

# Interpreting the climate record for trends in North Atlantic Hurricanes

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# Hurricanes and Society

- Cause billions of dollars of damage each year.
- The 5 most destructive Atlantic hurricanes of the past 10 years (not including Sandy) have caused a combined loss of ~\$190 billion.



Match the GDP of the Czech Republic



Match NASA's spending on the entire 40 year history of its space shuttle fleet

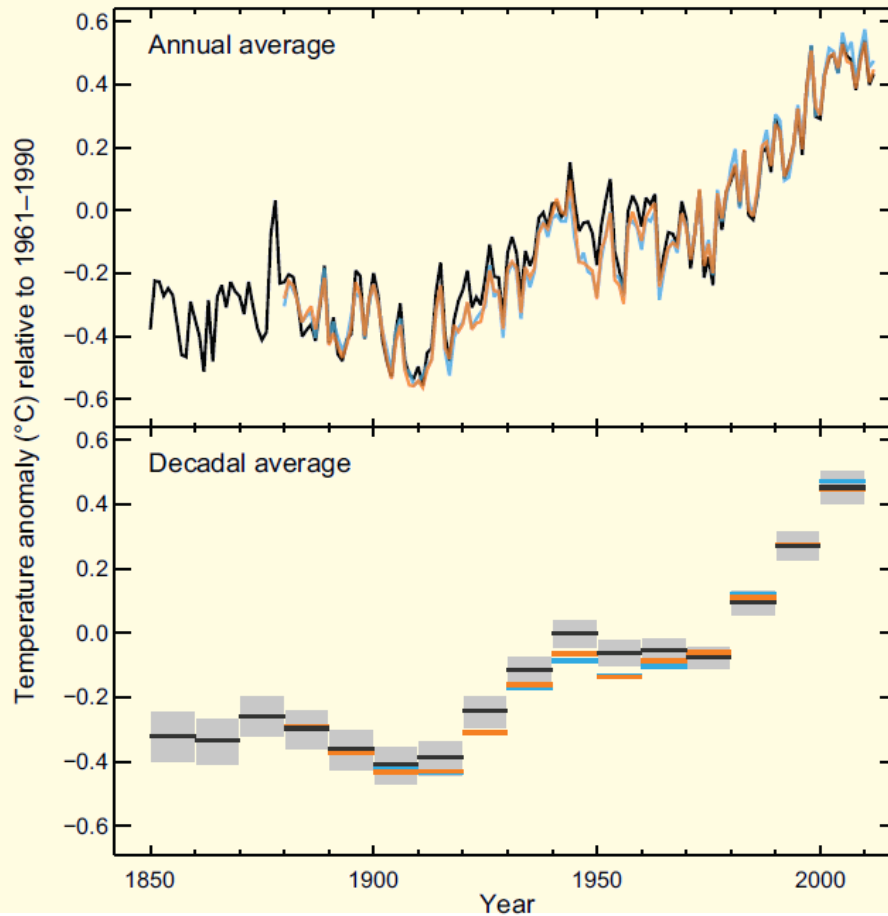


Have the lion's share of a deposit for a 2-bed ex-council flat in Marylebone

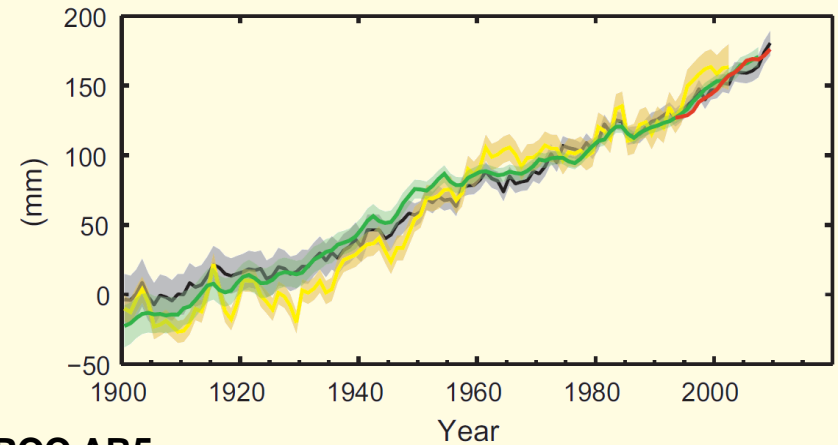
- Devastating loss of life – the Great Bhola Cyclone in Bangladesh, 1970, is estimated to have caused 300,000 – 500,000 deaths.
- In recent years, an obsession with weather and climate trends has developed, with particular emphasis on anthropogenic change...

# Climate Change is undeniable

Observed globally averaged combined land and ocean surface temperature anomaly 1850–2012

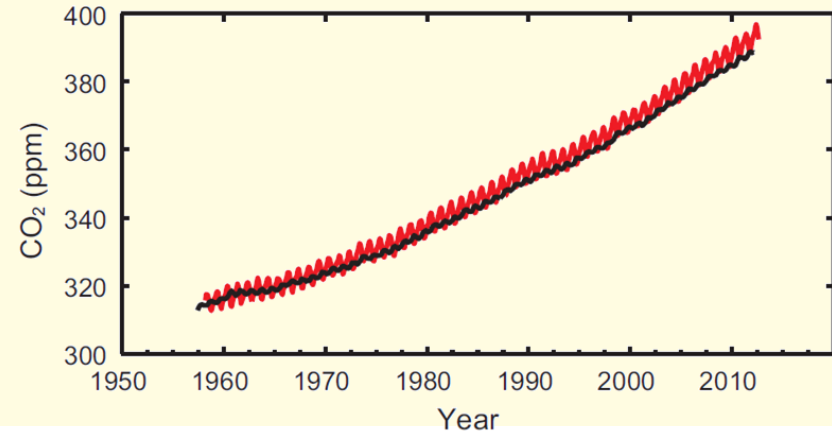


Global average sea level change



IPCC AR5

Atmospheric CO<sub>2</sub>



**HOWEVER:**

**Climate is **NOT** Weather**

**How anthropogenic climate change  
affects severe weather events remains  
uncertain**

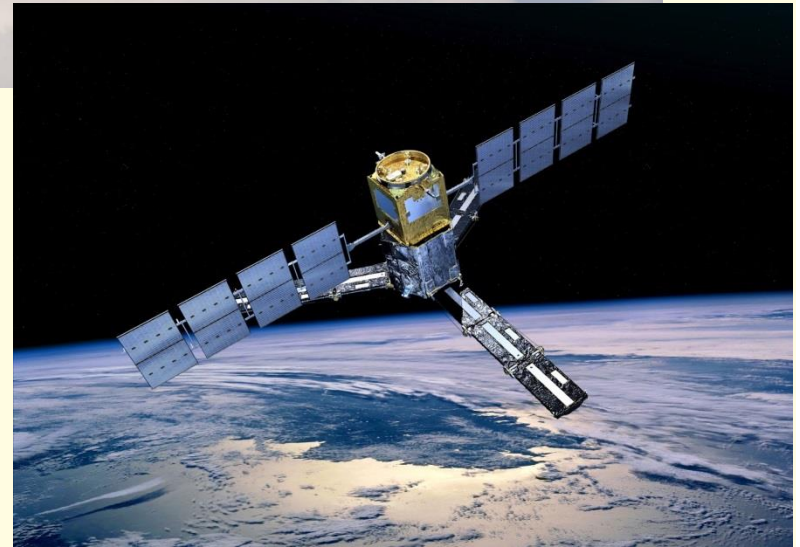
# Climate Change and Hurricanes: The Science

- From contemporary climate change projections, there are 3 large scale changes that look likely to impact Atlantic hurricane formation:
  - 1) Increased Sea Surface Temperatures:
    - ★ Greater Area for hurricanes to form over
    - ★ Increased intensity potential from deeper warm ocean.
  - 2) Increased vertical wind shear:
    - ★ Much like an El Niño event
    - ★ Decreased chance of hurricane formation.
  - 3) Decreased humidity:
    - ★ Drier mid-layer of atmosphere
    - ★ Decreased chance of hurricane formation.

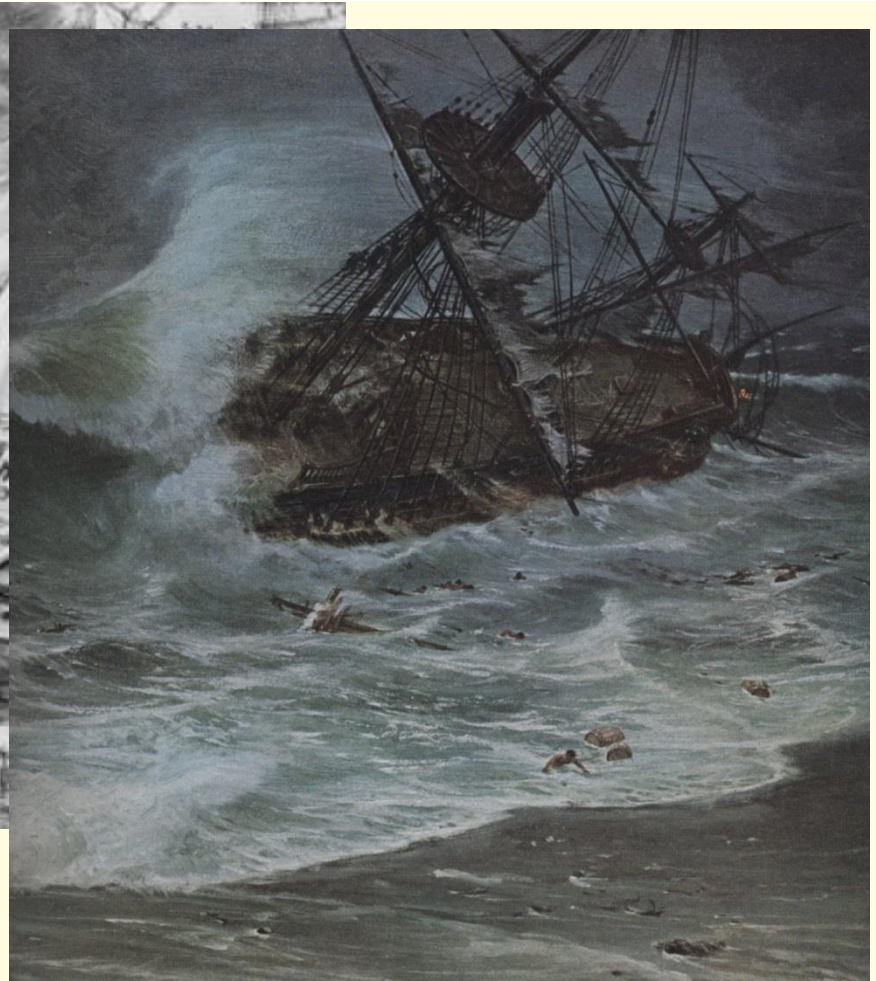
Ocean Basin	Ocean Warming	Wind Shear	Relative Humidity	Overall effect on TC numbers/intensities
Atlantic/E. Pac	Increase	Increase	Decrease	???
W. Pac/Indian	Increase	Decrease	Increase	INCREASE

# **Atlantic Hurricanes: Where do records come from?**

# Modern Flights and the Satellite Era



# Pre Flights and Satellites?





# The Hall of Records

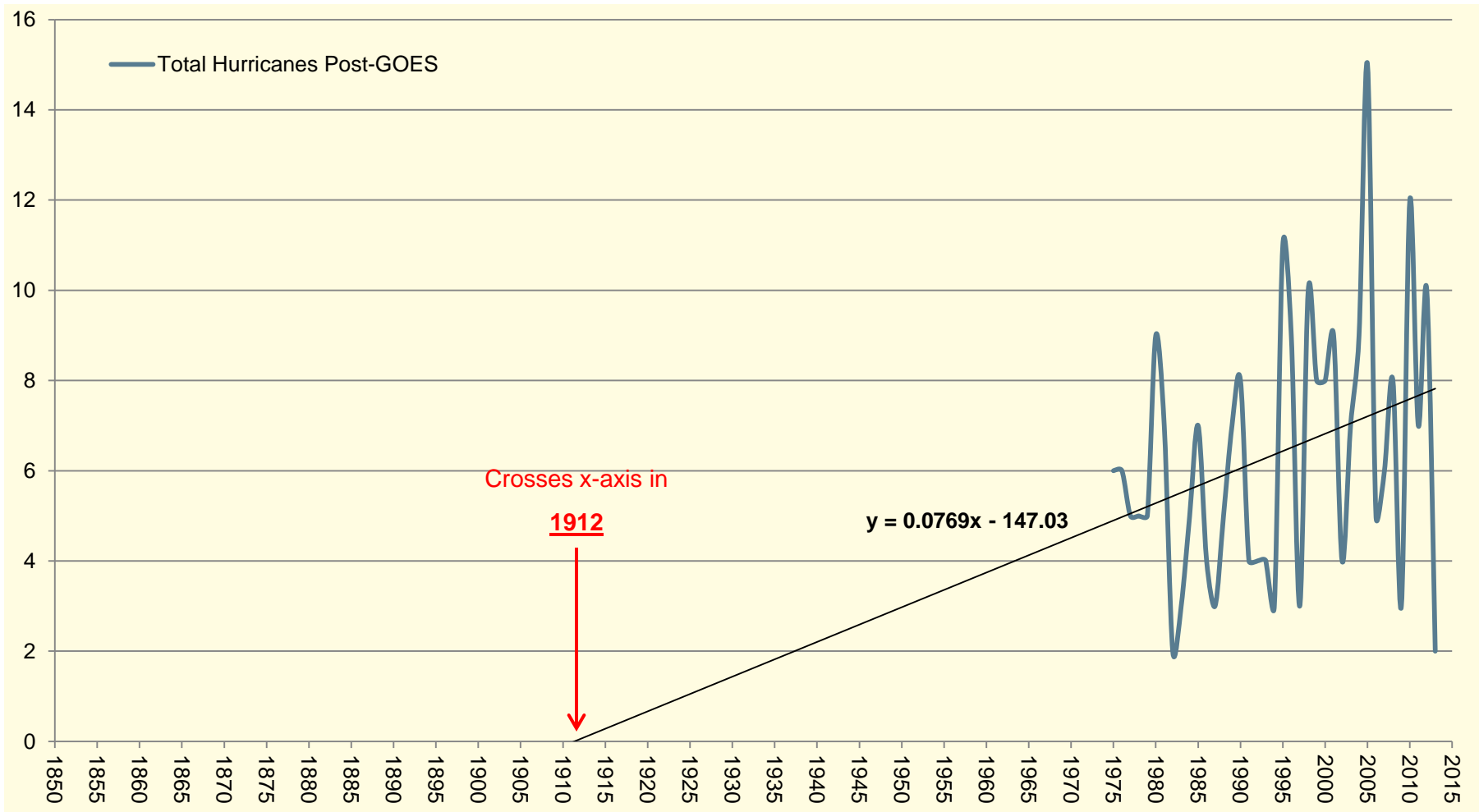
- **Homer** : Oh Lisa, there's no record of a hurricane ever hitting Springfield.
- **Lisa**: Yes, but the records only go back to 1978 when the Hall of Records was mysteriously blown away!

- *The Simpsons*

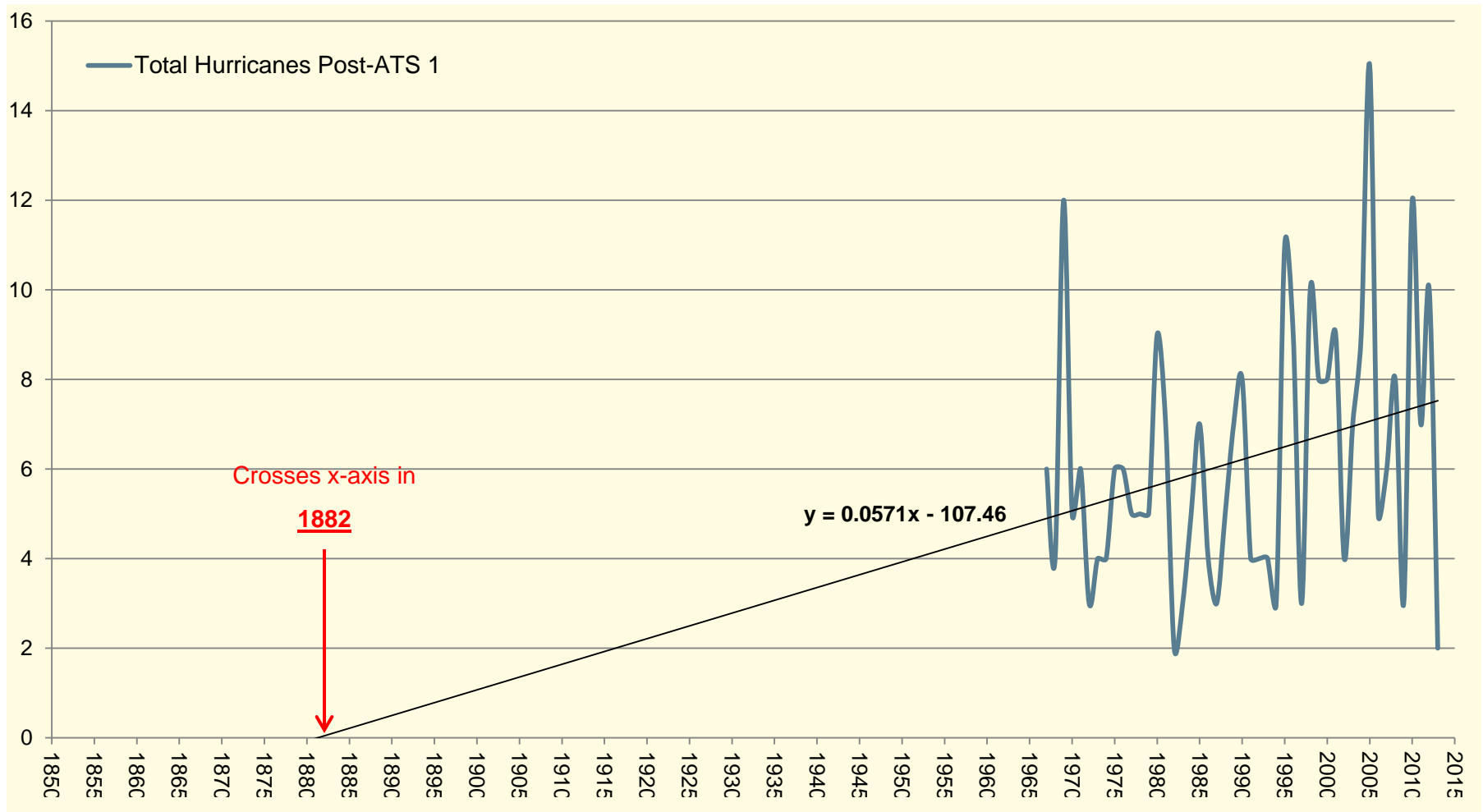


# **The Atlantic Hurricane Record: HURDAT**

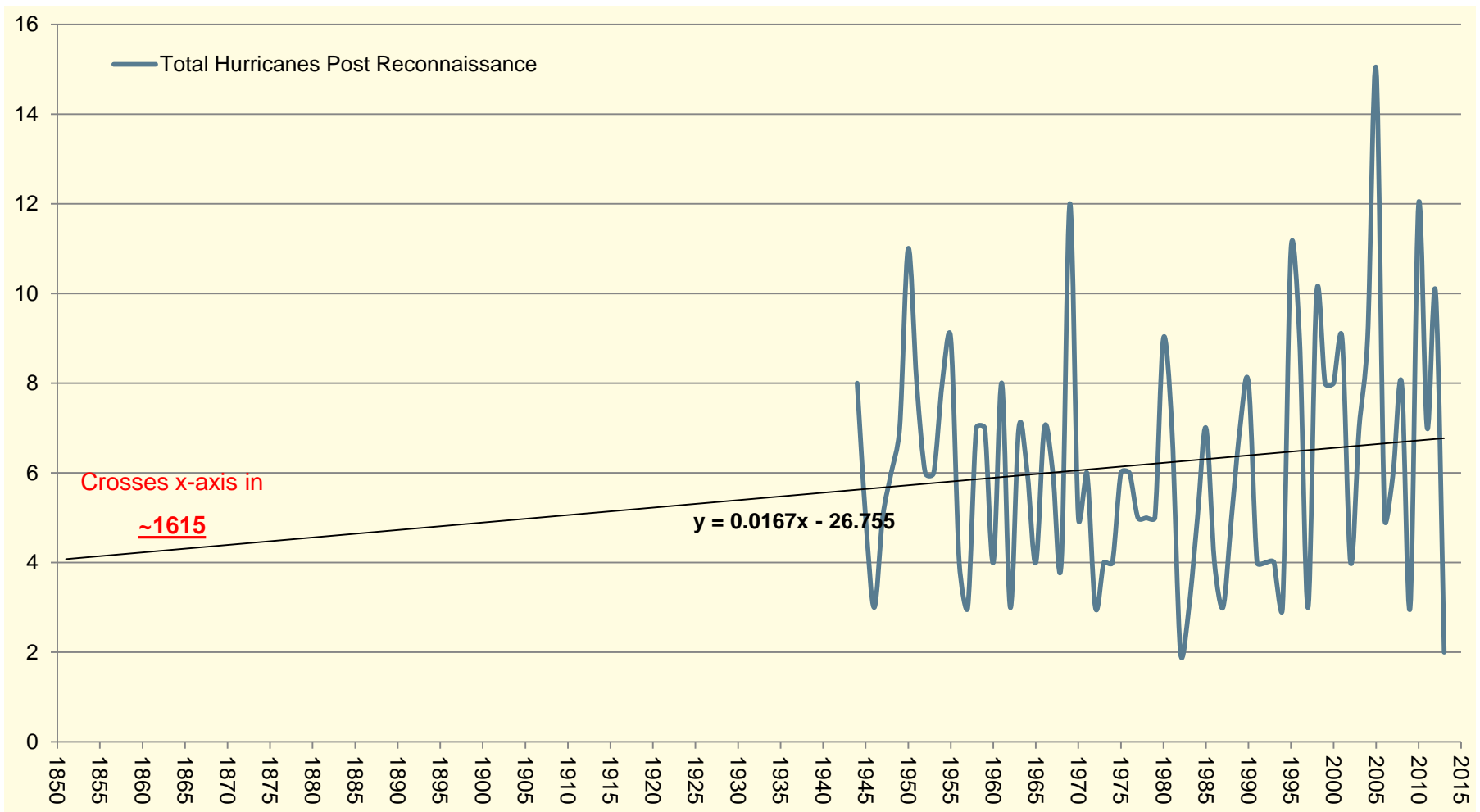
# Total Hurricanes, Post-GOES (1975)



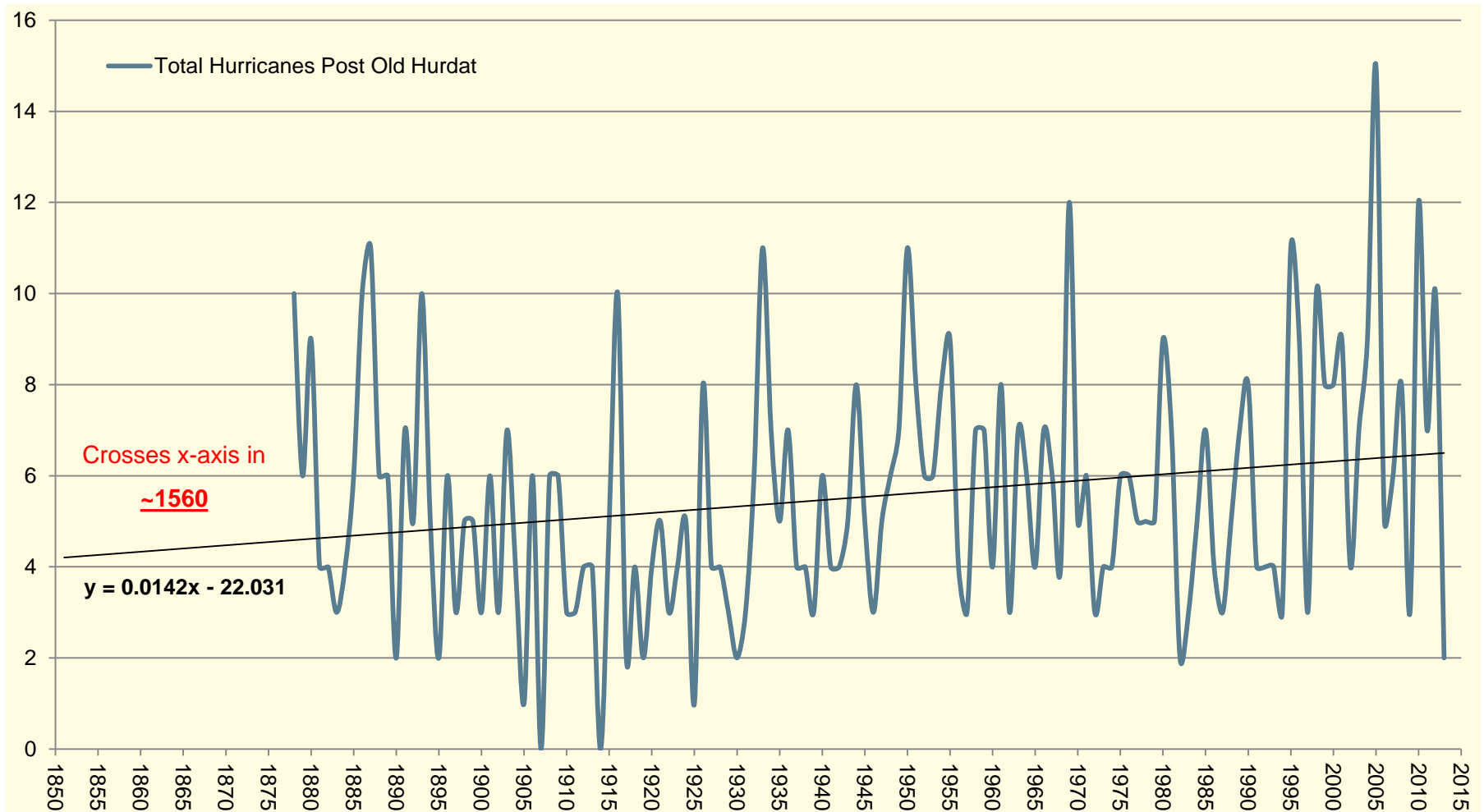
# Total Hurricanes Post-ATS 1 (Dec 1966)



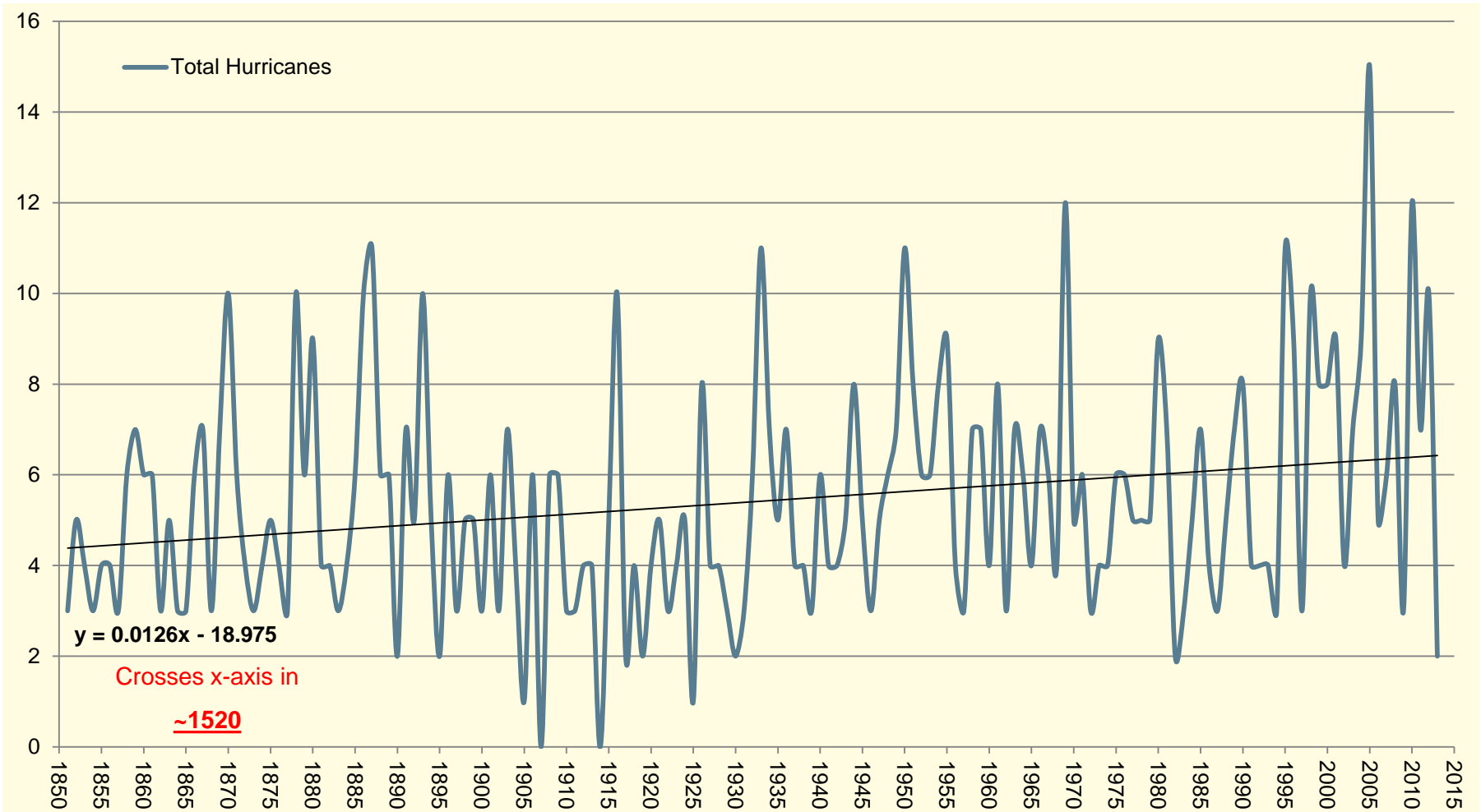
# Total Hurricanes Post-Reconnaissance Flights (1944)



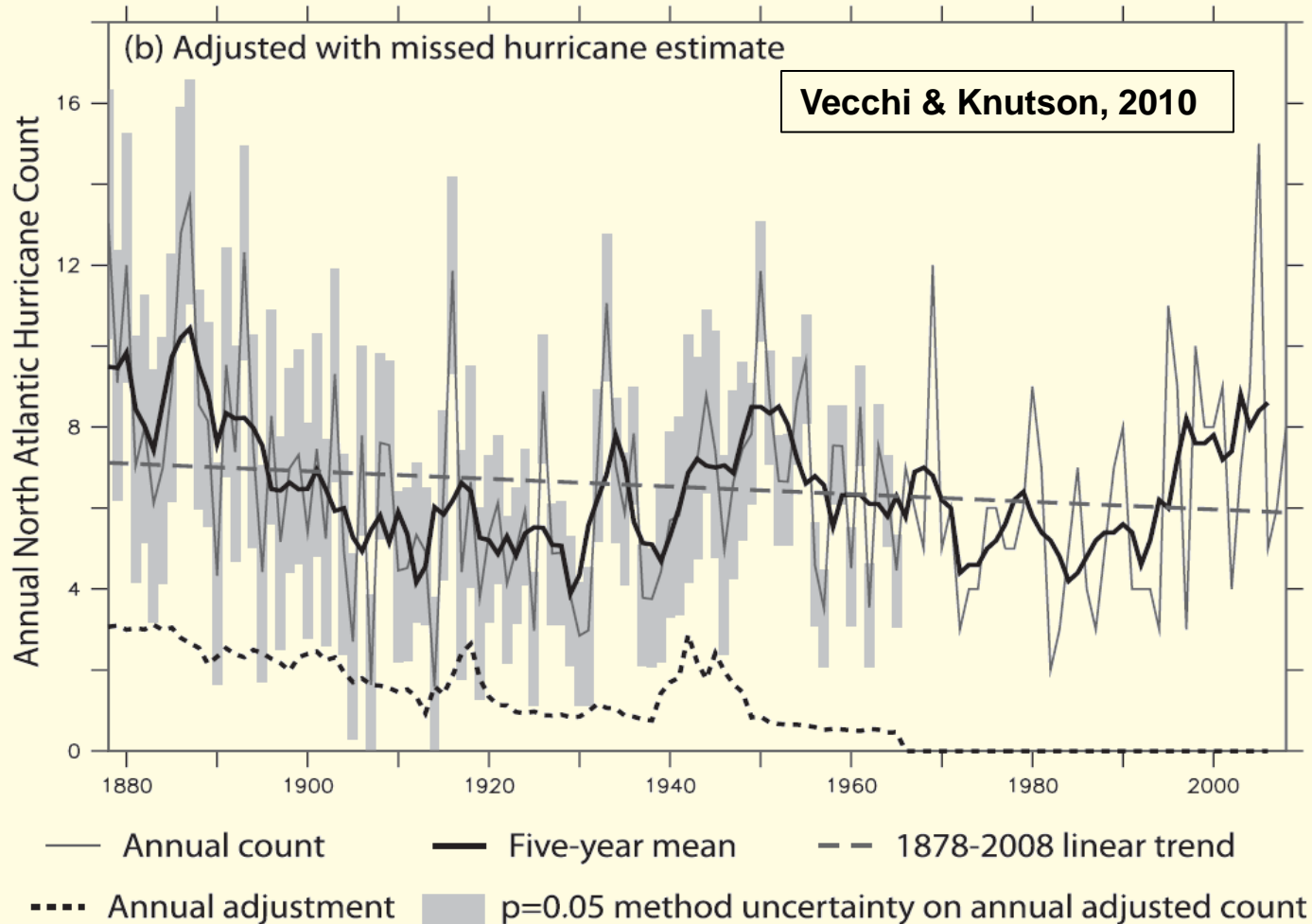
# Total Hurricanes Post-Old Hurdats (1878)



# Total Hurricanes, current HURDAT



# Adding in “Missing” Storms pre-ATS 1

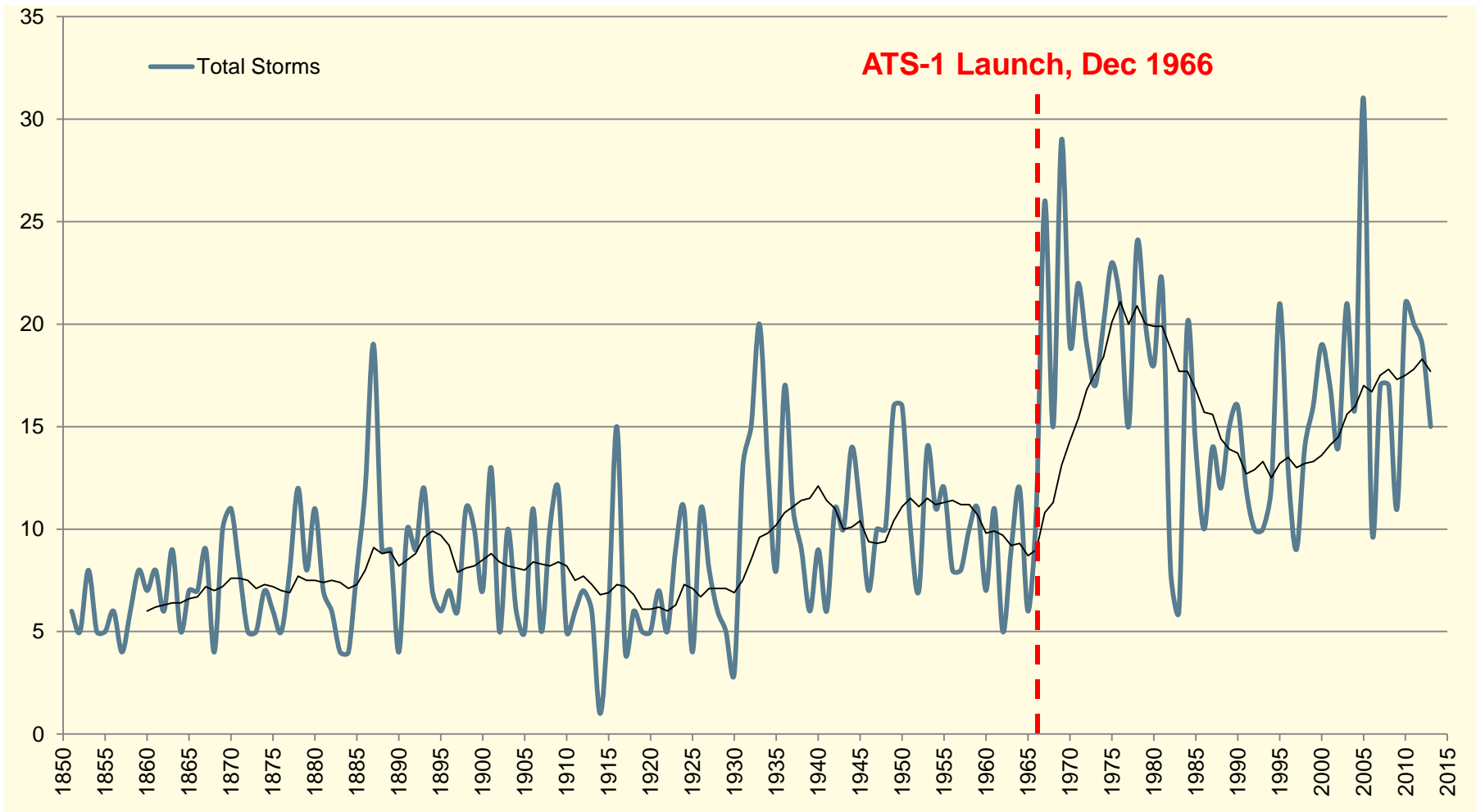




# Why Use Windspeed?

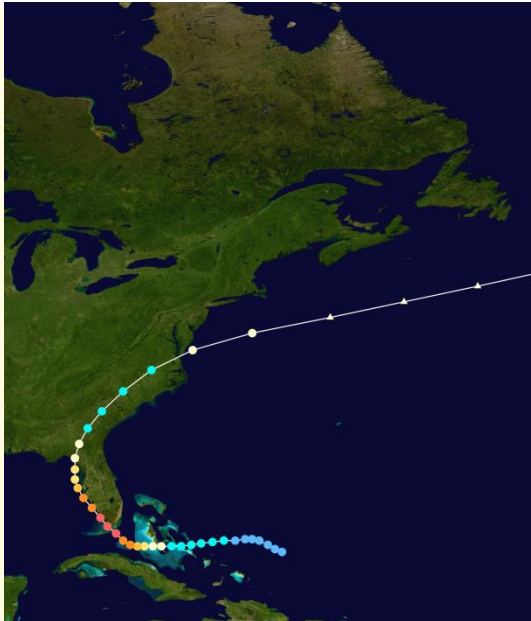
- Only 3 of the 10 deadliest US storms were “major” hurricanes (i.e. Category 3 or higher) at landfall.
- 6 of the 10 deadliest were Category 1 at landfall.

# HURDAT Total Tropical Storms Per Year



# Historical Hurricanes

# Case Study: Labor Day Storm, 1935



- Relatively Small: ~250km wide.
- BUT very intense – estimated winds of 200mph and storm surge of 15-20ft.
- Every single tree and building on Matecumbe Key disappeared, ~\$103million in 2014 currency.
- The majority of the population of the middle Florida Keys lost their lives, as well as a substantial fraction in the Northern Keys.



- 259 US veterans who had been tasked with building a highway linking the keys also died.
- “Ignorance has never been an excuse for murder or manslaughter.”

- Ernest Hemingway in an open letter to FDR's government

# Case Study: Hurricane Camille, 1969



- Rapidly intensified shortly before landfall to a category 5 hurricane near Bay St. Louis in Mississippi, ~50 miles east of New Orleans.
- 190mph winds and a 22.6ft storm surge, the highest in the US until Katrina.
- Flattened nearly everything in its path.
- 259 dead, \$9.13 billion damages in 2014 currency.

(Criswell and Cummins 1970)



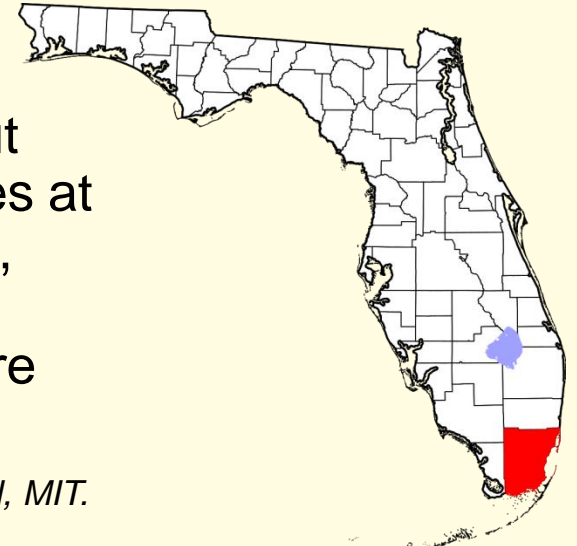
Motels West of Biloxi, Mississippi

- “Many were warned to evacuate. Some refused. Some did leave and returned. Everyone thought their houses and buildings were safe because they’d survived the last bad hurricane 22 years earlier.” - Julie Guice, Civil Defense Director for Biloxi, Mississippi

# Case Study: Great Miami Hurricane, 1926



- Made landfall as category 3, max wind 128mph, storm surges of 8-15ft.
- Much of downtown Miami and Miami beach lay in ruins.
- It caused ~\$2billion damages in 2014 currency.
- “In the 40 years from 1926 to 1966, Dade County, Florida, was struck by hurricanes **13 times**. But there were no hurricanes at all for the next 25 years, during which time the county’s population more than doubled.”

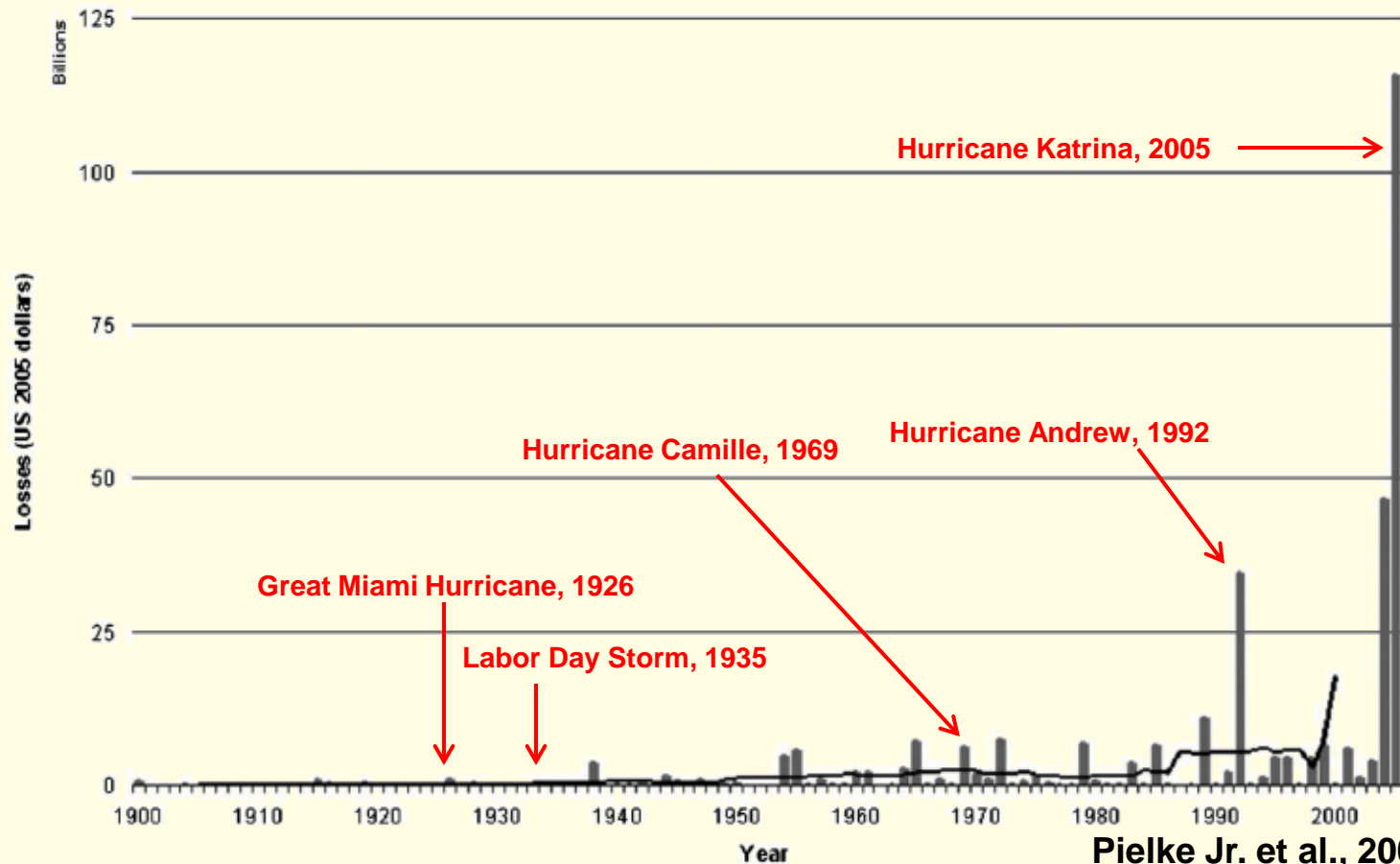


- Kerry Emanuel, MIT.

# The US Hurricane Loss Record

# Inflation Adjusted losses

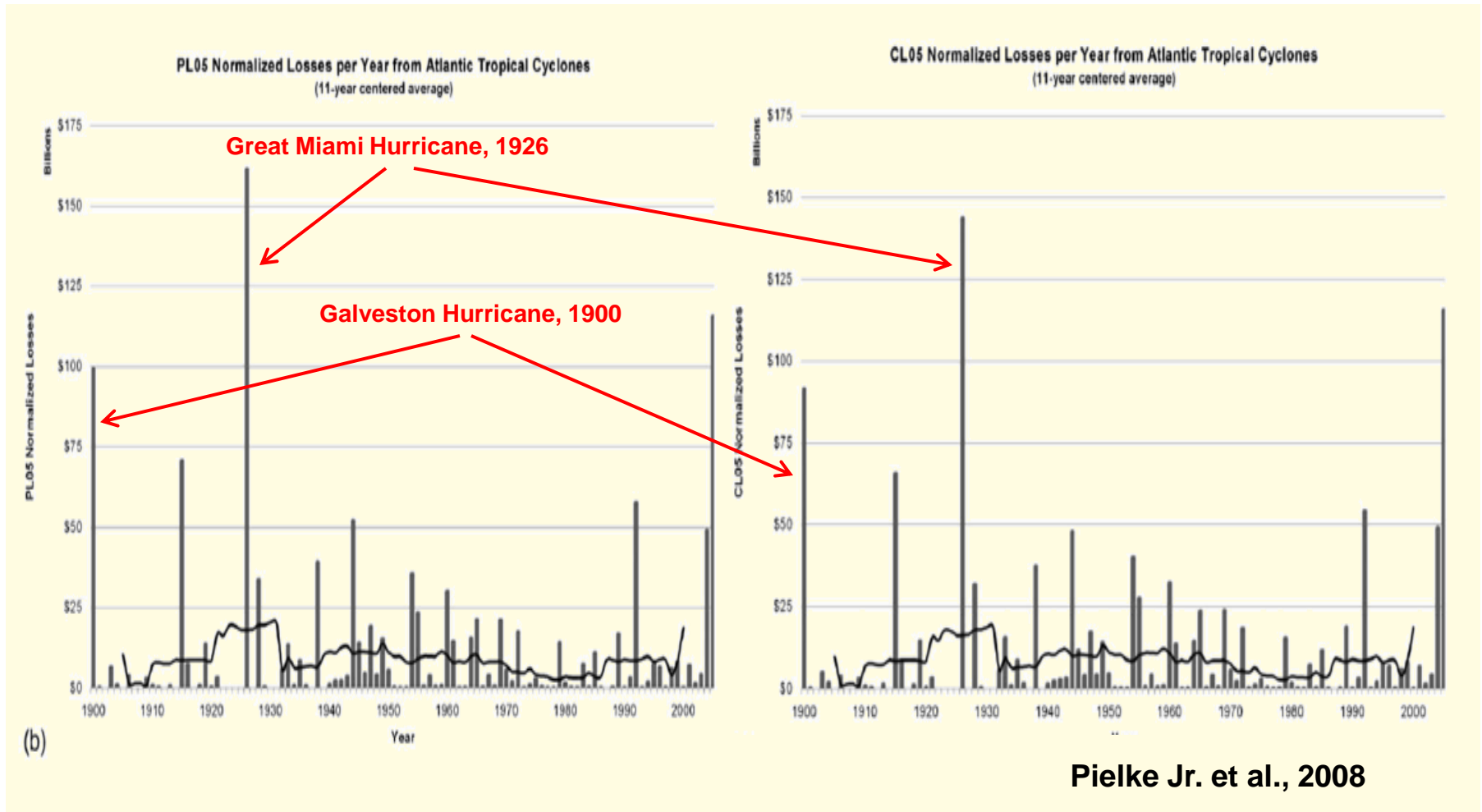
Total Losses per Year from Atlantic Tropical Cyclones in 2005 Dollars  
(11-year centered average)



Pielke Jr. et al., 2008



# Normalized losses



# Conclusions

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- Although it is indisputable that it is occurring, Climate Change is **ALMOST CERTAINLY NOT** the main driver of the increase in Atlantic hurricane losses in recent years.
- The main cause of this is much more likely the almost exponentially increasing **VULNERABILITY** of our insured societies.

**Questions?**