MEA 444, Spring 2009
Lab 8: COMET MCS Matrix [Out of 100 pts]
4/14/09

1.[15 pts.] **Compare Matrix simulations A1, C1, and G1. Considering the role of shear strength and depth, answer the following 5 questions. [A] Which simulation produces the strongest, most continuous (in time) FTR flow? [B] Which simulation produces the strongest, most elevated rear-inflow jet? [C] Which simulation produces the most stratiform precipitation? [D] Which simulation produces the most bowing structures? [E] Which simulation produces the most isolated cells?**

A) Based on viewing the vertical cross sections, C1, which is characterized by strong, shallow shear, appears to evolve the strongest and most continuous FTR flow of the three simulations. G1, which is characterized by moderate-to-strong deeper shear, also consistently produces strong updrafts, but they are periodic and more scattered along the line than in C1.

B) C1 produces the strongest, most elevated rear-inflow jet.

C) A1 produces the most extensive stratiform precipitation region.

D) C1 produces the most distinct bow echo type structures, with two specific bow echoes developing within the line by 6 h.

E) G1 produces the most isolated cells.

2. [15 pts.] **Compare Matrix simulations trios C1/D1/E1 and G1/H1/I1. How does the orientation of the shear vector relative to the initial squall line affect system evolution?**

Generally, a 45 degree orientation of the shear vector relative to the initial convective line leads to a more upshear-tilted structure (broader line) by 6 h than if the shear is oriented at 90 deg to the line, but the squall-line strength is still significant through the 6 h. If the shear is parallel to the initial lines, the systems develop an upshear tilt and weaken much quicker. They also tend to develop more extensive stratiform precipitation regions when the shear is parallel.

In the 45-degree shear simulations, bow-echo like elements within the line are reoriented northwest-southeast (rather than north-south), perpendicular to the direction of the low-level shear vector.

3. [15 pts.] **Compare the evolution of 2D, long squall lines to that of the shorter, 3D, non-Coriolis squall lines (simulation pairs A1/A2 and C1/C2). How is system evolution altered when the line ends are in closer proximity?**

The shorter squall lines in simulations A2 and C2, because they are allowed to have distinct line-ends in the model, develop line-end vortices at 2.5 km AGL, have much stronger and extensive rear-inflow jets between the line-end vortices (especially C2), and have an overall faster system propagation than do the longer 2D lines.

4. [15 pts.] **Compare the 3D non-Coriolis simulations to the 3D simulation WITH Coriolis forcing (simulation pairs A2/A3 and C2/C3). How does the presence of Coriolis forcing alter system evolution?**

With Coriolis forcing included, the northern cyclonic line-end vortex becomes larger than the southern, anticyclonic vortex after 4 h, producing an asymmetric system structure by 6 h. Also, the lines in simulations with Coriolis forcing propagate more southward than the non-Coriolis simulations, due to the southward bias (motion to the right) produced within the system-scale cold pool in the Coriolis simulations.

Also, without the symmetry evident in the strong shear non-Coriolis simulations, the strong-shear Coriolis simulation produces two significant bow echoes within the line between 3 and 6 h. Each of these bow echoes develops a dominant northern cyclonic vortex during this period.

5. [15 pts.] **Compare all of the 3D simulations with Coriolis forcing (A3 through J3) to answer the following questions. [A] Which simulations produce the largest regions of stratiform precipitation? [B] Which simulations produce the strongest, most elevated rear-inflow jet? [C] Which simulations produce the best defined Mesoscale Convective Vortices (MCVs)?**

A) A3, F3, and possibly B3 produce the most extensive stratiform precipitation.

B) C3, D3, G3, and H3 produce the strongest, most elevated rear-inflow jets.

C) The best defined MCVs at mid-levels are produced in A3 and C3.

6. [15 pts.] **Again comparing all of the 3D simulations with Coriolis forcing (A3 through J3), answer the following questions. [A] Which simulations produce bow echoes? Which parameter best distinguishes bow echo simulations from non-bow echo simulations? [B] Which simulations produce supercells? Which supercells persist the longest? [C] Does BRN help distinguish whether a simulation produces supercells? How about Us over 2.5 km? Us over 5 km?**

A) Significant smaller-scale bow echoes within the lines are produced in C3, D3, E3, G3, H3, and I3. Magnitudes of Us over 2.5 km of 20 m/s or Us over 5 km of 30 m/s, oriented either 90 deg or 45 deg to the line support bow echo development within the lines.

B) Splitting supercells are evident at early times in all of the strong, deep shear cases (G3,H3,I3, J3) but cell collisions within the lines between the right- and left-movers is generally detrimental to long-lived supercells, except at some of the line ends. In G3 and H3 (perpendicular and 45 deg shear), the longest-lived supercells are the anticyclonic left-movers at the northern end of the line, which move out of the northern part of the domain. Supercell structures at the southern ends of the lines in both simulations evolve into bow echoes after about 3 h. In I3 (line-parallel shear), the initial right- and left-movers both decay quickly as the cold pool spreads rapidly eastward and westward away from the splitting cells. Overall, the most distinct, long-lived supercells occur in simulation J3 (7.5 km deep, strong shear, with a low-level, clockwise turning hodograph). J3 is composed of predominantly cyclonic supercells within the line, especially at the southern half of the line through nearly the entire 6 h evolution.

C) The supercell cases are all associated with BRN's within the predicted range (e.g., less than 50), and are also associated with values of Us over 5 km greater than 20 m/s.

7. [10 pts.] **Compare the "Jet" simulations (B1, B3, F1, and F3) with the others. How does the reversing shear above 2.5 km AGL affect system evolution?**

The reverse shear above 2.5 km leads to the development of an upshear-tilted structure much earlier than if the shear doesn't reverse, especially for the Us = 20 m/s jet simulations in row F. This happens because the easterly system-relative environmental winds above 2.5 km advect cells rearward (westward) over the spreading surface cold pool.