Validation SIMEC adjacency correction for Coastal and Inland Waters?

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Summary

In many coastal and inland waters environment effects hamper the correct retrieval of water quality parameters from remotely sensed imagery. SIMEC (SIMilarity Environment Correction), a new approach for the correction of adjacency effects is presented in this paper. SIMEC is applied to a MERIS match-up dataset over coastal and inland waters.

Introduction

Several new satellites such as Sentinel-2, Sentinel-3 and the hyperspectral satellites EnMAP and PRISMA will be launched in the near future. These EO sensors will provide a wealth of new data at increased spatial, spectral and temporal resolutions. Although not all conceived as being ocean colour missions, the inland and coastal water community could benefit considerably from these new data sources. A higher spatial resolution extends the existing monitoring efforts to cover even the first nautical mile from coast where the Water Framework Directive (WFD) is still in force or to lakes which are small and have irregular shapes and can not be monitored with the existing missions.

However for these nearshore coastal and inland waters adjacency effects complicate the atmospheric correction process. Light reflected from the nearby land can be forward scattered by the atmosphere into the sensor field of view. This causes a "blurring" of the signal and the effect, generally known as adjacency, background or environment effect, modifies the spectral signature of the observed pixel.

Here, we present a sensor-generic adjacency pre-processing method, the SIMilarity Environment Correction (SIMEC). This correction method was first proposed by Sterckx et al. (2010) [1] for the correction of airborne hyperspectral imagery. The correction algorithm estimates the contribution of the background radiance based on the correspondence with the NIR similarity spectrum [2]. A key aspect of the method is that no assumptions have to be made on the NIR albedo.

The objective of this paper is to validate SIMEC on MERIS images acquired from coastal and inland waters. SIMEC is applied to correct the TOA radiance signal for adjacency effects for a series of MERIS FR data covering the Belgian North Sea coastal waters, the turbid Scheldt estuary and a lake Vänern in Sweden, the third largest lake in Europe. Next, the standard MERIS processor (MEGS) is applied using the ODESA (Optical Data processor of ESA) software, in order to retrieve the water reflectance and to compare with in-situ measured water reflectance.

Discussion

The normalized water reflectance retrieved from ODESA-MEGS processing on MERIS FR images with and without first applying SIMEC are compared to the in-situ measured normalized water reflectance. For several sampling stations the MERIS retrieved normalized water reflectance is strongly underestimated

without SIMEC pre-processing with often negative water reflectance values for the first two MERIS bands (Figure 1). The correspondence between MERIS retrieved normalized water reflectance and in-situ measured normalized water are quantified on the basis of the Root Mean Square Error (RMSE) and the correlation coefficient (R^2). A significant decrease in RMSE and increase in R^2 is observed for several stations after SIMEC pre-processing.
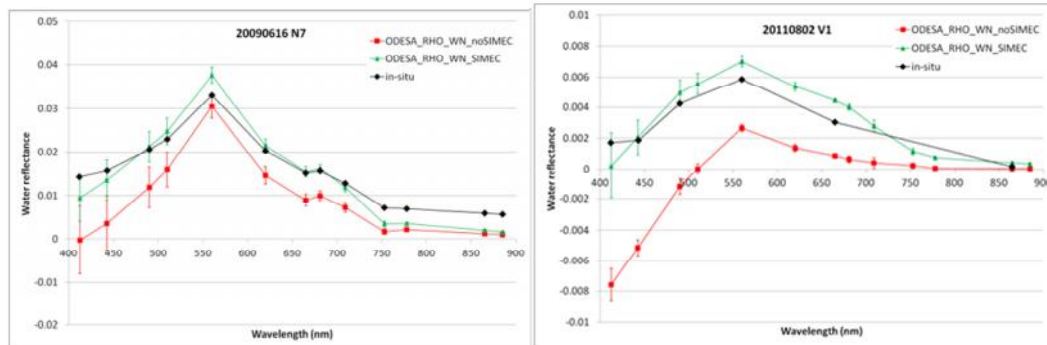

Fig. 1: Comparison between in-situ measured normalized water reflectance (black diamonds) and the normalized water reflectance extracted from MERIS FR within a 3x3 pixel box around the in-situ point derived from the ODESA-MEGS processor with (green triangles) and without (red squares) SIMEC pre-processing for North Sea (N) and Lake Vänern (V) sampling points. Error bars refer to the standard deviation calculated from the retrieved MERIS water reflectance for a 3 by 3 pixel window.

Conclusions

SIMEC is a sensor-generic approach and can therefore directly be applied to future. The performance of SIMEC was tested on MERIS FR images acquired over coastal areas, estuaries and lakes. SIMEC had a positive or neutral effect on the retrieved water reflectance calculated with the MERIS MEGS processor. A decrease in the RMSE up to 400 % was observed after SIMEC pre-processing.

References

[1] Sterckx, S., Knaeps, E., Ruddick, K., 2010, Detection and Correction of Adjacency Effects in Hyperspectral Airborne Data of Coastal and Inland Waters: the Use of the Near Infrared Similarity Spectrum. International Journal of Remote Sensing, 32(21), 6479-6505.
[2] Ruddick, K., De Cauwer, V., Park, Y., 2006, Seaborne measurements of near infrared water-leaving reflectance: The similarity spectrum for turbid waters, Limnol. Oceanogr., 51(2), 1167-1179.