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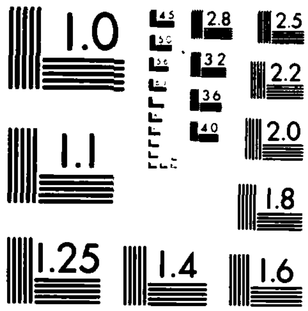

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ROBERT M. BANTA

WORLD METEOROLOGICAL ORGANIZATION

WEATHER MODIFICATION PROGRAMME

Annex to the

Notes on the Planning Session for the

International Cloud Modelling Workshop/Conference

held at Aspen, Colorado, USA from 3-6 October 1983

(containing material submitted to the planning
session by the participants)

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A newly established cloud modeling program in the Cloud Physics Branch of the Air Force Geophysics Laboratory will employ a three-dimensional cloud model to predict cloud dynamic and bulk-microphysical quantities and a "1½-dimensional" Eulerian cloud model to determine more detailed microphysical properties of clouds. These modeling studies will be applied to problems involving electromagnetic propagation in cloud and airframe icing. Four approaches for determining detailed microphysical properties of clouds from a 3-D bulk microphysical model are outlined in order of increasing complexity.

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AFGL Cloud Modeling Program

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A cloud modeling program has recently been established at AFGL to provide information on electromagnetic propagation in cloud and on aircraft icing effects. Areas of microphysical interest include prediction of the spatial and temporal distributions of regions of supercooled water *vs.* ice and prediction of cloud particle spectra. Areas of meteorological interest include systems with wide coverage and/or long persistence, such as marine stratocumuli, wintertime orographic snowfall, cyclonic storms, mesoscale convective complexes, cirrus, *etc.*, and recurrent diurnal phenomena such as the prediction of orographically-forced thunderstorms and thunderstorm systems. Current models being used in these studies include the 3-D cloud/bulk-microphysical model described by Tripoli and Cotton (1982), and the so-called "1.5-D" model of Silverman and Glass (1973), which contains detailed calculations of microphysical particle distributions. Nelson (1979) has added ice-particle and graupel physics to the latter model.

A basic problem in using 3-D model output for applications is that the bulk parameterizations predict only mixing ratios of the various water and ice species, while many applications require particle spectra (or at least number densities of particles within certain size ranges). We are considering a number of approaches to handling this problem. The easiest solution is to simply use the assumed distributions that are implicit in the bulk microphysical parameterizations to diagnose properties of the particle spectra. A second, more complex approach is to develop a time-dependent, "parasitic" microphysical model, in which the kinematic and thermodynamic fields within the cloud domain are prescribed by the 3-D bulk model, and the time history of the microphysical quantities are calculated from these fields using the microphysical model. A third approach is to conduct parallel studies with the 3-D model and dynamically simpler models, such as the "1.5-D" model mentioned previously. The simpler model would be initialized by profiles from the 3-D model. The final approach is to include predictive equations for distribution-function moments or parameters as Clark and Hall (1983) have pioneered. This is probably the most complex procedure for obtaining particle spectra from 3-D model results that is computationally feasible at present.

As "ground truth" for these studies we plan to compare modeling results against field data, including the data sets provided by the present Cloud Modeling Workshop. Additionally, colleagues at AFGL are participating in a wintertime field project in Michigan to investigate the properties of systems which produce snow in that region, and other possible field projects at AFGL are in the discussion stage. In addition to overall model evaluation and validation, observations from these and other projects will be used to develop more realistic condensation schemes (Banta and Cotton, 1980) and turbulent averaging operators (Banta, 1983) for use in modeling cloudy situations.

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