Cloud Life Cycle WG Opening Plenary

31 October 2012

ASR
Atmospheric System Research

U.S. DEPARTMENT OF ENERGY | Office of Science

CLWG Leadership

CLWG co-Chairs

Tony Del Genio

Matthew Shupe

CLWG Steering Committee

Jennifer Comstock

Stephen Klein

Steven Krueger

Jay Mace

A New Approach

- **What?** Science team organized more directly around programmatic scientific objectives (we've been moving in this direction!)
- **Why?** To better facilitate larger, and more significant, programmatic accomplishments (= bigger impact on models)

A New Approach

- **How?**
  - More discussion, coordination, collaboration.
  - More emphasis on group activities.
  - Modified meeting structure.
  - Active Focus and Interest Groups
  - Guidance from DOE managers and WG leaders
  - Individual PIs fit into, and shape, the priority research themes and activities

A New Approach

The Challenge: To have active participation from the Science Team.

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CLWG Meeting Design

- Opening plenary (here we are!)
- Science theme discussions
  - Shallow>Deep Convection (Wed. pm)
  - Mesoscale Convective Organization (Wed. pm)
  - Cu/Sc/St (Thur. am)
  - Phase partitioning (Thur. pm)
  - Ice size dist'n
- QUICR (Thur. am), MC3E (Tue. pm)
- No IcePro, No AMIE/Dynamo, No Radar
- CLWG wrap up (Thur. pm)
  - Building the bigger CLWG/ASR picture
  - What are our priorities moving forward?

Science Theme Discussions

- Topics determined by WG chairs and steering committee
- Invited overview presentations
- Panel-guided discussion

Science Theme Discussions

- Fine tune science question(s) as needed
- Prioritize scientific focus / foci
- Identify participating/contributing investigators and projects
- Draw strong guidance from model importance, limitations, and difficulties
- Identify critical measurements, parameters, and data products (VAP guidance)
- Establish plans for coordinated research activities and for informing model needs

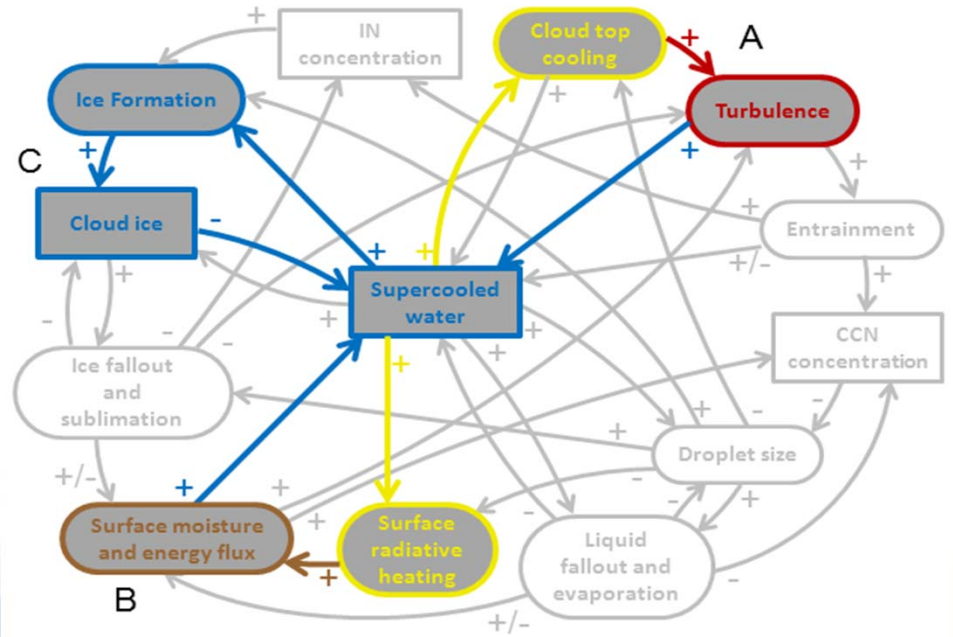
Science Discussion Considerations

- Important to establish ways to integrate modeling and observational work.
- Interface with existing Focus and Interest Groups (intentional similarities built in!)
- Consider working towards new groups if appropriate

An Example Science Theme

(& how theme-based activities might evolve in time)

- Arctic mixed-phase clouds
- Informal discussions and coordination over ~2 years among 5 investigators / groups.
- Morrison et al. 2012 Nature Geosciences overview lays out the topic, what is known, and the challenges.



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An Example Science Theme

(& how theme-based activities might evolve in time)

- Multiple pathways identified for future work
  - Model and observational studies looking at role of large-scale advective environment and atmospheric structure
  - Observational and process model studies examining specific cloud-scale processes
  - Apply systems dynamics approach for understanding and modeling a complex system
- This progress is just a start and will contribute towards one of the science themes selected for this meeting

CLWG Programmatic Themes

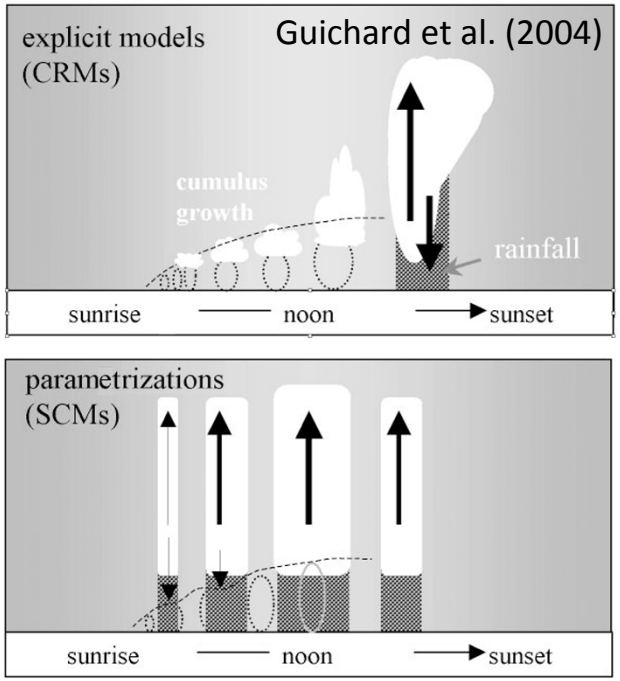
- Shallow to deep convection
- Convection organization
- Cu / Sc / St cloud processes
- Phase partitioning and mixed-phase processes
- Ice particle size distribution

What cloud and environmental processes control the transition from shallow to mid-level to deep convection and how does the transition differ over land and ocean?

- Role of environmental conditions
- Vertical motions inside and outside of cloud, cold pool
- Entrainment/detrainment
- Scales: diurnal, weekly, intraseasonal
- Key measurements: SGP, TWP, AMIE/MJO, MC3E
- Relevant groups: MJO, entrainment, VV

Speakers: *Steve Krueger, Chidong Zhang, ~~Steve Klein~~, Zhaoxia Pu*

Why do we care?

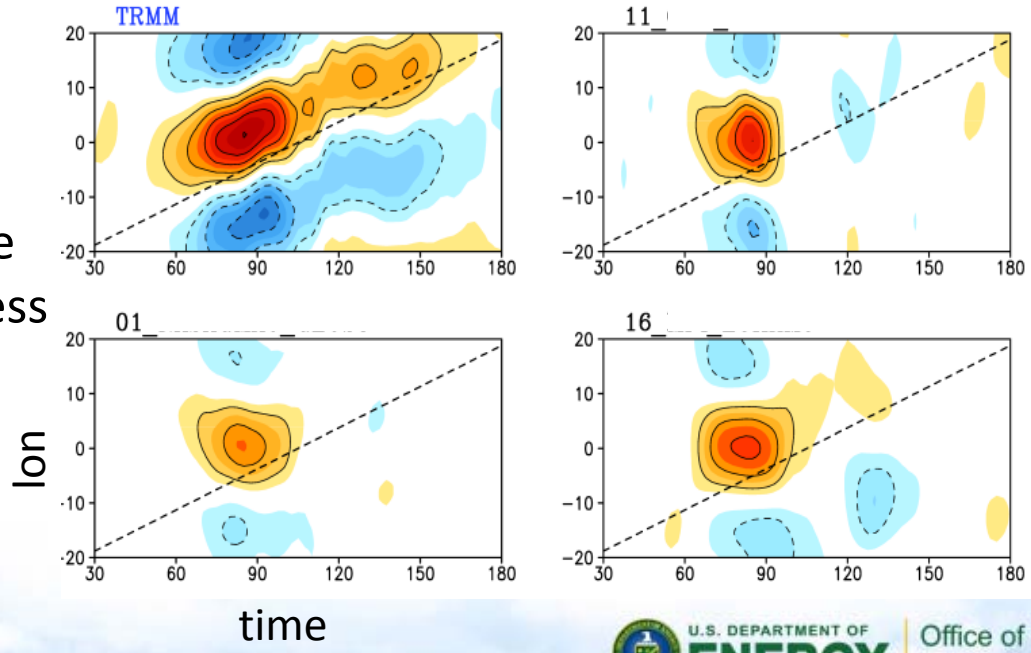


Most GCMs still rain most heavily over land near noon rather than later in the day

Implications for surface and atmospheric energy and water budgets, drought?

Most GCMs still have trouble simulating the MJO (& success comes at the expense of the mean state).
(courtesy N. Klingaman)

Lag correlation of precip with Indian Ocean point

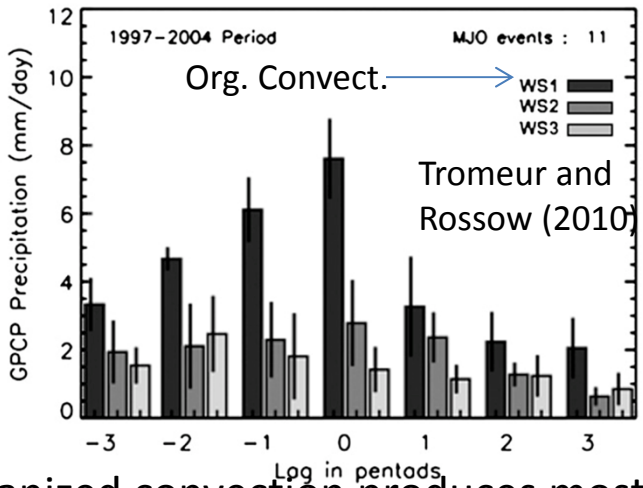


Under what environmental conditions does convection organize into mesoscale structures and why? What processes determine the persistence of the stratiform rain and anvil regions?

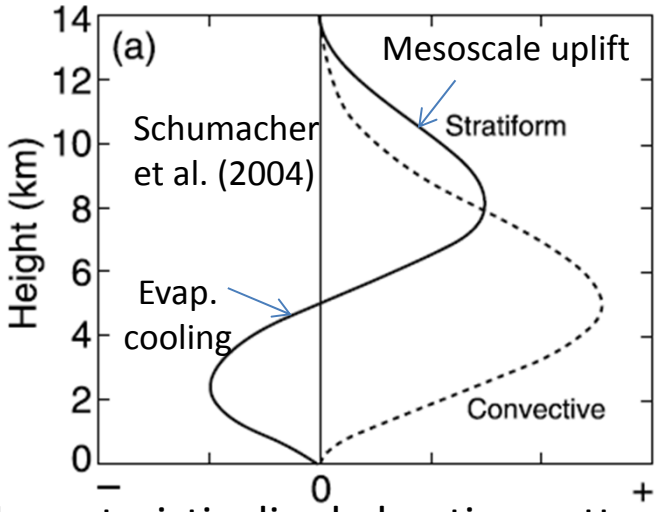
- Roles of wind shear, humidity, cloud microphysics, radiation
- Impact on precipitation processes
- Impact of convective organization on environment
- Key measurements: SGP, TWP, AMIE/MJO, MC3E, TWP-ICE
- Relevant groups: CStAT, VV, entrainment

Speakers: *Courtney Schumacher, Leo Donner, Dick Johnson*

Precip. from different ISCCP states



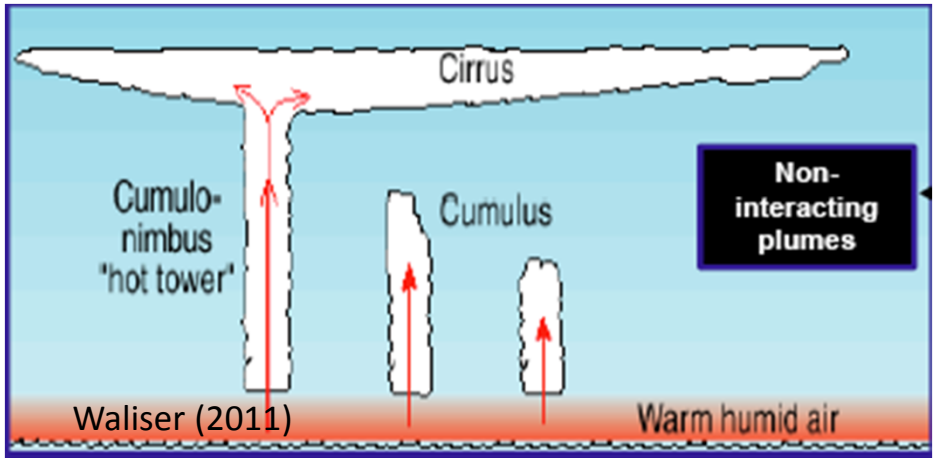
Organized convection produces most precip. and most extreme, long-duration events

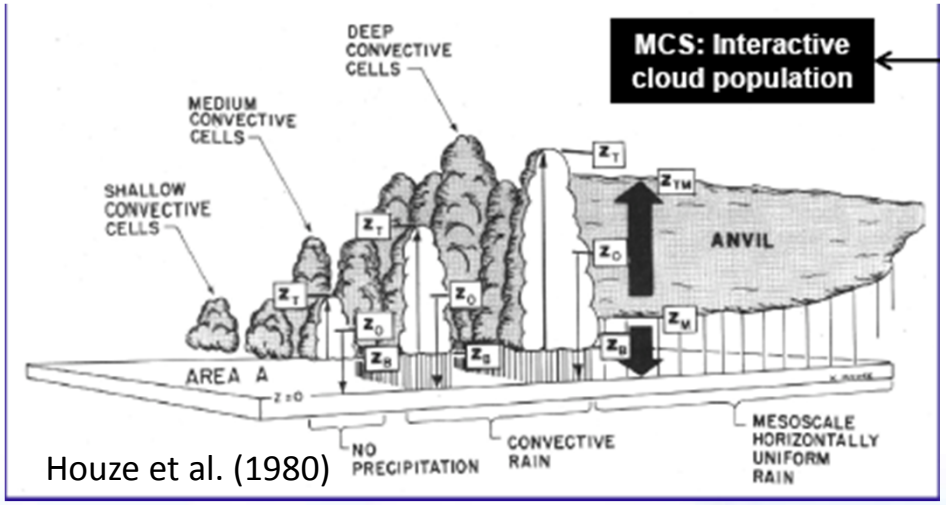


Characteristic dipole heating pattern

Why do we care?

Most GCMs treat convection as ensemble of isolated cells





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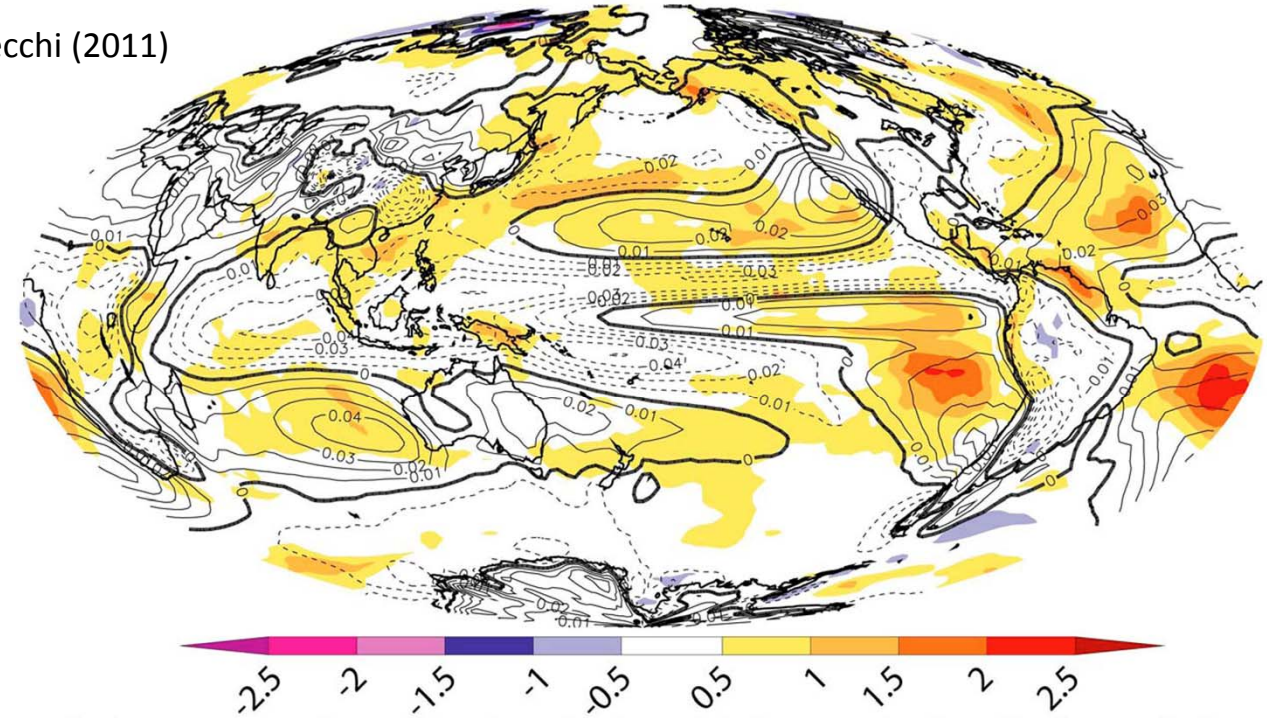
What processes determine the formation, persistence, and evolution of cumulus, stratocumulus and stratus clouds in warm and cold climates?

- Radiation-turbulence-entrainment-microphysics-drizzle-precip interactions
- Role of large-scale vs. local-scale processes
- Impacts of aerosols
- Similarities/differences between warm and cold climates
- Key measurements: SGP, Azores, MAGIC, Pt. Reyes, NSA, MPACE, ISDAC
- Relevant groups: Entrainment, VV

Speakers: ~~*Mark Miller*~~ *(>Virendra Ghate),* ~~*Minghua Zhang,*~~ *Xiquan Dong*

Why do we care?

Soden and Vecchi (2011)



Shade: Regression of Local Cloud Feedback to Global-mean Cloud Feedback ($W \cdot m^{-2} \cdot K^{-1}$)
Contour: Background 500hPa Pressure Velocity ($Pa \cdot s^{-1}$)

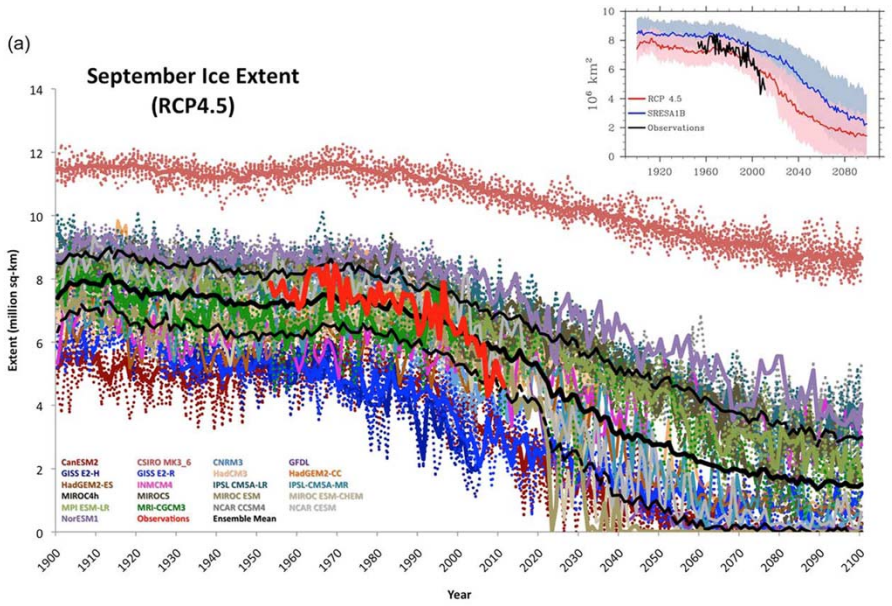
Model disagreement on low-cloud feedbacks is largely responsible for much of the spread in global cloud feedback in climate GCMs

What processes control the partitioning of phase in mixed-phase clouds of all kinds (Arctic stratus, midlatitude nimbostratus, and deep convective)?

- Relation to environmental temperature/moisture, vertical velocity, aerosols
- Impacts on persistence, latent heat, radiation, vertical dist'n of condensate, and precipitation formation
- Key measurements: NSA, MPACE, ISDAC, StormVex, TWP, SGP
- Relevant groups: AACI, Ice Nucleation, IcePro

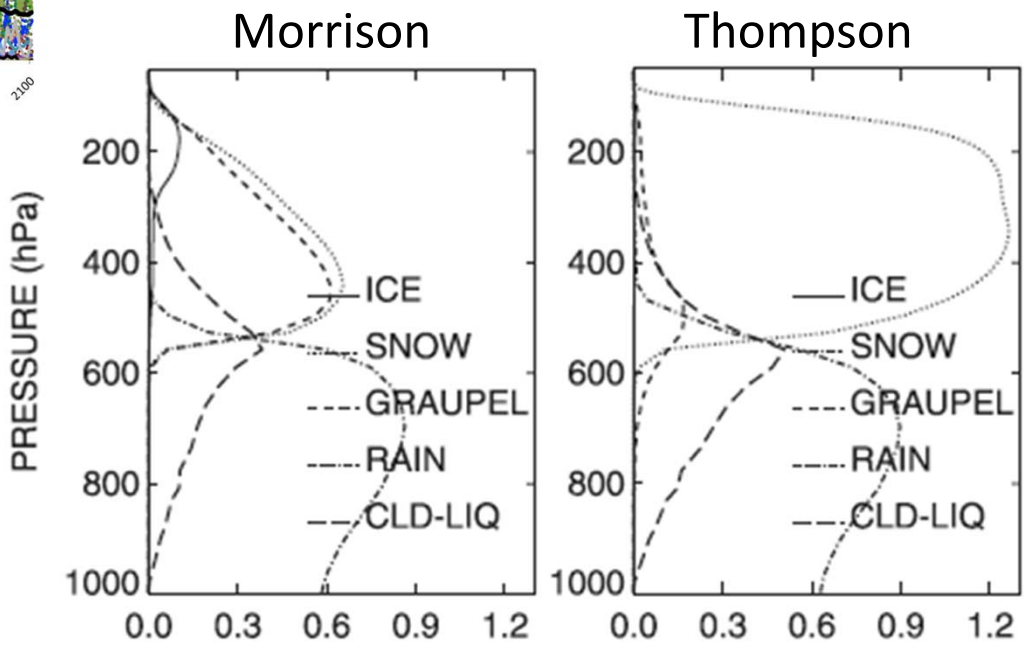
Speakers: *Gijs de Boer, Jerry Harrington, Ann Fridlind, Steve Ghan*

Why do we care?



Potential (probable?) role of clouds in Arctic sea ice decline. But….
What is the role?
What are the feedbacks?
How does phase matter?

- TWP-ICE WRF runs.
- Vast difference in graupel production (mixed-phase processes too active at expense of dep. growth?)
- Impacts convective intensity and cluster evolution in CRMs



Del Genio et al. (2012)

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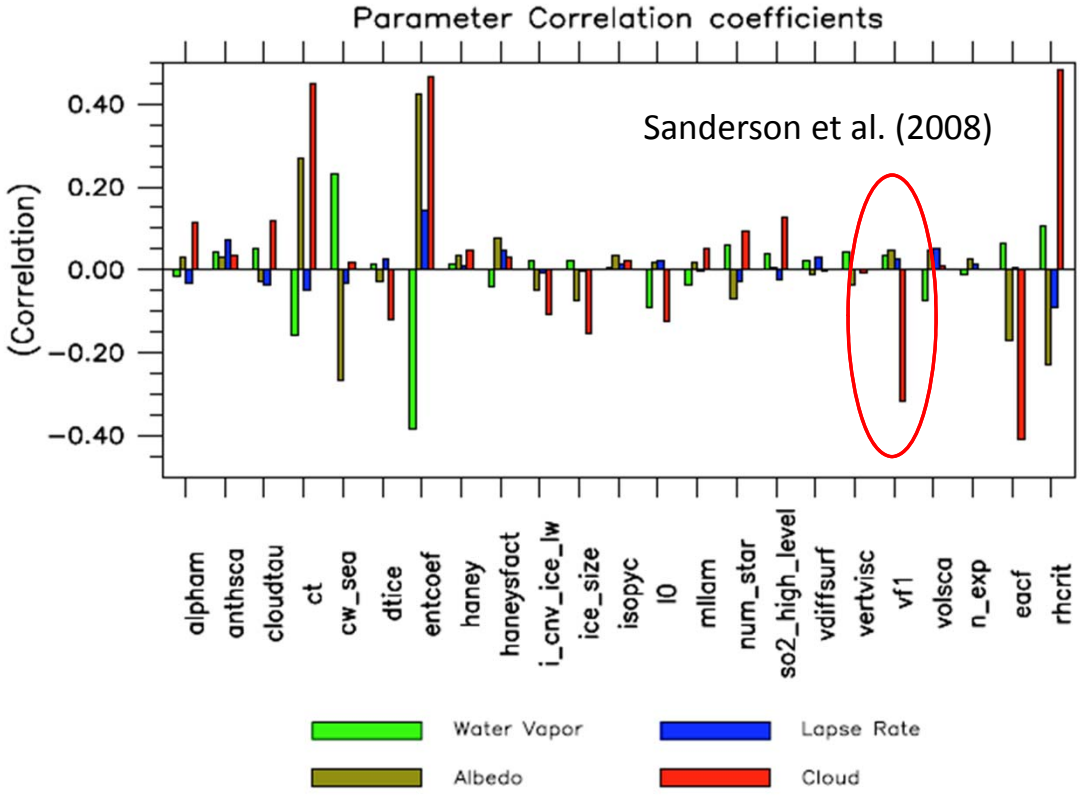
What processes determine the temporal evolution and vertical distribution of the ice particle size distribution in ice clouds of all kinds?

- Particle growth, microphysical processes, radiative properties, and fall speed
- Mass – area – density – size relationships
- Evolution in time and space
- Impact of measurement challenges
- Key measurements: SGP, TWP, NSA, StormVex, aircraft projects
- Relevant groups: IcePro, QUICR

Speakers: *Jay Mace, Eric Jensen, Greg McFarquhar, David Mitchell*

Why do we care?

Critical for cloud feedback and climate sensitivity



PSD determines ice fall speed, which affects cloud feedback, cloud albedo, longevity, etc.

Important to development of stratiform rain and anvil regions

- Small particles?
- Generality of PSDs?
- Mixed-phase vs. not?

General Discussions

- How do we obtain participation?
- How do we achieve the appropriate balance between focus and breadth?
- Ideal number of topics at a given time
- Are the scientific bases covered?
- Appropriate balance of individual PI work vs. collaborative work