EGU21-14662
https://doi.org/10.5194/egusphere-egu21-14662
EGU General Assembly 2021

Tropospheric delay parameters derived from GNSS-tracking data of a fast-moving fleet of trains

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Electromagnetic signals, as broadcasted by Global Navigation Satellite Systems (GNSS), are delayed when travelling through the Earth's atmosphere due to the presence of water vapour. Parametrisations of this delay, most prominently the Zenith Total Delay (ZTD) parameter, have been studied extensively and proven to provide substantial benefits for atmospheric research and especially the Numerical Weather Prediction (NWP) model performance. Typically, regional/global networks of static reference stations are utilized to derive ZTD along with other parameters of interest in GNSS analysis (e.g. station coordinates). Results are typically used as a contributing data source for determining the initial conditions of NWP models, a process referred to as Data Assimilation (DA).

This contribution goes beyond the approach outlined above as it shows how reasonable tropospheric parameters can be derived from highly kinematic, single-frequency (SF) GNSS data. The utilized data was gathered at trains by the Austrian Federal Railways (ÖBB) and processed using the Precise Point Positioning (PPP) technique. Although the special nature of the observations yields several challenges concerning data processing, we show that reasonable results for ZTD estimates can be obtained for all four analysed test cases by using different PPP processing strategies. Comparison with ZTD calculated from ERA5 reanalysis data yields a very high correlation and an overall agreement from the low millimetre-range up to 5 cm, depending on solution and analysed travelling track. We also present the first tests of assimilation into a numerical weather prediction (NWP) model which show the reasonable quality of the results as between 30-100 % of the observations are accepted by the model. Furthermore, we investigate means to transfer the developed ideas to an operational stage in order to exploit the huge benefits (horizontal/temporal resolution) of this special dataset for operational weather forecasting.