# Mapping the GPS Multipath Environment Using the Signal-to-Noise Ratio (SNR)

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The Global Positioning System (GPS) is an L-band radio navigation system used for a variety of positioning and scientific applications. GPS multipath, where a signal propagates and arrives by more than one path, creates some level of degradation in all GPS applications by introducing range errors. Multipath range errors will differ for individual GPS installations, and no GPS installation can be completely multipath-free. Thus it is important to understand the site-specific signature of multipath, which is a function of the direction of and distance to reflecting objects. A 'map' of the multipath environment surrounding a GPS antenna would be helpful for a variety of applications, aiding understanding of the potential sources of range measurement degradation.

This research presents a tool called power spectral mapping that visually represents the multipath environment of a GPS site using a common GPS observable, the signal-to-noise ratio (SNR). This technique uses the spectral content (frequency and magnitude) of SNR time series to determine which portions of the antenna environment experience high-amplitude multipath and at what frequencies. Wavelet analysis is used to extract the time-varying frequency and magnitude content of various multipath constituents, and these data are projected onto a map representing the GPS antenna surroundings. Power spectral map examples from permanent continuous GPS (CGPS) stations with very different multipath environments are presented. For each station, we interpret the maps in terms of potential sources of multipath reflections. When applicable, we also assess what the power spectral maps can tell us about range error effects on GPS applications such as precise positioning.