Regional Variations in Particle Fluxes and Biological Pumping in the Northern Indian Ocean.

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One of the key factors controlling biogeochemical cycling of trace elements and isotopes in the oceans is particle production and removal from the upper ocean to the interior of the deep sea. Particle production and settling in the northern Indian Ocean are mainly driven by wind-driven upwelling, thermo-haline mixing, and freshwater inputs. In the Arabian Sea the measured particle flux show a strong seasonality with enhanced fluxes during the SW and NE monsoon. At the onset of the SW monsoon the Findlater Jet leads to initial cooling of the surface water due to deepening of the mixed layer. This is followed by advection of up-welled water from the Oman coast. These nutrient rich waters leads to increase in primary production and particle fluxes in the western Arabian Sea the effects of which wanes eastwards, but is still felt in the central Arabian Sea. The carbonate/biogenic opal ratios as well as counts of foraminifera indicate an enhanced contribution of coccolithophorids to the export flux during the inter-monsoon and early SW and NE monsoons. Diatoms seem to dominate the export flux during the later phases of the two monsoons. The primary production rates during peak upwelling periods in July-August seems sensitive to iron supply from terrigenous sources. During winter, surface cooling and associated deepening of the mixed layer leads to enhanced nutrients accumulation and increase in primary productivity. Further studies have shown that deep mixing of photoautotrophic organisms initiates light-limiting conditions in the course of which the export of organic carbon gets reduced and nutrients including silicon accumulate in the mixed layer. In March/April, the shoaling of the mixed layer and the accumulated nutrients enables the development of the diatom dominated late NE monsoon bloom.

Monsoon-driven seasonality in the Bay of Bengal is less pronounced than in the Arabian Sea. Primary productivity and particle fluxes are enhanced due to enhanced nutrient supply by the Ganges/Brahmaputra and other rivers draining into the Bay. The freshwater supply also suppress phytoplankton blooms by forming a buoyant low salinity layer which caps the nutrient and CO2-enriched subsurface water, and reduces its entrainment into the euphotic zone. The phytoplankton community in the Bay are different compared to the Arabian Sea due to sharp seasonal variations in salinity and nutrient supply. POC/PIC ratios a measure of the “biological pump”, are higher in the northern and central Bay of Bengal compared to the Arabian Sea due to i) Reduction in the fluxes of foraminifera which are sensitive to sharp changes in salinity and ii) increase in organic matter fluxes due to the “ballast effect” in which mineral particles increase the density and settling rates of organo-mineral particles. And iii) enhanced supply of riverine silica which can favor diatom growth.