



INDIAN INSTITUTE OF TECHNOLOGY GUWAHATI
SHORT ABSTRACT OF THESIS

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SHORT ABSTRACT

The role of oceans in regulating the global climate is significantly affected by the spatial and seasonal variations in CO₂ gas exchange process at the marine-atmosphere interface. The concentrations of CO₂ gas in the atmosphere and ocean surface are the chief factor determining the flux direction, and are regulated by the physical, chemical and biological processes in the marine environment. These processes and their impacts vary regionally and seasonally, thereby impacting the spatial and seasonal trends in the CO₂ fluxes. The Indian Ocean, with its contrasting flux trends in the western and eastern counterparts, plays a unique role in the CO₂ transfer process. While the Arabian Sea acts as a net annual CO₂ source, the Bay of Bengal serves as a net sink. Being an underexplored oceanic region, the exact reasons behind this contrasting behavior are yet to be understood.

The present study has tried to compare and analyze the spatial and seasonal variations in these fluxes in relation to varying trends in the sea surface temperature and primary production caused by the differential availability of nutrients in both sub-basins. The northern Indian Ocean flux values were observed to reach a maximum range of 5 – 93 mmol m⁻² day⁻¹ in the northern Arabian Sea and drop to a minimum of -47 – 1.5 mmol m⁻² day⁻¹ in the southern waters of BoB during monsoon season. The ocean productivity exhibited the maximum values in monsoon, reaching up to 2500 mgC m⁻² day⁻¹ in the northern Arabian Sea and minimum values during the pre-monsoon season, falling down to 120 mgC m⁻² day⁻¹ in the northern BoB waters. However, the minimum range was observed in the southern Arabian sea with values in the range of 150–200 mgC m⁻² day⁻¹. BoB productivity was observed to exhibit less spatial fluctuation. An attempt

has been made to develop regional algorithms for estimating the sea water CO₂ partial pressures for both sub-basins using the in-situ observations. Arabian sea pCO₂ algorithm produced a model accuracy of 10.7 μatm with a coefficient of determination of 0.77 and the BoB algorithm provided an accuracy of 6 μatm and R² value of 0.78 with multiple polynomial regression function whereas, the prediction accuracy has improved with the implementation of random forest method which provided RMSE value of 0.05 μatm for Arabian Sea and 0.06 μatm BoB, with R² value of 0.98 for both basins.

Analysis of the nutrient dynamics over these basins showed higher concentrations of nitrate (44 μM), phosphate (3 μM) and silicate (65 μM) over BoB whereas low values of nitrate (17 μM) and phosphate (1.7 μM) and silicate (30.5 μM) were observed in the Arabian Sea. The study also investigated the impacts of climatological phenomena such as the warm and cold events on the flux distribution. The warm anomalies were found to attribute to reduced sea surface pCO₂ in the coastal and central Arabian sea, while cold events enhanced the coastal upwelling leading to increased surface pCO₂. A positive wind anomaly has caused a turbulent action leading to an increase in the pCO₂ in the southern Arabian Sea. Warm anomaly has resulted in an increase in surface pCO₂ in coastal, and both warm and cool events, as well as positive wind anomaly, enhanced the pCO₂ over the southern BoB waters.