

Climates of the Past

EES 2110

Introduction to Climate Change

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Class #19: Wednesday, February 22 2023

Black History Month Black Leaders in Environmental Research

Dr. Robert D. Bullard

- Born in Elba, AL in 1946.
- Bachelor's degree, Alabama A&M University, 1968.
- Ph.D. in Sociology, Iowa State University, 1976.
- Distinguished Professor of Urban Planning and Environmental Policy, Texas Southern University
- Former Dean of the School of Public Affairs at Texas Southern.
- Director, Bullard Center for Environment and Climate Justice.
- Founding Director of Environmental Justice Resource Center, Clark Atlanta University
- Pioneered the concepts of environmental justice and environmental racism
- Author of 18 books, more than 50 articles



Dr. Robert D. Bullard

- Used civil rights laws to stop polluters from targeting Black communities.
- Organized First National People of Color Environmental Leadership Summit in 1991.
- Led the development of “Principles of Environmental Justice” which President Bill Clinton implemented in Executive Order 12898.
- Awards Include:
 - United Nations Champions of the Earth Lifetime Achievement Award (2020)
 - William Julius Wilson Award for the Advancement of Justice (2019)
 - Stephen Schneider Award for Outstanding Science Communication (2019).
 - One of Newsweek Magazine’s 13 Environmental Leaders of the Century (2008).

ROBERT D. BULLARD & BEVERLY WRIGHT

THE WRONG COMPLEXION FOR PROTECTION



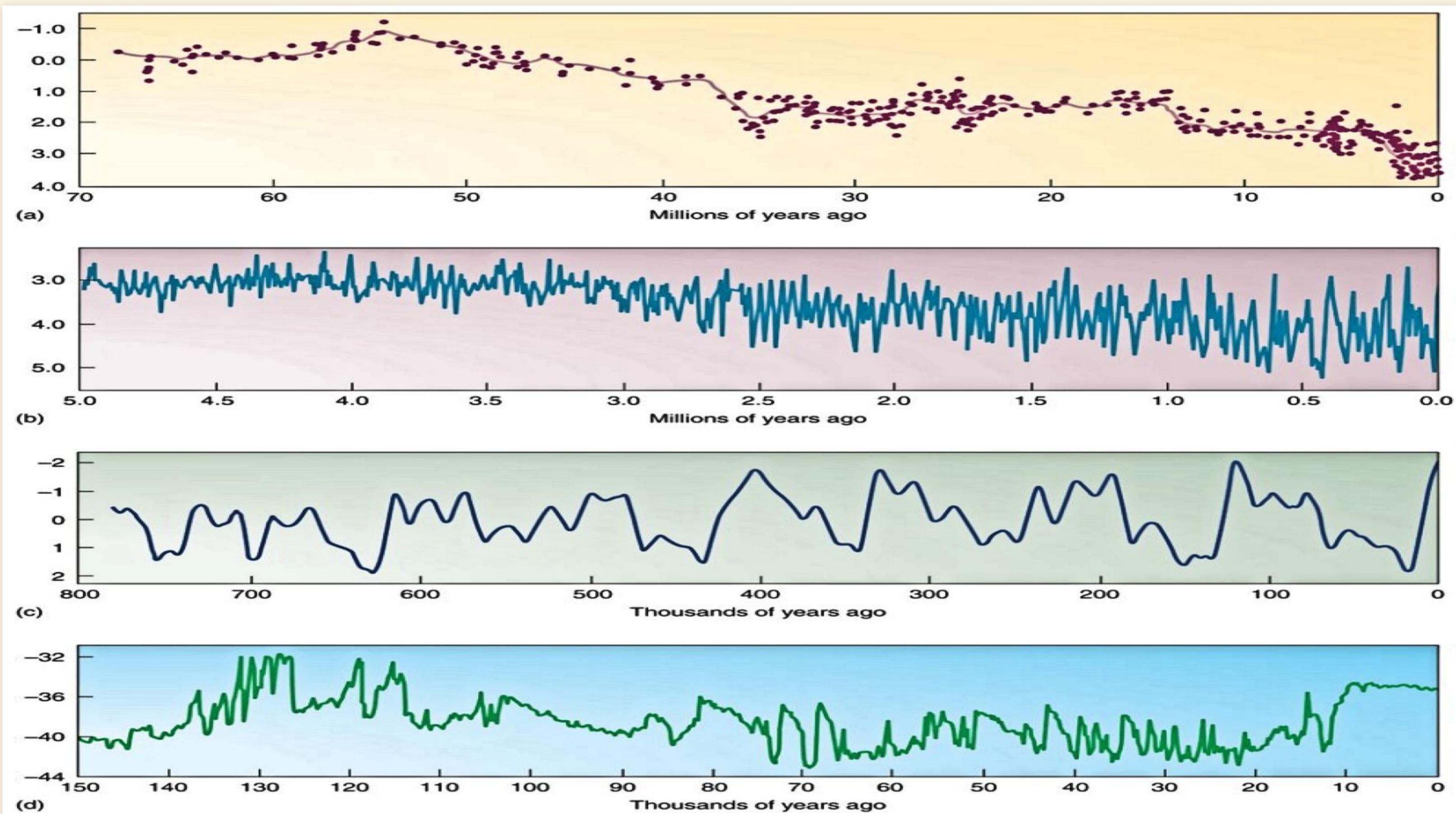
Dr. Robert D. Bullard

"People who fight... People who do not let the garbage trucks and the landfills and the petrochemical plants roll over them. That has kept me in this movement for the last 25 years. And in the last 10 years, we've been winning: lawsuits are being won, reparations are being paid, apologies are being made. These companies have been put on notice that they can't do this anymore, anywhere."

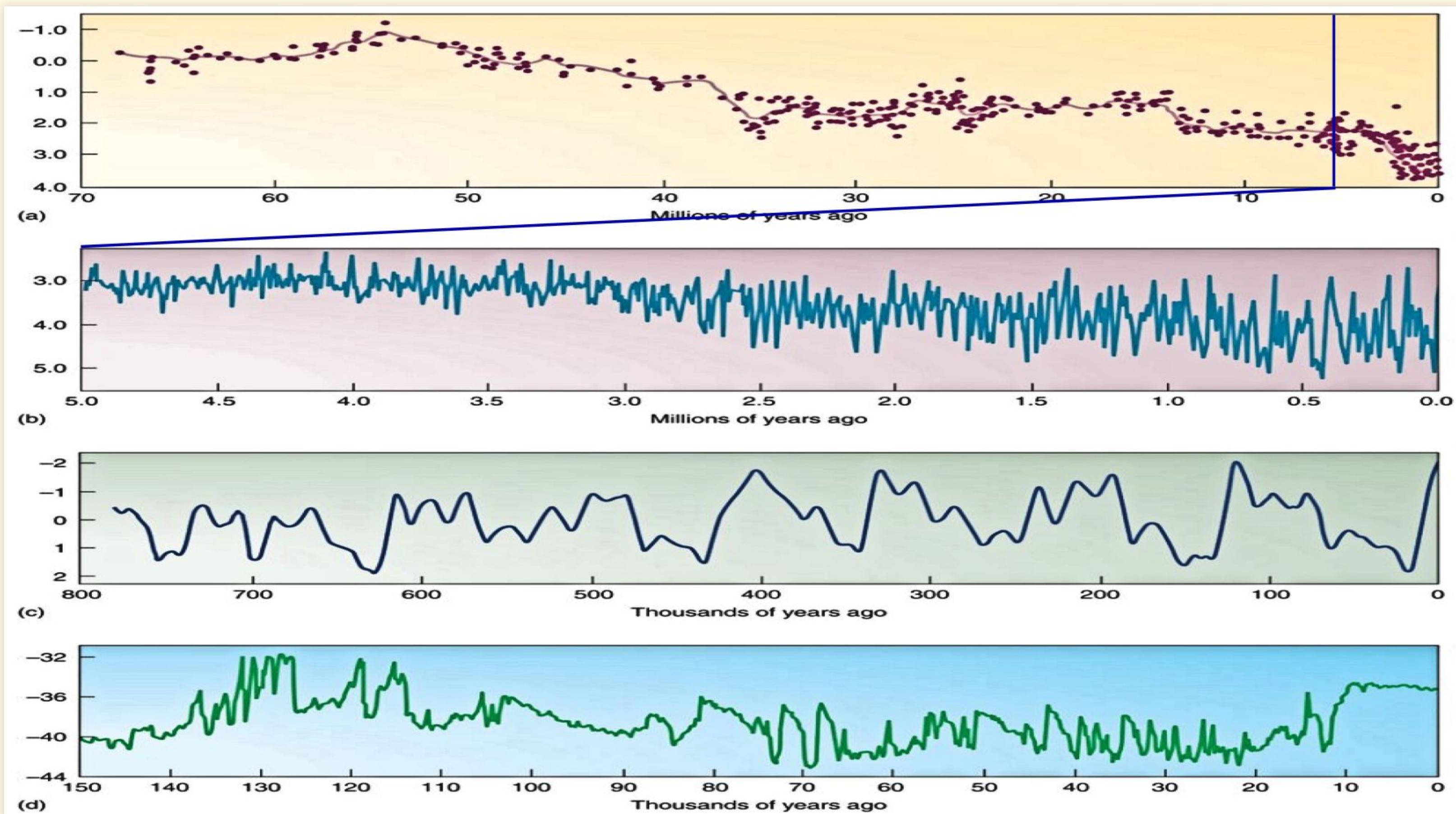


Climates of the Past

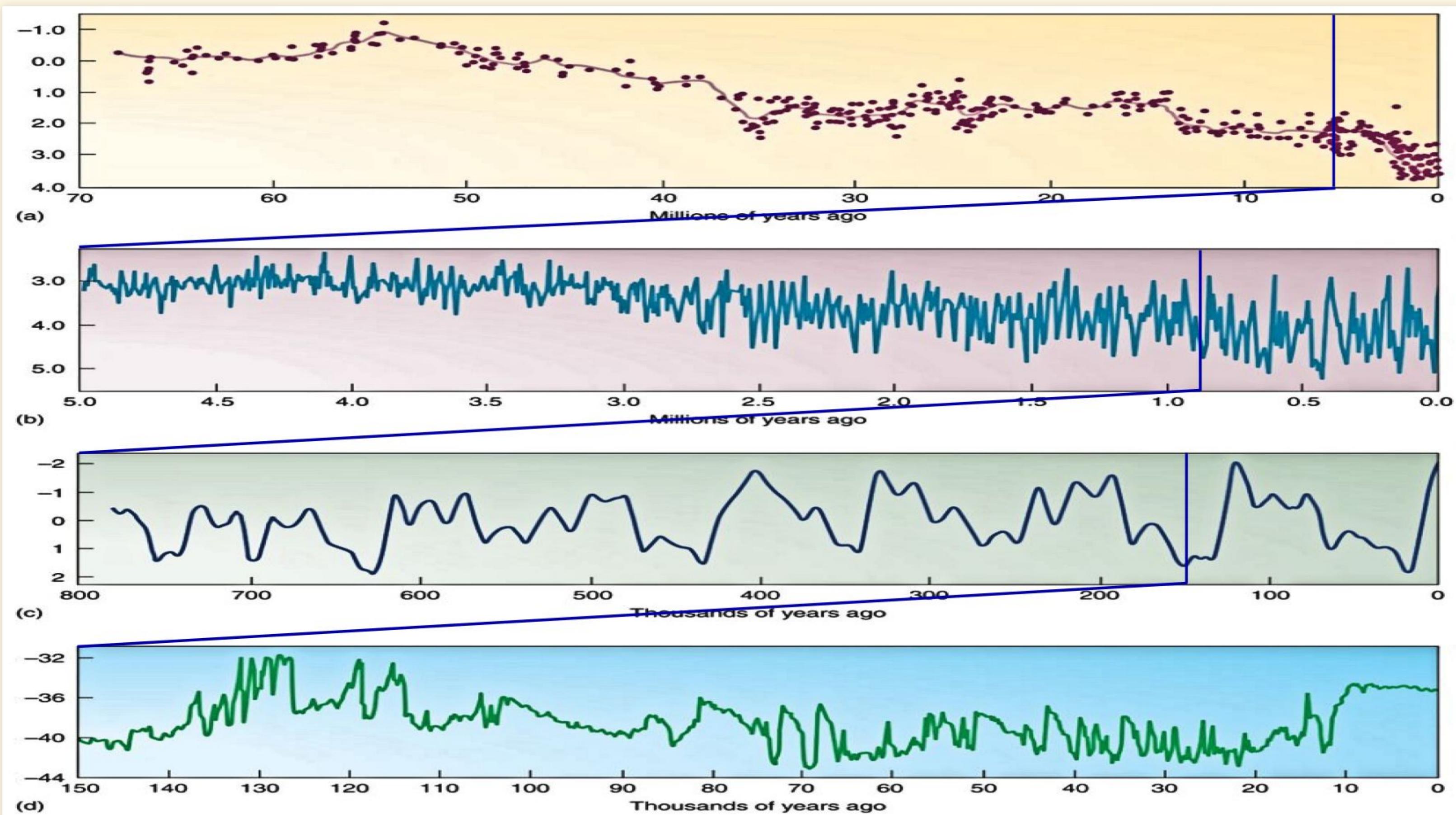
Climates of the Past



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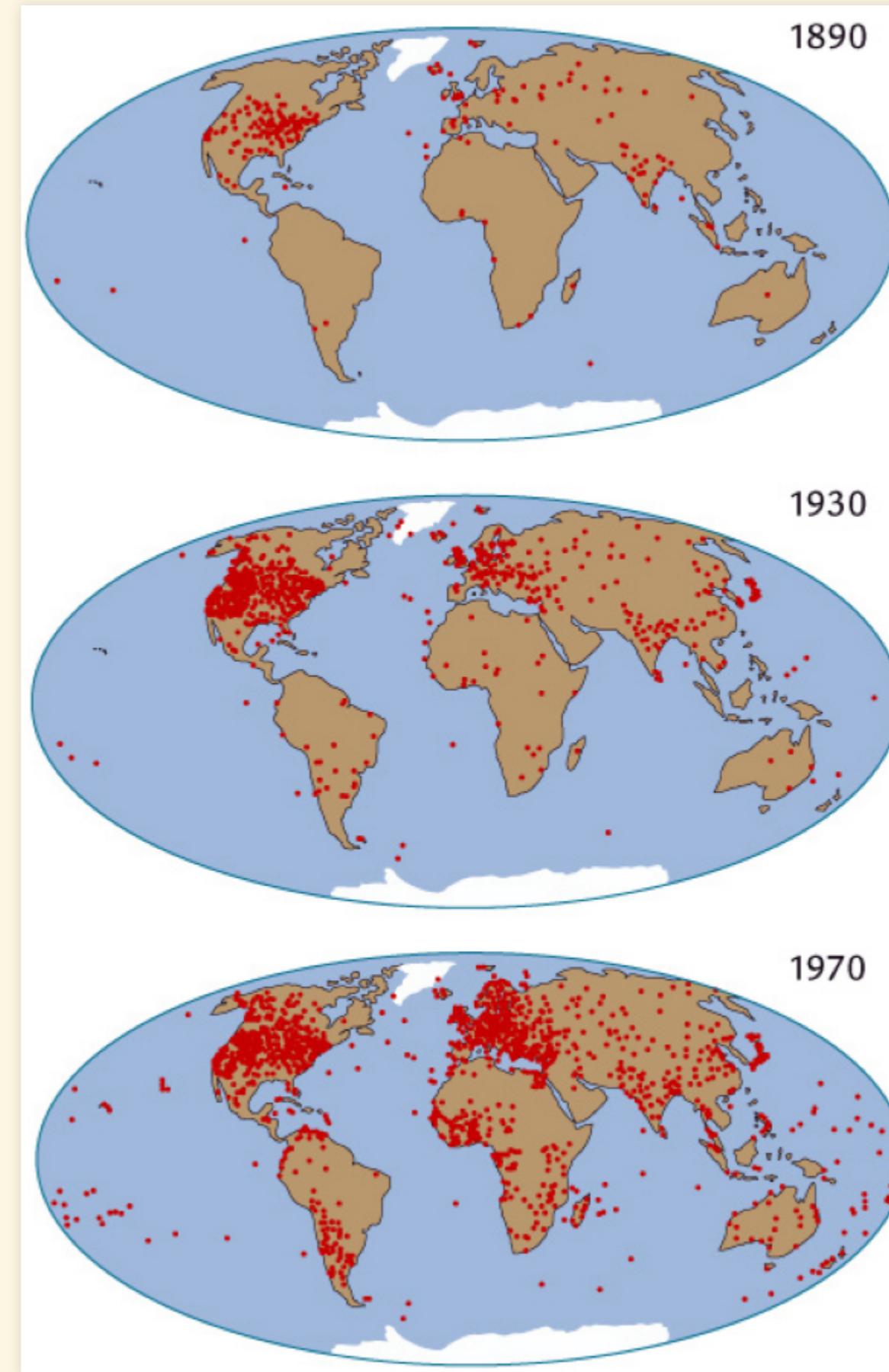
Climates of the Past



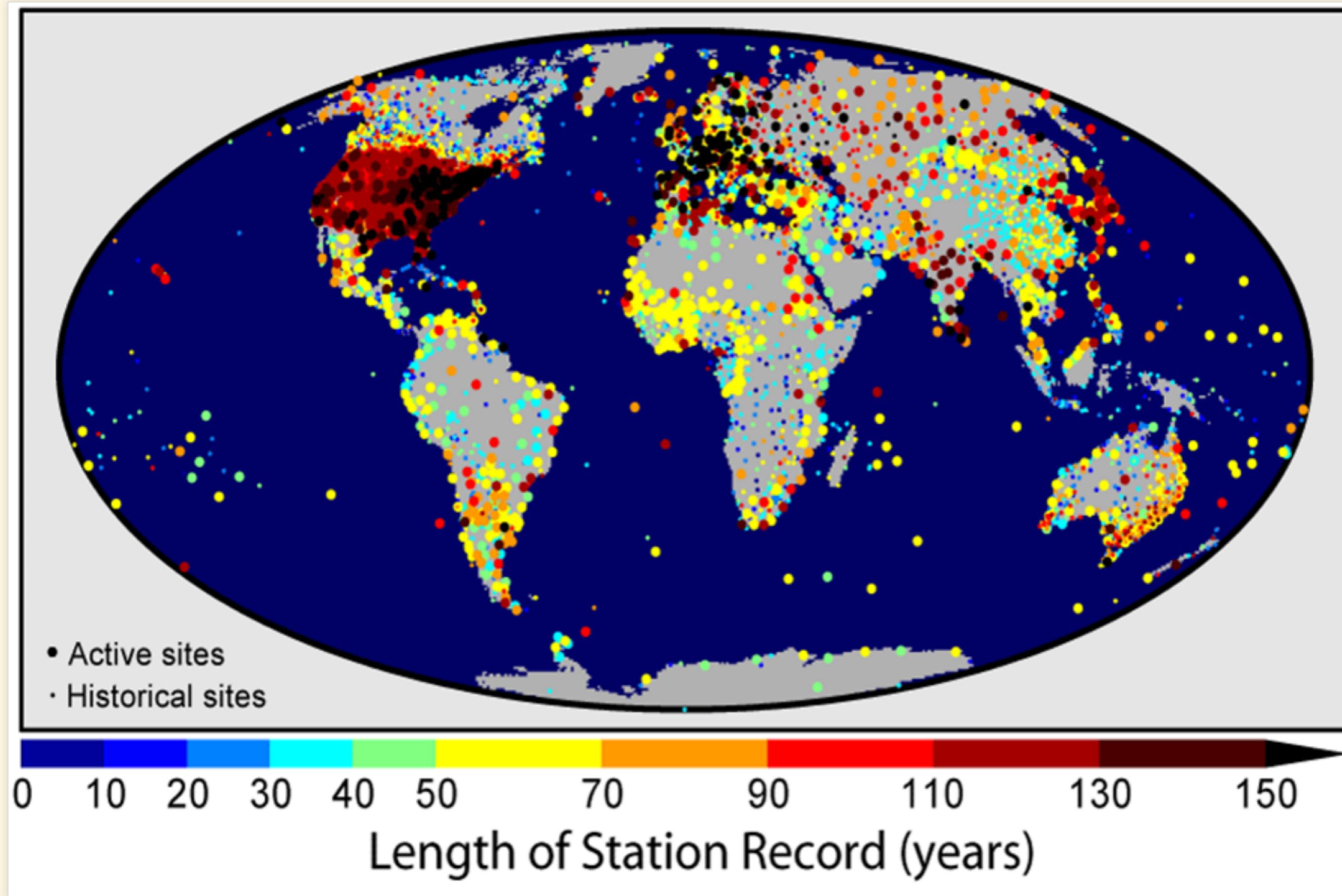
Digging into the past

Digging into the past:

Temperature measuring stations over the last 130 years.



Surface Temperature Monitoring



Temperature Anomaly

- **Global temperature change:**
 - Average temperatures are different at different places.
 - Temperatures change with the seasons
 - How to compare temperature change between places with different climates?
- **Temperature anomaly:**
 - Define a reference time period (several decades)
 - Anomaly = **actual temperature** at a place and time *minus* **average temperature** at that place during reference period

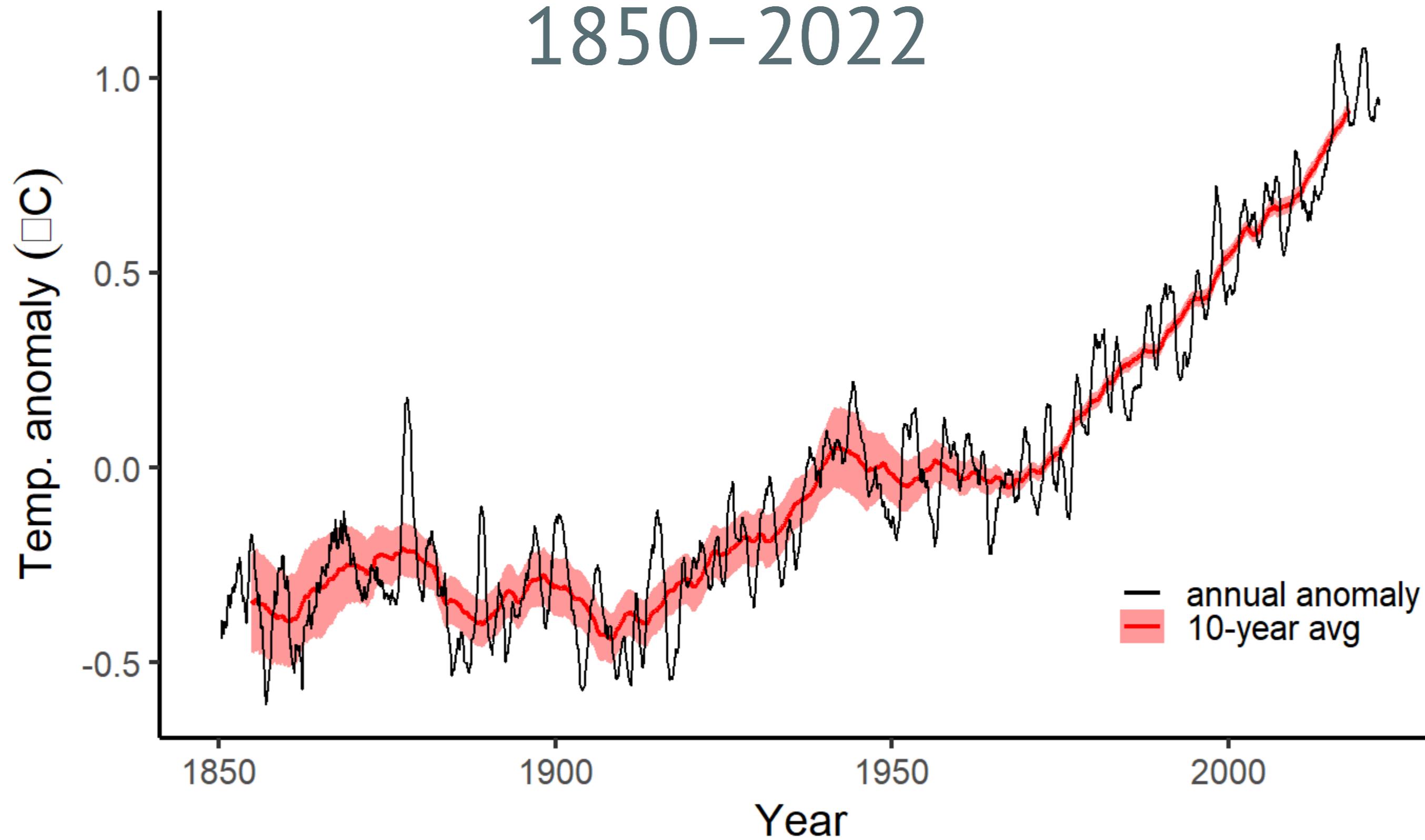
Temperature Anomaly

- Anomaly = **actual temperature** at a place and time *minus* **average temperature** at that place during reference period
- **Example: Anomaly for Nashville, January, 2020**
 - Monthly avg. temp. for January, 2020 = 7.3°C
 - Average January temp 1950–1979 = 3.0°C
 - Anomaly = $7.3^{\circ}\text{C} - 3.0^{\circ}\text{C} = 4.3^{\circ}\text{C}$

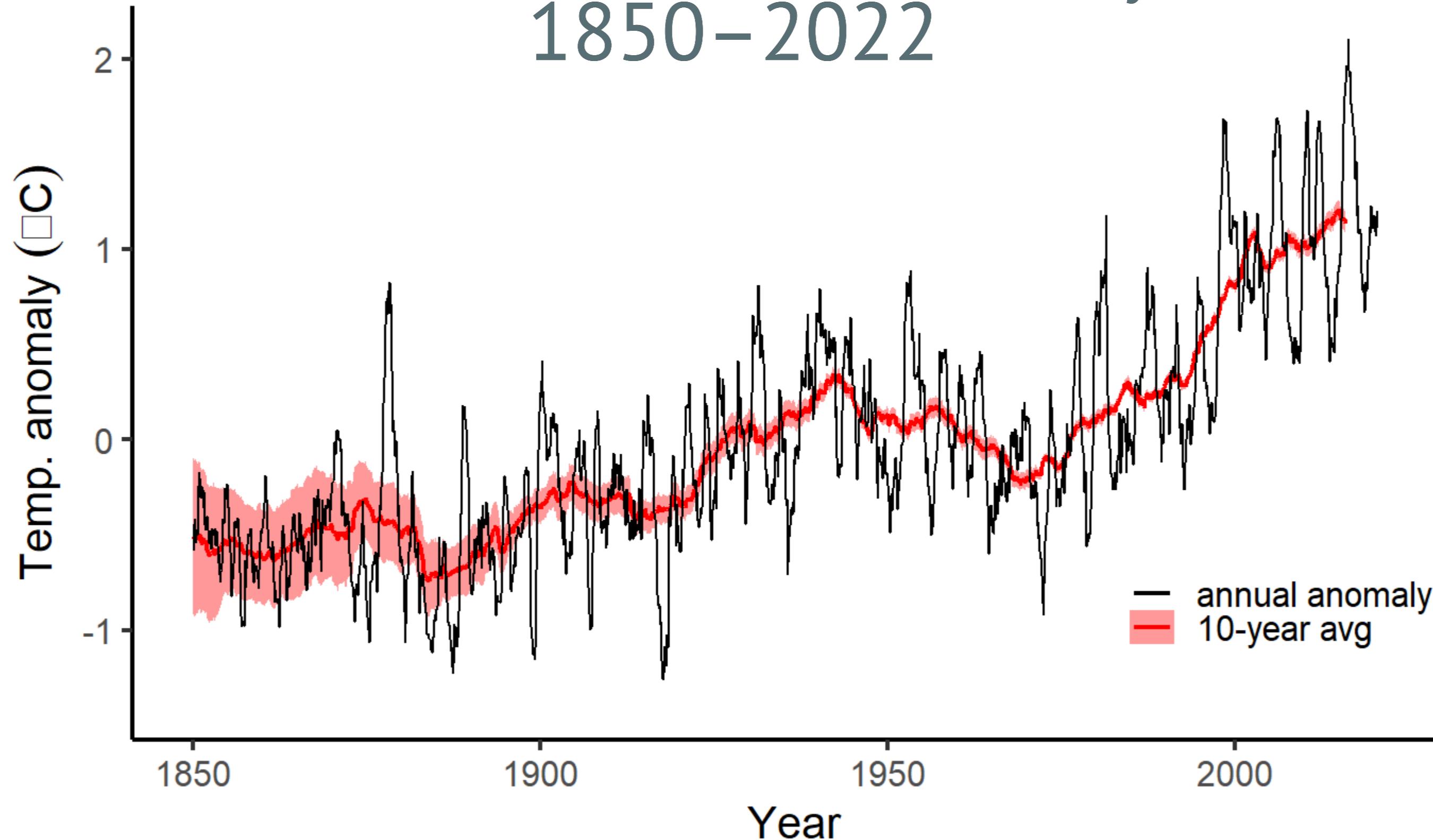
Global Anomaly

1850–2022

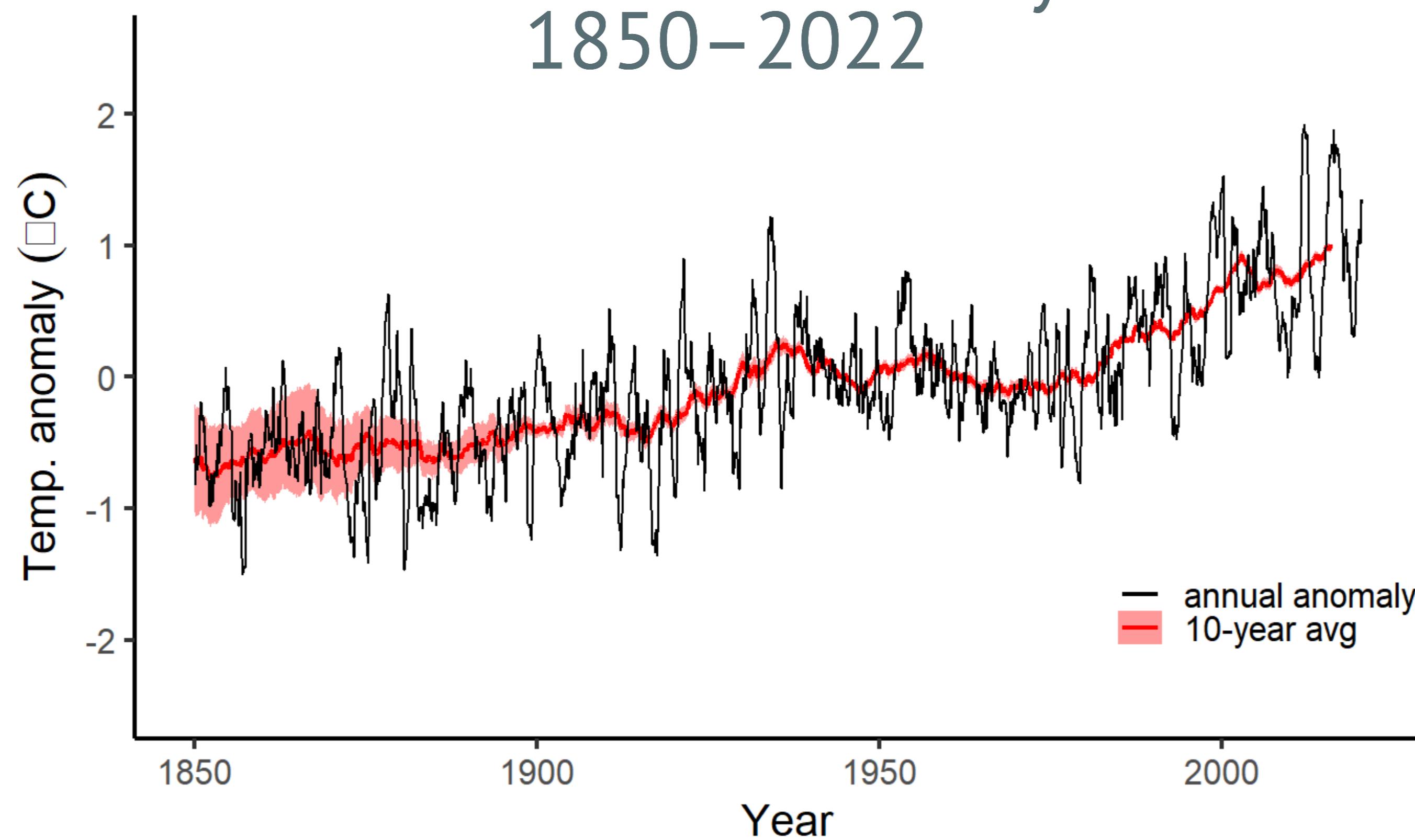
Global Land-Ocean North America 1850–2022



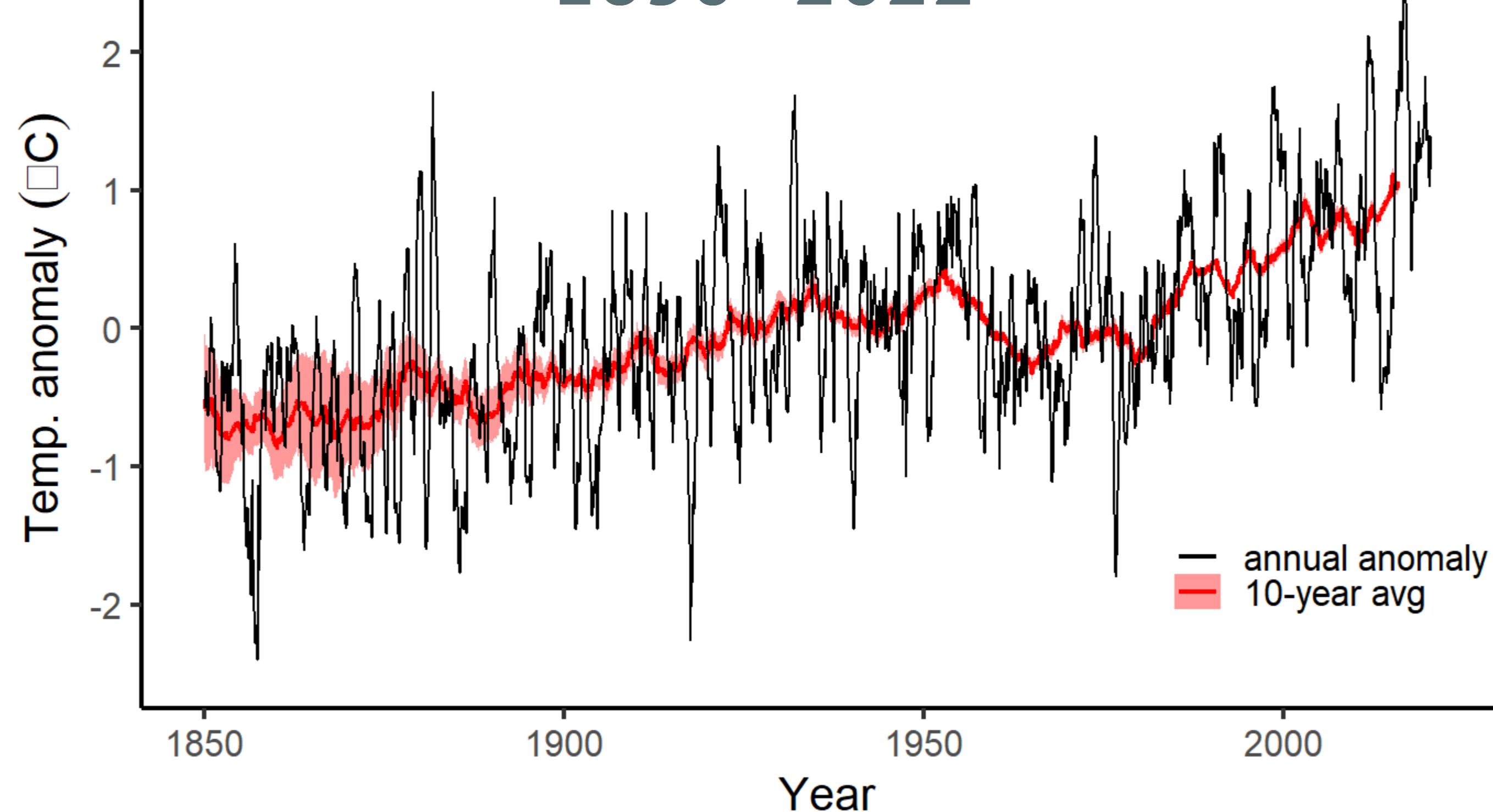
North America Continental US Anomaly 1850–2022



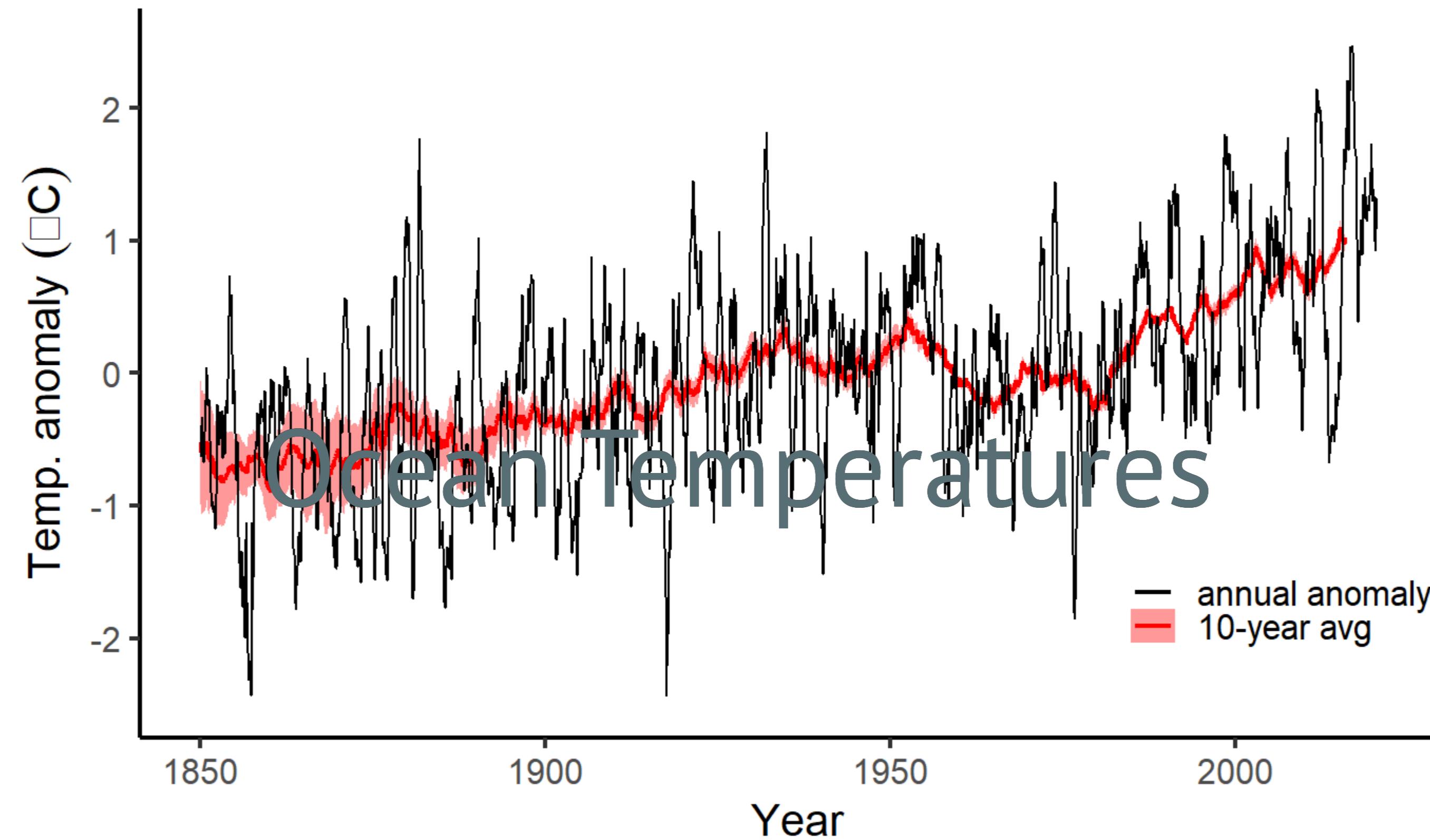
Contiguous US Tennessee Anomaly 1850–2022



Tennessee Nashville Anomaly 1850–2022



City of Nashville

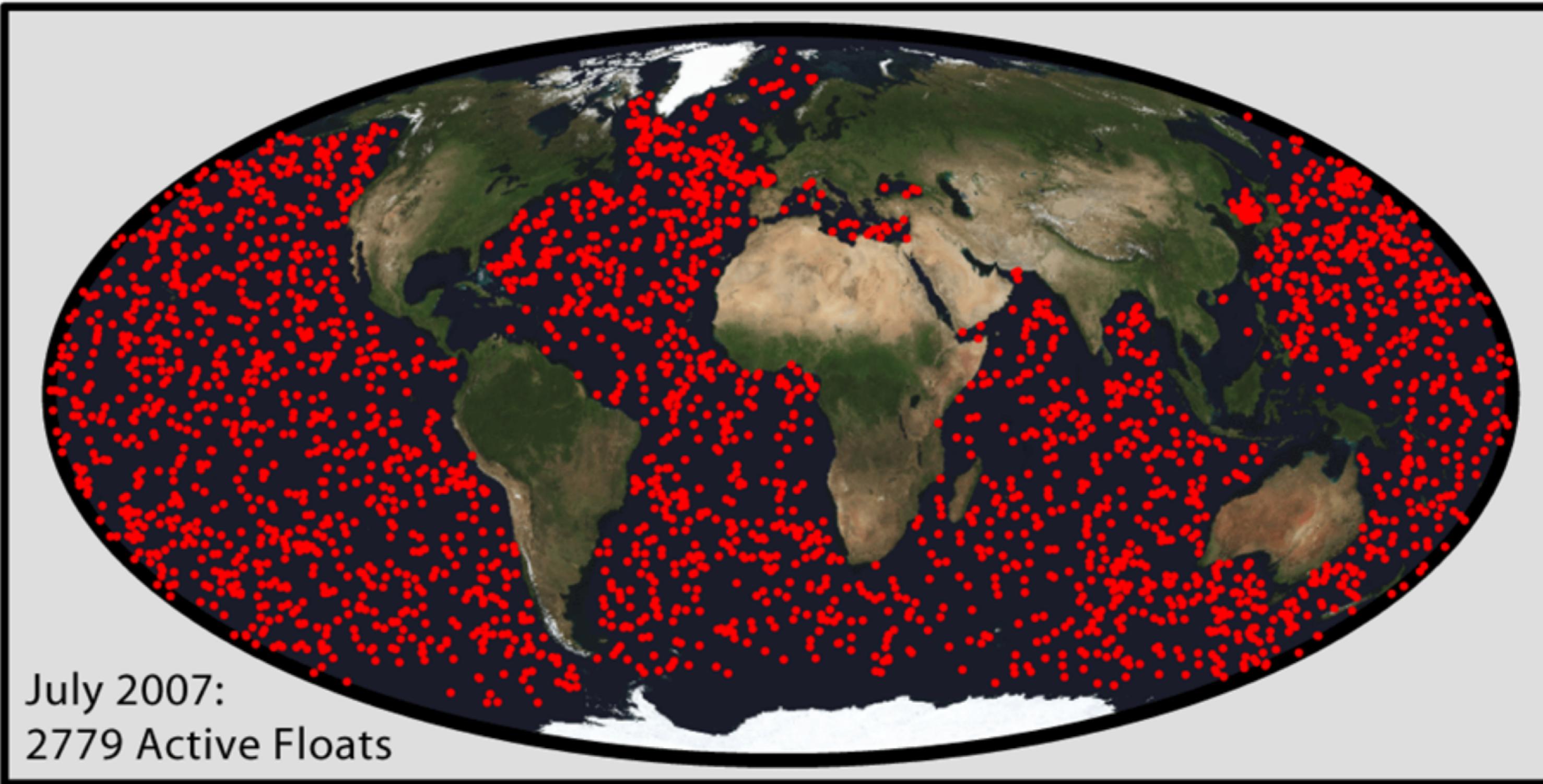


Ocean Temperatures

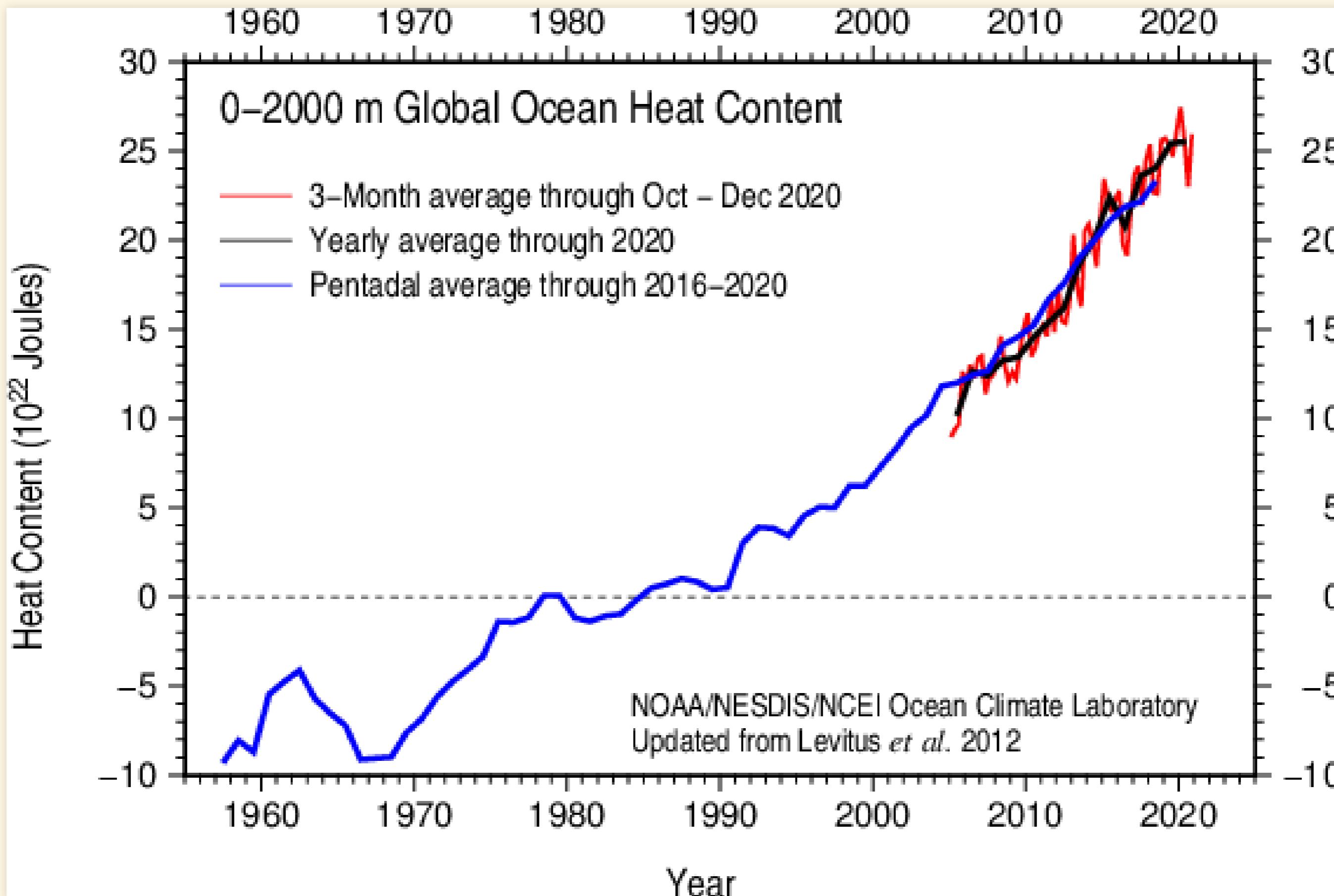


Ocean Temperatures

Argo Temperature/Salinity Float Network



Ocean Heat Content

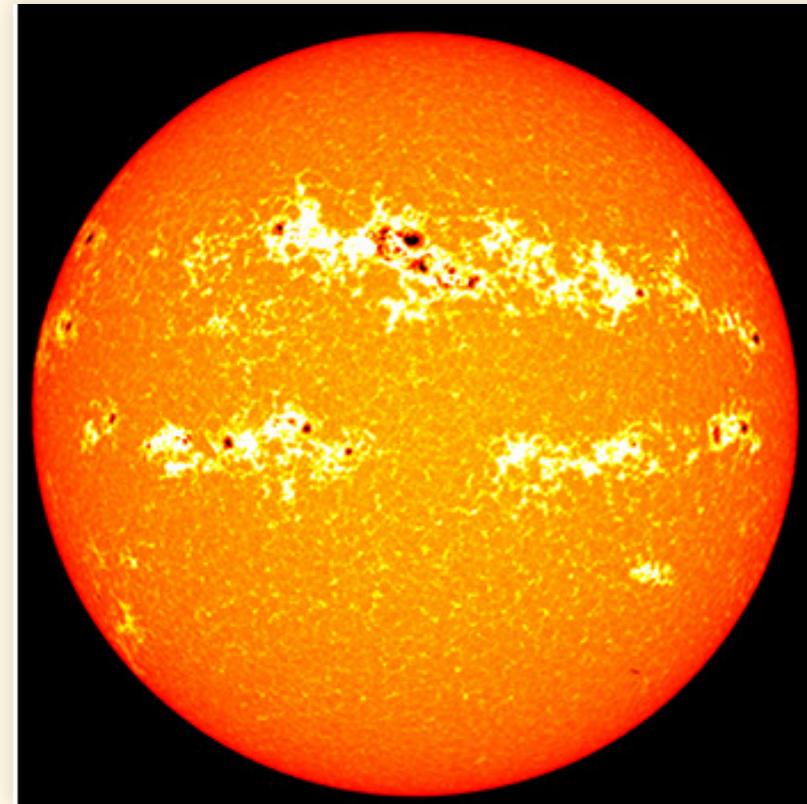


Searching for
a Smoking Gun:

What caused the warming?

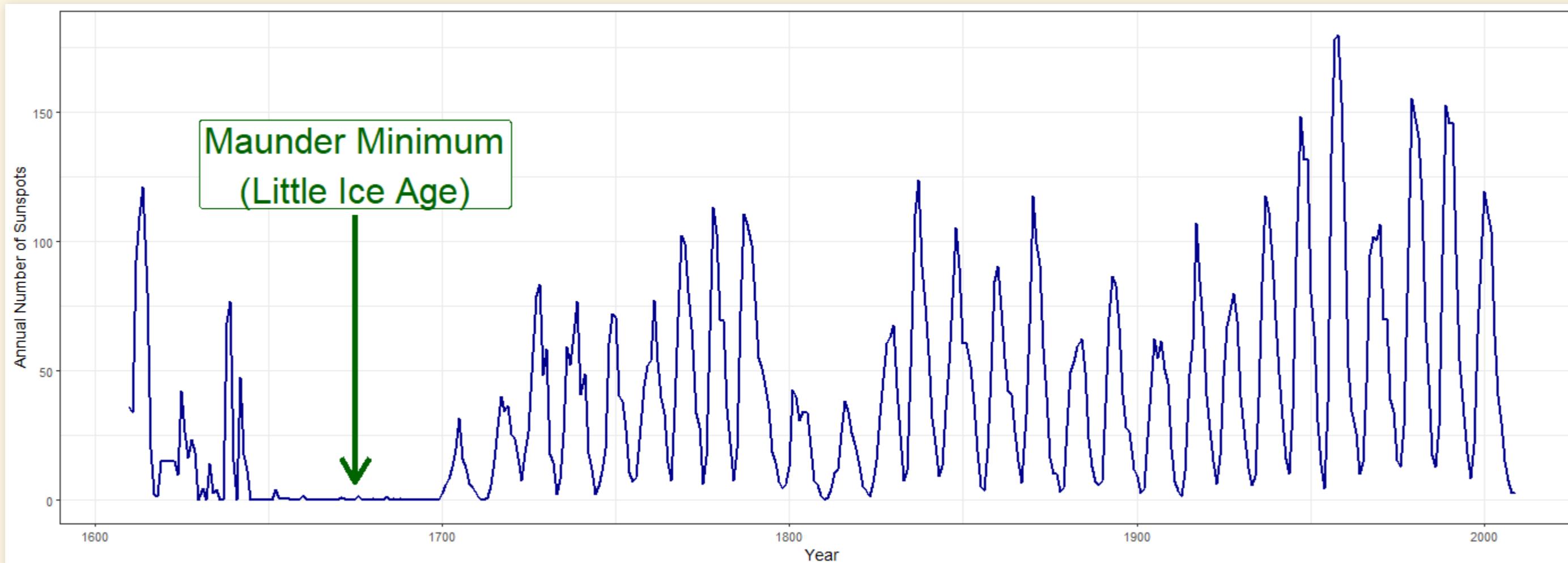
Sunspots?

Sunspots?

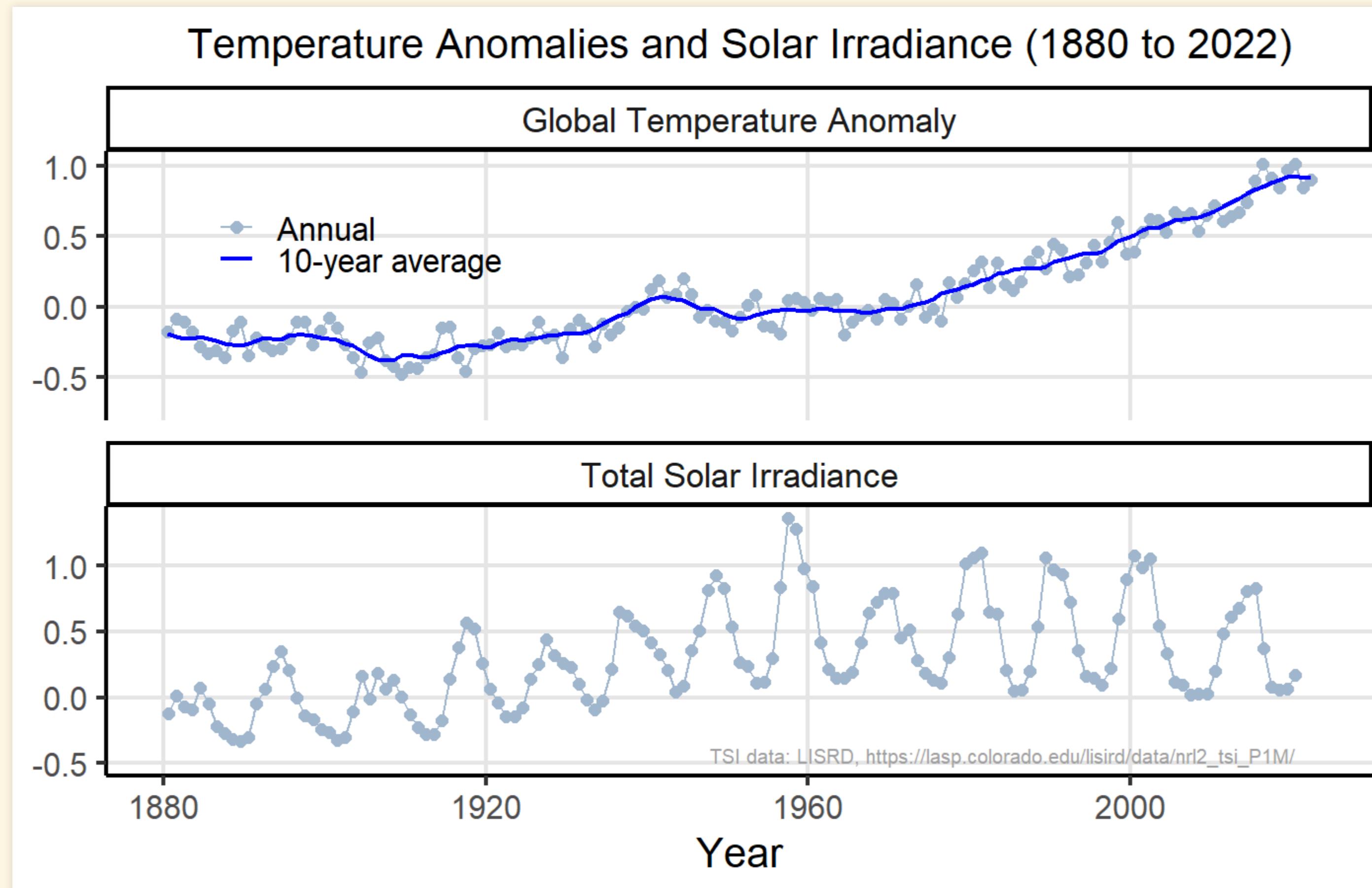


Sunspots

- Discovered 1611 by Galileo and J. Fabricius
- More sunspots → brighter
- 11 year cycle
- Intensity changes:
 - <1% for 11-year cycle
 - <0.1% change in decadal average from little ice age to present



Sunspots didn't cause recent warming



Fingerprints: Predictions and Patterns

Predictions: 1967

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MAY 1967

Thermal Equilibrium of the Atmosphere with a Given Distribution of Relative Humidity

SYUKURO MANABE AND RICHARD T. WETHERALD

Geophysical Fluid Dynamics Laboratory, ESSA, Washington, D. C.

(Manuscript received 2 November 1966)

ABSTRACT

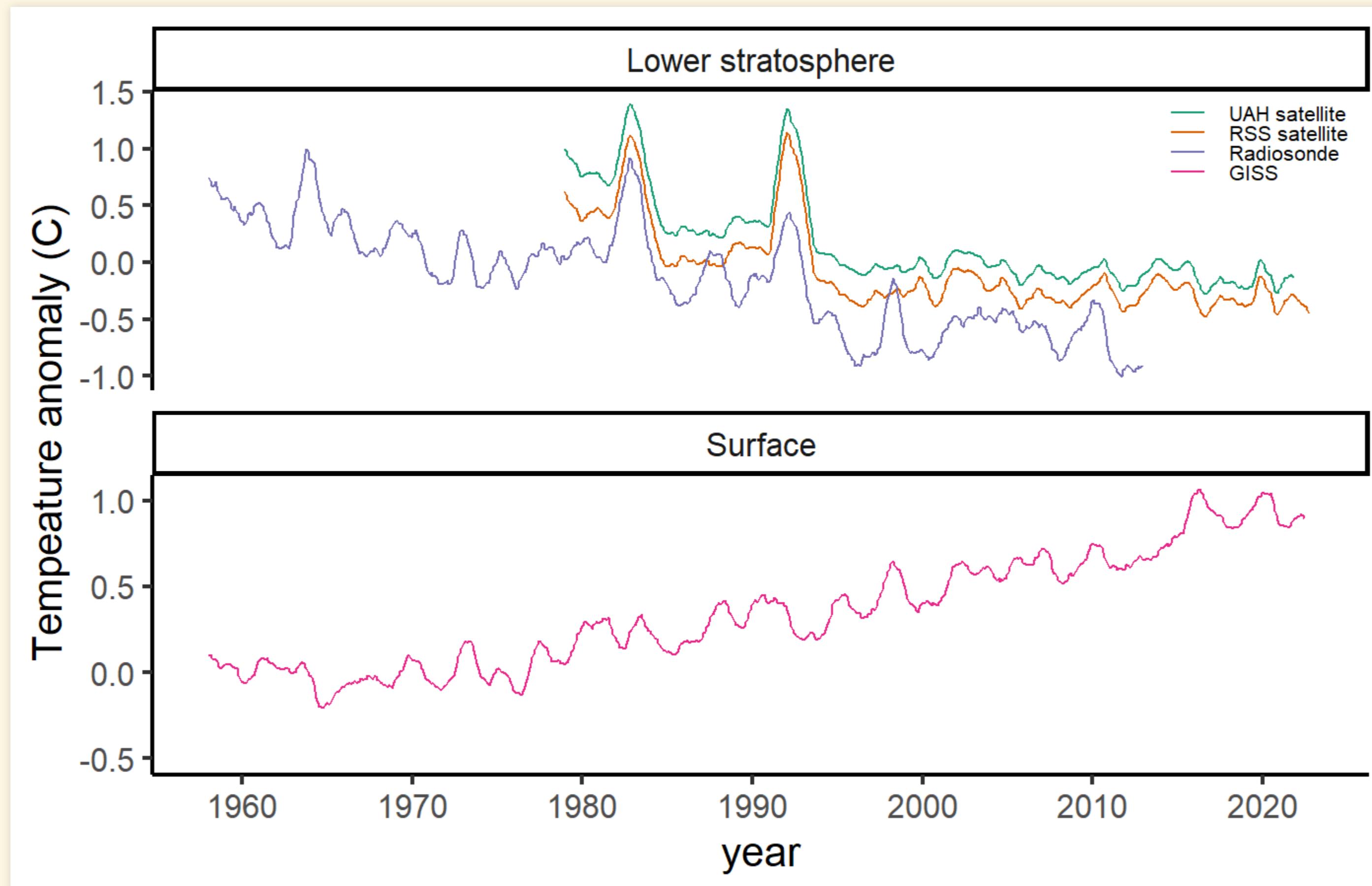
Radiative convective equilibrium of the atmosphere with a given distribution of relative humidity is computed as the asymptotic state of an initial value problem.

The results show that it takes almost twice as long to reach the state of radiative convective equilibrium for the atmosphere with a given distribution of relative humidity than for the atmosphere with a given distribution of absolute humidity.

Also, the surface equilibrium temperature of the former is almost twice as sensitive to change of various factors such as solar constant, CO_2 content, O_3 content, and cloudiness, than that of the latter, due to the adjustment of water vapor content to the temperature variation of the atmosphere.

According to our estimate, a doubling of the CO_2 content in the atmosphere has the effect of raising the temperature of the atmosphere (whose relative humidity is fixed) by about 2°C. Our model does not have the extreme sensitivity of atmospheric temperature to changes of CO_2 content which was adduced by Möller.

Stratosphere vs. Surface:



Day vs. Night

