1. Background & Research Questions

Laing et al. (2008) showed that convection typically moves at different speeds to the AEW and convection is found in all AEW phases, but is more prominent in the northerlies.

Figure 1: Histograms of zonal phase speed (m/s) for cold cloud episodes (black) and AEWs (grey) averaged between 5-15N for May-August, 2000–2003 (Laing et al. 2008).

Schwendike and Jones (2010) analyzed two convective systems in an AEW. The convective systems generated vorticity in the low- and mid-levels of the environment.

Figure 2: Vorticity tendencies in the environment produced by a West African MCS (Schwendike and Jones et al. 2008).

Research Questions
1. What is the difference between MCS and AEW propagation speeds? In what phase of the AEW are MCSs more frequent?
2. How does the AEW initiate and enhance MCSs?
3. How do MCSs modify the AEW? Are there asymmetries between the effects on the trough and the ridge?

2. Methods

AEW simulation (2017)
- 3rd Aug – 12th Aug
- Initialized with 0.25‟ GFS at Forecast hour 0
- 4km resolution with no convection scheme

AEW and MCS tracking
- AEW is manually tracked by following the smoothed maximum in vorticity and minima in meridional wind at 650hPa (AEW peak)
- MCSs are manually tracked in the wave relative framework by following the simulated radar reflectivity

Figure 3: WRF domain

Figure 4: Max radar reflectivity and terrain height (m) relative to the trough position (6km on the x-axis).

3. MCSs relative to the AEW

- MCSs move at a variety of speeds relative to the AEW.
- MCSs originate and propagate through all phases of the AEW.
- More, longer-lived MCSs in the northerlies and trough.
- MCSs impact the AEW in all phases.

Table 1: Summary of MCSs relative to the AEW.

<table>
<thead>
<tr>
<th>Date &amp; Time (UTC)</th>
<th>Duration (hrs)</th>
<th>AEW Phase</th>
<th>Surface Type</th>
<th>Speed</th>
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<tbody>
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<td>30</td>
<td>T</td>
<td>L</td>
</tr>
<tr>
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<td>4hr 15:20</td>
<td>39</td>
<td>S</td>
<td>O</td>
</tr>
<tr>
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<td>5hr 11:20</td>
<td>24</td>
<td>R to S</td>
<td>L</td>
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<td>5</td>
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<td>8hr 01:40</td>
<td>37</td>
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<td>O</td>
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</table>

4. Modulation of Convection by the AEW

Figure 5: Wave relative average a) Vwind, b) PV, c) divergence, d) CAPE, e) CIN, and f) OLR.

Relatively clearer air in the ridge likely leads to radiative surface heating (c)
Increased surface temperatures lead to a build up of CAPE in the ridge (d)
Forcing for ascent by the AEW supports convection in northerlies (f)
The build up of CAPE supports longer-lived systems in that phase
CAPE consumed in the northerlies and trough (d)
Fewer, weaker long-lived MCSs in the following ridge (table above)

5. Modulation of the AEW by MCSs

A PV budget: \( \frac{D\varphi}{Dt} = -g \left( \nabla \cdot \mathbf{V} \right) - g (\nabla \cdot \mathbf{V}) \times \mathbf{F} \), is used to assess the role of the MCSs on the AEW. The diabatic term is compared to the PV, \( \varphi = -g (\nabla \cdot \mathbf{V}) \) to generate four categories of amplification or decay of the positive or negative PV.

Due to diabatic processes associated with the MCSs, there is:
- a) Amplification of the positive PV in and ahead of the trough.
- b) Amplification of the positive PV in and around the ridge.
- c) Amplification of the negative PV.
- d) Decay of negative PV in and around the ridge.

Figure 6: Average vertical profiles of amplification (solid black lines) and decay (dashed black lines) of a) positive and b) negative perturbation PV by diabatic processes associated with the 10 MCSs. Red shading indicates where amplification is larger than decay and blue shading indicates where decay is larger than amplification. Black thick lines indicate the actual value of the difference between amplification and decay in each case.

7. Acknowledgements & References

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References