Focus Group: Aerosol Deep Convection/Cloud Interaction

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Overarching Question

What aerosol-related processes influence deep convection cloud properties relevant to climate (anvil radiative forcing, latent heating profiles, detrainment, precipitation)?

Objectives

- To find and reinforce key factors determining the impacts of aerosols on anvil radiative forcing, detrainment, latent heating and precipitation through rigorous and insightful analysis of **observations** from both ARM data and other datasets

- To improve our understanding of the mechanisms governing aerosol-deep convection interactions by means of **modeling** with incorporation of observational data.

- Identify differences in aerosol impacts on convection across **models and observations**, and understand specific processes responsible for explaining these differences.

What do we do for the breakout ?

- Show your progress
- Explore collaborations on analysis
- Identify unmet measurement/retrieval needs
- Discuss potential new field experiments
- Consider incorporation as a focus group
- Prepare to report for plenary tomorrow

Talks (10:15-12, 15min/each)

- Jiwen Fan, PNNL

  A new mechanism of aerosol ‘s impact on ADCI

- Zhanqing Li, University of Maryland

  Estimation of ADCI-iuduced changes in cloud radiative forcing of DCCs

- Susan C. van den Heever, Colorado State University

  The impacts of aerosols on MCSs observed during MC3E – preliminary results.

- Guang Zhang, Scripps Institute of Oceanography

  Aerosol effects on convection in NCAR CAM5

- Danny Rosenfeld, Hebrew University

  Satellite retrial of vertical microphysical profile of convective clouds and retrieving their cloud drop number concentrations

Talks (1:30-3:30, 15min/each)

- Marcus van Lier-Walqui (Ann Fridlind), NASA/GISS

  Analysis of storm-to-storm and within-storm variability of C-band and S-band polarimetric signatures in MC3E deep convection updrafts

- Xiquan Dong, University of North Dakota

  Diurnal and Life Cycles of DCS and associated precipitation and TOA CRFs.

- Pierre Gentine, Columbia University

  Representing the diurnal cycle of continental convection with an ensemble of plumes

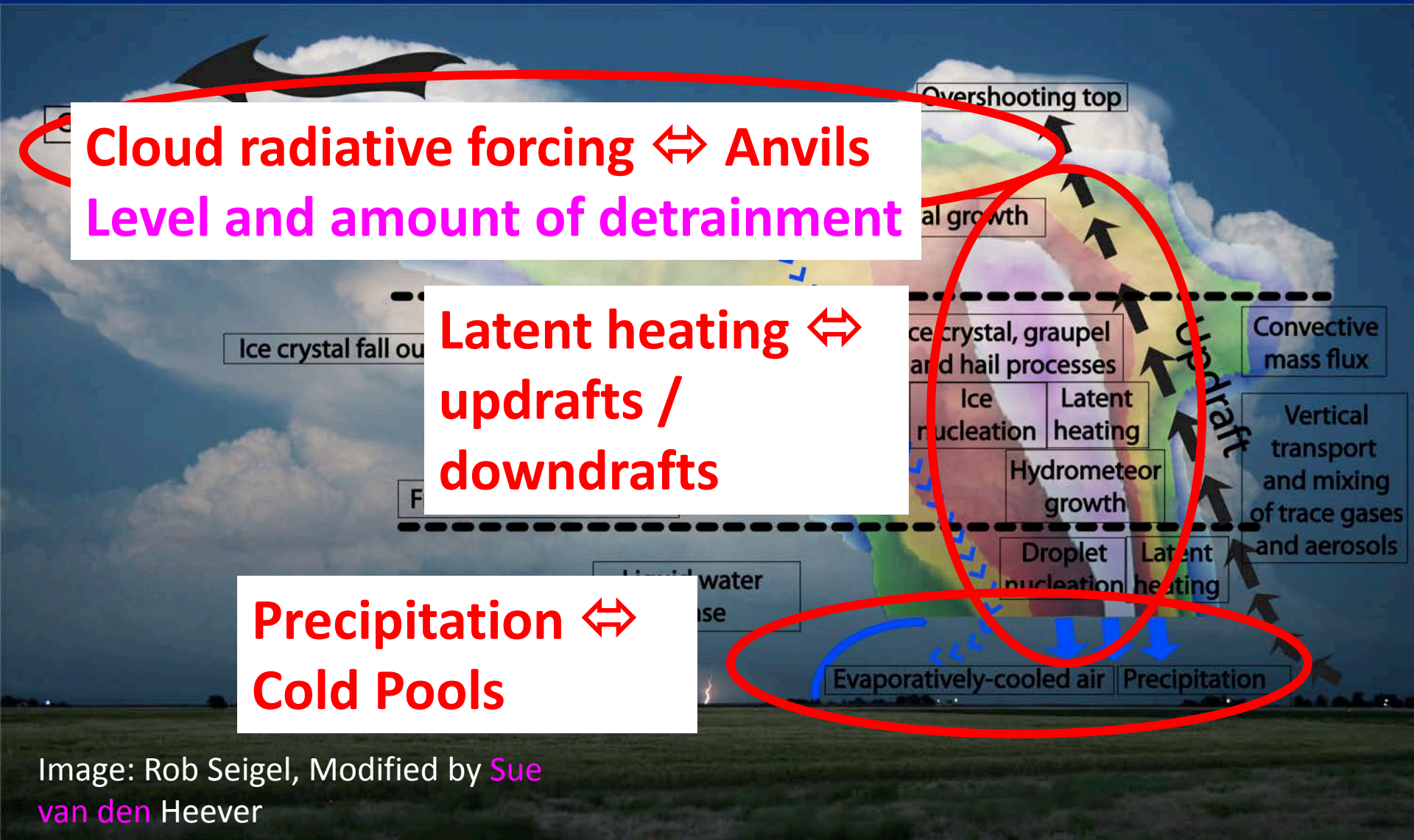
- Virendra Ghate or Jennifer Cmostock (tentative).

  Overview and update of the vertical velocity products for studying DCCs

- M.G. Manoj, University of Maryland

  Aerosol effects on deep convection over the Indian region during ARM GVAX Campaign

Aerosol Effects on Deep Convection



Cloud radiative forcing ⇔ Anvils
Level and amount of detrainment

Latent heating ⇔ updrafts / downdrafts

Precipitation ⇔ Cold Pools

Image: Rob Seigel, Modified by Sue van den Heever

Key Issues & Uncertainties

- Anvil radiative forcing

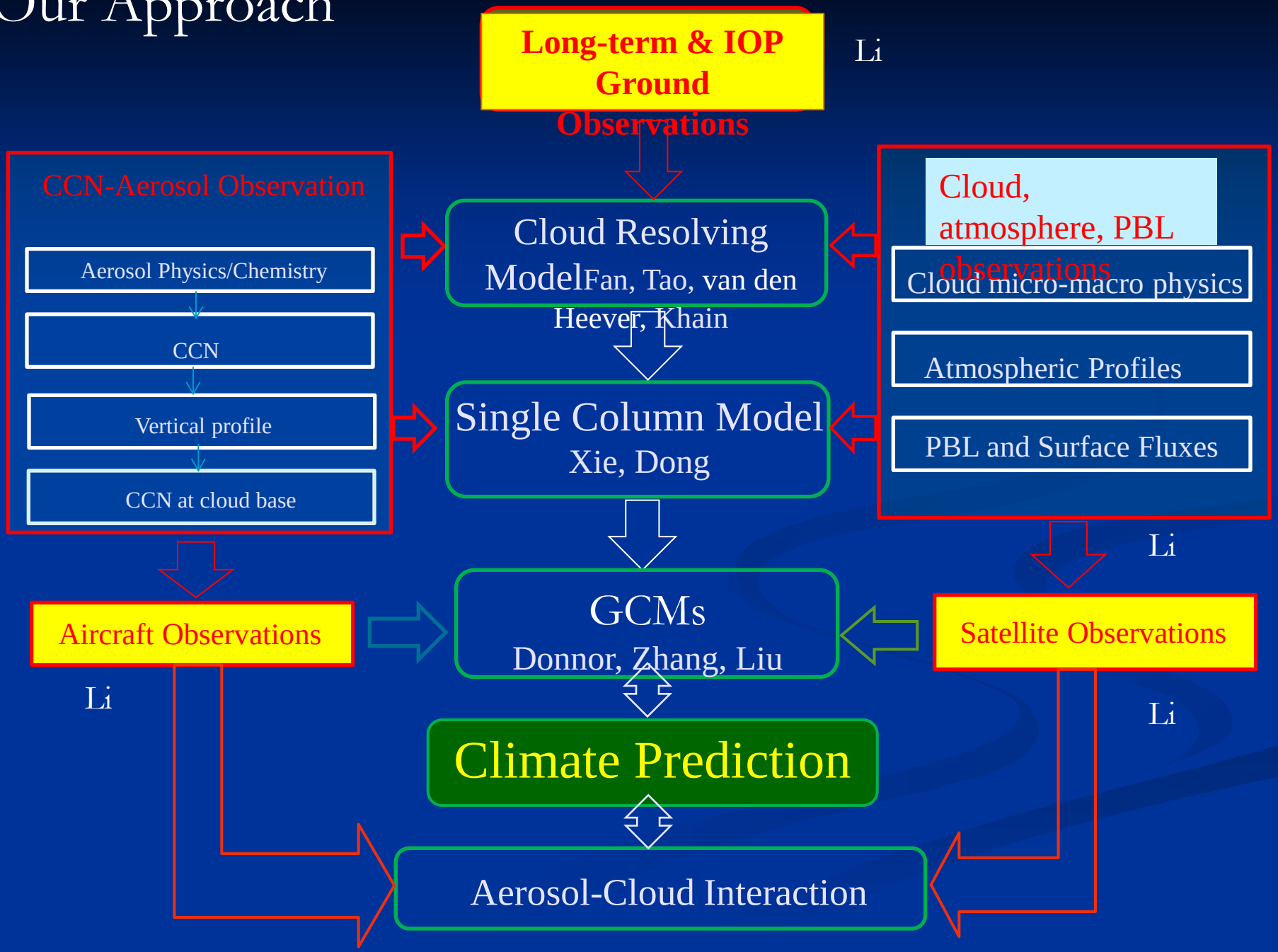
  Responses vary from negative to positive responses in recent observational, CRM and conceptual studies

  Anvil fractional coverage

- Latent heating & vertical velocity:
  - Cloud base height & mixed-phase microphysical processes
  - Vertical velocity
  - Feedbacks between latent heating and vertical motion
- Detrainment
  - Level and amount
- Precipitation

  "Among these modeling studies, the most striking difference is that cumulative precipitation can either increase or decrease in response to higher concentrations of CCN." (Tao et al 2012, Rev. of Geophy.). For CAPI, both rain amount and PDF matter !

Our Approach



Observations Needed & Challenges

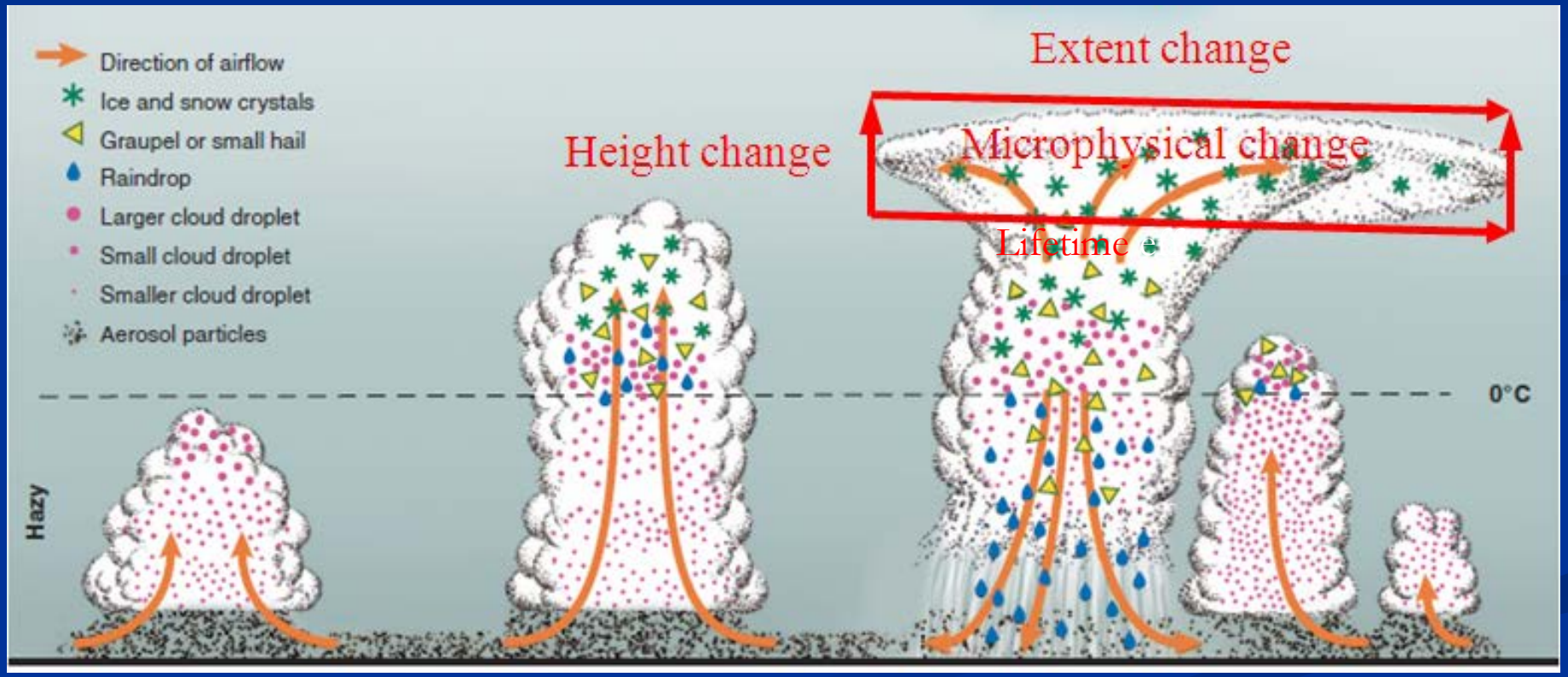
- **CCN near cloud base and IN inside clouds**
- **Vertical velocity through the depth of deep convective systems**
- Latent heat profiles
- Anvil heights and extent
- Large spatial domain measurements to monitor evolution of cloud system
- Continuous coverage of diurnal variation
- Diverse environmental conditions

Exploitation of All-kinds of Observations

In-depth and extensive analysis Of multiple datasets to reveal the Effects of aerosols on cloud, Precipitation & Radiation

Revealing Aerosol Effects → **Understanding Aerosol effects** → **Quantifying Aerosol effects**

Impact of aerosols on cloud radiative forcing (Aerosol-Mediated CRF) and levels of detrainment



Modeling Challenges

What can explain large differences among different modeling studies?

- - different cases (sensitivity to environment, e.g., shear, RH, CAPE)
- - differences in models and model parameterizations (e.g., bulk vs. bin microphysics)
- - different spatial and temporal scales
- Stage in the lifecycle
- How can we best use ARM observations (and other datasets) to constrain models?

What collaborative activities can we focus on to address these issues?

- - e.g., systematic modeling studies to address differences for

What are we doing collectively ?

1. Z. Li, Obtain observational estimation and constraints of both ERDari and ERFaci using ARM and Satellite data
2. D. Rosenfeld, Estimation of CCN at cloudbase
3. Ghate, Cmostock, Kirk North and Scott Collis, 3-D wind
4. X. Dong, Datasets tailored for DCS.
5. J. Fan, Real case simulations.
6. Susan van den Heever, idealized and case study simulations of aerosol effects on deep convection
7. G. Zhang Convective Microphysics Parameterization
8. Leo Donner (GFDL), ADCI Coupling in GFDL AM3
9. Ann Fridlind, Combining observations MC3E and CRM simulations to constrain aerosol-cloud interaction
10. Pierre Gentine, Convective dynamics

Recommendation for Observation

1. To continue the pursuit of challenging quantities as identified above
2. To exploit extensive measurements from ground-based (all ARM fixed sites and AMF sites), air-borne (ARM campaigns) and space-borne measurements to attempt to identify and quantify different types of AIEs
3. To provide metrics of the estimates of AIEs from a variety of observation platforms for validation and improvement of a hierarchy of models

Recommendation for Modeling

1. To continue process-oriented modeling exercises to tackle with challenging issues identified

2. To run LES, CRM, SCM and GCM models to try to simulate observed cloud scenes with diverse aerosol inputs and meteorological settings.

3. To analyze modeled quantities in the similar manner as the analyses of observations to examine various relationships as revealed from observations concerning different types of AIEs.

Recommendation for Observers & Modelers

1. Identify deficiencies in both modeling and observations regarding their validity in studying the AIE.

2. Sort out true effects from false appearance.

3. Evaluation of model's performance in simulating the AIEs from local to global scales

Approach - Modeling

- Step 1: Idealized simulations
  - using simple, common dynamical framework and multiple microphysical schemes
  - Basic environment determined using SGP data
  - Identify deficiencies in microphysical and aerosol processes using SGP observations => improve them
- Step 2: Case study simulations
  - MC3E cases
  - Comparisons with ARM observations
  - Identify microphysical-dynamical feedbacks
  - Identify processes and feedbacks important to represent in GCM parameterizations