A Comparative Analysis of Field Spectroscopy and NEON Atmospherically Corrected Airborne Reflectance Data

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National Ecological Observatory Network

Background and Problem

The **National Ecological Observatory Network (NEON)** is constructing an **Airborne Observation Platform (AOP)** that will provide high resolution RGB, LiDAR, and hyperspectral data over NEON field sites located across the United States. The AOP payload includes the **NEON Imaging Spectrometer (NIS)** that provides more than 420 bands of high resolution data across a spectral range of 380 nm to 2510 nm. NEON atmospherically corrects its hyperspectral remote sensing data using ATCOR-4, a method that calculates surface reflectance and temperature based on geocoded and orthorectified imagery. A challenge in atmospherically correcting the remote sensing data is ensuring that the airborne spectra are as minimally affected by the atmosphere as possible. This study compared field spectra to NEON atmospherically corrected airborne derived data to identify ways in which NEON could reduce uncertainty caused by a number of atmospheric variables.

Study Area

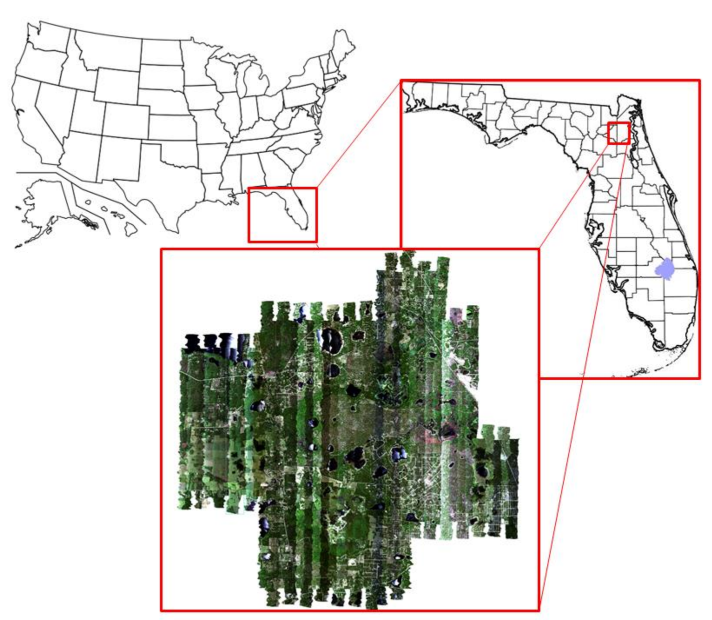


Figure 1. The Ordway-Swisher Biological Station and surrounding region, located 20 miles east of Gainesville in Putnam County, Florida.

Leaf-level spectra were collected with an ASD handheld spectrometer. Airborne remote sensing data were acquired using the NEON hyperspectral imaging spectrometer.

Defining Regions of Interest

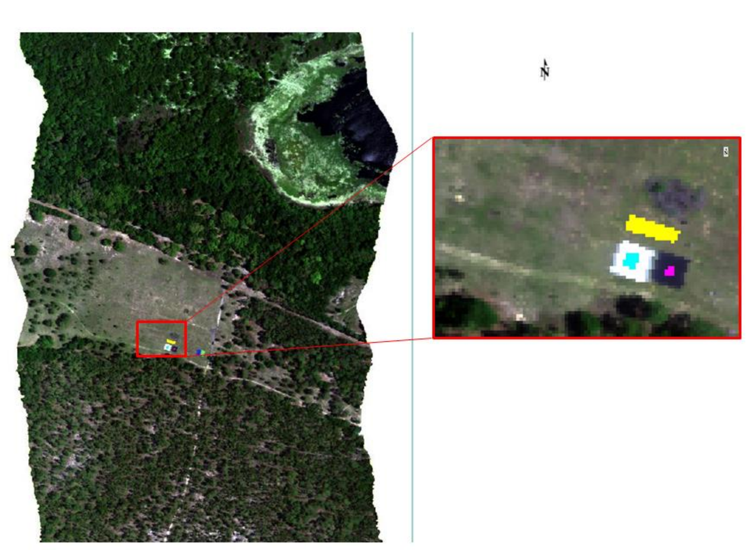


Figure 2. Regions of interest: 3% reflectance Tracor tarp in cyan, 48% reflectance Tracor tarp in magenta, and mowed vegetation transect in yellow.

In order to compare the airborne data to the field spectra, we determined regions of interest (specifically over the Tracor tarps and walking transects) in ENVI, and matched the location where the field spectra were collected to specific pixels in the spectrometer data (Figure 2).

Determining Variables and Improving the Corrections

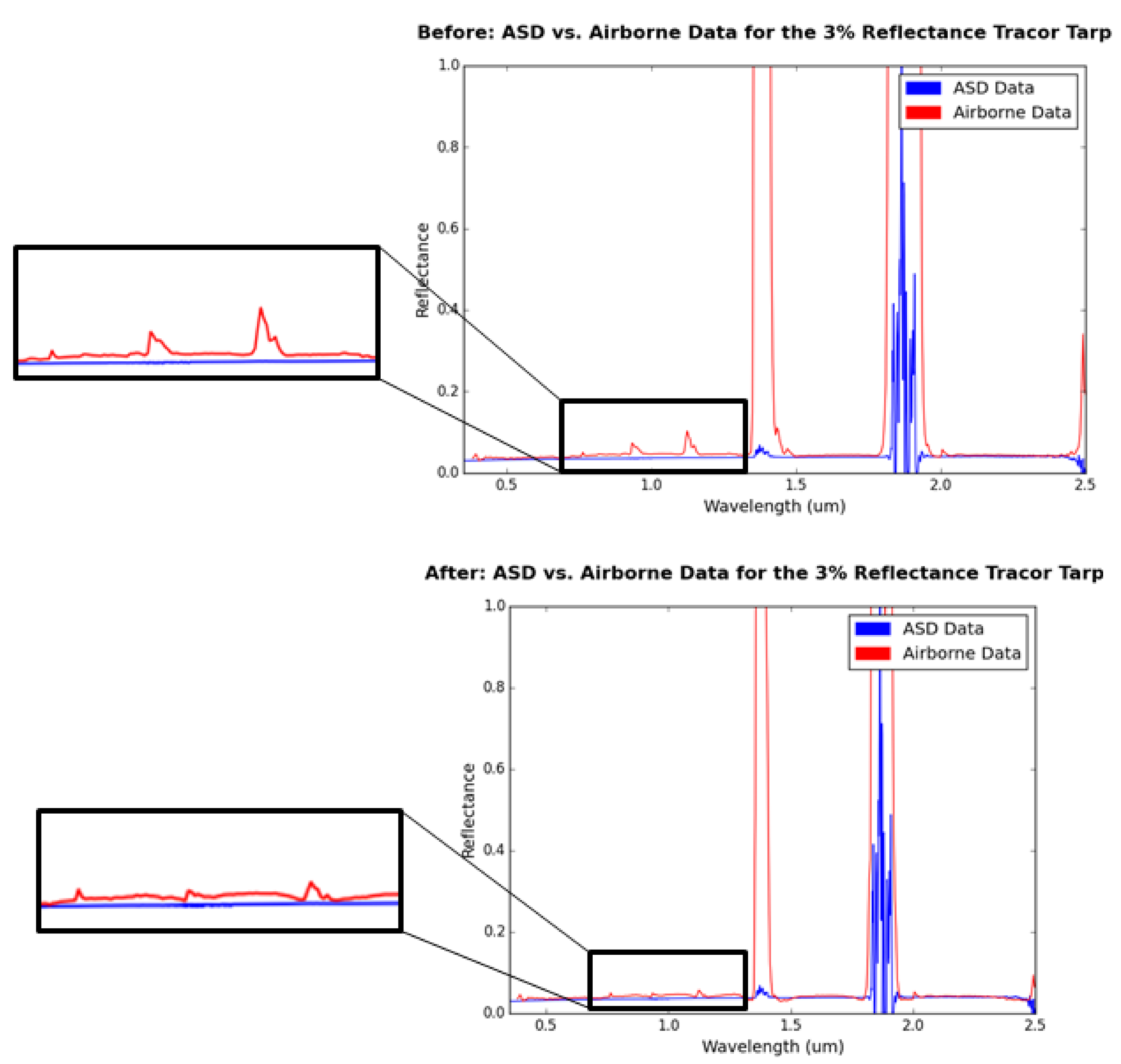


Figure 3. Top: The airborne data (red) is plotted against the ASD data (blue) from the 3% reflectance Tracor tarp in order to determine how the atmospheric corrections could be improved. As you can see, there is noise in the 940 and 1130 nm regions.
Bottom: The noise is decreased by 29.77% in the 0.94 um region, 41.74% in the 1.13 um region, and 77.2% in the 2.5 um region.

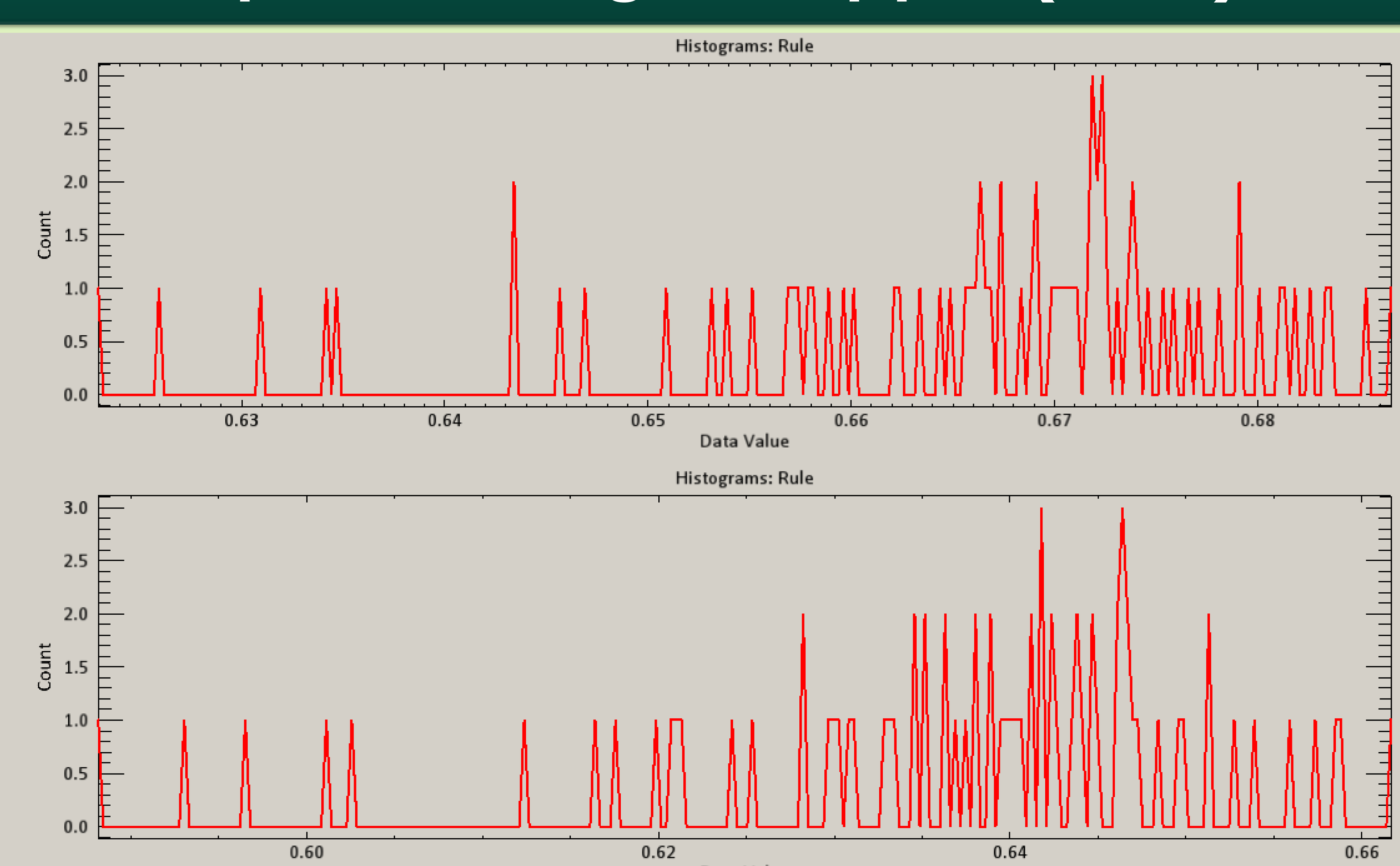
In order to link the field spectra with the remotely sensed data, we plotted the airborne data from the defined regions of interest against the ASD data (Figure 3). By comparing the plots to an atmospheric absorption spectrum, we were able to determine what variable might cause noise at that wavelength, and thus we knew which variables to alter in NEON's processing code. **These plots indicated that uncertainty was most often caused by the water vapor content of the air.**

It was determined that the Integrated Water Vapor (IWV) model introduced the most uncertainty into the processing code. Not utilizing the model decreased noise in the spectra by 29.77% in the 940 nm region, 41.74% in the 1130 nm region, and 77.2% in the 2500 nm region. These were regions that we determined were most affected by the atmospheric water vapor content. **The fact that the reflectance data did not improve with the IWV model indicates that the sensor is indeed calibrated correctly.** Further, not utilizing the IWV model in the processing code yielded lower reflectance values, which caused the visualization in ENVI to be brighter. **These lower reflectance values were closer to the ASD derived values than NEON's previously atmospherically corrected data values.**

The Spectral Angle Mapper (SAM) Classification

Before

After



SAM determines spectral similarity by calculating the angle between spectra and treating them as vectors with dimensionality equal to the number of bands. Without the IWV model, the average angle decreased from 0.859813 to 0.766812 radians, a 10.8164% change.

Figure 4. This histogram demonstrates how the average radian data value decreased when the IWV model was not utilized.

Other Variables Tested

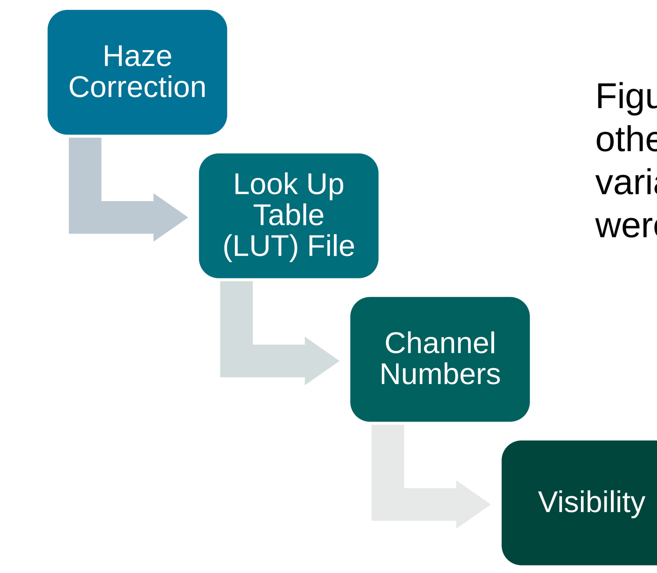


Figure 5. The other variables that were tested.

We also investigated other variables that might have introduced uncertainty into the processing code. However, these variables did not produce a significant change in the atmospherically corrected spectra.

Advantages and Disadvantages of Interpolation

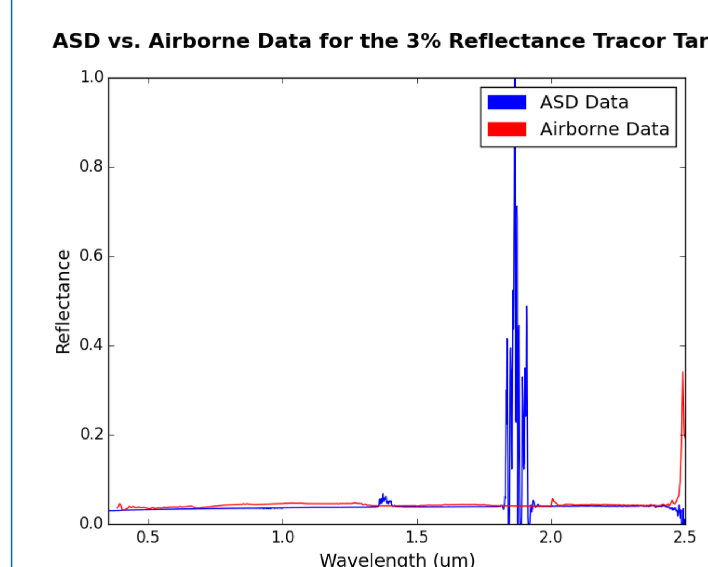


Figure 6. The airborne data plotted against the ASD data with interpolation turned on.

In addition, we investigated the advantages and disadvantages of interpolation. Although this feature produces a much smoother model, we determined that the scientific community should receive the preserved, authentic data instead of calculated, interpolated data.

Conclusions and Future Directions

This analysis demonstrates that the uncertainty in NEON's atmospheric corrections was most often caused by the water vapor content of the air, and that the reflectance data was sensitive to the IWV model, indicating that the airborne sensor is indeed calibrated correctly. This analysis also outlines the inherent differences between field-collected spectra and NEON's atmospherically corrected airborne derived reflectance data. Future studies could build off this research by examining other variables that might introduce uncertainty into NEON's processing code, as well as into other atmospherically corrected data outside of NEON, and the significance of these variables in the data product. Future data users can use the information in this poster to understand how and why uncertainty is introduced into atmospherically corrected reflectance data.

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