# Reduced Caribbean Hurricane Activity during the Maunder Solar Minimum

Valerie Trouet

Sun Climate Symposium

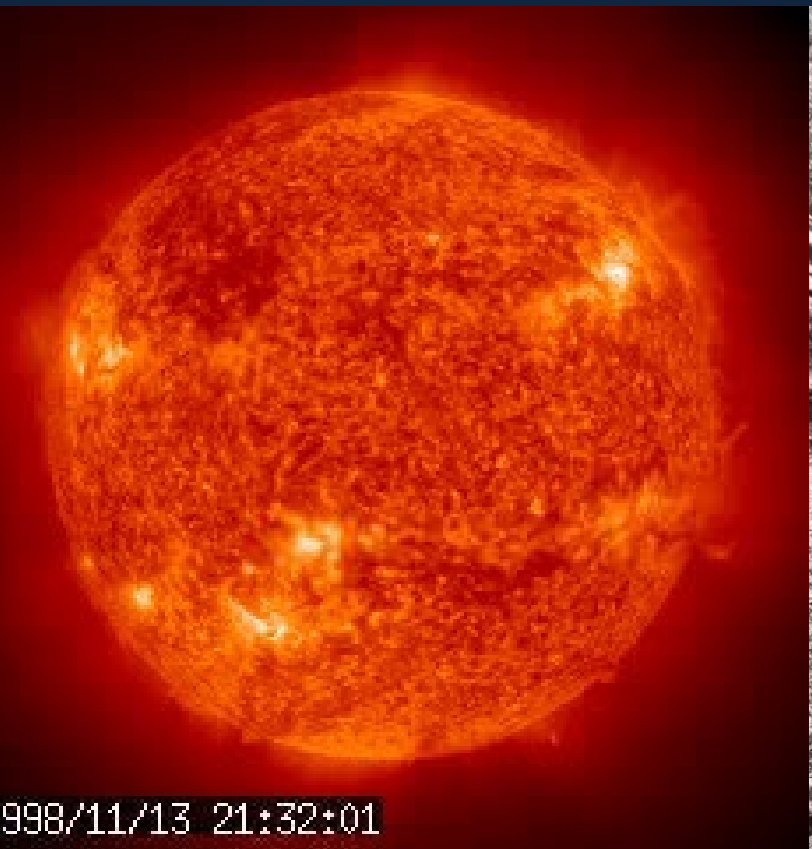
29 January 2020

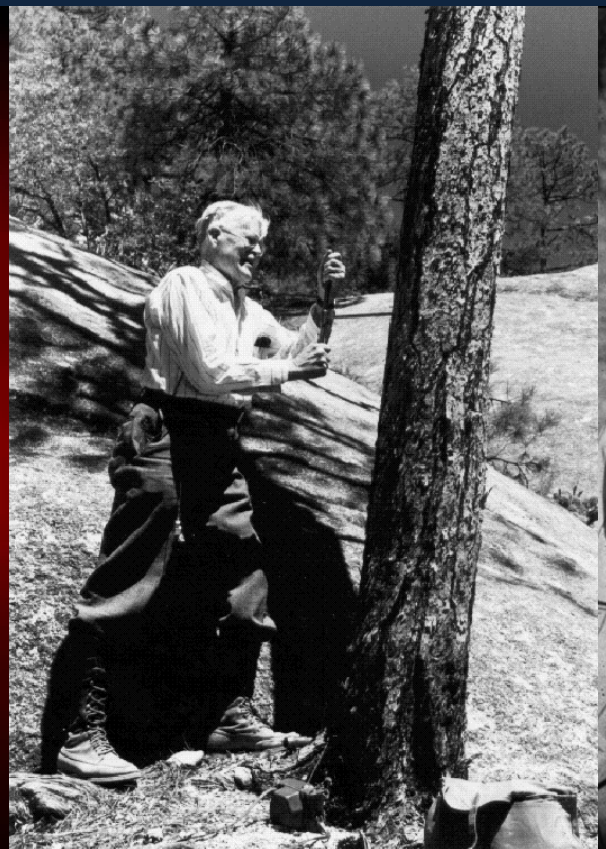
# A.E. Douglass (1867-1962)

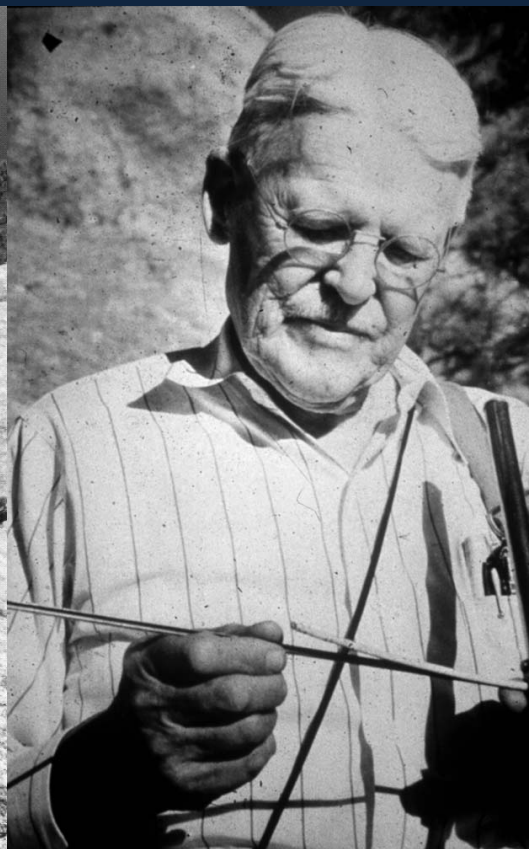
Founder of Modern Dendrochronology

&

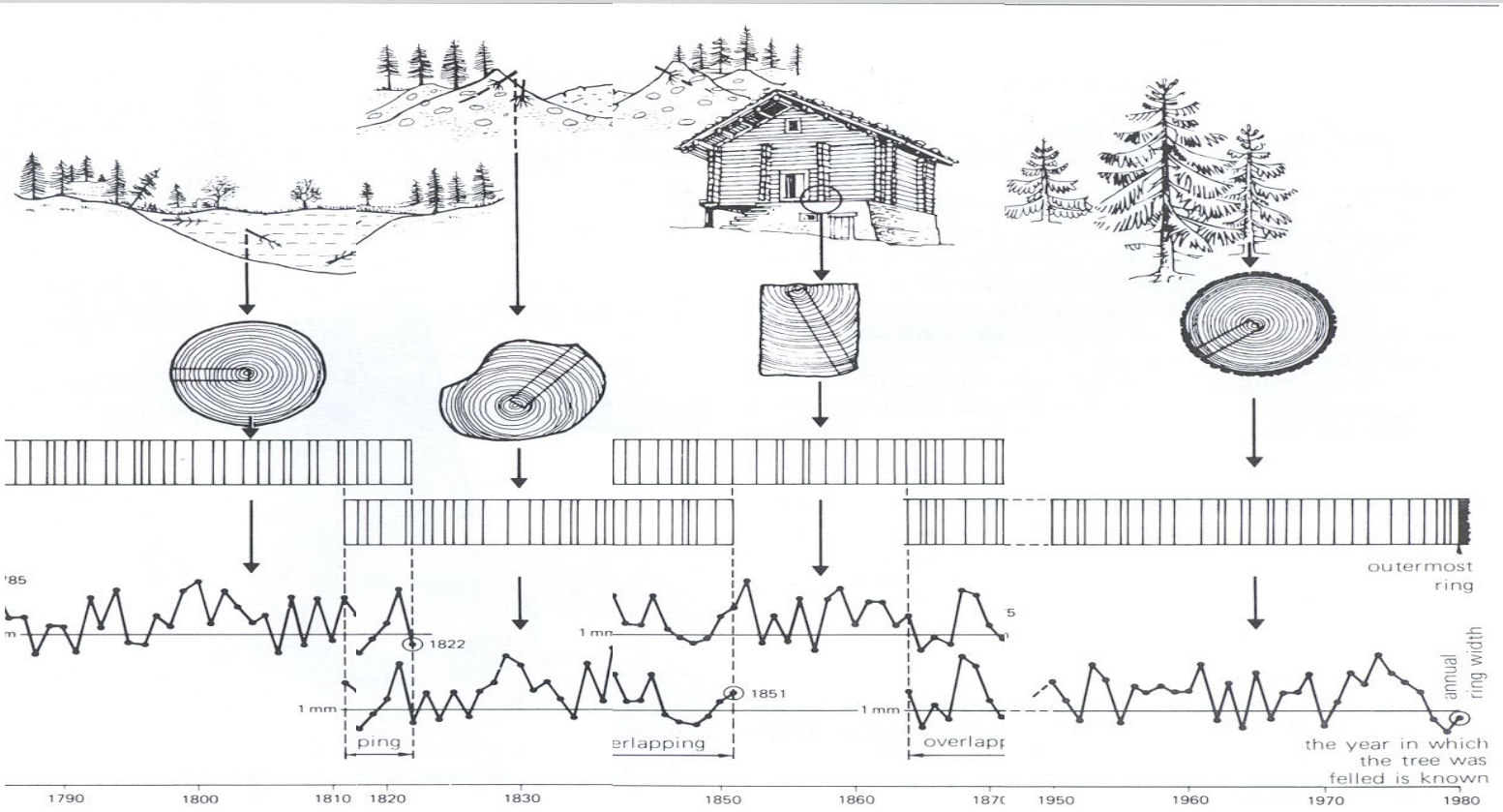
Laboratory of Tree-Ring Research (1937)





# Tree-ring data are available on time-scales that are linked to human history (~2K years)

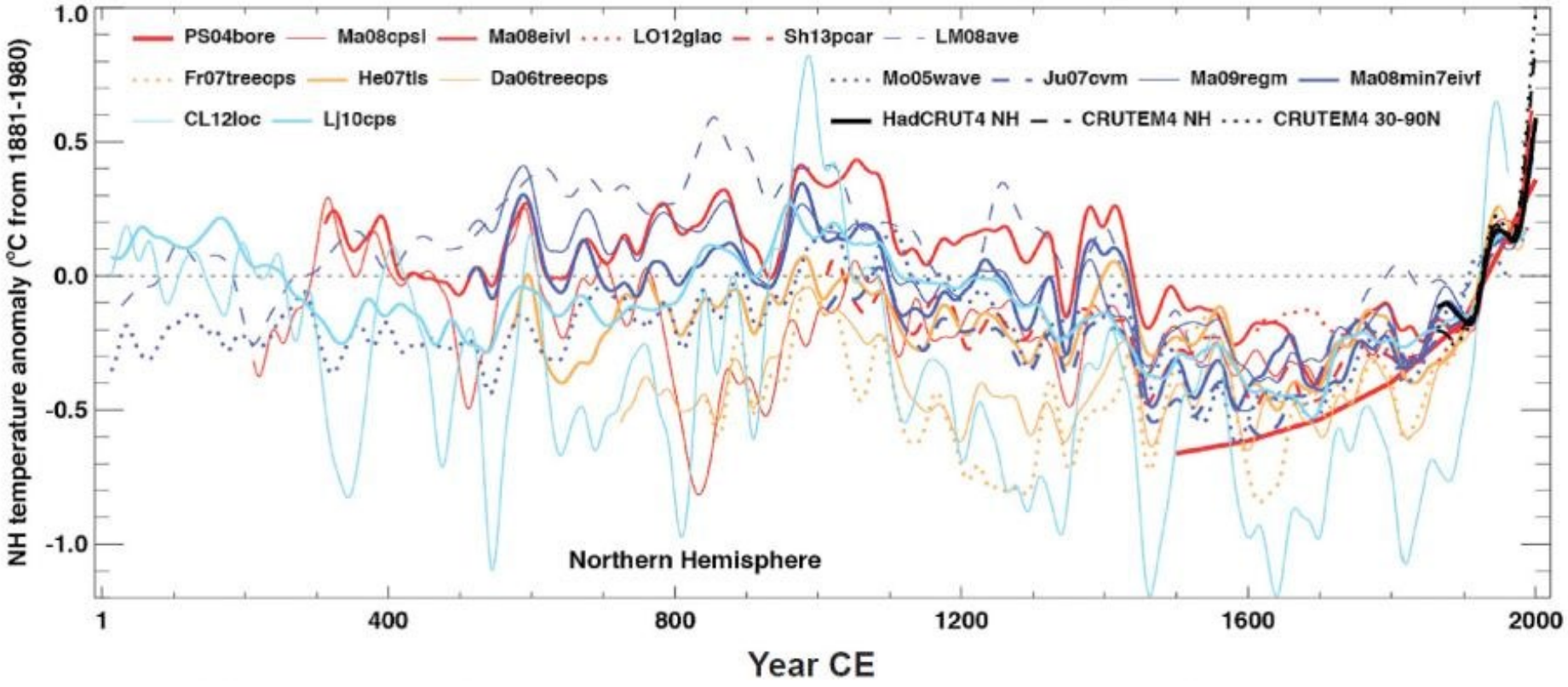



Buentgen et al. (2011) *Science*

# Tree-ring data allow us to study natural climate variability on time-scales that are relevant to policy and to human history (~2K years)

# NH temperature over the past 2,000 years

Medieval Warm Period (~900-1300)

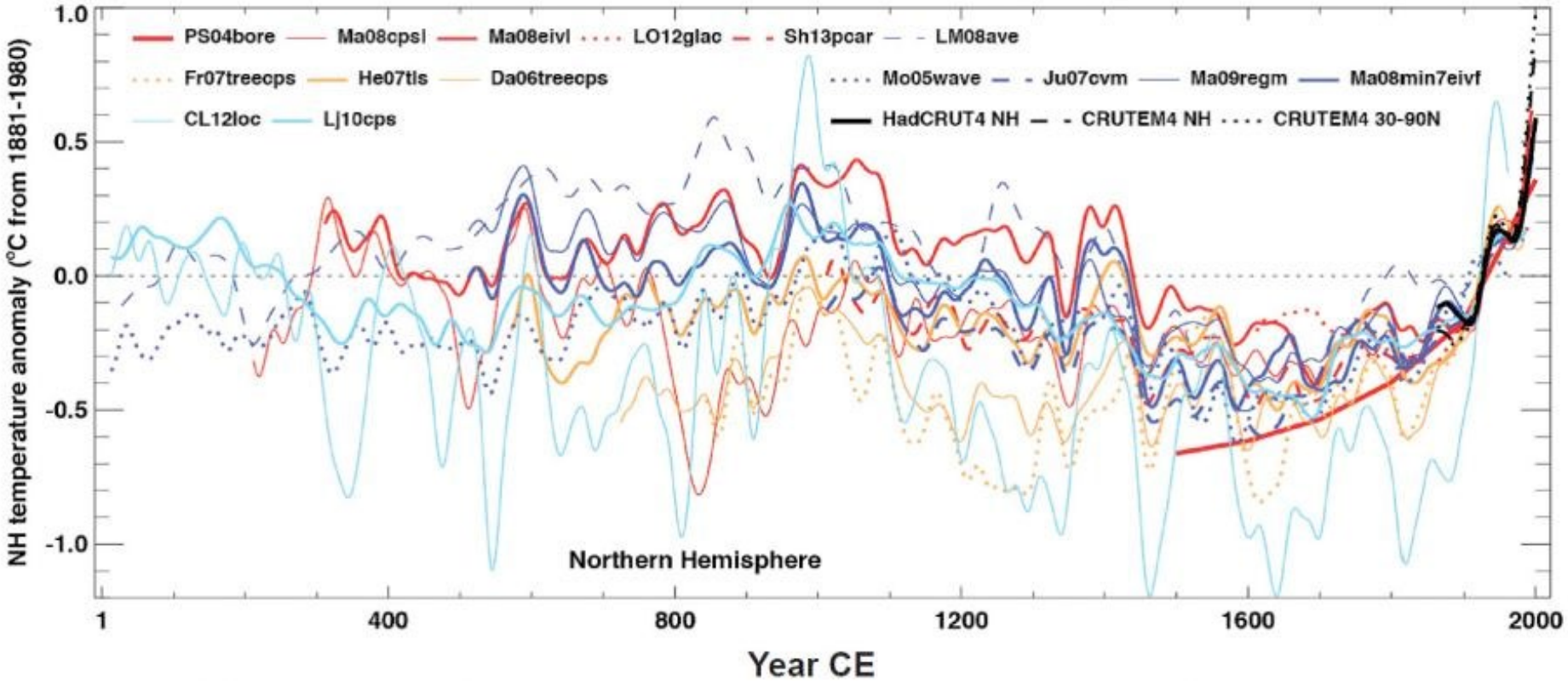



Late Antique Little Ice Age (~500-700)

Little Ice Age (~150 1850)

IPCC 2013

# During the **Little Ice Age**, average temperatures were up to 0.7C colder than "today"

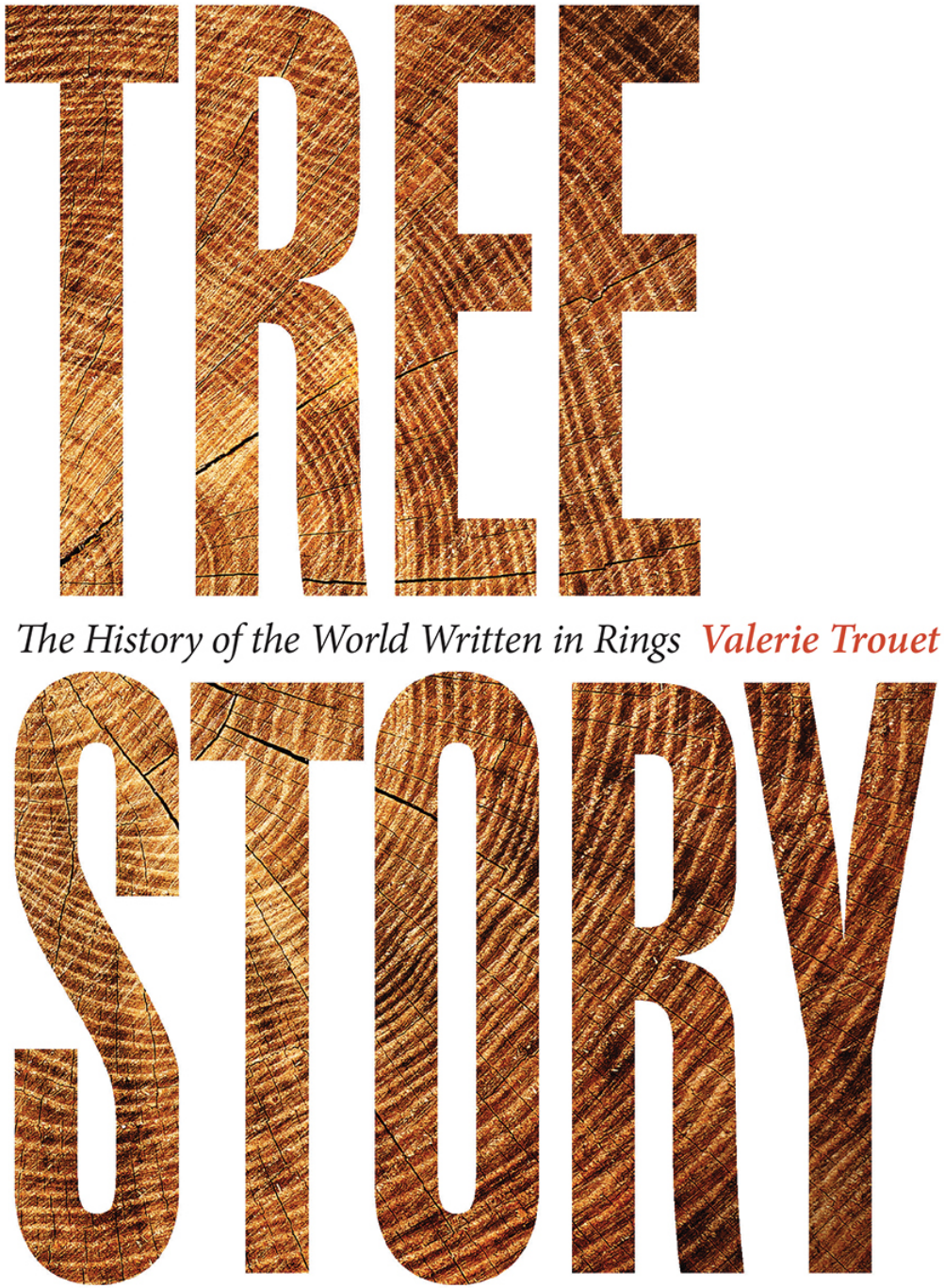



Little Ice Age (~150
1850)

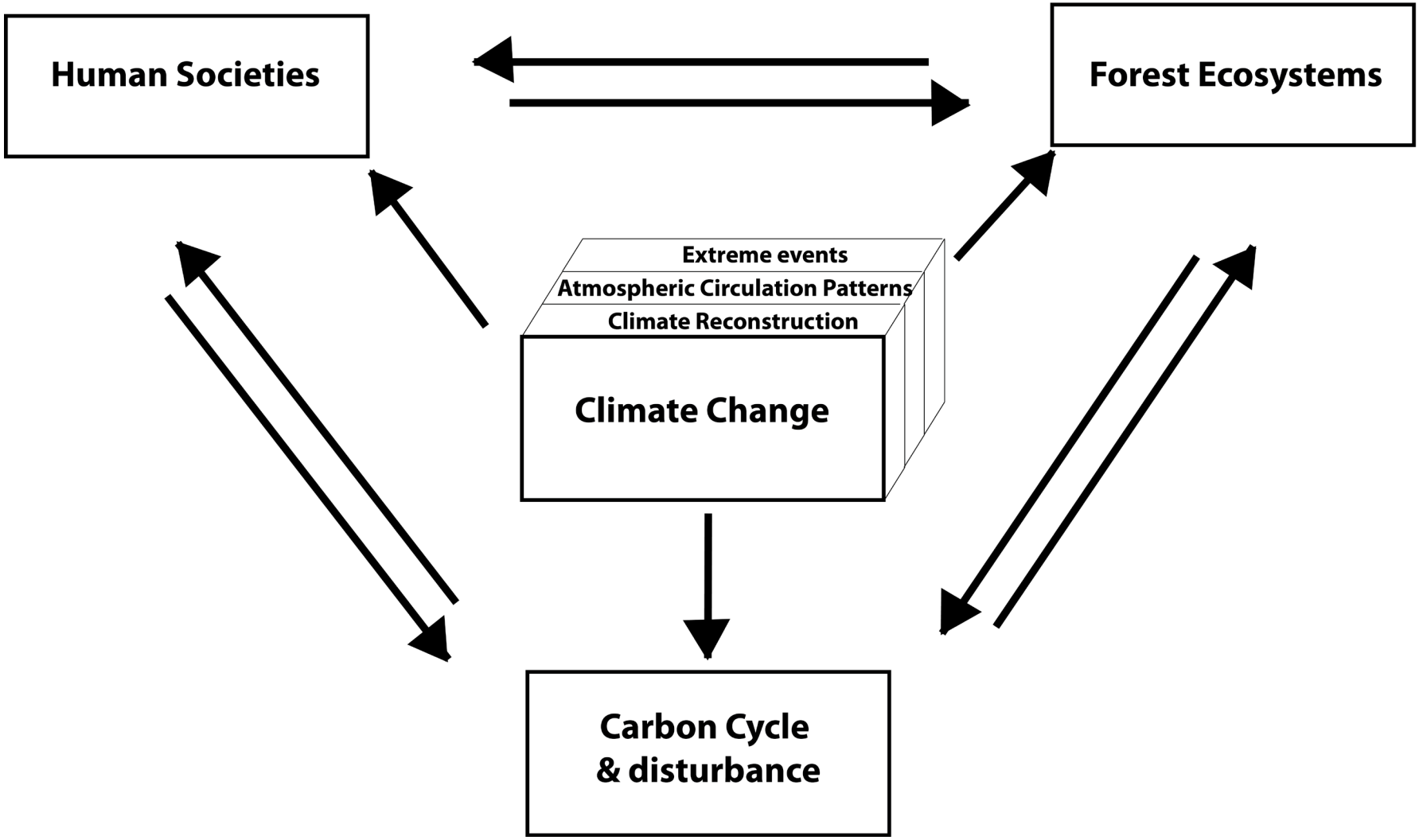
**Frank et al. (2010) *Nature***

# In particular during the Maunder solar Minimum (1645-1715 CE)

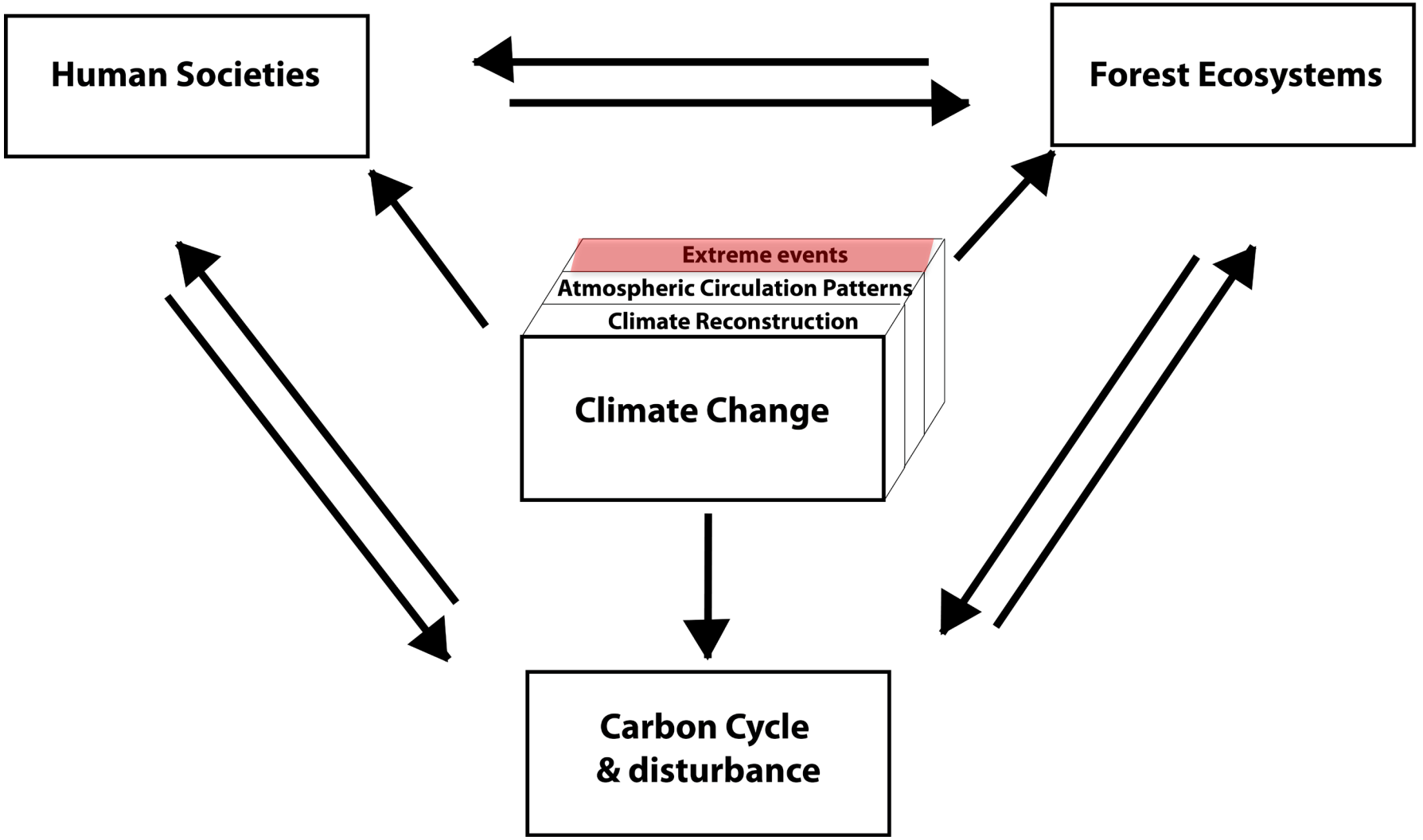
Louis XIV “The Sun King” of France (1643-1715 CE)

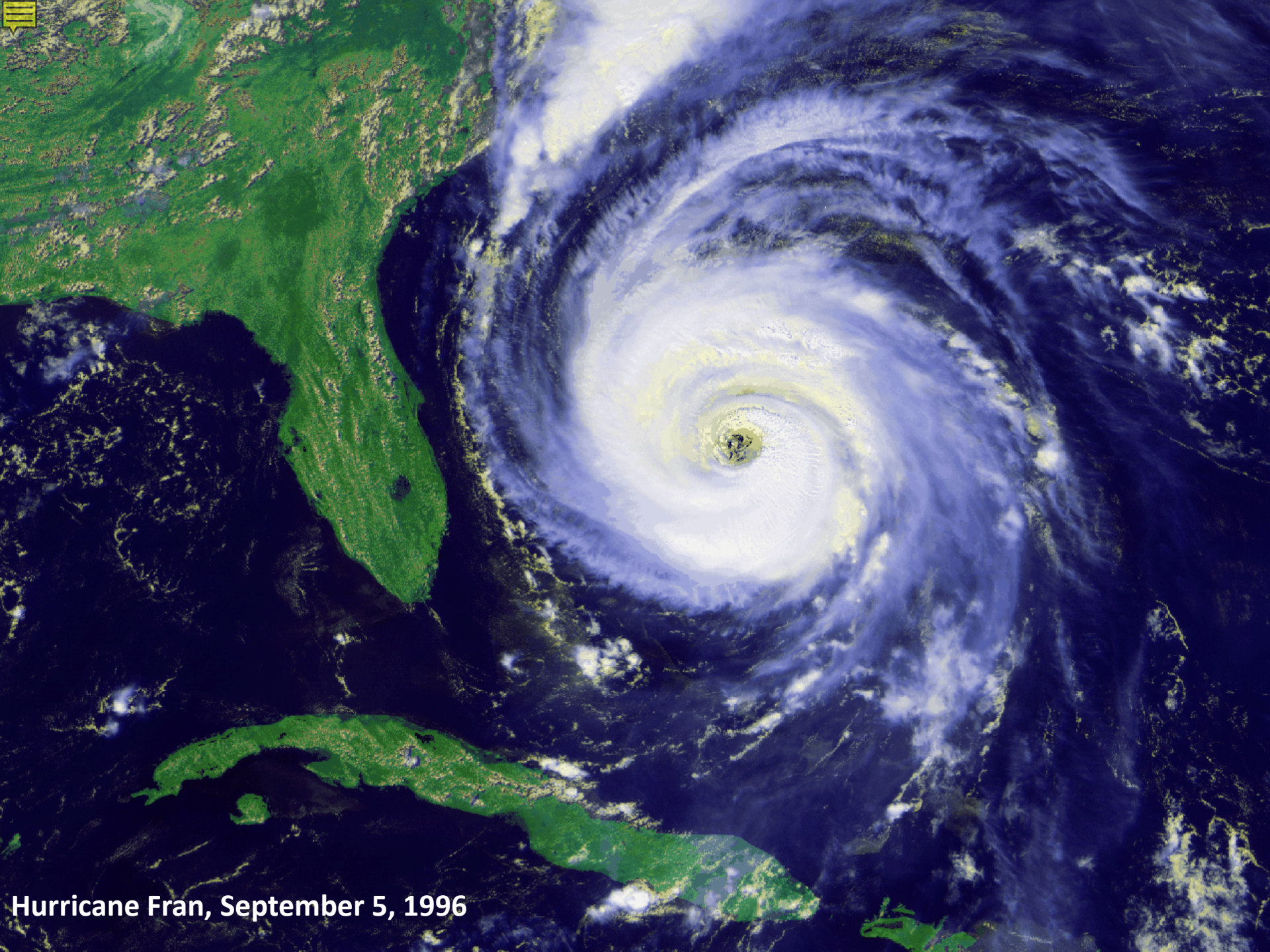



Johns Hopkins
University Press
April 2020


Human Societies
Forest Ecosystems
Extreme events
Atmospheric Circulation Patterns
Climate Reconstruction
Climate Change
Carbon Cycle
& disturbance

# Tree-ring based reconstruction of extreme events




Hurricane Fran, September 5, 1996

21st century model simulations generally agree that globally: Higher Tropical Cyclone intensity and lower frequency*

*but large uncertainties exist

"We find that for North Atlantic Tropical Cyclone frequency … the largest uncertainties are driven by the chaotic nature of the climate system and by the climate response to radiative forcing*"

*e.g. $CO_2$, the sun

*Villarini and Vecchi (2012) Nature Climate Change*

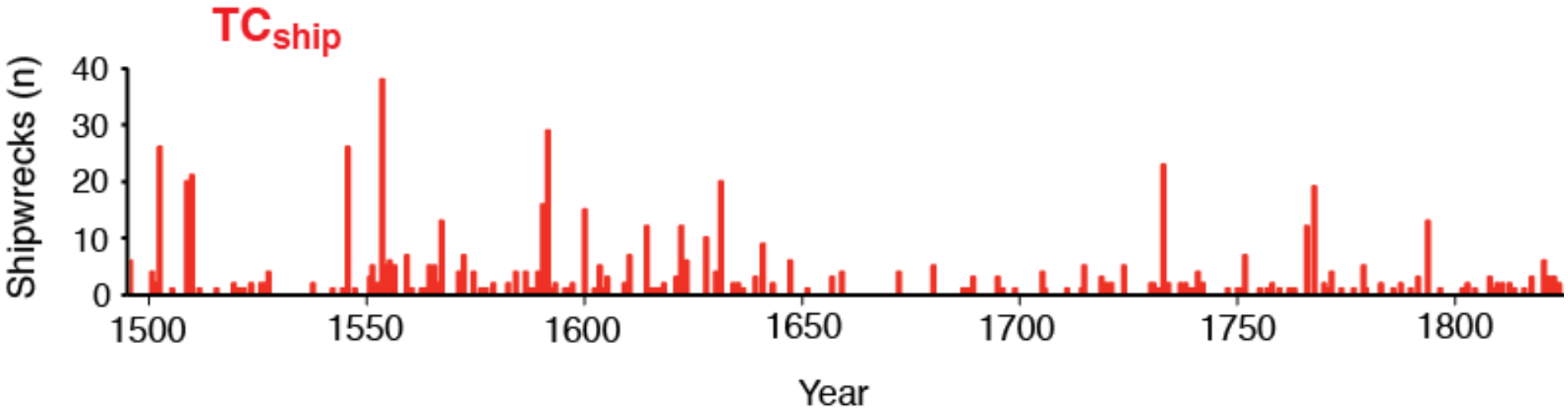
# Can we use paleoclimate records to reconstruct Caribbean hurricanes back to the Maunder Minimum?


# First Spanish West Indies voyage in 1492

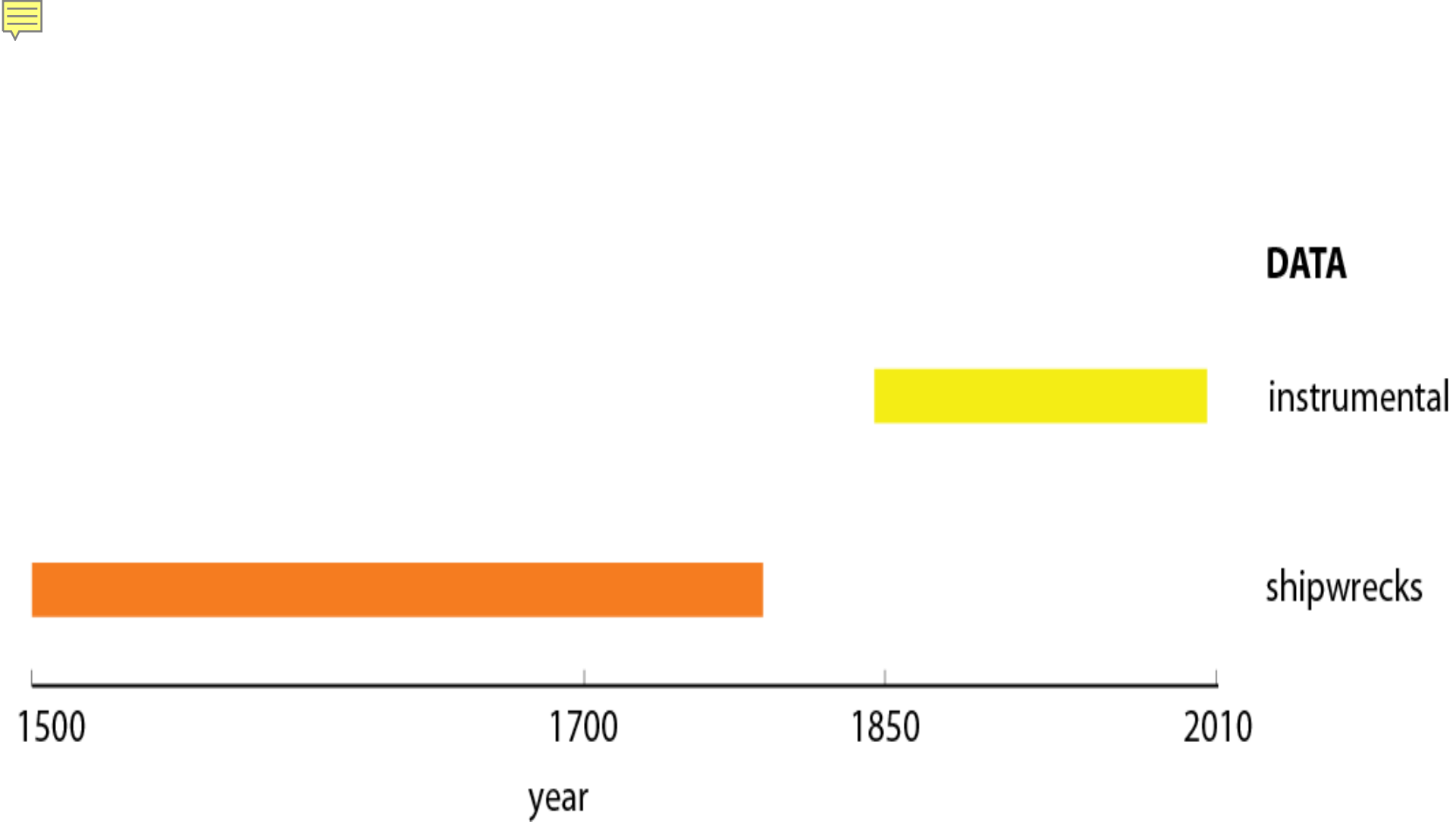
# Tropical storms were the primary cause of shipwrecks in the 16th through 18th centuries

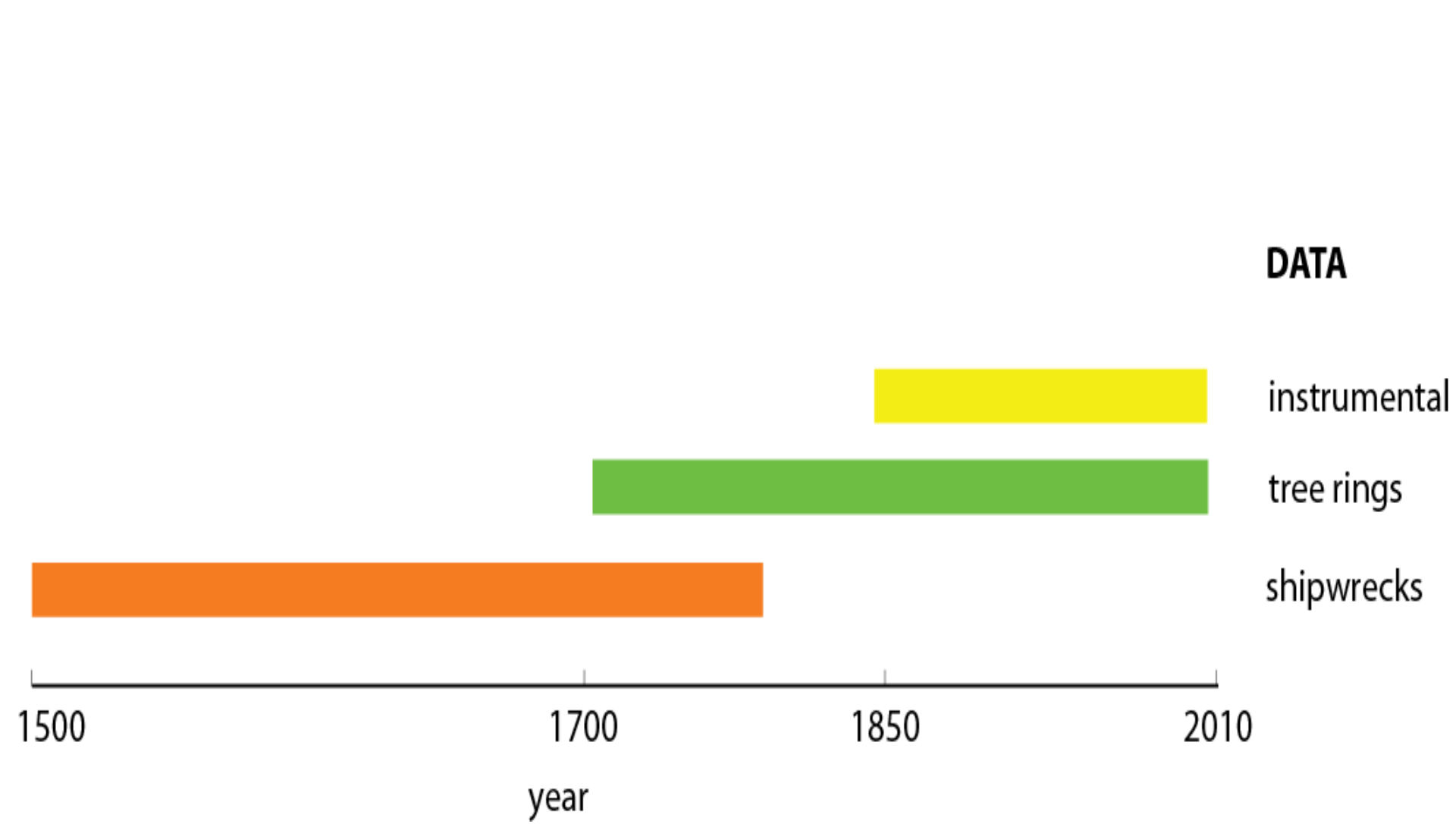
Can Spanish shipwreck rates be used as a proxy for Caribbean hurricane activity?

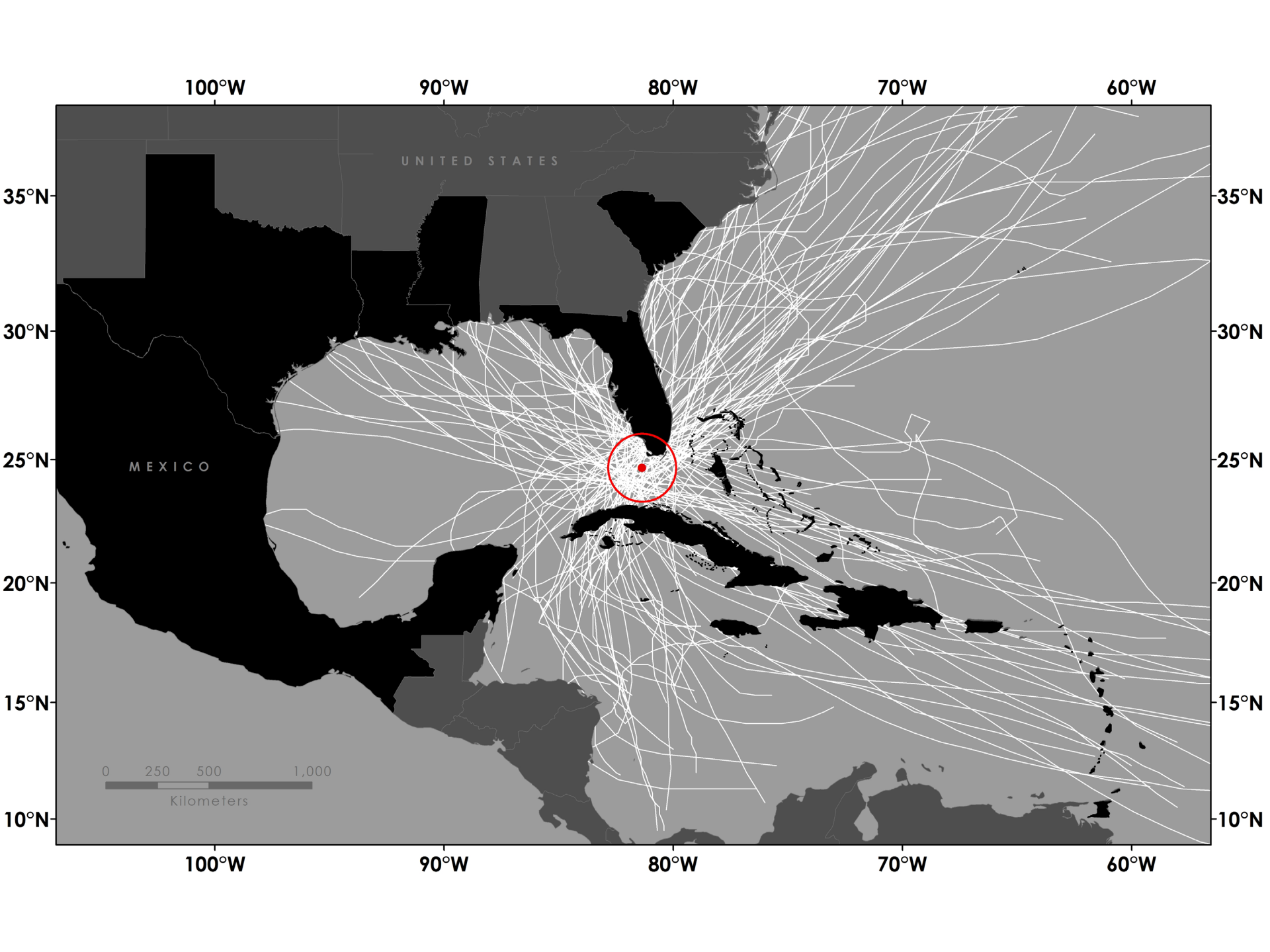
# # Spanish shipwrecks/year (1495-1825 CE)




Trouet et al. (2016) *PNAS*

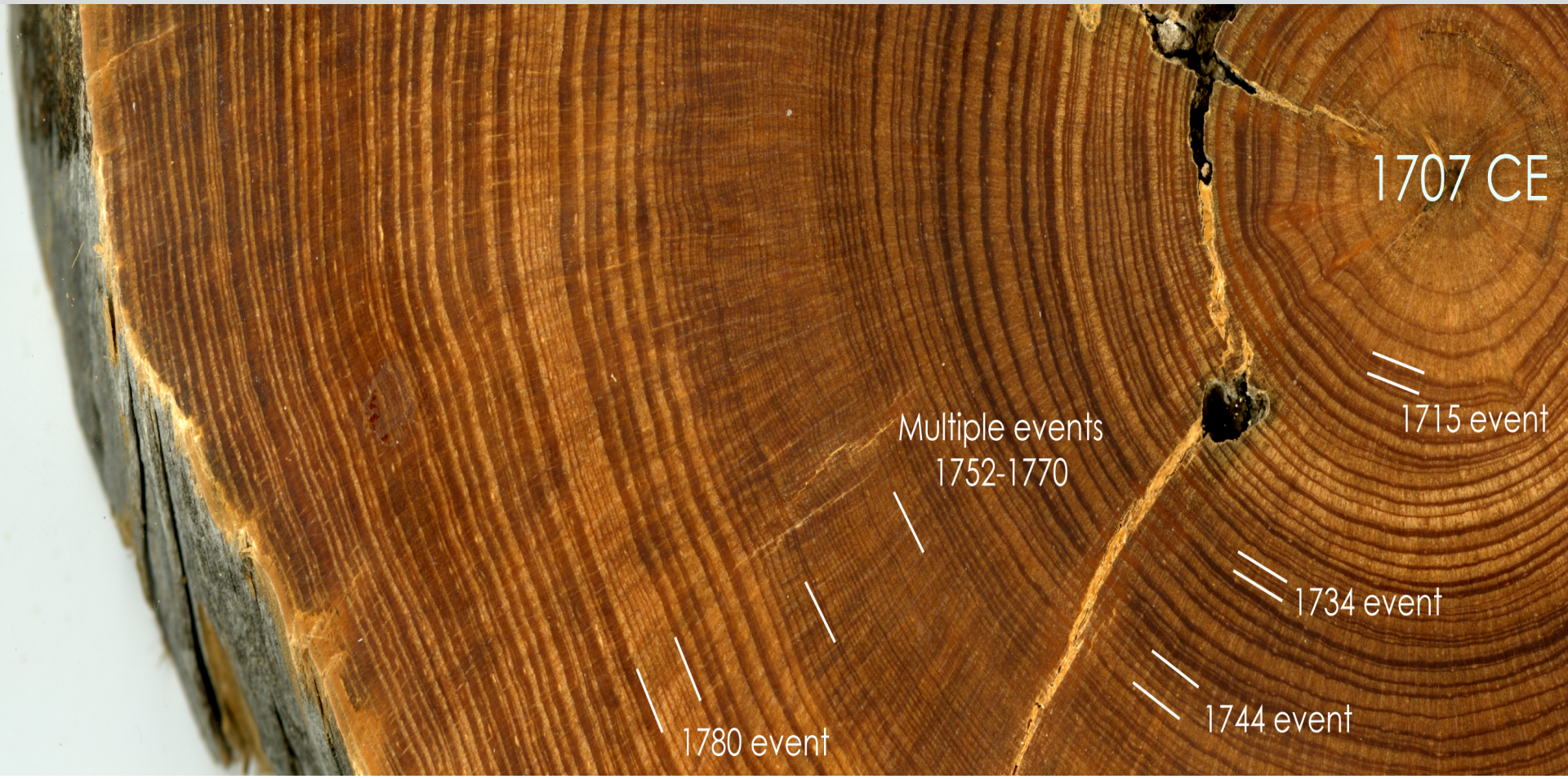

DATA
instrumental
shipwrecks
1500
1700
1850
2010
year


DATA
instrumental
tree rings
shipwrecks
1500
1700
1850
2010
year


100°W
90°W
80°W
70°W
60°W
35°N
30°N
25°N
20°N
15°N
10°N
UNITED STATES
MEXICO
0 250 500 1,000
Kilometers

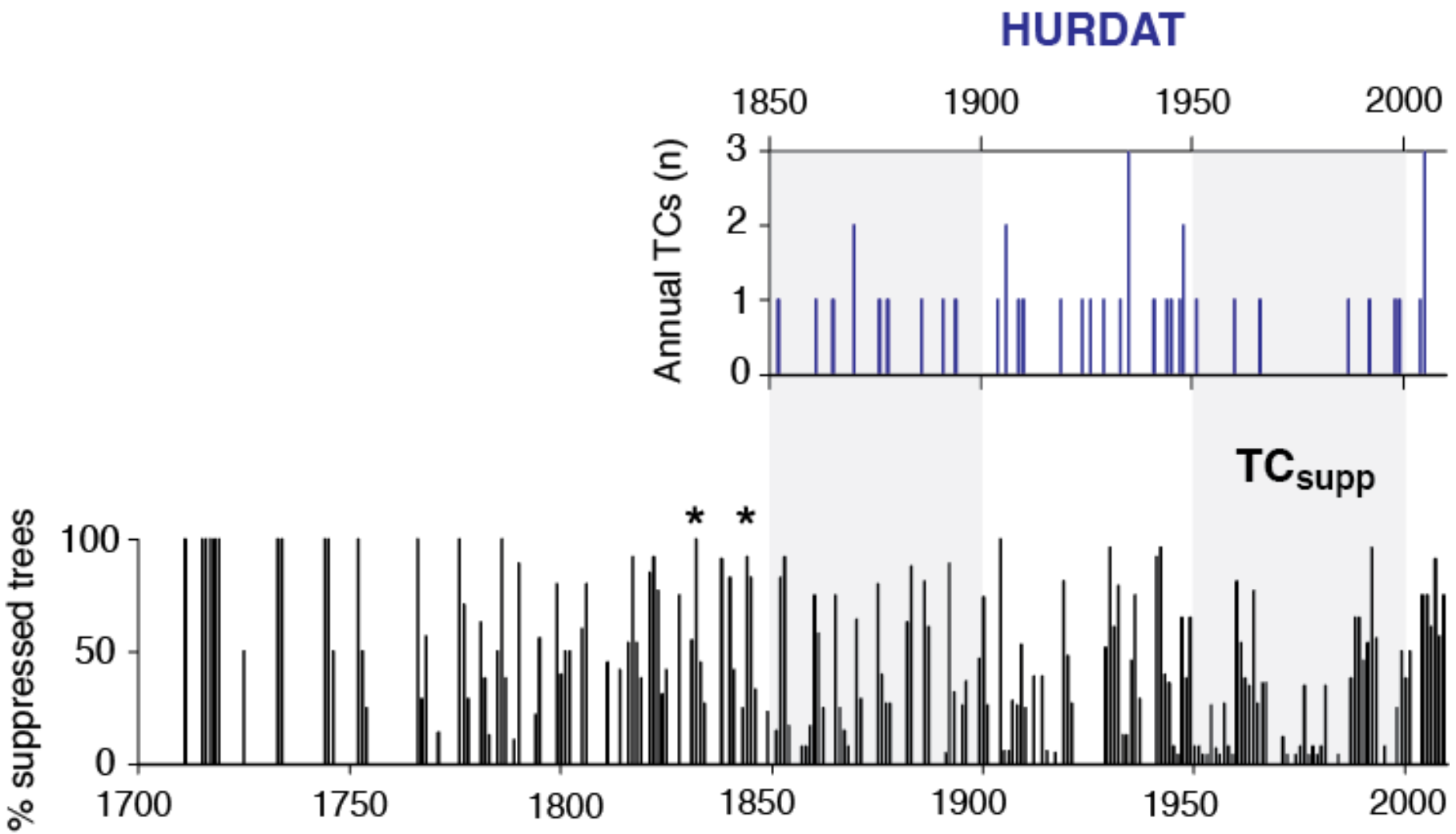
# Tree-ring sample collection on Big Pine Key

# Slash pines on Florida Keys show suppressed growth in years following storms

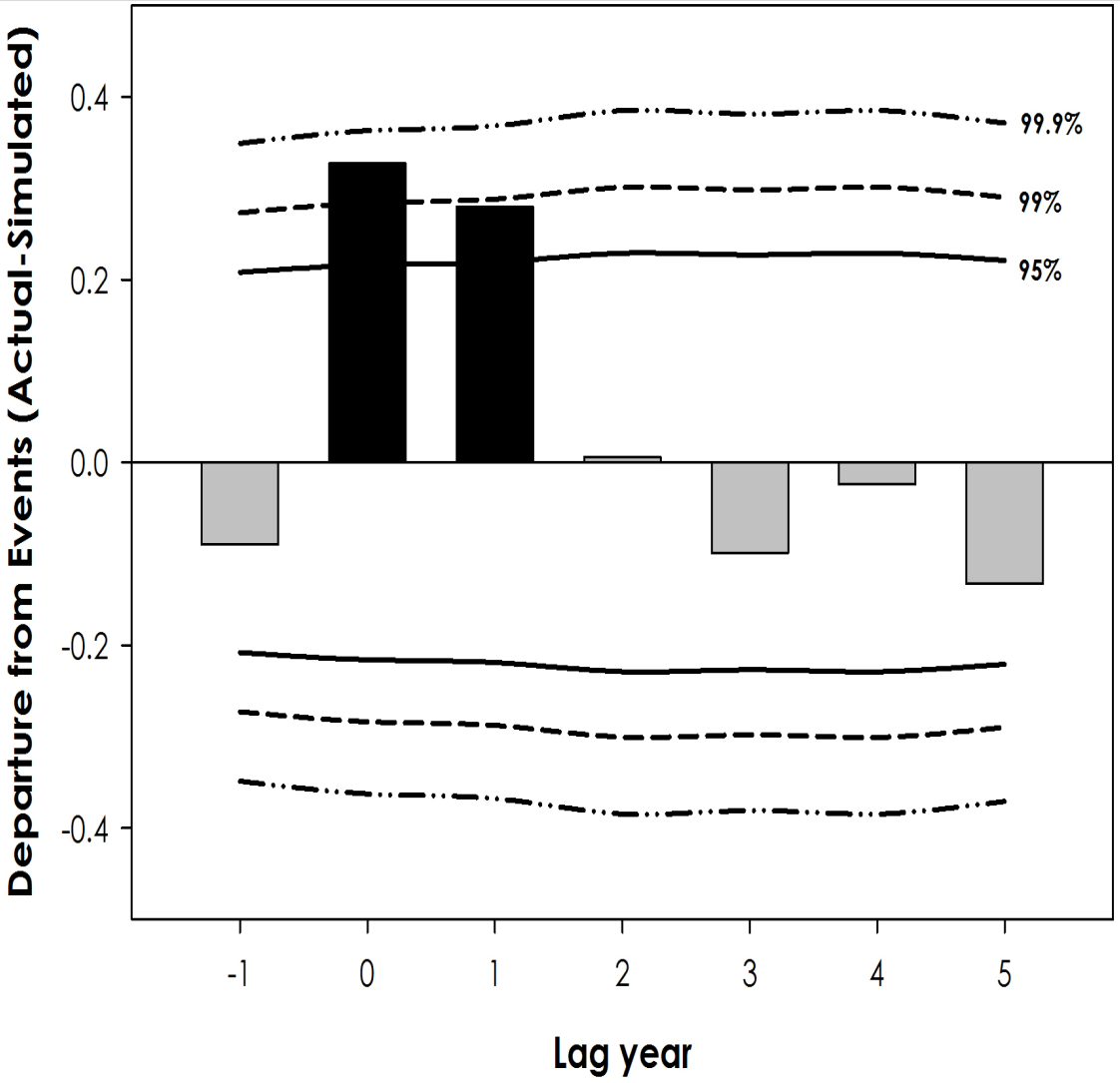


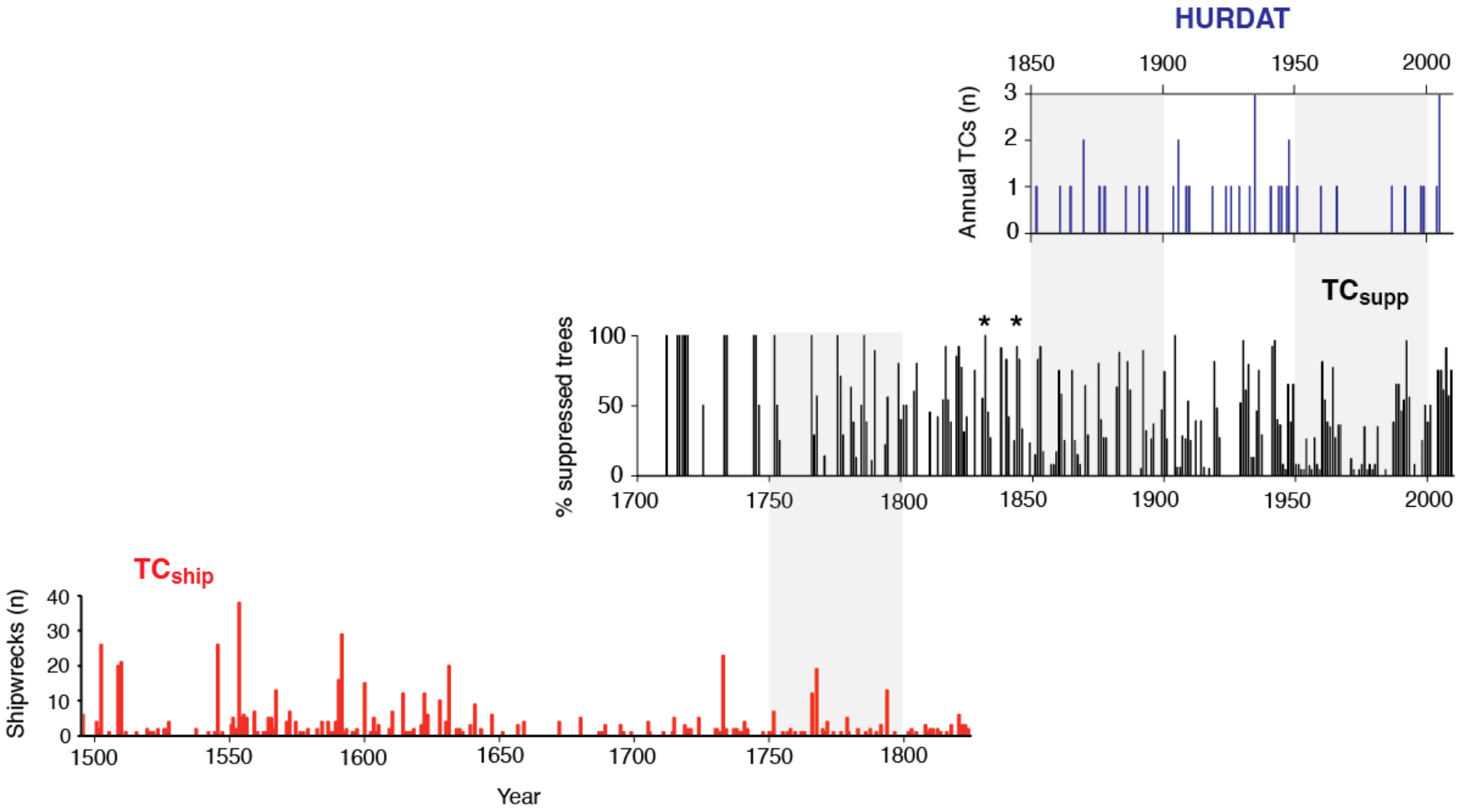

Trouet et al. (2016) *PNAS*

# % suppressed trees per year on Florida Keys (1707-2009 CE)

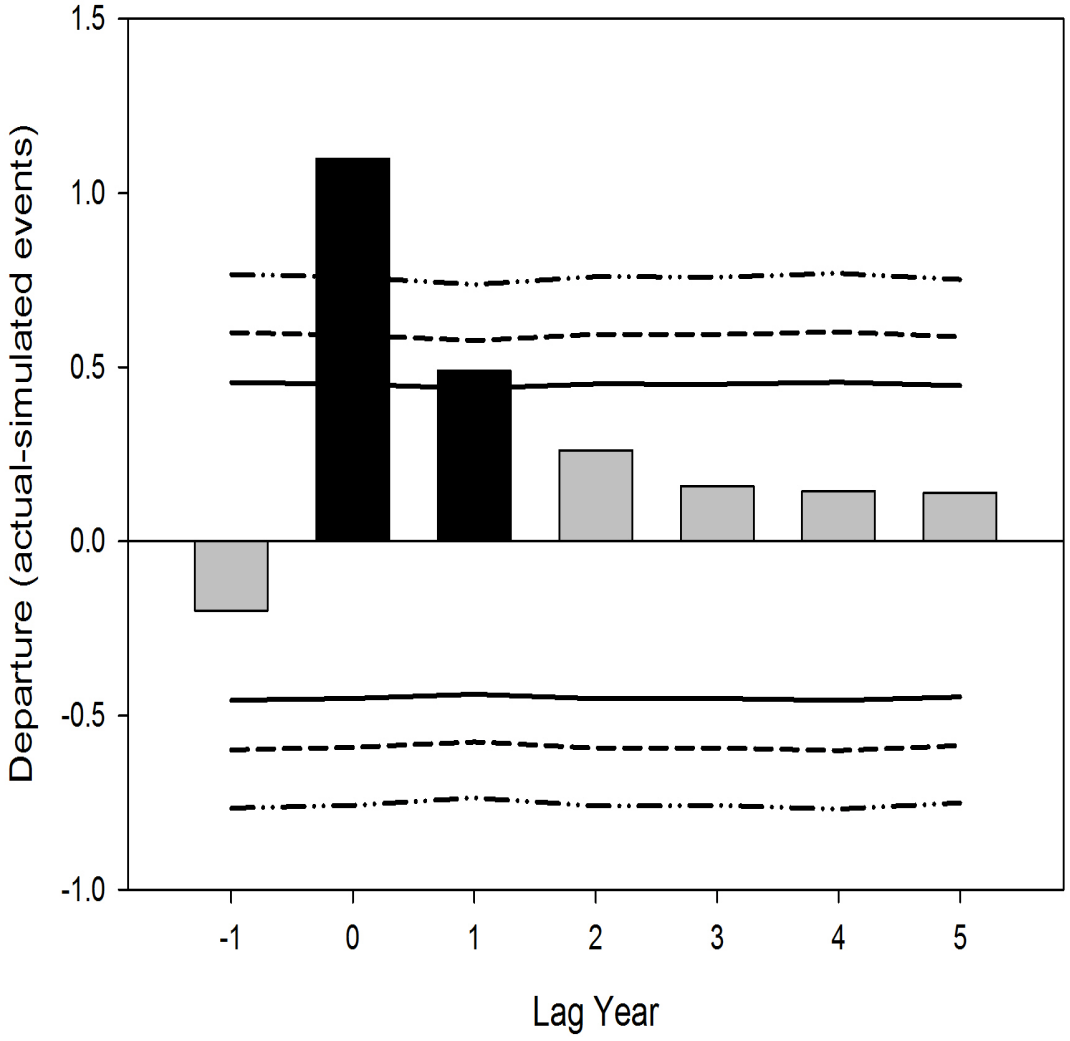


# Tropical storms result in tree growth suppression in year of storm + year after

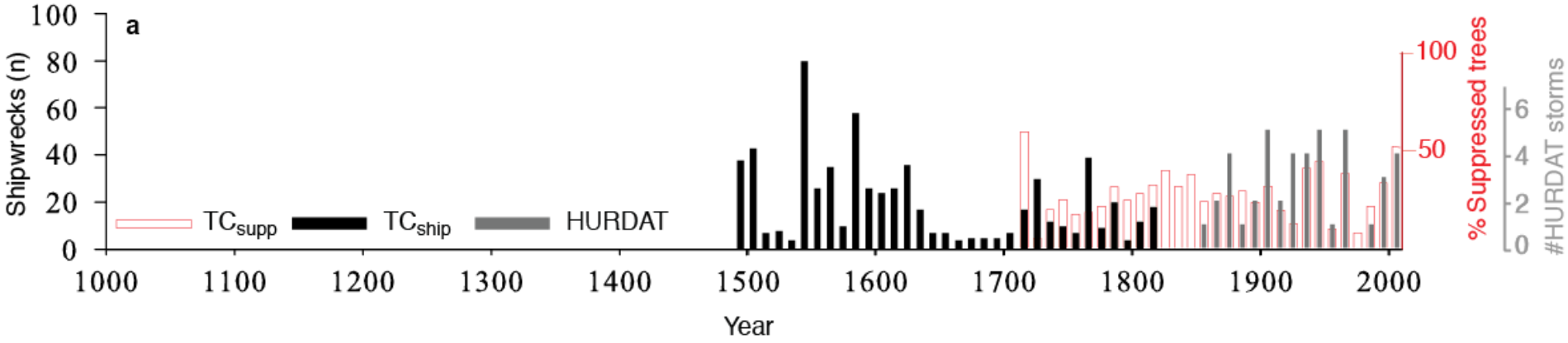



HURDAT
1850
1900
1950
2000
Annual TCs (n)
3
2
1
0
TCsupp
% suppressed trees
100
50
0
1700
1750
1800
1850
1900
1950
2000
TCship
Shipwrecks (n)
40
30
20
10
0
1500
1550
1600
1650
1700
1750
1800
Year

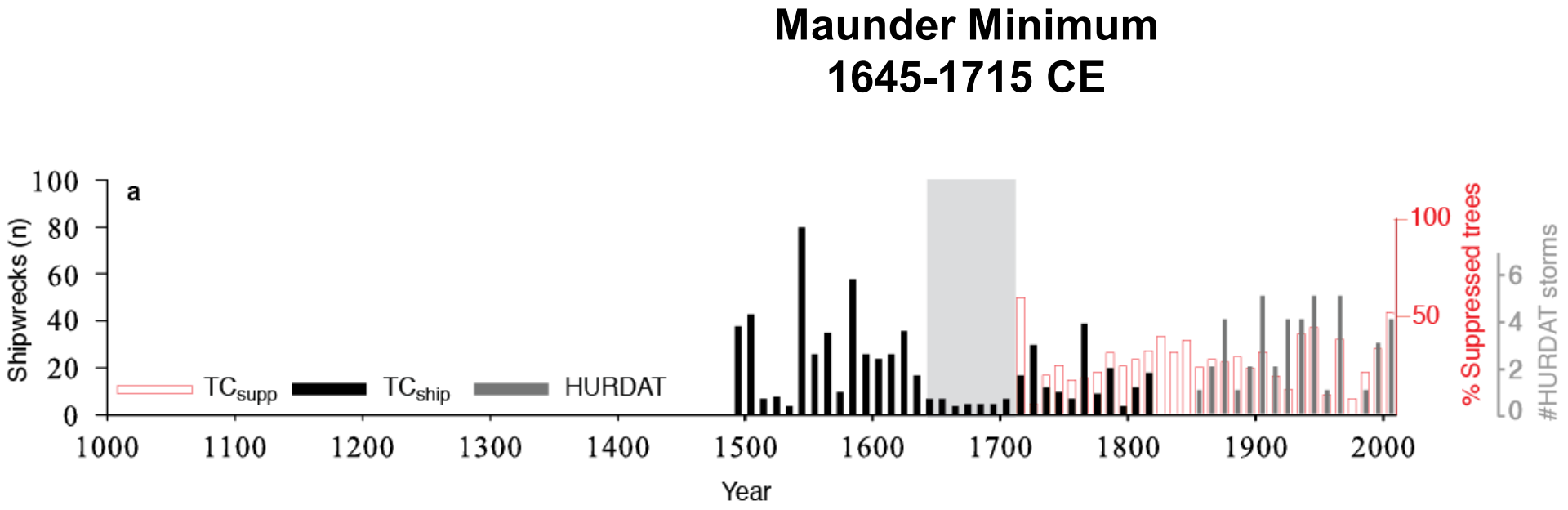
# High shipwreck years result in tree growth suppression (t0 and t+1)



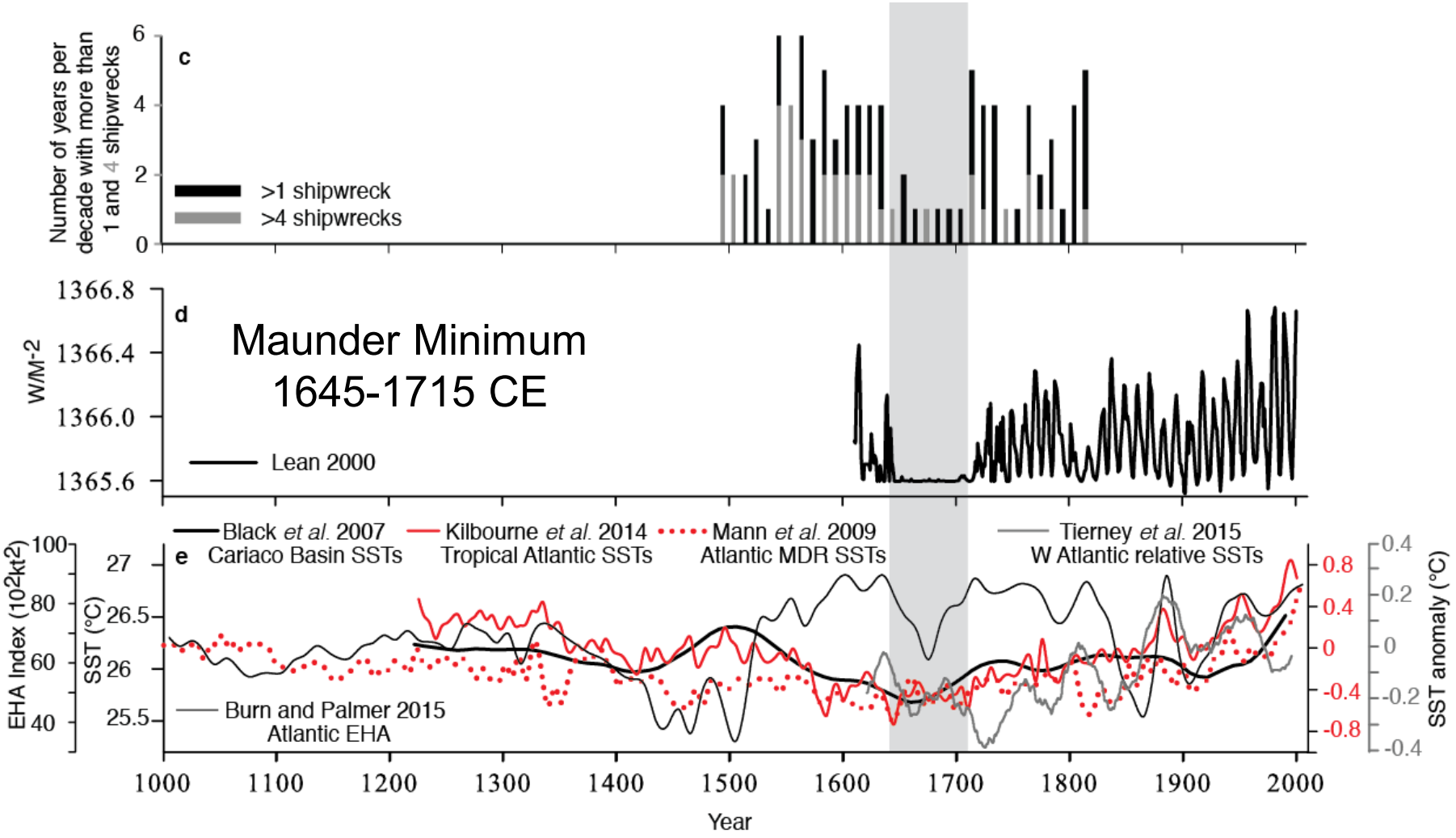
# Reconstruction of Caribbean tropical cyclones (1495-2010)



# We find 75% less Caribbean tropical cyclones during the Maunder Minimum



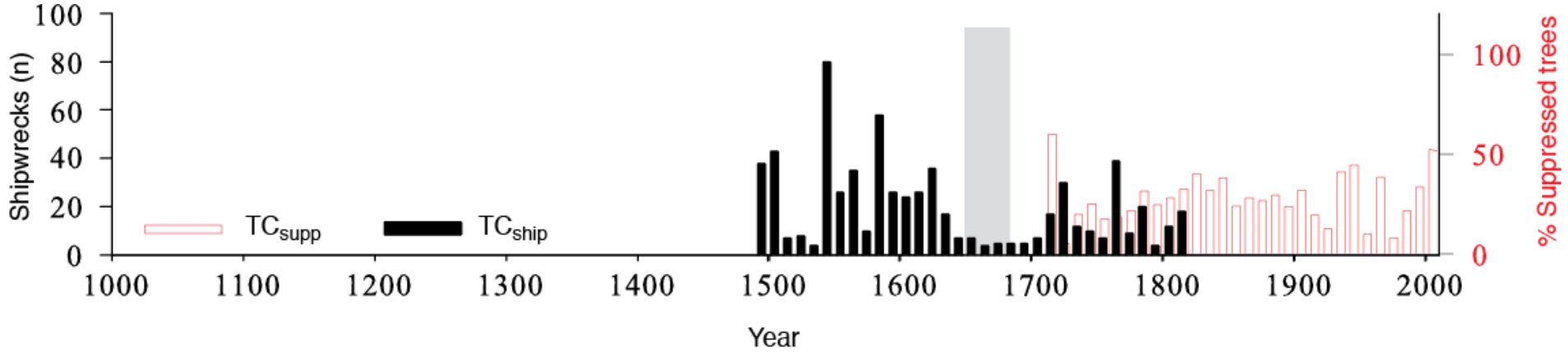
# Less Caribbean tropical cyclones during Maunder Minimum linked to lower sea surface temperatures



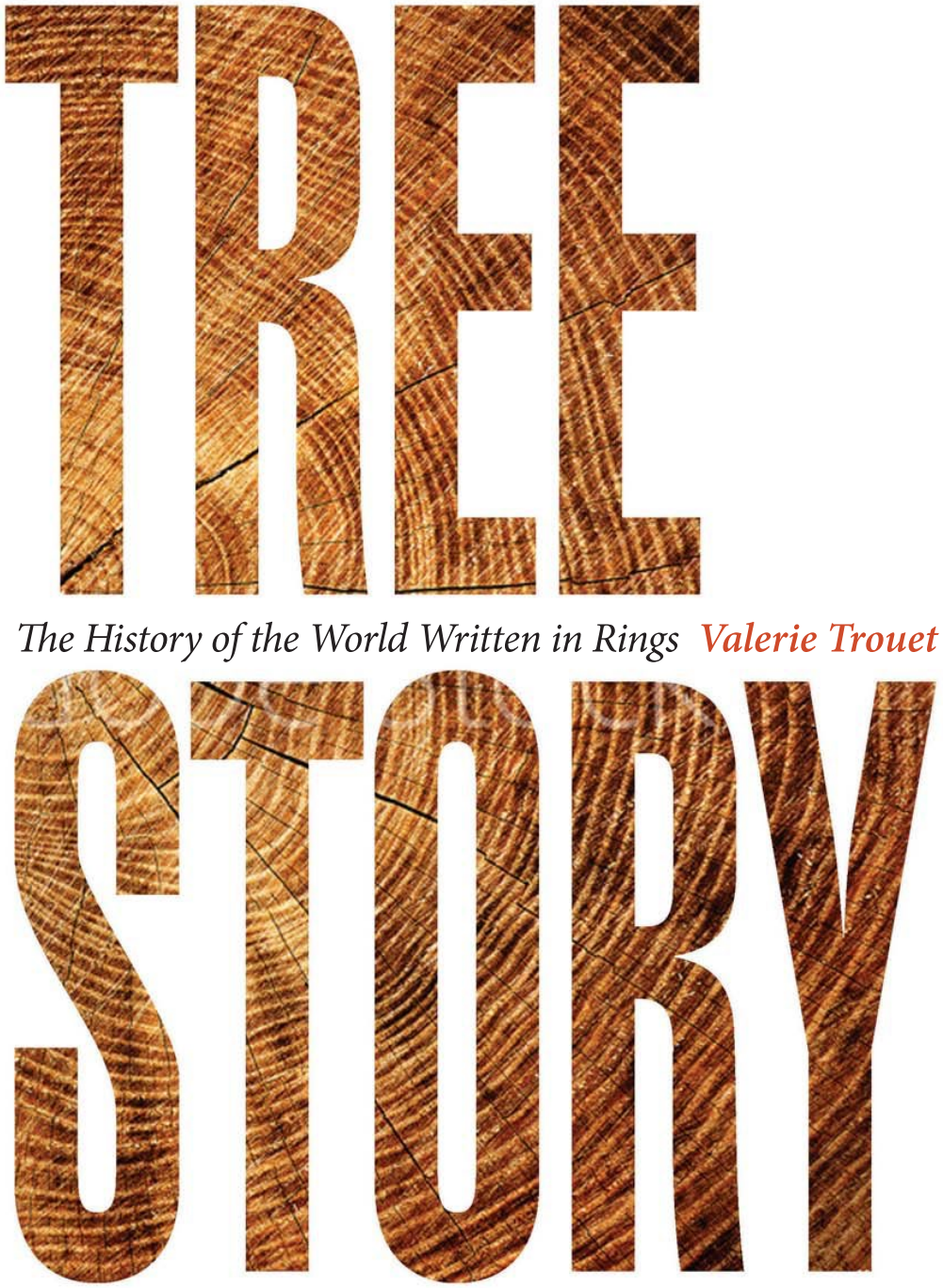

Trouet et al. (2016) *PNAS*

Our results can help improve models of future tropical cyclone activity by serving as a benchmark and thus reducing their uncertainty.

# „Golden Age of Piracy“
# 1650-1680 CE



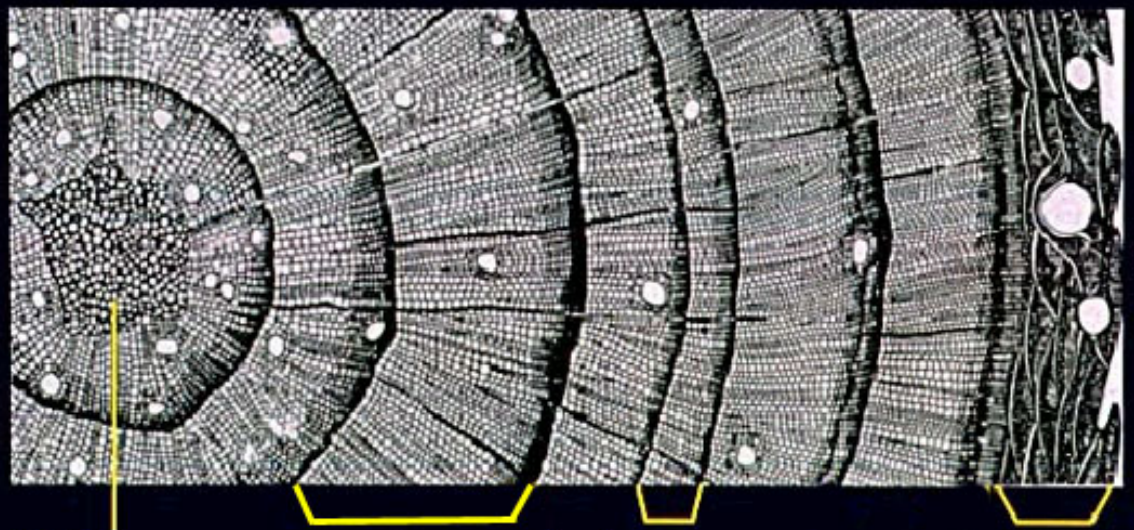

THE ART OF
PIRATES of the CARIBBEAN
ON STRANGER TIDES
IN BOOKSTORES SOON
Disney EDITIONS
Disney
PIRATES of the CARIBBEAN
ON STRANGER TIDES
IN THEATERS 5.20.11
Thank you
Trouetlab.arizona.edu
BLACKBEARD'S SHIP,
THE QUEEN ANNE'S REVENGE
© DISNEY



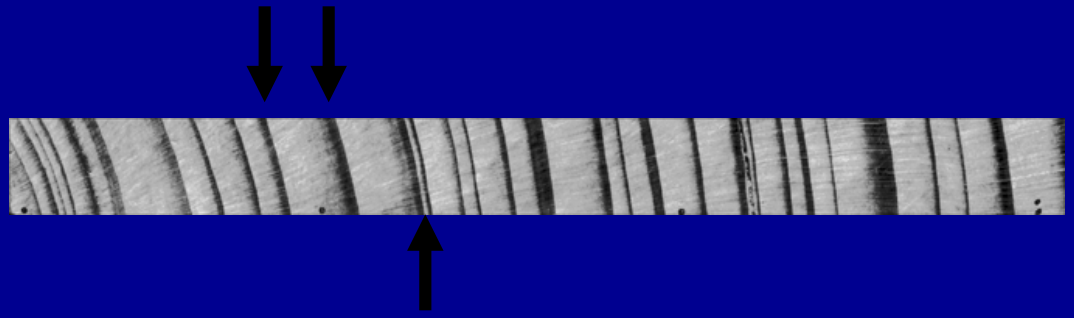

Johns Hopkins
University Press
April 2020


SHIPWRECKS
IN THE AMERICAS
A complete guide to every major shipwreck in the Western Hemisphere.
ROBERT F. MARX

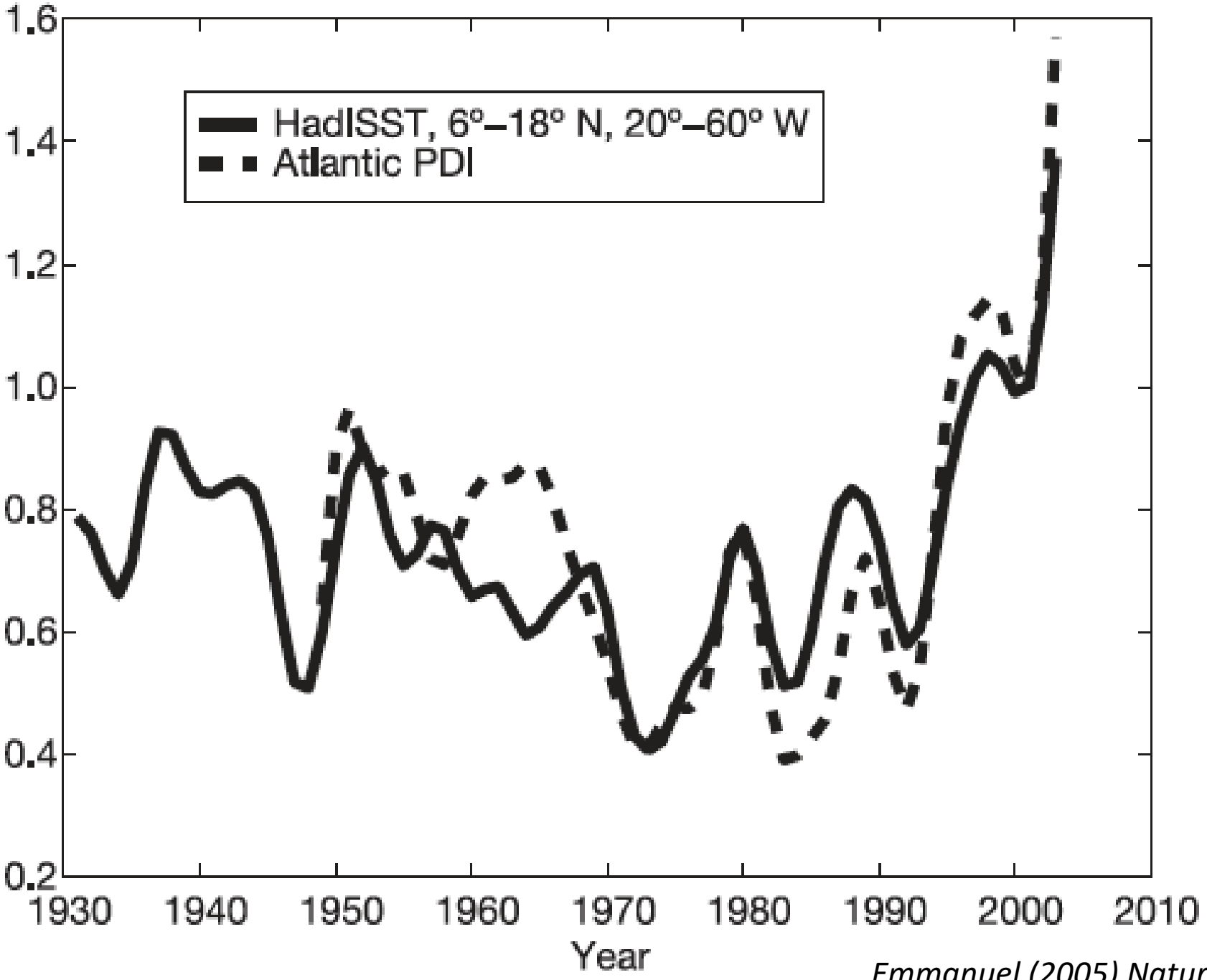
## Cross Section of a Conifer




**Environmentally beneficial years**



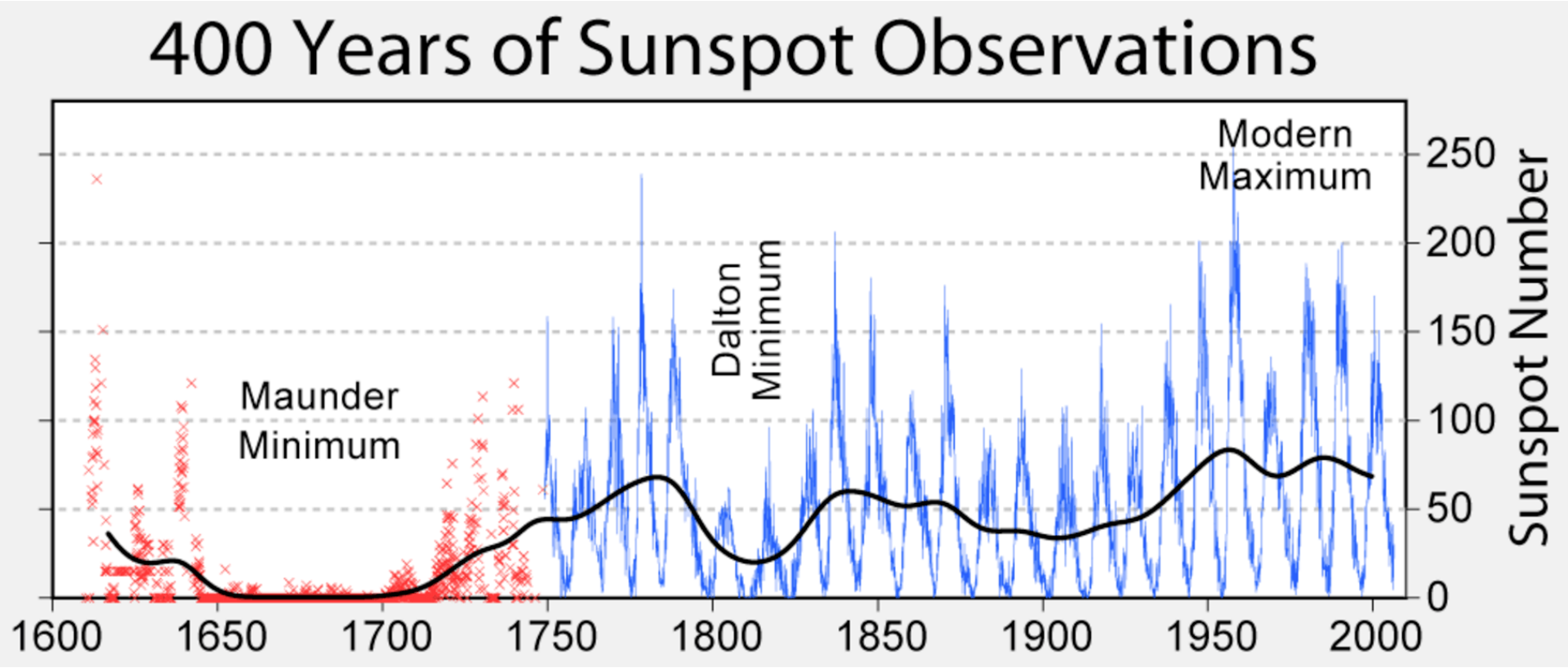
**Environmentally stressful year**

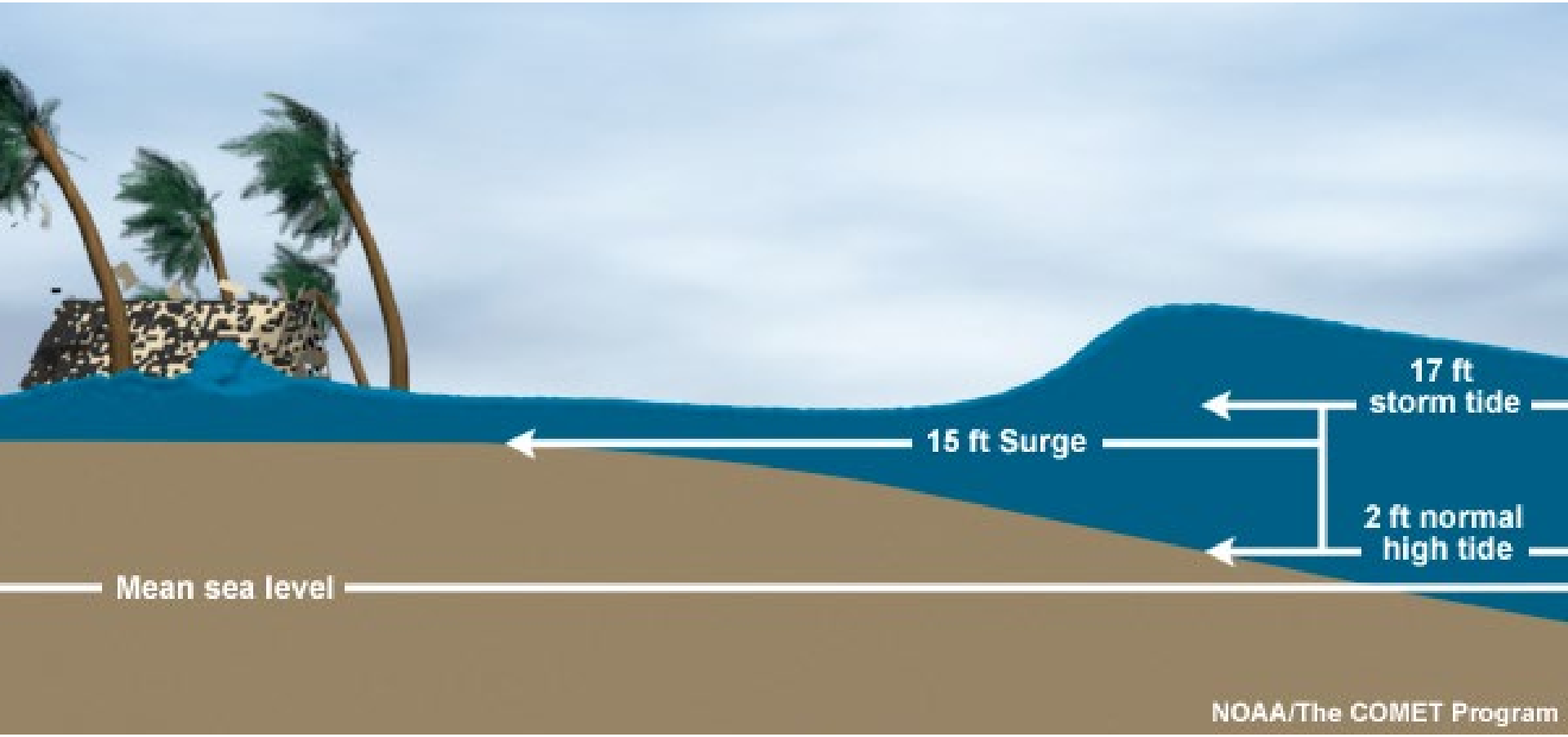



*Emmanuel (2005) Nature*

# Laboratory of Tree-Ring Research

## The University of Arizona


400 Years of Sunspot Observations
Modern
Maximum
Dalton
Minimum
Maunder
Minimum
250
200
150
100
50
0
Sunspot Number
1600
1650
1700
1750
1800
1850
1900
1950
2000




Sea level rise will increase storm surge


Increasing population in coastal communities