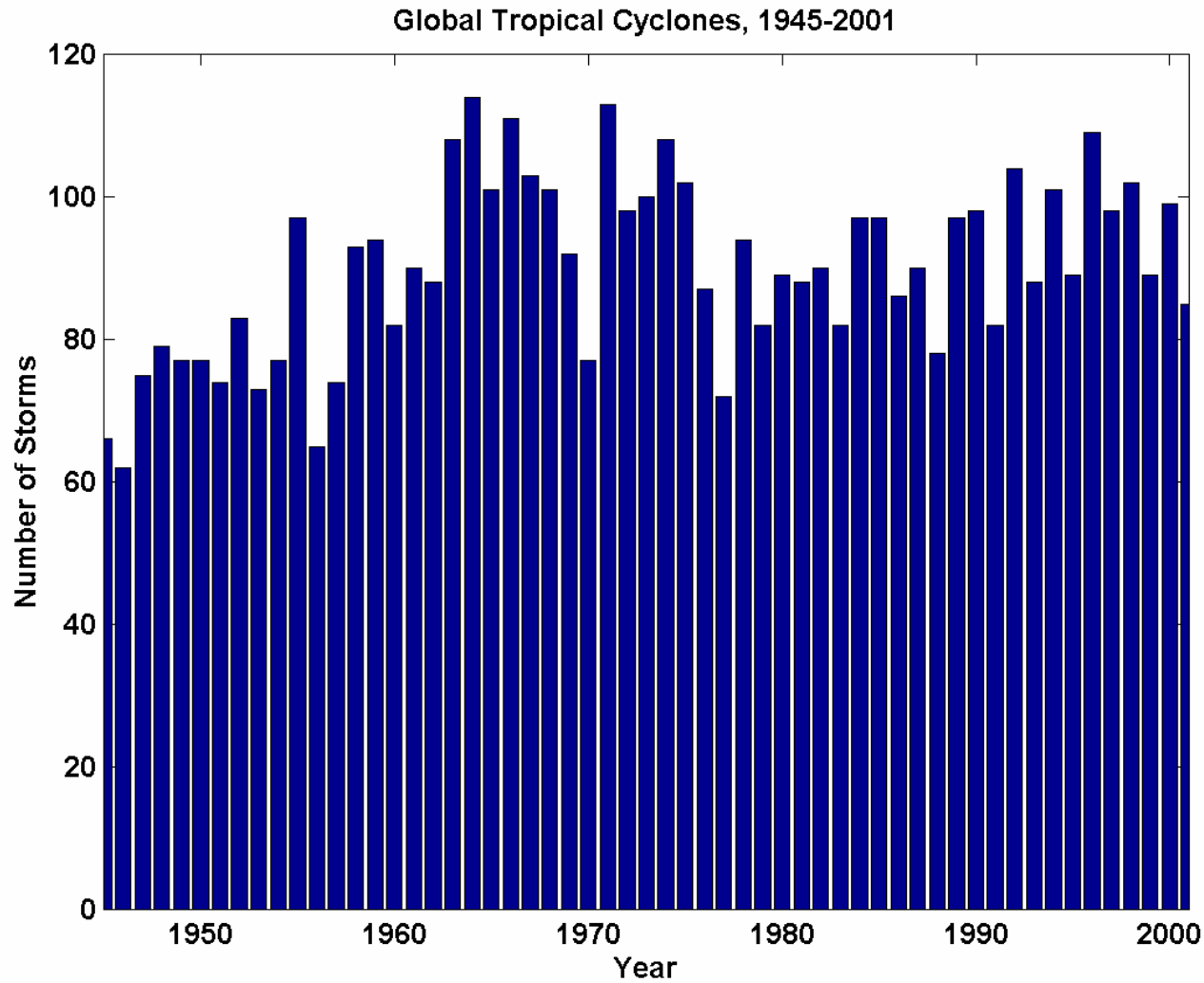


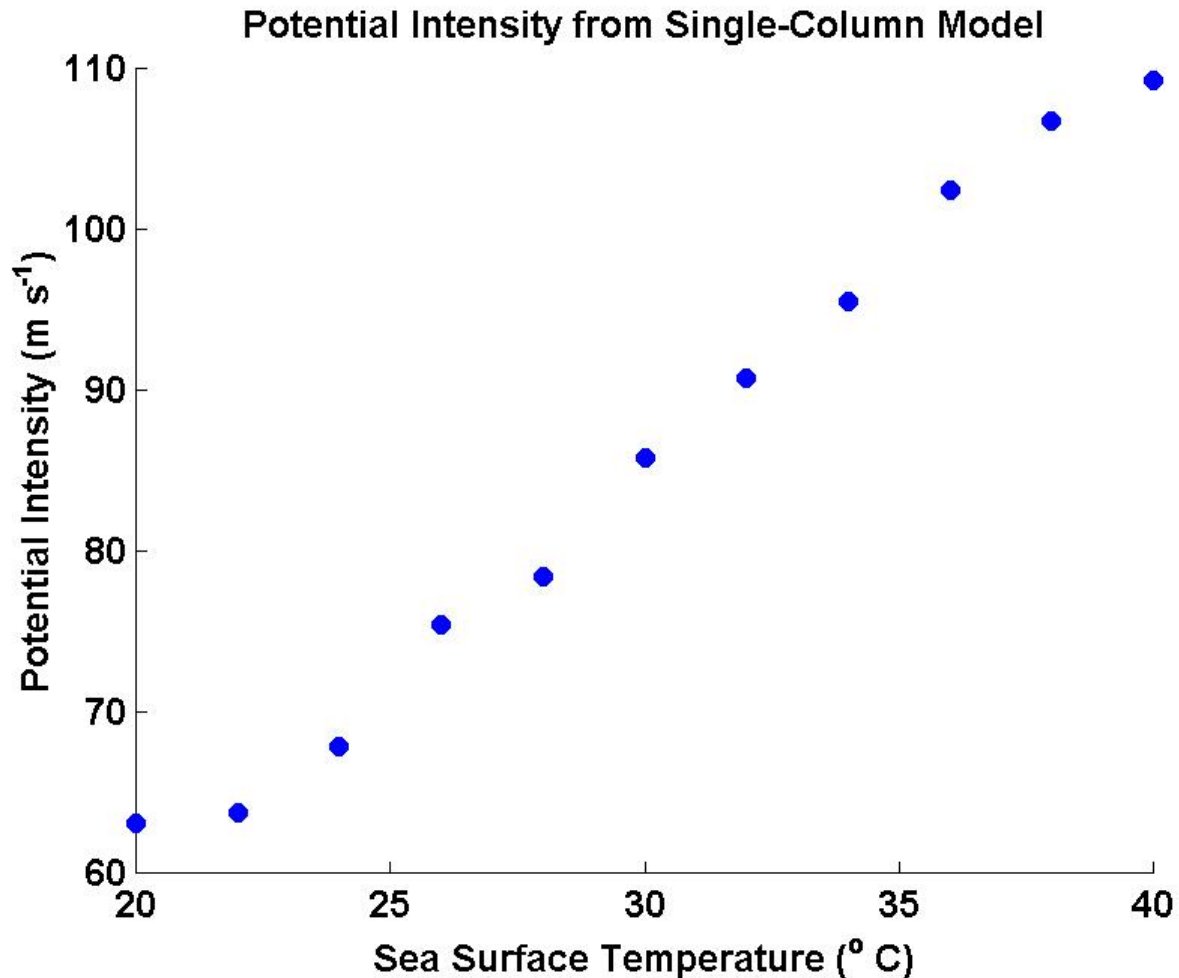
# Hurricanes and Climate

Kerry Emanuel  
Program in Atmospheres, Oceans, and  
Climate  
MIT

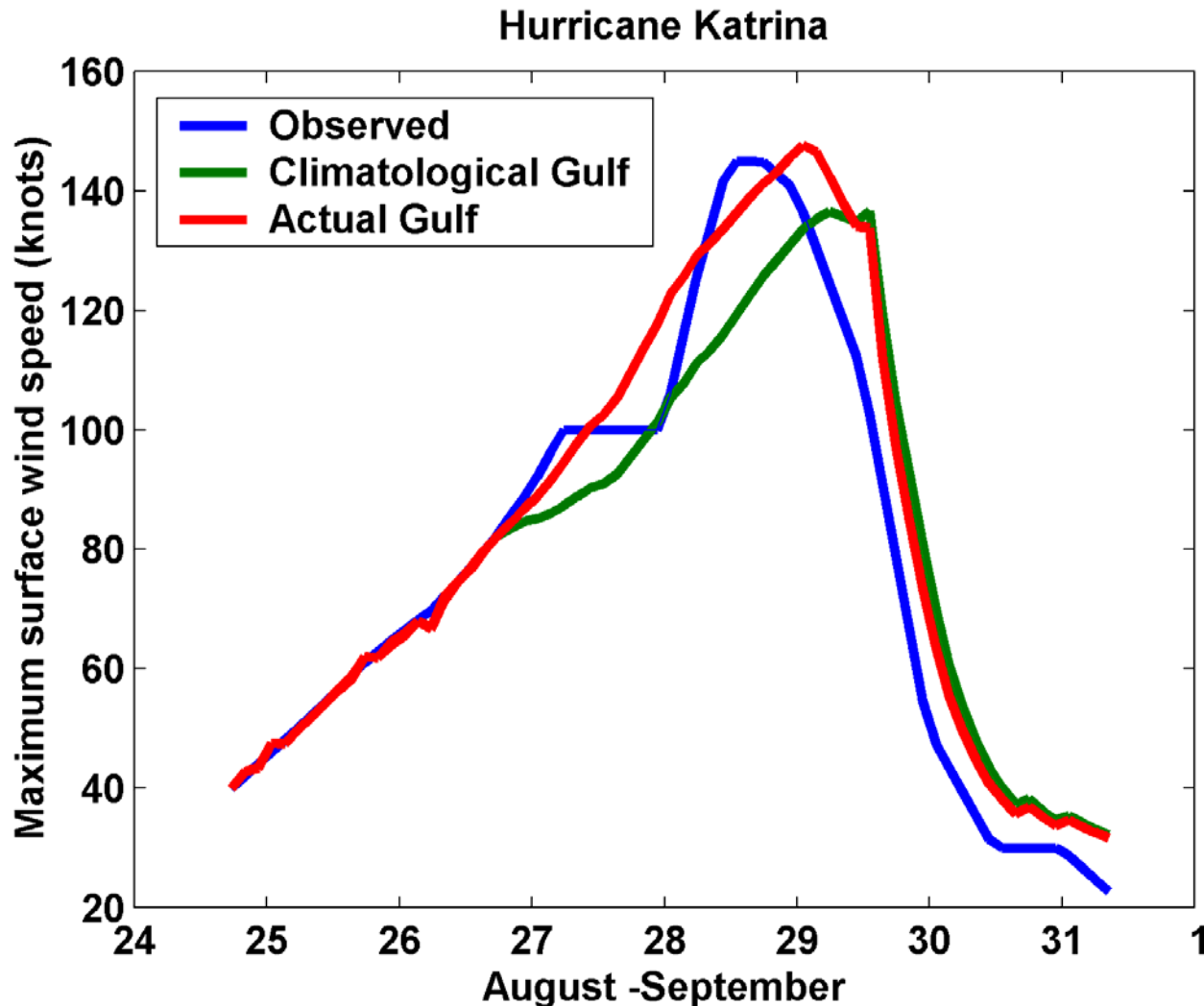
# No Long-Term Trend in Frequency



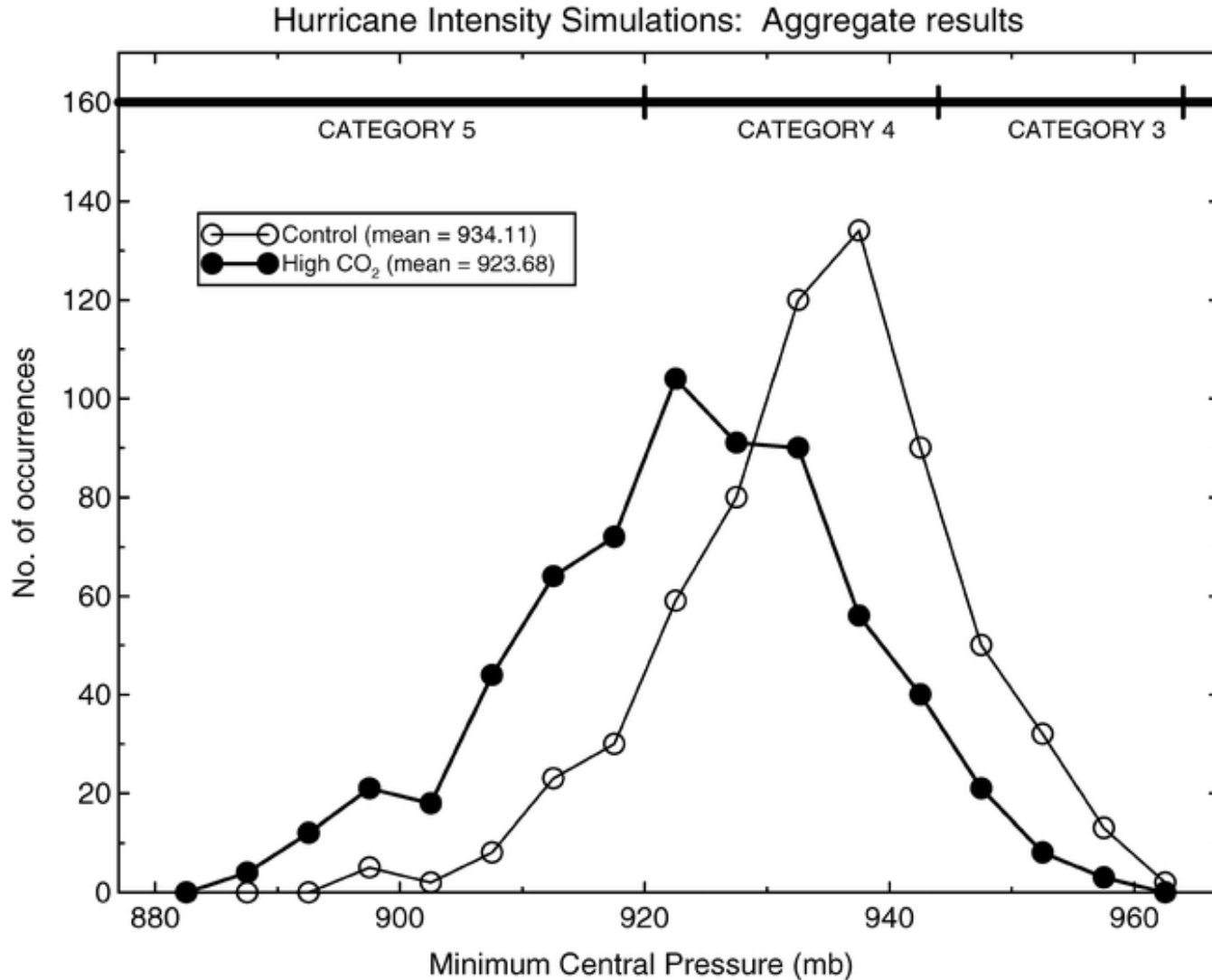
# Theory: Maximum Storm Intensity Increases with Tropical SST (Emanuel, Nature, 1987):



# Numerically simulated storm intensity scales with maximum intensity:



# Knutson and Tuleya, *J. Climate*, 2004

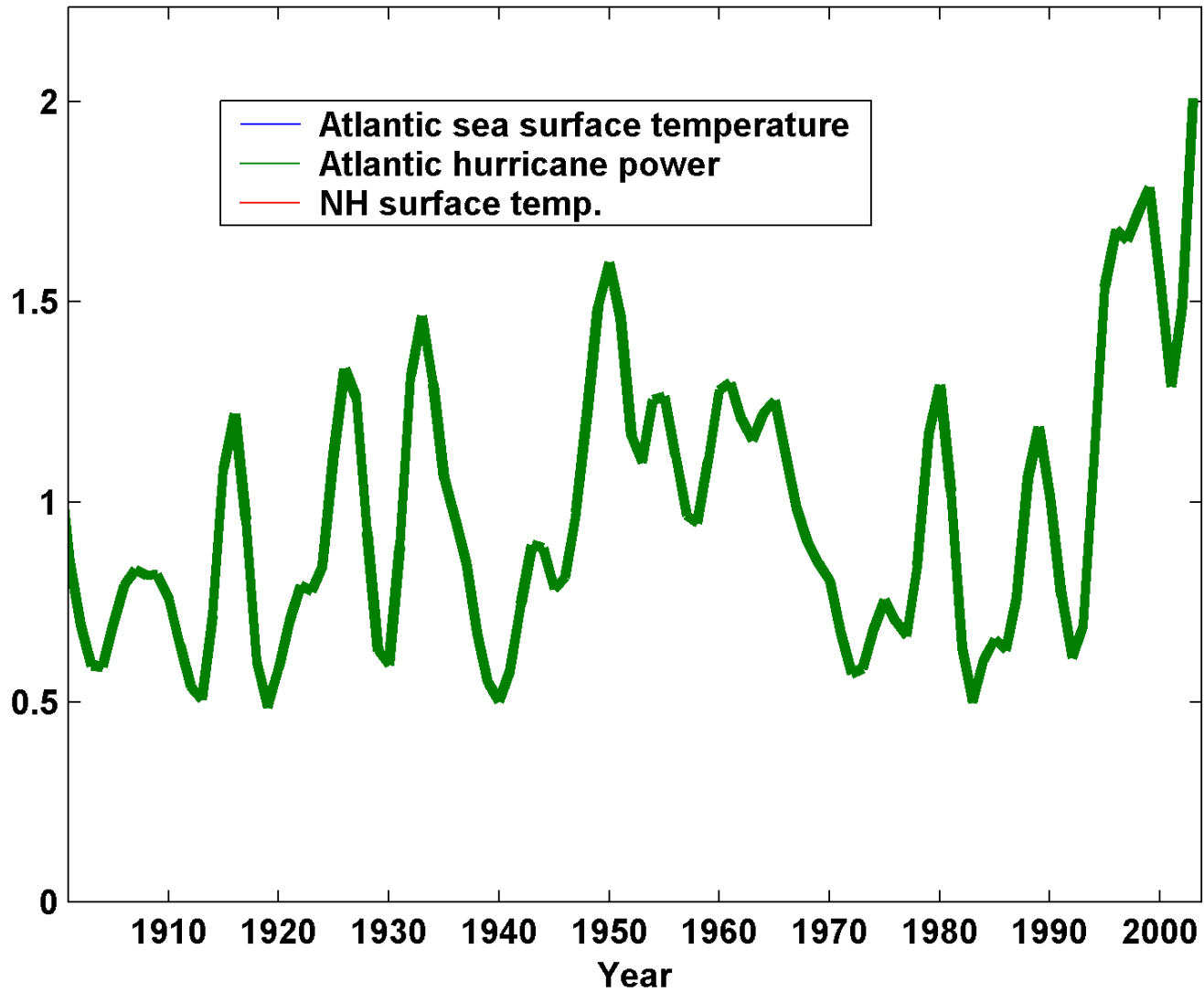


# How has Hurricane Activity Actually Changed?

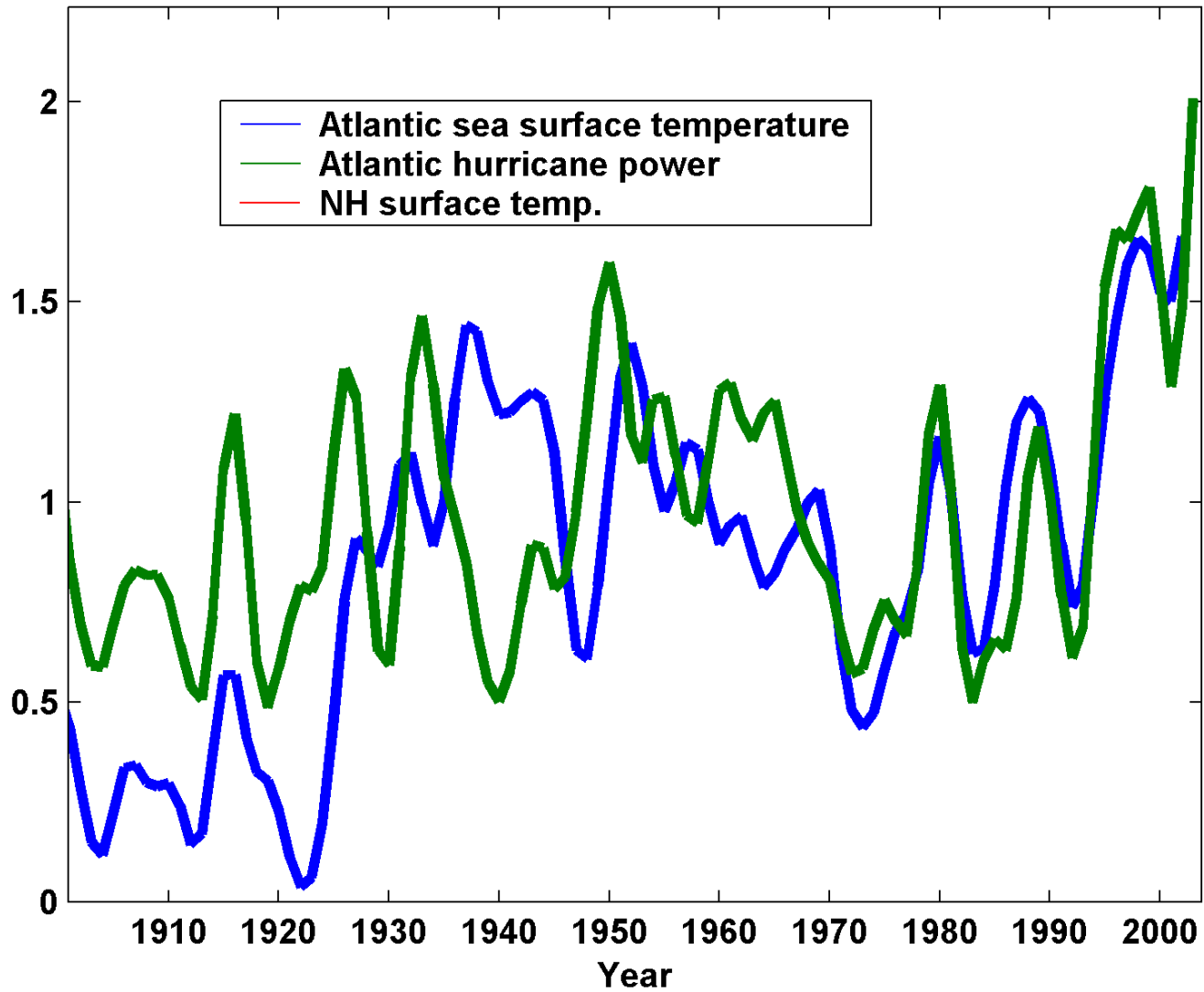
**Measure of total amount of  
energy released by a hurricane  
over its life:**

**The *Power Dissipation Index*, or  
“PDI”**

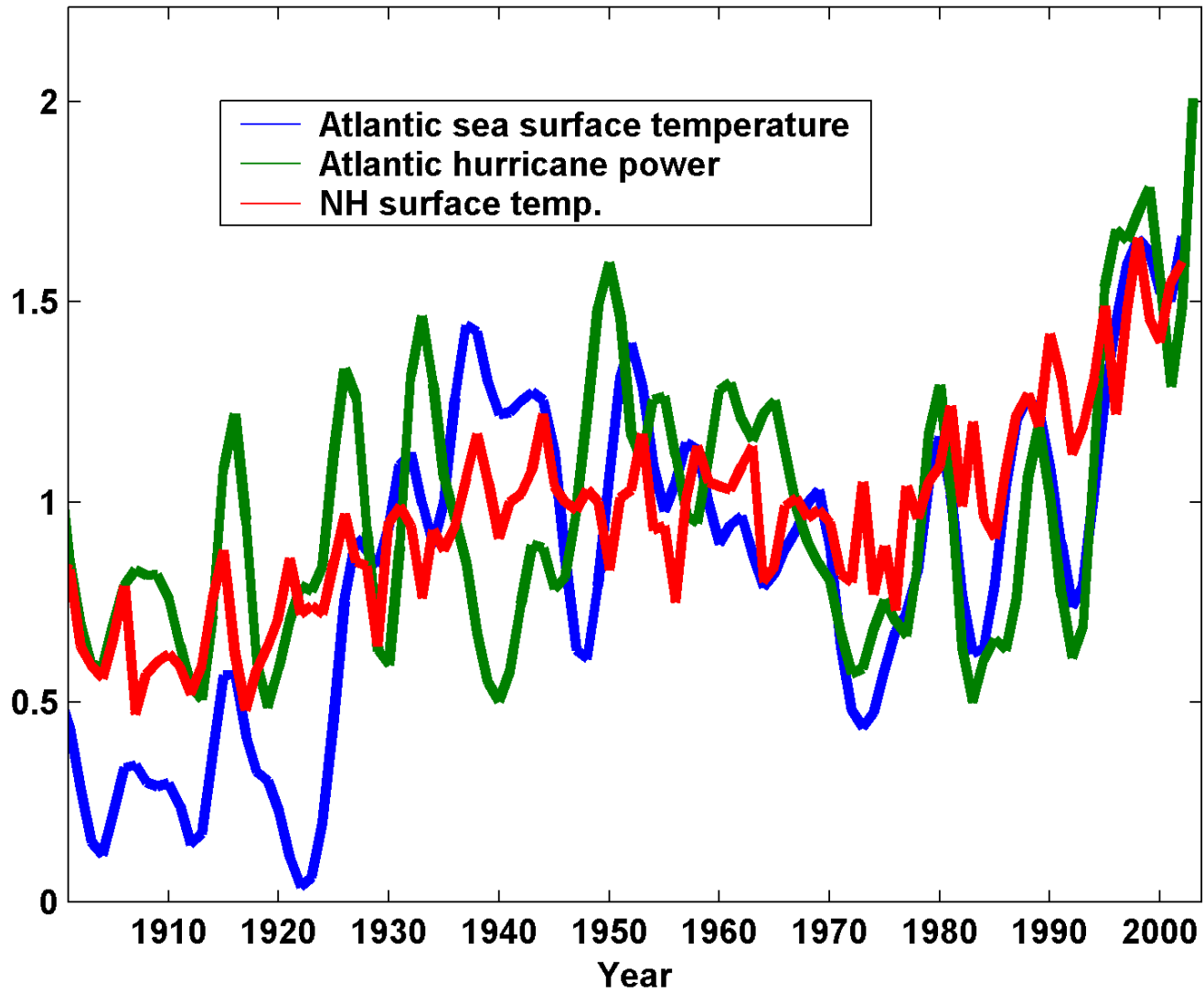
# Atlantic



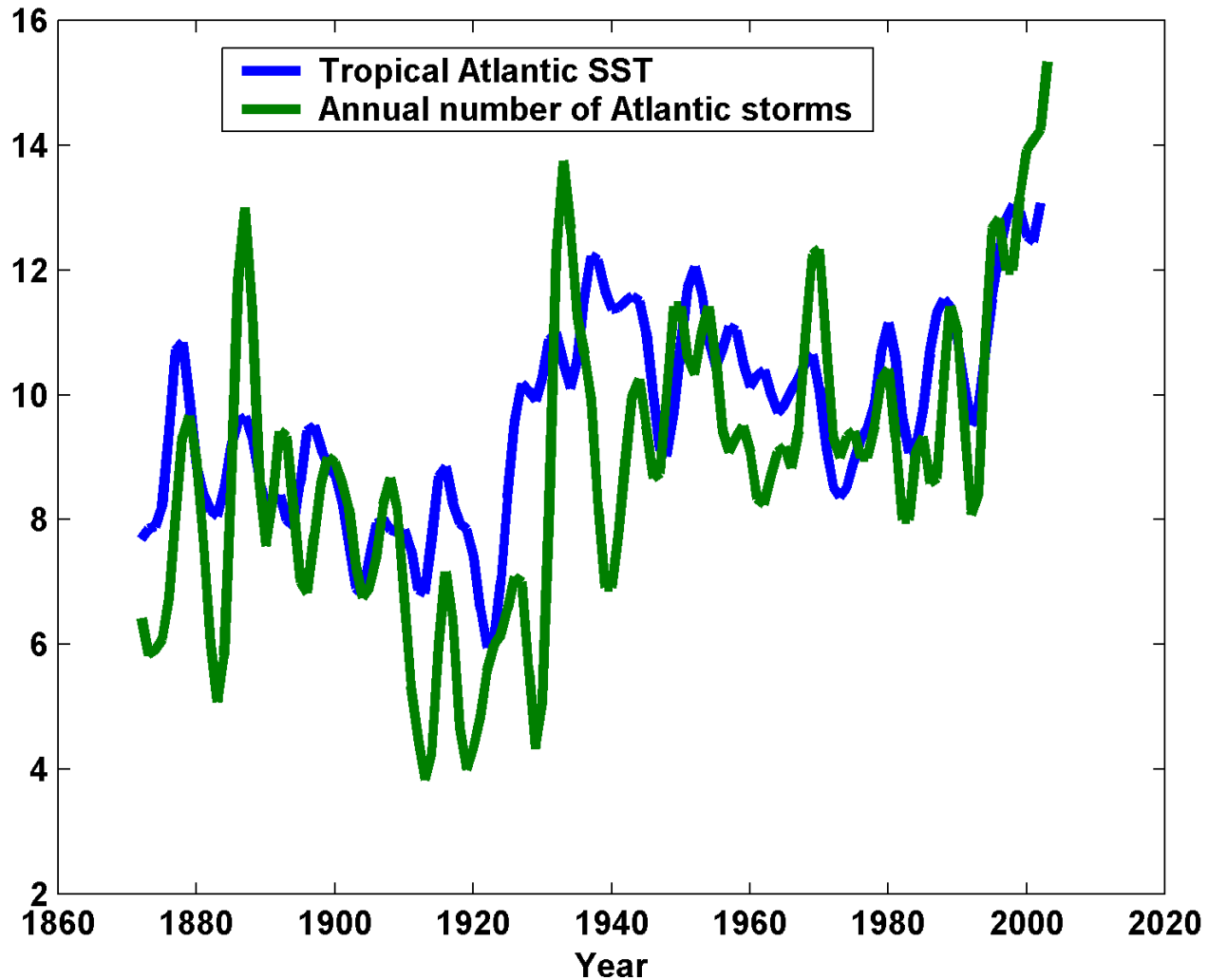
# Atlantic



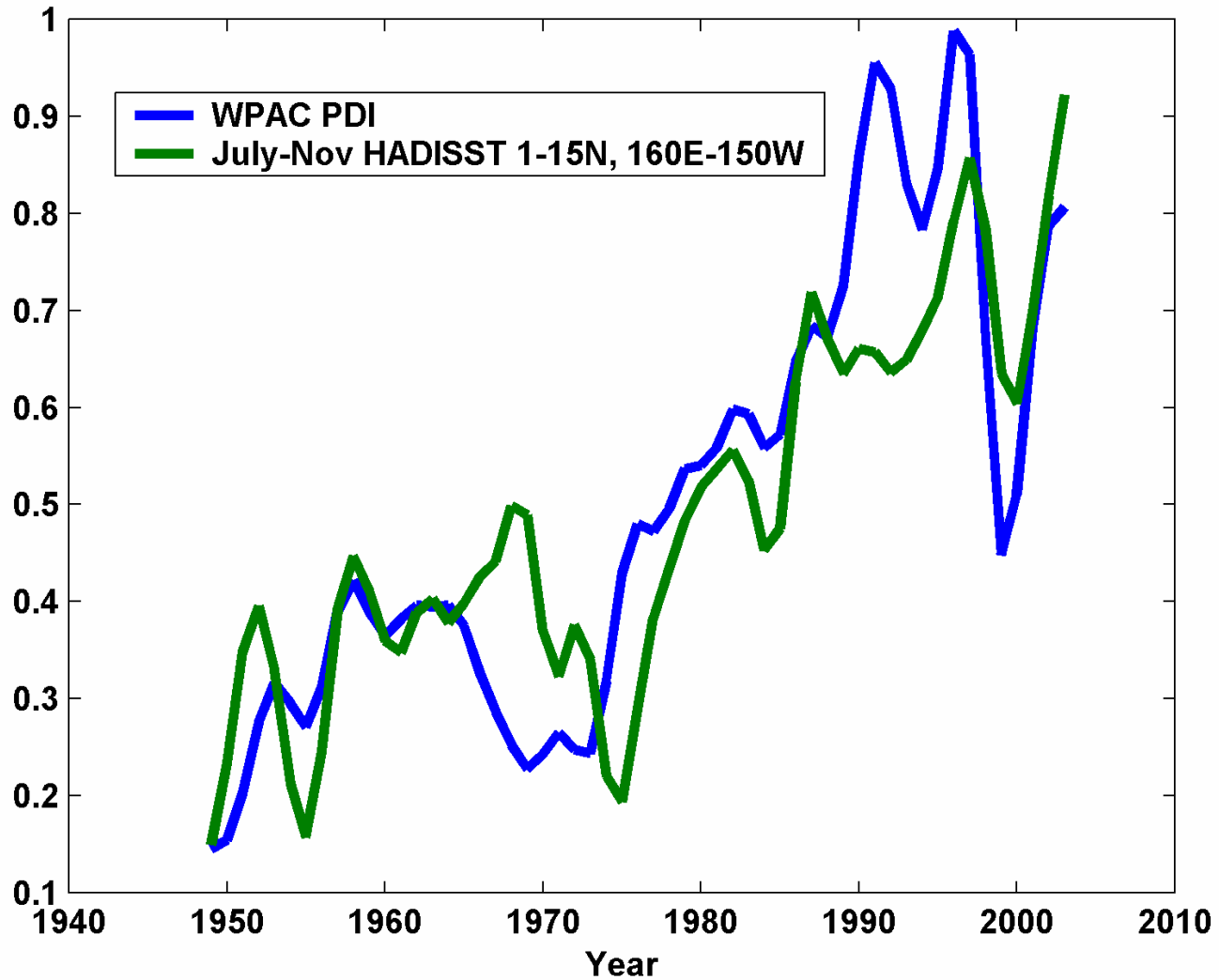
# Atlantic



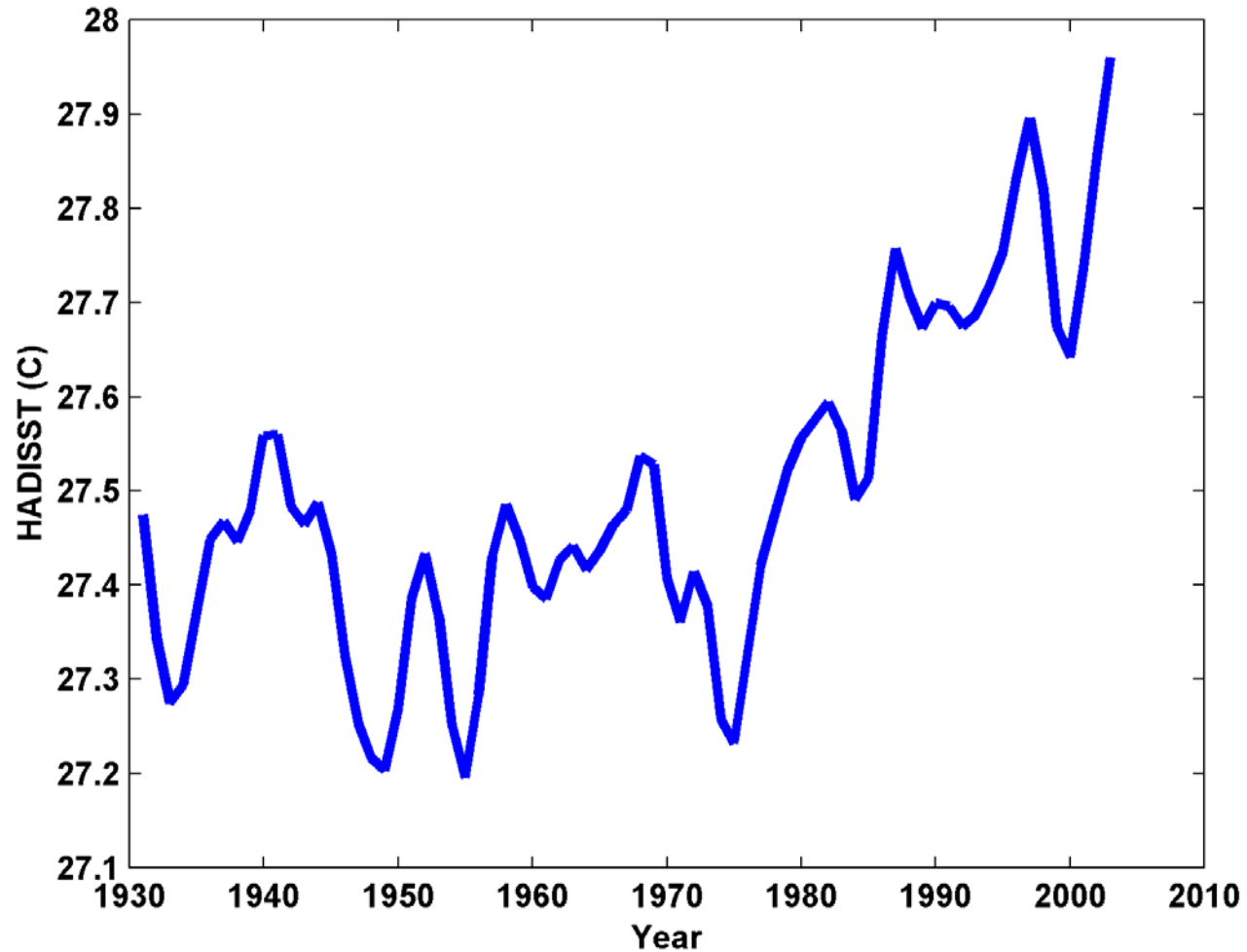
# Annual Storm Count and SST



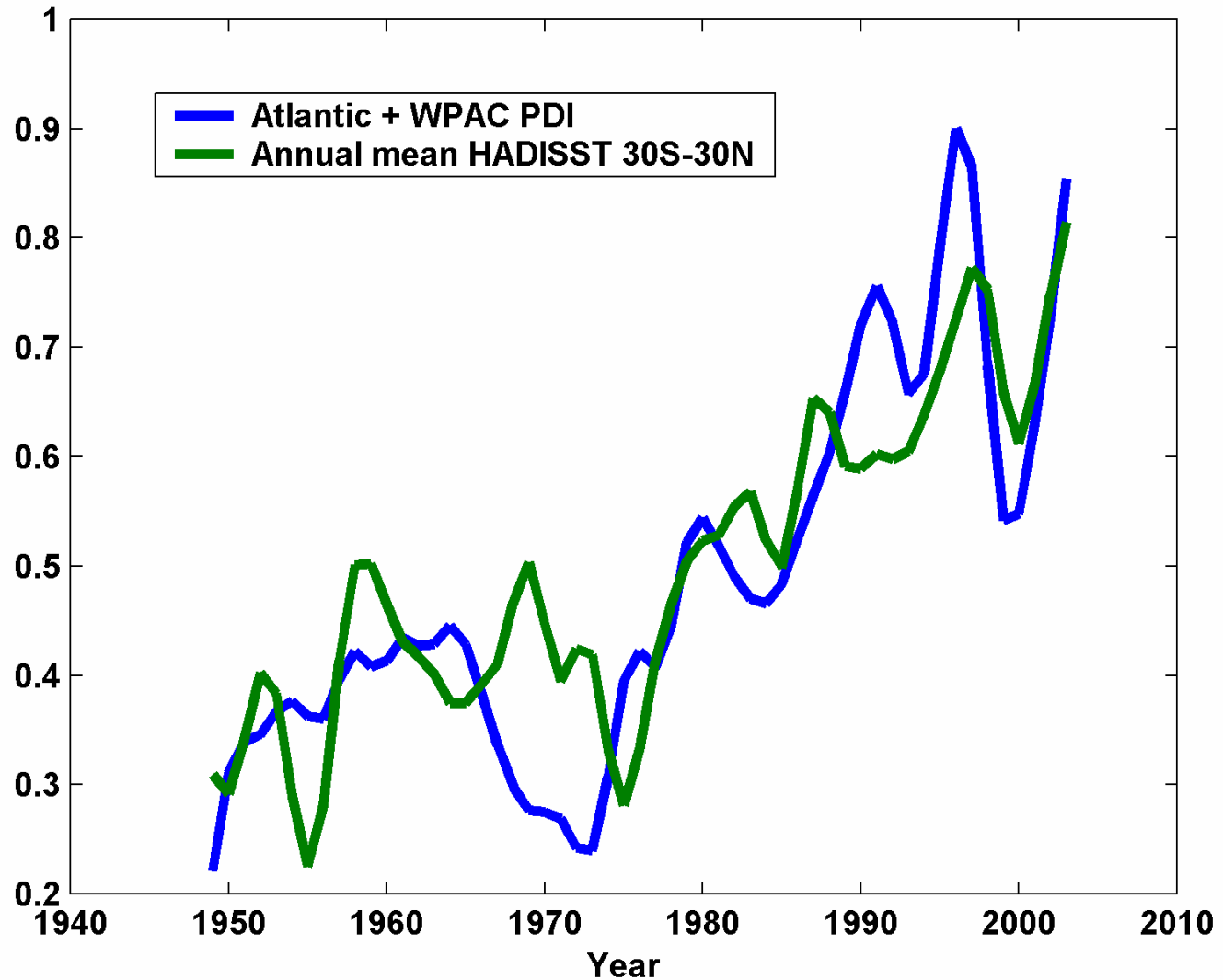
# Western North Pacific



# Longer record of Pacific SST:

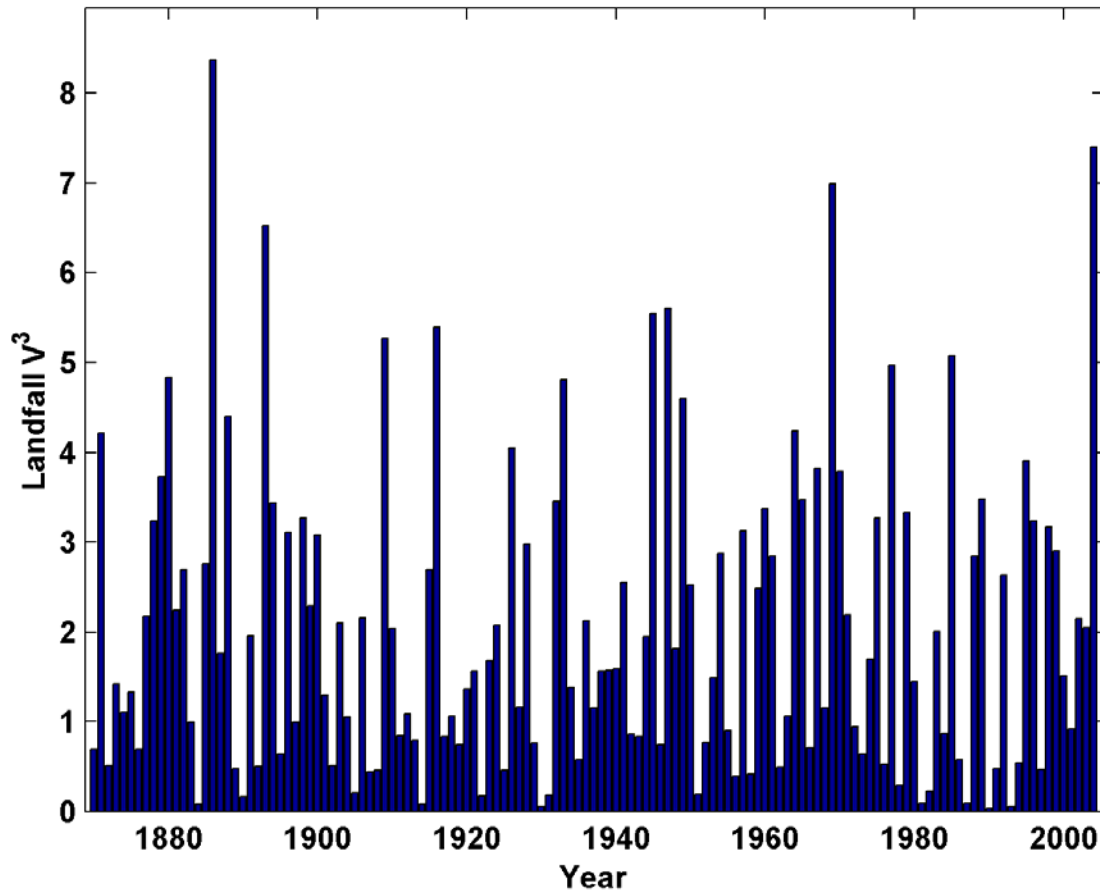


# Atlantic + western North Pacific



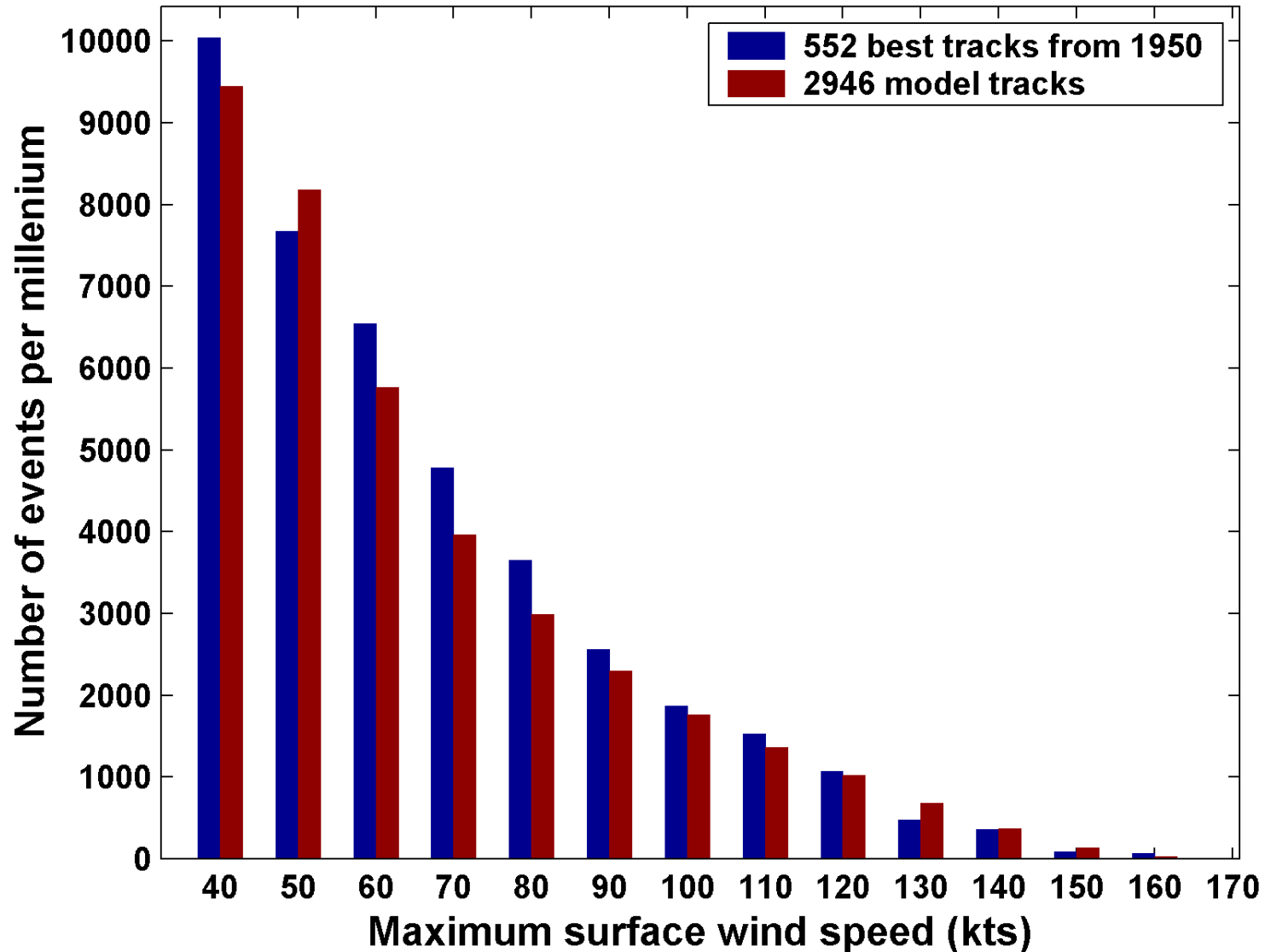
# Index of hurricane destructive power at U.S. landfall shows no systematic trend

$V^3$  at Landfall by Year, U.S.

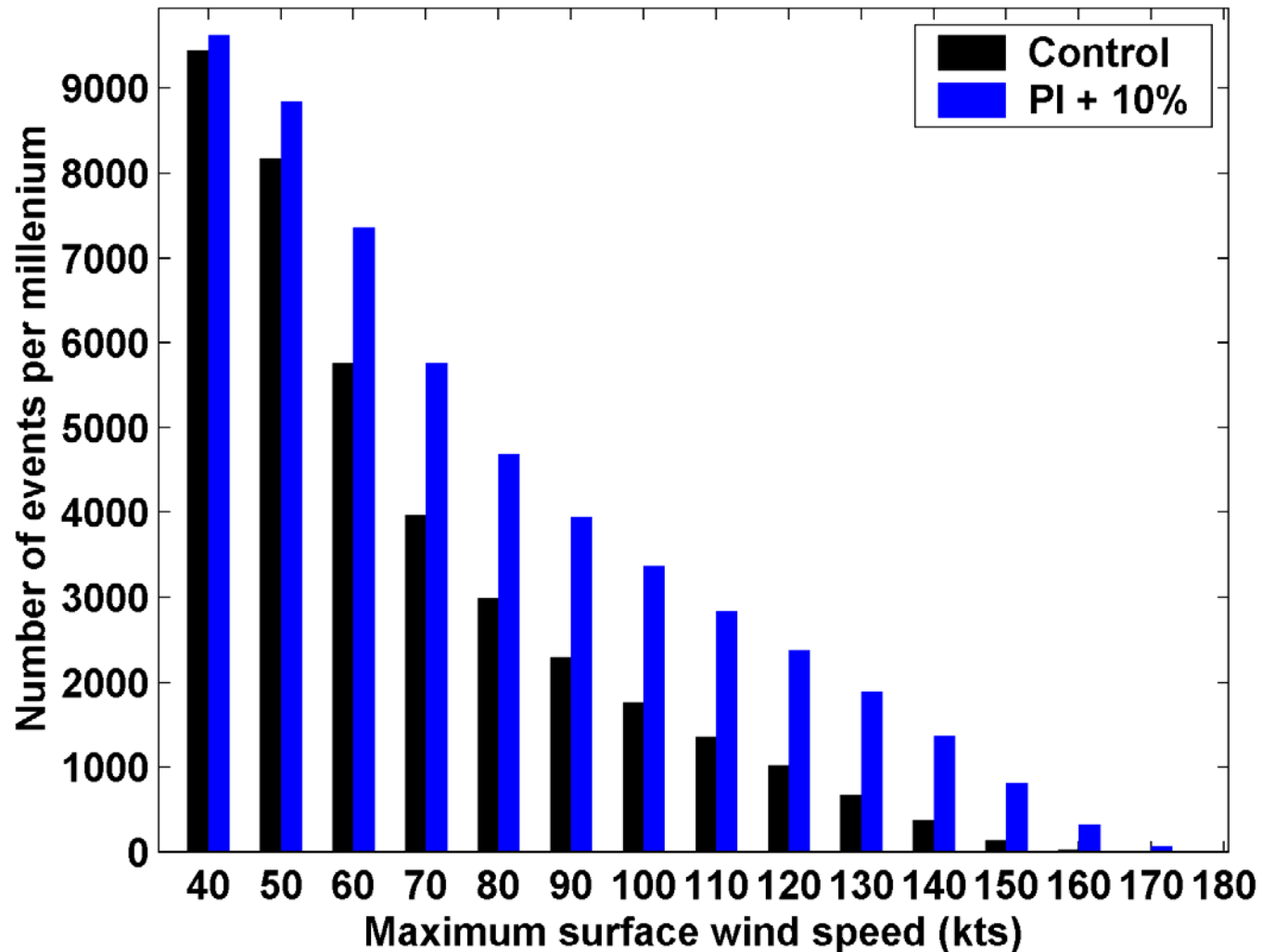


# Modeling Global Hurricane Activity

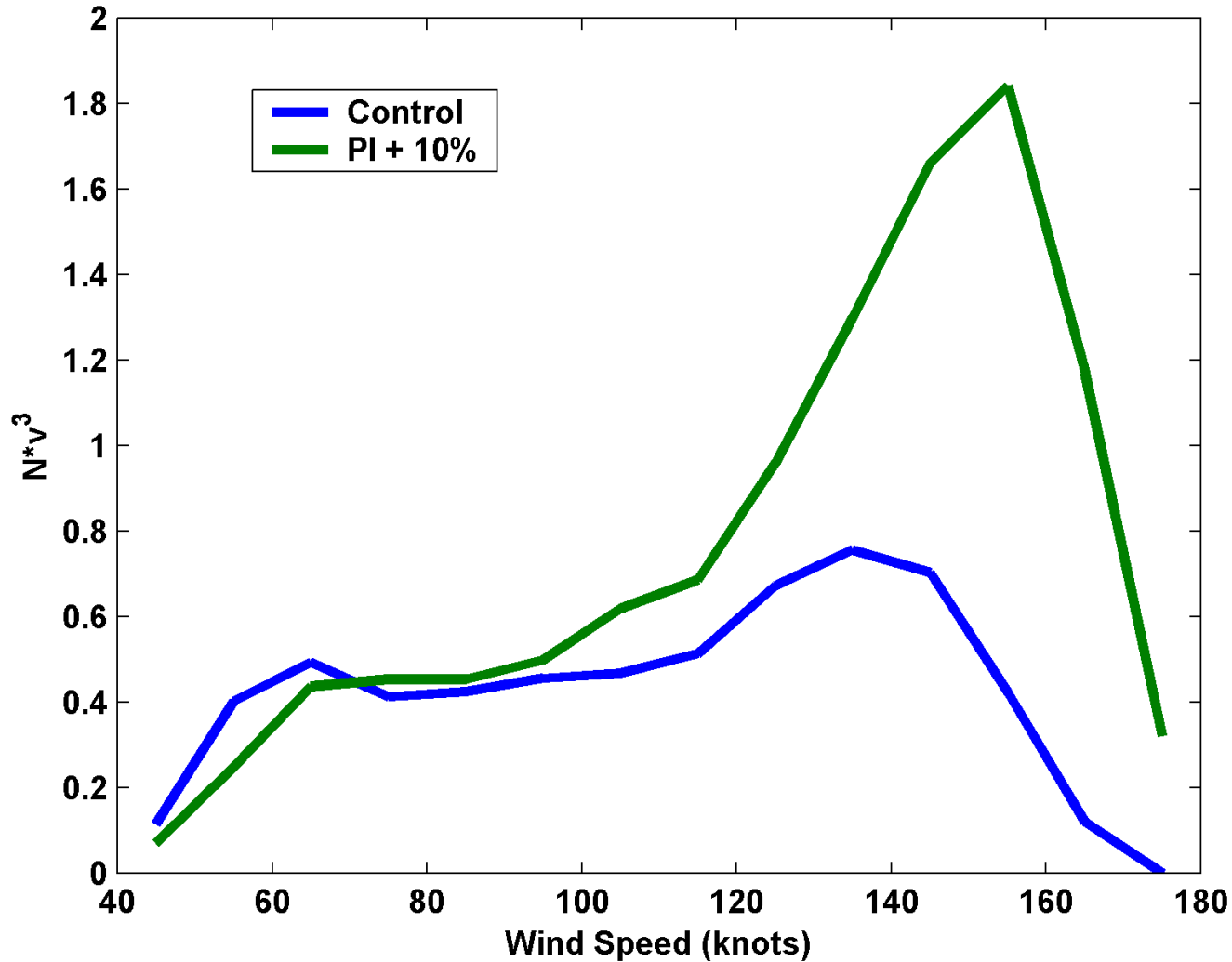
# 3000 Atlantic storms in the current climate



# Climate in which Maximum Intensity has been increased by 10%



# Number of events \* V<sup>3</sup>



Integrated  
power  
dissipation  
increases  
80%

# Summary

- Global tropical cyclone frequency shows no long-term trend
- A measure of total hurricane power generation shows a profound upward trend in the past 30 years, well correlated with SST in key cyclone regions. This is probably owing to global warming, and is a reflection both of increasing intensity and increasing duration.