ON THE EVOLUTION OF THE LONG-LIVED SUBSURFACE MESOSCALE EDDY SOUTH OF CYPRUS

D. Hayes [1]*, H. Gildor [2], A. Bosse [3], L. Mortier [3], P. Royer-Gaspard [3] and P. Testor [3]
[1] Oceanography Center, University of Cyprus - dhayes@ucy.ac.cy
[2] Hebrew University of Jerusalem
[3] University of Pierre and Marie Curie

Abstract

Since systematic measurements of ocean temperature and salinity began south of Cyprus in 1995, evidence for the presence of an anti-cyclonic mesoscale Cyprus eddy has been consistently observed. Initially, the Cyprus Basin Oceanography (CYBO) ship-based hydrographic program often found relatively warm, salty water at about 200-500 m depths. While not high enough in spatial resolution to observe the extent of the eddy, it was unmistakably one of the dominant features of the region. Recently, glider-based observations of the Cyprus eddy have shown how it has evolved since 2009. Every year since that intense, multi-platform 2009 study south of Cyprus, the eddy has changed. This descriptive study motivates further study as to the dynamics governing both the formation, evolution of the eddy and its size and position.

Keywords: Levantine Basin, Mesoscale phenomena

Introduction

We investigate a subsurface mesoscale eddy south of Cyprus using ocean gliders. We describe its characteristics, focusing on interannual variability. The glider data is compared with available ship and float observations in other studies [1]. The comparison on one hand highlights the need to use gliders to observe this eddy at adequate temporal, horizontal, and vertical resolution, and on the other hand, supports the reliability of the glider-derived parameters.

The diameter of the eddy, located south of Cyprus (Fig 1.) is usually about 80 km. While it can be seen in dynamic height calculations, in situ observations show that the core of the density anomaly is from 200-500 m depth, at which Levantine Intermediate Water (LIW) is located. Observations since 2009 suggest that this eddy is semi-permanent, and existed all these years [1]. Observed backscatter, oxygen, and fluorescence suggest that this subsurface eddy plays a role in biogeochemical processes as well [2].

Methods

In 2008, the Oceanography Center at the University of Cyprus acquired two underwater gliders from the University of Washington. Both gliders are rated to 1000 m and carry non-pumped conductivity-temperature-depth sensors (CTD) from SeaBird Electronics (SBE-4 and SBE-5), a dissolved oxygen sensor from SeaBird (SBE-43), an optical triplet from WetLabs (BB2F-VMG) is also installed to measure optical backscatter at 400 nm, 700 nm, and chlorophyll-a fluorescence. Since March 2009, the gliders have been used in a long-term observing program of the Cypriot EEZ, and by August 2015, have covered more than 16000 km and 3500 dive cycles in 942 of glider days, most to 1000 m (Fig. 1). The glider endurance lines criss-cross the region in order to more accurately locate and investigate the mesoscale structures south of Cyprus, and in particular the Cyprus eddy.

Results

The first goal is to chart the presence, location, size and intensity of the Cyprus eddy from the bow-tie pattern. The plots of maximum LIW depth in Fig. 1 show that the eddy is most commonly located near the Eratosthenes Seamount, but shifts by 0.5-1 degrees in both longitude and latitude. We also observe variations in intensity, core thickness and temperature/salinity values based on glider data (Table 1). The Cyprus eddy at its maximum is 90 km across and 400 m high, making it a distinct homogeneous biome of the Levantine Sea. However, the eddy structure varies by year, in some cases showing reversals in the salinity or downwelling at the outer edge [2, 3].

Discussion and Conclusions

This study demonstrates the usefulness of ocean gliders in acquiring mesoscale information. Similar characteristics can be obtained from ships and floats only in special cases, since it is not normally possible to obtain adequate spatial detail from low resolution or freely-drifting platforms. However, T/S values can be used to track the eddy between glider missions. Further study is required on processes involved in shaping, evolving eddy in order to understand why the changes are happening. More study is also needed to discover the mechanism that creates and maintains this eddy.

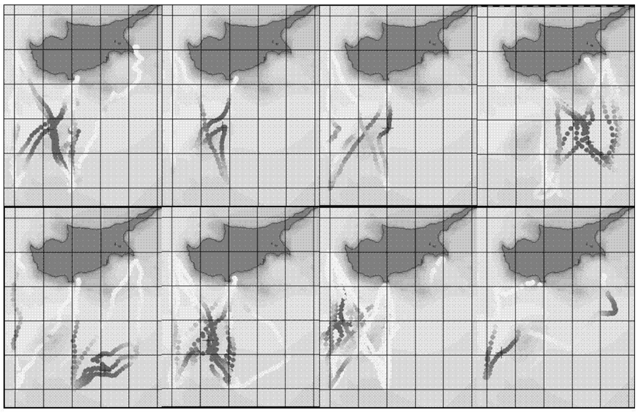

Fig. 1. Cyprus and a subset of the glider surfacing locations from 2009 to 2015. Darker colors mean deeper depth of the σ_θ_0 29.0 layer of the LIW . White is 100 m and darker shades begin at 400 m.

Tab. 1. Cyprus eddy characteristics from glider observations.

Dates	Center	Thickness/Max Dep	Temp, Sal
Mo/yr	Lat, Lon	m (S-based)	deg C, psu, m
05/09-08/09	32.59E, 33.85N	250, 404	17.13, 39.38
11/09-01/10	32.88E, 33.87N	260, 412	17.14, 39.38
01/10-02/10	33.02E, 33.87N	204, 400	17.13, 39.38
10/10-02/11	33.78E, 33.68N	230, 506	17.15, 39.39
12/11-02/12	33.58E, 33.28N	148, 458	17.16, 39.36
02/13-08/13	32.67E, 33.76N	420, 430	16.0-17.12, 39.11
04/14-05/14	32.12E, 33.94N	150, 352	16.88-17.18, 39.12
07/15-08/15	32.31E, 33.56N	125, 230	17.32-17.57, 39.08

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