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Digital L-band polarimeter and polarimetric measurements of Total Electron Content at mid-latitudes

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Various processes in the upper charged part of the Earth's atmosphere - the ionosphere - related to space weather can disturb the propagation of trans-ionospheric signals. One of the indicators of ionospheric influence on trans-ionospheric signals is Total Electron Content (TEC) along the signal path, which can also be used to correct the errors in the received signals. TEC values are commonly evaluated using L-band signal group delay and phase advance measurements from satellite navigation systems (GPS and GLONASS), by using Faraday rotation angle measurements for VHF/UHF signals from geostationary satellites, and by measuring the scattering of the HF signals from the surface-based ionosonde (Digisonde) measurements.

In order to provide an alternative tool for TEC monitoring in L-band, a digital L-band polarimeter was designed and tested. It is based on the open-source Universal Software Radio Peripheral (USRP) and toolkit software defined radio (GNU Radio) with KUHNE L-band super low-noise amplifiers, custom made bandpass filters with central frequency of 1691 MHz and bandwidth of 5 MHz and custom-made antenna feed capable of measuring both vertical and horizontal component of the incoming signal. The feed was mounted on a steerable 1.8 meter parabolic dish antenna located in Ljubljana, Slovenia. The system was used to measure 1691 MHz linearly polarized signal from the geostationary Meteosat 7 Indian Ocean Data Coverage (IODC) satellite. TEC values were estimated from measurements of the rotation angle of the signal polarization plane.

Preliminary campaign, performed from June 1 - 4, 2015 demonstrated functionality of the system. The obtained TEC values are in good agreement with those from individual GPS satellite signals passing through the same ionospheric volume, as well as with the available ionosonde data. An advantage of the presented system is also the capability to continuously monitor TEC in the same ionospheric volume when using signals from geostationary satellites, while the GPS ionospheric monitors receiving signals from satellites in Medium Earth Orbit provide continuous TEC averaged over a considerably larger ionospheric volume.