

ATMS 514/ESS 535 Energy Balance Climate Model Instructions

This handout accompanies the first homework. The energy balance climate model solves the one-dimensional, steady state energy balance equation developed in class:

$$QS(x)(1 - \alpha(T)) = A + BT - \frac{d}{dx}D(1 - x^2)\frac{dT}{dx}$$

The standard set of parameters and functions for the model are the following:

$$Q = 338.5 \text{ Wm}^{-2}$$

$$A = 203.0 \text{ Wm}^{-2}$$

$$B = 2.09 \text{ Wm}^{-2}\text{C}^{-1}$$

$$D = 0.44 \text{ Wm}^{-2}\text{C}^{-1}$$

$$S(x) = 1 - 0.482\left(\frac{3x^2 - 1}{2}\right)$$

$$\alpha = \begin{cases} 0.3; & \text{ice free: } T \geq -10^\circ\text{C} \\ 0.6; & \text{ice covered: } T < -10^\circ\text{C}. \end{cases}$$

Computer details

I have tried to set things up to make the lab possible with out any computer experience. There is a class account on a unix system, which can be accessed from any machine on the atmospheric science cluster. You may use the computers in room 627 whenever there are machines open (pretty much all the time).

Login name: atm514

send Cecilia an email to request the password

You can also logon to the account from outside using secure shell with
ssh -X atm514@grease.atmos.washington.edu

Things about the account:

1. The account will stay active for the whole quarter. You are welcome to use it whenever you like. Feel free also to use your own account if it is easier for you. Cecilia will demonstrate some unix basics. Ask for help if you need it.
2. Everybody has the same account/password. Set up your own directory using some part of your name as the directory name. That directory should be your work space. For example, at the unix prompt type
cp -r ebm.classdir cecilia
to copy the contents of the ebm class directory to your own personal directory (but use your own name please).
3. You have the power to wreak havoc in the account. So please be careful and make sure you are in you own directory before deleting large amounts of stuff.

Using the model

Type: **matlab** (to start matlab), and then set the directory in the little box in the upper right to “/home/disk/atmos/atm514/yourpersonaldirectory” type: **ebm**, at the matlab prompt to run the graphical user interface (GUI). This will bring up the GUI for the EBM. The assignment can be done without touching the model code at all.

Using the GUI

1. The model parameters are given in separate boxes in the GUI. Value may be changed by editing the numbers in the respective boxes. Q/Q_0 is the ratio of the solar constant to the current one (i.e. $Q_0 = 338.5 \text{ Wm}^{-2}$).
2. The model can be run by clicking on the **run ebm** box. This causes the model to integrate to equilibrium for the chosen set of parameters. When complete, matlab will bring up a separate figure with three plots: a) temperature, b) poleward net flux in petawatts (10^{15} W), and c) the three terms in energy balance equation (shortwave, longwave, and heat flux convergence). The graph legend can be moved by clicking and holding on the legend box, and moving it within the graph domain. The graph window can be resized in the usual way by grabbing on the window edge.
3. At any time you can revert to the standard parameter set by clicking on the **Use Defaults** button.
4. Graphs can be printed out on the lab printers by clicking on the tiny thing that resembles a printer on the window with the graphs.
5. If the GUI does something strange, the best course of action is to close all the graphics windows, type **close all; clear; ebm** (in one line or separate lines, matlab doesn't care) at the matlab prompt to restart the GUI. Avoid clicking in any window while the model is running if it gives you trouble.