

Lecture 14. Climate Data (Chapter 2, p. 17-31)

Tools for studying climate and climate change

Data Instrumental measurements (**direct**)
Historical documents
Natural recorders of climate or proxy data

Climate models

Understand climatic cause and effect
External factors → climate system
Feedbacks

Test hypothesis

Quantitative (put numbers on ideas) and
Predict the future

Instrumental Measurements (Direct)

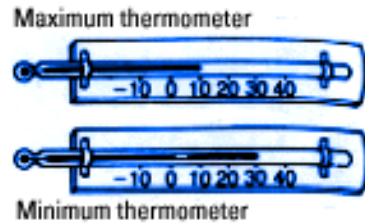
Weather Stations

- Stevenson Screen
- Temperature

~40 years old

Satellite

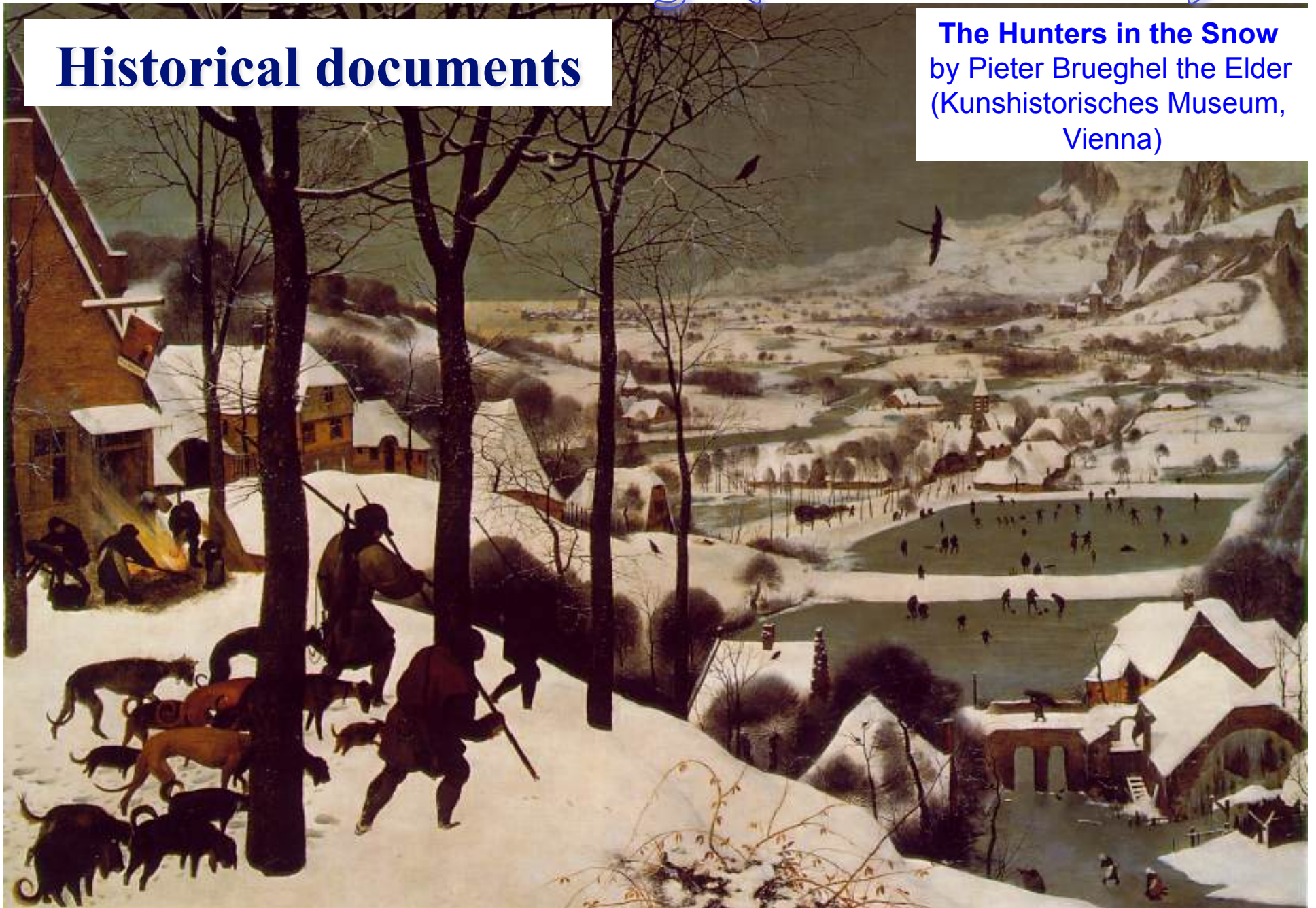
~140 years old



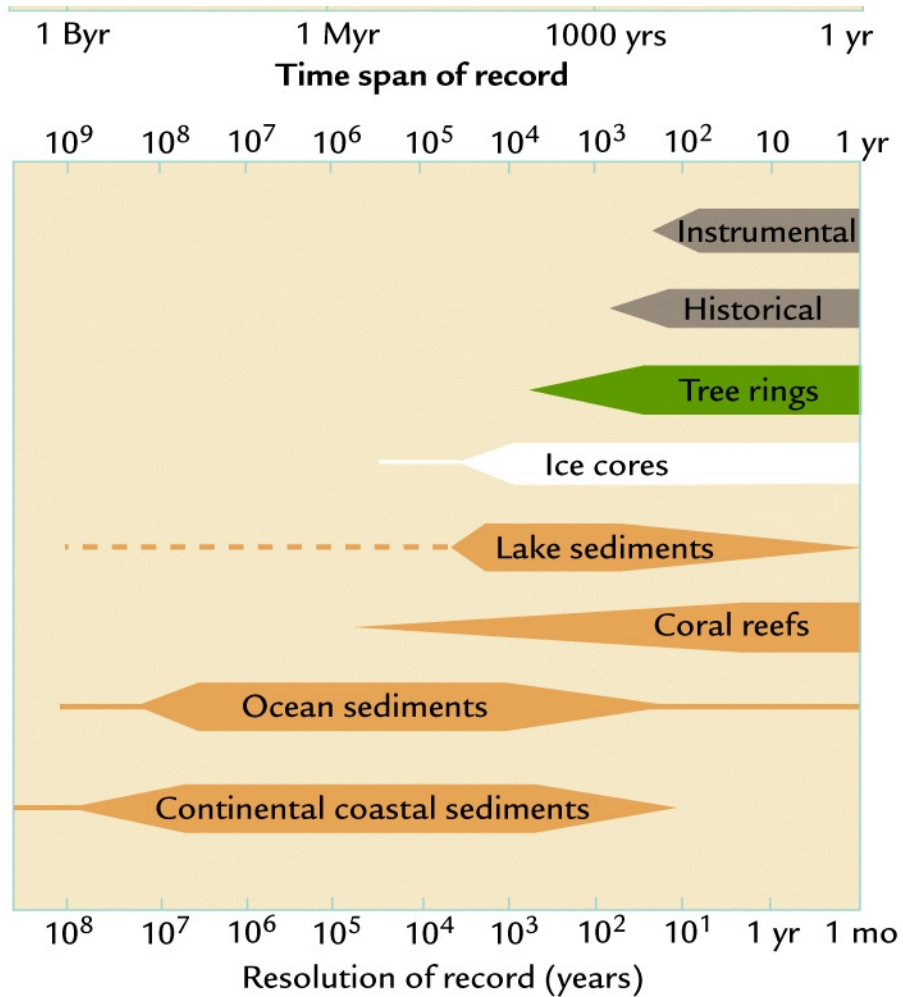
The Little Ice Age (~1270-1850)

Historical documents

The Hunters in the Snow
by Pieter Bruegel the Elder
(Kunshistorisches Museum,
Vienna)

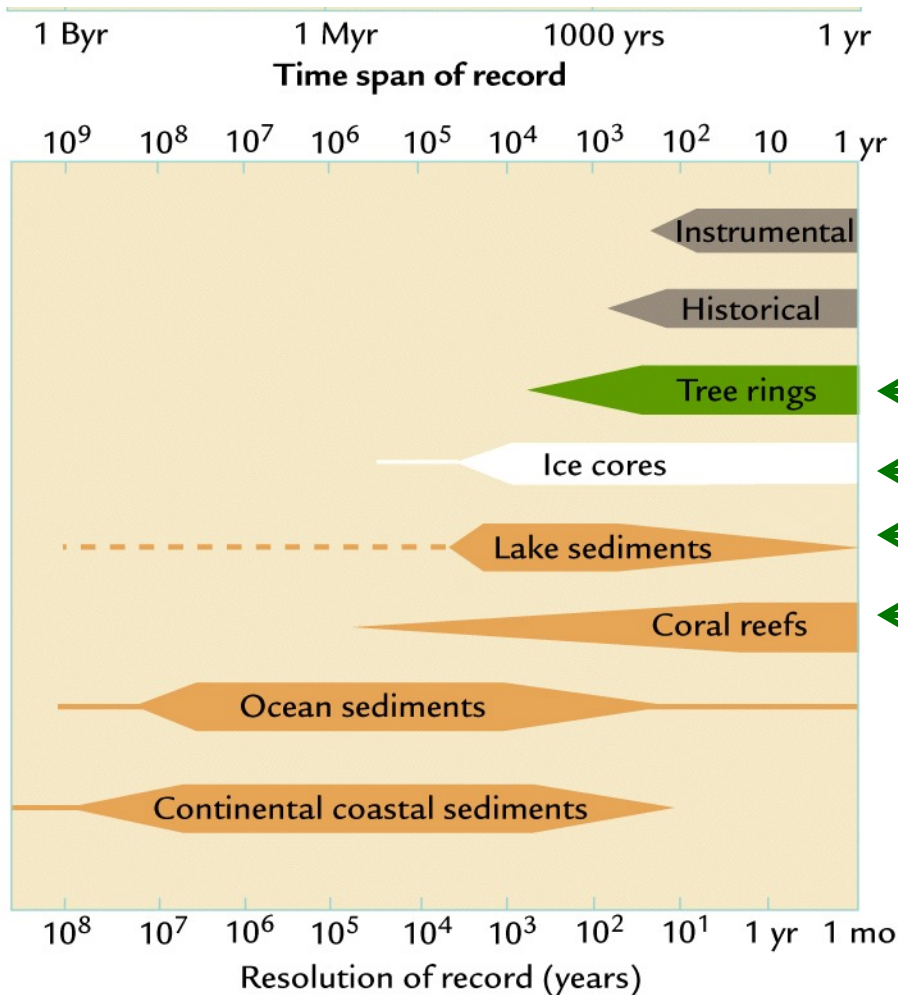


Proxy Records of Climate



- Uses of proxy records of climate depend on both
 - time span of record
 - resolution of record

Proxy Records of Climate



- Proxies that record **annual growth** patterns can indicate year to year variations in climate

← -tree rings

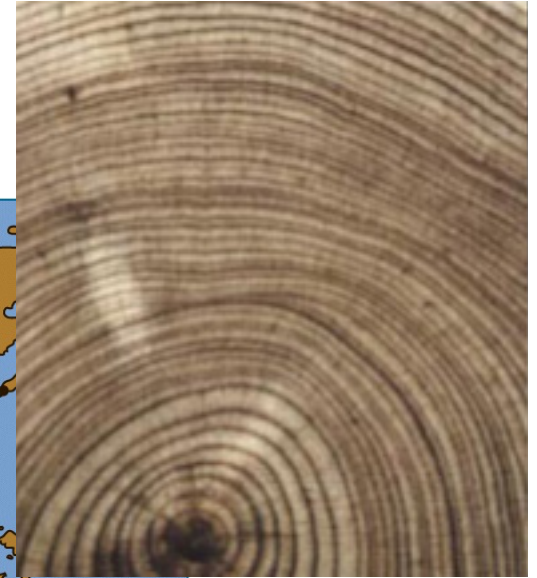
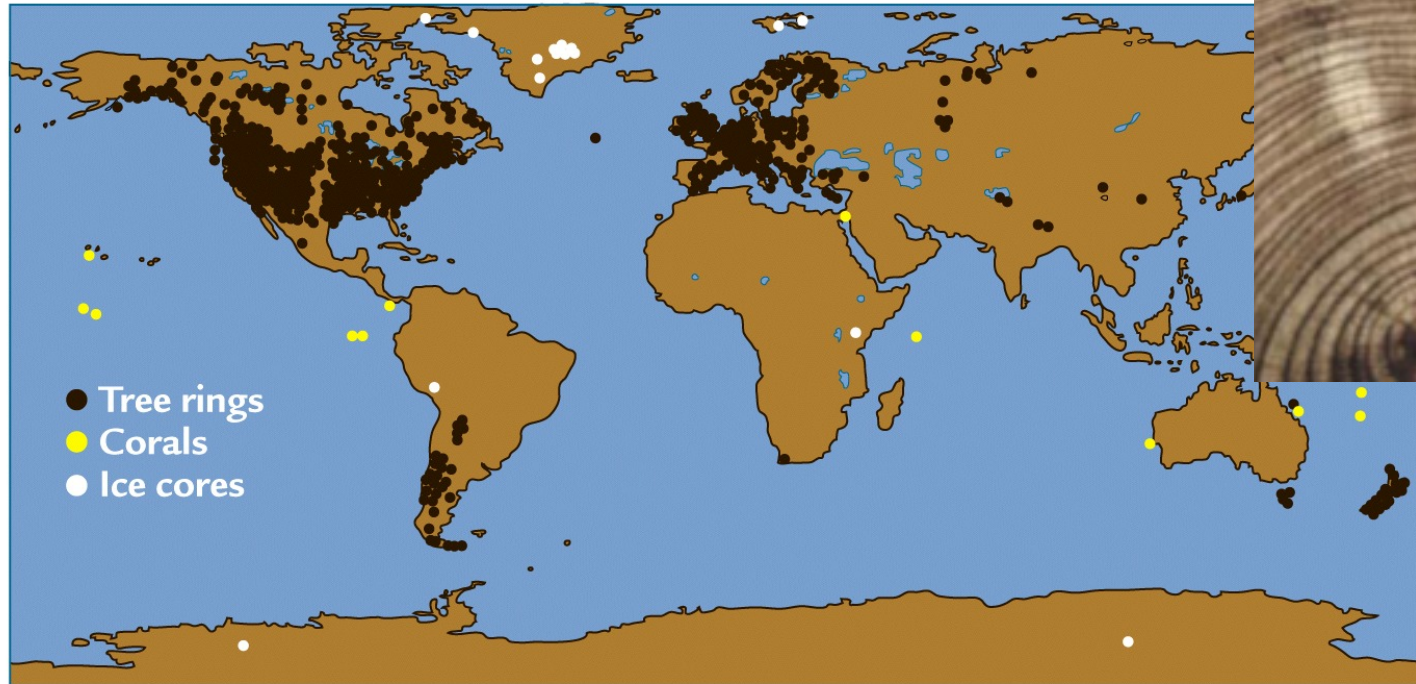
← -ice cores

← -deep lake sediments

← -coral reefs

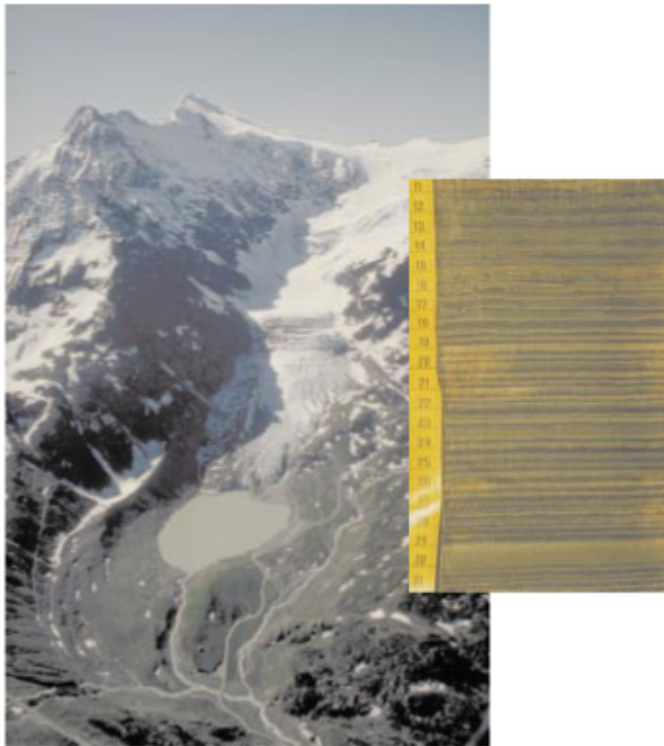
- Limited to last 500-1000 years except ice cores

Tree Rings



- Lighter, thicker wood tissue formed by rapid growth in spring and much thinner, darker layers marking cessation of growth in autumn and winter
- Limited to land areas outside of tropics
- Variations of tree ring width and density act as recorders of year to year changes in temperature and rainfall

Varved Lake Sediments



Photos: Above: Steinsee, Switzerland, A. Lotter
upper right: annually laminated sediments
from Soppensee, Switzerland, A. Lotter

- Complement tree ring records; most common in cold-temperature environments
- Occur in deeper parts of lakes that do not support bottom-dwelling organisms that would obliterate annual layers with their activity
- Layers usually result from seasonal alternation between light, mineral-rich debris and dark, organic rich material brought in by runoff – act as proxy of precipitation amount

At UT Austin

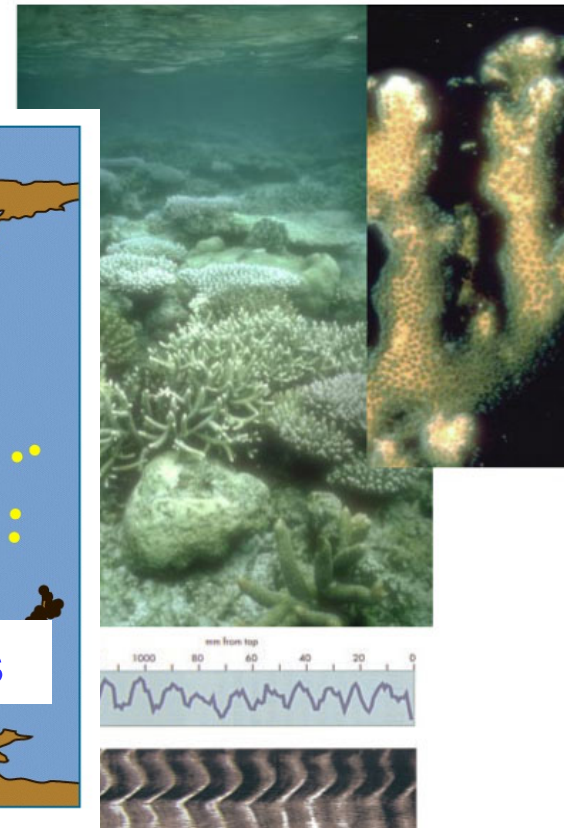


Prof. Shanahan

Varves: sediments deposited **annually** on the bottoms of lakes that freeze in winter and thaw in summer. Winter varve: fine sediments; summer varve: coarse sediments.

Varve **thickness** - length of freeze-free period - **summer temperature**.

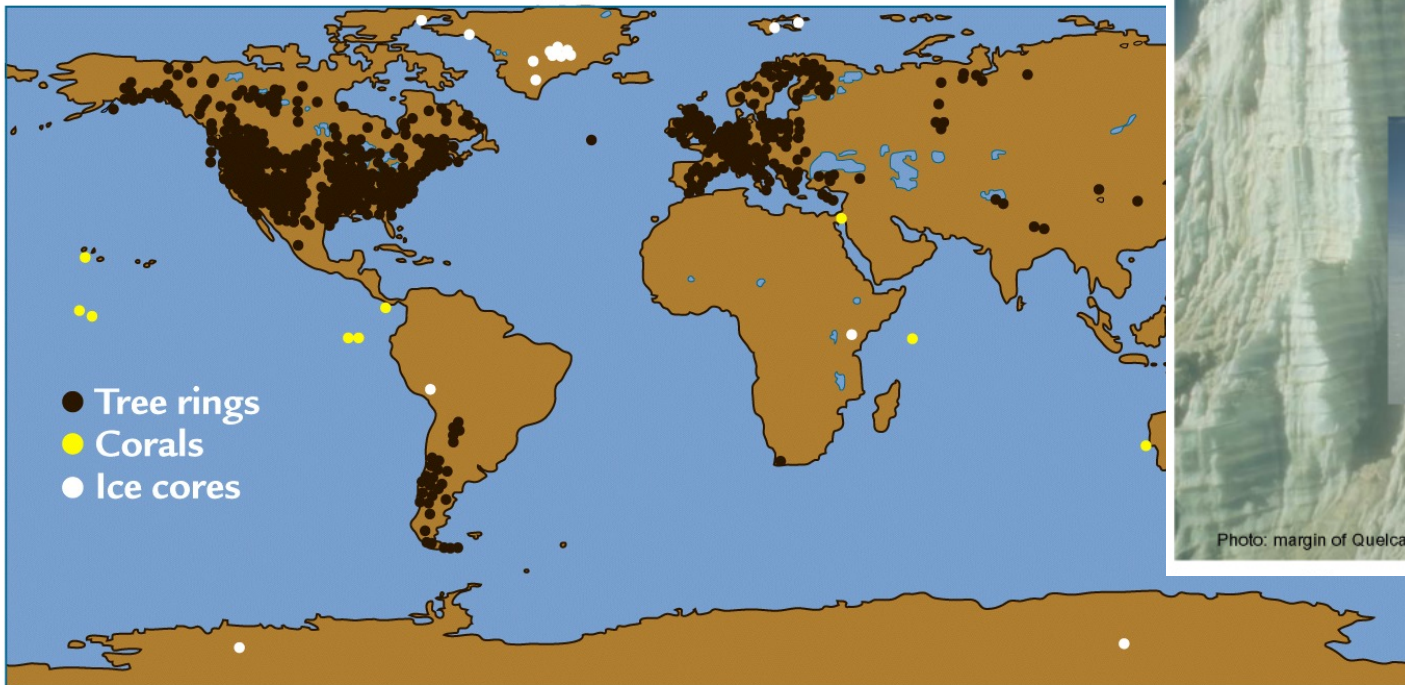
Corals



multi-celled organisms that build reefs in tropical oceans

- Texture of **calcite** (CaCO_3) incorporated **in skeletons** varies; **lighter** parts during periods of **rapid growth** in **summer** and **darker layers** during **winter**
- Measurements of oxygen-18 isotope concentration records sea surface temperature and salinity (precipitation and runoff) variations
- **Limited to tropical oceans**

Ice Cores



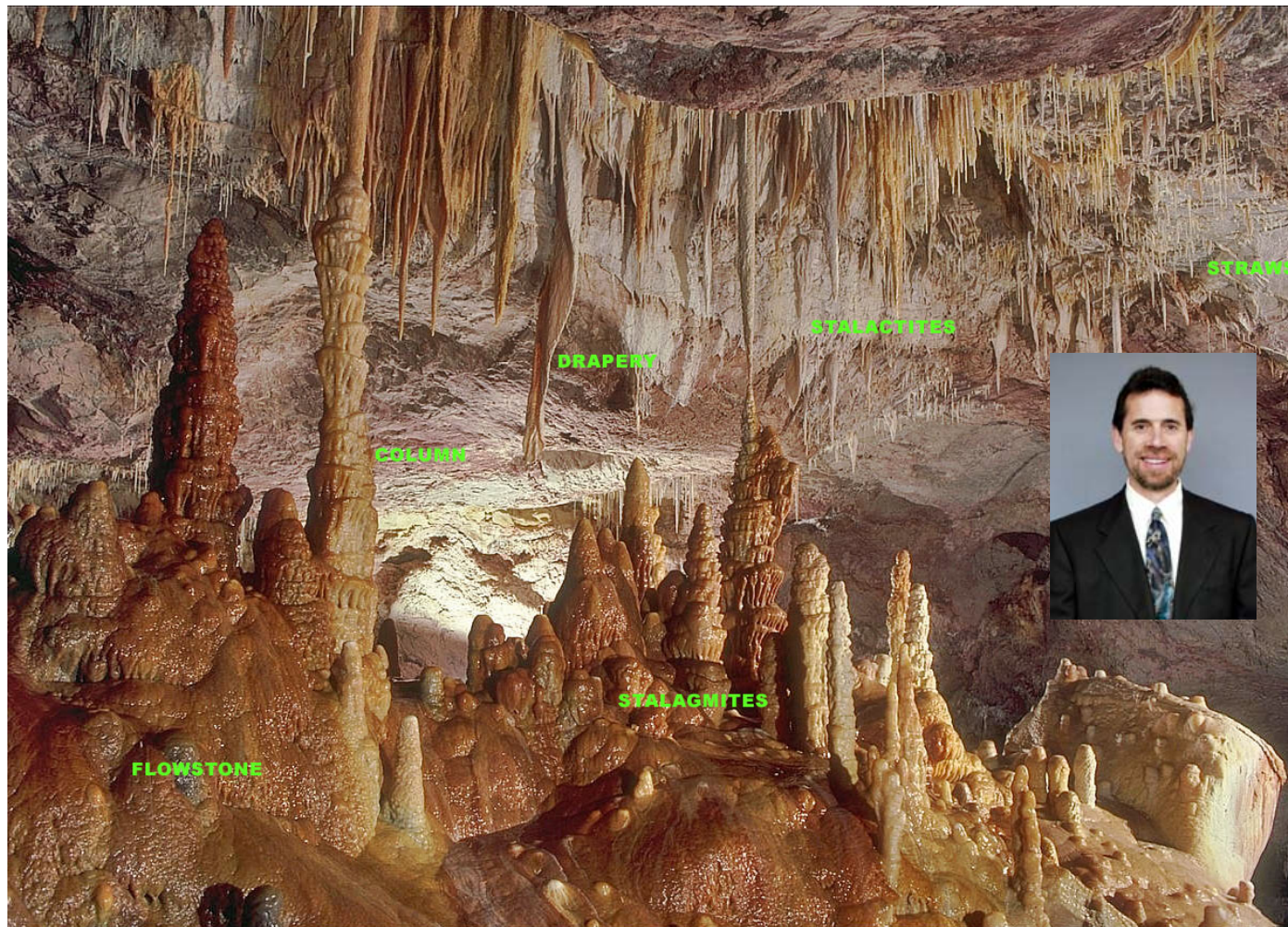
- Limited to polar latitudes and mountain glaciers
- Darker and lighter layers are more or less dust blown in seasonally
- Measurements provide information on temperature, snowfall, atmospheric composition (gases, dust, volcanic aerosols), sunspots, ...

Speleothems (cave deposits)

Mineral formations occurring in limestone caves (most commonly stalagmites & stalactites, or slab-like deposits known as flowstones)

Primarily calcium carbonate, precipitated from ground water

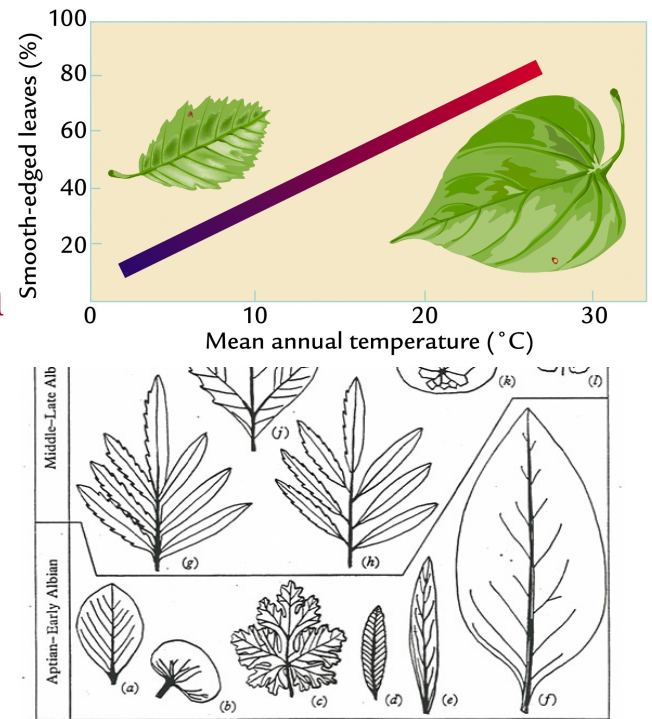
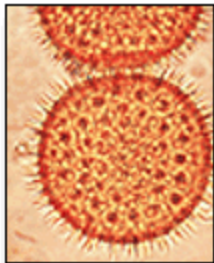
Uranium can be used to determine the age



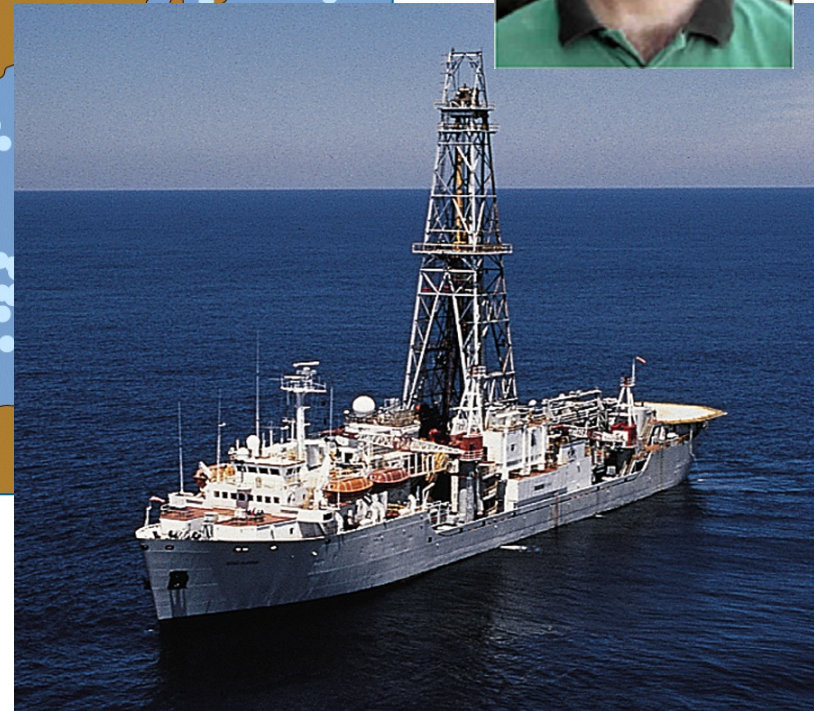
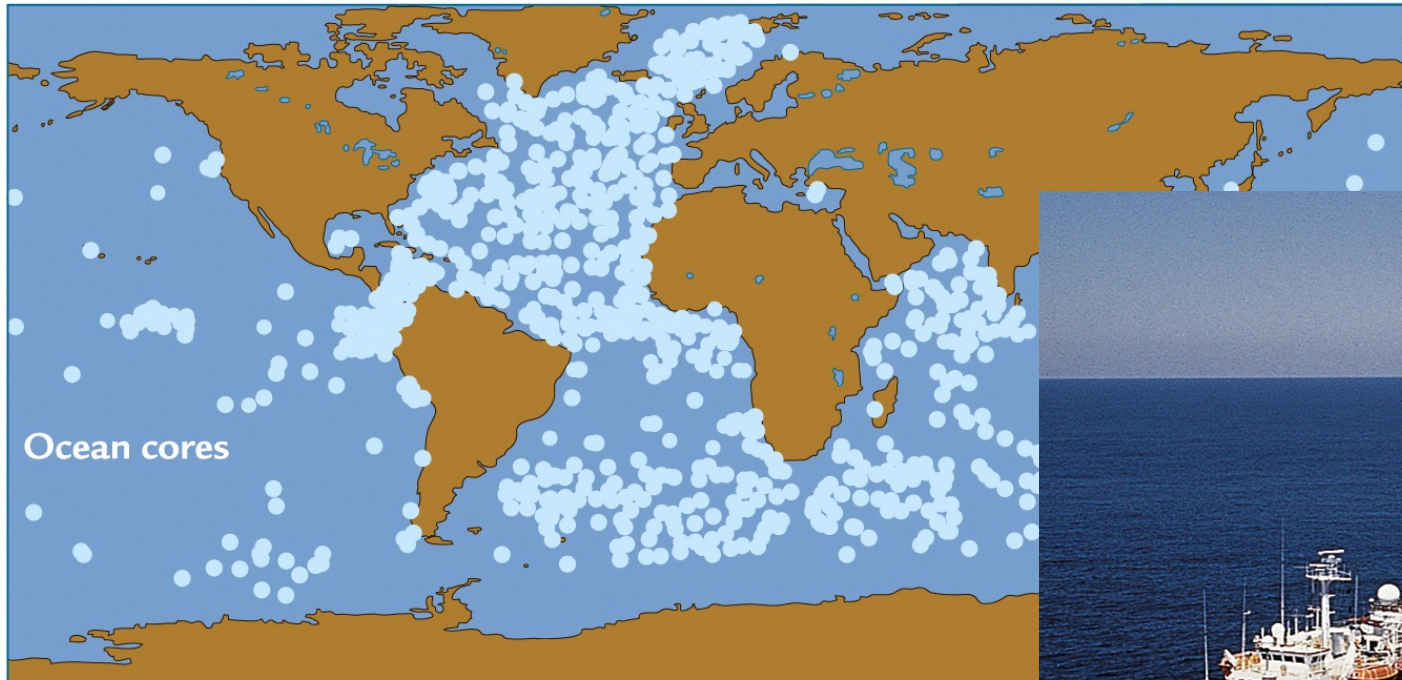
Fossils of Past Vegetation



- **Climate can be inferred from distinctive vegetation types**
- **Palm-tree like fossil in Wyoming 45 Myrs ago indicating the Cretaceous warm climate**
- **Climate can be inferred from leaf size and shape.**
- **Climate can be inferred from pollen in sediments: All flowering plants produce pollen grains with distinctive shapes.**

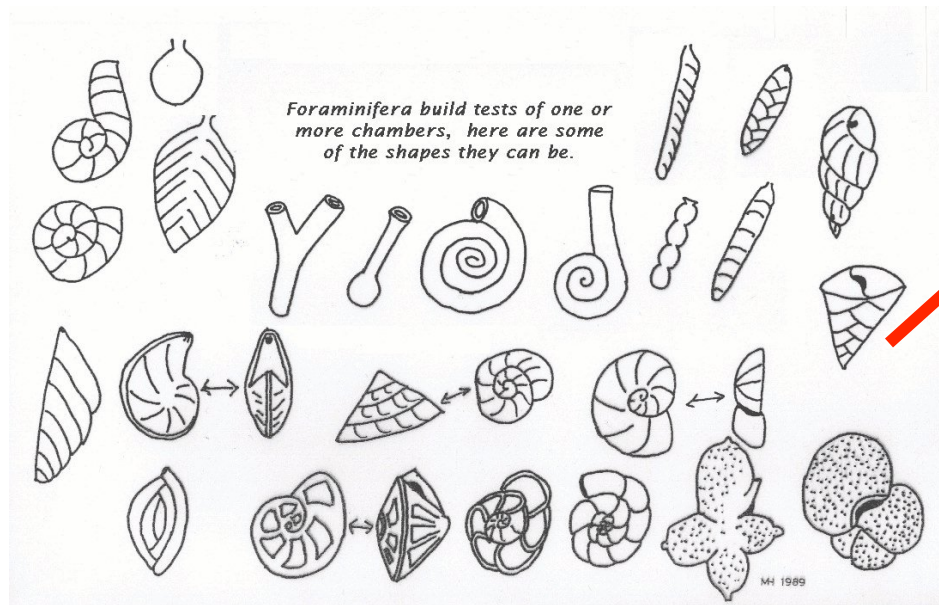


Marine Sediments



- Long cores drilled by specially equipped ships
- Dating only accurate to about 40,000 years ago and can resolve climate changes that occur on century scale or longer

Marine Sediments



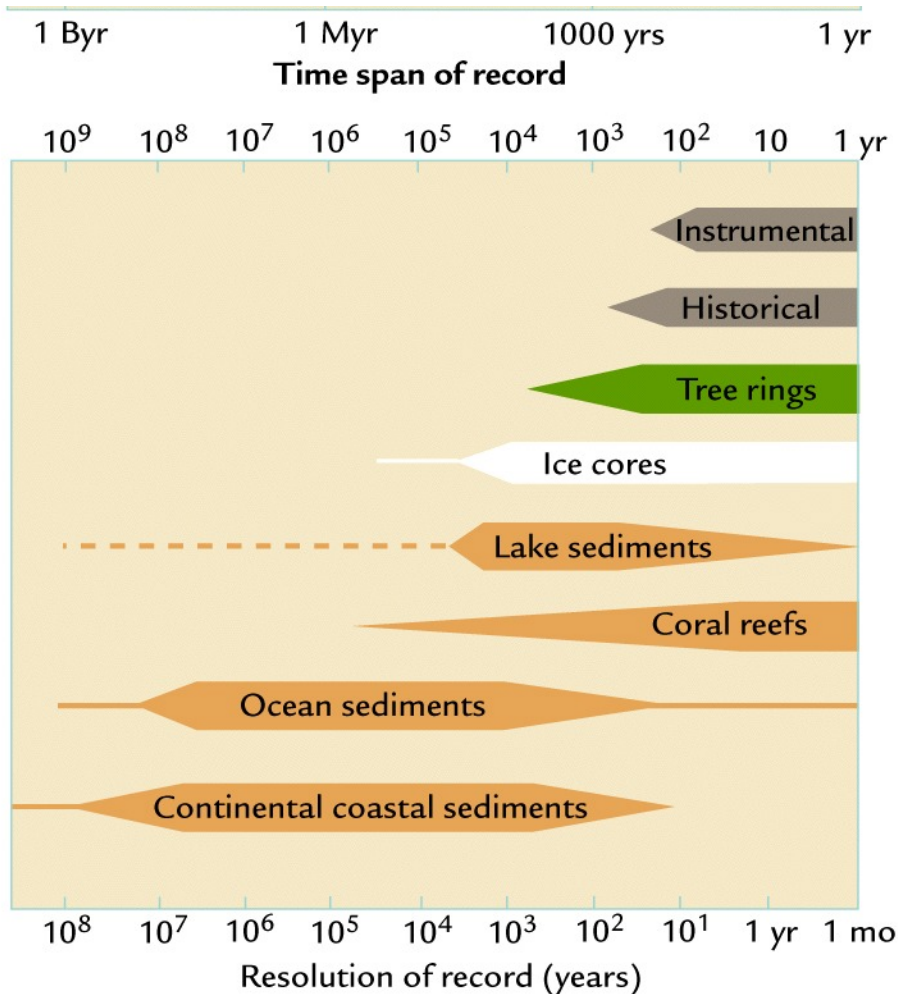
- Isotopes in shells of **foraminifera** can reveal temperature, salinity, and ice volume



- **Granular debris** from land can indicate **icebergs** breaking off of continental ice sheets, suggesting cold climates



Proxy Records of Climate



- Recent times: instrumental

- More recent times: historical, **tree rings**, ice cores

- Proxies for more ancient climates are found in sediments or inferred from fossils and land forms

- Can generally only resolve changes that occur over 100 years or greater