GNSS probing of local ionospheric disturbances in high latitude

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We present study of regional ionospheric perturbations in high latitude by monitoring dual frequency signals transmitted by Global Navigation Satellite Systems (GNSS).
The variations in the Total Electron Content (TEC) are identified from high rate dual frequency GNSS receivers placed in Ramfjordmoen and in Tromsø, Norway. TEC measurements are taken from two Topcon Legacy EGGDT 50Hz) receivers with Leica AR 25 antennas (operated with 20 Hz). The receivers are able to receive GPS (L1/L2), GLONASS (L1/L2) and WAAS/EGNOS. The separation of the two receiver locations is approximately 14 km. This experimental setup is designed to monitor the local ionosphere by multi satellite-GNSS receiver links simultaneously with European Incoherent Scatter (EISCAT) radars

It has been previously reported that perturbations of GNSS signals can be found due to ionospheric plasma irregularities caused by high power radio waves. During the experiments in winter 2010, High Frequency (HF) electromagnetic pumping waves from EISCAT heating facility in Ramfjordmoen were transmitted along the geomagnetic field lines. The HF heater was operated at a frequency around 4MHz. The heating and relaxation intervals ranged from 10 to 180 seconds. The modification of ionosphere was observed by EISCAT UHF radar. From the elevation angle (78°) and open width (14°) of the heating beam, we estimate the center of the heated area in 200km height as 41km south of the heating facility. The largest plasma disturbances are expected to be seen along the magnetic field line according to the magnetic zenith effect. High elevation angles are required to identify the available GNSS satellites in order to probe the estimated heated ionospheric volume with satellite-receiver links

We analyze TEC measurements from GLONASS satellites with regard to the distance between the ionospheric piercing points and estimated heated center at 200km. For the most of the experiments, TEC shows steady background increase over the heating cycles and in some localized variations which may be associated with heating on/off intervals. The largest variations from the background TEC (approximately 0.05 TECU) are seen during the longer heating intervals when increases of electron temperature are often observed by EISCAT radar. We have also found a different type of localized TEC variation (approximately between 0.1 and 0.2 TECU) in a particular experiment day. This seems to be caused by natural origin (e.g. precipitating electrons).We will discuss possible relation to the fluctuations seen in the magnetometer chain data.