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A survey of some systematic errors in IGS products

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Optimal use of any measured quantity depends on the associated measurement error. For GPS geodesy, observational noise is propagated rigorously into parameter estimates using complete variance-covariance information, but our understanding of the true GPS data noise is limited. For instance, different reference frame solutions can differ in variance by a factor of 100. Covariance rescaling, which requires some absolute reference solution or several fully independent solutions, is only approximately valid. Apart from random GPS measurement errors, evidence for significant unmodeled systematic errors in GPS results has been mounting. For at least a decade, researchers have recognized that time series of GPS station positions are temporally correlated, so empirical methods are routinely employed to inflate formal position and velocity errors accordingly. Moreover, some of the products of the International GNSS Service (IGS) show indications of systematic errors in their values as well as their covariances. This presentation will survey several examples and consider possible underlying causes, including:

(1) Jumps in clock values at the midnight boundaries between adjacent days point to unmodeled errors in the pseudorange observations. Since the overall clock bias is determined by the mean of the code noise and biases averaged (using the phase data) over each 24-hr processing arc, shifts in clock bias between adjacent days reflect variations in mean code noise or bias. The mean code noise due to multipath is non-zero and largest when antennas are placed closest to a reflecting surface (Byun et al., 2002). The very large dispersion in day-boundary clock jumps among IGS stations is probably indicative of the range of antenna mounting conditions in the IGS network. Tripod mounts of about 2-m height and antennas embedded in a radio-absorber matrix appear to perform best.

(2) Globally, all three components of the IGS station positions possess anomalous harmonics at N * 1.04 cycles per year, up to at least N = 6. This probably results from a beating of the near-daily repeat period of the local GPS geometry (based on a nodal year of 351 days) with the 24-hr processing arc of the IGS. The underlying error being aliased could be due to phase multipath from near-field back-reflections, which are also sensitive to the antenna mounting conditions as with the clock jumps, although this remains to be demonstrated.

(3) The IGS Earth orientation parameters display spurious spectral peaks in some solutions. These are commonly near known tidal lines and are probably due to deficiencies in the a priori geophysical modeling. High-frequency smoothing is also evident in some polar motion solutions (and the IGS combination) due to continuity constraints applied between adjacent days. Polar motion power can be attenuated by up to an order of magnitude at periods of 2 days.