Differences between MCS-AEW coupled-systems that result in tropical cyclogenesis and those that do not.

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Tropical Waves Session
## Role of Convection in the evolution of AEWs

- Perturbed unstable basic state (*Berry and Thorncroft 2005*).
- PV reversal gradient that support AEWs growth (*Hsieh and Cook 2005, 2008*).
- Convection on the scale of the developing Tropical Cyclone (TC) (*Lin et al. 2005*).
- Moist convection in East Africa and AEW activity (*Leroux 2010*).
Role of Convection in the evolution of AEWs

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- Evident role of convection in the growth and maintenance of AEWs and in tropical cyclogenesis

- Nature of the AEWs leaving the West African coast can impact the probability of tropical cyclogenesis in the eastern Atlantic (*Hopsch et al. 2010*)
Questions remain...

- Tropical Cyclogenesis related to the interaction of AEW and environment, the coupled MCS-AEW system or a combination of both factors?

- Why do some AEWs develop TCs and others don’t? Is it related to the MCS coupling?
Research Questions

- How does the MCSs coupled to an AEW affect the possibility of TC genesis?

- Is there distinct spatial relation or characteristics between a coupled MCS-AEW system of an AEW associated with TC genesis (DEV) that is not evident in a coupled system of an AEW that is not associated with TC genesis (NONDEV)?
Tracking Algorithm for Mesoscale Convective Systems (TAMS)

Identification
Centroids

Tracking
Area-Overlapping & Projected-Cloud-Edge Techniques

Classification

Precipitation assignment

Assigning MCSs to specific AEWs
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AEW tracks from Alan Brammer, University at Albany (extension of NHC Best Track data)
Background/Motivation

Methodology

Preliminary Results

Summary

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Period: July-September 2006 Season
Domain: 0° to 30° N and 35° W to 45° E

AEW tracks from Alan Brammer, University at Albany (extension of NHC Best Track data)
Background/Motivation

- AEWs tracked between 5°N and 20°N to capture both north and south tracks (Diaz and Aiyer 2012; Kiladis et al. 2006)
- Box defined by a total of 2000 km longitudinally centered on AEW vorticity maximum.
  - Allowing for symmetric and asymmetric AEWs
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ERAI-INTERIM

- Meridional average of $V$ between 5°N and 20°N to obtain northerly and southerly maximum of AEW
- 3 levels (850 hPa, 600 hPa and 700 hPa)
- MCSs will be coupled to AEW if its within the distance of trough length identified from the trough axis at the time of initiation
Meridional average of V between 5°N and 20° N to obtain northerly and southerly maximum of AEW

3 levels (850 hPa, 600 hPa and 700 hPa)

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Relative displacement of MCS within the AEW trough

Northerlies

Southerlies

Slower

Faster

MCS average speed relative to AEW

[ m s\(^{-1}\) ]

Nondev

Dev

AEW trough axis

Penn State
College of Earth and Mineral Sciences
Relative displacement of MCS within the AEW trough

MCS average speed relative to AEW

Initial MCS position relative to AEW trough
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Relative displacement of MCS within the AEW trough

MCS average speed relative to AEW

NONDEV

DEV

MCS position at termination relative to AEW trough
Relative displacement of MCS within the AEW trough

MCS average speed relative to AEW

Initial MCS position relative to AEW trough

MCS position at termination relative to AEW trough
2-Sample t-test:
P = 0.038    z = 1

MCSs speed relative to NONDEV
MCSs speed relative to DEV

[m s\(^{-1}\)]
2-Sample t-test:
$P = 0.038 \quad z = 1$

2-sided Wilcoxon test:
$P = 0.365 \quad z = 0$
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Summary

2-Sample t-test:
P = 0.038    z = 1

2-sided Wilcoxon test:
P = 0.020   z = 1

MCSs speed relative to NONDEV

MCSs speed relative to DEV

Actual speed NONDEV

Actual speed DEV

Actual speed MCSs NONDEV

Actual speed MCSs DEV

2-sided Wilcoxon test:
P = 0.365    z = 0
2-sample t-Test:

\[
p_{\text{ave}} = 0.017 \quad z_{\text{ave}} = 2
\]

\[
p_{850} = 0.009 \quad z_{850} = 2
\]
2-sample t-Test:
pave = 0.017  z_ave = 2
p850 = 0.009  z_850 = 2
2-sample t-Test:
\[ p_{\text{ave}} = 0.017 \quad z_{\text{ave}} = 2 \]
\[ p_{850} = 0.009 \quad z_{850} = 2 \]

Higher vorticity values associated to DEVs for a 3-layer vertical average driven by the 850 hPa level.
2-sided Wilcoxon test:
P = 0.000  z = 1

[mm]
Statistically significant differences exist between rainfall accumulations of DEVs and NONDEVs.

2-sided Wilcoxon test:

\[ P = 0.000 \quad z = 1 \]
Summary and Conclusions

• The coupling of MCSs—tracked by TAMS—to associated AEW was done resulting in a composite of MCS-AEW coupled systems to be analyzed.

• MCSs speeds relative to AEWs are faster for DEVs than for NONDEVs. This is due to faster propagating DEVs. Consequently, MCSs of DEVs are more probable to advance with the AEW as the AEW itself propagates at speeds close to the propagating speed of convection.

• Higher vorticity values of a 3-layer vertical average associated to DEVs when compared to NONDEVs driven by 850hPa vorticity layer.

• Statistically significant differences exist between rainfall accumulations of DEVs and NONDEVs.