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To advance our understanding of interactions between geologic, oceanic and atmospheric processes that give rise to the complex physical dynamics of the Indian Ocean region, and to determine how those dynamics affect climate, extreme events, marine biogeochemical cycles, ecosystems and human populations.

An improved method for quality control of in situ data from Argo floats using α convex hulls

Argo floats are autonomous CTD profiling floats that drift freely with the sub-surface ocean currents at prescribed parking depths and map temperature and salinity data from a profiling depth to the sea surface at preset time intervals. While the float rises to the surface of the ocean, it measures profiles of conductivity (C) and temperature (T) versus pressure through the water column. This measured temperature and salinity data are reported to various receiving centers via satellites and the autonomous floats sink back to its preset parking depth and continue their new cycles. The Argo program aims to deploy 3000 such autonomous profiling floats with a target profiling depth of 2000 m to observe temperature and salinity within the upper layers of the global ocean, and currents at the parking depths. Each profiling float is expected to have a mean lifespan of ~ 4 years giving good measurements of temperature and pressure, with issues arising with salinity measurements owing to biofouling and other problems (Wong et al., 2003). Since the inception of the Argo program in 1999, the geographic distribution of oceanographic T/S profiles data has become more uniform. Abundant data obtained from these profiling floats is being used in operational ocean models, enhancement to existing climatologies (Chaterjee et al., 2012) and generation of value-added products (Udaya Bhaskar et al., 2007).

Here we describe an improved method recently developed by us for detecting abnormal oceanic insitu temperature and salinity (T/S) profiles. This procedure is an improvement on the method previously developed by Udaya Bhaskar et al., [2017]. This new method employs World Ocean Atlas 2013 (WOA13) gridded climatology which is on 0.25° x 0.25° resolution to build convex hulls. These α shapes are then used to categorize "good" and "bad" in situ T/S data profiles. This method classifies the entire profiles instead of data for standard depths thereby avoiding any errors introduced by interpolation to standard depths. An 'n' sided polygon (convex hull) encompassing the T/S profile data is constructed first using Jarvis March algorithm. Then the Points In Polygon (PIP) principle is employed to judge a profile as good or bad. Extensive sensitivity experiments were done for arriving at the optimal α value such that false positives and true negatives are minimized. All types of issues associated with the in situ oceanographic data are identified and quality flag assigned. Examples of this improved method as applied to a few Argo floats are presented below.

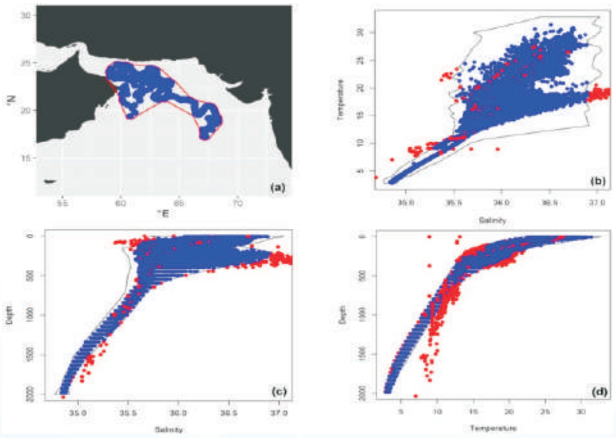

Figure-1. (a) Trajectory of the float 2900554 during its lifetime. (b) Observed profiles from Argo float overlaid on T/S α convex hull built from annual WOA13 profiles falling within the float trajectory. Blue indicates good and red indicates outlier. (c) Observed Salinity profiles from Argo float overlaid on Salinity-Depth α convex hull built from annual WOA13 profiles falling within the float trajectory. (d) Same as that of (c) for Temperature profiles.

This new method is definitely a significant improvement over the method proposed by Udaya Bhaskar et al., (2017) as it treats the whole observed profile and eliminates the possible error that might creep in due to interpolation. The applicability of the method for different ocean basins demonstrate the usefulness of the technique for identifying bad profiles over the global ocean to the extent possible, thereby minimizing manual invention. The big advantage of using the α convex hull method is its applicability to handle bulk amounts of profile data from any oceanic basin. As it is nearly impossible to visually check the correctness of individual profiles, this method can be used to detect good against bad profiles. However this method needs climatology to be updated continuously for obtaining the best possible α convex hulls for performing outlier analysis. Furthermore, this method can be augmented with other methods in use by the oceanographic community to make the data research quality and to be used for various applications.

Citation: R. Venkat Shesu, T.V.S. Udaya Bhaskar, E. Pattabhi Rama Rao, M. Ravichandran, B. Venkateswara Rao, An improved method for quality control of in situ data from Argo floats using α convex hulls, MethodsX, Volume 8, 2021, 101337, ISSN 2215-0161, https://doi.org/10.1016/j.mex.2021.101337.

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Potential mechanisms responsible for spatial variability in intensity and thickness of oxygen minimum zone in the Bay of Bengal

The oxygen minimum zones (OMZ) significantly impact marine biodiversity, biogeochemical cycling of elements, redox environment, and trace gases production (Breitburg et al., 2018). Migration of fishery resources is considered to be one of the serious impacts of the water column OMZ. The occurrence of water column OMZ in the open sea region has been reported only in some selected regions, such as Eastern Equatorial and Eastern Tropical Pacific Ocean (Ruch et al., 2012; Kalvelage et al., 2013; Castro-Gonzalez et al., 2014), Tropical Atlantic Ocean (Levin, 2018), and northern Indian Ocean (Naqvi et al., 1991; Sarma et al., 2016). Potential mechanisms responsible for the occurrence of OMZ in the open sea regions are variable in each region. Within the northern Indian Ocean, the Arabian Sea houses a more thick and intense OMZ than the Bay of Bengal (BoB). The weaker OMZ in the BoB has been attributed to lower primary production (Gauns et al., 2005) or faster sinking of organic matter to bottom (Nair et al., 1989; Ittekkot et al., 1991) leading to lower bacterial respiration rates in the OMZ region of the BoB than in the Arabian Sea (Naqvi et al., 1996). In contrast, Anand et al., (2017) noticed lower sinking carbon fluxes at the 100 m depth (< 3% of primary production)in the Bay of Bengal than Arabian Sea (5-10% of primary production; Anand et al., 2018) which they attributed to utilization of organic matter by heterotrophs in the upper ocean in the former basin. Recently Rao et al. (2020) estimated that about 50% of the primary production exudates as dissolved organic carbon in the BoB and it may be recycled within the upper ocean rather than exported, resulting in low sinking carbon fluxes. The role of stratification on intensity of OMZ has been reported,both in the coastal and offshore regions (Sarma et al., 2013; 2016), due to limitation of vertical oxygen transport to the OMZ, which is identified to be a major source of oxygen to the OMZ (Sarma, 2002). The stratification in the upper ocean is mainly driven by freshwater discharge from perennial rivers such as Ganges-Brahmaputra and Irrawady-Salween river systems to the eastern BoB, and Indian peninsular (seasonal) rivers, such as Godavari, Mahanadi, Krishna and Cauvery to the western BoB (Sarma et al., 2014). The magnitude of river discharge to the eastern BoB is an order of magnitude higher than that of western BoB (Durand et al., 2011). Therefore, spatial variations in the OMZ is expected due to variable strength of the stratification in the BoB.

In this work, spatial variability in boundaries and thickness of oxygen minimum zone (OMZ) is derived based on measured dissolved oxygen data obtained from sensors on board biogeochemical (BGC) Argo floats deployed between 2013 and 2019 in the Bay of Bengal (BoB). Upper and lower boundary of the OMZ varied from 60 to 200 m and 100 to 800 m respectively with the thickness of 80 to 650m in the BoB. Relatively thicker OMZ is noticed in the northern than southern BoB associated with stratification. The salinity difference between surface and 100 m is higher in the northeastern (NE; >2.5) followed by northwestern (NW; 1.8-2.5), and lower in the southern BoB (0.6 - 1.2) indicating weaker stratification in the latter region associated with weaker OMZ. The oxygen concentrations in the OMZ in the NW was low (<1.5 mM) than NE BoB (2.5 mM) indicating that thick and intense OMZ occurs in the NW region associated with stratification and high primary production. Significant decrease in particle-back scatter signal was observed towards offshore from shelf indicating that organic matter from the shelf sediments may be supporting bacterial carbon demand in the OMZ. The particle back-scatter signal peaked in the OMZ region with higher signal in the northern than southern BoB , consistent with the low oxygen concentration in the former region. In addition to this, the occurrence of eddies significantly control the intensity of the OMZ in the BoB, as anticyclonic eddies ventilate oxygen, weakening the OMZ, whereas cyclonic eddies intensify OMZ through increase in primary production and upwelling of oxygen-poor waters. Therefore, Our studies suggest that spatial variations in intensity of OMZ in the BoB is governed by stratification, primary production, sinking carbon fluxes and organic matter decomposition within the OMZ and modification of oxygen concentration in the OMZ by eddies.

Citation: Udaya Bhaskar, T. V. S., Sarma, V. V. S. S., & Pavan Kumar, J. (2021). Potential mechanisms responsible for spatial variability in intensity and thickness of oxygen minimum zone in the Bay of Bengal. Journal of Geophysical Research: Biogeosciences, 126, e2021JG006341. https://doi.org/10.1029/2021JG006341

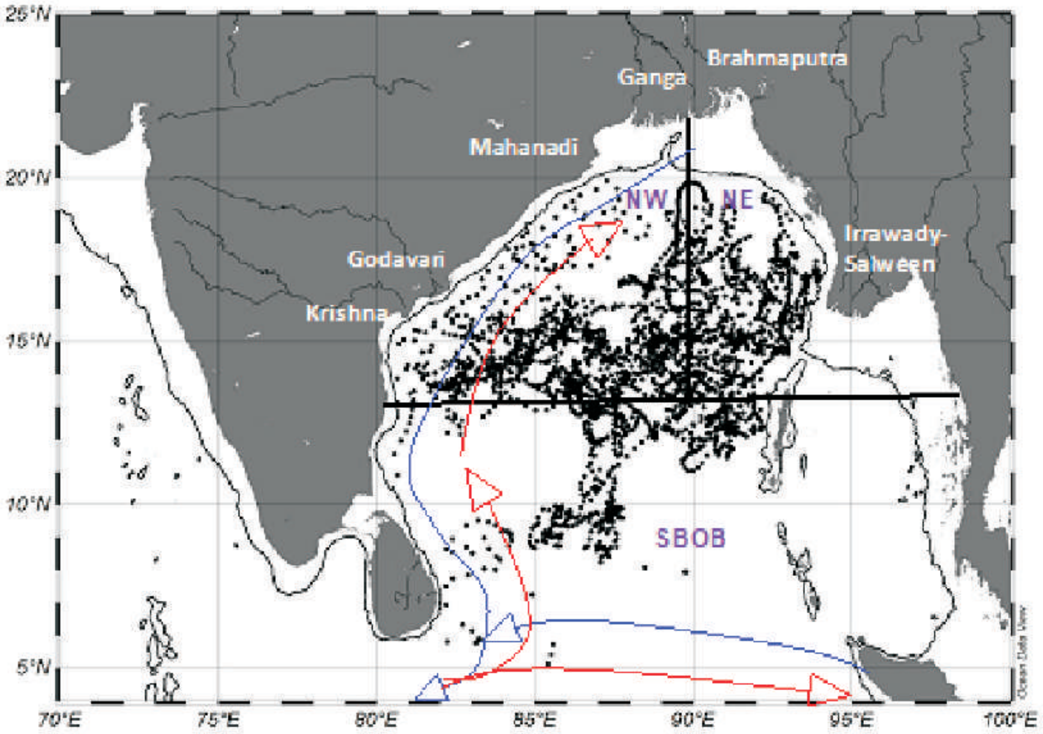

Figure: Map showing the location of argo profiles (black circles) used in this study. The purple lines denote the regions classified as northwest (NW), northeast (NE) and southern BoB. The general circulation during northeast (winter) and southwest (summer) monsoon are shown with blue and red arrows respectively. The location of discharge by different rivers are also shown.

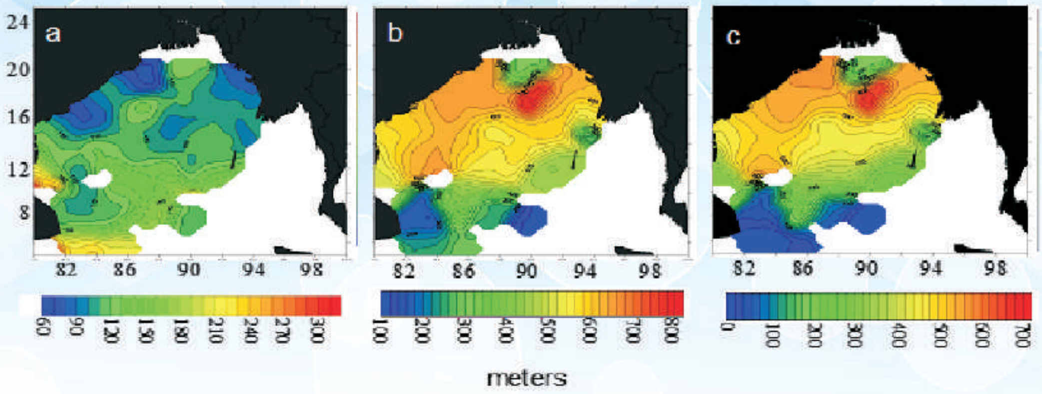

Figure: Variations in depth of a) upper boundary (m), b) lower boundary (m) and c) thickness (m) of OMZ in the BoB.

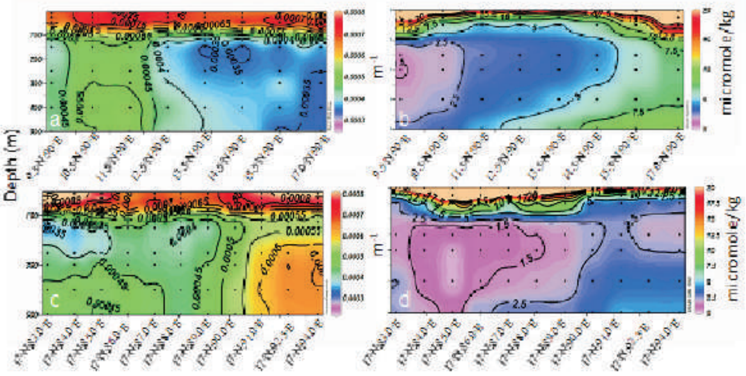

Figure: Depth profiles of a) particle back-scatter (m^{-1}) and b) dissolved oxygen (mM) along the 90°E and (c) and (d) represent along 17°N respectively

[Report Courtesy: Dr. T.V.S Udaya Bhaskar, INCOIS, Hyderabad, India. *E-mail: uday@incois.gov.in]*

IIOSC-2020 Conference rescheduled to 14-18 March, 2022
Call for Abstracts

In view of the continuing concerns related to the pandemic, the International Indian Ocean Science Conference (IIOSC)-2020 has now been rescheduled to 14-18 March 2022.

Conference Website: https://iiosc2020.incois.gov.in/

First Announcement: https://iiosc2020.incois.gov.in/WEBSITE_FILES/IIOSC2022/FirstAnnouncement-IIOSC2022.pdf

Call for Abstracts: https://iiosc2020.incois.gov.in/IIOSC2020/Abstracts.jsp

IMPORTANT DATES

Abstract Submission Opens: 01 September, 2021

Abstract Submission Closes : 31 October, 2021

Abstract Acceptance : 30 November, 2021

Registration opens on : 01 October, 2021

Early Bird Registration : 31 December, 2021

Last Date for Registration : 15 January, 2021

Endorse your projects in IIOE-2

Don't miss the opportunity to network, collaborate, flesh out your research project and participate in IIOE-2 cruises!!

The endorsement of your scientific proposal or a scientific activity focusing on the Indian Ocean region is a recognition of the proposal's or activity's alignment with the mission and objectives of IIOE-2, of its potential for contributing to an increased multi-disciplinary understanding of the dynamics of the Indian Ocean, and of its contribution to the achievement of societal objectives within the Indian Ocean region. Over 45 international, multi-disciplinary scientific projects have already been endorsed to date by the IIOE-2. Yours could be the next one!

Visit https://iioe-2.incois.gov.in/IIOE-2/EndorsementForm.jsp for further details and for projects already endorsed by IIOE-2 https://iioe-2.incois.gov.in/IIOE-2/Endorsed_Projects.jsp.

CLIVAR September 2021 Bulletin is available online

The International CLIVAR Project Office distributes a monthly bulletin with announcements, funding opportunities, meeting notifications relevant to the ocean/climate science community.

The latest CLIVAR Bulletin September, 2021 is available at:

https://mailchi.mp/clivar.org/clivar-september-2021-bulletin

Call for Contributions

Informal articles/short notes of general interest to the IIOE-2 community are invited for the next (October-end) issue of the IIOE-2 Newsletter. Contributions referring IIOE-2 endorsed projects, cruises, conferences, workshops, "plain language summary" of published papers focused on the Indian Ocean etc. are welcome. Articles may be up to 500 words in length (Word files) accompanied by suitable figures, photos.(separate.jpg files).

Deadline: **25 October, 2021**

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