# Comparison of Recalibrated Atmospheric Emitted Radiance Interferometer Observations with Line-by-Line Radiative Transfer Model Calculations

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## Abstract

The comparison of recalibrated spectra from the atmospheric emitted radiance interferometer prototype (AERI-00) and line-by-line radiative transfer model (LBLRTM) calculations show much smaller differences in the 800-1200 $cm^{-1}$ atmospheric window region under "clear conditions" compared with the preliminary calibrated data. Results indicate that the new AERI-00 data is in good agreement with similar comparisons using Spectral Radiance Experiment (SPECTRE) data. However, the recalibrated spectra have small changes in other spectral regions. Large observation-model differences still exist in the 550-630 $cm^{-1}$ region, especially for dry cases, indicating a potential problem in arctic radiance and atmospheric cooling rate calculations.

## Background

Preliminary calibrated spectra from AERI-00 showed differences with LBLRTM calculations in the 800-1250 $cm^{-1}$ interval under "clear conditions" that were much larger than similar comparisons using SPECTRE data (Ellingson et al. 1994a,b). Recently, University of Wisconsin personnel discovered some problems in the AERI-00 observations and corrections have been made to the data from April 1994—July 1995. The corrections primarily affect the window region with largest changes under clear conditions (Knuteson et al. 1995).

## Data Preparation

Clear-sky conditions for intercomparison of observations with calculations were selected from April, May, August, September, and November 1994 using Micro Pulse Lidar (MPL) data. A given radiosonde launch time is considered to be clear if the MPL data indicate no clouds within a 40-minute window (20 minutes before and after the given time). We have obtained 131 clear cases during the above five months. For each clear case selected, the AERI data were taken at the time closest to the radiosonde launch time (within a 20-minute window).

LBLRTM calculations were performed using radiosonde temperature and water vapor profiles and climatological trace gases as input (LBLRTM version ~ 3.5 with continuum CKD-2. 1). The line database is HITRAN 92. The model uses surface temperatures retrieved from the 675-680 $cm^{-1}$ AERI radiance, and 45 vertical levels up to 30 km are used in the calculations.

## Results

The differences between AERI-observed and LBLRTM-calculated radiance in the 800-1250 $cm^{-1}$ spectral interval are plotted in Figure 1 verses radiosonde integrated precipitable water vapor for the recalibrated AERI-00 (circles), the preliminary calibrated AERI-00 (crosses), and for the data collected during SPECTRE (dots). Note that effects of $0_3$ are not considered (i.e., only the 800970 + 1110-1250 $cm^{-1}$ intervals are considered). All cases are for clear conditions. It is obvious that the differences between the recalibrated

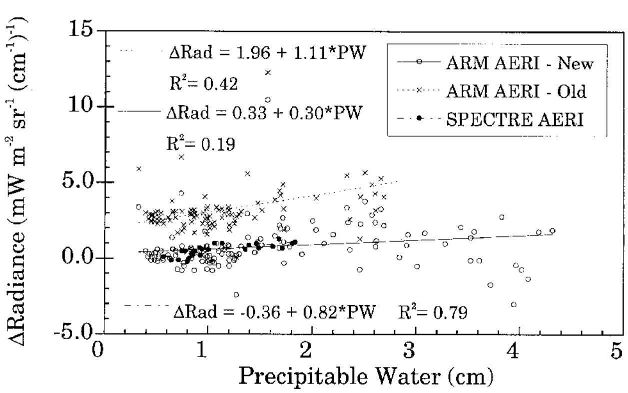


**Figure 1.** AERI observed and LBLRTM radiance differences in the interval of 800-970 + 1110-1250 $cm^{-1}$.

AERI-00 and calculations have been reduced significantly using the Wisconsin corrections. The agreement with similar comparisons made with SPECTRE data is very good. The mean and rms radiance differences using the recalibrated data for this window interval are 0.79 and 1.86 mW/($m^2$ sr $cm^{-1}$), respectively. The mean radiance difference implies a mean flux difference of about 1.15 W/$m^2$.

As the precipitable water vapor amount increases, the mean difference between the observed and LBLRTM window radiance increases slightly, as does the scatter about the mean. It is not clear that these differences are due to the observations, the model, or the inputs to the model. Comparisons of precipitable water estimates from radiosonde and microwave radiometer observations have shown disagreements for many situations. The radiosonde precipitable water is occasionally significantly larger than the microwave precipitable water, and these differences become more scattered at large water amounts (not shown herein). This may partly explain why the window radiance difference becomes more scattered when the precipitable water increases, but this cannot explain the increasing window radiance difference with increasing precipitable water, unless there is a systematic radiosonde error at large precipitable water.

Aerosol effects have not been included in our calculations, but they have large effects in some cases. This may be another source of the scatter in the window radiance differences. For example, at 02:31 (UTC) April 26, 1994 (figure not shown), the observed-LBLRTM radiance difference in the window region is about 14 mW/($m^2$ sr $cm^{-1}$), and this leads to a flux uncertainty of 17 W/$m^2$. Such a difference is not negligible. It is necessary to find a method to apply observed aerosol information, such as data from Raman Lidar, to reduce such differences.

Although Figure 1 showed that the radiance differences between the observed and LBLRTM are reduced to a low level in the window region under clear and low aerosol conditions, there is another part in the longwave response which showed large differences between observations and model calculations—the 550-630 $cm^{-1}$ interval (see Figure 2 ). The differences are large under dry conditions, but they become negligible as the water vapor amount increases. There are some outliners which are likely due to incorrect water vapor input profiles.

The interval from 550-630 $cm^{-1}$, known as the “dirty window,” is narrow for mid-latitude conditions and the problem is not important for surface downward flux calculations because it is nearly filled. However, this “dirty window” expands to about 300 $cm^{-1}$ under very dry arctic winter conditions. Hence, the above radiance difference indicates potential problems for arctic radiance comparisons. In addition, the clear-sky atmospheric cooling rate in the middle and upper troposphere is largely controlled by this spectrum short of 500 $cm^{-1}$. Therefore, until these differences are explained, the accuracy of clear-sky cooling rates in the middle and upper troposphere remains questionable.

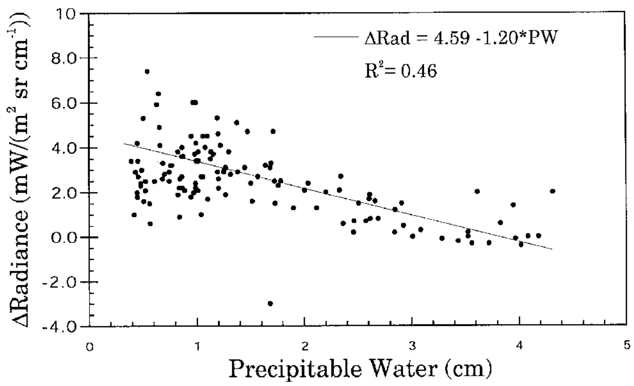


**Figure 2.** AERI observed and LBLRTM radiance differences in the interval of 550-630 $cm^{-1}$.

# References

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