Algorithm Description Ver.1.1 (2016.12.19)

Algorithm Description Ver.1.2 (2019.3.31)

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Derivation of the absorption coefficient of Colourd Dissolved Organic Matter (CDOM)

1. Physics of the problem

The IOP algorithm assumes that the remote sensing reflectance (R_{rs}) *just above the sea surface* (denoted by z=0+, where z represents a depth), or the water-leaving reflectance (ρ), is obtained in prior to its implementation.

The R_{rs} for a wavelength λ is defined by

$$R_{rs}(\theta_v, \varphi_v, z=0+, \theta_s, \varphi_s, \lambda) = L_w(\theta_v, \varphi_v, z=0+, \theta_s, \varphi_s, \lambda) / E_d(z=0+, \theta_s, \varphi_s,\lambda) \quad (1)$$

where L_w and E_d are the radiance and the downward plane irradiance at the observation angle (zenith angle θ_v, azimuth angle, φ_v) and the solar angle (zenith angle θ_s, azimuth angle φ_s). The water-leaving reflectance ρ can be obtained by $\rho = \pi R_{rs}$. Morel and Gentili (1993, 1996) showed that the Eq. (1) can be related to the absorption coefficient a_t and the backscattering coefficient of the bulk water b_{bt} by

$$R_{rs} (\theta_v, \varphi_v, z=0+, \theta_s, \varphi_s, \lambda)= R (W, \theta_s, \varphi_s, \lambda) F(\theta_v, \varphi_v, z=0-, \theta_s, \varphi_s, \lambda) [b_{bt} (z=0-, \lambda)/a_t(z=0-, \lambda)] \quad (2)$$

where R is a transmittance from water to air and W denotes the wind speed. For convenience, all dependencies of the variables on illumination and observation geometries, depth, wavelength etc in Eq. 2 are omitted hereafter, unless otherwise specified. In addition, R x F will be denoted by F' so that Eq.2 is simplified by

$$R_{rs} = F' [b_{bt}/a_t]. \quad (3)$$

The absorption coefficient of the bulk seawater is decomposed into the absorption coefficients of optically active components. It is a common exercise to define those components as pure seawater (a_w) , phytoplankton (a_{ph}), non-algal particles NAP (a_d), and CDOM(a_g), so that

$$a_t=a_w+a_{ph}+a_{dg} \quad (4)$$

where

$$a_{dg}=a_d+a_g \quad (5)$$

Among the components, a_{ph} and $a_d+a_g(=a_{dg})$, thus not a_d and a_g, can be derived from the SGLI/GCOM-C1 IOP algorithm (see Smyth et al., 2006 as wel as ATBD for IOPs). Hence, we assume that a_{dg} are known in this document. A Practical problem here is to decompose a_{dg} into a_d and a_g to retrieve a_g.

2. Dataset

A global in situ dataset was used (Werdell and Bailey 2005) to derive a_g from a_{dg}. Figure 1 shows the data distribution of the dataset.

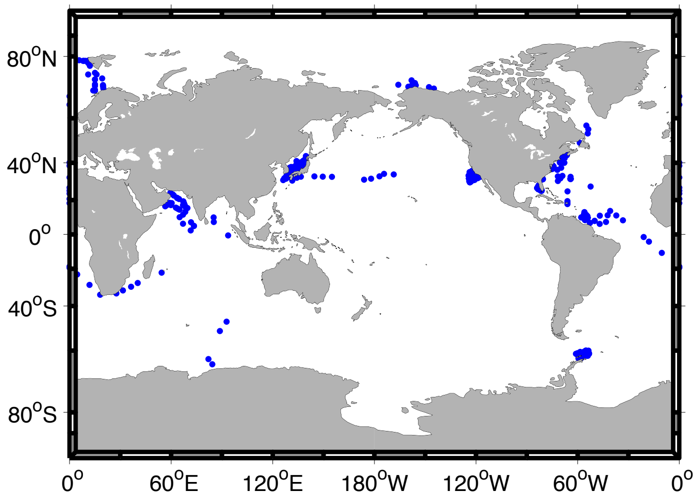

Figure 1 NOMAD data distribution

3. Algorithm

Since the IOP algorithm retrieves a_{dg} at 412, 443 and 490 relatively well than other longer wavebands, the former wavelengths will be considered below. From Eq. 5, we have:

$$a_g=a_{dg} - a_d \quad (5)$$

Considering that a_{dg} varies orders of magnitude over global scale and that a_{dg} derived from the IOP model would include some uncertainty in practice, we assume that there is the following relationship between a_{dg} measured in situ (a_{dg}(measured)) and a_{dg} derived from the IOP model (a_{dg}(measured)) so that

$$\log_{10}(a_g\,(\text{measured})) \quad = \quad g*\log_{10}(a_{dg}\,(\text{derived})) + h \qquad (7)$$

where g and h are a slope and an intercept obtained from a comparison between $\log_{10}(a_g$ (measured)) and $\log_{10}(a_{dg}$ (derived)) and depends also on instrument used to obtain $\log_{10}(a_{dg}$ (derived)) (if it is a satellite or in situ instrument).

Figure 2 shows a comparison between a_g measured in situ (a_g(true)) and derived from Eq. 7 (a_g(reproduced)), using the a_{dg} derived from the IOP algorithm that was applied to the in situ radiometry coincided with a_g(true).

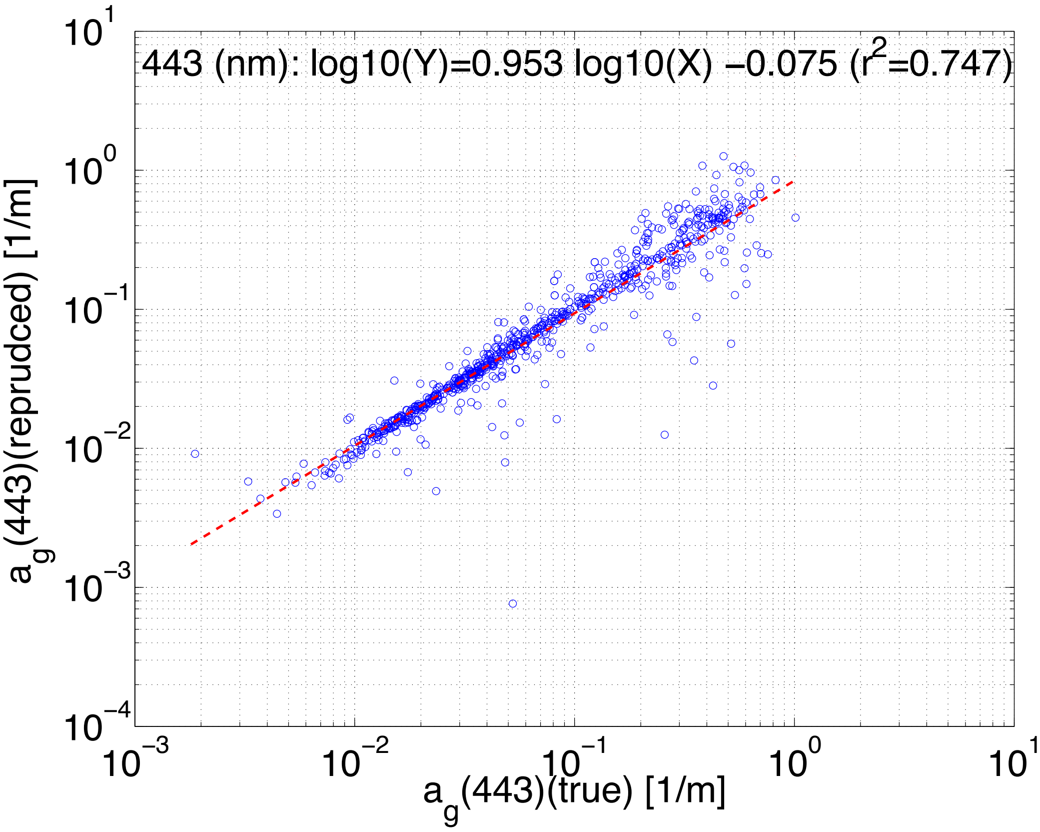

Fig. 3 Relationship between a_g(443nm) measured in situ and derived(reproduced) using Eq. 7.

Reference:

Smyth, T. J., G.F. Moore, T. Hirata, J. Aiken, Semianalytical model for the derviation of ocean colour inherent optical properties: description, implementation, and performance assessment, Applied Optics, 45, 8116-8131, 2006.

Werdell, P. J. and S. W. Bailey, An improved in situ data set for bio-optical algorithm development and ocean color satellite validation, Remote Sens. Environ., 98, 122-140, 2005