COMPARISON OF TWO ATMOSPHERIC CORRECTION ALGORITHMS IN COASTAL WATERS FOR SeaWiFS IMAGES: VALIDATION AND SENSITIVITY STUDY

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1. INTRODUCTION

The use of satellites to monitor the color of the ocean requires effective removal of the atmosphere signal. The methods for treating the atmosphere have depended on the high absorption of red and near-infrared (NIR) light by water. In coastal waters, the presence of water-leaving radiances in the NIR introduces two sources of error into the removal of the aerosol. As a result, the atmospheric radiances will be overestimated at all bands with increasing severity for shorter wavelengths, even leading to negative radiances in the blue bands in coastal water. This results in severe errors, if not complete failure, of various algorithms for chlorophyll-a concentration and inherent optical properties.

To solve this problem, several algorithms were proposed for the SeaWiFS sensor: Hu et al. (2000), Lavender (2003), Oo et al. (2008), Ruddick et al. (2000), Shanmugam (2007), Stumpf et al. (2003) among others. These algorithms do not have the same hypothesis. Only one study showed a comparison study of two algorithms for this sensor [8]. The authors stated that the algorithm developed by Stumpf et al. gave better retrievals than the algorithm of Ruddick et al. Since, no studies have been made to inter-compare those algorithms and to study their sensitivities to a NIR $L_{wn}(\lambda)$.

2. CHOICE OF THE ALGORITHMS

In this paper, we present the inter-comparison of two coastal waters atmospheric correction algorithms developed for the SeaWiFS sensor: the SeaWiFS standard algorithm (Stumpf, 2003) and an alternative approach developed by Ruddick et al. (2000). The choice of this alternative algorithm is due to its accessibility as it has been implemented in SeaDAS (SeaWiFS Data Analysis Software).

The standard atmospheric correction algorithm is based on an iterative solution which is used to solve the over correction of the atmosphere. A bio-optical model is used to determine the NIR backscatter at 670 nm, and specifically addresses inorganic particulates backscattering.

In the algorithm developed by Ruddick et al. (2000), the assumption that the water-leaving radiance is zero in the NIR is replaced by the assumptions of spatial homogeneity of the 765/865 nm ratios for aerosol reflectance and for water-leaving reflectance. These two ratios are imposed as calibration parameters. The aerosol reflectance ratio is evaluated from inspection of the 765/865 nm Rayleigh-corrected reflectance scatterplot. The water-leaving reflectance ratio is fixed at the value of 1.72.

3. DATA

The standard Level-2 products from the ocean color data of SeaWiFS were obtained directly from the GSFC Distributed Active Archive Center. The parameters in the standard SeaWiFS Level-2 product suite considered here include the normalized water-leaving radiance $L_{wn}(\lambda)$ at center wavelengths of 412nm, 443nm, 490nm, 510nm, 555nm and 667nm, 765 nm and 865 nm, notated as $L_{wn}(412)$, $L_{wn}(443)$, $L_{wn}(488)$, $L_{wn}(531)$, $L_{wn}(667)$, $L_{wn}(765)$ and $L_{wn}(865)$, respectively.

To estimate the accuracy of the estimation of the $L_{wn}(\lambda)$ obtained by the two algorithms, the retrieved values were compared to ground-based measurements, obtained in the framework of the AERONET-Ocean Color network [10]. We considered two stations located in the east coast of the U.S. as the location called MVCO [1] and in the Adriatic Sea (Venise Tower, [9]).

Multi-channel data are collected in seven spectral bands centered at wavelengths of 412, 439, 500, 555, 674, 870 and 1020 nm. The dataset used in this paper covers measurements over 14 months within the period from February, 2004 to November, 2005 for MVCO station and 6 years (2002 to 2007) for the Venise Tower station. We used the AERONET-OC Level 2 product, which is fully quality-assured.
For the sensitivity study, a synthetical database is used. The synthetic atmospheric reflectance and transmittance were computed for various geometries and aerosols models AP by solving the scalar RTE for a two-layer atmosphere system with aerosols confined to the lower layer. The sampling of the AP and Sun-viewing geometries for the atmosphere gave us a wide range of realistic configurations. For the water-leaving reflectances, in-situ measurements done in estuaries are used.

4. FIRST RESULTS

For the MVCO station, the relative error varies between 31.35% (λ=510nm) and 72.58% (λ=412nm) for the standard algorithm and between 27.93% (λ=510nm) and 68.11% (λ=412nm) for the algorithm of Ruddick. For the Venise Tower, the relative error varies between 15.71% (λ=490nm) and 75.41% (λ=670nm) for the standard algorithm, and between 21.93% (λ=510nm) and 537.86% (λ=670nm) for the algorithm of Ruddick.

The synthetical database is used to fully study the sensitivity of the two algorithms to a NIR water-leaving reflectance. We compare the retrievals obtained by the two algorithms as a function of the value of the NIR $L_{wn}(\lambda)$. This exercise allows obtaining the range of validity of each algorithm.

5. CONCLUSIONS AND PERSPECTIVES

We showed that the two algorithms give similar retrievals in term of RMSE and relative error. But the algorithm developed by Ruddick et al. shows a systematic bias. The understanding of this bias was analyzed and this bias is due to the relationship between $L_{wn}(765)$ and $L_{wn}(865)$. To a better understanding, a sensitivity study of an error on the evaluation of the epsilon parameter in the algorithm of Ruddick is necessary. In parallel, a sensitivity study to the presence of a NIR L_{wn} with synthetical data for the atmosphere and in-situ measurements for the ocean is done to compare more precisely the two algorithms. Finally, we expect to add more algorithms [2] and [7] for instance.

6. REFERENCES

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