ON THE CIRCULATION OVER THE ISRAELI MEDITERRANEAN CONTINENTAL SHELF AND SLOPE

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Abstract
Results are presented from a long term monitoring program of the circulation on the Israeli Mediterranean continental shelf and slope conducted using subsurface current moorings. The currents direction on the shelf and slope was found to be generally northward with maximum monthly mean velocities observed during the summer and stormy winter seasons. Winters were characterized by downwelling circulation while during summer a seaward increase in the magnitude of the along-shelf currents was observed. Both seasons also exhibited an energetic along-slope northward jet, a finding supported also by results from numerical modeling studies.
Keywords : Circulation, Levantine Basin.

The Israeli Mediterranean continental shelf is narrow O (15 km) and has a relatively simple bathymetric relief structure with isobaths roughly parallel to the coastline. In 1987 the Israeli National Institute of Oceanography started a 10-year observational study to investigate the circulation and the thermohaline structure off the Israeli coast [1, 2, 3, 4, 5]. It was conducted with subsurface current meter moorings on the shelf and at mid-slope as well as with hydrographic across-shelf sections. Statistical and spectral analyses of the currents over the shelf show almost no evidence of currents at the semidiurnal tidal frequency; however, quite a strong signal ($\sim$0.1 cm/s) is found at a daily period during the warming season due to the sea breeze. The most important part of the current energy is present in the synoptic and seasonal time scales. The synoptic currents over the Israeli shelf are mainly northwards and follow the bathymetry. The monthly mean along-shore current over the inner or mid-shelf has a seasonal period with a maximum northward velocity magnitude during summer and winter seasons of O(0.1 m/s). During the stratified summer season, both the monthly mean currents and synoptic velocity along-shore fluctuations decrease with depth below the surface mixed layer. The decrease of the mean velocity is in agreement with the strong stratification and sloping isopycnals over the shelf, resulting in low velocities of only a few cm/s near the bottom at the outer shelf. Characteristic for this season is an offshore increase in the northward seasonal current within the upper water layer. During winter the water over much of the shelf is homogenous and the synoptic currents are highly coherent and vertically uniform. Although occasional southward currents have been observed, the winter season is characterized, mainly, by strong northward currents (O(0.6 m/s)) during the winter cyclonic storms which exhibit a strong along-shore wind stress component. These currents also imply, in addition to a large along-shore transport, strong bottom friction and vertical mixing. The magnitude of the along-shelf synoptic velocity component depends mainly upon the along-shelf wind stress and pressure gradients. The direct response to the wind is mostly confined to the inner and mid-shelf, whereas the shelf edge sites show open sea influence [4]. The cross-shelf circulation during the cooling season is characterized by onshore surface Ekman transport that is compensated for by a seaward (downwelling) flow in the bottom boundary layer. At the shelf break sites the seaward flow is also accompanied by an intensification of the northward current. Current measurements, as well as hydrographic cross sections, indicate the possibility that part of this transport is also due to gravitational advection and downslope cascading of dense shelf water, induced by winter cooling and evaporation.

Current measurements from a single mooring on the continental slope off Hadera (water depth of 500 m) reveal, occasionally, during summer and winter, the existence of a strong northward along-slope baroclinic jet confined to the upper 50-200 meters (respectively) with monthly mean velocities of 0.2-0.4 m/s. During winter storms the hourly velocities at the upper layers of the jet may reach a magnitude of 0.9 m/sec, or be as high as 0.3 m/s near the bottom, at the end of the winter mixing season. The seasonal characteristics of the along-slope jet are supported by results from numerical modeling studies [6, 1, 5]. These results suggest that the permanent northward circulation observed during the summer on the shelf, and the seaward increase in current intensity, are closely related to a strong cyclonic jet flowing along the eastern rim of the Levant Basin. In spite of the expected increase in the topographic steering effect during the winter season, the daily MFSTEP-OGCM reanalysis fields, as well as high-resolution model simulations [7], suggest that the high velocities observed on the slope are due to a local intrusion of an open sea, large-scale, meander. The observations during this season show no obvious influence of the along-slope jet on the inner-shelf circulation during calm weather conditions although it does seem to affect the outer- and mid-shelf circulation.

References

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