Summary
Physical Processes in Convection

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Cloud Electricity and Lightning:

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Aerosols, Cloud Physics and Radiation:

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Chemistry:

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Cloud Electricity and Lightning

Science Issues

1) Microphysics interactions with electrification and lightning
   Kinematic interactions with electrification and lightning
2) Environmental interactions with electrification and lightning
3) Lightning initiation

Measurements Needed

1) Hydrometeor properties – *cloud water in mixed phase*
2) High-resolution 3-D flow of advective and turbulent flows
3) Lightning properties, particle charge, E-field
4) Updraft in-flow state parameters, wind, aerosol

Aerosols, Cloud Physics and Radiation

Science Issues

1) Feedbacks between *vertical motion* and aerosol and microphysical processes for various storms and environment
2) Role of *hydrometeor size distributions* in microphysical processes and cloud-radiative forcing
3) *Graupel/hail characteristics* for various storms and environment
4) *Vertical and horizontal aerosol distribution* effects on cloud microphysical and radiative processes

Key Measurements Needed

1) Entire particle size distribution
2) In situ, co-located u, v ,w, T, q, p, PSDs, CCN/IN concentrations
3) Higher spatial and temporal sampling of above parameters near cloud/storm top
4) 3D measurements of T, q, & aerosol characteristics
5) Long-term statistics on u, v ,w, T, q, p, CCN/IN

Chemistry

Science Issues

1) Convective Transport of trace gases and aerosols
2) Lightning NO_x production
3) Ozone production/loss
4) Wet Scavenging of soluble trace gases and aerosols
5) New Particle Formation
6) Composition of Fire Plumes

Key Measurements Needed

1) Broad suite of chemical species (CO, O_3, NOy, NMHC, halogens)
2) Lightning flash rates, extent, energy
3) Composition of trace gases and aerosols in hydrometeors
4) Environmental conditions (including photolysis rates)
5) Fluxes: surface, PBL to free trop, inflow, outflow

Specific Instruments and Facilities Needed

1) Large-sampling volume in-situ particle size distribution probe
2) Storm penetrating aircraft
   - microphysics package, cloud water mixed phase, electric field, particle charge, trace gas package, aerosol package, radiation, u, v ,w, T, q, p
3) Slow moving platform for (deep) convection (e.g., UAVs, helicopters, etc)
4) Community Lightning Mapping (LMA, interferometer, e-field change, efield)
5) Fast-scan, mobile, multi-frequency (S, C, X, Ku, Ka) Doppler/dual-pol radars
6) Enhanced mobile profiling (with aerosols), surface mesonet

Specific Instruments and Facilities Needed

7) Trace gases: In situ continuous analyzers (1 Hz), grab samples (on-board and/or lab analysis of canisters or tubes at high frequency) for aircraft and balloons
8) Aerosols: aerosol mass spectrometer, impactors
9) Counterflow virtual impactor (hydrometeors for lab analysis)
10) Aerosol, ozone, water vapor, NO_2 lidars
11) 3-D volumes of tracer concentration
12) Long path absorption; networks desired
13) UV/Vis spectrometer for trace gas column amounts
14) Spectral-radiometer for actinic flux
15) In-cloud instrument inlets