GEOL 5430: Paleoceanography and Paleoclimatology
Fall 2012

<u>Critical concepts and learning goals:</u> Below are some fundamental concepts that form the core of the science needed to understand the fields of paleoceanography and paleoclimatology. These concepts ***do not cover everything*** that you will learn, but rather form a foundation of fundamental principles and ideas. Topics are arranged in the order of their first main appearance during the course.

Greenhouse effect: Explain the radiative physics behind the GH effect, and relate it to Earth's radiative balance. Calculate the blackbody temperature of the Earth.

Thermohaline circulation: Explain why (and what) energy is required for the THC, and under what conditions deep waters may form.

Insolation: Distinguish between insolation and the solar constant, and describe why and how modern insolation varies spatially and temporally.

Orbital theory: Describe the geometry and periods of the three dominant orbital parameters that affect Earth's climate.

Stable isotope fractionation: inorganic: Explain the pertinent molecular thermodynamics behind inorganic isotopic fractionation. Predict the relative enrichment/depletion of a solid/liquid/gas as a function of temperature.

Rayleigh fractionation: Explain why and how the isotopic composition of a cloud evolves as precipitation proceeds. Calculate the isotopic composition of rain as a function of the fraction of vapor remaining in the cloud.

Spectral analysis: Explain why spectral analysis is useful in paleoclimatology, and describe the basic concept behind Fourier theory.

Radiometric dating: Describe the fundamental requirements and assumptions involved in radiometric dating. Derive the generic age equation from first principles.

Factor analysis: Describe the concept and basic mathematical approach behind factor analysis, as it relates to planktonic assemblages.

Gas age-ice age difference: Explain why the bubbles/clathrates in an ice core have a different "age" than their surrounding ice. Predict how this age difference varies with snow accumulation rate.

Marine carbonate chemistry: Describe the speciation of DIC in seawater. Predict the direction of pCO_2 change with changing alkalinity and total DIC.

Weathering feedback: Write an equation illustrating the effect of silicate weathering on atmospheric CO_2. Explain the need for a negative feedback in the tectonic-scale carbon cycle.

Numerical modeling: Describe the need for, and basic structure of, numerical climate models. Explain the concepts of parameterization, boundary conditions, and sensitivity tests.

Hysteresis: Explain the concept of hysteresis, and how it relates to deep water formation and rapid climate change. Construct a hysteresis diagram of NADW strength as a function of freshwater flux.

Stable isotope fractionation: organic: Explain how organic fractionation differs from inorganic. Predict how the isotopic composition of a nutrient pool changes with primary productivity.