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GPS height time series: short period origins of spurious long period signals

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GPS coordinate time series are used in the definition and maintenance of the ITRF, and therefore must be as accurate as possible, with all systematic errors mitigated accordingly. Such systematic errors that must be mitigated include (sub-) daily periodic ground displacements, such as those caused by solid Earth tides, ocean tide loading and atmospheric pressure loading. Traditionally, such errors have been assumed to largely average out if 24 hour processing sessions are used. However, by analyzing several years of continuous GPS data from globally distributed sites at which controlled errors were not modeled, this paper shows such an assumption to be erroneous. It is shown that each unmodeled (sub-) daily periodic displacement can propagate to several spurious long wavelength features in a GPS height time series, ranging in period from about 2 weeks to 1 year. Admittances (ratio of amplitude of spurious long wavelength output signal in the GPS height time series to amplitude of unmodeled periodic ground displacement) depend on the coordinate component and the tidal constituent considered. For example, it is shown that an unmodeled S2 North component periodic ground displacement can propagate to a semi-annual height signal with admittance of greater than 100%, whereas the height admittance is around 5-10%. Model errors in ocean tide loading, atmospheric pressure loading and solid earth tide displacement amplitudes can be several millimeters, and this presentation considers how these errors will propagate. This helps to provide an indication of the effect that such spurious long period signals may have on the stability of the reference frame. The importance of ambiguity resolution in reducing the impact of short period ground displacement model errors is also demonstrated.