ENSO Impacts on Hurricane Landfalls

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North Atlantic Tropical Cyclone (TC) Record

Observations of TCs affected by:

- Populated areas
- •Marine traffic
- •Aviation (TC recon started ~1940s)

•Satellites (near constant coverage since mid-1970s).

There are an unknown number of 'missed' unobserved TCs.



FIG. 1. Time series of unadjusted HURDAT Atlantic basin TC counts over the period 1878–2006. Black line shows the annual count of tropical and subtropical storms, and hurricanes in the HURDAT database. Dashed lines indicate the linear least squares trends computed over the periods 1878–2006 and 1900–2006.

Vecchi and Knutson (2008)

North Atlantic Tropical Cyclone (TC) Record

- The North Atlantic TC record may be biased due to changing observation technologies and metrics of intensity.
- However, the US hurricane landfall record is a homogeneous dataset.
 - Coastal Atlantic areas have been populated for 100+ years.
 - Extreme events (hurricanes) are likely to be recorded.







Landsea (2007)

US Hurricane Landfalls (1851-2009)



ENSO Influence on TCs

ENSO phases have an irregular periodicity.

Onset of various ENSO phases affect SSTs and wind shear.

In the Atlantic:

- •El Nino (warm) leads to a decrease in TC activity
- •La Nina (cold) has opposite affect



US Hurricane Landfalls by ENSO Phase (1900-2009)



US Landfalls by ENSO Phase Split into two ~55 year segments

The period 1900-1955 shows distinct cold, neutral, and warm ENSO signals in US hurricane landfalls.

Post-1956, cold and neutral ENSO events show similar US hurricane landfall distributions.



Dynamic US Hurricane Landfalls

- There is diversity in the frequency and distribution of landfalling hurricanes in the US through the historical record.
- The ENSO signal is among the most prominent of several cyclic oscillations that influence the number of US landfalling hurricanes.
 - ENSO impact on hurricane landfalls changed between 1900-1955 and 1956-2009
- It may be advantageous to demonstrate geographical differences in hurricane landfall characteristics.

US Gulf Coast Hurricane Landfalls (1851-2009)



Florida Hurricane Landfalls (1851-2009)



US East Coast Landfalls (1851-2009)



Year

Differing Geographic Influences of ENSO on Hurricanes

Cyclical trends of hurricane landfall frequency differ by US coastal region.

Thus, impacts of ENSO on hurricane landfalls in different regions may depend on ENSO phase.



From Columbia University IRI: http://iri.columbia.edu/climate/ENSO/globalimpac t/TC/Atlantic/track.html

Gulf Coast Hurricane Landfalls by ENSO Phase (1900-2009)



Florida Hurricane Landfalls by ENSO Phase (1900-2009)



East Coast Hurricane Landfalls by ENSO Phase (1900-2009)



Return Frequency of at least one landfalling hurricane during a La Nina year



Return Frequency of at least one landfalling hurricane during an El Nino year



Conclusions

- Variability in North Atlantic tropical cyclone a combination of various factors, including:
 - Natural cyclical patterns in climatology
 - Changes in observing methods
- In particular, the phase of ENSO affects the frequency of US hurricane landfalls.
 - The character of this impact appears geographically and temporally dynamic.

Conclusions

- Influence of ENSO phase on US hurricane landfalls may be changing with time.
 - 1900-1955: distinct difference in hurricane landfall frequency between La Nina and Neutral phases.
 - 1956-2009: above phases indistinguishable in hurricane landfall response.
- Landfall risk by ENSO varies geographically
 - Gulf Coast and Florida have reduced hurricane landfall frequency in El Nino.
 - East Coast hurricane landfalls elevated in La Nina.

Questions?