ARM Science Plan
Possible RPWG Contributions

RPWG Steering Committee

18 November 2008

Things to Consider in Our Discussion

(from the guidance for the ‘ARM Futures’ meeting)

- What are the outstanding science questions that should/can be addressed by ARM in the next 10 years?

Possible Science Questions

- Molecular absorption
  - Are the water vapor absorption bands correctly treated in detailed RT models?
  - Is the water vapor continuum absorption adequately modeled to get surface, TOA, and atmospheric fluxes accurate to within 1% for clear sky atmospheres?

- Radiative properties of ice particles
  - Are the single scattering properties of ice consistent (and accurate) across the entire electromagnetic spectrum, including the far-infrared?
  - Are the scattering properties of ice in single- and mixed-phase clouds the same?
  - Can the habit (effective density) of the ice particles be determined from remote sensing observations?
  - What is the radiative importance of small ice particles on the radiative HR profile and on the cirrus dynamics?

Possible Science Questions

- Global dimming and brightening
  - What are the mechanisms that cause this phenomenon?
  - How well can we quantify it using ARM's long-term observations?
  - What are the regional aspects of the dependence?

- Upper tropospheric humidity (UTH)
  - What controls UTH in different environments?
  - What is the radiative HR impact of UTH in different environments?
  - Is UTH changing over time at the different sites?
  - How does UTH (and ice nuclei) affect cirrus nucleation, the growth of the ice crystals, and the subsequent impact on the radiative profile?

Possible Science Questions

- Importance of 3-D RT (both SW and LW)
  - What are the errors associated with not accounting for 3-D RT at different scales, from remote sensing to climate modeling?
  - How well can we measure the 3-D distribution of cloud water content?
  - What is the importance of 3-D RT in the “twilight zone”?
  - How do 3-D RT heating rate effects impact the cloud dynamics and microphysics at different scales?

- Radiative Heating Rate (HR) profiles
  - What is the relationship between radiative HR profiles and atmospheric state/clouds/aerosols?
  - What controls the radiative HR in different environments?
  - What is the relationship between the radiative and latent HR profiles in different atmospheric conditions?
  - How sensitive are the dynamics to the radiative HR profile at different scales?

Possible Science Questions

- Latent Heating rate profile
  - Can we measure latent heating rate profiles at the ARM facilities for different rain rates?
  - How dependent is the condensation and evaporation on the ambient environment (especially for falling precipitation)?

- Diurnal cycle
  - Is the mean diurnal structure of the temperature and humidity (T/q) profiles in the boundary layer changing over time?
  - What controls the diurnal evolution of shallow convection?
  - Is the diurnal pattern of the boundary layer turbulent structure and entrainment changing over time?
  - Is the diurnal cycle of radiation at the surface (which is related to the diurnal cycle of T/q, cloud macro- and microphysical properties, and aerosol macro- and microphysical properties) changing over time?

Possible Science Questions

- CLOWD clouds (clouds having $0 < LWP < 100$ g/m^2)
  - What are the statistical distribution of the radiative, macro-, and microphysical properties of these clouds?
  - How do changes in the ambient aerosol, humidity profile, turbulence, and other parameters affect the radiative and microphysical properties of these clouds?
    - Especially for marine StCu ?
  - What is the relationship between surface fluxes, boundary layer flux profiles, and cloud structure in shallow convection?
  - How are mixed-phase Arctic stratus clouds maintained for long time periods?
  - How can we parameterize these often sub-grid scale clouds and their processes properly into larger scale models?

Things to Consider in Our Discussion

(from the guidance for the 'ARM Futures' meeting)

- What are the outstanding science questions that should/can be addressed by ARM in the next 10 years?
- What specific locations are appropriate to address these science questions?
- How long of an observational dataset is needed there?
- What measurements / instruments / data products are needed to answer these questions?
  - What new measurement capabilities are needed?