Oceanographic study of an identified meso scale eddy in the central Bay of Bengal during second inter monsoon 2013

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Abstract

Bay of Bengal (BoB) is comprised of mesoscale eddies during October to December. Conductivity-Temperature-Depth (CTD) profiles collected from R/V Dr. Fridtj of Nansen in the central BoB during October to November 2013 were used to describe seasonal mesoscale features in the central BoB. Sea Surface Temperature (SST) map of the area indicated an eddy. Geostrophic currents were calculated from CTD profiles while assuming the depth of no motion at 1000 m. Surface geostrophic velocities were estimated from AVISO Sea Surface Height (SSH) anomaly maps. Validation of plotted SST map was done with NASA/JPL high resolution SST images. A high saline water cell (34.4 PSU) was observed at the center of the SSS map. Isotherms of this water mass were domed upward, indicating a cold core eddy. But geostrophic currents calculated for this section didn't emphasize an existence of an eddy, but flowed downward with averaged speed of 40 cms^{-1}.It was significant that the geostrophic currents at the bottom of the survey area was moved northward with averaged 50 cm s^{-1} speed. AVISO data and satellite SST maps of the area didn't express the presence of an eddy. By this study it can be concluded that the suspected high saline and warm (28.8^0C) water mass at the center of survey area cannot be considered as an eddy. It was noted that below about 300m currents get weak at zero. It can be considered as a subsurface current. Further studies can be carried out to understand the behaviour of the geostrophic currents in Bob.

Keywords: Geostrophic currents, eddy, CTD, isotherm, isopycnal

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Introduction

Sri Lanka is an island state centered in the Indian Ocean, between the Bay of Bengal in the east of Sri Lanka and the Arabian Sea in west of Sri Lanka, and the upper ocean circulation around the island changes with the monsoons. North Indian Ocean (upper area of 100S) is distinguished by the presence of seasonally reversing currents that flow between the Bay of Bengal (BoB) and the Arabian Sea (AS). These currents are located between the equator and approximately 100N. The Summer Monsoon Current (SMC) flows eastward during the summer monsoon (May–September) and the Winter Monsoon Current (WMC) flows westward during the winter monsoon (November–February), March–April and October being months of transition between these well-defined current systems (Shankar et.al, N.D). During the inter monsoons, the behaviour

of BoB and AS is much differ. Between October and December, BoB is mixed by meso scale eddies. The SMC enters BoB during October and November month.

A hydrographic data set which was captured by CTD 19+ with Rosette attached to R/V Dr. Fridjoft Nansen ship during a cruise from 22 October to 02November 2013 in central BoB (6.50N-10.50N and 84.50E-88.50E). Along with SSH maps, SST maps were used to examine meso scale variability in the central part of the BoB.

Materials and methods

Data organizing, processing, analyzing and mapping were completely done by MATLAB 2007b software by MATLAB Inc. SST and Sea Surface Salinity (SSS) maps were used to study the eddy structure in the area. Temperature and salinity profiles were plotted for each CTD cast line. The density of the water column was calculated by using temperature and salinity data by Gibbs Sea Water tool box. Density profiles were plotted by using this calculated data. The T-S diagram was created for all profile data. Geostrophic currents between two most far profiles of each line were calculated by the method described by Pond and Pickard, 1993 assuming Depth of no motion as 1000m. Sea Surface Height (SSH) maps was plotted by deriving AVISO SSH data with 7 day composites. Validation of plotted SST map was done by using ultra high resolution (1km) satellite imageries by Jet Propulsion Laboratory (JPL) in http://ourocean.jpl.nasa.gov/SST/

Results

SSS map showed that a high saline (34.4 PSU) water cell was located at the center of the area. It was surrounded by 34.2 PSU water. 28.8^{0}C temperature cell of the SST map at the center of the survey area emphasized an eddy at the center of the area. So it can be considered as a warm and high saline water cell. CTD profile plot for northern most CTD cast line (Fig 1) showed that the 28^{0}C isotherm domed indicating a cold core eddy. But while it goes far down; 28^{0}C isotherm deepens with the decreasing of latitude. Isotherm deepening was gradually increased with the decreasing of latitude. It was clear that on the surface, this deepening and doming was prominent, but at the deeper layers (80m), these changes are not significant. Surface (>40m) layer salinity structure was much wavy, but at the second CTD cast line at the center, there was a low salinity (33.6 PSU) pool. But it was not appeared in the next sections. This low saline water mass moved further westward into southern most areas, but completely spread over the northern most CTD cast line. The density structure of the area was not identical to either salinity or temperature distribution. It was wavy rather than smooth

isopycnals. 21 kgm^{-3} (sigma-t) isopycnals was at the surface (Fig 2). Sub surface isopycnals were parallel to each other, but surface isopycnals was not. Calculated geostrophic currents from these profiles didn't show any of the clear current patterns. It was identical, that the surface current was in to the page, but subsurface currents were out to the page. Middle CTD cast line (Line 3) showed a significantly faster current (10-40 cms^{-1}) out of the page (Southward), line 5 (far down the coast line) had the strongest current (>50cms^{-1}), but oppositely directed (northward). It can be an entrance of South Monsoon Current to BoB. After ~ 400m, current was quite near to zero, significantly differ from turbulent surface waters.

SSH altimetry data derived from AVISO didn't indicate any significant SSH anomaly. Average SSH was ~70-85cm. Surface geostrophic currents were slow (<1 cms^{-1}) at the region. Also SST map derived from JPL model archive didn't express any significant SST anomaly.

Discussion

The SST map derived from the CTD cast data showed an eddy at the center of the area. But all together analyzed data didn't express such a good evidence of eddies. Geostrophic currents in warm or cold core eddy have their distinct patterns. But resulted geostrophic currents in this study didn't indicate such a relationship. So this can be a water cell, deviated away from the SMC. It may not show any significant SSH anomaly. But as it contains higher saline and high temperature water, it can be considered as a deviated water cell of SMC.

Conclusion

Observed high saline, the warm water cell could not be concluded as an eddy. The possibly turbulent geostrophic currents are restricted to surface waters. The turbulent nature of the upper ocean of BoB, during inter monsoons has described by this study. Further studies are required to understand the behavior of different currents in the region during inter monsoons.

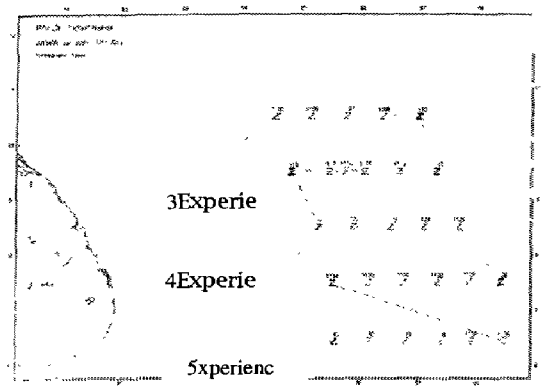

Figure 1: CTD cast lines

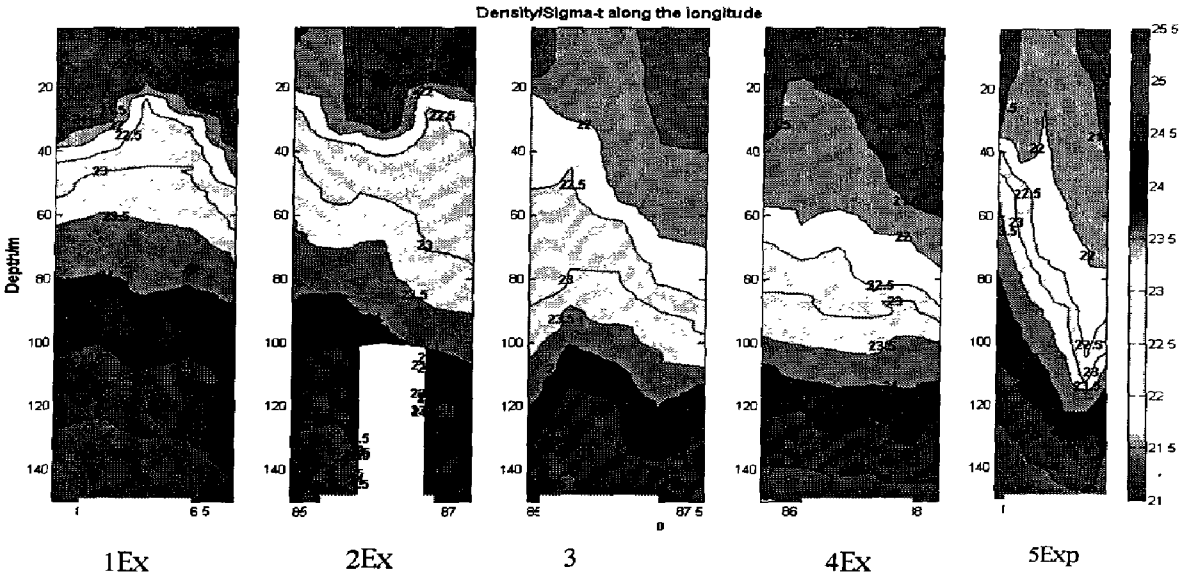

Figure 2: Density-sigma t of the CTD lines

References

- Pond, S. and Pickard, G.L. (1983). Introductory Dynamical Oceanography. 2nd edn, p 367. Pergamon press. Great Britain.