

## **Tropical Meteorology – Homework #6**

**Due Date:** Thursday, 5 May 2016

In this assignment, you will explore sensitivities to maximum potential intensity.

At <http://derecho.math.uwm.edu/classes/TropMet/assignments/hw6/>, you will find a Fortran program named `mpi.f` and four input files (`mpi-dunion2011mt`, `mpi-dunion2011sal`, `mpi-dunion2011mldai`, and `mpi-jordan1958`). These represent the mean soundings across the tropical North Atlantic basin from Dunion (2011) that we discussed in our Tropical Climatology lecture. Respectively, these represent the “moist tropical,” “Saharan air layer,” “mid-latitude dry air intrusion,” and “overall tropical mean” soundings. The first line of each of these files is the sea level pressure (hPa); subsequent lines contain the pressure (hPa), temperature (°C), and mixing ratio (g/kg), with data on selected isobaric surfaces between 1000-50 hPa.

Download the code and all four input soundings. For this task, I recommend using the Macs in EMS W434; however, you are free to use any machine on which you can compile FORTRAN 77 code. I have attempted to describe each of the necessary steps in detail below. If you run into any technical problems with anything that is being asked, please ask me for help as soon as possible. Please think critically over each question, giving particular focus to connecting MPI theory to both necessary conditions for tropical cyclogenesis and the WISHE paradigm. Only a limited number of points are associated with your successful execution of the model code.

1. (25 pts) The default configuration for the MPI program utilizes the Jordan (1958) mean sounding. In a terminal window, compile the `mpi.f` code as follows: “`gfortran -o mpi mpi.f`” (without the quotes). Next, run the code using “`./mpi`” (again without the quotes).
  - a. (3 pts) What are the maximum sustained surface winds (kt) and minimum sea level pressure (hPa) resulting from this routine for this sounding?
  - b. (3 pts) Examine the `mpi.f` code in a text editor. What is the specified sea surface temperature (°C)? Next, examine the `mpi-jordan1958` sounding in a text editor. What are the pressure (hPa) and temperature (°C) closest to the surface?
  - c. (6 pts) From (b), compute the temperature difference (°C) between the air and sea surface temperatures. What is the inferred direction of sensible heat transfer? Would you characterize such transfer as weak, moderate, or strong, and why?
  - d. (6 pts) Compute the efficiency ( $\epsilon$ ) for this sounding. Show all work.
  - e. (7 pts) With your answers to (b), (c), and (d) and the necessary conditions for tropical cyclone formation and intensification in mind, is the maximum potential intensity obtained in (a) reasonable? Why or why not?

2. (25 pts) We now wish to consider the Dunion (2011) moist tropical, Saharan air layer, and mid-latitude dry air intrusion soundings. This requires editing the file name (given by FILE='mpi-jordan1958') in Line 44 of mpi.f. Note that each time that you change the file name, you must re-compile and re-execute the code.
  - a. (5 pts) Consider the Dunion (2011) moist tropical sounding. Repeat Question 1, parts (a) through (d), for this sounding.
  - b. (5 pts) Consider the Dunion (2011) Saharan air layer sounding. Repeat Question 1, parts (a) through (d), for this sounding.
  - c. (5 pts) Consider the Dunion (2011) mid-latitude dry air intrusion sounding. Repeat Question 1, parts (a) through (d), for this sounding.
  - d. (10 pts) Interpret your answers to parts (a) through (c). Why do you believe the maximum potential intensities obtained for these soundings to vary as they do?
3. (25 pts) In which of the Dunion (2011) environments would you expect the intensity of a given tropical cyclone to reach closest to its maximum potential intensity? Conversely, in which environment would you expect the intensity of a given tropical cyclone to be kept furthest from its maximum potential intensity? Physically, why?
4. (25 pts) Change the 1000 hPa temperature in the Dunion (2011) mid-latitude dry air intrusion sounding to 25.3°C. Re-compile mpi.f, first editing the file name if needed, and re-execute the mpi program.
  - a. (5 pts) What are the maximum sustained surface winds (kt) and minimum sea level pressure (hPa) resulting from this routine for this sounding?
  - b. (10 pts) Describe how these estimates of maximum potential intensity compare to those obtained in Question 2(c). Are the results what you expected? Discuss why.
  - c. (10 pts) Would you expect tropical cyclone formation to require somewhat less, about the same, or somewhat more time in the modified or unmodified Dunion (2011) mid-latitude dry air intrusion environment? Discuss why.