ESE 101:

Homework 3 (due October 26):

Insolation. Write a program that calculates the diurnally averaged insolation as a function of time t given the orbital parameters obliquity γ, longitude of perihelion ϖ, and eccentricity e. (See the book draft for how to calculate insolation.) With your program, please do the following:

1. Calculate and plot the insolation as function of latitude at the top of Earth's atmosphere for each day of 2017.
2. Calculate and plot the annually averaged insolation as a function of latitude.
3. Turn the longitude of perihelion $180°$ compared to its present value. What is the date of perihelion now? Plot insolation for each day of year and averaged over the year. What are the principal differences to the situation in 1. and 2., and how do they arise?
4. Now reset the longitude of perihelion to its present value and decrease the obliquity to $22°$. What are the principal differences to the situation in 1. and 2. now, and how do they arise? Now decrease obliquity further to 18^circ. What changes?
5. Earth's longitude of perihelion and obliquity vary almost periodically, with periods of about 21 kyr and 40 kyr. Given your results in the previous two exercises, how do you think can precession of the longitude of perihelion and/or obliquity variations lead to the inception and termination of glacial periods?
6. Repeat 4. with an obliquity of $60°$. What new phenomenon arises and why? (Uranus has an obliquity of $97.86°$. Where is the annually averaged insolation maximal on Uranus?)
7. Develop an expression for insolation to first order in eccentricity $e \ll 1$ and obliquity $\gamma \ll 1$. Show that at this order of approximation, insolation at the equator is independent of obliquity. Explain what this implies for signals of orbital variations in tropical climate records.