Seasonal and Inter-annual Variability of Sea Surface Temperature in the North Indian Ocean and associated Climate Change Signatures

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Sea surface temperature (SST) is an essential parameter for describing ocean circulation and dynamics in the study of upper ocean physical and biogeochemical processes. In conjunction with other met-ocean parameters, SST is used in the estimation of latent and sensible heat fluxes which are indicative of air-sea exchanges of heat. Studying the variations of SST over a long period is thus important in understanding the nature of global climate change. Classically SST is measured using conventional techniques, but satellite derived SST have advantages of synoptic view and temporal coverage.

In the present work, monthly area-averaged SST obtained from Terra-Modis satellite over four locations in the North Indian Ocean (NIO) have been analysed for a 10 year period from January 2003 to December 2012. The four areas in the NIO are selectively chosen so as to cover the varied oceanic conditions in this region (Figure 1). The regions are the northern Arabian Sea (1), the southeastern Arabian Sea warm pool (2), the northern Bay of Bengal (3) and the Andaman Sea (4).

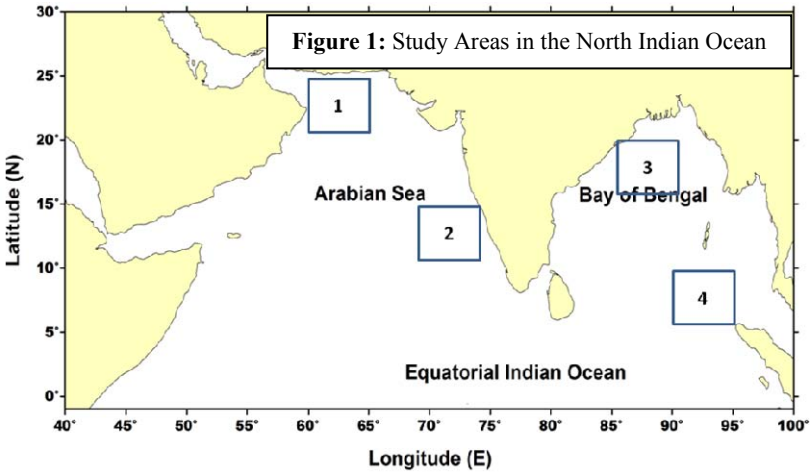

Figure 1: Study Areas in the North Indian Ocean

Analysis of area-averaged monthly mean SST in the four regions showed strong inter-annual variability during the period with a warming trend. The observed SST variability could be attributed to intrinsic ocean response, in the form of regional climate-shift and other external forcing. In addition to the oceanic thermal inertia, upwelling-driven cooling in the Arabian Sea, fresh water forcing in the Bay of Bengal and signatures of El Nino and Indian Ocean Dipole are responsible for the strong inter-annual variability of SST. The increasing trends in SST indicate the strong signature of climate change in this region indicating global warming-induced rising SSTs. Our analysis supports the observation made in few earlier works that the tropical Indian Ocean exhibits some of the highest SST warming rates observed in the global oceans, much of which can be attributed to anthropogenic climate change.

This observation of rising SSTs in the NIO has other strong implications as the low-level moisture and temperature in the atmosphere are strongly dependent on the local SST. Changes in SSTs in the NIO have the potential to affect monsoon rainfall by altering the amount of moisture available for transport towards India. Furthermore, due to the strong air-sea coupling over the Arabian Sea and equatorial Indian Ocean, SSTs vary greatly in response to dynamical changes associated with variations in the strength of the Indian monsoon. This is determined largely by external factors such as ENSO and the Indian Ocean dipole effects. Anomalies in northern Arabian Sea SSTs can also potentially affect monsoon rainfall as well as result in intensifying cyclonic storms in the region. A detailed analysis would be made to discern the exact impacts of SST increase on other climate parameters.