Changes in Spatial Distribution of North Atlantic Tropical Cyclones

NG31A-07

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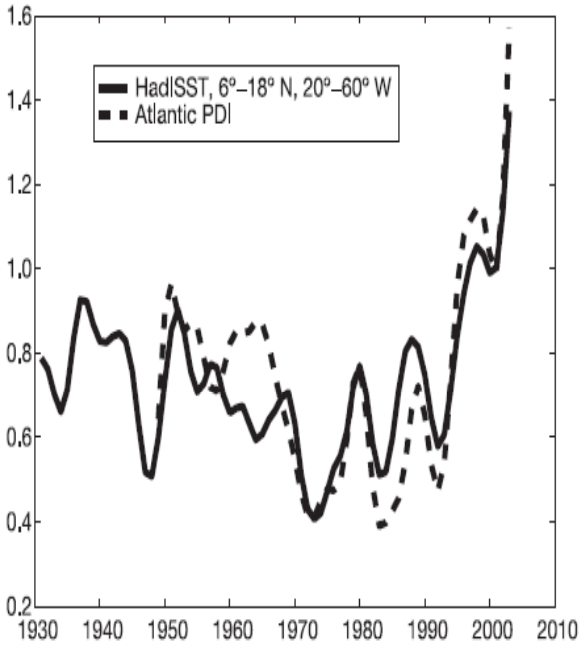
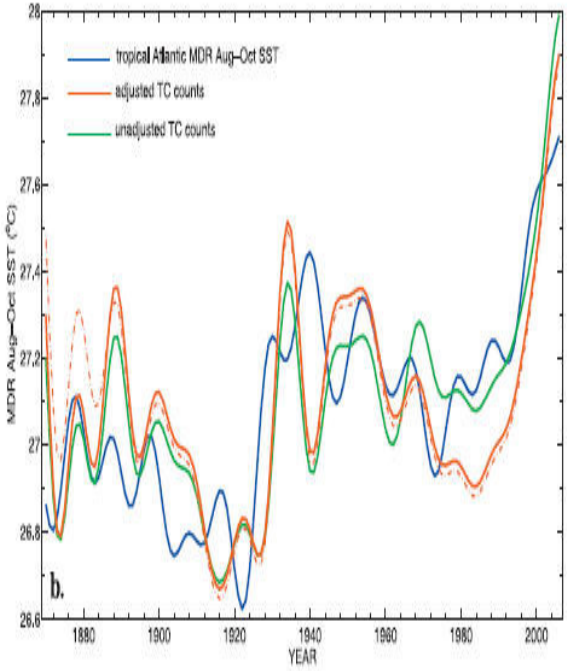
Roger Pielke, Jr. and Stephen McIntyre

www.climateaudit.org/pdf/agu07.ppt

Increase in Atlantic PDI and Storm Counts: Canonical Images



Emanuel 2005: PDI (windspeed^3 over time) has "doubled" in the past 30 years (graphic shows 1930-2004)



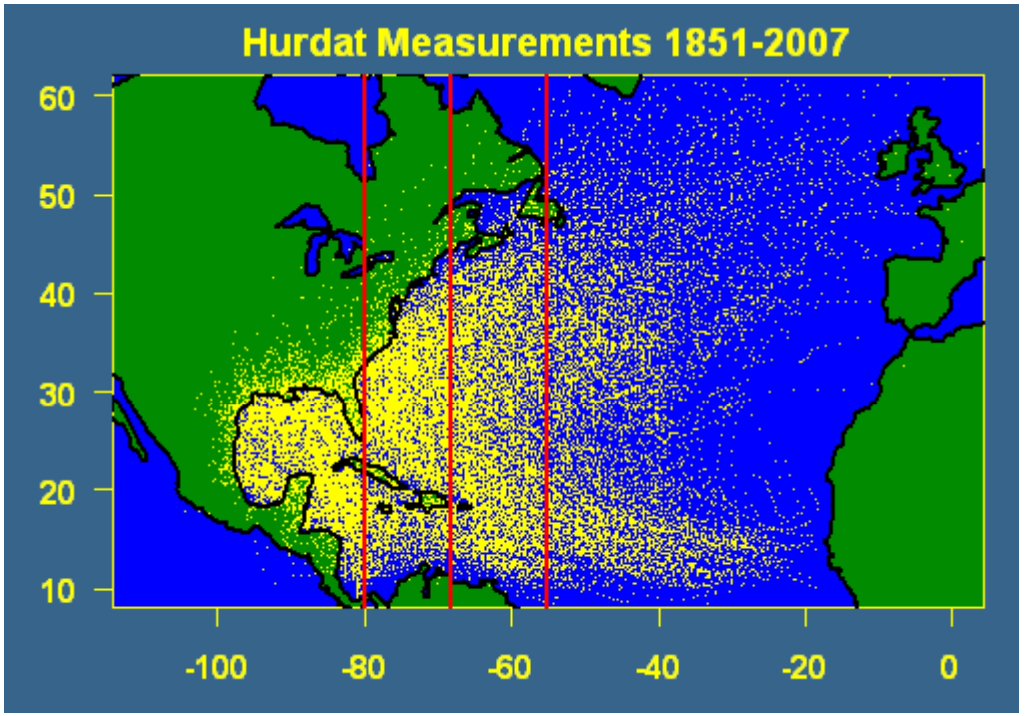
Mann and Emanuel 2007: cyclone counts have increased in the 20th century (graphic shows 1870-2006, decadally smoothed)

Our current viewpoint

1. There has been a large eastward movement in reported cyclone locations;
2. There has been no statistically significant increase in cyclone activity in the western Atlantic basin; the entire increase in measured storm and hurricane activity has taken place in the mid-Atlantic;
3. The above simple observations do not presently appear in peer-reviewed literature, only blogs; they can illuminate outstanding controversies.
4. The eastward shift could be technological or climatological or some combination; there is no plausible statistical basis for saying that the shift to the mid-Atlantic is not a trend and that the overall increase is a trend.
5. If the trend only occurs in the mid-Atlantic, should policy-makers care?

HURDAT "Best Track" Database

- 39,125 records
- 1851-2007
- 6-hour intervals
- Lat-Longs
- Wind Speed
- Sometimes Pressure



Red lines show longitude quartiles, i.e., 25% of observations are found in each quartile.

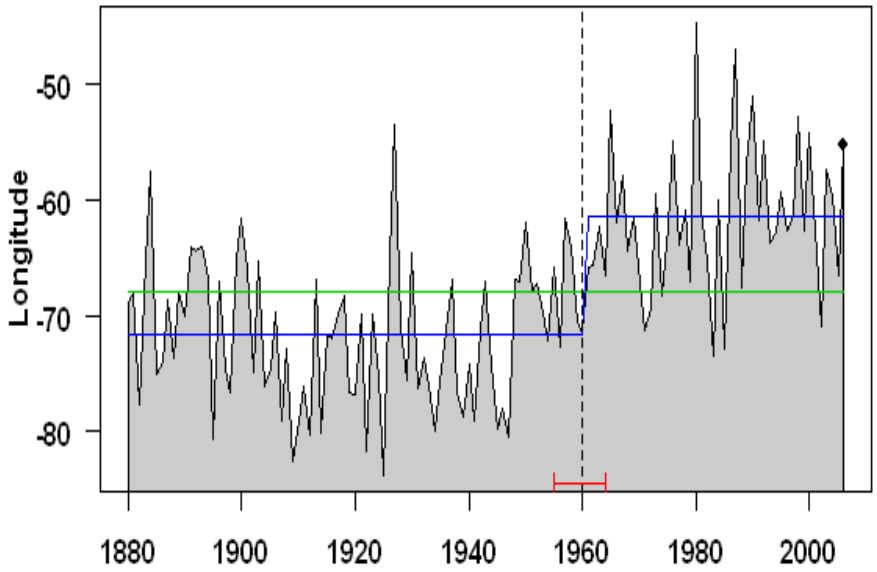
Many inhomogeneities affect counts and wind speed estimates

- **Satellites introduced in 1960s**
- **Aircraft reconnaissance in 1947**
- **Changing algorithms for wind speed**
- **Changing density of shipping routes and settlements**
- **Changing inclusion criteria (extra-tropical storms, short-lived storms)**

PLUS

- **Low-frequency (multidecadal) variability as well as annual variability**

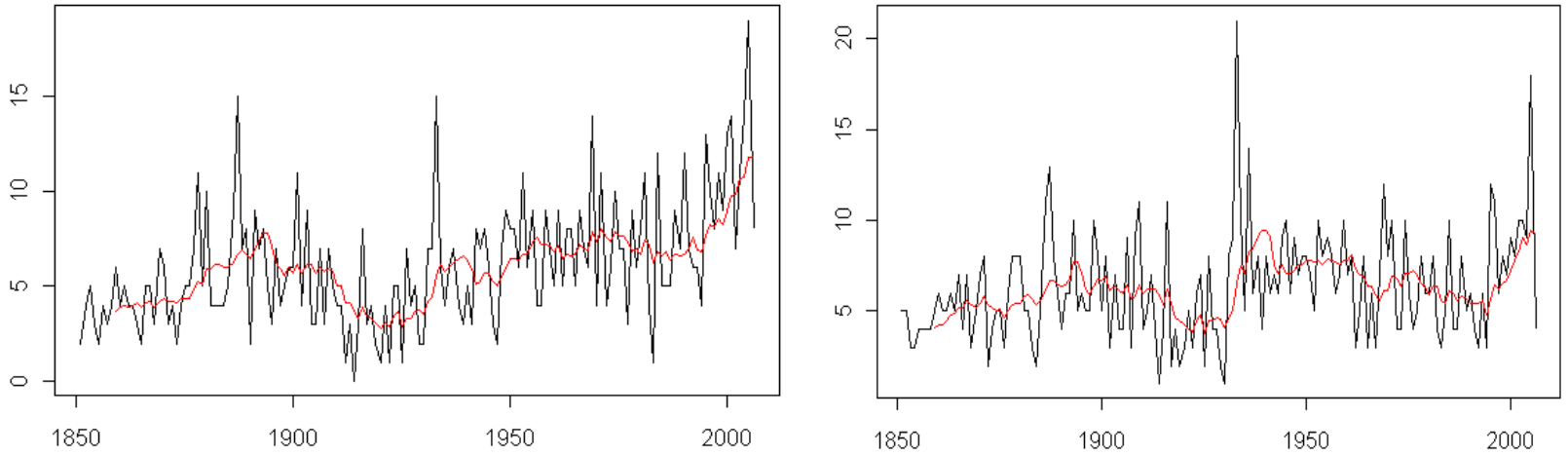
1. Median longitude has shifted 10 degrees east since start of aircraft reconnaissance



Left - Median location of Hurdat storm track location (McIntyre, Climate Audit 991, Dec 2006; Pielke, AMS Conference, Jan 2007). Breakpoint is statistically significant and occurs as aircraft and satellite reconnaissance introduced.

2. The entire increase in cyclone counts has taken place in the mid-Atlantic. In west, 2005 was very high but not "unprecedented"

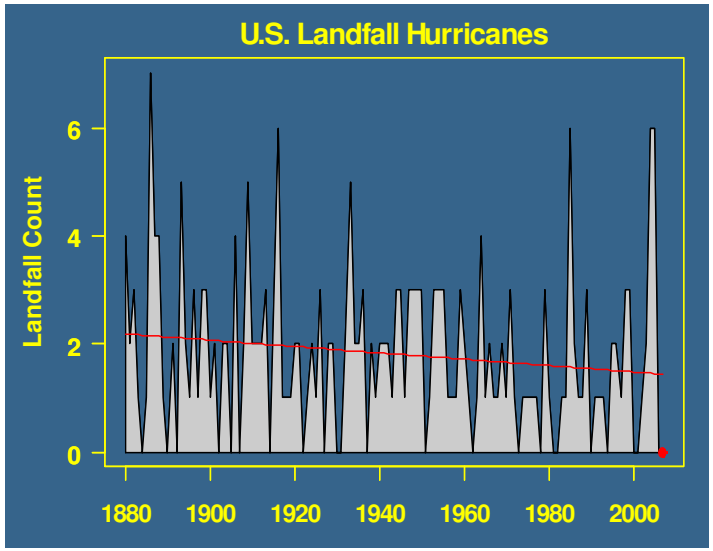
EAST OF 69W **WEST OF 69W**

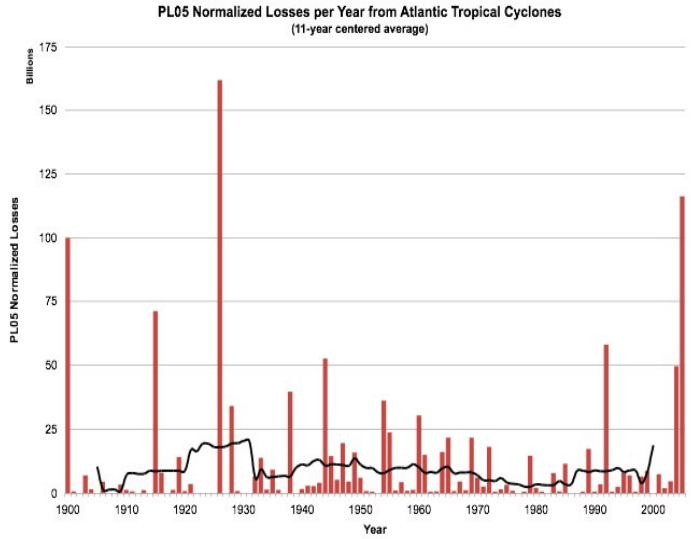


Cyclone counts in sector. Left – East of 69W (in mid-Atlantic); right – west of 69W (including landfalls). McIntyre, Climate Audit #1000, Jan 2007.

3a. Clarifying controversies:

Why has a trend been observed in overall NATL basin statistics but not in landfall observations or damages?



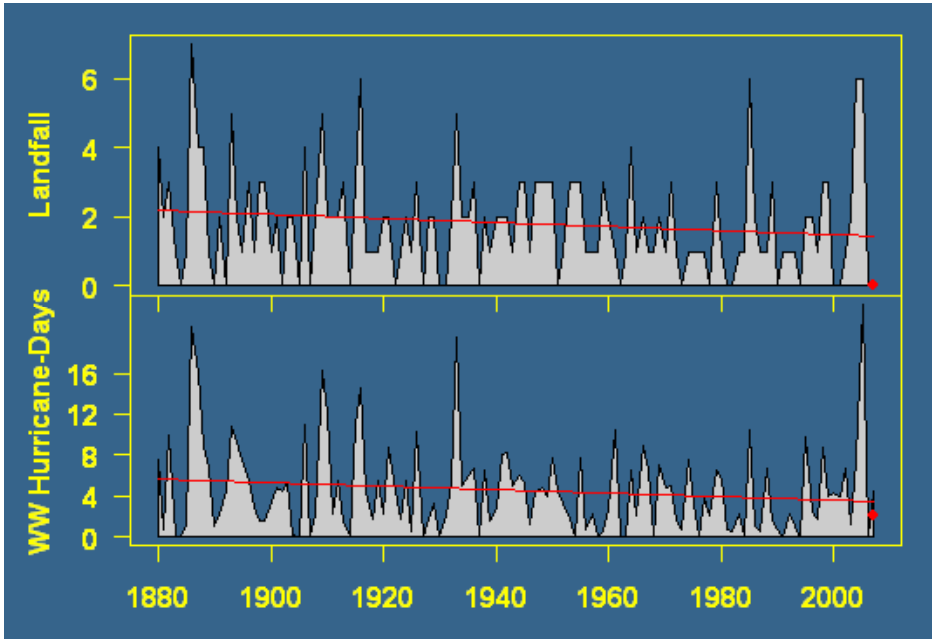


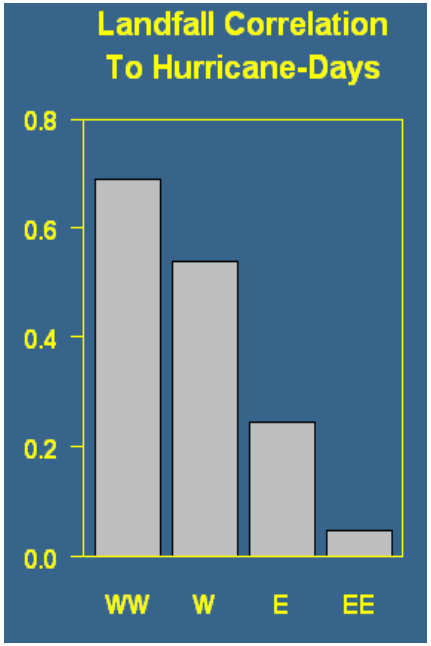
Left: U.S. landfalls (Hurdat); right: normalized losses (Pielke et al 2008)

3a. Emanuel 2005b: “randomness”

“my index has a signal-to-noise ratio that is ten times [greater] ... possible that the real trend is detectable in the power dissipation but not in landfalling statistics.”

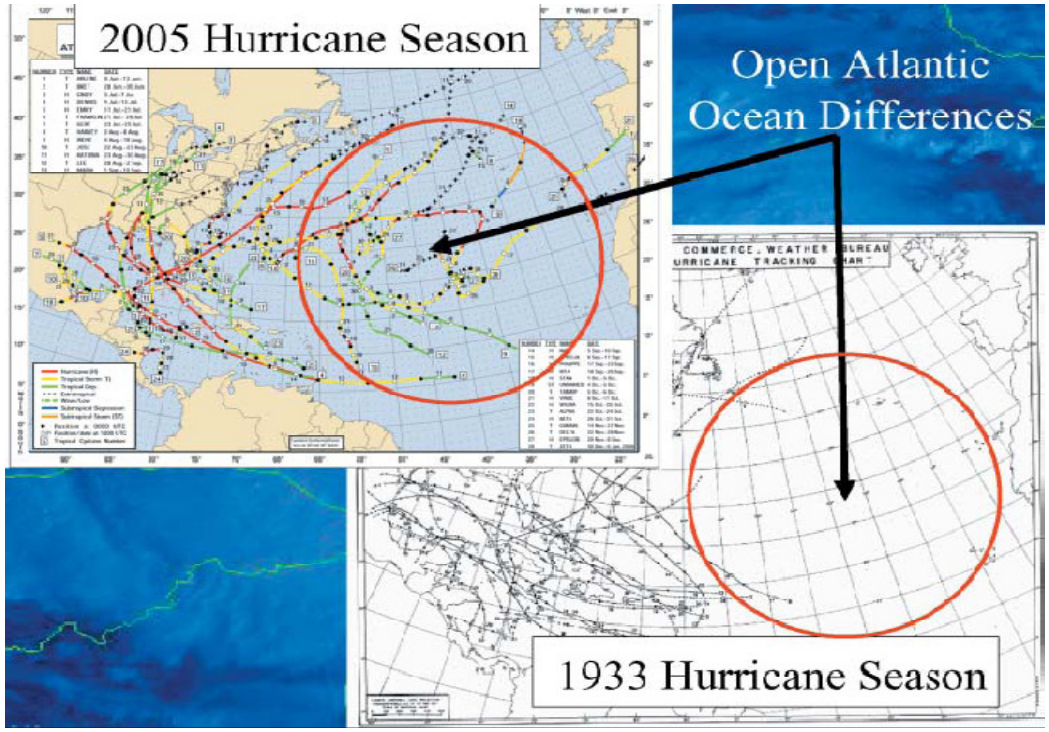
3a. Not “random” at all. Landfall related to western quartile activity and not “random”. Correlation decreases to the east.





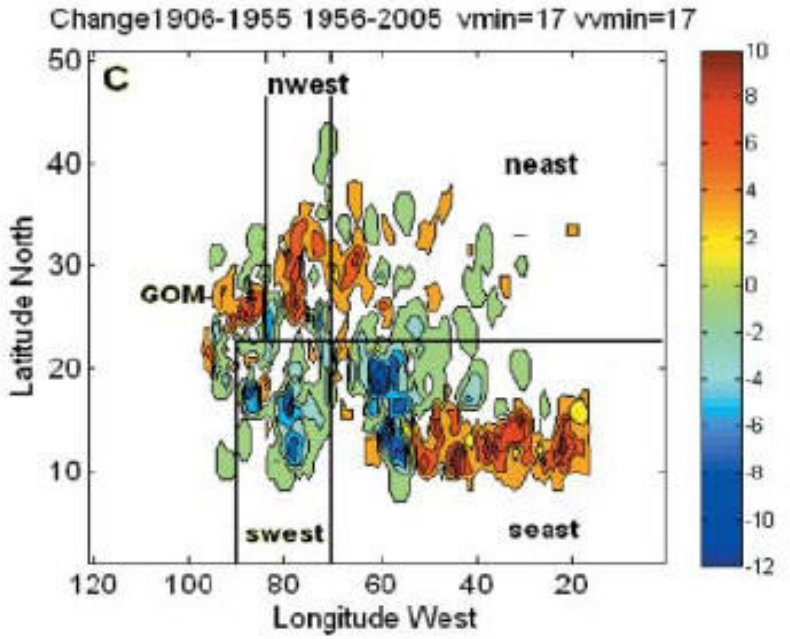
Left: Top: landfalls; bottom – western quartile (Caribbean-Gulf) hurricane-days. Right: decreasing correlation with quartile to the east.

3b. Landsea vs Holland on early detection. Landsea: differences in storm locations shows historical undercount



Landsea 2007 compared tracks in active 1933 and 2005 seasons, showing big difference in mid-Atlantic observations.

3b. Holland: "most of these systems simply were picked up later in their lifetimes"

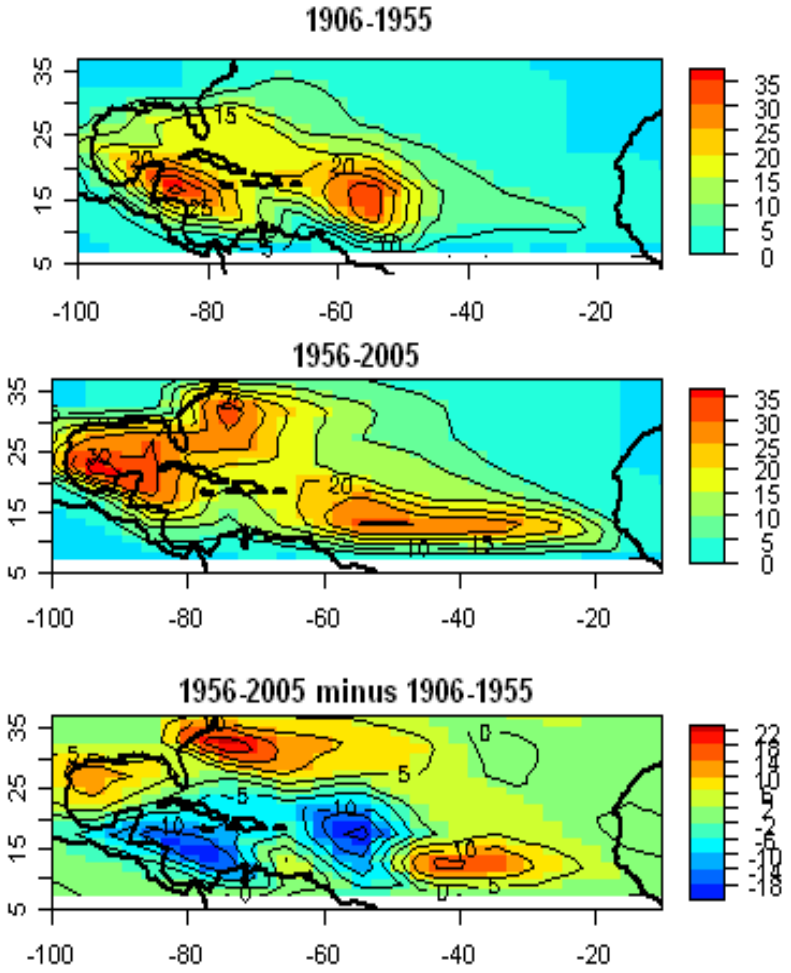


Above graphic would be clearer with continents mapped on it. Color code shows increase in genesis counts in east Atlantic (Holland, EOS, Aug 2007; Holland and Webster, AMS Conf, Jan 2007)

3b. Genesis story is a little more complicated than that. Here we further subdivided space into 5 degree grids and contoured.

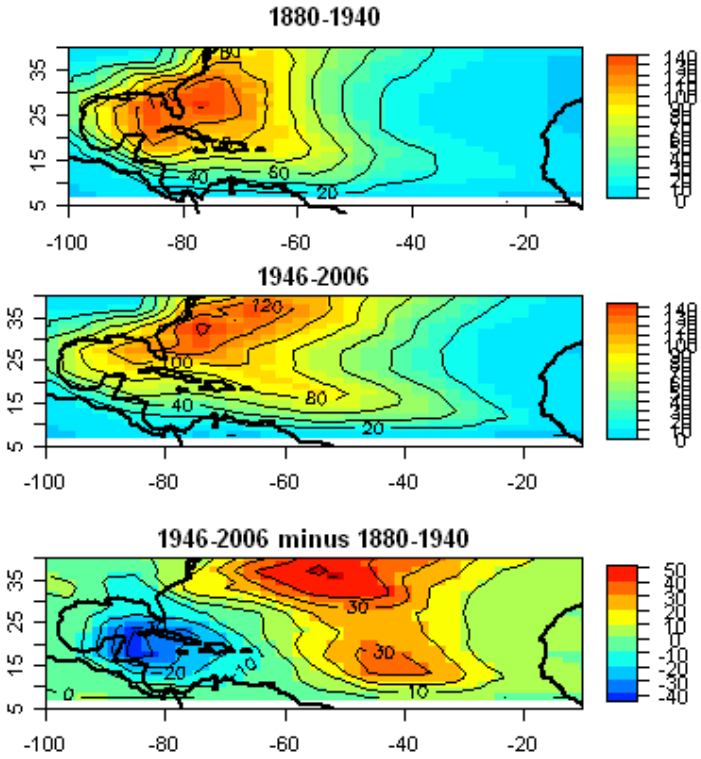
Storm genesis count contour plots. Top – 1906-55; middle 1956-2005; bottom – change between periods and **compares to Holland graphic**.

If storms are simply picked up later, then there should be no inter-period change in storm counts or storm-days in the Caribbean and Gulf.

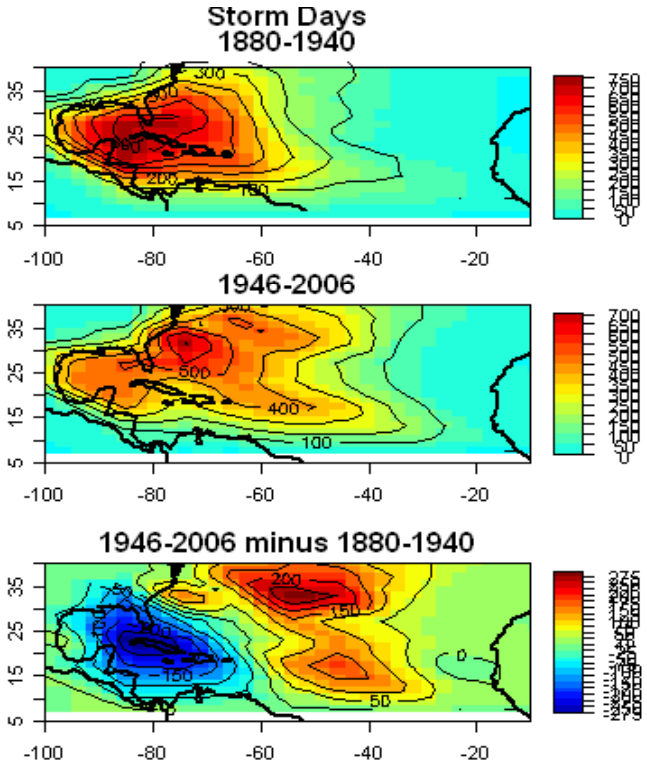


3b. But that's not what happened. Storm count and storm days also decline in the west, offset by mid-Atlantic increase, refuting Holland argument and pointing to larger issue.

COUNT

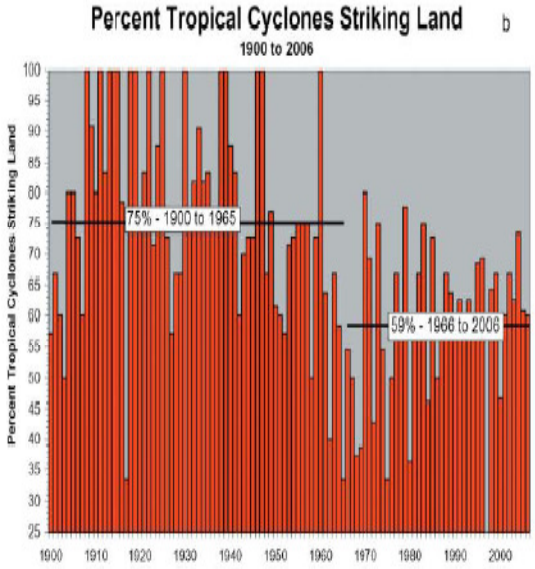


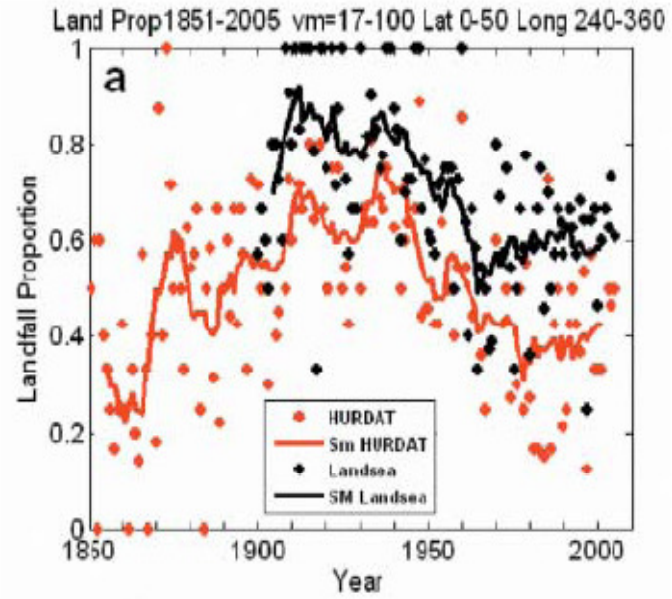
DAYS



Left- storm count. Right – storm days. Top – 1880-1940; middle 1946-2006; bottom – difference.

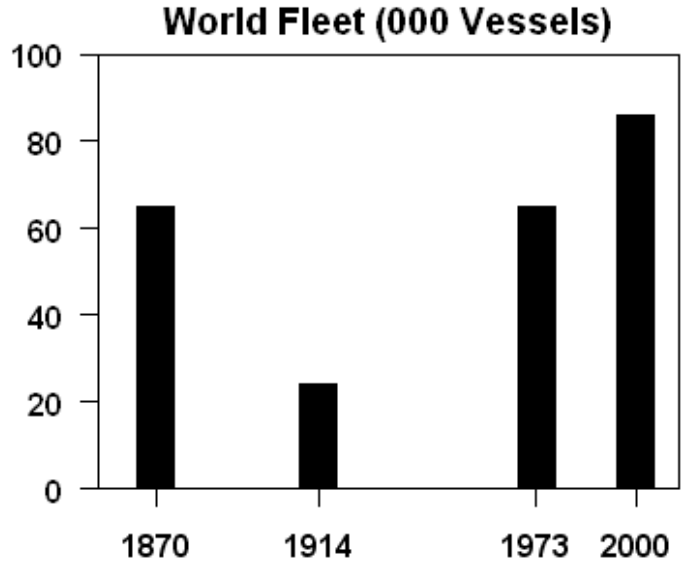
4. Climatological or technological: Landsea vs Holland on 19th century undercount

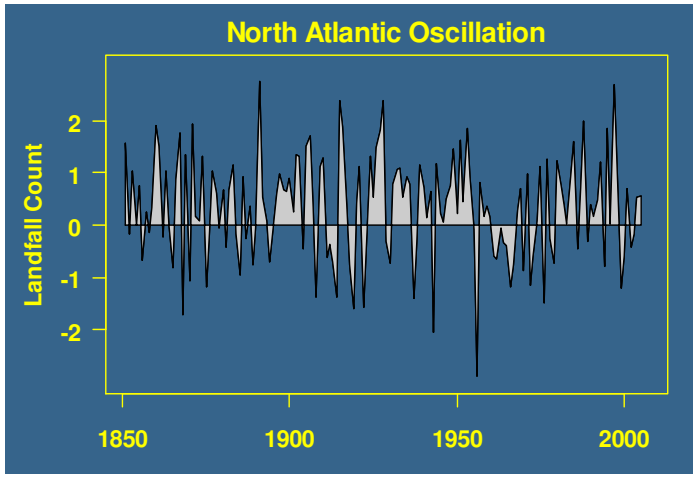




Landsea (graphic from 1900-2005): "'missed' tropical cyclones in the 19th century would likely be substantially larger because of the even sparser coverage from shipping tracks and fewer coastal regions being inhabited." Holland (showing 1850-2005): landfall proportion fluctuates and is therefore climatic, attributing variation to NAO.

Neither party considers shipping data. In 1870, there were 65,000 vessels in the world fleet, as compared with 24,000 in 1914. The world fleet did not build back up to the 1870 figure until 1973.

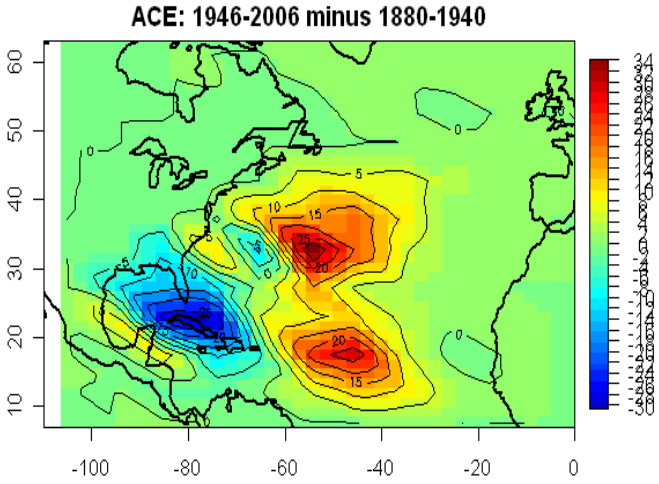


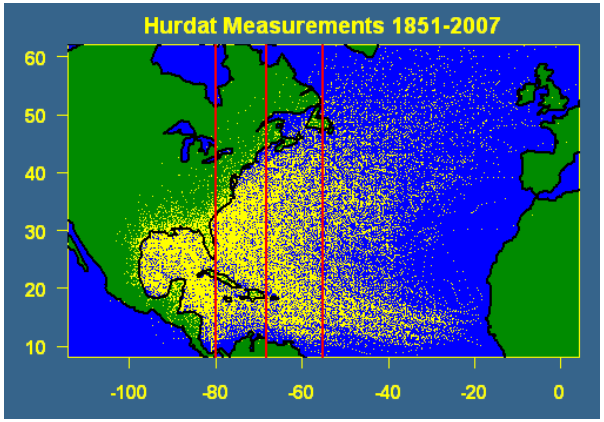


Left: World shipping fleet, selected years. Right: NAO (redrawn from Elsner and Jagger, 2006).

The NAO has little correlation to landfall proportion while changes in world fleet suggest possibility of **better** late 19th century observation than early 20th.

Technological or climatological?





- **Mid-Atlantic increase could be due to technological artifact: aircraft and satellite reconnaissance. But what if cyclones are forming earlier and re-curving earlier?**
- **There is no statistically significant evidence so far that this "trend" is any less significant than the overall increase (although a large technological component seems likely)**

What Happens in Vegas

The increased hurricane activity that everyone is debating has occurred entirely in the mid-Atlantic remote from human impact.

If one of the effects of AGW is an increase in hurricane activity in the mid-Atlantic due to earlier re-curving hurricanes, should policy-makers care?

Conclusions

1. Spatially descriptive statistics can contribute to analysis of controversial hurricane issues.
2. There has been no statistically significant increase in cyclone activity in the western Atlantic basin; the entire increase in measured storm and hurricane activity has taken place in the mid-Atlantic;
3. Lack of trend in landfall and normalized damage reconciles perfectly with lack of trend in western quartile storm and hurricane indices
4. The eastward shift cannot be attributed merely to earlier detection.
5. The shift could be technological or climatological or some combination; there is no plausible statistical basis for saying that the shift to the mid-Atlantic is not as important or relevant as the overall increased.
6. If the trend only occurs in the mid-Atlantic, should policy-makers care?