

DETERMINATION OF THE IN-FLIGHT SPECTRAL CALIBRATION OF AVIRIS USING ATMOSPHERIC ABSORPTION FEATURES

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1. IN-FLIGHT SPECTRAL CALIBRATION

Spectral calibration of the Airborne Visible/Infrared Imaging Spectrometer (AVIRIS) as data are acquired in flight is essential to quantitative analysis of the measured upwelling spectral radiance (Green, 1995). In each spectrum measured by AVIRIS in flight, there are numerous atmospheric gas absorption bands that drive this requirement for accurate spectral calibration. If the surface and atmospheric properties are measured independently, these atmospheric absorption bands may be used to deduce the in-flight spectral calibration of an imaging spectrometer (Conel et al., 1988, Green et al., 1988, 1993).

Both the surface and atmospheric characteristics were measured for a calibration target during an in-flight calibration experiment held at Lunar Lake, Nevada on April 5, 1994 (Green et al., 1995). This paper uses upwelling spectral radiance predicted for the calibration target with the MODTRAN radiative transfer code (Berk et al., 1989) to validate the spectral calibration of AVIRIS in flight.

Surface reflectance, atmospheric optical depths, and water vapor measurements were used to constrain the MODTRAN and predict at high spectral resolution the upwelling radiance at AVIRIS over the in-flight calibration target (Figure 1). To compare this MODTRAN radiance with AVIRIS radiance, MODTRAN must be convoluted to the AVIRIS spectral channels (Figure 2). The radiance reported by the AVIRIS channels in the vicinity of each atmospheric absorption is strongly dependent on the laboratory-calibrated (Chrien et al., 1990) spectral wavelength position of each AVIRIS channel. An algorithm was developed in 1988 to derive the in-flight spectral calibration of AVIRIS using these atmospheric absorption bands (Green et al., 1988). This algorithm optimizes the agreement between the AVIRIS-measured spectrum and the MODTRAN-predicted spectrum across a single absorption band by varying the AVIRIS channel spectral calibration characteristics (Figures 3 through 6). Results for this algorithm, when applied to the April 1994 calibration experiment data, are given in Table 1. The spectral locations of the atmospheric band, the band source, the AVIRIS spectrometer affected, the AVIRIS channel spectral shift from laboratory calibration, and the confidence level are given.

Table 1. AVIRIS In-Flight Spectral Calibration

Wave Length, nm	Source	Spectro-meter	Shift from Lab, nm	Confidence, nm
430	Solar	A	-0.3	±2.0
520	Solar	A	+0.4	±2.0
620	H ₂ O	A	-0.4	±2.0
650	H ₂ O	A	+1.2	±2.0
690	H ₂ O	B	-0.6	±2.0
730	H ₂ O	B	+0.4	±2.0
760	O ₂	B	-0.7	±1.0
820	H ₂ O	B	+0.3	±2.0
940	H ₂ O	B	-0.5	±1.0
1140	H ₂ O	B	+0.0	±1.0
1260	O ₂	C	+0.0	±2.0
1470	H ₂ O	C	-0.2	±2.0
1580	CO ₂	C	+1.2	±2.0
1610	CO ₂	C	-0.9	±2.0
2020	CO ₂	D	-0.3	±1.0
2060	CO ₂	D	-0.8	±1.0
2350	CH ₄	D	+0.2	±2.0
2380	CH ₄	D	-0.8	±2.0
2420	CH ₄	D	+0.0	±2.0
2460	CH ₄	D	-0.1	±2.0

In this analysis, none of the derived in-flight spectral channel calibrations exceeded the uncertainty of the algorithm. The uncertainty, or confidence level, is based on the spectral contrast of the absorption band. Contrasts of the absorption band *minima to continua* of greater than 25 percent are given a confidence of ± 1.0 nm. Bands with less than 25 percent contrast are given a ± 2.0 nm confidence. Levels of 1.0 and 2.0 nm are estimated based on confidence in the MODTRAN model, AVIRIS radiometric stability, and in situ measurement. These confidence levels are supported in the algorithm results by the discrepancy for pairs of absorption bands in the same spectrometer. For example, the strong CO₂ bands at 2020 and 2060 nm give differing results of 0.5 nm and the results for the weak CO₂ bands at 1580 and 1610 differ by 2.1 nm. In overview, this analysis shows that the in-flight spectral calibration had not changed with respect to the laboratory spectral calibration at the level of confidence in the algorithm.

2. ACKNOWLEDGMENTS

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3. REFERENCES

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4. FIGURES

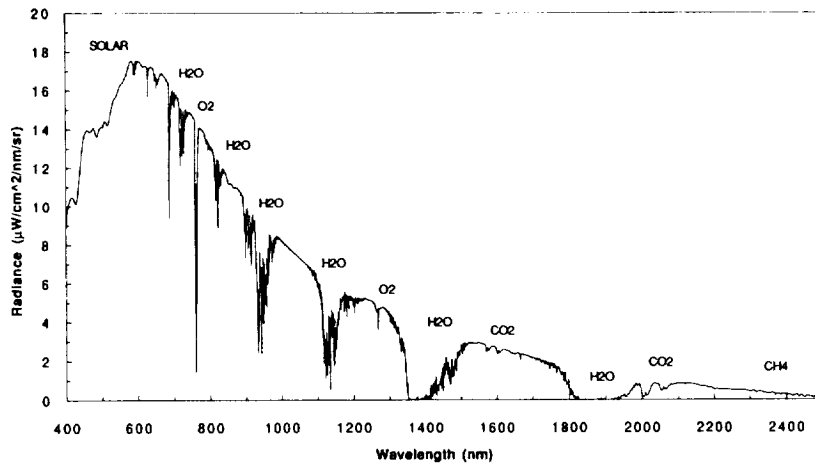


Figure 1. Upwelling spectral radiance predicted by MODTRAN for the AVIRIS over flight of Lunar Lake, NV on April 5, 1994.

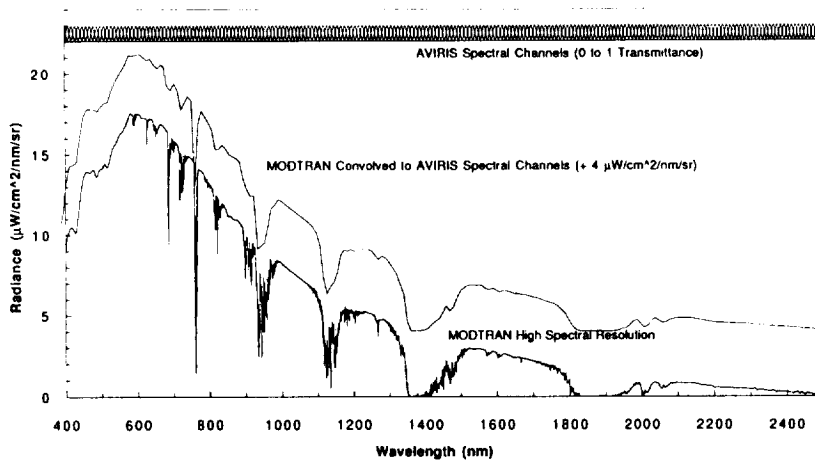


Figure 2. Convolution of MODTRAN to AVIRIS spectral channel characteristics.

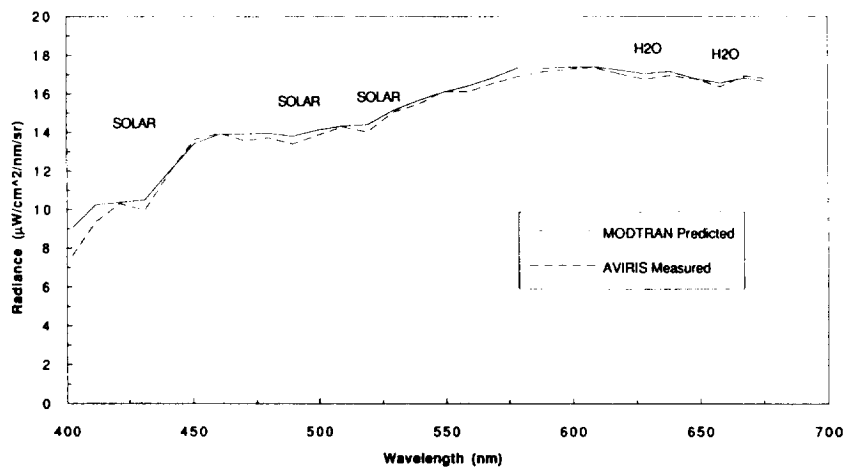


Figure 3. AVIRIS-measured and MODTRAN-predicted radiance for the A spectrometer, based on the laboratory spectral calibration.

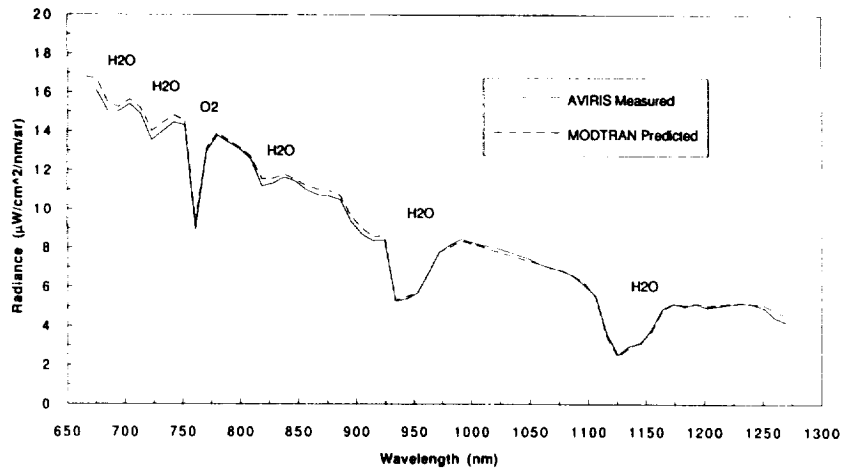


Figure 4. AVIRIS-measured and MODTRAN-predicted radiance for the B spectrometer, based on the laboratory spectral calibration.

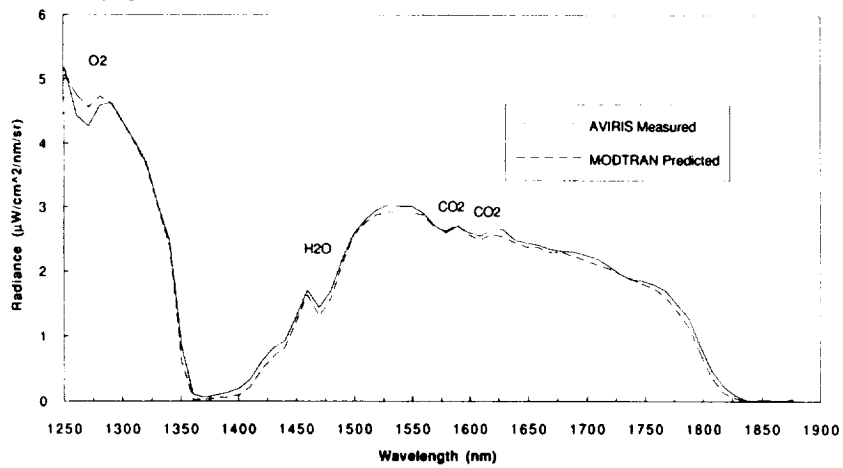


Figure 5. AVIRIS-measured and MODTRAN-predicted radiance for the C spectrometer, based on the laboratory spectral calibration.

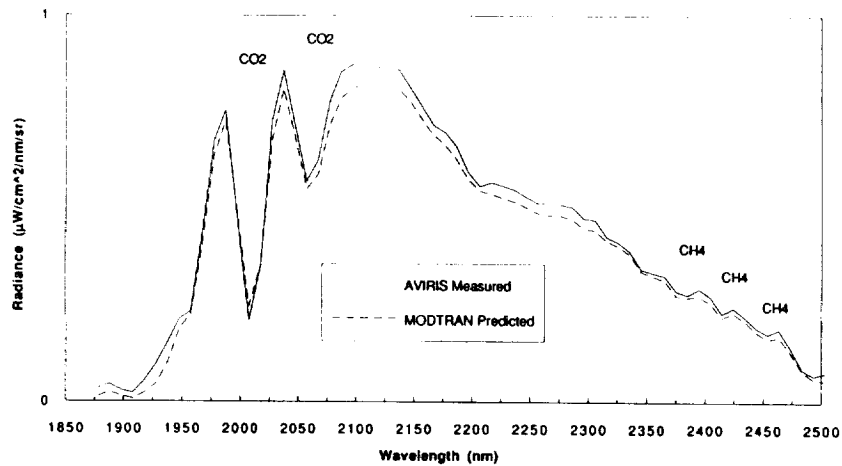


Figure 6. AVIRIS-measured and MODTRAN-predicted radiance for the D spectrometer, based on the laboratory spectral calibration.