The first of two main goals of this project has been to develop and implement a correction procedure that maximizes the accuracy of relative humidity (RH) measurements from ARM (Vaisala) radiosondes, and to evaluate the correction algorithm using a dataset of simultaneous measurements from Vaisala radiosondes and the reference-quality NOAA/ CMDL cryogenic hygrometer. The second main goal has been to determine how comparison of radiosonde RH measurements to reference-quality RH measurements obtained routinely in the ventilated "mailbox" at the SGP launch site can be used to characterize and improve the accuracy of ARM radiosonde measurements. This project is important to a broad variety of ARM research areas, including initializing numerical models and evaluating model results, improving the accuracy of radiative transfer calculations and parameterizations, evaluating water vapor retrievals from ground-based or satellite instruments, and developing water vapor and cloud parameterizations. Tobin et al. (2003) showed that in order to achieve a target accuracy of 1 W/m² in the downwelling and outgoing longwave flux, the water vapor profile must be known with an absolute accuracy of 2% in the total-column integrated water vapor, and 10% in the upper troposphere (UT).

As to the first goal, we developed an algorithm that corrects the radiosonde RH data for known "sensor-based" errors, including a correction for time-lag error caused by slow sensor response at low temperatures (developed under a separate ARM grant to Miloshevich), and also corrections for inaccuracy in the calibration of R880 radiosondes at low temperatures, and contamination of the sensor polymer in R880 radiosondes produced before June 2000. The correction algorithm was validated using the NOAA cryogenic hygrometer dataset. The correction procedure, validation study, and impact on ARM IOP datasets was published (Miloshevich et al. 2004). The corrected IOP datasets were disseminated to several ARM researchers, and contributed to several publications (Ferrare et al. 2004; Soden et al. 2004; several ARM and AMS conference papers). Ferrare et al. (2004) showed from radiosonde comparisons to the airborne LASE instrument during AFWEX that this correction approach reduced the dry bias in R880-H measurements in the UT from 15-20% to <5%.

As to the second goal of using the surface T/RH reference measurements from the mailbox to characterize the accuracy of individual ARM radiosondes, we found that the current mailbox/sensor system was neither accurate nor reliable enough for either radiosonde accuracy characterization or for general use as surface conditions for model input. These reference measurements are important because the sensor-based corrections discussed above do not address the "production variability" in the accuracy of the Vaisala calibration.
model, which is a random bias for any individual radiosonde. We
initiated an ECR to develop a new and more suitable system for
surface reference measurements, which consists of 6 T/RH sensors
housed in a ventilated chamber within a "Stevenson screen" that
protects the sensors and measurements chamber from solar radiation.
The ECR was approved, and the system was designed, built, and
deployed for testing at SGP during the recent AWEX experiment. The
results of this testing are reported at this year's ARM meeting
(Miloshevich et al. 2004a). The current status of the ECR is that we
are moving forward with implementing the datastream at ARM, and we
are working with vendors to improve the accuracy of the reference
measurements still further based on our initial findings from AWEX.

Given that this project was originally funded for only a
two-year period rather than the requested three-year period, it is
not surprising that the final Best Estimate radiosonde datastream has
not been implemented operationally at ARM, especially in light of the
unexpected need to design and implement an entirely new system for
surface reference measurements. A Renewal proposal to continue this
work was tentatively funded, but was later rescinded due to budget
constraints, with the recommendation that we resubmit to the current
ARM Call. A Renewal proposal is currently being prepared, seeking to
implement operationally a more comprehensive and useful Best Estimate
radiosonde datastream than was originally envisioned (due to things
learned over this grant period).

B. SPECIFIC ACCOMPLISHMENTS AND DELIVERED PRODUCTS

1. Validation of Time-lag Correction Algorithm

An algorithm that corrects Vaisala radiosonde humidity measurements
for time-lag and other sensor-based measurement errors has been
produced, extensively tested, and applied to ARM radiosonde data.
The algorithm was validated against a reference standard, its impact
on ARM radiosonde data was evaluated, and the results have been
published.

2. Dissemination of Results

Corrected radiosonde data from five ARM Water Vapor IOPs, including
documentation and analysis, was disseminated to several ARM
researchers and contributed to several coauthored publications.

3. ARM Instrument Development

We initiated an ECR to design an improved system for acquiring
reference T/RH measurements at the SGP radiosonde launch site,
suitable for characterizing the accuracy of ARM radiosonde
measurements. Additional details of the current and new surface
reference measurement systems, and scientific justification for the
change, can be found at http://www.mmm.ucar.edu/science/ecr/ecr.html.

4. AWEX Field Experiment Participation
We contributed in two ways to the success of the AIRS Water Vapor Experiment (AWEX) at SGP in November 2003, which was primarily a Radiosonde Intercomparison experiment. We deployed the new surface T/RH measurement system for initial field testing, and the results are reported at this year’s ARM meeting. We also operated 4 of ARM’s Vaisala data systems to acquire a dataset of Vaisala R880-H, R890, and R892 measurements for comparison to the operational and reference-quality radiosondes brought by AWEX investigators. We tested the new Vaisala R892 radiosonde during this intercomparison, and the results point strongly toward ARM adopting the R892. Our participation in AWEX constitutes a strong ARM contribution to the AIRS validation effort, because the ARM radiosonde measurements are a key element of the AIRS validation plan, and analysis of the AWEX dataset will produce a robust accuracy assessment for ARM radiosonde data, to the benefit of both ARM and NASA.

5. Publications

a. Journal Papers


b. Conference Papers


