

Energy Balance Climate Model

This handout accompanies the first lab class, and hopefully should explain what is going on. The climate model we are asking you to work with solves the one-dimensional, steady state energy balance equation that we 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:

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

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

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

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

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

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

You will be asked to vary these values in some of the lab exercises.

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 be integrated to equilibrium for the chosen set of parameters. When complete, matlab will bring up a separate figure with three plots in it: a) temperature, b) poleward heat 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 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. I am not sure of the foolproof-ness of the GUI. If it 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.
6. If somehow, you scramble your version of the code, just delete the model files in your directory, and retrieve the default versions from the ebm directory.