MEA712, Fall 2009
Semester Project Guidance

The goal of the project is to carry out a scientific experiment using the model that we are developing. The project may have two components: 1) additional model development, and 2) testing of a hypothesis with the model. Model development is optional, and should be dictated by the needs of the particular science question that you want to address. The hypothesis test is the heart of the project, and must be present in every case. I will weight my grade of each project based on the relative proportion of time spent on model development versus doing actual science with the model. *However, even if you spend a significant amount of time on adding to the code, my primary criterion for a graduate level project is that you must show that you have used the model as a part of the scientific method, and that you have done some interpretation.* I will have some comments on using a model to test hypotheses during a forthcoming lecture.

Criteria for evaluating model development: degree of difficulty, appropriateness for selected science problem, accuracy of coding (you will turn in your added code as an appendix: does code look right and do the results look realistic?).

Criteria for evaluating science component: well-conceived hypothesis, design of appropriate test using the model, completion of appropriate number and scope of simulations to test the hypothesis, graphical presentation of supporting results in an attractive way, accurate interpretation of results (physically and numerically).

Note: By the end of the semester, the model will include a warm rain precipitation scheme. You may assume that this will be available for your project (if desired).

End products:

due Tuesday 11/3, start of class: One page proposal for your semester project. You should include: an overview of the science problem; your working hypothesis; your proposed experimental design (including grid size, grid spacing, time step, model configurations); and, your proposed modifications to the model code (if any).

due Friday, 12/11, 5 PM: Paper on your semester project: 5 pages of text in AMS style. You should use extensive figures to illustrate your results and an appendix to show any novel code that you added, but these do not count against the 5-page limit. Figures should have captions and should be referred to by number in the text. Consider using roughly 1 paragraph to describe any model modifications you made, 1 paragraph to explain the experimental design and its logic, and the remainder of the paper to discuss the science problem and interpret the results of your experiments. The paper should end with a conclusion summarizing the key scientific insights of your work.

Tuesday, 12/15, 1-4 PM: Class colloquium in which you present your semester project in a 14 minute PPT presentation (followed by 6 minutes for questions). You will be graded on content (above), effective use of time (and not going long), presentation style, and effective use of legible, attractive, well-labeled graphics to illustrate points. Talks should emphasize science, not model development. Audience members are expected to ask questions, and this will factor into classroom participation grades.

Weighting of semester project:

30% of your semester grade, divided as follows:
5% proposal, 10% presentation, 15% paper

Some Previous Semester Projects

- Study of an extreme lake effect snow event
- Sensitivity of a 2D CMM simulation to grid spacing
- Comparison of time integration methods (leapfrog vs. 3rd-order Runge Kutta)
- Effects of low-level chilling on a simulated storm
- Study of colliding outflow boundaries
- Investigation of 3D flow over a mountain
- Effects of an urban heat island in the 2D CMM
- Study of a simple sea breeze
- Sensitivity of 2D convection to environmental shear
- Sensitivity of 2D convection to environmental lapse rate
- Study of a density current with a 3D version of CMM
- Study of gravity waves in various environments
- Behavior of an artificial passive tracer in warm thermal simulations
- Idealized simulation of wedge front convection
- Comparison of flux and advective forms of model equations
- Study of Kelvin-Helmholtz instability
- Effect of stability on boundary layer velocity profiles
- Impacts of initiating convection by an imposed warm thermal vs. imposed convergence

Other Ideas

- Sensitivity to the artificial speed of sound in various physical problems
- Solve the diagnostic pressure equation and study the buoyant and dynamic parts of the pressure field
- Study of vortices in an axisymmetric version of CMM
- Study of downdraft intensity/sensitivity
- Impacts of adding ice processes
- Study of advection schemes with higher order accuracy
- Add Coriolis and study geostrophic adjustment

Basically, you can do just about anything so long as it involves the model and interests you. Creativity is a plus, and adding something useful to the model is also a plus. But, again, *you must be able to cast your project in terms of a testable working hypothesis!* You should not propose "look and see" research (i.e. "Can CMM simulate a haboob?").