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4.4.2 Session on modeling of radiative transfer processes

Piotr Flatau

a. Current status of modeling needs

Six critical issues surfaced in the discussion concerning scale-interactive radiative processes relevant to MCSs, namely the needs to:

- Expand basic knowledge of how MCSs influence climate through extensive cloud shields and increased humidity in the upper troposphere.
- Improve radiation parameterizations used in mesoscale and GCM models.
- Improve our basic understanding of the influence of radiation on MCS dynamics due to diabatic heating, production of condensate, and vertical and horizontal heat fluxes.
- Quantify our understanding of radiative impacts of MCSs on the surface and free atmosphere energy budgets.
- Quantify and identify radiative and microphysical processes important in the evolution of MCSs.
- Improve the capability to remotely sense MCS radiative properties from space and ground-based systems.

One emphasis of these six critical issues is clearly on global climate through MCS-generated "cirrus" clouds; "cirrus" here is used in the broad sense including optically thin or thick stratified upper level clouds. Thus, the FIRE I and II Cirrus projects (Starr 1990; see also special issue of *Monthly Weather Review,* November 1990) and ARM objectives are relevant. For this reason we suggest to *collaborate with the FIRE and ARM communities.* This is also why research on "dissipative" stages of MCSs is strongly emphasized here. It is quite challenging because there is a natural tendency to study "weather" but not weak systems. The other new and challenging issue related to the dissipative MCS stage is the development of non-local GCM parameterization of cirrus and related cloud radiative forcing. In that way CME will complement the "local" strategy of an ARM CART site.

b. Most critical unknowns

Our present approaches to the MCS radiation problem are inadequate for the following reasons:

- There is no emphasis on climate issues; long-term mesoscale model integrations and the study of the dissipative stage of MCSs are needed.

- Our knowledge of the optical properties of clouds related to MCSs is incomplete.

- Very importantly, no consistent radiation-microphysical coupling exists in current mesoscale radiative transfer schemes.

c. Specific recommendations

The recommended activities by this group consist of the needs to:

- Develop and validate a community radiative transfer code suitable for use with mesoscale models, and establish an intercomparison project to isolate and understand radiative processes in mesoscale models.

- Encourage work on the sensitivity of long-term mesoscale model integrations to changes in radiative transfer parameterizations.

- Assess which measurement strategies are needed for remote active and passive sensors, radiometers, and microphysics probes.

- Develop field strategies to study climatic influence of MCSs; these may include long level flight legs in stratiform region "debris" downwind of dissipative stage of MCS (in contrast to step legs in the region of active MCS), and measurements of upper level humidity increase due to MCSs.

d. Implications for observing system strategies

The foregoing concerns indicate the need for these observational approaches:

- Measure moisture, cloud cover, microphysical properties on large spatial and temporal scales. Combine in situ, active and passive remote sensors, and satellite data.

- Determine MCS related cloud optical properties such as optical thickness, their morphology, and microphysical composition.

- Provide observations to establish the radiative budgets of different kinds of MCSs throughout their entire life cycle.

- Collaborate with other radiation field campaigns and projects.

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4.5 Session on coupled atmospheric/chemistry coupled models

Anne Thompson

a. Current model limitations

- *Current coupled regional meteorological/chemical models have fairly crude parameterizations of surface and boundary layer processes.* For example, deposition of trace gases to the surface and emission of other species from the soil and from vegetation need to be better specified in the models. One of the most critical boundary layer meteorological parameters is the depth of the mixed layer. The simulated diurnal variation of this depth needs to better follow observations.