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Vertical Total Electron Content Maps Over Europe From EUREF Permanent Network GPS Data

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The study of the ionosphere over Europe is essential for applications in the field of geophysics and space weather research (e.g. seismic monitoring, study of the interaction between Sun and Atmosphere) and it can also provide valuable information in support of radio system transmissions. Moreover, GPS errors induced by the ionosphere will increase in the next years due to the growing solar activity since the beginning of the 24th sunspot cycle in March 2008.

To better understand the physics of the ionosphere and its effects on GPS positioning, the Royal Observatory of Belgium (ROB) is developing an automatic monitoring to detect rapid ionospheric changes in both time and space domains using the EUREF Permanent Network (EPN) GNSS data.

In this study, we describe the method adopted by ROB to obtain 1°/1° hourly maps of the Vertical Total Electron Content (VTEC) over Europe from the phase-smoothed code observations from 150 to 200 EPN stations. We focused on two characteristic ionospheric activity periods: 1) a period of rapid changes in the ionospheric state due to the Halloween geomagnetic super-storm of 29-31 October 2003; 2) a period of normal ionospheric activity in the beginning of 2008.

To validate our results we compared our VTEC maps with Global Ionospheric Maps (GIM) GPS based products (e.g. from CODE, IGS). The comparisons during normal ionospheric activity show differences of 0.1 ± 1 TECU between the ROB and GIM products. However, during rapid changes in the ionospheric state, the differences are estimated to 1 ± 3 TECU. This is caused by the smoothing of the ionospheric signal in the GIM which are given for 2 hourly intervals on a 5°/2.5° grid.

In conclusion, our TEC products are in good agreement with GIM products during normal ionospheric activity and allow to better detect rapid changes in the ionospheric state compared to global products.