

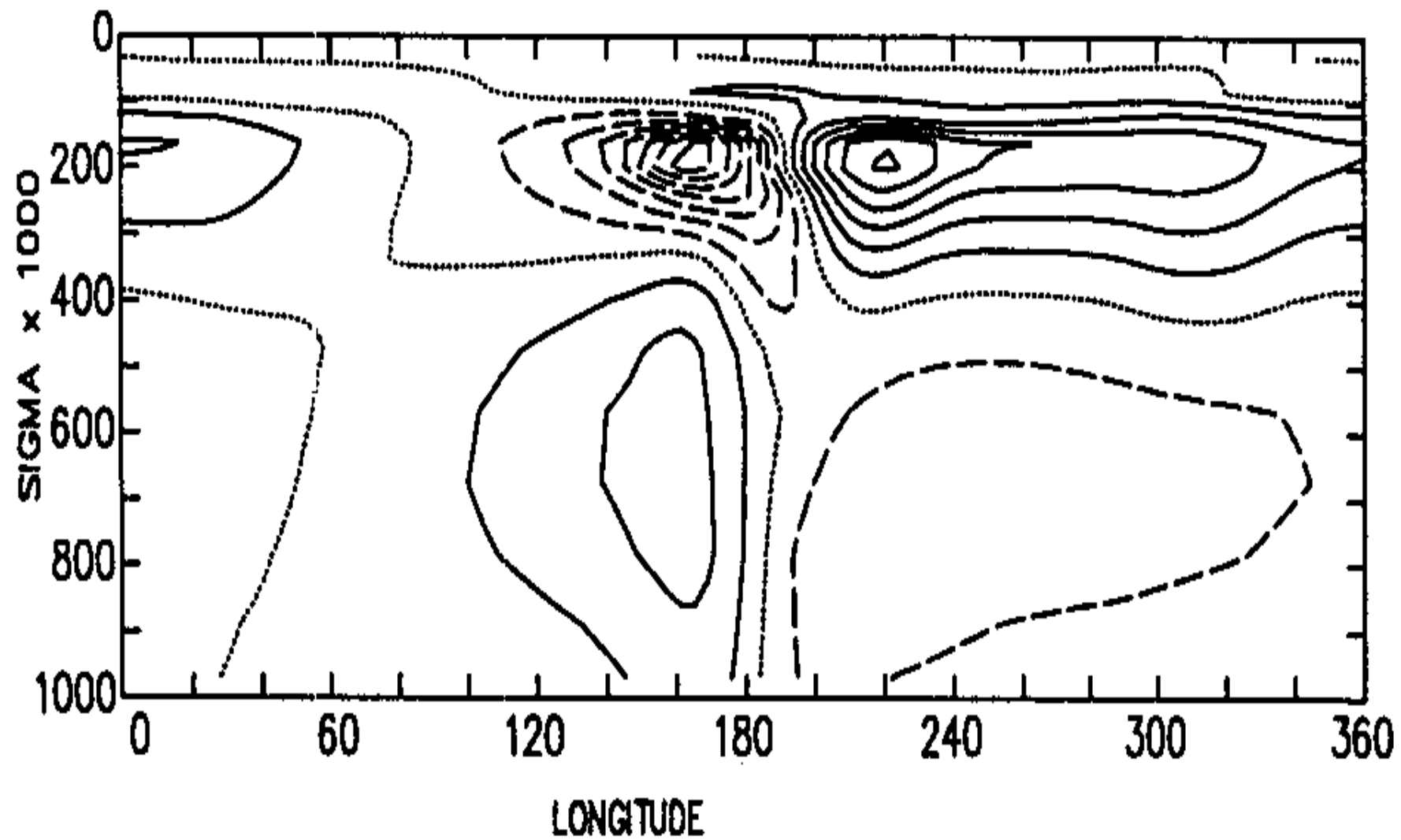
# EQUATORIAL ROSSBY WAVES, THE MADDEN JULIAN OSCILLATION, AND THEIR IMPACTS ON MONSOONS

PAUL E. ROUNDY

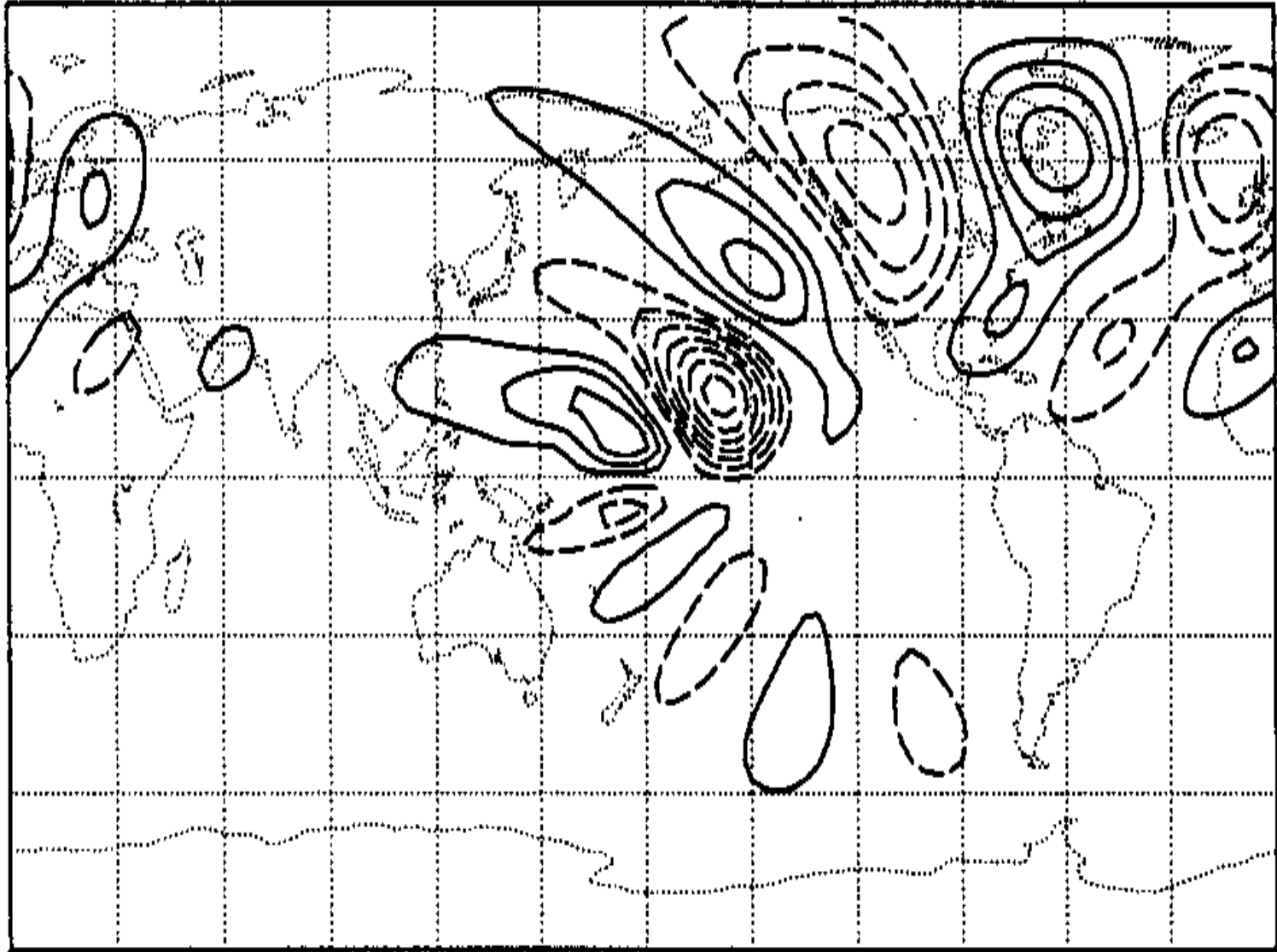
UNIVERSITY AT ALBANY, UNITED STATES

# INTRODUCTION

- The MJO and other subseasonal oscillations modulate eastward and poleward propagating break and active periods in monsoon regions
- Seasonally modified equatorial Rossby waves modulate westward and poleward-moving break and active regions
- Extratropical Rossby wave breaking is a major player relevant to both the impacts of the MJO and equatorial Rossby waves on monsoons



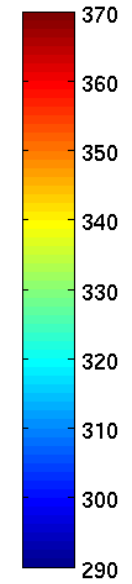
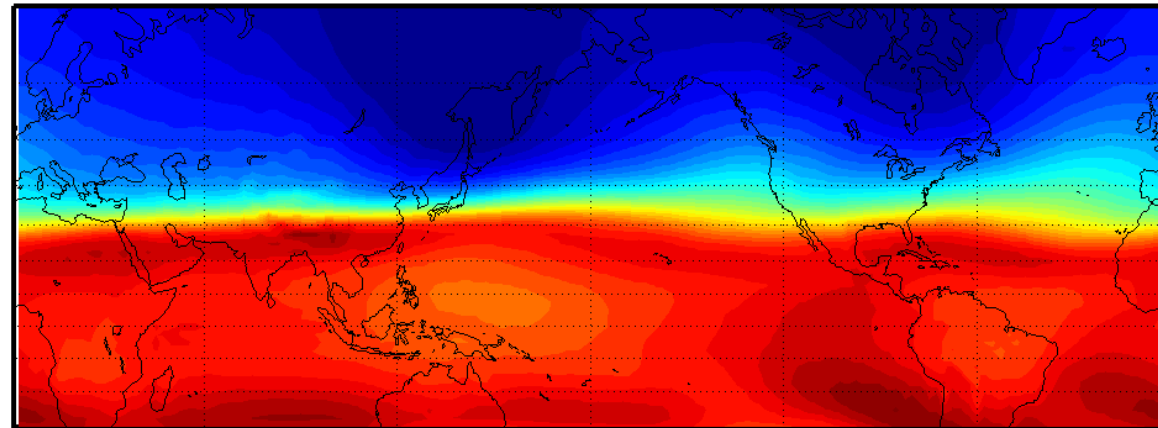
Jin and Hoskins (1995)



# THE MJO AND ER WAVES AND EXTRA TROPICAL WAVE BREAKING

- For this illustration, Focus Northern Winter
- Identify those events that include central Pacific wave breaking when MJO convection is over the eastern Indian Ocean
- Compare progression of events with wave breaking to events without
  - MacRitchie and Roundy (2016)

Potential Temperature on the Tropopause, Northern Winter



Potential Temperature on the Tropopause, Northern Winter

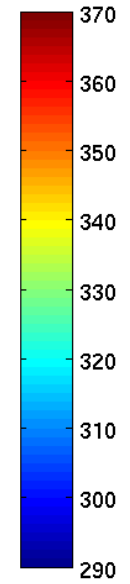
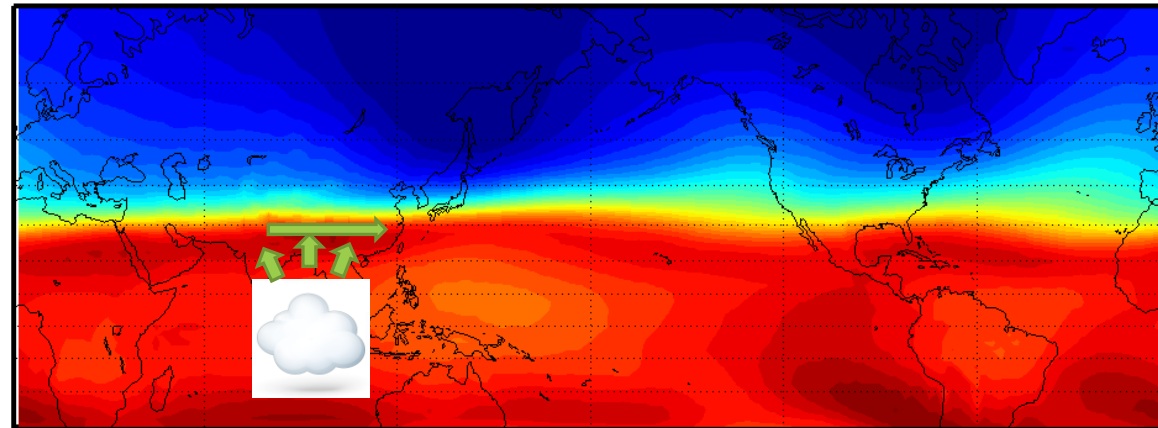


Figure 12. Figure 9 from Moore et al. [2010] showing how the MJO induces AWB.

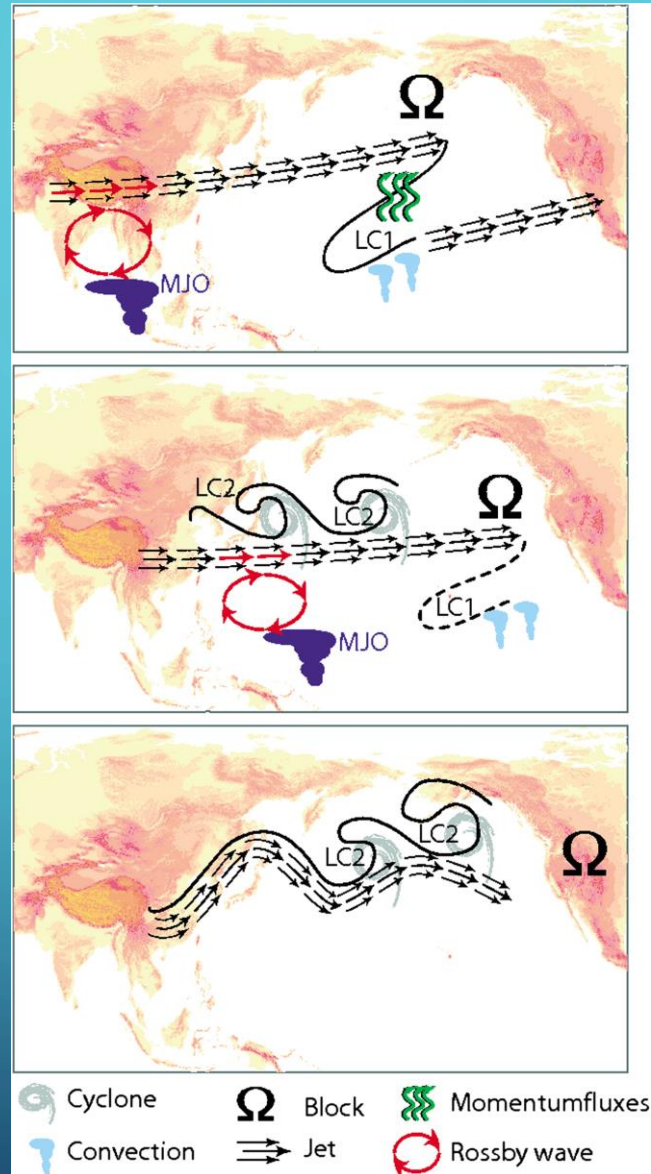
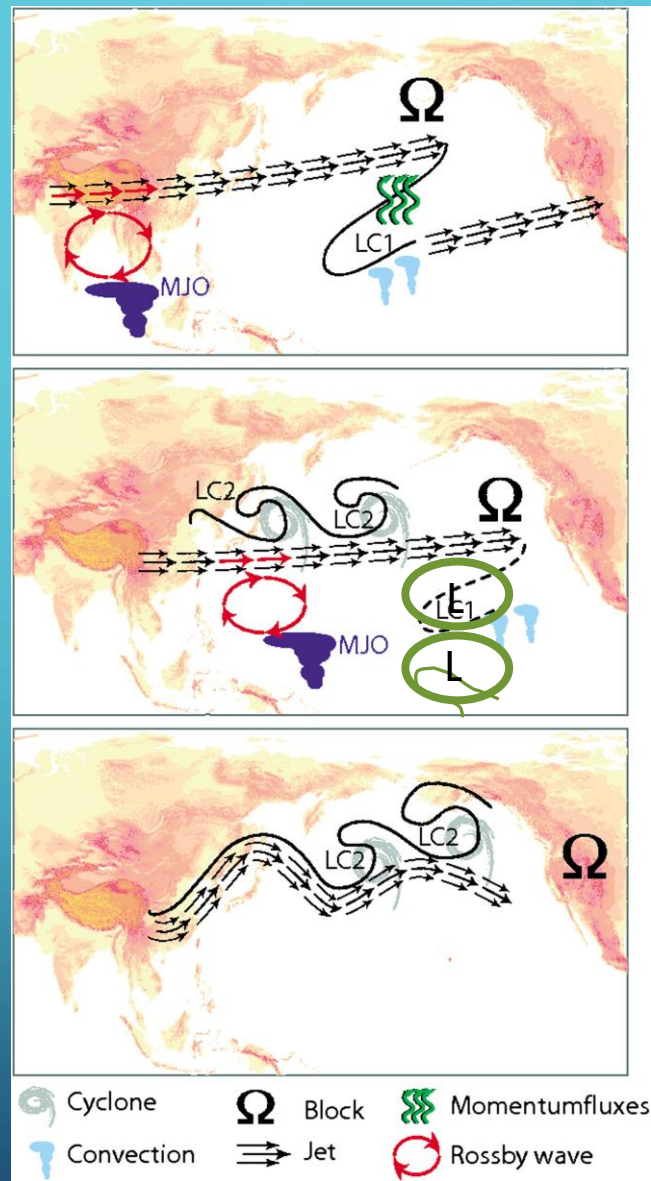




Figure 12. Figure 9 from Moore et al. [2010] showing a schematic of the way in which the MJO induces AWB. ©American Meteorological Society.



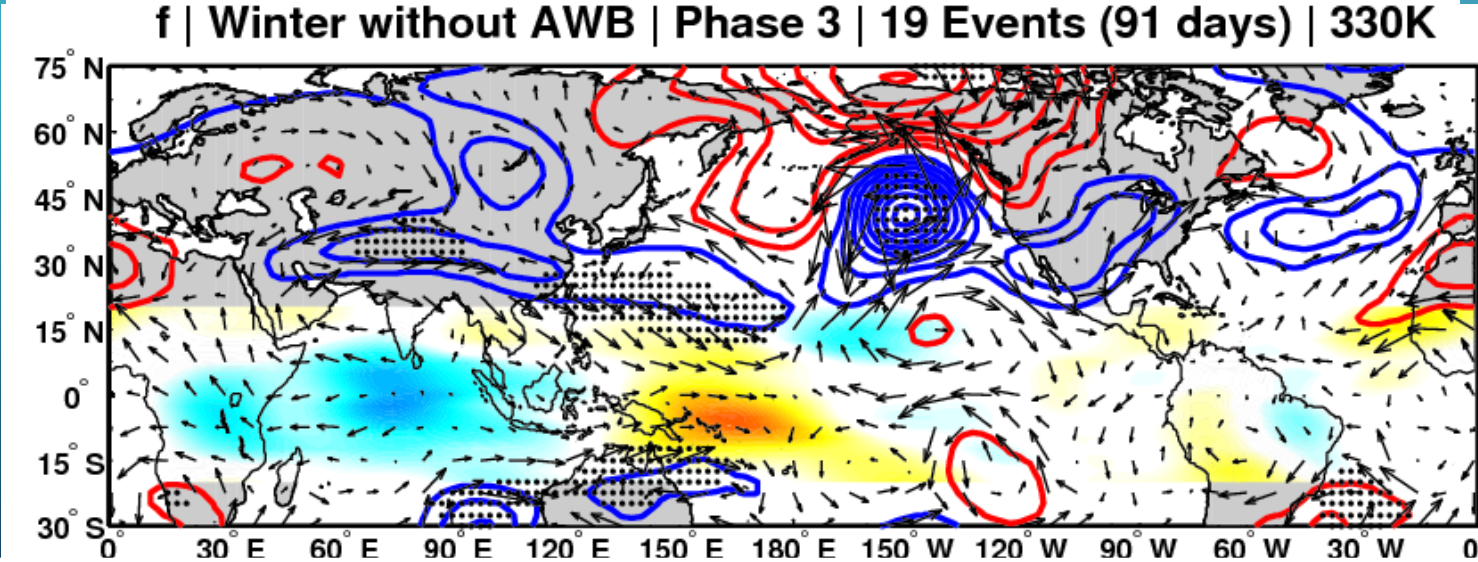
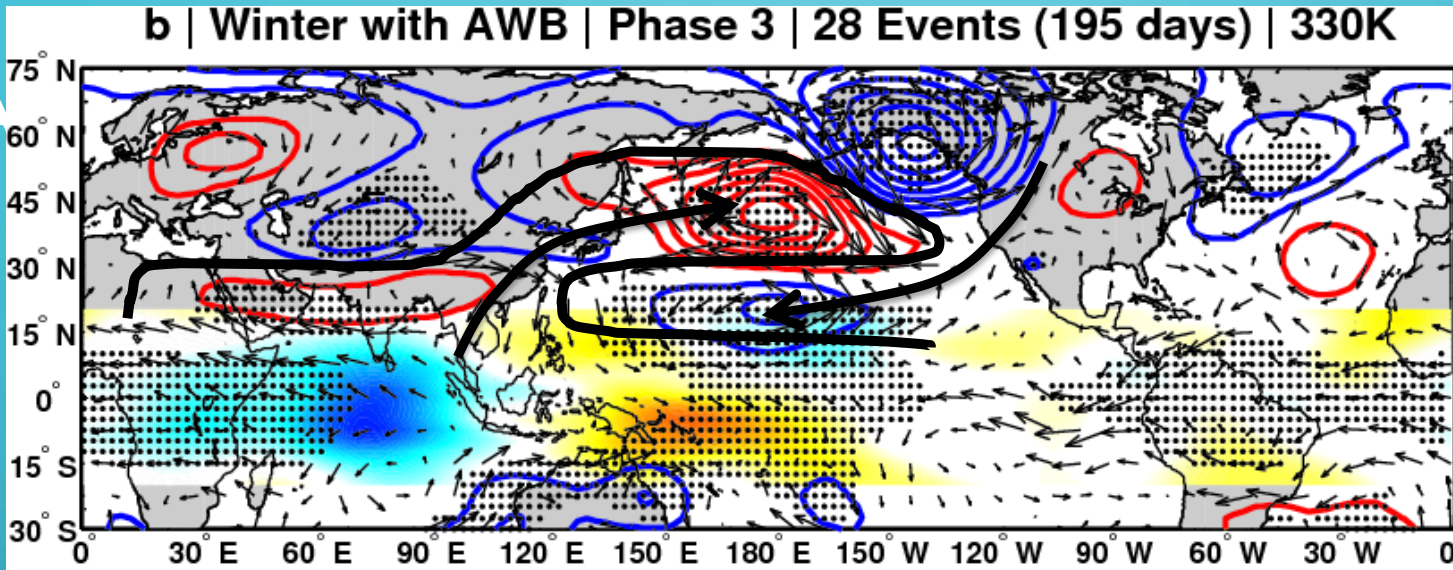
Equatorial Rossby wave

From MacRitchie and Roundy (2016, QJRMS)

PHA

RMM Amp:  
1.85

RMM Amp:  
1.27



Positive Height Anomalies (15 m):

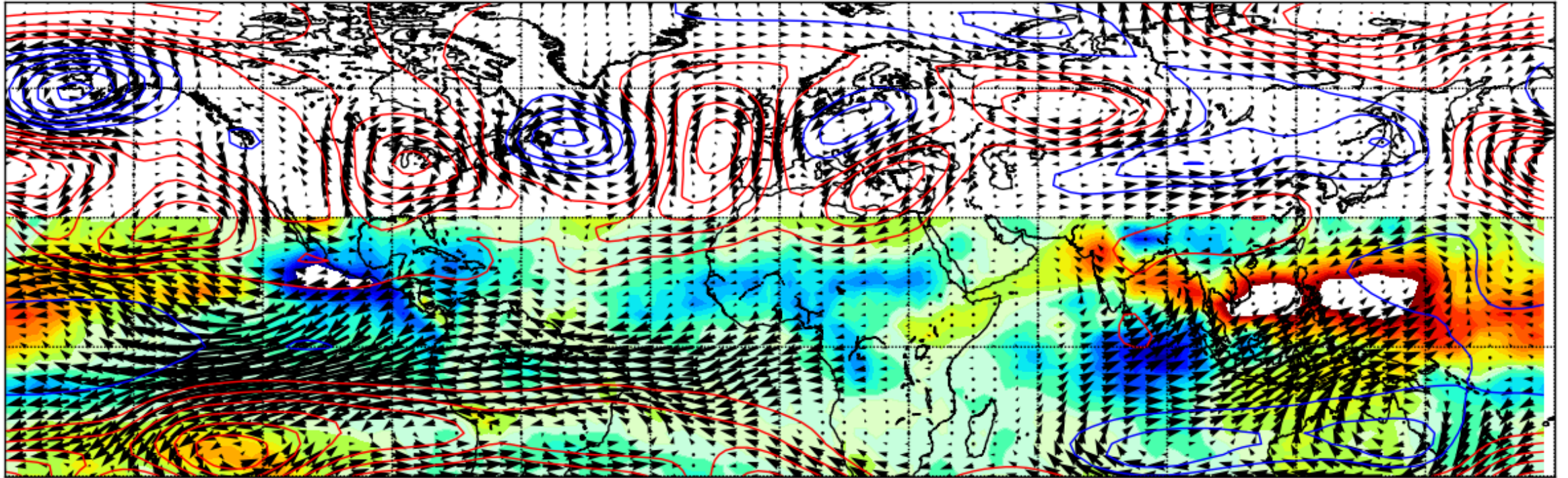
Negative Height Anomalies (15 m):

OLR Anomalies:

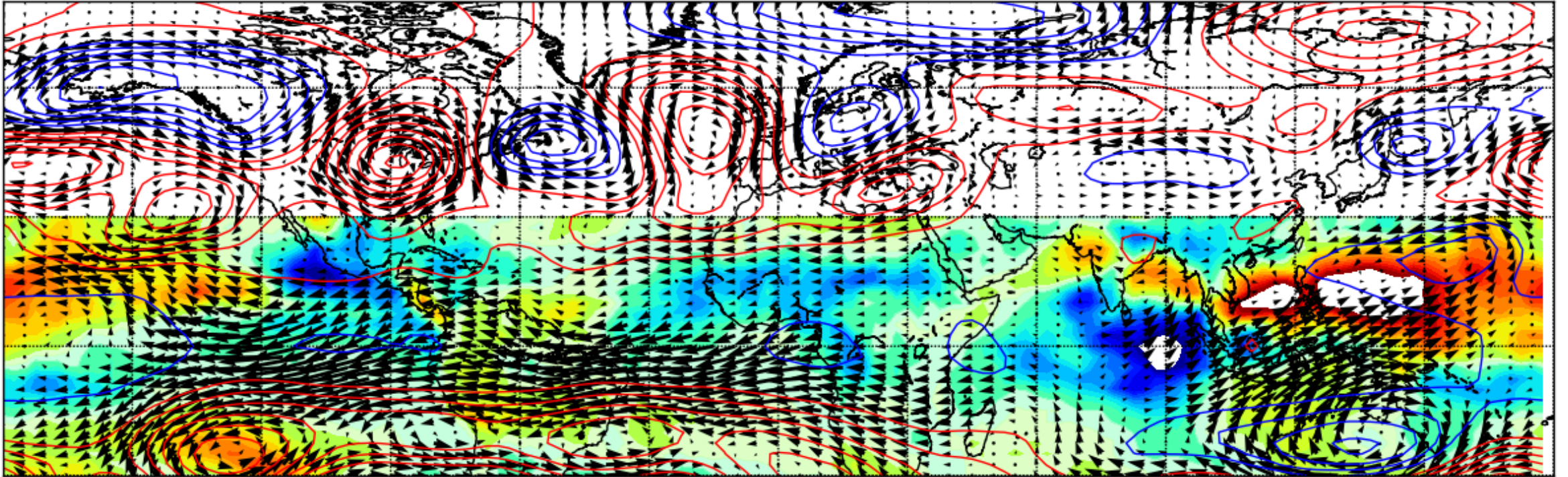
# RECONSTRUCT GENERALIZED NORTHERN SUMMER MJO AND EQUATORIAL ROSSBY WAVE CYCLE

- Follow Roundy (2017 QJRMS), Method of Seasonally Varying Regression Slope Coefficients
- Method allows us to diagnose the global atmospheric circulation patterns associated with MJO indices as a continuous function of the seasonal cycle.
- Results here are based on the RMM index of Wheeler and Hendon, and on the first two PCs of equatorial Rossby-filtered OLR anomaly.

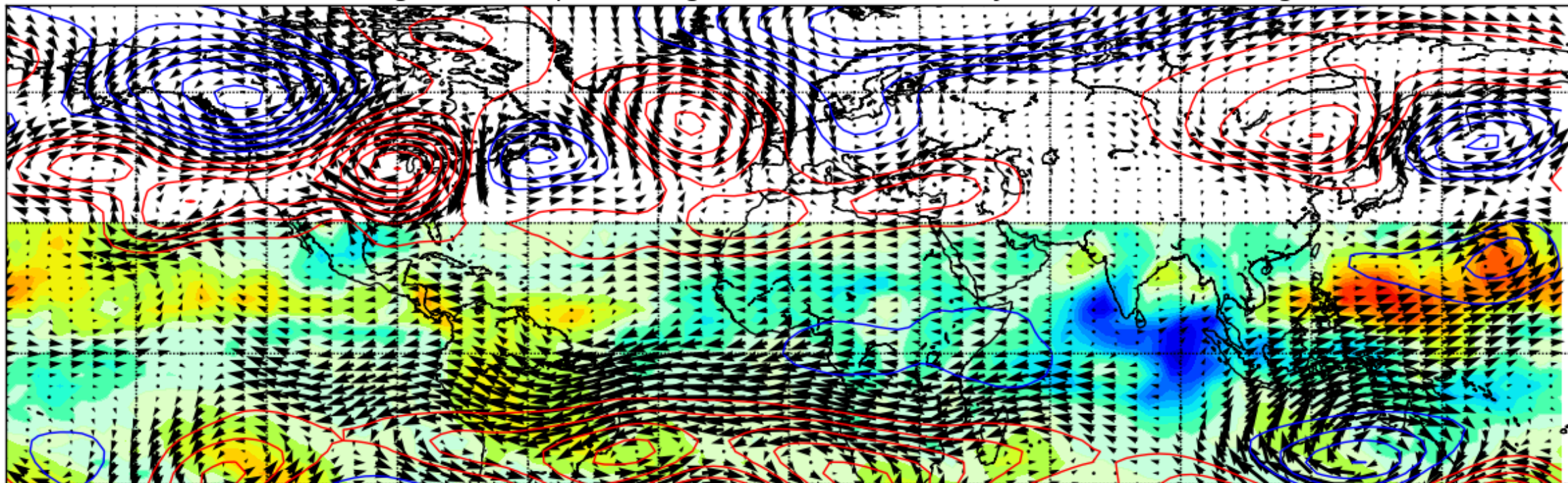
RMM Regression Map 200 Height (2 SDs) Phase 1 day 220 week 31,09-Aug



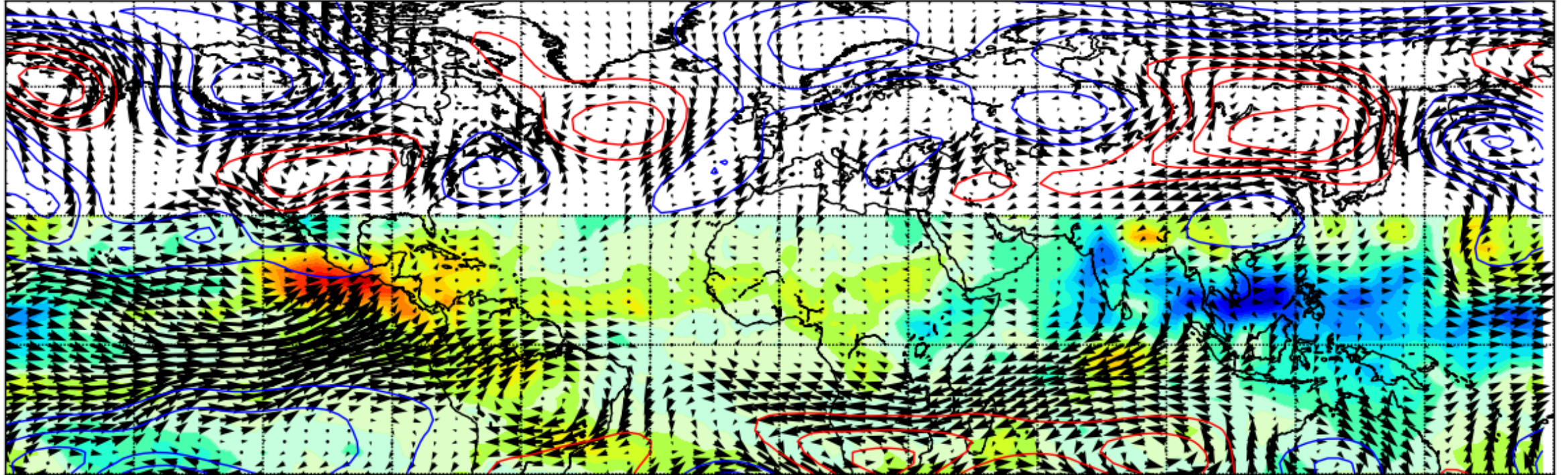
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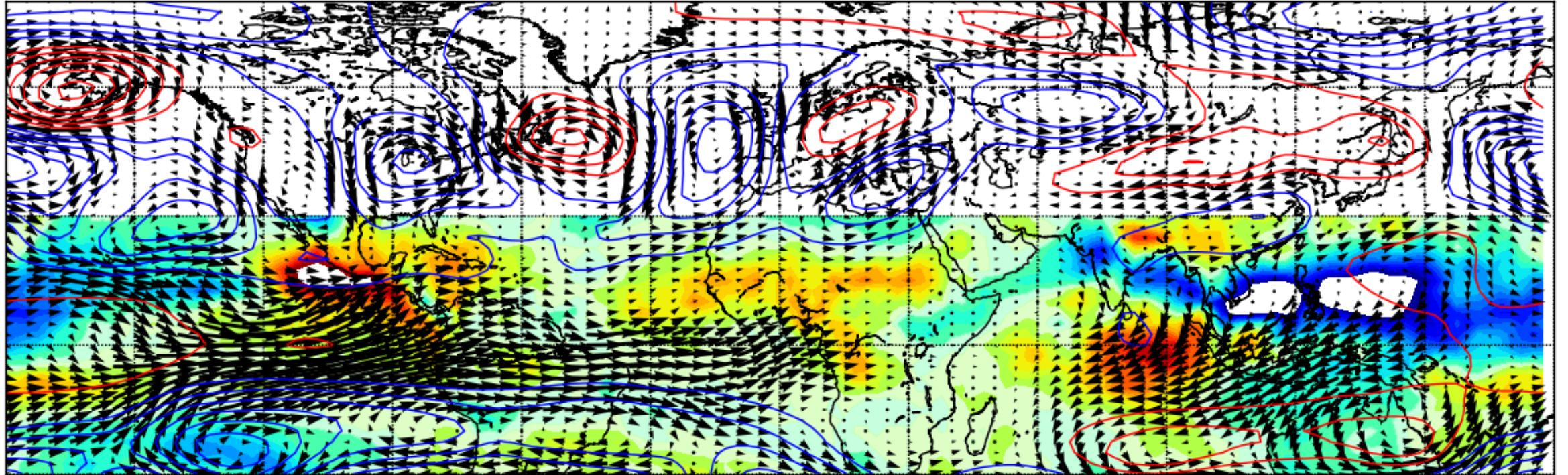
RMM Regression Map 200 Height (2 SDs) Phase 3 day 220 week 31,09-Aug



RMM Regression Map 200 Height (2 SDs) Phase 4 doy 220 week 31,09-Aug

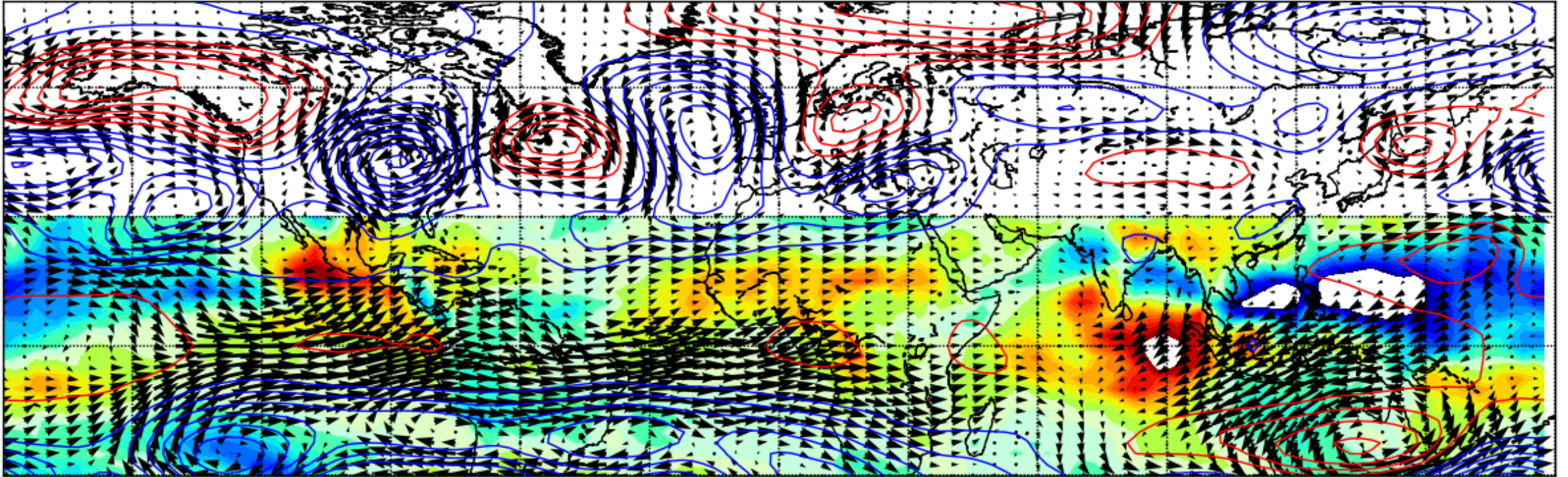


RMM Regression Map 200 Height (2 SDs) Phase 5 doy 220 week 31,09-Aug





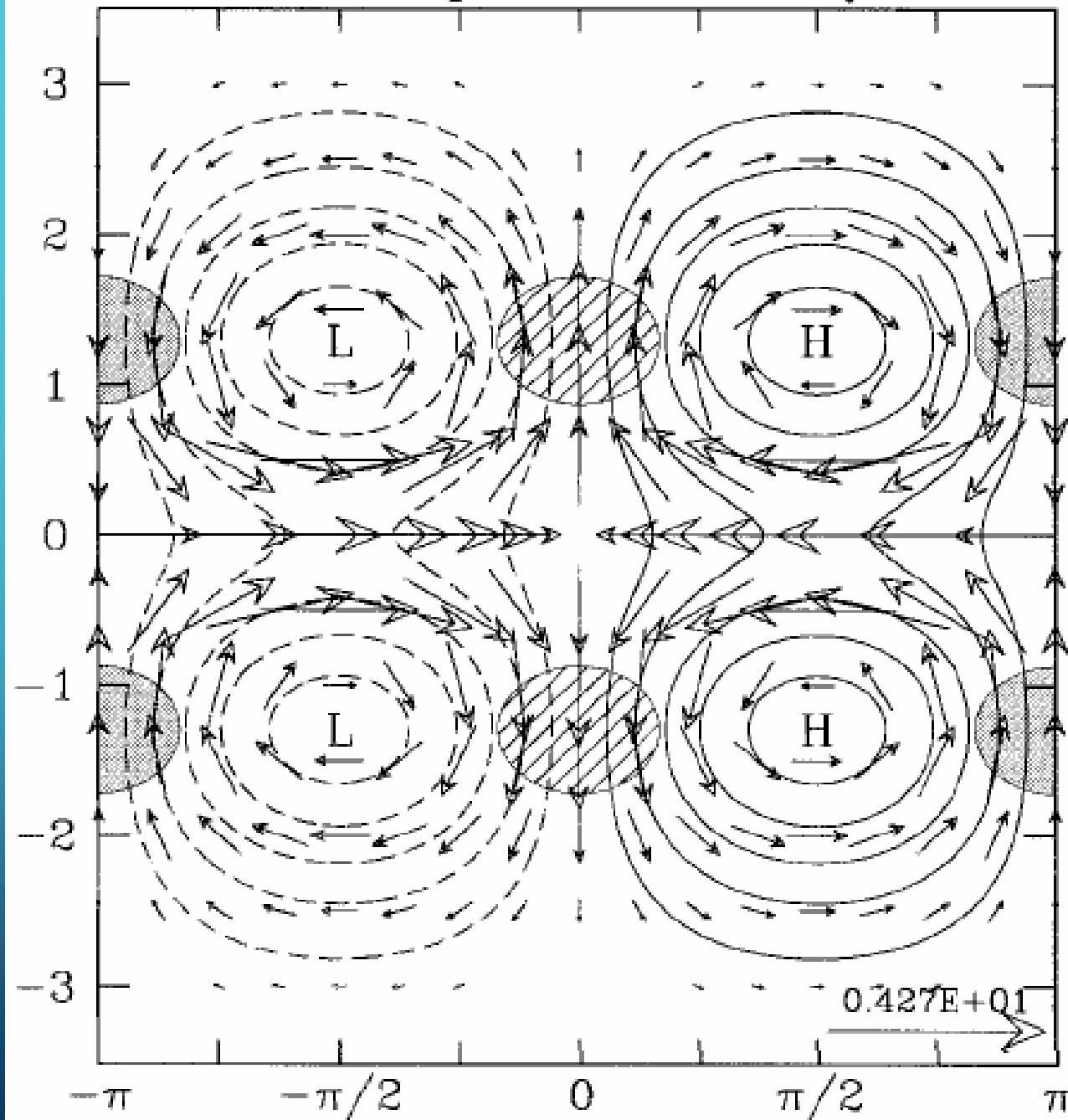
RMM Regression Map 200 Height (2 SDs) Phase 6 doy 220 week 31,09-Aug



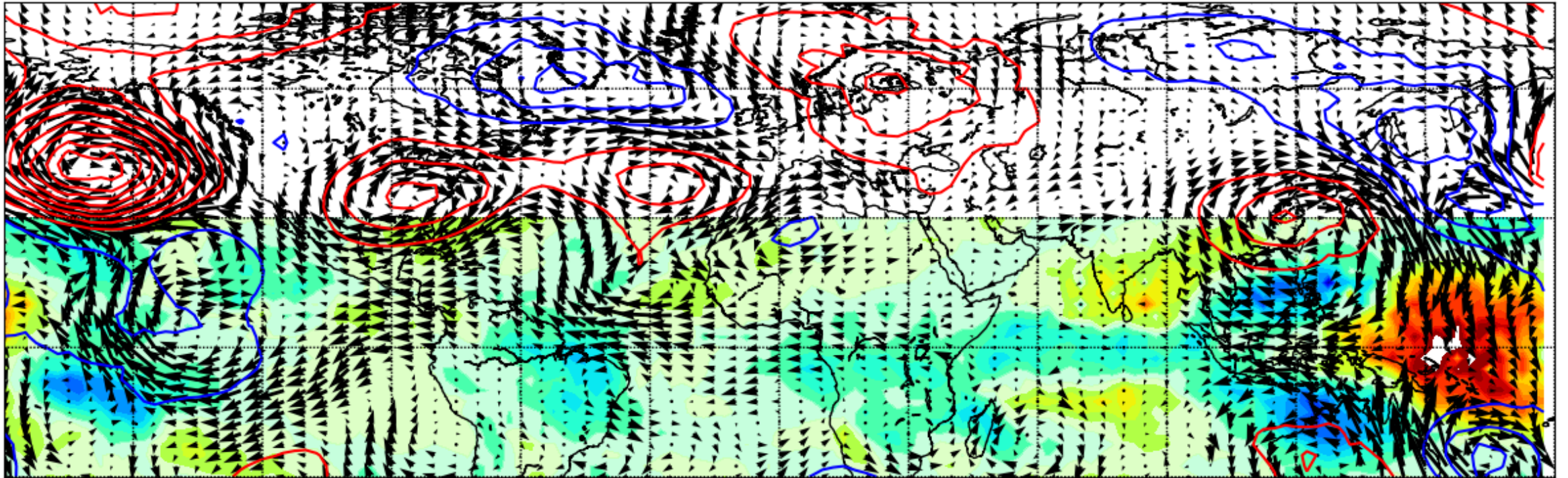
# ROLE OF EQUATORIAL ROSSBY WAVES

- Wang and Xie (1997, J. Atmos. Sci) showed one mechanism of the northern summer MJO is eastward propagation along the equator, then with equatorial Rossby waves shed westward from the Pacific MJO
- The present work suggests that such ER waves can also emerge due to tropical extratropical interaction

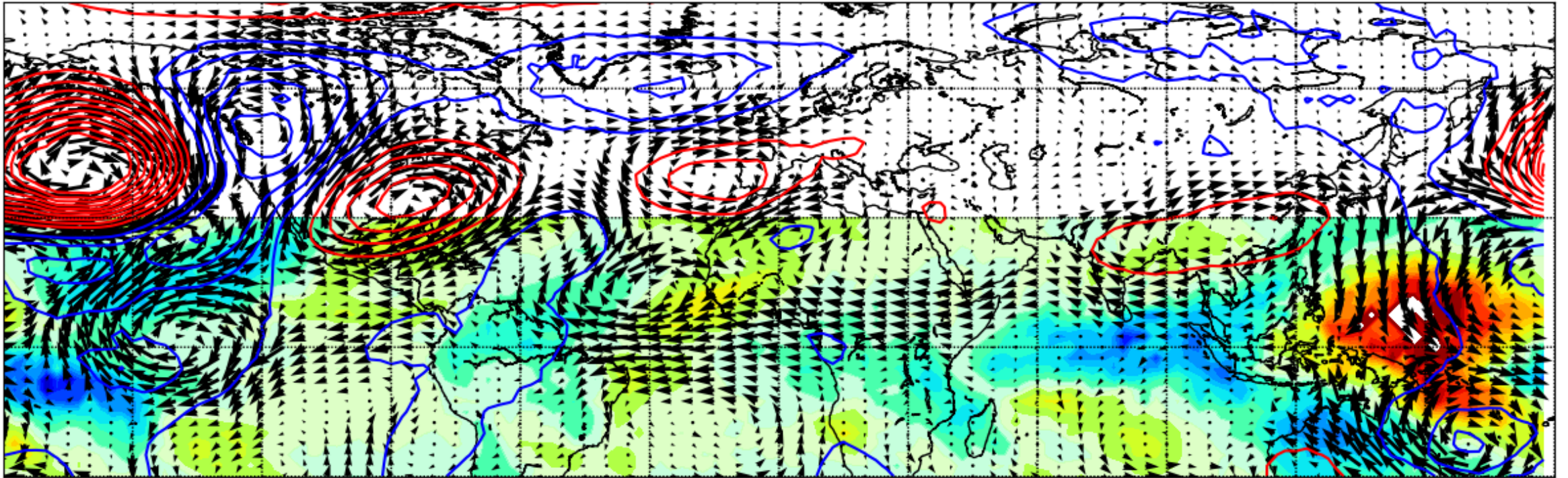
$n=1, k^*=1$ , Equatorial Rossby



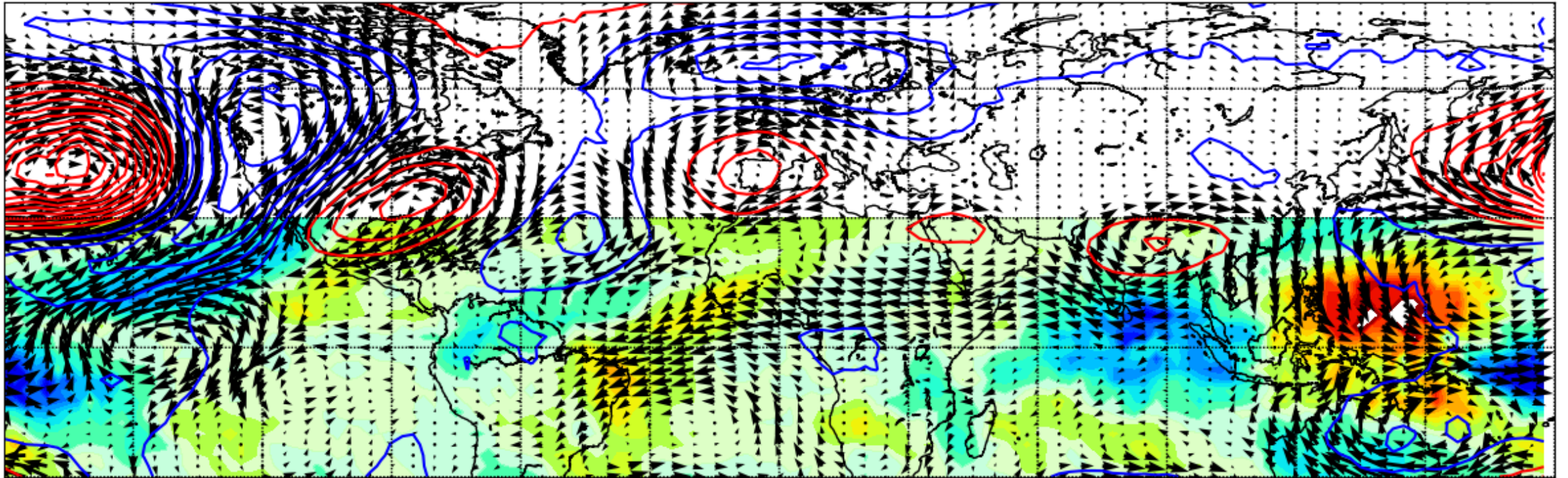
RMM Regression Map 200 Height (2 SDs) Phase 1 day 10 week 1,11-Jan



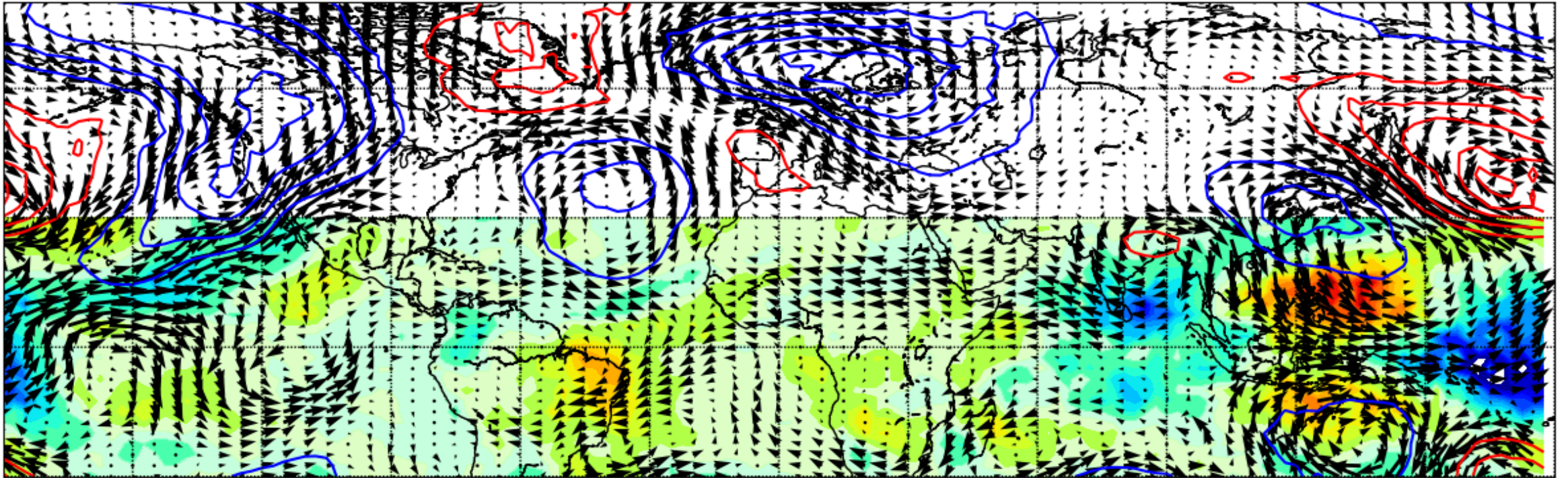
RMM Regression Map 200 Height (2 SDs) Phase 2 day 10 week 1,11-Jan



RMM Regression Map 200 Height (2 SDs) Phase 3 day 10 week 1,11-Jan



RMM Regression Map 200 Height (2 SDs) Phase 4 day 10 week 1,11-Jan

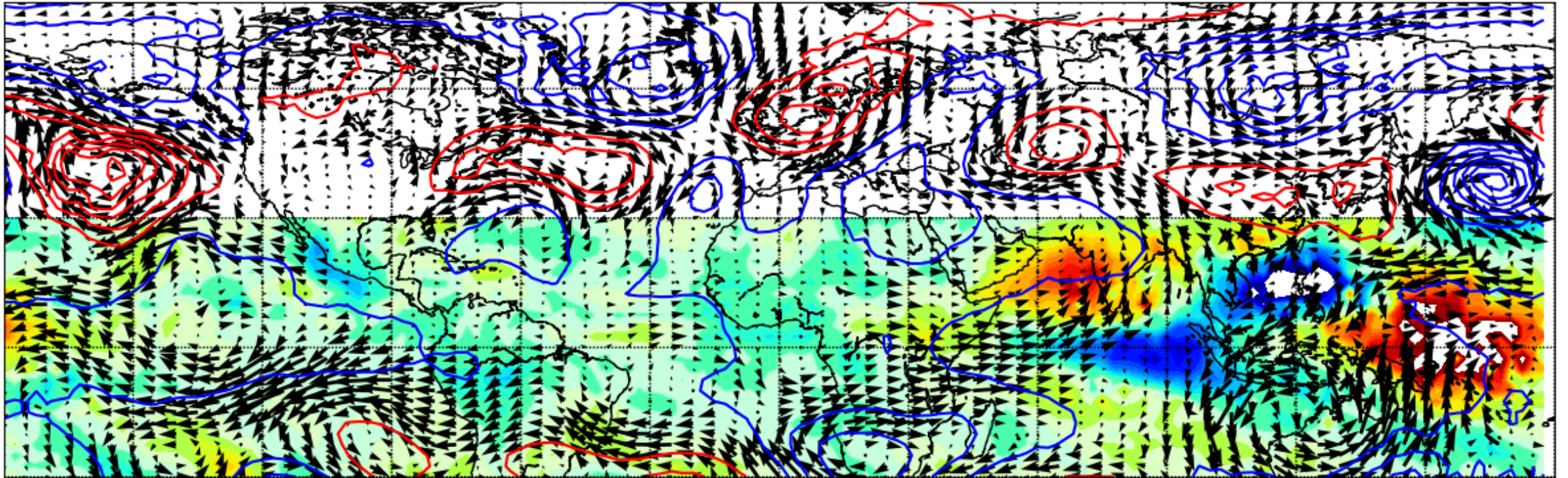


The background is a solid teal color with a subtle gradient. In the four corners, there are decorative white line-art elements resembling circuit traces or a stylized tree structure. These elements consist of thin lines that branch out and terminate in small circles.

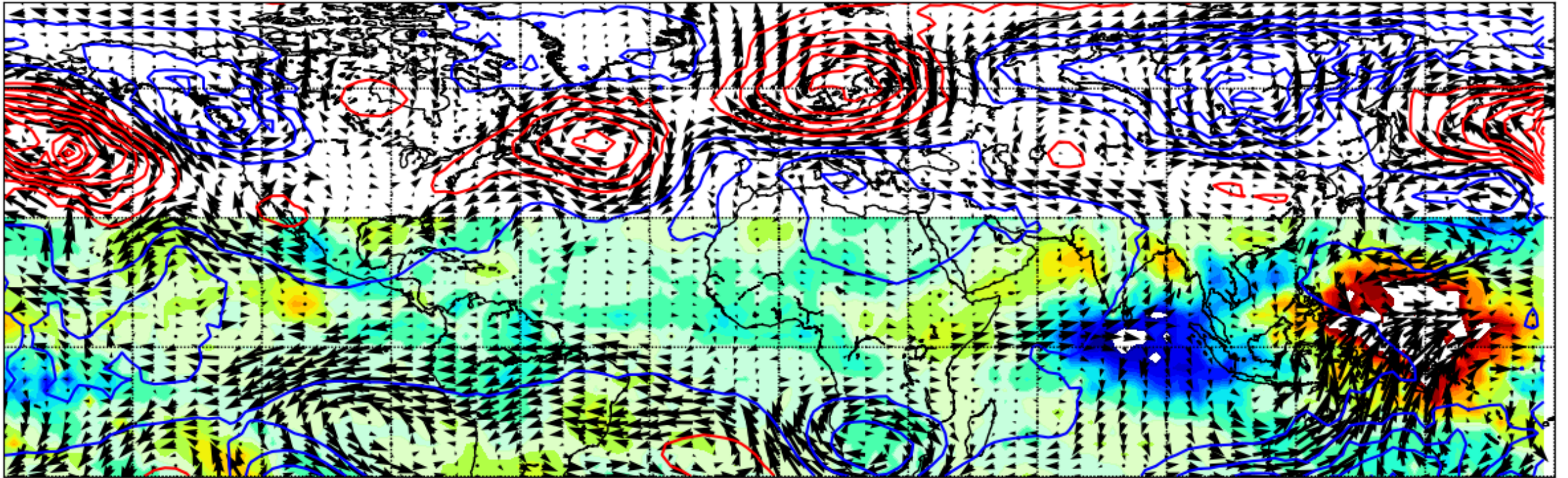
# NORTHERN SUMMER



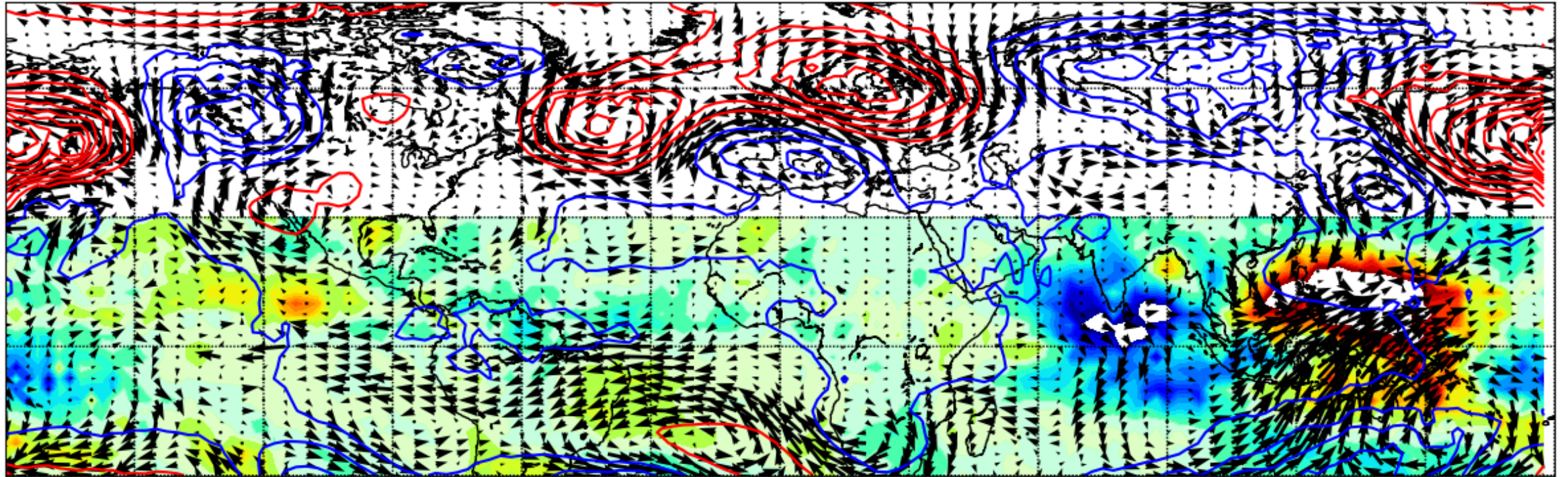
RMM Regression Map 200 Height (2 SDs) Phase 1 day 180 week 25,30-Jun



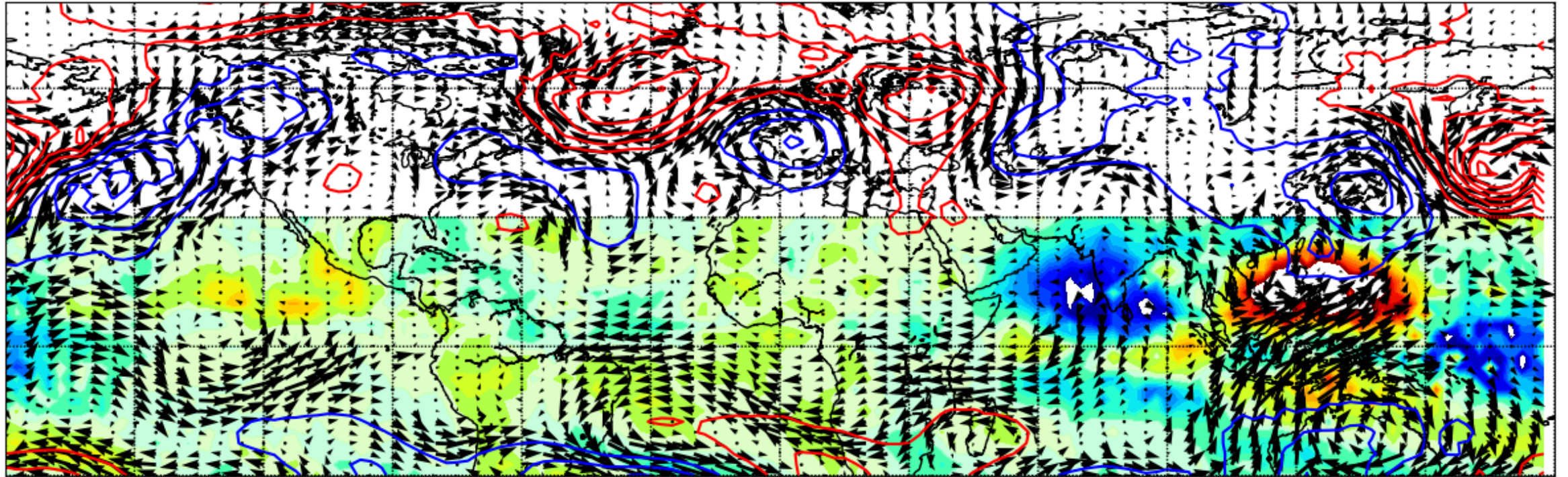
RMM Regression Map 200 Height (2 SDs) Phase 2 doy 180 week 25,30-Jun



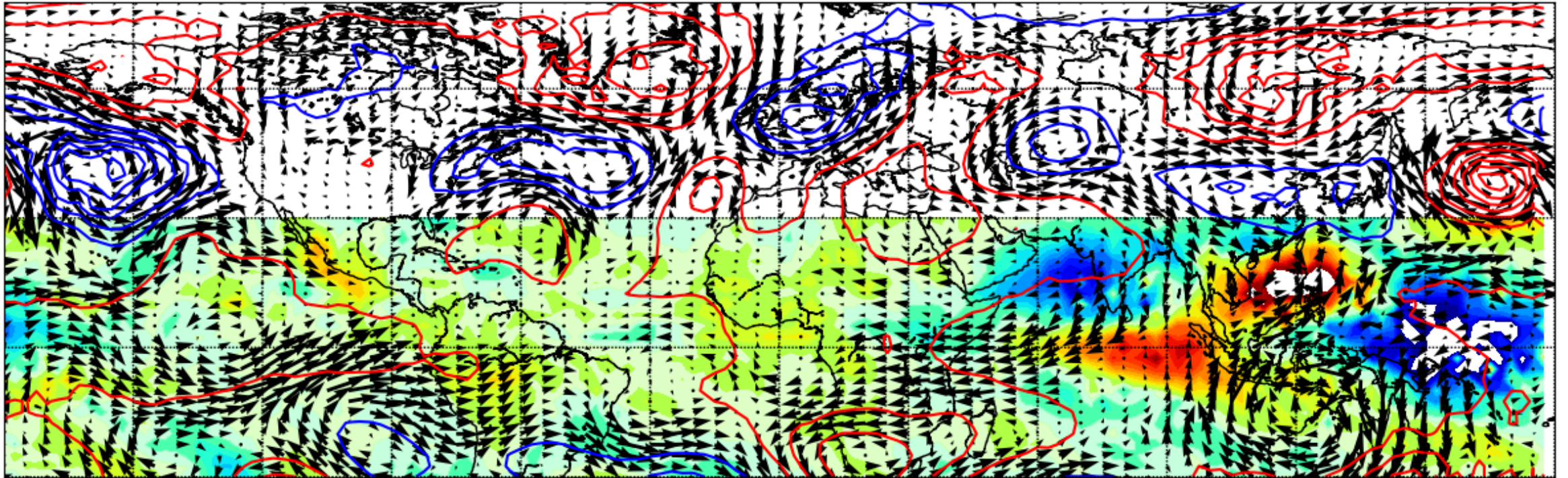
RMM Regression Map 200 Height (2 SDs) Phase 3 day 180 week 25,30-Jun



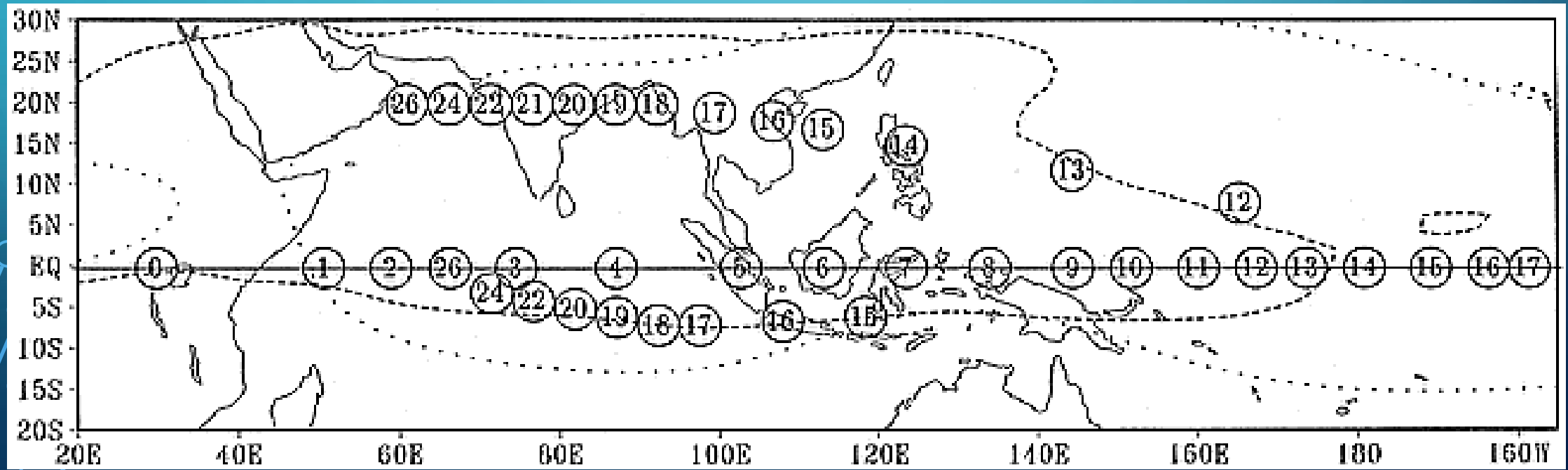
RMM Regression Map 200 Height (2 SDs) Phase 4 doy 180 week 25,30-Jun



RMM Regression Map 200 Height (2 SDs) Phase 5 doy 180 week 25,30-Jun



# WANG AND XIE (JAS 1997)



# CONCLUSIONS

- The MJO and equatorial Rossby waves interact with extratropical Rossby wave breaking
- A portion of eastward and northward components of the northern summer monsoon systems break and active cycles associate with the MJO
- Westward and northward-moving features associate with seasonally modified equatorial Rossby wave signals initiated by extratropical Rossby wave breaking