The Influence of El Niño - Southern Oscillation (ENSO) on African Easterly Waves and Tropical Cyclogenesis

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Background

- Shifts in Walker circulation during El Niño (La Niña) episodes cause stronger (weaker) vertical wind shear in the Caribbean.
- This results in suppressed Atlantic tropical cyclone activity during El Niño years and enhanced activity during La Niña years (Klotzbach 2011).
- These are known effects in the Caribbean only on developed tropical cyclones.

Goals of This Study:

- We seek to discover if ENSO influences African easterly waves (AEWs) and their eventual genesis into tropical cyclones.
- ENSO’s effect on wind shear is known in the Caribbean, but how far into the main development region (MDR) does this reach?
- Investigate vertical wind shear and relative humidity during El Niño and La Niña years:
  - Average values during the peak of the Atlantic hurricane season
  - In the immediate environment of AEWs

Methods

- Dataset: ECMWF ERA5 reanalysis, 1° x 1° resolution.
  - https://www.ecmwf.int/en/forecasts/datasets/reanalysis-datasets/era5
- Initially test for 2010 and 2015, and later extend to multiple hurricane seasons with strong El Niño and La Niña episodes.
- Key variables from the Statistical Hurricane Intensity Prediction Scheme (SHIPS, DeMaria et al. 2005) are tested, and extended for AEW cases.

SHIPS Wind Shear

Shading: 200-850 hPa wind shear Averaged in 200-800 km annulus
Blue Contours: 700 hPa vorticity Dots show each 1° grid point

SHIPS Relative Humidity (RH)

Shading: 700 hPa humidity Averaged in 200-800 km annulus
Blue Contours: 700 hPa vorticity Dots show each 1° grid point

Summary of Results

- Scatterplot of RH versus Wind Shear for each Invest day during the 2010 and 2015 hurricane seasons.
- Surprisingly, many of the higher wind shear points are observed during the La Niña year.
- Differences in average wind shear are evident in the Caribbean (stronger in 2015) and East Pacific (stronger in 2010)
- These differences are less clear in the eastern half of the MDR: the average shear is very slightly stronger in 2010
- The average 700 hPa relative humidity in the western and central MDR is higher in 2010.
- In 2010, it is also very slightly (but perhaps not significantly) higher in the eastern MDR too.
- Individual cases can defy expectations: Pre-Earl 2010 (higher shear, lower RH) versus Pre-Ida 2015 (lower shear, higher RH)

Concluding Remarks

- The well-known effects of ENSO in the Caribbean are corroborated in the 2010 and 2015 Atlantic hurricane seasons, and are expected to be evident in other seasons.
- The effects of ENSO are less clear in the eastern part of the MDR, and more seasons will be tested for robustness.
- In 2015, several Invests developed into tropical cyclones, in spite of higher wind shear. This was surprising and requires further investigation.
- More detailed investigations of AEW structure, strength, and environments over multiple ENSO episodes are necessary.

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