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Improving the description of non-tidal ocean signals in rapid polar motion

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The numerical modeling of non-tidal ocean dynamics has been instrumental in contributing to the complete description of the motion of the Earth's rotational pole. However, non-negligible discrepancies (as large as 2 cm) between the observed and modeled position of the pole endure at sub-monthly frequencies, thus prompting renewed scrutiny of the dynamic ocean response to atmospheric stresses and its representation by numerical means. Here, we present a systematic assessment of the oceanic component of sub-monthly polar motion through the use of two different time-stepping models, both forced by pressure loading and wind stress from the same atmospheric reanalysis, and both inclusive of the Arctic domain. The first is a coarse-resolution baroclinic model and the second is a high-resolution barotropic model which contains a step-wise treatment of SAL (self-attraction and loading) effects and a parameterized topographic drag scheme. Multi-year runs allow for validation by, and cross-comparison to, ocean bottom pressure observations from daily GRACE (Gravity Recovery and Climate Experiment) solutions and space-geodetic observations of polar motion. Results achieved thus far show that the baroclinic model is far too energetic on sub-monthly time scales unless allowance is made for higher lateral eddy viscosity through the reduction of the time step in the momentum equations from 60 min to about 10 min. Excitation functions inferred from the barotropic model explain 50-60% of the polar motion variability at periods below 60 days, but unmodeled residuals of $\sim$2-4 cm equivalent water height in bottom pressure persist across the Southern Ocean and in the Arctic. Taken together, our analyses point to uncertainties in the atmospheric forcing data and a misrepresentation of dissipative processes in both modeling frameworks. Future work will be devoted to properly account for flow interactions with topography within high-resolution baroclinic setups.