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CRM Model Intercomparison Study on Aerosol-Deep Convective Cloud Interactions

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Background

- Aerosol-cloud interactions are important to radiative budget and hydrological cycle but the uncertainty remains the largest (IPCC, 2013)
- For deep convective clouds (DCCs), the magnitude and even sign of changes in convective intensity and surface precipitation with aerosol loading often vary, depending on the particular model and microphysics parameterization.
- CRM simulations are often used to develop parameterizations. Large spread of CRM model simulations of deep convection and aerosol effects on DCCs makes difficult to define "benchmarks" and limits their use in parameterization developments.
- Past model intercomparison used different models and compared in a complex system with the dynamic-microphysics interactions.

Objectives and Plans

- To identify processes/factors contributing to the large spread of CRM deep convection simulations and provide insights to improve bulk parameterizations.
- To identify processes and feedbacks important to represent in GCM parameterizations in aerosol-DCC interactions.

➢ **Using the same model (WRF3.4.1) with the same aerosol setup, we want to conduct two-step investigations:**

Step 1

Identify major contributors from microphysical processes.

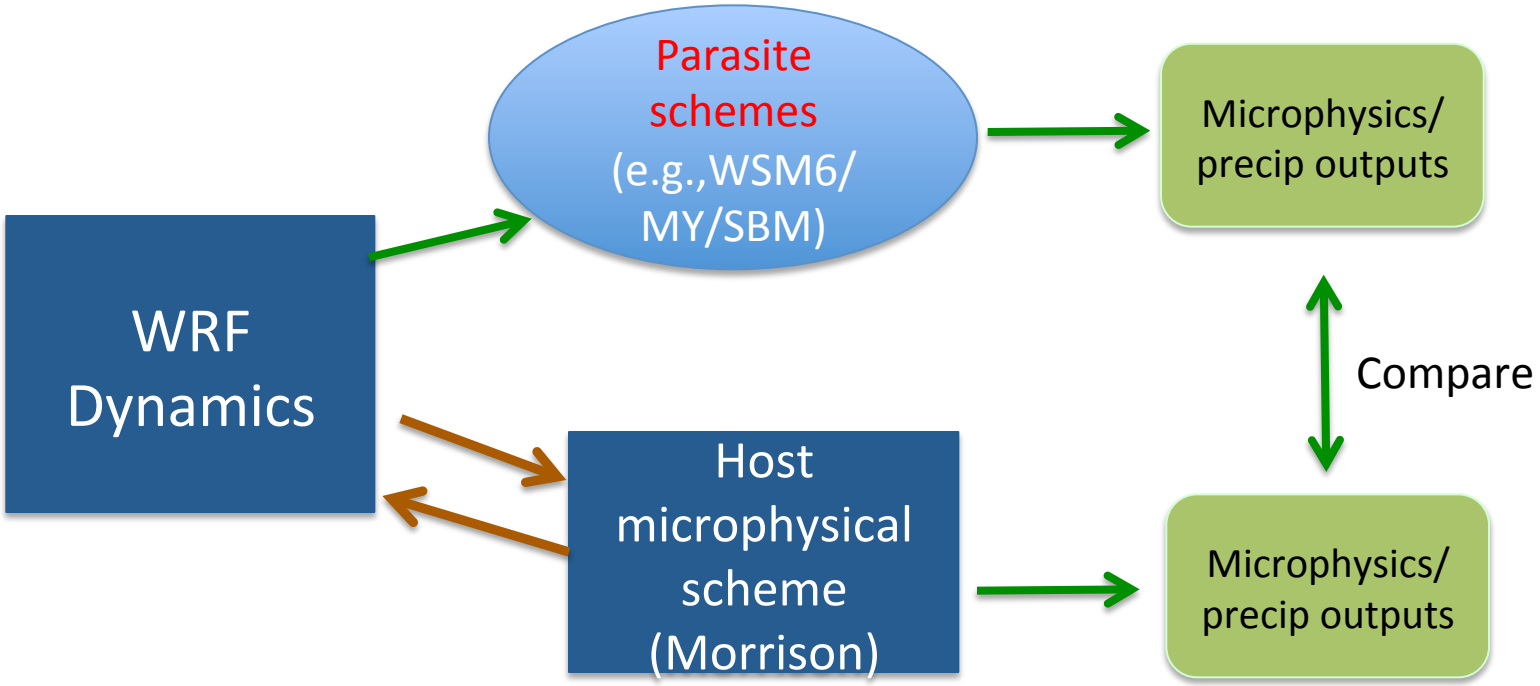
1. Standard full package run, compare with obs. and examine model differences
2. No ice run to identify contribution from warm cloud processes
3. Sensitivity tests for each ice microphysical process

Step 2

Identify major feedback processes between dynamics-microphysics interactions.

(1) Feedback of latent heat from each process to convection
(2) Feedback of hydrometeor loading to updraft/downdraft
(3) Cold pool feedback.

Step 1 concept



Preliminary results

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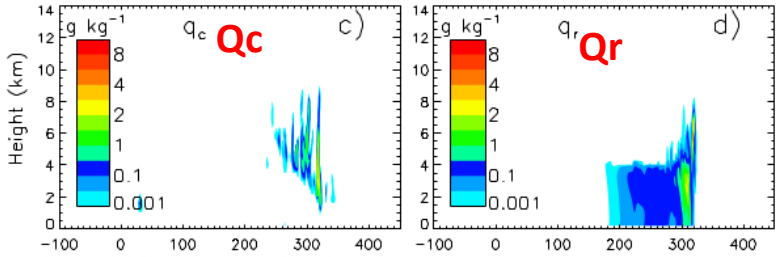
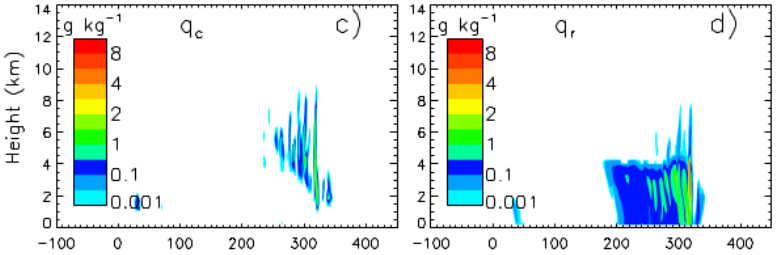
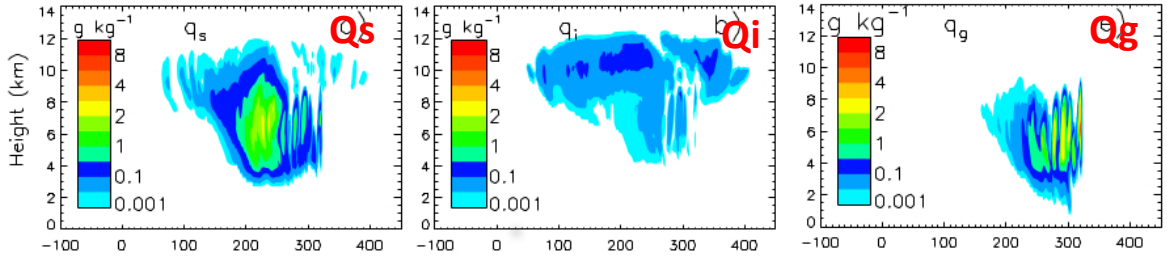
Morrison



WSM6



Morrison



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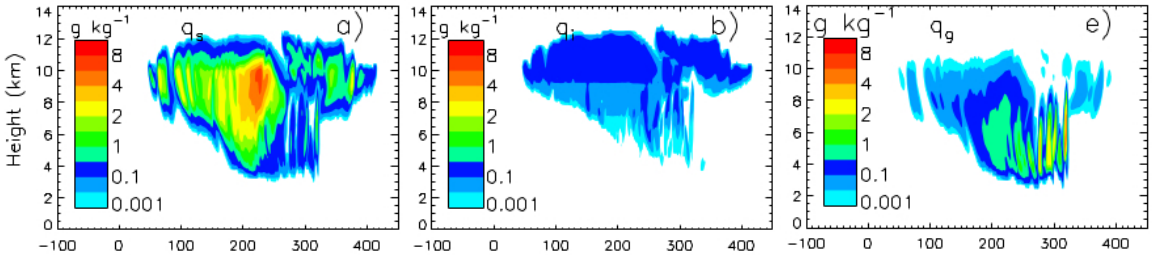
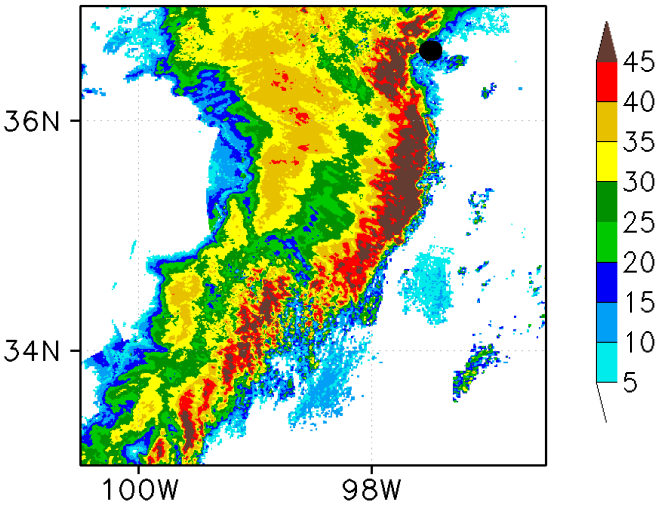
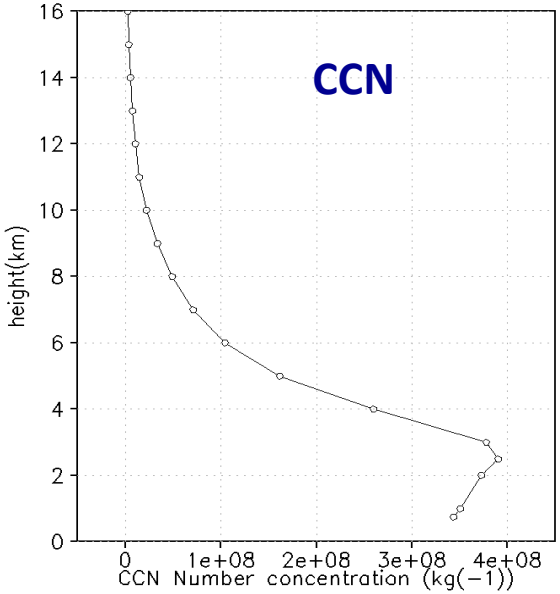


Target Case Study: May 20 of MC3E

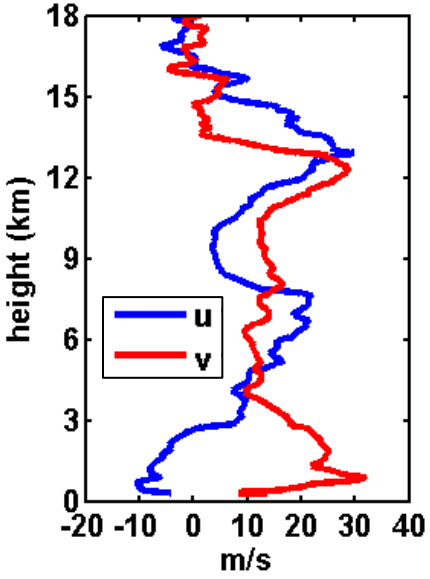
10 UTC 20 May

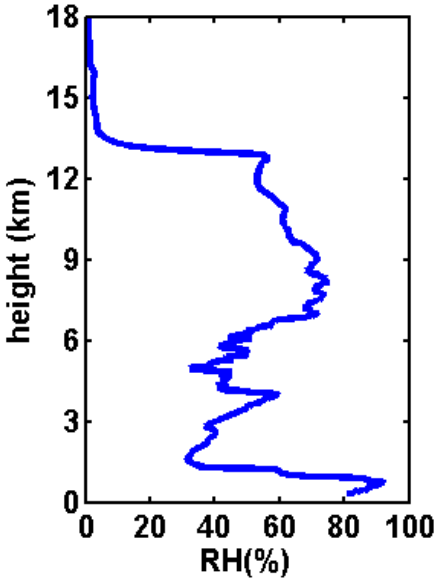




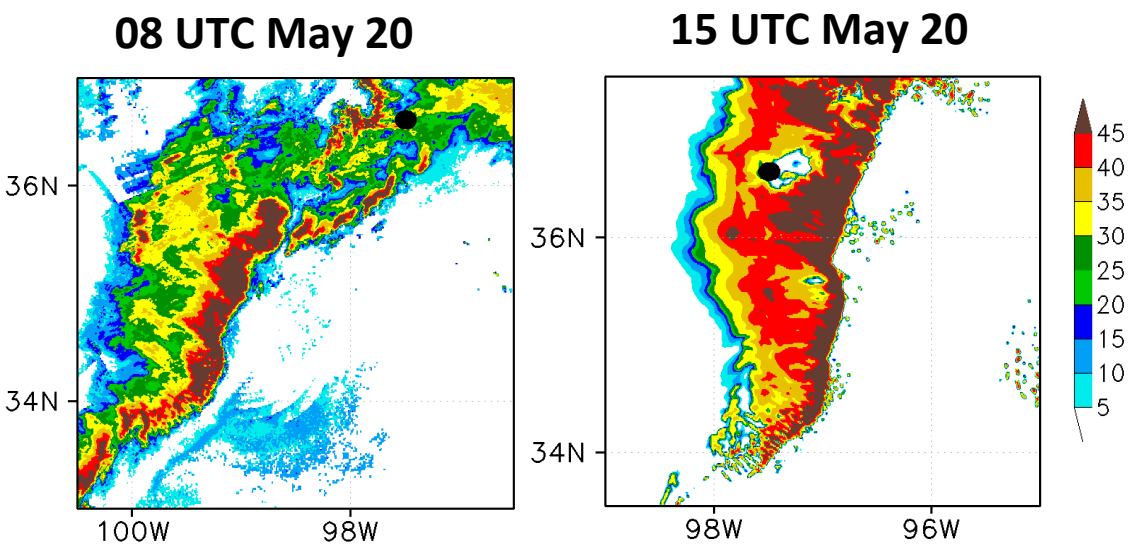
- **Strong vertical wind shear and clean condition**

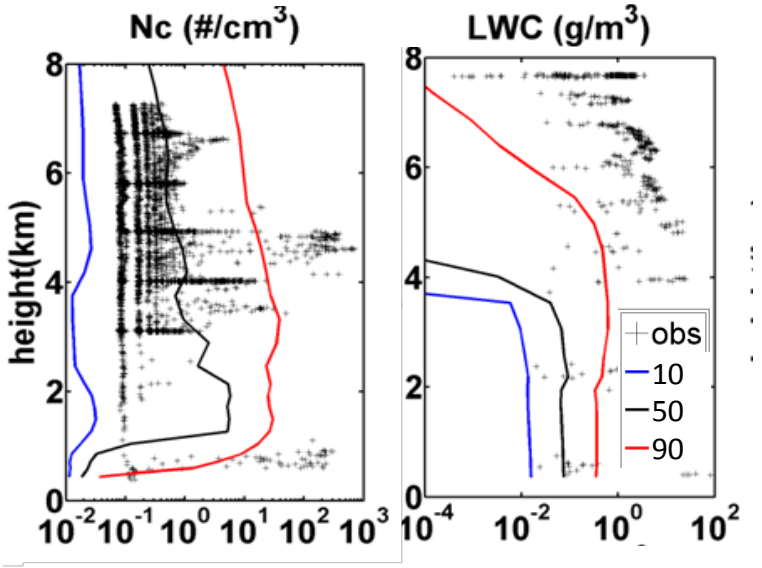
Observed Sounding at 0230 UTC May 20

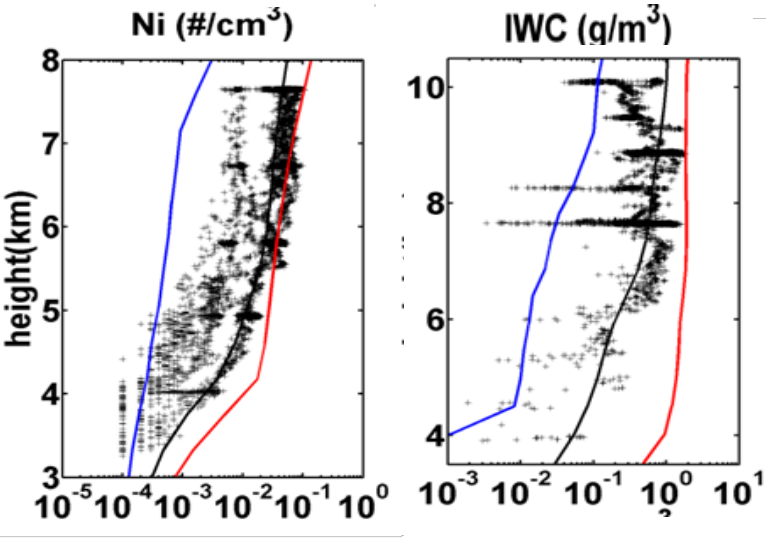




Real-case Simulation with NARR

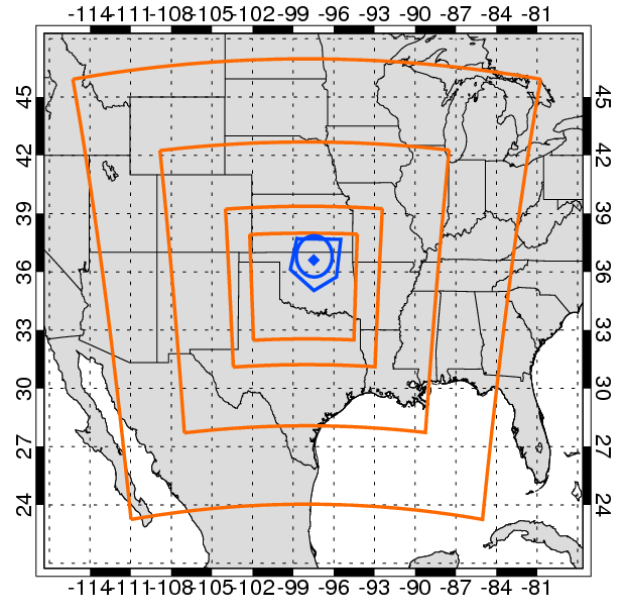




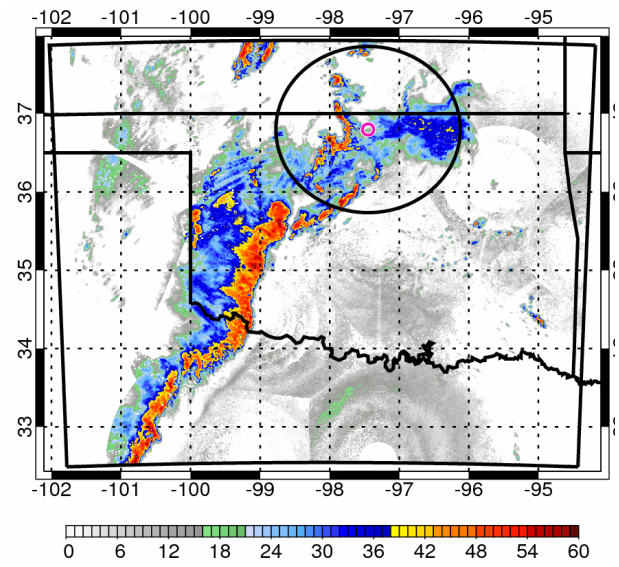


- Timing and location shifts of the simulated squall-line.
- Cloud microphysical properties fall in with the observed ranges

Adam's nested simulation with NCEP



08 UTC May 20



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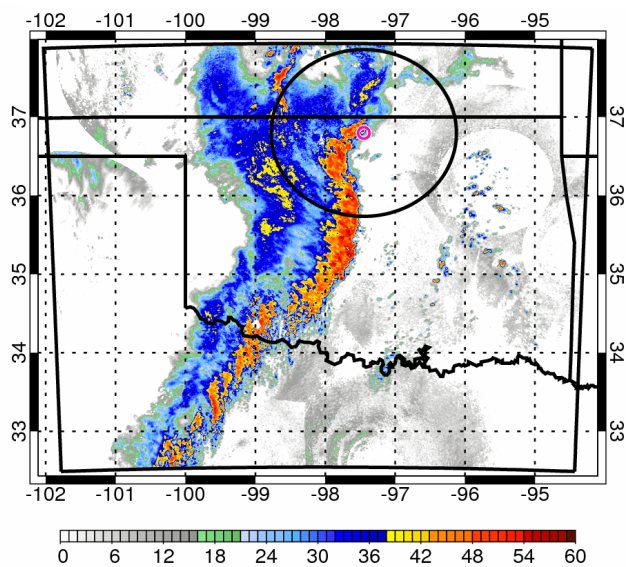

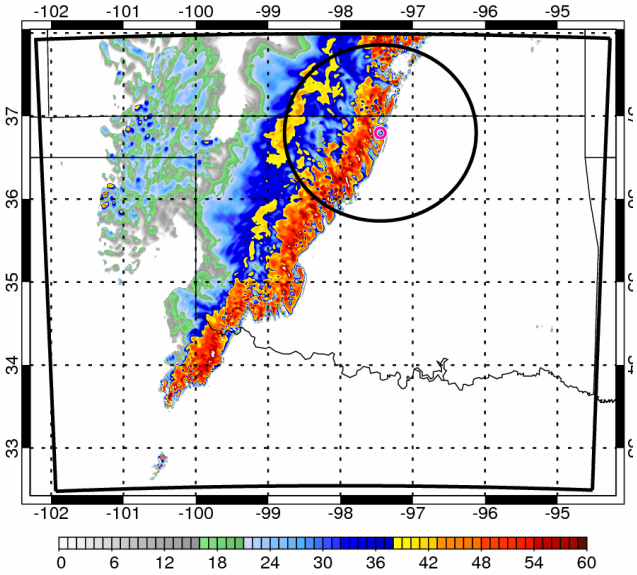

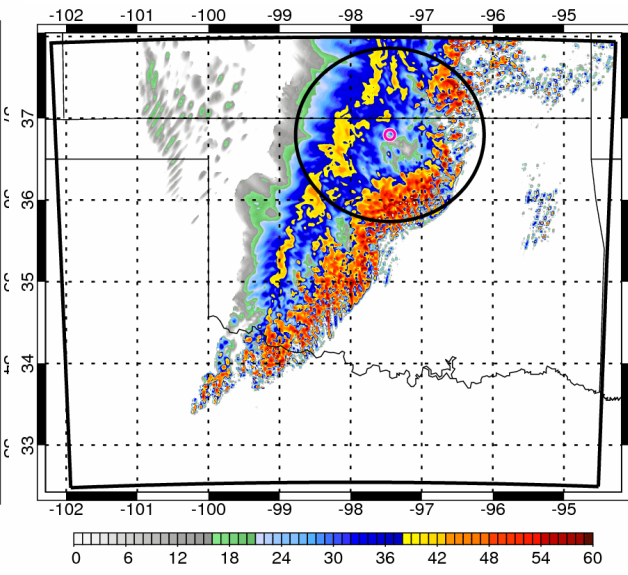

- **Timing and location of the simulated squall-line are close to observations**

Summary of setup of Step 1

- WRF3.4.1 real-case run for May 20 based on Adam's setup
- Prescribed aerosol size distribution and vertical profile.
- Parasite runs for different microphysical schemes.
- Parasite runs for different microphysical schemes under a polluted condition
- Examine differences in cloud microphysical properties, and aerosol effects, and look into the factors/processes contributing to the major differences

Discussion

- Are objectives good? Additional objectives?
- Does the plan sound good?
- More case study besides May20?
- Experiment designs?
- Potential participants?