Mesoscale Analysis and Forecasting

Review sheet for Final Exam: 2 May 2008, 1–4 PM

This exam will count for 12.5% of your final grade. Unit 4 includes the topics that we covered from tornadoes through US severe weather climatology. The exam will be conceptual, and will not require you to do derivations.

Comprehensive aspect:

- There will be one or two questions related to the most frequently missed items from each of the previous three exams. Old questions could re-appear either verbatim, or with slight modifications/improvements; and, I may design new questions that cover the same concepts.

Some things to have down:

- Know your way around skew-$T$ In-$p$ diagrams and hodographs
- Be able to draw phenomena: ordinary cells, multicells, supercells, and mesoscale convective systems... plan views and cross-sections... reflectivity, flow fields, cloud outlines, etc.

Unit 4 questions/topics for thought and review:

- Know the keys on the “basic, ingredients-based approach to the convective forecasting process” handout. What are the key environmental parameters that select between ordinary cells, multicells, and supercells? Why is each parameter physically relevant for each mode? When do squall lines become likely? When is severe weather unlikely? Be able to apply this approach in a quasi-forecast mode.
- What are the generally observed environmental ingredients that accompany supercellular tornadoes? What are the generally observed storm-scale processes that accompany tornadogenesis in a supercell? What are some sources from which large vertical vorticity at the ground can arise? What is needed in order for this large vertical vorticity to be stretched into a tornado? Why are most tornadoes produced by supercells? Why do such a small fraction of supercells actually produce tornadoes?
- What are the ingredients in the significant tornado parameter? Why is each ingredient important?
- What are common large scale patterns that accompany tornado outbreaks? Why are these patterns favorable (think in terms of ingredients)? What are the likely failure modes for each pattern? What should you key on to identify each pattern in observational data (make sure you can do this)?
- What is a mesoscale convective system (MCS)? Why are they important? What are the impacts of their large size and long lifetimes? Why do many MCSs develop trailing stratiform precipitation? What does the flow field in a mature MCS with trailing stratiform precipitation look like? What does the reflectivity field look like? Why does the rear inflow jet develop? What is its importance? Why can MCSs be so long-lived? What is a line-end vortex? What processes lead to such vortices? What is a bow echo? A line echo wave pattern? What are the roles of bowing lines and mesovortices in producing severe winds? In producing tornadoes? How does the Coriolis acceleration factor into the structures and behavior of MCSs? What is a mesoscale convective vortex (MCV)? What processes lead to MCVs? What are the impacts of MCVs?
- What is a mesoscale convective complex (MCC)? What is the climatology of MCCs like?
- What is the "first law of QPF"? What are the necessary ingredients for flash flooding? Why are MCSs often implicated? What kinds of scenarios favor slow ground-relative storm motions?
- What are derechos? Why are they a forecast concern? What are typical derecho ingredients and patterns?
- What is the basic physical process for growth of a hailstone? What are the environmental ingredients for severe hail? Why is each ingredient important? What kinds of storms produce the largest hail? Why?
- What are the primary features of the U.S. thunderstorm and severe weather climatologies?
- Revisit both of the COMET module lab exercises... What is the impact of high vs. low CAPE? Dry vs. moist soundings? Deep vs. shallow shear? Curved vs. straight hodographs? Varying hodograph shape? Varying shear vector orientation?