RADAR OBSERVATIONS OF MJO/WAVE INTERACTIONS DURING DYNAMO/CINDY2011/AMIE

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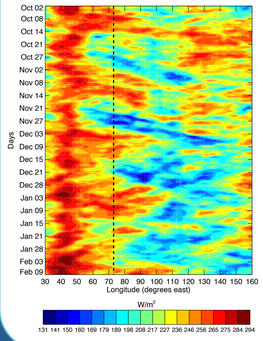
1. Introduction

Total Daily OLR During DYNAMO/CINDY2011/AMIE



The Madden-Julian Oscillation (MJO) initiates over the Indian Ocean and propagates into the western Pacific as a series of convective events. These convective events may interact with other convectively-coupled waves, like Kelvin and Equatorial Rossby waves. The DYNAMO/CINDY2011/AMIE field campaigns from October 2, 2011 to February 9, 2012, collected data to better understand MJO initiation. On Gan Island in the Maldives, Texas A&M University deployed a C-band Doppler radar, called SMART-R.

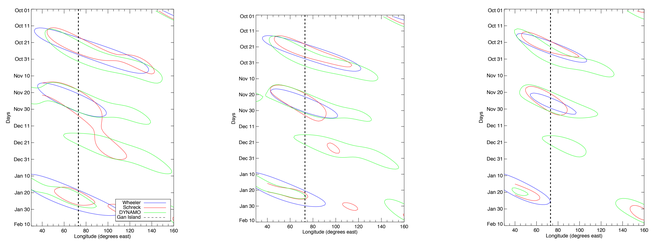
2. Event Identification

- Convectively coupled equatorial waves are identified by wavenumber-frequency filtering of outgoing longwave radiation (OLR) using 3 different filters and plotted by OLR anomalies at a -10 W/m^2 threshold

	Wheeler	Schreck	Dynamo
MJO	30-96 days	30-100 days	20-100 days
Kelvin Wave	2.5-30 days	2.5-17 days	2.5-20 days

MJO Events

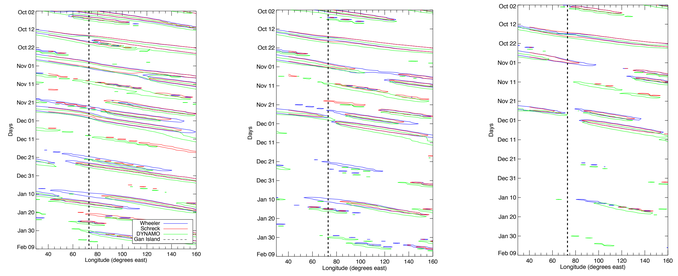
-5°S to 5°N | -10°S to 10°N | -15°S to 15°N



- Each filtering method identifies the first two strong MJO events with less agreement in December and January and as the domain size increases

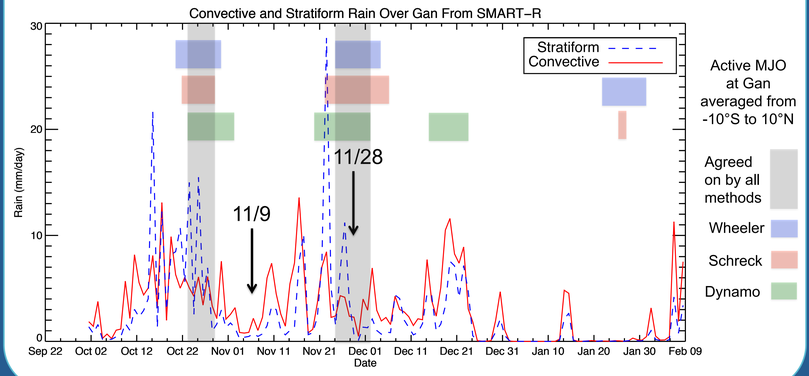
Kelvin Waves

-5°S to 5°N | -10°S to 10°N | -15°S to 15°N



- The Dynamo method captures a combination of the Wheeler and Schreck methods
- Narrow domains capture more Kelvin waves

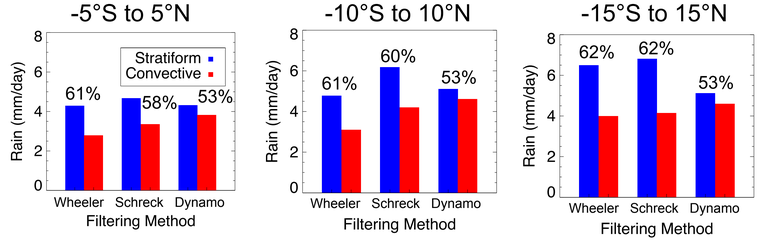
3. SMART-R Rain Rate



4. Average Rain Rates by Domain

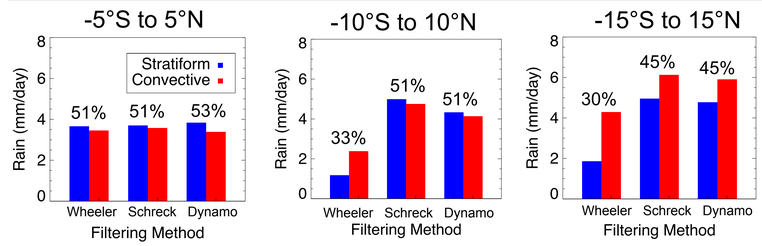
- Composite MJO and Kelvin wave rain rates and stratiform percentages calculated based on identification method and domain

Composite MJO



- MJO events always have more stratiform rain than convective rain
- Stratiform percent is consistent at different domain size for Wheeler and Dynamo methods, but increases with domain size for the Schreck method
- Total rain increases as event identification domain gets larger due to the reduction in events sampled

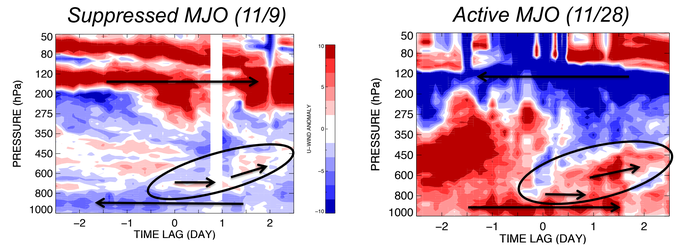
Composite Kelvin Wave



- Kelvin waves have more stratiform rain than convective rain until the largest domain for event identification
- All three methods are in good agreement using the narrowest domain for event identification
- As the domain widens, stratiform percent decreases and convective rain dominates, due to fewer identified events

5. Kelvin Wave Interaction

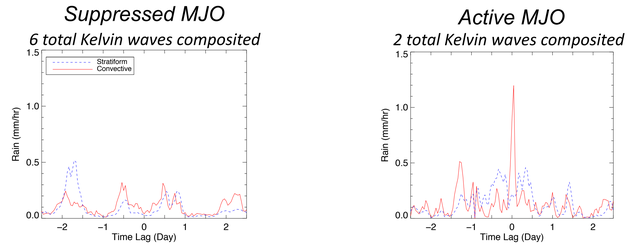
Zonal Wind Anomalies During Kelvin Wave



- Suppressed MJO: zonal winds from soundings show a vertical enhancement of easterly anomalies leading up to the wave passage followed by westerly anomalies after the wave passes over Gan
- Active MJO: zonal winds are dominated by MJO (strong upper-level easterlies and strong lower-level westerlies), but the vertical enhancement of westerly anomalies at the Kelvin wave passage is evident

Composite SMART-R Rain Rate During Kelvin Wave

- Using the Dynamo method and averaging from -10°S to 10°N, 8 Kelvin waves and 3 MJO events were identified at Gan and rain rates were composited by zonal wind anomaly



- Suppressed MJO: convective and stratiform rain are similar in rate, and a maximum of convective rain occurs a few hours after the wind shift
- Active MJO: significantly more convective and stratiform rain occur with a convective maximum centered at the wind shift

6. Conclusions

- To study wave interactions, careful consideration of filtering method and domain size is necessary
- While smaller domain size is better for identification of shorter, faster Kelvin waves, larger domains are better for MJO events
- There is an enhancement of convective rain during a Kelvin wave passage, but significantly more convective and stratiform rain during an active MJO, even though the westerly wind anomalies are similar
- More work is needed to examine the interaction of the MJO with Equatorial Rossby waves and consider other environmental properties like humidity

Acknowledgements: Thanks to Matthew Wheeler and Carl Schreck for providing filtered data

References: Wheeler M, and Kiladis GN. 1999. Convectively-coupled equatorial waves: Analysis of clouds in the wavenumber-frequency domain. *J. Atmos. Sci.* 56: 374-399.
Carl Schreck's website: http://monitor.cicsnc.org/mjo/current/