Abstract

The annual total continental runoff into the Bay of Bengal (BoB) is more than half the runoff into the entire tropical Indian Ocean. The net freshwater (FW) content in the Bay of Bengal mixed layer increases from a minimum of 6200 km3 in May to a maximum of 8700 km3 in November. For steady state freshwater balance, there has to be a net transport of around 0.11 Sv (1 Sv = 106 m3s−1) out of the Bay. This large transport of freshwater has a significant influence on regional hydrological balance. In this thesis, we investigate the seasonal pathways of BoB freshwater based on climatological observations. In order to trace the movement of BoB freshwater in the tropical Indian Ocean, we remove the influence of local precipitation minus evaporation by subtracting seasonal P-E from FW at each point. Although this recipe does not remove advected rainwater for simplicity we call the difference "runoff water" (RW), as the major source of this water is continental runoff as well as freshwater from the Indonesian Throughflow (ITF). The datasets used in this work are (1) World Ocean Atlas 2001 Salinity and Temperature (2) Satellite-gauge merged precipitation from GPCP and CMAP (3) SOC and COADS evaporation (4) Surface currents from WOCE drifters (5) Dai and Trenberth River Runoff Data (6)SK197 Cruise data from north Bay in October 2003 (7) NIOT Buoy observations, including DS1 thermistor chain data and (8) Sea Surface Temperature from TRMM Microwave Imager (TMI). Estimates suggest that the net annual input of freshwater into the Bay (from runoff plus rain minus evaporation) is more than 4000 km3. The upper ocean freshwater content is highest in the north Bay in the post monsoon season. We also study the effect of the upper ocean freshwater pool on ocean cooling due to cyclones in the north Bay.

We find two principal pathways for the export of freshwater out of the northern Bay of Bengal. These pathways had been identified in previous model studies. However, most models underestimate the true reach of Bay of Bengal freshwater because model mixing is unrealistically large. The two pathways are as follows:

(1) The western pathway, during November-May. Observations, and a few model studies using passive tracers and drifters, suggest that runoff water from the north Bay flows down the east coast of India in the East India Coastal Current (EICC) and into the eastern Arabian Sea around Sri Lanka during November-December. Later in winter, water from south Bay flows past Sri Lanka in the Northeast Monsoon Current (NMC) (January-February). We see BoB freshwater in the Arabian Sea up to 15 0N along the west coast of India in February, with RW decreasing gradually to the north. Bay runoff spreads in the southern Arabian Sea up to the coast of Africa by May. Upper ocean currents around the Lakshadweep high and smaller vortices (January-April) might then carry the BoB water west.

(2) The eastern pathway, during the second half of the year, carries BoB freshwater south. The surface water flows along the Indonesian coast, joins the Indonesian Throughflow and flows west in the surface south equatorial current (SEC), in agreement with some model results.

High space and time resolution sea surface temperature (SST) from satellite shows that premonsoon cyclones cool SST in the Arabian Sea(AS) and the southern Bay of Bengal by up to 50C, but post monsoon cyclones do not cool the north Bay by more than 10C. In situ data is used to examine the possible reasons for the small SST cooling in the north Bay, even under strong post-monsoon cyclones.

The cyclone of June 1998 in the eastern AS passed within 200 km of the NIOT mooring DS1. The thermistor chain on DS1 showed strong thermal stratification in the upper ocean before the storm developed. The cyclone deepened the mixed layer from about 10 m or less to about 70 m. The potential energy input to the upper ocean is about 11,000 Jm−2. We do not have similar subsurface temperature profiles, recording the influence of a cyclone in the north Bay. We use CTD data from Sagar Kanya cruise SK197 in October 2003 and ask the question: What would happen to north Bay SST if 11,000 Jm−2 of potential energy were supplied by a cyclone to mix the upper ocean? We find that the mixed layer would deepen from about 10 m to 40 m, but this would not lead to significant SST cooling because the isothermal layer is around 40 m deep. This suggests that vertical mixing due to post monsoon cyclones does not lead to SST cooling of the north Bay because (a) salinity stratification resists deep vertical mixing, and (b) the sub mixed layer water is warm. Therefore, the observed cooling of under 10C must be mainly due to evaporation.