

Adjacency effects in Sentinel-2 data: application of SIMEC (SIMilarity Environment Correction)

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ABSTRACT

With its high spatial resolution, and suitable spectral bands, Sentinel-2 data can support the implementation of the Water Framework Directive by providing systematic observations over (small) inland waters, estuaries and coastal waters. However before remote sensing can be used in a fully operational way, the correction for atmospheric scattering over waters close to land surfaces needs to be satisfactorily addressed. Such “adjacency effects” modify the spectral signature of the observed pixel, particularly in the near infrared.

Here we show the results of the SIMEC adjacency correction method applied to an airborne dataset spectrally and spatially resampled in order to mimic S-2 data.

First, a detection of the magnitude of the environment effects is performed based on the deviations from the NIR similarity spectrum.

Secondly, the SIMEC algorithm is applied to the data to correct for adjacency effects.

SENTINEL-2 SIMULATION USING HYPERSPECTRAL AIRBORNE DATA

An AHS (Advanced Hyperspectral Sensor) dataset was acquired from several small inland ponds in Mol (Belgium) with ground sample distance (GSD) of 7.4 m.

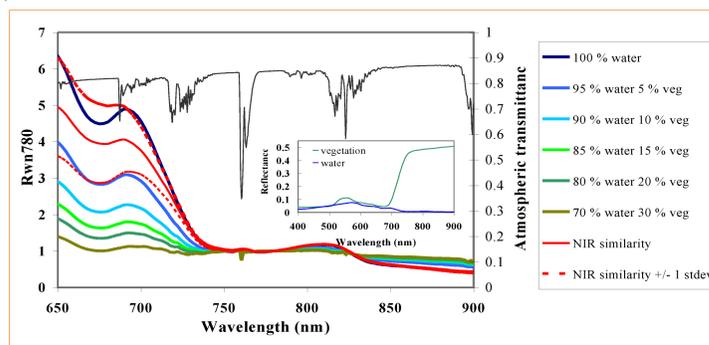
High aerosol optical depths (AODs) were measured with a Microtops II during the flight, with an average of 0.59 at 675 nm and with an Angström exponent of about 1.1. Geometric correction was done through the VITO’s Central Data Processing Center (CDPC) for airborne remote sensing.

For the atmospheric and air-interface correction the approach given by de Haan et al. (1996) based on MODTRAN radiative transfer simulations is followed. Within this correction the SIMEC adjacency detection and correction is integrated.

Next, an AHS image is selected for the S-2 data simulation and spectrally and spatially resampled to S-2 configuration.

SIMEC

Sterckx et al. (2011) recently proposed an image-based approach for detection and correction of adjacency effects based on the correspondence with the invariant shape of the water-leaving reflectance of the NIR (700-900 nm). This invariant shape was defined by Ruddick et al. (2006) by normalization at 780nm and referred to as *NIR similarity spectrum*. The basis of the SIMEC approach is that pixels affected by adjacency effects have water leaving reflectance spectra with different shape from this reference spectrum. The advantage of the approach is that it requires no a priori assumptions on the sediment load or related reflectance values in the near infrared and can therefore be applied for turbid waters.

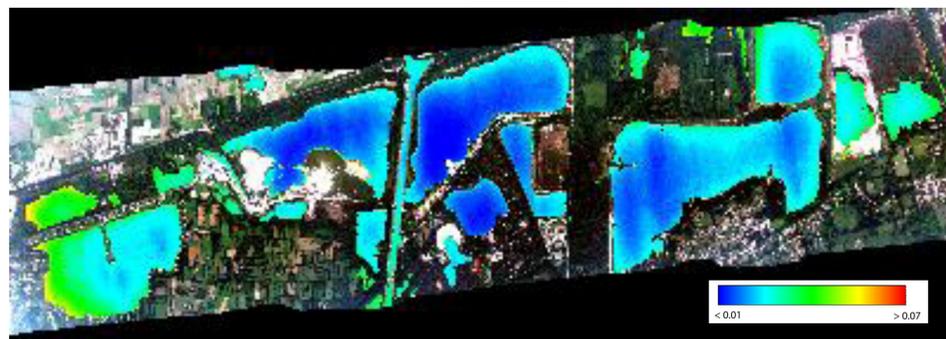


SIMEC: ADJACENCY DETECTION

To detect adjacency effects an atmospheric correction is performed neglecting adjacency effects and the spectra are normalized at 783 nm. From these normalized spectra one or several suitable wavelengths need to be selected that can be compared to the NIR similarity spectrum. Considering the rules as defined in Sterckx et al. (2011) the Sentinel-2 705 nm band was selected.

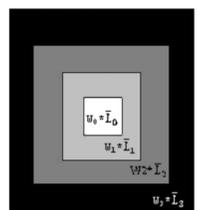
The error due to adjacency effects can then be calculated as :

$$\epsilon_{05,783} = \frac{R_{wn780}^{retrieved} - R_{wn780}^{retrieved} \cdot R_{wn780}^{similarity}}{R_{wn780}^{similarity} - 1}$$



SIMEC: ADJACENCY CORRECTION

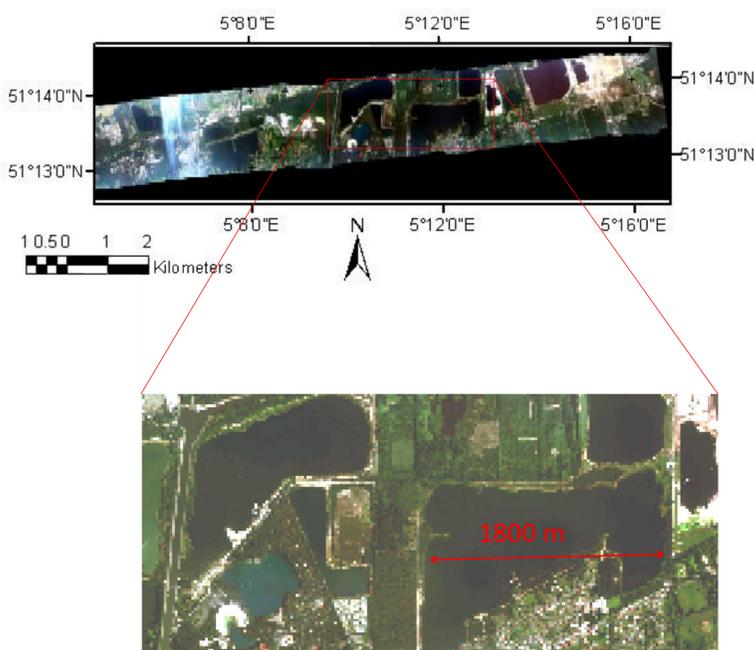
To correct for adjacency effects, the average radiance detected by the sensor for the background, has to be known. For satellite imagery the background radiance is calculated as a weighted average of the radiance values surrounding the target pixel within a selected radius (range X). The optimal value for X and/or background is found when the retrieved normalized water leaving reflectance spectrum of the target pixel agrees with the NIR similarity spectrum +/- 1 stdev.



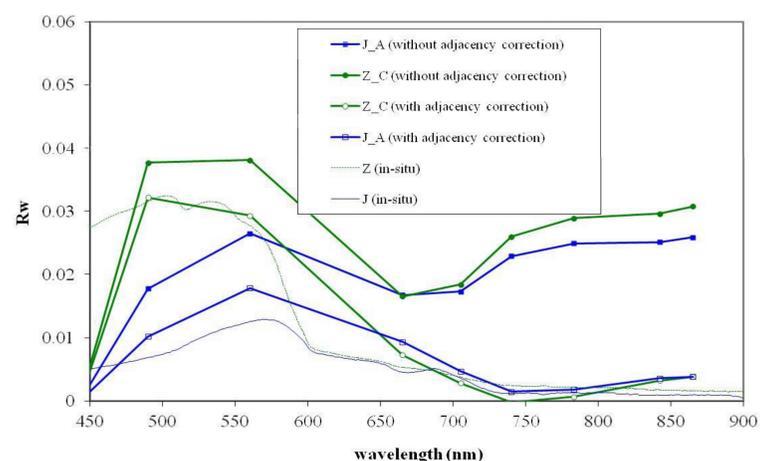
$$L_{backgr}^{rs} = \sum_{i=0}^{X-1} w_i \cdot L_i$$

Due to limited extent (especially in the across-track direction) of airborne data, we assume that the background radiance can be approximated as :

$$L_{backgr}^{rs} = w L_{target}^{rs} + (1-w) L_{landavg}^{rs}$$



AHS Resampled to S-2 resolution (subset)



References

- Sterckx, S., Knaeps, E. and Ruddick K., (2011). International Journal of Remote Sensing, 32: 21.
- Ruddick, K., De Cauwer, V., Park, Y. and Moore, G., 2006, Limnology and Oceanography, 51, 1167-1179.
- Knaeps, E., Sterckx, S., Ruddick, K., Giardino, C. and Bresciani, M., 2010. Proceedings of the Ocean Optics XX conference.