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Near-inertial internal waves in the Black Sea

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The Black Sea is practically tideless basin where inertial variability dominates the energy spectra at the high-frequency band $f > 1$ day^{-1}. The near-inertial internal waves are easier to infer from the observational data in the absence of the tidal motions. Modern observing tools e.g., the temperature sensor strings, the ADCPs, and the profiler moorings allow for continuous measurements at fixed locations with high temporal resolution sufficient to resolve the inertial time scale.

Here we present an analysis of the time series of hydrophysical measurements both at the continental slope and in the deep central part of the Black Sea. The measurements over the continental slope were carried out using the Aqualog moored profiler with the CTD probe and acoustic Doppler current meter [1] in different seasons during 2015–2019. The time series of vertical profiles of temperature, salinity, density, dissolved oxygen, and current velocity were obtained for the water column from 20–30 m to 200–230 m depths. As for the deep basin measurements, these were done by using the moorings equipped with the temperature sensors and acoustic Doppler current meters at fixed depths of 100 m and 1700 m. The data included the year-long time series of temperature and current velocity from December 2016 to October 2017.

The vertical oscillations with a period close to the local inertial were clear cut in the multiparameter data vertical profiles in the main pycnocline at the continental slope. The examples of the near-inertial wave packs trapped in the pycnocline are shown. The maximum heights of the observed internal waves reached 30 m. During the passage of the near-inertial internal wave, the direction of the current changes to the opposite, which is typical for the first mode wave.

The seasonal variability of the near-inertial internal motions was studied by applying conventional statistical tools including spectral analysis to the mooring data in the Black Sea central part. It was found that intensification of inertial oscillations occurs from September to February. At the frequency close to the local inertial, the velocity rotation vector (hodograph) rotates clockwise, which is typical for inertial internal waves. The radius of the circle described by the vectors of the inertial currents varies within 0.5–1.5 km. The seasonal change of the cross-correlations between inertial motions in the upper and near-bottom layers was also revealed.

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