Studies on relative performance of different satellite-based navigation systems during adverse ionospheric conditions from equatorial ionization anomaly crest location

Ashik Paul[(1)]* and Samiddha Goswami[(1)]
(1) Institute of Radio Physics and Electronics, University of Calcutta, 92 Acharya Prafulla Chandra Road, Calcutta - 700009, India
ashik_paul@rediffmail.com

Extended Abstract

Multi-constellation satellite signal reception capability has provided an important tool for enhancing the performance of satellite based navigation system through inter-operability under conditions of intense ionospheric scintillations as experienced during equinoctial months at anomaly crest locations. A multi-constellation GNSS receiver capable of tracking GPS, GLONASS and GALILEO satellites at L1, L2 and L5 frequencies is operational at the Institute of Radio Physics and Electronics, University of Calcutta (22.58°N, 88.38°E geographic; magnetic dip: 32°N), Calcutta, India since April 2013. The present paper reports relative robustness of GPS, GLONASS and GALILEO satellite signals present in a common ionospheric volume during periods of ionospheric scintillations as determined from relative fluctuations of detrended C/N_0 deviations and S_4 indices observed during March and September 2014, and March 2016. Intense GPS and GLONASS scintillations (S_4>0.6) were noted on several days mainly during local pre-midnight hours. In addition, intense scintillations on GALILEO SV 81, 82, 89 and 90 were observed on March 12, 25 and 26, 2014 and are perhaps some of the first reporting of ionospheric scintillation on GALILEO links from India. C/N_0 fluctuations at L1 frequency were studied on days for time intervals when a pair of satellites from different constellations (GPS, GLONASS and GALILEO) exhibited ionospheric scintillations over a common volume of 5°×5°. On March 12, 2014, it was found that SV8, 9 from GPS and SV49 from GLONASS showed intense scintillations during 14:06-14:51UT over a common ionospheric volume 24.4°-26.2°N, 86.2°-89°E with peak-to-peak fluctuations nearly 60% less in GLONASS compared to GPS during the same time period. On that date, GLONASS SV60 and GALILEO SV82 exhibited intense scintillations over a common ionospheric volume during 13:57-14:30UT with almost 75% more fluctuations on the GALILEO link during the above interval. Similar analyses were done for other dates in March and September 2014. In summary, 24 nights of scintillations were observed on GNSS from Calcutta during March 2014 and 16 nights of scintillations in September 2014. Out of these, 6 cases of co-located (5°×5°) ionospheric scintillations were observed in March 2014 on GPS, GLONASS and GALILEO satellites and 3 in September 2014. Out of these 9 cases, 6 cases showed more C/N_0-L1 fluctuations in GPS (50%-64%) and 3 cases where GLONASS satellites exhibited more C/N_0-L1 fluctuations (50%-53%). In March 2016, 2 cases of co-located ionospheric scintillations were found, namely SV5 and 42 on March 26th, and SV7 and 100 on March 27th. On March 26, 2016, SV5 (GPS) exhibited more C/N_0-L1 deviations for 68% of time than SV42 (GLONASS) over 19.5°-22.5°N, 91.5°-95°E. On March 27, 2016, SV7 (GPS) showed more C/N_0 fluctuations for 72% of time compared to SV100 (GALILEO) over the swath 12.5°-15.1°N, 78.4°-80°E. Further analyses are presently being done from Siliguri, a station located beyond the northern crest of the EIA in the Indian longitude sector.