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Aerosol Wet Removal in Deep Convective Clouds

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ASR WG meeting, Aerosol Wet Removal breakout

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Introduction/motivation

- Aerosol wet removal remains key sources of uncertainty that affects aerosol vertical distribution and long-range transport
- Challenging to evaluate parameterizations used in global models using in-situ measurements because of uncertainties in other modeled cloud processes
- We use cloud-resolving modeling to bridge the gaps
- Many studies have focused on low clouds
- Here we focus on deep convective clouds

A DC3 case study using WRF-Chem

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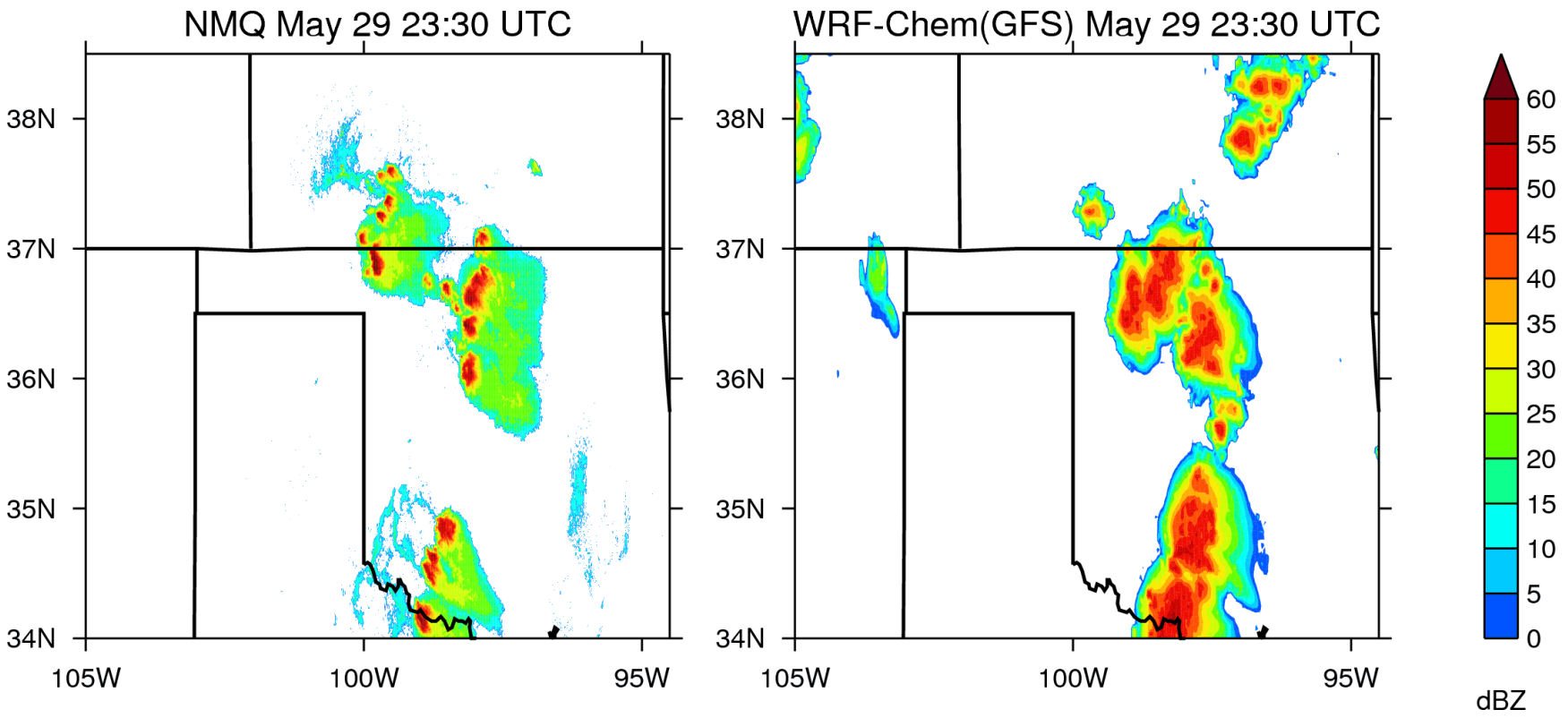
- The Deep Convective Clouds and Chemistry (DC3) field campaign conducted during May-June of 2012
- Provides measurements to evaluate the representation of aerosol wet scavenging in models and to further study the impact on aerosol vertical distribution
- A storm occurred in Oklahoma (May 29, 2012) has been selected for a WRF-Chem case study
- Model runs at 4-km horizontal resolution driven by GFS
- MOZART chemistry + aerosol emissions

The Storm (radar reflectivity)

NEXRAD

Model



Signature of aerosol wet removal

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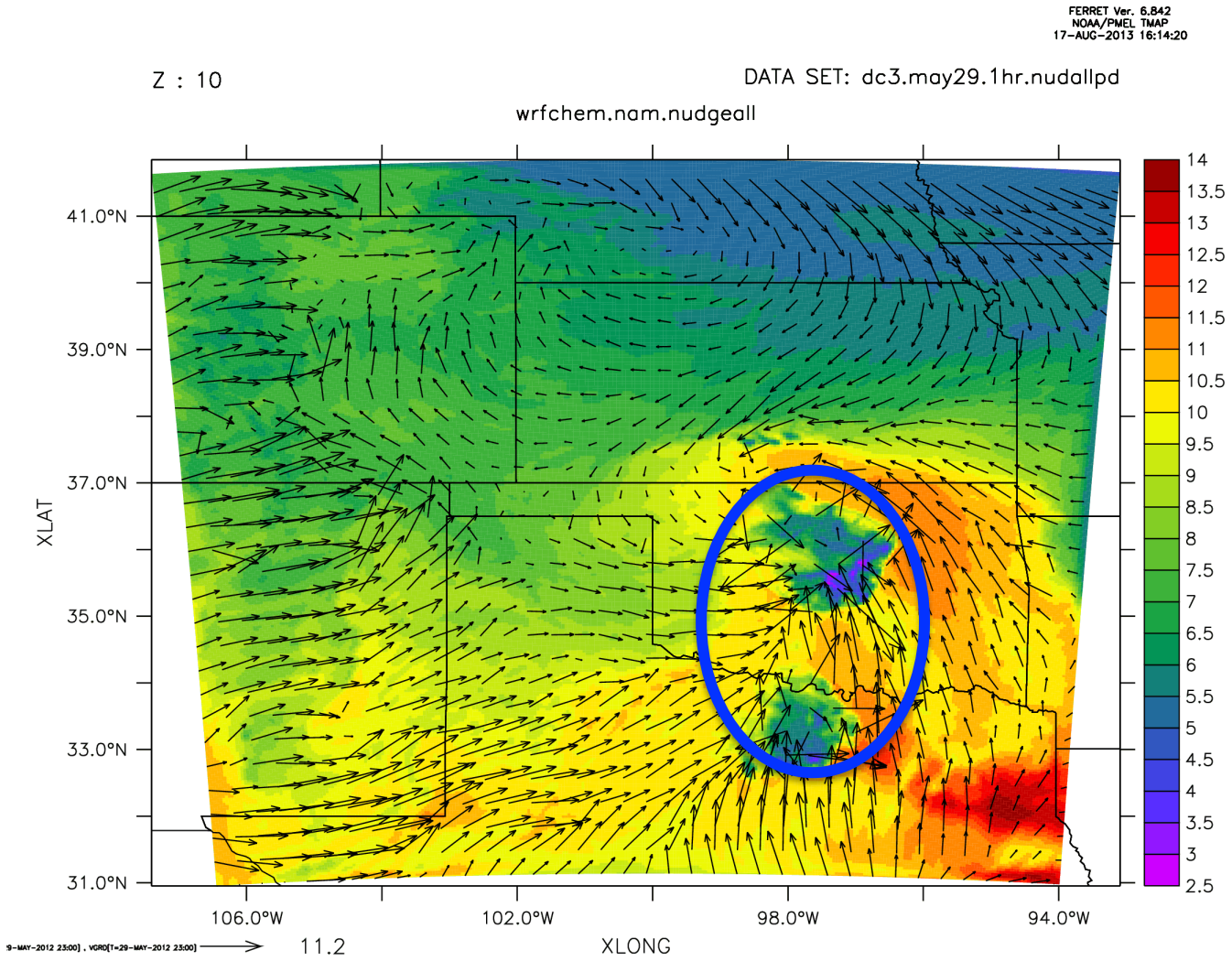
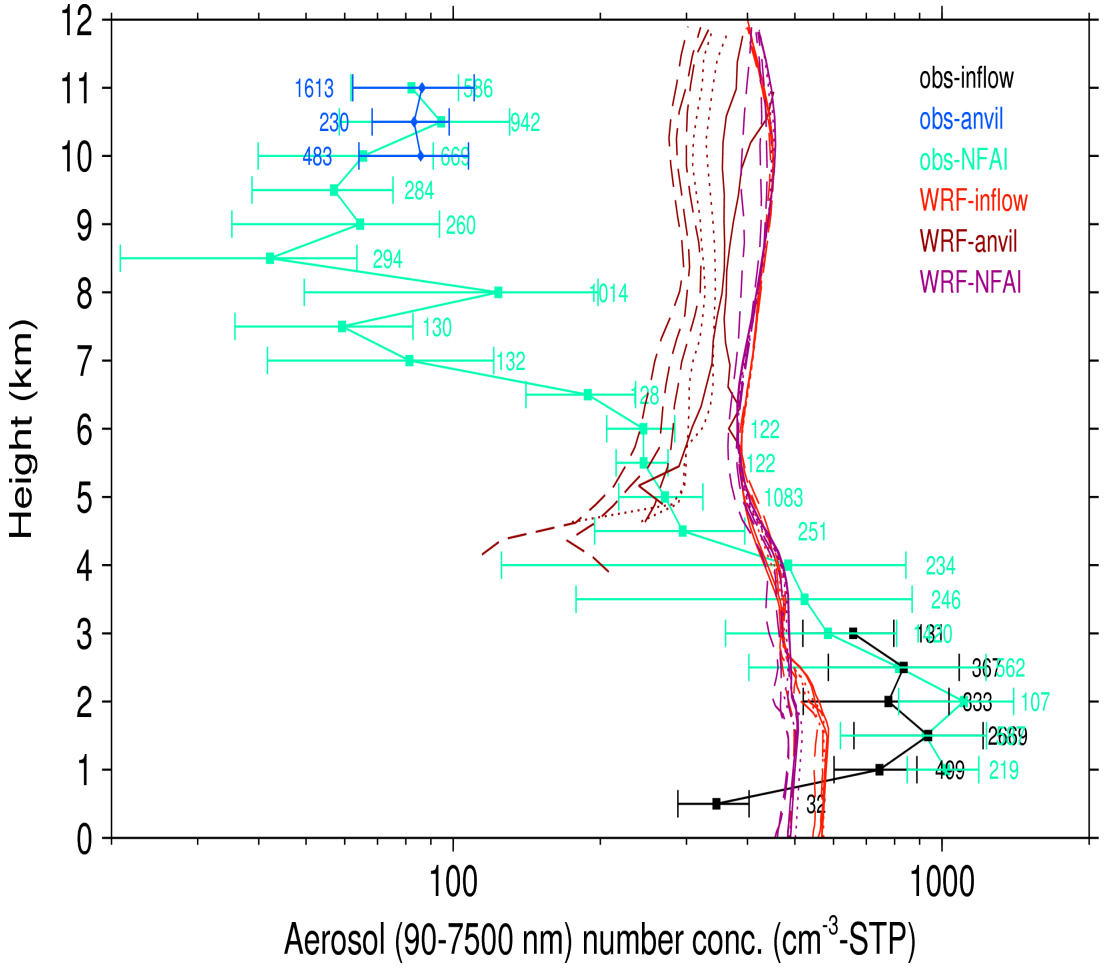


pm25_m

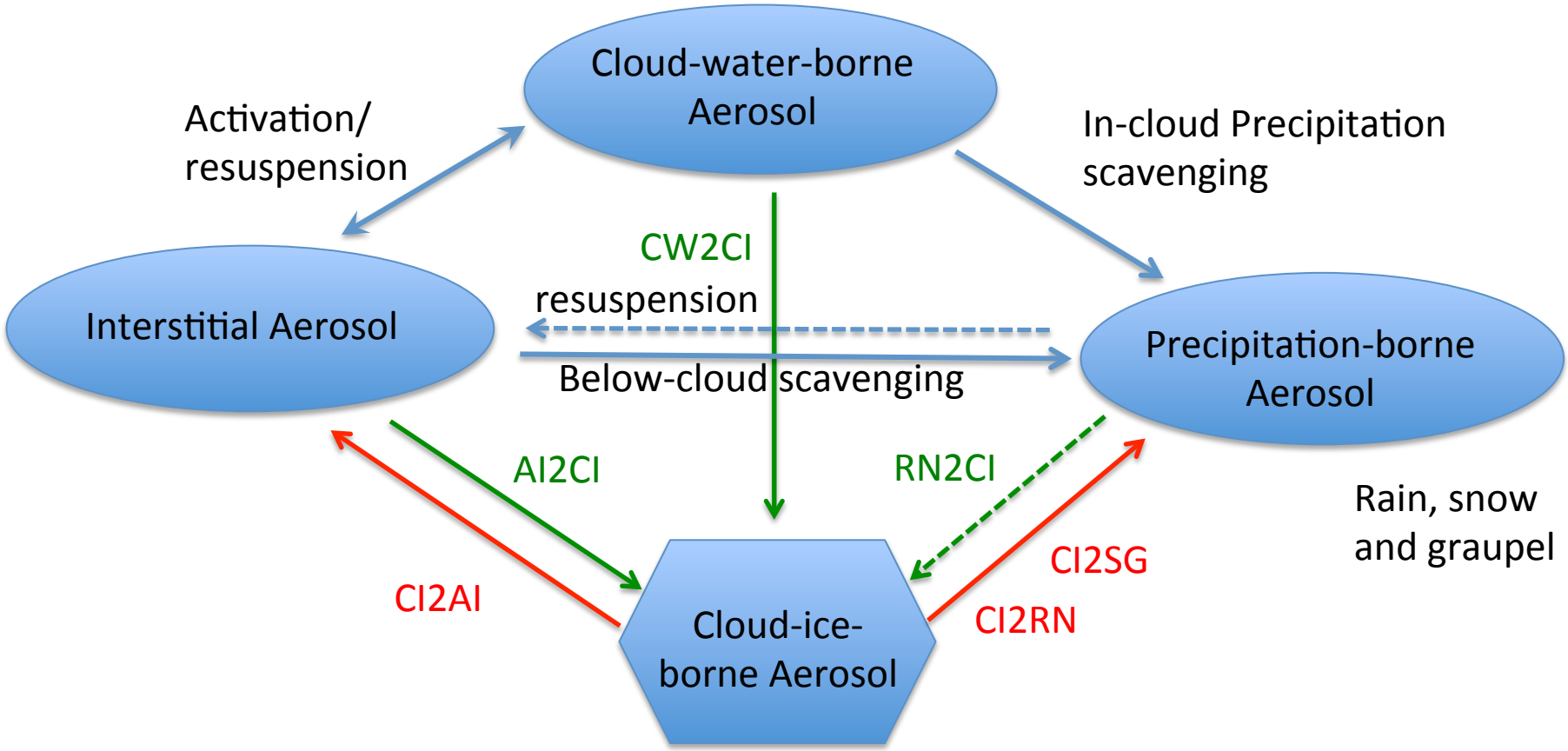
Aerosol vertical profiles (model vs. obs)



Plans for improvement:

- Initial aerosol for the model (use obs)
- Secondary activation (above cloud base)
- Cloud-ice-borne aerosol
- Aerosol resuspension (from rain evaporation)

Aerosol transformation b/w phases



Test case setup

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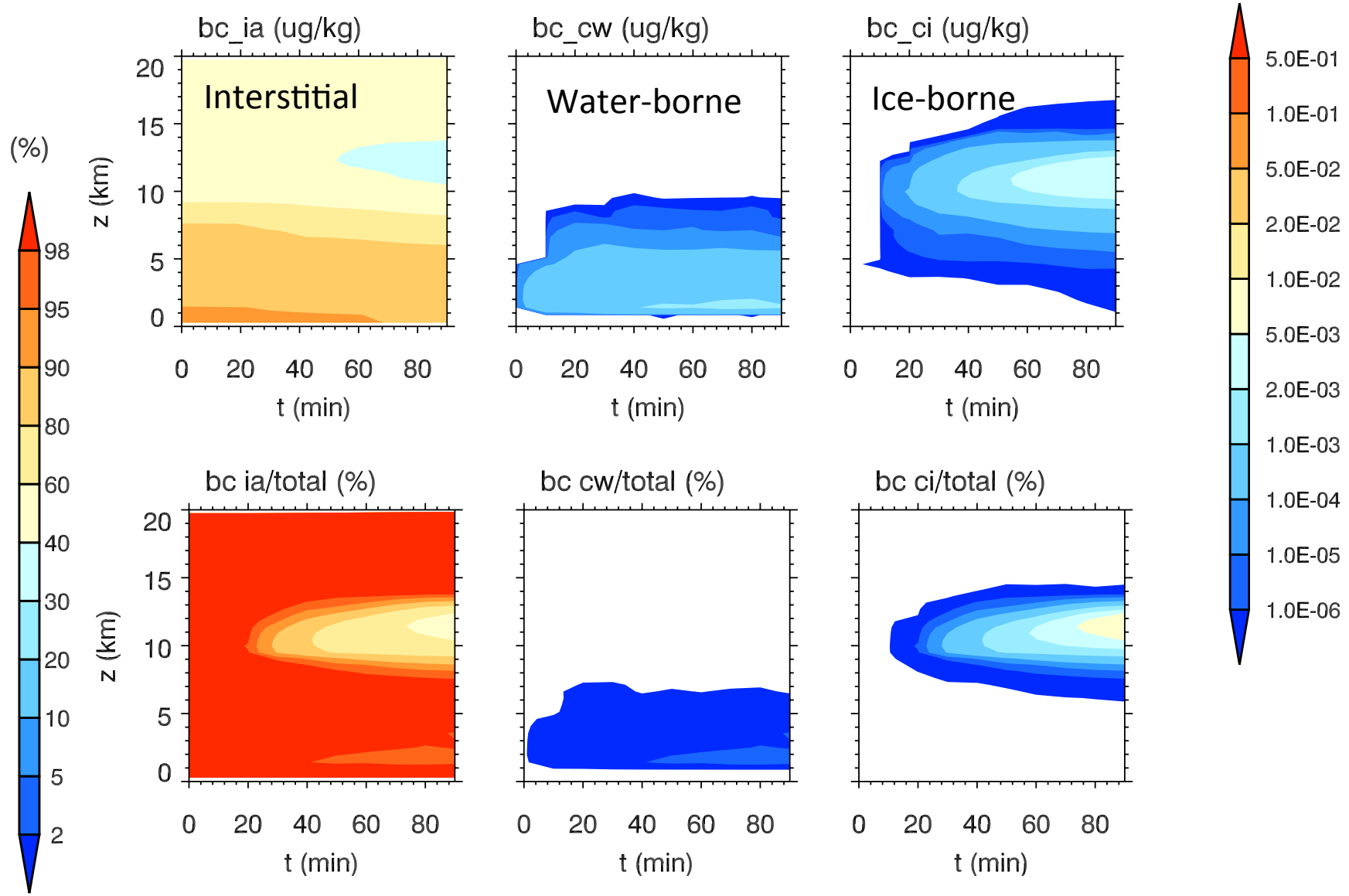
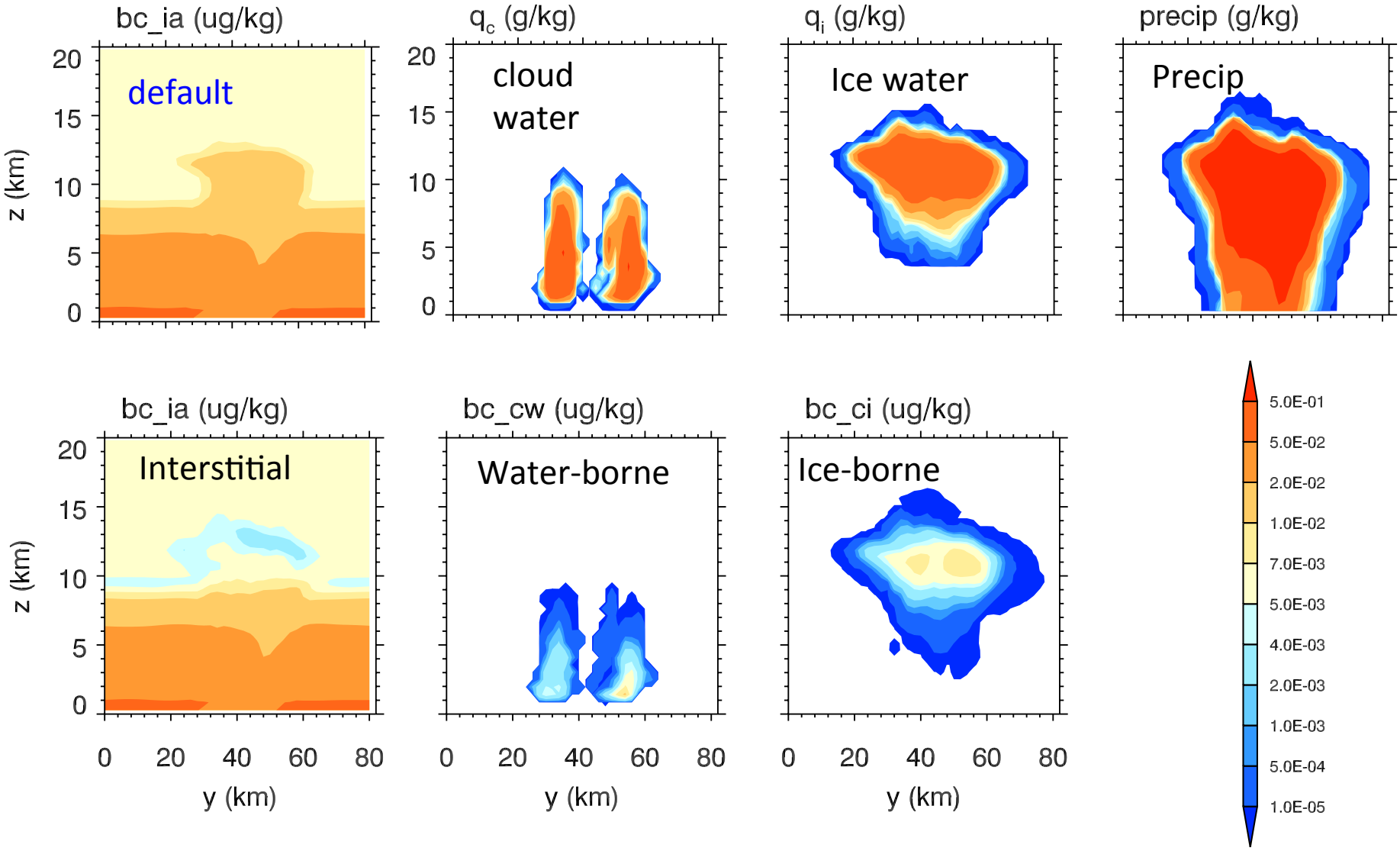
- The idealized em_quarter_ss (super cell) case
- dx=dy=2 km; dt =12 s
- 42x42 grids; 40 layers and 20 km deep; 90-min simulation
- Periodic boundary conditions
- No emissions but prescribed initial aerosol profiles (modified Texas-2004 case)
- No subgrid convective transport (chem_conv_tr=0)

Time evolution of aerosol profiles (w/ ice-borne aerosol)



y-z cross-section (at t=60 min)



Summary

- WRF-Chem is capable of capturing the signature of aerosol wet removal
- More model improvements needed
  - Cloud-ice-borne aerosol
    - Implemented to WRF-Chem, coupled with Morrison microphysics; preliminary results show significant impact on aerosol vertical distribution
  - Precipitation-borne aerosol
    - To account for aerosol resuspension
  - Secondary activation (above cloud base)
    - Particularly for convective clouds with strong updrafts
- More measurements needed to evaluate models