Simulated RACORO Clouds and Their Sensitivities to Microphysics

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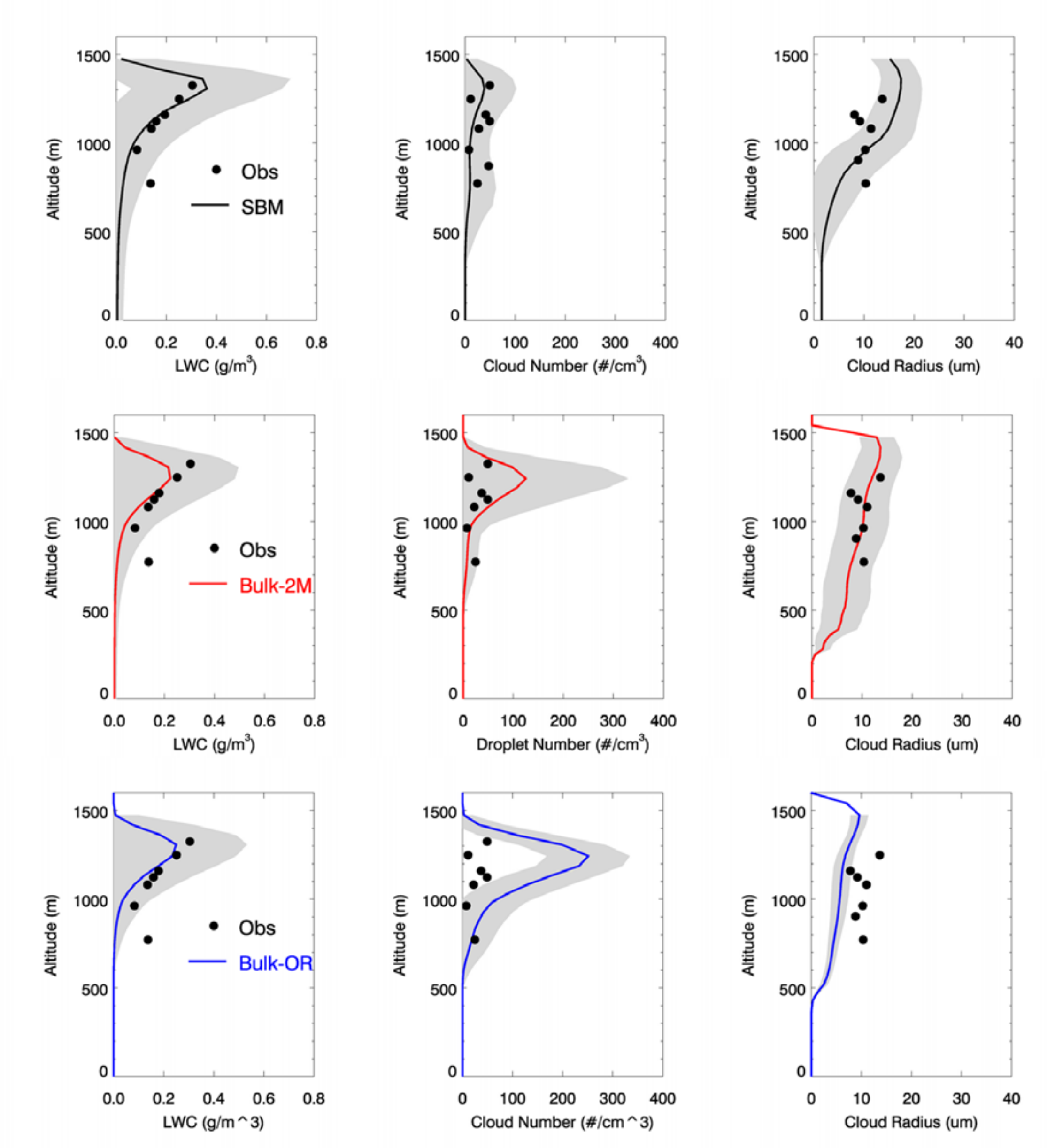
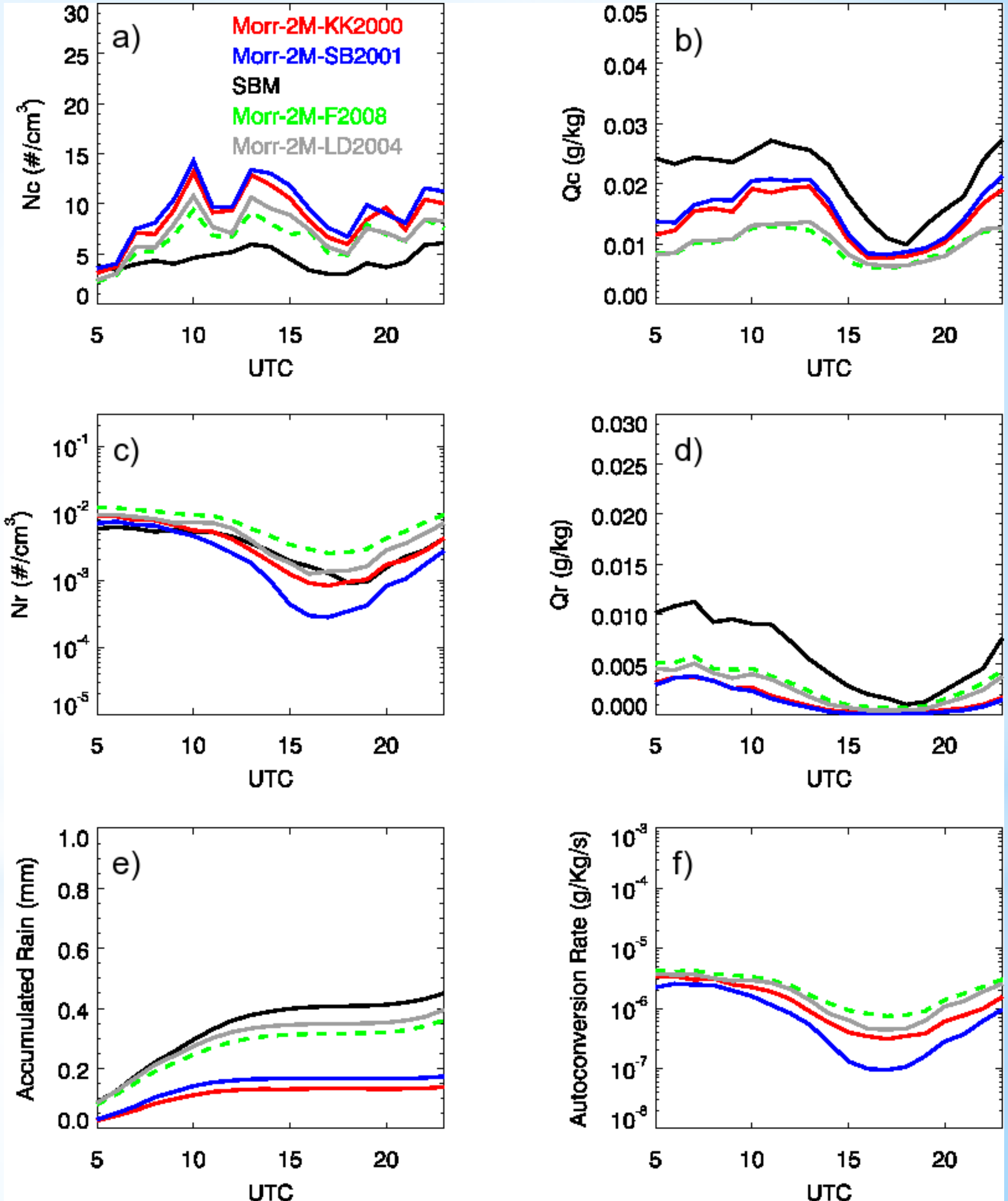
Importance of Aerosol Scheme

- Maritime stratocumuli [*Wang et al.*, under review]
- Bulk-OR:
  - fixed CCN spectrum
  - overestimate Nc
  - underestimate Rc
- Bulk-2M:
  - prognostic Na and Qa
  - better agreement with SBM

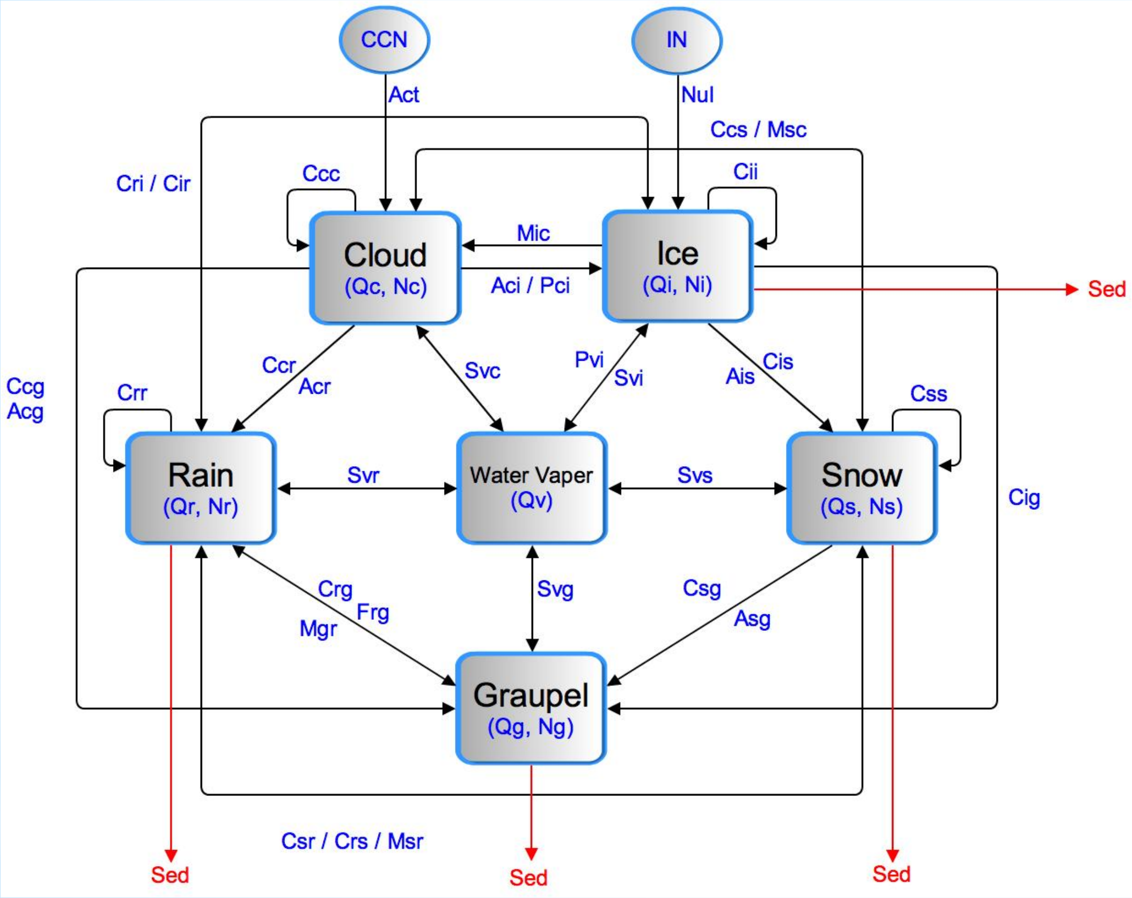


Importance of Autoconversion

- VOCALs maritime Sc Cloud[*Wang et al.*, under review]
- The scheme incorporating the relative dispersion of the cloud droplet distribution [*Liu and Daum*, 2003] and the scheme considering the effect of turbulence on the collisions and coalescences [*Franklin*, 2008] outperform other schemes.
- Embroynic rain drop radius is suggested to be 41 micron for Sc.



Microphysics in CR-WRF



[Li et al. 2008]

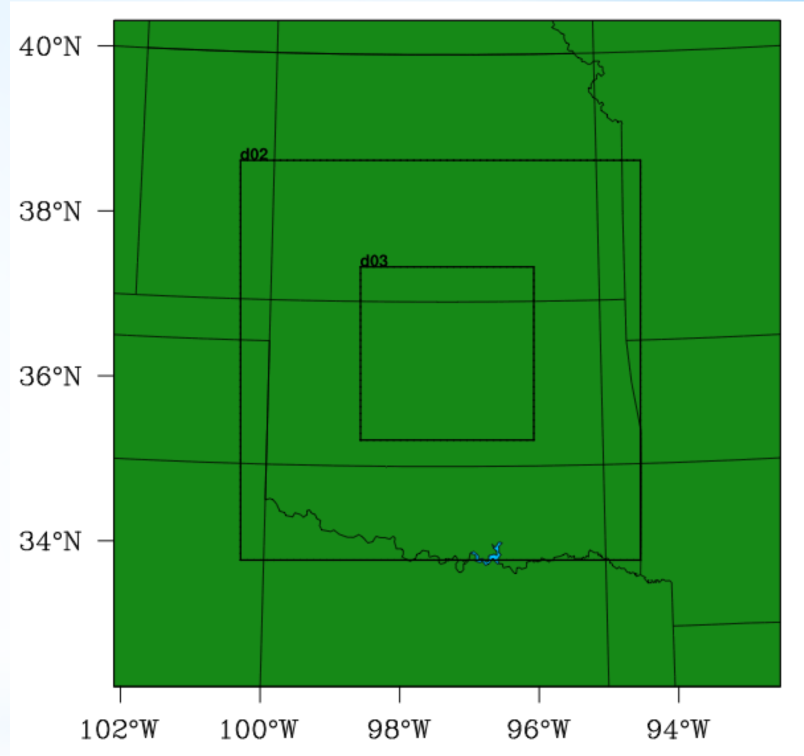
- Prognostic number concentration and mass mixing ratio for cloud, rain, ice, snow graupel
- Explicitly predicted water vapor mixing ratio and super saturation
- Six autoconversion options including *Liu and Daum* [2003]
- Three moment aerosol modal approach with three prognostic Qa, Sa and Na
- Interacting with radiation scheme to consider aerosol radiative properties

Proposed Reseach Activities

- Inter-comparison with other microphysics in the FASTER testbed
- Investigation of aerosol effects on the low-level clouds
  - Direct/Semi-direct Effect
  - Indirect Effect
- Examination of the paramterizations in the microphysics
  - Autoconversion
  - Saturation Adjustment/Predicted Saturation for Condensation
  - Aerosol Scavenging and Regeneration

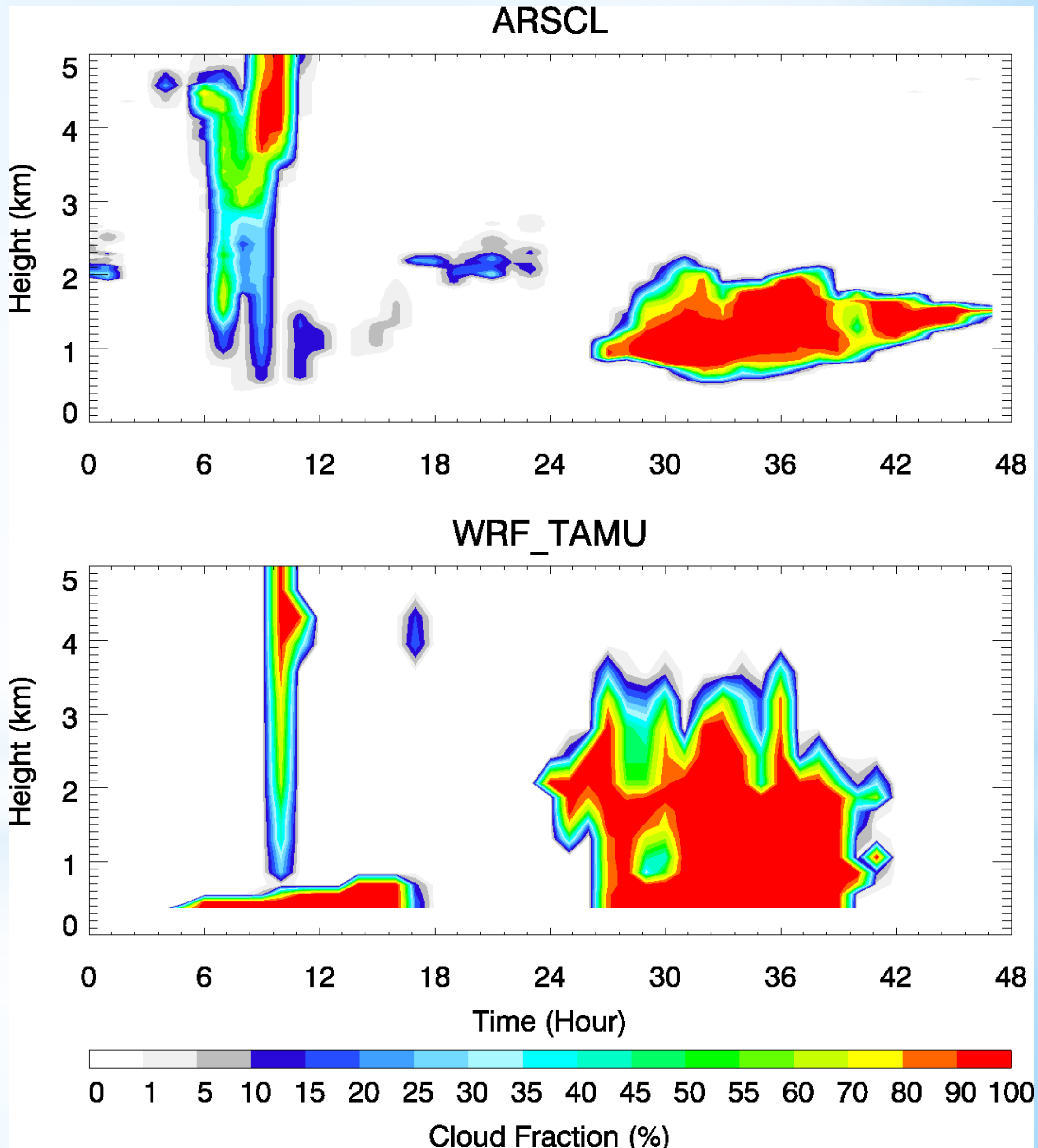
Model Setup and Case Description

- WRF v3.1.1 with TAMU two-moment bulk microphysical scheme
- 3 interactive domains
- Innermost domains covers SGP central Facility and RACORO flights routes with 750m spatial, 50 vertical res.
- North American Region Reanalysis
- May 26-28, cumulus and drizzling stratus, low CCN, low updraft
- Two different aerosol profiles used: control case (c-case) ~ 400 particles/cm^3 and polluted case (p-case) ~ 2000 particles/cm^3
- Aerosol radiative effects are considered seperately (prad-case)

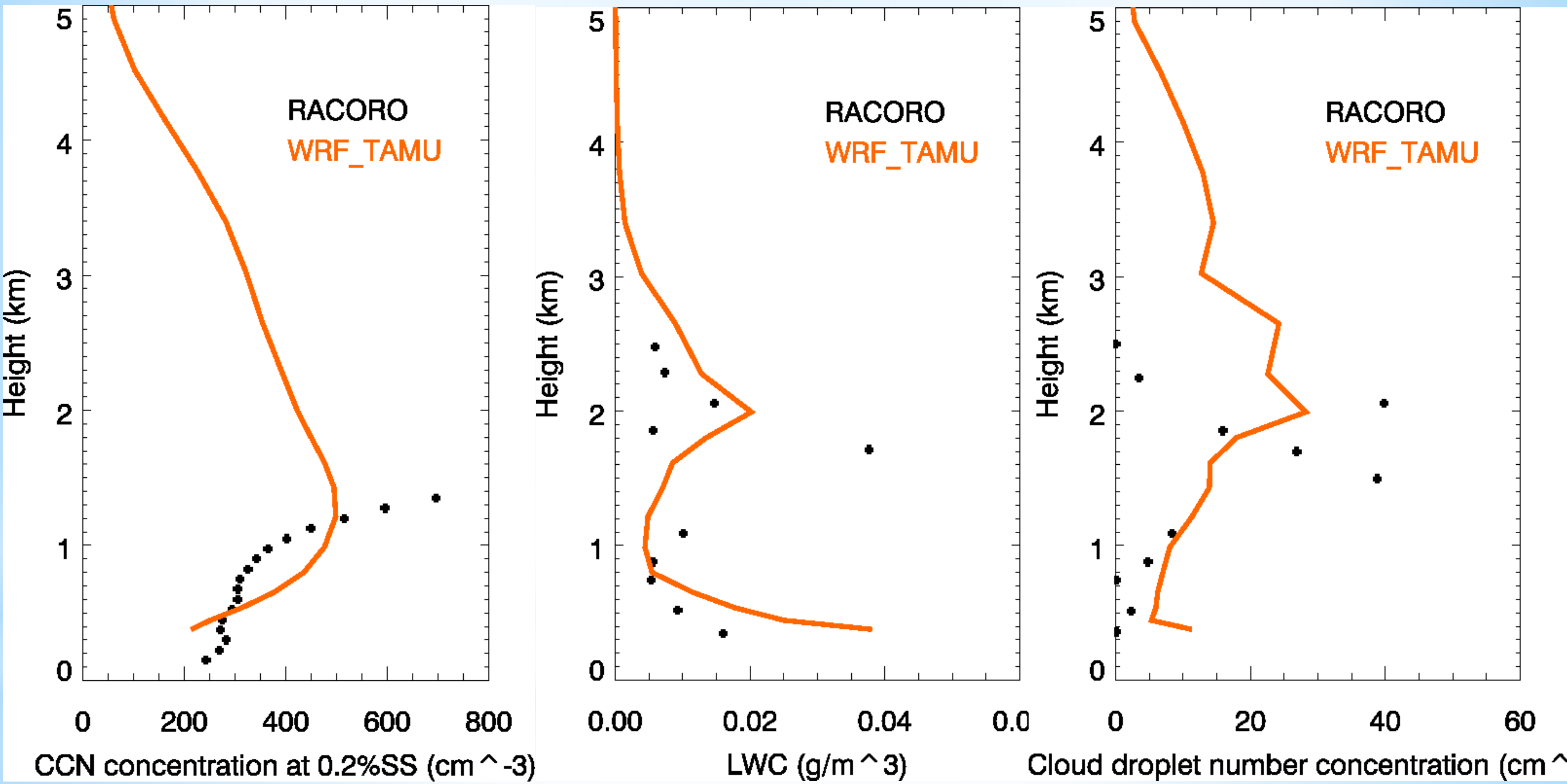


Cloud Fraction

- Obs: ARSCL
- Model: 5x5 box
  - Qtot > 10^{-6} kg/kg
- Cumulus & Status
- Modeled cases similar
- Timing consistent
- Overestimation close to the surface



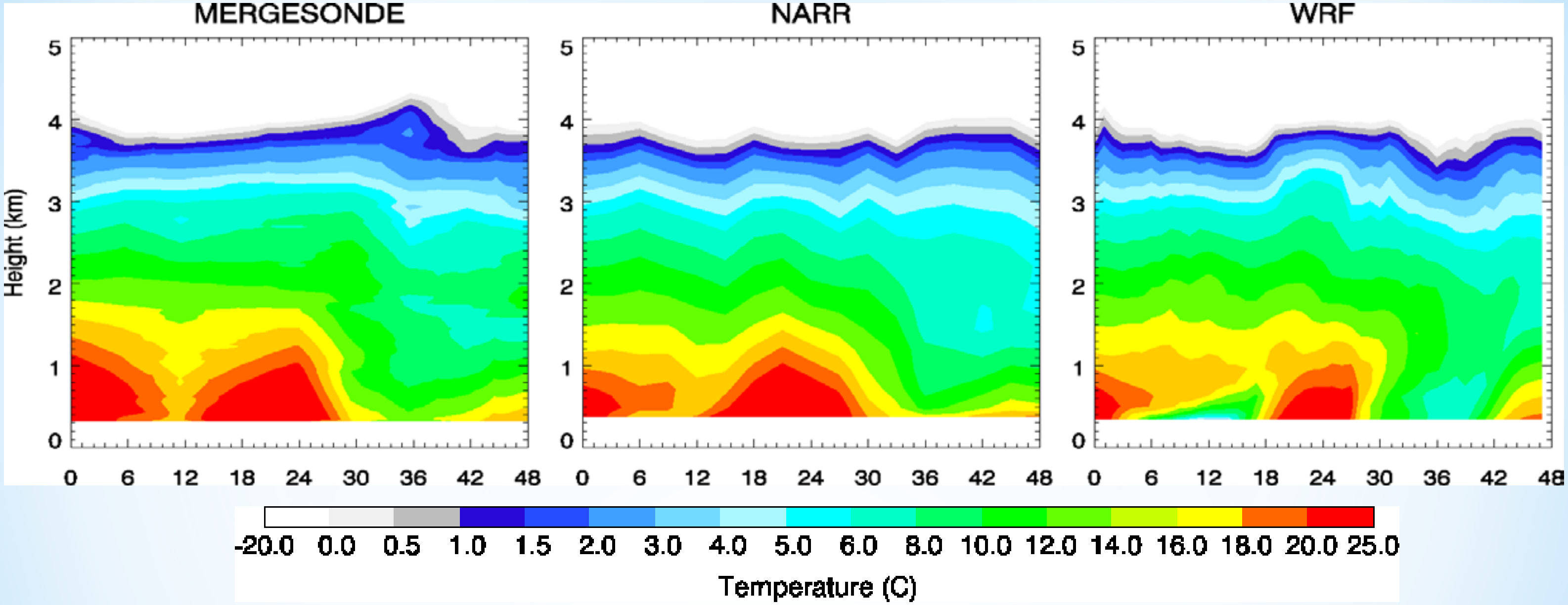
Microphysical Properties



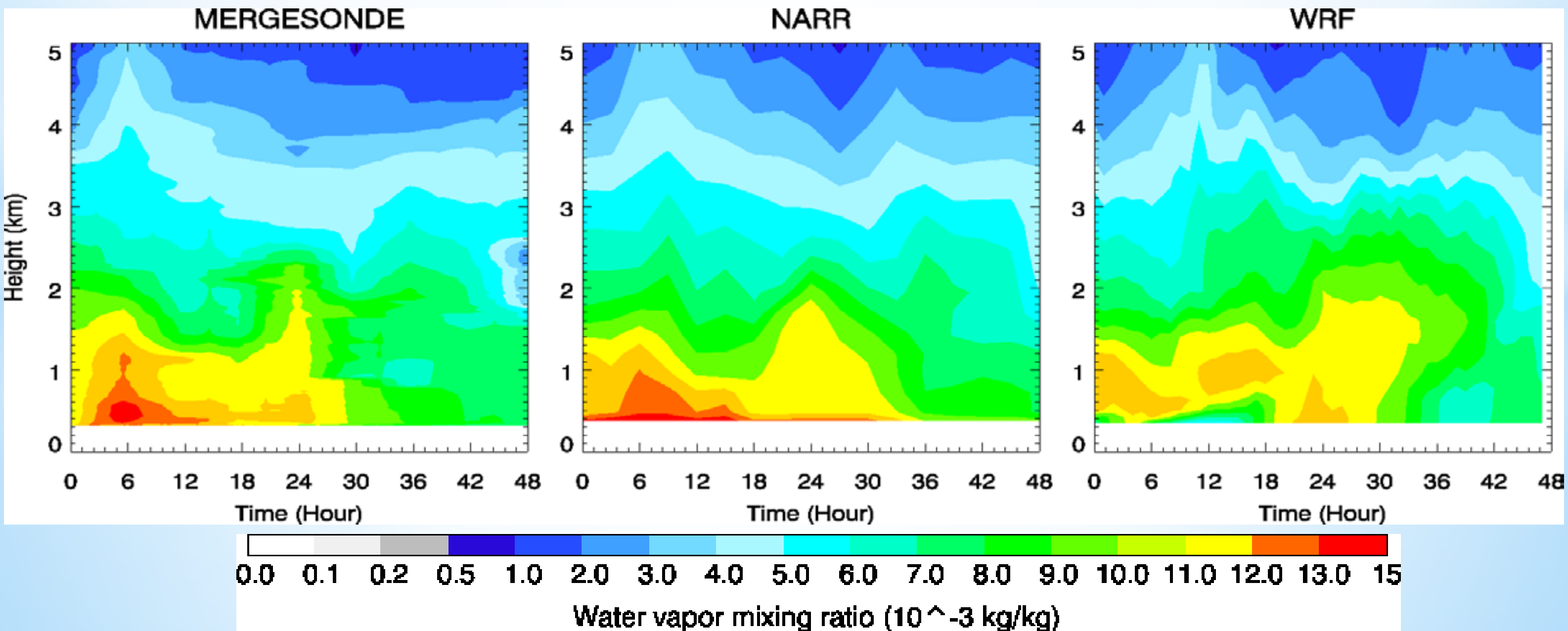
CCN LWC Nc

Atmospheric Sate

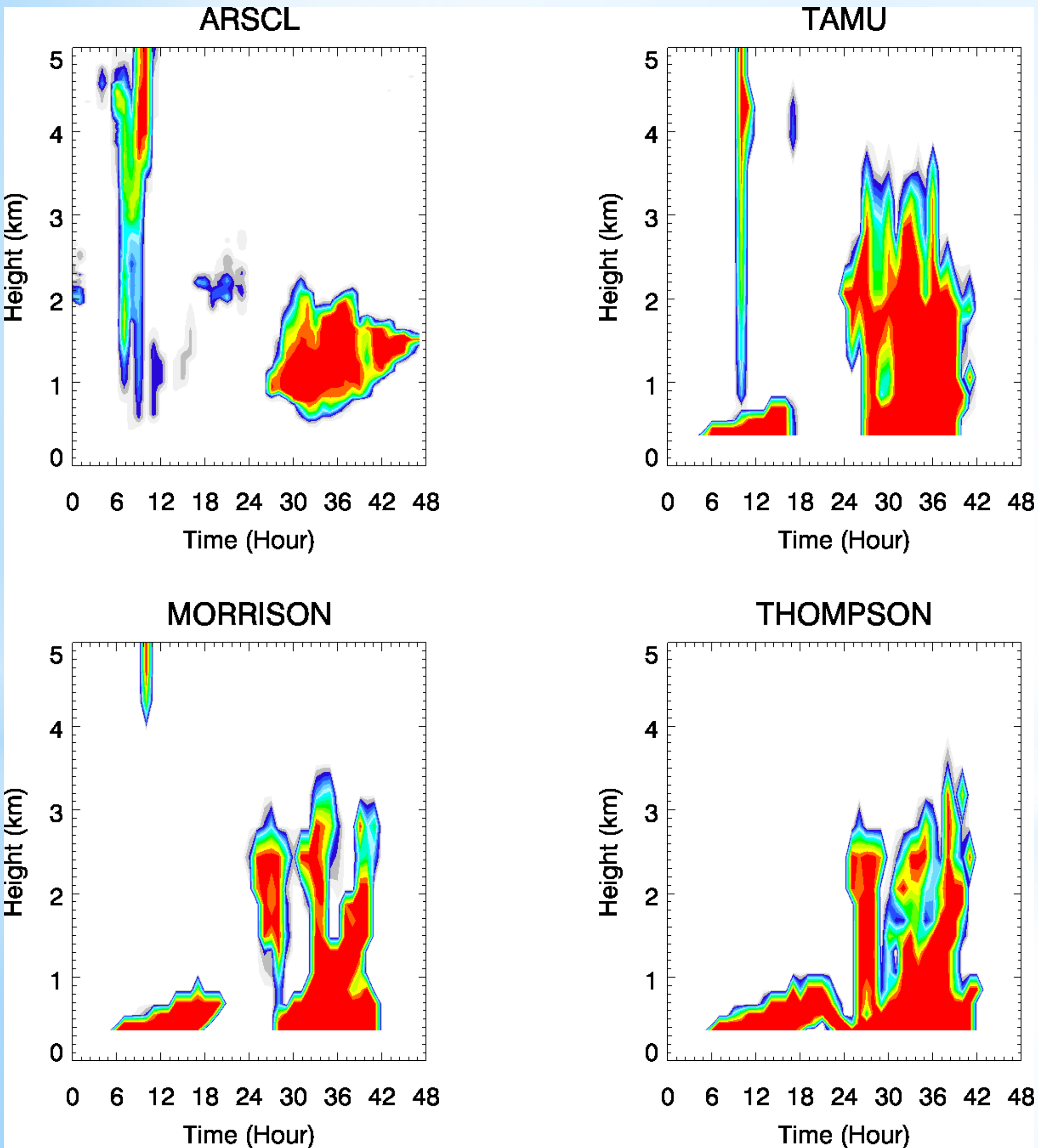
T

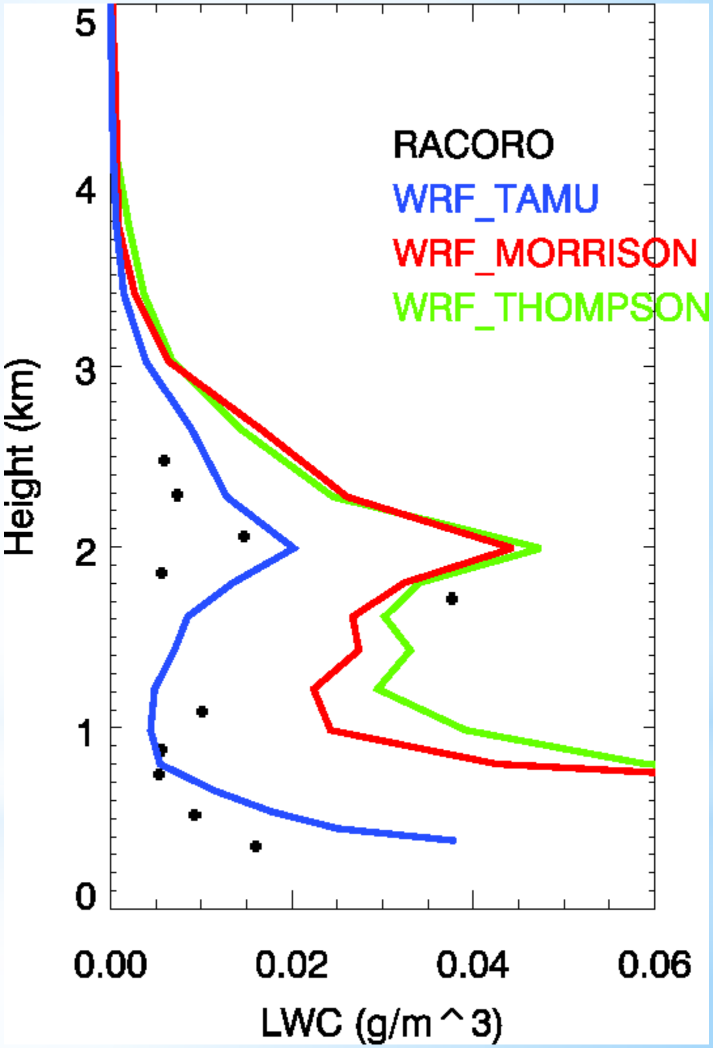


Qv

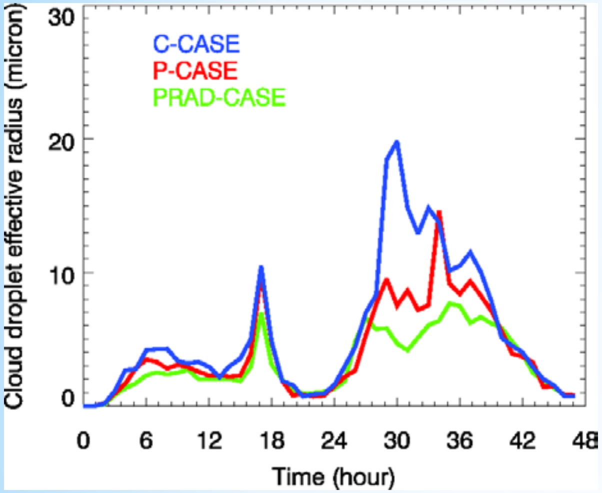


Sensitivity to Microphsics

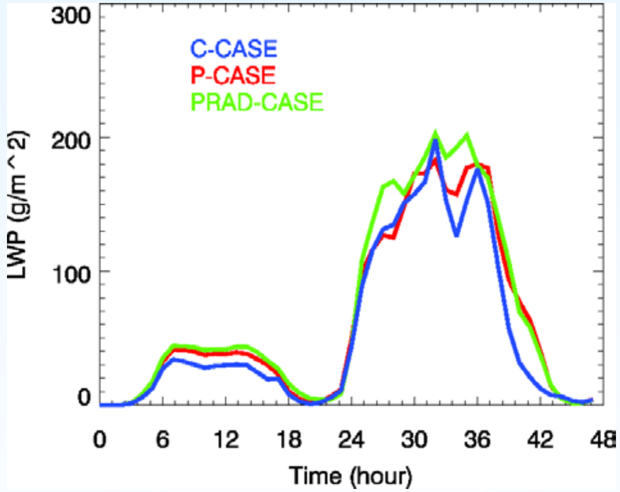




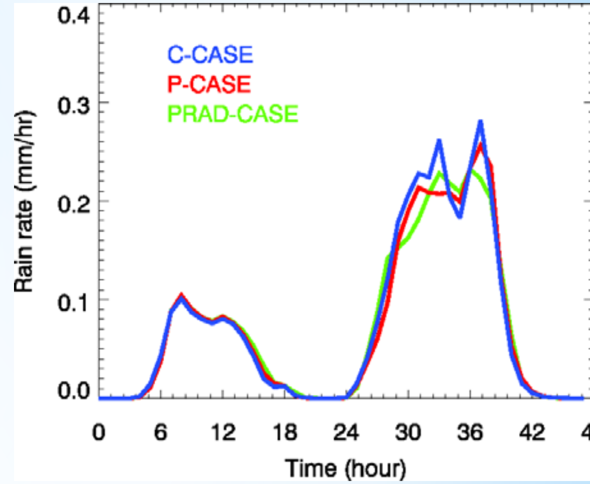
Sensitivity to Aerosols



Rc

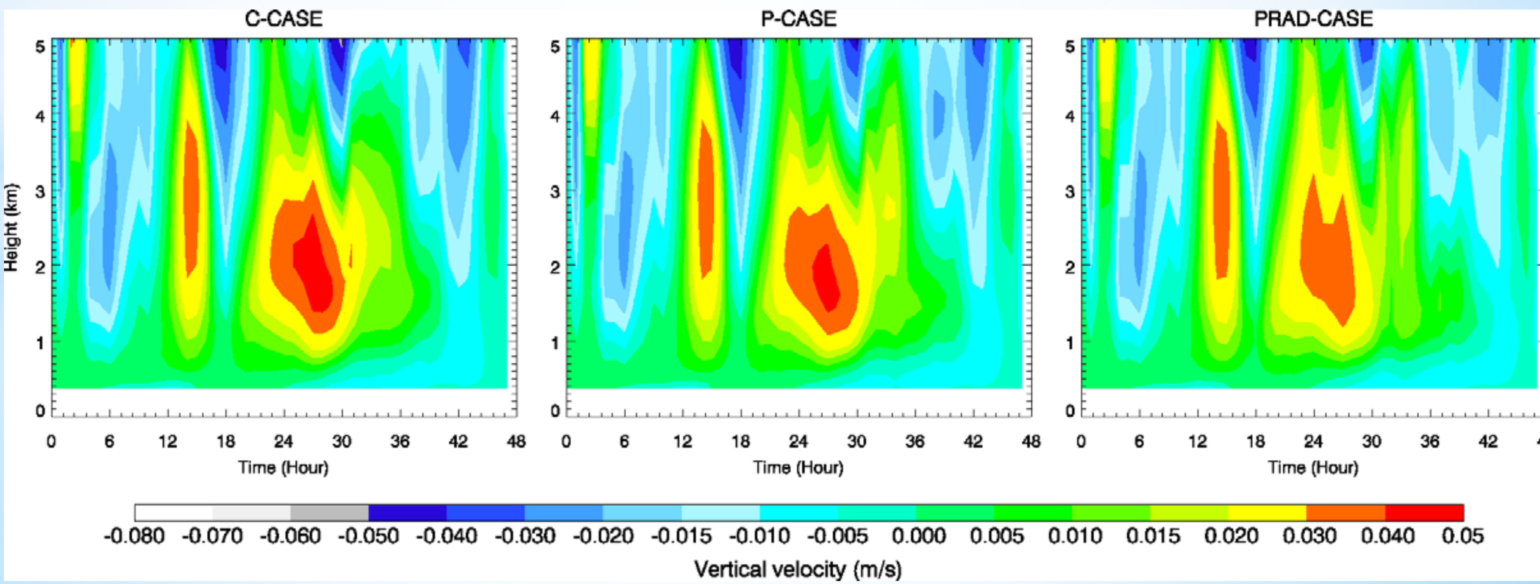


LWP



Rainfall

Vertical Velocity



Conclusions

- WRF model with two-moment cloud microphysics and three moment aerosol scheme predicted the evolution of low lever cumulus, stratus as well as CCN.

- Over-estimated cloud amount near the surface is mainly caused by biased temperature simulation in the WRF.

- Cloud microphysics developed at TAMU show a better agreement with field measurement than some of the other microphysics in the WRF.

- Aerosol efficiently affect the cloud effective radius, precipitation efficiency and the cloud dynamics.