Impact of terrigenous materials on satellite bio-optical variables in the Bay of Bengal

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Transported by atmospheric deposition and river discharge, the Bay of Bengal (BoB) largely receives terrigenous iron-contained alluvial dust and dissolved inorganic nitrogen, the micro-macro nutrients which fuel phytoplankton growth and ocean primary productivity (e.g., Jutla et al. 2011; Srinivas et al. 2012; Narvekar and Kumar 2014; Sarangi 2016). Besides nutrients, river discharge also supplies the BoB suspended sediment and dissolved organic carbon, the sizable presence of which may be detrimental for phytoplankton growth and primary productivity. To date however, there is no information how the long-term river discharge variability may interannually affect the above-said in-water bio-optical variables in the BoB. In this analysis, by utilizing satellite-retrieved remote sensing reflectance (Rrs), the optical variables of chlorophyll-a concentration (Chl-a, a proxy for ocean primary productivity), total suspended matter concentration (TSM), and colored dissolved organic carbon absorption coefficient (CDOM) were derived within the period from September 1997 to December 2015. In-situ Ganges-Brahmaputra River (GBR) discharge (a proxy for nutrient input), and satellite-derived rain rate (RR) within the same time-span were also analyzed, and their interannual impacts on the ocean color variables were identified. The flood season in the GBR basin is in summer with the peak (in August) approximately lagged RR (in July) by one month. Chl-a, TSM, and CDOM in the BoB had larger non-seasonal component variances than seasonal ones, indicating that they might be sensitive to climate changes. Observing meridional distributions, the coastal water (with high bio-optical variables) can be roughly separated from the open ocean (with low bio-optical variables) approximately at 21°N. In summer of the years 1998, 2007, and 2011 however, it was obvious that bio-optical variables dispersed more southward to occupy the open ocean. In the same periods, RR and GBR discharge were remarkably higher than those during the normal summer season. This might indicate that high GBR discharge caused by high RR during summers 1998, 2007, and 2011 supplied terrigenous nutrients, suspended solid, and dissolved organic carbon into the BoB. In addition, the summers in 1998, 2007, and 2011 were the moderate La Niña periods, and it is well known that summer rainfall in the upstream GBR basin was anomalously high during La Niña years (e.g., Chowdhury 2003; Cai et al. 2015). Even though the aforesaid results showed increments of bio-optical variables through La Niña teleconnections with RR and GBR streamflow, further analysis is required to clarify whether any factors other than GBR discharge may also modulate the bio-optical variables. This is because, strengthened physical factors such as, wind speed, surface current, and vertical mixing, may entrain nutrients, suspended sediment, and dissolved organic carbon from deeper layer. Terrigenous alluvial dust deposition may also fertilize the BoB, thereby may also enhance Chl-a at interannual time-scale. La Niña teleconnections with atmospheric alluvial dust, wind speed, current, and vertical mixing in the BoB also need to be investigated. Therefore, we will analyze other geophysical variables such as, satellite-derived aerosol absorbing index (a proxy for alluvial dust), wind speed, surface ocean current, and reanalyzed mixed layer depth data, and identify whether or not those factors also interannually modulate the BoB bio-optical variables.

Keywords: Remote sensing, Ocean color, River discharge, Aerosols, La Nina