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Volume 22, Algorithm Updates for the Fourth SeaWiFS Data Reprocessing

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Chapter 4

Modifications to the SeaWiFS NIR Correction

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ABSTRACT

This chapter describes several changes made to the NIR correction implemented during the fourth reprocessing of SeaWiFS data. The changes made were both to correct flaws in the actual implementation of the NIR correction and to improve the estimation of NIR reflectance. The changes include revised water absorption coefficients, the addition of a scaling factor to allow for the gradual introduction of the NIR correction as the derived chlorophyll concentration increases, improvements to the iteration control, and an alternative model for the backscatter estimate. The revised NIR correction reduces discontinuities in the aerosol model selection at the boundaries where the correction is introduced. It also reduces the attenuation effect that the original correction had on high chlorophyll concentrations.

4.1 INTRODUCTION

One of the primary assumptions used in the SeaWiFS atmospheric correction process is what is known as the *black pixel assumption.* This assumption states that the contribution to the total radiance by water-leaving radiance in the NIR region is negligible, and therefore, the TOA radiance in the NIR bands is solely due to atmospheric path radiance. For most conditions, this assumption is valid, however, in turbid or highly productive waters, this assumption breaks down. Various methods have been proposed to account for NIR water-leaving radiance for these situations. The SeaWiFS Project implemented an NIR correction (Siegel et al. 2000) with the third reprocessing in May 2000. Since then, refinements to the implementation of the NIR correction algorithm, as well as significant changes to the algorithm have been developed. While the basic concept for estimating NIR water-leaving radiance proposed by Siegel et al. (2000) is maintained, the methods have changed. This chapter describes these modifications.

4.2 BACKSCATTER MODEL

The NIR correction implemented with the third reprocessing used the particulate backscatter ($b_{\rm bp}$) estimate described in Loisel and Morel (1998) to estimate backscattering (b_b) at 555 nm and the spectral backscattering function described in Morel (1988) to extrapolate this value into the NIR. In practical application, the NIR correction is applied most often in highly productive waters ($>3\,{\rm mg\,m^{-3}}\,C_a$) and turbid or Case-2 waters. The Loisel and Morel model is explicitly Case-1, developed with a data set of chlorophyll values ranging from 0.01–4.53 $\rm mg\,m^{-3}$, with the majority of the data having values of less than 1.5 $\rm mg\,m^{-3}$. The Loisel and Morel model is not applicable to Case-2 waters. Gould et al. (1999) developed a spectral dependence model for the scattering coefficient in Case-1 and Case-2 waters. This model was implemented in place of the Morel (1988) model as being more appropriate to the practical application of the NIR correction in SeaWiFS.

A reflectance-based estimate of backscatter (Sydor and Arnone 1997) at a reference wavelength of 670 nm has been adopted in place of the chlorophyll-based estimate described in Loisel and Morel (1998). This reflectance-based estimate relies on the assumption that water absorption is dominate at wavelengths greater than 650 nm. This assumption allows for the estimation of $b_b(670)$ from $R_{\rm rs}(670)$ by (3):

$$b_b(670) \;=\; R_{\rm rs}(670)\frac{a_w(670)}{0.051}, \qquad (3)$$

where a_w is the absorption coefficient for water.

There can, however, be a measureable amount of particulate absorption (a_p) at 670 nm.