# Atmospheric Emitted Radiance Interferometer Temperature and Water Vapor Retrievals: Southern Great Plains Cloud and Radiation Testbed Seasonal Statistical Analysis, Monthly Climatic Means for Model Integration, and Future GOES/AERI Retrievals

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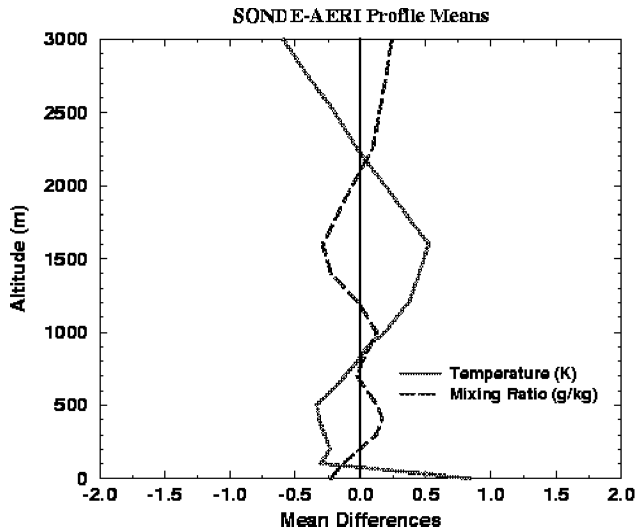
## Introduction

The Atmospheric Emitted Radiance Interferometer (AERI) (Revercomb et al. 1993) is providing radiances to routinely produce temperature and water vapor retrievals in the first three kilometers of the Earth's atmosphere at the Atmospheric Radiation Measurement (ARM) Southern Great Plains (SGP) Cloud and Radiation Testbed (CART) site (Smith et al. 1995). AERI retrievals have the ability to record air mass transitions at high temporal resolution (Feltz 1994). A comparison of an AERI versus radiosonde temperature cross-section (Appendix A) indicates the skill at which AERI captures a frontal passage at 6 Universal Time Coordinates (UTC). Radiosondes exist at the long dashed lines every three hours. For the same day, the water vapor cross-sections (Appendix A) for AERI, Raman lidar (Goldsmith et al. 1994), and radiosonde all show the same trends; however, both the AERI and Raman lidar indicate a dramatic increase in water vapor at the frontal passage time shown by the AERI temperature field.

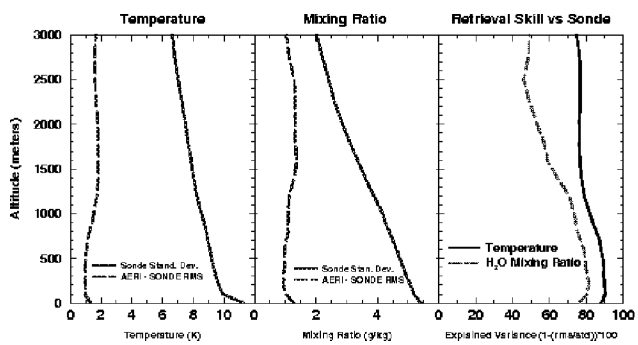
Beginning on July 1, 1996, the AERI retrieval algorithm was fully automated at the Pacific Northwest National Laboratory to provide continuous thermodynamic monitoring of the Planetary Boundary Layer (PBL) near Lamont, Oklahoma, in clear conditions and to cloud base. Retrievals were also produced from July 1, 1995, (installation of operational AERI-01 with meteorological hatch) until the automation date specified above at the University of Wisconsin. This has allowed robust analysis of how AERI retrievals compare to radiosondes (634 matches) in different seasons in the SGP. Accuracy of temperature retrievals are better than 0.8 to 1.5 degrees Kelvin from the surface to 3 km and mixing ratio retrieval errors are less than 1 g/kg as judged using coincident radiosondes (Figure 1a). The root mean square (RMS) differences shown in Figure 1 must be viewed as an upper bound on the error of AERI retrievals because the radiosonde observations possess errors, and there are differences between the columns of air being sampled by AERI and the horizontally drifting balloon observations. Mean differences in the AERI retrievals compared to radiosondes show no great positive or negative bias to 3 km (Figure 1b).

The high temporal resolution of the AERI retrievals (every ten minutes) can provide monthly/hourly means of temperature and water vapor for the PBL. These averages are useful to the modeling community since they may use longer time steps than ten minutes (Figure 2).

Geostationary Operational Environmental Satellite (GOES)-8 temperature and water vapor profiles (now provided by University of Wisconsin Space Science and Engineering Center (SSEC) every three hours over the CART site) are to be combined with the AERI retrievals to allow full profiles of the troposphere. An example of AERI and GOES retrievals derived independently from each other are plotted (Figure 3) over radiosondes launched on September 22, 1996. Notice that AERI passive retrievals

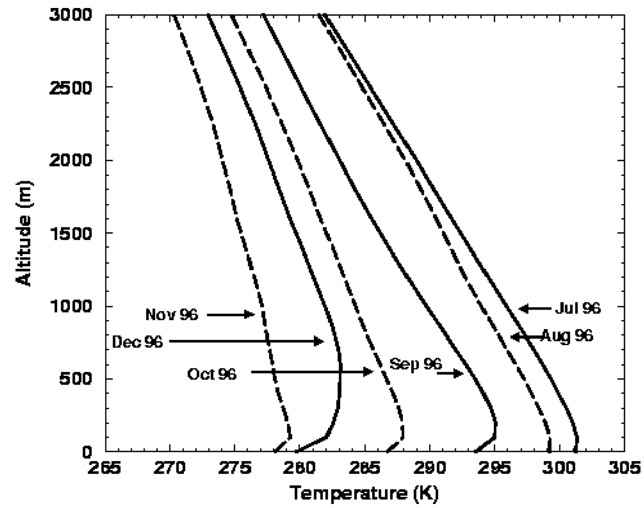



(a)

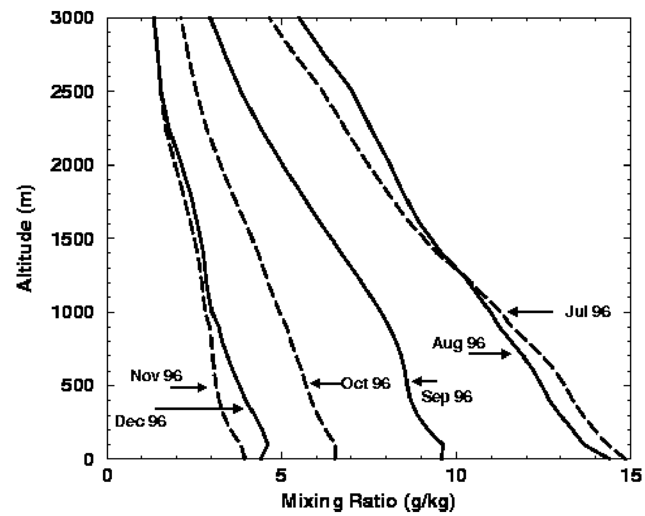



(b)

**Figure 1.** Above, RMS summary of retrieval skill compared to radiosondes (a). Below, mean differences between radiosonde and AERI temperature and water vapor profiles are shown (b).



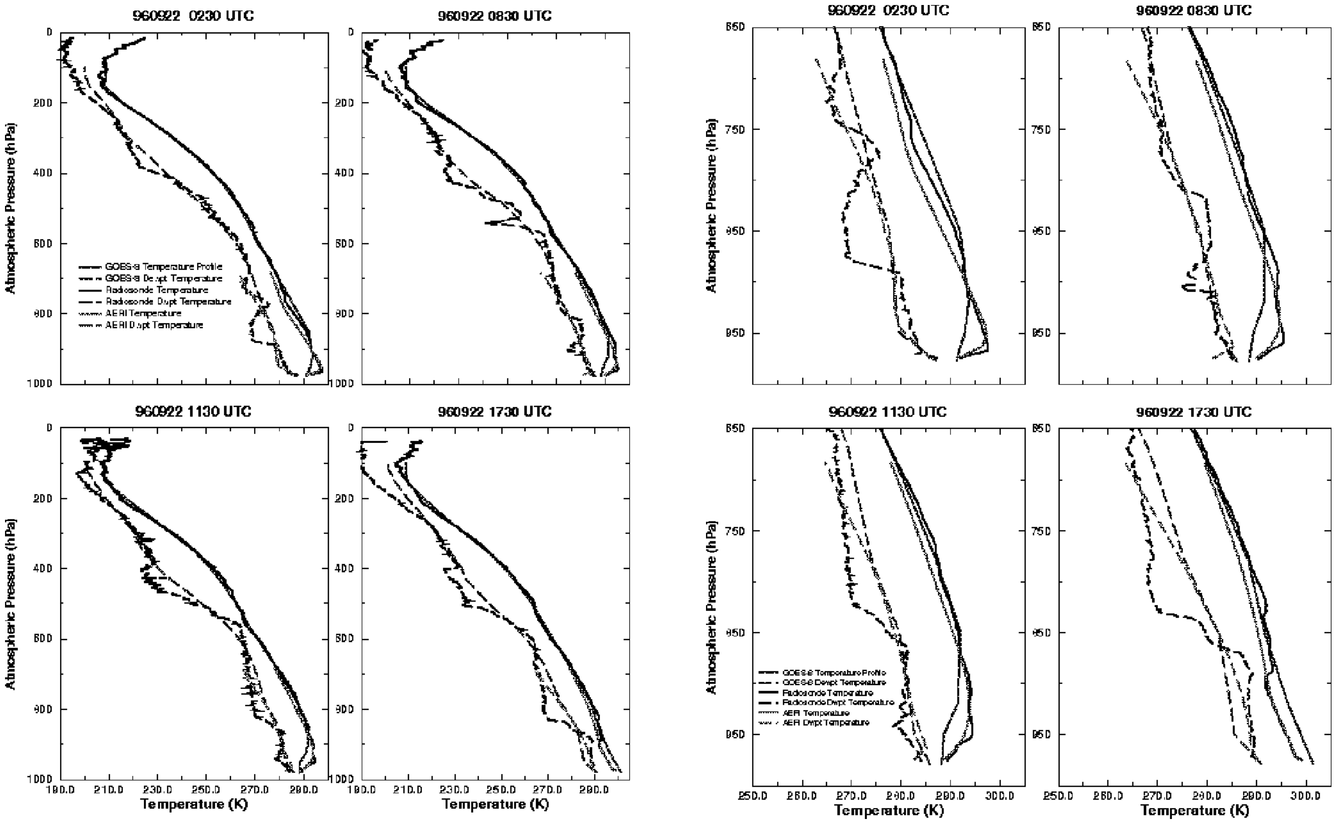

(a)




(b)

**Figure 2.** Monthly averages of AERI temperature and water vapor profiles in clear sky for July - December 1996 (a,b). These averages will be useful for boundary layer model verification on a long time scale.

easily detect the nocturnal temperature inversion present from 0230 - 1130 UTC between 0-500 meters (shown better in the lower figure). The GOES retrievals offer the most information about the temperature and water structure in the mid and high troposphere. Work is currently being done to combine the GOES and AERI radiances to perform a full physical retrieval of the troposphere (Hoe 1997). Figure 4 shows simulations for 153 cases—the expected retrieval performance for the combined space-based and ground-based radiances. Notice the AERI+GOES retrievals are more accurate than either system by itself.




(a) (b)

**Figure 3**. GOES/AERI retrievals overlaying time coincident radiosonde profiles indicating a useful synergy by combining the two instruments.

AERI retrievals have made significant progress, including full automated implementation for the SGP CART site. Future plans include automating the GOES/AERI retrieval program, retrieval algorithm development for the North Slope of Alaska/Tropical Western Pacific, and implementation of retrievals into a mesoscale model once four additional AERIs are installed at the SGP CART boundary sites.

## References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Goldsmith, J.E.M., S. E. Bisson, R. A. Ferrare, K. D. Evans, D. N. Whiteman, and S. H. Melfi, 1994: Raman Lidar profiling of atmospheric water vapor; Simultaneous measurements with two collocated systems. *Bull. Amer. Meteor. Soc.*, **75**, 975-982.

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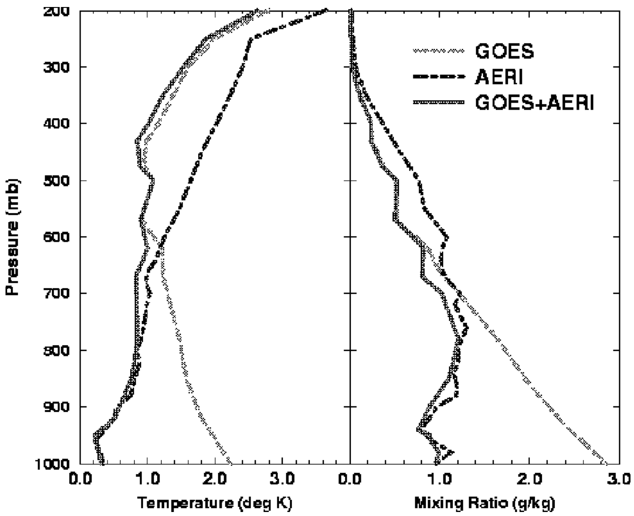


**Figure 4**. AERI, GOES, and AERI+GOES temperature and water vapor mixing ratio profile root mean square differences compared to radiosondes for 153 simulated retrieval cases. Notice the improvement in retrieval accuracy when AERI and GOES radiances are used together to retrieve temperature and water vapor.

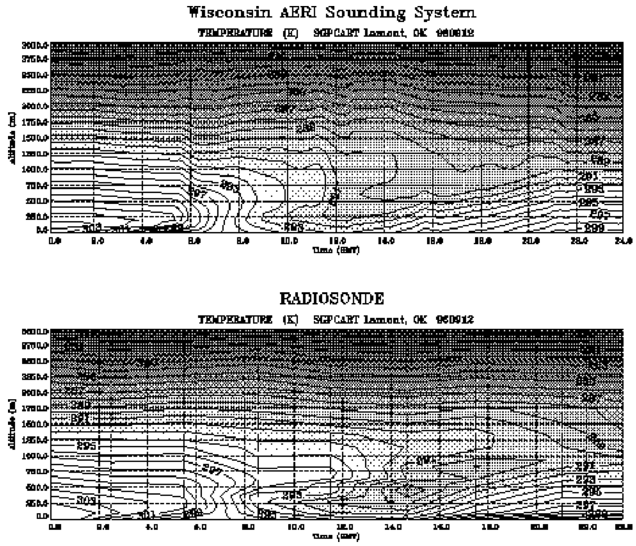


**Figure 5**. AERI temperature and water vapor cross-sections compared to radiosondes. Notice the AERI retrieval skill in capturing the magnitude and tendency of the air mass transition at 6 UTC.

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Smith, W. L., W. F. Feltz, R. O. Knuteson, and H. E. Revercomb, 1995: PBL Sounding and Cloud Emittance Observations with ARM-CART AERI Observations. *Proceedings of the Fourth ARM Science Team Meeting*, San Diego, California, March 19-23, 1995, 203-205.

# Appendix A

AERI temperature and water vapor cross-sections compared to radiosondes and Raman LIDAR for a cold frontal passage on September 22, 1996, 6 UTC at the SGP CART site. Notice the AERI retrieval skill in both capturing the magnitude and tendency of the air mass transition at 6 UTC (Figures 5 and 6).

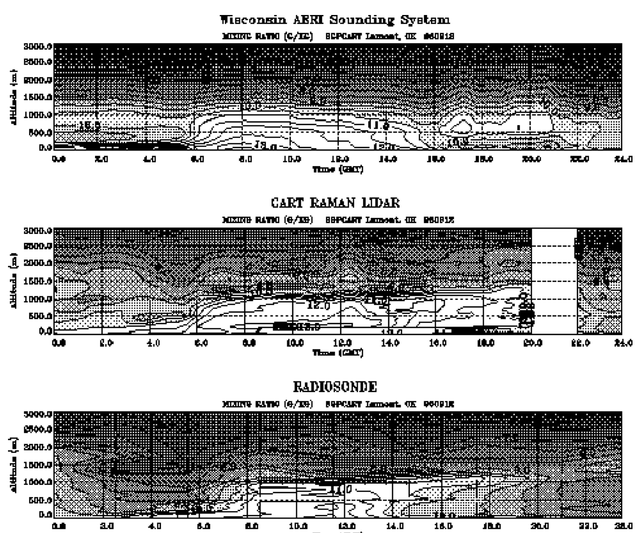


**Figure 6**. Raman lidar for a cold frontal passage on September 12, 1996, at the SGP CART site. Notice the AERI retrieval skill in capturing the magnitude and tendency of the air mass transition at 6 UTC.