Characteristics of GNSS signal outages observed from the Arctic and Antarctic regions

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Ionospheric irregularities impact satellite-based communication and navigation systems and services, often rendering them unusable for reliable operations. GNSS signals are increasingly being used for characterizing such phenomena and the resulting signal outages. The polar regions are some of the most challenged in terms of maintaining high of levels of performance. The impairment of satellite-based services in the polar and high latitudes is often associated with geomagnetic storms, which may result in steep spatial and temporal gradients of electron density and ionospheric scintillations [*Aarons*, 1982; *Basu et al.*, 1998; *Aarons et al.*, 2000]. Intense phase scintillations in transionospheric satellite signals can introduce errors in phase lock loops (PLL) in GNSS receivers which results in loss of lock and cycle slips.

The present paper aims to study loss-of-lock observed from GNSS stations operated by Istituto Nazionale Geofisica e Vulcanologia (INGV) in the Arctic and Antarctic region for geomagnetic quiet periods during 2012-14 and tries to understand any difference in the characteristics between the two regions. Efforts have also been put to understand similarities and differences, if any, between the ionospheric activities in the northern and southern hemisphere auroral zone, cusps and polar caps.

An estimation of GNSS cycle slips in relation to impact on satellite-based technological system is being conducted from conjugate polar locations within the framework of an international GNSS project at the International Space Science Institute (ISSI), Bern. The period chosen for this study corresponds to equinoctial months of high-to-moderate solar activity period of 2012-

2014. Only geomagnetic quiet conditions (Dst ≥ -50 nT) are considered for this study. . The GNSS receivers are operated by INGV, Italy. Currently the three stations located in conjugate polar region from which analysis are being conducted are 1) Longyearbean (78.22°N, 15.63°E geographic, geomagnetic dip 82.21° geomagnetic declination 7.06°), 2) Mario Zucchelli (74.70°, 164.11°E, geomagnetic dip -82.58° geomagnetic declination 134.64°) and 3) Concordia (75.10°S, 123.35°E, geomagnetic dip -80.72° geomagnetic declination -141.24°).

The receivers provide at their output GPS Time of Week (TOW in seconds), TEC, Detrended TEC and Accumulated Doppler Rate (ADR) at sampling rate of 50Hz. Satellite PRN number, satellite elevation and azimuth are also available. The time derivative of ADR (TADR) provides the received phase from a particular satellite at an instant. Cycle slip is computed from 50Hz time derivative of Accumulated Doppler Range (ADR). During September 2012, cycle slip of duration 295 seconds has been observed at Longyearbean. During September 2012, 80% cycle slips recorded are confined within the duration of 1-2 seconds at Longyearbean. The same for Concordia is 85%. Occurrences of cycle slips of more than 5 seconds are found to be higher in Longyearbean than that in Concordia in September 2012.