

論文の内容の要旨

論文題目 Evaluation and development of remote sensing techniques for accurate water quality monitoring in turbid lakes and coastal areas
(閉鎖性及び海岸水域における高精度な水質モニタリングに向けたリモートセンシング技術の開発)

氏名 Salem Ibrahim Salem Mohamed Salem
サレム イブラヒム サレム モハメット サレム

Many techniques have been proposed for monitoring the eutrophication of coastal areas and inland lakes using remote sensing data; However, there is no accurate continuous monitoring for these water bodies. Thus, the objectives of the current research can be divided into three major points: (1) evaluation of satellite products (i.e., chlorophyll-a (Chla) concentrations) using seven processors developed for MERIS sensor; (2) evaluation of seven semi-analytical algorithms that are widely used for Chla retrieve in coastal areas and inland lakes; and (3) developing a novel technique that combine the strength of these algorithms and approaches.

Firstly, the evaluation of seven processors based on neural network and band height that developed for MERIS sensor reveals that the maximum chlorophyll index (MCI) and fluorescence line height (FLH) processors outperformed other processors. Both the MCI and FLH require MERIS L1 products as inputs which leads to avoidance of errors arising from atmospheric correction. In addition, the results reveal that these processors underestimate or overestimate Chla concentration and local tuning is required to adjust the retrieved concentrations. Secondly, the evaluation study conducted for seven semi-analytical algorithms using different band combinations (i.e., multispectral and hyperspectral bands) and three regression approaches (i.e., linear, quadratic polynomial and power regression). Results show that the selection of regression approaches has low influence on Chla retrieval; whereas, the selection of algorithms' indices has significant influence on retrieval accuracy. The two-, three-, four- band algorithms and normalized different chlorophyll index tend to provide high retrieval accuracy

than ocean color V4 (OC4E), maximum chlorophyll index and synthetic chlorophyll index. The spatial distribution of the most accurate algorithms indicates that no single algorithms can produce outstanding retrieval accuracy. In addition, the retrieved relationship for semi-analytical algorithms are location and data limited.

Based on the previous evaluation that indicate the strength and limitation of these algorithms and approaches, the Multi-Algorithm Indices and Look-Up Table (MAIN-LUT) technique was proposed. The MAIN-LUT combines the strength of both the semi-analytical algorithms (i.e., provide indices that highly correlated with Chla concentrations) and look-up table (i.e., simulated dataset covers different trophic statuses). The MAIN-LUT technique was also developed for multispectral ocean color sensors. A validation process was performed using in-situ and simulated datasets. Results reveal that the MAIN-LUT provide a comparable retrieval accuracy with locally tuned algorithms in Tokyo Bay and Lake Kasumigaura. Furthermore, the MAIN-LUT could accurately retrieve Chla concentration in Lake Kasumigaura, despite the fact that the look-up table was created based on inherent optical properties (IOPs) from Tokyo Bay. Thus, the MAIN-LUT could be applied in similar water bodies. The Spatial and temporal distribution of Chla concentration are accurately retrieved from MERIS data over 10-years mission data.