Geophysical Research Abstracts, Vol. 9, 04213, 2007
SRef-ID: 1607-7962/gra/EGU2007-A-04213

The Adriatic Sea tidal energy budget: energy fluxes and dissipation sinks

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Tidal dynamics of the Adriatic Sea is a relevant phenomenon, both scientifically and practically. The Adriatic Sea has the most pronounced diurnal tidal signal in the whole Mediterranean Sea, and one of the strongest in the semidiurnal band, providing relevant contributions to scientific problems like satellite altimetry correction, or to applied coastal seas engineering studies. Its current understanding builds on more than a century long tradition, largely concentrated on harmonic analyses and modeling of the sea level, with more recent forays into the current field modeling and analysis. The Adriatic tidal energy budget has received much less attention. Present work aims to resolve spatial distribution of tidal energy fluxes, and to quantify various sources and sink terms. The analysis is performed for all the most important constituents (M2, S2, K2, N2, K1, P1, and O1). To accomplish the task extensive numerical experiments were carried out using a suite of three dimensional models (Quoddy, ADCIRC, and ROMS) with structured and unstructured grids and very high spatial resolution. The Quoddy model in particular was previously calibrated to reproduce barotropic tidal dynamics via data assimilation of the sea level, with results extensively tested against independent sea level and current observations (Janekovic and Kuzmic, 2005). ADCIRC proved to be well suited for very high resolution, parallelized 2D and 3D runs, whereas ROMS offered better framework for baroclinic experiments. Both direct astronomical forcing and co-oscillation with the Mediterranean have been considered, with latter explaining more of the observed tidal variance. Baseline results of our study (elaborated with further experiments) indicate that the tidal energy flux of the seven major constituents through the open boundary (located at the Otranto strait) amounts to 29.43 MW. The M2 constituent exhibits the largest power contribution (about 60.3%), the K1 contributing the next 21.4%, the S2 16.3%, whereas the re-

maining four constituents con-tribute only 2%. Predictably, the loss of barotropic tidal energy is dominated by bottom friction. Most of the semidiurnal tidal energy is dissipated in the northern Adriatic (between 76.5% and 81.5% depending of constituent), while only one third of the diurnal energy is dissipated there. Most of the diurnal tidal energy (about 55%), and only about one fifth of the semidiurnal, is dissipated in the middle Adriatic. In the southern Adriatic only a minor part of the overall tidal energy is dissipated (about 0.5% of semidiurnal and 12% - 15% of diurnal). The K1 energy flux is particularly pronounced at the border between the middle and southern Adriatic characterized by steep bathymetry slope, pronounced frictional dissipation, and larger velocities, conductive to generation of diurnal shelf waves and internal tides.

Janekovic, I., Kuzmic, M., 2005. Numerical simulation of the Adriatic Sea principal tidal constituents. Annales Geophysicae, 23, 3207-3218.