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Validation of Predicted Diurnal and Semi-diurnal Tidal Variations in Polar Motion with GPS-based Observations

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In this paper we reconcile predicted diurnal and semi-diurnal tidal variations in polar motion using observations from the Global Positioning System (GPS) space geodetic technique. We demonstrate closure at the level of less than 4 microarcseconds of the budget between our adopted models for predicted polar motion tidal variations and our GPS-based observations. Our GPS-based observations are composed of a 10-year continuous time series of polar motion estimates with 15-minute temporal resolution. Our adopted models account for the contribution from the relative angular momentum of the ocean tides and so-called libration. We compute predicted ocean tide contributions using a modern hydrodynamic model of tide heights and currents that assimilates satellite altimetry data. We use the model for libration effects provided by the current IERS conventions, as taken from Mathews and Bretagnon [2003]. We also show that the currently recommended models from the International Earth Rotation Service (IERS) conventions do not close the budget with respect to our GPS-based observations. In particular, residual diurnal and semidiurnal tidal variations in polar motion are observed when using the current IERS conventions for ocean tide effects and libration. We infer that the root source for these residual tidal variations is errors in the 20-year old model for ocean tide effects from the IERS conventions, and that predicted ocean tide effects from a modern model mitigates these errors.

The noise floor of our high-rate GPS-based times series of polar motion is less than 4 microarcseconds in the diurnal and semidiurnal tidal frequency bands, and is well below the level of the predicted effects of both the ocean tide and libration effects. Diurnal and semidiurnal tidal variations in polar motion are predominantly caused by the ocean tides, which have amplitudes of a few hundred microarcseconds. Libration, namely the effect of external luni-solar torques acting on the triaxial Earth figure, contribute to prograde diurnal tidal variations in polar motion and have amplitudes of tens of microarcseconds. Our results provide an opportunity to constrain the contribution of atmospheric angular momentum on polar motion, particularly at the S1 and S2 tidal frequencies, as well as to potentially investigate the impact of the triaxial core on libration effects.