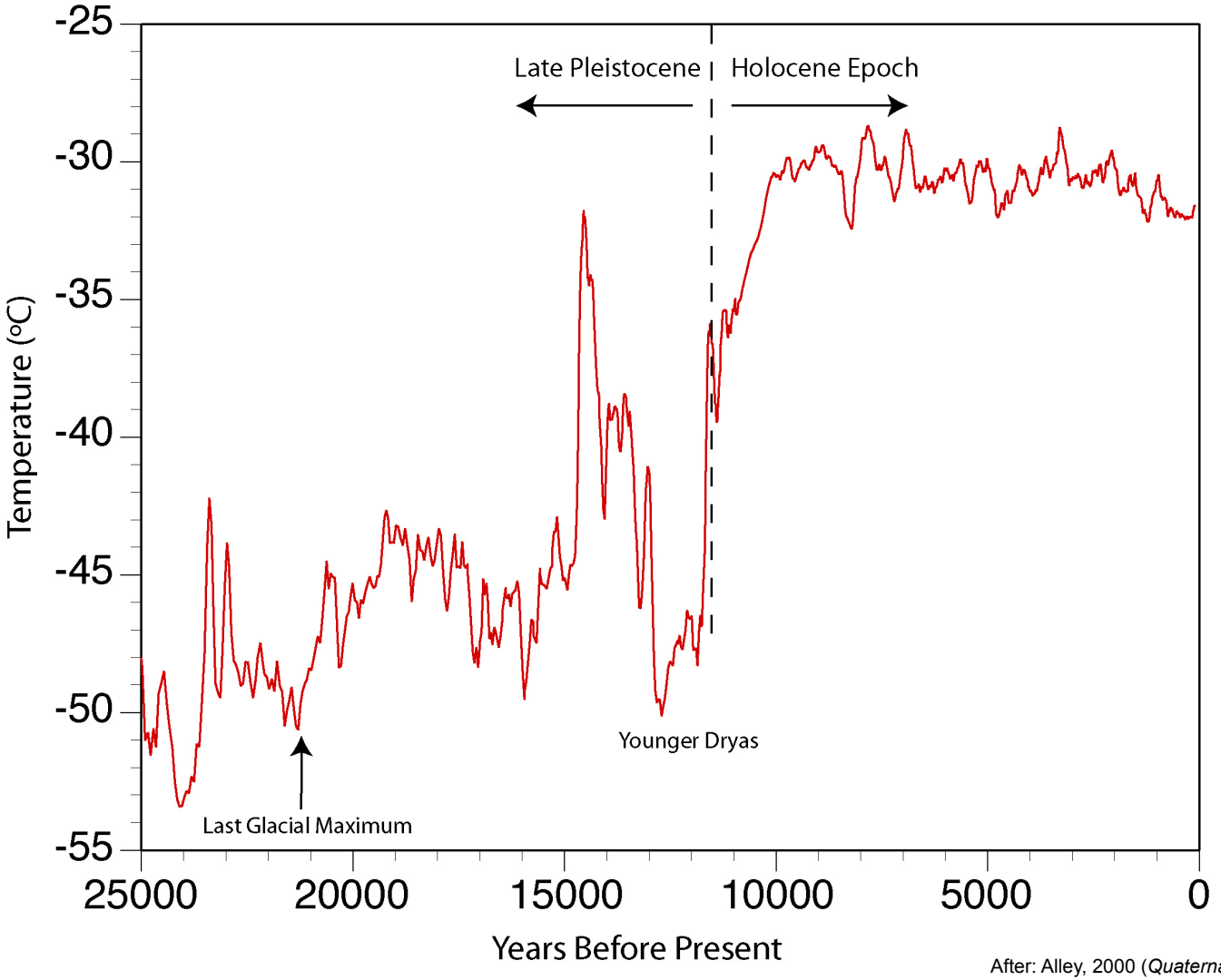
# Global Warming:

*Hurricanes*

# Holocene Paleoclimate

## Central Greenland: GISP2




After: Alley, 2000 (*Quaternary Science Reviews v.19)*

# What is a tropical cyclone?

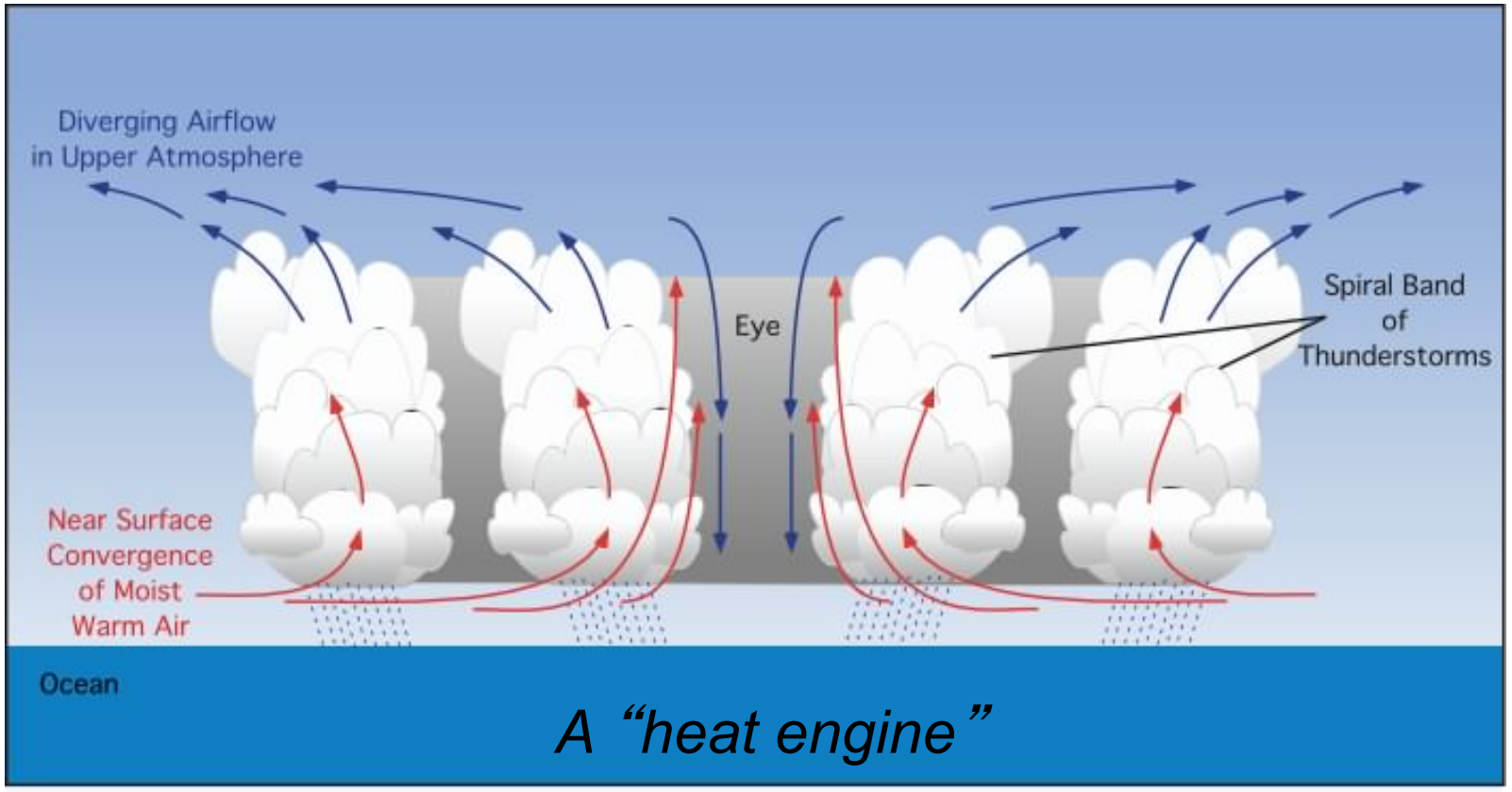
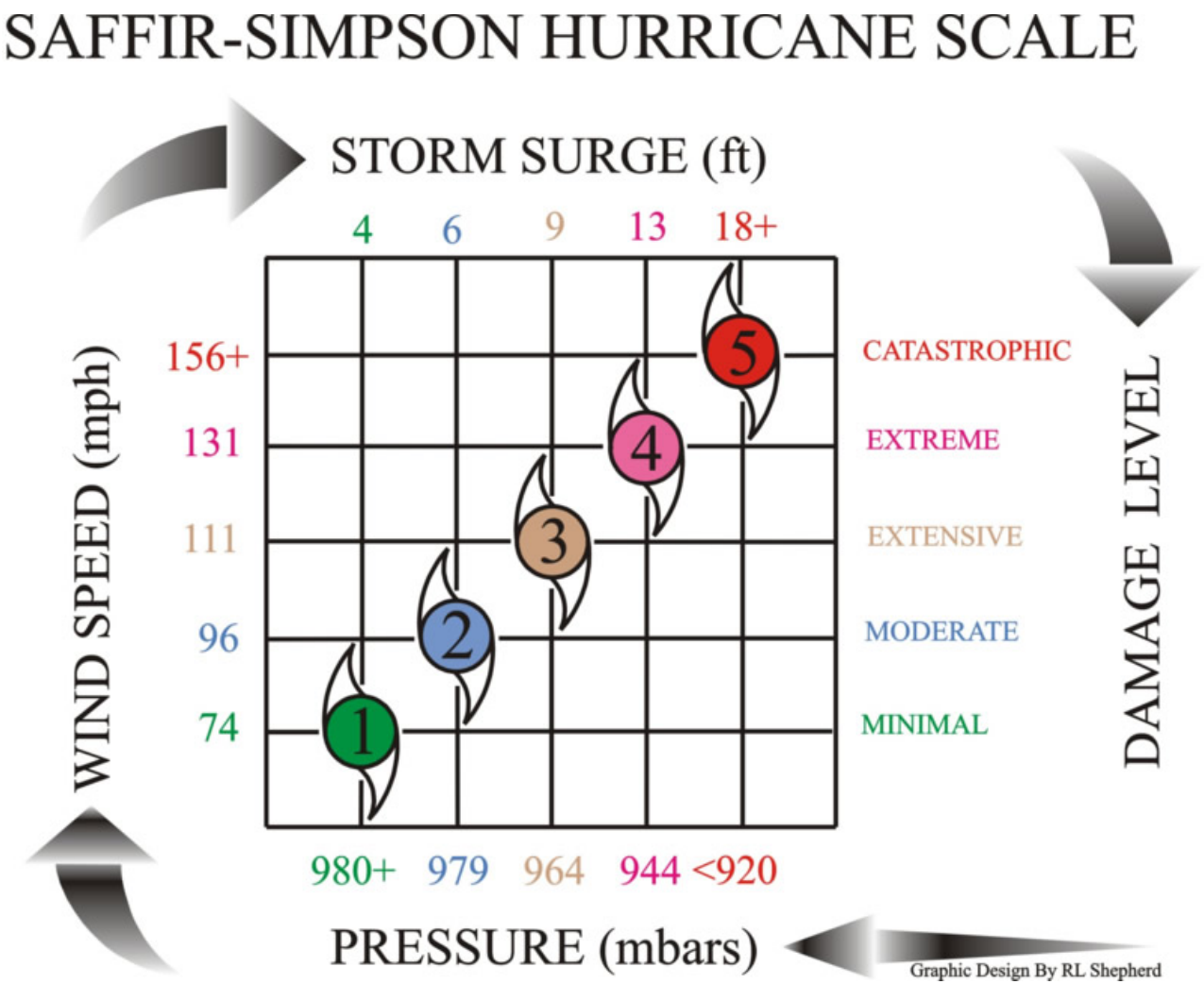



Image: Dr. Michael Pidwirny, University of British Columbia

Hurricane FAQ: http://www.aoml.noaa.gov/hrd/tcfaq/tcfaqHED.html

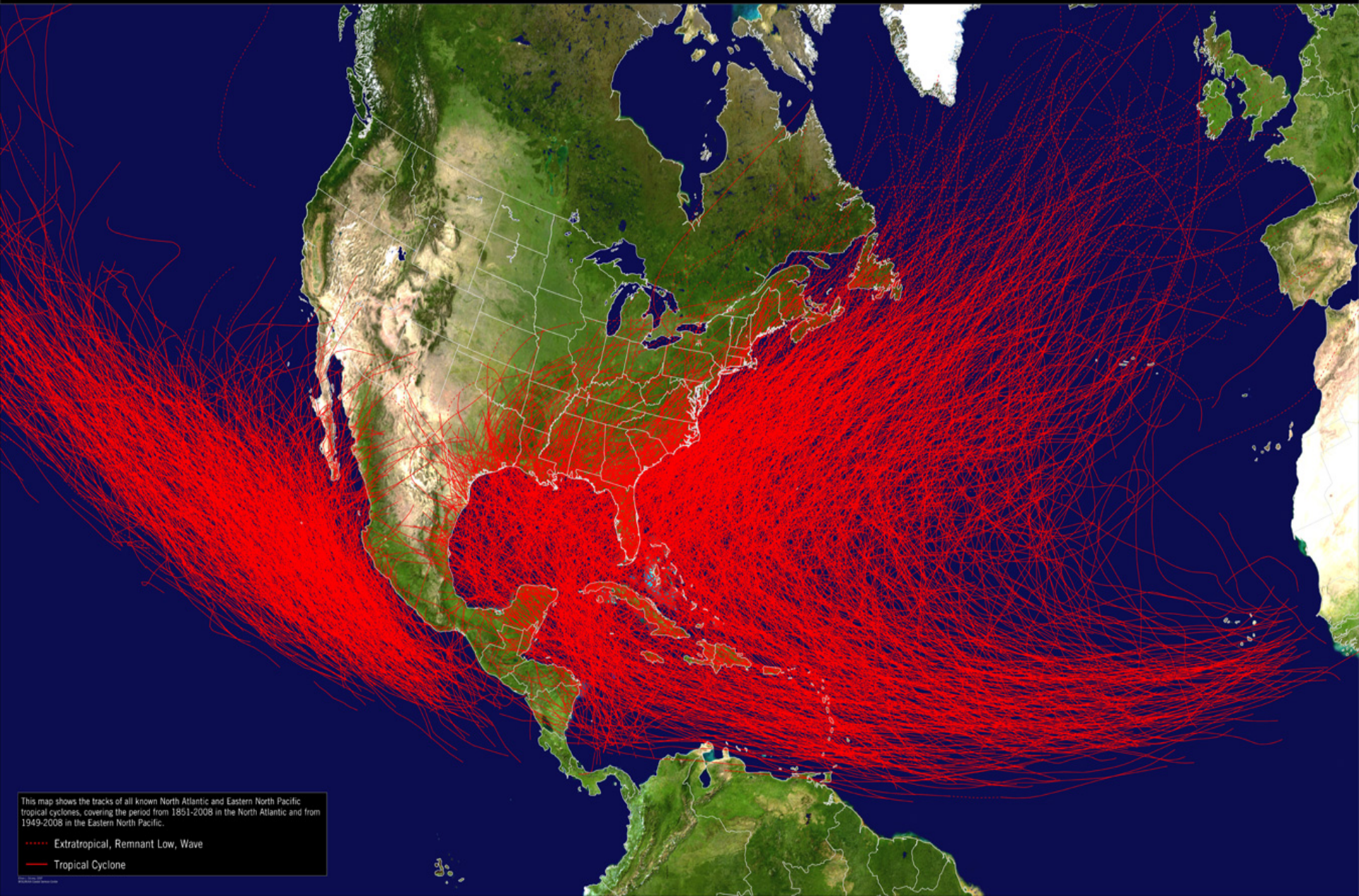
Understanding and attributing hurricane variability



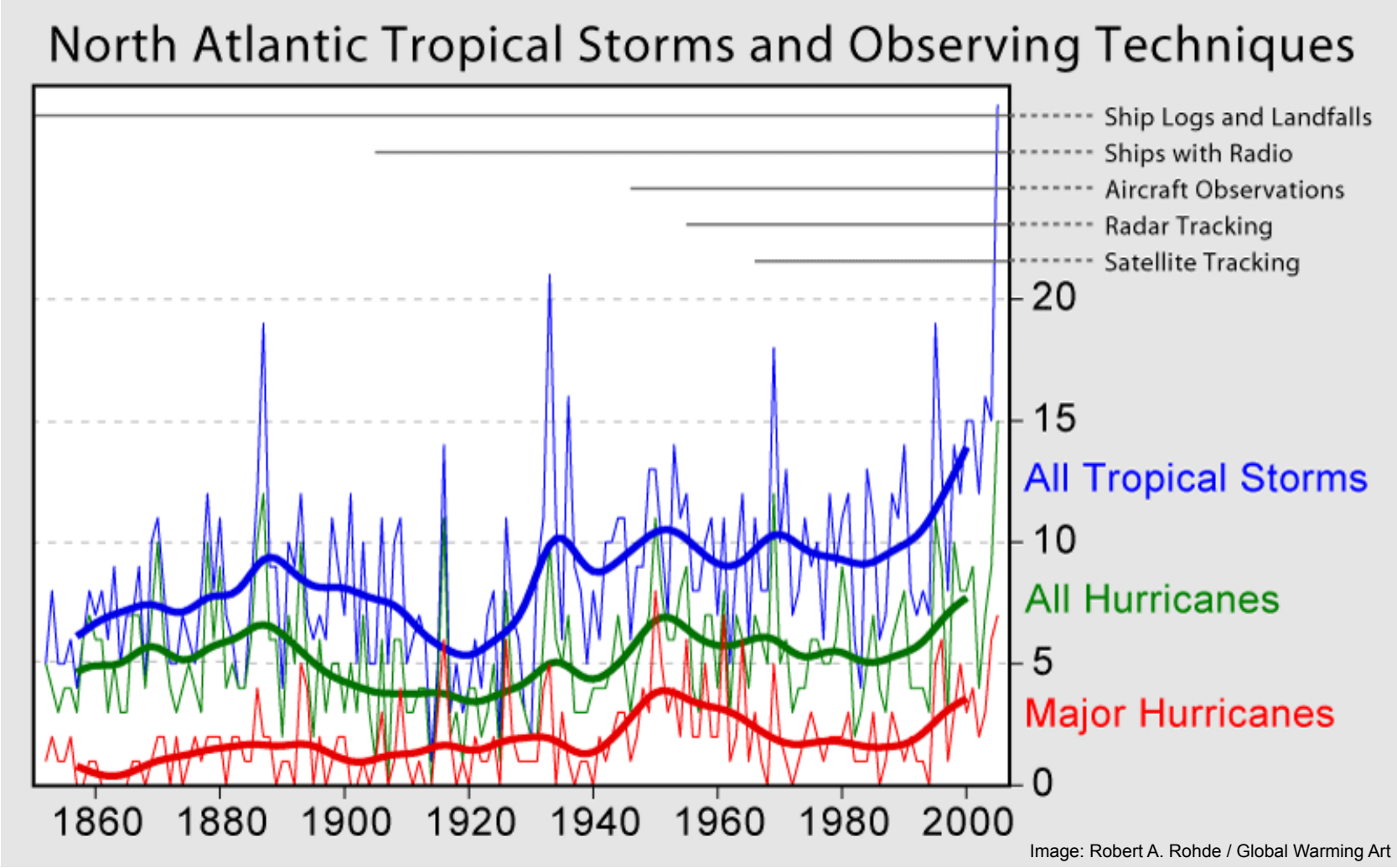

Storm Energy

# Tropical Cyclone History

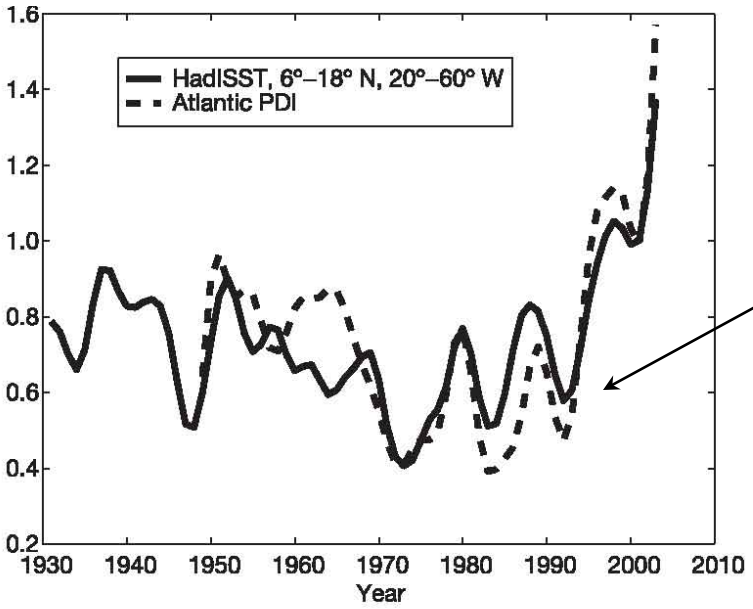
Data from 1949 in the Pacific, from 1851 in the Atlantic



# Atlantic Hurricane Database since 1851



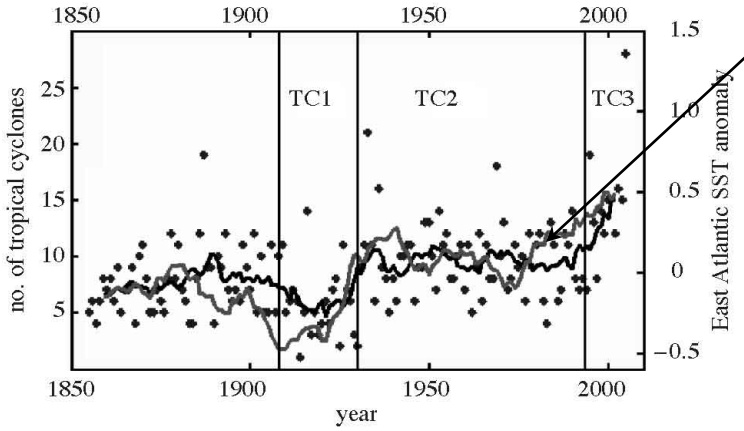
# Is recent variability due to GCC…….



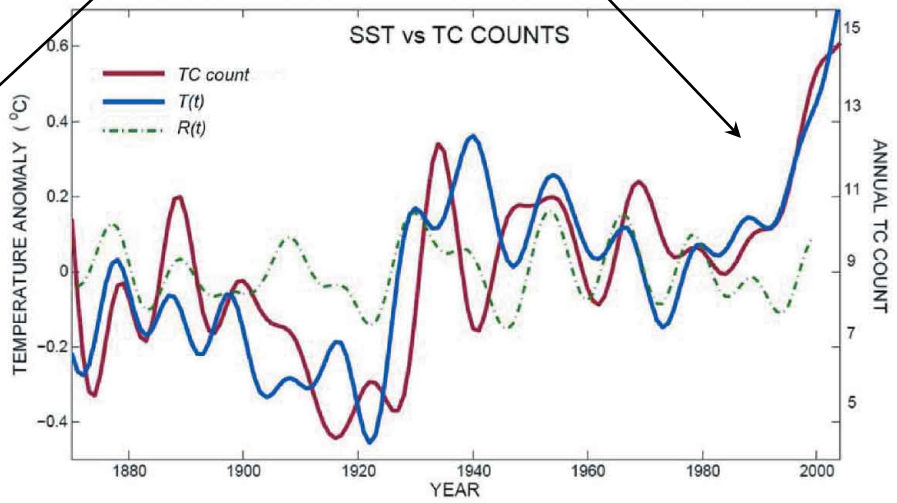

Emanuel, 2005 (*Nature v.436)*

Increasing Intensity

Increasing Frequency




Holland and Webster, 2007 (*Phil. Trans. R. Soc. doi:10.1098))*



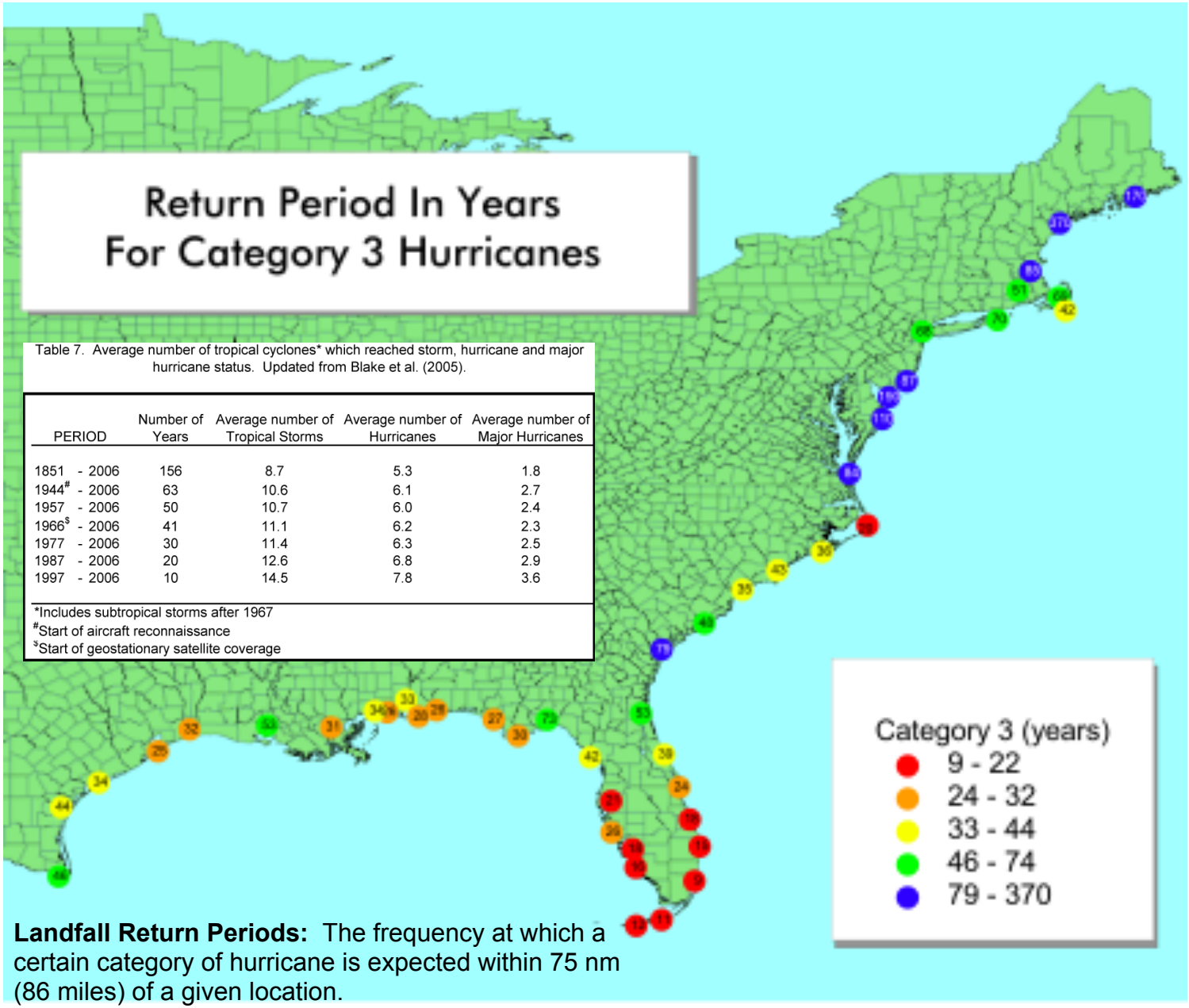

Mann & Emanuel, 2006 (*Eos v.87)*

# Return Period In Years For Category 3 Hurricanes

Table 7. Average number of tropical cyclones* which reached storm, hurricane and major hurricane status. Updated from Blake et al. (2005).

| PERIOD | Number of Years | Average number of Tropical Storms | Average number of Hurricanes | Average number of Major Hurricanes |
|---|---|---|---|---|
| 1851 - 2006 | 156 | 8.7 | 5.3 | 1.8 |
| 1944[#] - 2006 | 63 | 10.6 | 6.1 | 2.7 |
| 1957 - 2006 | 50 | 10.7 | 6.0 | 2.4 |
| 1966[$] - 2006 | 41 | 11.1 | 6.2 | 2.3 |
| 1977 - 2006 | 30 | 11.4 | 6.3 | 2.5 |
| 1987 - 2006 | 20 | 12.6 | 6.8 | 2.9 |
| 1997 - 2006 | 10 | 14.5 | 7.8 | 3.6 |

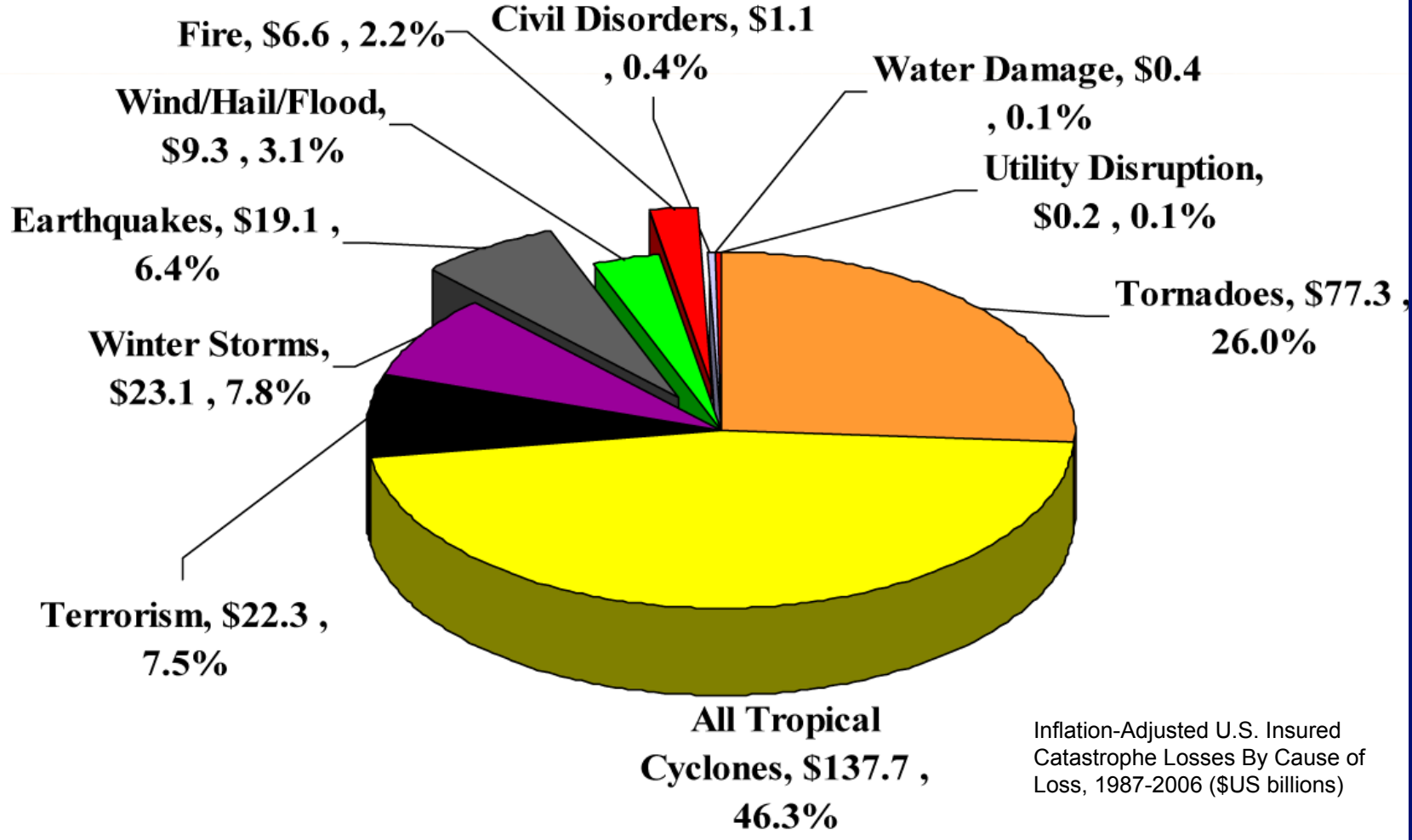
*Includes subtropical storms after 1967
[#]Start of aircraft reconnaissance
[$]Start of geostationary satellite coverage




**Landfall Return Periods:** The frequency at which a certain category of hurricane is expected within 75 nm (86 miles) of a given location.

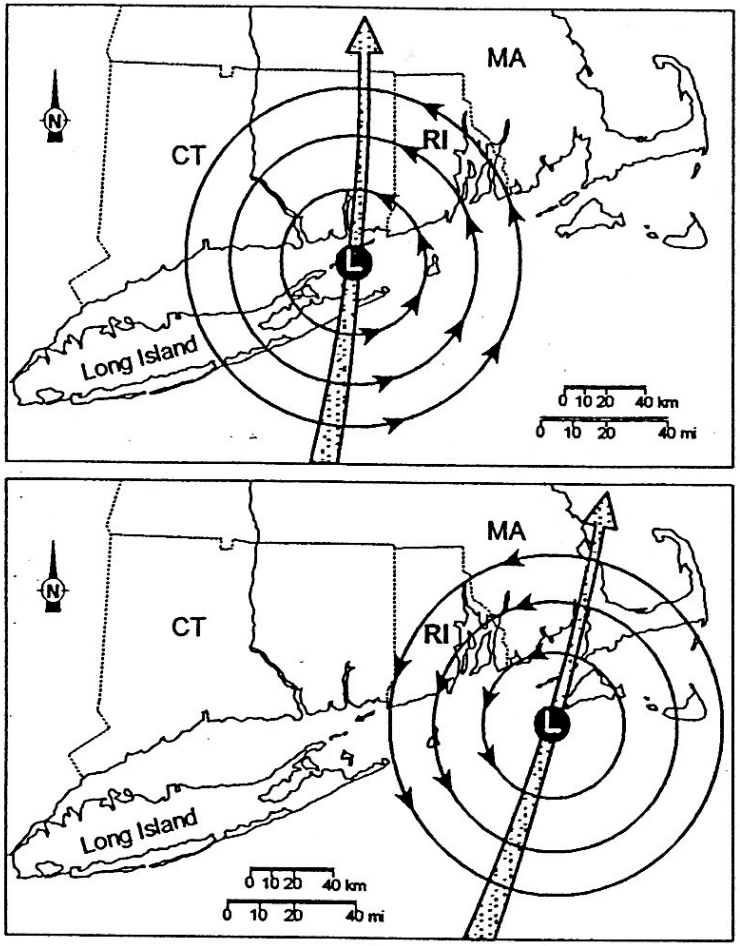
Source: National Hurricane Center

# Assessment of Hurricane Risk




Inflation-Adjusted U.S. Insured Catastrophe Losses By Cause of Loss, 1987-2006 ($US billions)

# Impacts of Landfalling Storms




Wright & Sullivan, 1980

- Strong winds
- Coastal flooding
  - Large waves and swells
  - Storm surge
- Inland flooding
  - Heavy precipitation
  - Severe thunderstorms
- Tornados

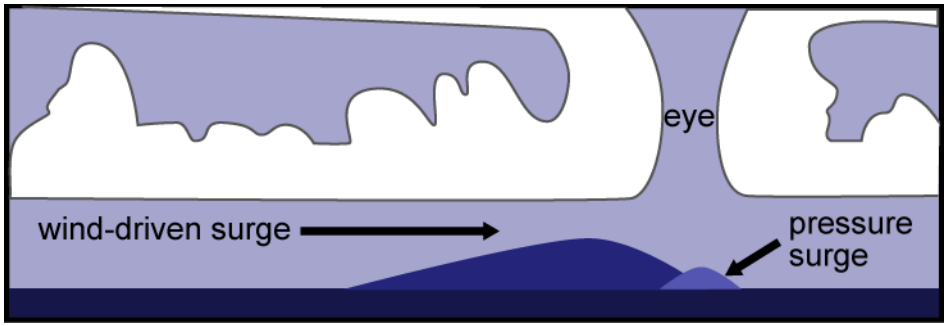
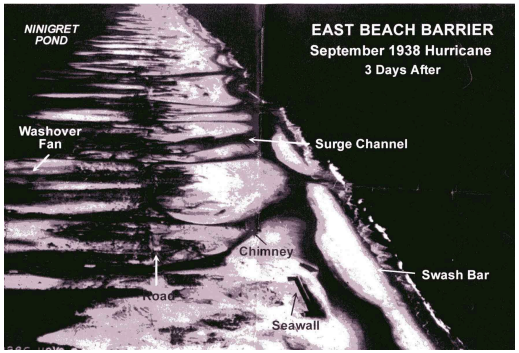


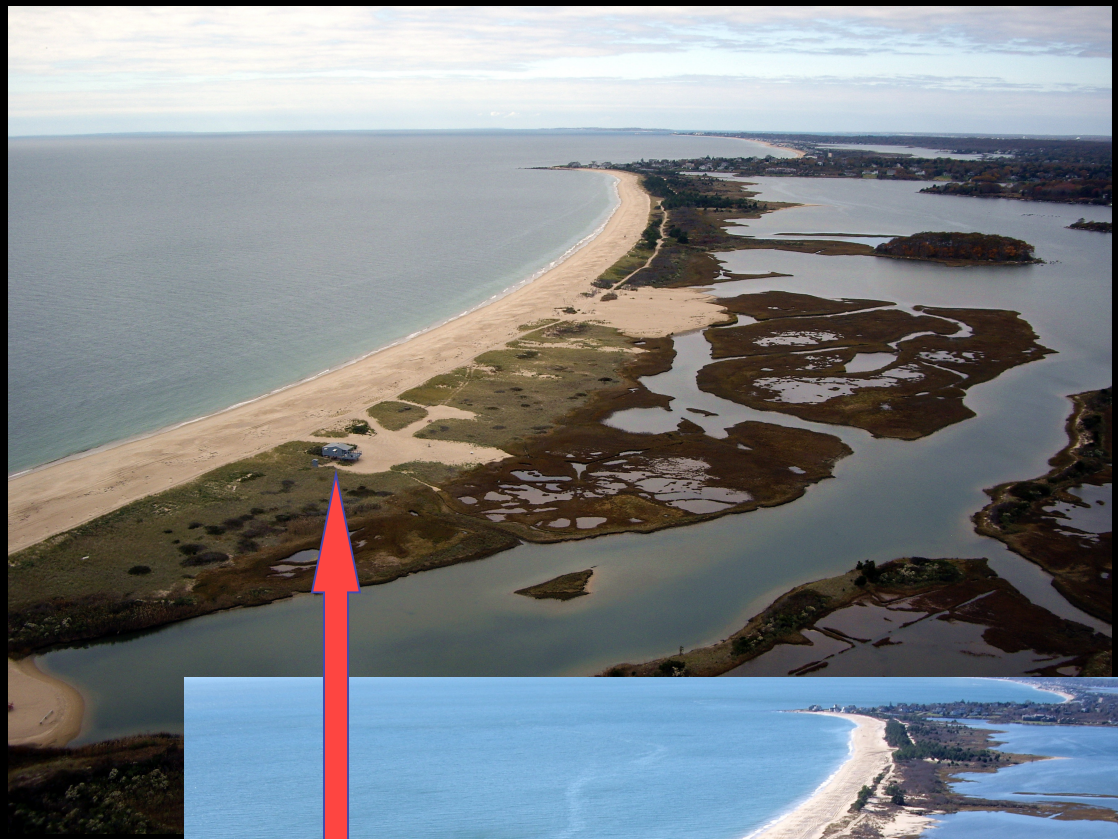

Image: NASA Earth Observatory

# Records of coastal flooding


# Overwash of barrier beaches

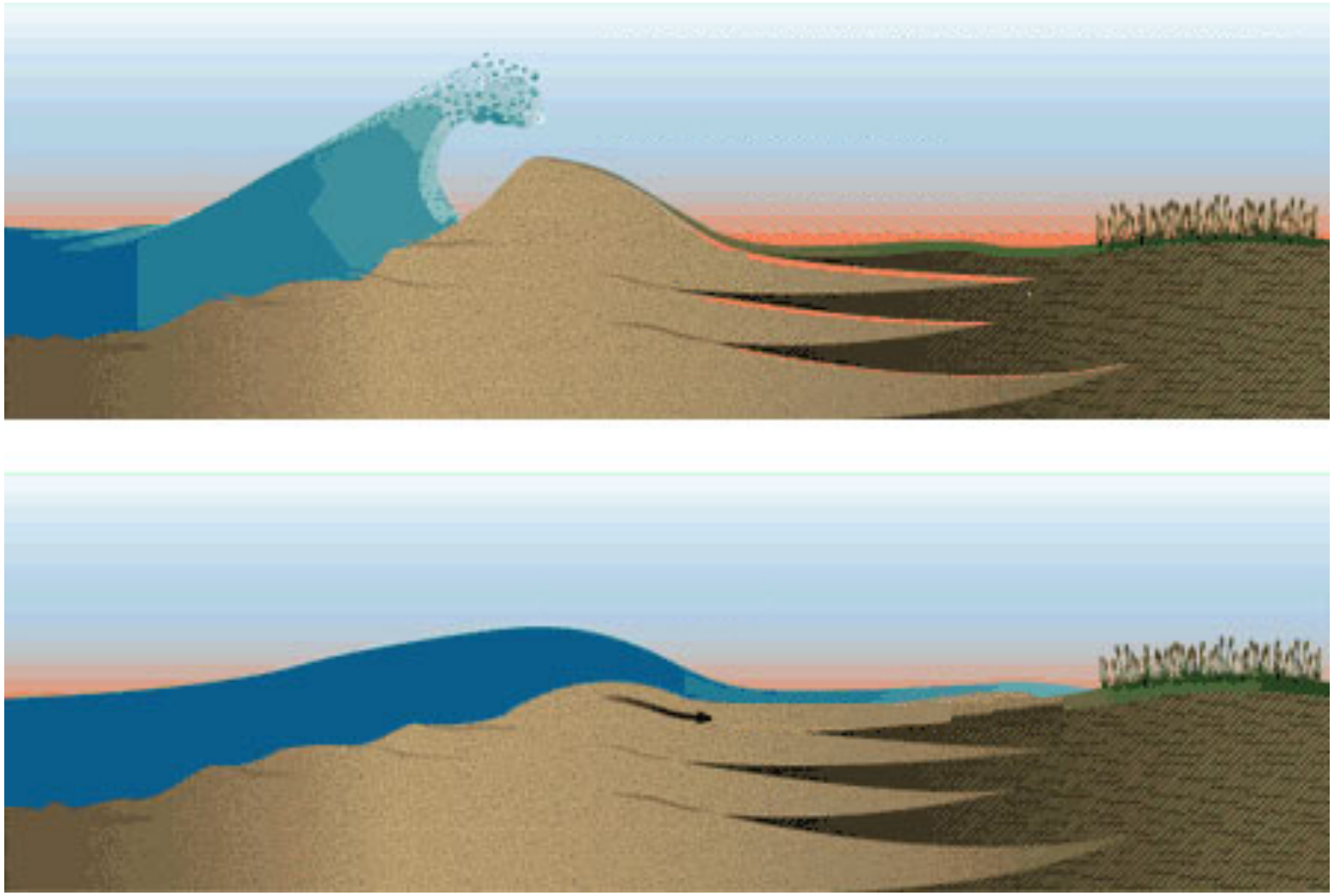


Before



After

# Overwash of barrier beaches

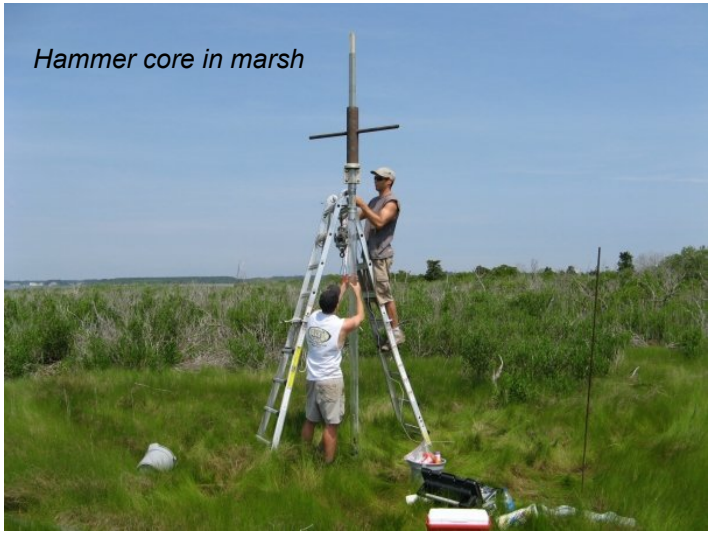


*LSU Paleotempestology Group*

# Shallow Water Coring

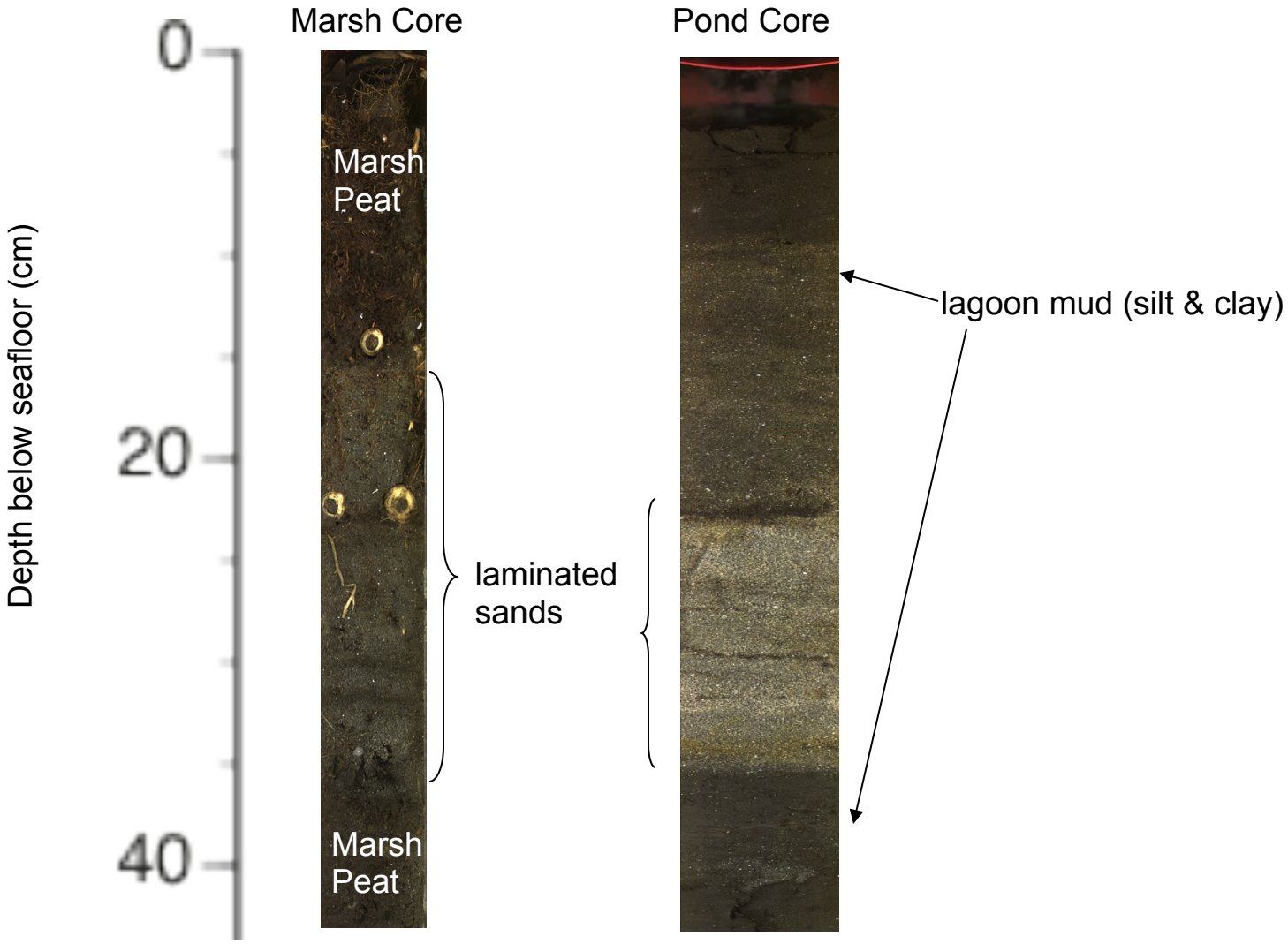
*Fixed piston push core*


*Coring platform*

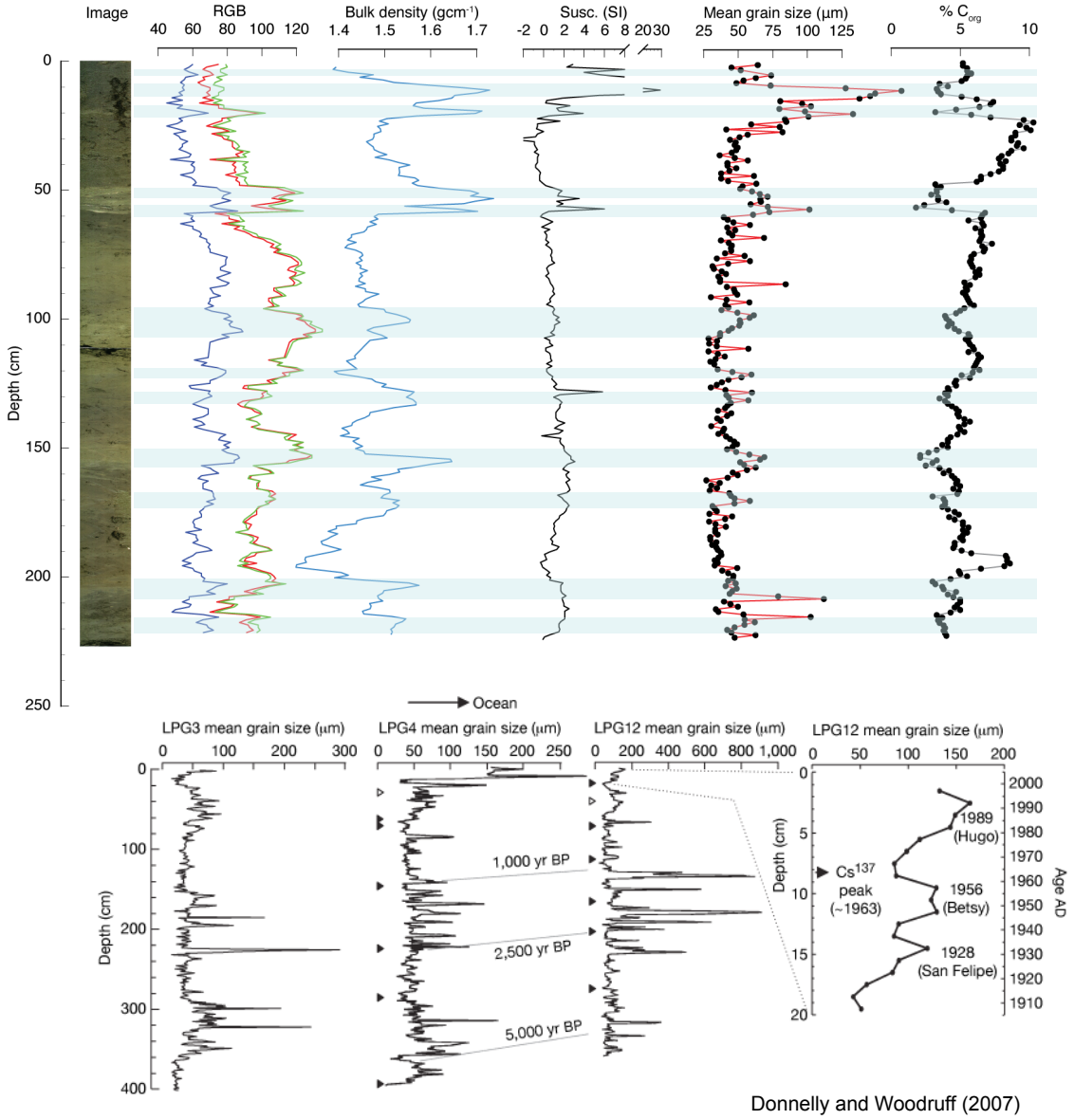

*Hammer core in marsh*


*Geologists excited to find storm deposits*

# Identification of storm deposits



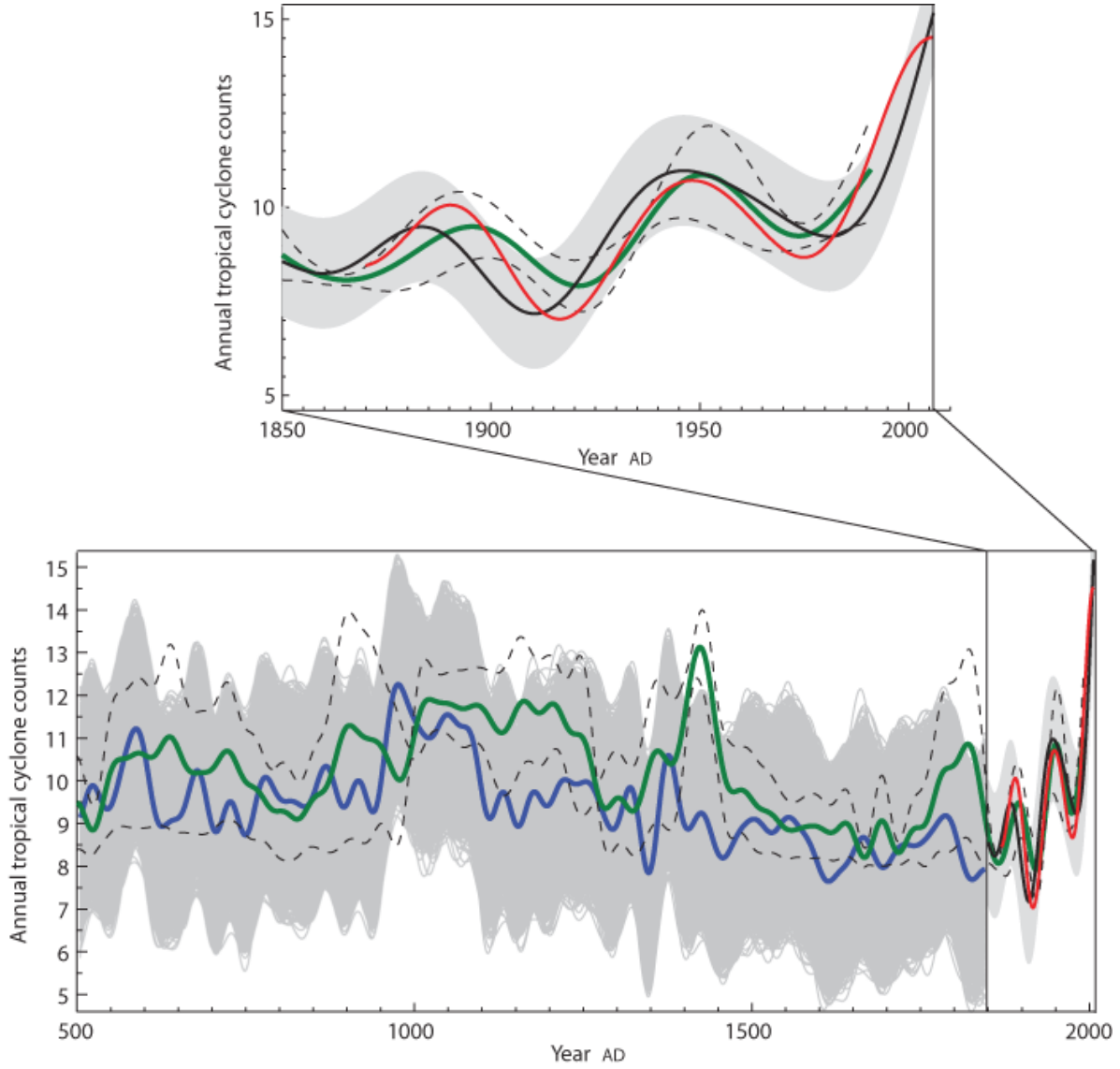
# Sedimentary record of hurricane strikes



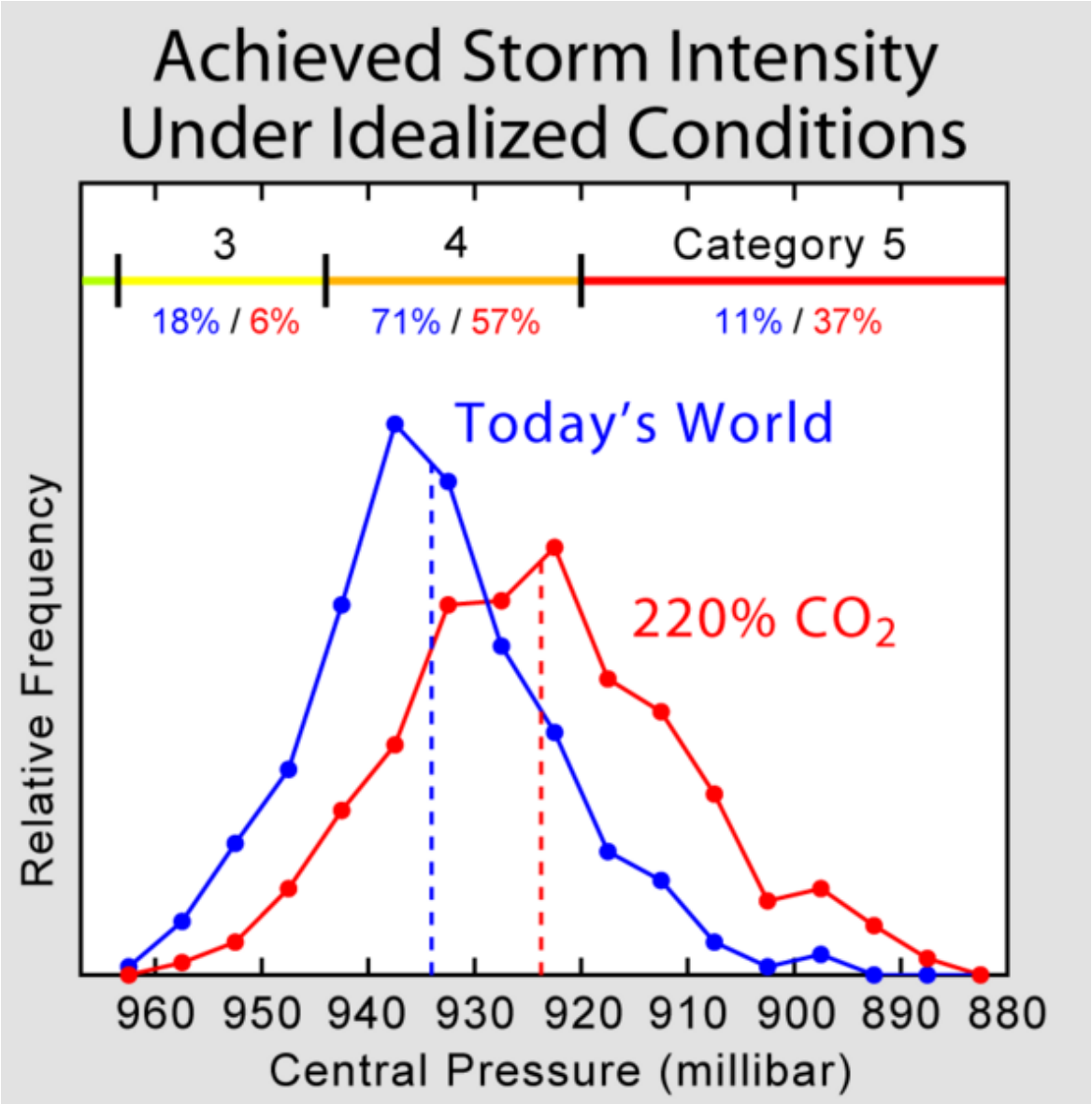

Donnelly and Woodruff (2007)

1. Overwash layers identified
   - physical properties (density, color)
   - grain size
   - organic carbon content
   - microfossils
2. Layers correlated between cores
3. Sediments are dated
   - radiocarbon
   - 210Pb, 137Cs
4. Record compared to period of instrumental and historical overlap

# Atlantic hurricanes and climate over the past 1,500 years




Mann et al. (2009)




Knutson & Tuleya (2004))