Our most important contribution to the ARM-UAV (Atmospheric Radiation Measurement - Unmanned Aerospace Vehicle) program is our analysis of the aircraft observations taken during the Atmospheric Radiation Measurement Enhanced Shortwave Experiment (ARESE). We analyzed aircraft measurements and compared these to computations made from a 3-D radiative transfer model (SB3D) that was partially developed under the UAV program.

The 3-D radiative transfer model was enhanced and modified to be a research tool for analysis of future UAV missions. The enhancement includes extending the spectral range of the model from 0.25 to 50 ums. Additionally, an ocean surface component has been added that includes ocean waves, foam, and ocean column microphysics. This component provides a much more accurate characterization of the ocean BDRF for analyzing reflectance measurements over the ocean made by the UAV. A copy of the user manual is attached.

The first part of this analysis was to determine if theoretical calculations of atmospheric column absorption of solar radiation in the presence of clouds matched observations. This analysis included both spectral and broadband fluxes. The second part of the analysis was to analyze the spectral signature of the absorption in order to develop potential physical processes that could explain the discrepancy between observations and models.

Our primary findings for the data analyzed is that broadband solar radiation absorption is underestimated in theoretical models. The difference we found when using the spectral measurements as a guide for our broadband computations is about 20 W m\(^{-2}\). This value is much less than that found by investigators using broadband measurements, but still significant. From the spectral comparison, we identified three potential causes for the discrepancy we found. The most dominant is related to the difficulty of parameterizing aerosols in radiative transfer models. By reducing the single scattering albedo and asymmetry factor of aerosols in our model we were able match the spectral observations in the visible. A second cause is that the silicon detectors used in instruments underestimate the flux near 1.06 um leading to erroneous estimates of atmospheric absorption. Our analysis showed that unresolved O2-O2 dimers in this spectral range could not account for the discrepancy. Finally, we demonstrated that cloud droplets required a three-fold increase in cloud albedo to match spectral measurements in the near-infrared region. We modified the droplets by introducing soot in the droplets but showed that the absorption in the visible would be to high for soot to provide the explanation for the cloud absorption anomaly.
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These results have been presented at a number of professional meetings and as an invited talk at the 1998 Gordon Conference on Solar Radiation and Climate. Attached are some recent proceedings and a paper under review in the Journal of Geophysical Research based on this research.

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