Determination and Analysis of the Refractive Contribution to GPS Phase Variations

Anthony M. McCaffrey[1,2], and P.T. Jayachandran [1]
(1) The University of New Brunswick, Canada, Physics Department
(2) a.mccaffrey@unb.ca

As L-band radio waves travel through the ionosphere, such as those transmitted by the Global Positioning System (GPS) satellites, changes in the electron density along the ray path may induced refractive or diffractive variations in the signal's phase. Typically, the refractive component of these variations are thought to be slow varying changes in phase, associated with frequencies less than 0.1 Hz. The diffractive contribution is then thought to be of frequencies greater than 0.1 Hz. These rapid diffractive variations are referred to as scintillation, while in scintillation studies the refractive variations are very often ignored. We propose that rapid changes in the electron density, and therefore changes in the refractive index, along the ray path of the GPS signal can induce dominantly refractive variations at frequencies greater than 0.1 Hz. These variations then appear to be diffraction-induced, and may be used improperly in diffraction-focused scintillation research. Using recent advances in GPS, including an improved signal tracking technique and increased sampling rates, we present examples of rapid refractive variations in the GPS signal's phase. These high frequency variations are shown to be refractive using a combination of techniques, one adapted from previous techniques used for the low frequency refractive contributions to the phase, and new techniques only possible with these advances in GPS tracking. Preliminary analysis of these rapid refractive variations and the changes in electron density associated with them are also presented.