*Environmental Engineering and Management Journal* *November 2013, Vol.12, No. 11, 2219-2232*
*http://omicron.ch.tuiasi.ro/EEMJ/*

*"Gheorghe Asachi" Technical University of Iasi, Romania*


# AN EVALUATION OF MODIS/AQUA BIO-OPTICAL ALGORITHMS IN ARCTIC WATERS

**Palanisamy Shanmugam[1], Hyun-Cheol Kim[2*], Yu-Hwan Ahn[3], Jeong-Eon Moon[3], Surya Prakash Tiwari[1]**

*[1]Indian Institute of Technology Madras, Department of Ocean Engineering, Chennai – 600036, India*
*[2]Division of Polar Climate Research, Korea Polar Research Institute, Incheon –406840 , Korea*
*[3]Korea Ocean Satellite Centre, Korea Ocean Research & Development Institute, Seoul – 425600, Korea*

## Abstract

Despite the Moderate Resolution Imaging Spectrometer (MODIS/Aqua) presently collects data on operational basis, evaluation of its biogeochemical products from standard bio-optical algorithms is scare especially in Arctic waters. The present study is aimed to evaluate several MODIS/Aqua bio-optical algorithms and MODIS/Aqua remote sensing reflectance ($R_{rs}$) products in Kongsfjorden waters on the western side of Svalbard, Arctic. Data sets consisting of in-situ measurements of radiometric quantity ($R_{rs}$), Chlorophyll-a (Chl-a) and Suspended Sediment (SS) concentrations, and absorption coefficients of coloured dissolved organic matter ($a_{CDOM)}$ and phytoplankton ($a_{ph}$) collected coincidently with MODIS/Aqua observations during the 2007 and 2008 cruises were used to evaluate performances of the MODIS/Aqua algorithms in a wide range of waters within Kongsfjorden and its offshore regions with Chl-a varying from 0.01 to 5.8 mg $m^{-3}$, $a_{CDOM}$ (400) from 0.01 to 0.4 $m^{-1}$, and $a_{ph}$ (400) from 0.01 to 0.08 $m^{-1}$. The comparison of MODIS/Aqua $R_{rs}$ from the standard atmospheric correction (SAC) with in-situ measurements at six wavelengths (412, 443, 488, 531, 551 and 667nm) showed that these satellite $R_{rs}$ values are notably higher at 412nm and 443nm and lower at 551nm and 667nm than in-situ $R_{rs}$ values at these wavelengths. By contrast, $R_{rs}$ values from the MUMM atmospheric algorithm are slightly better than those of the SAC algorithm at 412 and 443nm, although being severely underestimated at 551 and 667nm. The over- and underestimated $R_{rs}$ values in short and long wavelengths may be caused by adjacent effects and sub-pixel contamination of the ice cover and clouds in the region. An evaluation of the bio-optical algorithms revealed systematic and large overestimations with Chl-a and $a_{CDOM}$(400) retrievals and underestimations with $a_{ph}$(675) retrievals from the SAC_$R_{rs}$ data. There was an inverse trend with MUMM that underestimated Chl and $a_{ph}$ values although producing nearly consistent results for $a_{CDOM}$. Among the algorithms tested, MODIS_DC_case-2_Chl (Default case), MODIS_OC3_Chl and MODIS_DAAC-v4_ Chl algorithms had the relatively better statistics than other pigment algorithms. The analyses further demonstrate that algorithms for estimating the absorption coefficients of CDOM and phytoplankton also tended to produce high errors (with overestimation at 400nm for $a_{CDOM}$ and underestimation at 675nm for $a_{ph}$). These analyses suggest that an independent treatment of the atmospheric correction and the development of new bio-optical algorithms are required to obtain reliable estimates of water constituents and inherent optical properties in high latitude waters.

*Key words:* arctic waters, atmospheric correction, bio-optical algorithms, MODIS/Aqua

*Received: June, 2010; Revised final: March, 2012; Accepted: April, 2012*

∗ Author to whom all correspondence should be addressed: e-mail: kimhc@kopri.re.kr, Phone: +(82)32 7605335