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GPS Tomography: Validation of Reconstructed 3D Humidity Fields with Radiosonde Data

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Water vapour plays a key role in various atmospheric processes, e.g., its long-term variations are related to climatological temperature trends. To precisely characterize the influence of water vapour to these processes the knowledge of its temporal and spatial distribution is a key requirement. In recent years, ground based GPS sounding systems became operational and demonstrated the ability to provide such spatiotemporal information on the water vapour distribution. The provision of Integrated Water Vapour information (IWV) and atmospheric Zenith Total Delay (ZTD) was established as a standard sounding technique. ZTD and IWV are currently operationally assimilated to regional weather forecast models. The derivation of 3D water vapour distributions is currently under development.

GFZ developed a tomographic system to derive 3D distributions of the tropospheric water vapour above Germany using GPS data from about 300 ground stations. Input data for the tomographic reconstructions are provided by the near-real time GPS data processing systems of the GFZ. This system provides ZTD, IWV and Slant Total Delay (STD) data operationally with a temporal resolution of 2.5 minutes (STD) and 15 minutes (ZTD, IWV).

The tomographic technique uses a 3D grid for the atmosphere over Germany to describe the water vapour distribution. The quality of the solution is related to many factors such as the spatial coverage of the atmosphere with the slant paths, the spatial distribution of their intersections and others. Independent observations are required to validate the tomographic reconstructions and to get precise information on the accuracy of the derived 3D water vapour fields. Radiosonde measurements are used to evaluate the quality and capability of the GPS Tomography from GFZ. More than 8,000 vertical water vapour profiles at 13 German radiosonde stations for 2007 were used for the comparison study. The profiles are available twice a day (00:00 and 12:00 UTC). Furthermore, criteria for selecting regions with sufficient observations for reliable tomographic reconstructions are defined. The quality of the tomography profiles can be determined by comparing the wet refractivity, zenith wet delays or absolute humidity with the those, derived from the radiosonde data. The temporal and spatial distribution of the slant paths, base for the tomographic reconstructions, as well as their angular distribution are also considered.