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Investigating Surface Mass Loading Effects on Geodetic GPS Observations Using Loading Models

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We evaluate the benefit of different combination of environmental (atmospheric, non-tidal oceanic and hydrological) loads on the internal scatter of GPS height time series from 38 uniformly distributed stations in Eurasian. We focus on atmospheric loading and non-tidal ocean loading estimated from TUGO-m barotropic model (ATMMO), and hydrological loading estimated from the Global Land Data Assimilation System (GLDAS) and the Global Land Surface Discharge Model (LSDM) respectively. We notice that ATMMO[U+FF06]GLADS outperforms ATMMO[U+FF06]LSDM on reducing the WRMS of GPS data due to the phase asynchrony and/or smaller amplitude at the annual timescale between GPS observations and ATMMO[U+FF06]LSDM. Consequently, comparing GPS observations and mass loading at annual timescale may be more reasonable to quantify different loading model combinations. We give a detailed comparison for two representative sites located adjacent to the great lakes and rivers in terms of differences in amplitude and phase at annual timescale. The outcomes indicate that LSDM is instable to model small-scale hydrological loading like the water storage in river channels in Eurasian. Further, the cross wavelet transform based (XWT-based) semblance analysis is adopted to investigate the phase relationship between GPS time series and different loading model combinations respectively for all sites selected. The results show that mass loading is a representation of the driving force for the annual fluctuations in GPS observations and LSDM may not work well in Eurasian with its current accuracy. Finally, we investigate the impacts of mass loading corrections on the velocity and noise estimates. For some sites having subtracted the loading deformation from GPS data, their velocity uncertainty are increased due to undesirable changes in noise properties, suggesting using mass loading models to directly correct GPS time series is potentially feasible but not sufficient. Hence, we model the annual signal in mass loading models adopting the SSA approach and remove it from GPS height time series. In this way, for most sites the error of velocity becomes lower than it was before without changing the stochastic part of GPS data.