VHFレーダーによる電離圏観測のディファレンシャルGNSS及び地球物理学への応用

Application of a VHF ionosphere backscatter radar for differential GNSS system and geophysics

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Global navigation satellite systems (GNSS) are more and more widely used for various applications. To enhance accuracy and reliability of position, navivgation and timing (PNT), differential GNSS (DGNSS) techniques are often used. DGNSS techniques work fine when the error environment can be assumed constant in space and time.

The ionospheric delay, or equivalently the total electron content (TEC) is one of the largest error sources for GNSS, not only for single-frequency users but also for dual-frequency users in some applications. In the low latitude ionosphere, plasma bubbles are known to have sharp changes in ionospheric delays in space and time, which may break down the assumptions for DGNSS to work. Indeed, a ground-based GNSS augmentation system (GBAS) which is based on single-frequency DGNSS used for precision approach and landing for aircraft suffers from ionospheric variability associated with plasma bubbles and its performance is limited. As one of the possible mitigation techniques, use of VHF radar for plasma bubble detection has been proposed and preliminary performance improvement has been demonstrated [Saito et al., ION GNSS 2010].

In this study, further applications of a VHF radar for plasma bubble detection for systems based on DGNSS techniques are studied by simulation. A VHF radar is assumed to be located at the magnetic equator. Plasma bubbles are assumed as depletions developed along the magnetic field lines. Performance of a satellite-based DGNSS systems with existence of plasma bubbles and possible improvement by the VHF radar monitoring are investigated as a function of the density and distribution of DGNSS ground reference stations.

Electronic Navigation Research Institute and National Information and Communications Technology are working on demonstrating these concepts by using a VHF radar located at Chumphorn, Thailand. It will support not only DGNSS applications but also further understanding physics of plasma bubble generation.

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