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Seasonal variations in global mean sea-level and consequences for the excitation of length-of-day changes

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Mass transports between the Earth subsystems oceans, atmosphere, and continental hydrosphere cause a predominantly seasonal signal in Earth rotation excitation that superimposes the effects of each individual Earth subsystem. Especially for annual and semi-annual length-of-day variations a consistent consideration of the global mass balance among atmosphere, ocean, and continental water is necessary to compare the simulated effective angular momentum functions for Earth rotation from geophysical models with geodetic observations. In addition to atmospheric, oceanic, and hydrological contributions, we estimate the contributions due to the global mass balance effect using the new ESMGFZ SLAM product as well as estimates of the barystatic ocean bottom pressure anomalies including loading and self-attraction from the GRACE Level 3 GravIS products. For the annual cycle the global mass balance effect compensates nearly all the contributions to length-of-day variations from terrestrial hydrology. Moreover, most of the atmospheric surface pressure contribution is also compensated. The global mass balance effect has to be applied for each combination of geophysical Earth system models specifically. Considering the global mass balance as second most important influence on seasonal length-of-day variations the mass induced excitation can be determined accurate enough to attribute the remaining gap in the length-of-day excitation budget between models and observation clearly to an underestimation of atmospheric wind speeds in the global European weather forecast model. Magnifying its wind speeds by +6% the sum of all ESMGFZ angular momentum functions can almost perfectly explain the total length-of-day excitation.