Impacts of the Madden-Julian Oscillation on Global Tropical Cyclone Activity

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Outline

- Motivation
- Data
- MJO Impacts on Large-Scale Atmospheric/Oceanic Fields
- MJO Impacts on Global Tropical Cyclone Activity
- MJO Impacts on Tropical Cyclone Landfalls
- Summary

Gray (1979)

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YEAR	2		YEARLY TOTAL
1958	<u> </u>		6
1959	6	G 6 5 I C 0 2 3 2 6 2	
1960			<u>→7</u> → 48
1961	<u>9</u>		· 58
1962	9		<u>→ 7 → 50</u>
1963	<u> </u>		
<u>1964</u>	<u> </u>		
1965	8		
<u> 1966 </u>	<u> 8</u>	10.7 22 7 10.0 27.00 (10.00) 3 (24) 5	-464
_1967	•		63
<u>1968</u>			
1969	<u> </u>	<u>0 2 0 7</u> 4	<u>→10→ 49</u>
<u> 1970 </u>	<u>8</u>		7 56
1971		0 [4] 3 [7] 0 [5] 1 [8. 08 0 [march 17 (2011) 0 [4] 2 B	70
1972			
1973			<u>→ 8</u> → 46
1974	5+	(25) 4 (5) (8 3 (4) 5 (5)	<u>4</u> <u></u> 55
1975			-2 47
1976	7	5 0 44 0 53 0 66 0 69 1 55 1 53	← 7 → _ 55_
1977	4→	[3] 6 [4] 2 <u>6</u> 0 [483 2 59	7 47
	APR	MAY JUN JUL AUG SEP OCT NOV	DEC

Clustering of Northern Hemisphere Tropical Cyclones



Hurricane Blas (2016) – Rapid Intensification



Wheeler-Hendon MJO Dataset (1974-Present)

- Documented in Wheeler and Hendon (2004) – utilizes 200 and 850 hPa winds and outgoing longwave radiation to construct an MJO index

- 120-day mean and ENSO-associated interannual variability removed

Extended MJO Dataset (1905-2014)

- Documented in Oliver and Thompson (2012) – utilizes surface pressure from 20th Century Reanalysis to reconstruct an MJO index

- 120-day mean removed – eliminates most of the ENSO signal

NCEP/NCAR Reanalysis (1948-Present)

- Documented in Kalnay et al. (1996) and Kistler et al. (2001) – 1st generation reanalysis product

ERA-Interim Reanalysis (1979-Present)

- Documented in Dee et al. (2011) – 2nd generation reanalysis product

TC Statistics

- U.S.-Based Warning Agencies as archived in the International Best Track Archive for Climate Stewardship (IBTrACS)



200-850 mb Vertical Shear Anomalies

1979-2014 (Wheeler and Hendon (2004) index)



600 mb Relative Humidity Anomalies

1979-2014 (Wheeler and Hendon (2004) index)



Camargo et al. (2009)



Major Hurricane (>=96 knots) tracks by MJO Phase (1974-2014)



Tropical cyclone activity tends to be enhanced during and just after convectively-enhanced MJO phase passes over a region

Tracks were only selected when MJO amplitude > 1

Major hurricane used to describe TCs with one-minute maximum sustained winds >= 96 knots







Conclusions

- MJO impacts tropical cyclone activity through modulations in large-scale fields such as vertical wind shear and mid-level moisture
- Enhanced tropical cyclone activity typically occurs concurrently and immediately following the convectively-enhanced phases of the MJO
- Relationships between the MJO and tropical cyclone activity remain relatively consistent since the middle part of the 20th century

Questions?



Summit of Mount Amos, Freycinet National Park, Tasmania

Greatest Observational Needs

 Development of long-term reanalysis products (such as the 20th Century Reanalysis and ERA-Clim)

 Global tropical cyclone reanalysis similar to what is currently being done in the Atlantic by the National Hurricane Center