12.811

Tropical Meteorology

Problem Set 3

1. Modify the simple model of the Walker Circulation derived in class by allowing boundary layer entropy (s_b) to be advected from the cold box to the warm box by the circulation, thus affecting the boundary layer quasi-equilibrium convective closure for the warm box. Assume that the width of each of the two boxes is L and that the depth of the subcloud layer is h ; use mass continuity to relate the horizontal advecting velocity to the vertical velocity in the boxes. Non-dimensionalize the equations as in class and describe any new nondimensional parameters that appear. Finally, discuss how including horizontal advection affects the solution in each of the two regimes (i.e. with and without convection in the cold box).

2. This problem is designed to test the predictions of the simple Walker Circulation model derived in class (or modified according to problem 1 above) against another two-box model, but having the full physics of convection and radiation. To do this problem, you must have an account on a LINUX- or UNIX-based machine running MATLAB and having a FORTRAN compiler. (See me if you do not.)

Create a directory on your UNIX or LINUX system and download into it all of the files (including the subdirectory *output* and its contents) from ftp://texmex.mit.edu/pub/emanuel/iso2 . It will be helpful to read the file *Readme.pdf*, but note that in this case the subdirectory *output* is not empty. Use a FORTRAN compiler to compile the program *TwoD.f*. This is a two-box configuration of the program described in Readme.pdf. It is set up initially to run with identical sea surface temperatures in both columns. Run the program. (This should take a few minutes.) Open MATLAB and use the script *imenux.m* to display the output. Note that you may conveniently store the results by copying the whole subdirectory *output* to a new subdirectory of your choice of name. (Note: copy, do not move *output*.)

Now use a text editor to open the initial condition file *sounding.in* and manually decrease the sea surface temperature of the second box by 0.5 C. Run the program again. Do this for successive increments of 0.5 C. Compare the results to the predictions of the simple Walker Circulation model.

These experiments have used fixed values of clouds and water vapor for the purpose of calculating radiative transfer; these values are the same in both boxes. Now allow for both interactive clouds and water vapor by using a text editor to modify the file params.in. Run the sequence of experiments again with interactive clouds. Compare these experiments to those with fixed clouds and water vapor.