ADCP OBSERVATIONS ABOUT THE MEAN STRATIFICATION AND THE VERTICAL STRUCTURE OF TIDAL AND INERTIAL CURRENTS IN THE NORTHERN ADRIATIC

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Mounted on the GEOSTAR benthic observatory (Beranzoli et al., 2000) which was deployed in August 1998 at about 42 m in the northern Adriatic for test purposes, a 300-kHz ADCP was operated during 18 days with an hourly sampling rate. The reduced cell size of 80 cm allowed to study finely i) the temporal variation of the mean stratification, ii) the vertical structure of tidal currents and iii) an energetic few-day episode of inertial oscillations.

Even though no thermistor string was available to monitor the stratification’s evolution, the maximum magnitude of the current shear was found to be a relevant indicator of the pycnocline’s depth, as confirmed by ship-handled CTD profiles performed just before and after the experiment. From the depth evolution of the shear maximum, it was possible to detect a sudden deepening of the pycnocline (from about 14 m down to about 30 m), consistently with simultaneous temperature and salinity increases recorded by an observatory-mounted SBE16 CTD. Such a deepening might be attributed to the advection of a neighbouring thicker mixed layer, to an intense vertical mixing due to sea roughness or, more probably, to a downwelling phenomenon. Indeed, it was associated with south-easterly winds that prevailed in the northern Adriatic and with downward vertical velocities (1-2 cm/s) that were sampled over the whole depth during the pycnocline’s deepening.
Rotary spectral analysis and band-pass filtering at all depths in the inertial, diurnal and semi-diurnal frequency bands revealed the complex vertical structure of the related currents. This is particularly striking for the diurnal components whose energy is confined in a few-meter surface layer, contrary to the energy of the semidiurnal components which is distributed over the whole water column. Concerning the former (K1 mainly), the tidal harmonic analysis (Foreman, 1978) evidences a clockwise polarisation of the currents and a roughly constant orientation of the related ellipses within a 10-m surface layer. Concerning the latter (M2, S2), relatively flat ellipses account for a more rectilinear motion, with roughly constant semi-major axis length (20-30 mm/s) and inclinations regularly veering clockwise with depth so as to fit the north-south isobaths orientation near the seafloor.

Analysis of meteorological data revealed that the episode of inertial oscillation was triggered by rapid and marked wind variations induced by an atmospheric low that first developed in the Ligurian Sea before spreading over the whole northern Italy. As regards the inertial band, three layers were evidenced (surface (0-10 m), intermediate (13-20 m) and deep (22-33 m)), each separated by a low-motion interface. The shallowest interface sharply delineated currents in opposite directions, which is a classical structure of inertial oscillations in stratified conditions (e.g. Millot and Crépon, 1981). The currents on both sides of the deepest interface were roughly in the same direction, with a slowly varying phase along the vertical. Interestingly, maximum currents were found at the same time in the surface and intermediate layers, while they were observed significantly lagged (by about 2 days) in the deep layer. This might suggest a downward propagation of the inertial motion, furthermore inertial energy remained present in the deep layer while it had vanished within the surface and intermediate layers. Other remarkable features were different mean frequencies in each layer, namely about 0.058 cph in the surface layer, about 0.062 cph in the surface layer, about 0.062 cph in the intermediate layer and again about 0.058 cph in the deep layer.

The detailed analysis that will be presented about tidal and inertial currents is focused on the role of stratification and bottom friction, already reported to have a major influence on the vertical structure of these currents in shallow areas (Maas and van Haren, 1987).

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REFERENCES


