WINTERTIME CROSS SHELF CIRCULATION AND SHELF/SLOPE INTERACTION OFF THE CENTRAL ISRAELI COST

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Abstract

Results are presented from two field experiments, conducted during winters 2007/8 and 2008/9, and modeling work focusing on winter cross shelf and slope transport processes off the central Israeli coast. Our study shows that this transport is, apparently, driven by both downwelling circulation off the Israeli coast and by the strong impact of the flow of the adjacent deep sea upon the flow over the upper slope and over the narrow Israeli shelf due to the presence of an along-slope jet, open sea meanders, and eddies.
Keywords: Continental Shelf, Levantine Basin, Circulation

Results from two field experiments, conducted during winters 2007/8 and 2008/9, and modeling work focusing on winter cross shelf and slope transport processes will be presented. Our study shows that this transport is apparently driven by both downwelling circulation off the Israeli coast and by interaction between the flow over the narrow Israeli shelf and that of the deep sea. In comparison to studies of upwelling systems, downwelling driven circulation has been relatively little explored in the world ocean. Moreover, while modeling studies and a limited number of field experiments suggest that flow dynamics in the deep sea have a strong impact on the cross shelf/slope transport in the region, this has been only slightly explored [1, 2].

Field measurements included extensive hydrographic surveys using vessel-mounted and a vessel- towed ADCPs (acoustic Doppler current profilers) and CTD (conductivity, temperature, depth) casts off the central Israeli coast (depths from 10 to 800 m), long-term time-series measurements of water-currents and thermal structure in the water column from bottom mounted ADCP sites over the shelf (water depths of 25, 60, and 130m) and Aanderaa RCM7 current meters moored at a site on the upper slope (300 m depth). Several thermistors were attached to the mooring line of the upper and shelf break sites. These measurements were complemented by forecasts and simulations using the Princeton Ocean Model (POM) with grid resolution of 1.25, nested within the eastern (ALERMO) and the general (OGCM) Mediterranean Sea models. This study is part of an ongoing US-Israel Binational Science Foundation funded project, which also includes microstructure and turbulent profile measurements aimed at combining the meso-scale and micro-scale transport and mixing processes.

The ADCP surveys revealed the temporal and high spatial variability of the currents on the shelf and slope region with length scales of O(10-20 km), accompanied by cross shelf transport due to the presence of eddies and onshelf intrusions of deep sea meanders up to the inner shelf. They also confirm the occasional existence of an along-slope northward baroclinic current jet during the winter season and provide important information about its structure. The surveys, with the help of the modeling simulations, show the along-slope jet to be part of the cyclonic jet following the eastern rim of the Levantine Basin during and following the southeastern winter storms or as a local intrusion of a deep sea current.

Measured velocities of the jet were relatively high with speeds as high as 1m/s and the jet was found to interact with the upper slope to produce strong northward currents close to the seabed. Data from the current meter sites showed that the downwelling flow over the shelf and at the shelf edge was mostly confined to the bottom boundary layer (BBL). This is believed to be due to the presence of seaward Ekman veering of the velocity within the BBL (vertical extent of 20-30 m) occurring during winter storms and during the relaxation period after the storms. The seaward flow at the BBL over the shelf break was found to be higher during the presence of an along-slope jet due to the stronger velocities over the seabed.

A persistent characteristic of the currents over the shelf break was the increase of current velocity with depth, resulting in a local maximum with speeds as high as 1 m/s at the top of the BBL. This local maximum is consistent with the existence of significant horizontal density gradients observed over the shelf break during the two winter experiments These density gradients were accompanied by a deep density front on the upper slope during the presence of the along-slope jet. Towards the end of the winter season the frontal jet weakened and the water column at the 300 m site became mixed, allowing for the strong upper layer currents to reach the bottom. Although the presence of both the along-slope jet and the downwelling circulation were well simulated by the numerical model, the strength of the jet was underestimated and the model failed to reproduce the observed increase of the current speed with depth over the shelf break.

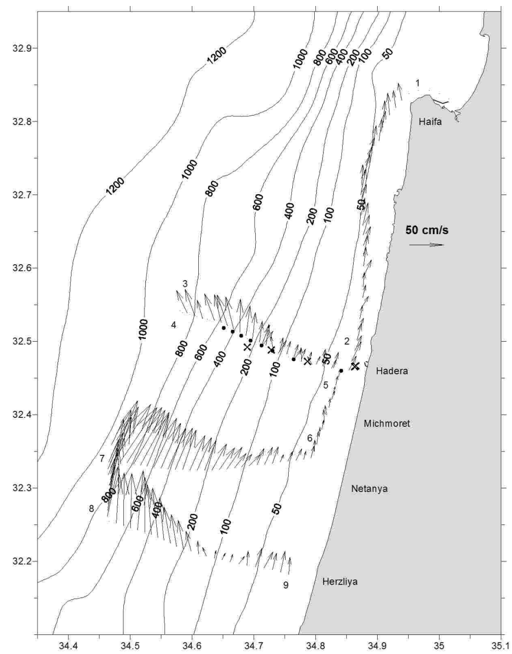

Fig. 1. Current vectors at -14 m from ADCP transects: 25 Feb 2009. Also shown are the positions of the CTD stations during the cruise (circles) and fixed current mooring stations during 17 Dec 08- 31 Mar 2009 (X).

References

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