



Last Glacial Maximum

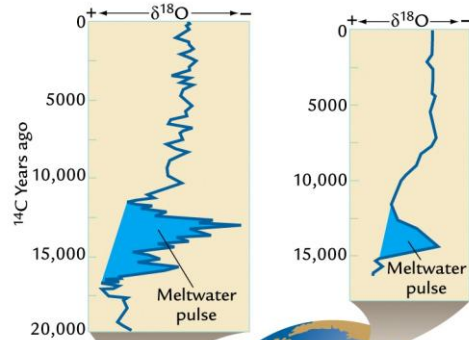


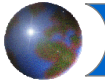
(d) Severe Dry Lake



Deglaciation

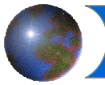
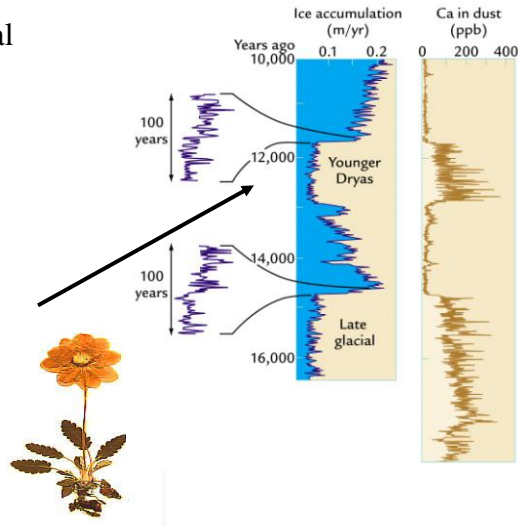
- Meltwater pulses...
 - ▣ Several different ones interrupt steady retreat of ice sheets





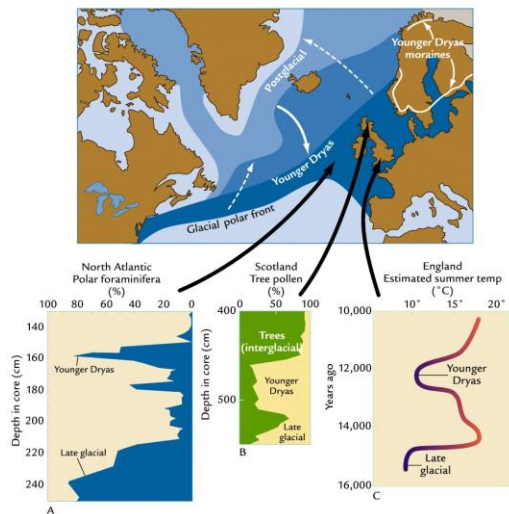
Younger Dryas

- ~3,000 year return to glacial conditions in midst of deglaciation
- “Younger Dryas”
 - 15-12,000 years ago
 - Pollen of dryas returns to Europe
 - Scary part: transitions very sudden, within a decade!!!



Younger Dryas

- Think caused by movement in polar front.
 - Front: area between two air masses
 - Was S of England during glacial, shifts N during interglacial.
 - During YD, it reverted...

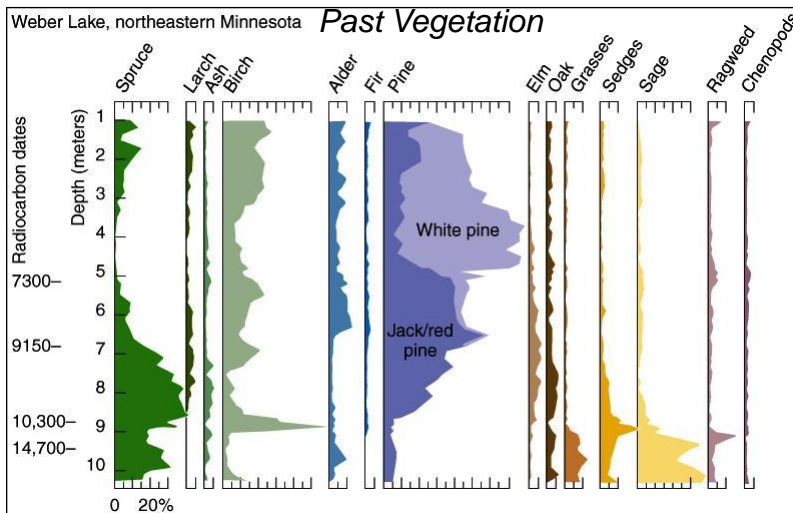
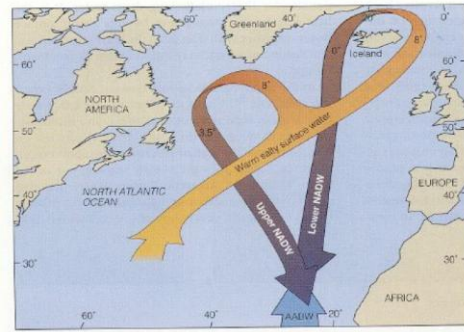




Thermohaline Circulation

Wally's hypothesis:

- ❑ Cut off NADW = return to glacial conditions
- ❑ Must suddenly change input into North Atlantic...
- ❑ What could happen???

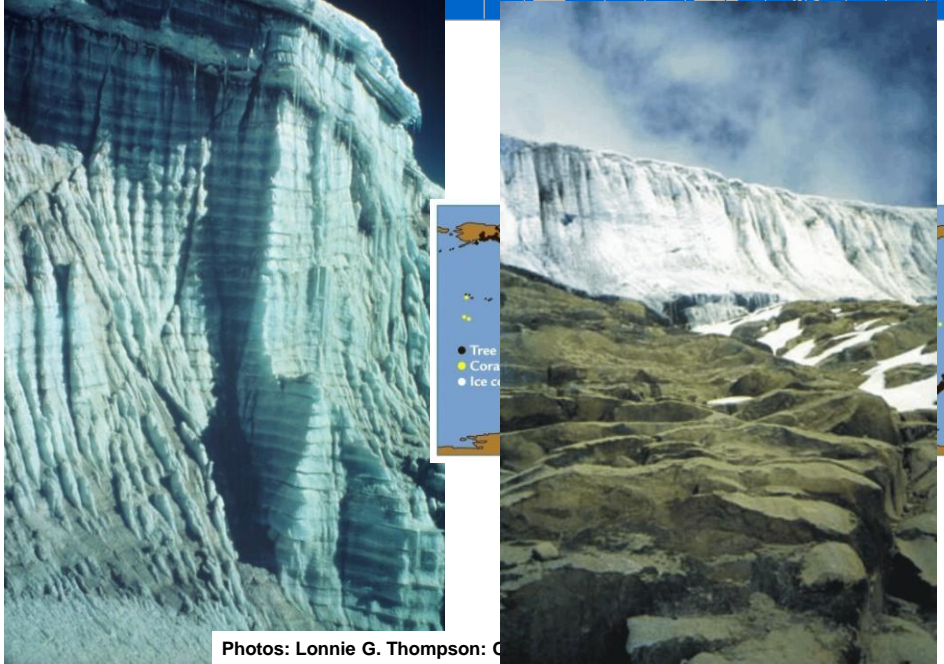


Pollen diagrams provide information on past vegetation at a site, which is useful for determining past climates.

1977

Quelccaya Ice Cap, Peru

2002



Photos: Lonnie G. Thompson; C

Quelccaya Ice Cap, 2002

200 – 400 m
above its
modern range



Cushion
Plant

Photos: Lonnie G. Thompson
Ohio State University



Distichia muscoides

Quelccaya Plant Modern
5177 ± 45 yr. B.P.

Radiocarbon dates of plants from base of Quelccaya Ice Cap

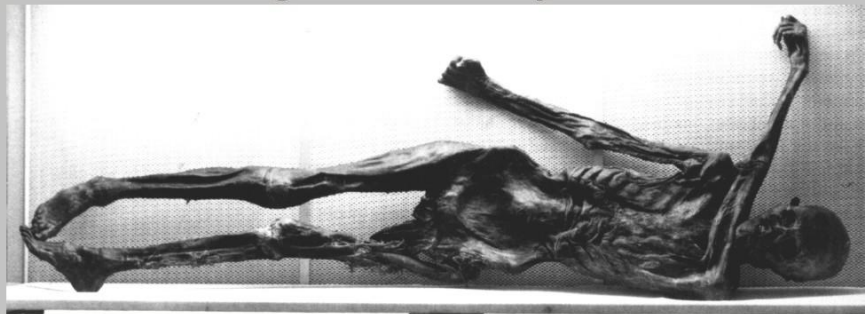
	¹⁴ C age	Error (+/-)	Calibrated age (Before 1950 A.D.)	Relative area under probability distribution
Lawrence Livermore National Laboratory				
Sample 1 First run	4470	60	5284-5161 (1σ) 5302-4961 (2σ)	.534 .926
Sample 1 Second run	4525	40	5186-5121 (1σ) 5311-5047 (2σ)	.413 1.000
Sample 2 First run	4530	45	5186-5120 (1σ) 5317-5040 (2σ)	.396 .993
Sample 2 Second run	4465	40	5278-5171 (1σ) 5295-4967 (2σ)	.580 .984
National Ocean Sciences AMS Facility at Woods Hole Oceanographic Institution				
Sample 1	4530	45	5186-5120 (1σ) 5317-5040 (2σ)	.396 .993
Sample 2	4510	40	5188-5119 (1σ) 5307-5040 (2σ)	.404 .988

Unpublished data:
Courtesy of the
Thompsons
at Ohio State
University; for
educational use only;
Plant identification
by Don Les (U Conn)
and Blanca Leon
(UT Austin)



"The Tyrolean Iceman" - "Ötzi" "Man from the Hauslabjoch"

Age 5175 ± 125 years



Source: <http://info.uibk.ac.at/c/c5/c552/Forschung/Iceman/iceman-en.html#Finding>



“Drought Events”

- Now looking for more evidence of that shift in climate 5000 years ago...
- Kind of show both linear & cyclic trend depending on which examined...
- Very messy picture, especially on regional scale.

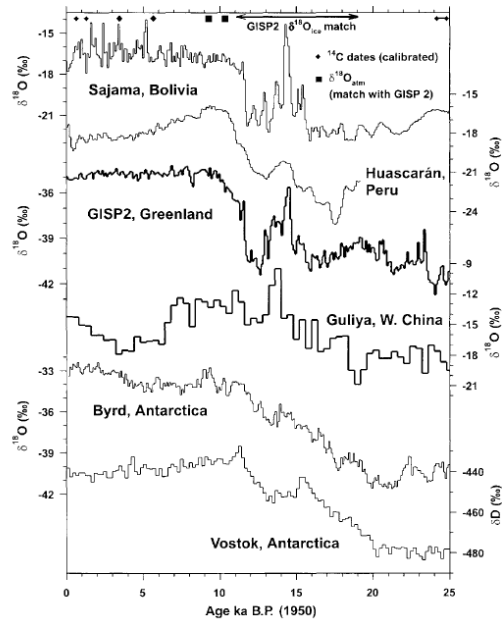
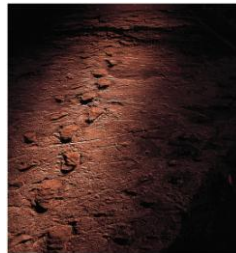


Figure 4. The $\delta^{18}\text{O}_{\text{ice}}$ histories for the last 25,000 years for six cores from the tropics to the poles show similar isotopic depletion (~ 5 to 7%) in the Late Glacial Stage ice relative to Holocene ice.



Anthropocene

- Term used for climate where humans are the dominate controlling mechanism...

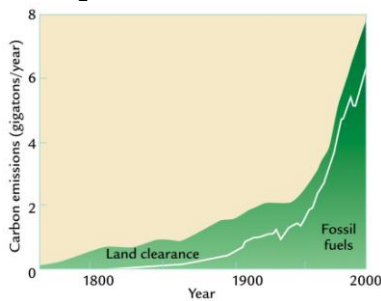




Clearing of Land

Deforestation:

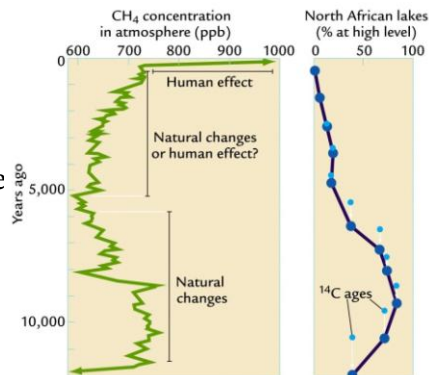
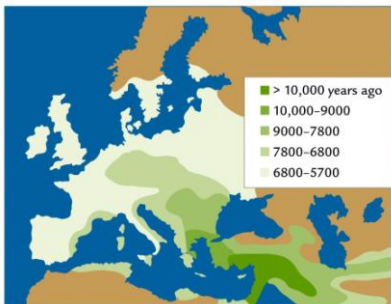
- Since 8000 years ago in Europe...
- Sagan proposed in 1970s
- Ruddiman proposes change in CO₂ since then



Effects of Agriculture

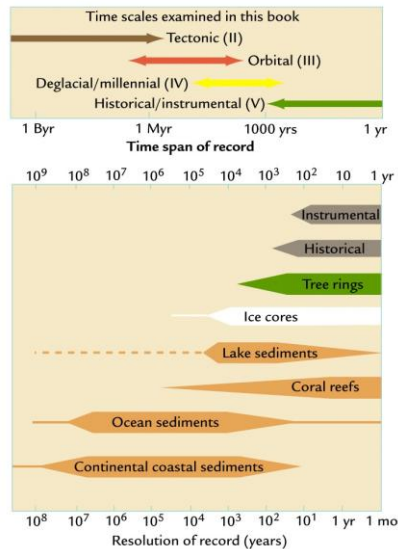
Agriculture:

- First arose in fertile crescent & Yellow River Valley in China...
- Unexplained rise in methane
- Ruddiman credits irrigation of rice





Time scales for Proxy Data



Take Home

- Proxy data is very important to our understanding of climate.
- We are improving our ability to read these signals and what they tell us about the Earth's past.
- They are revealing a complicated but fascinating story about our Earth's climatic evolution.
- We still have a great deal to learn.



Climate of the Last 2000 Years...

- Coming next Tuesday...



Additional Courses

- GEOS 108N – Climate Change: Past&Future
- GEOG 322N – Weather & Climate
- GEOS 382 – Global Change
- FOR 407 – Biogeochemistry
- GEOG 550 – Seminar in Paleoclimate &
Global Change

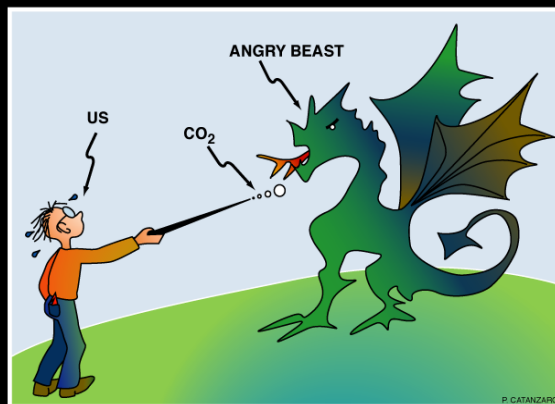


Resources

- W. Ruddiman. *Earth's Climate: Past and Future*. 2008. W.H. Freeman.
- E.C. Pielou. *After the Ice Age: The Return of Life to Glaciated North America*. 1992. University of Chicago Press.
- Broecker & Kunzig. *Fixing Climate*. 2008. Hill & Wang.



FOSSIL FUEL CO₂ AND THE ANGRY CLIMATE BEAST



W.S. BROECKER