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Diurnal signals in length-of-day changes and their geophysical excitation

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State-of-the-art determinations of short period Earth rotation variations from long-term space geodetic observations all report an as-yet unexplained LOD (length-of-day) perturbation of roughly 4 microseconds at the principal diurnal frequency corresponding to 1 cycle per solar day. The present study gives a detailed account of this signal component in terms of its possible geophysical excitation from the atmosphere and oceans, including both a direct effect due to pure atmosphere dynamics as well as an indirect effect associated with the oceans' response to diurnal air pressure variations. In particular, we assemble multi-year excitation estimates from a number of modern-day meteorological analysis systems and different hydrodynamic time-stepping solutions for the oceans. A simultaneous application of two legitimate modeling approaches - using either mass and motion terms of fluid angular momentum or pressure and friction torques acting on the Earth's crust - allows for an examination of the balance relationship existing between torques and the angular momentum derivative within each model. Significant violations of this constraint for each of the atmospheric analysis systems mainly originate from seemingly deficient mass term values and cast doubt on the validity of those estimates for sub-diurnal Earth rotation studies. On the contrary, oceanic angular momentum changes are well balanced by the pressure torque on the bathymetry. In light of these results and after thoroughly discussing possible consistency issues between various model estimates, a combined excitation term is constructed on the basis of atmospheric torques and oceanic angular momentum. The obtained solution displays a sufficiently close agreement with observed diurnal changes in LOD, and by virtue of the computed pressure and friction torques, this result can be augmented by a regional analysis of the underlying angular momentum transfer in the axial direction between the solid Earth and its fluid envelope.