African Easterly Waves and Atlantic Hurricanes

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When West Africa gets more rain, we get more hurricanes!
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<tbody>
<tr>
<td>• Formed from an African Easterly Wave that left the coast of Africa on Aug 17</td>
<td>• Formed from an African Easterly Wave that left the coast of Africa on September 2</td>
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Atlantic Tropical Cyclones and African Easterly Waves

• More than half of all Atlantic tropical cyclones, including Dennis and Floyd, form in African Easterly Waves

• African Easterly Waves form in the African Sahel.
What is an African Easterly Wave?

Like our own Jet Stream, cyclonic meandering in winds over the African Sahel favors the formation of storms.
**Formation Mechanisms**

- Reversed meridional temperature gradient between warm Sahara and cool Gulf of Guinea
- Intertropical convergence zone (ITCZ) convection

(e.g., Carson 69, Burpee 74, Rennick 77, Mace 77, Reed et al 77, Norquist 77, Thorncroft and Hoskins 94)
African Easterly Waves

1999

~20 AEW passed through Niamey

8 of 12 Atlantic Tropical Cyclones Formed in African Easterly Waves

including Hurricanes Dennis and Floyd
Goal: Study the connections between Sahel Rainfall and Atlantic Hurricanes
Two different regimes of rainfall in Equatorial Africa

AEW Regime

- At the peak of the rainy season (JAS),
  - It rains every 3-4 days in Niamey.
  - About 12 mm per rainy day

ITCZ Regime

- At the peak of the rainy season (JAS),
  - It rains every day in Abuja.
  - About 12 mm per rainy day

2006 GPCP 1dd Rainfall - Niamey

2006 Total : 410 mm

2006 GPCP 1dd Rainfall - Abuja

2006 Total : 1436 mm
African Easterly Waves

2006

~21 AEW passed through Niamey

7 of 8 Atlantic Tropical Cyclones Formed in African Easterly Waves

including Hurricane Ernesto and Tropical Storm Alberto that affected NC
West African ‘Rainmakers’

Organized as *squall lines*: the largest, rainiest systems observed over land

- African Easterly Waves ↔ African Squall Lines

- Squall lines produce most of the monsoon rain vital to subsistence agriculture in West Africa
MIT Radar - Niamey, Niger, West Africa
Squall line precursor to Hurricane Helene
8 September 2006
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Hurricane Precursors: The Squall Line

Squall lines are the largest, rainiest systems observed over the Sahel

- A total of 28 squall lines
- Squall lines produced 82% of the 2006 rainfall in Niger

(Rickenbach et al. 2009, GRL)
Relation between squall lines and African Easterly Waves

Two Tracks

- 15 squall lines were associated with AEW troughs that propagated along 10-16°N (Northern Track)
- 13 squall lines were associated with AEW troughs that propagated along 2-6°N (Southern Track)

(Nieto Ferreira et al. 2009, MWR)
Structural differences in northern vs. southern track squall lines

The rainfall produced by northern track and southern track squall lines is very similar but the mode of delivery of rainfall is very different:

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<th>Stratiform Rain Fraction</th>
<th>Convective Rain Fraction</th>
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<tr>
<td>Northern</td>
<td>47%</td>
<td>53%</td>
</tr>
<tr>
<td>Southern</td>
<td>35%</td>
<td>65%</td>
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_Hypothesis_: AEW troughs present near Niamey in northern track squall lines favor stratiform rain production
Conclusion

There is a direct relationship between Sahel rain and Atlantic hurricanes

Squall lines are the main rainmakers in the Sahel

Distinct types of squall line form ahead of AEW troughs along two different AEW tracks

Understanding the interaction between squall lines and AEWs in the African Sahel may lead to improved Atlantic hurricane prediction
Sahel Rainfall, African Easterly Waves and Atlantic Tropical Cyclone Activity

Normalized Indices

AEWI x ACE = 0.390855
AEWI x SAHEL RAIN = 0.537412
ACE x SAHEL RAIN = 0.368345
ACE x TH2001600 = 0.475390
AEWI x TH2001600 = 0.167793

WET  DRY  WET