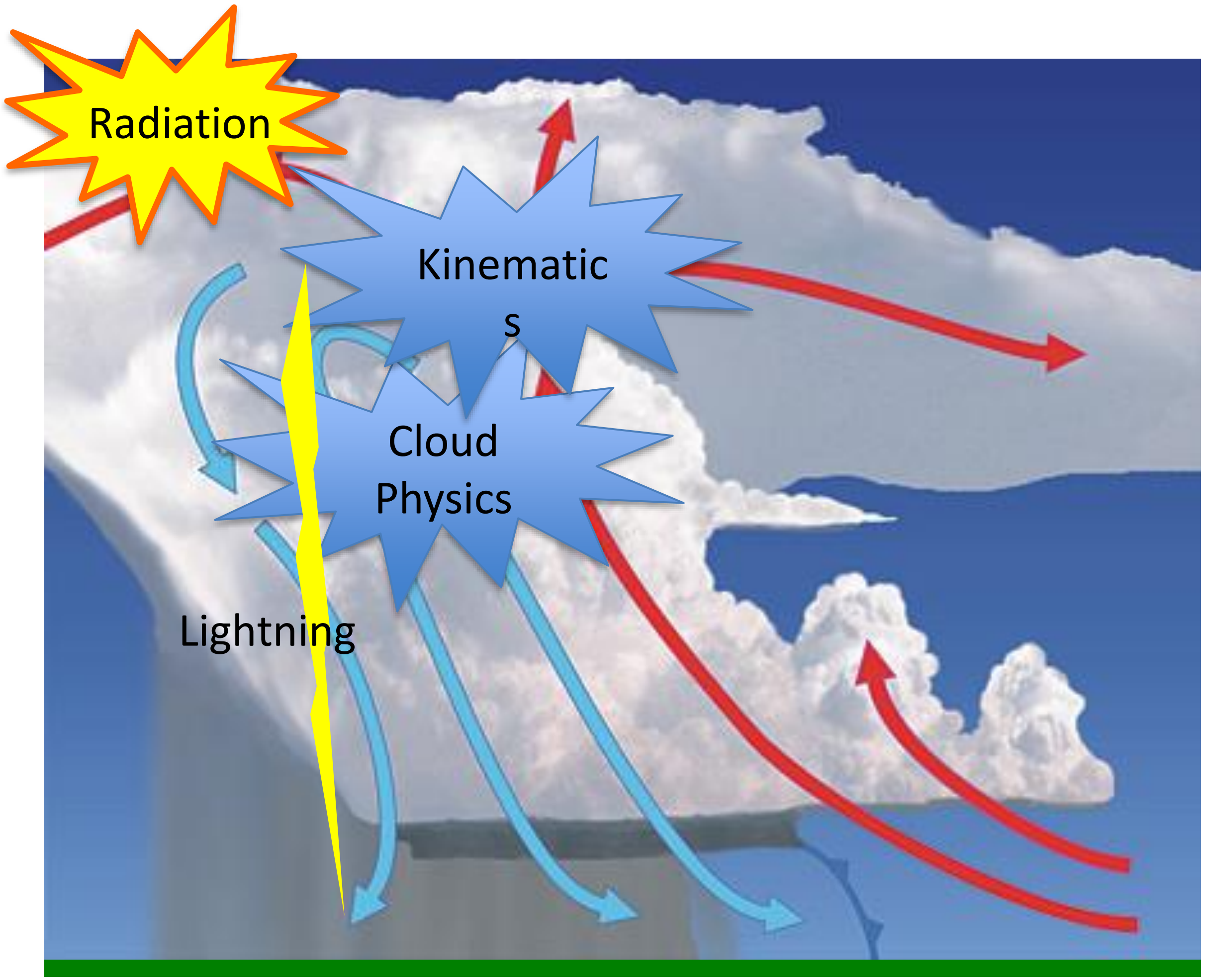
Introduction
Physical Processes in Convection

Mary Barth (NCAR)
Gretchen Mullendore (UND)
Andy Detwiler (SDMST)

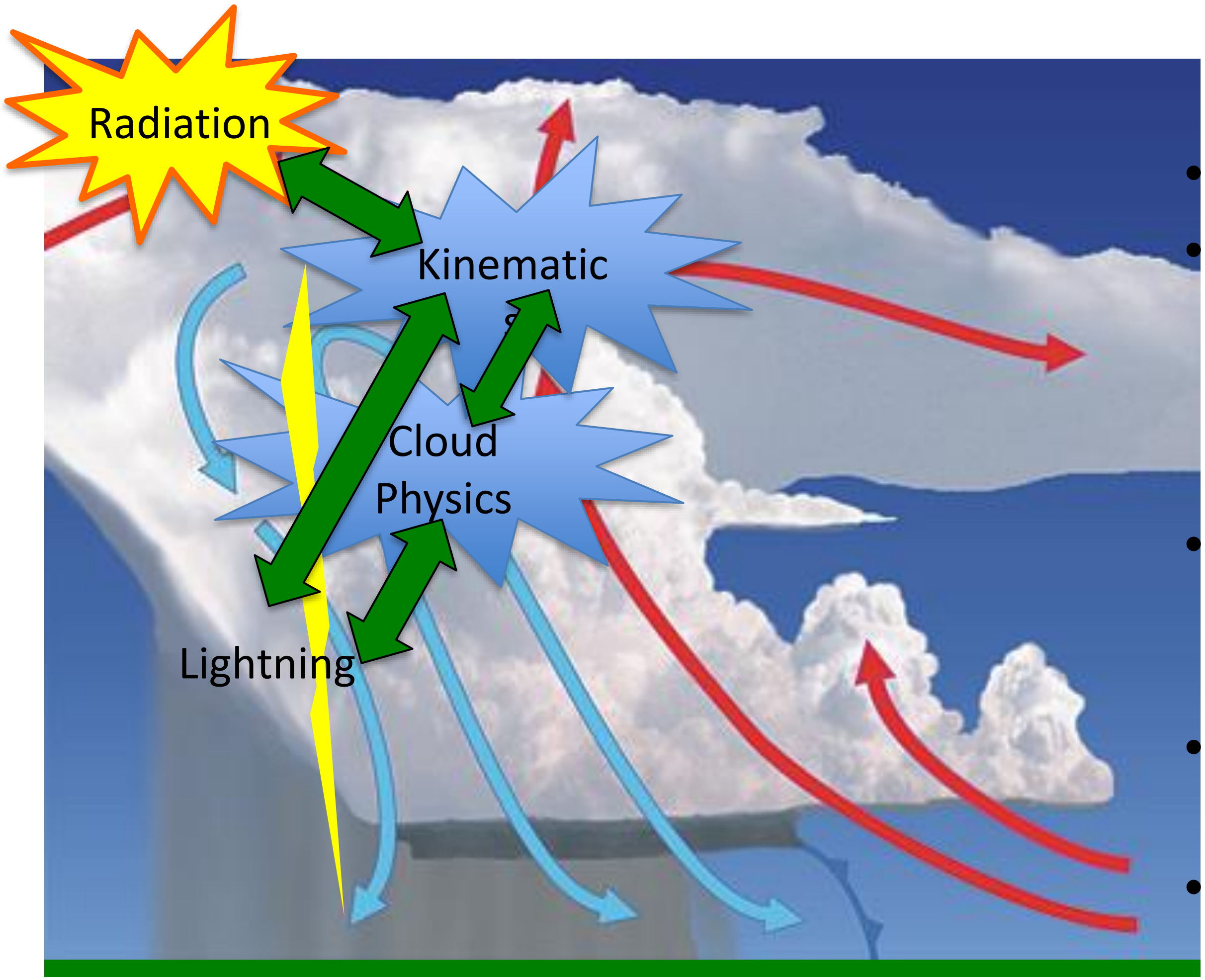
Explain what we mean by "Physical Processes"

Give my opinion of some of our challenges with these processes

A Complex Set of Processes



Processes that Interact with Each Other



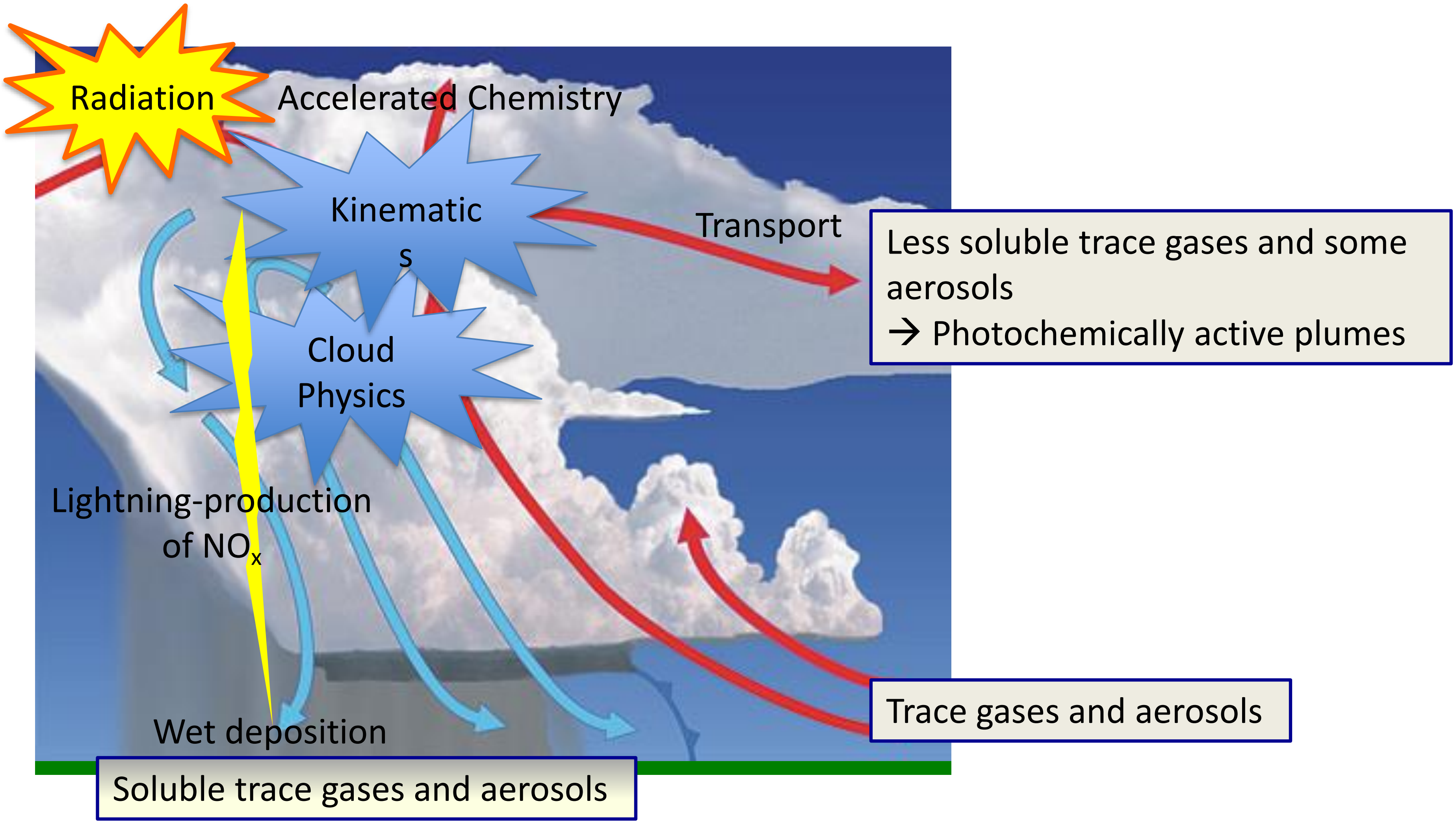
Cloud Physics

- Ice Characteristics
- Affects composition of troposphere

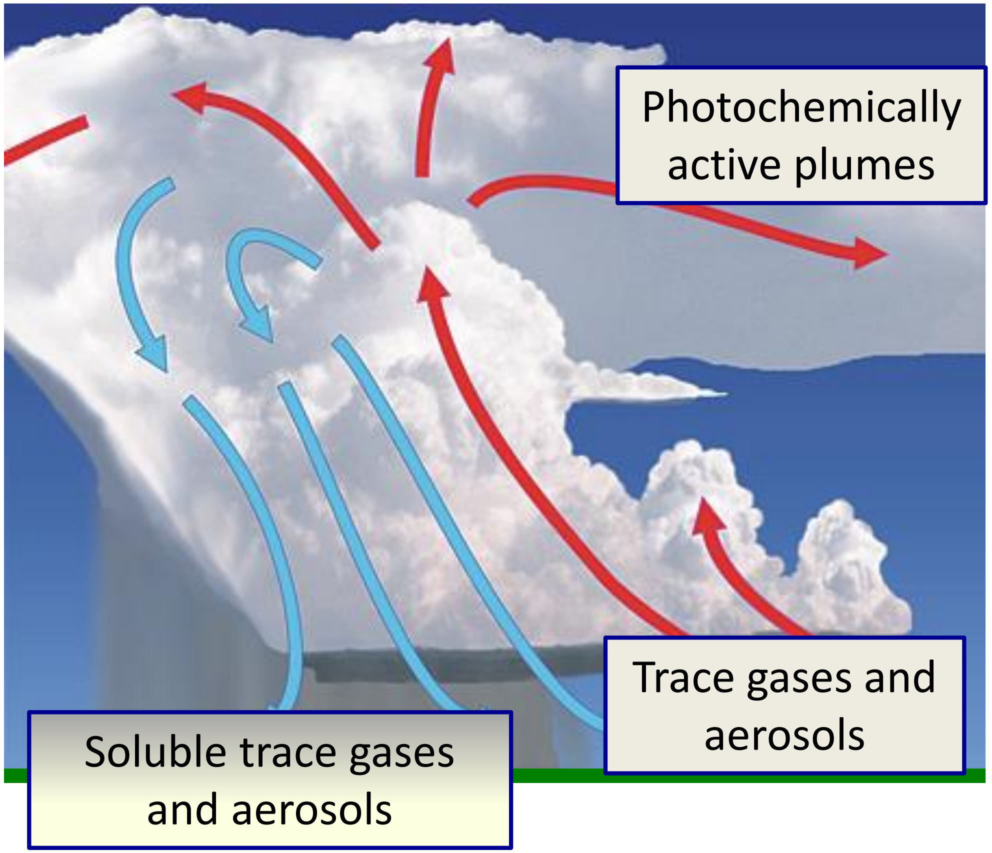
Lightning

- Strong connections to kinematics and cloud physics
- Affects composition of troposphere
- Challenge of predicting lightning flash rate

Convection Impacts Chemistry



Trace Gases Illuminate Aspects of Convection



- Updraft depth and strength
- Updraft entrainment/detrainment rates
- Updraft "protected core" (undiluted parcels)

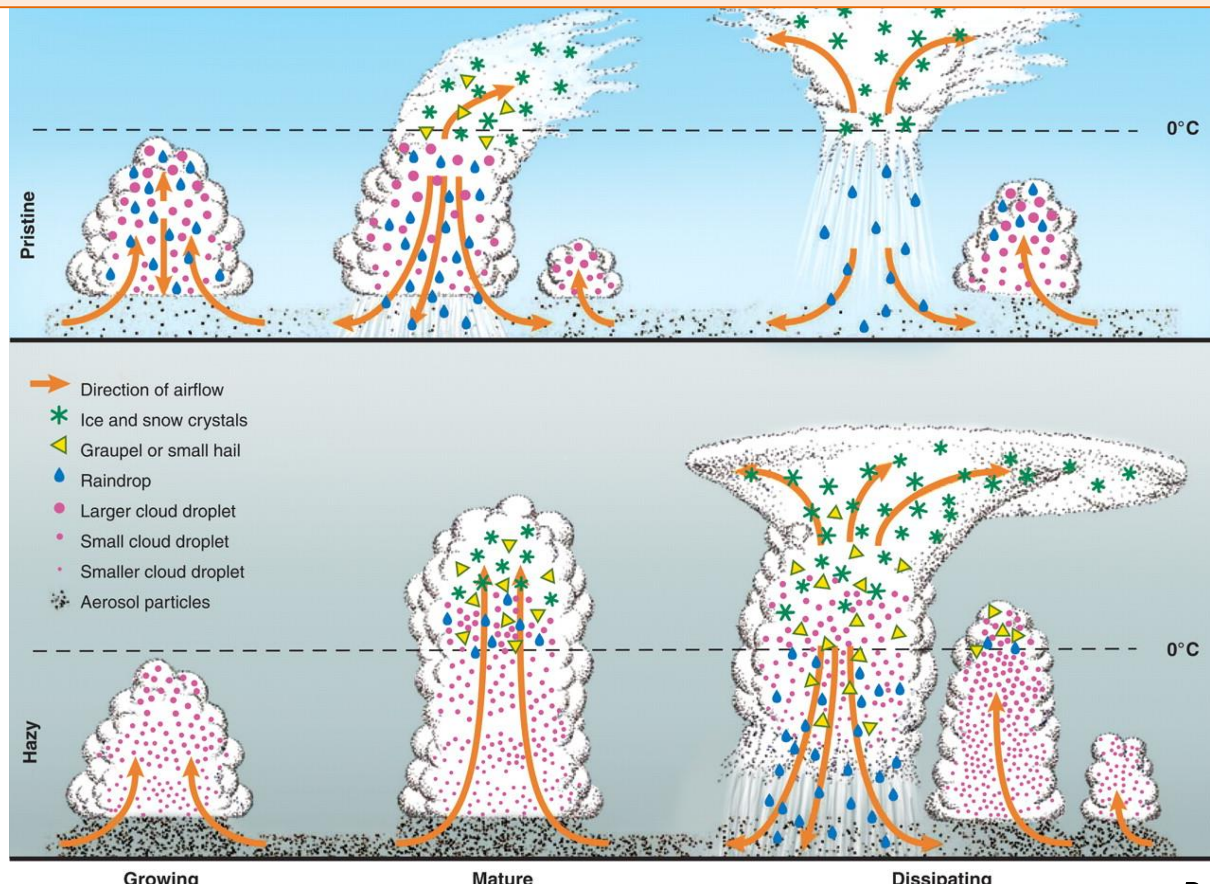
Determination of convective detrainment level (or level of maximum detrainment), helps understand entrainment, chemical transport, and updraft characteristics

Aerosol Effects on Convective Clouds

Increased number of aerosols → more, smaller drops
→ reduce collision-coalescence and decrease precipitation, **or**
→ loft drops into mixed phase region, freezing invigorates storms and increase precipitation, **or**
→ both
How do we get good observations of this complex process?

Low aerosol number concentrations

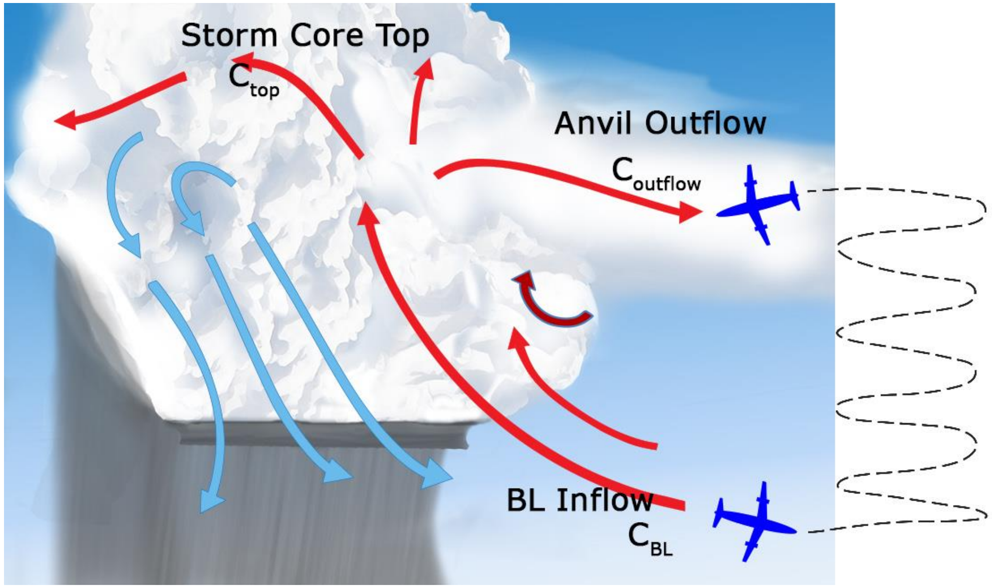
High aerosol number concentrations



Rosenfeld et al. (2008) *Science*

Field Experiments to Understand Convection and Chemistry

- Aircraft are needed to get in situ composition measurements
- Small cumulus to airmass thunderstorms
  - Challenge of getting one cloud for process understanding
  - Go to a statistical approach
- Severe convection
  - Aircraft generally sample outside the storm core



Physical Processes in Convection

- Cloud Electricity and Lightning
- Aerosols, Cloud Physics and Radiation
- Chemistry

Cloud Electricity and Lightning

Larry Carey

Associate Professor and Chair, Department of Atmospheric Science, The National Space Science and Technology Center (NSSTC), University of Alabama in Huntsville

Research is to understand the integrated kinematic, microphysical and electrical nature of clouds and precipitation systems

Aerosols, Cloud Physics and Radiation

Sue van den Heever

Full Professor, Department of Atmospheric Science, Colorado State University

Research Interests

- Cloud Physics and Cloud Dynamics
- Convective and Cloud Processes
- Cloud Modeling
- Cloud-Aerosol-Precipitation Interactions

Chemistry

Ken Pickering

Research Professor, Department of Atmospheric & Oceanic Science, University of Maryland

Senior Physical Scientist, Emeritus, NASA/GSFC

Research Interests

- Chemical transport modeling
- Convective transport of trace gases
- Lightning NOx production
- Investigation of relationship between column amounts of trace gases and surface air quality
- Application of satellite observations for air quality
- Continental export of air pollution

Physical Processes in Convection

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Cloud Electricity and Lightning

Andy Detwiler

Professor Emeritus, Department of Atmospheric and Environmental Science, South Dakota School of Mines and Technology

Research Expertise

- Airborne Meteorology Measurements
- Atmospheric Physics

Aerosols, Cloud Physics and Radiation

Dave Turner

Research Scientist, Global Systems Division, Earth System Research Laboratory, NOAA

Research Interests

- Boundary layer thermodynamic and dynamic structure, diurnal evolution, convection and convective initiation
- Life cycle of clouds with very low liquid water paths and their impact on the radiative energy budget
- Microphysical properties in mixed-phase clouds, and investigating the importance of the two phases on the radiative energy budget, with a focus on Arctic clouds
- Longwave radiative transfer, especially at low water vapor amounts in the upper troposphere

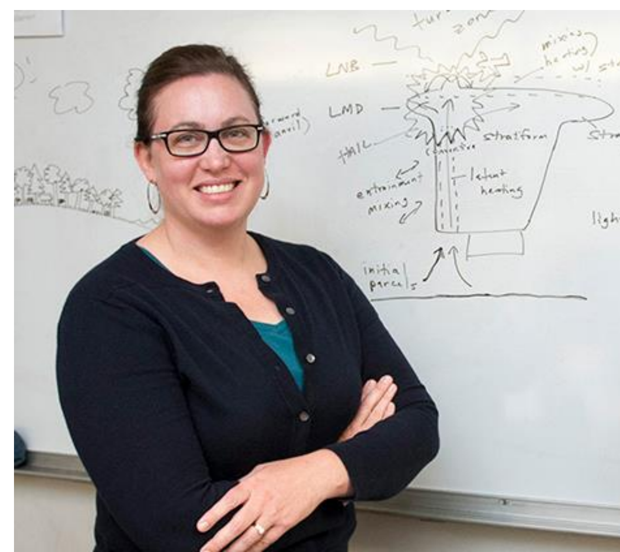
Chemistry

Gretchen Mullendore

Associate Professor, Department of Atmospheric & Oceanic Science, University of North Dakota

Research Interests

- Numerical modeling
- Convective transport
- Mesoscale dynamics
- Tropospheric-stratospheric exchange
- Cloud modeling
- Convection initiation



Physical Processes in Convection

- Cloud Electricity and Lightning South Auditorium
- Larry Carey (U. Alabama – Huntsville) 30
- Andy Detwiler (SDSMT – breakout moderator)
- Justin Whitaker (CSU – rapporteur)

- Aerosols, Cloud Physics and Radiation Center Auditorium
- Sue van den Heever (Colorado State U.) 60
- Dave Turner (NOAA/ESRL – breakout moderator)
- Mikael Witte (NCAR – rapporteur)

- Chemistry Room 3150
- Ken Pickering (U. Maryland) 10
- Gretchen Mullendore (UND – breakout moderator)
- Minghui Diao (SJSU – rapporteur)