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Case study of windstorm effects on zenith tropospheric delay for RTK networking in northern Germany

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Tropospheric refraction is one of the major error sources in satellite-based positioning. The dependency of the troposphere on physical quantities such as temperature, pressure and humidity makes troposphere modeling challenging in severe weather conditions. One such severe weather event was the Xavier windstorm that occurred in northern Germany at the beginning of October 2017. Here, we report on an analysis of the tropospheric influence on GNSS measurements during this windstorm and compare the results with periods before and after the event. 41 GNSS stations of the LGLN-SAPOS (Landesamt für Geoinformation und Landesvermessung Niedersachsen - Satellitenpositionierungsdienst) network in Lower Saxony are used for the analysis which is based on the tropospheric products of the Geo++® GNSMART (GNSS - State Monitoring And Representation Technique) software. In particular, the variations of the Zenith Tropospheric Delay (ZTD) are investigated. The ZTD fluctuation is compared with the variation of published weather data of the Deutscher Wetterdienst (DWD) to observe possible correlations. The largest values and variations of the ZTD are located before the beginning of the storm, when humidity and precipitations were already considerable. The comparison with calm weather conditions and dry periods showed that the ZTD spatial correlation length is decreased by several kilometres before and during the windstorm. The performance of the interpolation of the ZTD has been evaluated varying from less than 1 mm RMS to roughly 10 mm RMS depending on the station of the network and time considered. A post-processing rover test has been carried out to compute the performance in the position domain during the windstorm period. Testing the convergence time with a scheduled reset of 30 s, the RMS of the errors w.r.t. the known position in the height direction varies frequently during the period considered, exhibiting the largest values before the storm.
All aspects of the analysis suggest that especially before the windstorm ZTDs can differ significantly within the network, changing rapidly in time and affecting the performance of the GNSS correction interpolation for a user, while during the storm the ZTD fluctuation is locally quite homogeneous.