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A new empirical global ocean tide and Mean Sea Level model based on Jason-1 satellite altimetry observations

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In this contribution an empirical approach to global ocean tide and Mean Sea Level (MSL) modeling based on satellite altimetry observations is presented with all details. Considering the fact that the satellite altimetry technique can provide sea level observations at the global scale, spherical harmonics defined for the whole range of spherical coordinates ($0 \leq \lambda \leq 2\pi$, and $-\pi/2 \leq \phi \leq +\pi/2$) could be among the possible choices for global ocean tide modeling. However, when applied for modeling of global ocean tide, spherical harmonics lose their orthogonality due to the following reasons: (1) Observation of sea surface is made over discrete points, and not as a continuous function, which is needed for having the orthogonality property of spherical harmonics in functional space. (2) The range of application of spherical harmonics for global ocean tide modeling is limited to the sea areas covered by satellite altimetry observations and not the whole globe, which is also required for the fluffiness of the orthogonality of spherical harmonics. In this contribution we have shown how a set of orthonormal base functions at the sea areas covered by the satellite altimetry observations can be derived from spherical harmonics in order to solve the lack of orthogonality. Using the derived orthonormal base functions, a global MSL model, and empirical global ocean tide models for six major semidiurnal and diurnal tidal constituents, namely, S2, M2, N2, K1, P1, and O1 as well as three long term tidal components, i.e., Mf, Mm, and Ssa, are developed based on six years of Jason-1 satellite altimetry sea level data as a numerical case study.