Algorithm Theoretical Basis Document for Primary Production and Red Tide Algorithm for SGLI/GCOM-C (Ver. 1.0)

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I. Introduction

Primary production and red tide are two important research products for Second-generation Global Imager (SGLI) on Global Change Observation Mission – Climate (GCOM-C). This document briefly described those algorithms.

II. Primary Production Algorithm

The primary production algorithm is based on Vertically Generalized Production Model (VGPM) developed by Behrenfeld and Falkowski (1997). This model is expressed as following;

$$IPP = 0.66125\ P^{B}_{opt}\ PAR/(PAR+4.1)\ Zeu\ Chl\ Dirr$$

where IPP , P^{B}_{opt}, PAR, Zeu, Chl and Dirr is depth integrated primary production (mgC m^{-2} d^{-1}), maximum chlorophyll-specific photosynthesis rate within a water column (mgC (mg Chl)$^{-1}$ h^{-1}), photosynthetically active radiation above the sea surface (mol quanta m^{-2}), depth of euphotic zone (m), chlorophyll-a concentration (mg m^{-3}), and photoperiod (hr), respectively. Chl is originally defined to be the chlorophyll-a concentration at the depth of P^{B}_{opt}; however, it is replaced to sea surface value which is calculated from remote sensing reflectance. PAR is also input from other algorithm of SGLI. Dirr can be calculated from Julian day and latitude.

P^{B}_{opt} is originally defined by 7th order polynomial function of T (sea surface temperature, ^{o}C); however, Kameda and Ishizaka (2005) redefined with a function of T and Chl assuming two phytoplankton community.

$$P^{B}_{opt} = 0.071\ T - 3.2\text{x}10^{-3}\ T^{2} + 3.0\text{x}10^{-5}\ T^{3})/Chl$$
$$+ (1.0 + 0.17\ T - 2.5\text{x}10^{-3}\ T^{2} - 8.9\text{x}10^{-5}\ T^{3})$$

Zeu should be used calculated value by other algorithm of SGLI; however originally used and coded as the functions of Morel and Berthon (1989) which is only applicable to Case I water.

Behrenfeld, M. and P. Falkowski (1997) Photosynthetic rates derived from satellite-based chlorophyll concentration. Limnol. Oceanogr. 42, 1-20.

Kameda, T. and J. Ishizaka (2005) Size-fractioned primary production estimated by a two-phytoplankton community model applicable to ocean color remote sensing, J. Oceanogr. 6, 663-672.

Morel, A. and J.-F., Berthon (1989) Surface pigments, algal biomass profiles, and potential production of the euphotic layer: Relationships reinvestigated in view of remote-sensing applications. Limnol. Oceanogr., 34, 1545-1562.

III. Red Tide Algorithm

Detail of the red tide algorithm can be found attached unpublished manuscript. It is based on sequence of steps to discriminate normalized water leaving radiance (nlw) spectral shapes and identify the water type. First step is to identify the peak wavelength of the nlw spectra and to discriminate clear water. Second step is to identify the curvature of the nlw spectra and to discriminate high suspended and/or colored dissolved organic matter water. Third step is to compare the slope of nlw spectra and chlorophyll-a concentration and to discriminate mixed water. In general remaining condition indicate red tide condition. However, because high demand to discriminate diatom and dinoflagellate, the algorithm further tests magnitude (fifth step) and shape (sixth step) of the nlw spectra to distinguish two different diatom groups and dinoflagellate.

This algorithm is developed to identify *Karenia mikimotoi* red tide off Ohita coast, and further study is required whether this algorithm works in other areas. It is also noticed that the algorithm is developed based on MODIS data, and the wavelength is different from SGLI. It is further required to adjust the parameters for different wavelength.