N91-10463

Cirrus Microphysics and Radiative Transfer: A Case Study

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During the Cirrus Intensive Field Operation of FIRE, data collected by the NCAR King-Air in the vincinity of Wausau,WI on October 28th were selected to study the influence of Cirrus cloud microphysics on radiative transfer and the role of microphysical approximations in radiative transfer models.

The instrumentation of the King-Air provided, aside from temperature and wind data, up- and downwelling broadband solar and infrared fluxes as well as detailed microphysical data (e.g., particle size distributions and two-dimensional particle images).

The selected case saw the aircraft traverse on seven flight legs of constant altitude from the cloud bottom (6km) to the cloud top (8km), as indicated in Figure 1.

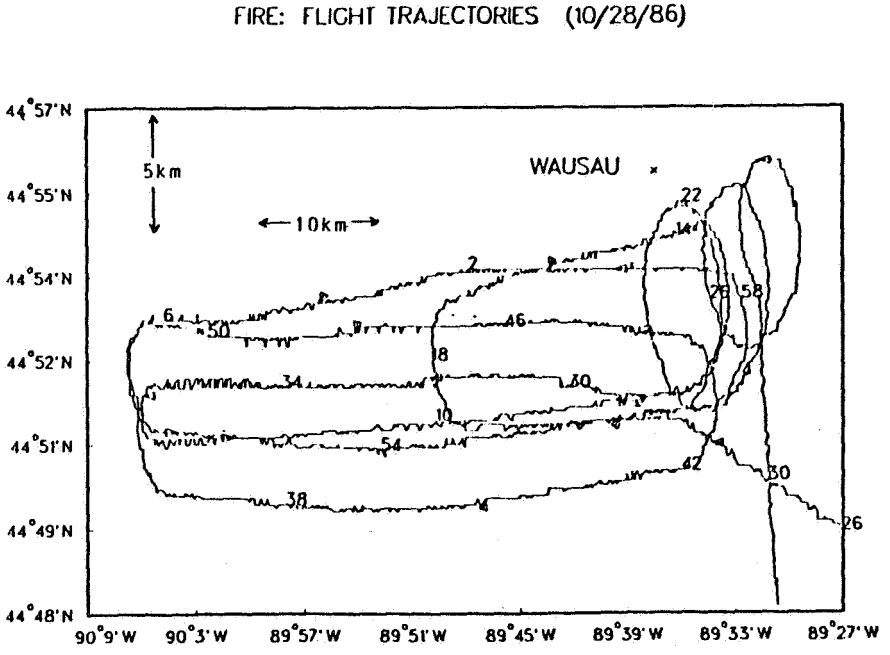

Figure 1
Trajectories of the NCAR King-Air aircraft on the 28th of October 1986 between 16.26 and 17.31 GMT. (the digits indicate the minutes of the hour, the arrows indicate the direction)

The aircraft data, supplied every second, are averaged over these legs to represent the properties for that altitude. The resulting vertical profiles, however, suffer from the fact that each leg represents a different cloud column path. Figure 2 shows these legs as they appear to a fixed cloud system at 17 GMT.

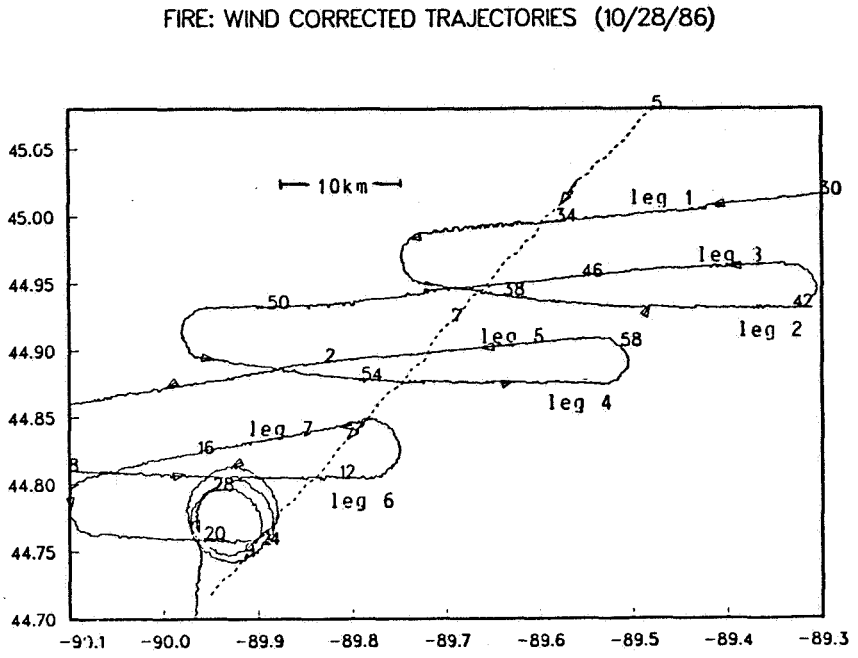

Figure 2

Trajectories of the NCAR King-Air (solid line) and the NASA ER-2 (dashed line) as they relate to a fixed cloud field at 17.00 GMT, for the time interval of Figure 1.

Except for the first leg below the cloud all other flight legs pairwise penetrate almost the identical cloud column path. This helps to correct any irregularities in the vertical profiles of the averaged data and provides information about the vertical structure of an individual cloud cell as well.

Based on the measured microphysical data particle size distributions of equivalent spheres for each cloud level are developed. Accurate radiative transfer (MIE and Matrix-Operator) calculations are performed, incorporating atmospheric and radiative data from the ground (Wausau) and the stratosphere (NASA-ER2). The location of Wausau is indicated in Figure 1, while the corrected flight tracks of the ER-2 aircraft are displayed in Figure 2. The radiative transfer calculations determine solar and infrared fluxes below, in and above the cirrus cloud.

Comparing calculated to the measured up- and downwelling fluxes at the seven cloud levels for both the averaged and the three "crossover" data will help to assess the validity of particle size and shape approximation as they are frequently used to model cirrus-clouds. Once agreement is achieved the model results may be applied to determine, in comparison to a cloudfree case, the influence of this particular cirrus on the radiation budget of the earth atmosphere system.