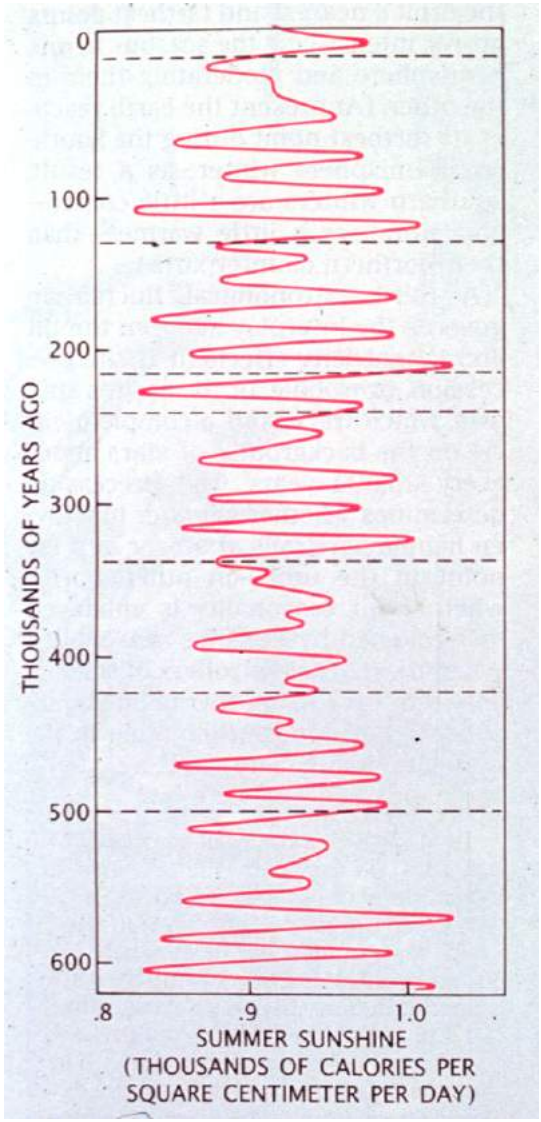
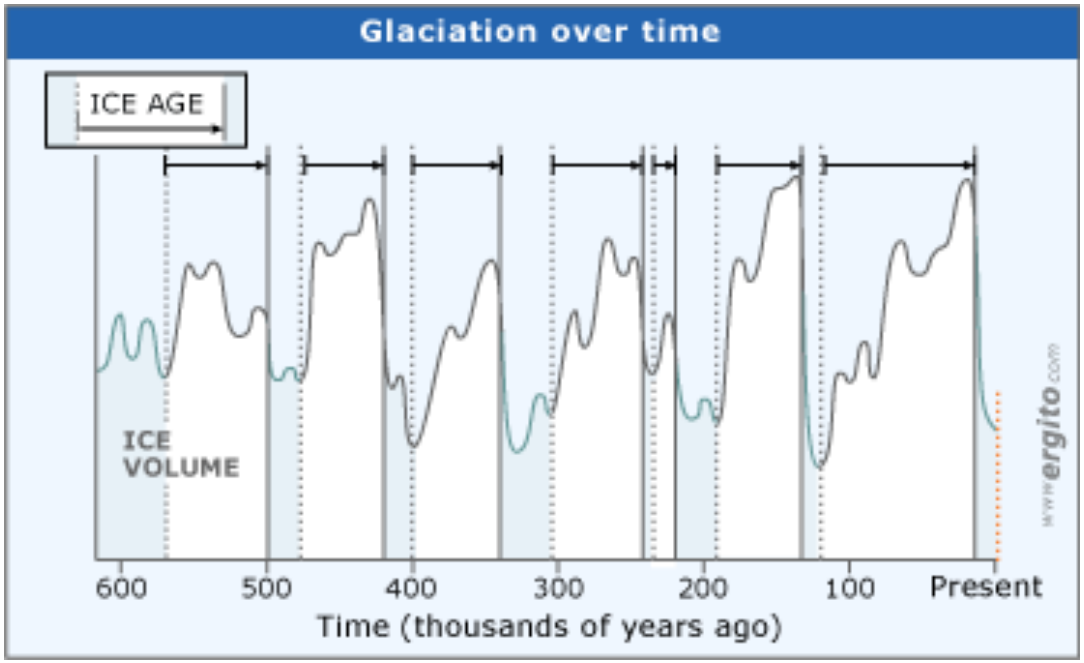
Pleistocene - the Ice Ages

Evidence for Pleistocene glaciation cycles?



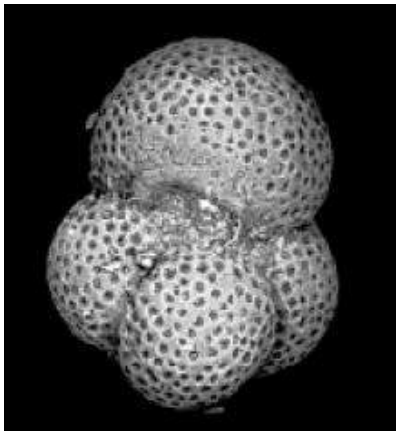
- A number of "paleothermometers" indicate that these ice ages occurred on a cycle about 100,000 +/- years



Pleistocene - the Ice Ages

Paleothermometers - telling temperature back in time

Foraminifera - zooplankton of marine water
- produce outer hard coverings of $CaCO_3$



Foraminifera ("forams")

The **oxygen** in calcium carbonate comes in two basic isotopes from H_2O:

^{16}O - typical, lighter form

^{18}O - rare (0.2%), heavier form

$^{18}O/^{16}O$ ratio is important in $CaCO_3$ sample

when $\delta^{18}O$ is big, the ratio is large and the sample is **heavy**

when $\delta^{18}O$ is small, the ratio is small and the sample is **light**

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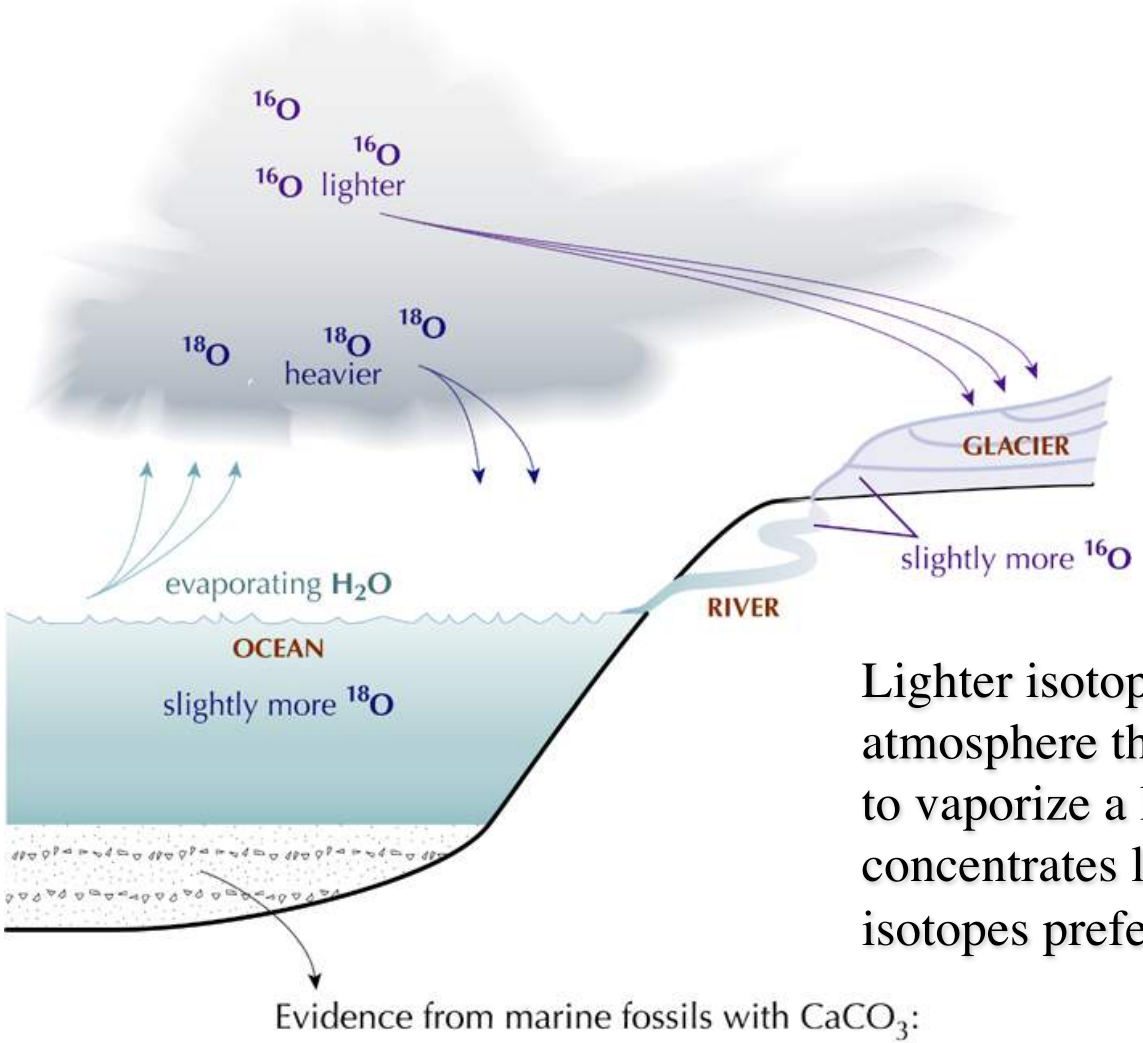
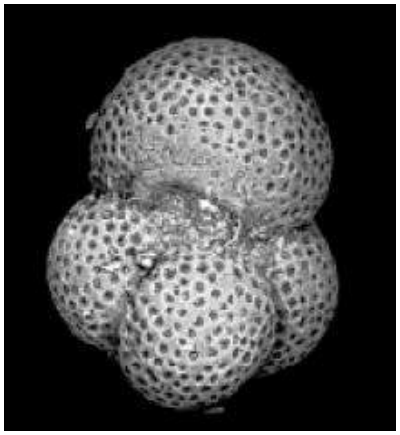
Paleothermometers- telling temperature back in time





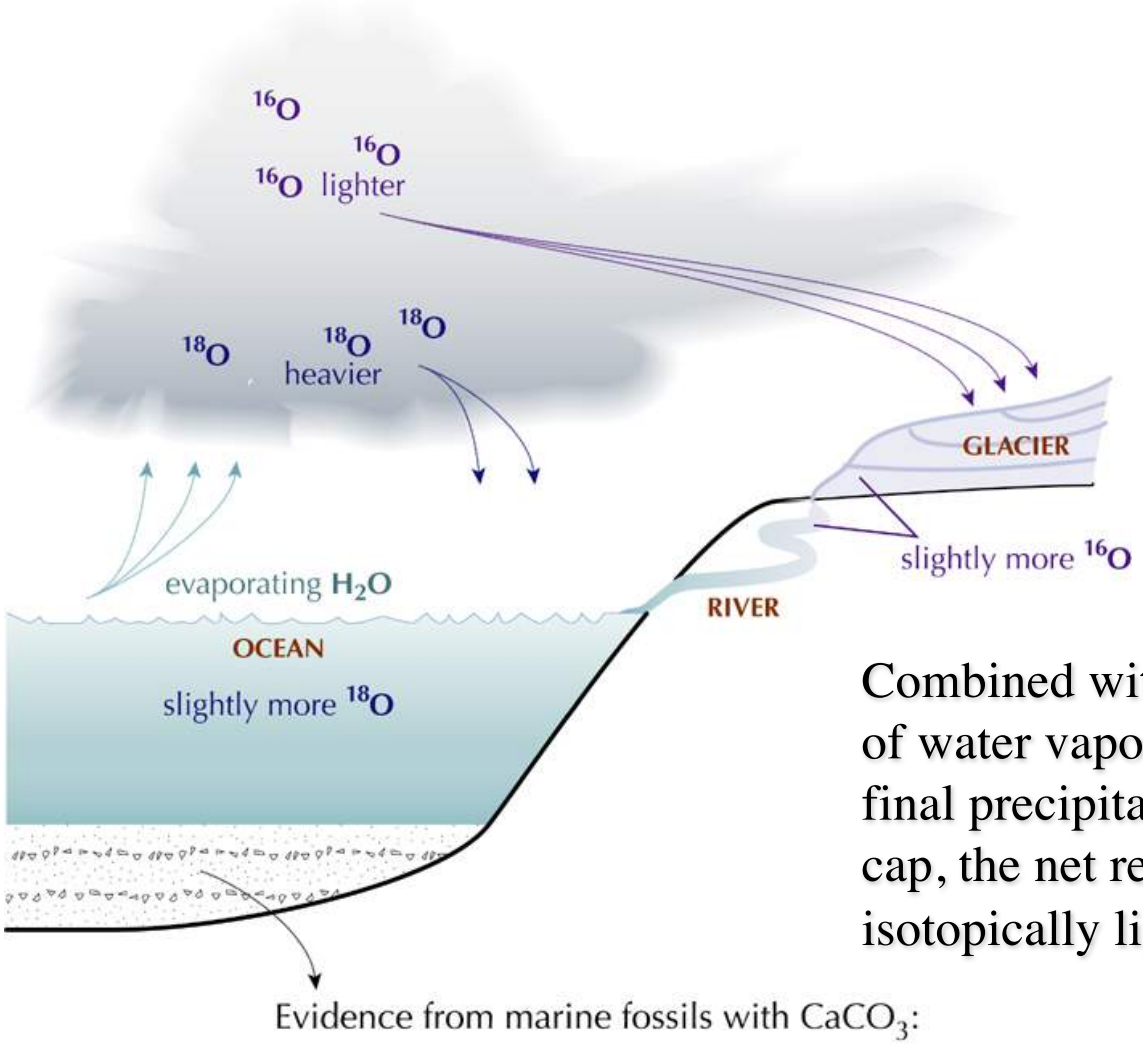
Foraminifera ("forams")

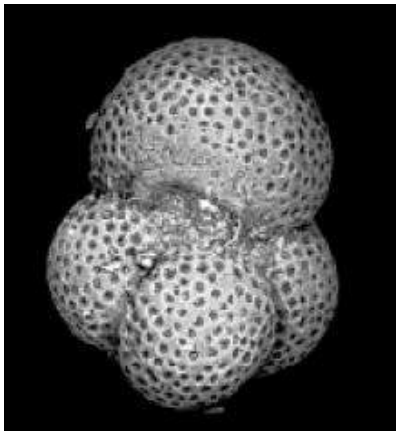
Lighter isotopes become concentrated in the atmosphere through evaporation - it is easier to vaporize a light molecule. Rain further concentrates lighter isotopes because heavier isotopes preferentially precipitate.

Evidence from marine fossils with $CaCO_3$:

Pleistocene - the Ice Ages

Paleothermometers- telling temperature back in time





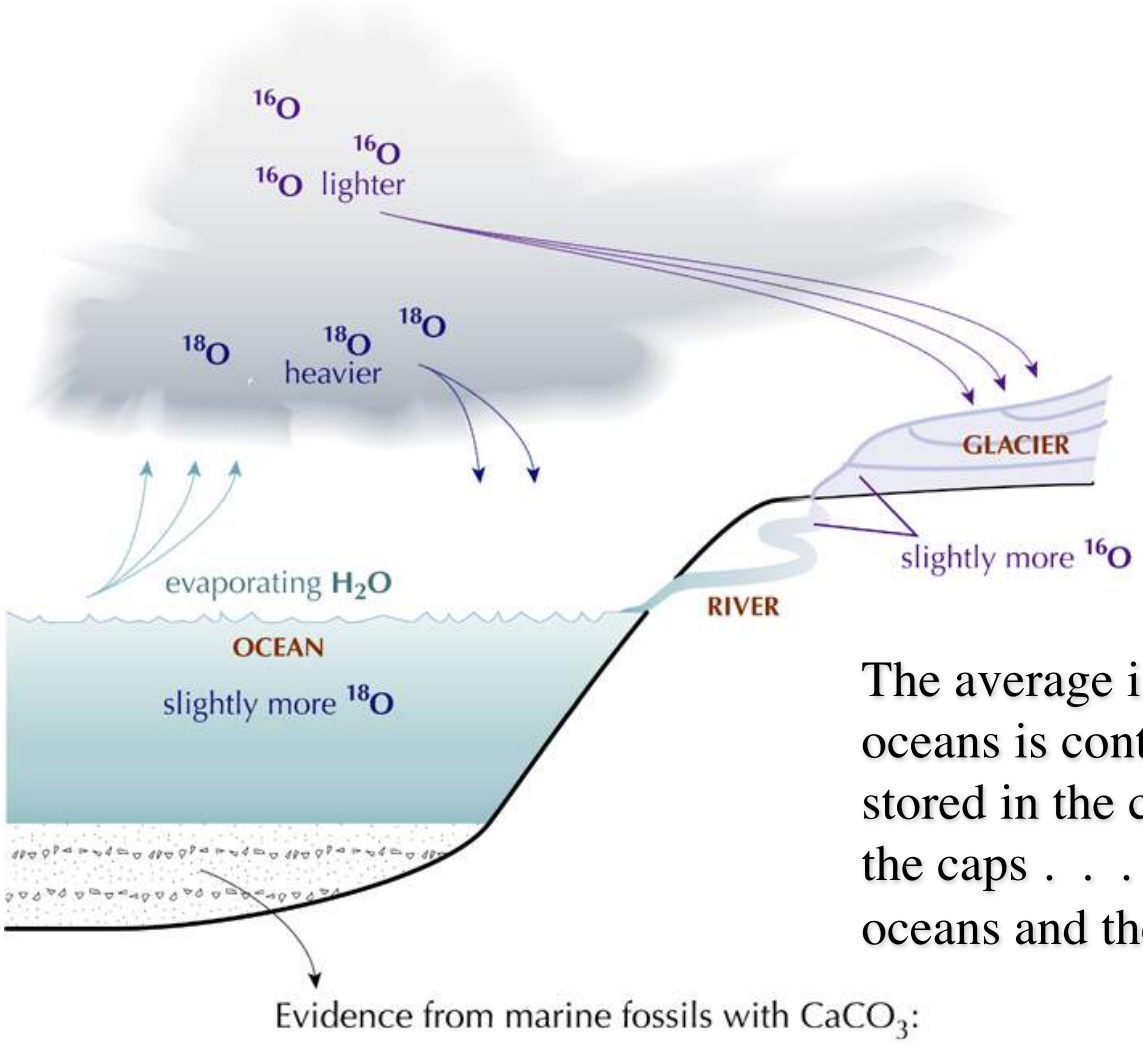
Foraminifera ("forams")

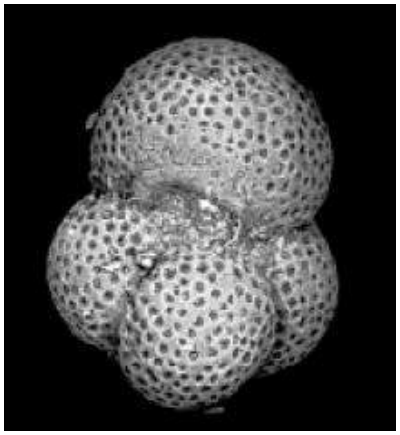
Combined with the net poleward movement of water vapor in the atmosphere, and the final precipitation of water vapor into the ice cap, the net result is that the ice caps are isotopically lighter than the oceans.

Evidence from marine fossils with $CaCO_3$:

Pleistocene - the Ice Ages

Paleothermometers- telling temperature back in time



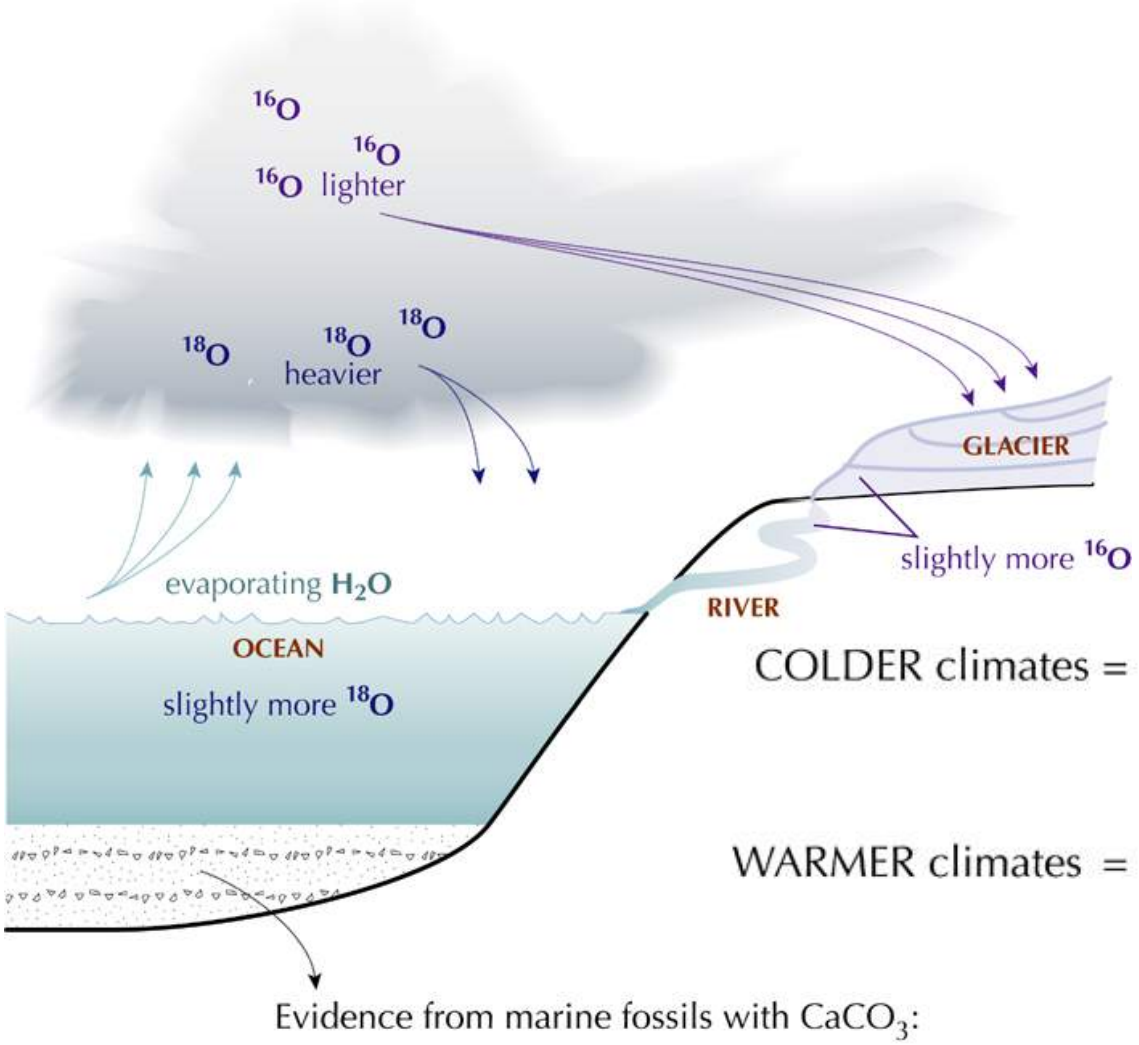


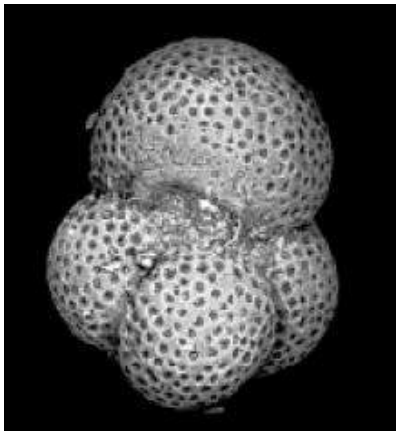
Foraminifera ("forams")

The average isotopic composition of the oceans is controlled by how much ice is stored in the caps. The more ice stored in the caps . . . the isotopically heavier the oceans and the Foraminifera become.

Pleistocene - the Ice Ages

Paleothermometers- telling temperature back in time





Foraminifera ("forams")

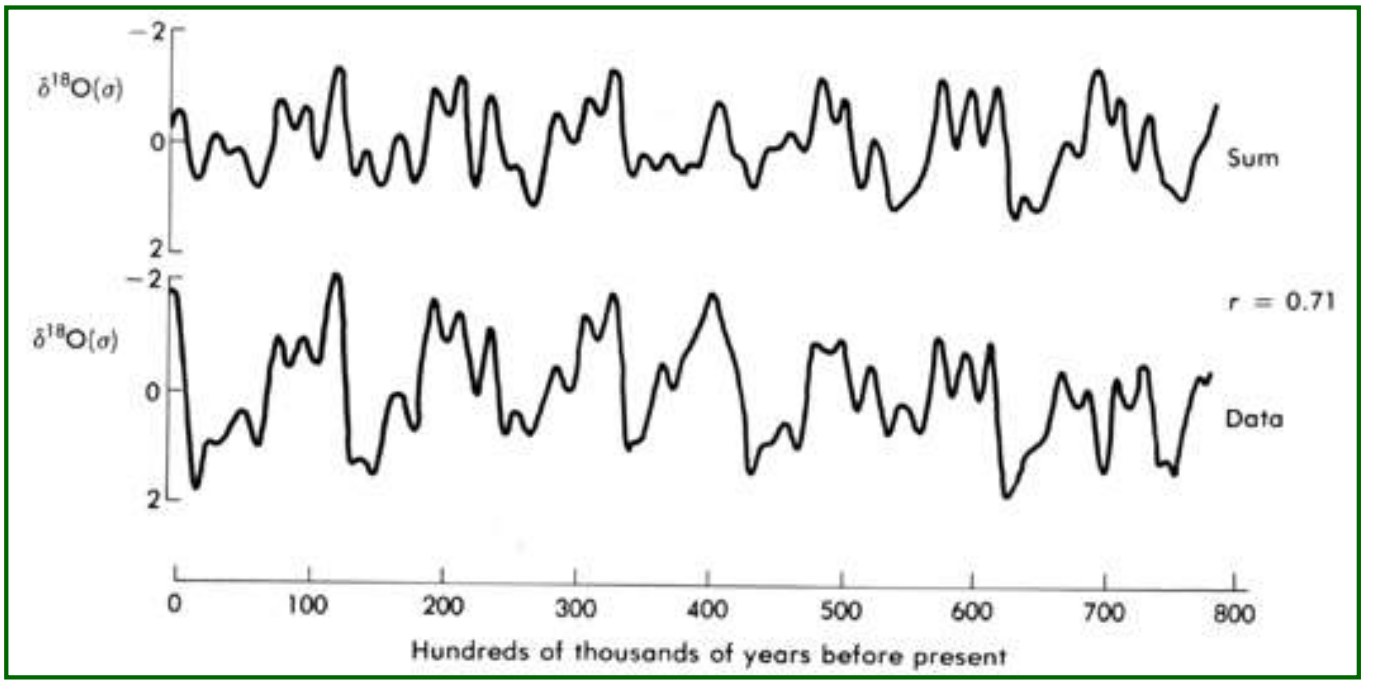
COLDER climates =
- more H_2O locked up in glaciers
- oceans (and marine fossils) show *higher* $^{18}O/^{16}O$ ratios

WARMER climates =
- more H_2O flows from land to sea to *lower* $^{18}O/^{16}O$ ratios in oceans and marine fossils

Pleistocene - the Ice Ages

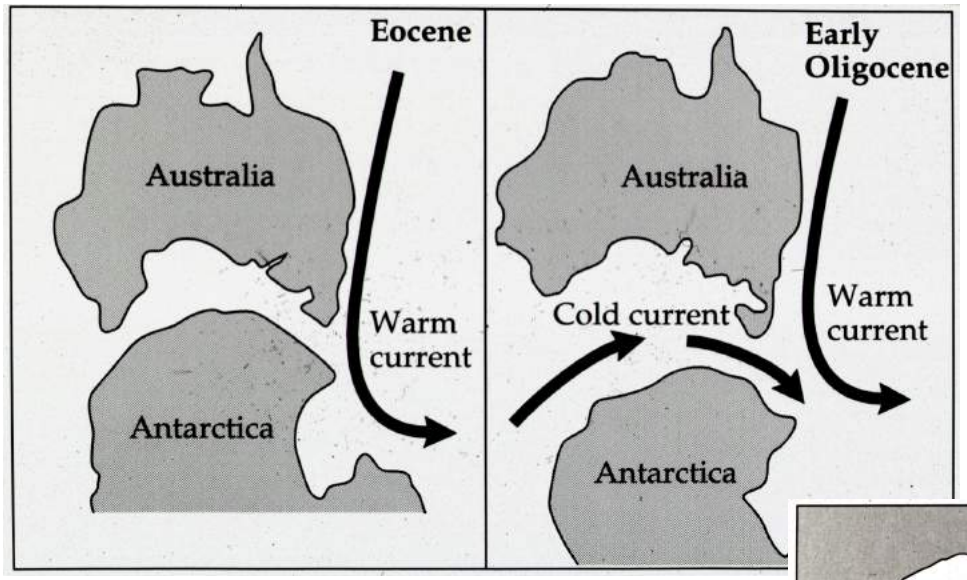
Evidence for Pleistocene glaciation cycles?

- including ocean temperatures using $^{18}O/^{16}O$
- rise/fall of fossil corals in Bahamas
- CO^2 concentration in atmosphere
- stomate density on Pine needles

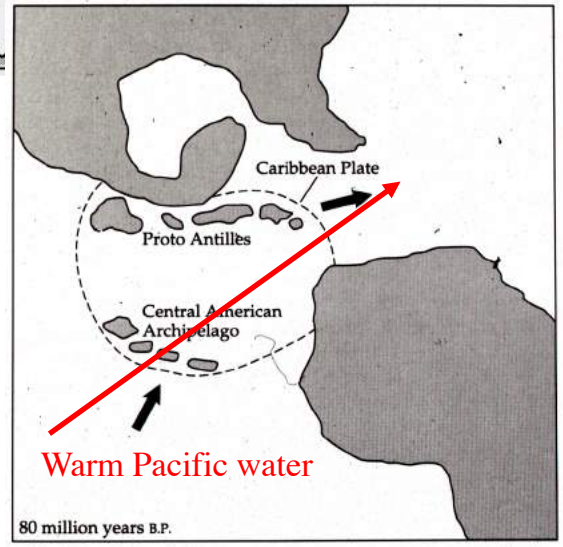


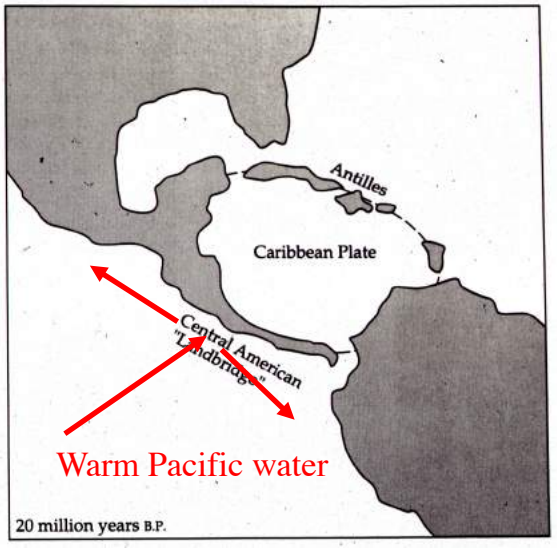
Pleistocene - the Ice Ages

Why did Pleistocene glaciation occur?



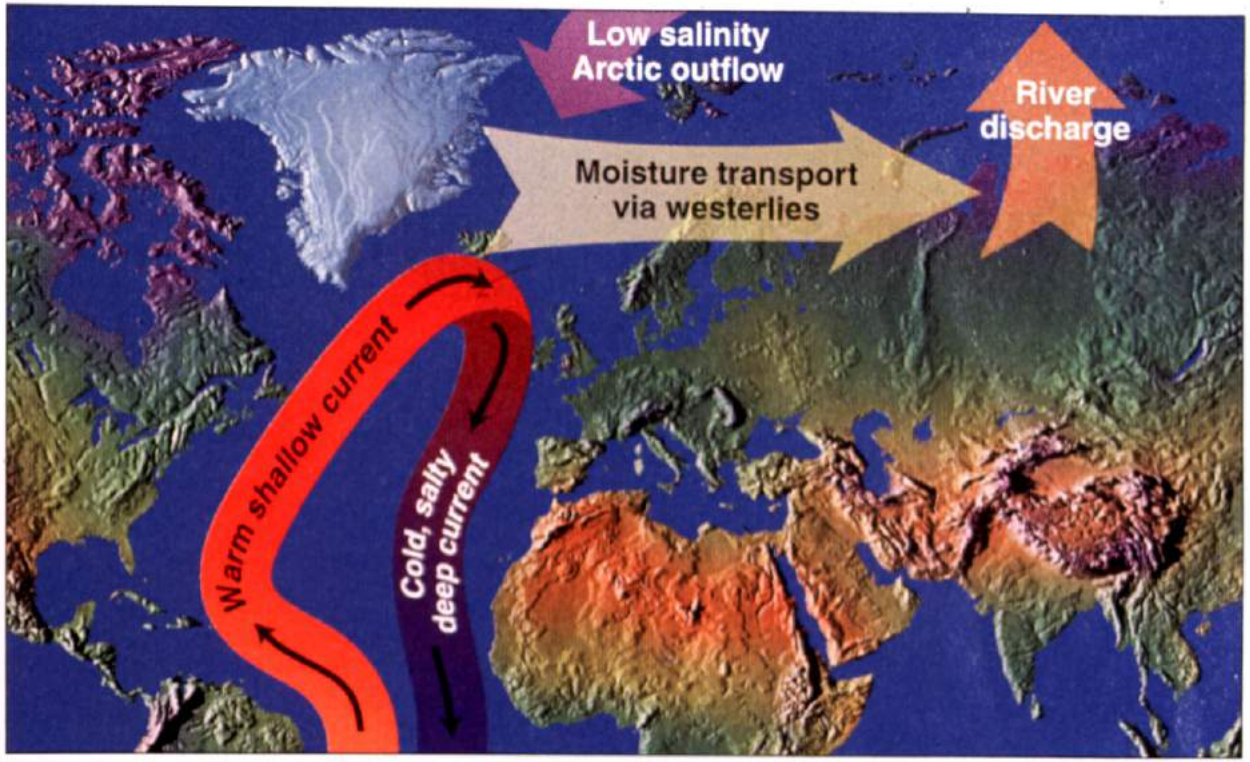
1. Continental movements bringing cold water into Atlantic or stopping flow of warm water into Atlantic





Pleistocene - the Ice Ages

Why did Pleistocene glaciation occur?



1. Continental movements bringing cold water into Atlantic or stopping flow of warm water into Atlantic

and disruption of the warm shallow "salt" current (not surface current) that brings extra heat to North Atlantic

2. Albedo effect - once continental glaciers form, the reflectance of sunlight off white glacial ice further decreases heat budget of north Atlanic

Pleistocene - the Ice Ages

Why did Pleistocene glaciation occur?

3. Milankovitch cycles:

a. Ellipticity cycle - 105,000 y
b. Tilt cycle - 41,000 y
c. Axis wobble - 26,000 y

Importance is the synchrony or asynchrony of the cycles (especially first two)