Conceptual Models for Origins and Evolutions of Convective Storms

Advanced Warning Operations Course

IC Severe 1

Lesson 6: Summary

Warning Decision Training Branch

Performance Objective

- The trainee will demonstrate ability to incorporate the knowledge of conceptual models to help describe convective storm structure and evolution.

Review of Key Objectives

1. Role of shear
   - Important for developing organized deep rotation in supercells; determines propagation and movement: low-level shear correlated to significant tornado potential in supercells.
2. ID Method
   - Uses 0-6 km shear vector; 7.5 m/s left/right of mean wind along orthogonal line.
3. Role of baroclinic generation of vorticity
   - Increases streamwise vorticity in a zone through solenoidal effects; eventually updraft tilts this vorticity into vertical and is stretched via shear-induced pressure forces.

Review of Key Objectives

4. Characteristics of favorable boundaries for tornadoes
   - Ones that have enhanced horizontal vorticity and storm relative helicity on the immediate cool side; important source for vertical vorticity.
5. Role of Rear-Flank Downdraft (RFD)
   - Helps to produce tornadoes if air possesses similar buoyancy to environmental inflow
   - Enhances boundary layer RH, lowers LCL
6. Buoyancy effects in supercells
   - Increases stretching, related to lower CIN, lower LCL, LFC heights

Review of Key Objectives

7. Fundamental conceptual model of a supercell
   - Gust fronts, RFD, FFD, core, location of potential vortex
8. Tornadoes can be cyclic
9. Characteristics of a severe squall line
   - Leading reflectivity gradient
   - Front end echo, possible BWER, MARC, DCZ
10. Characteristics of line-end vortices
    - Develop in mature phase of squall line, bookend vortices develop on end or at line breaks, cyclonic member dominates
11. Characteristics of squall-line tornadoes
    - Nondescending TVS, surface vortex located on leading edge of line, south of front-flank notch, north of rear-inflow notch

Review of Key Objectives

12. Mid-level storm-scale rotation can enhance updraft strength.
    - non-hydrostatic upward directed pressure perturbation in the center of the mesocyclone can increase the updraft strength
13. Steep lapse rates in the hail growth zone are favorable for large hail.
    - Hail growth zone basically between –10°C and –30°C
    - thick CAPE is more favorable for large hail than thin CAPE
14. Melting parameters should only be applied to small hail sizes.
    - RH, Temp., density of hail, all important to smaller hail

Review of Key Objectives

15. Hail growth trajectories vary widely from storm to storm.
    - Residence time in an updraft is the most important factor to large hail growth trajectories
16. 3 main sources of hail embryos in convective storms: Nearby flanking lines of growing Cbs, stagnation points, and shed liquid drops.
    - All 3 regions may operate in a single convective storm
17. Deep-layer shear, steep lapse rates, thick CAPE, are favorable sounding parameters for large hail.

Review of Key Objectives

18. Characteristics of the hybrid Multicell-Supercell hailstorm.
    - Deep convergence zone, huge size/depth of hail core, few and very weak tornadoes
19. There are 3 modes of linear MCSs
20. Factors governing evolution of organized multicells
    - Environmental winds and shear (all levels), storm-relative winds, cold pool strength, orientation of gust front relative to storm low-level inflow, instability gradients, boundary interactions

Review of Key Objectives

21. Role of storm–relative winds on multicells
    - Influences propagation via where updrafts will develop
22. Cold pool effects
    - Positive shear – deeper lifting along downshear side
    - Negative shear – diminishes lifting
23. Role of Rear-Inflow Jet
    - Produced by buoyancy gradients across updraft, enhances rear-to front with vorticity generated by cold pool, results in upshear tilted structure; if RIJ remains elevated, it can help to restore balance of cold pool with environmental shear

Review of Key Objectives

24. RKW theory (see cold pool effects)
25. Effects of instability on multicell movement
    - Convection will develop toward regions of higher surface based instability
26. Meteorological ingredients for heavy rainfall.
    - Max rainfall occurs just east of the maximum moisture convergence in low levels
    - Deep moisture, and lots of it
    - Weak wind shear, but strong turning with height favorable

Review of Key Objectives

27. Hydrological ingredients for heavy rainfall
    - Topography, size, condition of basin and/or stream channel very important
    - Antecedent precipitation can prime a basin for flash flooding and may not be included in FFG
    - Urban areas especially prone to flash flooding

Review of Key Objectives

28. Characteristics of the Watershed response to excessive rainfall
    - Rainfall rate more important than final rainfall amounts in most flash floods
    - FFG may not incorporate recent rainfall, and typically does not accurately represent actual basin characteristics due to differences in scale
    - Burn areas significantly enhance flash flood threat
    - Smaller basins flood much more easily than large basins
29. Precipitation efficiency can not be directly measured, but can be inferred: higher PE requires a deep warm cloud depth, high PW, low wind shear, “thin” CAPE.

Review of Key Objectives

30. Characteristics of supercell flash flooding
    - Slow movement most important, and moisture inflow into an HP more than makes up for low precipitation efficiency
31. <u>Backward propagating</u> MCSs far more likely to produce flash flooding

References

- See handout list of references

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