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On resonant properties of tides in the Adriatic Sea

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The long-term hourly data (record lengths of 8 - 58 years) from five tide gauges (Trieste, Rovinj, Zadar, Split, and Dubrovnik) were used to examine the resonant origin of tidal oscillations in the Adriatic Sea. The diurnal and semidiurnal tidal peaks and their overtones are well-defined in the sea level spectra. High-resolution spectra revealed the fine structure of discrete peaks at tidal frequencies. Furthermore, a wide spectral "hump" with a central frequency of about 21.9 h was found in all examined spectra, associated with the fundamental eigen mode of the Adriatic Sea. The spectral energy of this “hump” increases northward toward the head of the sea (from Dubrovnik to Trieste). Harmonic analysis of the tides for individual yearly series, with subsequent vector averaging over the entire observational period, was applied to estimate mean amplitudes and phases of tidal constituents for the five stations. In addition to the major tidal harmonics (M2, S2, K1, and O1), significant amplitudes were also detected for other diurnal tidal harmonics (P1, J1, and OO1). This particularly applies to Zadar, where the amplitude of diurnal harmonic OO1 (3.8 cm) exceeds the amplitudes of harmonics O1, Q1, S2, N2 and K2, although the theoretical equilibrium amplitude of OO1 is significantly smaller. To examine the generation properties of tides in the Adriatic Sea, the equilibrium response was estimated and found to rise sharply with increasing frequency, i.e. when approaching the fundamental Adriatic eigen mode period of 21.9 h: from Q1 (26.87 h) to J1 (23.10 h) and OO1 (22.31 h). The resonant amplification of the OO1 and J1 amplitudes increases toward the head of the sea. These results indicate that the diurnal tides in the Adriatic Sea have a resonant character and that the significant relative amplification of harmonics OO1 and J1 are caused by the influence of the corresponding eigen mode. In the semidiurnal tidal band, the equilibrium response also amplifies slightly with increasing frequency: from N2 (12.66 h) to K2 (11.97 h). This appears to be related to the first Adriatic eigen mode with period of 10.7 h, which is also noticeable in the background spectra. Thus, our results indicate that the modal structure of eigen oscillations in the Adriatic Sea plays an important role in the formations of tides in this basin.