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GPS Tomography: Validation of the Reconstructed Humidity Fields

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Ground based GPS atmosphere sounding provides various atmospheric quantities with a high temporal resolution for all weather conditions. The Zenith Total Delays (ZTDs) and the Integrated Water Vapour (IWV) are currently used by numerous meteorological applications and assimilated by several weather services in order to improve the numerical weather forecasts. These data provide only information about the horizontal water vapour distribution in the atmosphere and efforts have been made to estimate the vertical structures from the Slant Total Delays (STDs) which describe the delay of the GPS signal in the neutral atmosphere as compared to undisturbed signal propagation in vacuum. As these observations provide only a quantity integrated along the whole signal path tomographic reconstruction techniques are required to estimate the spatial humidity distribution. GPS tomography is related to ill-posed inverse problems and the quality of the results depends on several parameters, such as the total number of STDs available, the satellite constellation, the STD errors, etc. The parameters vary in space and time and validation studies are required to estimate the quality of the tomographically reconstructed humidity fields.

The number of German GPS stations operationally processed by the GFZ in Potsdam was
recently enlarged to more than 300. About 28000 IWV observations and more than 1.4 millions of STD data per day are currently available with a temporal resolution of 15 min and 2.5 min, respectively. The extended network leads not only to a higher spatial resolution of the tomographically reconstructed 3D fields but also to a much higher stability
of the inversion process and with that to an increased quality of the results.

Two validation studies will be presented. The first one is based on simulated STDs which are reconstructed and compared to the original humidity field. It is an advantage of this approach that the „real“ field is known and the errors of the reconstruction can be computed without any uncertainties. In the second case humidity fields reconstructed from real STD observations will be compared to radiosonde profiles. Up to 14 profiles are available every 6 or 12 hours and can be used to estimate the spatial and temporal variations of the reconstruction quality. In both cases several parameters of the tomography will be varied in order to find the optimal spatiotemporal resolution of the reconstruction.