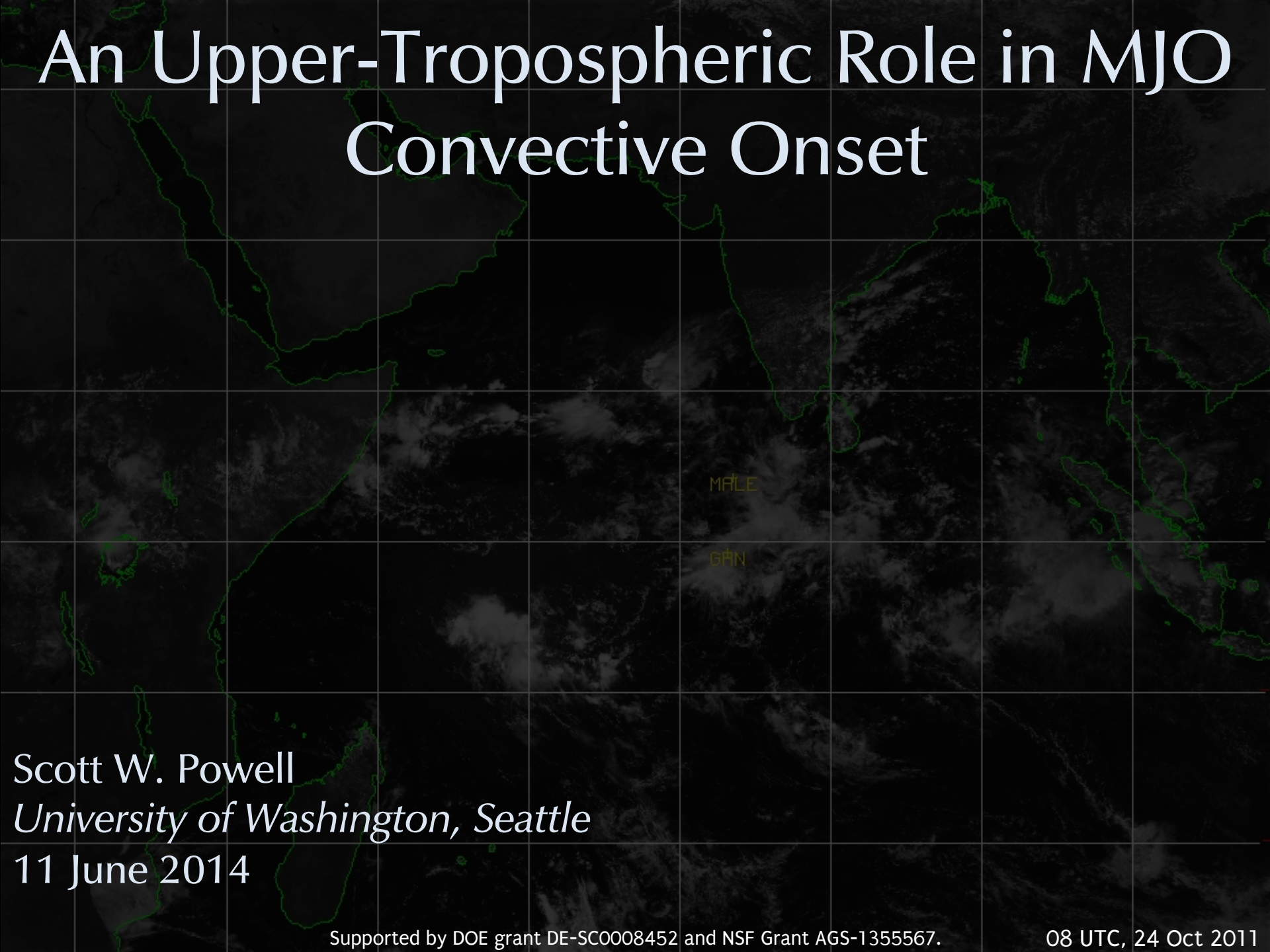


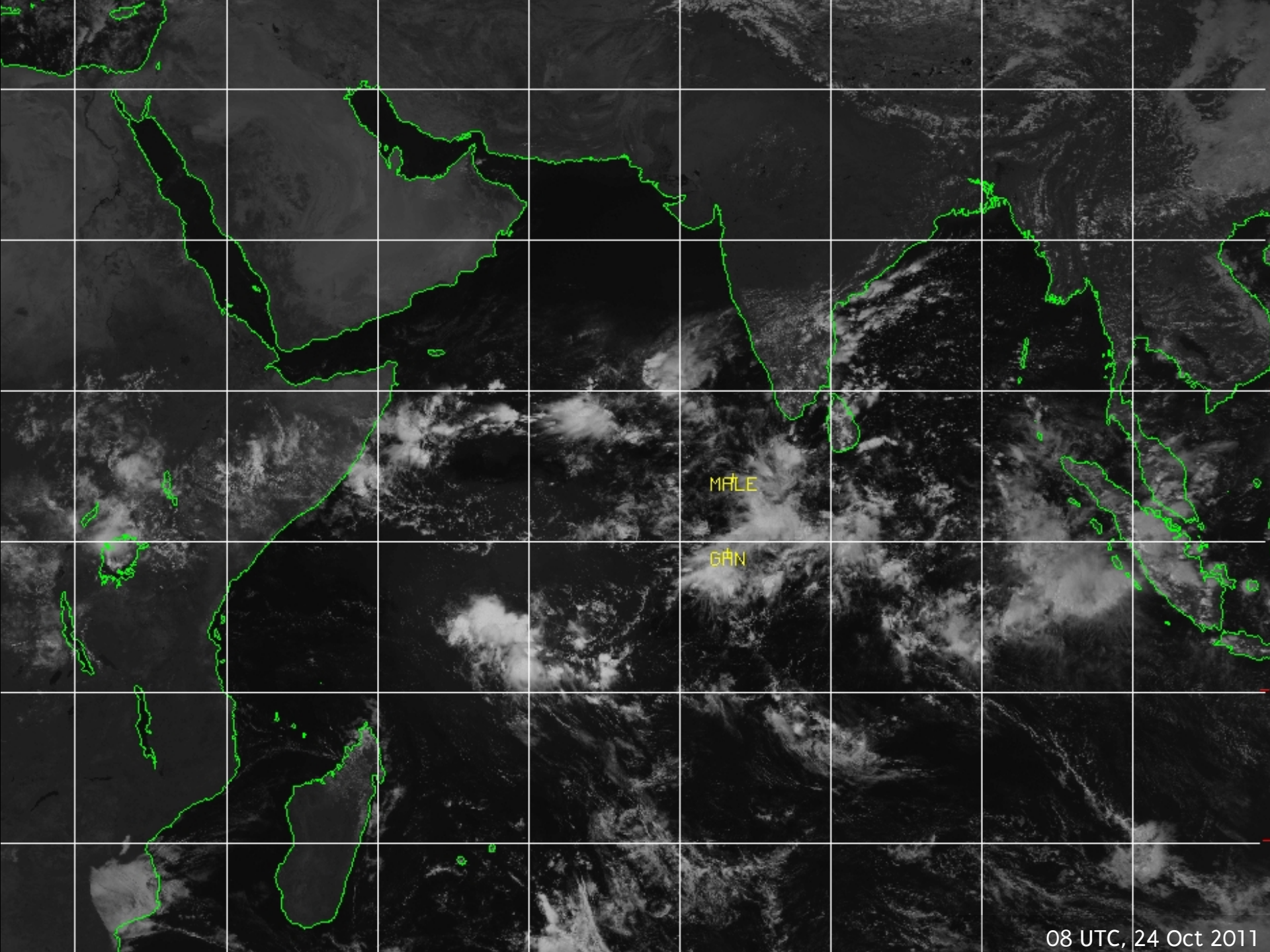
# An Upper-Tropospheric Role in MJO Convective Onset

A satellite image of the tropical Indian Ocean region, showing cloud patterns and a grid overlay. The image is dark with lighter, textured areas representing clouds. Landmasses are outlined in green. The title is overlaid in white text at the top.

MFLE

GRN

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

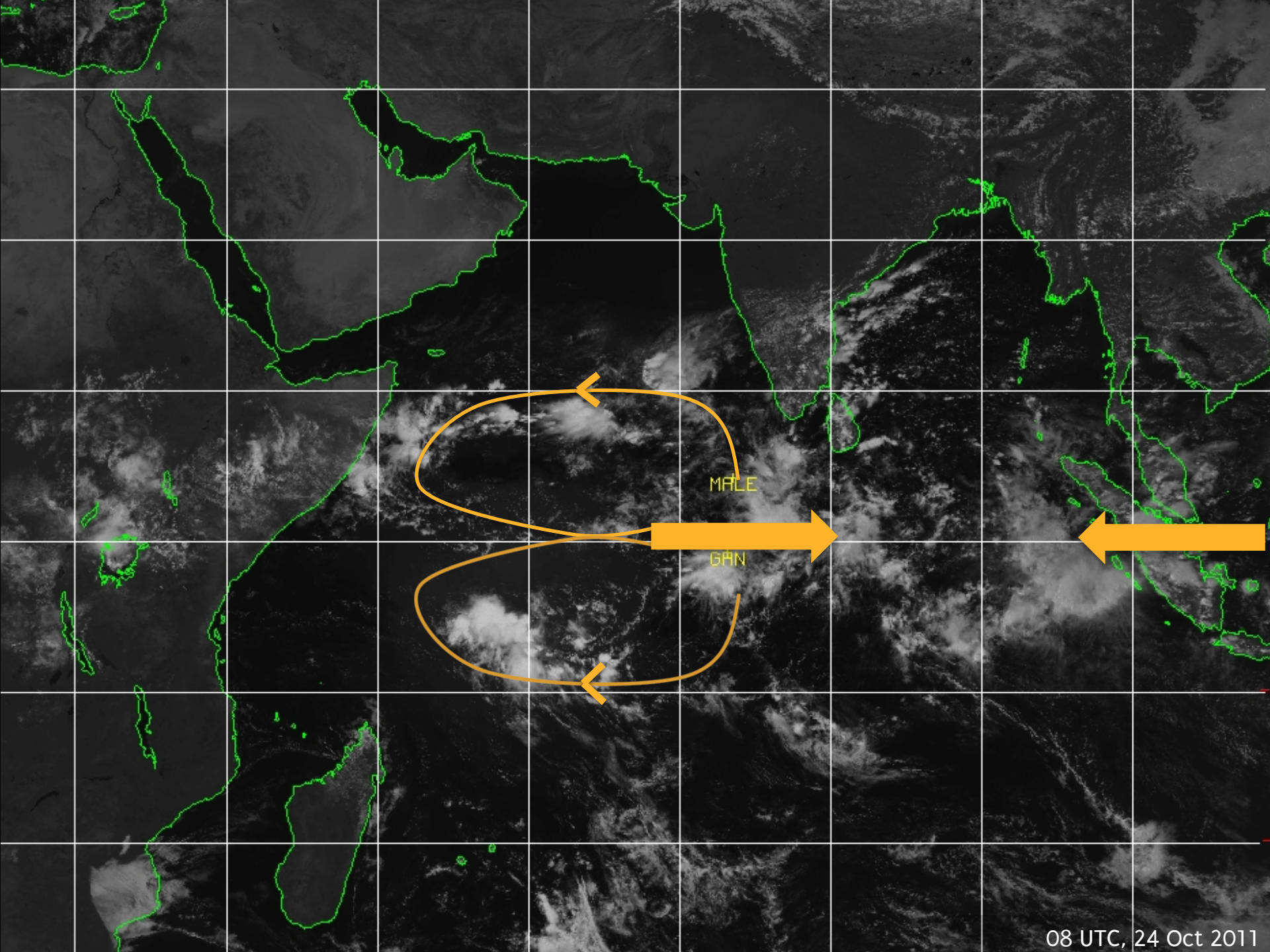


MALE

GPN

08 UTC, 24 Oct 2011



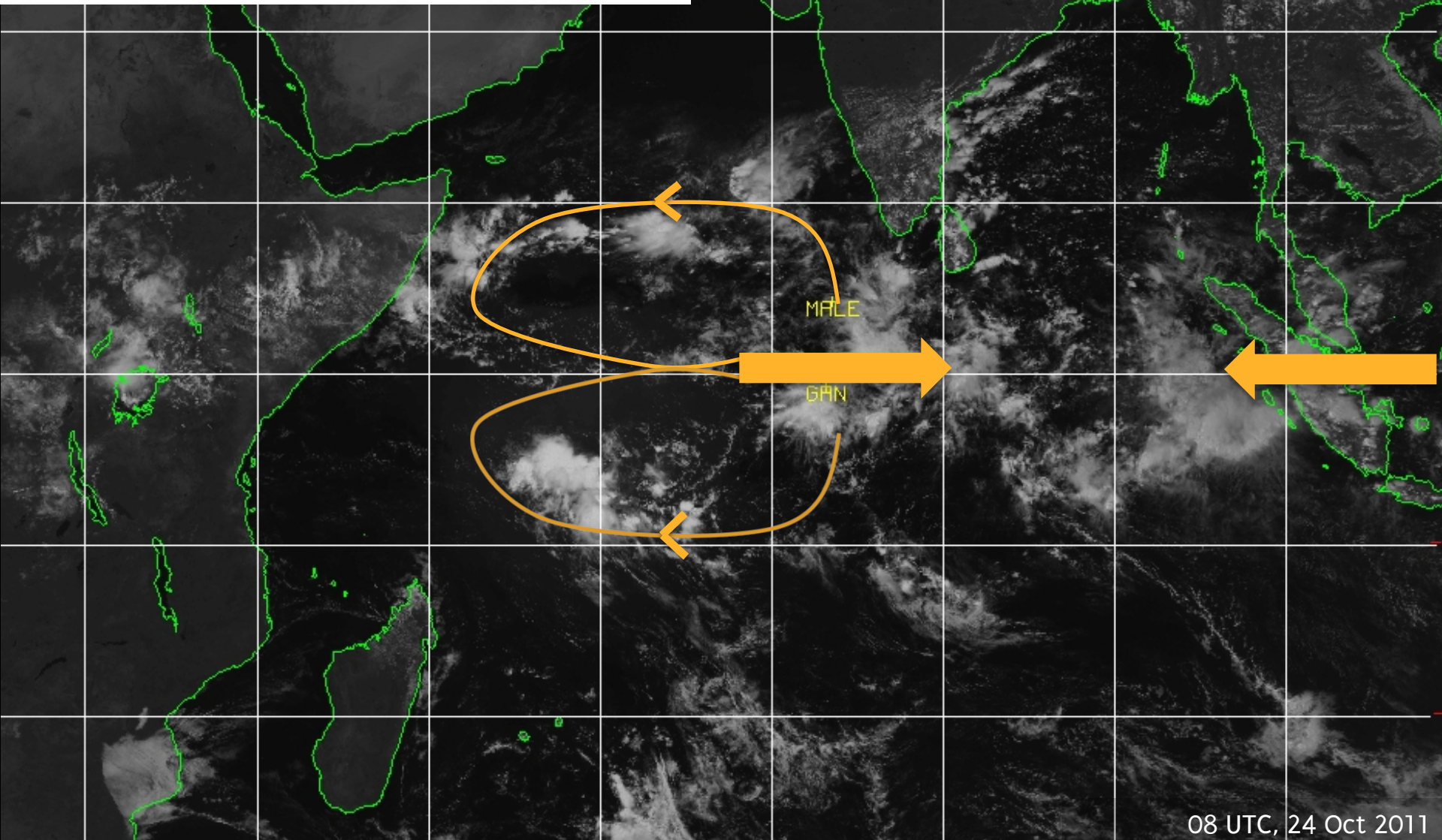
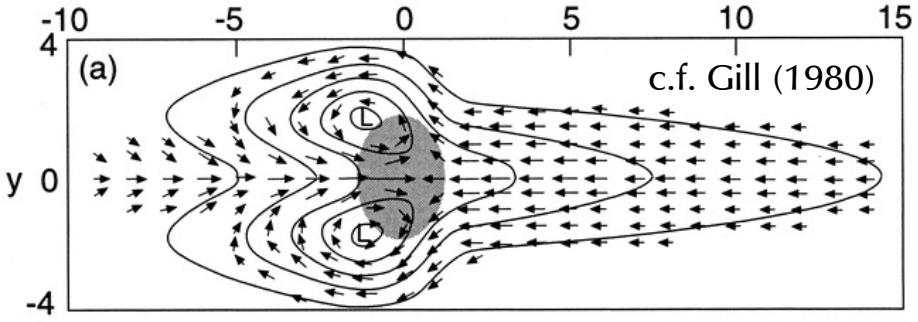


MALE

GAN

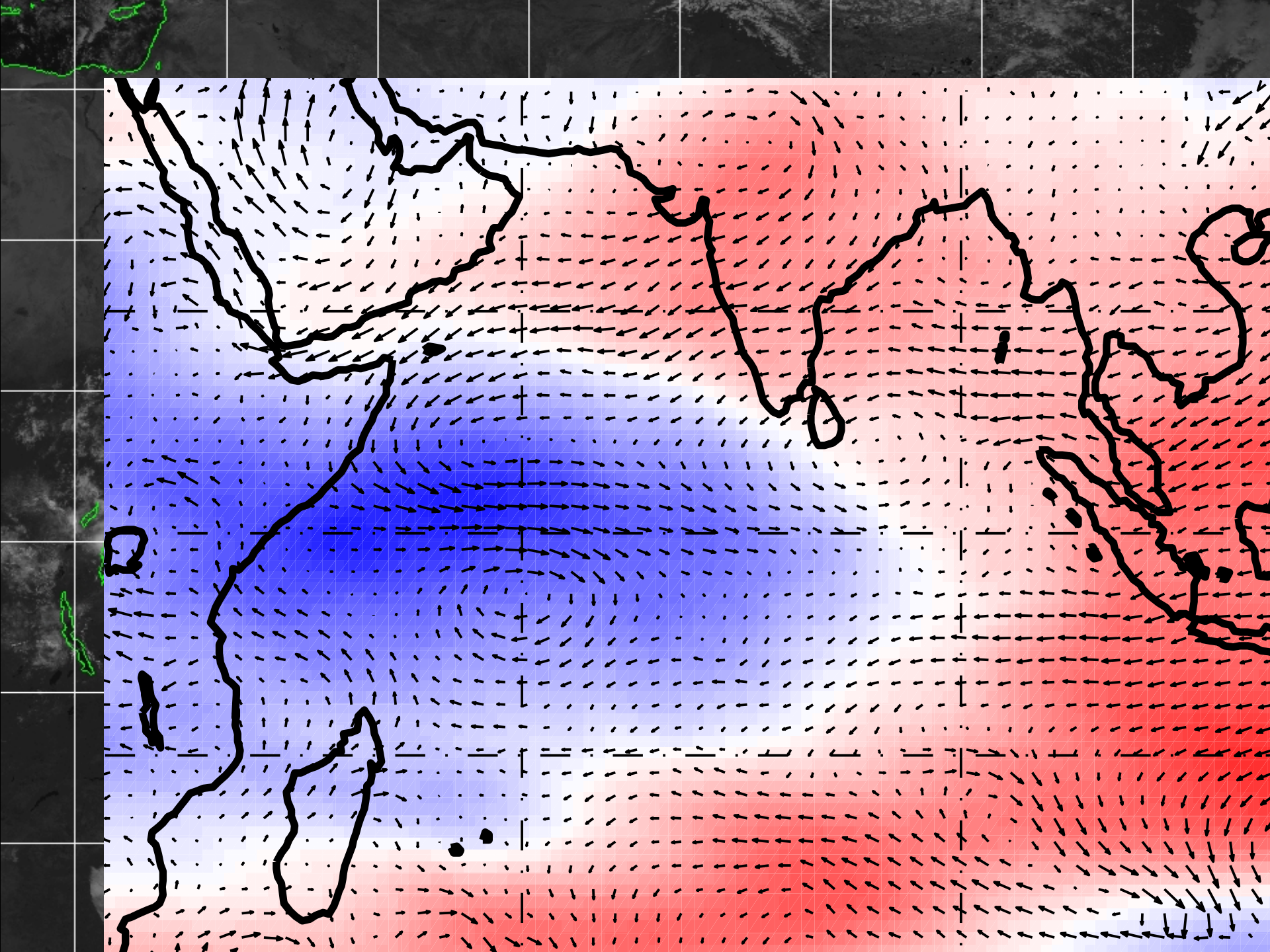
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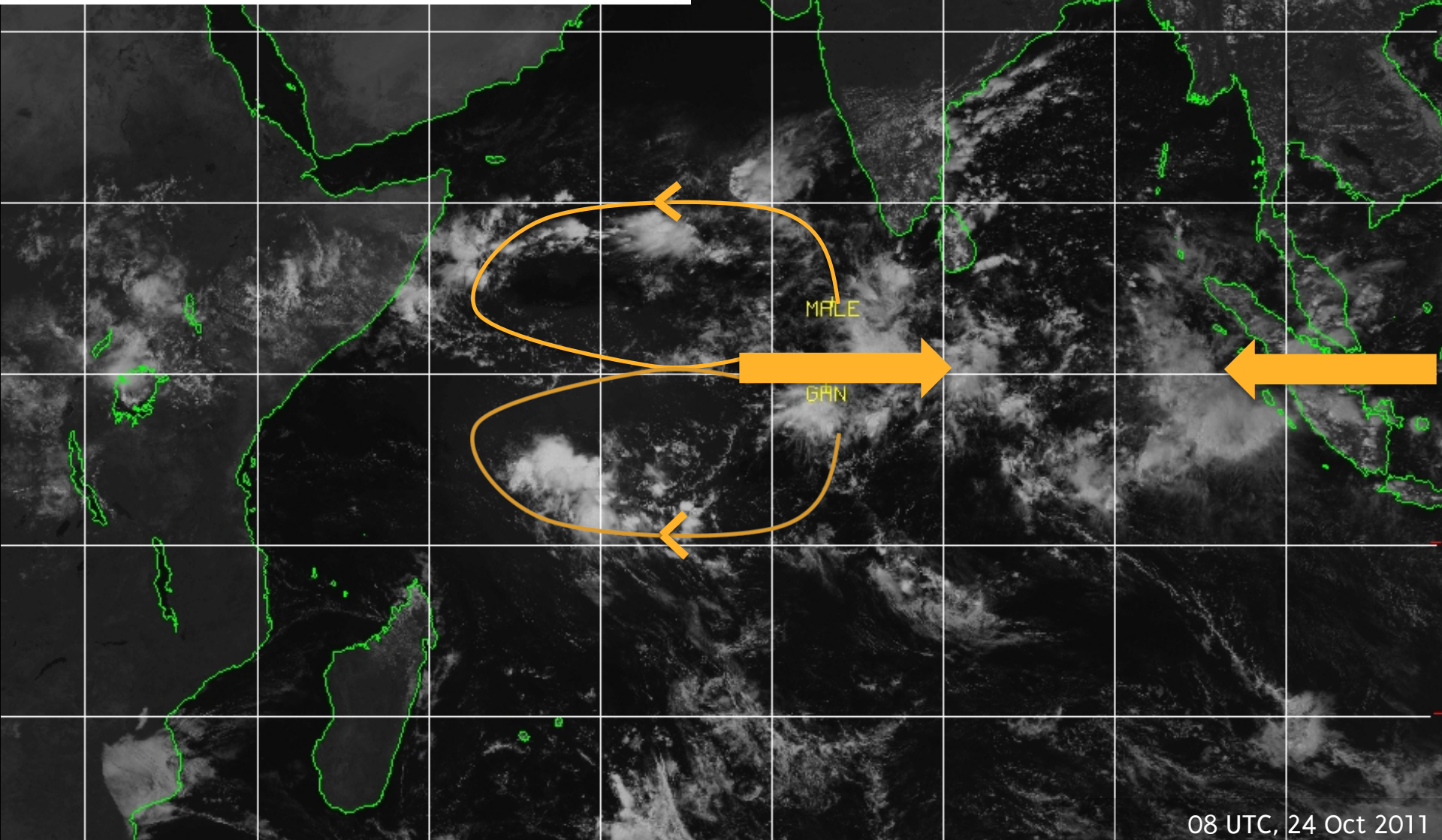
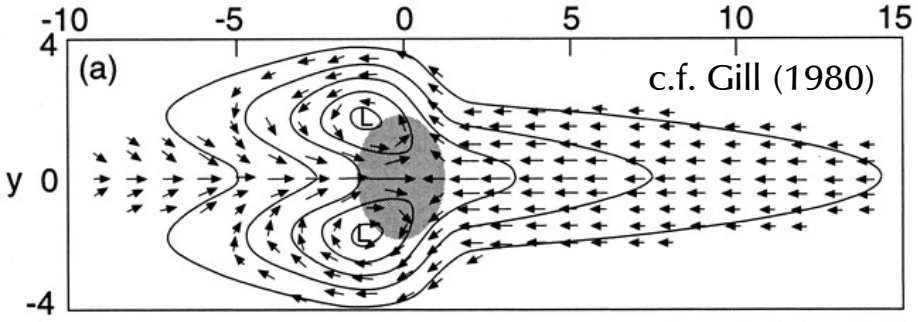




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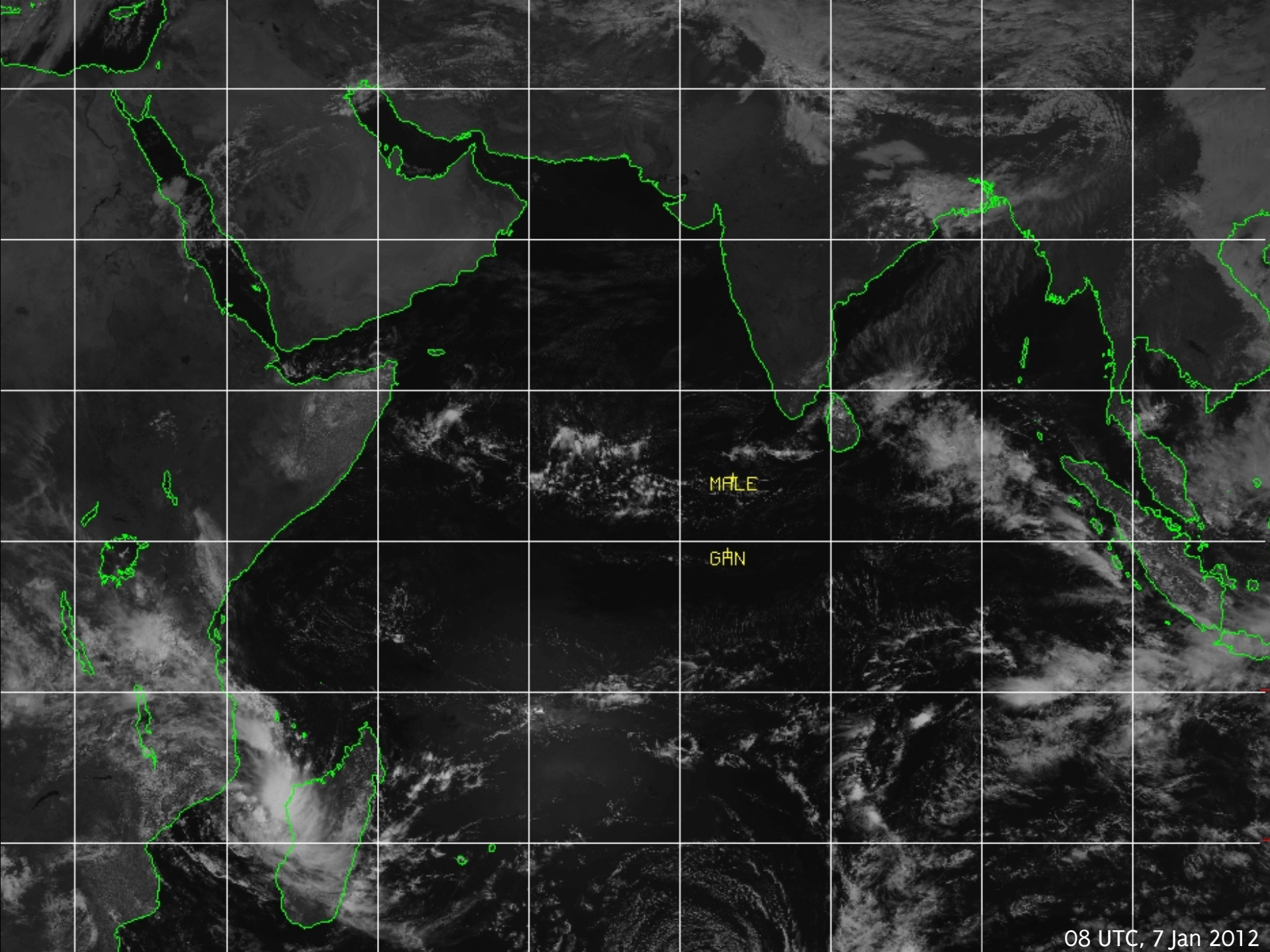






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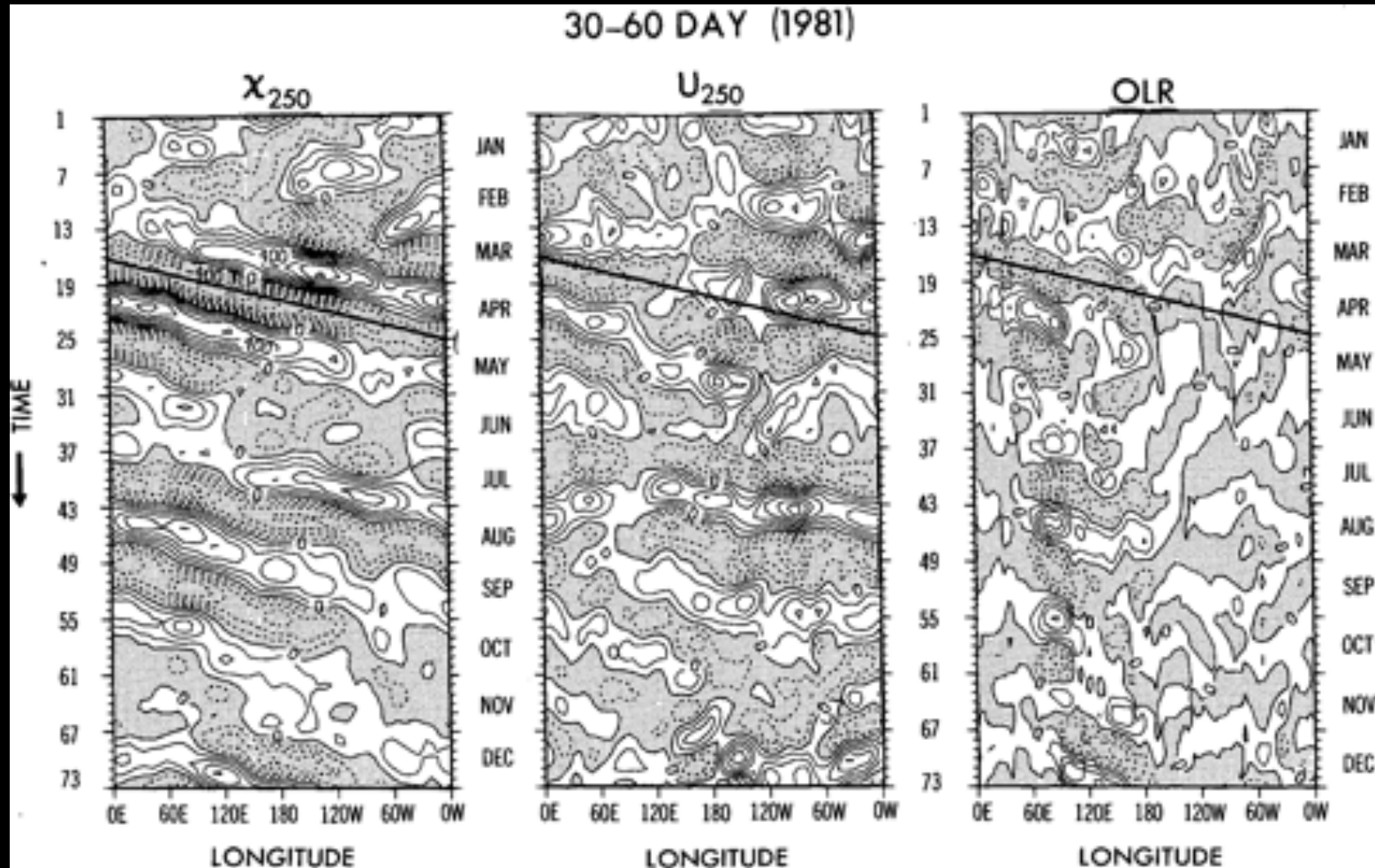


MALE

GPN

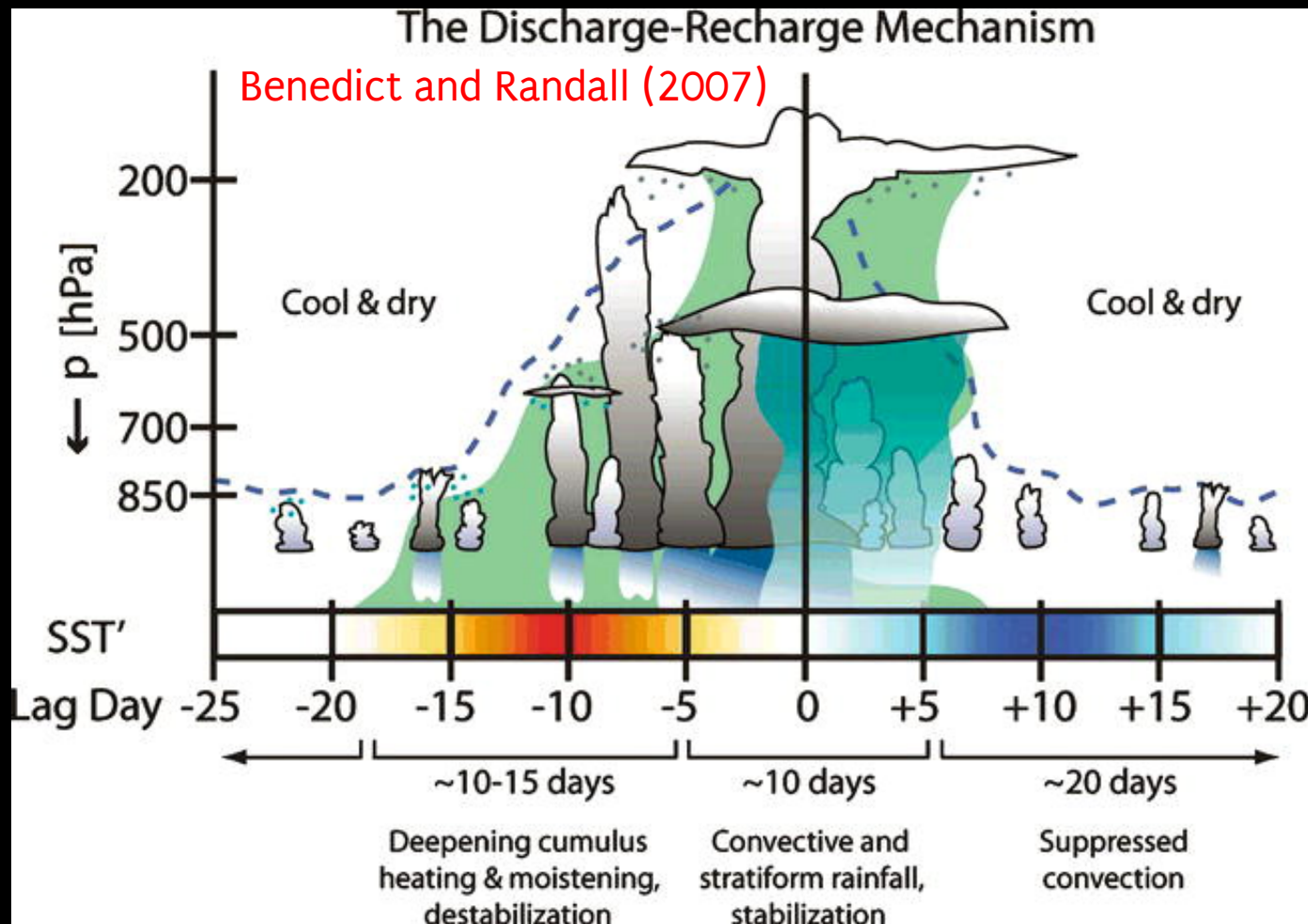
08 UTC, 7 Jan 2012

Knutson and Weickmann (1987)

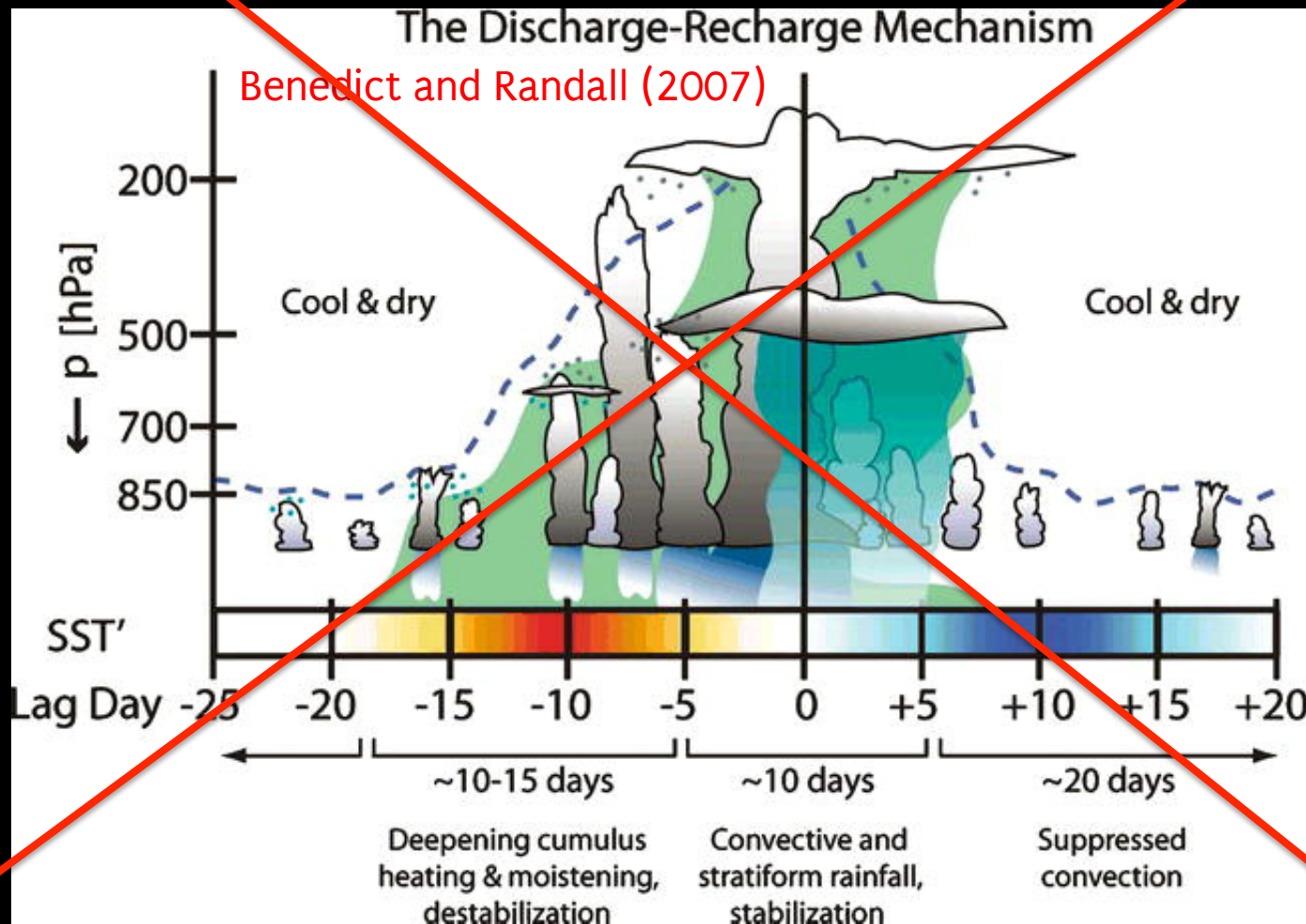




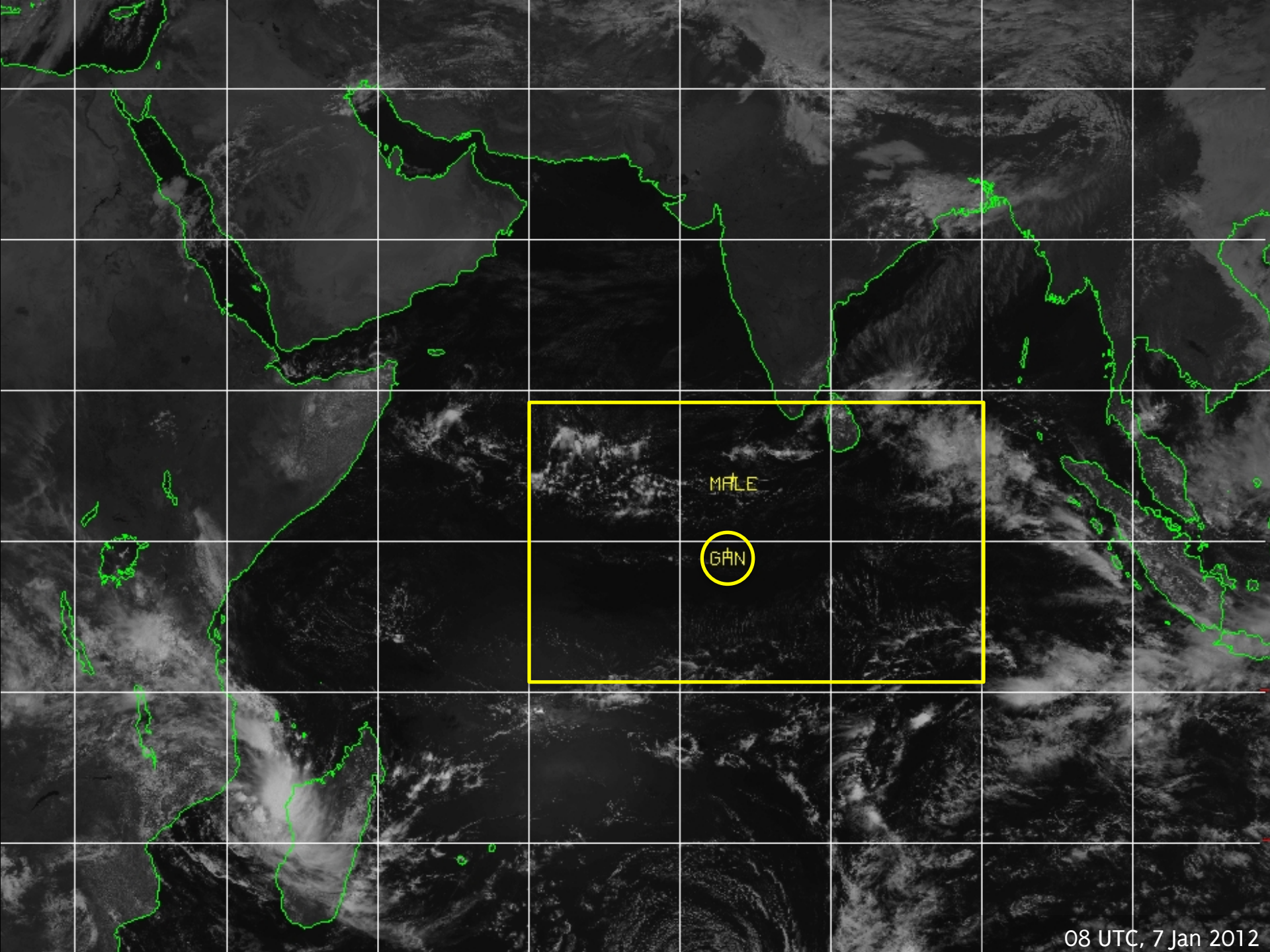
Hypothesis: Gradual moistening leads to systematic build-up of convection, ultimately resulting in MJO (“discharge-recharge”; Bladé and Hartmann (1993), Kemball-Cooke and Weare (2001), Benedict and Randall (2007), and others.)



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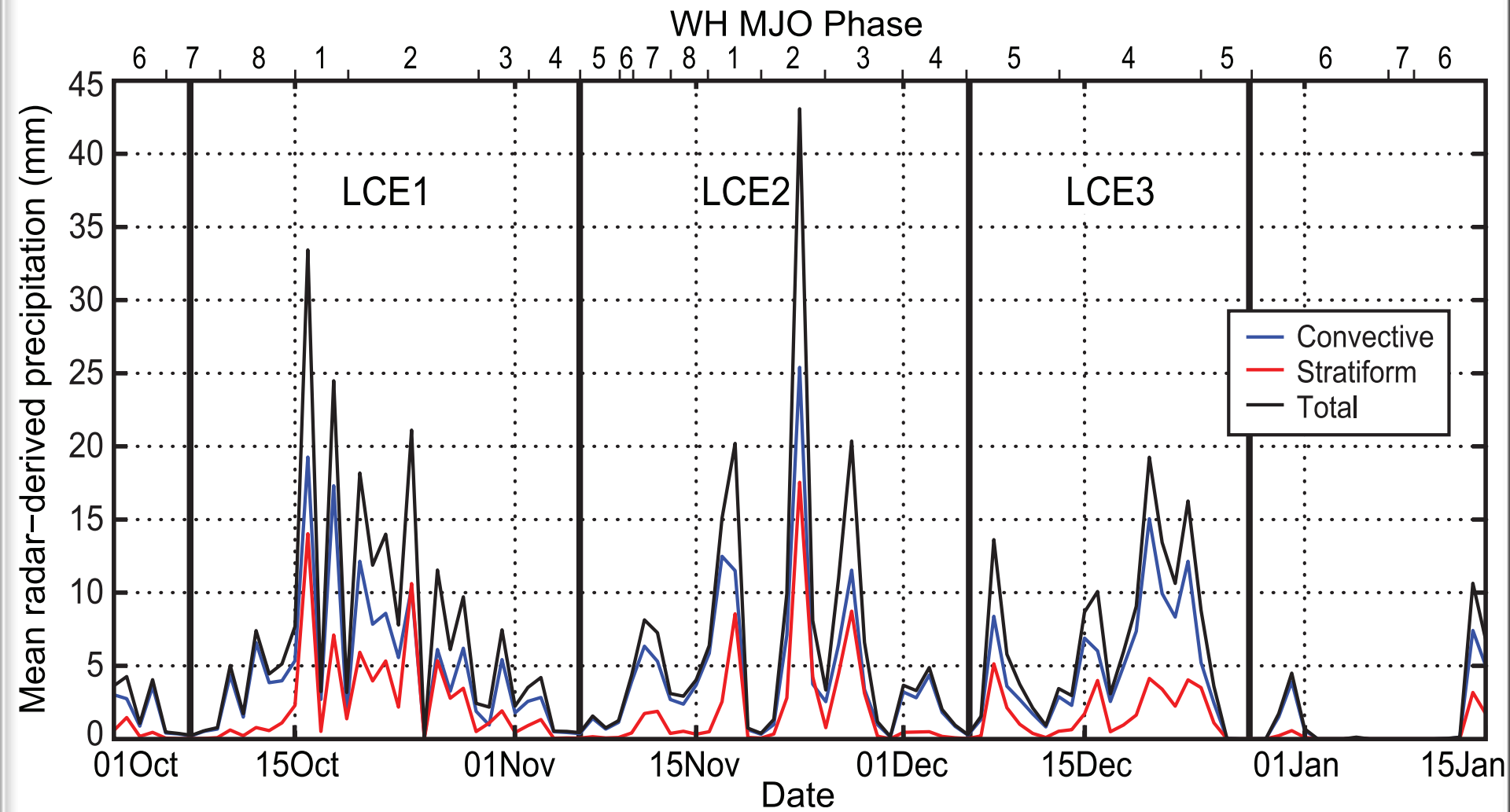


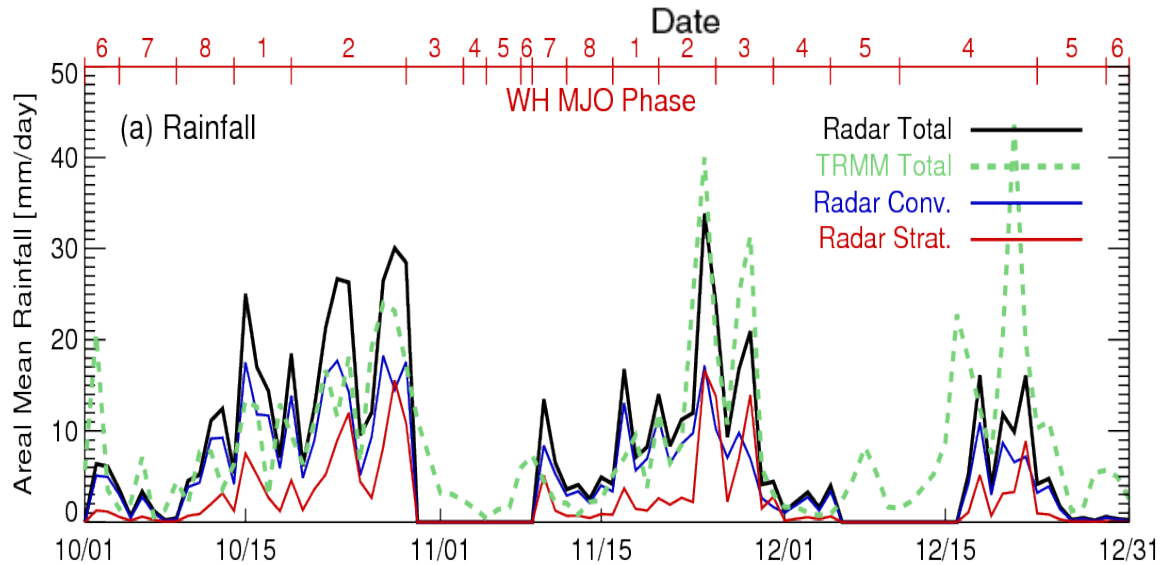
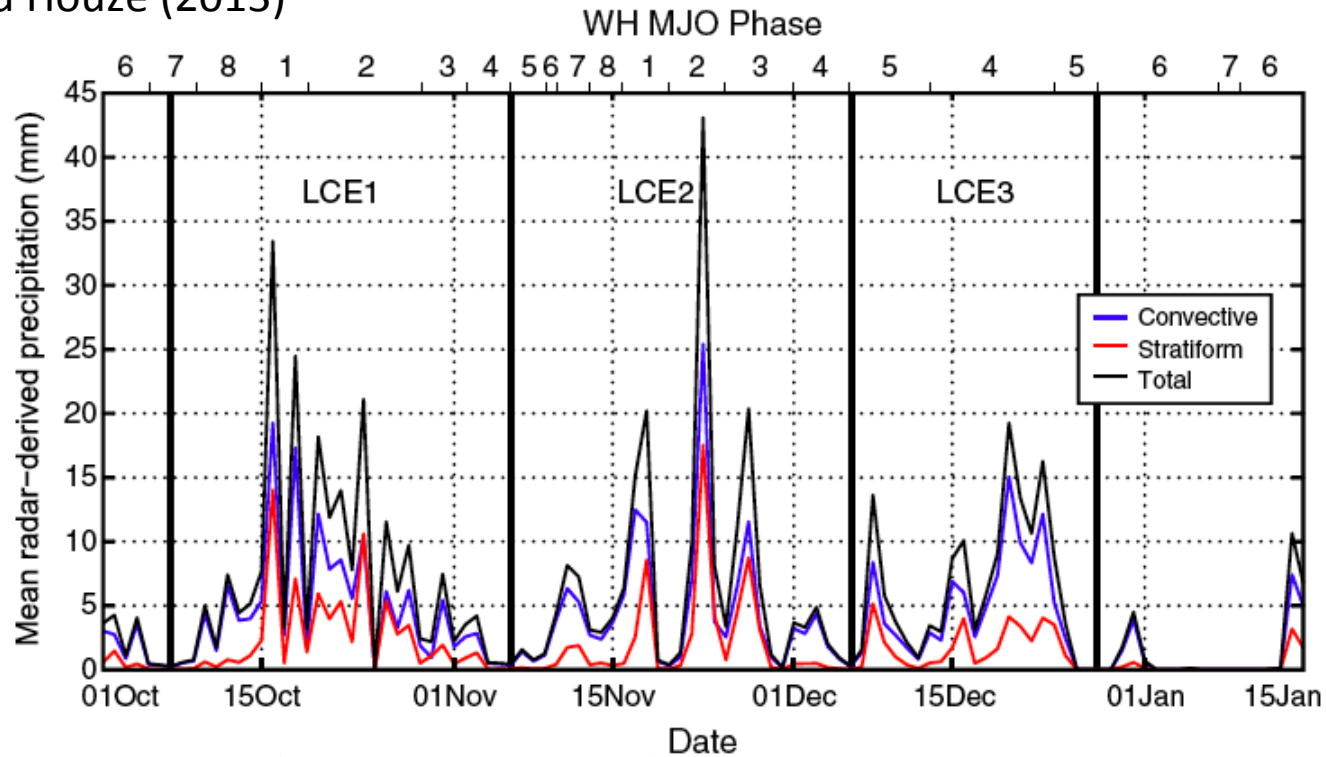


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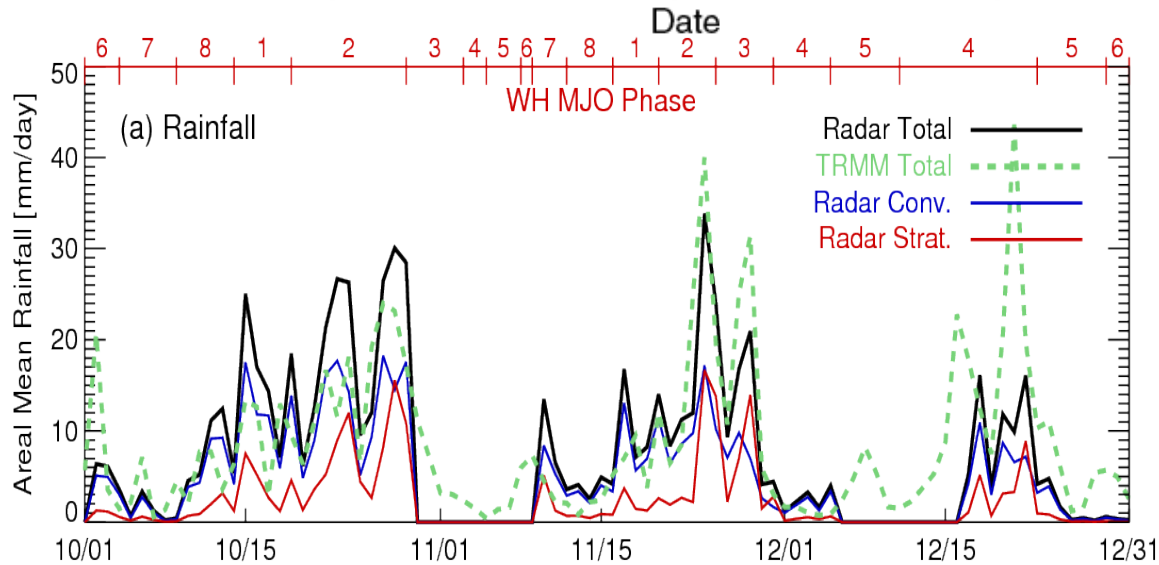
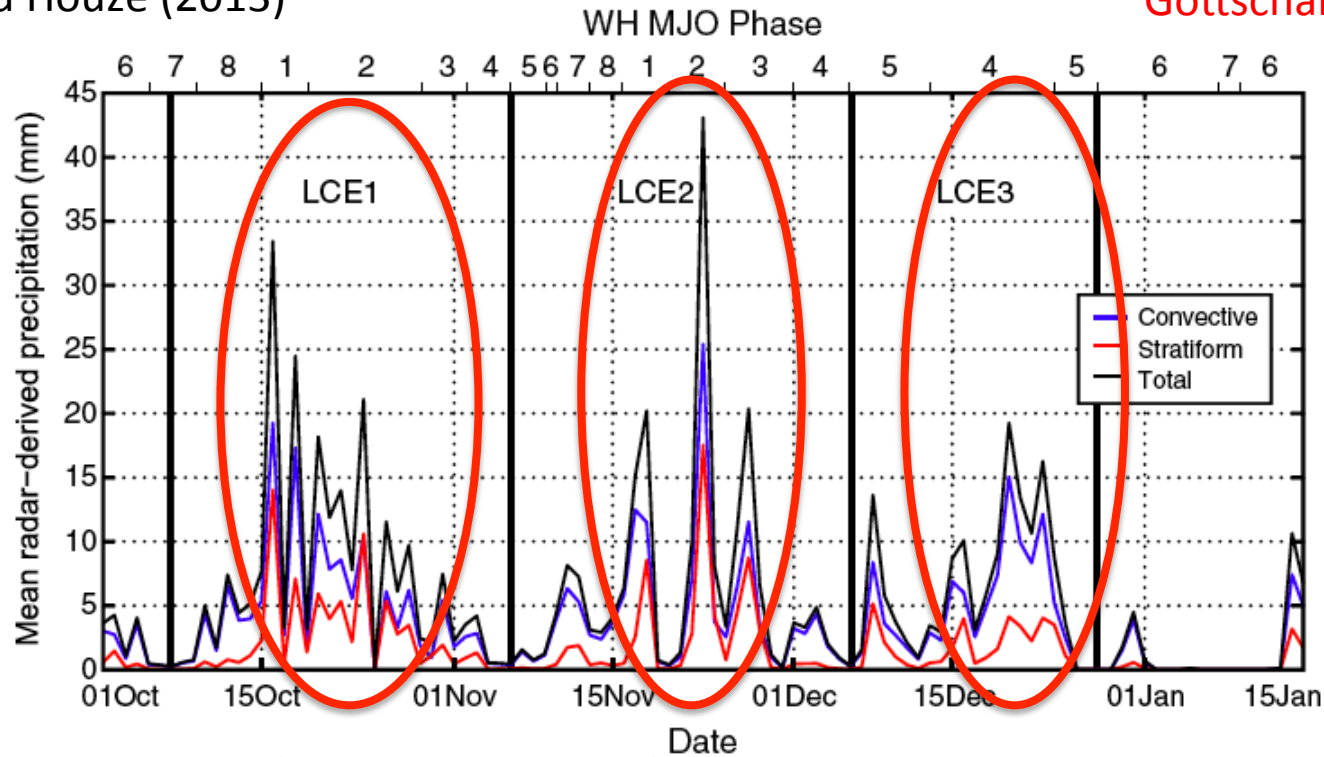
*Evolution of Cloud Population,  
Precipitation, and Humidity  
Fields*



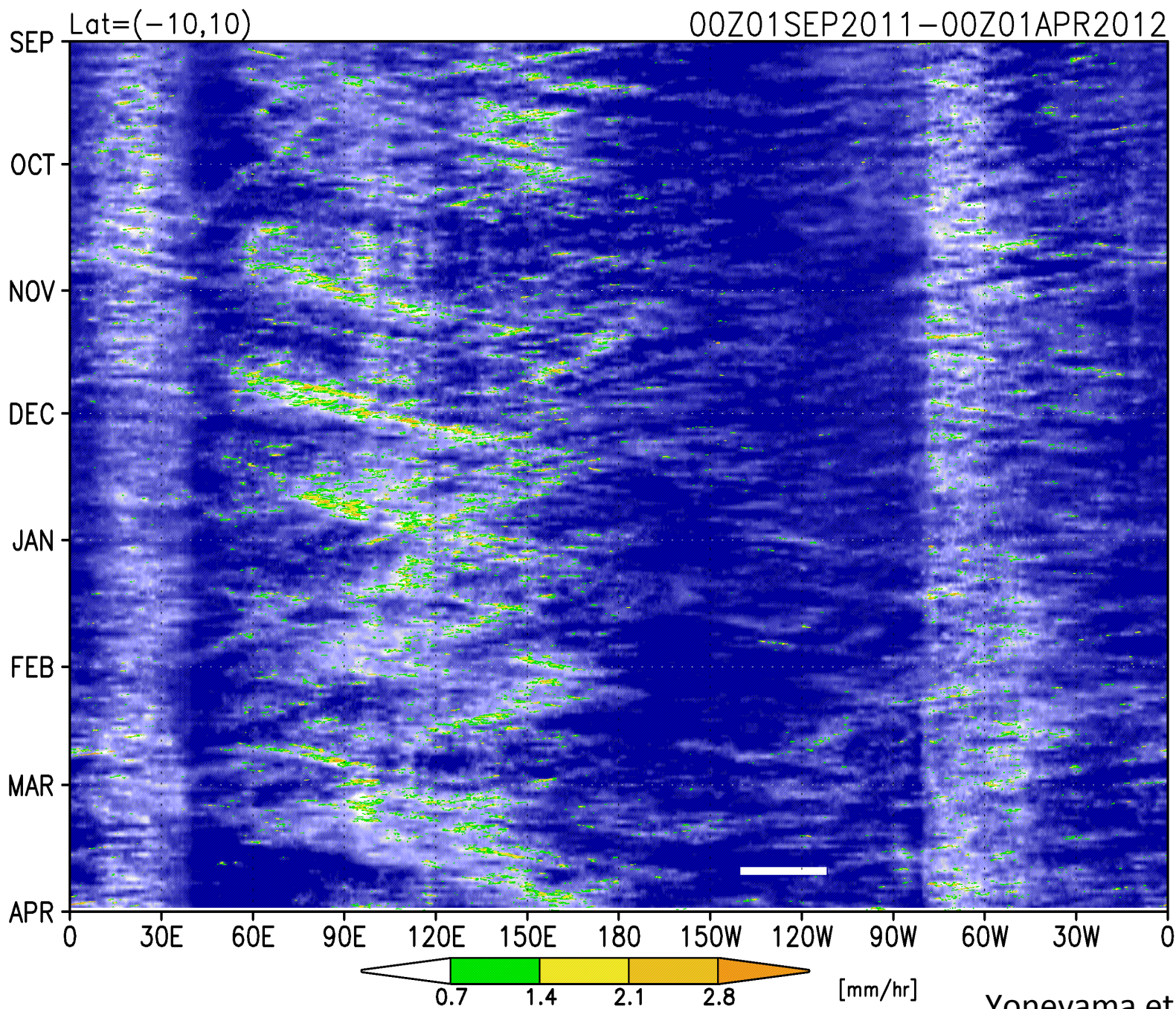






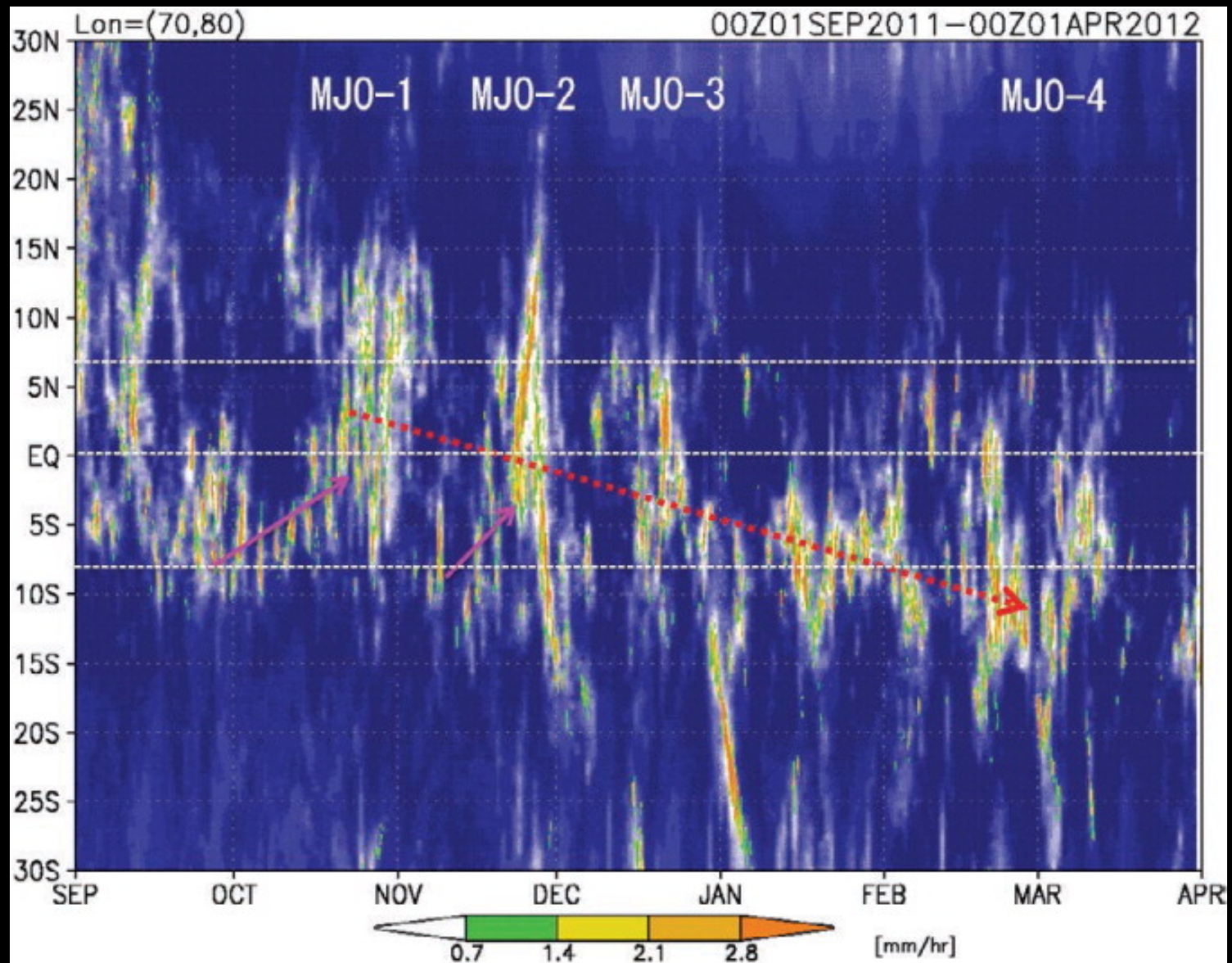




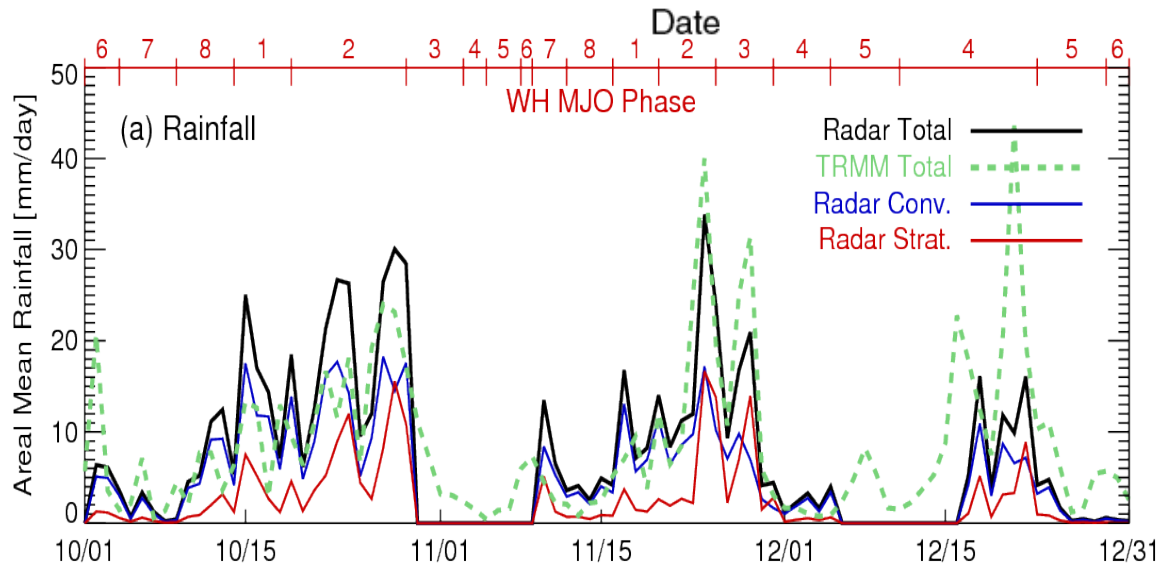
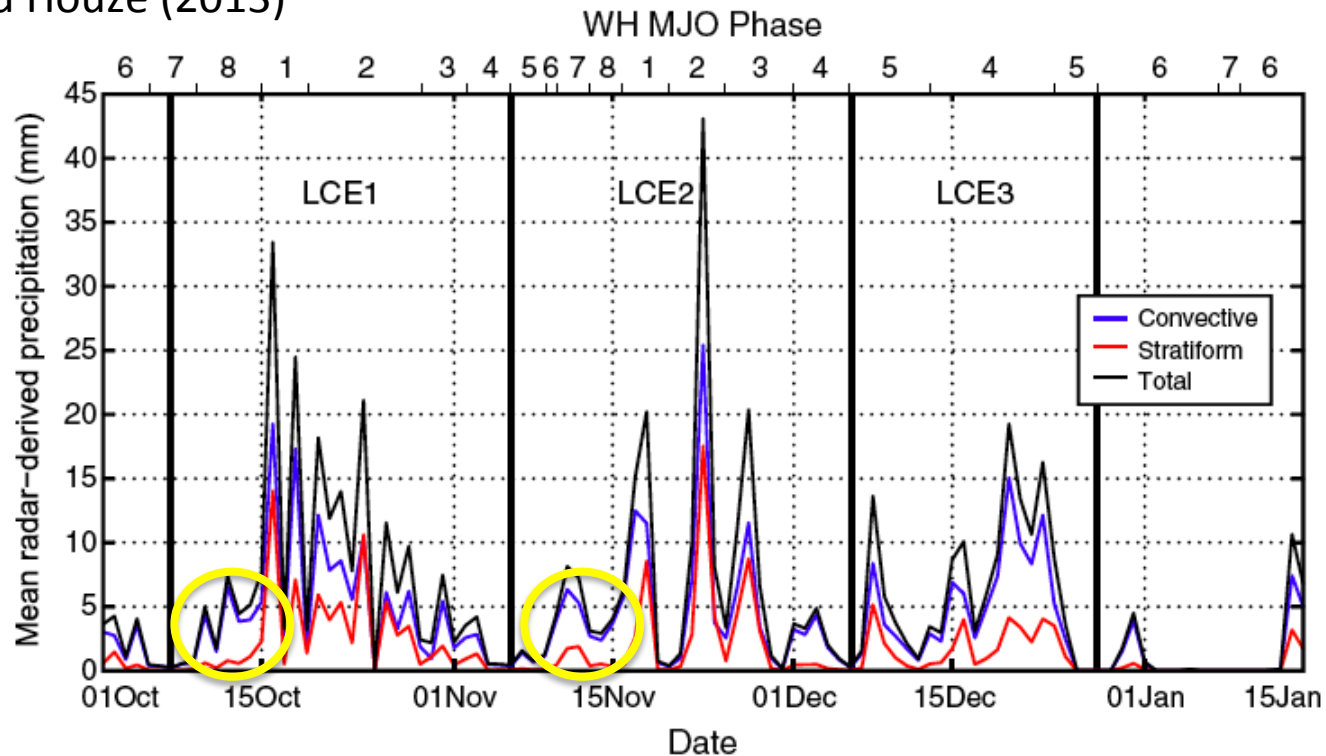


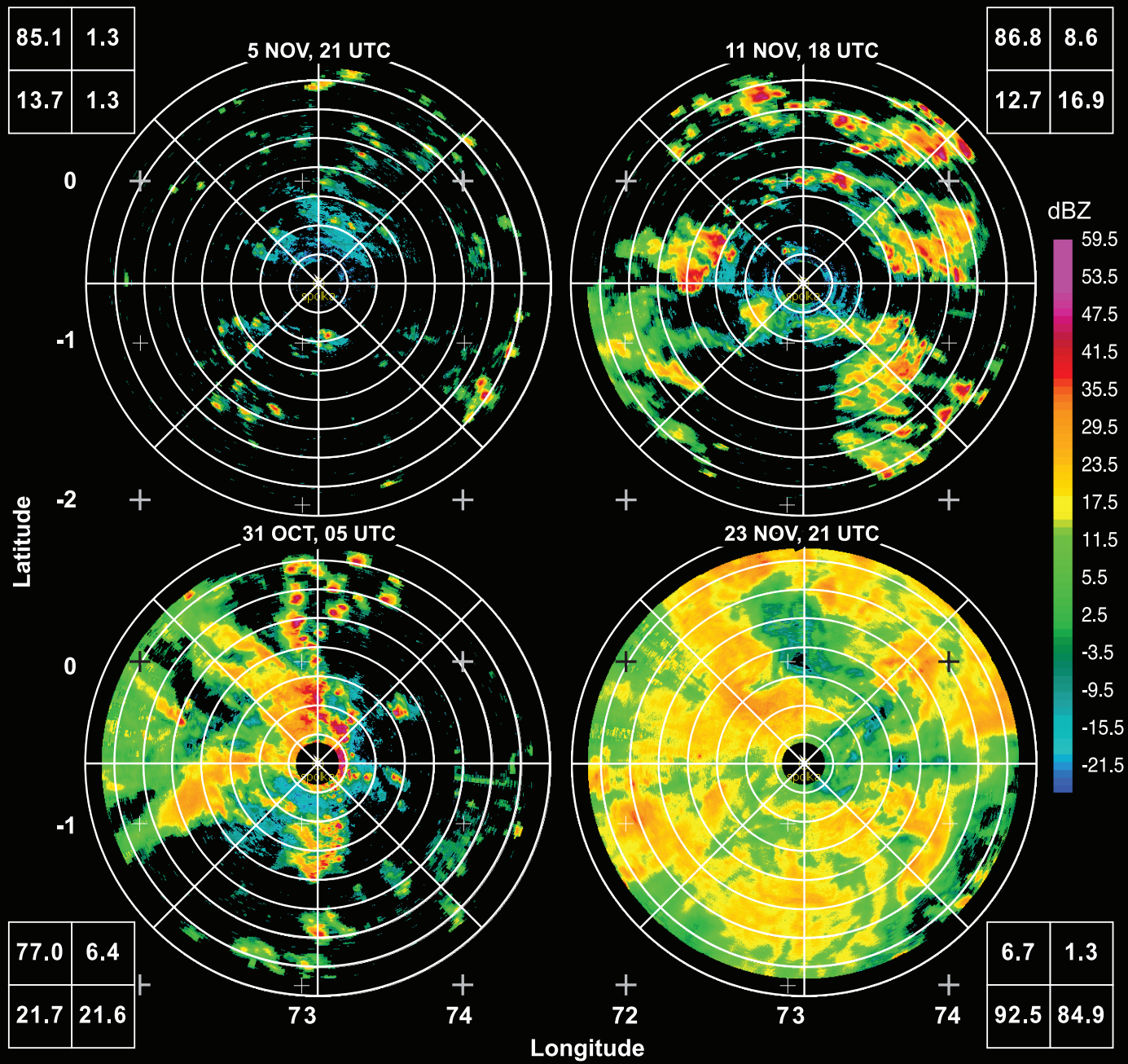
Yoneyama et al (2013)



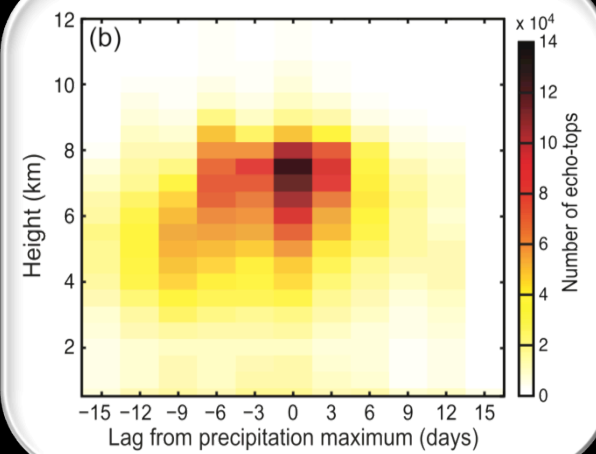
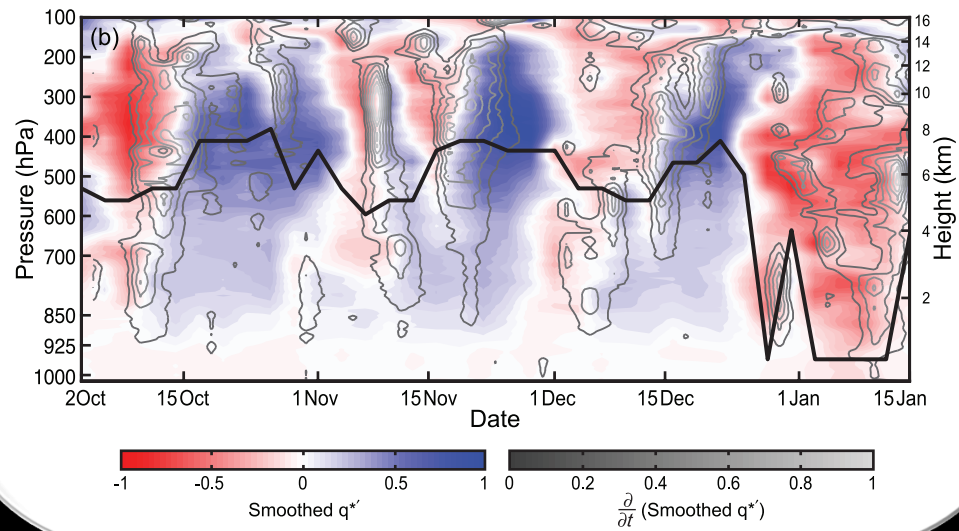
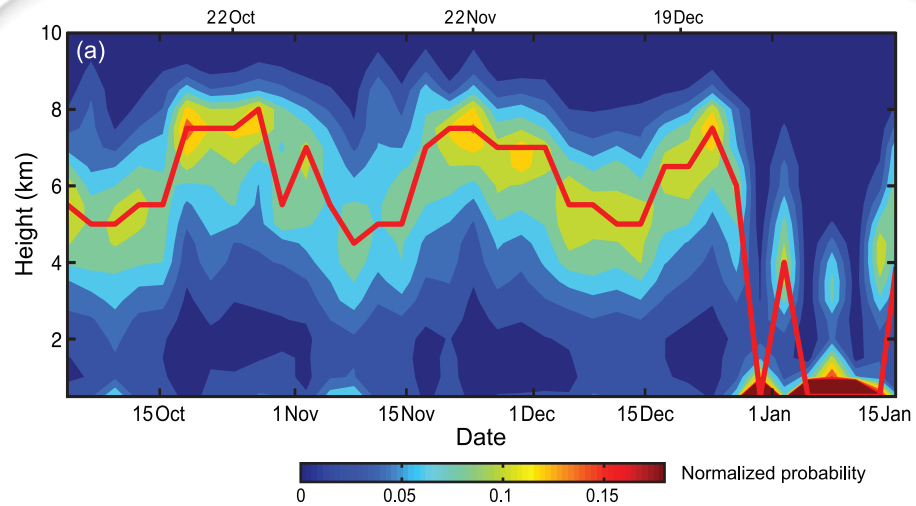


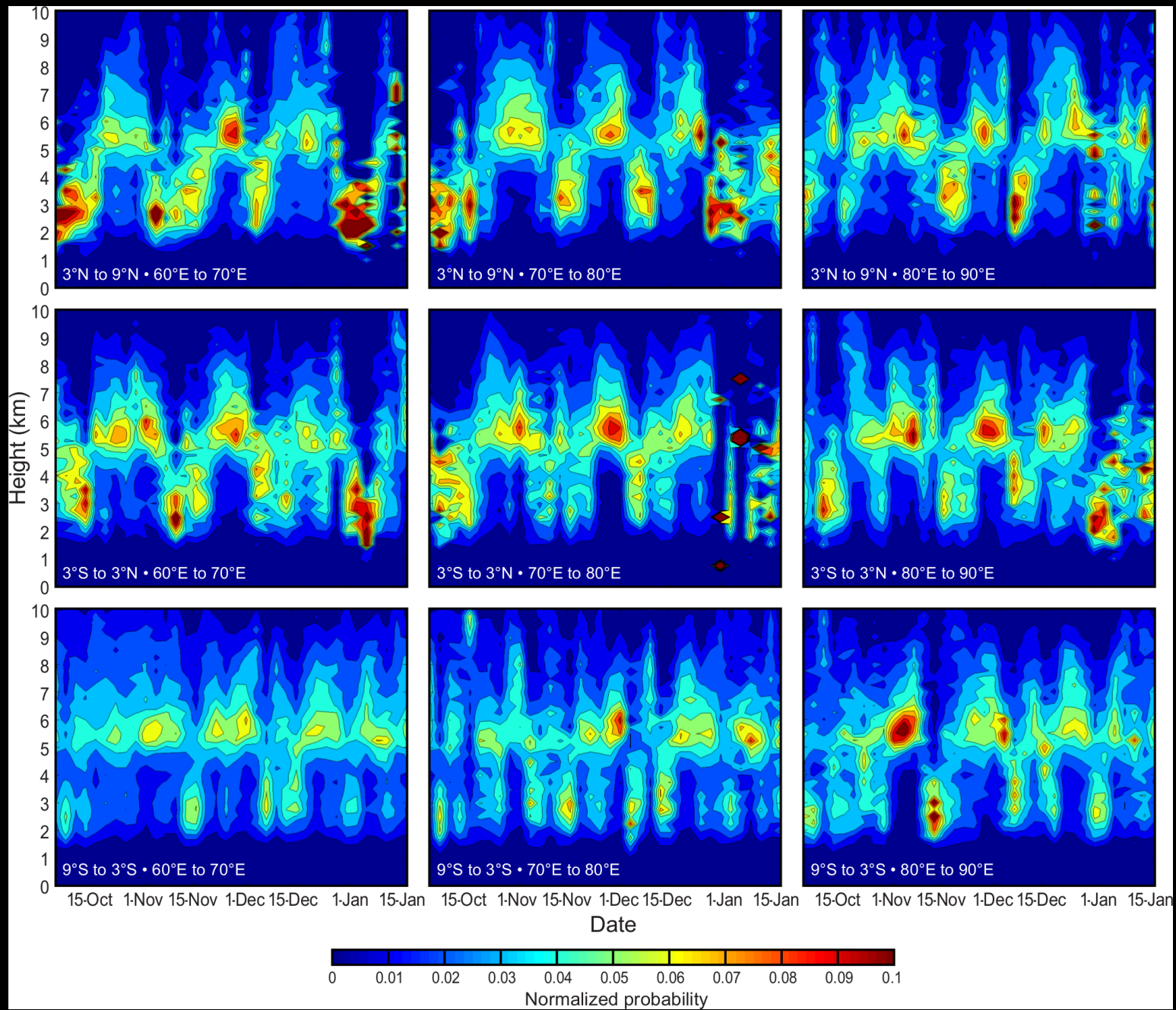




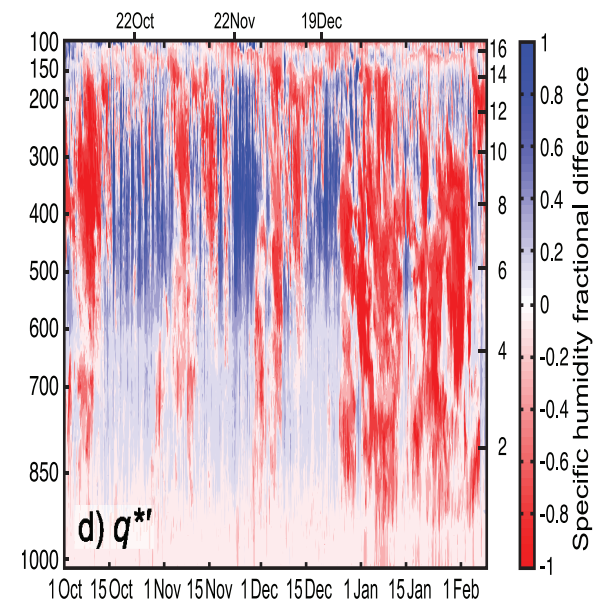
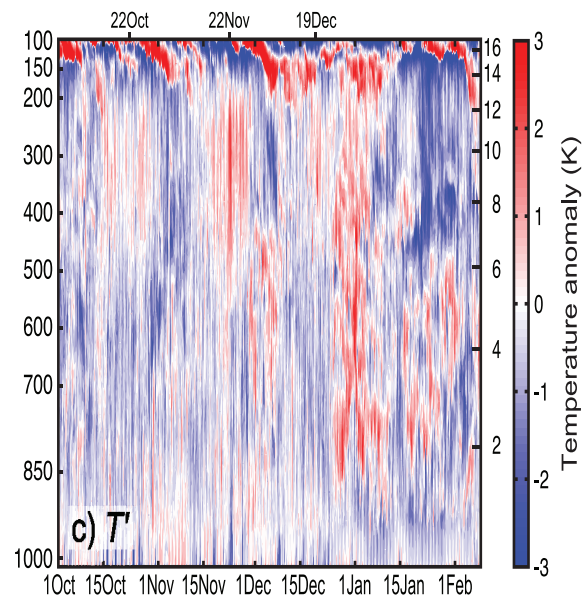
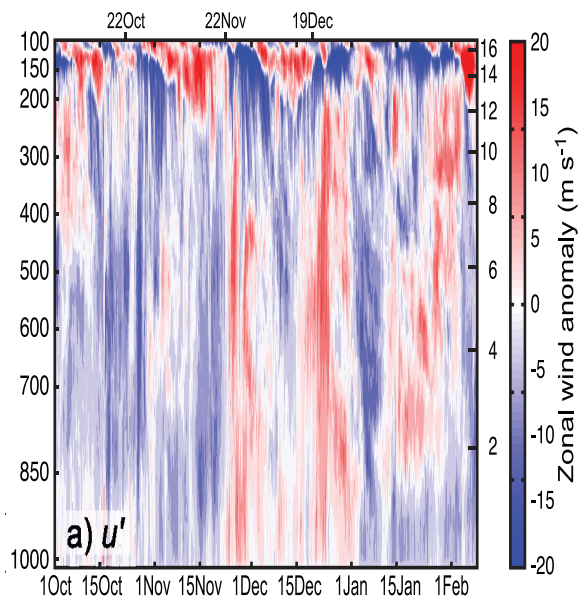






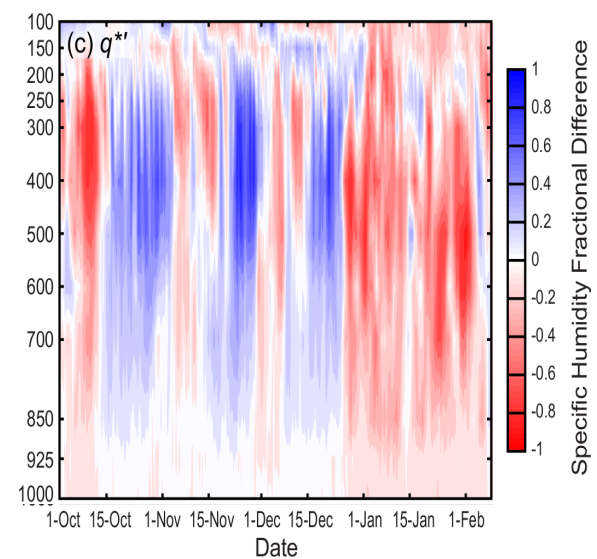
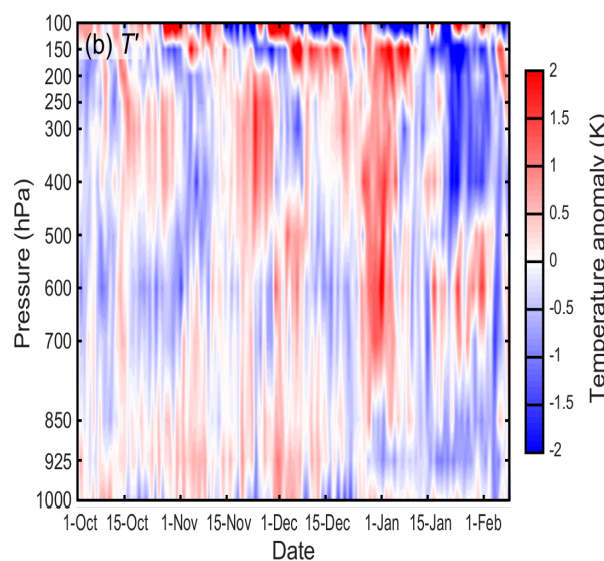
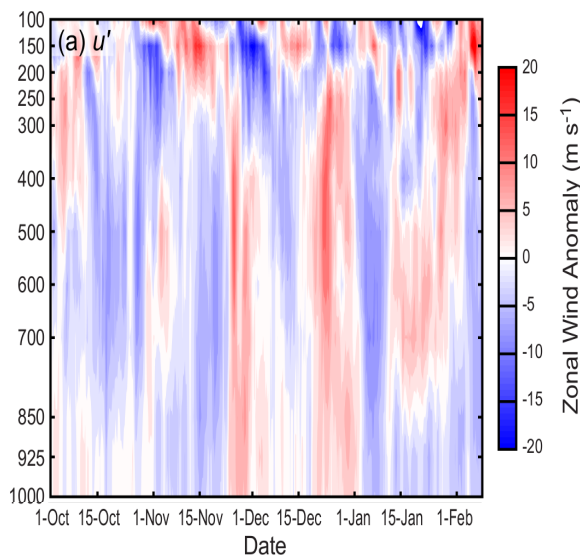






Top row: Gan rawinsonde data

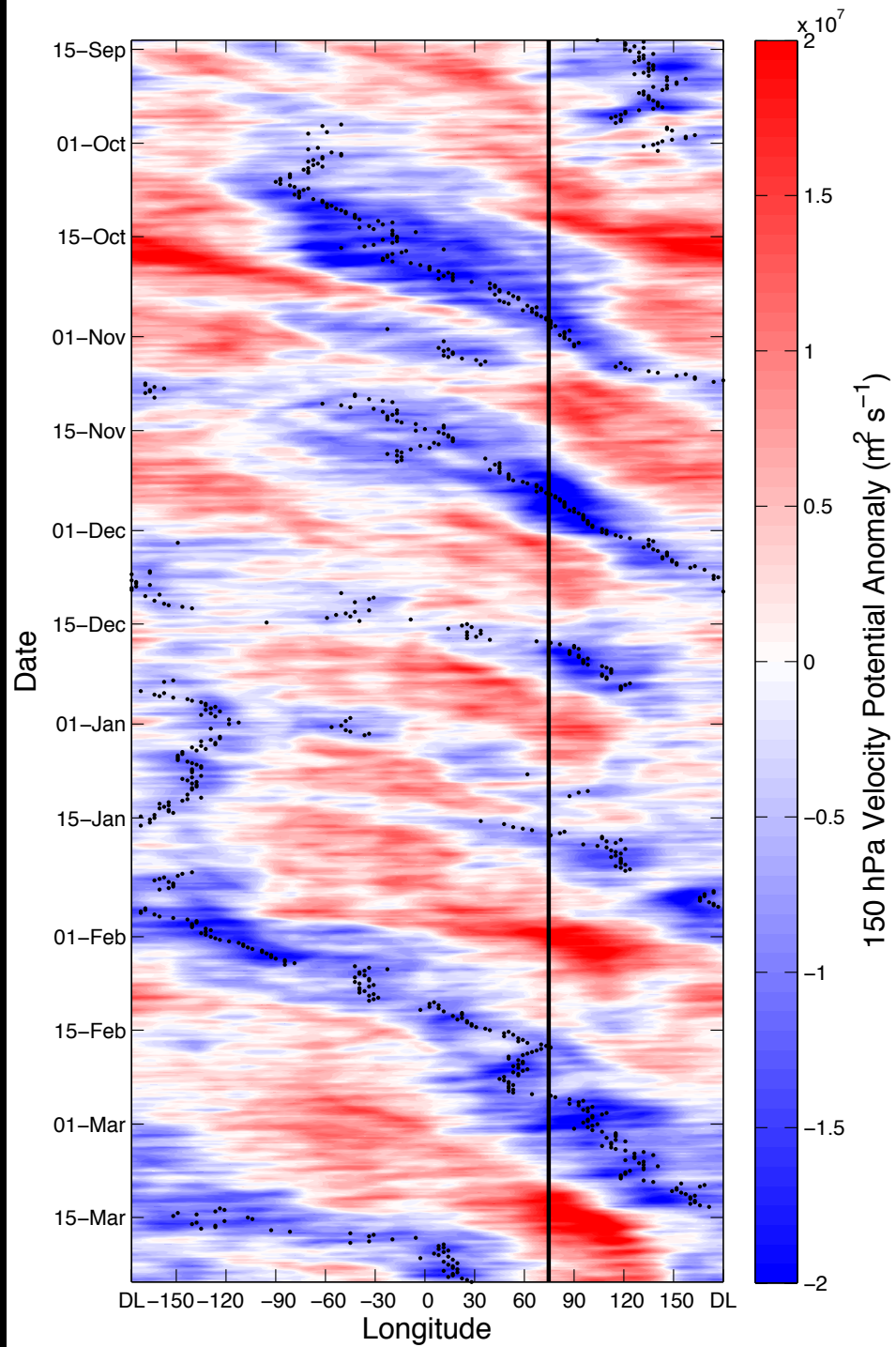
Bottom row: ERA-Interim ( $3^{\circ}\text{N} - 3^{\circ}\text{S}$ ,  $68^{\circ}\text{E} - 78^{\circ}\text{E}$ )



# *Upper-Tropospheric Dynamics*

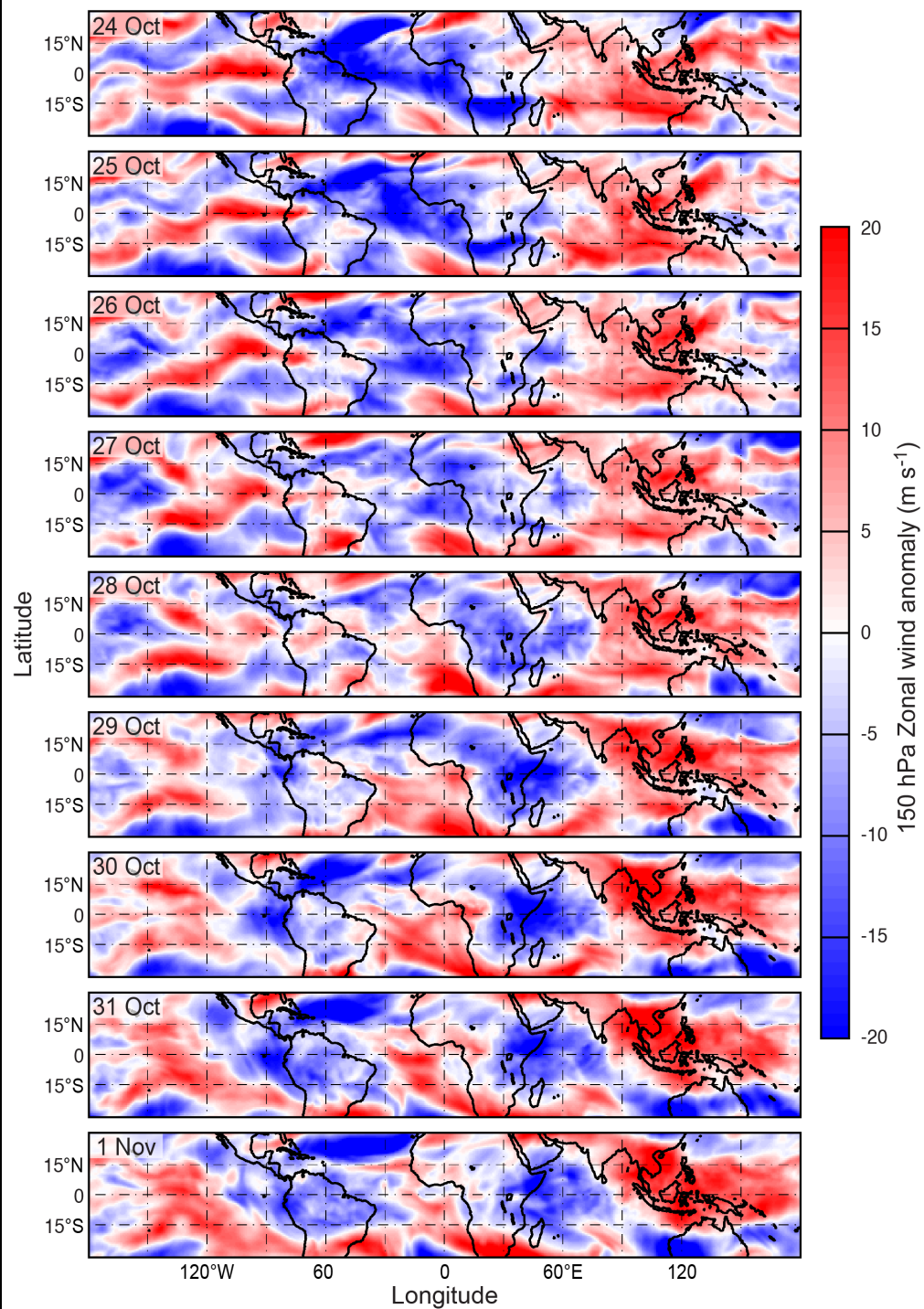
$\chi'_{150}$ 

$$U = \nabla \chi$$

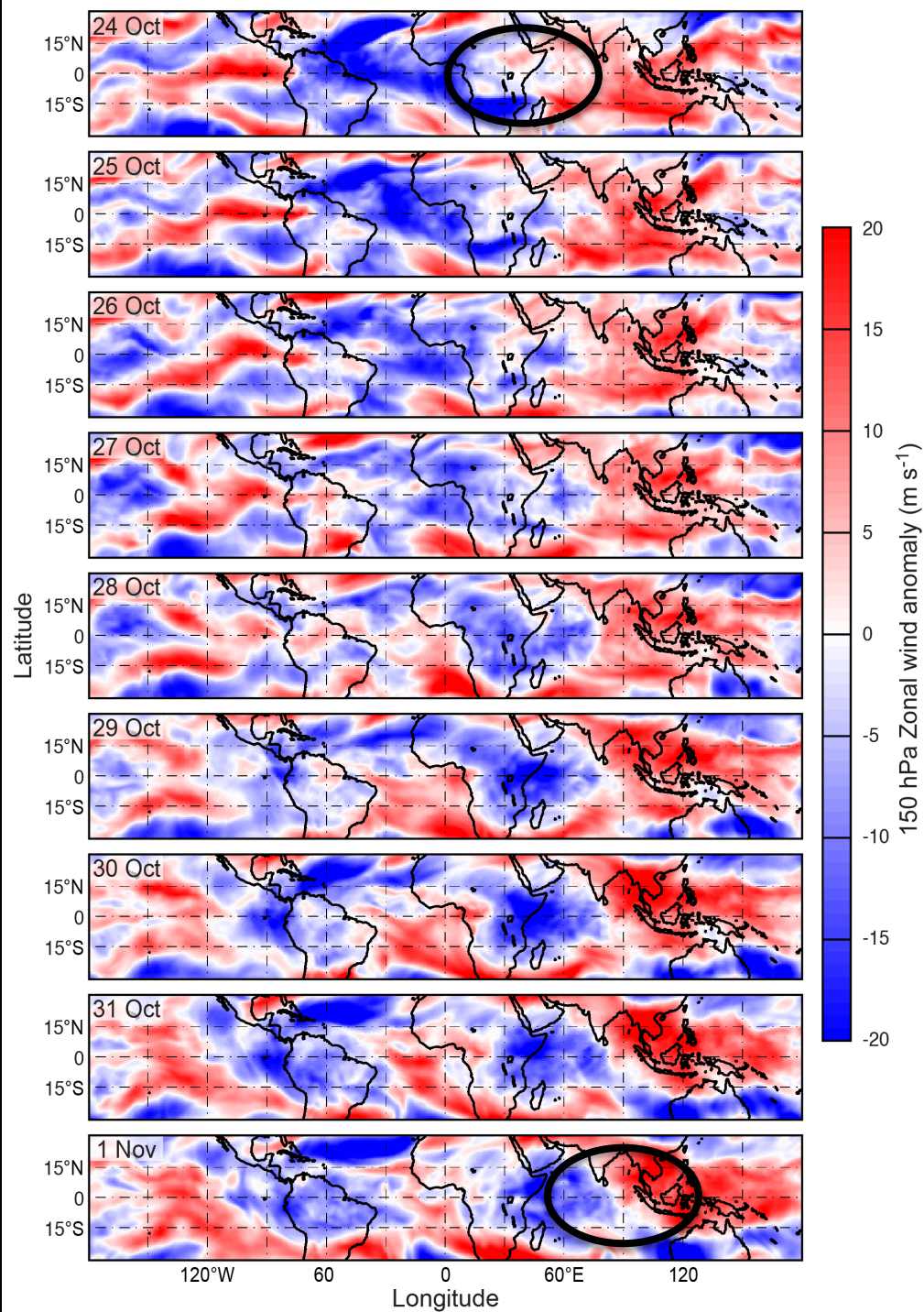




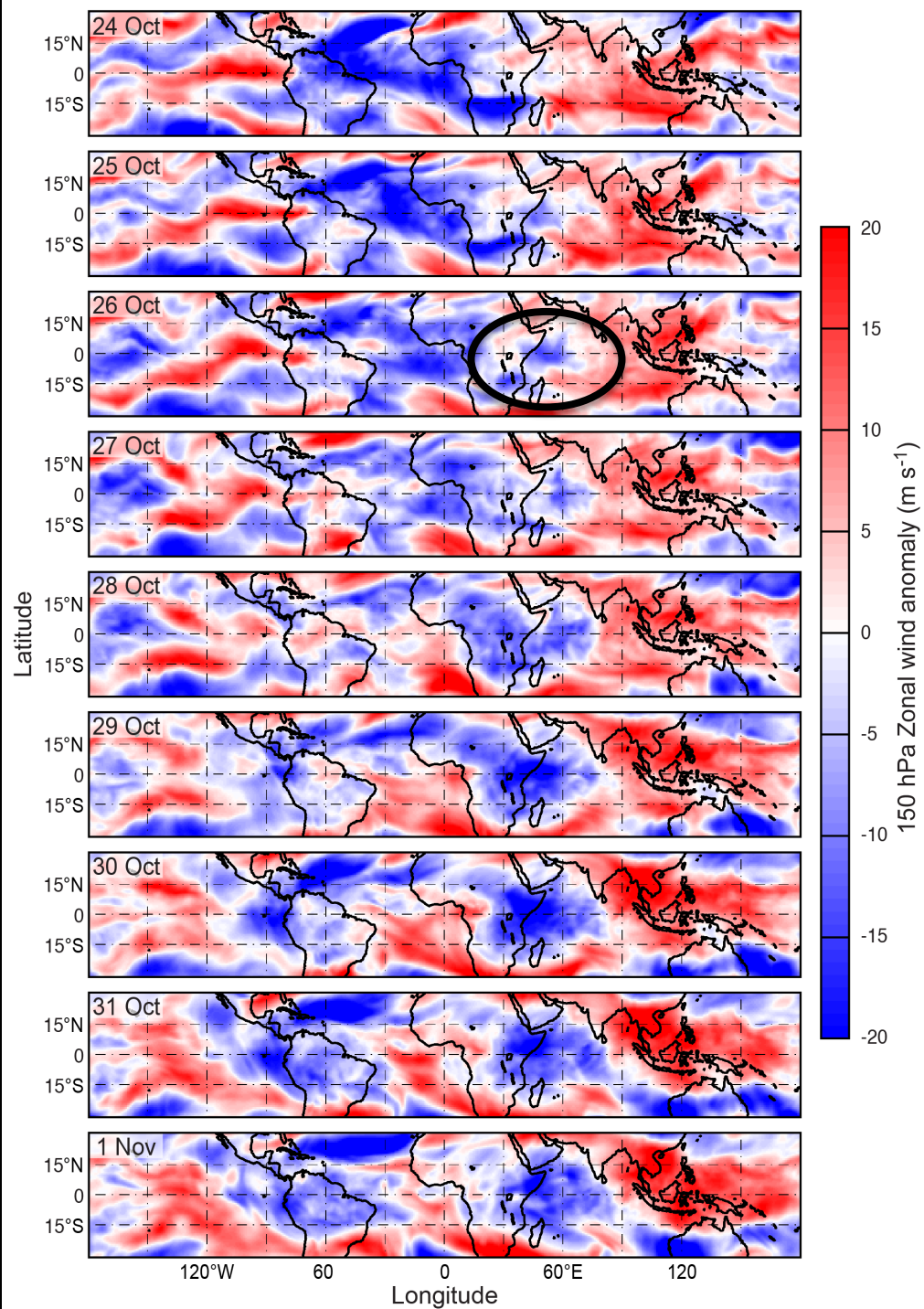
150 hPa  $u'$   
Blue: Easterly  
Red: Westerly



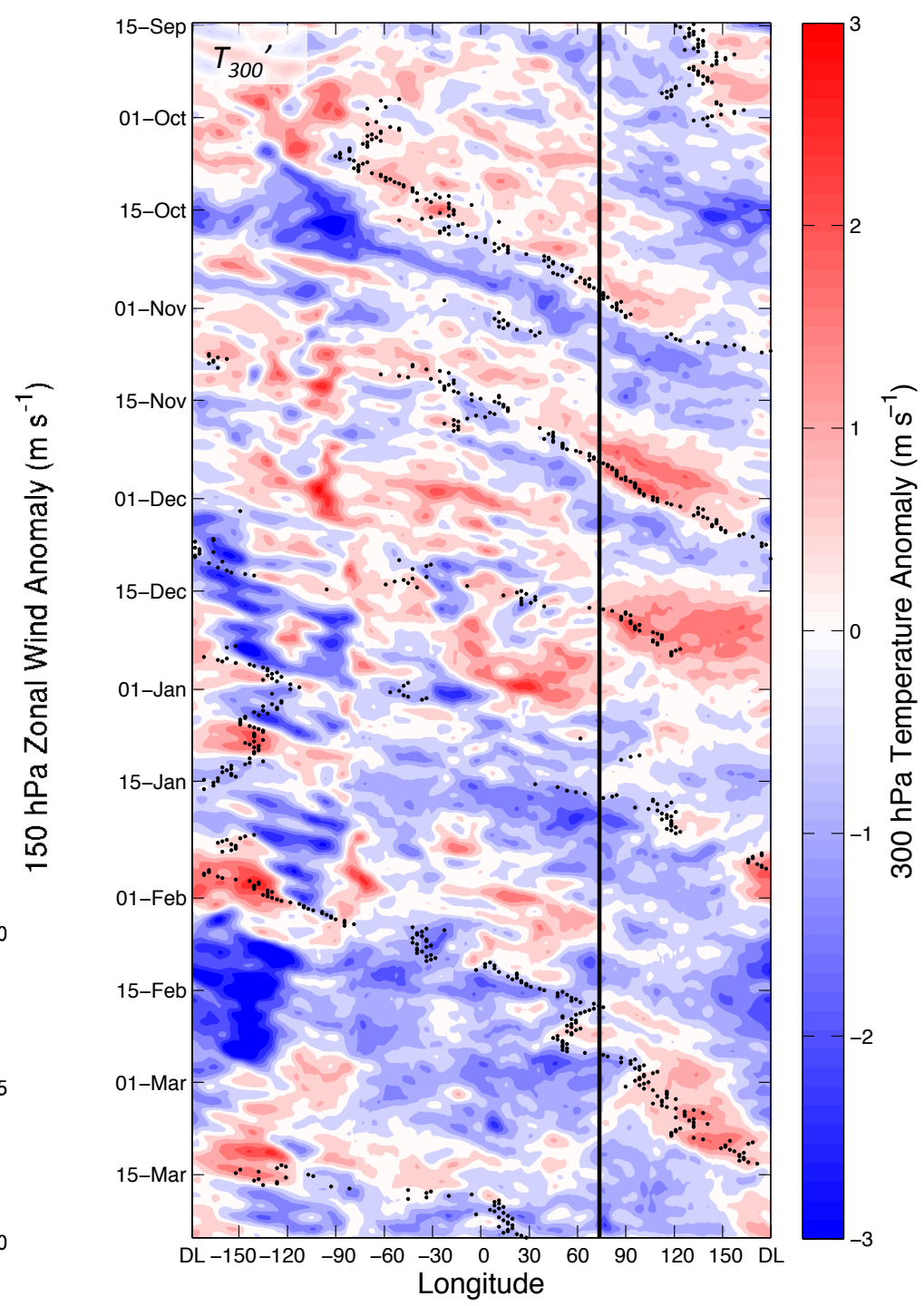
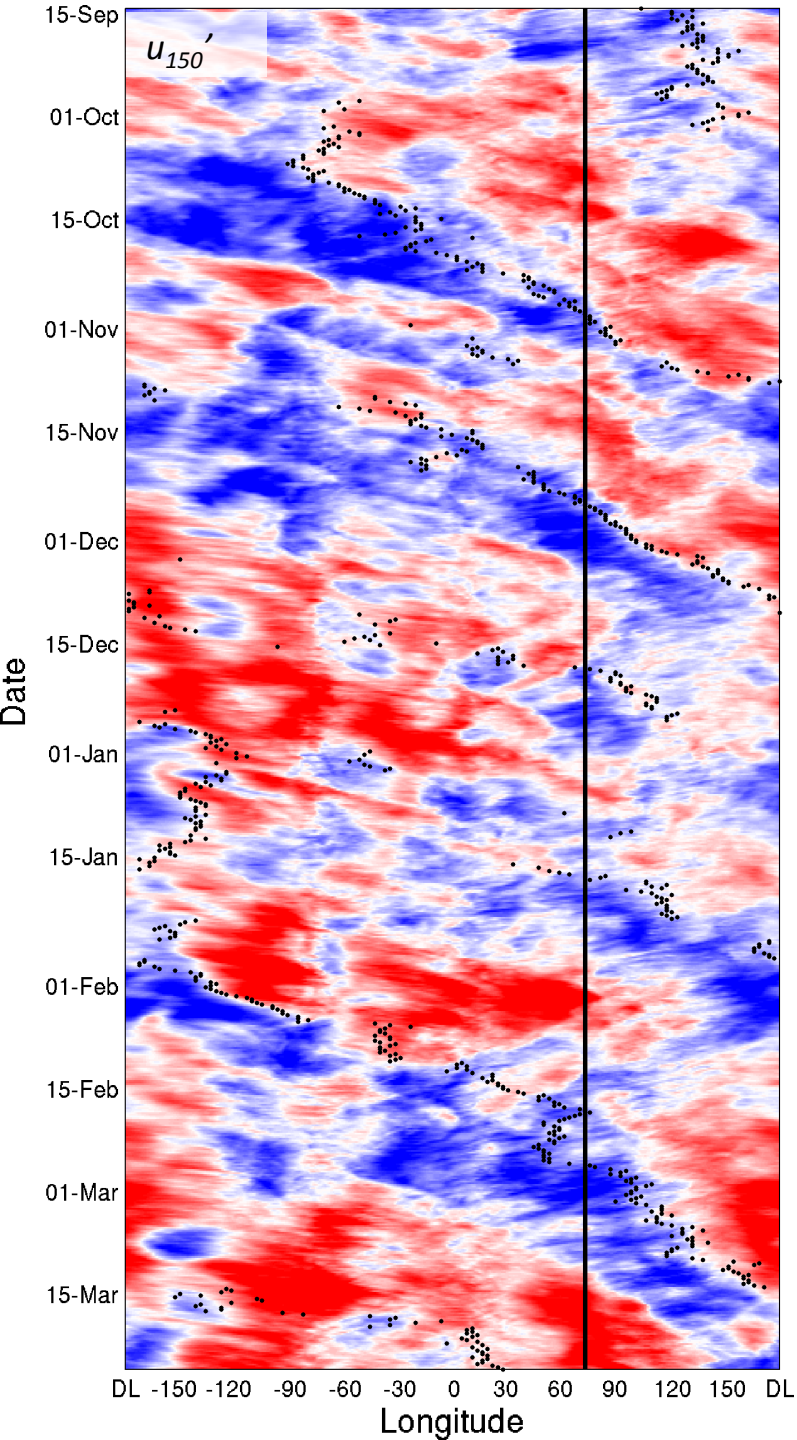
150 hPa  $u'$   
Blue: Easterly  
Red: Westerly

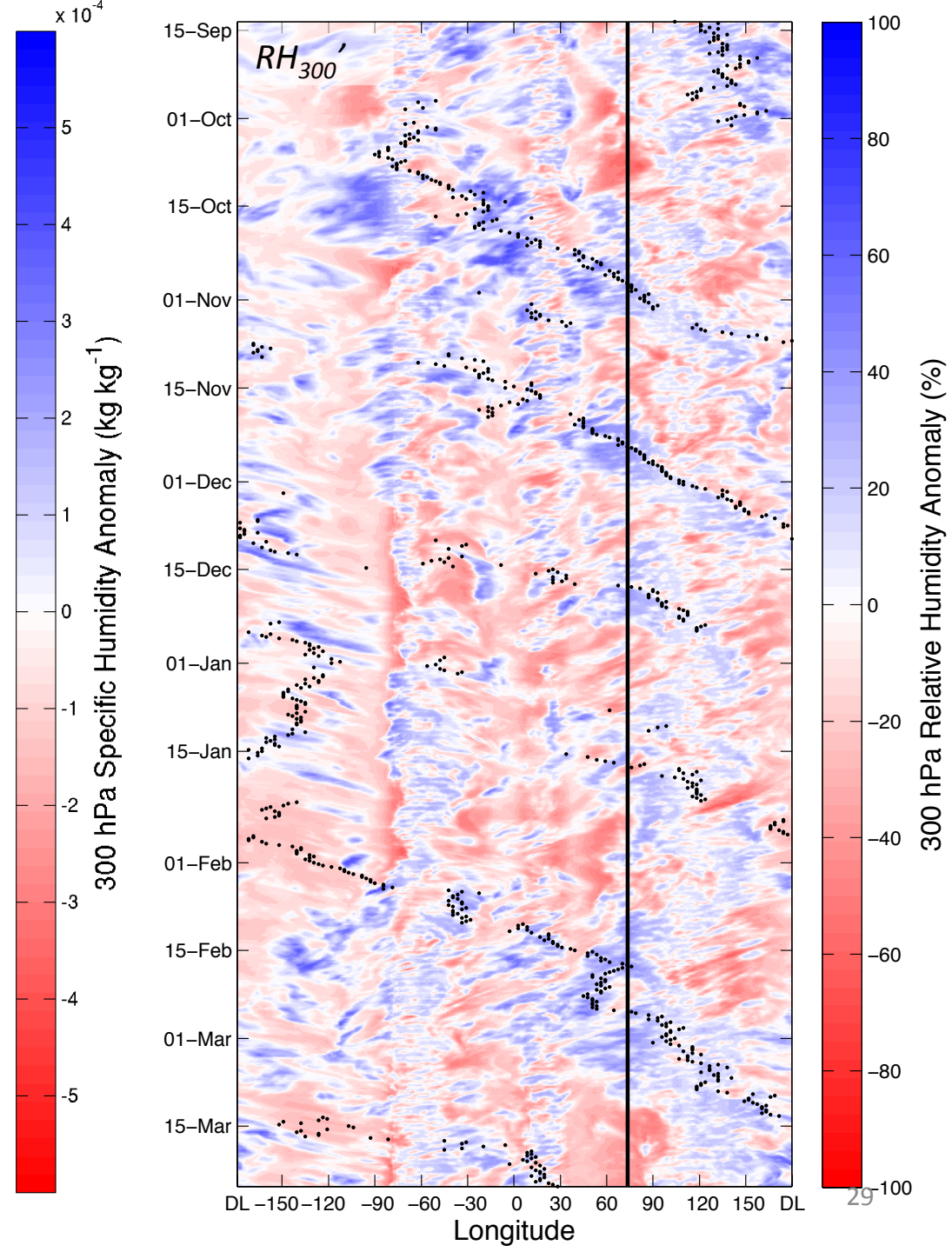
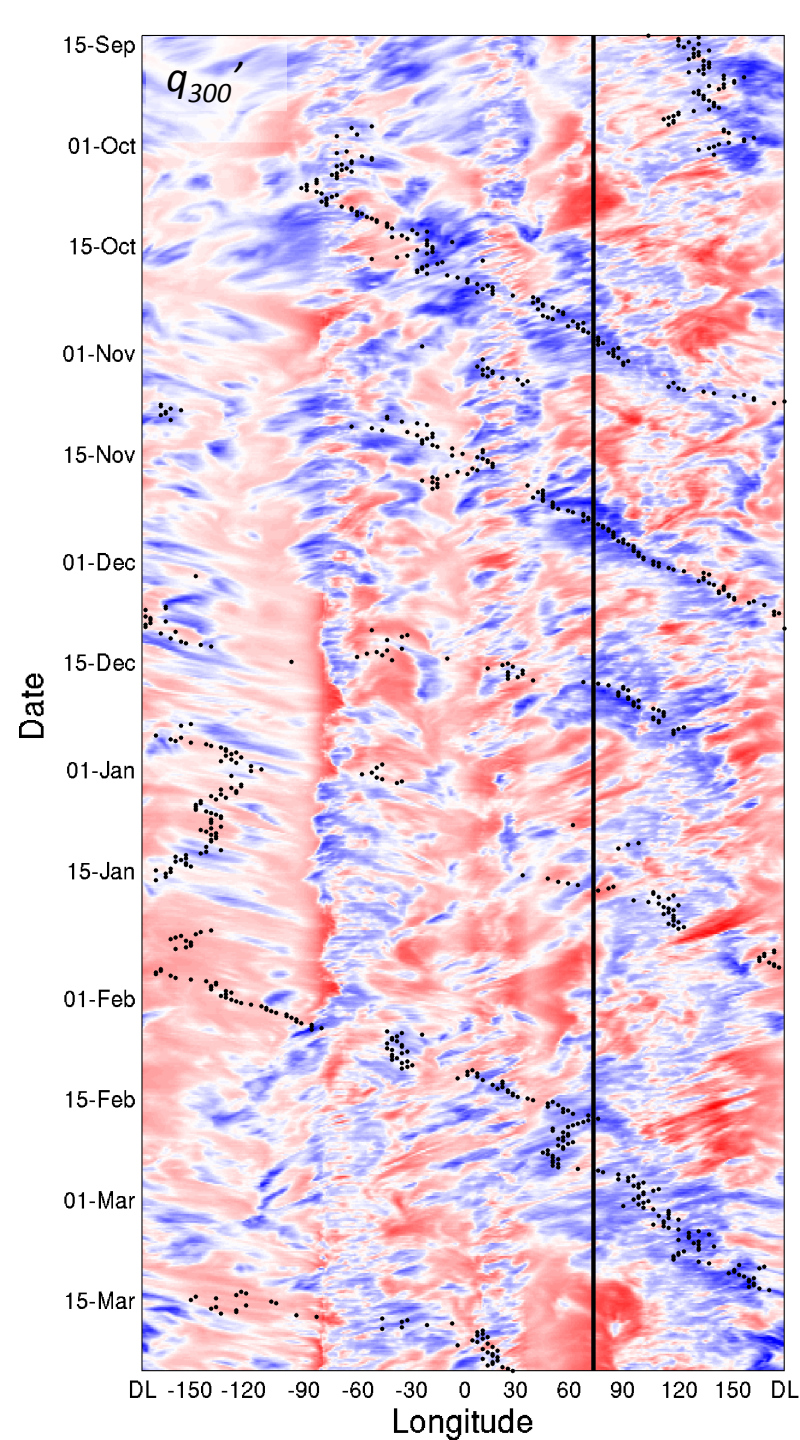


150 hPa  $u'$   
Blue: Easterly  
Red: Westerly



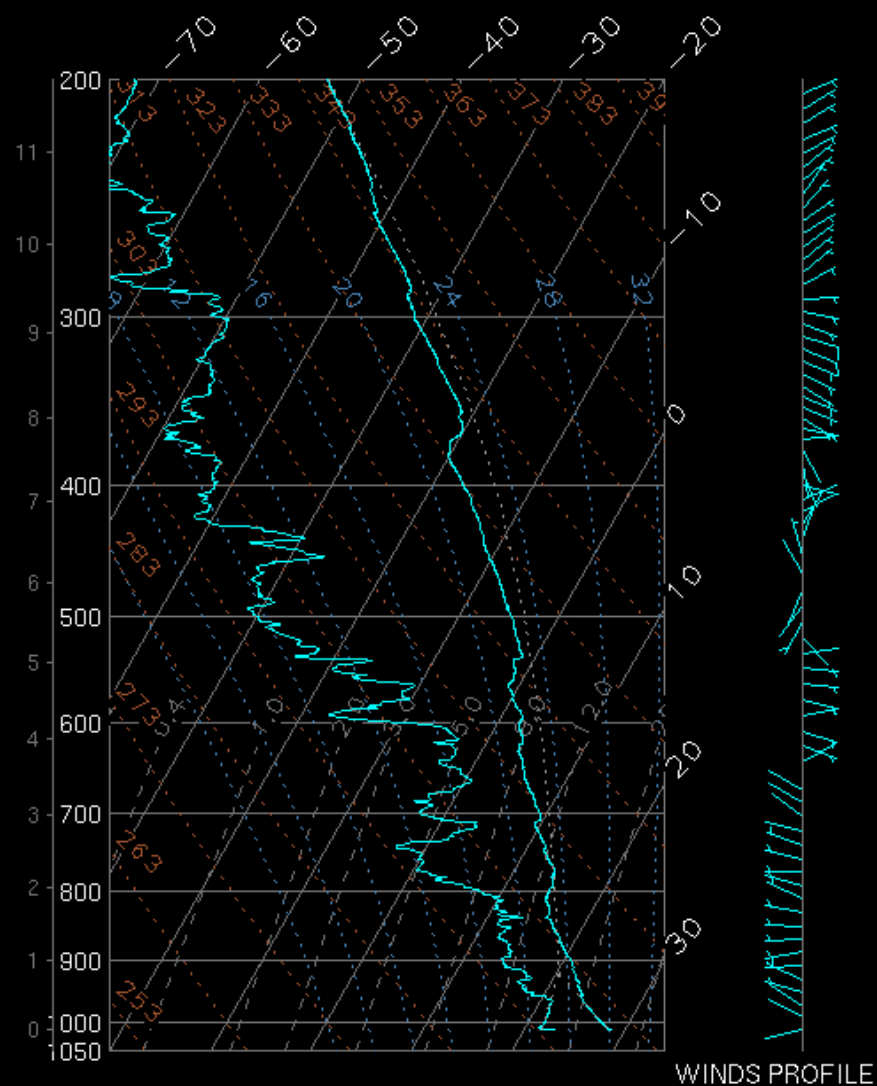




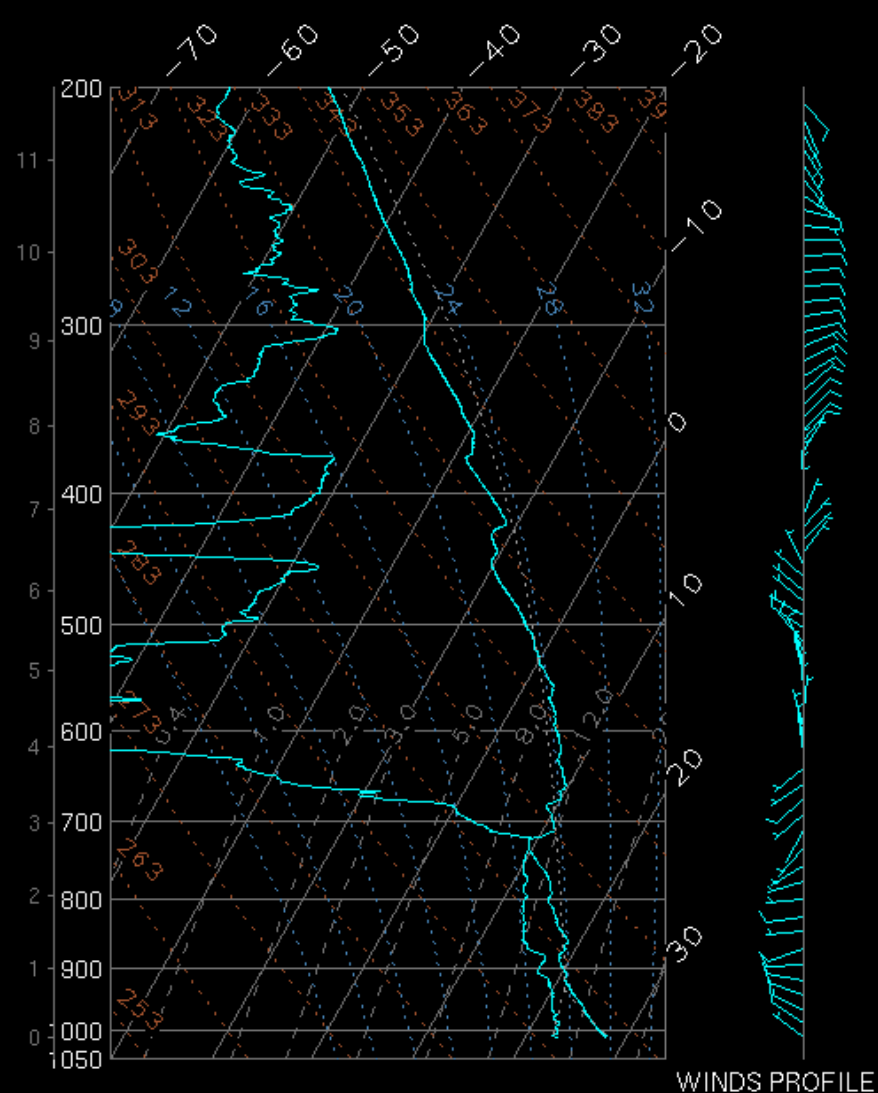




0234 UTC, 9 October

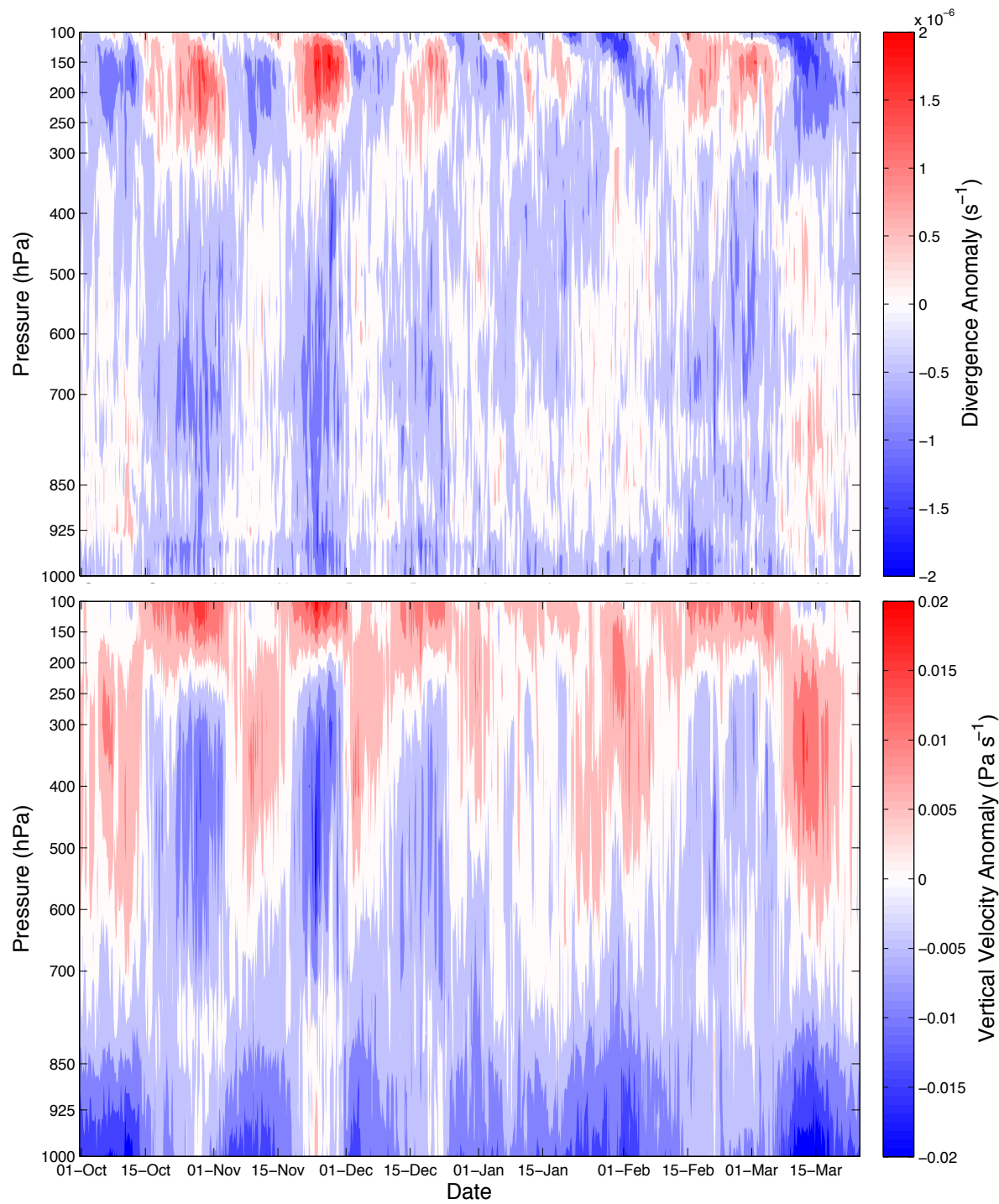


0236 UTC, 1 January

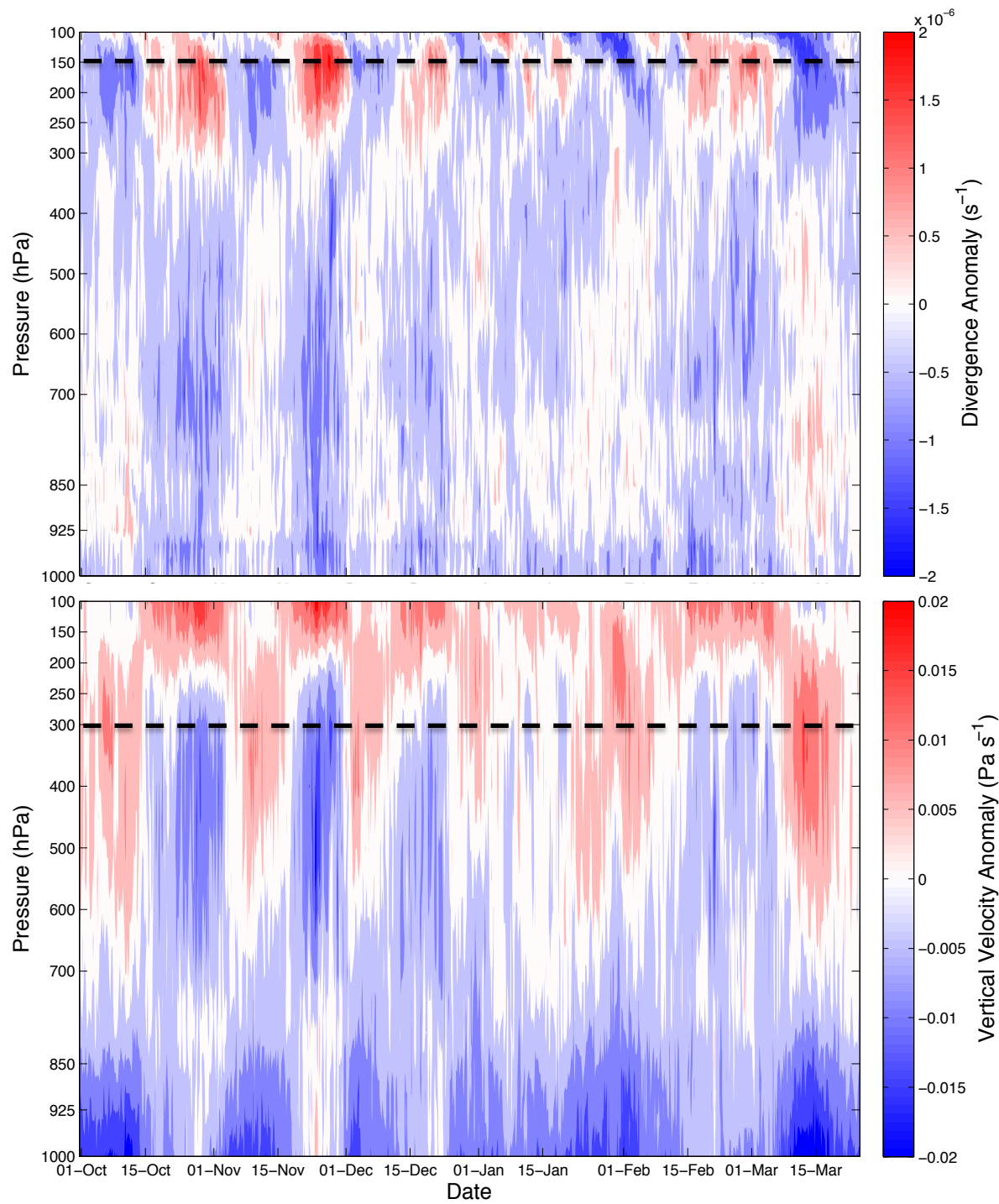


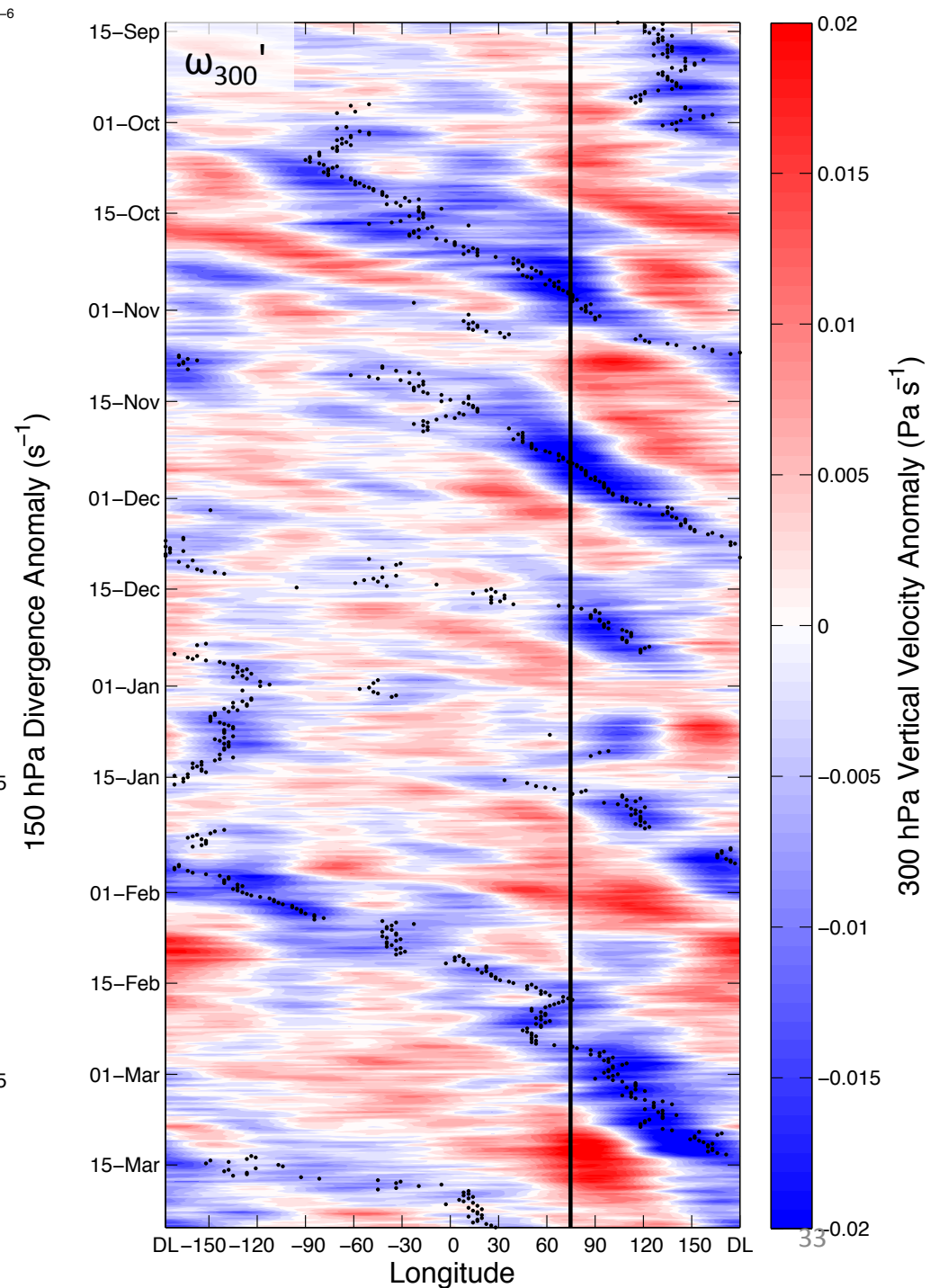
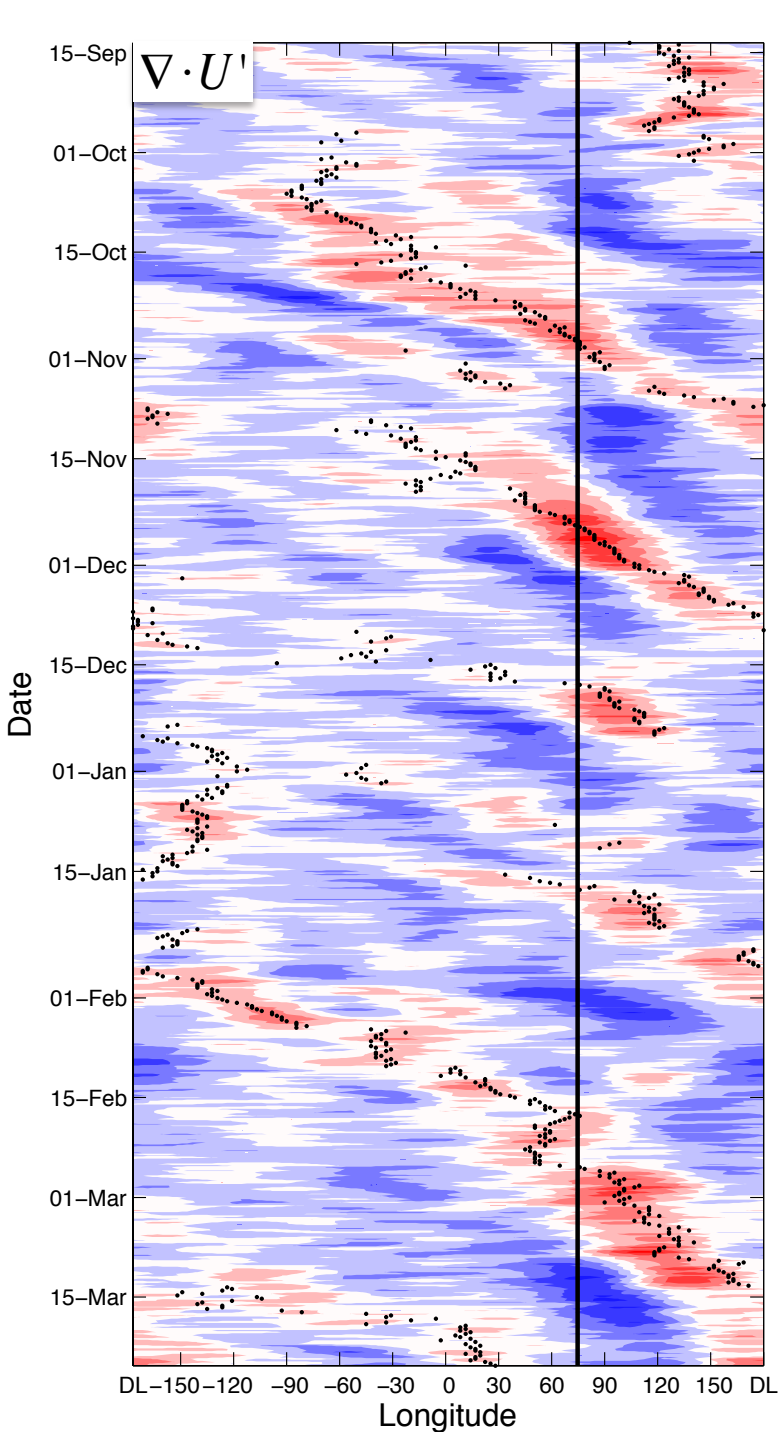


$$\nabla \cdot \mathbf{U}'$$

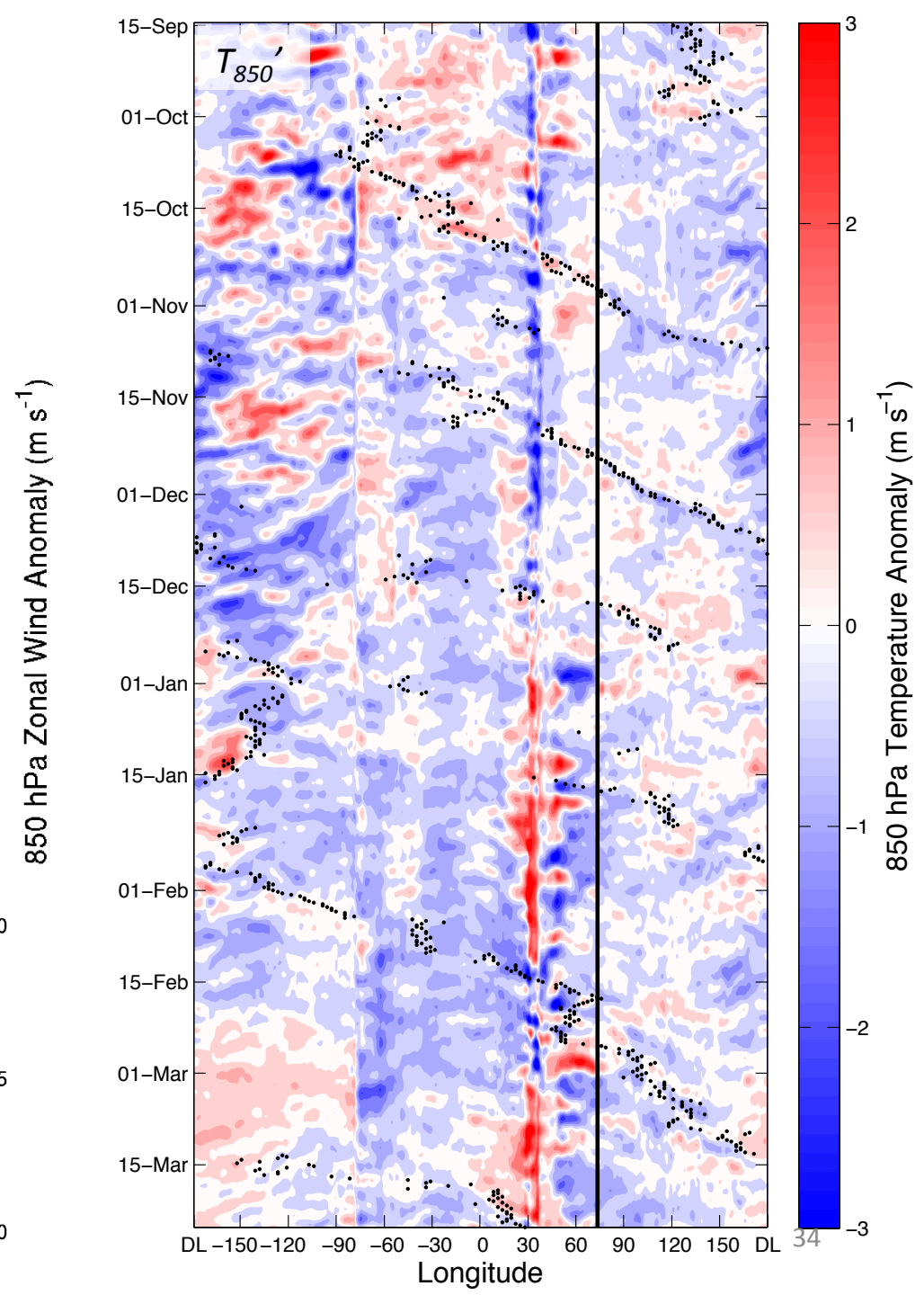
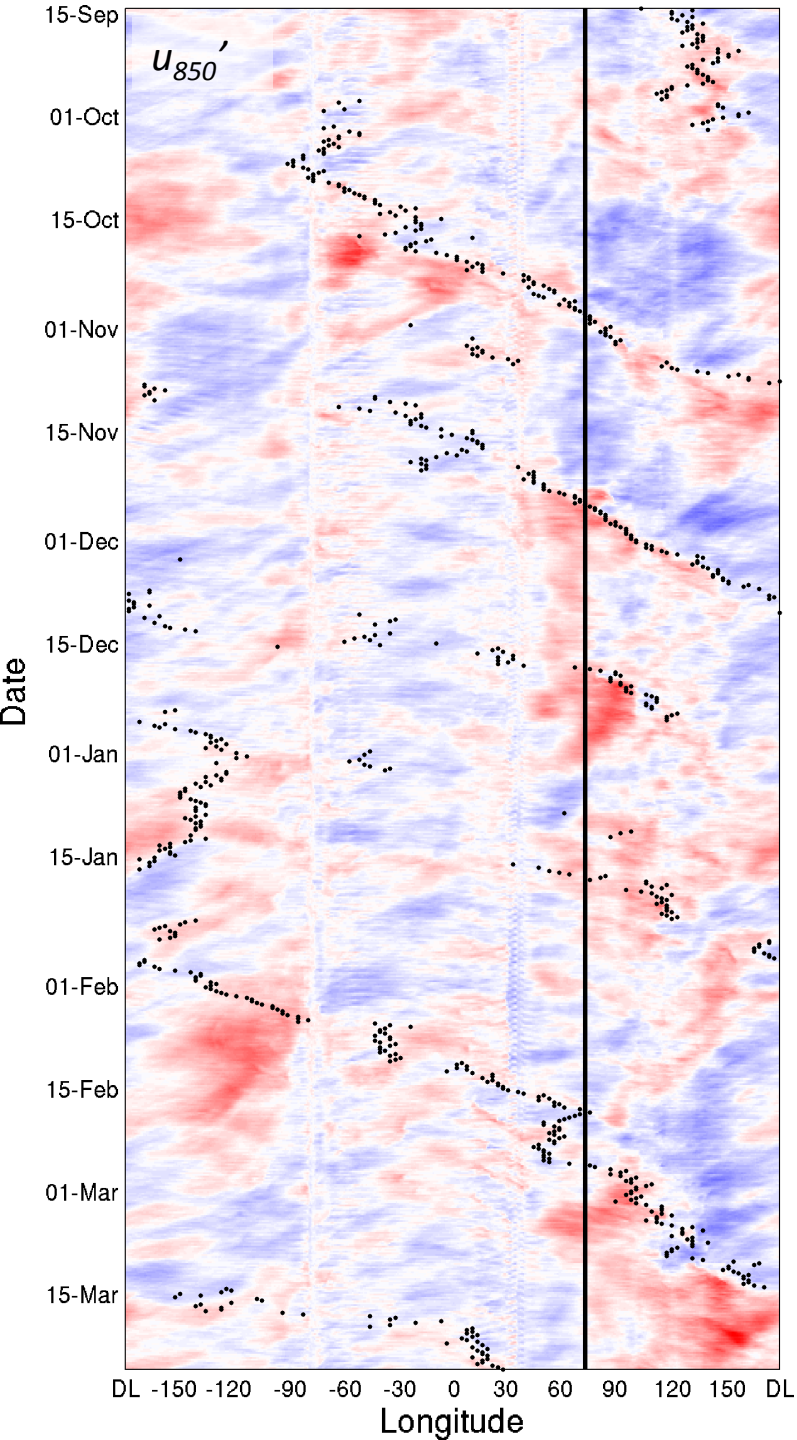

 $\omega'$

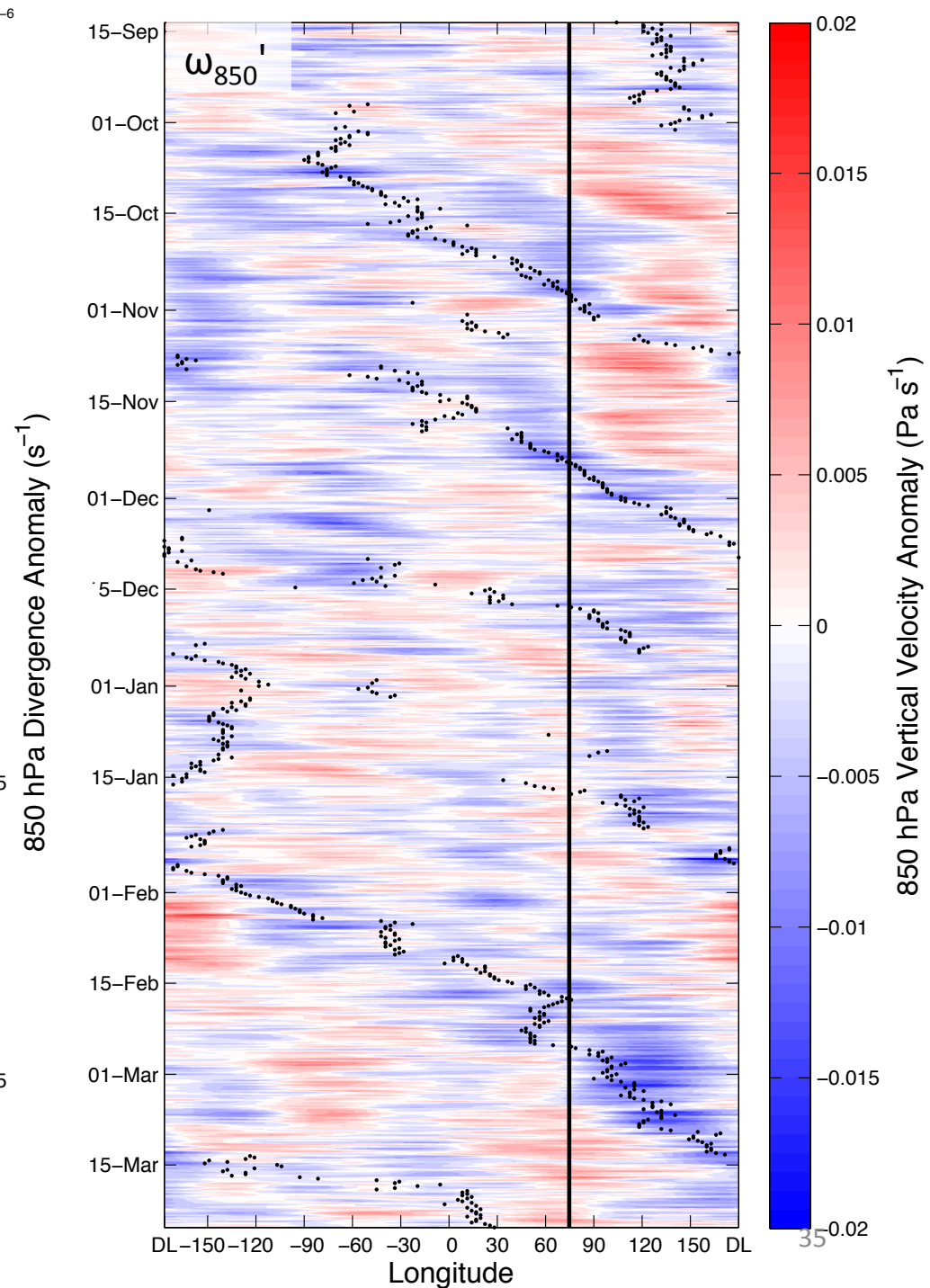
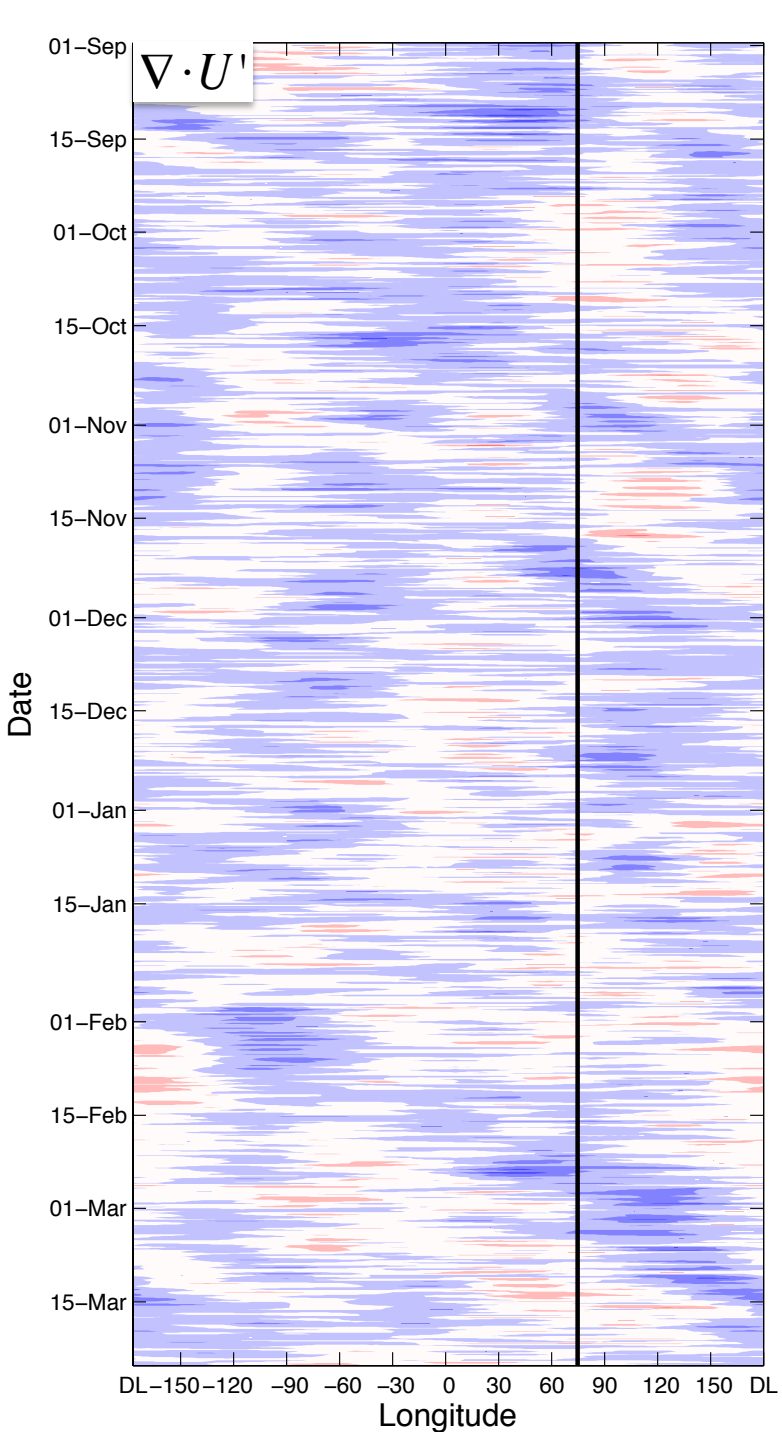
$$\nabla \cdot \mathbf{U}'$$

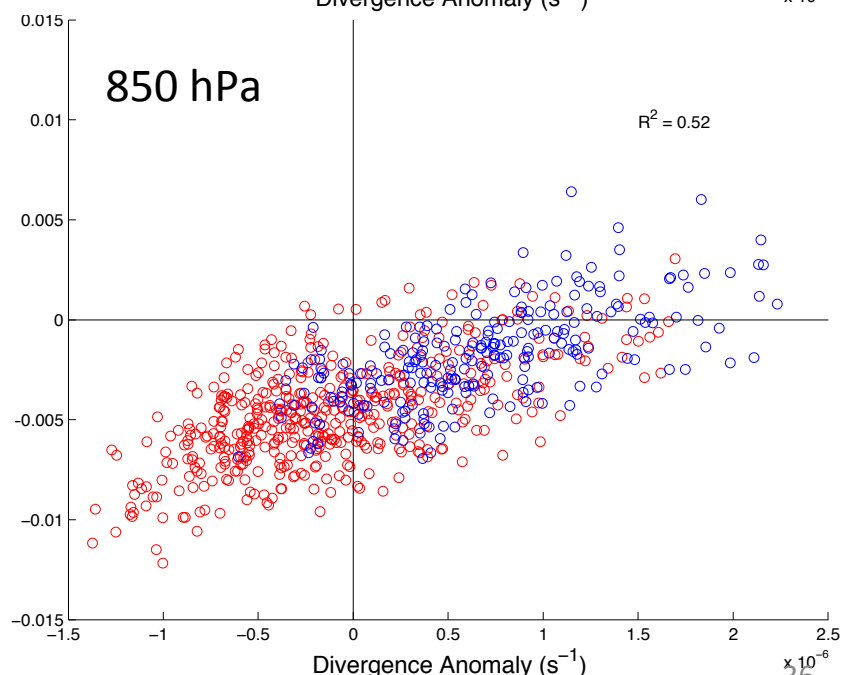
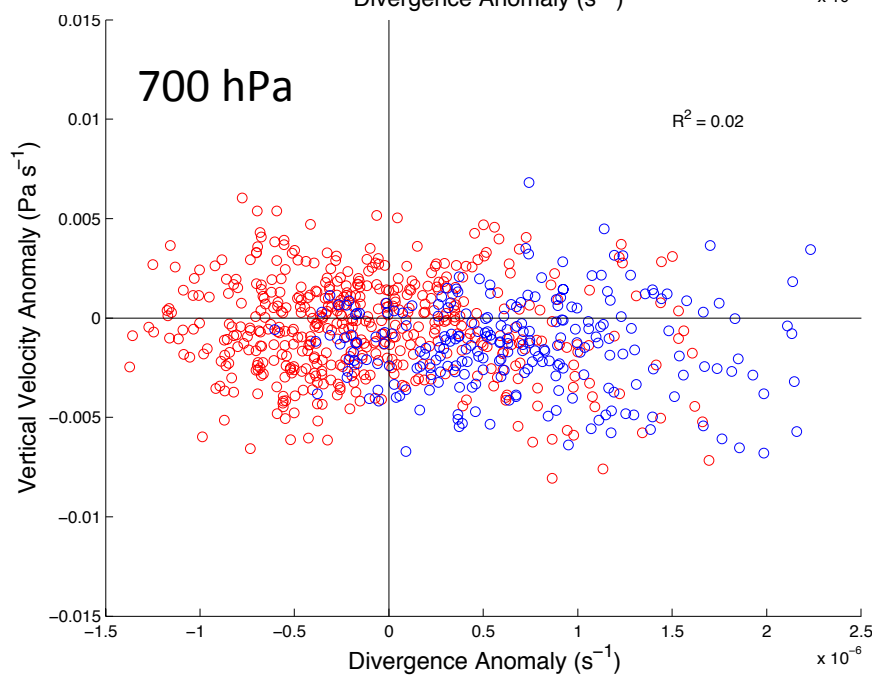
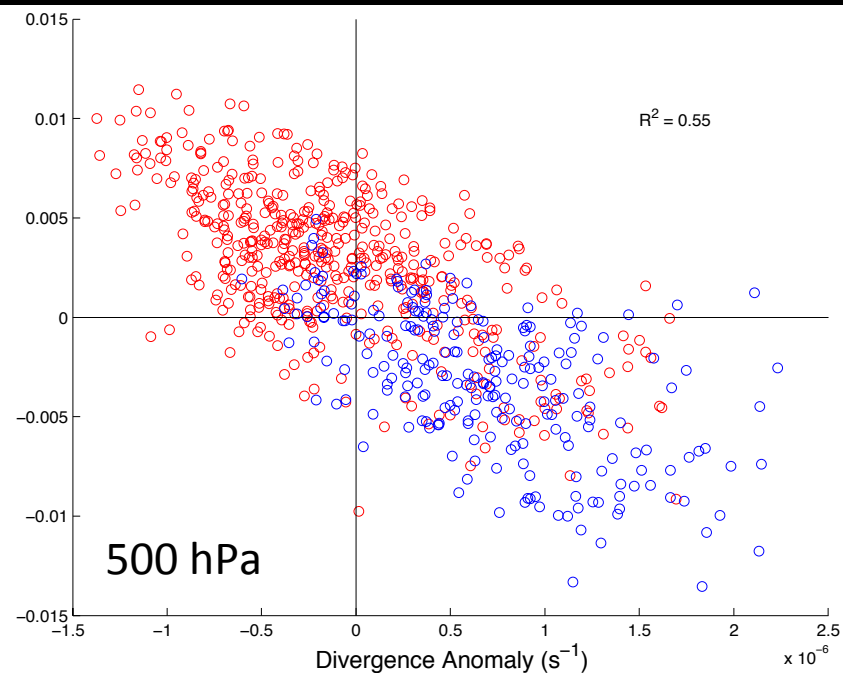
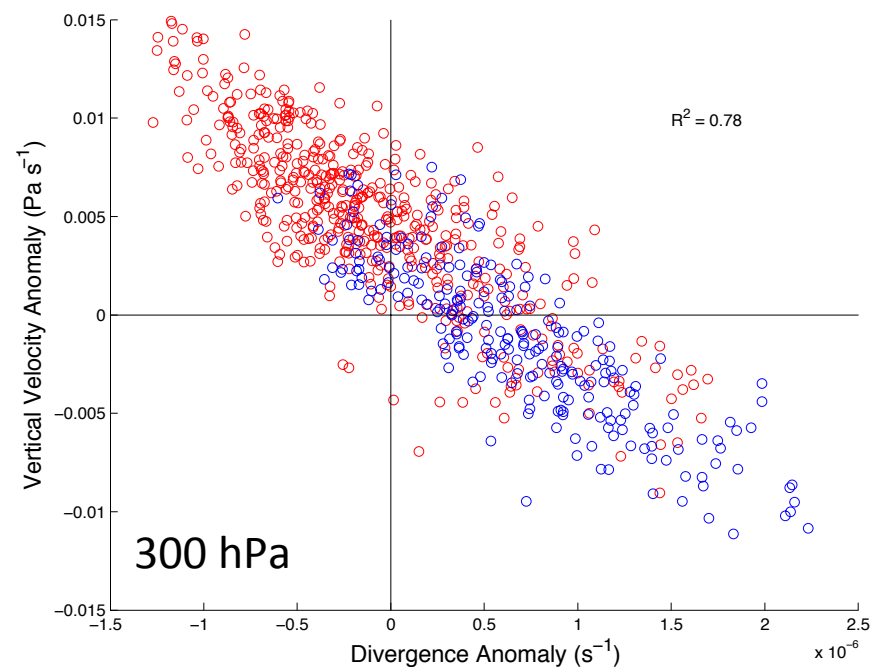






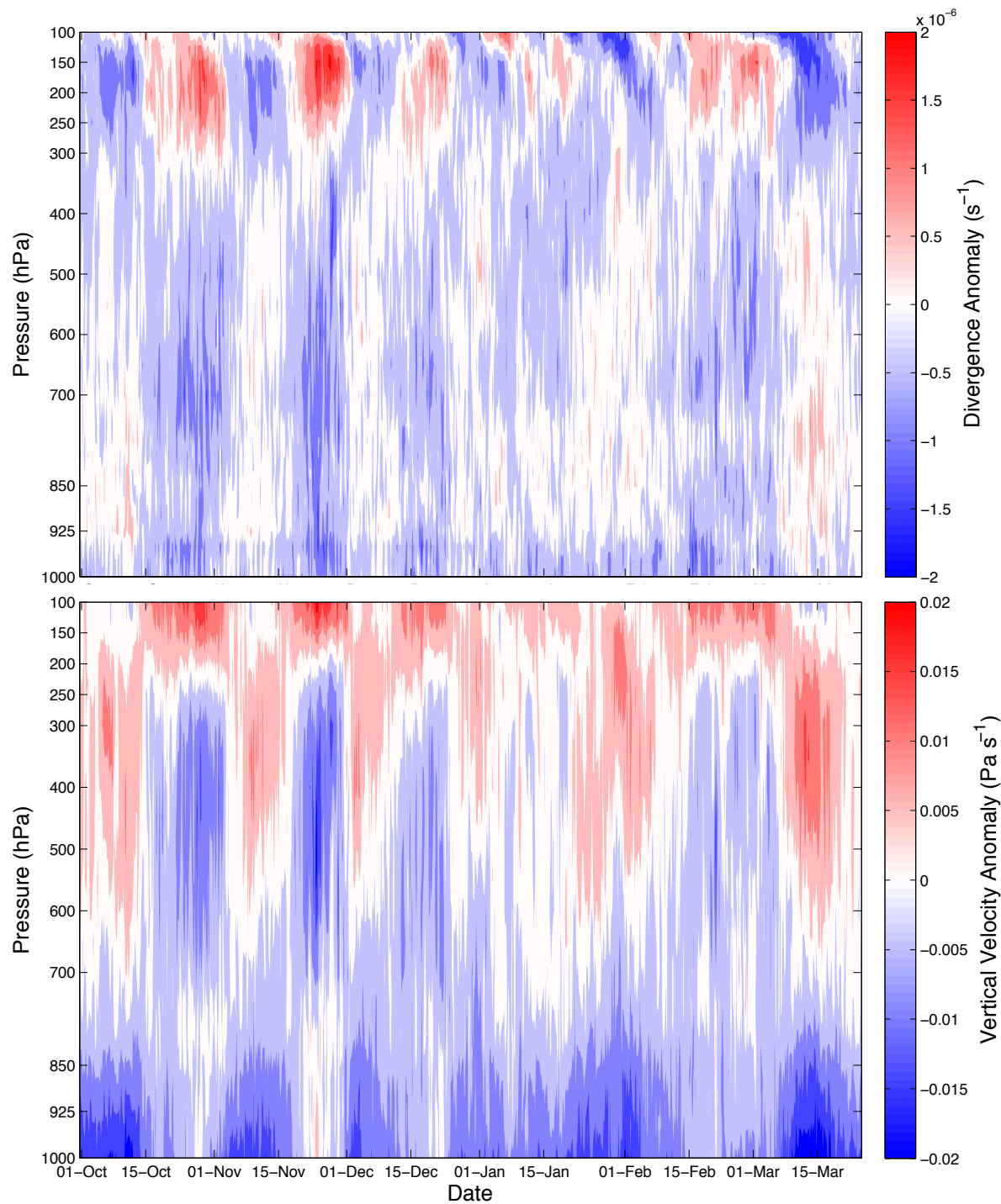




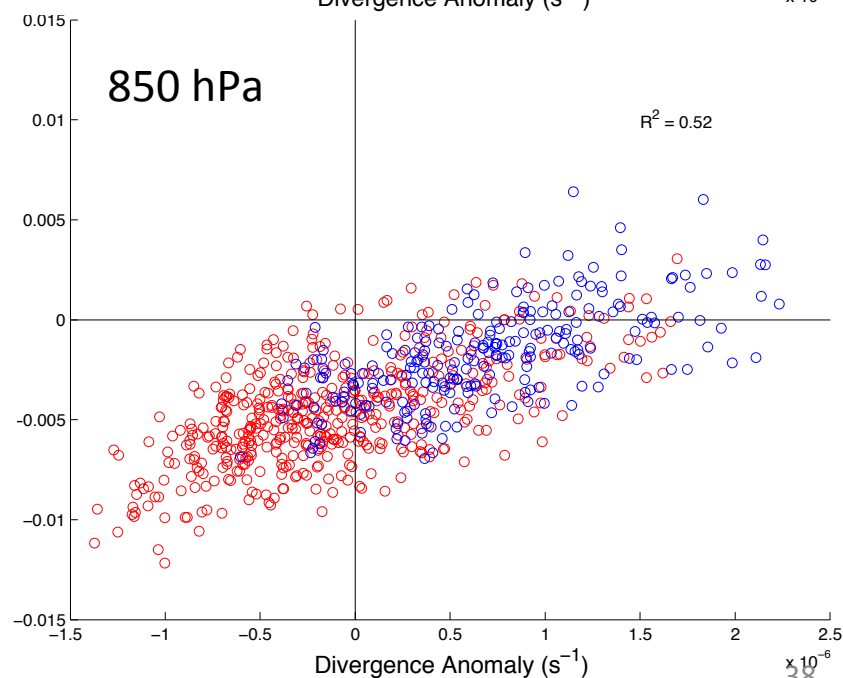
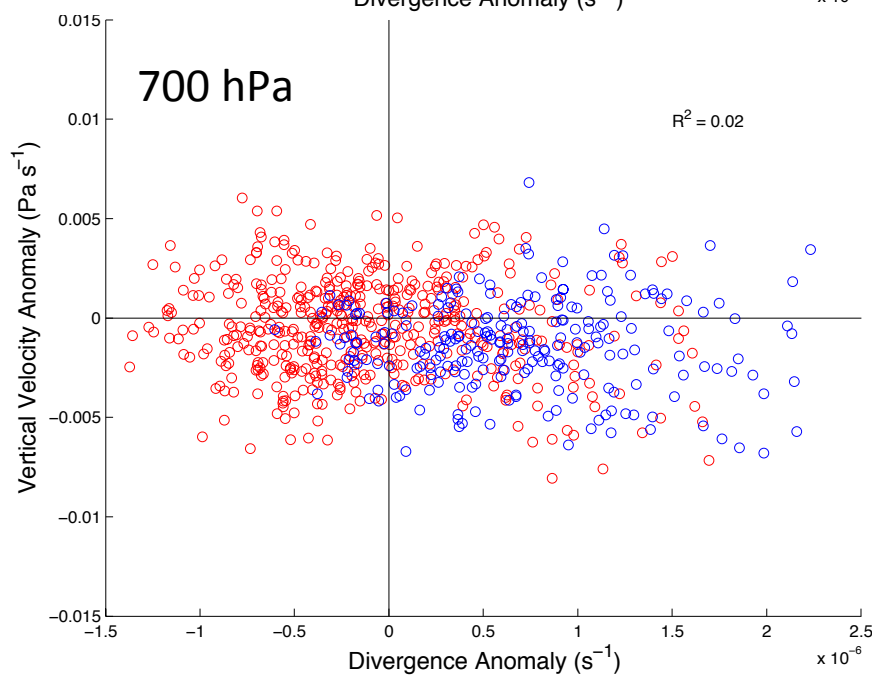
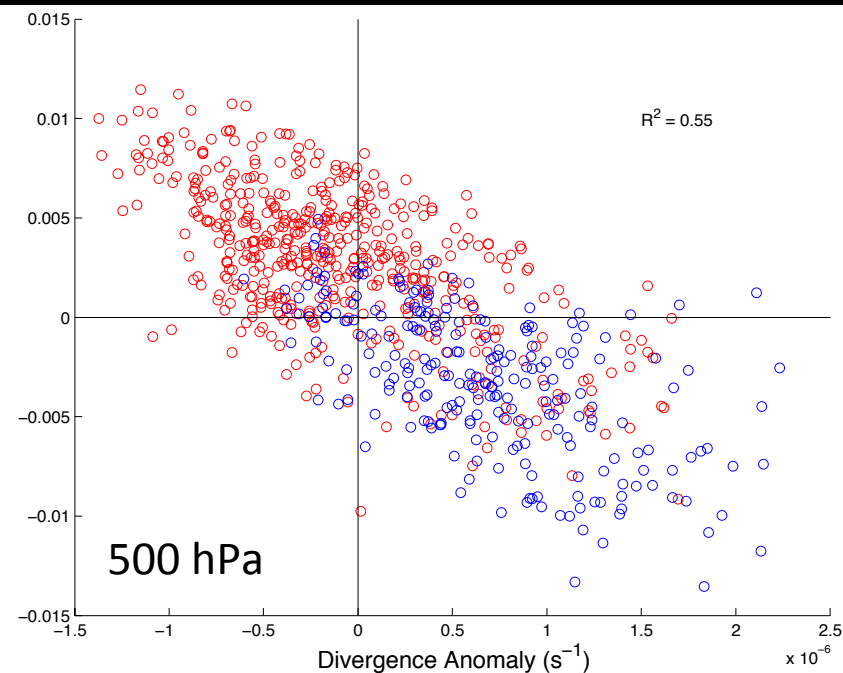
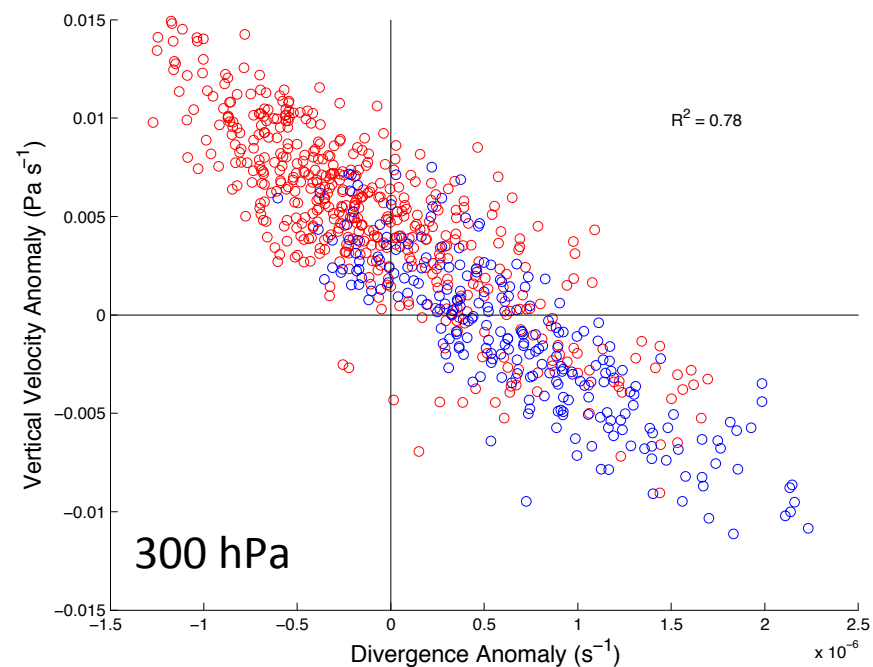




$$\nabla \cdot \mathbf{U}'$$

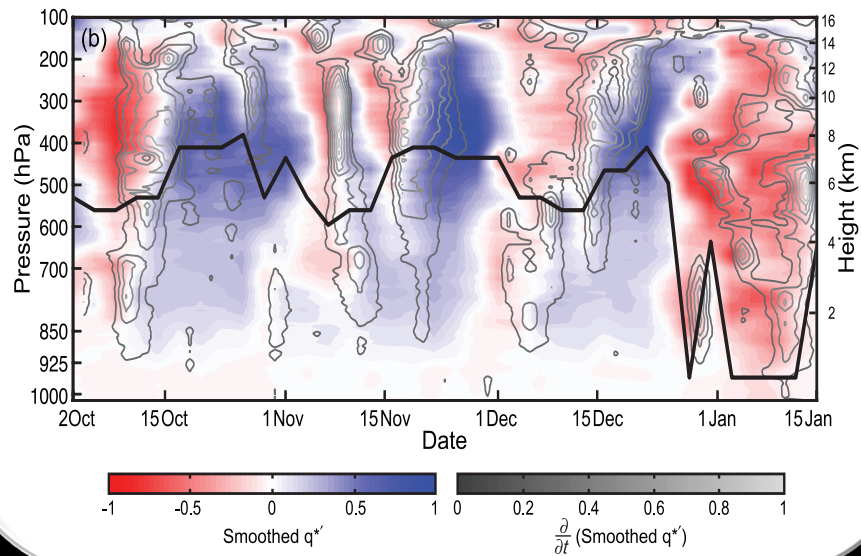
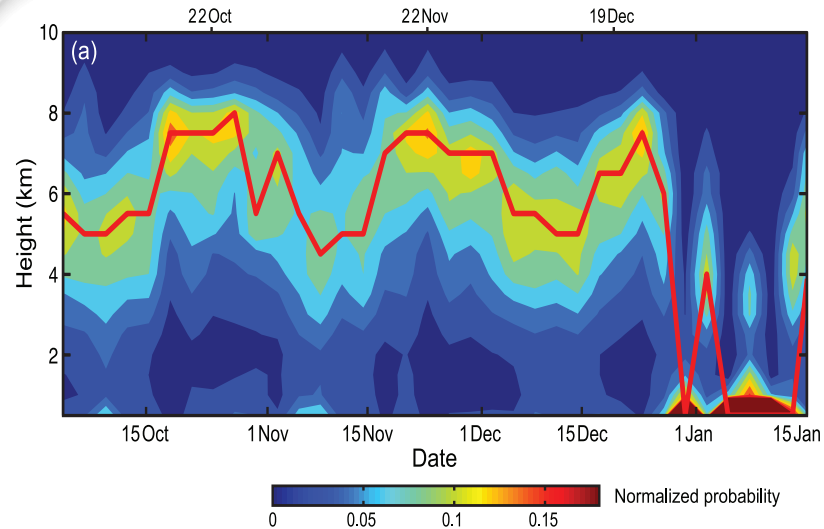


$$\omega'$$



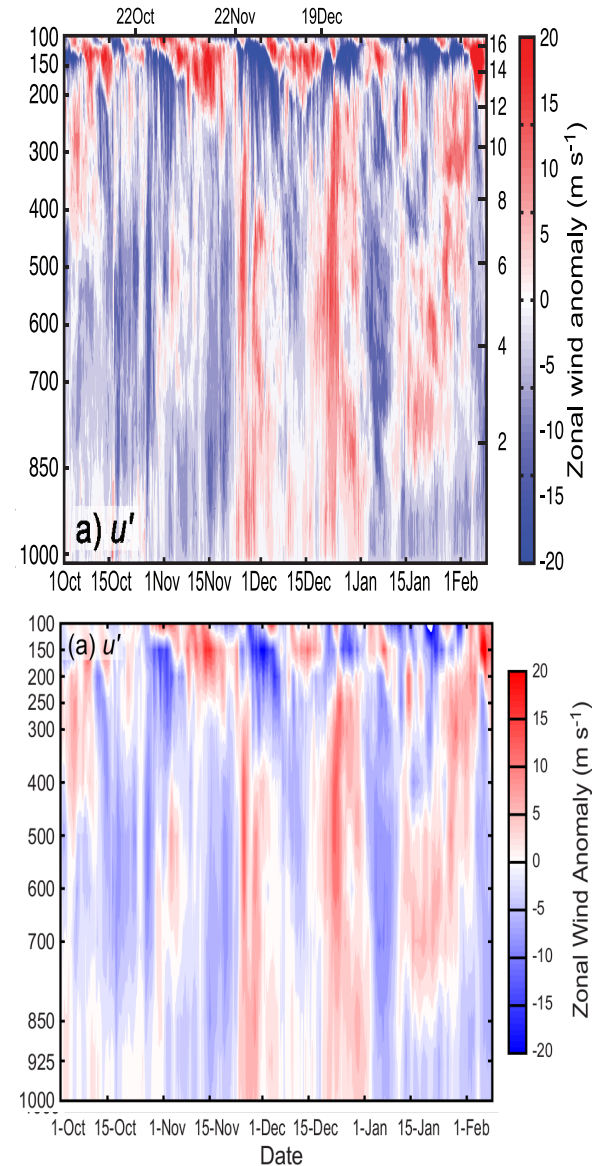
# *Conclusions*



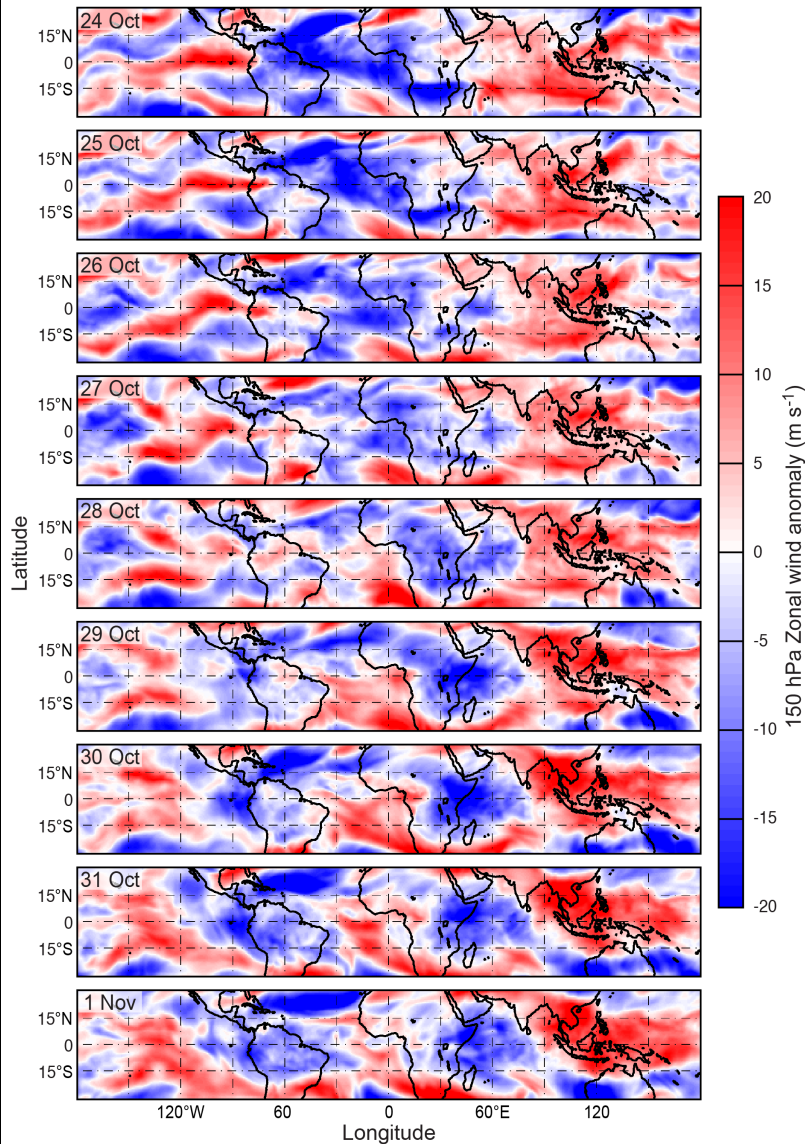


1. Humidity anomalies at various levels and depth of convection increase rapidly at MJO convective onset.

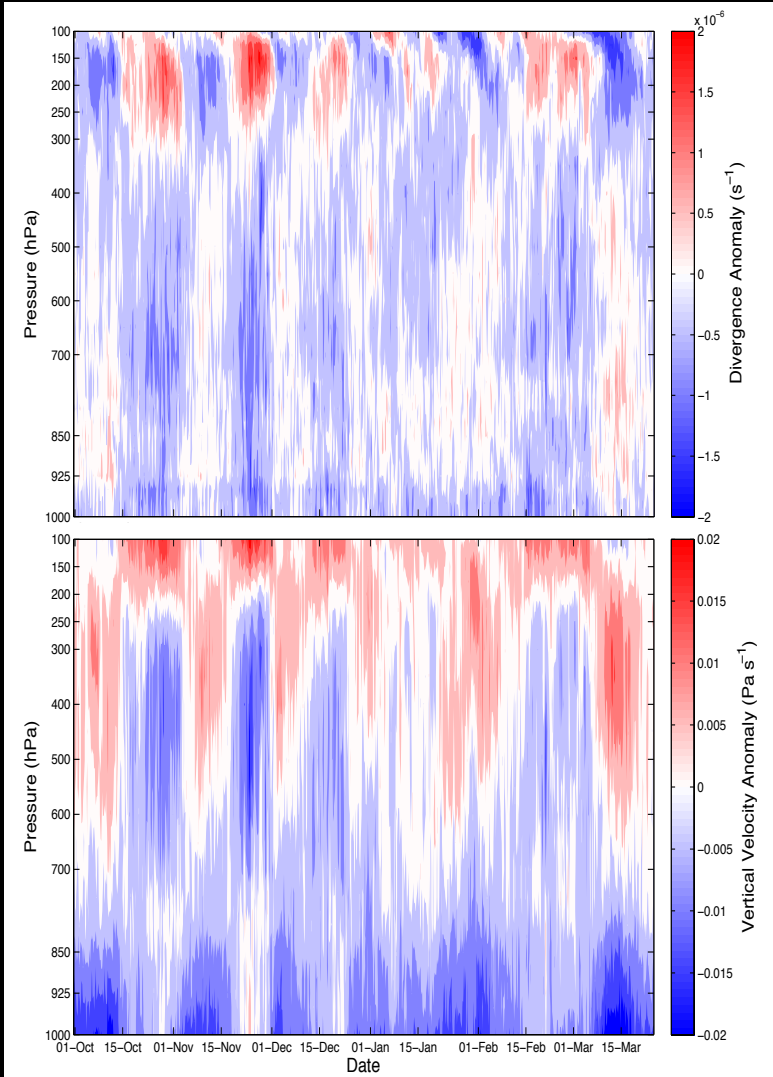
2. ~30 day variability in fields observed by radar and rawinsonde are consistent with that over larger domain in Indian Ocean where initial MJO convective onset occurs.



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



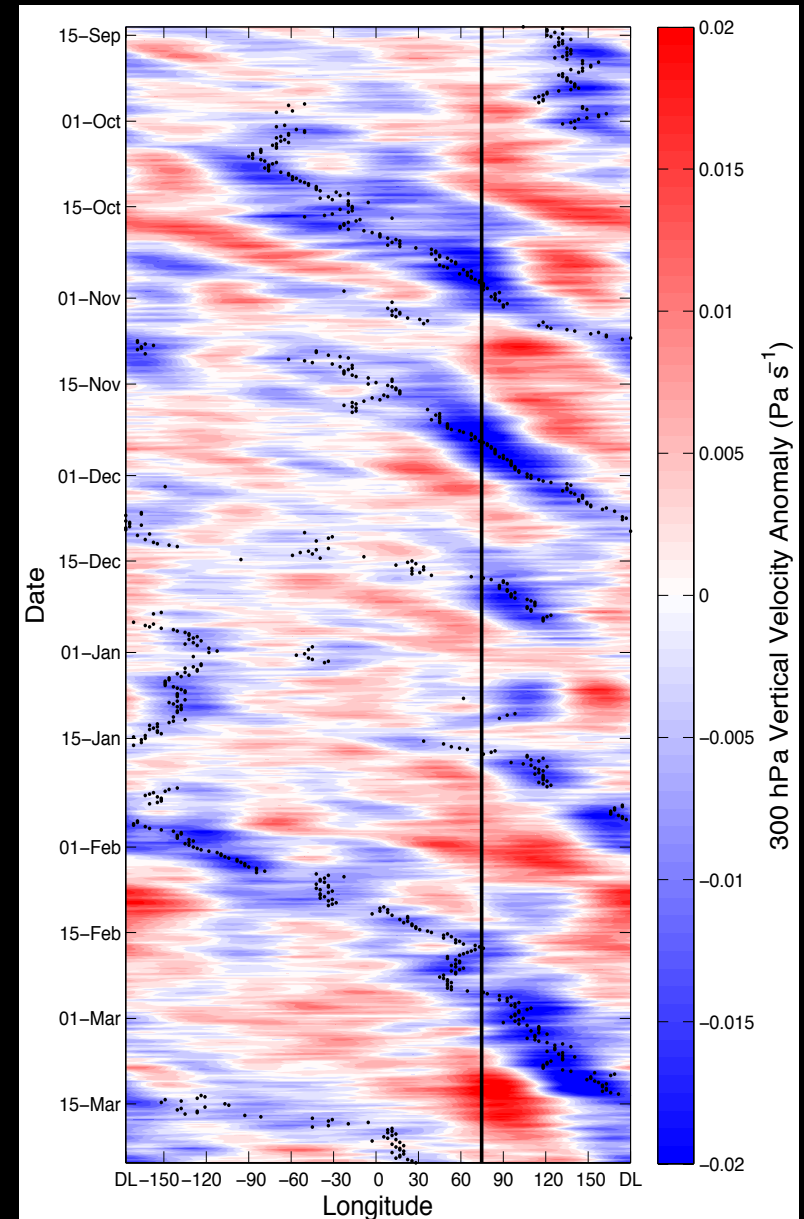
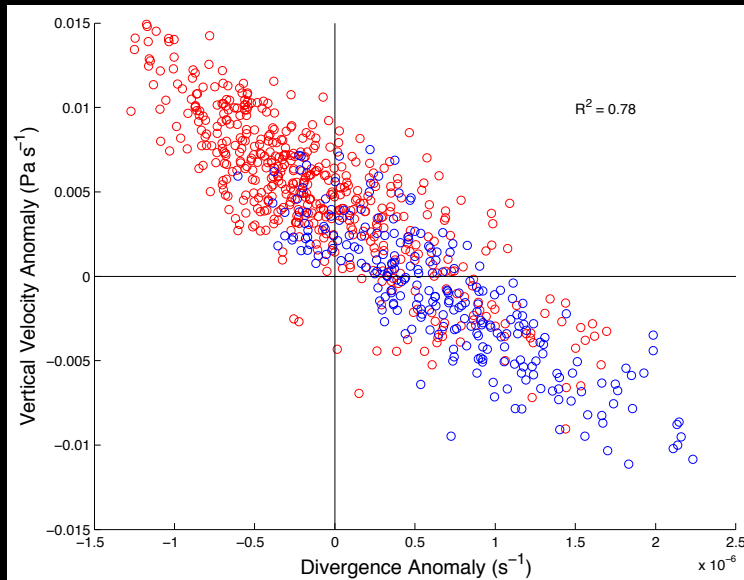




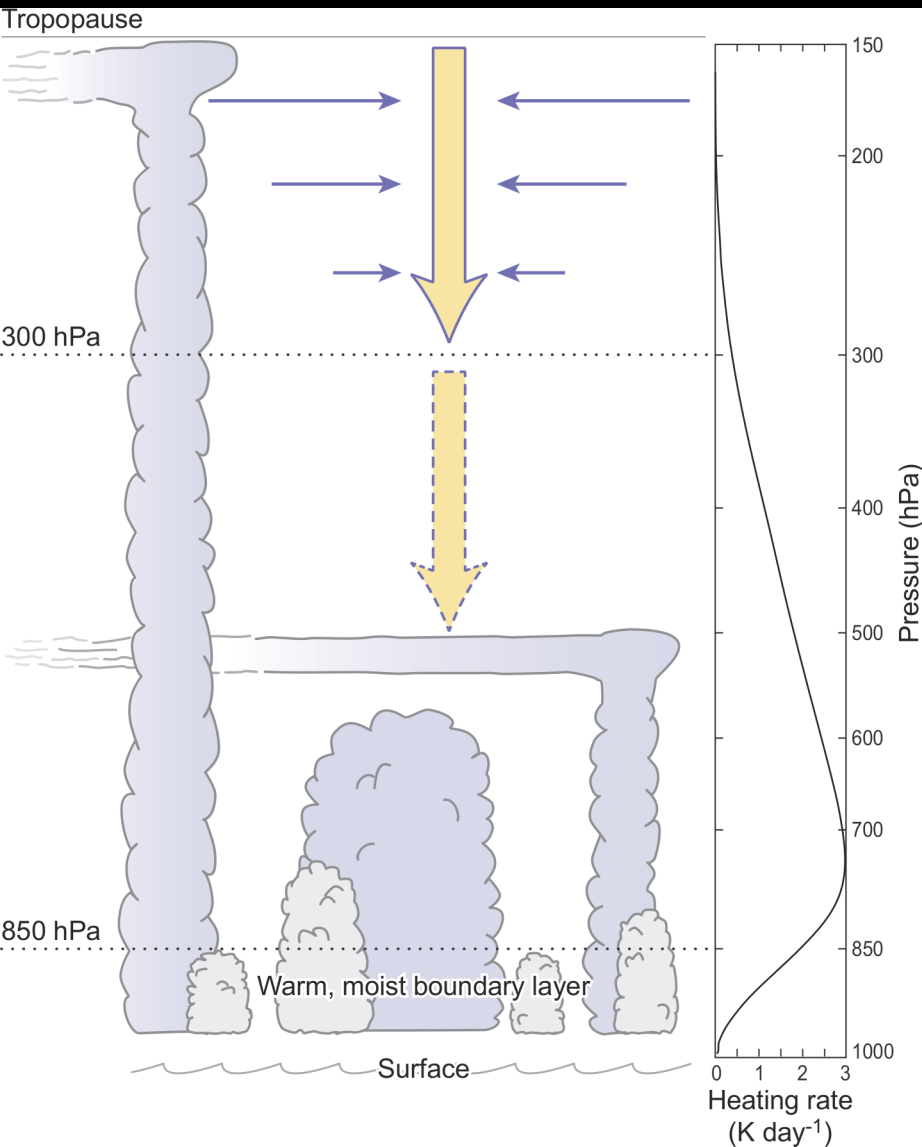
4. Periods of suppressed convection characterized by low-level upward motion. Enhanced convection occurs with upper-level upward motion.

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

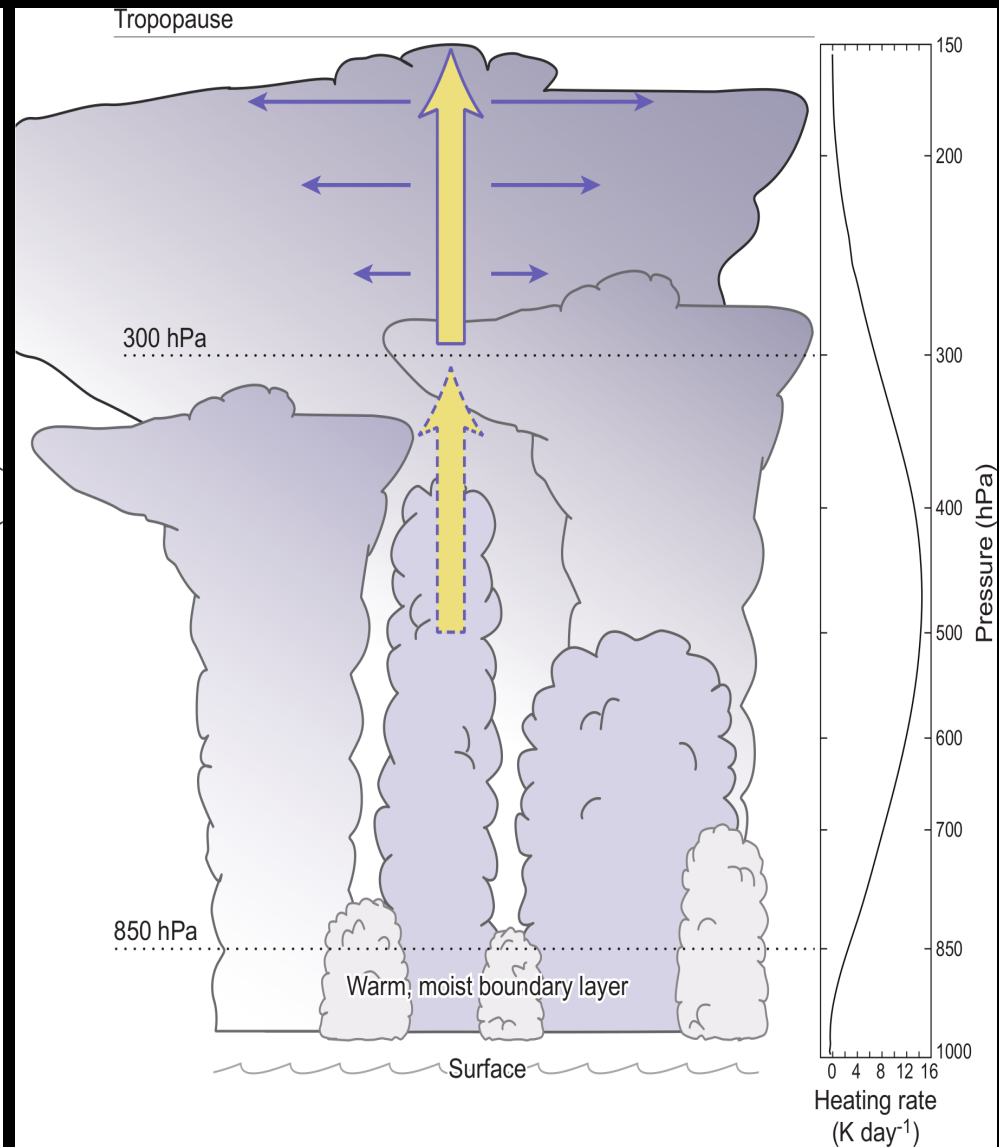
6. MJO convective onset occurs when UT downward motion anomaly moves out of Indian Ocean.



# Suppressed Convection

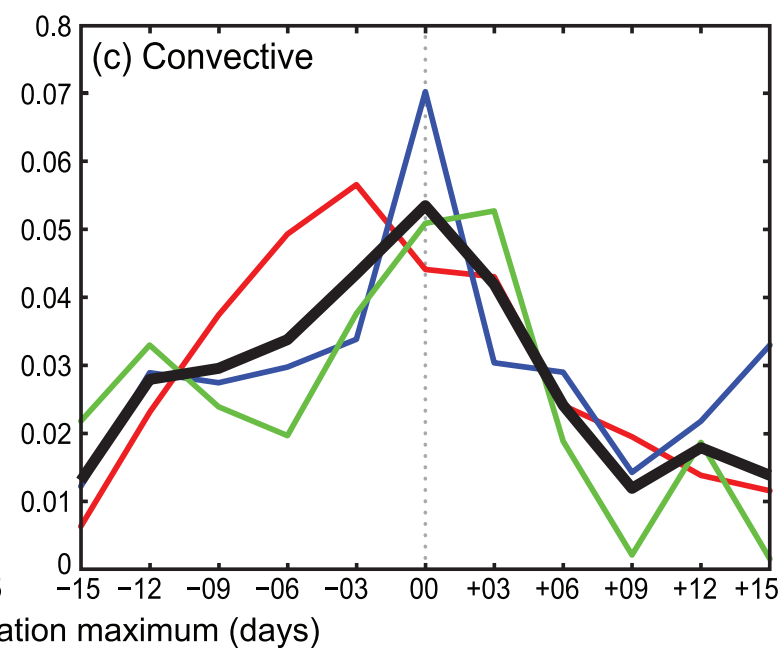
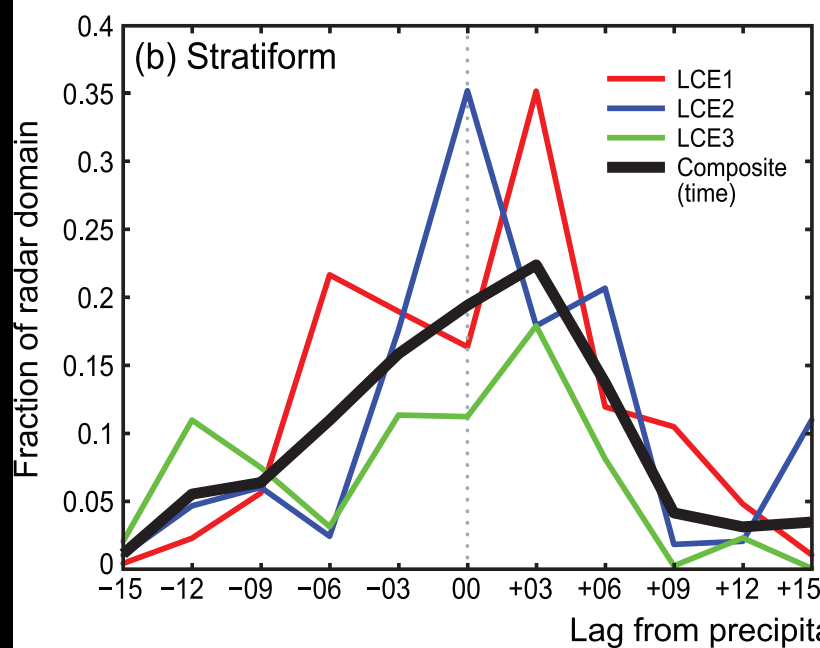
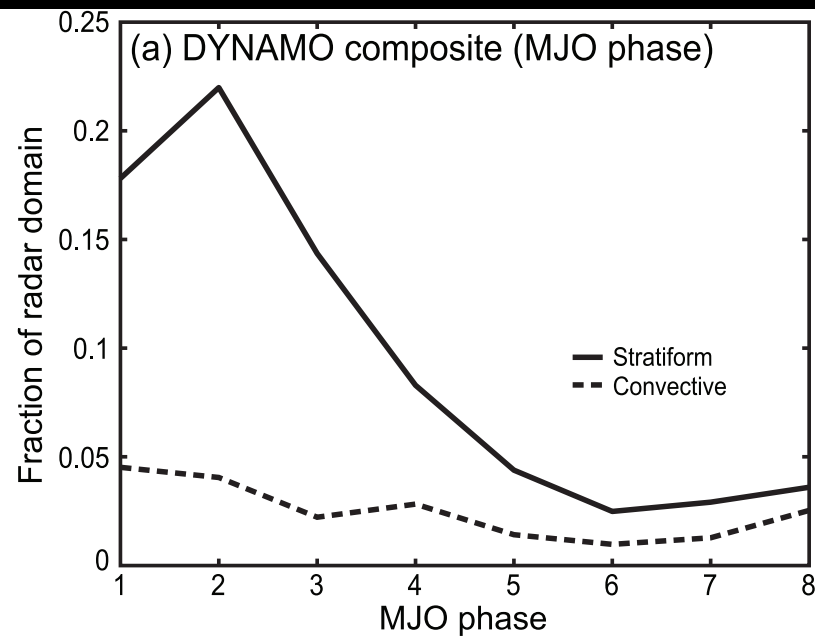


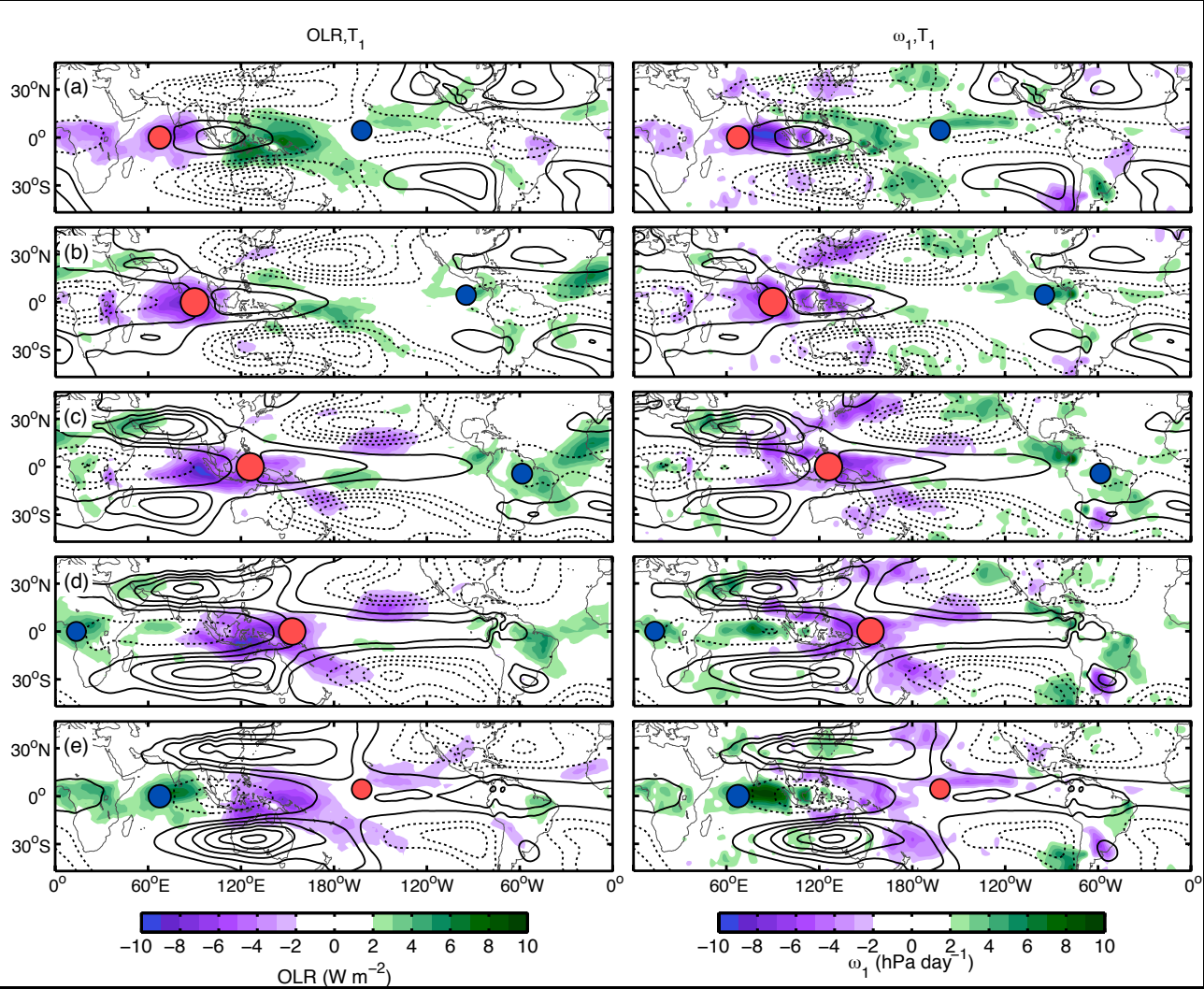
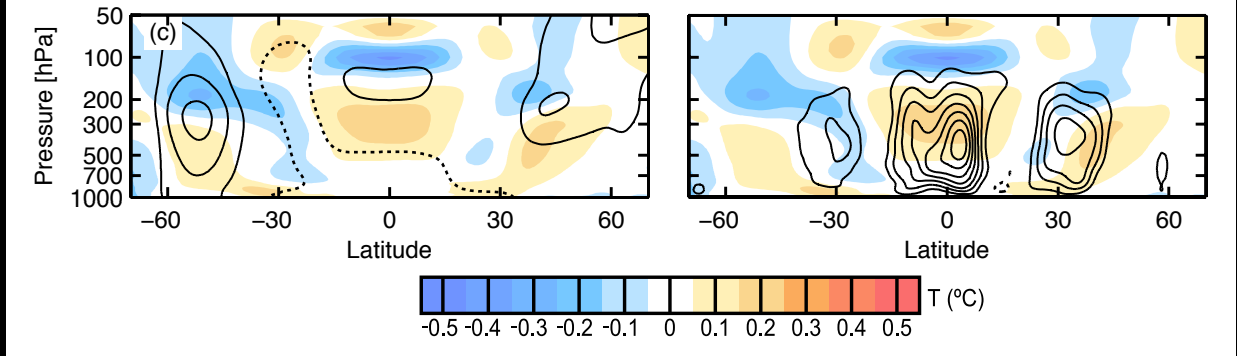
# Enhanced Convection



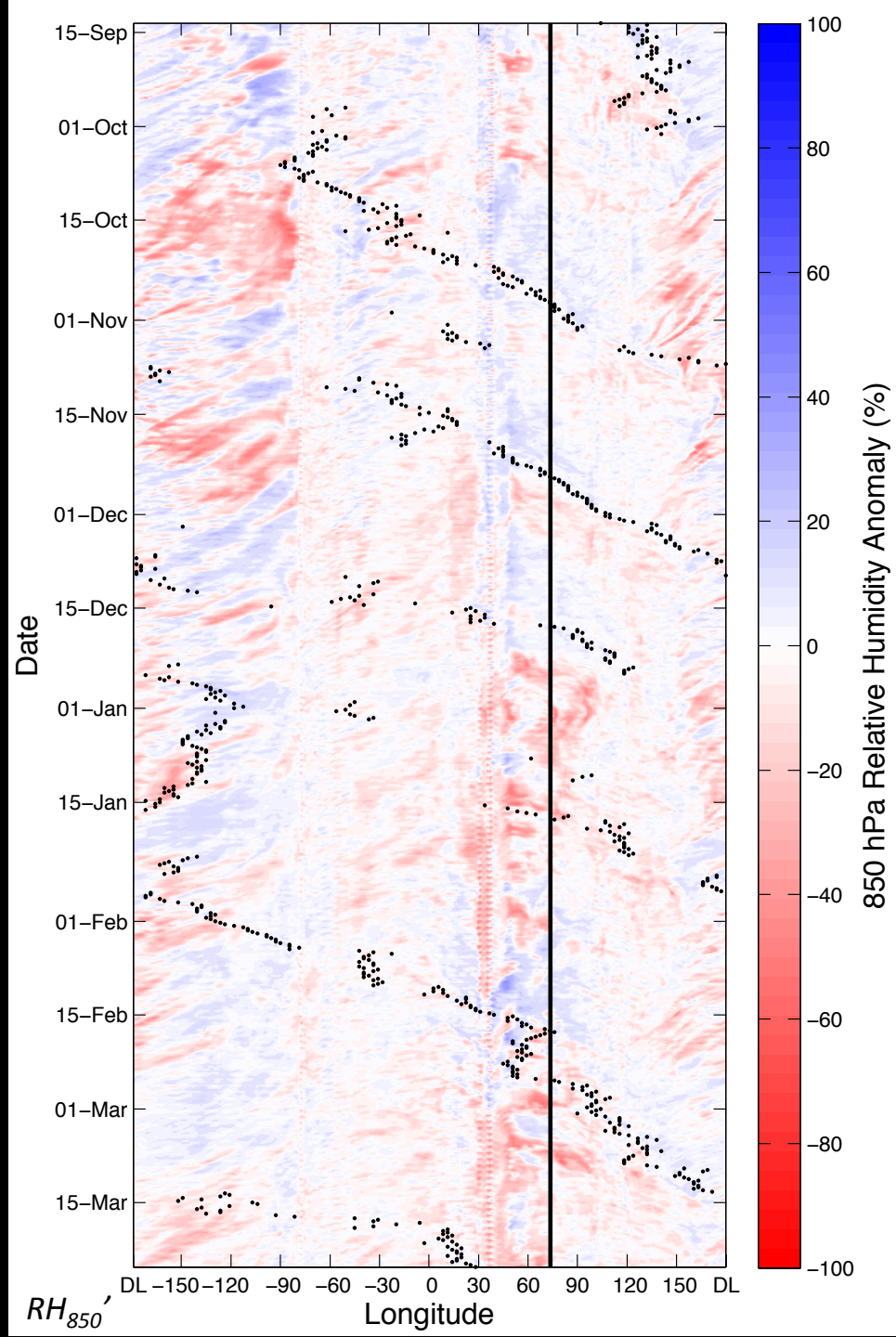


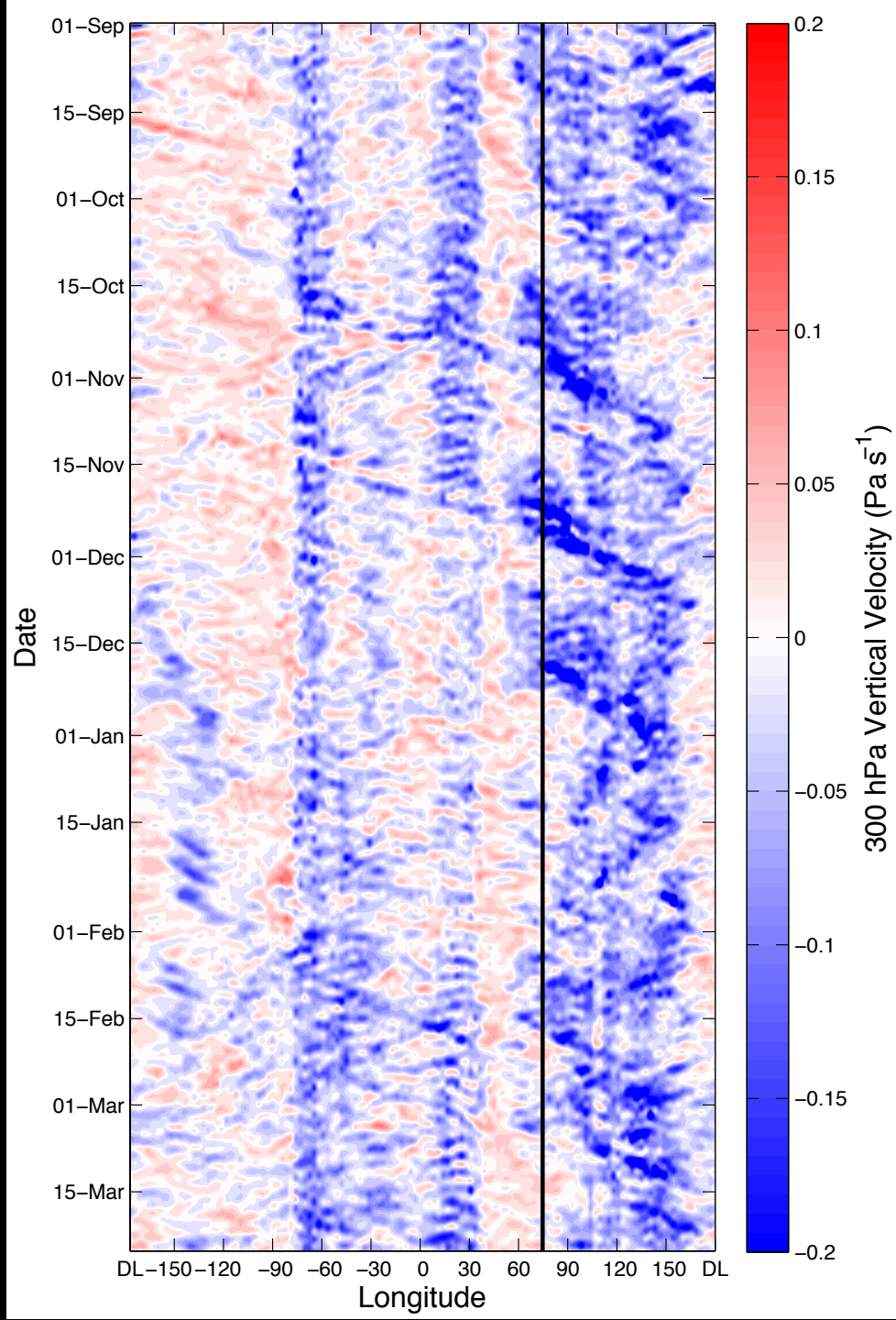
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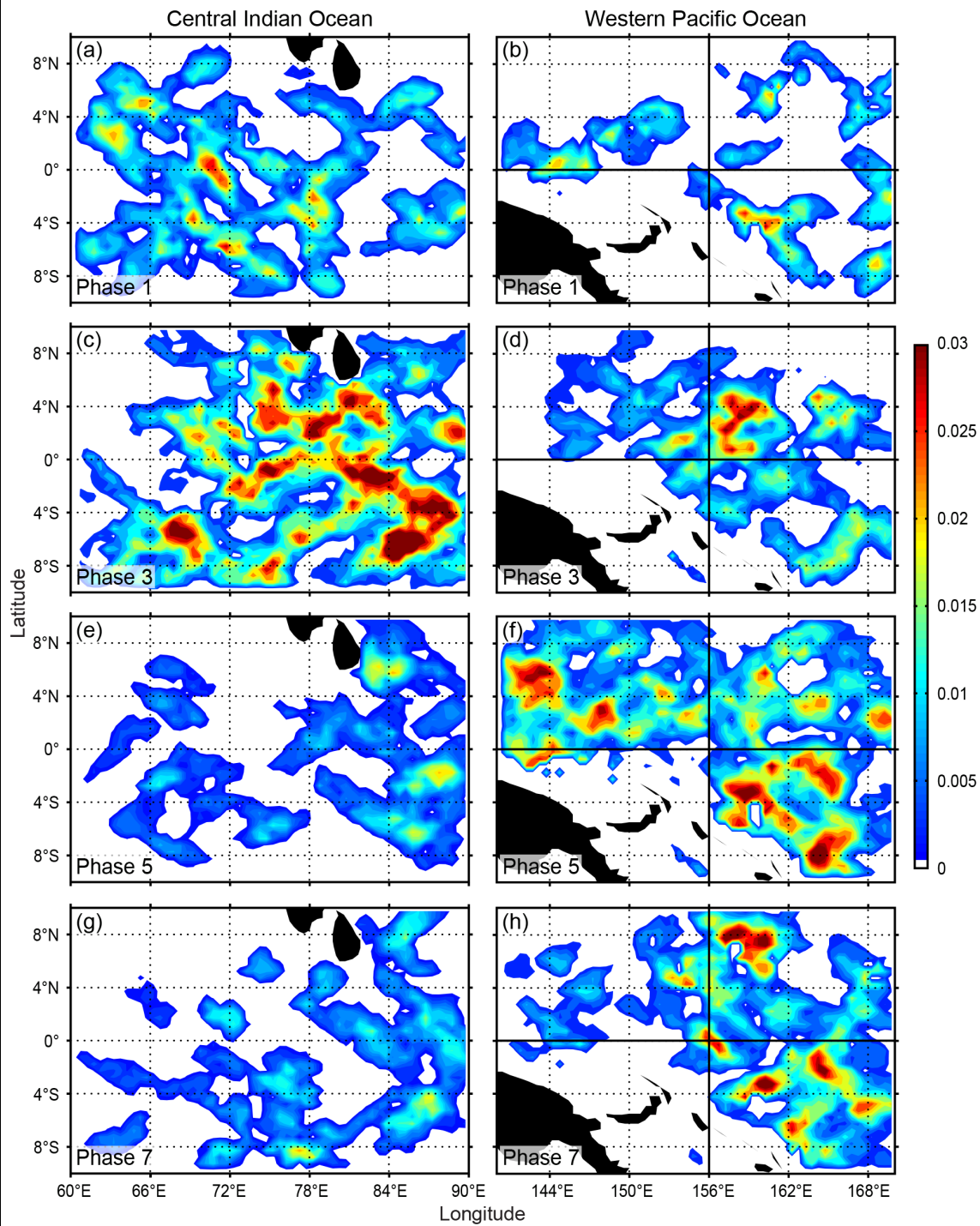




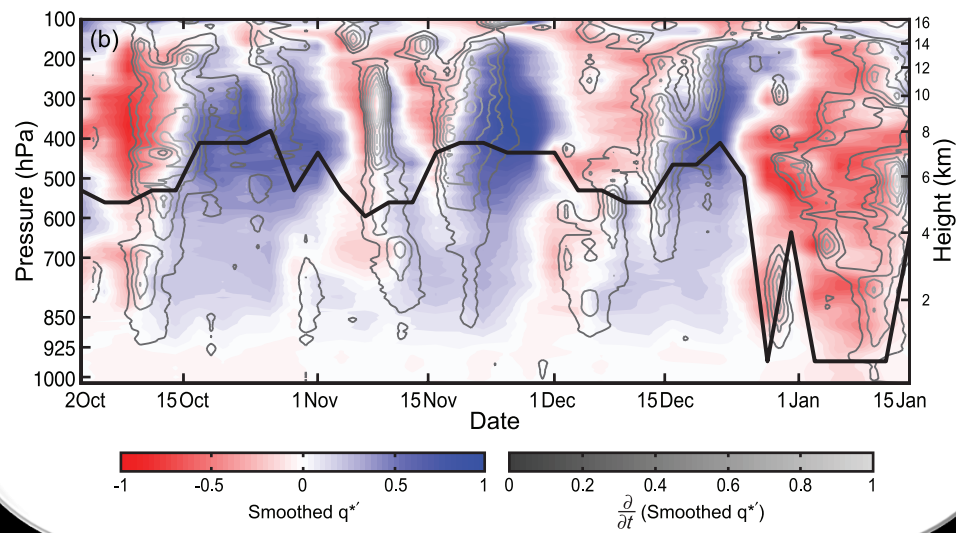
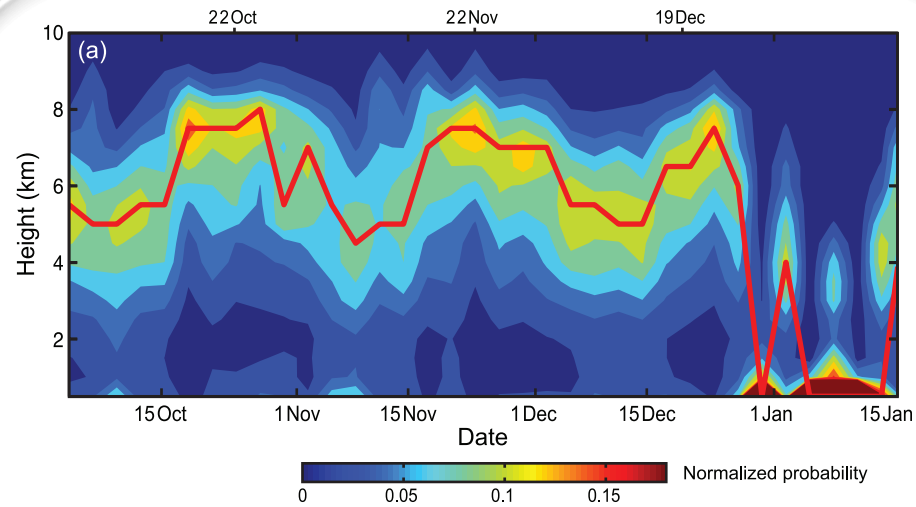


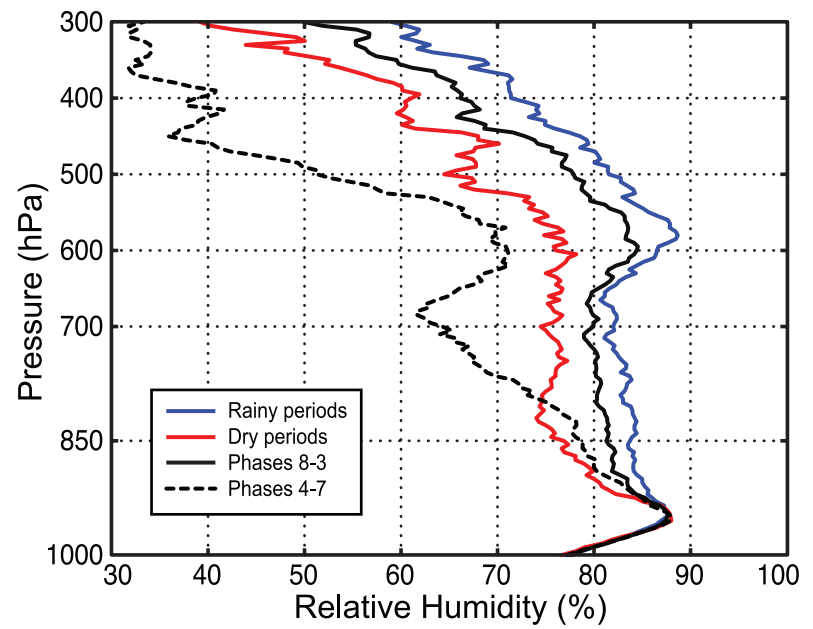
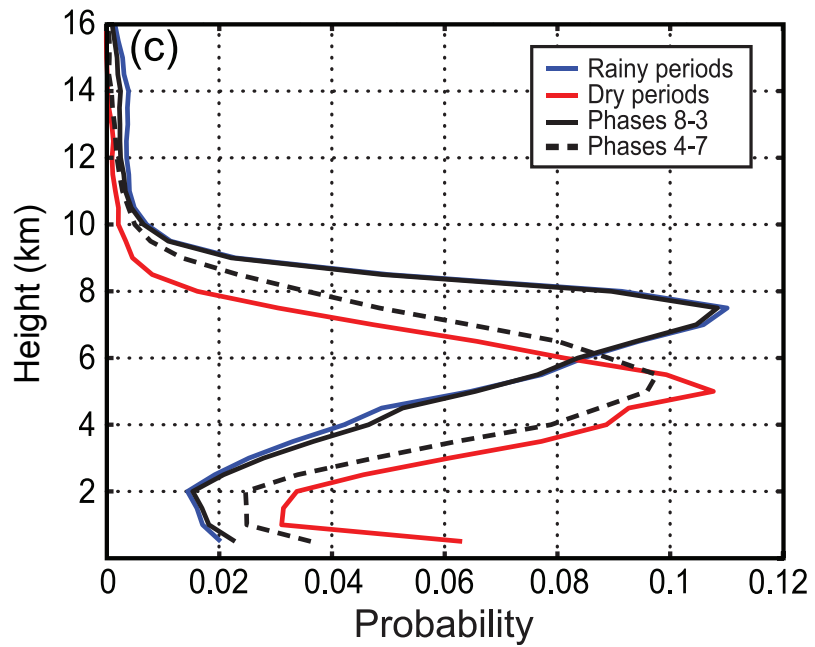


# Barnes and Houze (2013)









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

