A Comparison of Radiometric Fluxes Influenced by Parameterized Cirrus Clouds with Observed Fluxes at the Southern Great Plains (SGP) Cloud and Radiation Testbed (CART) Site

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As the data stream from the ARM Southern Great Plains (SGP) site matures, the value of this resource is becoming more readily apparent. For the first time, research on the coupling of clouds and radiation is not limited to data from short duration field campaigns. While data from these campaigns are necessary, the full spectrum of naturally occurring variability must be considered in the development and verification of parameterizations for global models.

To exploit the SGP data stream fully, we have developed an operational data processing and analysis methodology that allows us to examine continuously the influence of clouds on the radiation field and to test new and existing cloud and radiation parameterizations. Our approach is sketched out in Figure 1. In order to place the observations into a large-scale context and obtain hourly descriptions of the profiles of temperature, humidity, and vertical motions over the SGP site, we acquire the Mesoscale and Analysis Prediction System (MAPS) output

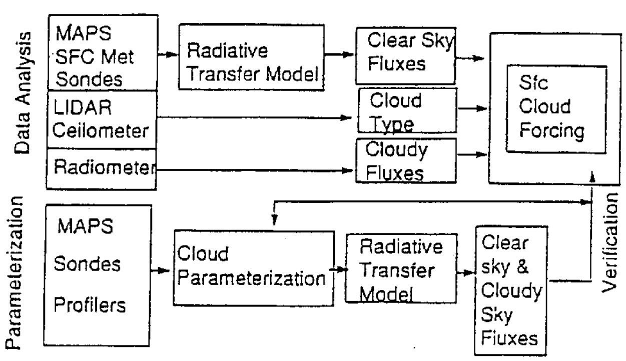

Figure 1. Schematic diagram of an operational methodology for cloud parameterization testing. The upper portion depicts the data analysis procedure, while the lower portion depicts parameterization forcing and evaluation.

on an hourly basis from the National Meteorological Center. The MAPS profiles serve as input to a radiative transfer model, which is used to determine clear sky fluxes of solar and infrared radiation. These computed fluxes are compared to observed fluxes. By then examining the micropulse lidar or Belfort ceilometer output, the presence of a cloud is ascertained. If a cloud is detected, the difference between the observed fluxes and computed clear sky fluxes (the surface cloud forcing) is linked to the observed cloud. Initial results from this method demonstrate that, as expected, infrared cloud forcing is well described by the cloud base temperature. The solar cloud forcing, however, shows a large degree of variability among cloud events that is likely attributable to variations in cloud microphysics and water path. It is this variability that must be understood and captured if the parameterization of clouds in climate models is to be improved.

Some results of our approach to validating cloud parameterizations are shown in Figure 2. In this case, the MAPS data were used to force the cirrus cloud parameterization of Heymsfield and Donner (HD) (1990). The upper panel shows the parameterized ice water contents for a cloud event that occurred on December 11, 1994. The predicted cloud base compares well with observations from the multipulse lidar (MPL). The ice water contents derived from HD are incorporated into the Ebert and Curry (1992) radiative parameterization to determine cloud optical properties. These properties serve as input to a radiative transfer model to estimate the cloudy sky radiative fluxes. For this case, the computed surface radiative fluxes are in good agreement with the observed fluxes (lower panel). Using this ongoing analysis in conjunction with improved cloud diagnostic algorithms (see Long et al., this volume) and detailed case studies (see Albrecht et al., this volume), we intend to compute seasonal and annual statistics of cloud forcing and compare them with the results derived from cloud parameterizations.

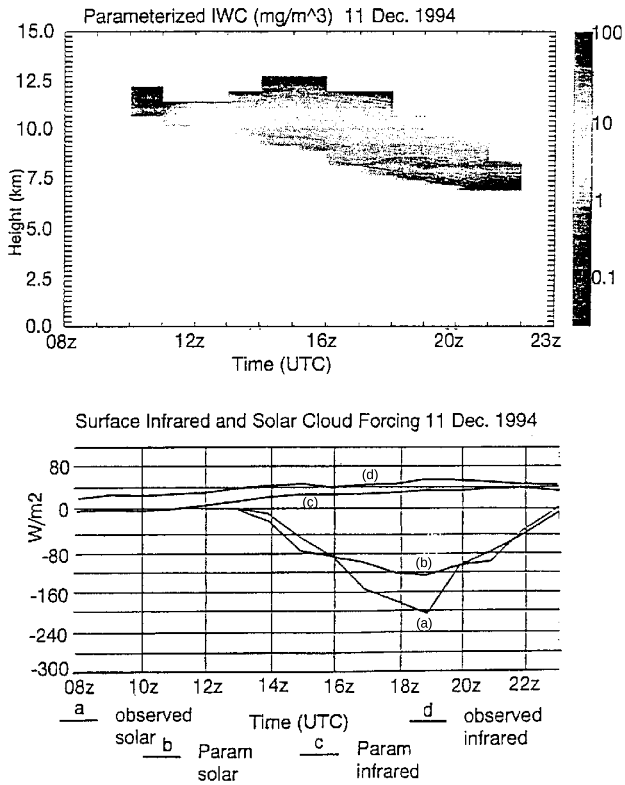

Figure 2. Example of the application of the operational methodology for a cirrus case on December 11, 1994. The upper panel shows ice water content from the Heymsfield-Donner parameterization as a function of time. The lower panel shows the observed (a) and computed (b) downward solar fluxes and the observed (c) and computed (d) downward infrared fluxes as a function of time. The ice water path for the upper panel is used as an input for the computed fluxes.

References

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Heymsfield, A. J., and L. J. Donner. 1990. A scheme for parameterizing ice-cloud water content in general circulation models, *J. Atmos. Sci*, **47**, 1865-1877.