Atmospheric Emitted Radiance Interferometer Temperature and Water Vapor Retrievals: Improvements Using an Integrated Profile Retrieval Approach

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Introduction

A major focus of the U. S. Department of Energy (DOE) Atmospheric Radiation Measurement Program (ARM) is to best characterize the thermodynamic state of the atmosphere using a suite of in situ and remote sensing instrumentation. The goal is to take advantage of each property measured by the instruments to provide a clear picture of atmospheric state. An Atmospheric Emitted Radiance Interferometer (AERI) has now been operating nearly continuously since December 1993, obtaining high-resolution infrared atmospheric spectra. Temperature and water vapor retrievals can be calculated from these spectra with a 10-minute time resolution through the Planetary Boundary Layer (PBL). The retrievals have been improved significantly by adding the following instrument information (Figure 1).

A one-year set of radiosonde data allowed a regression to be performed between radiance calculations from the sondes and the sonde temperature and humidity profiles, to provide a unique statistical retrieval to be used as a guess for each physical retrieval. The Surface Meteorological Observation System (SMOS) and Microwave Radiometer allows surface atmospheric state and atmospheric total precipitable water, respectively, to be used as supplemental information for the initial guess. This provides a better first guess for the physical retrieval algorithm.. Finally, and most important, micropulse lidar cloud base heights enable accurate retrievals under all cloud conditions. The result of these developments is the capability for continuous monitoring of the PBL thermodynamic structure using CART site instrumentation.

Temperature and water vapor statistics shown below (Figures 2 and 3) indicate good agreement of the PBL measurements with radiosondes. All retrieval and radiosonde matches for clear sky conditions were used in the statistical sample, totaling 255 cases from July 3, 1995 through October 30, 1995. Root Mean Square (RMS) differences between AERI temperature retrievals and radiosonde profiles are less than 1°K from the surface to 1 km and degrade to 1.5°K for 1 km to 3 km. Dewpoint temperature differences are less than 3°K to 1 km and then decay to 4°K to 1.5 km as weighting functions decay rapidly with height.

Thermodynamic structures within the PBL are very evident when viewing time cross sections of AERI retrievals. Here is an example of a dramatic cold frontal passage on October 13, 1995, at the ARM CART site in Lamont, Oklahoma (Figure 3). The upper cross section is a temperature comparison with time between AERI retrievals and linear interpolation of radiosonde launches for this day. The lower figure is a similar comparison, except mixing ratio is the field of interest.

AERI temperature and water vapor retrievals will soon be a value added product available in net cdf format to the ARM science team community. Continuous profiling of the PBL with AERI spectra combined with the new Geostationary Operational Environmental Satellite (GOES) sounding capability, should provide full tropospheric profiles of temperature and water vapor in the very near future.

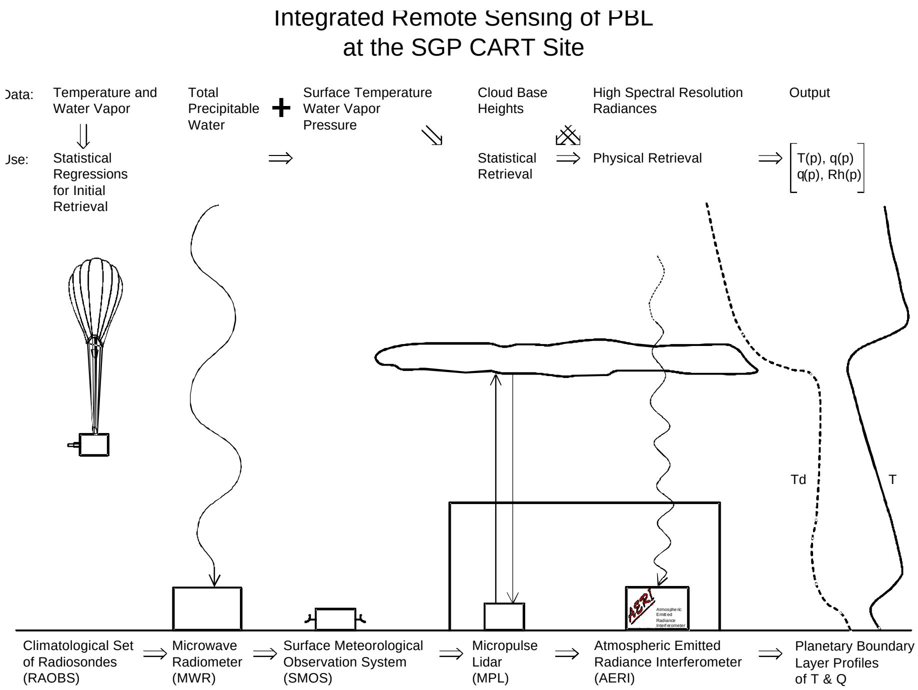

Figure 1. A schematic of the Cloud and Radiation Testbed (CART) site instrument integration procedure used to calculate temperature and water vapor retrievals in the Planetary Boundary Layer (PBL).

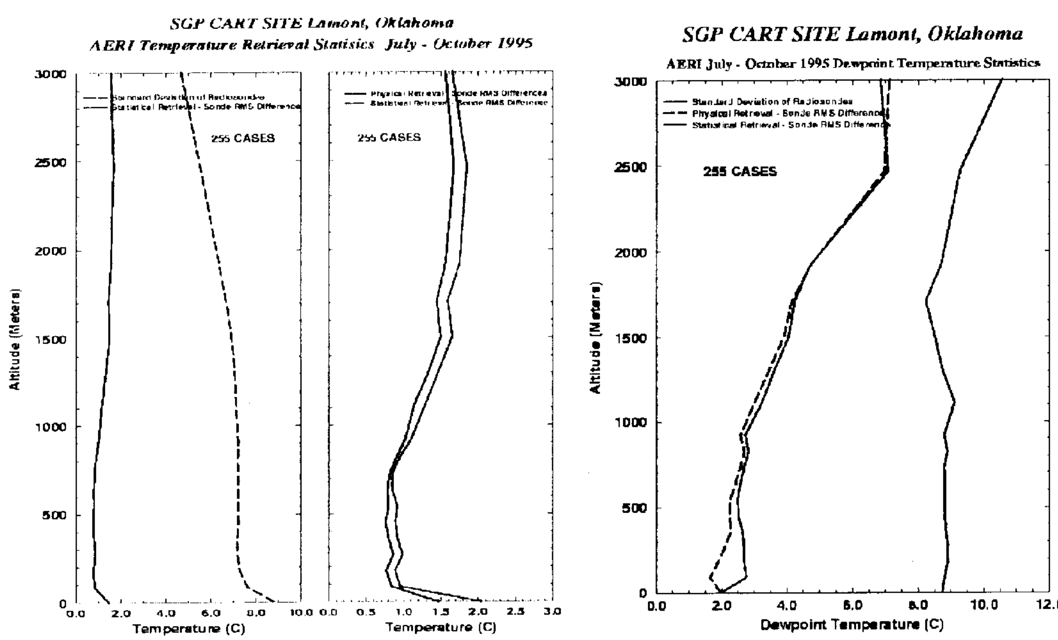

Figure 2. AERI temperature and water vapor retrieval statistics compared to matching sonde launch times.

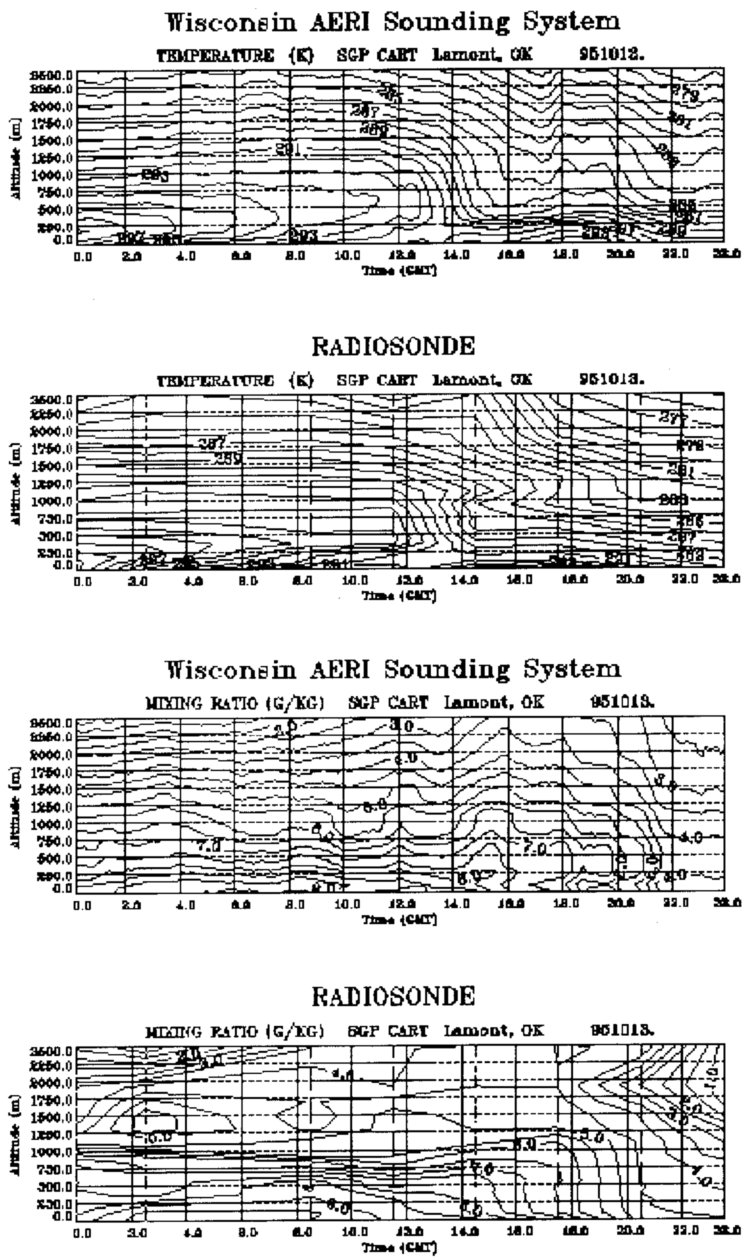

Figure 3. AERI vs. Radiosonde temperature and water vapor time cross sections, indicating excellent agreement in field tendency and magnitude. Radiosondes exist at long vertical dashed lines in the radiosonde cross sections.