

## **Recent Improvements in Cloud Liquid Water Path Retrievals Using Two-Channel Microwave Radiometer Measurements from the ARM Sites**

Eugene E. Clothiaux, *The Pennsylvania State University*

Shepard A. Clough, *Atmospheric & Environmental Research Inc.*

James C. Liljegren, *Argonne National Laboratory*

Karen Cady-Pereira, *Atmospheric & Environmental Research Inc.*

Sid Boukabara, *Atmospheric & Environmental Research Inc.*

Eli J. Mlawer, *Atmospheric & Environmental Research Inc.*

The first sets of statistically-retrieved cloud liquid water paths using two-channel microwave radiometer measurements collected by the US Department of Energy (DOE) Atmospheric Radiation Measurements (ARM) Program in the mid- to late-1990s exhibited too little accuracy to be of value in detailed atmospheric radiative transfer studies above the ARM sites. In particular, the use of monthly-mean climatological coefficients in the first retrievals was not sufficient to model important atmospheric thermodynamic state variability and the resulting errors in the retrieved cloud liquid water paths were significant. Since these early retrievals, further work by a number of investigators has led to improvements in the retrievals, a better understanding of the uncertainties in the model physics embedded in the retrievals, and improved characterization of the radiances input to the retrievals. Incorporating these improvements into a physical retrieval with a first-guess provided by a statistical retrieval that is based on instantaneously varying retrieval coefficients has led to the development of a new set of retrieved cloud liquid water paths. The relevance of these more recent retrievals to radiation studies over the ARM sites is considered and the remaining problems in the current retrieval are summarized.