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Mineral Dust and Anthropogenic Trace Element Inputs to the Tropical North-Indian Ocean

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The present-day anthropogenic and natural changes in climate and global biogeochemistry are expected to alter the transport pattern and chemical characteristics of aerosols entering the ocean from atmosphere. This, in turn, may cause significant changes in biogeochemistry of surface ocean. Our recent study conducted in the marine boundary layer (MBL) of Bay of Bengal, NE-Arabian Sea and N-Indian Ocean was designed to assess the concentrations of Fe, Al and heavy metals in aerosol particles transported from south and south-east Asia during the late NE-monsoon (February-March 2001 and 2003). The Fe and Al concentrations exhibit large spatial variability over these oceanic regions (Table-1); with systematic lowest concentrations observed over Indian Ocean and highest over NE-Arabian Sea. But their scatter-plot shows an excellent covariance ($R^2 = 0.96$) suggesting that similar dust sources are impacting concentrations throughout the late NE-monsoon. However, a slope = 1.2 of regression line is significantly higher than their crustal ratio of 0.44; reflecting an overall enrichment of the Fe in the mineral dust entering the MBL. Assuming 1 cm sec^{-1} as the deposition velocity, the dry deposition flux of Fe over the N-Indian Ocean, Bay of Bengal and Arabian Sea is 160, 230 and 660 μg m^{-2} d^{-1}, respectively. Such seasonal atmospheric transport and deposition of Fe to surface ocean is an important source for the primary productivity. In contrast, after the onset of SW-monsoon, the aerosol Fe and Al concentrations over the Bay of Bengal decrease significantly (Fe range 9.5 – 79.7 ng m^{-3}, Av = 29.5 ng m^{-3}; Al range 17.0 – 79.5 ng m^{-3}, Av = 48.6 and Fe/Al = 0.61).

Table 1. Spatial variations and average concentrations (ng m^{-3}) of Fe and Al during the late NE-monsoon (February-March)

Region	Fe: Range, (Av)	Al: Range, (Av)	Fe/Al
Indian Ocean	123-291, (193)	141-263 (187)	1.03
Bay of Bengal	40-807, (272)	40-645 (265)	1.03
Arabian Sea	326-2488, (953)	309-1865 (762)	1.25

The impact of anthropogenic sources on heavy metal concentrations is evident over the Bay of Bengal and NE-Arabian Sea; with concentrations (ng m^{-3}) varying as Mn: 0.8 – 38.4, Cu: 0.6 – 6.1, Zn: 2.1 – 34.6 and Pb: 2.2 – 22. The EFs for Pb averaging around 100 are common over north Bay of Bengal during the late NE-monsoon. Such regional scale studies are essential in documenting climatic responses and constituent fluxes across the air-sea interface.