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TOMOREF operator as a tool to improve weather forecasts

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The numerical weather model starts from the initial state of the Earth's atmosphere in a given place and time. The initial state is created by blending the previous forecast runs (first-guess), together with observations from different platforms. The better the initial state, the better the forecast; hence, it is worthy to combine new observation types. The GNSS tomography technique, developed in recent years, provides a 3-D field of humidity in the troposphere. This technique shows positive results in the monitoring of severe weather events. However, to assimilate the tomographic outputs to the numerical weather model, the proper observation operator needs to be built.

This study demonstrates the TOMOREF operator dedicated to the assimilation of the GNSS tomography□derived 3□D fields of wet refractivity in a Weather Research and Forecasting (WRF) Data Assimilation (DA) system. The new tool has been tested based on wet refractivity fields derived during a very intense precipitation event. The results were validated using radiosonde observations, synoptic data, ERA5 reanalysis, and radar data. In the presented experiment, a positive impact of the GNSS tomography data assimilation on the forecast of relative humidity (RH) was noticed (an improvement of root□mean□square error up to 0.5%). Moreover, within 1 hour after assimilation, the GNSS data reduced the bias of precipitation up to 0.1 mm. Additionally, the assimilation of GNSS tomography data had more influence on the WRF model than the Zenith Total Delay (ZTD) observations, which confirms the potential of the GNSS tomography data for weather forecasting.