IN-FLIGHT CALIBRATION OF THE SPECTRAL AND RADIOMETRIC CHARACTERISTICS OF AVIRIS IN 1991

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SUMMARY

On March 7, 1991, an in-flight calibration experiment was held at the Ivanpah Playa in southeastern California for the AVIRIS imaging spectrometer. This experiment was modeled on previous work for the in-flight calibration of imaging spectrometers (Conel et al., 1987, Green et al., 1988, Conel et al., 1988, Green et al., 1990, and Green et al., 1992).

Five AVIRIS overflights were acquired of a calibration target designated on the Ivanpah Playa surface. At the time of the overflights, the reflectance of the calibration target was measured with a field spectrometer. In addition, the atmospheric optical depths and water vapor abundance were measured from a radiometer station adjacent to the calibration target. These in situ measurements were used to constrain the MODTRAN radiative transfer code (Berk et al., 1989) to model the upwelling spectral radiance incident to the sensor aperture during the overflights. Analyses of this modeled radiance in conjunction with the laboratory-calibrated radiance were used to determine the spectral and radiometric calibration of AVIRIS while in flight. Figure 1 gives the comparison of one of the MODTRAN-modeled and AVIRIS-laboratory-calibrated radiance for the overflights of the Ivanpah Playa calibration target.

The modeled and measured spectra used in this experiment are generated through independent pathways allowing direct validation of AVIRIS performance in flight. The MODTRAN spectrum is derived from a measured solar irradiance spectrum imbedded in the computer code. The AVIRIS-laboratory-calibrated spectrum is derived from to a National Institute of Standards and Technology (NIST) traceable standard lamp maintained at JPL.

The in-flight radiometric calibration of AVIRIS is validated by the agreement between these spectra. This agreement is better than 7% excluding the opaque regions of the terrestrial atmosphere. To generate the in-flight calibration directly, radiometric calibration coefficients were calculated from the MODTRAN-modeled radiance and the AVIRIS digitized signal for the Ivanpah Playa calibration target.

Spectral calibration was validated by the agreement between the modeled and the laboratory-calibrated data in spectral regions of strong atmospheric gas absorption features. For example, the oxygen band at 760 nm is expressed equivalently in these two independently derived

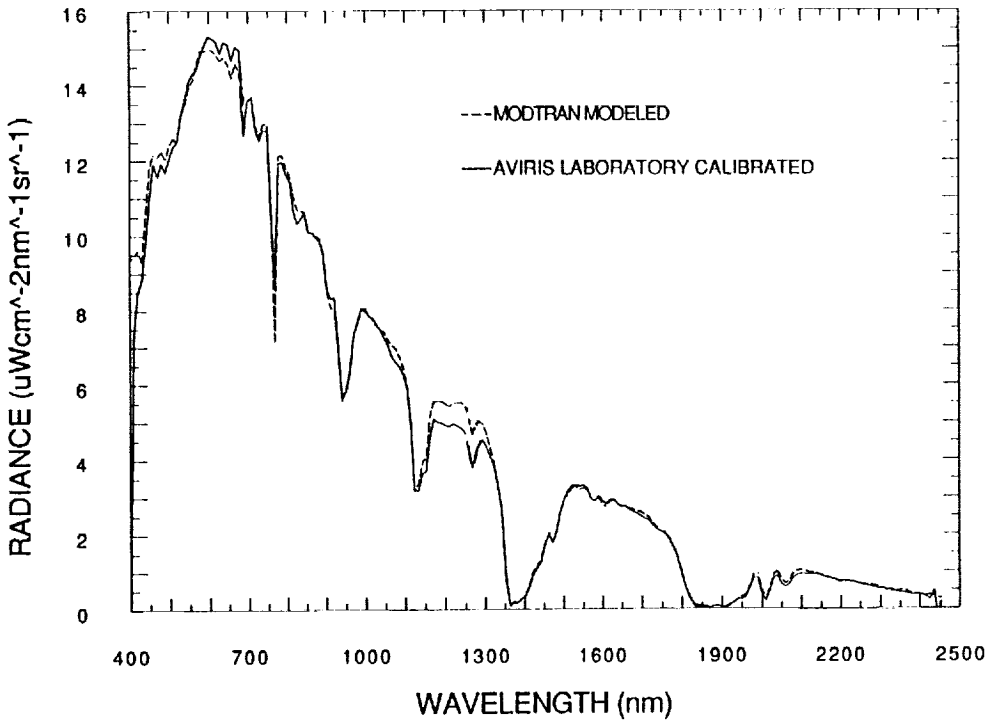

Figure 1. Comparison of the MODTRAN radiative transfer code modeled and AVIRIS laboratory calibrated radiance from the Ivanpah Playa calibration target.

spectra. Quantitative analysis of the 14 strong absorption features present in the AVIRIS spectral range with a nonlinear least squared fitting algorithm was used to validate the calibration across the spectral range. A complete in-flight spectral calibration was generated for all 224 AVIRIS channels through interpolation between the spectral absorption feature analyzed.

Data from this calibration experiment were used to determine the precision or signal-to-noise of AVIRIS in-flight. Sensor noise was determined as the root mean squared deviation (RMSD) of the AVIRIS dark signal spectra measured for the overflight of the calibration target. The AVIRIS measured signal from the calibration target was normalized to the AVIRIS reference radiance to allow comparison with previous signal-to-noise determinations. In-flight signal-to-noise was calculated as the ratio of normalized-signal to the RMSD noise and is shown in Figure 2.

Based on this experiment, AVIRIS was shown to be well calibrated at the beginning of the operational season in 1991. Experiments in May and late June showed the calibration to be maintained with the exception of the 1900- to 2450-nm spectral region. Damage to the sensor caused throughput reduction in this spectral region in early June. Radiometric calibration of this 1900- to 2450-nm region was reestablished using the late June in-flight calibration experiment.

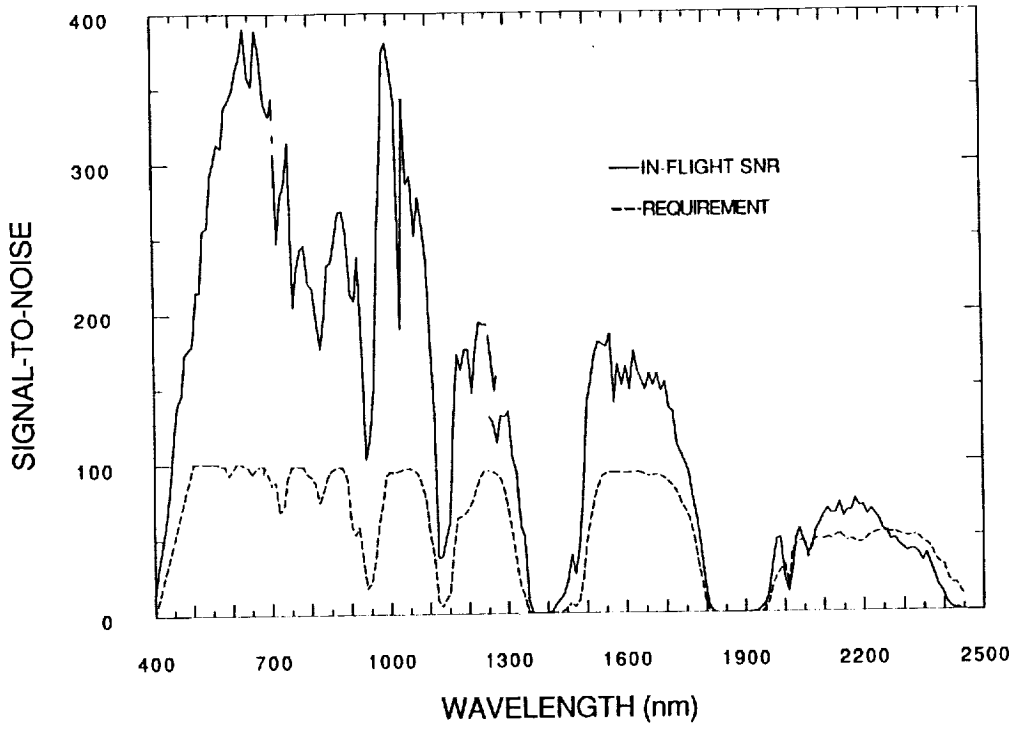

Figure 2. In-flight determined signal-to-noise at the AVIRIS reference radiance for the March 7, 1991, calibration experiment.

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