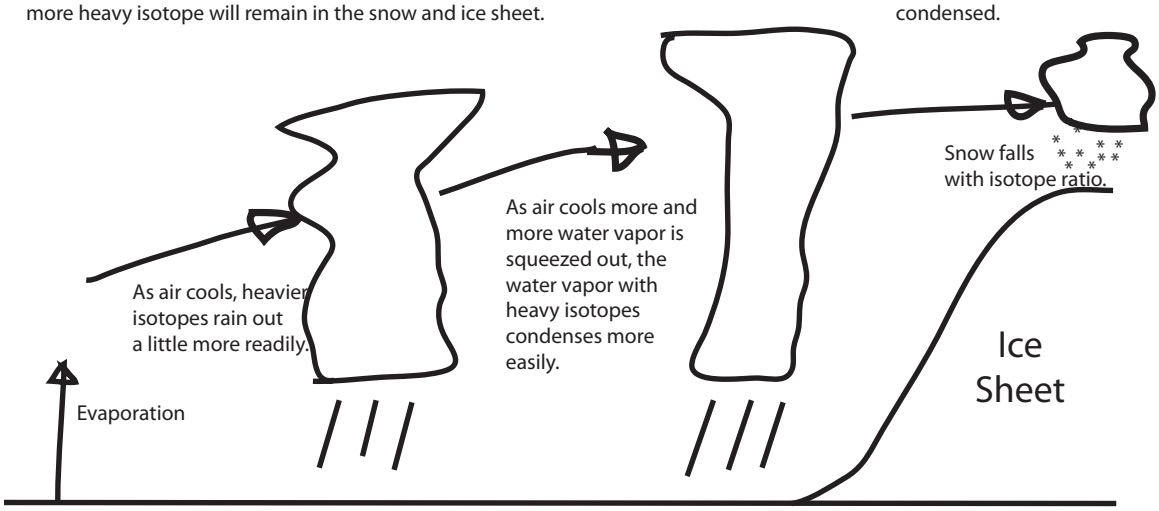
Stable Isotopes of Oxygen (also Hydrogen)
Mass Fractionation by Evaporation and Condensation in Water
Effect on concentrations in ocean sediments and ice cores.

During an ice age, heavy isotopes are enhanced in the ocean water and ocean sediments formed at that time.

When the air is very cold above the ice sheet, less heavy isotope is present. When the air is warmer when snow forms, more heavy isotope will remain in the snow and ice sheet.

The colder the air gets, the more heavy isotope is condensed.



When evaporation occurs, the lighter isotopes evaporate more readily, so that the vapor has less heavy isotope and the ocean becomes enriched in heavy isotopes (e.g. $_{2}H$ and $_{18}O$)

Diagram showing how stable isotopes such as are enriched in the ocean during the ice ages and can therefore be a measure of the ice volume on land.

Lighter isotopes ^{16}O and ^{1}H evaporate more readily. Heavier isotopes ^{18}O and ^{2}H condense sooner. This is because if energy is equipartitioned, then the heavier ones are moving more slowly. The mass fractionation that occurs in evaporation and condensation is very slight, but measurable.

The lighter isotopes evaporate more readily and so when this water is condensed as snow on land it enriches the heavy isotopes in the seawater by its absence.

As the water vapor in air condenses as the air cools, the heavy isotopes condense first, in the reverse preference (or consistently) as to evaporation. Thus if there is a big difference in the temperature between evaporation and condensation, the heavy isotopes will be depleted in say snow. If the snow falls at relatively warm temperatures, then the snow will have more heavy isotope. Thus the amount of heavy isotope in snow is inversely proportional to the temperature at which the snow formed. So relatively high amounts of heavy isotope in snow mean that the air above the ice sheet was relatively warm when the snow formed and fell. If the heavy isotopes in ice is relatively less than normal, then the air above the ice sheet must have been colder than normal when that snow fell onto the ice sheet.