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# Effect of solar radio bursts on GNSS signal reception over Europe for the period 1999-2013

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Intense solar radio bursts (SRB) emitted at L-band frequencies can affect the carrier-to-noise $C/N_0$ ratio of Global Navigation Satellite Systems (GNSS) signals by increasing the background noise. Such space weather events can consequently decrease the quality of GNSS-based results especially for kinematic high-precision positioning. It is thus important to develop a method capable to detect such events in near real time on a wide area.

For this purpose, the ROB-IONO software was adapted for analysing the effect of SRB on the dense EUREF Permanent GNSS Network (EPN). First, S1 and S2 raw data extracted from RINEX files were converted into the $C/N_0$ unit (dB.Hz) taking into account manufacturer corrections. Then, the differences ($\Delta C/N_0$) between all these $C/N_0$observables and their medians of the 7 previous satellite ground track repeat cycles, i.e. their normal quiet state, were computed. The mean of all these well-calibrated $\Delta C/N_0$values from different GNSS receivers and satellites offer at each epoch a reliable metric to detect and quantify the impact of a SRB.

We investigated the degradation of GPS and GLONASS $C/N_0$ on the entire EPN during 10 intense SRBs occurring at daylight over Europe between 1999 and 2013. The analysis shows that: (1) GPS and GLONASS $\Delta C/N_0$ agree at the 0.1±0.2dB.Hz level; (2) The standard deviation of the mean $\Delta C/N_0$of the EPN GNSS receivers is below 1dB.Hz 96% of the time, and below 0.6dB.Hz 76% of the time; (3) maximum $\Delta C/N_0$ degradation occurs at the epoch of maximum solar peak flux delivered by the solar ground observatories; (4) $C/N_0$ degradation becomes larger with increasing solar zenithal angle.

Consequently, the ROB-IONO software is capable to detect the degradation of GNSS signal reception over Europe due to SRBs. In addition, by taking advantage of the increasing number of EPN stations delivering $C/N_0$ data since 2005, even less intense SRB events can now be detected. Finally, the developed method can be completely applied in near real time.