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Significance of biological forcing on the spatio-temporal variability of carbon dioxide fluxes over the Northern Indian Ocean

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The oceanic uptake and release of carbon dioxide (CO_2) play a critical role in global carbon cycle since oceans can act both as sink and source of CO_2 which vary spatially and temporally. The ocean primary productivity has significant effects on the CO_2 flux, as it consumes the dissolved CO_2 at the sea surface for the photosynthetic carbon production, reducing the surface carbon content, while higher production rates at surface layers cause higher respiration rates in the subsurface layers, thereby increasing the sea water CO_2 partial pressures (pCO_2) in these layers. Northern Indian Ocean is found to be a perennial source of CO_2 and also one of the most productive regions of Indian Ocean, however, while the western sub basin acts as an annual source, the eastern counterpart is a seasonal sink, especially during the monsoon and winter seasons. The major factors contributing to its high productivity is the summer and winter blooms caused by the wind-driven upwelling and winter cooling as well as convective mixing. The present study attempts to understand the relation between the CO_2 fluxes and primary productivity in the western and eastern sub basins of the northern Indian Ocean. The study divides the Sea in to North, West, East and Central parts based on the productivity and analyses the spatial and temporal variation of the CO_2 exchange between the sea and atmosphere in connection with the primary production. Satellite as well as climatological data were used to derive the monthly CO_2 fluxes and ocean primary productivity. Both sub basins exhibited high rates of productivity during the monsoon and winter seasons; high monsoon and winter CO_2 outfluxes were observed over the western sub basin in the northern waters towards the coast, while the eastern basin was found to have strong influxes in both the seasons over the northern waters. Towards the open ocean part, both fluxes and productivity showed decreasing trends in the western basin, whereas, the eastern sub basin showed an increasing trend of CO_2 outflux over the open ocean waters in the south. Surface stratification and limited nutrient availability have resulted in the low productivity rates during the pre- and post-monsoon seasons in both basins, while the absence of the surface mixing resulting from the stratification along with photosynthetic consumption lowered the fluxes. The primary production was observed to have a significant influence over the western basin fluxes while the fluxes over the eastern basin were primarily affected by the physical forcing i.e., the thermohaline stratification.