Multipath Characteristics of GPS Signals as Determined from the Antenna and Multipath Calibration System (paper, 2002)

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Multipath Characteristics of GPS signals as determined from the Antenna and Multipath Calibration System

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ABSTRACT

Geophysical applications of the Global Positioning System (GPS) for studies such as global sea level change and glacial isostatic adjustment require very high accuracy (1 mm yr-1) determinations of site velocity, especially of its vertical component. Despite the many efforts devoted by investigators to the calibration of sitespecific errors, signal scattering and multipath remain an unsolved problem. We have developed an Antenna and Multipath Calibration System (AMCS) for characterizing site-specific GPS phase measurement errors. The system consists of a high-gain, multipath-free, 3-m diameter parabolic antenna, a test antenna, and two Trimble GPS receivers. There are two modes of operating the AMCS: Zero-baseline (ZBL) and AMCS modes. In ZBL-mode, the two receivers simultaneously record the signal from the test GPS antenna. In this operating mode, one can determine the receiver clock synchronization error and the phase biases for each satellite. Typical RMS accuracies of ZBL-mode phase residuals are sub-millimeter level, ranging from 0.4 to 0.7 mm. In the AMCS-mode, one GPS receiver records the signal received at the test antenna, and the other records the signal from the parabola. Thus, one can compare the phases from the two receivers, and determine the antenna and multipath calibration errors of the test antenna. In our test cases with the test antenna located in a multipath-rich environment, the phase residuals obtained by tracking the same satellite over several days show large amplitude variations over small elevation angle ranges with highly repeatable patterns. The amplitude is 4-6 mm for low elevation angles and 1-2 mm for high elevation angles. Modeling and subtracting the repeating patterns from the phase residuals results in RMS of about 1 mm. We have recently installed a second GPS antenna at a nearby location where the multipath effects are presumably less significant than at the location of the first GPS antenna. To further reduce multipath effects, all-weather microwave absorbers surrounded the second antenna. The amplitude of the phase residuals

obtained for the second antenna location is significantly smaller than for the first antenna, implying that the second antenna is less affected by multipath. These independent results also served to confirm that the origin of the phase patterns measured is multipath.

[See attached .pdf file for more.]