Impact of the oceanic S_1 tide on Earth's rotation – answering questions related to dissipation and forcing by numerical modeling

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Oceanic mass redistributions at the principal diurnal S1 frequency elicit small but measurable variations in universal time, polar motion, and the prograde annual component of nutation. Furnishing an accurate account of these signal components for the analysis of space geodetic observations is a delicate challenge that involves the determination of reliable OAM (ocean angular momentum) estimates from free-running forward integrations of the shallow water equations. The present study employs a simple barotropic ocean model to assess the dependency of the diurnal OAM vector on several key model components such as the amount of dissipation in the deep ocean. A realistic simulation of tidal elevations and velocities across the diurnal band is achieved by parametrizing the sub-grid scale conversion of barotropic currents into small internal tides through a linear drag term. Moreover, we demonstrate that our S1 simulations critically depend on the fidelity with which the actual meteorological forcing due to diurnal air pressure variations is known. Having selected an appropriate air tide solution from a range of atmospheric reanalyses through comparison with barometric in situ data, we investigate the relevance of ocean self-attraction and loading (SAL) for OAM considerations in an additional numerical experiment. Handling the SAL term in parametrized form instead of the full integral formulation is found to have little impact except for zonal spherical harmonics that couple to variations in universal time. OAM values for our optimally-configured hydrodynamic S1 solutions are documented and discussed in the specific context of their contribution to the prograde annual signal in Earth's nutation.