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Subtle, but insidious: GPS orbit model biases and reference frame realisation

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GPS geodesy observation techniques are now *precise* at the millimetre and even sub-millimetre level: the availability of continuous tracking stations numbering in the hundreds, a full (and growing) constellation of satellites, regional filtering, sidereal day multipath filtering and the estimation of horizontal troposphere gradients have all played a significant role in pushing the edge of the performance envelope. Despite the high temporal and spatial resolution now achievable, some old enigmas still haunt the community: the battle over phase centre offset and variation is in full swing, and GPS orbits still differ systematically from SLR observations at the level of 5 centimetres.

The current and critical measurement of sea level and polar ice cap change demand a stable and accessible reference frame: GPS provides the most cost effective and global method, but how do these residual biases affect the reference frame?

These modelling problems have been attacked in the past by parameterisation and estimation of unknown quantities: station positions, LOD, phase centre offset and variation, force model parameters and troposphere delays. However, our choice of what parameters and what data we use in the estimation can lead to correlation and the inappropriate absorption of energy in residuals by the available parameters space.

In this paper we present the implications for the reference frame of choosing to model satellite surface forces using either largely empirical or largely analytical approaches. We explain the current approaches that are available in this arena. Results and analyses will be shown based on both orbit determination through linearization of tracking observables and through large scale simulation. This latter analysis is chosen to isolate the effects of force modelling independently of phase centre and atmospheric effects.

We show evidence for long term periodic biases in the reference frame at the level of several millimetres and at a bi-annual frequency as a result of adopting a largely empirical parameterisation. We also briefly present our progress in modelling surface force effects analytically for solar radiation pressure, anisotropic thermal re-radiation, earth radiation pressure effects and antenna thrust.