近海海洋环境科学国家重点实验室（厦门大学）

State Key Laboratory of Marine Environmental Science (Xiamen University)

Assessing Remote Sensing Algorithms for the Diffuse Attenuation Coefficients in the Ultraviolet Bands

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Abstract

The penetration of solar radiation in the ultraviolet (UV) domain of the ocean is determined by the diffuse attenuation coefficient (K_d(UV)). There is no standard global K_d(UV) product yet distributed by the remote sensing agencies, limiting comprehensive studies of biogeochemical cycles in the global ocean. In this study, six existing algorithms (both empirical and semi-analytical) developed for the estimation of K_d(UV) (at the near-blue UV bands, specifically 360, 380, and 400 nm) were evaluated from a dataset of 316 points collected globally. In particular, the semi-analytical algorithm used remote sensing reflectance (R_{rs}) in the near-blue UV bands estimated from a recently developed deep learning system ($UVISR_{dl}$) as the input. For K_d(380) in a range of 0.018 – 2.34 m^{-1}, it is found that the semi-analytical algorithm has better accuracy, where the average absolute relative difference (MARD) is 19%, and the coefficient of determination (R^2) is 0.94. For VIIRS and *in situ* matchup data covering oceanic and coastal waters (N = 62), the MARD at K_d(380) is 21%, with R^2 as 0.94. For the empirical algorithms, the MARD and R^2 values are 0.24 – 0.90, and 0.70 – 0.92, respectively, for the field measured data. These results indicate that a combination of $UVISR_{dl}$ and semi-analytical algorithms can provide reliable K_d(UV) from satellite ocean color measurements. Such an approach offers a route to fill the gap of near-blue UV data in the global ocean, which are important for the study of marine primary productivity.

1. Data

Two data sources, which cover waters from the ultra-oligotrophic ocean to turbid coastal waters, are employed in this effort. The first measurements of ultra-oligotrophic ocean were around the center of the South Pacific Gyre (SPG, see Figure 1*a*) from the BIOSOPE cruise (a total of 25 data). The second measurements were taken from 2014 to 2019 (a total of 294 data points), covered both open ocean and relatively turbid coastal waters (see Figure 1*b*).

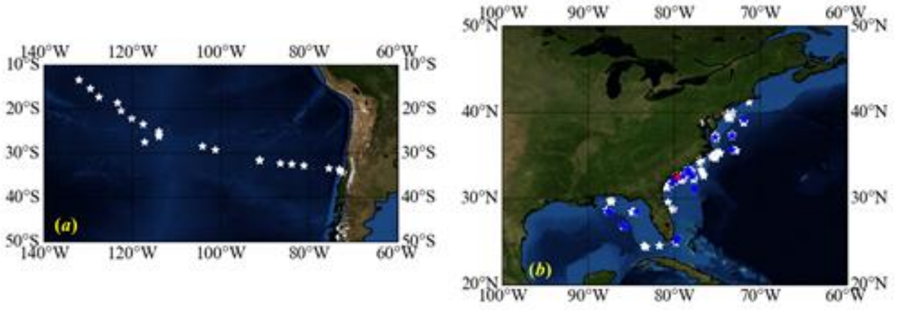

Fig. 1. (*a*) The data comes from the BIOSOPE cruise. (*b*) The data comes from the East Coast of the United States and the Gulf of Mexico. The blue stars represent stations for satellite and field measurements matched up.

2. Field-measured K_d(UV) Results

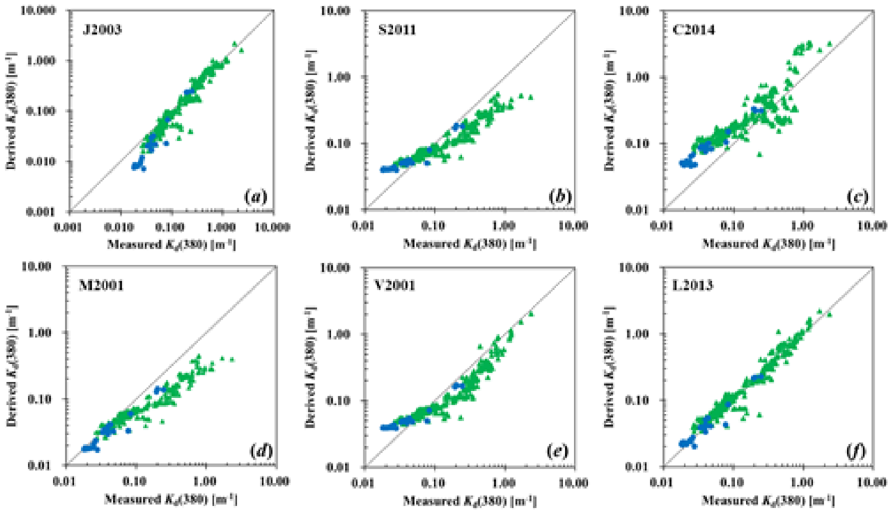

Fig. 2. Comparison between measured and inversion Kd(380) (the blue dots represent data from the BIOSOPE cruise, the green dots represent data from the NOAA Cal/Val cruise.): (a) J2003, (b) S2011, (c) C2014, (d) M2001, (e) V2001, (f) L2013.

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3. Ocean Color Satellite Results

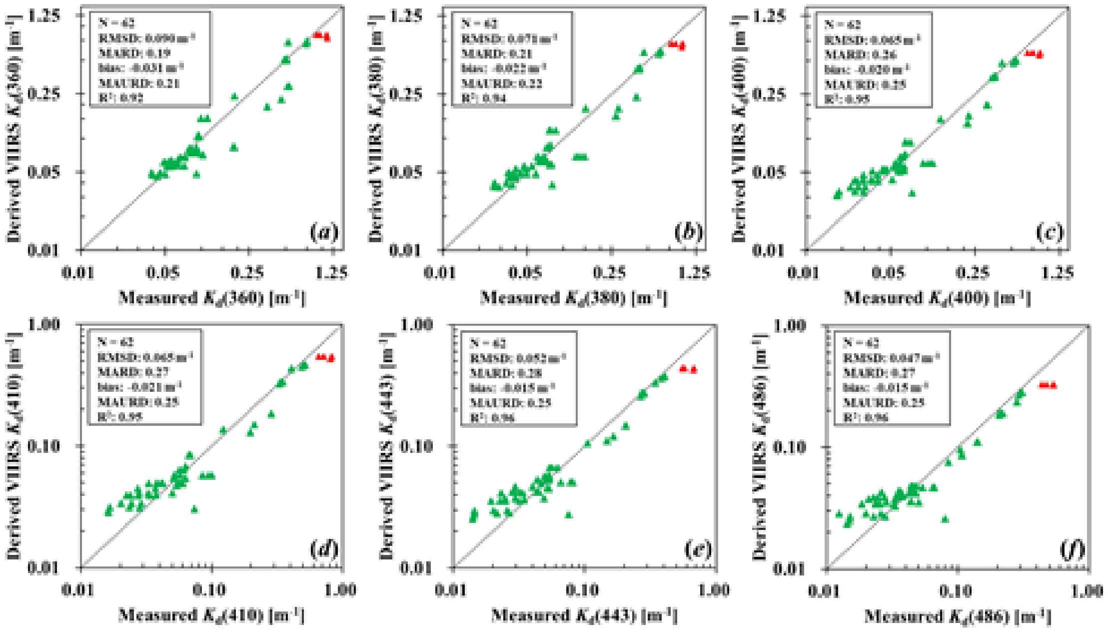

Figure 3. Comparison between VIIRS and measured K_d. (*a*) $K_d(360)$, (*b*) $K_d(380)$, (*c*) $K_d(400)$, (*d*) $K_d(410)$, (*e*) $K_d(443)$, and (*f*) $K_d(486)$. The red triangles represent the matching data of the red star in Fig. 1b.

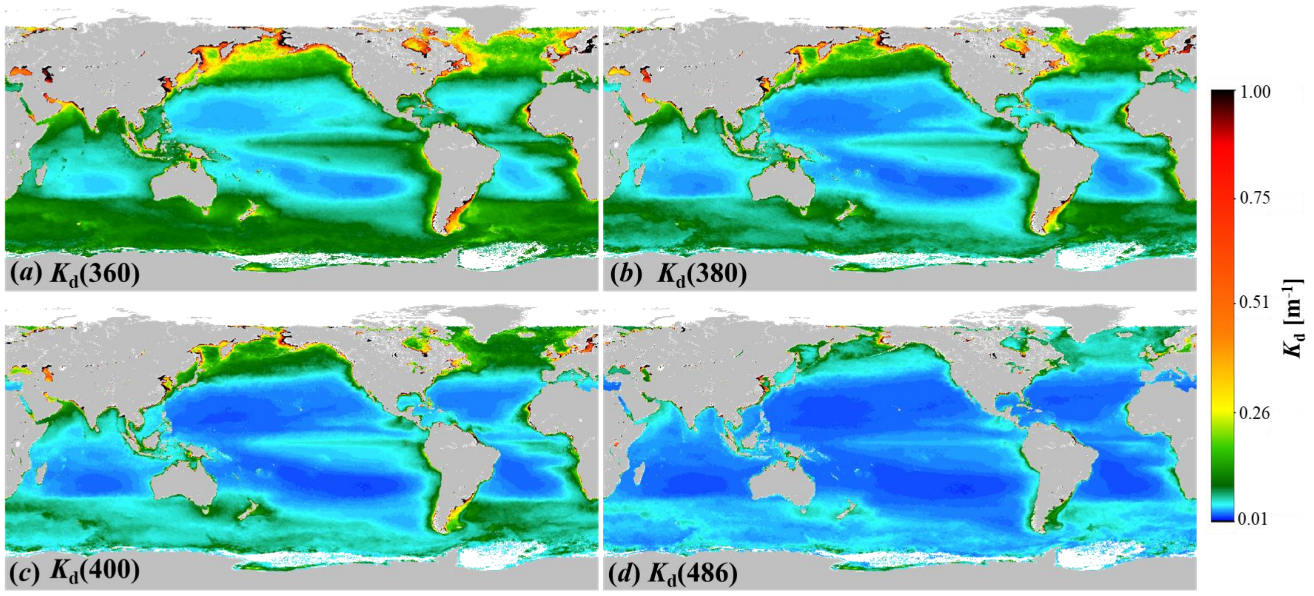

Figure 4. Global distribution of VIIRS $K_d(\lambda)$ climatology data. (*a*) $K_d(360)$, (*b*) $K_d(380)$, (*c*) $K_d(400)$, (*d*) $K_d(486)$.

4. Conclusions

1. Evaluating the applicability of six algorithms in K_d(UV), the results show that the semi-analytical algorithm is more reliable and stable than the empirical algorithm.

2.Penetration of radiation in the UV domain in the global oceans can be clearly characterized through the combination of UV radiation products at the ocean surface.

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