MODIFICATION OF SEADAS SWIR ATMOSPHERIC CORRECTION SCHEME FOR ACCURATE RETRIEVAL OF NIR REMOTE SENSING REFLECTANCE IN THE RIVER DELTA REGIONS OF THE WORLD

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1. INTRODUCTION

Coastal waters in the vicinity of the river delta regions of the world are characterized by significant concentrations of suspended sediments. To estimate the water sediment load from satellite observations, an important step is to accurately remove the optical effects of the intervening atmosphere. The NASA SeaDAS code [1] has been shown to accurately correct MODIS satellite data for atmospheric effects over most aquatic regimes, using near infrared (NIR) bands where water turbidity is low, and shortwave infrared (SWIR) bands where the NIR bands indicate high turbidity [2]. However, at very high sediment loads, of circa 500 g/m^3 and above – and this is not an unusually high level in delta regions – the SWIR bands can themselves be influenced by the suspended sediment and their utility for atmospheric correction thus compromised. Indeed, the ocean color NIR bands saturate under these conditions and so become unviable for any manner of atmospheric correction. We have employed the MODIS water vapor bands in the 900 nm region of the spectrum to provide a correction to the 1.24 μm band MODIS reflectance, thereby extending the utility of the SeaDAS SWIR atmospheric correction to very high sediment concentration waters.

2. BACKGROUND

Coastal waters near the world's river delta regions are case-2 in type, where the optically active constituents of chlorophyll (Chl), colored dissolved organic matter (CDOM) and suspended mineral sediment can and do vary independently of each other. However, numerical radiative transfer simulations with Hydrolight v5 [3] reveal that beyond wavelengths of approximately 800 nm, significant variations in the remote sensing reflectance are primarily associated with changes in the mineral suspended sediment concentration. This means that the MODIS 250 m spatial resolution band centered at circa 859 nm may be an effective probe to estimate suspended sediment concentration, without significant uncertainty due to unknown Chl and CDOM concentrations, provided that an accurate atmospheric correction is first applied. Our approach has been to employ the MODIS bands in the 900 nm region of the spectrum to adjust the 1.24 μm band MODIS reflectance to the levels expected for low sediment concentration, so that the SeaDAS SWIR atmospheric correction is again valid. This has required an approximate model of the water remote sensing reflectance, based upon Hydrolight simulation data, and atmospheric transmittance and scattering simulations from 6SV1.1 [4]. We present our findings in terms of the sensitivity of the SeaDAS estimated remote sensing reflectance at 859 nm to the correction we have made to the 1.24 μm band MODIS band and how the revised remote sensing reflectance estimates compare to in-situ measurements drawn from the SeaBASS database [5].

3. NUMERICAL MODELING

The remote sensing reflectance in the region 800-1000 nm, as simulated by Hydrolight for four sediment types, can be accurately estimated by a cubic function of $b_b/(a+b_b)$ where b_b is the backscatter and a is the absorption – of water and suspended sediment alone. The coefficients of this equation are approximately linear in the cosine of the solar zenith angle. We have extrapolated the specific absorption and scattering coefficients, for the four sediment classifications, from the 1 μm upper bound in Hydrolight to 1.3 μm, so that we may estimate the remote sensing reflectance of the MODIS 1.24 μm band. In conjunction with atmospheric radiative transfer simulations from 6SV1.1, using aerosol properties drawn from the SYNAER aerosol models [6], the top of atmosphere (TOA) reflectances were simulated for a range of water and atmosphere conditions.

4. DISCUSSION AND CONCLUSIONS

The spectral proximity of the MODIS 900 nm water vapor bands to the 1.24 μm band, means that precise diagnosis of aerosol type is not paramount. Regressed relationships between TOA radiances in the MODIS water vapor bands and the 1.24 μm band permit a small downward adjustment to be made to the 1.24 μm band TOA reflectance that brings the SeaDAS SWIR atmospheric correction back into its range of validity. The impact of this adjustment, and the possible need to augment the SeaDAS aerosol look-up tables, is discussed with reference to the retrieved remote sensing reflectance at 859 nm and its impact upon the accurate assessment of the derived suspended sediment concentration in the very turbid waters of the river delta regions of the world.

5. REFERENCES

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