



Oceanographic processes influence the high primary productivity in the Visayan Sea, Philippines

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The mechanisms behind the high productivity of the Visayan Sea (Philippines) need to be understood for better fisheries management. However, current global ocean models are limited to spatial resolution of $1/8^\circ$ to $1/12^\circ$ which is around 8-14 km in grid size. Due to the presence of islands, shallow depths and narrow straits surrounding the Visayan Sea, global models cannot resolve and explain the Visayan Sea surface currents. In this paper, we explore the possible reasons for the high productivity in the region through analysis of satellite-derived chl-a and high resolution hydrodynamic models of the Visayan Sea in DELFT3D-Flow and SURF-NEMO.

Tide analysis suggests that the dominant constituents in the Visayan Sea are both semi-diurnal - M2 (principal lunar) and S2 (principal solar). In the larger Philippine Internal Seas which include the Visayan Sea, notably higher M2 and S2 amplitudes are observed in the latter. This can be attributed to the possible resonance of wave-wave interaction by tides coming from surrounding basins. Being a relatively shallow body of water (30-90 m) surrounded by deeper waters (100-1,700 m) and an area where maximum tidal amplitudes are found, stronger vertical mixing and nutrient exchange are ensued, thereby reinforcing productivity.

Satellite-observed chlorophyll-a concentrations from 2002 to 2022 in the Visayan Sea and adjacent seas are consistently high, regardless of monsoon reversal. Empirical orthogonal function (EOF) analysis of chlorophyll data was also conducted to determine the dominant patterns of chl-a variance. The first 10 modes contribute 65.2 % of the total variance. Mode 1 (18.8 %) is attributed to the seasonal variability (i.e., monsoons). Mode 2 (11.1 %) pattern can be associated with the Nino3.4 ENSO Index, suggesting that primary productivity in the Visayan Sea could be well affected by the changing climate.

Lastly, this study presents a recommendation of areas that need protection and focused management for better implementation of fishing seasonal closure in the Visayan Sea.