Abstract

In the north Indian Ocean, the Bay of Bengal (BoB or bay) and the Eastern Arabian Sea (EAS) receive a huge amount of rainfall during summer. Several rivers along their boundaries discharge enormous amounts of freshwater into the coastal regions. Strong near-surface stratification induced by rainfall and river discharge has been linked to warmer sea surface temperature (SST) of the BoB, which forms as a favourable ground for the formation and intensification of the monsoon disturbances during summer. In this thesis, the influence of rainfall and river discharge on the dynamics and thermodynamics of the BoB and the EAS is studied using an ocean general circulation model (OGCM). We use an eddy-permitting Indian Ocean model based on MOM4p1 (Modular Ocean Model version 4.1), with a horizontal resolution of ~26 km. The vertical resolution of the model varies from 5 m in the top 60 m and the resolution gradually decreases with depth below 60m. The upper ocean hydrography and circulation of the north Indian Ocean is reproduced very well by the model.

Individual and combined effects of rainfall and river discharge on the BoB is investigated using the model. A set of four sensitivity experiments, forced with same air-sea heat flux, but retaining either river runoff or rainfall or both are carried out. These experiments show that the river water is exported out of the bay along the western boundary during winter and rain water along the eastern boundary during summer. Runoff leads to a large (>3 psu) decrease in salinity in the northern bay during summer and along the western boundary during winter, with a weaker contribution from rainfall. The East Indian Coastal Current strengthens by 10–15 cm sec^{-1} during winter owing to river discharge. The SST response to freshwater forcing shows large

spatial variations with eastern bay showing higher differences. The northwestern bay warms by ~1.5°C in the presence of freshwater during summer, due to greater heat absorption within a shallow mixed layer (ML). This warming is caused in nearly equal proportions by rain and river water in early summer, but the contribution by river water dominates during peak and withdrawal phases of the summer monsoon. Northeastern bay, in contrast, is cooler by 1.5–3 °C in the presence of freshwater, caused primarily by river runoff, owing to the winter cooling over a thin ML. Temperature inversions form due to surface cooling of a river stratified layer during winter in the northwestern bay and due to radiation penetrating below the ML during summer in the northeastern bay.

The west coast of India and the adjoining EAS is one of the high rainfall zones of Indian summer monsoon. The summer monsoon rainfall in this region is about 1036 km^3, which is comparable to that of the Ganga-Brahmaputra river system. We have investigated the impact of EAS rainfall on the Arabian Sea salinity with a suite of experiments using the model. The role of low-salinity water originating in the BoB on reducing the EAS salinity has also been examined. The sea surface salinity (SSS) of EAS decreases progressively from June to September by 0.5 to 1 psu. A numerical experiment that isolates the effect of EAS rainfall suggests that this SSS decrease is due to local rainfall. The spatial pattern of SSS decrease, however, is influenced by the prevailing West India Coastal Current. The SST in the southern EAS cools by 0.5°C in response to EAS rainfall freshening during summer. The SST cooling in the presence of salinity stratification is attributed to the enhanced upwelling along the southwest coast of India. In the southeastern Arabian Sea, during winter, the SSS decreases by about 1.5 psu. This freshening is caused by rainfall during the early winter in the southwestern BoB between 6–15°N. Neither rainfall to the north of 15°N nor river runoff into the BoB contribute much to the SEAS freshening during winter.

The northern bay has been known to remain warm (>28.5°C), which favour the deep atmospheric convection, during summer. The study has been able to identify the individual and combined effects of rainfall and river discharge on the northern

BoB. The near-surface salinity stratification allows the northwestern bay to remain warmer during the summer. The cooling in the northeastern bay, in the presence of freshwater forcing, points out the significance of ocean-atmosphere coupling along the eastern boundary of the bay. The local rainfall maintains the surface salinity of EAS below 36 psu throughout the year. Interestingly, the summer monsoon upwelling along the southwest coast of India is stronger in the presence of near-surface stratification induced by the EAS rainfall. The possible implications of this strong upwelling in response to local rainfall and river discharge along the west coast of India on its ecological system needs to be studied.