# Comparing TWP-ICE and MC3E Observations to Mesoscale Simulations to Improve Simulated Convective, Stratiform, and Anvil Structure

Adam Varble[1], Nick Bassill[1], and Ed Zipser[1] with contributions from many others

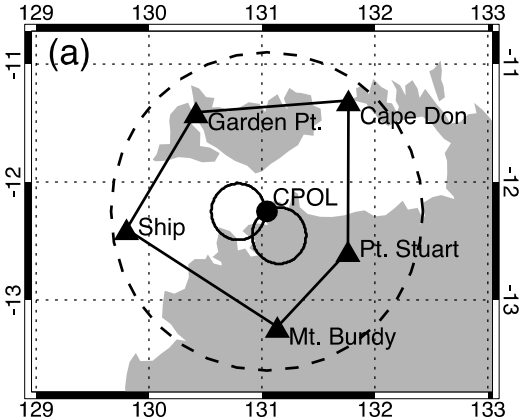
[1]University of Utah

ASR Fall Meeting, 11/4/13

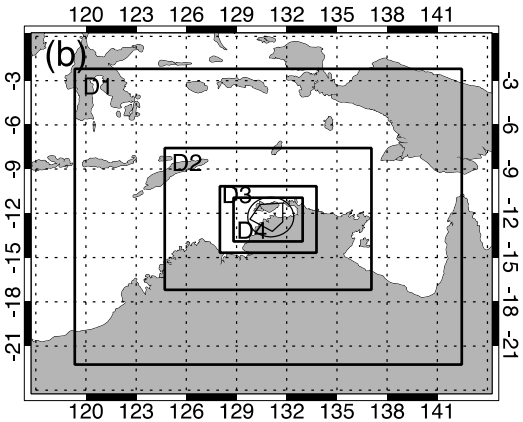
# Case Study: Tropical Coastal MCS

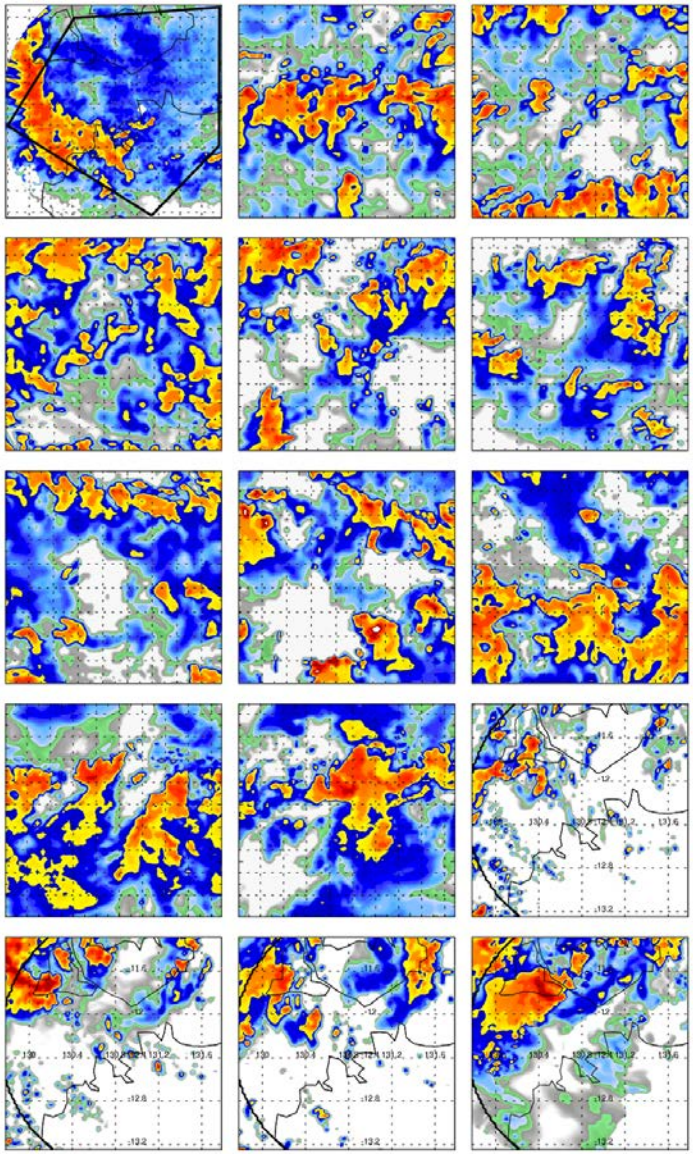
- 1/23/06 TWP-ICE
- 10 CRM and 4 LAM simulations
  - ~1-km horizontal grid spacing with 76-102 vertical levels
  - Various bulk microphysics schemes

CRMs




LAMs



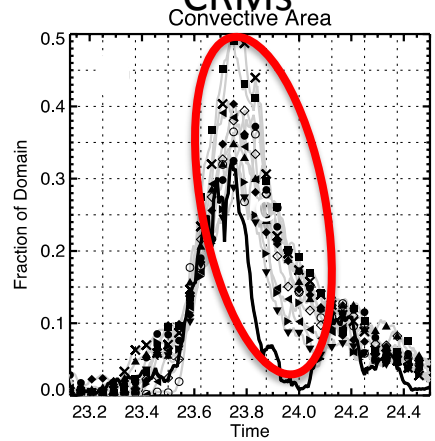
# Simulation Convective Biases

High bias in convective area and radar reflectivity

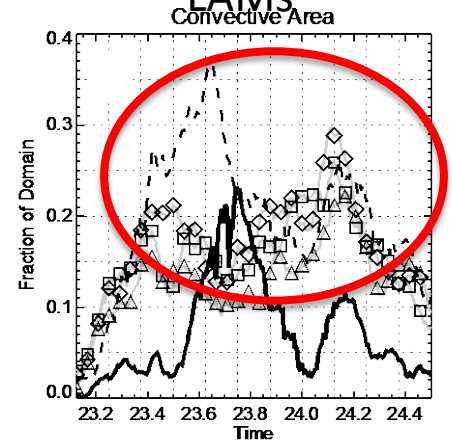
Nearly undilute deep updraft cores

Convective Area Time Series

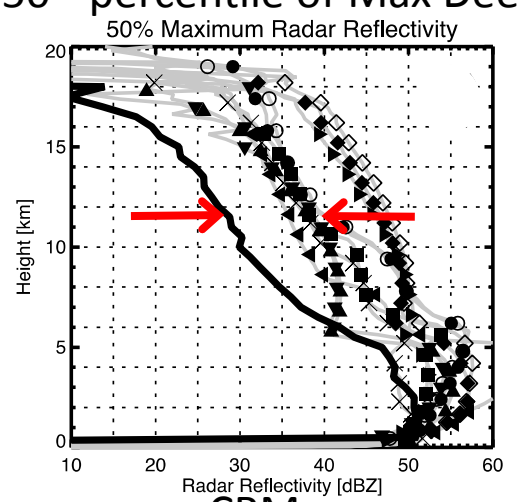
CRMs



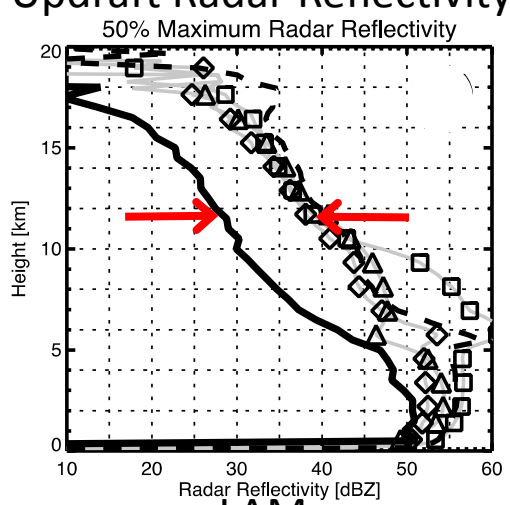

LAMs




50th percentile of Max Deep Updraft Radar Reflectivity

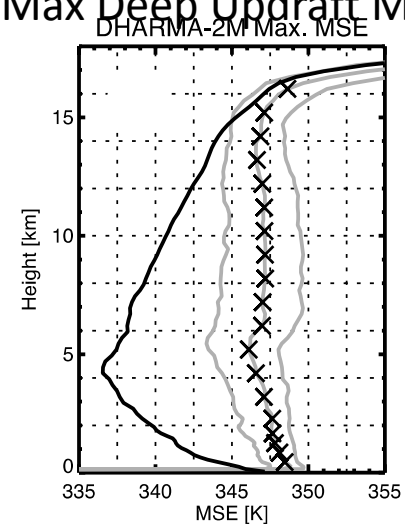



CRMs




LAMs

Max Deep Updraft MSE



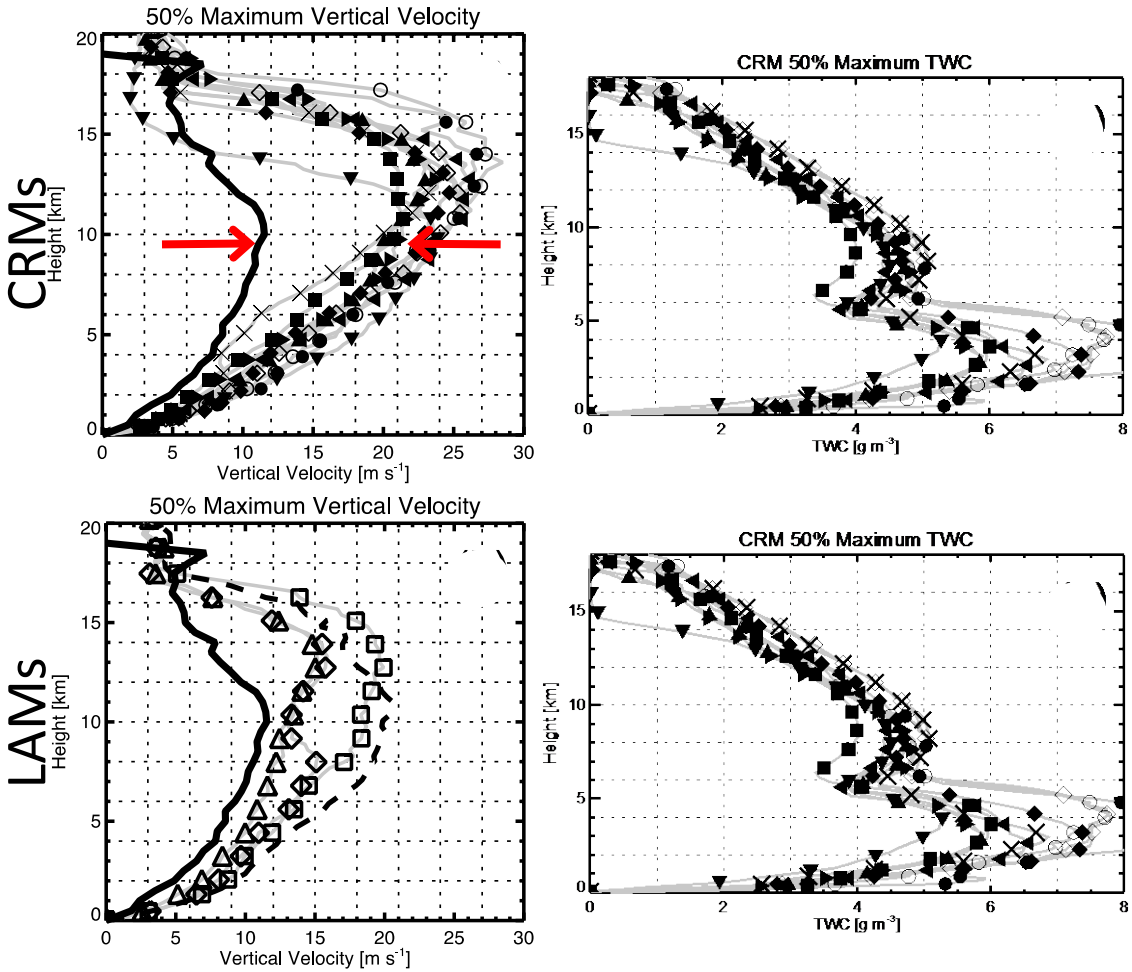
# Why the Biases?

In addition to biases created by bulk MP assumptions, deep convective updrafts are too strong

Some are wrong mode (supercellular) even though the large-Scale Environment/Forcing is similar in the mean

Possible to resolve proper updraft width given shallow PBL?

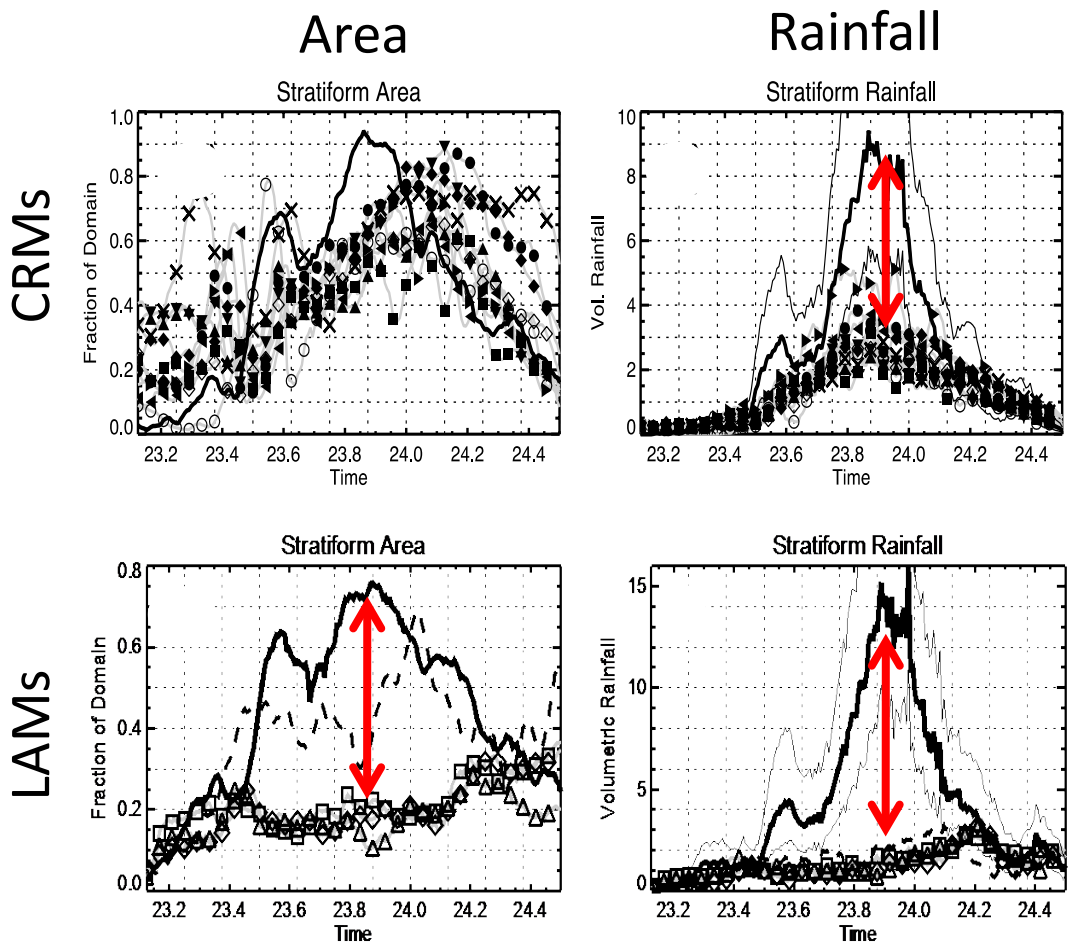
50th Percentile Deep Updraft W and TWC



# Impact on stratiform precipitation

Overly intense convection negatively affects stratiform regions, as can model setup (periodic B.C.'s) and large-scale moisture biases

Increasing grid spacing to 100 m slightly improves but does not eliminate the high bias in vertical wind speeds and precipitating condensate aloft

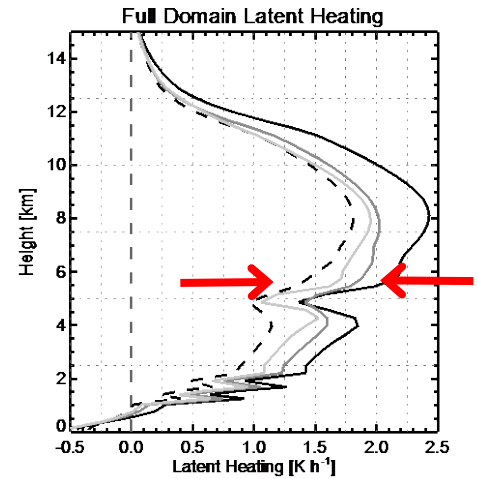


# Impact on Stratiform Precipitation

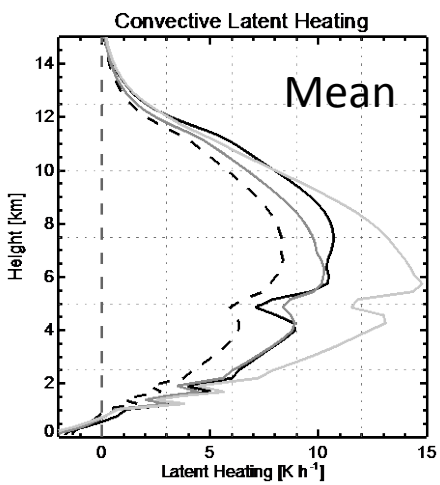
Different microphysics parameterizations can alter latent heating, modify convective drafts, and alter detrainment, even with the large-scale environment constrained through nudging of outer domains

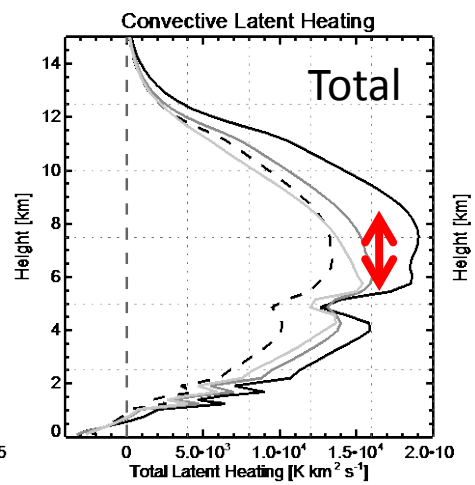
Large-scale environmental relative humidity can impacts stratiform area and convective strength

Full Domain Mean LH

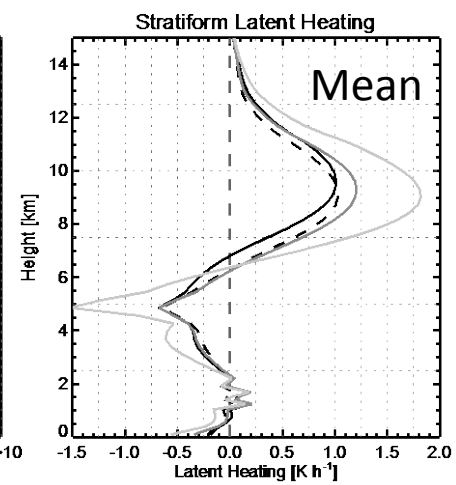


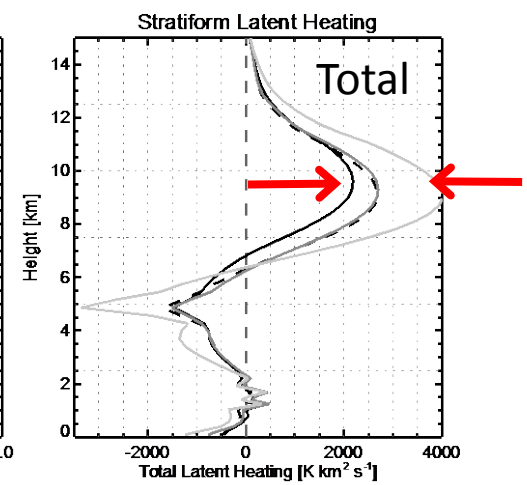

Convective LH




Stratiform LH



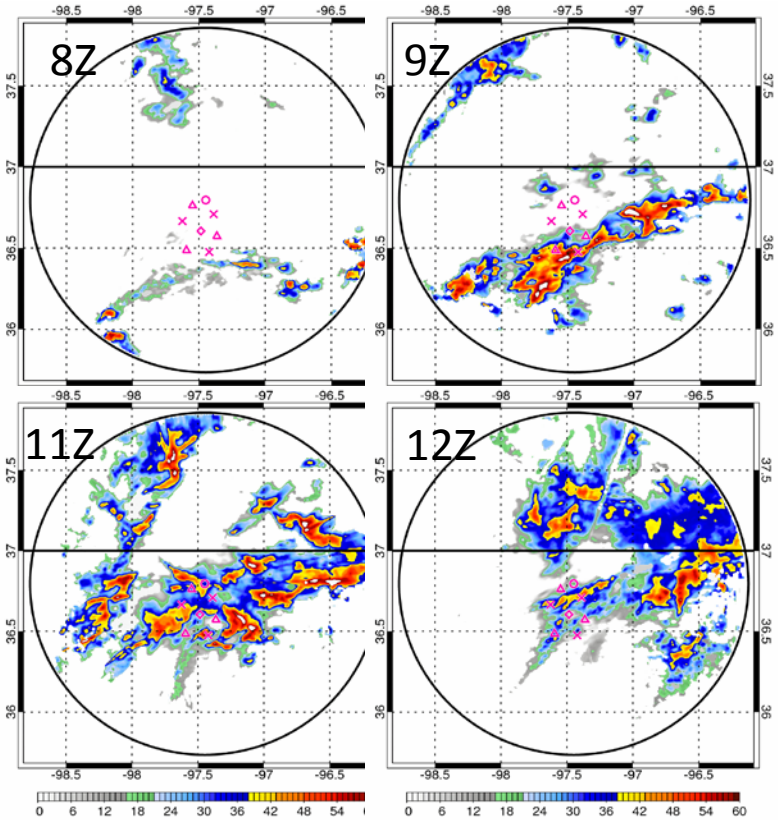



# Case Study: Mid-Latitude Elevated MCS

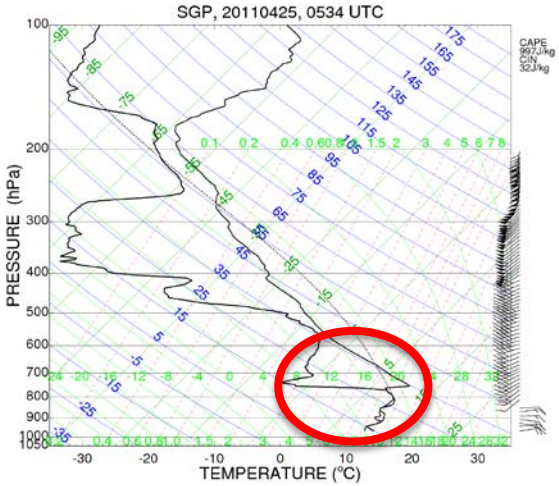
## 4/25/11 MC3E

Multiple LAM (WRF) simulations with different setups and microphysics

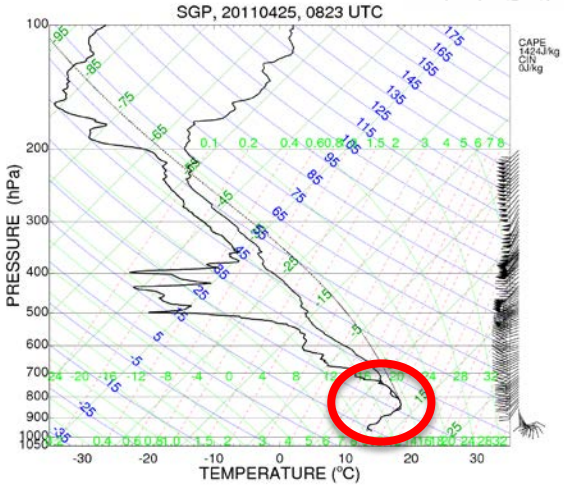
Examine how the interaction of microphysics and convective dynamics impacts mesoscale precipitation and cloud structure



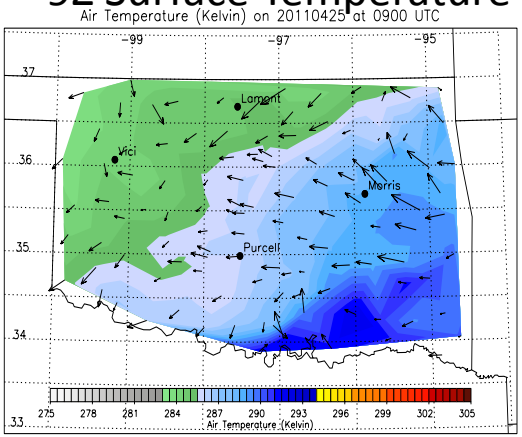

6Z Sounding




9Z Sounding




9Z Surface Temperature

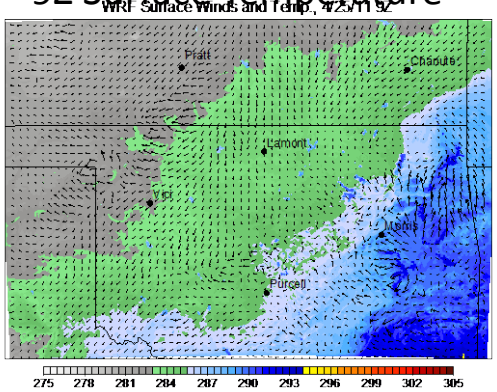


# Mesoscale Simulations

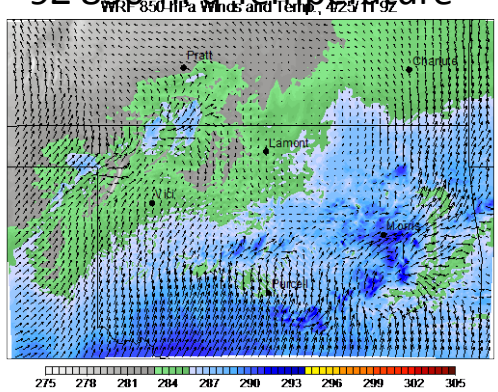
Forcing WRF with the FNL analysis yields the best outcome because it is accurate for this case

Large-scale environments in simulations are realistic and similar in different model setups because analysis nudging is used in outer domains

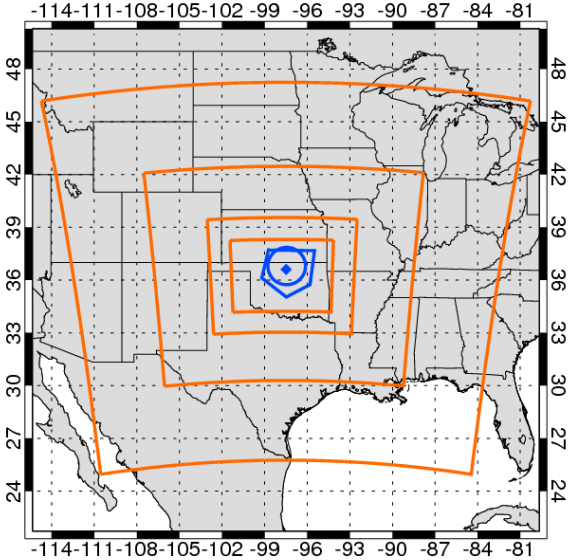
9Z Surface Temperature

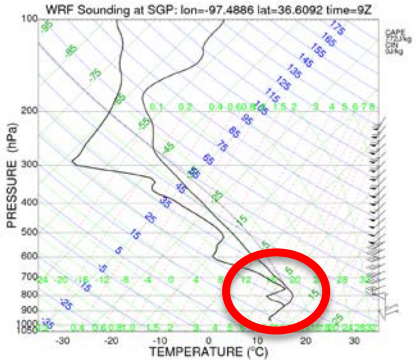


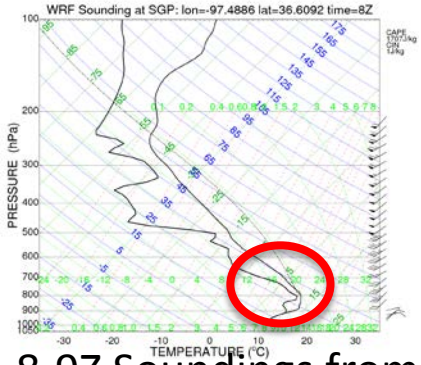

9Z 850-hPa Temperature

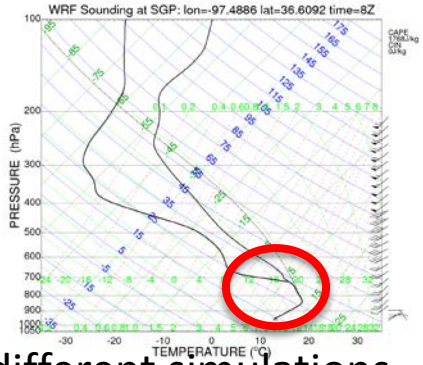


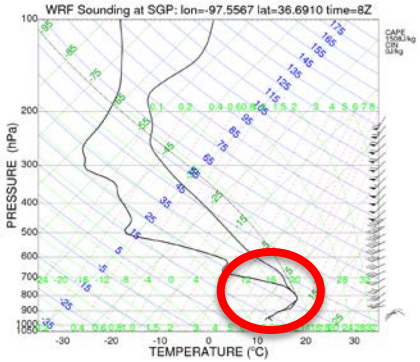

WRF Domains




8-9Z Soundings from different simulations

# Mesoscale Organization

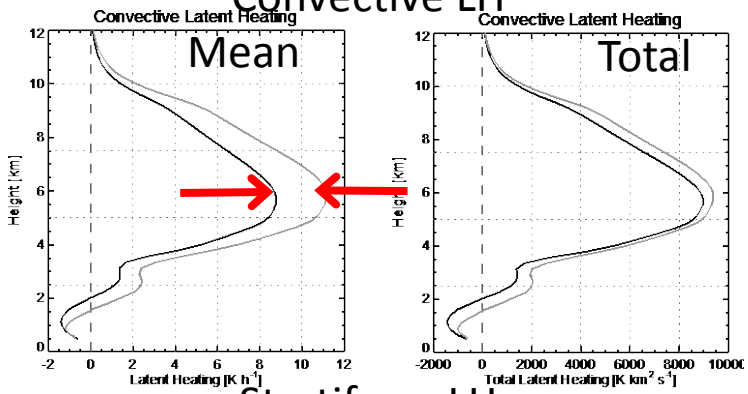
Very sensitive to model setup, even when nudged on ~1-hr time scale in all but inner domain

Large-scale environment looks similar, but feedbacks yield different organizational modes

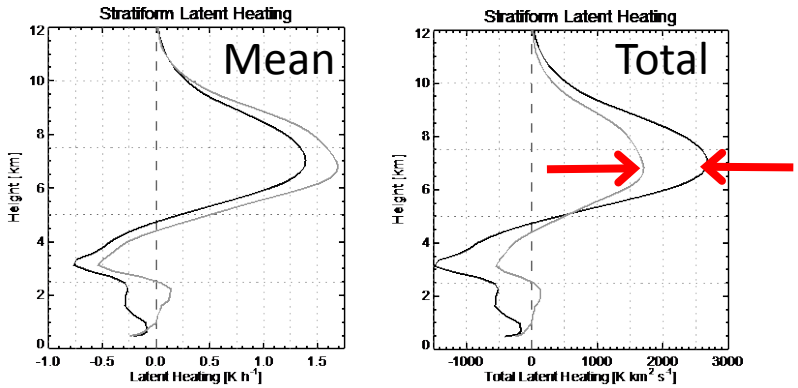
More sensitive for 1-km grid spacing than 3-km

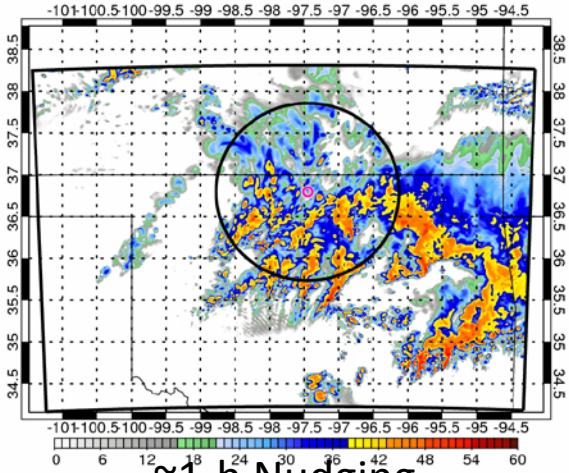
More sensitive in mid-latitudes than in tropics?

Convective LH

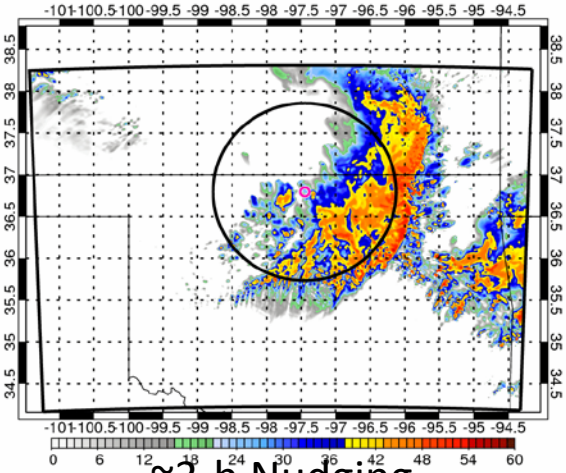



Stratiform LH

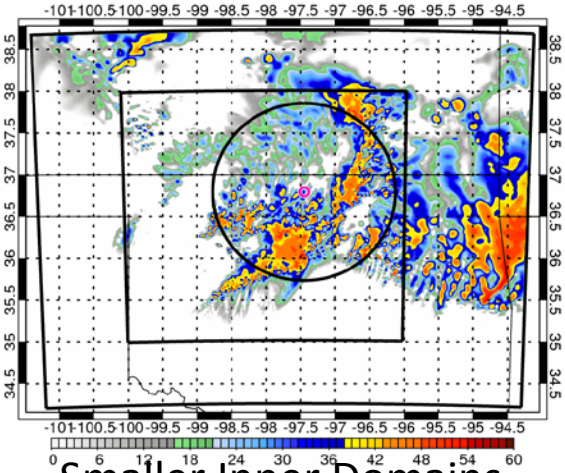


~1-h Nudging



~3-h Nudging



Smaller Inner Domains

# Future Research Directions

1. Are simulated biases for MC3E cases similar to those in the TWP-ICE case?

2. What can new observations and simulations tell us about convective dynamics and microphysics interactions, including how they affect mesoscale cloud/precipitation structure?

3. Given a large-scale environmental profile, what are the possible mesoscale convective responses and how do these different responses affect the heat, moisture, and momentum budgets?

    a. What are the sensitivities to convective dynamics and parameterized microphysics?

    b. What are the relevant feedbacks that can create different mesoscale solutions?

    c. Which environments are most susceptible to a variety of solutions?