From Airborne Hyperspectral to Space-borne Multispectral Optical Simulations: Demonstration of Sentinel-2a simulations of a Northern Ombrotrophic Bog

H. Peter White¹, Raymond J. Soffer², Lixin Sun¹
¹Canada Centre for Remote Sensing, Natural Resources Canada
²Flight Research Laboratory, National Research Council Canada

Introduction
Simulation of space-borne optical (spectral) Earth Observation imagery has become a useful tool to support the design of future systems and to evaluate the impact of system designs on remote sensing applications. To this end, the Imaging Spectrometry Data Analysis System (ISDASv2) was developed allowing for simulations of space-borne imagery from airborne and field data. The processing chain includes simulating impacts of potential (or existing) sensor artefacts (spectral/spatial resolutions, detector noise, atmospheric influences (atmospheric water vapour, etc.) and a varying view/illumination orientation to the remotely recorded radiance. Simulated at-sensor radiance imagery can then be compared to imagery acquired by a space-borne sensor, or used to evaluate sensitivities of information extraction methods to sensor design and atmospheric influences.

In this demonstration, the ISDASv2 Optical Satellite Simulation processing chain is applied with a focus on utilizing field and airborne data of the Mer Bleue Peatland (a northern ombrotrophic bog located near Ottawa, Canada) acquired as part of the MBASS (Mer Bleue Arctic Surrogate Simulation Site) 52/18 Validation Project to simulate coincident Sentinel-2a acquisitions. Initial comparisons to the Sentinel-2a acquisitions are used to demonstrate the validity of the simulation, followed by an evaluation of the simulated data set with the initial airborne imagery investigating the impact of spatial scaling and atmospheric contributions.

Field/Airborne/Space-borne Data
Several field campaigns were accomplished during the summer 2016 growing season at the Mer Bleue Bog. This included Field Spectrometry campaigns to capture surficial BRF due to biochemistry and structure of various land cover types at various periods during the growing period. Airborne campaigns were undertaken coincident with Sentinel-2a overpasses using complimentary CASI and SASH hyperspectral pushbroom sensors from which mosaics images were generated of the peatland. This preliminary investigation focuses on the results of the June 23, 2016 acquisitions. UAV campaigns were also flown, and were used in this part of the study to aid in validation and visualization of the field acquired data only.

Simulation Workflow

Sensor Simulation - Imagery
Imagery simulated to match the spectral and spatial characteristics of an actual sensor acquisition can be compared to demonstrate efficacy of the methodology.

Sensor Simulation - Pixels
Pixel-to-pixel comparison of the Sentinel-2a and SimS2 derived surface BRF for 23 June 2016 are compared (Bands 4 and 8a are shown here). Dark blue pixels represent mixed pixels, such as watershorelines or clumps of trees in the bog. Bright blue represent pixels over relatively homogeneous (spectrally) surfaces. Cloud/Haze pixels were identified and masked.

Future Directions
Understanding the relationship between field acquired surface reflectance and surface reflectance derived from space-borne acquired imagery requires detailed understanding of the influences impacting the space-borne acquisition. Simulations allow the opportunity to assess impacts of spatial resolution on derived image products. Future work includes further evaluating of the influences of atmospheric and sensor design on acquired imagery, and how to better identify pixels that include a wide diversity of sub-pixel constituents.

References