

POWER SPECTRUM ANALYSIS OF GPS SIGNAL SCINTILLATIONS

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Abstract:

The study of power spectra of transionospheric scintillations essentially leads to an understanding of properties of the irregularities in the medium and the possible mechanism of this phenomenon because there exists a close relationship between the spatial spectrum of irregularities and the power spectrum of intensity scintillations observed on the ground. Power spectra of transionospheric scintillations have been studied by many investigators in the VHF and UHF ranges. Saturation effects in these frequencies due to the severe perturbations usually make the interpretation of the scintillation data very difficult. However, GHz scintillation often are not too strong under such conditions. Hence many researchers have studied the power spectra of GHz scintillations. In this chapter, for the first time, an attempt has been made to study the characteristics of GPS L1 (1.57542 GHz) carrier level scintillations by power spectral analysis of some selected scintillation events observed from Calcutta. The data taken in the campaign period 1994-95 correspond to the sunspot number minimum epoch. GPS carrier fluctuations are less frequent and intense at that time. Under this condition also, there are several occasions when carrier levels of some of the satellite links show saturated scintillations. Signals recorded from GPS satellites are generally steady. The signal strength increases as the satellite approaches a station from the horizon. Superimposed on the steady level, sometimes three types of fluctuations are recorded: (1) slow repetitive fluctuations, (2) the quasi-periodic scintillations with moderate intensity fluctuations and (3) quasi-random, intense scintillations. The first type is characterised by its repetitive nature from day to day with a precession of 4 min per day. The phenomenon may be attributed to so called multi-path effects due to reflection from structures near the receiving antenna. Superimposed on the steady level the faster fluctuations are due to scintillations. Scintillations are classified into two types. One is quasi-periodic and other is quasi-random. Quasi-periodic scintillations are normally observed in the beginning and/or at the end of the intense scintillations and they are caused by the diffraction at the sharp boundary of the irregularity clouds. On the other hand, deep and quasi-random fast scintillations occur over periods varying from a few minutes to several hours. Intense amplitude scintillations at 1.6 GHz frequency observed at the present location are caused by equatorial plasma bubble. Power spectra of the scintillations show different

nature under different circumstances. On occasions the spectrum has a flat part at lower frequencies with a definite corner frequency and roll-off at higher frequencies. The corner frequency gives the outer scale of the power law type irregularities; the slope of the roll-off giving the nature of the distribution. The roll-off often has a break with different slopes. The slopes of the power spectra are observed to lie between -0.68 and -2.84 . The slopes of the L-band weak scintillation spectra corresponding to the high frequency roll-off varies usually from -2.4 to -4.8 . Some scientists have measured the slopes by temporal spectral analysis and all of them have reported a three dimensional slope of -4 . In many cases the flat part of the spectrum is absent with the power level decreasing gradually at higher frequencies. This roll-off sometimes shows Fresnel oscillations. Presence of Fresnel oscillations in a spectrum indicate that the irregularities causing scintillations are confined to a narrow altitude range. Absence of well-defined Fresnel oscillations in some occasions may be due to multiple scattering from the irregularities in a thick layer.