Abstract

The Bay of Bengal (BoB) is a semi-enclosed ocean basin situated in the eastern part of the North Indian Ocean. Though the physical dynamics and physical state variables of the Bay of Bengal have been studied and measured in detail, the carbonate chemistry of this basin has been less explored, and very few reliable data exist. This study uses coupled physical-biogeochemical (ROMS-PISCES) model and machine learning to understand the variability of the sea-surface pCO_2 and pH in the open oceans of BoB. The initial part of the thesis establishes the coupled model configuration, which is then rigorously analyzed against the available data. The physical parameters (SST, SSS, and currents) and chlorophyll-a were found to match the observations satisfactorily. The carbonate variables (DIC, TALK, pCO_2, and pH) are well emulated by the coupled model. Since the BoB is a recipient of high freshwater it plays a significant role in moderating the sea-surface pCO_2 and pH of the BoB region. The spatial analysis of the CO_2 flux shows the Northern BoB to be a sink of atmospheric CO_2 (-0.35 ± 0.75 mol C m^{-2} yr^{-1}). The Southwestern BoB is a source of CO_2 (0.72 ± 0.61 mol C m^{-2} yr^{-1}) throughout the year and has the highest magnitude of flux, whereas the Southeastern BoB is a weak source of CO_2 (0.214 ± 0.52 mol C m^{-2} yr^{-1}). Mixing-induced changes in DIC and TALK result in high pCO_2 ($+570$ μatm) and, consequently, the positive CO_2 flux. TALK plays a buffering role, whereas DIC and SST primarily drive the BoB's pH. Using the satellite data, we found that during 2010-2019, the central BoB is warming at a rate of 0.0175 yr^{-1}, whereas the SSS is decreasing at a rate of -0.0088 yr^{-1}. The machine learning algorithms reveal that the sea-surface pCO_2 in the open oceans of the BoB is decreasing (-0.4852 μatm yr^{-1}) throughout the past decade (2010-2019). Seasonal analysis reveals the pre-monsoon season to have the highest rate of decrease of the sea-surface pCO_2.

Keywords: Bay of Bengal, DIC, TALK, pCO_2, pH, SST, SSS, Stratification, Barrier Layer Thickness, Freshwater Plume, ANN, XGBoost