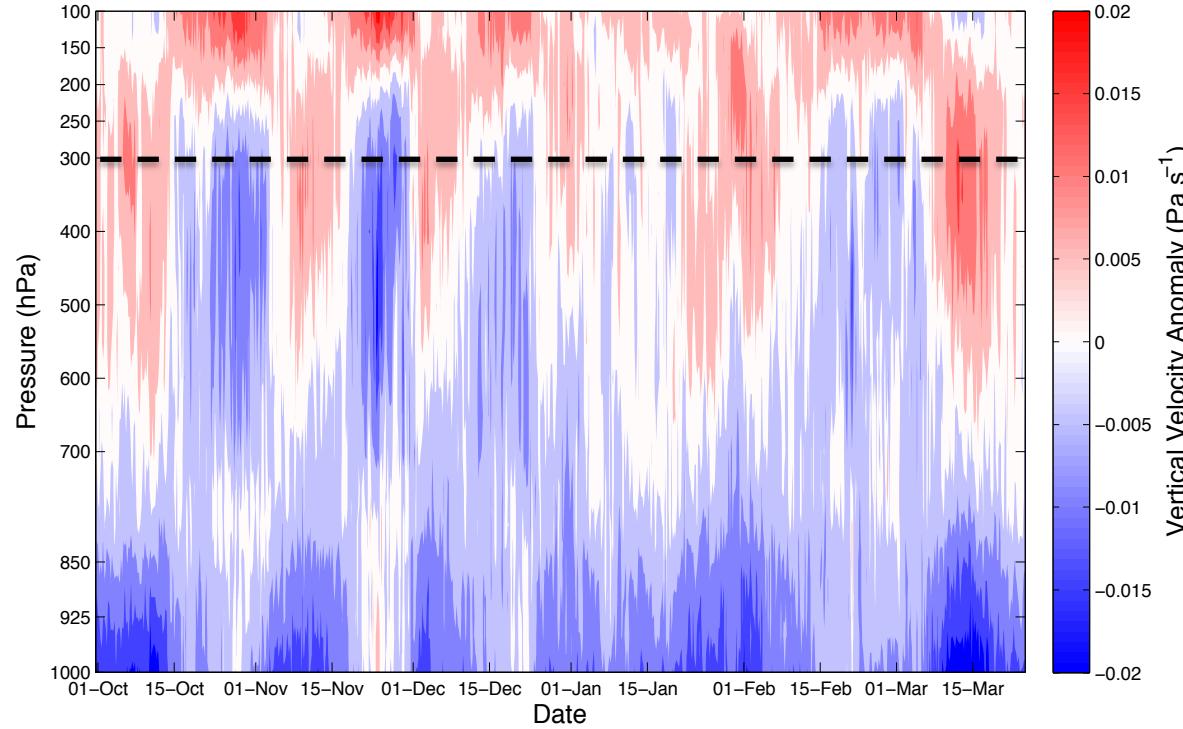
0234 UTC, 9 October

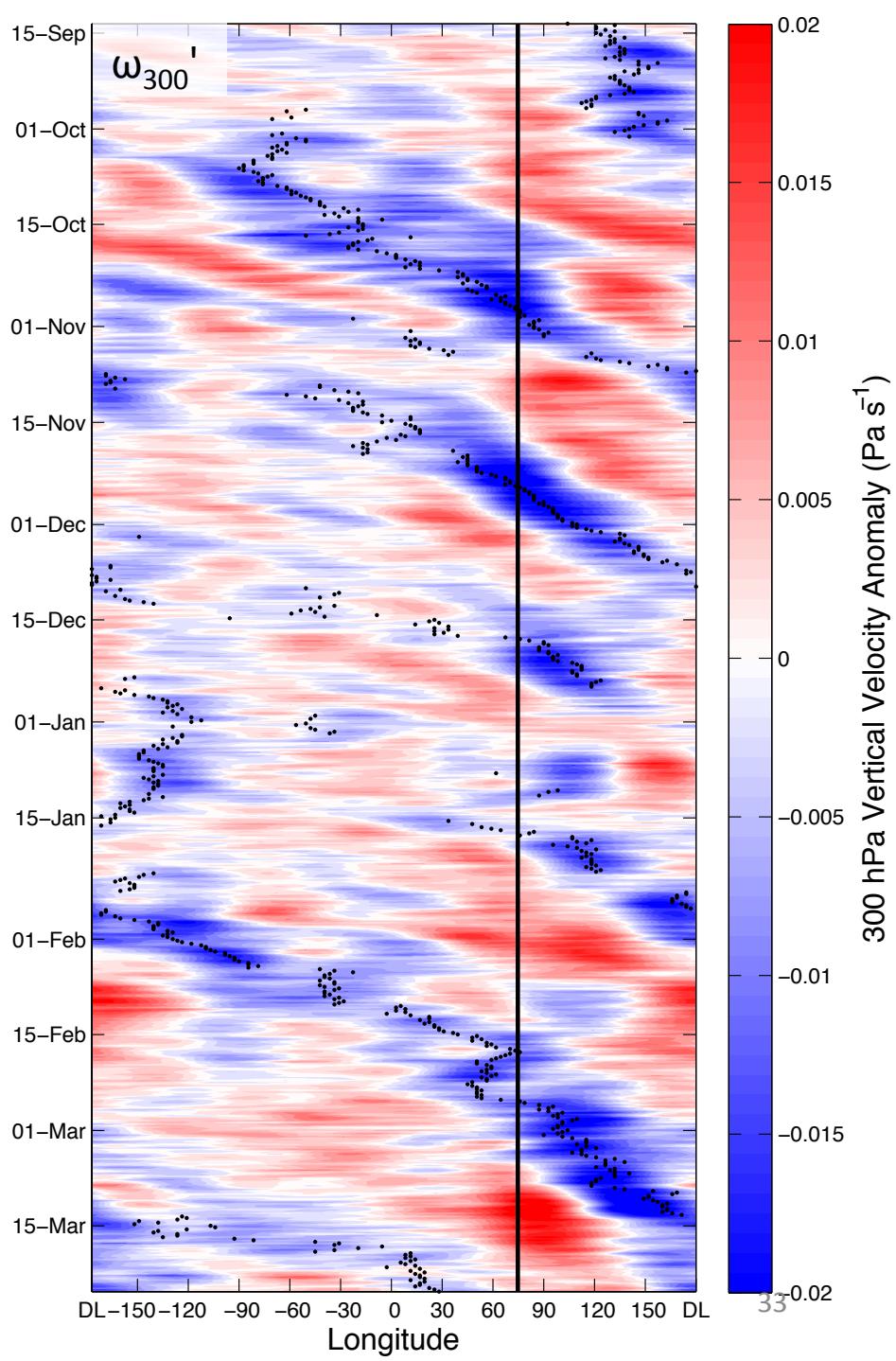
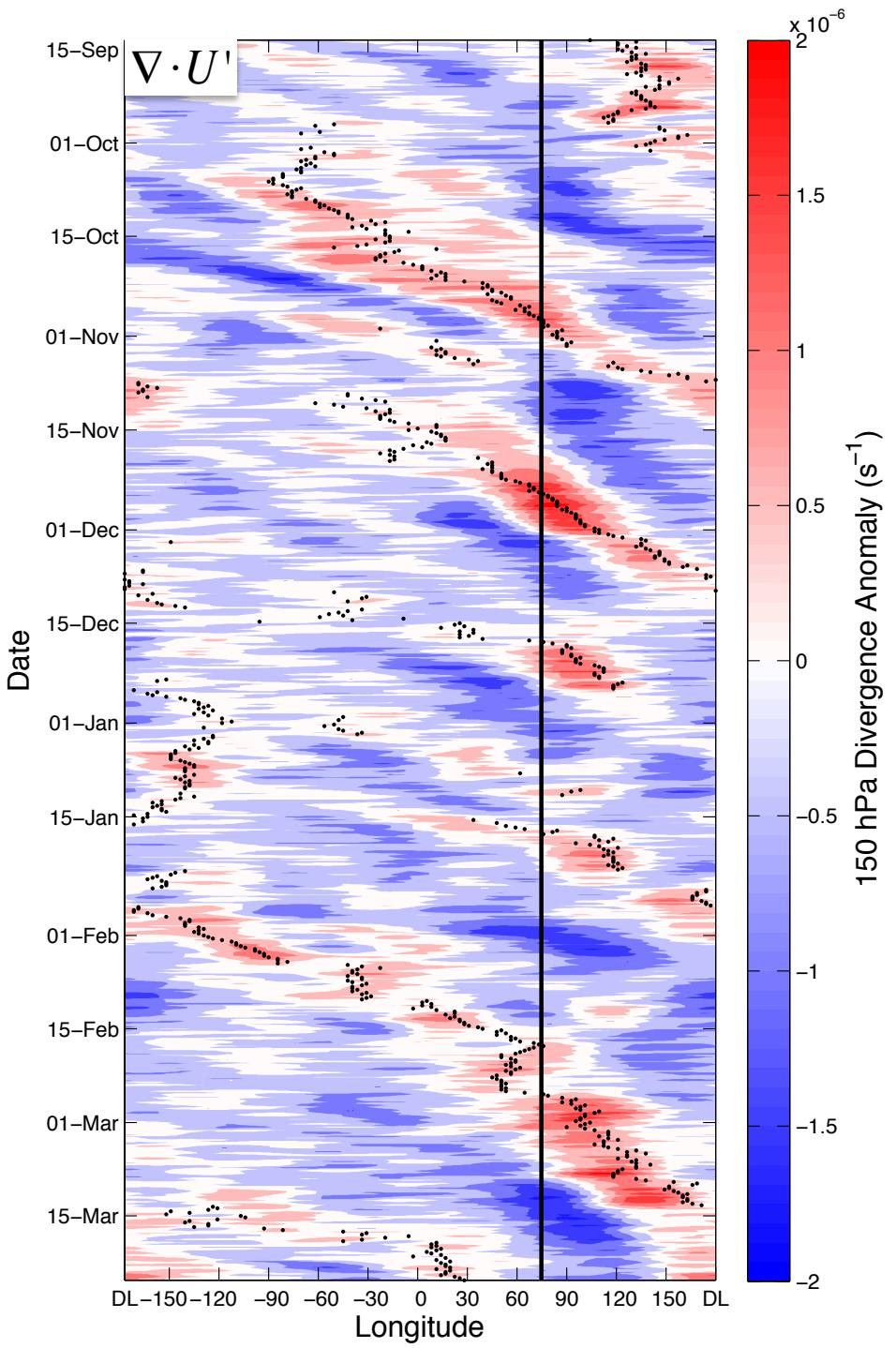


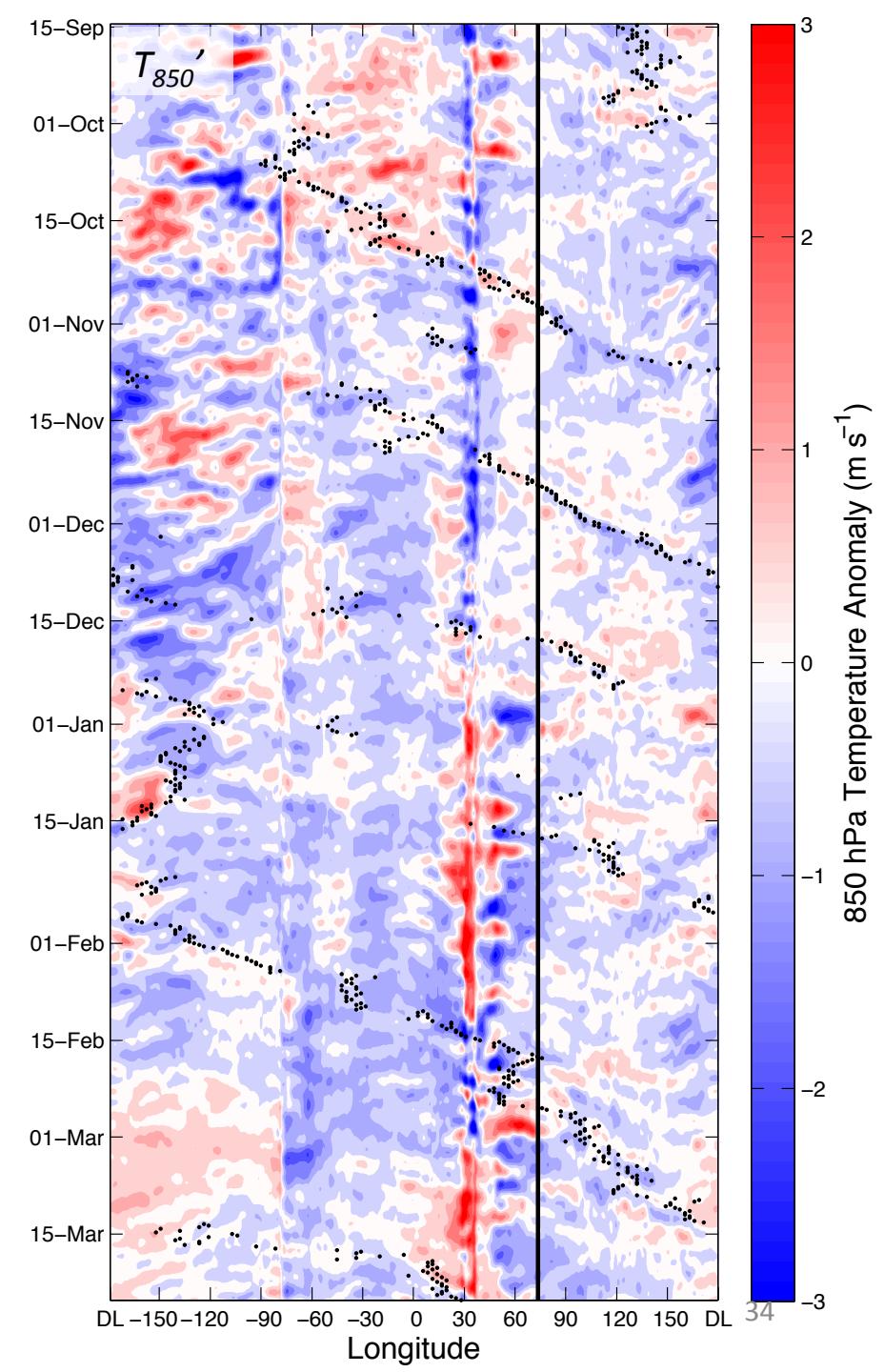
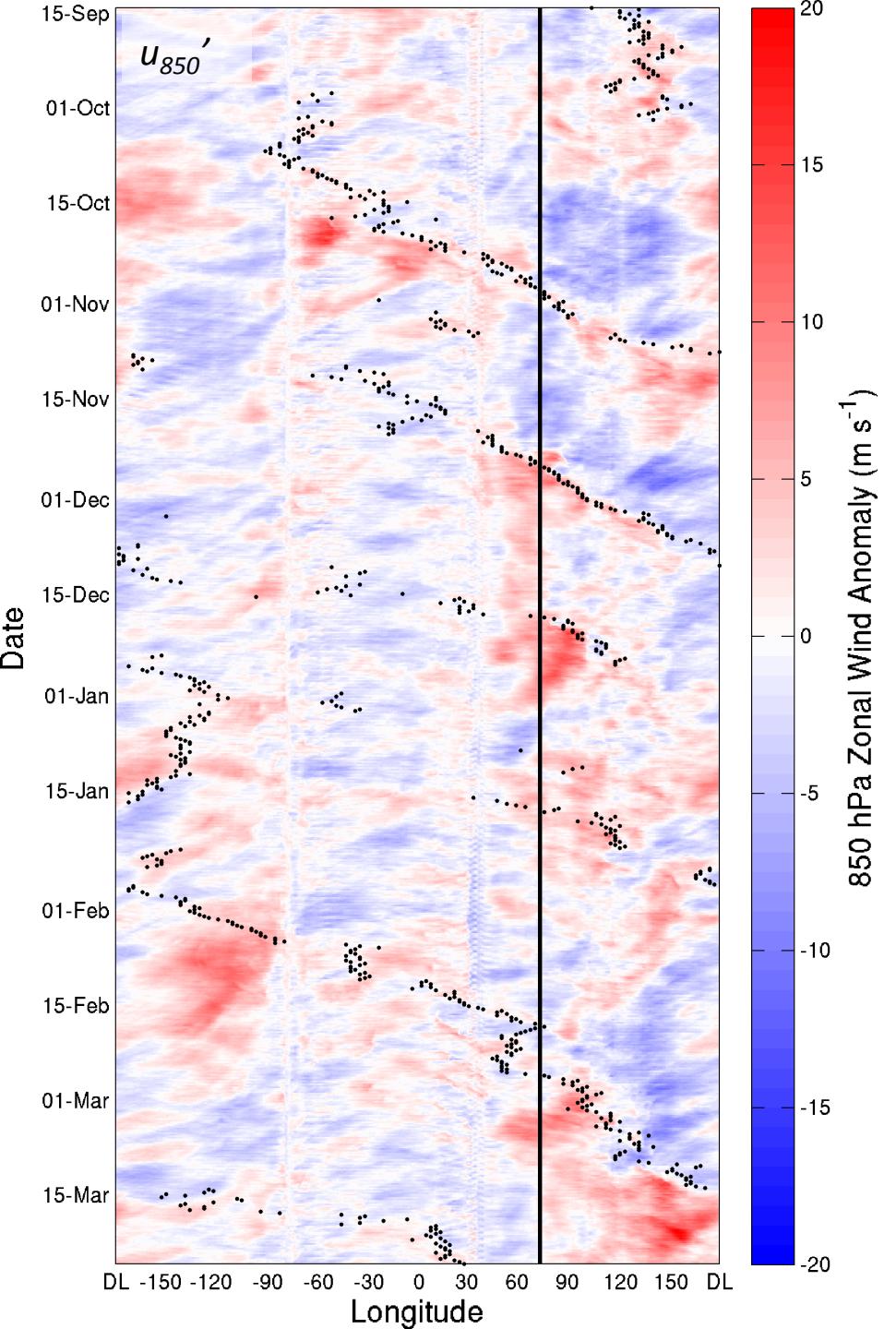
0236 UTC, 1 January

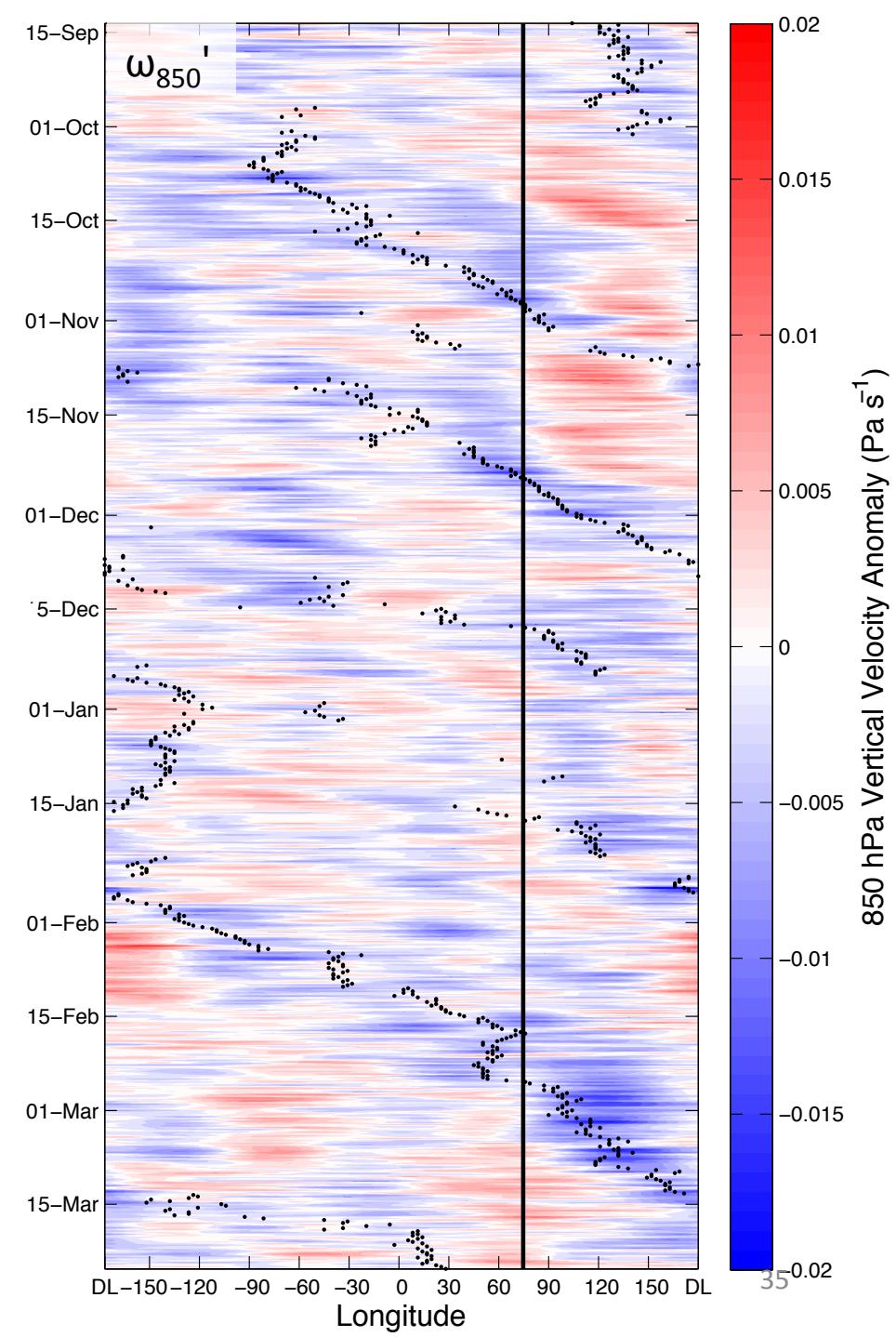
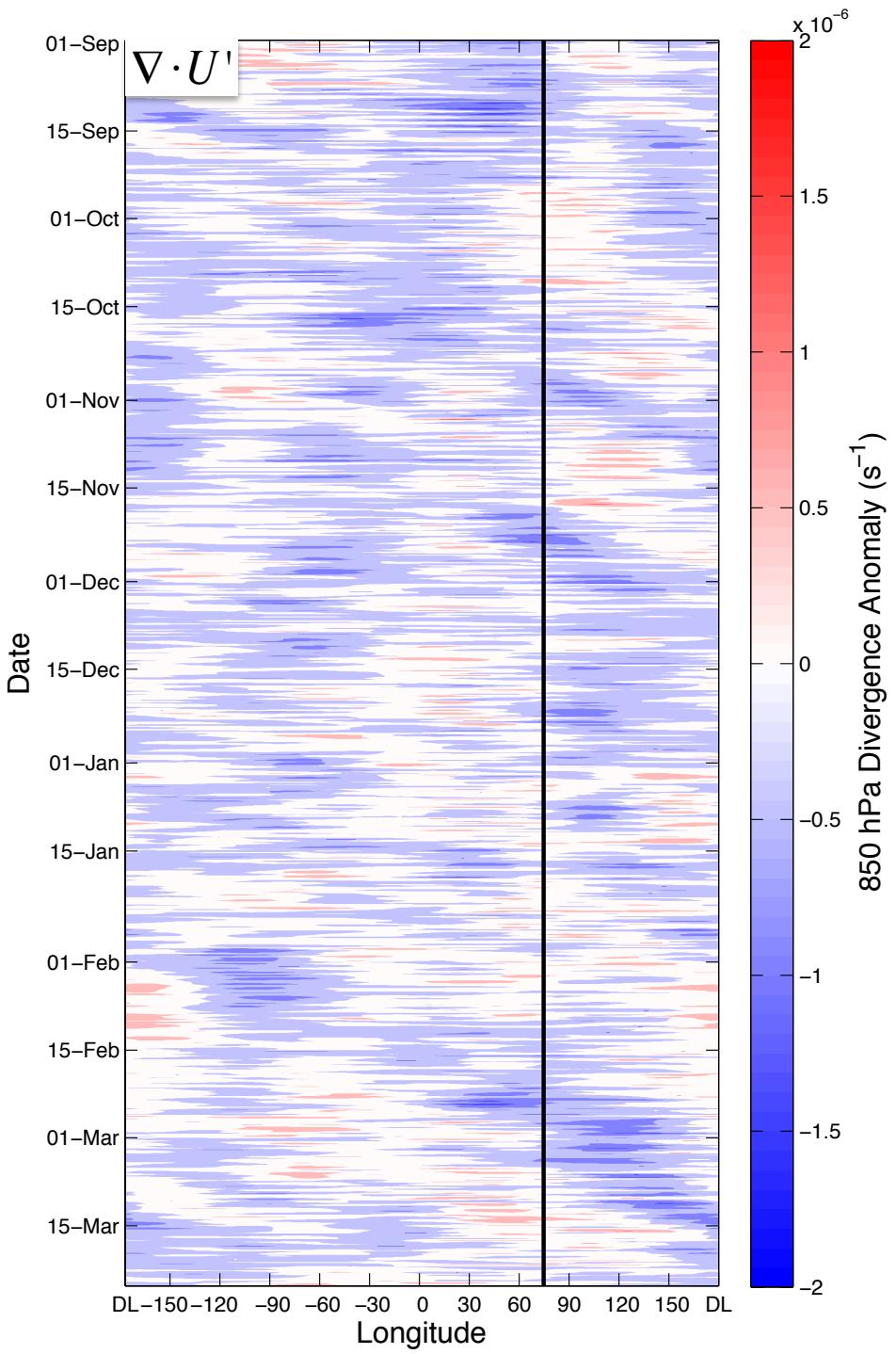


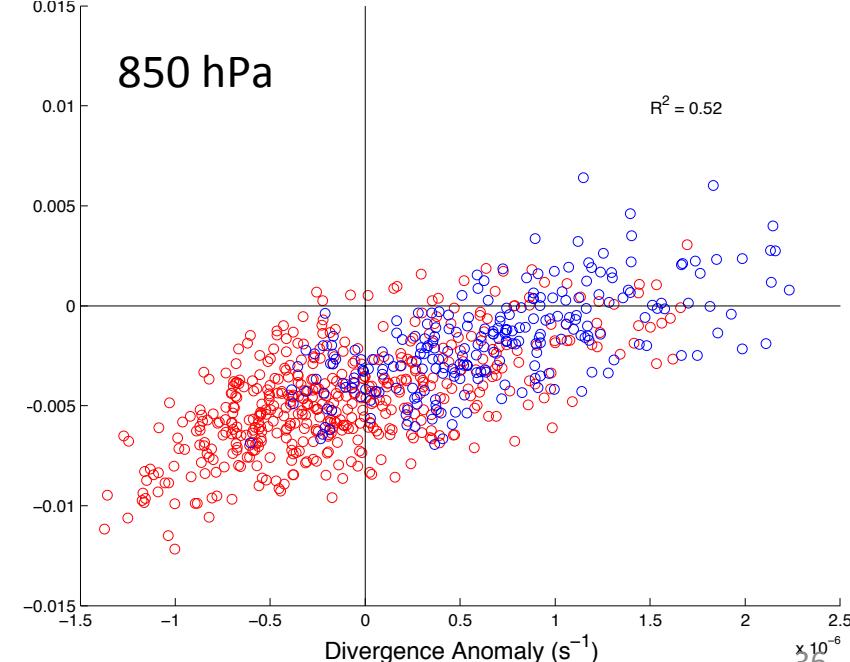
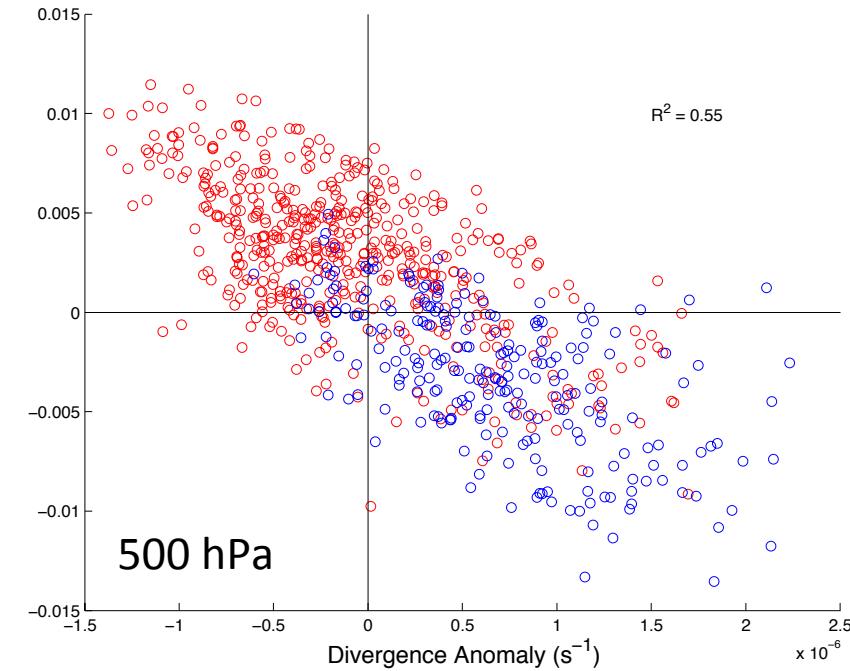
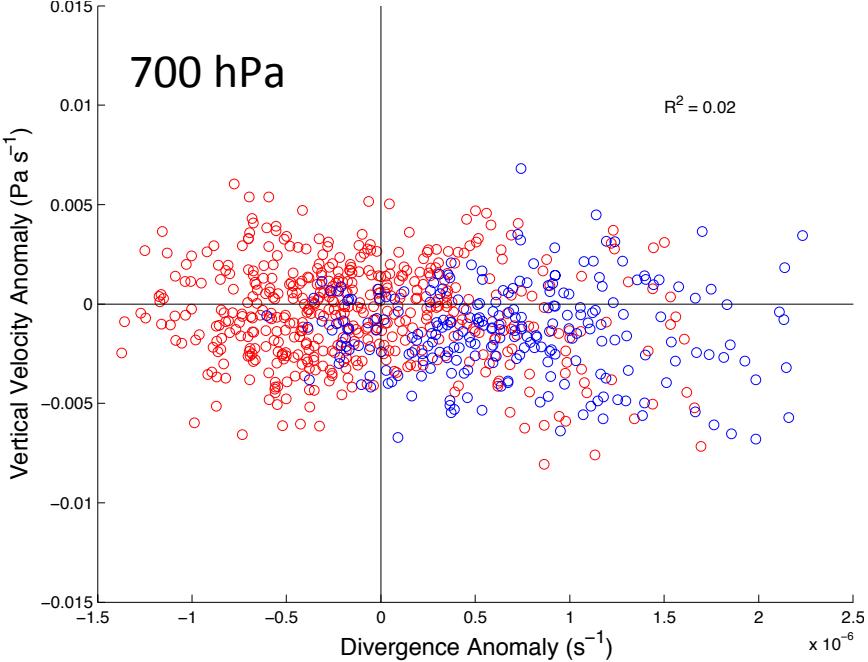
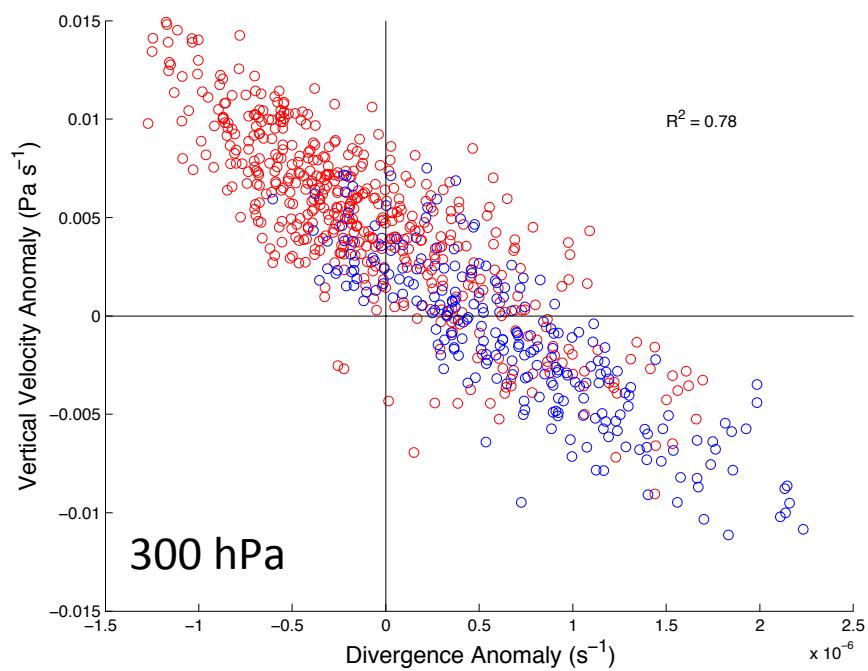
$\nabla \cdot U'$  ω' 

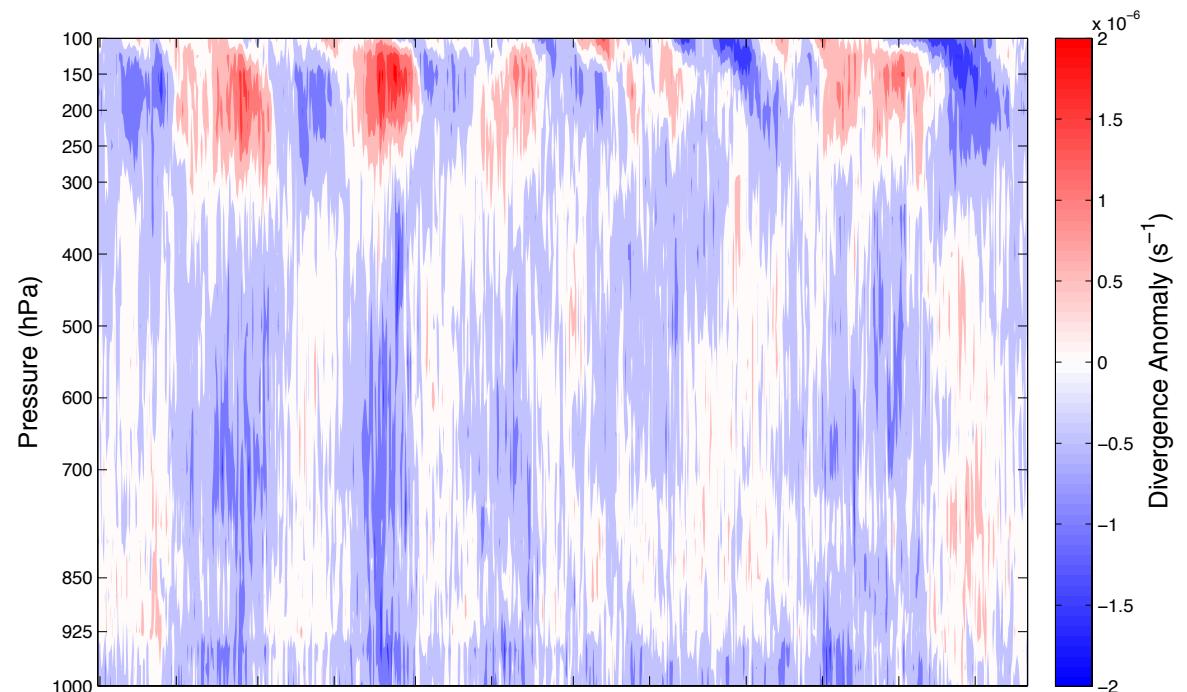
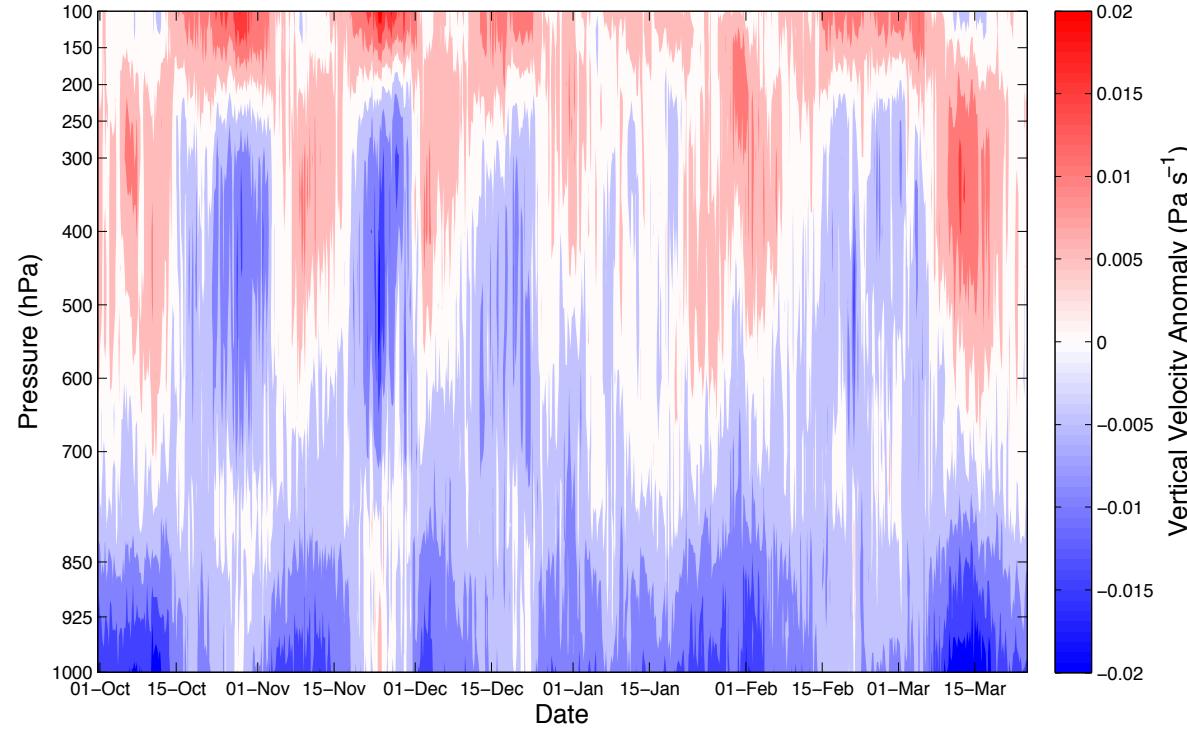
$\nabla \cdot U'$  ω' 

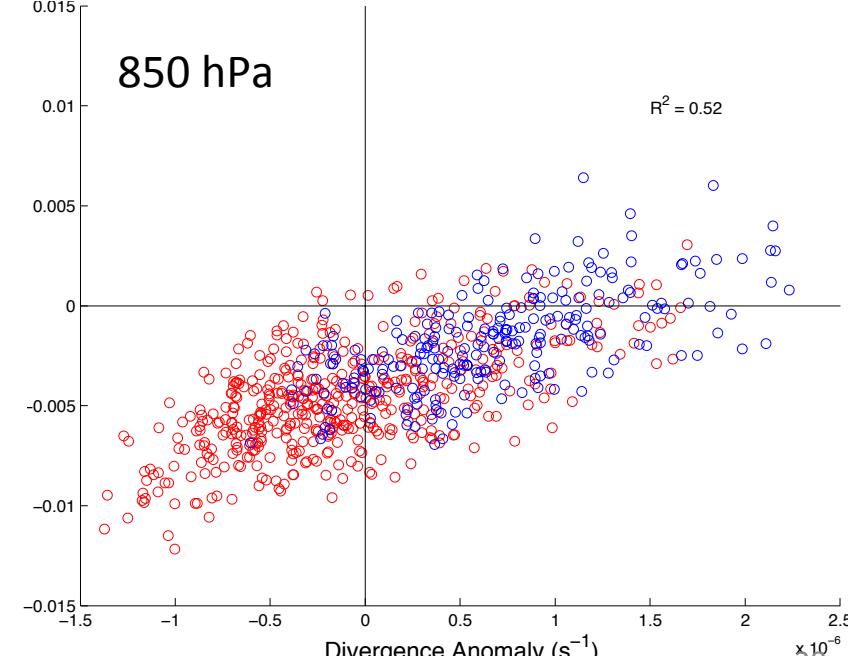
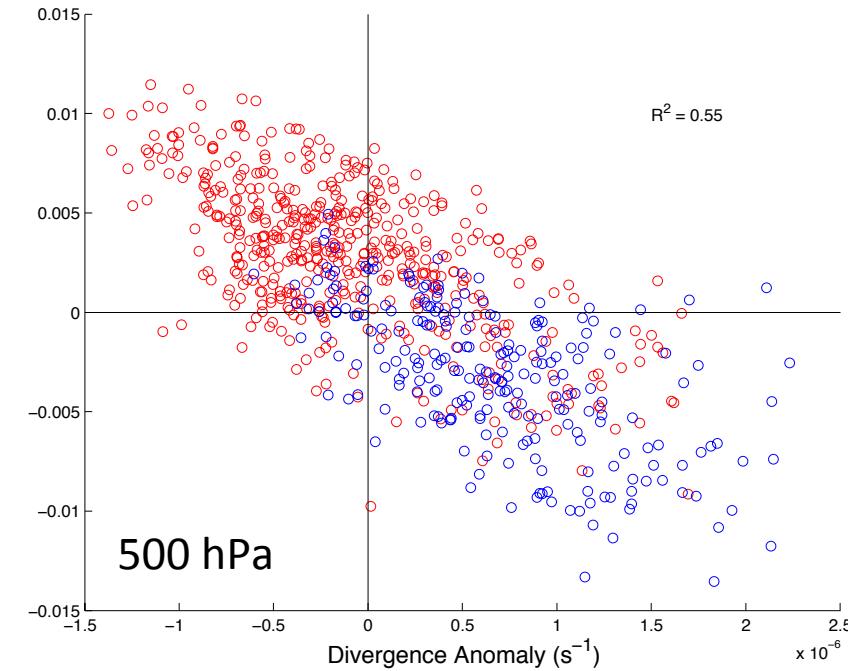
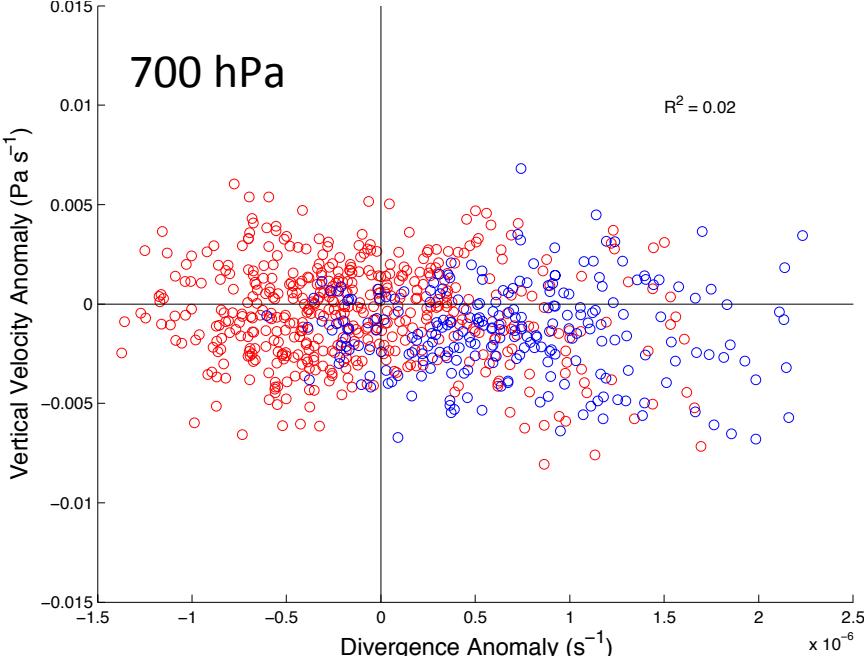
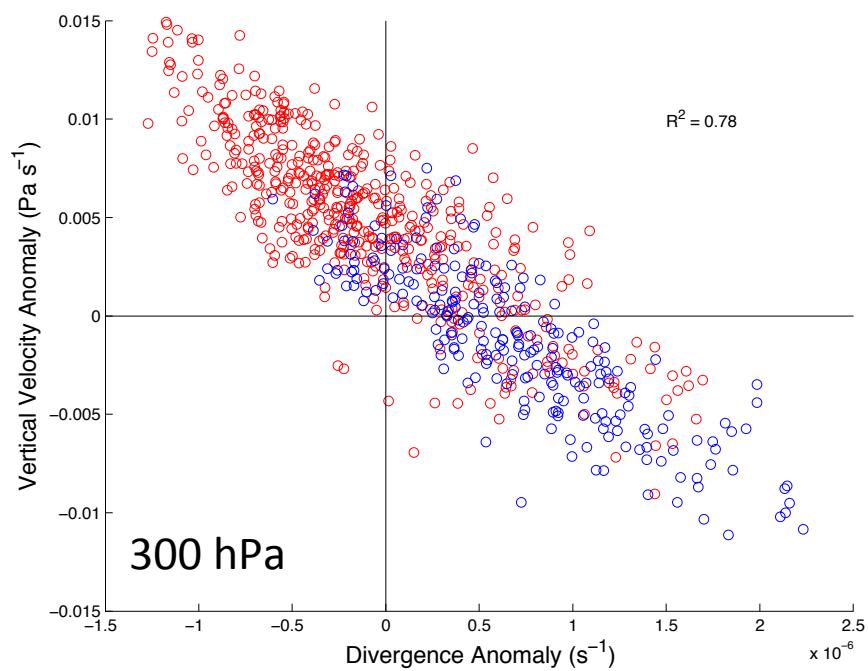




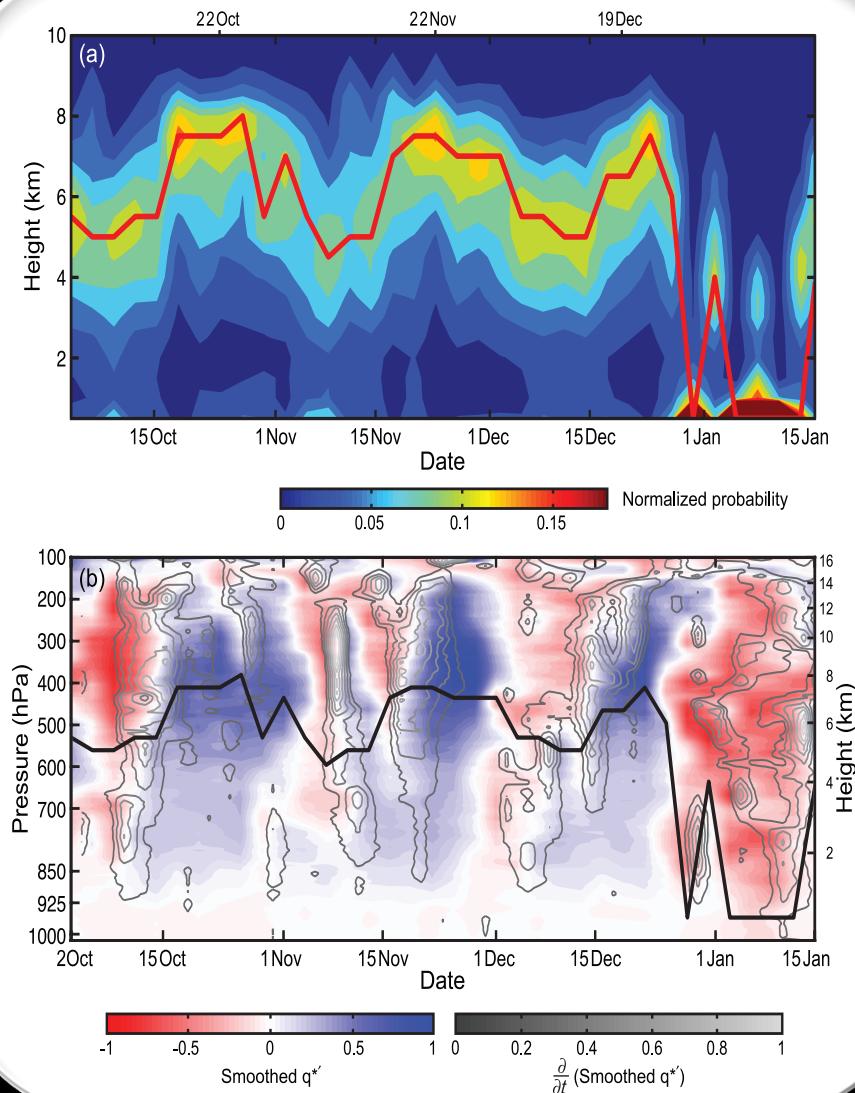




$\nabla \cdot U'$  ω' 

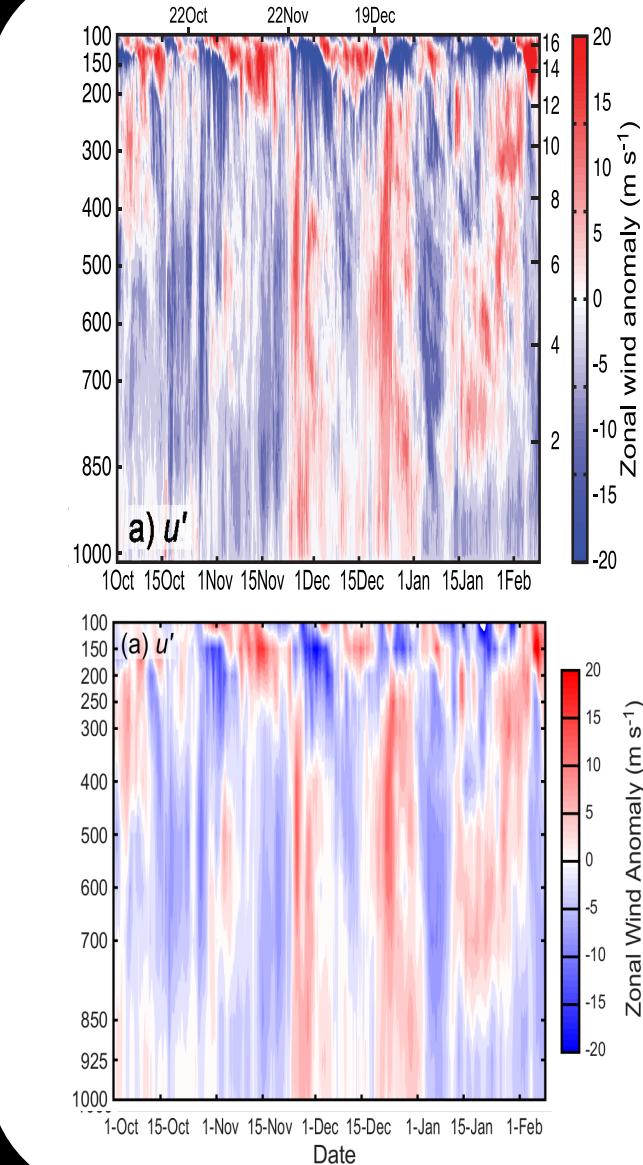


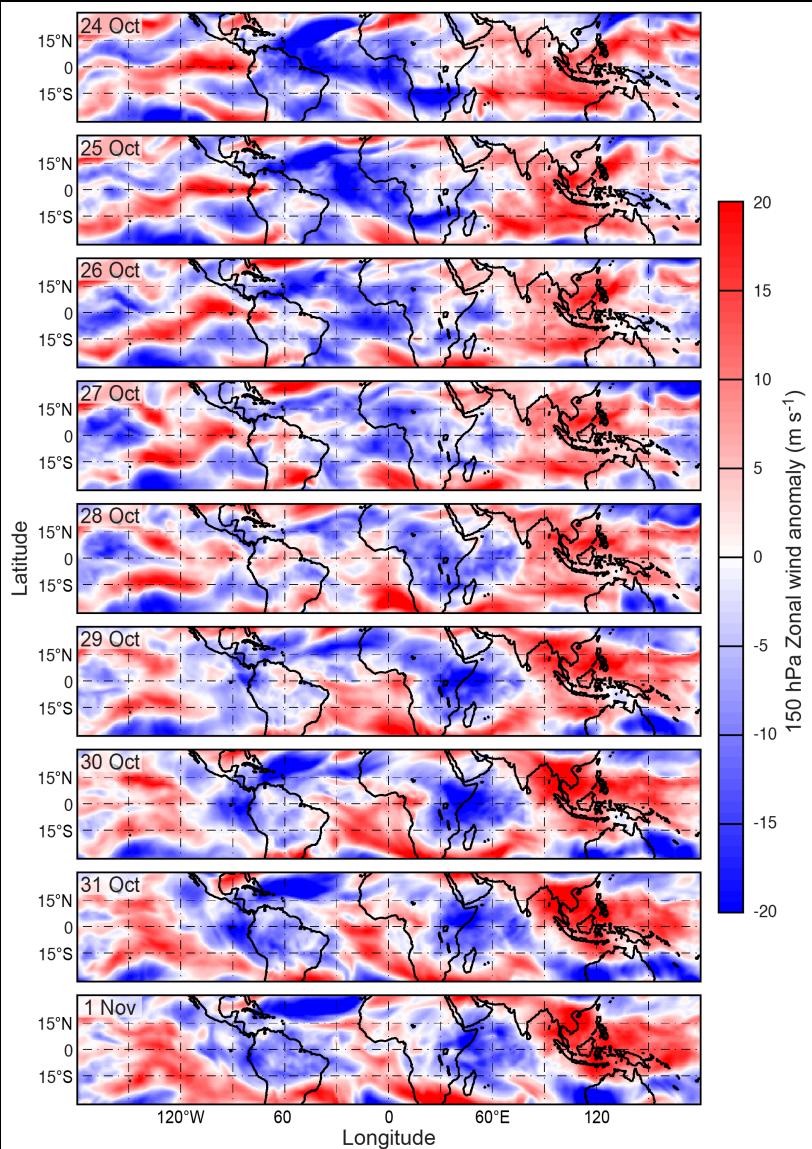
Conclusions



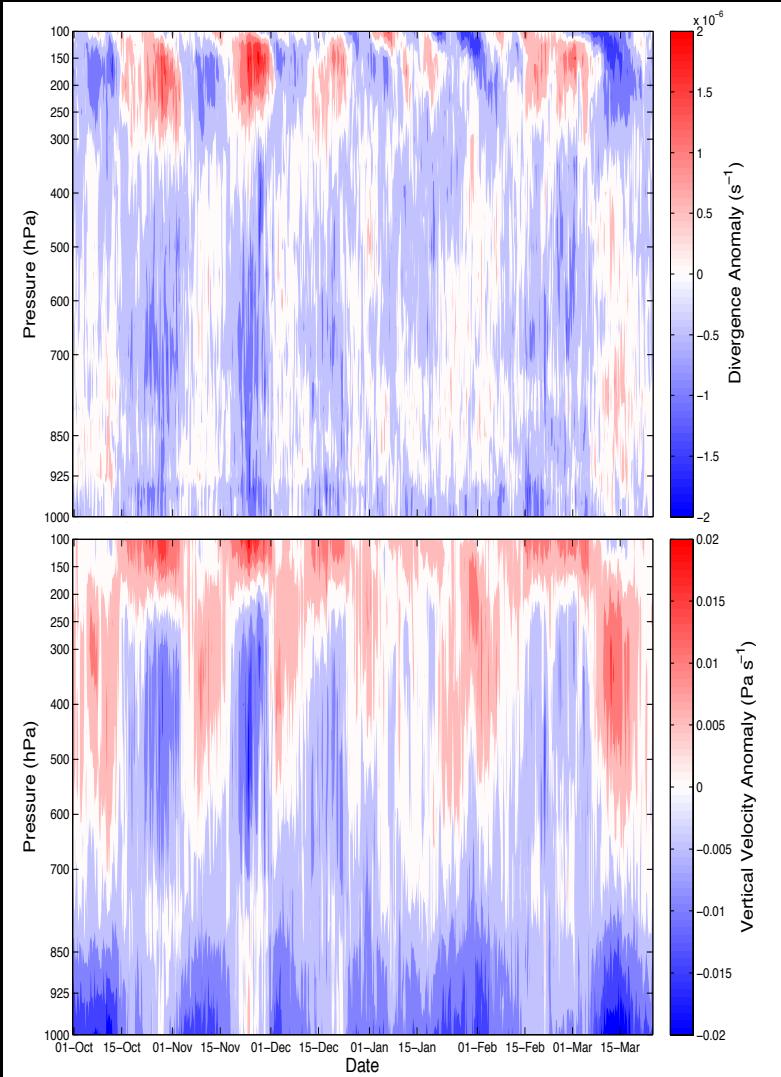
1. Humidity anomalies at various levels and depth of convection increase rapidly at MJO convective onset.

2. ~30 day variability in fields observed by radar and rawinsonde are consistent with that over larger domain in Indian Ocean where initial MJO convective onset occurs.





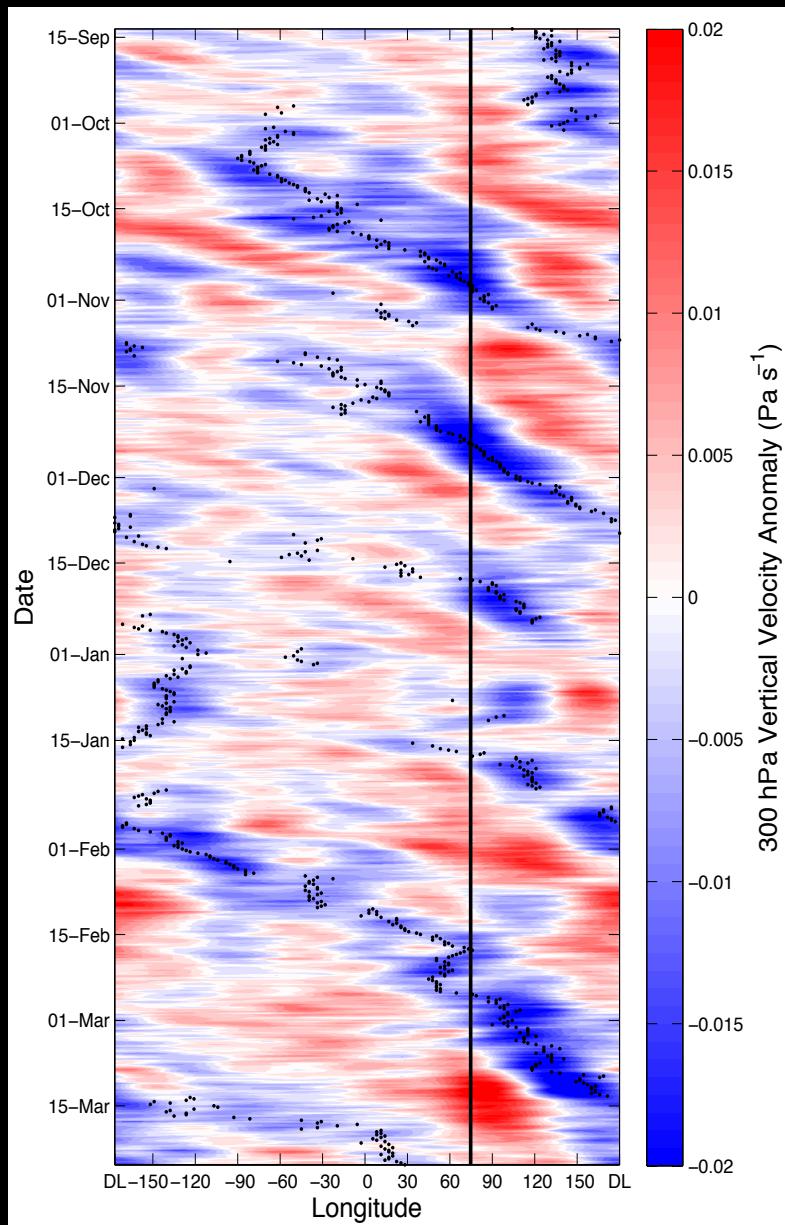
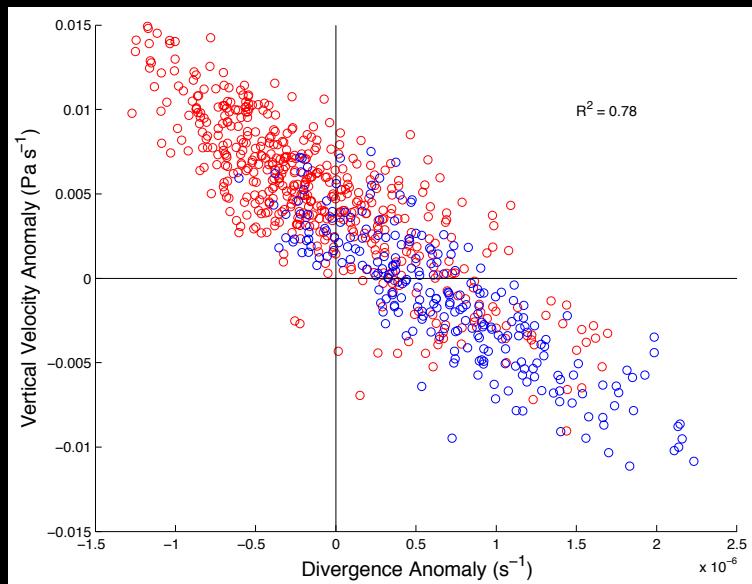
3. Large scale semi-global structures of anomalous zonal wind (and other fields) enters Indian Ocean from west.



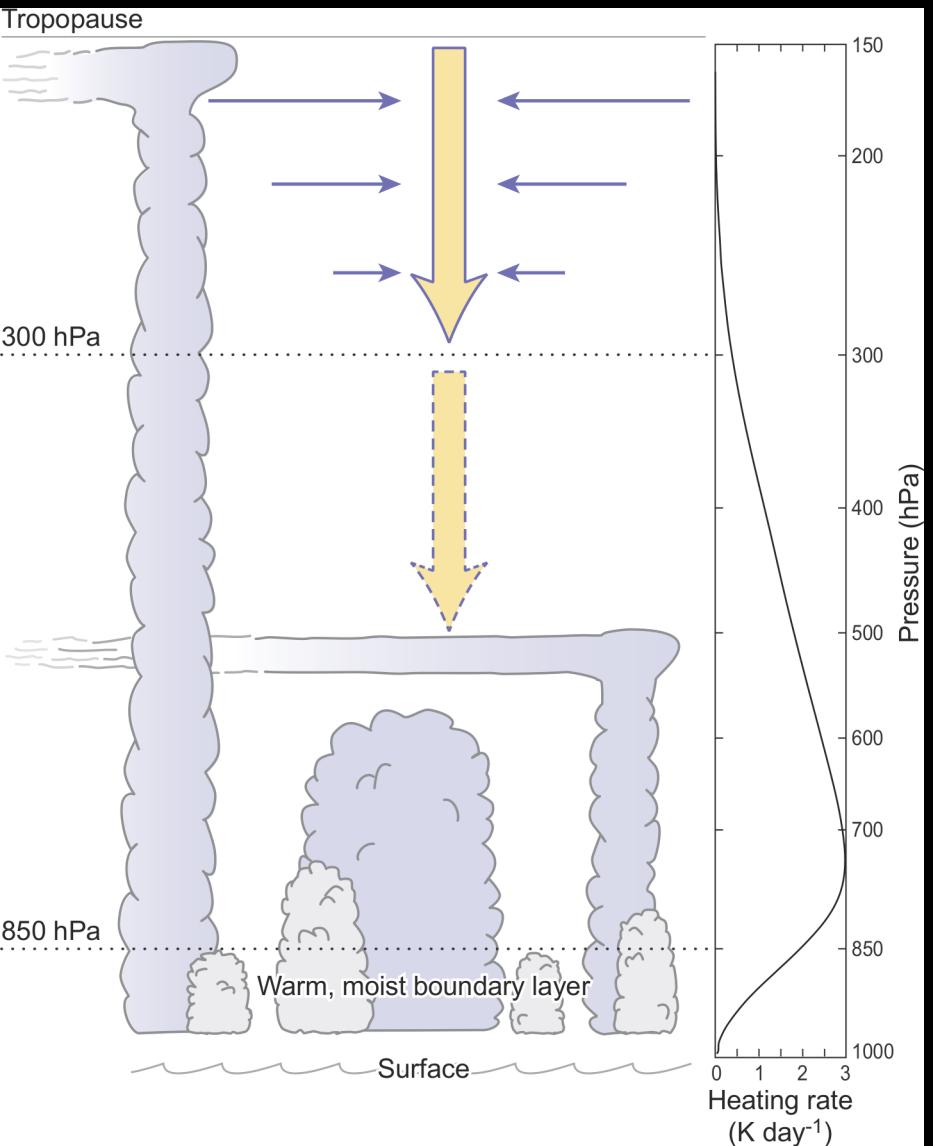
4. Periods of suppressed convection characterized by low-level upward motion. Enhanced convection occurs with upper-level upward motion.

5. Anomalies of vertical velocity are coupled with divergence and sometimes circumnavigate tropics.

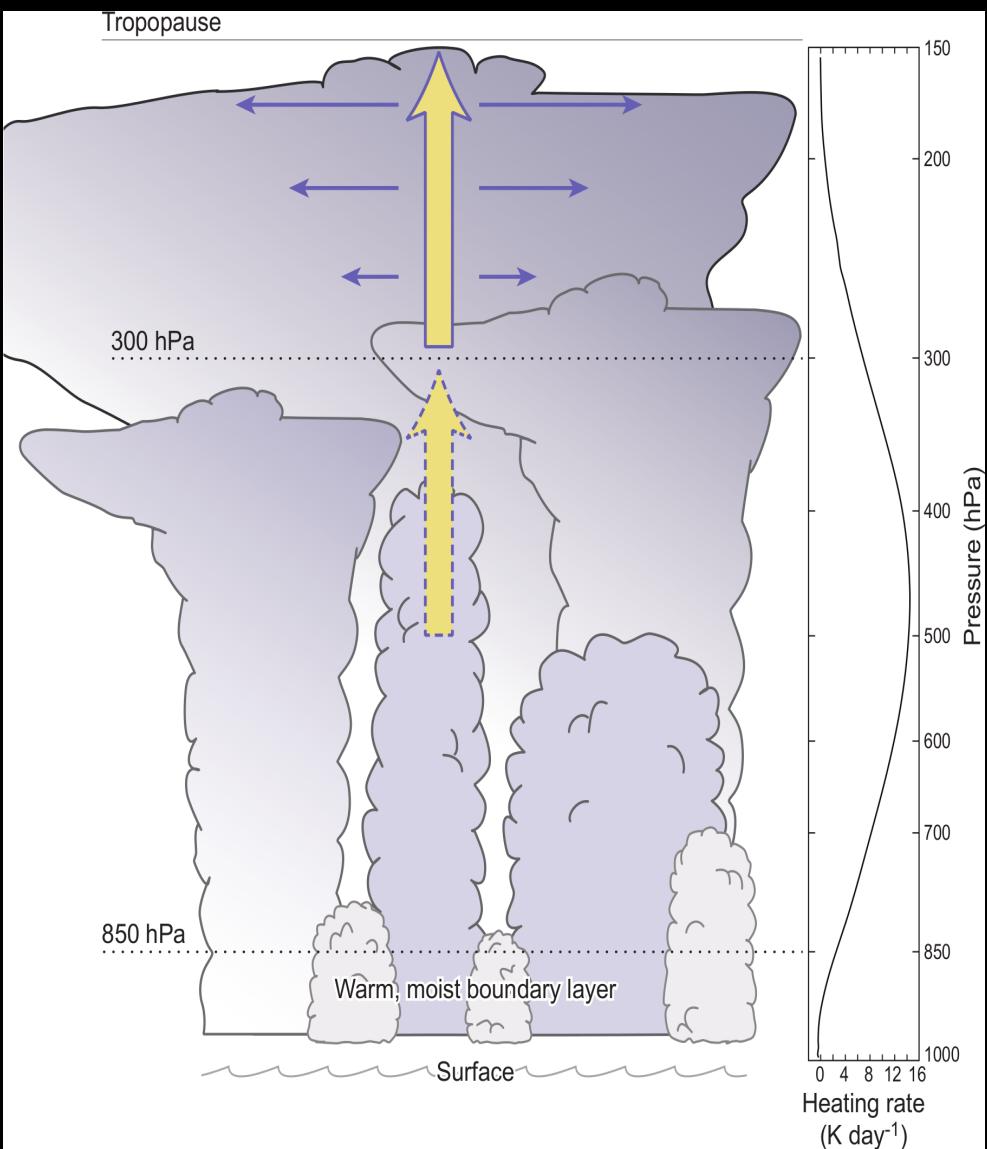
6. MJO convective onset occurs when UT downward motion anomaly moves out of Indian Ocean.



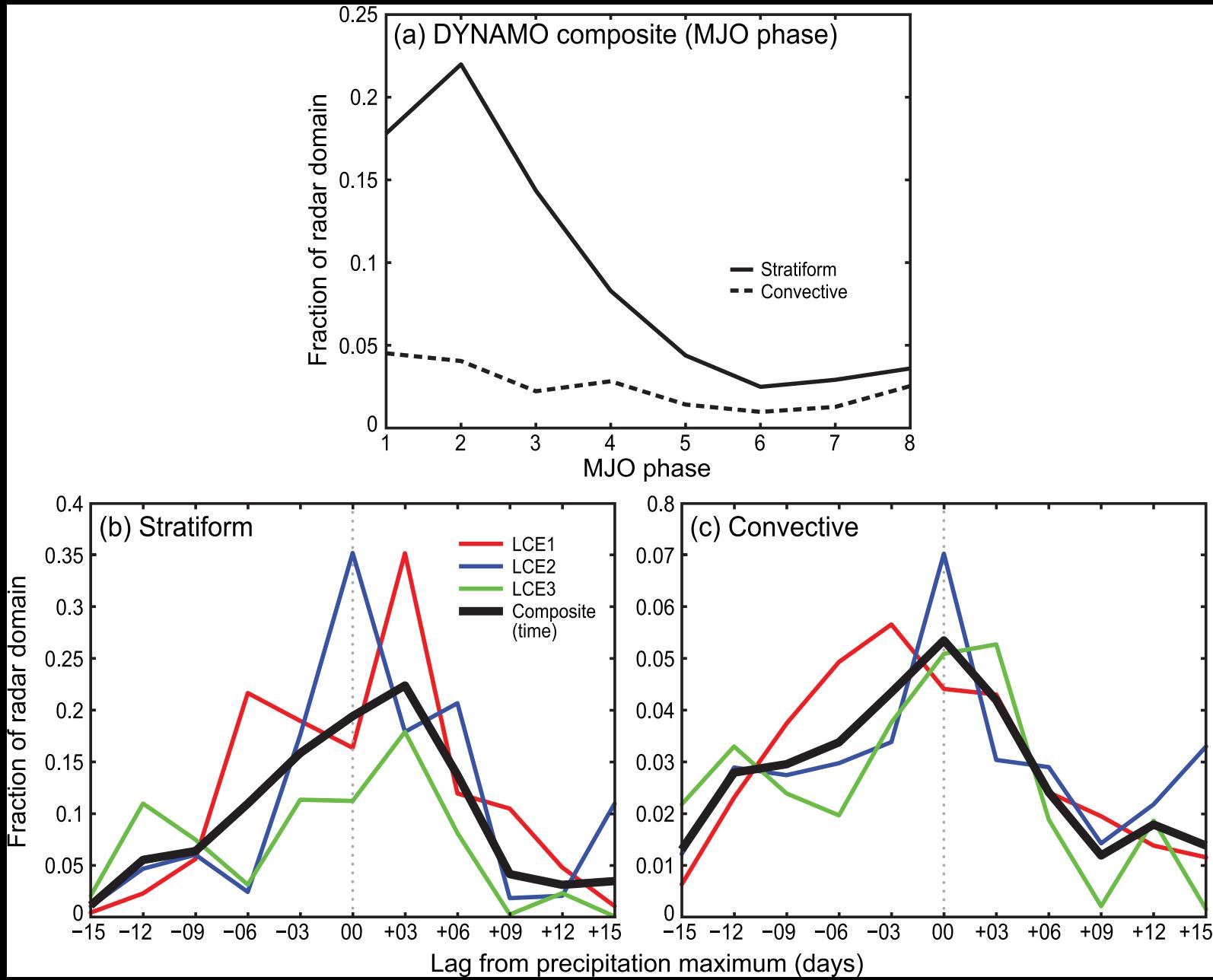
Suppressed Convection

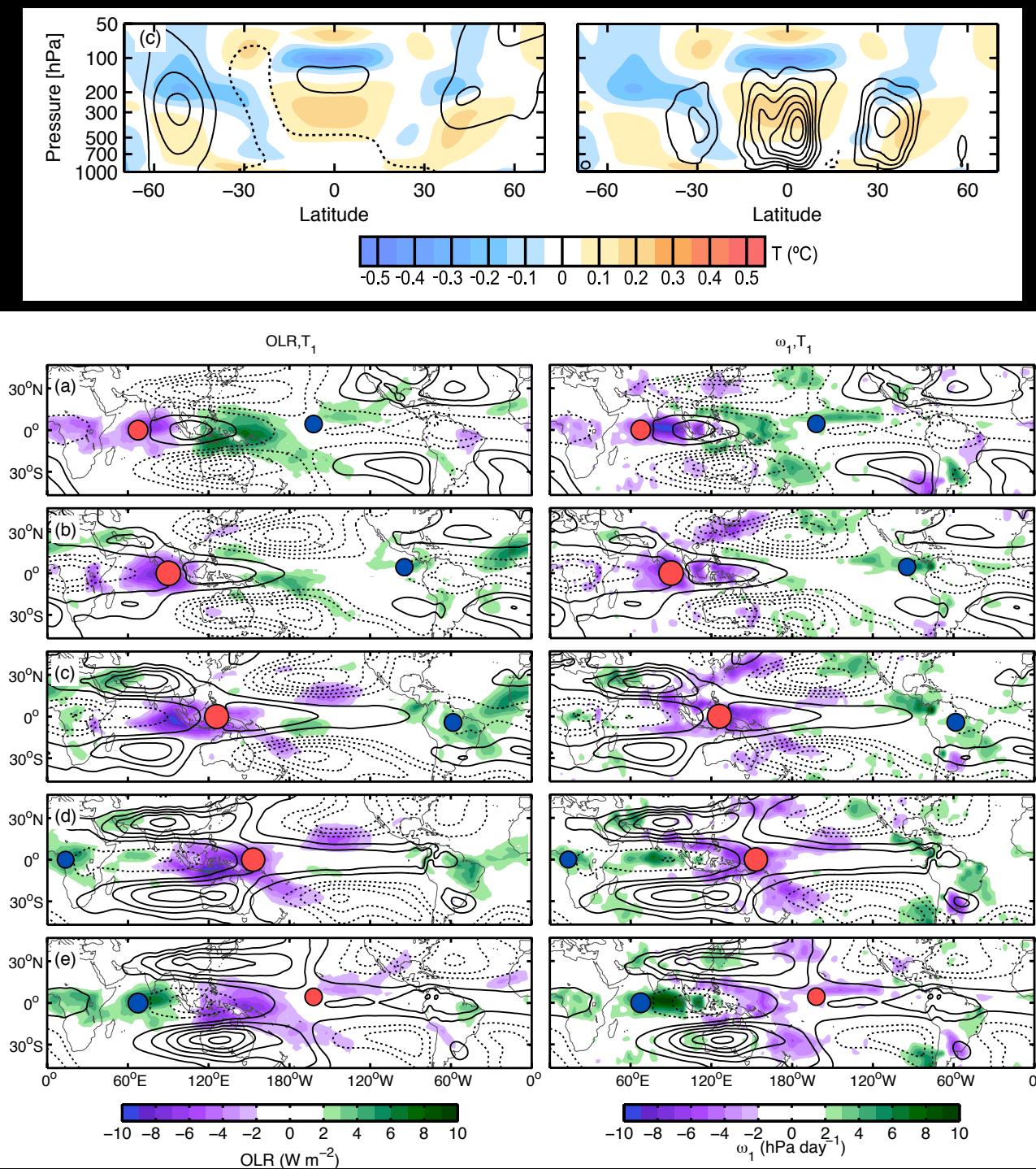


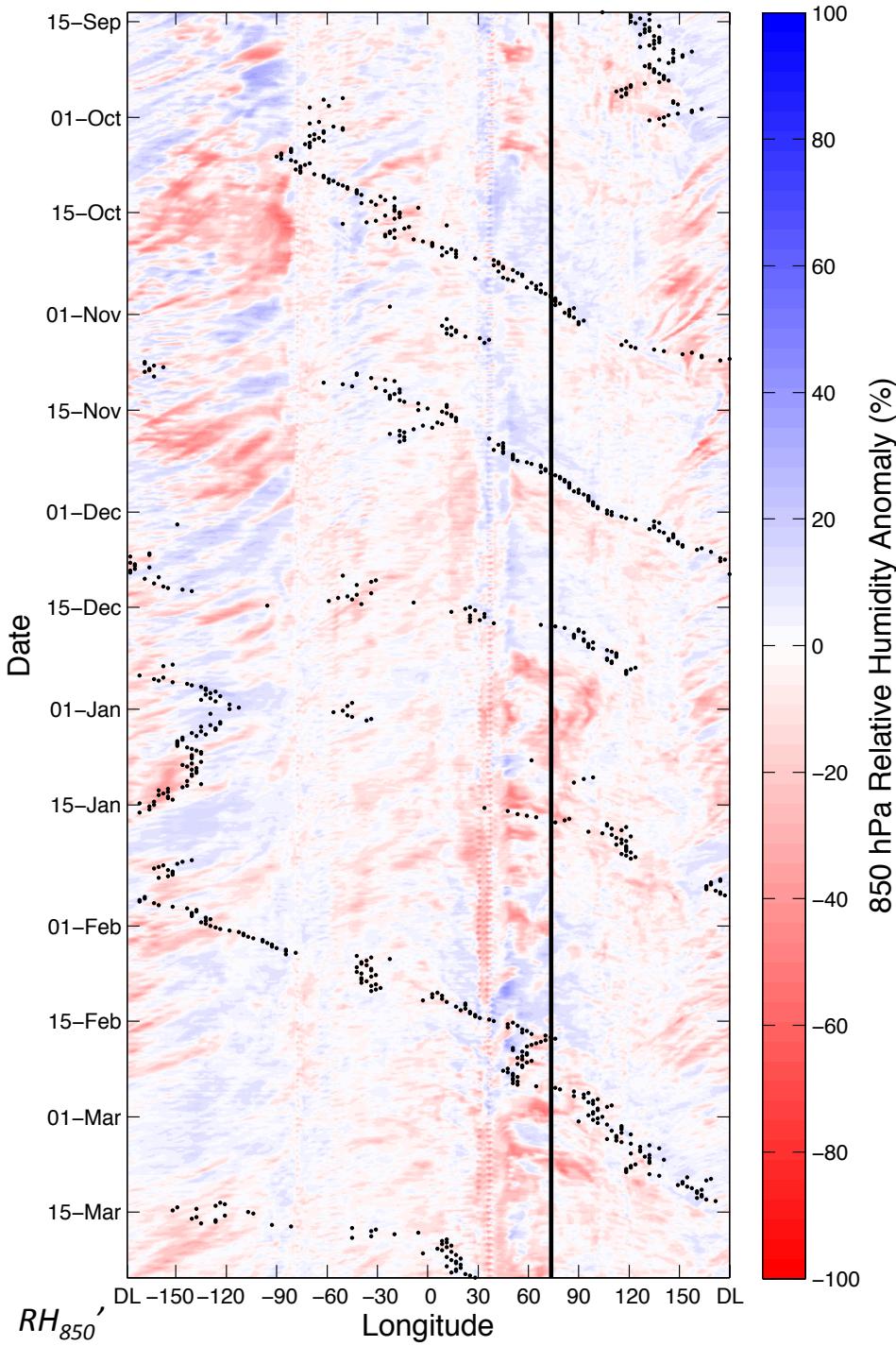
Enhanced Convection

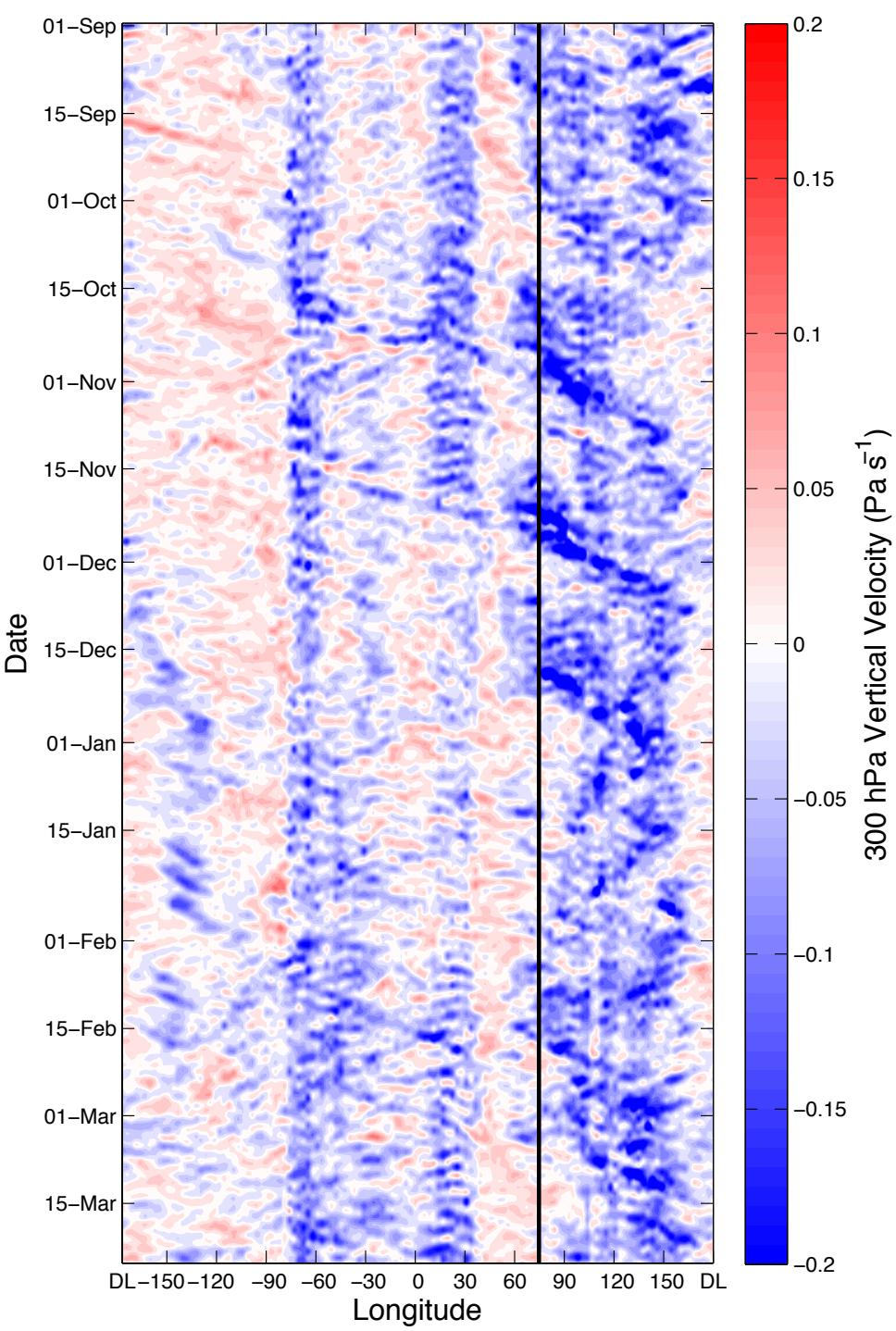


End

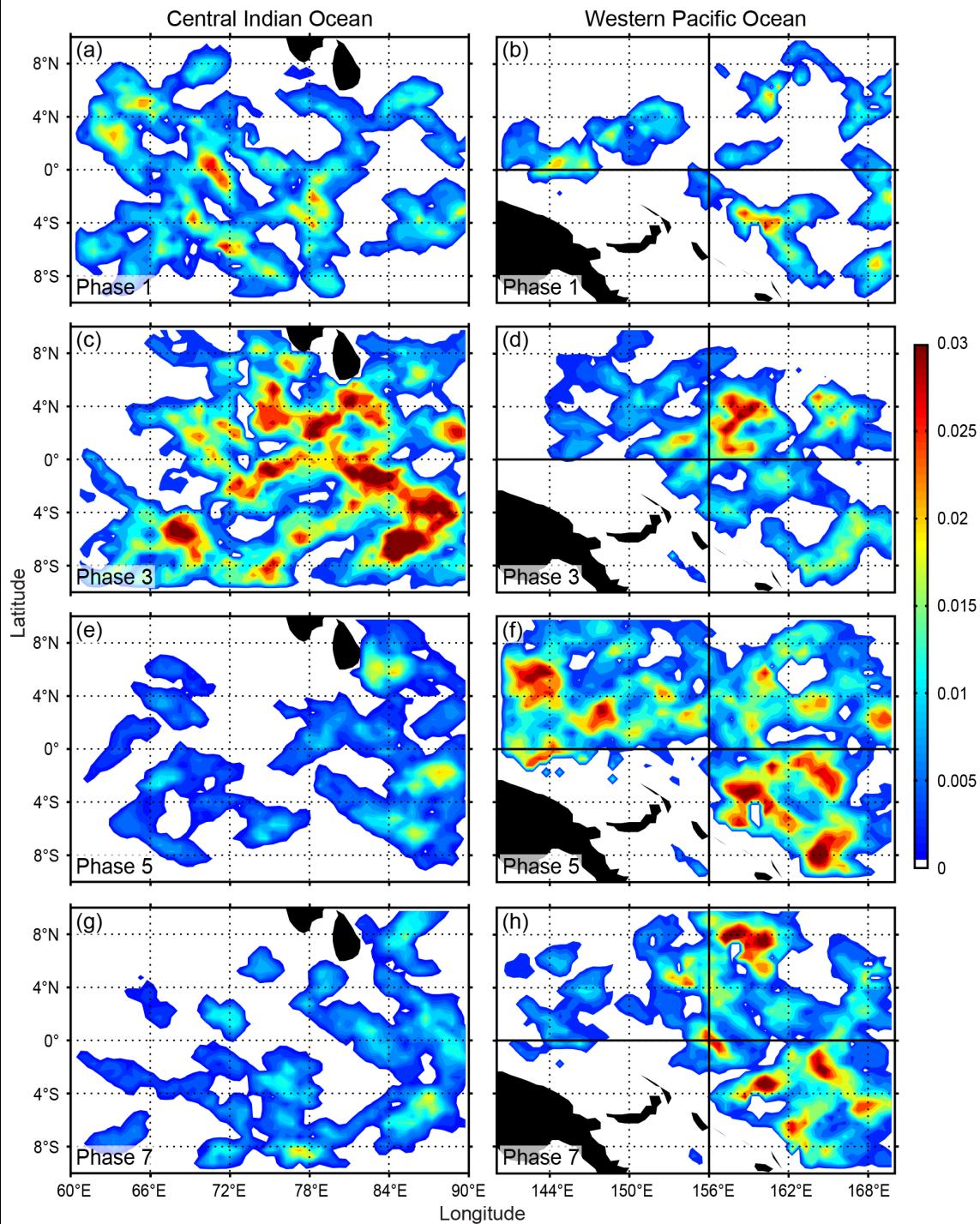


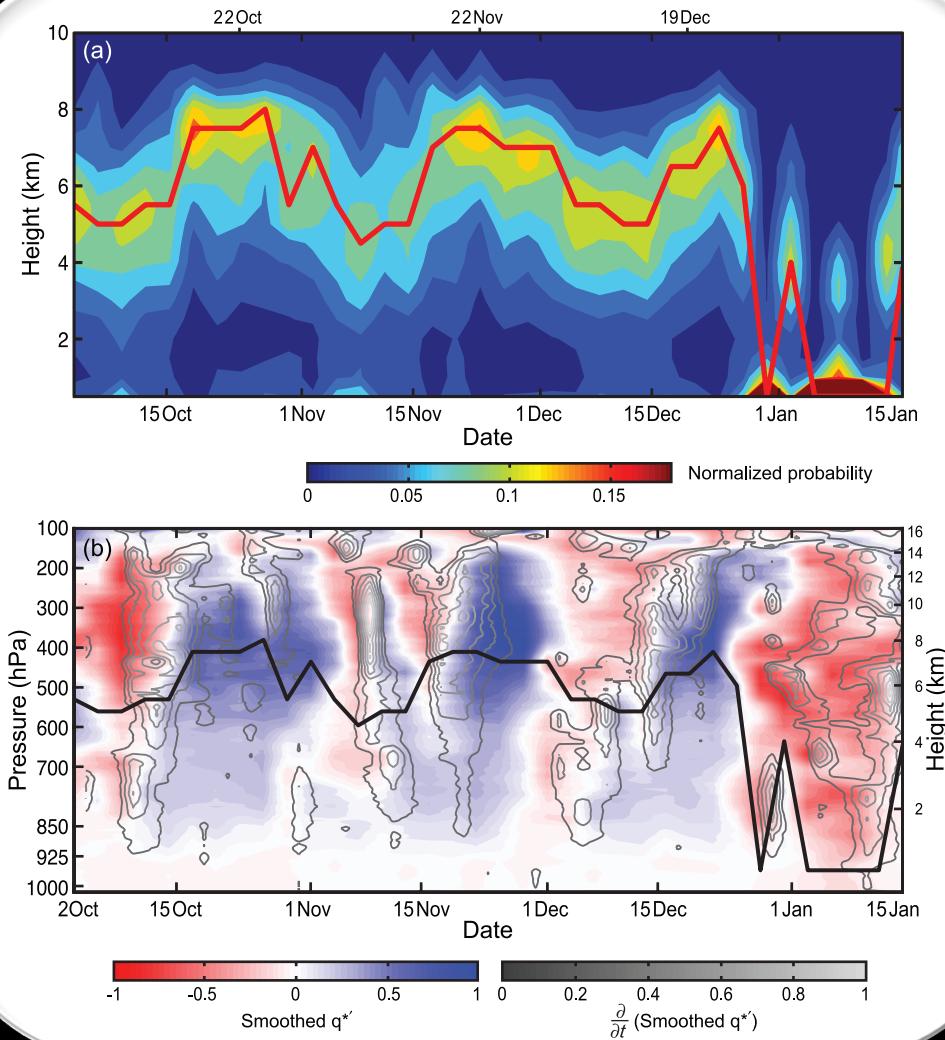


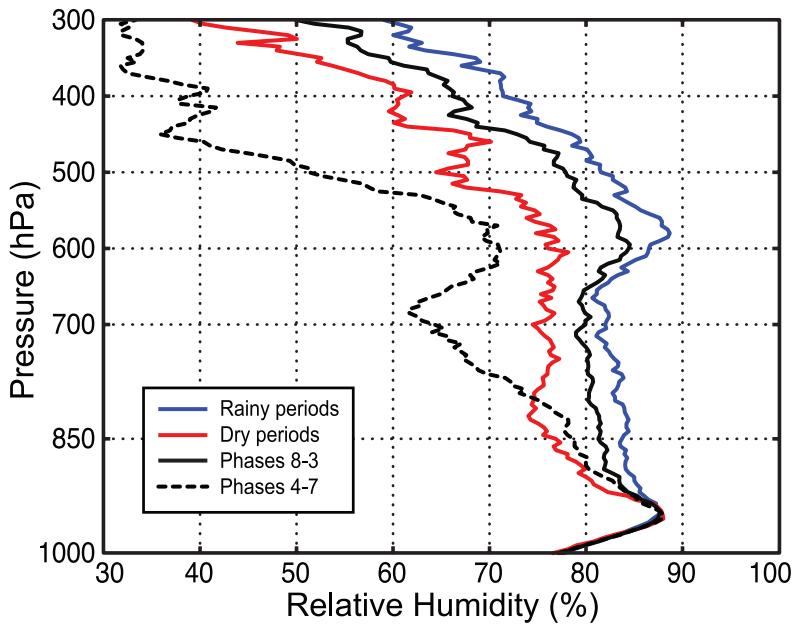
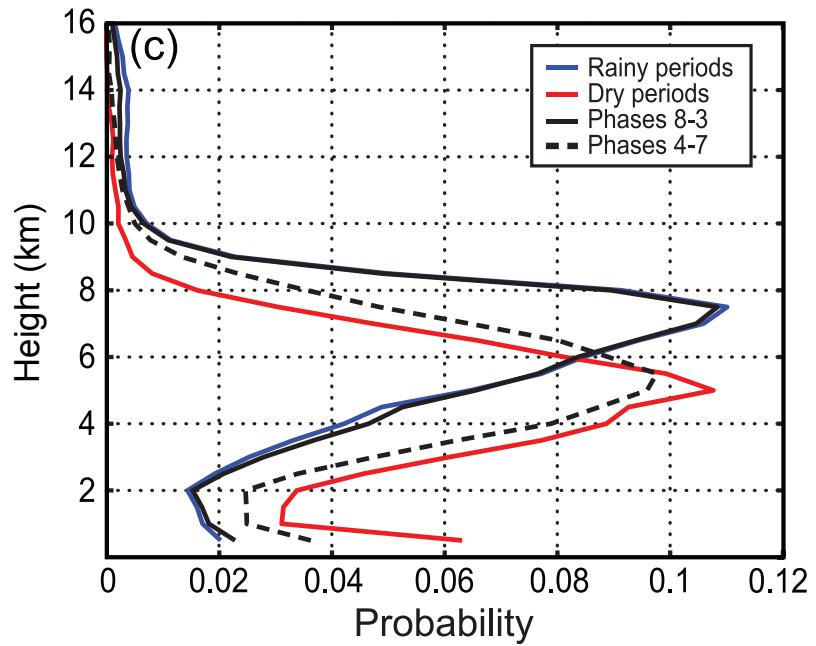




Barnes and
Houze (2013)







1. Variability in stratiform (and deep convective) elements is a key part of the evolution of the cloud population during an MJO episode.

