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Long-term study about water vapor retrieval with parameterized GPS tomography

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Water vapor affects tropospheric dynamics, thermal feedback, and refractivity, thus forming a crucial parameter in meteorology, climatology, and geodesy. The accurate knowledge of the 3D tropospheric water vapor field is essential for initializing precise numerical weather predictions, especially for quantitative precipitation forecasting. In now-casting, the water vapor content has become increasingly important in recent years as water vapor fields are combined with radar data.
Many space geodetic techniques are affected by refractivity effects and, therefore, can be used to derive tropospheric delays. These estimates can then be used to numerically reconstruct the water vapor distribution in the atmosphere. GPS tomography is a technique to estimate the tempo-spatial distribution of water vapor by combining integral measurements derived from GPS phase observations. Our tomographic software is driven by a Kalman filter and uses GPS double difference delays obtained from the BERNESE GPS Software. The tomography software features different parameterizations of the voxels (volumetric pixel) which will be presented. Compared to the classical constant-voxel parameterization, these new approaches lead to a continuous field in space. For validation, a long-term study with a duration of more than 1 year has been carried out in Central Europe using the Swiss permanent GPS network (AGNES) and stations from the EUREF permanent network (EPN). In this study, results from different tomographic approaches, data from numerical weather models, and balloon soundings are mutually compared. It has been shown, that the new approaches ameliorate the RMS by about 15% compared to the constant-voxel parameterization. Especially, seasonal effects and the influence of the complex topography are mirrored in the results and will be discussed. The accuracies of the different approaches will be analyzed and pros and cons of the specific approaches will be addressed.