Past Climate Reconstruction and Climate Proxies

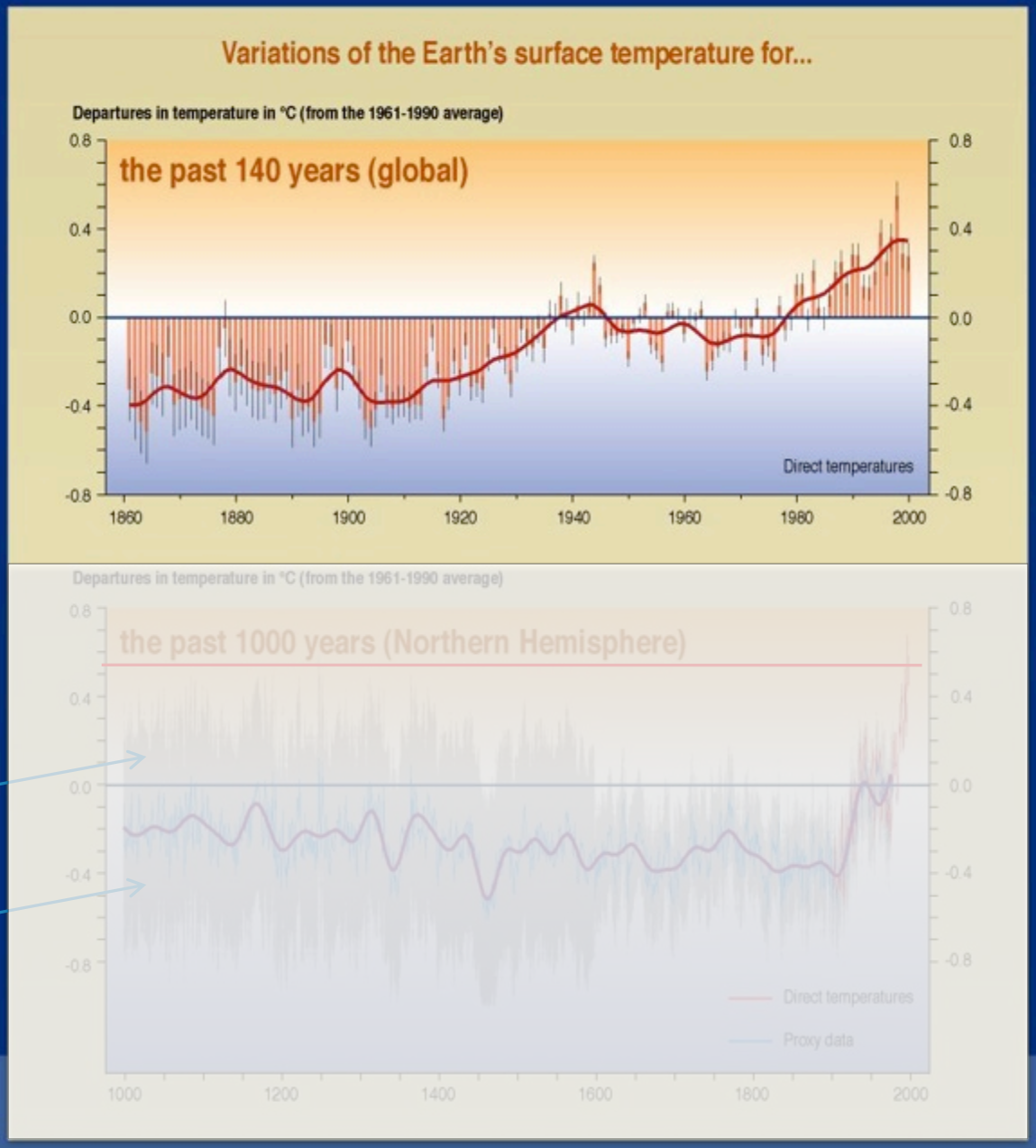
The past is the key to the present and the future!

SOUTH CENTRAL CLIMATE SCIENCE CENTER
LSU LOUISIANA STATE UNIVERSITY
Flower Hill Institute

Instrumental Records

Paleoclimate Records

Error bars for proxy data

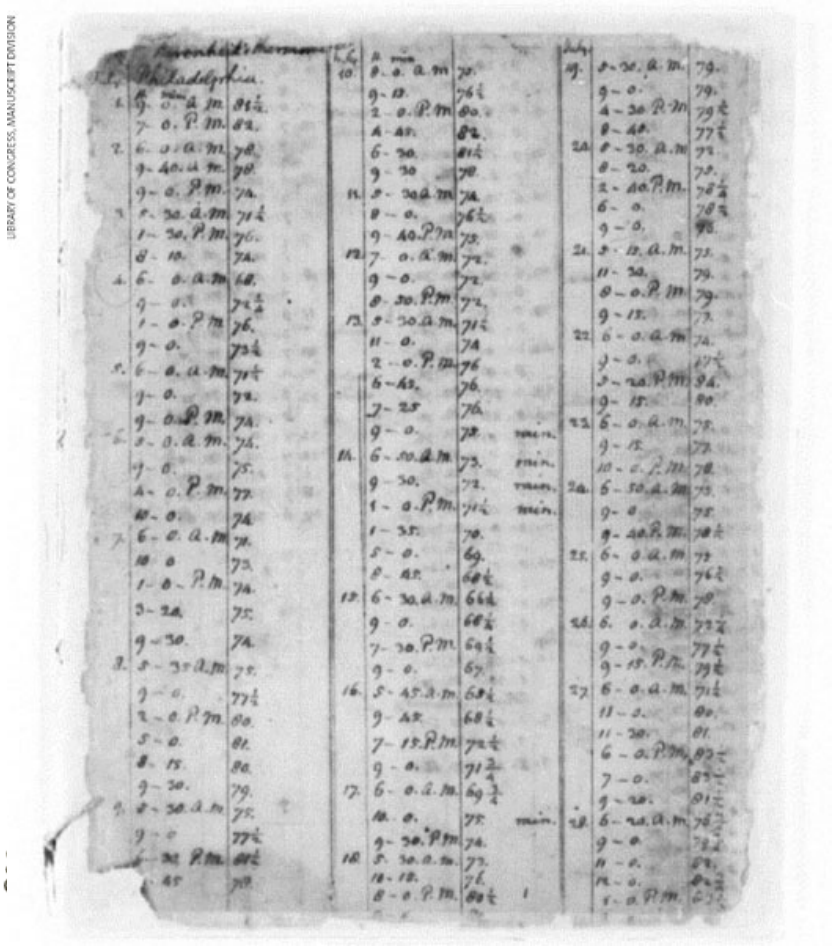


SYR - FIGURE 2-3

The Instrumental Record

The earliest records of temperature measured by thermometers are from western Europe in the late 17th century and by the early 20th century records were being collected in almost all regions. Records from polar regions began in the 1940s.

The National Climatic Data Center maintains a collection of temperature records from over 7,000 stations worldwide, about 1,000 go back to the 19th century.



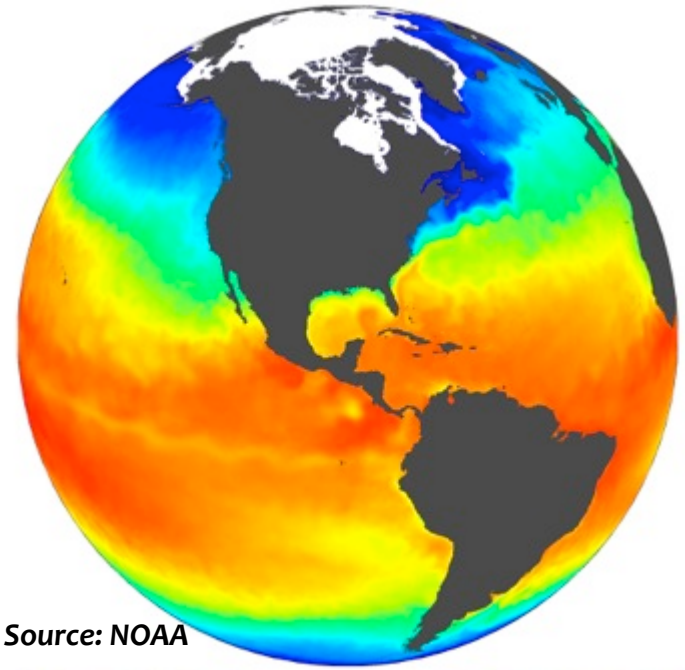
Temperature observations the first 2 weeks of July 1776 in Thomas Jefferson's Weather Memorandum Book

Satellite-Derived Temperature Record

Satellite measurements have been used to construct globally complete land and oceanic temperatures since 1979.

Provides a spatially uniform perspective whereas weather observations are biased towards where people are located. Allows for measurements over hard-to-sample areas like the oceans and ice sheets.

Source: NOAA



SOUTH
CLIMATE SC

Source: NOAA

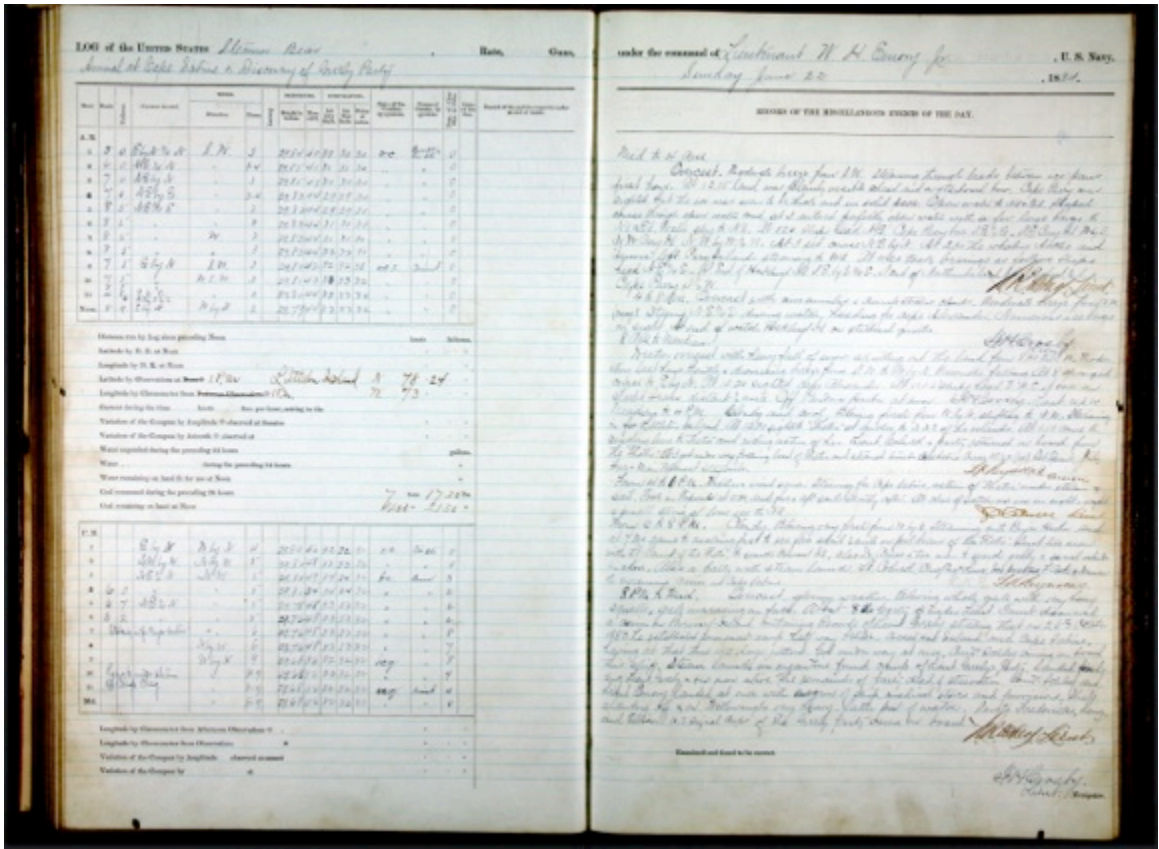
Historical Records

Historical documents contain past weather and climate information.

Ship logs are particularly useful for accounts of sea ice, storms, and hurricanes.

Farmers' logs can include useful information such as planting or harvest dates and overall crop health.

Personal diaries are another resource.



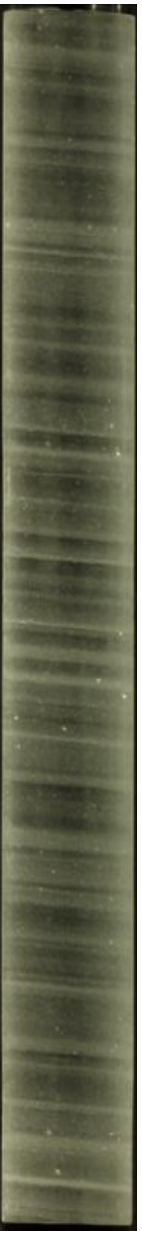
Paleoclimatology

is the study of past climate that does not use instrumental observations but proxies from the environment.

Proxies of climate variability are recorded in the rings of trees, coral colonies, ice sheets and glaciers, cave deposits, layers of sediments (pollen, microfossils, and organics) and more.

These natural recorders of climate contain a chronology or way to tell time and they record changes in environment, driven by climate.

Annual Banding



Ice cores

Varve sediments

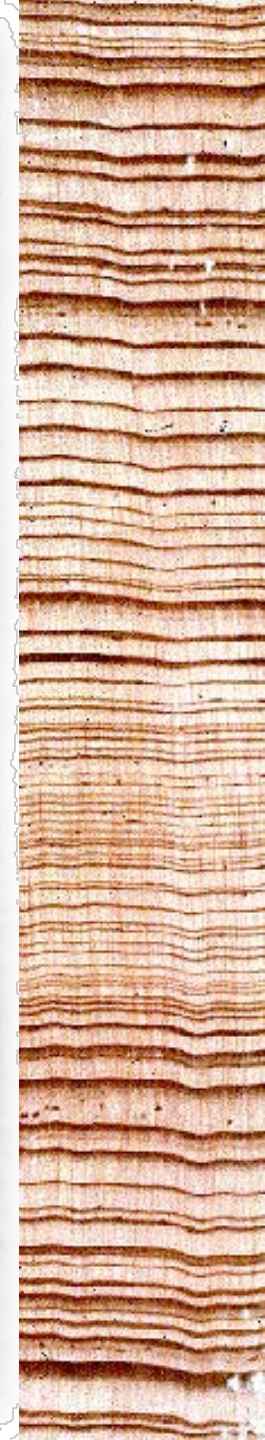
Tree rings

Corals

Count years

Absolute age if date of collection is known

Varves of Lehmilampi lake (Eastern Finland), light layer = spring flood mineral layer, dark layer=organic summer-winter layer



GISP2
National Ice Core Laboratory USGS

SOUTH CE
CLIMATE SCIEN

Tree Rings


03/15/2014

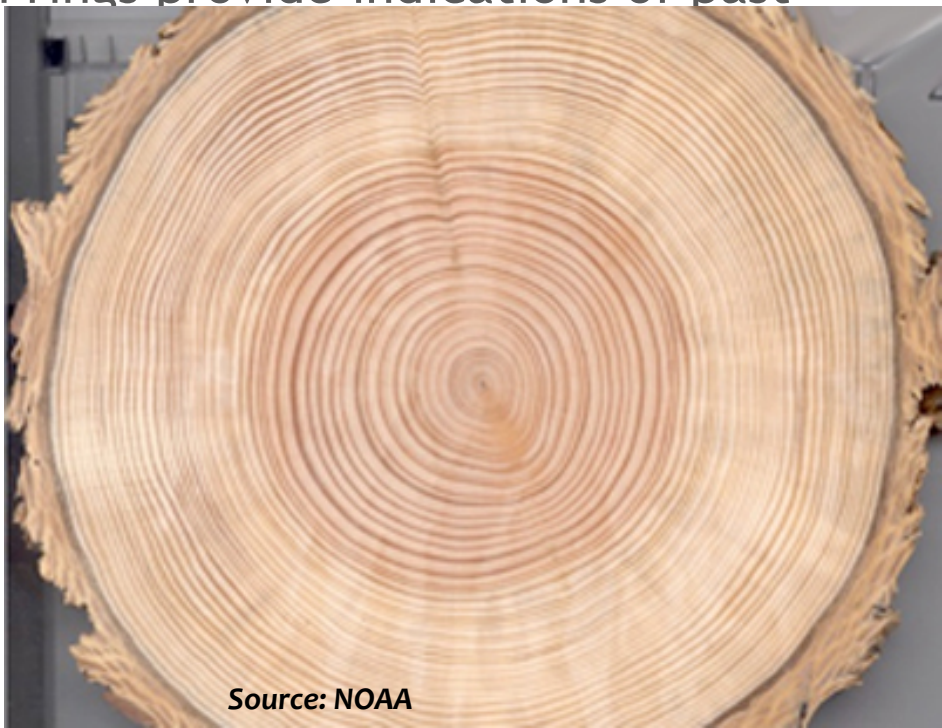
Tree Ring Record

Cross dating of tree rings can provide exact date matches between trees with different ages or from different locations.

Major events such as fire, flood, avalanche, drought, and insect infestation can all be evident.

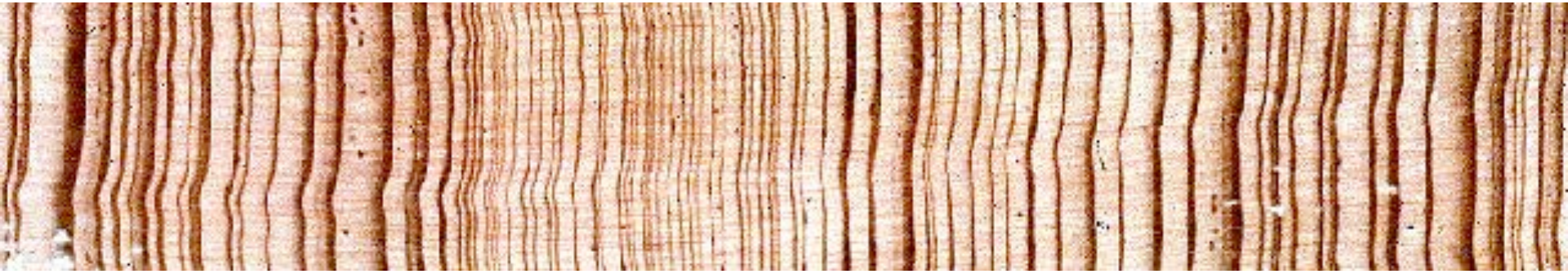
The regular year to year variations in rings provide indications of past temperature, precipitation and streamflow.

Using petrified or fossilized wood, tree ring records go back more than **10,000 years** in some locations.

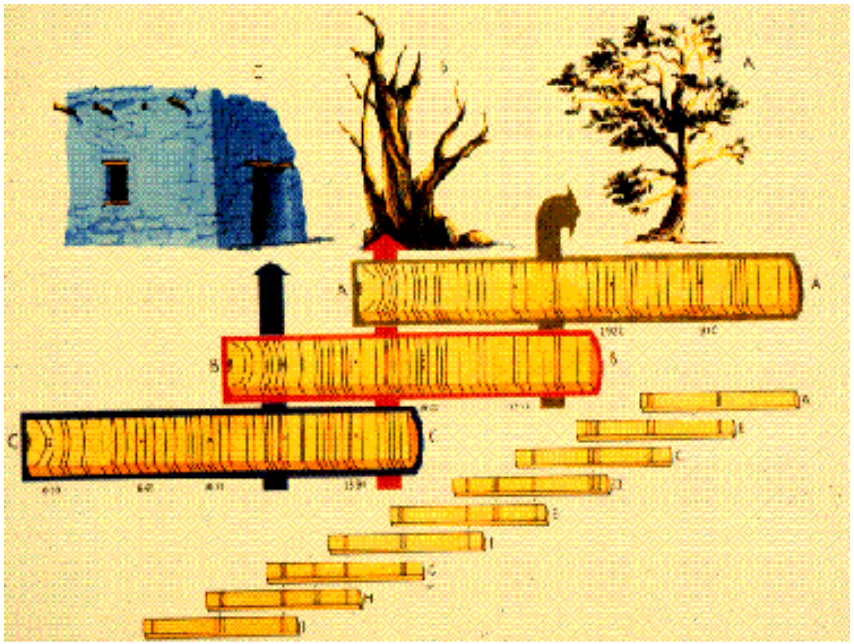


Source: NOAA

Dendrochronology



* Master chronology
  * Many trees from a region are cross-dated
  * Locally absent years
  * False rings
* Quality Checked
  * COFECHA



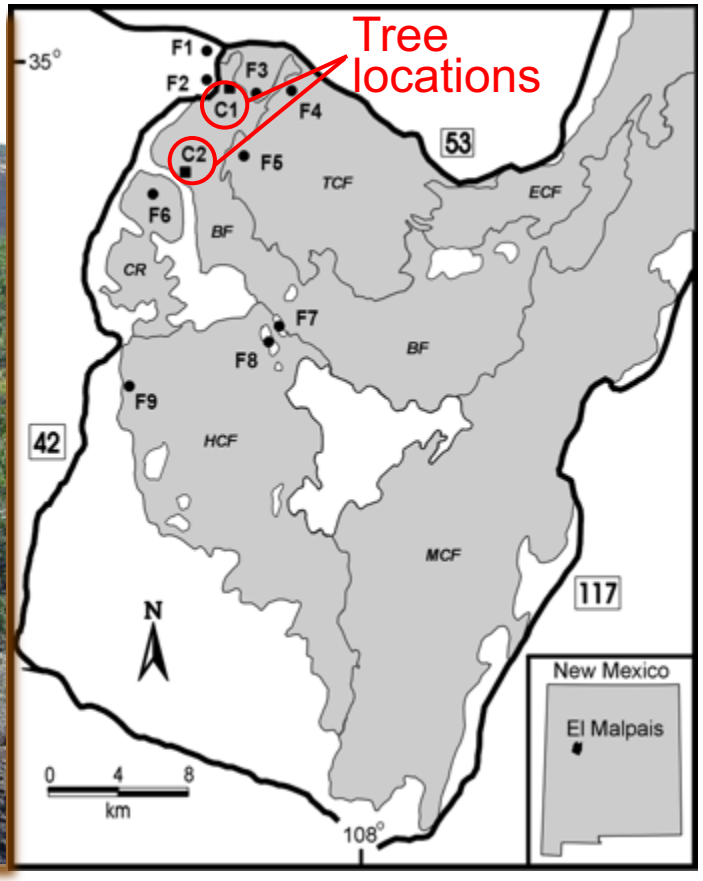
SOUTH CENTRAL CLIMATE SCIENCE CENTER

LSU LOUISIANA STATE UNIVERSITY

Flower Hill Institute

El Malpais Tree-Rings

Lava fields are an isolated and harsh environment with good wood preservation



Grissino-Mayer, 2000

New Mexico region is precipitation sensitive

Ring width varies with annual precipitation

SOUTH CENTRAL CLIMATE SCIENCE CENTER

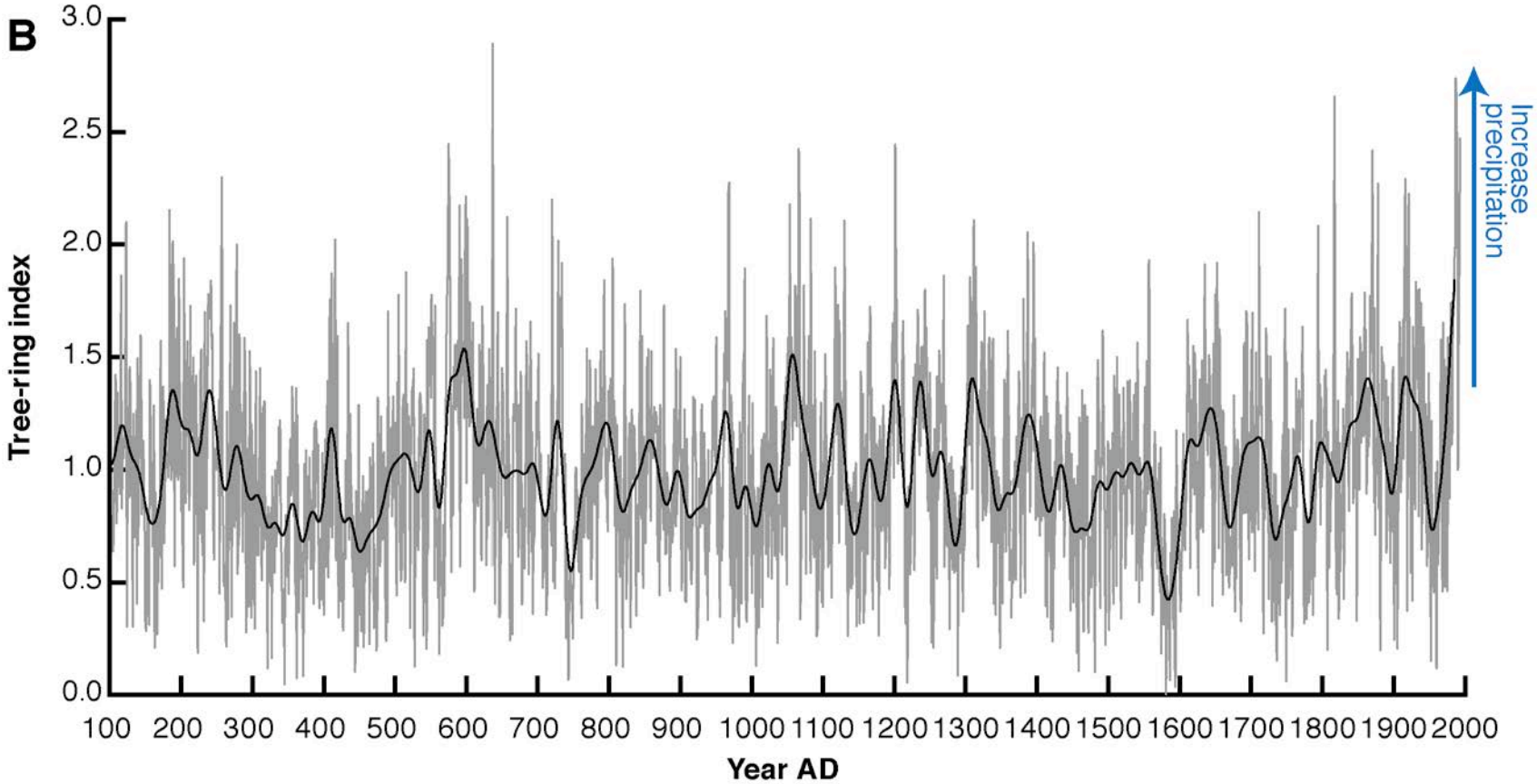
LSU LOUISIANA STATE UNIVERSITY

Flower Hill Institute

El Malpais Tree-Ring Record

Average tree age = 391 years, 76 trees > 500 years

Oldest living tree found is a 1274-year old Douglas-fir.



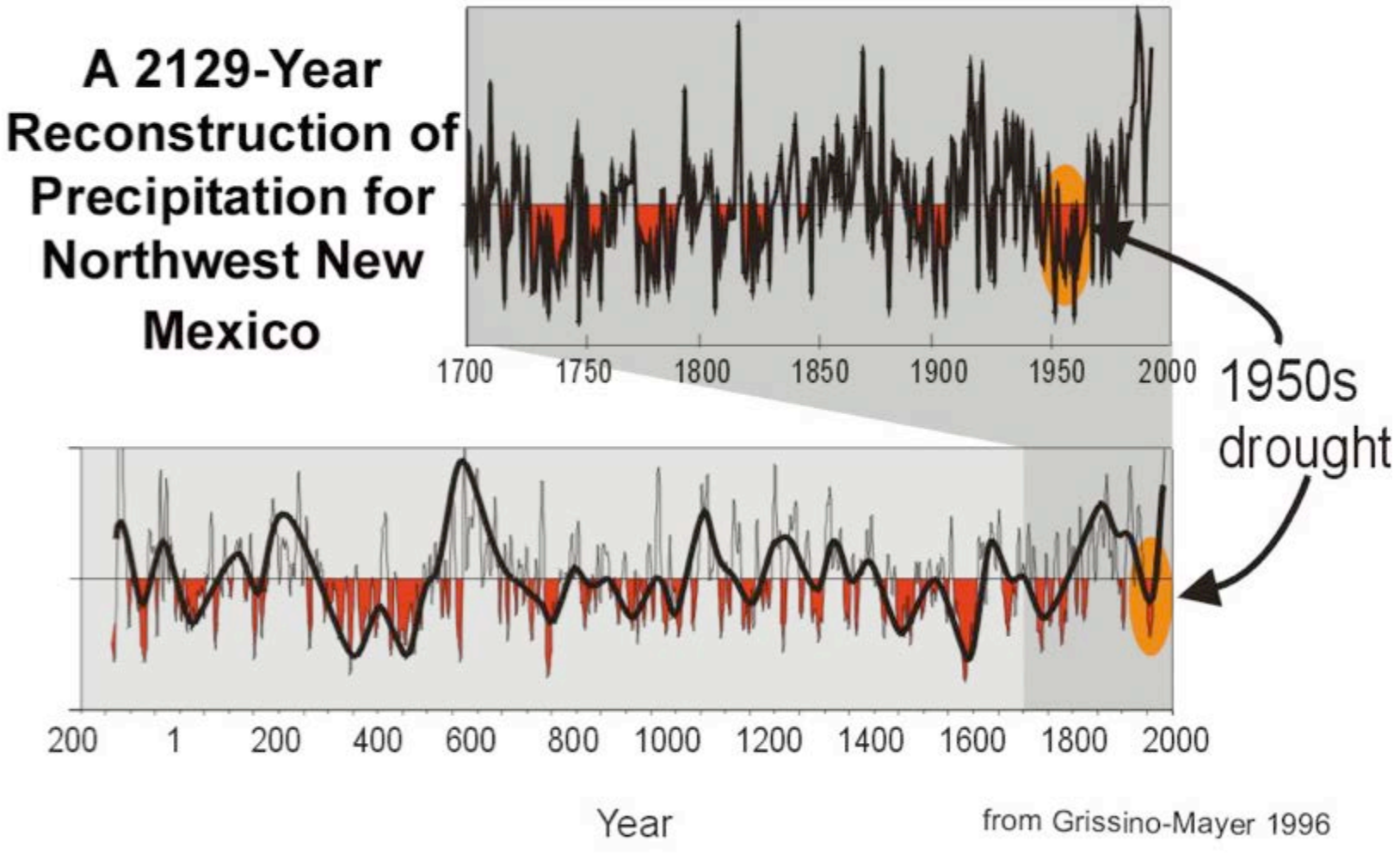
DeLong et al., 2009 and Grissino-Mayer 1996

SOUTH CENTRAL CLIMATE SCIENCE CENTER

LSU LOUISIANA STATE UNIVERSITY

Flower Hill Institute

El Malpais Tree-Ring Record



https://www.ncdc.noaa.gov/paleo/drought/drght_grissno.html

SOUTH CENTRAL CLIMATE SCIENCE CENTER

LSU LOUISIANA STATE UNIVERSITY

Flower Hill Institute

Corals as Climate Archives

Corals

A coral is a colony composed of hundreds of thousands of tiny animals called coral polyps.

Coral polyp deposits calcium carbonate, which forms the coral skeleton, and many corals form the coral reef.

Within the coral skeleton are density bands, similar to tree rings and chemistry with the Skeletal depends on temperature and other environmental conditions.

USGS DeLong

A long core of a coral skeleton can cover hundreds of years and exact dates can be determined based on counting the growth bands or U-Th dating.

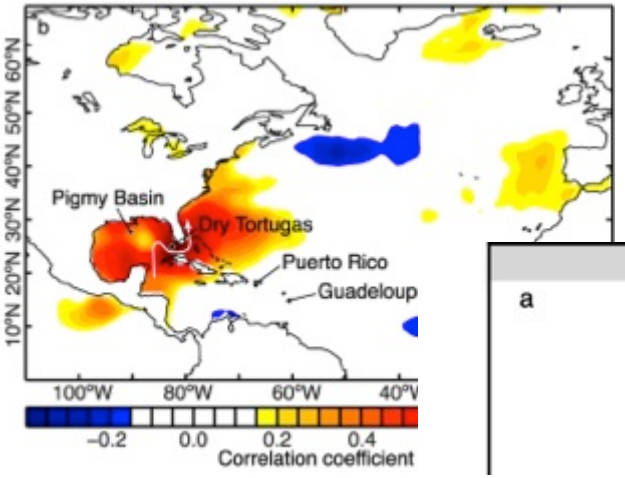
Coral records help us understand the tropical climate system, which is a strong driver of global climate.

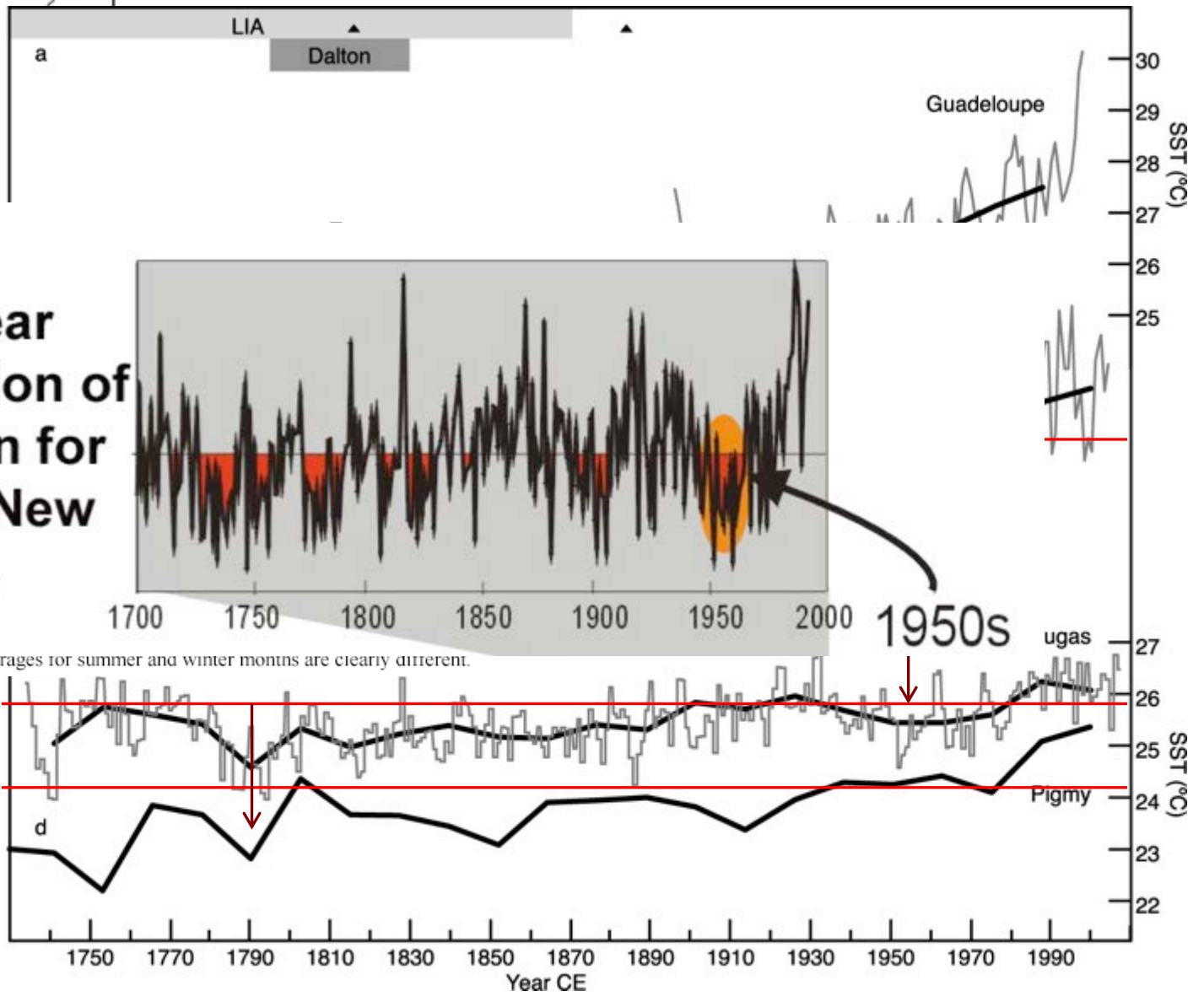
SOUTH CENTRAL CLIMATE SCIENCE CENTER

LSU LOUISIANA STATE UNIVERSITY

Flower Hill Institute

Coral SST Reconstruction





A 2129-Year Reconstruction of Precipitation for Northwest New Mexico

Fig
variation between individual storms, the averages for summer and winter months are clearly different.

DeLong et al., 2014

Ice Core Records

The Greenland ice sheet is nearly two miles thick and provides climate history going back **200,000 years.**

Parts of the Antarctic ice sheet are even thicker, going back over **700,000 years.**

Layers of dust present in ice cores from past windy seasons or could represent past volcanic eruptions.

Tiny fossil air bubbles are even trapped in the ice, time capsules of past air.

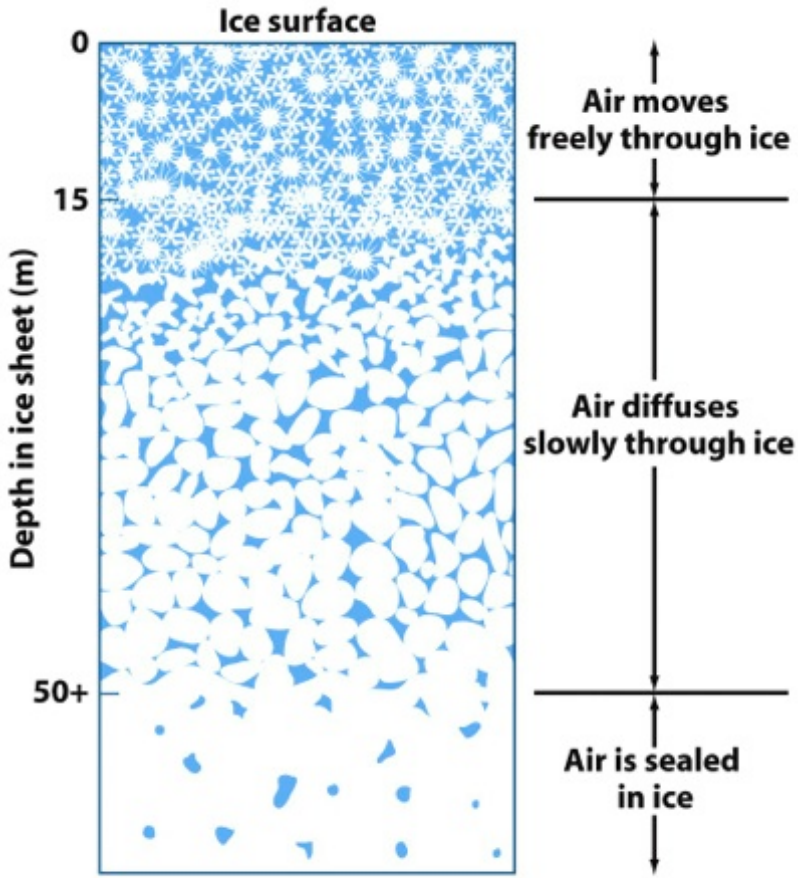
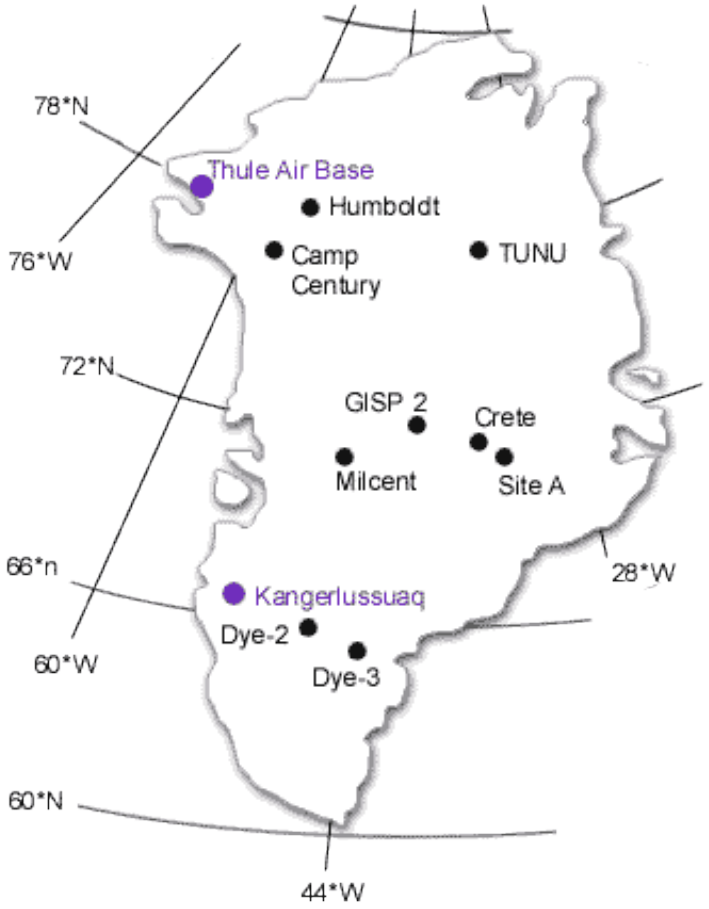
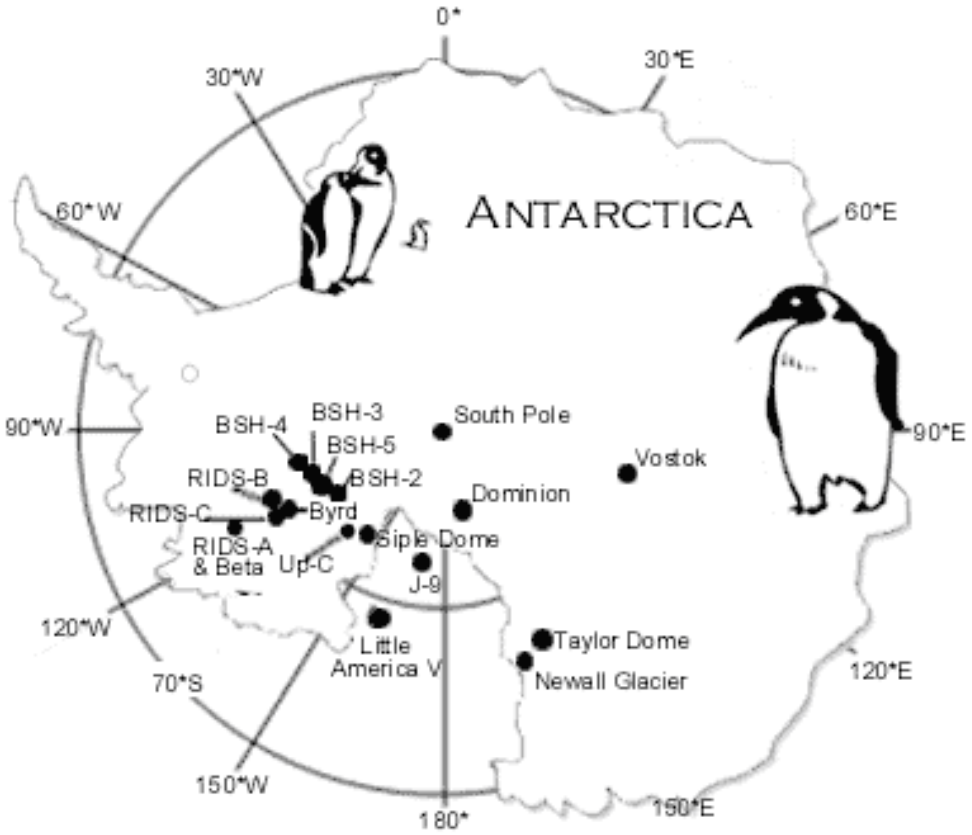


Figure 10-3
Earth's Climate: Past and Future, Second Edition

High Latitude Ice Records

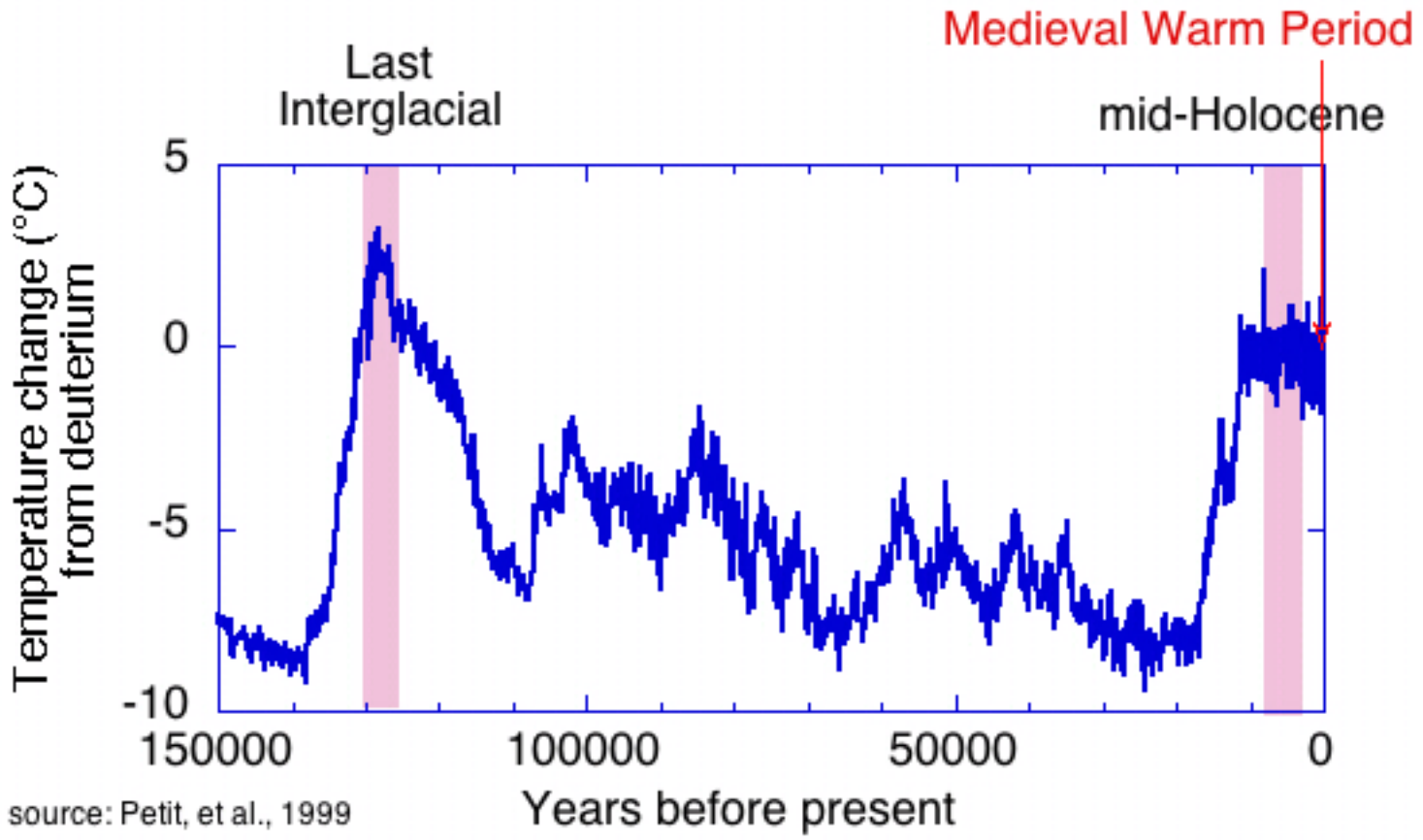
Most ice cores have been retrieved from high latitude sites in Greenland (GISP, GISP2, GRIP) and Antarctica (Taylor Dome, Siple Dome, Vostok)





Ice Core Records

Temperature change for the past 150,000 years from an Antarctic ice core.

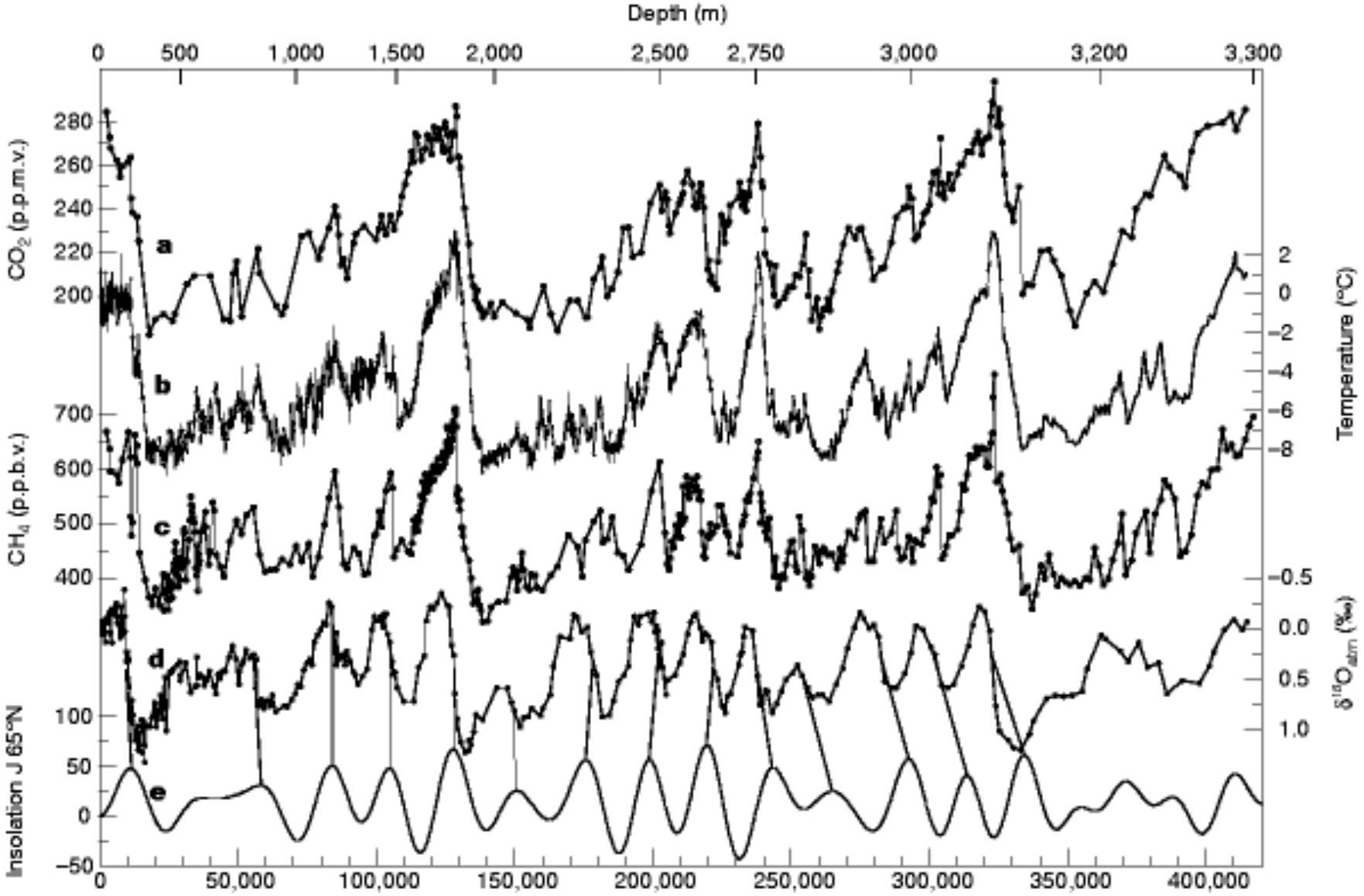


SOUTH CENTRAL CLIMATE SCIENCE CENTER

LSU LOUISIANA STATE UNIVERSITY

Flower Hill Institute

Vostok Antarctica Ice Core Record



Petit et al., 1999

Sediments

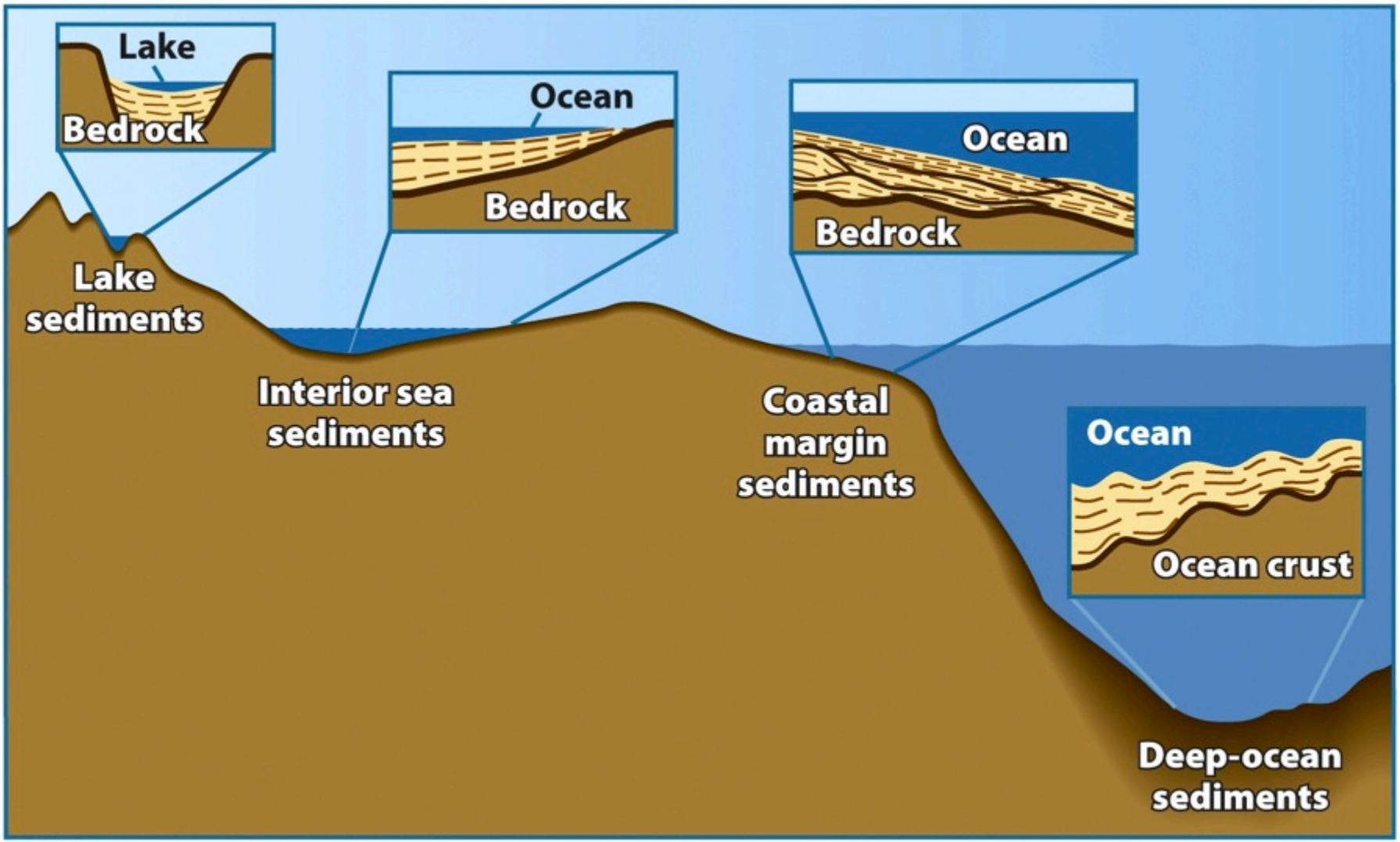
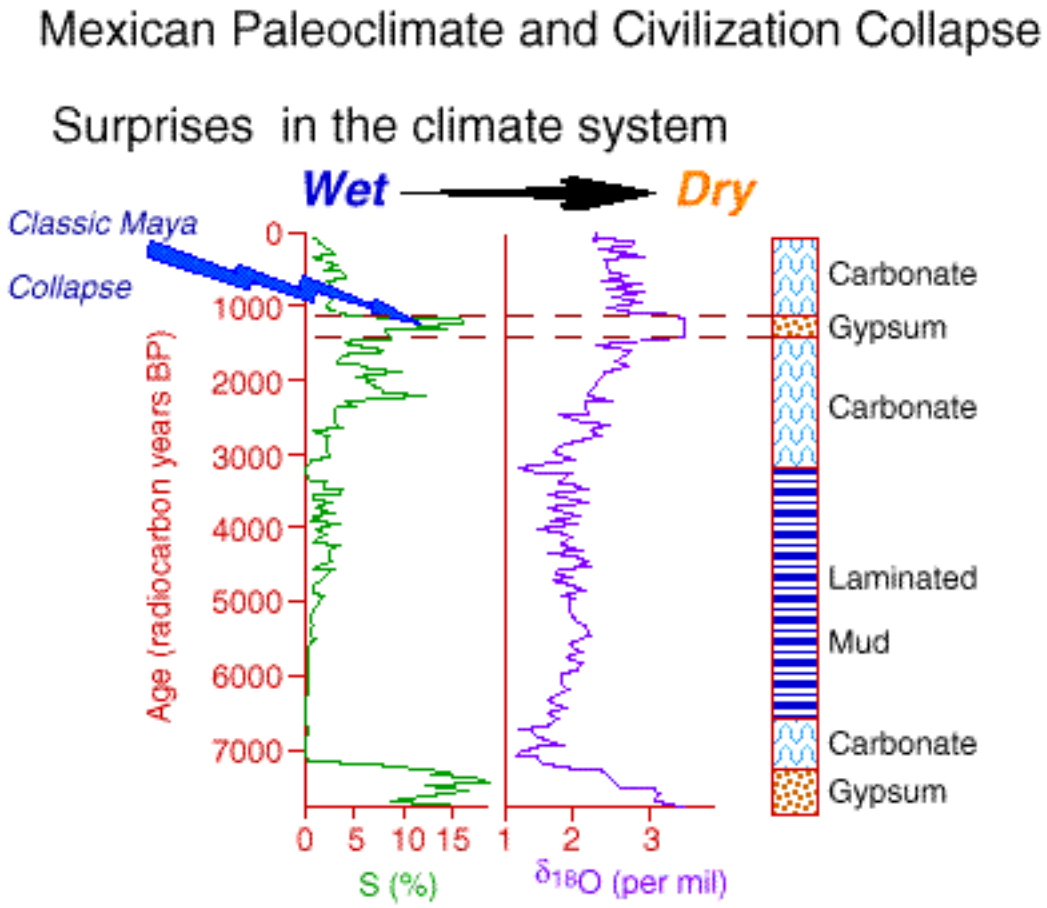


Figure 2-1
Earth's Climate: Past and Future, Second Edition

Sediment Records

Sediment cores from closed basin lakes in the Yucatan Peninsula indicate evidence of an intense period of drought that coincides with the collapse of the Classic Mayan Civilization.

An archaeological mystery, southern Mayan cities were abandoned between 800 and 900 AD.



(Hodell et al, 1995 *Nature*)

Ocean Drilling

Figure 2-4b
Earth's Climate: Post and Future, Second Edition

Figure 2-4c
Earth's Climate: Post and Future, Second Edition
© 2008 W. H. Freeman and Company

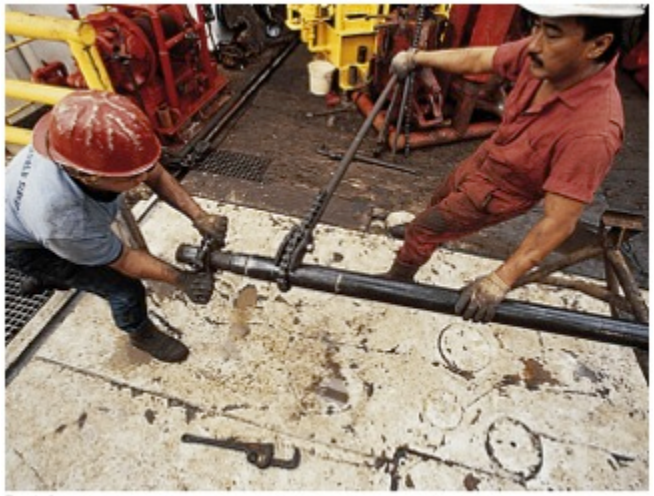
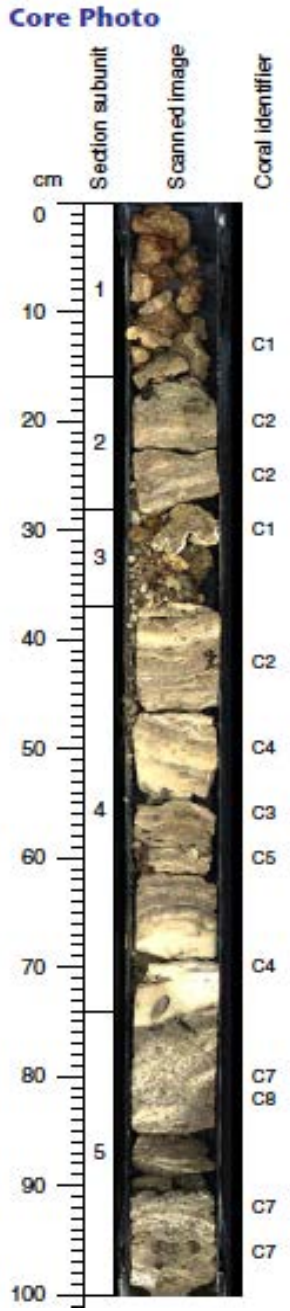


Figure 2-6d
Earth's Climate: Post and Future, Second Edition
© 2008 W. H. Freeman and Company

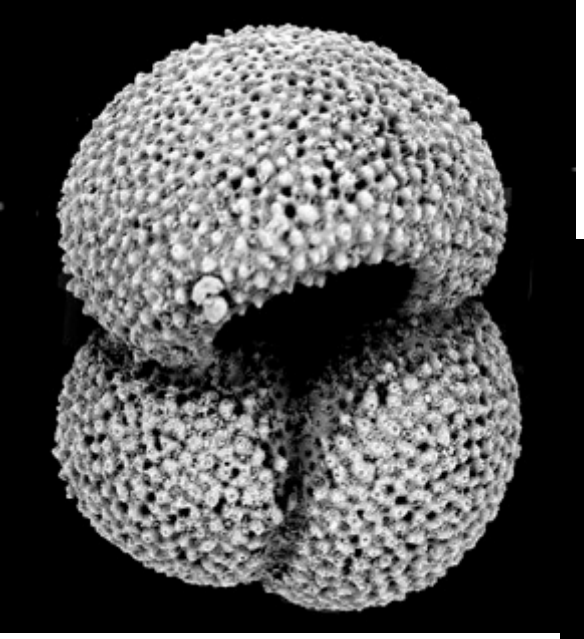


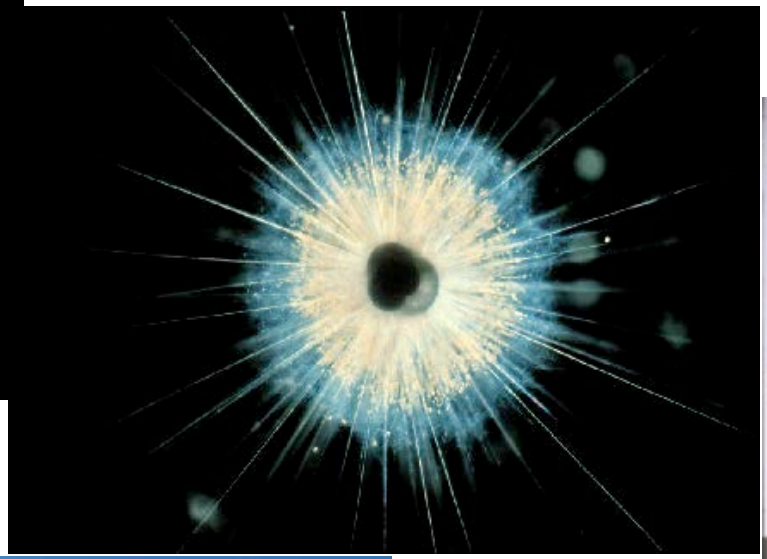
SOUTH CENTRAL CLIMATE SCIENCE CENTER

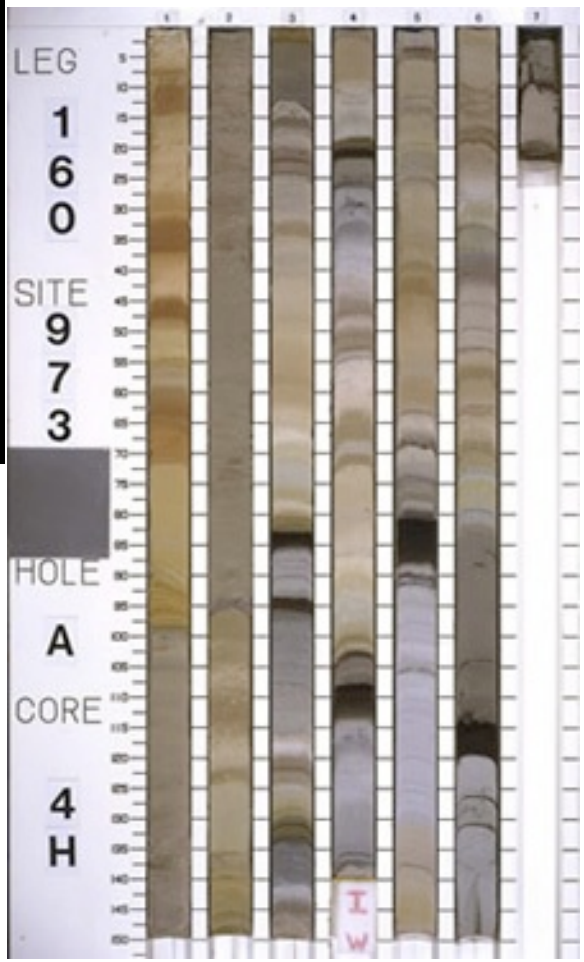
LSU LOUISIANA STATE UNIVERSITY

Flower Hill Institute

Marine Sediments



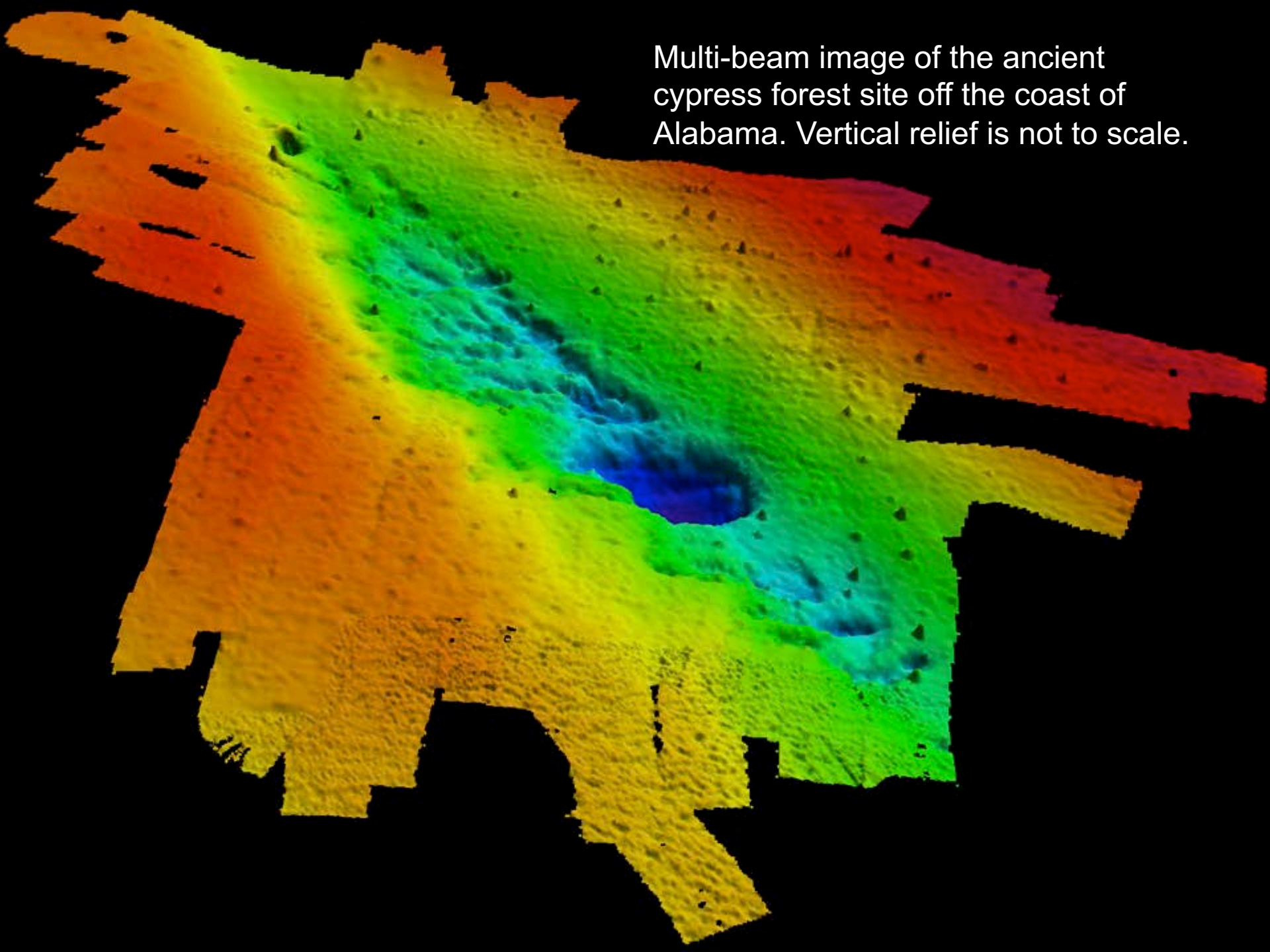


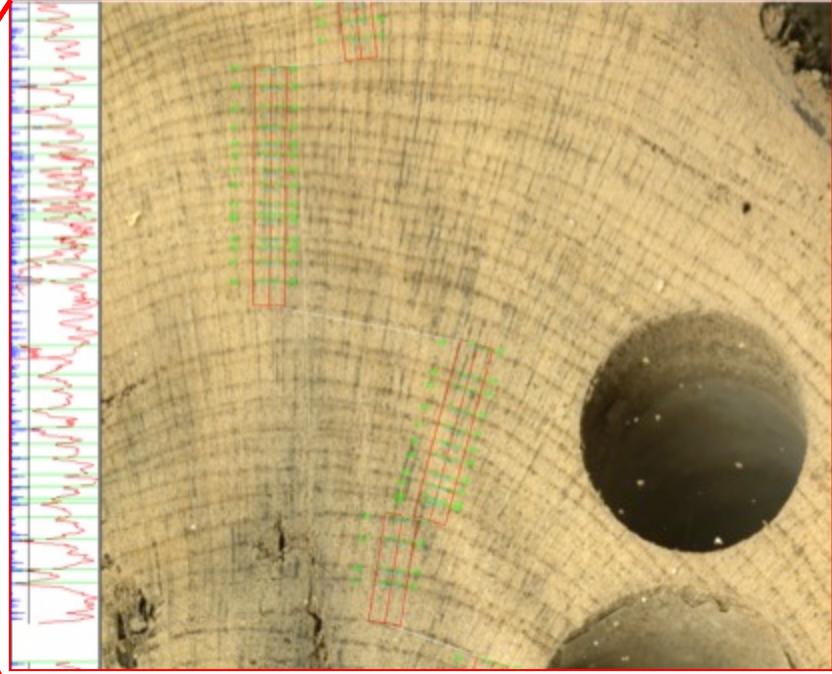


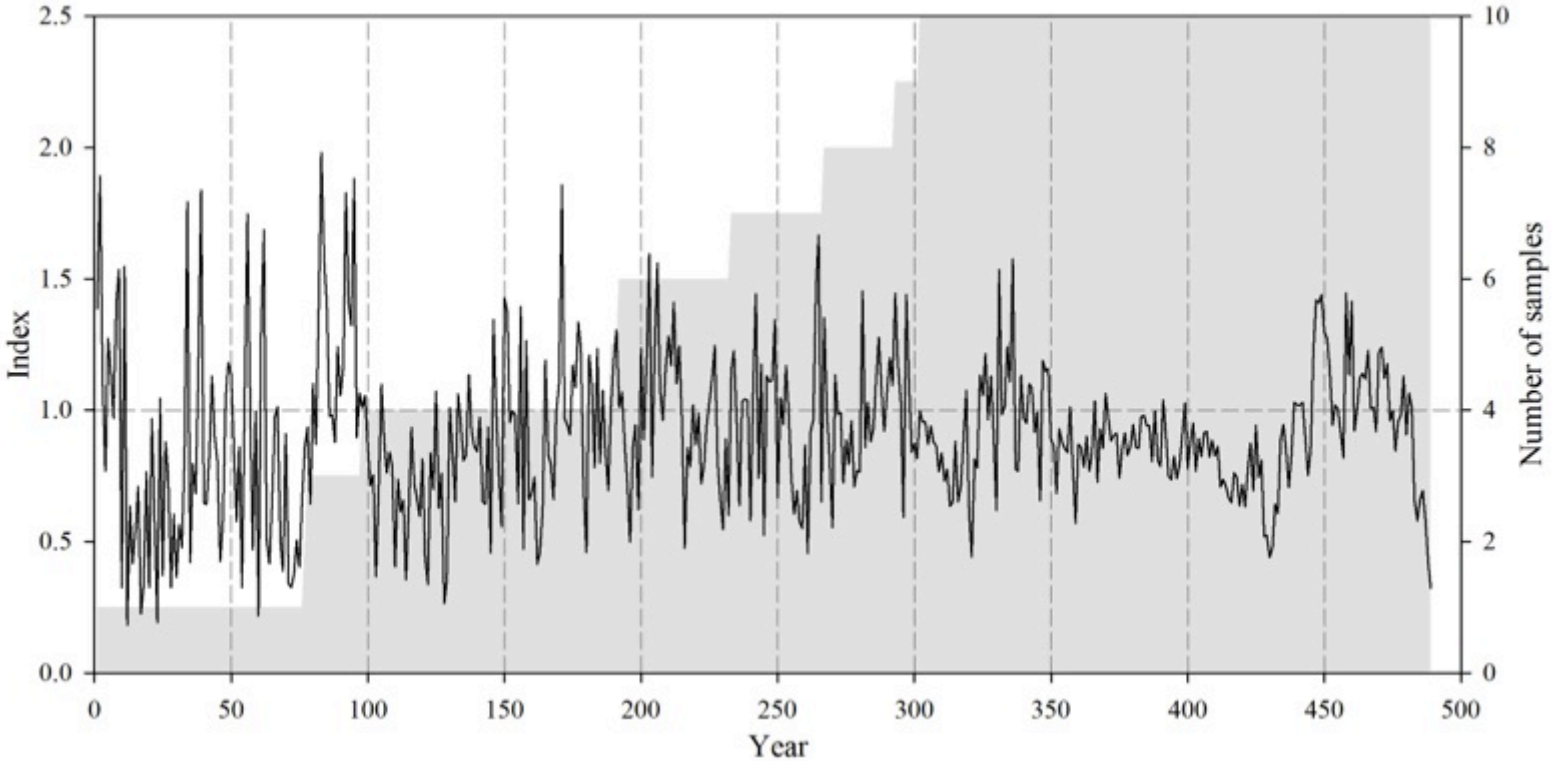
SOUTH CENTRAL CLIMATE SCIENCE CENTER

LSU LOUISIANA STATE UNIVERSITY

Flower Hill Institute


Multi-beam image of the ancient cypress forest site off the coast of Alabama. Vertical relief is not to scale.



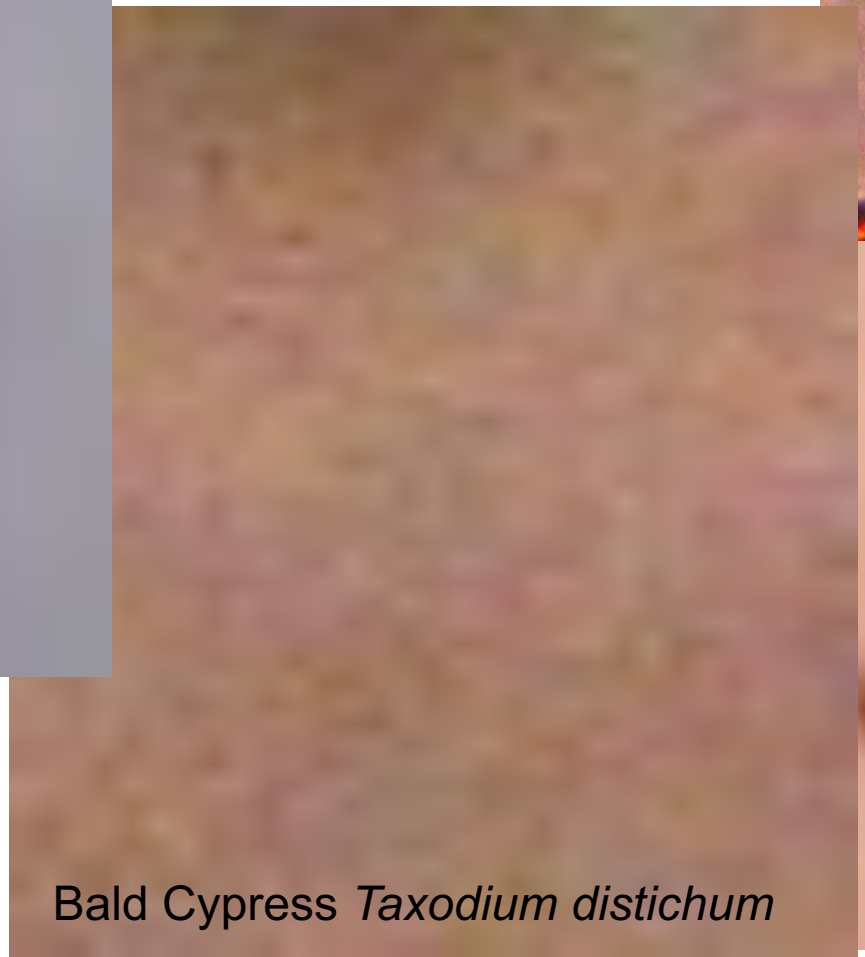


nain study
d with the

ower
ll
stitute

Pollen

Tupelo (*Nyssa aquatica)*



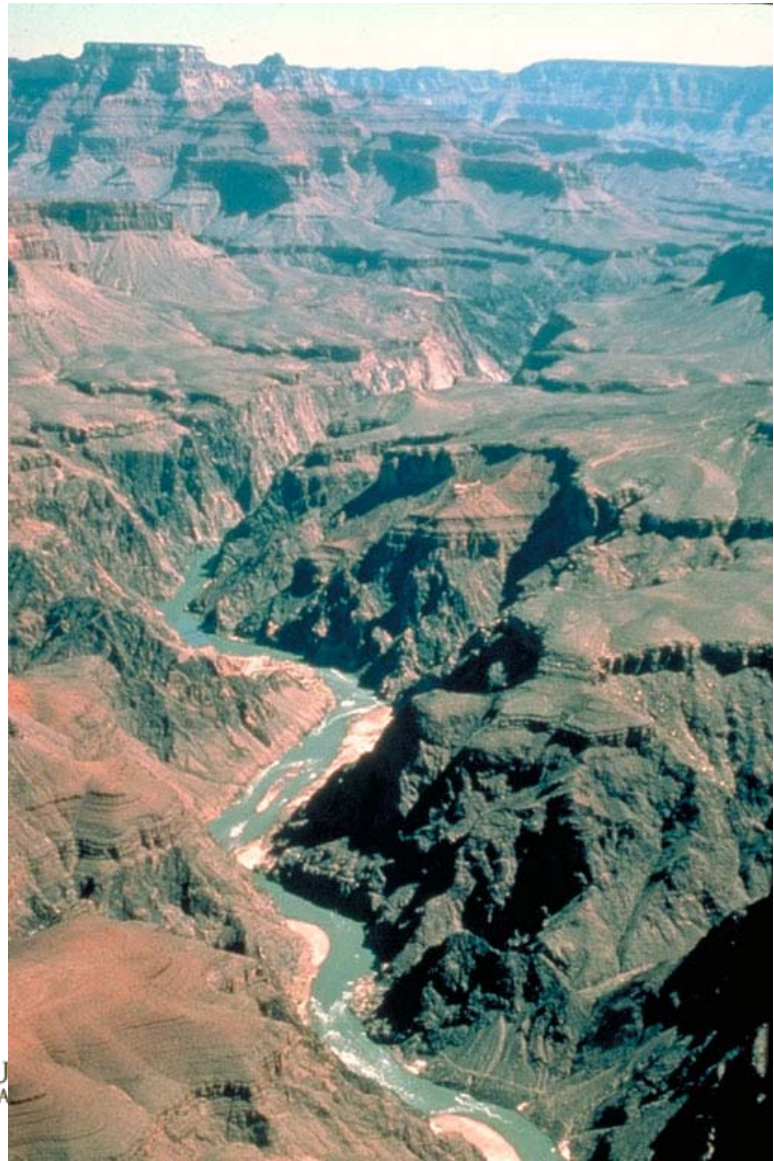
Bald Cypress *Taxodium distichum*

Pine (*Pinus spp.*

Other Proxy Records

The geologic, fossil and sediment record also provide indications of Earth's past climate.

Pollen grains are especially well preserved in sediment layers, like at the bottom of a lake or ocean.



Questions and Discussion