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Determining spectral parameters (p and T) and GPS receiver tracking jitter from scintillation indices

Hal Strangeways
School of Electronic and Electrical Engineering,University of Leeds, Leeds LS2 9JT, UK (h.j.strangeways@leeds.ac.uk)

A basis for a method of mitigating the effect of ionospheric scintillation on GPS positioning is to weight the measurements from each satellite in the positioning calculation inversely according to the tracking jitter present [1]. Tracking jitter resulting from scintillation for GPS/SBAS C/A code processing and semicodeless GPS L1 and L2 Y-code can be determined from formulae presented by [2] but require input of the spectral parameters p(inverse power law of the phase PSD) and T (spectral strength of the phase PSD at 1 Hz) which will not generally be available, It is certainly more convenient if tracking jitter can be found just from phase and amplitude scintillation indices which are easier to determine than spectral parameters since they only require time-domain processing, obviating the requirement of applying FFT transforms to every minute of data. Thus it is desirable to find a method of transforming scintillation indices into spectral parameters. The main difficulty is that the Fresnel frequency, which is an important feature of the amplitude PSD, really needs to be known. It has been shown [3] that utilizing approximate models of the PSD for both amplitude and phase, it is possible to define equations, utilizing known values of both scintillation indices, that can be solved for p and T. However, although this method requires the Fresnel frequency, it is found that the tracking jitter can be determined to a reasonable degree of accuracy by restricting the solution to physically realistic values of the Fresnel frequency.

The method has been used to determine the spectral parameters and tracking jitter for both high and low latitude GPS data and comparison made with tracking jitter determined using p and T values measured from phase PSDs. As would be expected, for the method to work successfully, the amplitude and phase spectra of the data must approximately match the model spectra employed in the calculations. This condition can fail either for too much noise (particularly for low scintillation levels) or for very strong scintillation conditions when the spectra can become dual-slope or more Gaussian in shape. This is discussed together with problems in validating the method from experimental data; in particular experimental determination of the Fresnel frequency and the problem of measuring the slope for both the amplitude and phase PSDs.

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