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Machine Learning based prediction of atmospheric zenith wet delay: A study using GNSS measurements in Wettzell and co-located VLBI observations

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The tropospheric delay is one of the error sources in microwave space geodetic measurements, especially in those from Global Navigation Satellite Systems (GNSS) and Very Long Baseline Interferometry (VLBI). Typically, the tropospheric delay is estimated through least square adjustment or Kalman filtering for the geodetic applications. However, these approaches could destabilize other geodetic parameters such as station coordinates or clock offsets due to high correlation in the normal equation. Thus, the impact of the tropospheric delay should be separately eliminated to reach a proper geodetic solution from space geodetic techniques observation. Nowadays, with a significantly improved performance of machine learning (ML) techniques, they show a promising capability in modeling variables with a complex behavior, such as tropospheric effect, with reliable accuracy. Considering the functional performance of ML, an algorithm to predict tropospheric delay for the next couple of hours can be beneficial for many applications such as VLBI Intensive sessions. In this study, we investigate the tropospheric delay from the GNSS stations in Wettzell with Precise Point Positioning technique (PPP) from 2010-2018. First, we analyze and model the tropospheric delay time series using two ML techniques that are named, long-short-term memory (LSTM) recurrent neural network and the combination of the Copula-based analysis and SSA (Copula+SSA) technique. At the end, the prediction results are compared to the tropospheric delay from GNSS and also VLBI Intensive sessions data in co-located site Wettzell for investigating the prediction performance of the models statistically. Our preliminary studies demonstrate that LSTM and Copula+SSA methods can be applied for ultra-short-term prediction of the tropospheric delay in an appropriate resolution.