MBASSS: The Mer Bleue Arctic Simulation Study Site

Atmospheric Correction in the Visible Near-Infrared [VNIR]

McGill

By: Lillian Fradin, B.A. Honours Geography
Supervisor: Dr. Margaret Kalacska

Introduction

For the purposes of this study, the Mer Bleue Artic Simulation Study Site (MBA3S) in Ottawa, Ontario (**figure 1**) is used as a calibration and validation site for the European Space Agency's (ESA) Sentinel 2 satellite. Sentinel 2 hosts a 13-band multispectral imager for vegetation and land monitoring [1]. In order for Sentinel 2 data products to be used by the greater community, the spectral variability of Sentinel 2 is assessed using the Mer Belue peatland as the study area. The variability assessments are carried out using the Compact Airborne Spectral Imager (CASI, ITRES, Calgary AB.) CASI imagery of Mer Bleue was collected year-round and therefore needs to be corrected for the influence of the atmosphere at the time of data collection in order to be useful for simulation of Sentinel 2 data products.

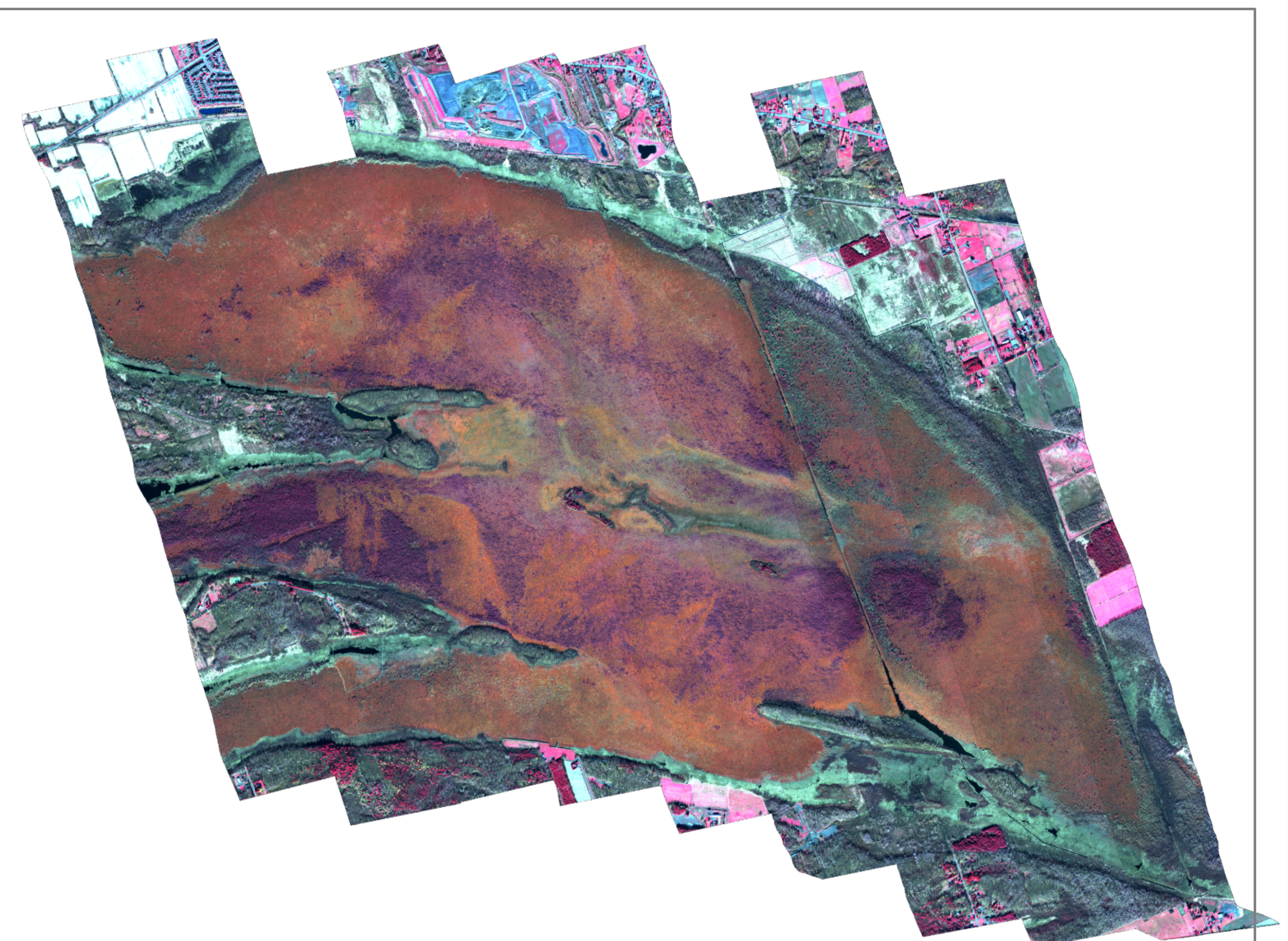

Figure 1: CASI VNIR airborne mosaic of the Mer Bleue peatland in Ottawa, On. 199 bands from 366 – 1052 um collected November 15, 2015 by the National Research Council.

Results

This study focused mainly on assessing the variability in the concrete tile calibration site for the MBASSS project in relation to data products meant for the fulfillment of data products for the European Space Agency's Sentinel 2 satellite calibration and validation project. The variability assessment carried out here was based on a statistical approach to remote sensing and ultimately determined the least variable pixels of concrete tile in airborne CASI imagery collected to aid in same day airborne CASI imagery of Mer Bleue bog in order to correct for sensor-produced artifacts in the radiance imagery before performing a two-pronged atmospheric correction approach to reflectance. The atmospheric correction process uses ATCOR, supported by ground spectra data, as well as FLAASH using the sub arctic summer atmospheric model with varying visibility and atmosphere parameters based on atmospheric conditions.

Figure 5a shows statistics for the concrete tile based on spectral band while **5b** shows the difference in FLAASH algorithms at 35km visibility in the sub arctic summer location for the Ottawa area. **Figure 5b** shows the affect of atmospheric correction on **figure 4.**

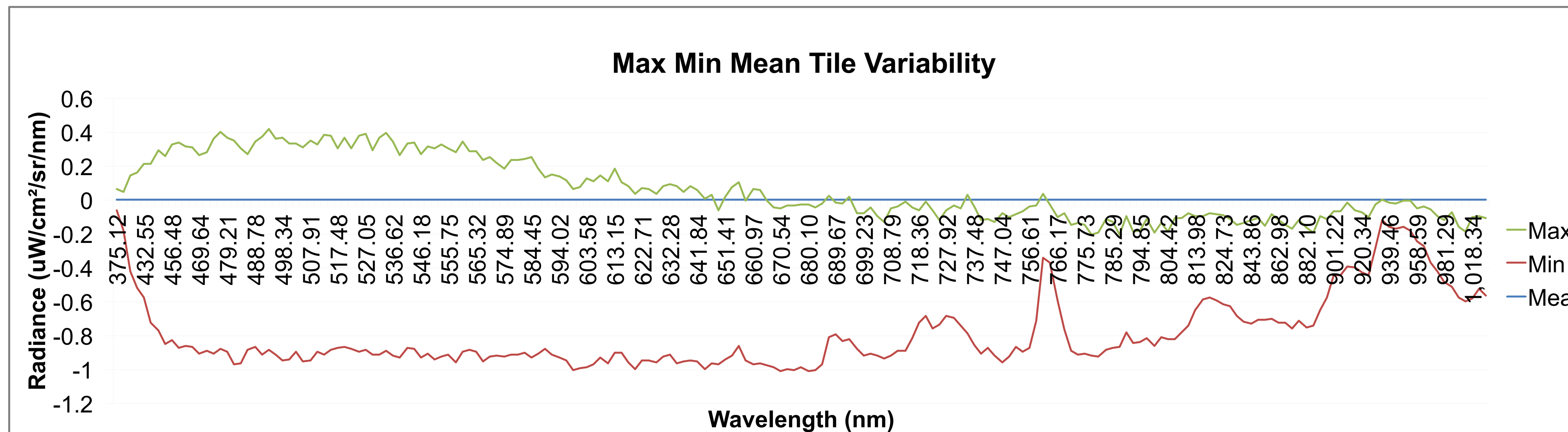

Figure 5a: Concrete tile spectral statistics based on spectral signature of each pixel of concrete tile present in the image.

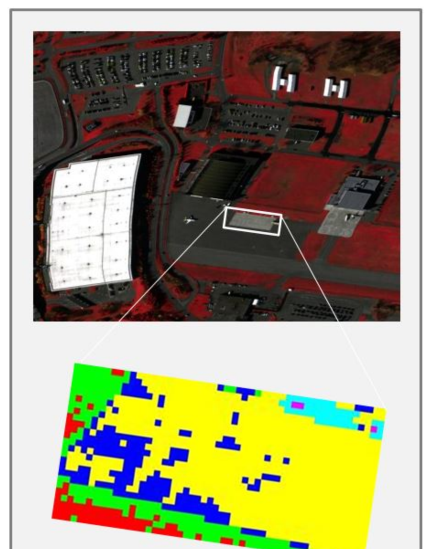

Figure 6: Concrete tile spectral variability classes

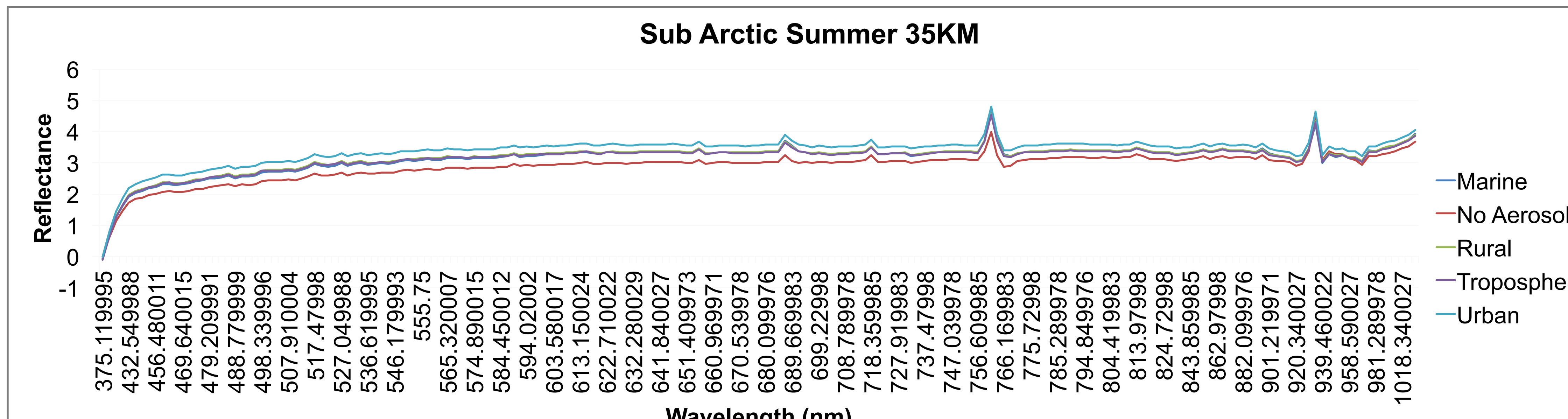

Figure 5b: Graphs of concrete tile spectral statistics and examples of five atmospheric aerosol models at 35km visibility in the ENVI FLAASH algorithm.

Methodology

The methodology for the atmospheric correction was created with artifacts present in the imagery post radiometric calibration in mind. This primarily entails low radiance in the blue end of the spectrum, especially in the CASI imagery [2]. **Figure 2** shows a detailed flow chart of the atmospheric correction steps. Here, the focus is on the variability analysis of the calibration site, located at the Ottawa Macdonald-Cartier International Airport, a vital step in the derivation of vicarious calibration coefficients (**figure 3**). The purpose of the vicarious calibration is to remove, before atmospheric correction, radiance artifacts that are inherent to the sensor and not to the signal obtained from the ground target [3]. Ideally, vicarious calibration adds a gain or an offset to each band (in this case, 199 bands of the CASI imagery) which is based on the spectral signature of a spectrally homogenous target. In order to determine the best coefficients, it is necessary to assess the spatial variability of the spectral signature of the concrete tile to choose the pixel with the least variability to maintain integrity and minimize error further into the analysis (**figure 4**).

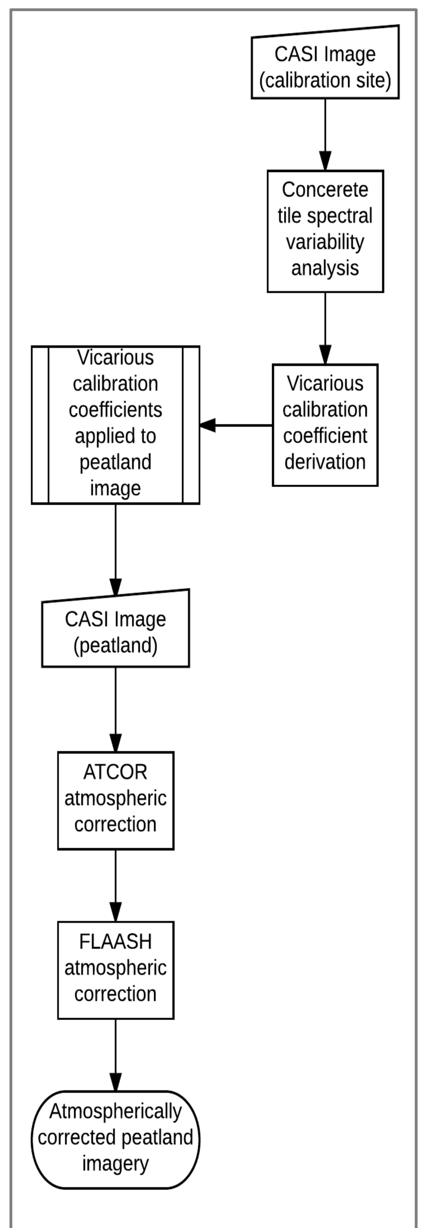

Figure 2: Atmospheric correction methodology.

Figure 3: Satellite Image of Ottawa Airport Calibration Site

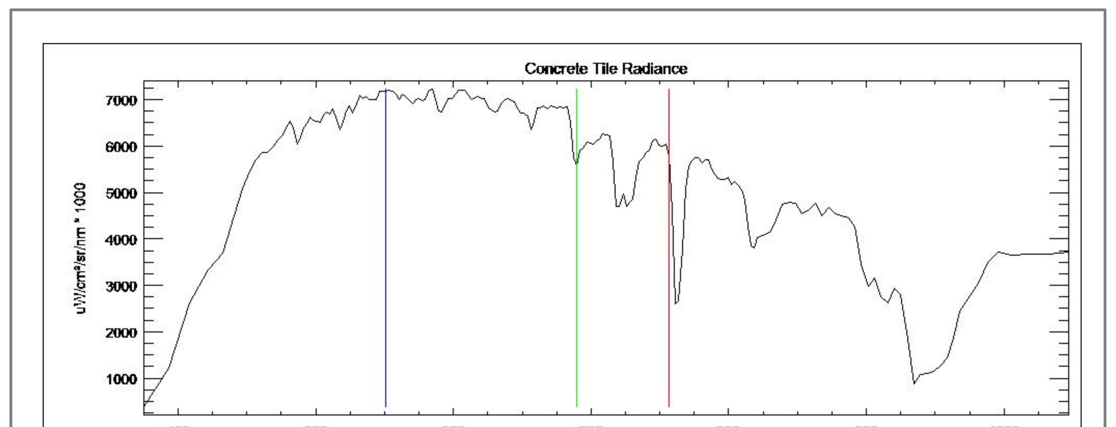

Figure 4: Uncorrected Radiance of concrete tile pixel.

Conclusions

- Some areas of concrete tile are better than others for calibration purposes, based on low spectral variability. **Figure 6** shows less variable areas in dark blue.
- Atmospheric correction algorithm for FLAASH component varies based on season and visibility but remains as mid latitude summer geographically.
- Preliminary analysis shows that the spatio-spectral response of the concrete tile varies depending on other conditions (fuel spills, weather events, parked aircraft.)
- Ground data integral as support to ATCOR atmospheric correction technique in 199 and 288 band formats.

Next Steps

- Create ATCOR atmospheric correction module for 288 band CASI configuration
    - Apply ATCOR module to relevant imagery
- Adjust FLAASH atmospheric correction parameters based on atmospheric conditions
- Atmospherically correct SASI imagery from same dates

Key sources

[1] Drusch, M., et al. "Sentinel-2: ESA's optical high-resolution mission for GMES operational services." *Remote Sensing of Environment* 120 (2012): 25-36.

[2] Korwan, Daniel R., et al. "Hyperspectral Imager Calibration in the Blue: Issues and Experiments." (2015).

[3] Secker, Jeff, et al. "Vicarious calibration of airborne hyperspectral sensors in operational environments." *Remote Sensing of Environment* 76.1 (2001): 81-92.