SIO 115 Homework 2 (due Friday 25 January 2019): *Ice ages and ice cores*

Please write your answers on a separate sheet with your name clearly written at the top. You will be graded on your writing style as well as the content of your answer.

In Q1 of this homework you will analyze ice core data from North GRIP in Greenland and Dome C in Antarctica. The data is freely available on the NOAA-paleo website, but for convenience, they are interpolated to the same timescale,

Download the files icecore_data.txt and NHinso1.txt from the class website.

The columns of the data set are as follows:
C1. Time, in year before 1950, commonly referred to as year BP (before present)
C2. $d^{18}O$, from NorthGRIP in per mil
C3. dD from Dome C, in per mil
C4. CO_2 concentration in ppm (parts per million), from Dome C and Byrd ice cores
C5. CH_4 concentration, in ppb (parts per billion), from Dome C.

On your plots, don't forget to label the axes, the curves if there are more than one, and to include units.

You can use Excel to do everything that is asked, but if you know of a more powerful graphing or computing software (matlab, R, python, igor…), it might be easier. In Excel, you can open the text file, and go to 'Data<text to column' and follow the process to have each column of data in the right place.

1. The temperature record.

a. Oxygen isotopes are used as a proxy for temperature in ice cores. Explain in a few sentences how this proxy works. (3)

b. In Greenland ice cores, temperature can be reconstructed from d18O following the equation $T=3.05\ d^{18}O+75.4$ (Cuffey et al., 1997). At Dome C, the equation is $T=(\delta D-5.5)/6.2$ (Jouzel et al., 2007). Calculate temperature for each site from the available data, and plot both curves against time on the same graph, taking care to label each curve. You may use two different y-axes if you want. (3)

c. Write on the graph an arrow representing time with a point towards the present (past → present). Identify (on the graph) a) the last glacial maximum; b) the deglaciation; c) the Holocene; d) an example of abrupt climate change. (4)

2. Milankovitch cycles

a. The file NHinso1.txt is from the World Data center (http://www1.ncdc.noaa.gov/pub/data/paleo/climate_forcing/orbital_variations/berger_insolation). Graph each of these along the same x-axis used in previous parts of the HW. The first column is years before present. The other columns contain the amount of solar energy received at a given latitude for a given month per forcing due to the Milankovitch cycle. [2]

i. Which latitude and time of year correlates best with Antarctic temperatures? [1]
ii. Greenland temperatures? [1]
iii. Why is the insolation at this latitude and time of year so important for global ice volume? [2]

b. "King Tide" or the day of the year when the tidal range is greatest, usually occurs just a little after northern hemisphere winter solstice (this year it was on New Year's Day for California) what parts of the Milankovitch cycle control the timing and magnitude of "King Tide?" [1]

c. Suppose you were an archeologist and someone wanted you to look at a 10,000 year old cave painting portraying people following the North Star: based on your knowledge of the Milankovitch cycles, why might you be suspicious? [1]

d. The following picture (source: Wikimedia Commons) is from a highway in Northeast Mexico. The numbers on the signs by the side of road refer to the year when the location of that sign marked the location of the Tropic of Cancer.

i. Which part of the Milankovitch Cycle is documented here? [1]

ii. Given that the strength of the seasons is decreasing in part due to this part of the Milankovitch cycle: was this picture taken facing north or south? [1]