N94-24389

3.8 The role of radiation in mesoscale flows: physics, parameterizations, codes

P. J. Flatau: Review of radiation parameterization for mesoscale models

Dean Churchill: *An overview of radiation and mesoscale flows*
Robert D. Cess: *Lessons learned from the intercomparison of GCM radiative codes*

Piotr Flatau discussed three issues in his keynote talk on radiative transfer parameterizations for mesoscale models:

- How mesoscale processes influence climate by interaction of extensive stratiform cloudiness, cirrus debris, and increased moisture with the radiative field
- The importance of cloud microphysical/radiation processes (such as changes in particle shape and size, varying refractive index, and changes in albedo) in mesoscale dynamics
- Which local processes (e.g., convection, turbulence, entrainment fluxes, and evaporation) are most influenced by radiative fluxes, and what time scales are involved

He suggested that, knowing what the issues are, one is faced with several technical problems, including what optical properties to measure and observe, and whether we can transform our knowledge about the radiative properties of MCSs and mesoscale phenomena into consistent radiative transfer parameterization. It is also essential to consider how to convincingly present results from mesoscale models and field studies in their more global climate context, and how experiences in other radiation and climate related projects (ARM, FIRE (Starr 1990), etc.) could contribute to the design of the CME field project. Flatau then discussed several topics related to radiative parameterizations and cloud microphysics, including assumptions needed to develop a two-stream approximation to the radiative transfer equation, assumptions needed to get single scattering properties such as single scattering albedo and asymmetry parameter, and coupling of radiative transfer with particle size distributions through averaged single scattering properties. It is possible, he concluded, to tie properties such as irregular cirrus particles, inhomogeneous particles, and particles with refractive index other than that of water or ice (aerosols, chemistry) to radiative transfer schemes but only at a cost comparable to that of explicit microphysical schemes. Current theoretical approaches of single scattering parameterizations consist of anomalous diffraction theory, power law fits to Mie calculations, and table look-ups. Theoretical approaches for scattering calculations on non-spherical particles presently consist of discrete dipole approximation, ray-tracing, and multipole methods. These are costly calculations not suitable for parameterizations in their current form. Flatau also discussed the unified approach to radiative transfer solvers showing that all existing schemes reduce to the banded (blocked) type linear problem. As for the infrared emissivity approach, the mesoscale radiative transfer differs from solvers employed in GCMs because more details are available in mesoscale models. This presentation concluded with the presentation of several current radiative transfer schemes in use.

Dean Churchill's presentation concentrated on the phenomenology of mesoscale flows as influenced by radiation. He gave a short summary of interactions between radiation and cloud physics, radiation and dynamics, and radiation and convection. He discussed Houze's (1989) paper stressing the differences between convective and stratified parts of mesoscale convective systems and their implications for large-scale heating. He then reviewed the work of Churchill (1992) discussing the role of solar and infrared radiation in stratified regions of tropical cloud clusters (an EMEX case study), and that of Churchill and Houze (1991) concerning the interaction between turbulence and radiation. Finally, he mentioned some implications of mesoscale circulations in tropical cloud clusters for large-scale dynamics and climate (Hartman et al. 1984).

Robert Cess discussed lessons learned from the intercomparisons of GCM radiative transfer codes. He discussed an international project to isolate and understand interactive processes in general circulation models as well as in observational data. To date 12 GCMs have been used to produce 24 simulations of global warming caused by a doubling of atmospheric carbon dioxide. Cess enumerated possible reasons for model disagreement, namely differences in radiation codes, differences in atmospheric temperature structure, differences in radiative overlap by atmospheric water vapor, differences in the radiative impact of clouds, and coding errors. He warned to "never adjust more than one thing at a time or it will be impossible to tell which adjustment produced what result".

N94-24390

3.9 Chemistry on the mesoscale: modeling and measurement issues

Anne Thompson

John Pleim:	*RADM - A coupled chemistry/mesoscale model*
Christopher Walcek:	*Convection in RADM (Regional Acid Deposition Model)*
Jason Ching:	*Unresolved issues for mesoscale modeling with chemistry: non-precipitating clouds*
Frank Binkowski:	*Unresolved issues for mesoscale modeling with chemistry: aerosols*
Wei-Kuo Tao:	*Tracer Studies with GCEM (Goddard Cumulus Ensemble Model)*
Russell Dickerson:	*Field observations of trace gas transport in convection*
Kenneth Pickering:	*Photochemical consequences of convection*