論 文

동해에서 대기에어로졸이 해색위성자료에 미치는 영향

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Influence of atmospheric aerosol on satellite ocean color data in the East/Japan Sea

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ABSTRACT : *The influence of atmospheric aerosol on satellite ocean color data were evaluated using SeaWiFS monthly standard mapped image products. The atmospheric optical thickness (AOT) was increased in spring and summer, and it showed the strong positive correlation with remote sensing reflectance, normalized waterleaving radiance /solar irradiance, at 555 nm (Rrs555) which is a component of the satellite chlorophyll estimation. Such the high AOT and high Rrs555 pixels showed overestimation of satellite chlorophyll in spring, especially in the area which showed large phytoplankton absorption which is expressed by low remote sensing reflectance at 443, 490 and 510 nm (Rrs 443, Rrs490 and Rrs510)..*

KEY WORDS : *Atmospheric optical depth, Normalized water leaving radiance, chlrophyll, SeaWiFS OC4 algorithm*

1. Introduction

Recently, chlorophyll concentration estimated by satellite ocean color is widely used for the evaluation of phytoplankton distribution and biomass, and primary productivity in the ocean. Satellite chlorophyll concentration is calculated by empirical equation using the relation of water-leaving radiances at two or more wavelength measured by satellite. The estimated chlorophyll concentration is accurate at offshore area because the ocean color is almost decided by only chlorophyll concentration. However, some researches were pointed out the possibility that existence of atmospheric aerosol affected the value of water-leaving radiance and led the overestimation of satellite chlorophyll concentration (Fukushima & Toratani, 1997, Schollaett et al., 2003). In this study, we tried to evaluate the influence of atmospheric aerosol on the Sea-viewing Wide Field-of-view Sensor (SeaWiFS) ocean color data operated by NASA. When we observe seasonal change of chlorophyll or calculate the primary productivity by model, monthly standard mapped image (SMI) provided in the NASA homepage are widely used. We focused our analysis on the monthly data in the East/Japan Sea (34-50°N, 127-143°E) where the several kinds of atmospheric aerosol such as yellow sand, smoke and sulfate come flying.

2. Data

2.1 Satellite Data

Monthly data of SeaWiFS SMI were used from 1998 to 2007. Used products were chlorophyll concentration, Tau865, normalized water leaving radiance at 443, 490, 510 and 555 nm (nLw443, nLw490, nLw510 and nLw555). Tau865 indicates the atmospheric optical thickness at 865 nm. In this study, the amount of atmospheric aerosol was evaluated by Tau865. Normalized water leaving radiance is the radiance at flat surface of ocean with the sun at zenith without atmospheric effects. The nLw443, 490 and 510 are indicators of phytoplankton absorption. Thus, the decrease of these values means phytoplankton increase. On the other hand, nLw555 is an indicator of suspended matter.

2.2 Satellite chlorophyll algorithm

The chlorophyll concentration of SeaWiFS SMI is calculated by the OC4 algorithm (O'Reilly et al., 1998) as follows,

$$\text{Chlorophyll } (\mu g\ l^{-1}) = 10^{(0.366*R-3.067*R^2+0.649*R^3-1.532*R^4)}$$

$$R=\log_{10}(RrsNNN/Rrs555)$$

Rrs indicates remote sensing reflectance which is a value of nLw divided with the solar irradiance of same wavelength. For RrsNNN, maximum value of Rrs443, Rrs490 and Rrs510 was applied.

3. Result and Discussion

Seasonal variability of chlorophyll concentration averaged in the study area showed large peak in April and small peak in November. These corresponded to the phytoplankton bloom in spring and fall. Tau865 started to increase from February gradually, and peaked at April and May. Tau865 was also high during summer, though chlorophyll concentration was low in summer. In the low chlorophyll range under 1.0 μg l^{-1}, there was no correlation between chlorophyll concentration and Tau865. On the other hand, they showed positive correlation in the higher chlorophyll range over 1.0 μg l^{-1}. It means that high chlorophyll value observed by SeaWiFS is possible to be affected by existence of atmospheric aerosol even monthly composite.

The Rrs555 varied similar with Tau865 except low value in February and March. Tau865 and Rrs555 showed strong positive correlation (Y=84.00*X-0.03, R=0.696, N=117, Fig.1(a)). In spring (March-May), Tau865 was totally higher than other seasons, and the range of Rrs555 was large (0.0016 - 0.0024). Thus, Rrs555 changed sensibly with small increase of atmospheric aerosol. Positive correlation was also found in summer, though range of Rrs555 was small to the changing range of Tau865. The Rrs443, 490 and 510 were high in summer and low value in spring and fall, which seemed to correspond with the low phytoplankton biomass. They were no correlation with Tau865 (Fig. 1(b)).

As the result showed that RrsNNN for chlorophyll estimation was not affected by existence of atmospheric aerosol, we tried to calculate the change of chlorophyll concentration caused by increase of Rrs555 (Fig. 2). Estimated chlorophyll concentration was increased with the increasing of Rrs555, and it was remarkable in the case of lower RrsNNN.

These results indicate that chlorophyll concentration might be highly overestimated in spring in the pixels of low RrsNNN (large phytoplankton biomass) and high Rrs555 corresponded with high Tau865 (much aerosol). In the presentation, the distribution of overestimated pixels by atomospheric aerosol in the East/Japan Sea will be shown and the overestimation will be evaluated.

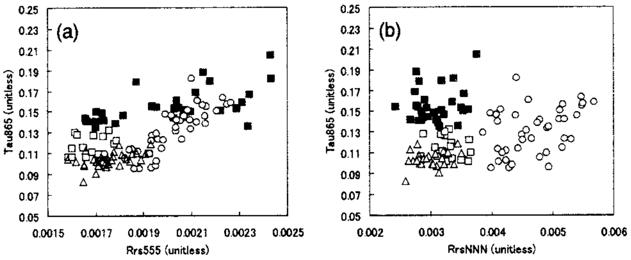

Fig. 1 Relationships between Tau865 (y axis) and Rrs555 (a) and RrsNNN (b). Values of RrsNNN were applied Rrs443 and Rrs 490 in summer and other seasons, respectively.

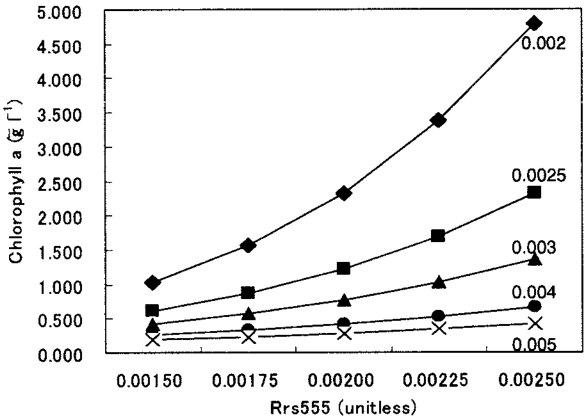

Fig. 2 Validation of estimated chlorophyll concentration with increase of Rrs555. The numbers with lines indicate the values of RrsNNN.

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