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Evolution of the internal wave field in the changing Aral Sea

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This study is based on field data collected in October 2006 and November 2013 and on 3D numerical simulations. Over 7 years separating the two observations, the sea surface level of the Aral Sea has decreased by 3.25 m, salinity has increased and stratification generally decreased.

In 2006, velocity data above the bottom were measured at the central part of the basin at 39 m depth together with a series of CTD profiles at several stations. In 2013, the bottom velocities were recorded at 4 satiations situated at the intermediate region of the lake along the Western and Eastern coasts between of 23-25 m depth. In 2013, four thermistor chains were placed at the same stations than the current meters, thus allowing to study the vertical structure of the internal waves.

Because of difficult access to the lake and working conditions time series are short (a few days each) allowing only for the study of sub-daily modes. However, the longer period variability can be discussed based on numerical simulations using POM. In 2013, both velocity and isotherm levels showed relevant periodicities of about 14, 7, and 4 hours. In 2006, the sub-daily velocity modes were found to be of 11 and 6 hours which, according to the simulations, can be identified as a first and a second longitudinal modes, both being two vertical modes. Based on simulations, the first vertical first longitudinal mode is found to have a periodicity of about 36 hours.

According to the numerical results and analysis of field data, in 2013, the periods of 7 and 4 hours also corresponded to the second vertical and the first and the second longitudinal modes. The period of 14 hours corresponded to the first vertical first longitudinal mode. Because differences of density between the upper and bottom layer of the lake were much larger in 2013 than those in 2006, the periods of equivalent modes should be larger. In fact, according to Mortimer's (1953) formula, the ratio between the periodicities of the first vertical and the first horizontal mode should be equal to the square root of the normalized densities. Considering that in 2013 this mode was of 14 hours, in 2016 it should be expected to be about 36 hours, which is in accordance with the numerical simulations. In both years, within the southern part of the lake, which is much wider than the northern part, the longitudinal modes present an important transversal structure.

Thus, in both campaigns separated by 7 years and characterized by rather different conditions of the lake, the predominant excited modes were the same, although their periodicities have decreased due to the sharper stratification during the 2013 campaign. However, level variation between the two years affects the location of the nodal points, which have moved several tens of kilometers. Furthermore, for all the modes observed in 2013, there existed an extra nodal line at the north part of the lake which is connected to main body of the lake through a neck of only about 2 m depth.

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