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BIO-OPTICAL CHARACTERISTICS OF BRUNEI BAY DURING THE NORTHEAST MONSOON SEASON

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INTRODUCTION

Knowledge of the variability of oceanic optical and bio-optical properties are essential to understand many physical, biological and chemical processes in the oceans (Dickey & Falkowski, 2002). The ability of light to penetrate farther into seawater is not only important for oceanic phytoplankton primary production, but it is also crucial to the ocean biogeochemical cycling of chemical elements and the variability of upper-ocean heat budget. An understanding of the optical properties of seawater (absorption and backscattering) can provide insight into the contributions of different optically active constituents to the spectral ocean signature of water or remote sensing reflectance, R_{rs} in both coastal and oceanic waters. Generally, the optically active constituents of the water can be represented by broadly defined substances such as phytoplankton, dissolved organic matter and suspended inorganic sediments. The relative amount of these substances in the water is used to classify the types of water, either as case-1 or case-2 (Morel & Prieur, 1977). In most cases, although it does not always hold as a good assumption, open ocean waters are generally considered as case-1 type, whose optical properties are determined primarily by phytoplankton and its related co-varying decay products of biological origins (e.g. detritus and coloured dissolved organic matter). In contrast, case-2 waters are typically coastal like the Brunei Bay, where other substances which do not always covary with the phytoplankton pigment, significantly affect the ocean colour signal.

Satellite ocean colour remote sensing has been widely used to map biological parameters in the ocean. One of the applications of this remote sensing system is to measure primary productivity, chlorophyll and suspended particulate matter (SPM). This has been achieved using a set of global algorithms that are based on an average trend of in-situ datasets collected in different parts of ocean. These in-situ datasets covered a wide range of the water types from coastal to offshore water with nearly

90% of them are collected in oligotrophic ocean region or case-1 water (Werdell & Bailey, 2005) with smaller contribution from coloured dissolved organic matter (CDOM) and detritus. At a global scale, this algorithm has been showed to perform well and can be used to provide general information about the ocean. However, at a regional scale, the retrieval accuracy of satellite ocean colour products is not always as expected (e.g. Carder *et al.,* 2004; Blondeau-Patissier *et al.,* 2014) and the establishment of regional algorithms has been suggested to better interpret the satellite data. Especially in a broad range of water types such as those in the study area, the main factors contributing to the errors in the satellite ocean colour products are primarily associated with uncertainty in the atmospheric corrections and regional differences in optical properties of phytoplankton and uncorrelated concentrations of CDOM and suspended sediments in different ocean regions. In most cases, however, these uncertainties are related strongly to seasonal changes in local environmental conditions in a given area. Since biological and physical dynamics of the ocean are known to be highly intermittent, the understanding of the variability of the bio-optical state of ocean is very important for characterizing the marine optical environments and developing the most reliable remote sensing ocean colour algorithms.

Motivated by attempting to understand the applicability of satellite ocean colour products and the limits of reliability of this space-based measurement in the study area, this study focuses on the variability of bio-optical properties and how this variability may affect the accuracy of the Chl retrieval from satellite ocean colour data. Thus, the objectives of this study are to (1) describe and characterize the variability in bio-optical properties in the Brunei Bay coastal water; and (2) evaluate the applicability of the MODIS ocean colour algorithm, which is the most widely used and published algorithm for the study of near near-surface optical properties and particularly for the estimation of Chl concentration.

METHODS

Bio-optical Cruise

Optical and in-water constituents data were collected during the middle of the northeast monsoon season from 6th to 11th January 2014 using a 15 m fisherman boat in Brunei Bay. The study area spans approximately from latitudes 4° 54′ N to 5° 16′ N and longitudes 115° 03′ E and 115° 33′ E (Figure 1), with depths ranging from 4 m to 34 m. The sampling grid consisted of 34 stations which were spaced about