Sensitivity Analysis of Atmospheric Correction Methods for Hyperspectral Imagery Using ATCOR4 and FLAASH: A Wetland Example

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ABSTRACT

In order to generate accurate surface reflectance estimations of radiometrically corrected imaging spectroscopy data sets, atmospheric absorption and scattering effects must be taken into consideration. More typically, reflectance data (atmospherically corrected spectroscopy data) is used as the input for analyses. As a result of the need to have properly corrected reflectance data, multiple correction algorithms have been developed to facilitate the conversion of the data from radiance to reflectance. These algorithms include the Atmospheric and Topographic Correction (ATCOR4) and the Fast Line of sight Atmospheric Analysis of Spectral Hypercube (FLAASH). Both ATCOR4 and FLAASH are atmospheric correction algorithms based on MODTRAN-5 atmospheric radiative transfer code and include features such as spectral smoothing, adjacency effect correction, advanced aerosol profile, and multiple atmospheric scattering options. ATCOR4 also includes modules to perform smile detection and correction, as well as topographic correction. Errors in the radiative transfer results are often apparent in the resulting reflectance data due to less than adequate knowledge of the atmospheric conditions at the time of data collection, the sensor characteristics, and/or, inappropriate modelling sensitivity to various in-scene characteristics - such as solar zenith angle, atmospheric visibility, and aerosol type. Empirical approaches make use of field spectral measurements from ground calibration sites have been combined with these models to minimize such errors. The continuous development of new and improved correction methods leads to a better understanding of the atmospheric compensation process, and more importantly, better quality hyperspectral reflectance data and subsequent data products.

In this study, our primary objectives are: (1) perform a sensitivity analysis of in-scene atmospheric correction modelling parameters impacts on at-surface reflectance derived from airborne hyperspectral imagery for both ATCOR4 and FLAASH, and (2) evaluate the impacts of in-scene atmospheric correction modeling parameters in a wetland environment. The hyperspectral data used in this study was collected in support of the ESA funded Mer Bleue Arctic Surrogate Simulation Site (MBASSS) Sentinel-2 data product validation project. The airborne hyperspectral data was collected using a CASI-1500 sensor (360 nm to 1050 nm - 288 bands), and a SASI-644 sensor (870 nm to 2500 nm - 160 bands) over a calibration/validation (cal/val) site, located in Ottawa, and over the Mer Bleue Peatland located on the outskirts of Ottawa, Ontario. Field spectrometry data of homogenous targets (i.e. concrete, asphalt, black and grey tarp) were also acquired near simultaneously with the airborne hyperspectral imagery over the cal/val site for correction purposes. Preliminary results suggest that inaccurate estimation of certain parameters, such as visibility, can have an impact on the retrieval of surface reflectance. The performance of both atmospheric correction models was found to depend greatly on user accuracy, especially in the case of ATCOR4 where the user has a greater control over the in-scene atmospheric correction modelling parameters. The study further outlines the impacts of selecting the best representative pixels for the airborne imagery calibration coefficients and the implications of using these coefficients for data where no in-scene ground calibration measurements were acquired.