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Seasonal effects in length-of-day due to the global mass balance as seen by geophysical models, GRACE and Earth rotation observations

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Global mass redistribution between the oceans, the atmosphere, and the continental hydrosphere cause a predominantly seasonal signal in Earth rotation excitation that is not negligible in terms of intra-annual polar motion and especially length-of-day changes. A consistent consideration of the global mass balance among atmosphere, ocean, and continental water is necessary to compare 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 products. At seasonal timescales the global mass balance effect nearly cancels all the contributions to the length-of- day variations simulated by the hydrological model. Comparisons with former studies indicate that the global mass balance effect depends essentially on the choice of the hydrological model and has to be estimated for each combination of geophysical Earth system models individually. Length-of-day changes calculated for barystatic sea-level changes derived from GRACE satellite observations can help to validate the geophysical modes in describing the large-scale mass redistributions on seasonal timescales. Good correlations between observed and modeled global mass balance excitations lead to the conclusion, that the discrepancies between observed length-of-day variations and the Earth rotation excitation from geophysical models is most likely caused by errors of the atmospheric models, in particular of the wind fields.