Post-ATREM Polishing of AVIRIS Apparent Reflectance Data using EFFORT : a Lesson in Accuracy versus Precision

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Since the focal plane refit before the 1995 flight season, AVIRIS has consistently produced calibrated spectral radiance data of extremely high precision. This high precision has not translated directly into high accuracy in the spectral radiance data or in the apparent surface reflectance spectra derived from them. The reason for this is the limited accuracy of the combined chain of absolute standards, calibrations, models and measurements that connect the high precision raw DN to the final output of relatively low accuracy apparent surface reflectance. Sources of error including: errors in the NIST standard bulbs; spectral and radiometric calibration uncertainty; in-flight system changes; solar irradiance model errors, inaccuracy in atmospheric parameter estimation; and radiative transfer code errors combine to limit the accuracy of the final apparent reflectance data to no better than several percent. Filtered by this relatively inaccurate signal processing chain, the very high precision (1 part in thousands) of the new AVIRIS data is underutilized. It is like a very high quality rifle in the hands of a near-sighted marksman, lots of precision but limited accuracy.

We have developed a process, EFFORT (the Empirical Flat Field Optimal Reflectance Transformation), to bootstrap a linear adjustment to the data to recover accuracy that matches the precision. It has its roots in the Empirical Line method, often used to reduce data from uncalibrated sensors using field measured spectra. However, in our application we use no ground data, and only apply the empirical gains and offsets after a theoretical data reduction has been done using the ATREM radiative transfer code. EFFORT asks a simple question, "Is there a mild linear transformation, a gain near unity and an offset near zero for each channel, that will make the spectra look more like real material spectra?". Since 1995, we have found that such a mild correction does exist and the application of these statistically insignificant adjustments, well within the error budget to the data calibration and reduction process, makes a profound improvement in the AVIRIS apparent reflectance spectra. It is like a guiding hand, gently steering our near-sighted marksman back to the bull'seye. After EFFORT adjustment, comparison to library-based spectra is much improved. We believe that high quality imaging spectrometers will for ever more have precision that exceeds the accuracy of the atmospheric models needed to reduce them to reflectance. Thus, EFFORT seems sure to play a role in future applications requiring cutting-edge spectral fidelity.