Climate Archives, Proxies, Models Outline

Climate Archives

types of archives
- sediments (lakes, continental shelves, deep marine, moraines, loess, etc.)
- glacial ice
- tree rings
- cave deposits
- coral
- historical records
- instrumental record

Dating Climate Records

radiometric dating
- unstable parent atoms decay into stable daughter products
- count ratio of remaining unstable parent atoms to stable daughter atoms
- ^{238}U, ^{235}U, K-Ar dating crystallization ages, hundreds of millions to billions of years
- ^{230}Th dating for corals within the past few hundred thousand years
- ^{14}C dating for organic carbon produced within the past 50,000 years

counting annual layers in
- tree rings
- coral
- varves (annual sediment layers) in glacial lake and ocean sediments
- annual snow/ice layers

cyclic sedimentation modulated by orbital cycles

age resolution
- rate of deposition vs. depth of disturbance (bioturbation)

Climate Proxies

biotic proxies
- terrestrial plant fossils
- pollen
- marine microfossils
  - calcareous - foraminifera (“animal”) & coccoliths (algae)
  - siliceous - radiolaria (“animal”) & diatoms (algae)

geologic proxies
- ice-rafted, aeolian, fluvial sediments preserved in marine sediments
- determination of sources of sediments by mineral and chemical means

geochemical proxies

- chemical weathering - dissolution & hydrolysis yields dissolved ions
- deposition of chemical seds indicates changing fluxes of Ca, Si, C, O
- O, C, and other isotopes in marine seds indicate changing climate
- concentration of CO_2 & CH_4 in glacial ice
- changes in annual snow layer thickness
- changes in windblown dust in ice layers
- cave deposits, lake sediments, coral bands indicate changes in chemistry
- tree ring widths indicate changing temperature and precipitation

Climate Models

numerical models (run on computer for speed)
1d (vertical), 2d (vertical & equator to pole), 3d
3-d atmospheric General Circulation Models, A-GCMs
Ocean General Circulation Models, O-GCMs
Coupled General Circulation Models
other models: ice sheet models, vegetation models, geochemical tracer models
specify equations of state describing flow the flow of heat and energy
specify grid geographic size

- the smaller they are the better the results
- but the more calculations must be done and the longer one model run takes and more expensive it is
- it is not possible with today's most powerful supercomputers to run a model with an ideally small grid spacing
- but the best models can now give a good approximation of modern and and ancient climates
- giving us faith in the general results of climate model projections for the future

specify initial conditions (temp, pressure, humidity, wind, atmos comp, etc.)
model takes a long "spin-up" period before reaching equilibrium
control case: run model with modern conditions to see if model reasonably reproduces modern climate; if not, improve model
experimental case: change one or more conditions (insolation, CO_2) & run model

- analyze the climate data output to see how the simulated climate changes
- compare with geologic data to see if simulated climate is reasonable