

Multi-event analysis of distributions of ROTI and losses of lock associated with equatorial plasma bubbles

Hayato Kikuchi^{1*}, Hiroyuki Nakata¹, Takuya Tsugawa², Yuichi Otsuka³, Michi Nishioka⁴, Toshiaki Takano¹, Shin Shimakura¹, Kazuo Shiokawa³, Tadahiko Ogawa²

¹Graduate School of Eng., Chiba Univ., ²NICT, ³STELAB, Nagoya Univ., ⁴Boston University

Equatorial plasma bubbles (EPBs) are local depletions of the electron density in the ionosphere. Due to various-scale irregularities, EPBs affect wide-band radio waves and cause scintillations in the GPS navigation system, in which L band is used. Strong scintillation leads to loss of lock (LOL) on GPS signals because of rapid variations of signal amplitude and phase. Therefore, it is important to examine the effect of EPBs on GPS systems. Since the Fresnel length for L-band radio waves is about 100m, we can detect the evolution of 100m-scale disturbances in the ionosphere by observing scintillations associated with EPBs. In addition, standard deviation of temporal variations of TEC in 5 minutes is good proxy for kilometer-scale disturbances, in considering the velocity of GPS satellites.

In this study, we analyzed rate of TEC change index (ROTI) and LOL to examine the scales of electron density disturbances in EPBs. From 31 EPBs observed by an all-sky imager at Sata during 2001-2002, we selected 11 events where EPBs developed above 30 degrees northern latitude. We selected 800 GPS receivers of GEONET and ROTI and Rate of LOL in 5 minutes are calculated from GPS data when the elevation angle of satellites were larger than 30 degrees. ROTI and LOL maps were made by projecting the ROTI values and Rate of LOL to the ionospheric pierce point (IPP) at 350km altitude.

As a result, it is shown that LOL occurred inside or in the vicinity of EPBs and ROTI enhanced in wider area as compared to LOL. In 5 events, however, LOL didn't occur although ROTI enhanced. It is conceivable that the irregularities inside of EPBs decayed in those events.

Keywords: EPBs, loss of lock, ROTI, GPS, TEC