Preprocessing and Atmospheric Correction of an EO-1 Hyperion and SPOT 4 Seasonal Time Series from Hyytiälä, Southern Finland

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While spaceborne satellite data has been extensively used to extract biophysical forest characteristics through reflectance characteristics and indices, there are still many questions regarding the seasonal changes in reflectance. Boreal forests have already seen changes in growth patterns from climate change, and the large scale monitoring of these forests is becoming more important. The seasonal changes in reflectance need to be understood for effective monitoring. Interpreting these changes from satellite images requires preprocessing and atmospherically correcting the images to create a time series of hemispherical-directional reflectance factors (HDRF).

This presentation explains the preprocessing and atmospheric correction of a seasonal time series of six SPOT4 images and five Hyperion EO-1 images from Hyytiälä, Southern Finland (61° 51'N, 24° 17' E). The time series of images range from 26.4.2010 to 6.10.2010, covering the main growing season and the seasonal changes in reflectance.

The SPOT4 satellite contains two High Resolution Visible and InfraRed (HVIR) sensors, which can capture over a spectral range of 500 to 1750 nm using four broad bands. The spatial resolution on the ground is 20m. Hyperion is a narrowband imaging spectrometer aboard the U.S. Geological Survey (USGS) Earth Observer-1 (EO-1) satellite. In contrast to SPOT's four bands, Hyperion captures data across 242 spectral bands covering a spectral range of 356 to 2577nm resulting in a nominal spectral range of 10nm. Hyperion has a spatial resolution of 30m on the ground. The Hyperion data is provided courtesy of the USGS and the SPOT imagery was obtained from SPOT data/ISIS Programme (©CNES (2010). Distribution Spot Image SA).

The SPOT4 images required little preprocessing as they were received radiometrically corrected and orthorectified. Atmospheric correction of the images was performed using the Fast Line-of-sight Atmospheric Analysis of Spectral Hypercubes (FLAASH) algorithm. Atmospheric aerosol levels were estimated using a ground based optical weather sensor and atmospheric water levels using a sun photometer located at the site. The Hyperion data however required considerable preprocessing in addition to atmospheric correction. An approach similar to the method outlined in [1] was taken for preprocessing the Hyperion data; covering destriping, desmiling, atmospheric correction and finally geocorrection. FLAASH was taken for the atmospheric correction with atmospheric water levels determined automatically by the FLAASH algorithm using the 1135 nm water absorption feature, while the atmospheric aerosol levels were estimated from a ground based optical weather sensor.

The final atmospherically corrected HDRF images were evaluated using *in situ* handheld spectrometer reference measurements of a grass field in the area. An average RMSE value of 4.3% was achieved for the Hyperion images and under 4% for the SPOT images.

References

[1] Goodenough, D.G., A. Dyk, K.O. Niemann, J.S. Pearlman, H. Chen, T. Han, M. Murdoch, & C. West, 2003, "Processing Hyperion and ALI for Forest Classification", *IEEE Trans. Geosci. Rem. Sens.*, 41, 1321-1331