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Poster
Understanding the functionality and performance effects of ionospheric density structures on GNSS receivers is vital for informing various end-users such as emergency management, precision agriculture, and autonomous transportation, of the impact of space weather on their specific application. Small-scale ionospheric plasma irregularities (< 1 km) can significantly alter Global Navigation Satellite System (GNSS) signals leading to receiver loss of lock and degradation of positioning accuracy. Studies have shown that plasma density gradients caused by large-scale phenomena such as storm-enhanced density (SED) plumes and the midlatitude ionospheric trough (MIT) can also modify the amplitude and phase of GNSS signals. However, the impact of such modifications on subsequent positioning errors is unclear. In this study, we analyze GPS receiver data during a collection of SED and MIT events that caused large spatial plasma density gradients overthe continental United States and determine the effect on real-time kinematic (RTK) positioning error. We evaluated the effect on the signal-to-noise ratio of signals traversing these density gradients, the number of losses of lock on the signal during the events, as well as the spatial and temporal rate-of-change of the total electron content (TEC). Finally, we performed a superposed epoch analysis of the RTK single-point positioning (SPP) and precise point positioning (PPP) error of multiple stations during the SED and MIT events as well as a case study of the 2024 Gannon Storm. We found that the 3D SPP error at three stations for a collection of SED and MIT events ranged from 7-23 meters and showed only marginal increases during the events as compared to geomagnetically quiet periods when the ionospheric phenomena was not present. During the Gannon storm, SPP error reached as large as 30 meters. The PPP errors for all events was less than 1 meter. Thus, for many GNSS receiver dependent end-users that can tolerate meter(s) level accuracy, such as emergency management users, effects due to gradients associated with large-scale phenomena will have minimal impact on their operations except in the most extreme cases.
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