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Combination of ground-based and space-based GNSS tomography (2021-2025)

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Global Navigation Satellite Systems (GNSS) sense the atmosphere remotely and provide low-cost, high-quality information about its state. Nowadays, radio occultation (RO) profiles from space platforms and tropospheric delays from ground-based stations are routinely assimilated in Numerical Weather Models (NWM).

In spite of provision of valuable information for weather forecasting, both space- and ground-based data have significant limitations. The RO technique has low horizontal resolution and does not provide reliable profiles in the first 3-5km of the troposphere. Whereas, the station-specific integrated value of troposphere are sparse and pose a problem to NWM adjoint operator for correcting model fields at different heights. These deficiencies could be resolved by the GNSS tomography technique that utilizes an inverse Radon transform to derive the 3D refractivity distribution over certain troposphere space. The combination of space-based and ground-based observations in the tomographic model will enable us to increase the number of intersections of GNSS signals and improve the refractivity solution within individual model locations.

The aim of this research is to harness the full potential of Space 4.0 era, rapidly growing numbers of RO and GNSS satellite constellations as well as low-cost GNSS ground-based networks worldwide. We will not only use current infrastructure but also examine impact of future constellations on model performance. 3D model of refractivity from dense observations should be an excellent tool in weather prediction. Our previous research proves that the assimilation of the GNSS tomography outputs into the NWM improves relative humidity and the short-term weather forecasts. Therefore, the research goal of this project is to assess the benefit of integrated tomography model on the severe weather prediction and urban scale weather models.