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# Regional ionospheric tomography in GNSS error correction

**J-P. Luntama**

Finnish Meteorological Institute, Helsinki, Finland

The GNSS (Global Navigation Satellite System) applications use the measurements of the range between the transmitters and the receiver to solve the location of the receiver. The range measurements are based on the phase of the code modulated on the satellite carrier signal and on the phase of the carrier signal itself. Both the code and the carrier phase suffer distortions when the signal passes through the ionosphere and the plasmasphere surrounding the Earth. Without correction the ionospheric error in the navigation solution can be up to 30 m. The ionospheric refraction error is proportional to the total electron content (TEC) integrated along the signal propagation path.

With two-frequency GNSS receivers the ionospheric error can be mostly eliminated by a linear combination of the range observations at two frequencies. However, many civilian GNSS users are using single frequency receivers and the standard ionospheric correction is not possible. Climatological ionospheric models can be used to reduce the ionospheric error. However, these models do not work well when the ionosphere is disturbed by solar events. Especially at Auroral latitudes the ionosphere is often too complex for the climatological models to provide good ionospheric corrections.

Finnish Meteorological Institute (FMI) is investigating the feasibility of using high resolution ionospheric tomography to derive regional ionospheric corrections for single frequency GNSS receivers. We are using ground based and space borne GNSS observations processed with the MIDAS (Multi-Instrument Data Analysis System) algorithm developed by the University of Bath [Mitchell et al, 2003]. The dense network of fiducial GNSS stations in Finland allows the retrieval regional electron density maps with an unprecedented horizontal resolution [Luntama et al. 2007].

This presentation shows the results from using ionospheric tomography based corrections in positioning of reference GNSS receivers in Finland. The results are based on observations during a test period in December 2006. The ionospheric tomography has been performed by using observations from the dense GNSS network operated by the Geotrim Ltd. The independent reference GNSS receivers are part of the Finnref network operated by the Finnish Geodetic Institute. The presentation contains results from comparing correction accuracy during calm ionospheric periods and during two magnetic storms on the 12th and 15th of December 2006. Finally, the presentation will discuss the feasibility of providing regional near real time ionospheric correction service based on the tested approach.

References:

Mitchell, C.N. and Spencer, P.S.J., 2003, A three-dimensional time-dependent algorithm for ionospheric imaging using GPS, Ann. Geophys., 46, pp. 687$-1òó696.

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