



# Hurricane Trend detection

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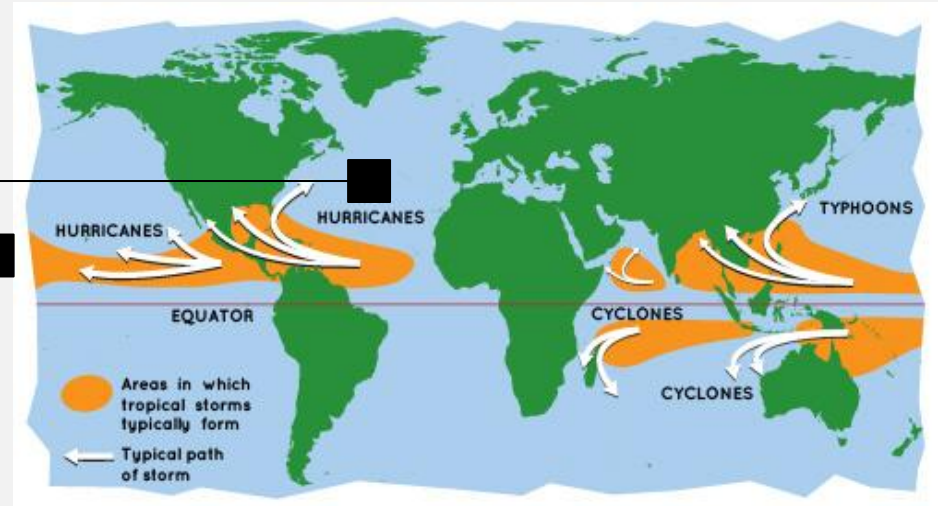
# What is a hurricane?

## Tropical cyclone

a severe, rotating storm  
with heavy rains and  
cyclonic winds

## Hurricane

tropical cyclones formed over the  
Atlantic Ocean or eastern Pacific  
Ocean.





# Formation of Hurricanes



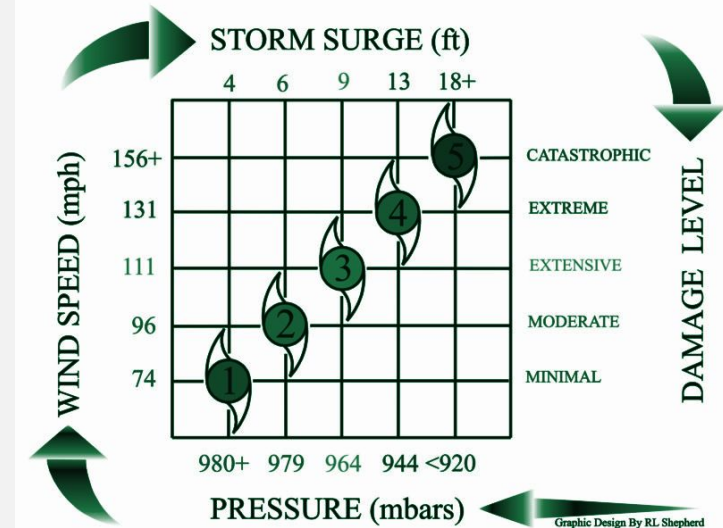
Hurricanes form only over warm ocean waters near the equator: warm air rises, causing an area of lower air pressure below. The whole system of clouds and wind spins and grows, fed by the ocean's heat and water evaporating from the surface. As the storm system rotates faster and faster, an eye forms in the center. In the eye it is very calm, with very low air pressure.



# Intensity

The Saffir-Simpson scale categorizes hurricanes on a scale from 1 to 5. Category 1 hurricanes are the weakest, and 5's the most intense. Hurricanes strong enough to be considered intense start at category 3 or with sustained winds exceeding 96 knots (111 mph).

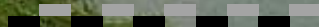
## SAFFIR-SIMPSON HURRICANE SCALE





Is the rate at which something occurs over a particular period of time or in a given sample.

# Frequency



# Does climate change affect the increase in hurricanes?

By Craig Loehle and Erica Staehling





# Description of the problem

Some argue that ocean warming should increase hurricane frequency and intensity, though others disagree. Various studies have found upward, downward or flat trends in hurricane numbers over various time periods.



# How the authors faced it

## Collection of Data

Data were collected from the National Hurricane Center

1



## Poisson distribution

The distribution of data can be represented by a Poisson regression

2



## Statistical tests

Many statistical tests were performed in order to find out whether there could be correlation

3



## Interpreting results

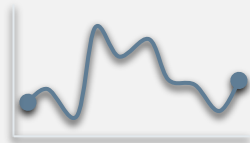
Results showed a lack of explanatory power in this kind of model

4





# Results



Hurricane trends are usually attributed to cyclic forces and more recently to external anthropogenic forces.

Researches found out an interesting correlation between the frequency of hurricanes and the AMO index: transitions between AMO phases generate positive trends for negative-positive transitions of the index. This direction of shift supports the AMO influence theory, but individual AMO shift influence is not statistically significant.

These results suggest that detection of changes is difficult in the short term due to high variability of data.

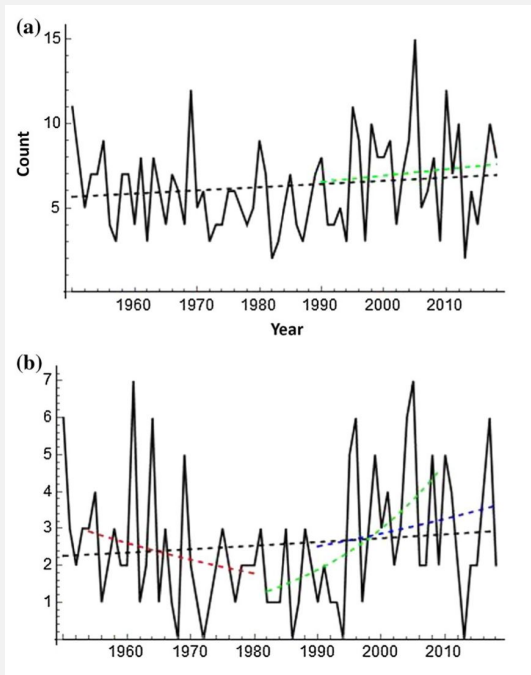
**Table 1** Hurricane counts and ratios for US landfalling storms versus AMO phase (after Klotzbach and Gray 2008 and Klotzbach et al. 2018). Columns 3 and 4 are mean annual counts (first five rows) or ratios (last five rows)

Period	AMO phase	All hurr	Cat. 3–5
1878–1899	Positive	2.27	0.636
1900–1925	Negative	1.73	0.462
1926–1969	Positive	1.84	0.682
1970–1994	Negative	1.24	0.44
1995–2012	Positive	1.83	0.556
Ratio (1878–1899/1900–1925)	Positive/negative	1.31 ns	1.38 ns
Ratio (1926–1969/1900–1925)	Positive/negative	1.06 ns	1.48 ns
Ratio (1926–1969/1970–1994)	Positive/negative	1.48*	1.55 ns
Ratio (1995–2012/1970–1994)	Positive/negative	1.48 ns	1.26 ns
All positive/all negative	Positive/negative	1.32*	1.43 ns

ns not significant: \* $P < 0.05$ ; \*\* $P < 0.01$



# Conclusions



## Challenge

Global warming - increase in long-term mean global hurricane activity



## Spurious Correlations

When based on short series studies



## Temporal Biases

Inferences highly dependent on period chosen



## "A globally consistent reanalysis of hurricane variability and trends"

- ❖ Inconsistent records
- ❖ No direct correlation local SST- hurricane intensity
- ❖ An increase of SST does increase the maximum potential intensity



## "Modeled Impact of Anthropogenic Warming on the Frequency of Intense Atlantic Hurricanes"

- X2 frequency for category 4-5
- Decrease in overall frequency!



*Bander et al. (2010)*

## "Increasing destructiveness of tropical cyclones over the past 30 years"

- Index of potential destructiveness
- Global warming ↗ destructive potential



*K. Emanuel (2005)*





# References

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- Craig Lohele and Erica Staehling, (2020), Hurricane Trend Detection, Springer Nature, 104:1345–1357
- Emanuel KA (2005) Increasing destructiveness of tropical cyclones over the past 30 years. *Nature* 436:686–688. <https://doi.org/10.1038/nature03906>
- Kossin JP, Knapp KR, Vimont DJ, Murnane RJ, Harper BA (2007) A globally consistent reanalysis of hurricane variability and trends. *Geophys Res Lett* 34:L04815. <https://doi.org/10.1029/2006gl028836>
- Saunders MA, Lea AS (2008) Large contribution of sea surface warming to recent increase in Atlantic hurricane activity. *Nature* 451:557–560. <https://doi.org/10.1038/nature06422>

# Thanks!

Do you have any questions?

