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Science Goals for the ARM Recovery Act Radars

JH Mather

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ARM
CLIMATE RESEARCH FACILITY

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1.0 Science Goals for the ARM Recovery Act Radars

In October 2008, an ARM workshop brought together approximately 30 climate research scientists to discuss the Atmospheric Radiation Measurement (ARM) Climate Research Facility's role in solving outstanding climate science issues. Through this discussion it was noted that one of ARM's primary contributions is to provide detailed information about cloud profiles and their impact on radiative fluxes. This work supports cloud parameterization development and improved understanding of cloud processes necessary for that development. A critical part of this work is measuring microphysical properties (cloud ice and liquid water content, cloud particle sizes, shapes, and distribution). ARM measurements and research have long included an emphasis on obtaining the best possible microphysical parameters with the available instrumentation. At the time of the workshop, this research was reaching the point where additional reduction in uncertainties in these critical parameters required new instrumentation for applications such as specifying radiative heating profiles, measuring vertical velocities, and studying the convective triggering and evolution of three-dimensional (3D) cloud fields.

ARM was already operating a subset of the necessary instrumentation to make some progress on these problems; each of the ARM sites included (and still includes) a cloud radar (operating at 35 or 94 GHz), a cloud lidar, and balloon-borne temperature and humidity sensors. However, these measurements were inadequate for determining detailed microphysical properties in most cases. Additional instrumentation needed to improve retrievals of microphysical processes includes radars at two additional frequencies for a total of three at a single site (35 GHz, 94 GHz, and a precipitation radar) and a Doppler lidar. Evolving to a multi-frequency scanning radar is a medium-term goal to bridge our understanding of two-dimensional (2D) retrievals to the 3D cloud field. These additional microphysical measurements would allow detailed cloud properties to be derived even in the presence of light precipitation. It is important to couple these detailed measurements of cloud microphysics to vertical motion on the cloud scale to couple microphysics with meteorological processes. Vertically pointing Doppler radars provide the vertical motion of cloud particles but, to separate particle motion from air motion, a wind profiler is required.

The American Recovery and Reinvestment Act provided the means to address these needs and implement a multi-frequency suite of radars, including scanning radars, at each of the ARM sites. In addition, Doppler lidars have been deployed at several sites. With these new measurement capabilities, ARM has the measurement capabilities to tackle the problems of improving microphysical profile descriptions and evaluating the relationship between our current narrow-field-of view, zenith perspective on clouds to a description of the full 3D cloud field and its temporal evolution.

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