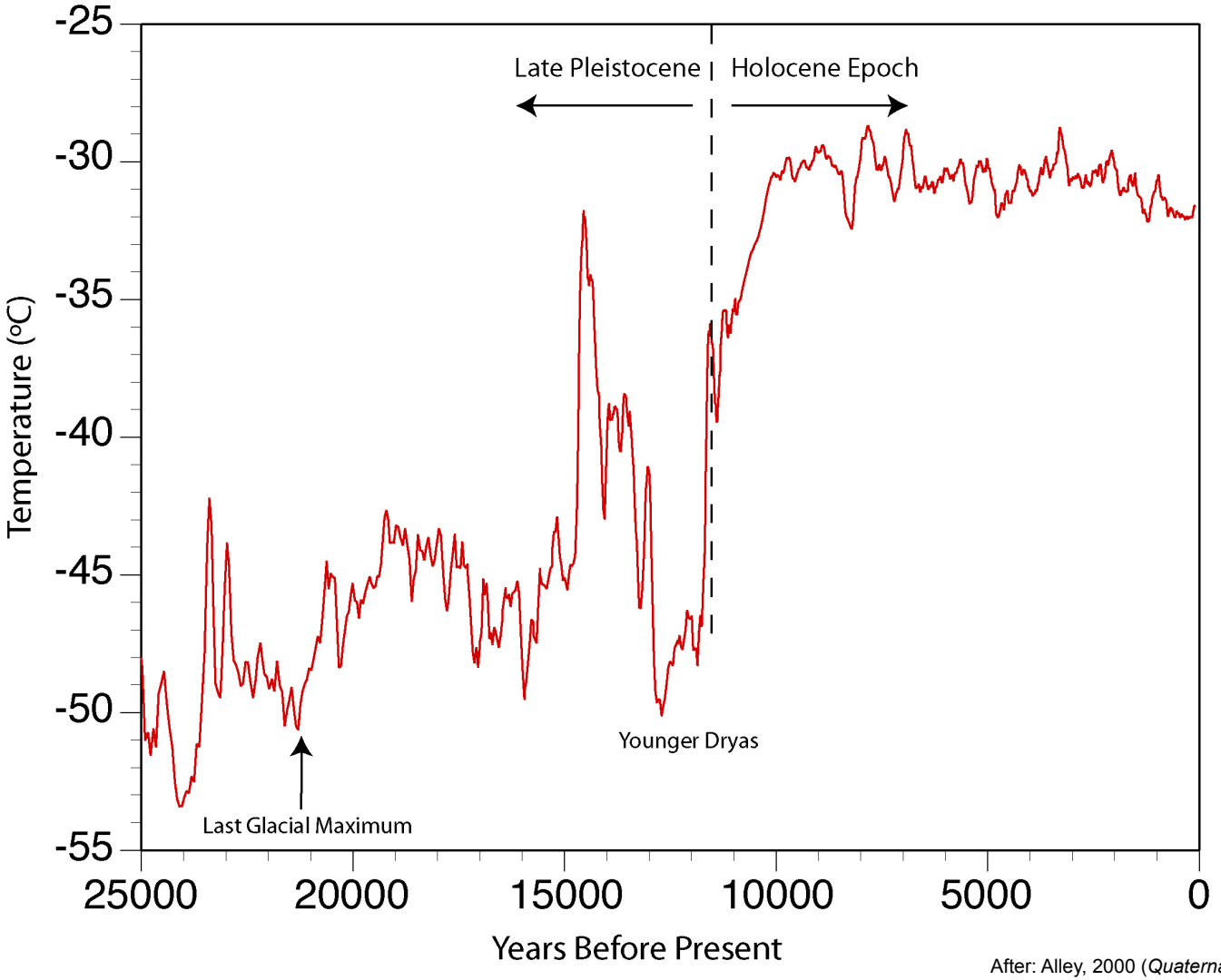
Global Warming:

Hurricanes

Holocene Paleoclimate

Central Greenland: GISP2



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

What is a tropical cyclone?

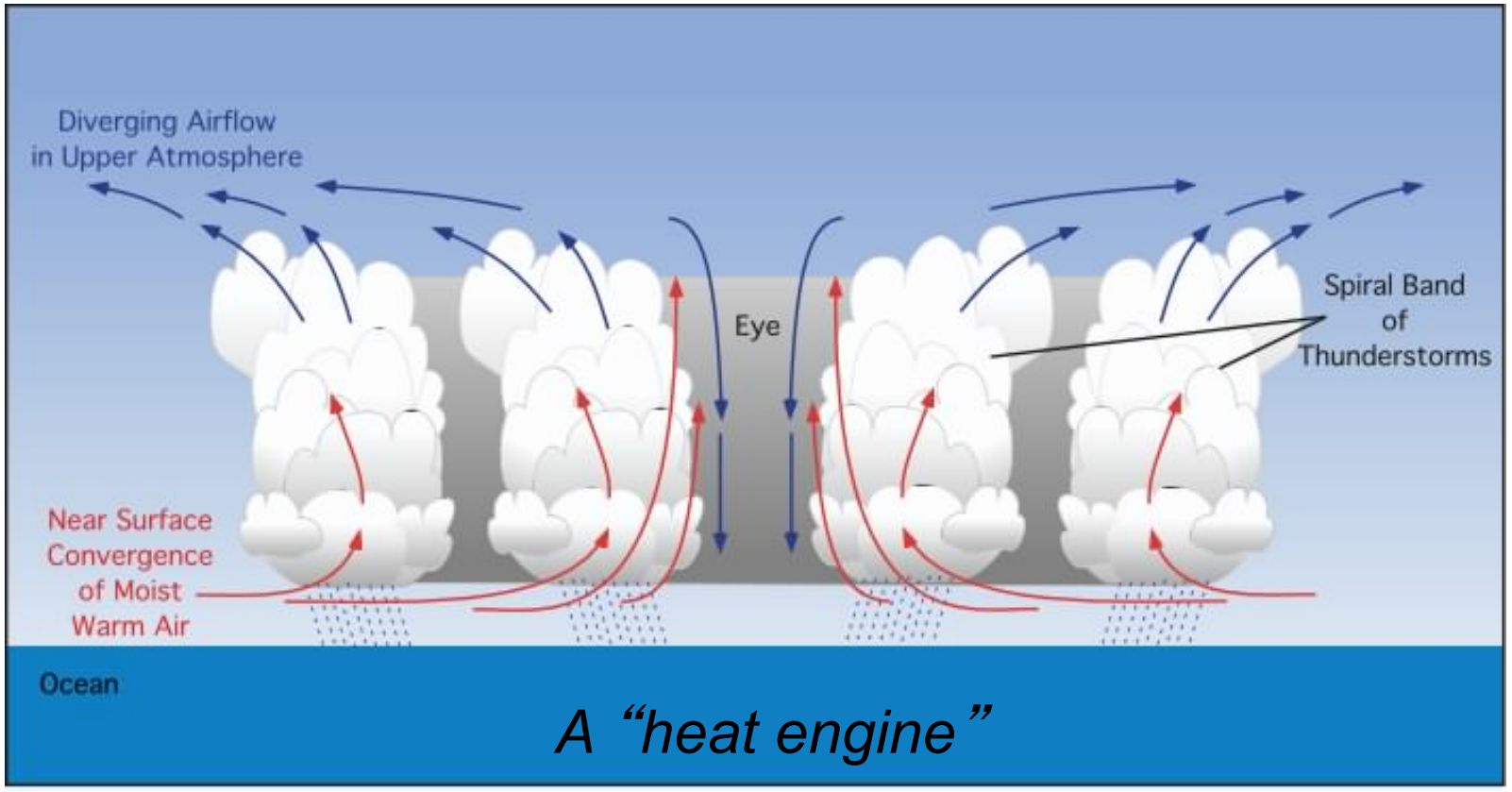
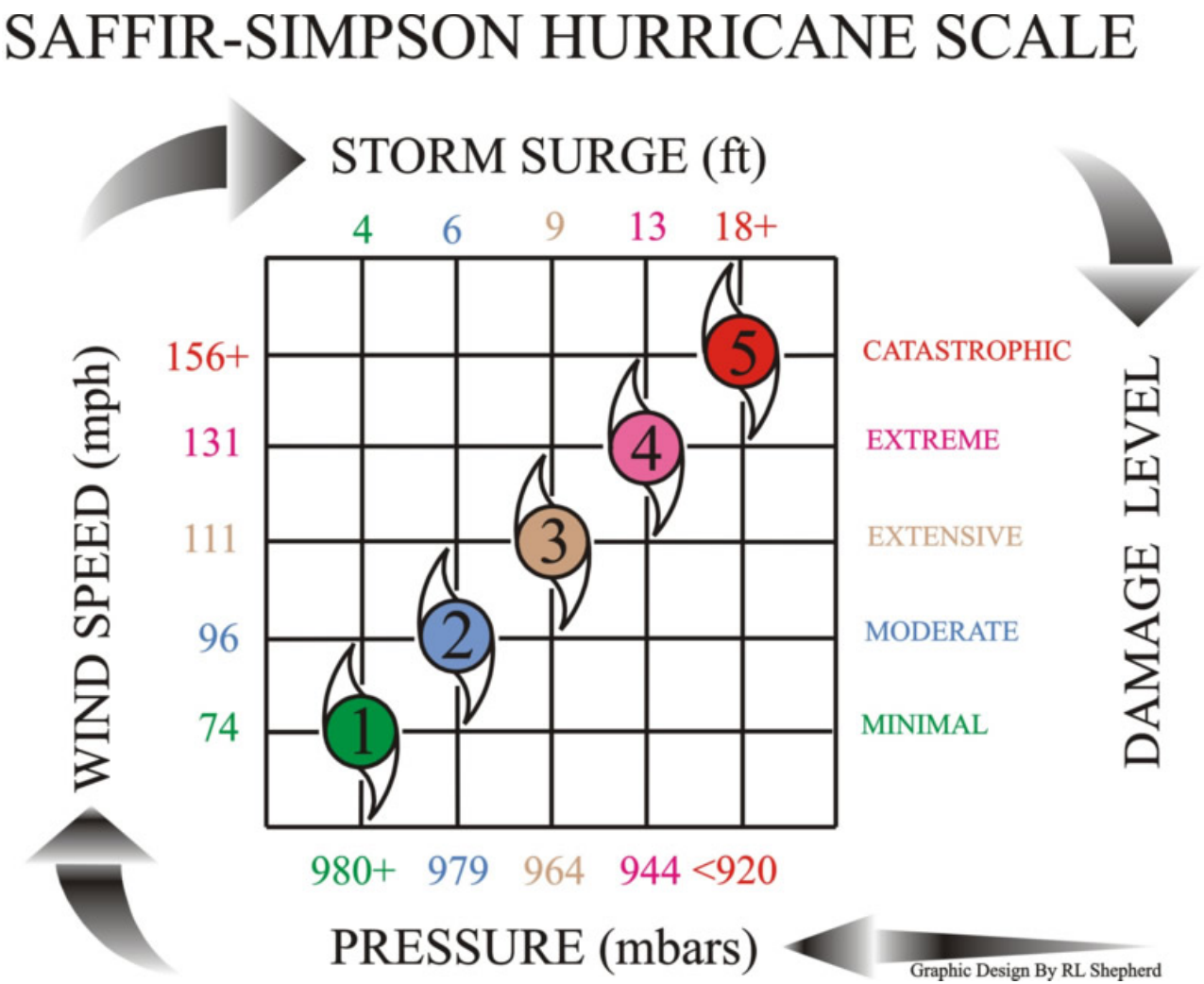


Image: Dr. Michael Pidwirny, University of British Columbia

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

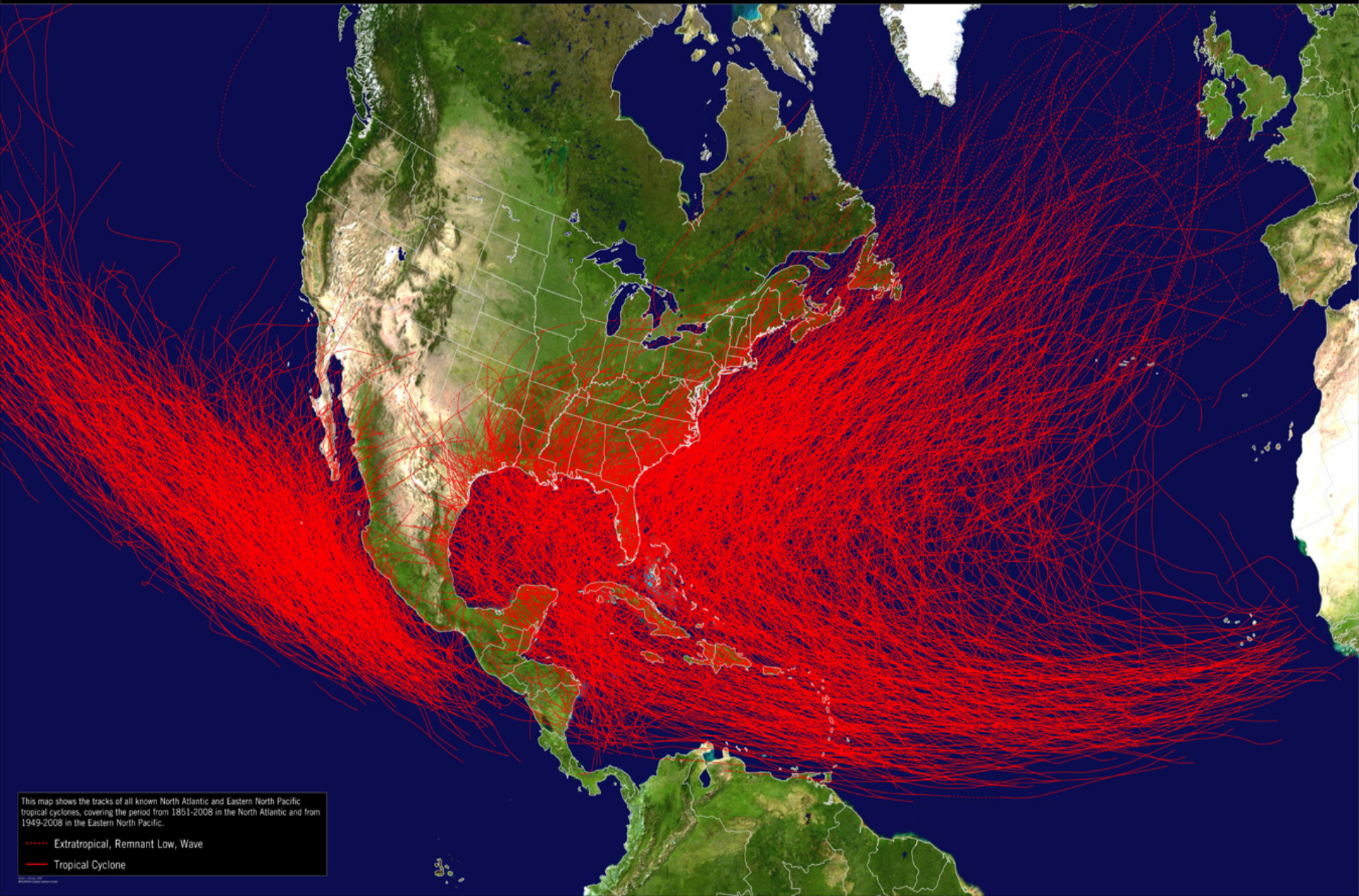
Understanding and attributing hurricane variability



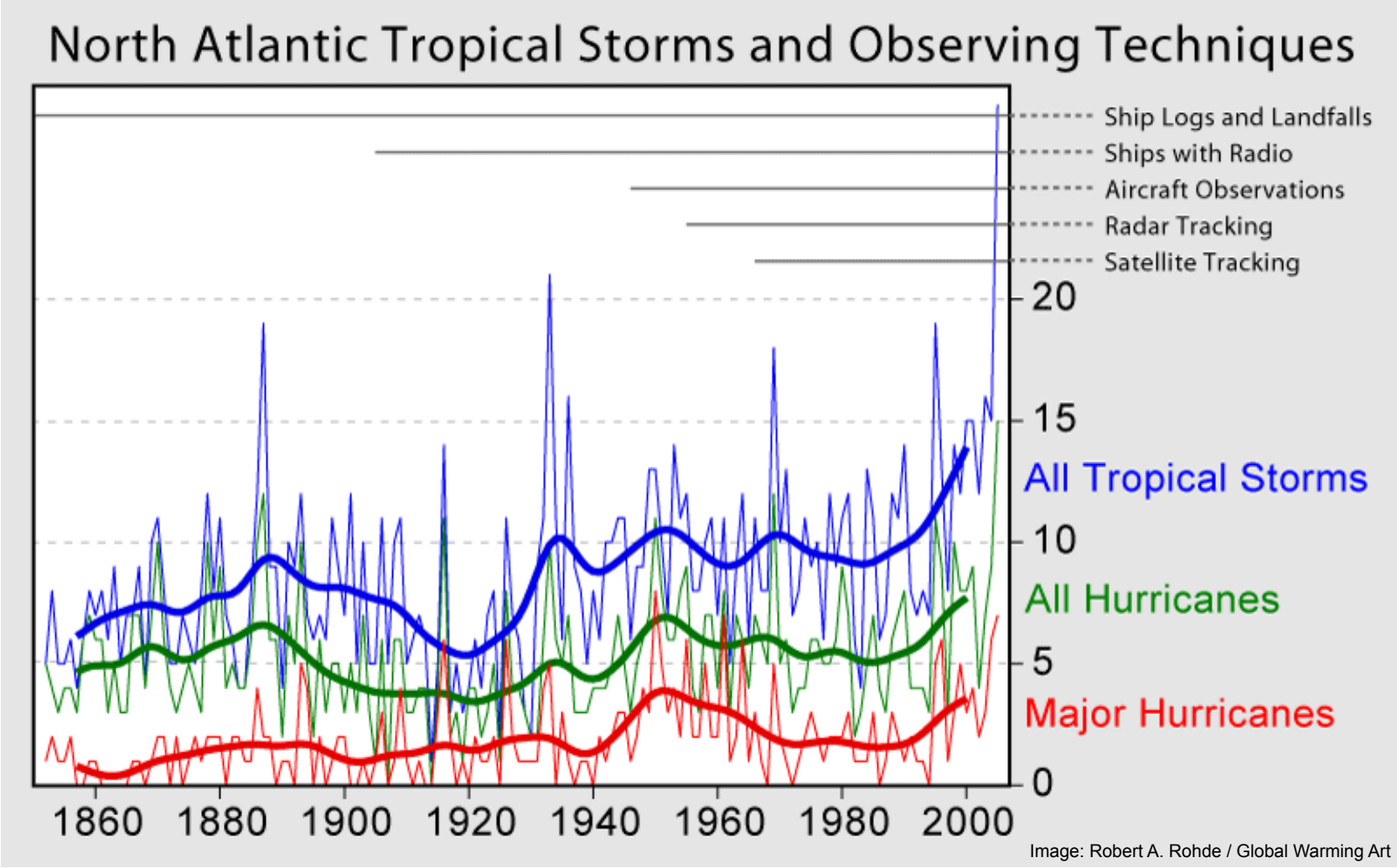
Storm Energy

Tropical Cyclone History

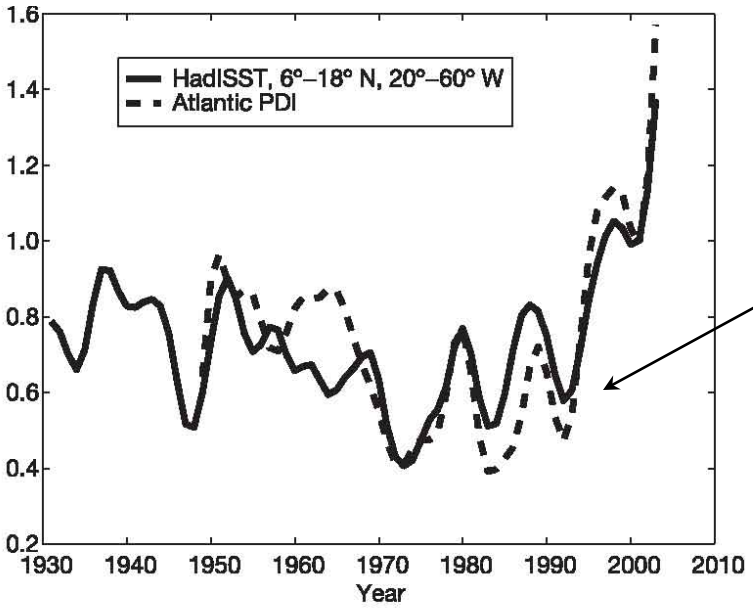
Data from 1949 in the Pacific, from 1851 in the Atlantic



Atlantic Hurricane Database since 1851



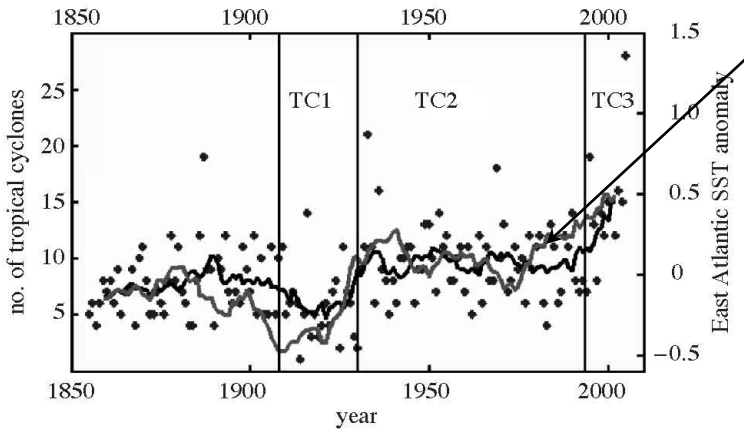
Is recent variability due to GCC…….



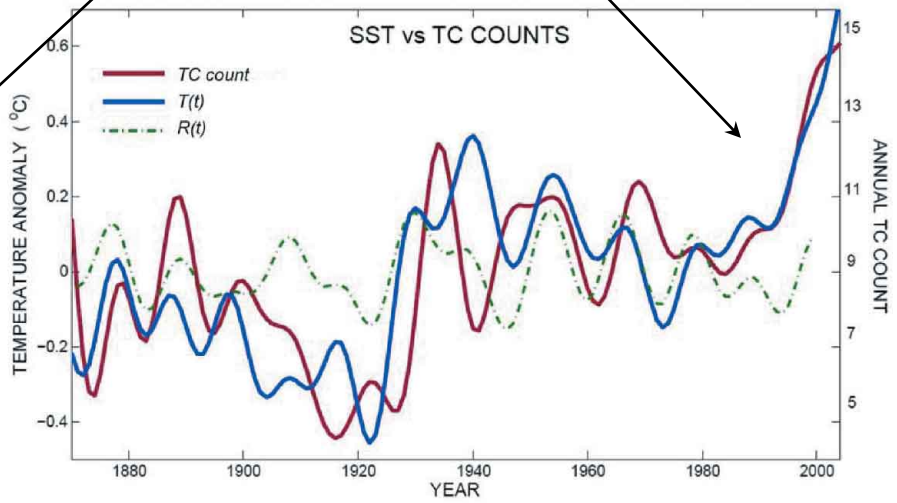
Emanuel, 2005 (*Nature v.436)*

Increasing Intensity

Increasing Frequency



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



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

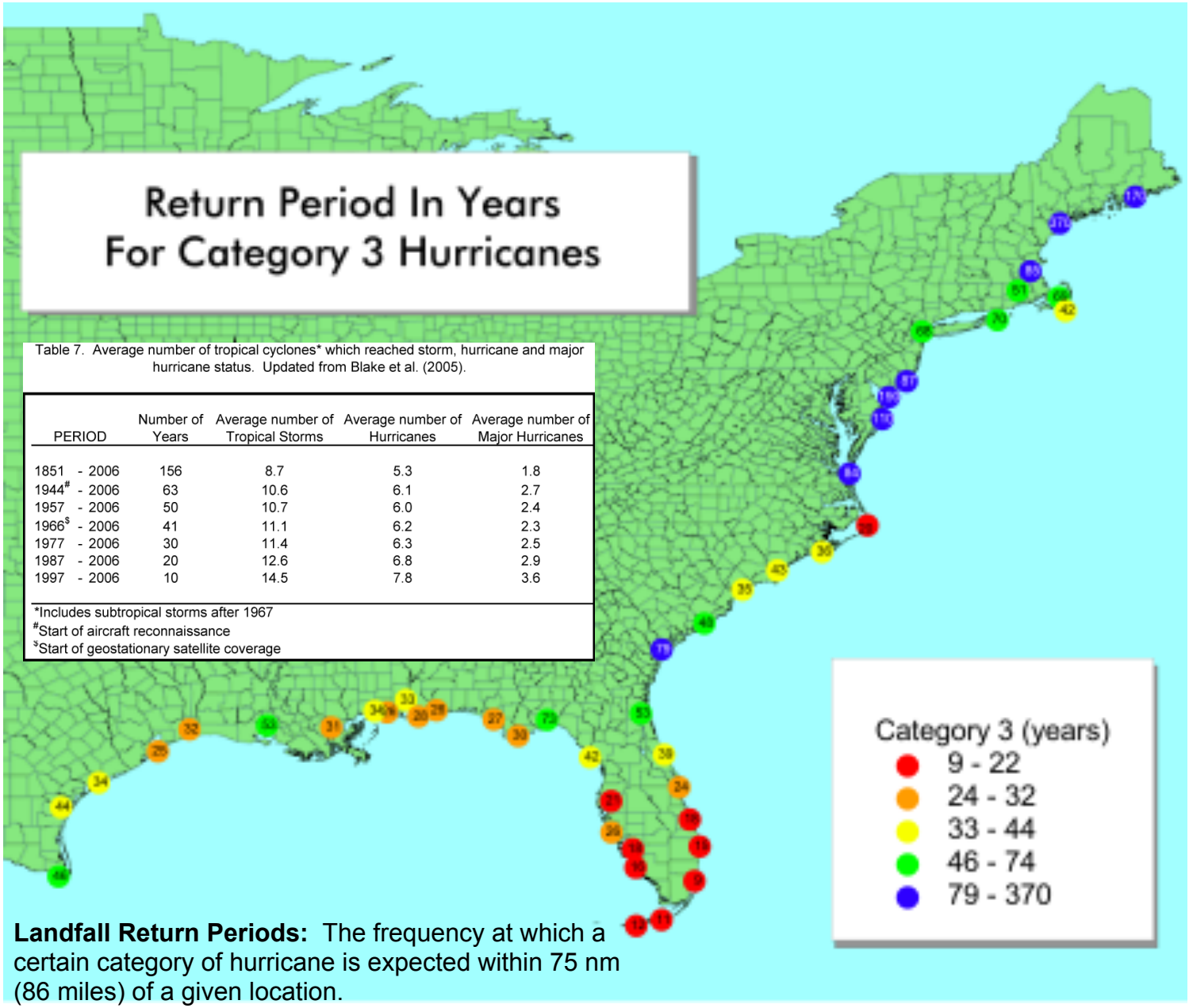


Table 7. Average number of tropical cyclones* which reached storm, hurricane and major hurricane status. Updated from Blake et al. (2005).

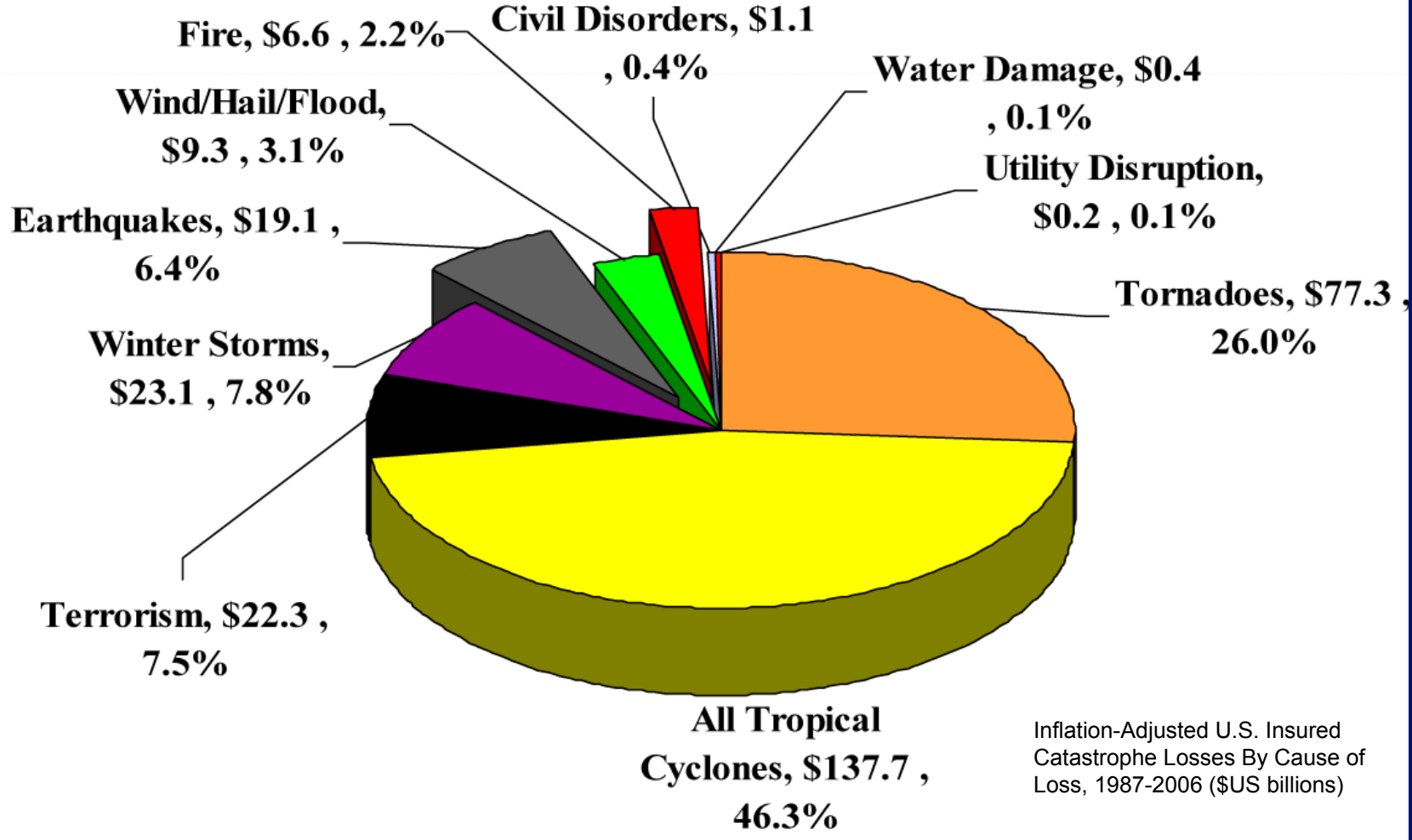
PERIOD	Number of Years	Average number of Tropical Storms	Average number of Hurricanes	Average number of Major Hurricanes
1851 - 2006	156	8.7	5.3	1.8
1944# - 2006	63	10.6	6.1	2.7
1957 - 2006	50	10.7	6.0	2.4
1966$ - 2006	41	11.1	6.2	2.3
1977 - 2006	30	11.4	6.3	2.5
1987 - 2006	20	12.6	6.8	2.9
1997 - 2006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

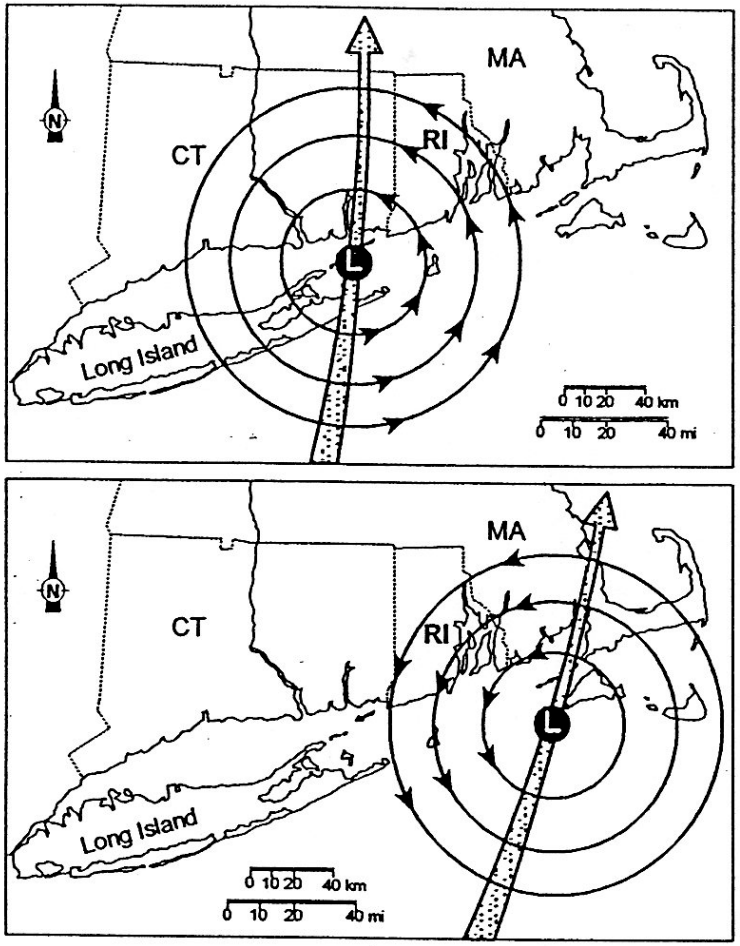
Source: National Hurricane Center

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

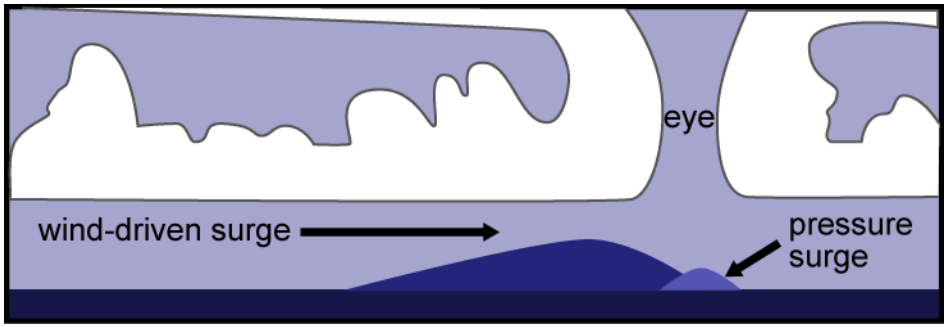
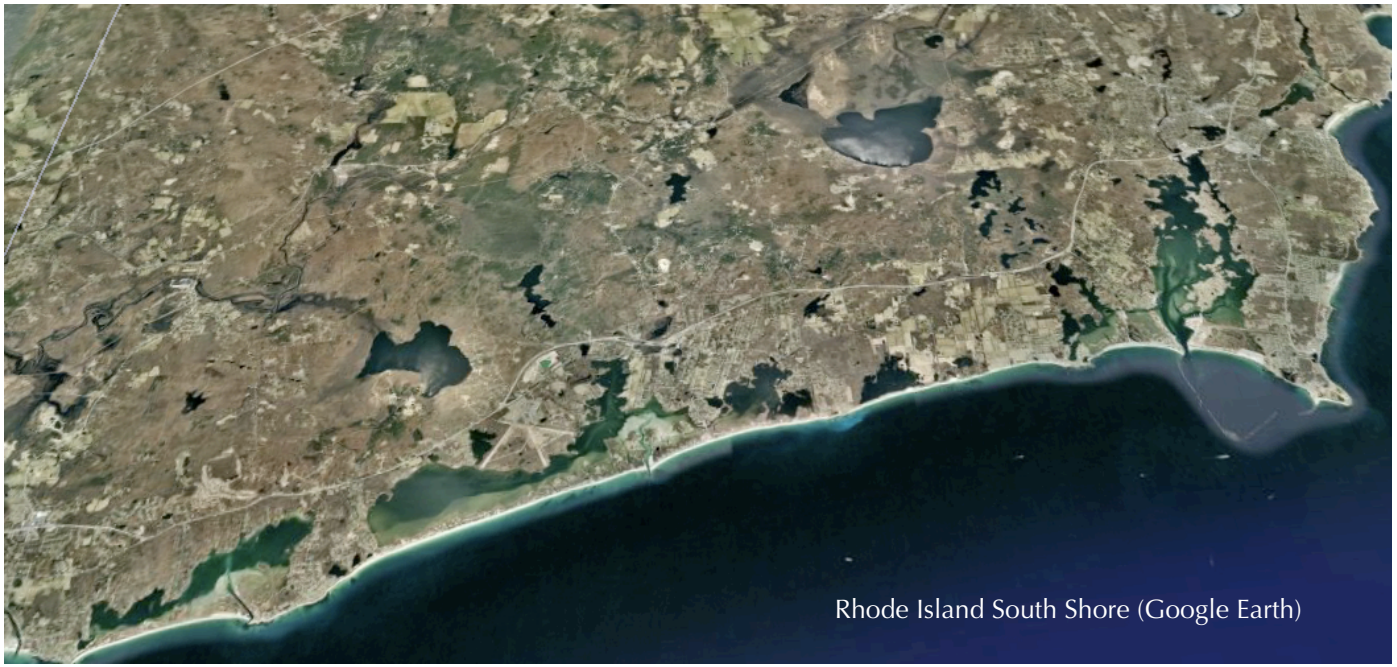
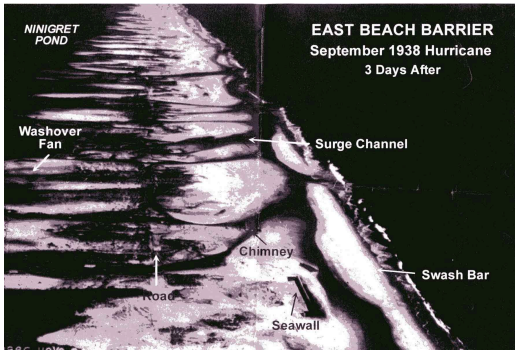


Image: NASA Earth Observatory

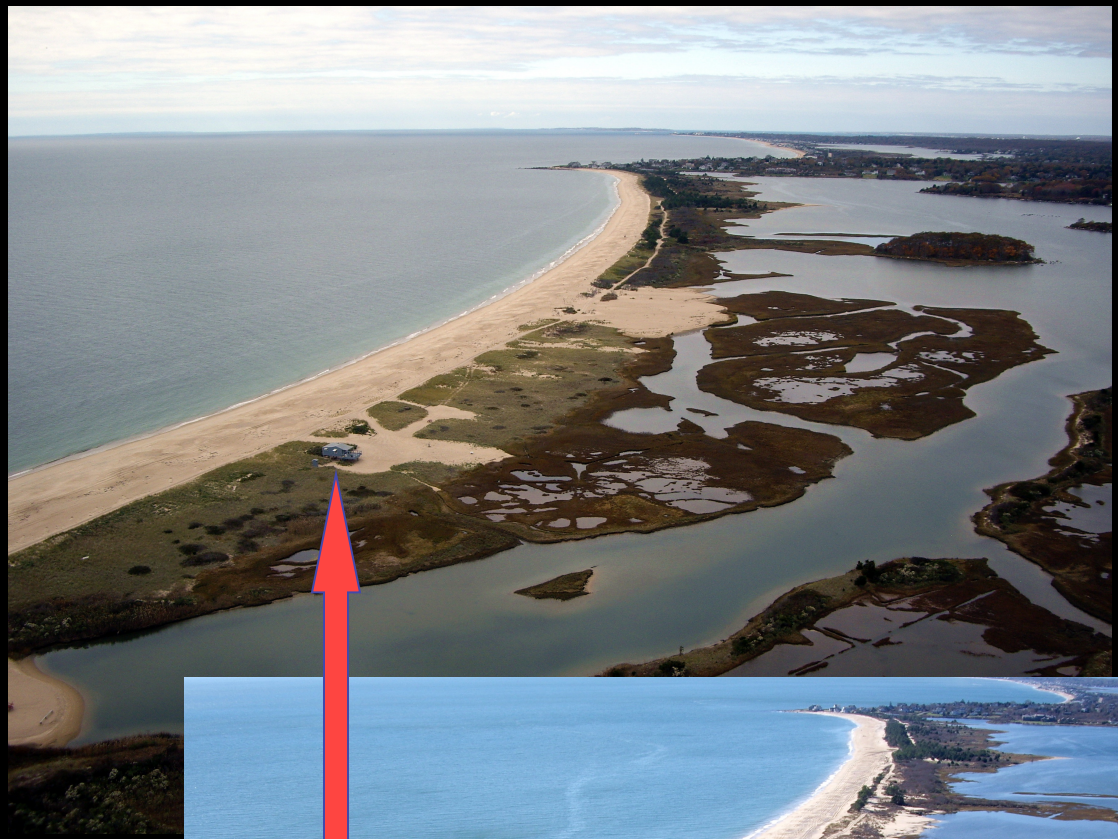
Records of coastal flooding



Overwash of barrier beaches

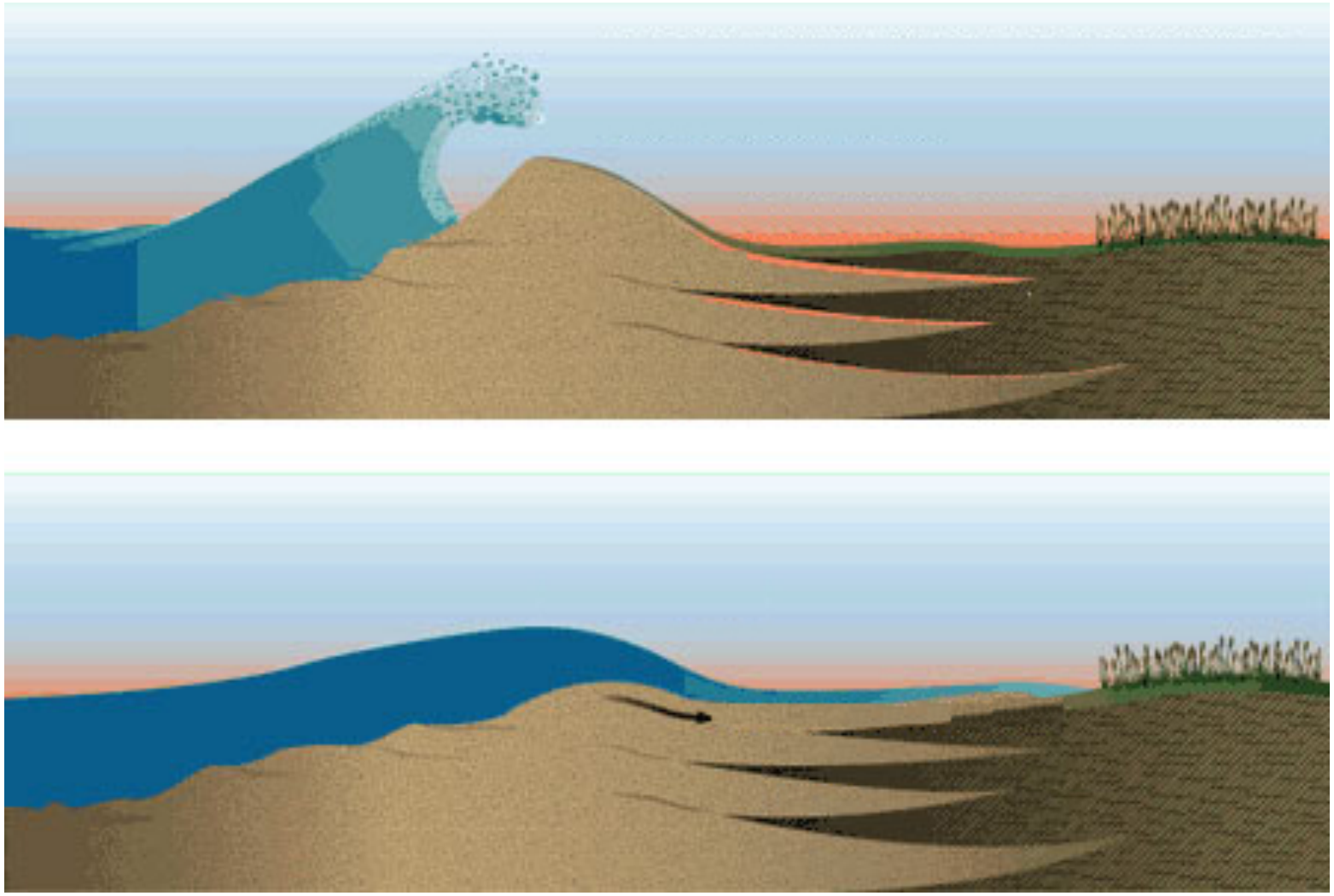


Before



After

Overwash of barrier beaches

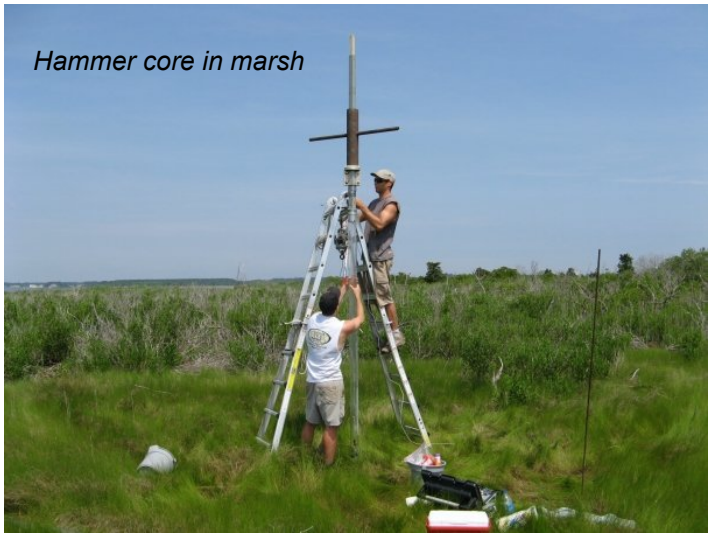


LSU Paleotempestology Group

Shallow Water Coring

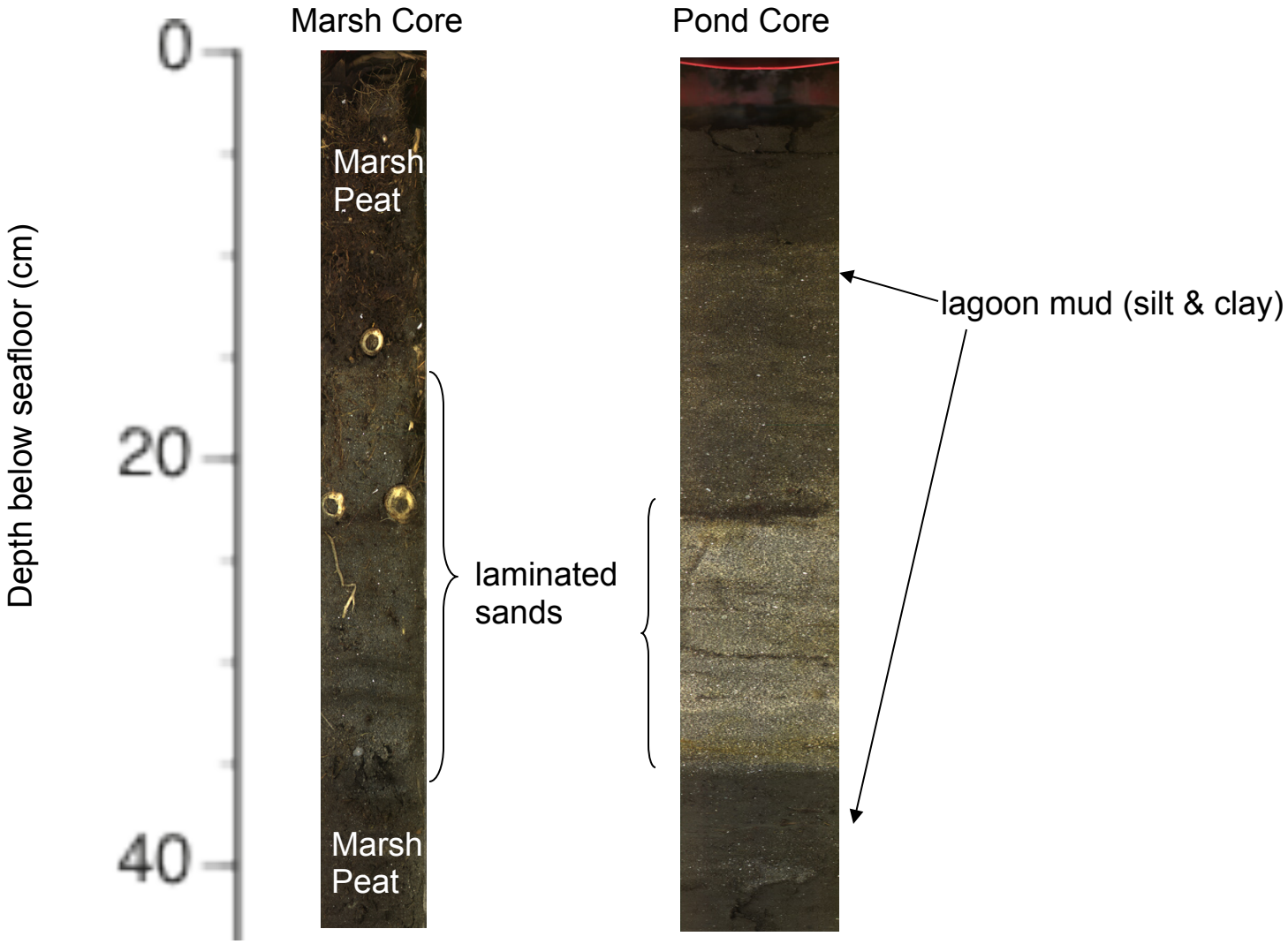
Fixed piston push core


Coring platform

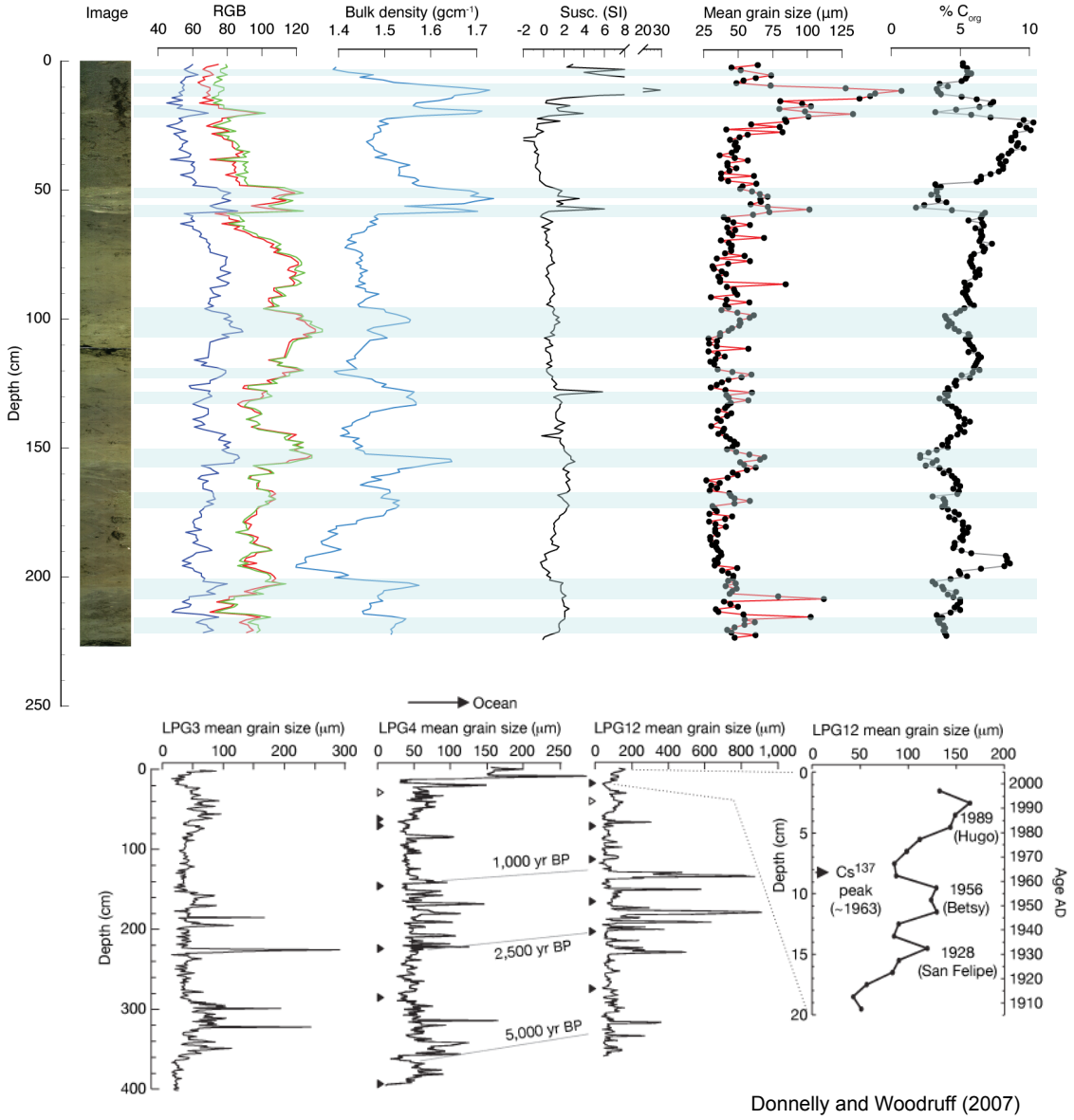

Hammer core in marsh


Geologists excited to find storm deposits

Identification of storm deposits



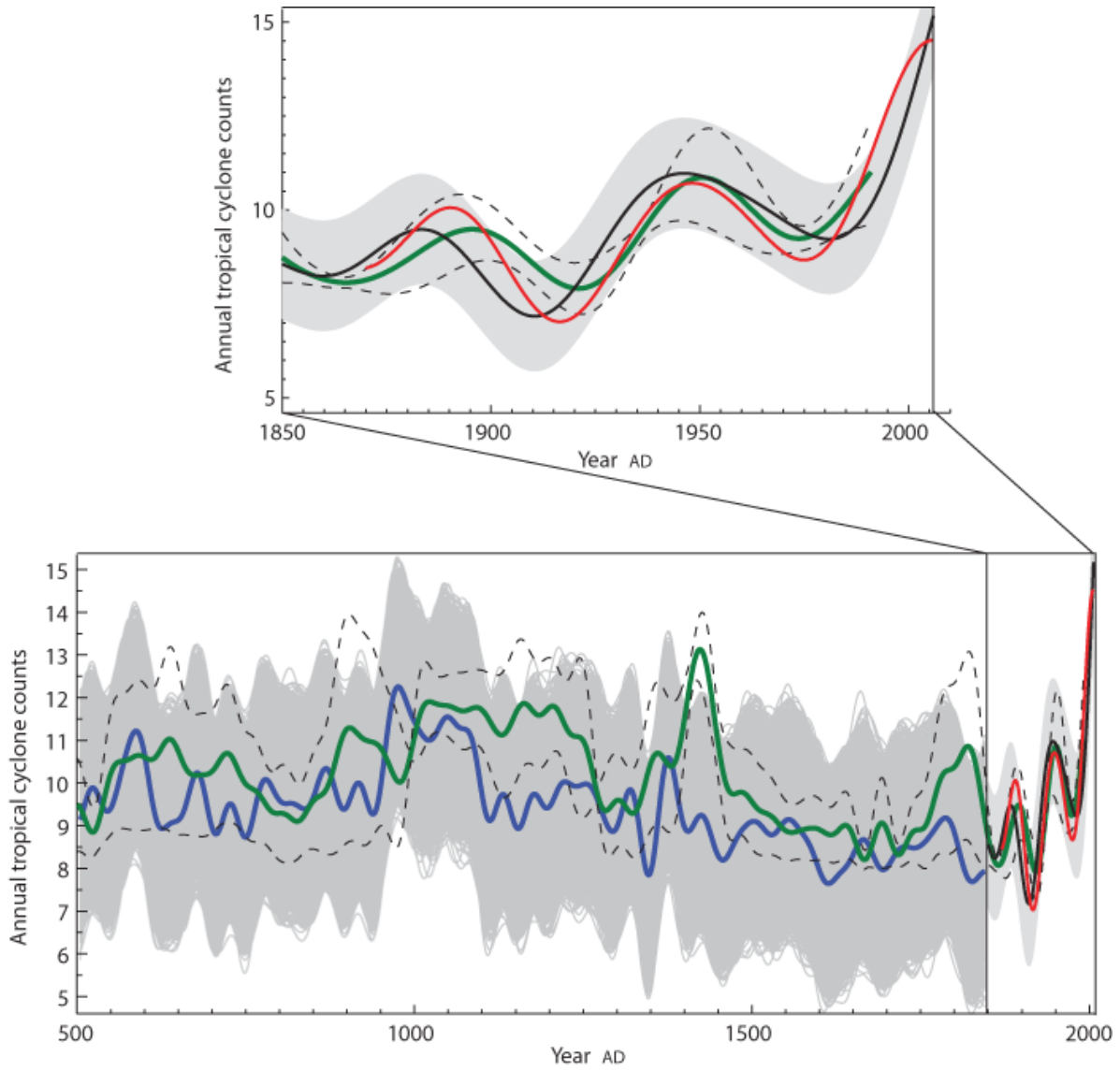
Sedimentary record of hurricane strikes



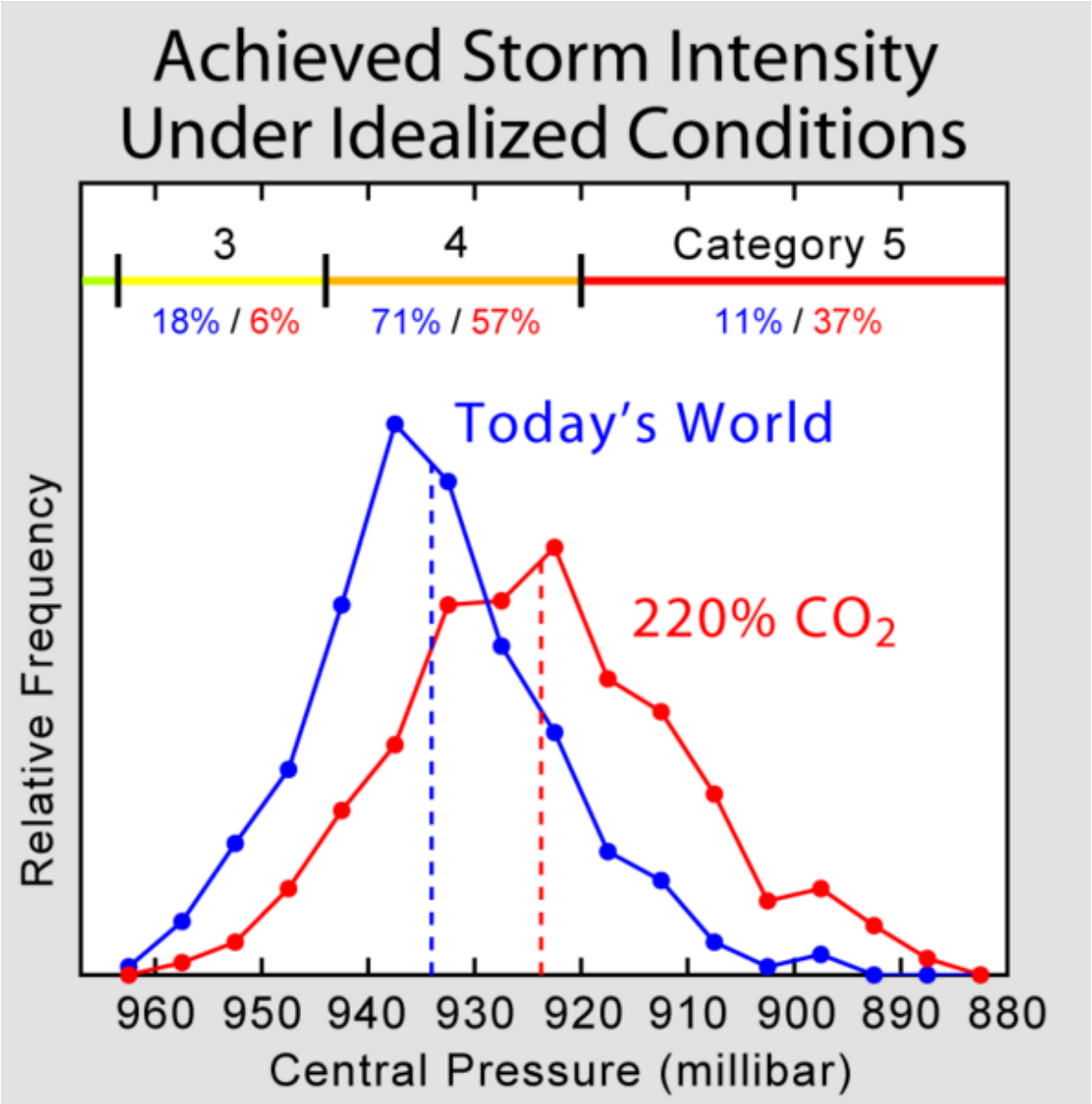
Donnelly and Woodruff (2007)

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))