Development of an Antenna and Multipath Calibration System for Global Positioning System Sites (paper, 2004)

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Development of an antenna and multipath calibration system for Global Positioning System sites

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Abstract

Site-dependent errors such as antenna phase-center variations, multipath, and scattering can have a significant effect on high-precision applications of the Global Positioning System (GPS). Determination of these errors has proven to be elusive since no method has been developed to measure these effects accurately in situ. We have designed and constructed a prototype Antenna and Multipath Calibration System (AMCS) to obtain such in situ corrections. The primary components of the AMCS are a steerable parabolic antenna, two GPS receivers, and a computer for control and data-logging functions. We obtain phase corrections for site-dependent errors by forming the difference between the carrier-beat phases from the GPS antenna to be calibrated and from the AMCS antenna, which is relatively free of such errors. Preliminary “sky maps” of the antenna phase and multipath contributions show root-mean-square (RMS) phase variations that are a factor of 10 or more greater than the AMCS system noise, which is 0.5 mm. To explore the source of this “noise,” we acquired observations over small (few degrees) patches of the sky. From the analysis of these experiments we concluded that the source of the phase variations was antenna and multipath errors that vary by 5 mm amplitude over small changes in satellite direction. Thus, for example, differences of 1 in elevation angle can result in several millimeter variations in phase. Similarly, small variations in azimuth angle can also result in significant phase variations. We have also observed day-to-day millimeter-level changes in the calibration. We hypothesize that these phase variations are due to changes in multipath caused by changes in the local electromagnetic environment associated with, e.g., weather.

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