Thermohaline structure and cold intermediate layer properties of the Black Sea as inferred from Argo floats

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Abstract

The thermohaline structure of the oxygen-rich cold intermediate layer (CIL) with temperatures below 8^{o}C in the Black Sea is of great importance due to the oxygen deficiency of the water column below the biologically productive euphotic zone. The long-term data compiled from the Argo float profiles document temporal and spatial variability of its distribution and the likely mechanisms leading to its formation.

Keywords: Cold Intermediate Layer, Thermohaline Circulation, Black Sea, ARGO floats

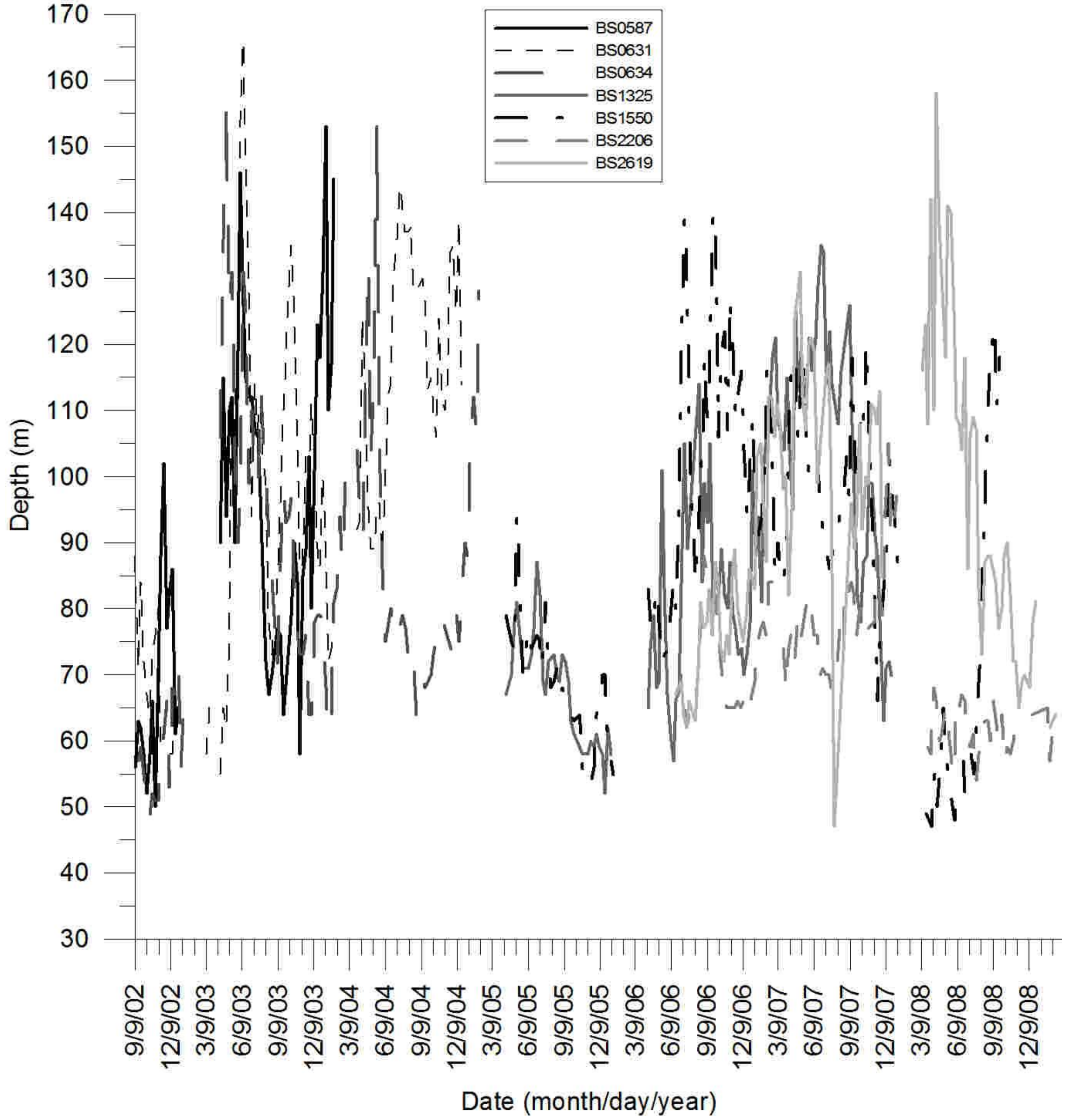
Data from seven ARGO profiling floats operating in the Black Sea between 2002-2009 have been used in this study. Three of these floats were located at the parking depth of 1550m, and the rest at 200m, 500m, 750m and 1000m depths. All of them collected vertical profiles of temperature and salinity from 1550m depth to the surface once a week. Both the CTD data and position data have been used to examine temporal changes in the horizontal current velocity and temperature and salinity at the floats parking depths. Sea surface height anomaly data from AVISO have been used as supplementary data set in order to identify the mesoscale features provided by the float data. In this work the CIL thickness and lower boundaries are considered as an indicator for the intensity of ventilation of subsurface waters in the Black Sea (Table.1-Fig.1).

A thick CIL is generally observed in March, but there is no seasonal cycle or a specific parameter affecting CIL thickness. The results suggest that CIL is thicker and deeper in anticyclones whereas it is thinner and is at shallower depths in cyclones. Simultaneous observations in cyclonic and anticyclonic patterns reveal an 80m difference in the lower boundary of CIL and a 60m difference in CIL thickness. Among the average thickness values obtained from the floats, the smallest value is ~29m due to its location in the cyclonic Western Gyre. CIL is observed as an isothermal layer formed when the cold water formation at the surface merges with the already existing “old” CIL, prefarably in the cyclones during February-March, Its formation in the cyclonic gyres emphasizes importance of the uplift of the pycnocline and the upwelling of the “old” CIL to the surface rather than generation of cold water as a result of convection only. Cold water formation seems to be affected by mesoscale processes as well.

Table1: Average depth, temperature, salinity, sigma-theta and thickness of CIL for each float

Float no.	Mean Depth (m)	Mean Temperature (°C)	Mean Salinity (psu)	Mean Sigma-theta (kg/m3)	Average Thickness (m)
BS0587	61.10	7.46	18.62	14.50	44.66
BS0631	66.62	7.42	18.62	14.50	54.61
BS0634	62.24	7.47	18.60	14.48	46.63
BS1325	73.86	7.57	18.83	14.65	43.56
BS1550	59.46	7.54	18.75	14.59	47.16
BS2206	51.24	7.65	18.84	14.65	29.37
BS2619	70.07	7.67	18.64	14.49	42.09
Overall					**44.16**

Fig.1 Distribution of CIL lower boundary over time. Each line represents data from a different float



BS0587
BS0631
BS0634
BS1325
BS1550
BS2206
BS2619
Depth (m)
170
160
150
140
130
120
110
100
90
80
70
60
50
40
30
9/9/02
12/9/02
3/9/03
6/9/03
9/9/03
12/9/03
3/9/04
6/9/04
9/9/04
12/9/04
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9/9/06
12/9/06
3/9/07
6/9/07
9/9/07
12/9/07
3/9/08
6/9/08
9/9/08
12/9/08
Date (month/day/year)