Introduction to "Atmosphere-Ocean Dynamics of Bay of Bengal”
Volume 1

Each of the world’s oceans is unique in their own way. The narrow, salty Atlantic Ocean stretches from the northern to southern polar regions with major sites of abyssal ocean ventilation that induce global overturning circulation cells. The immense relatively fresh Pacific Ocean is home to the El Niño/Southern Oscillation (ENSO) and is linked to the Indian Ocean via the Indonesian Throughflow (ITF) within the Maritime Continent. And, then there is the Indian Ocean, which distinguishes itself in part due to the blocking of its northward extent by the Asian landmass, defined by two embayments: the Bay of Bengal (BoB) and the Arabian Sea (AS). These adjacent seas consist of very different stratification and greatly affect the South Asian monsoon.

The sea surface salinities (SSS) of BoB and the AS differ by more than 3 psu, more so than that of the ‘salty’ Atlantic and the ‘fresh’ Pacific. The contrast between the eastern and western tropical Indian Ocean extends to near 10°S where the ITF spreads westward within the Southern Equatorial Current. The low SSS of BoB is a consequence of the large freshwater input of about 0.13 Sv, of which 0.09 Sv is due to river discharge, whereas AS losses about 0.11 Sv of freshwater as a consequence of excessive evaporation. The SSS contrast between BoB and AS depends on the efficiency of the water interchange between the two basins, as the salty AS invades BoB within the thermocline as BoB exports low salinity surface layer in an estuary-type circulation. Much of this exchange is highly seasonal and occurs along the periphery of Sri Lanka, including the Sri Lanka Dome.

Ocean processes blend the fresh and salty features along and across density surfaces, influencing sea surface temperature (SST) and air-sea fluxes. The low sea surface salinity of BoB generates a barrier between the buoyant surface layer and the cooler subsurface thermocline waters, inhibiting vertical fluxes of deep cool, nutrient-rich waters, impacting air-sea interaction and modifying the lower atmospheric boundary layer. The barrier layer depth and intensity vary across BoB within the field of anticyclonic and cyclonic eddies and associated sub-mesoscale fronts and swirling filaments of river water, as well as subsurface and intrathermocline eddies.

At its eastern margin, from the tidally active Andaman Sea, eddies, internal waves and solitons leak into BoB via gaps in the Andaman and Nicobar Islands. High-frequency internal waves, which originate from tidal flow over the shallow sills within the island chain, are evident in the southern BoB. Across the BoB, eddies migrate westward at a rate of 6-7 cm s^{-1}. These eddies and associated submesoscale features, display a surprisingly large thermohaline range, often obscuring the more regional surface water and thermohaline stratification patterns.

The Air-Sea Interactions in the Northern Indian Ocean (ASIRI) program (Wijesekera et al., 2016), the US umbrella for an international research effort from 2013 through 2017, involving more than 20 research institutions, was focused on understanding and quantifying coupled atmosphere–ocean dynamics of the BoB with relevance to improved Indian Ocean monsoon prediction. To address this focus, ASIRI utilized a broad range of ship-based, mooring, and autonomous field observations resolving sub-kilometer to regional scales, coupled with operational and high-resolution models. ASIRI companion programs are: "Indian Ocean Mixing and Monsoon" (OMM of India, as part of their Monsoon Mission) and the "Effects of Bay of Bengal Freshwater Flux on Indian Ocean Monsoon" (EBOB of Sri Lanka-NRL). Many initial results of ASIRI field efforts are presented within the *Oceanography* special Issue: “Bay of Bengal: From Monsoons to Mixing” (Mahadevan et al., 2016). Deep-Sea Research Part 2 "Atmosphere-Ocean Dynamics of Bay of Bengal” composed of two volumes, the first of which is presented in this issue, includes a broad range of topics covered in 13 articles. The first 7 deal with regional views, the other 6 focus on specific features.

Hormann et al., using an array of satellite tracked surface drifters and Argo floats identify two freshwater export pathways from the BoB. The western route feeds into the westward Northeast Monsoon Current south of Sri Lanka into the AS during the winter monsoon, whereas the eastern path extending to the western margin of Sumatra, reaching at times as far south as the ITF plume within the South Equatorial Current near 10°S, is a year round feature,.

Roman-Stork et al. use satellite observations and NEMOv3.4 ocean model output to exam the spatial and temporal characteristics of atmospheric 10-20 day (intraseasonal) oscillations, which contribute to periods of intensified rainfall rates within the BoB, the moisture being derived from the western tropical Pacific Ocean and South China Sea.

Seo et al. explore the influence of surface currents in air-sea flux bulk formulae, finding that relative wind contributes to a reduction in the mean and eddy kinetic energies within the BoB, as well as a reduction in mixed layer depth and increase in stratification.

Sandeep and Pant, using an idealized numerical model with realistic river discharge data, quantify the impact of wind speed and direction on transferring coastal river water plume into the interior of the BoB as well as the impact on stratification.

Kantha et al. use a one dimensional mixing model driven by a dense set of mooring data to study the variability of upper BoB and AS, illustrating the importance of rainfall, stratification in model initialization, solar radiation penetration on summer SST predictions as well as the roles of inter- and intra-seasonal variability.

Jampana et al. study the impact of the strong salinity barrier layer near 10-20 m depth within the BoB on vertical mixing during the later summer monsoon of 2011. They find that the low salinity surface layer essentially ‘slips’ (glides) over the denser, stratified subsurface water, as vertical momentum transfer is inhibited.

Kumar et al., using in situ Lagrangian float and satellite observations, along with model simulations, explore the impact Tropical Storm Roanu on sea surface temperature (SST) and upper 80 m stratification. Tropical Storm Roanu, which formed north of Sri Lanka on May 17, 2016, moved north-northeast following the Indian coastline and made landfall in Bangladesh on May 21, cooled SST by about 2°C across a wide region of the BoB.

Cullen and Shroyer utilizing a 22 year remote sensing record, detail the seasonal and its considerable interannual variability, in timing, strength, and position, of the Sri Lanka Dome, an upwelling feature of the summer monsoon, east of Sri Lanka. The variability is directly related to the local wind stress curl, east of Sri Lanka, which is expression of the larger scale wind patterns.

Lozovatsky et al., using observed profiles of temperature, salinity, density, currents and turbulent kinetic energy dissipation rate in the southwestern periphery of the Sri Lanka Dome, find a functional form for the cumulative probability distribution of the dissipation rate as well as an eddy diffusivity parameterization, as a function of Ri.

Pham and Sarkar, use a high-resolution large-eddy simulations, to investigate the evolution of ageostrophic secondary circulation of an initially geostrophic balanced front. They find enhanced turbulent mixing near the front and the development of a barrier layer characterized by a temperature inversion and that the mixed layer actually shoals on both sides of the front.

Mathur et al., using satellite-derived ocean surface currents in the northern BoB, investigate the orientation of thermal fronts during the winter months, December 2015–March 2016, within a framework of Lagrangian Coherent Structures. They find that freshwater parcels from the river water run-off are subjected to intense stirring by the ocean surface currents, which contain both geostrophic and wind-forced Ekman currents factors.

Adams et al., with a high-resolution, multiplatform observations of upper ocean temperature, salinity, and velocity demonstrate the sensitivity of air-sea fluxes to ocean conditions over scales of 1 kilometer, which is far smaller than those used in ocean, atmosphere, and coupled forecast models.

Wijesekera et al., analyze internal-tide observations from six deep moorings deployed in the southern BOB from December 2013 to August 2015. They find that incoherent internal tides account for at least 60% of the semidiurnal tidal energy in the area. The role of internal tide in soliton generation is identified, and both internal tides and associated high frequency waves were found to interact with mesoscale features to enhance vertical mixing.

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