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GPS-based estimation of sub-daily and rapid polar motion at 15-minute temporal resolution

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We present results from the homogeneous re-analysis of ten years of data from a global Global Positioning System (GPS) network specifically targeting the recovery of the Earth's pole coordinates at 15-minute temporal resolution. We deliberately treat prograde semidiurnal nutation as retrograde diurnal polar motion in our parameter estimation strategy in order to gain insight into potential deficiencies in the sets of precession and nutation models applied. Doing so, we are able to retrieve meaningful polar motion signal in the retrograde diurnal frequency band. This leads us to evaluate the coupling between models of precession-nutation and diurnal variations on polar motion from the ocean tides on total observed polar motion. To assess the quality of our polar motion solution outside of the retrograde diurnal frequency band, we focus on its capability to recover tidally driven and non-tidal variations manifesting at the ultra-rapid (intra-daily) and rapid (characterized by periods ranging from 2 to 20 days) periods. We first evaluate the fit of our polar motion estimates to the IERS 2010 recommended model. This tidal analysis reveals discrepancies manifesting at specific tidal periods and stresses difficulties in separating technique-specific errors and estimation strategy artifacts from model errors. We discuss some of these error sources. After accounting for the effects of diurnal and semi-diurnal ocean tides in our estimation procedure, we convert our series of pole coordinates into the excitation formalism and contrast the resulting series with independently obtained geodynamic excitation functions. We demonstrate that increasing the temporal resolution does not compromise the fidelity of our estimates to predicted rapid variations in polar motion caused by the oceanic and atmospheric circulations. Our results infer a noise level of about 4 μas from our decade-long time series.