Realtime ionospheric disturbance analysis and monitoring with GEONET realtime data

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In recent years, GNSS receiver networks have been utilized for ionospheric studies. A dense GNSS receiver network enables us to monitor 2-D images of ionospheric disturbance in terms of ionosphereic total electron contents (TECs) on a map. Realtime ionospheric disturbance monitoring is getting more and more important not only for ionospheric sciences but also for GNSS-based applications that are widely used in the world.

Electronic Navigation Research Institute (ENRI) ENRI collects realtime data from 200 out of 1200+ GEONET stations at a sampling rate of 1 Hz with a data transfer delay of a few seconds. The data received at ENRI can be immediately analyzed for different studies not only for ionospheric studies but also for GNSS augmentation systems.

Since raw derived TECs have biases associated with receiver and satellite specific inter-frequency bias and TECs have temporal variations associated with the change of satellite locations and elevation angles, TEC disturbances are usually derived by subtracting averages of TECs in a certain time interval centered at the time of interest [Saito et al., 1998]. However, with this method, delay of the half of the average time by obtaining the estimated TEC disturbances are inevitable, even if GNSS observation data are provided in realtime.

We have developed a system to analyze the GEONET realitime data to derive ionospheric perturbations over Japan in realtime. The perturbation components of TEC is derived by detrending the TEC by estimating the trend by fitting a polynomial function to the TEC in the most recent period of a certain duration. The perturbation components of TECs are derived for the 200 GEONET stations, plotted on a map, and published on a website. The total processing time is less than 1 minute in the current system.

This analysis and monitoring system was used in a rocket campaign for ionospheric disturbances conducted by JAXA in July 2013, and contributed to successful launches of rockets by providing essential information on ionospheric disturbance occurrence during the launch window.

At the meeting, details of the analysis and monitoring system will be presented. TEC disturbances derived with our method will be compared with those with the traditional method. Performance of the two methods will also be compared by using an empirical ionospheric density model and realistic GPS satellite constellations.

The realtime ionospheric TEC perturbation map is found at the following URL:
http://www.enri.go.jp/cnspub/susaito/rocket/recent_mstid.html