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Impact of TEC Fluctuations on GPS Positioning During Halloween 2003 Storm

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With increasing reliance on space-based platforms for global navigation and communication, concerns about the impact of ionospheric scintillation and total electron content (TEC) fluctuations on these systems have became a high priority. In this paper, GPS trans-ionospheric signals have been used to study the development of ionospheric phase fluctuations observed at Antarctic (Mawson, Syowa, Vesleskarvet) and European (Ebre, Lamkówko, Cagliari, Hailsham, Potsdam, Wettzell) IGS permanent stations. The use of the multi-station, multi-path observations of the GPS beacons has allowed the study of the time development of irregularities of individual geomagnetic storms as a function of latitude and longitude. The basic storm studied here was this of October 29 - 31, 2003 (sum of Kp = 58). Over Europe, the ionospheric irregularities during this storm were analyzed on the base of TEC maps. Our estimation technique provided TEC maps with 15 min interval and with spatial resolution of 150 - 300 km. Over Antarctic region the rate of TEC (ROT) parameter was used to study the occurrence of TEC fluctuations. The results showed the unique nature of each storm.
Fluctuation effects, causing dramatic changes in TEC, can have a different impact on GPS positioning accuracy (especially on phase ambiguity resolution). Bernese ver.5.0 software was used for the processing of the GPS permanent data from analized IGS stations. Two methods of GPS elaboration: relative and absolute (Precise Point Positioning - PPP) was applied to elaborate these data. The analyses rely on studying the repeatability of vector coordinates. The impact of TEC fluctuations at the high latitude ionosphere on GPS positioning accuracy has been discussed in terms of the total number of observations of double-differences (DD) and the ratio of the total number of all ambiguities to unresolved ones. For extremely disturbed conditions at high latitudes, the occurrence of medium and strong TEC fluctuations caused a significant increase in the total number of DD unresolved ambiguities (about 6 times).