Investigating How Background State Affects The Propagation of The MJO

Kristina Laboy [1], Eric Maloney [2]

[1] Millersville University, Millersville, Pa, [2] Colorado State University, Fort Collins, CO

Introduction

- The Madden-Julian Oscillation (MJO) is a cycle of anomalous tropical precipitation and winds.
- The MJO is characterized by 30-60 day periods.
- This phenomenon starts in the tropical Indian ocean and propagates eastward to the middle of the Pacific Ocean.
- The processes that contribute to propagation are not well-understood.
- Understanding MJO propagation may help to predict tropical cyclone activity at weekly timescales.

Objective

- To improve MJO forecasts and tropical cyclone forecasts by understanding why the MJO moves eastward.

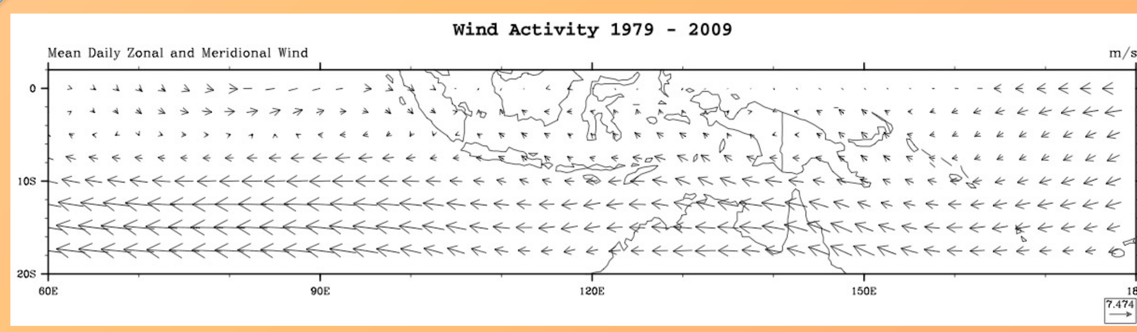
Hypothesis

- Strength of the background zonal winds should impact the propagation speed of the MJO, following the hypothesis of Maloney et al. 2010

Data

- NCEP Reanalysis data during 1979-2009 provided by the NOAA/OAR/ESRL PSD, Boulder, Colorado, USA, from their Web site at http://www.esrl.noaa.gov/psd/
- MJO amplitude and propagation speed were determined from the MJO index of Wheeler and Hendon 2004

Results



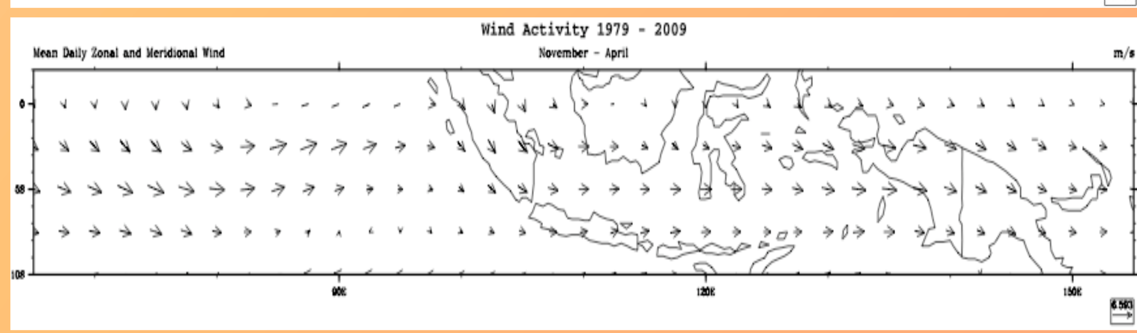


Figure 1 (top) The average wind vector at 850 hPa over all seasons. Figure 2 (bottom) The average wind vector during austral summer, when the MJO is active in the Southern Hemisphere A smaller region is plotted than in Figure 1.

- Figure 2 shows mean low-level westerlies during austral summer where the MJO is active.
- The region used in Figure 2 is used to compute the statistics below.

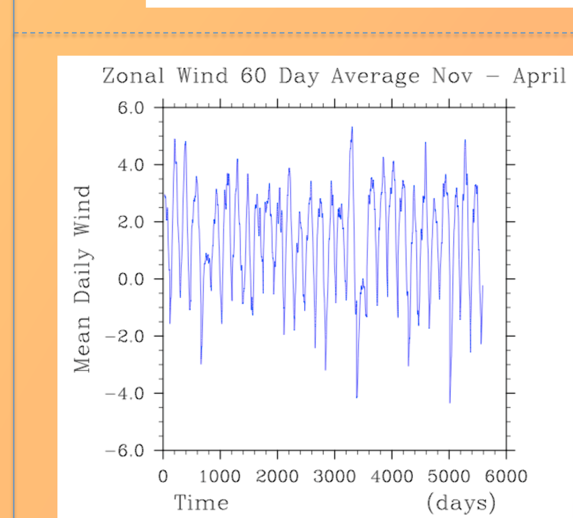


Figure 3. 60-day running average of background zonal wind speed during November to April for 1979 – 2009, calculated over the region of Figure 2.

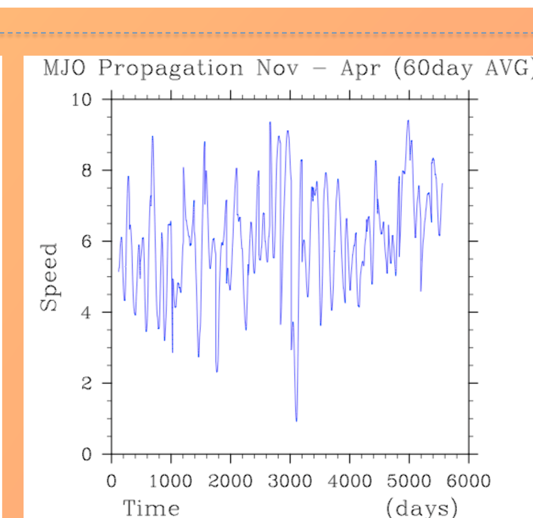


Figure 4. 60-day running average of MJO propagation speed during November to April of 1979 - 2009.

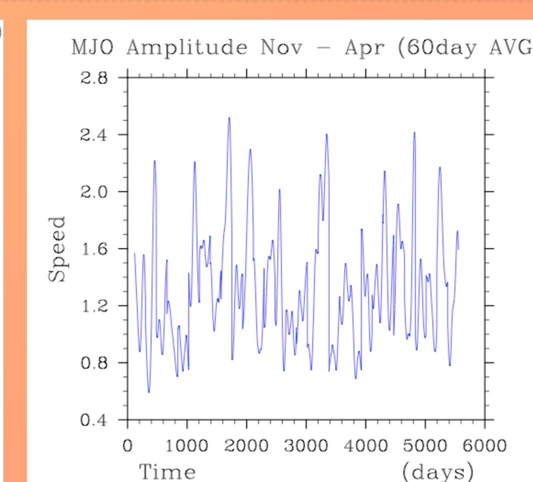


Figure 5. 60-day running average of MJO amplitude during November to April of 1979 - 2009.

- These figures show average zonal wind over the region in Figure 2, and MJO propagation speed and amplitude during austral summer (Nov-Apr)
- A correlation coefficient of magnitude 0.20 is significant in the plots below.

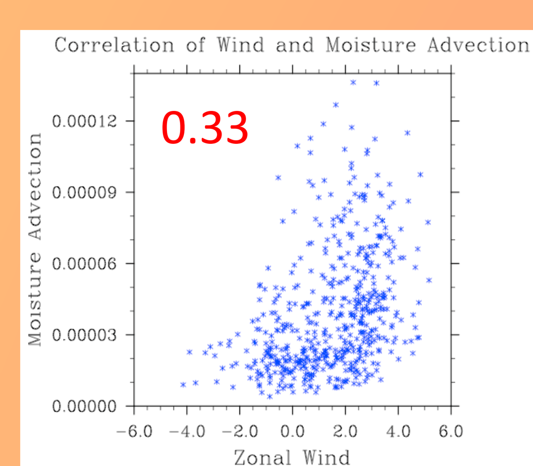


Figure 6. The correlation of background zonal winds and intraseasonal moisture zonal advection amplitude.

- There is a significant correlation between background zonal wind and the strength of intraseasonal zonal moisture advection, confirming that background zonal wind is related to eastward moisture advection.

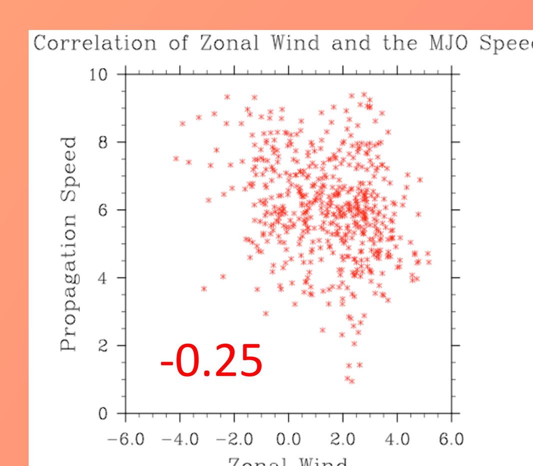


Figure 7. The correlation of background zonal winds and the MJO propagation speed.

- However, there is a significant negative correlation between background zonal wind and MJO propagation speed, contradicting the hypothesis of Maloney et al.

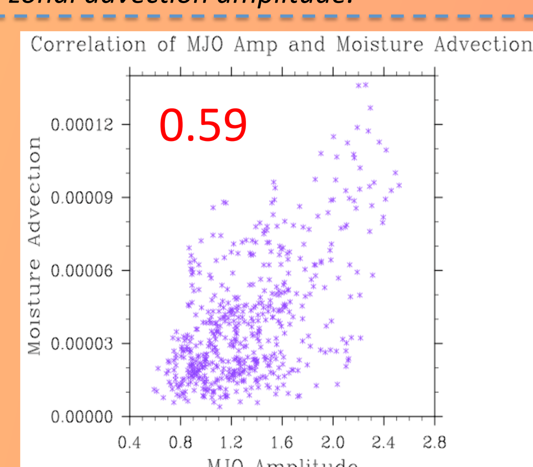


Figure 8. The correlation of intraseasonal zonal moisture advection and MJO amplitude.

- There is a high correlation between the strength of intraseasonal moisture advection and MJO amplitude

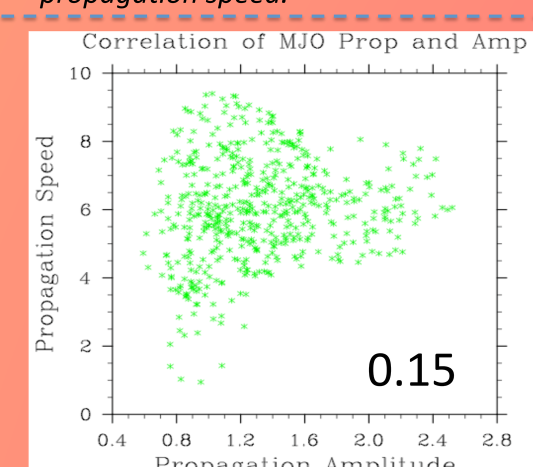


Figure 9. The correlation of MJO propagation speed and the MJO amplitude.

- However, there is no significant correlation between the MJO propagation speed and MJO amplitude.

	Zonal Wind	Amp	850mb Spec. Hum.	925mb Spec. Hum.	Moisture Advection
Prop	-0.252	0.152	0.04	0.012	-0.024
Amp	0.038*	-	0.085	0.011	0.593
Zonal Wind	-	0.038*	0.675	0.636	0.329

Figure 10. Correlations over the region of Figure 2.

Indicates a significant correlation ** Indicates a repeated value*

- A high correlation exists between background zonal winds and the specific humidity at the 850mb and 925mb levels.
- The correlation between specific humidity at 850mb and 925mb levels and the propagation speed and amplitude of the MJO is near zero.
- The correlation between background zonal wind and MJO amplitude is near zero.

Conclusions

- This NCEP reanalysis dataset does not support the hypothesis that stronger background zonal winds cause an increase in MJO propagation speed. In fact, they are negatively correlated.
- It is demonstrated that stronger zonal moisture advection is associated with stronger MJO amplitude. However, this does not translate to significant variations in propagation speed.
- Background specific humidity at 850mb and 925mb have no relationship to the propagation speed or amplitude of the MJO.
- The speed of the MJO propagation is not significantly correlated with MJO amplitude

References

- Hendon, Harry H. and Murry L. Salby, 1994: The Life Cycle of the Madden-Julian Oscillation. *Journal of the Atmospheric Sciences*, **51**, 2225-2237
- Maloney, Eric D. and Dennis L. Hartmann, 2000: Modulation of Hurricane Activity in the Gulf of Mexico by the Madden-Julian Oscillation. *Science*, **287**, 2002-2004
- Maloney, Eric D., Adam H. Sobel and Walter M. Hannah, 2010: Intraseasonal Variability in an Aquaplanet General Circulation Model. *J. Adv. Model. Earth Syst.*, ***Vol. 2***, *Art. #5, 24 pp., doi:*10.3894/JAMES.2010.2.5

Acknowledgments

- This work has been supported by the National Science Foundation Science and Technology Center for Multi-Scale Modeling of Atmospheric Processes, managed by Colorado State University under cooperative agreement No. ATM-0425247.
- A special thanks to Walter Hannah, Gus Alaka, and everyone who helped with my project.