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Assimilation of GNSS tomography in Near-Real Time mode products into the Weather Research and Forecasting model

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GNSS tropospheric tomography is a technique that aims to derive 3D distribution of wet refractivity in troposphere using slant GNSS observations (Slant Wet Delay), domain parametrization and the inversion process. This method of GNSS meteorology is one of the most promising since it enables to obtain not the column or slant amount of water vapor, but its 3D distribution. It makes the products of tomography more efficient and convenient to assimilate into NWP models, which is the main potential application for the technique. Although GNSS tomography has been intensively developed last years, the quality of data has not been discussed in terms of assimilation into NWP models. This kind of analysis is essential in further works on the utilization of GNSS tomography products in operational NWP models.
This work presents Near-Real Time (NRT) tomographic solution that was performed on the area of Poland using $TOMO_2$ model, in order to verify if tomographic products meet accuracy requirements and could be assimilated into NWP models. The solution was performed using Zenith Total Delays (ZTD) estimated in NRT for ASSG-EUPOS and Leica SmartNet stations by WUELS processing center. Validation based on the Universal Rawinsonde Observation Program (RAOB) data shows the RMSE of the solution is about 7 ppm in the lower troposphere (altitude below 3 km) and not more than 5 ppm in the upper layers. The first attempts of 3D-Var assimilation into Weather Research and Forecasting (WRF) model were made using GPSREF observation operator. Global Forecasting System (GFS) data were used as initial and boundary conditions.
The first results show that the impact of GNSS tomography data assimilation on meteorological forecast is visible. Validation of the results performed using data from RAOB shows decrease of correlation for Relative Humidity after assimilation. Values of Integrated Water Vapor (IWV) calculated in WUELS processing center, show increase of bias by 1.5 mm and decrease of standard deviation by 10% after assimilation. Synoptic station comparison shows increase of RH bias by 10% and slight decrease of standard deviation, the correlation coefficient is also improved slightly after assimilation. The impact on pressure is negative in terms of bias and positive in terms of standard deviation and correlation. 2m temperature was not changed.