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Investigating the Small-Scale Spatial Variabilty of Precipitable Water Vapor by Adding Single-Frequency Receivers into an Existing Dual-Frequency Receiver Network

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Exploiting GNSS signal delays is one possibility to obtain Precipitable Water Vapor (PWV) estimates in the atmosphere. The technique is well known since the early 1990s and by now an established method in the meteorological community. The data is crucial for weather forecasting and its assimilation into numerical weather forecasting models is a topic of ongoing research. However, the spatial resolution of ground based GNSS receivers is usually low, in the order of tens of kilometres. Since severe weather events such as convective storms can be concentrated in spatial extent, existing GNSS networks are often not sufficient to retrieve small scale PWV fluctuations and need to be densified. For economic reasons, the use of low-cost single-frequency receivers is a promising solution. In this study, we will deploy a network of single-frequency receivers to densify an existing dual-frequency network in order to investigate the spatial and temporal PWV variations. We demonstrate a test network consisting of four single-frequency receivers in the Rotterdam area (Netherlands). In order to eliminate the delay caused by the ionosphere, the Satellite-specific Epoch-differenced Ionospheric Delay model (SEID) is applied, using a surrounding dual-frequency network distributed over a radius of approximately 25 km. With the synthesized L2 frequency, the tropospheric delays are estimated using the Precise Point Positioning (PPP) strategy and International GNSS Service (IGS) final orbits. The PWV time series are validated by a comparison of a collocated single-frequency and a dual-frequency receiver. The time series themselves form the basis for potential further studies like data assimilation into numerical weather models and GNSS tomography to study the impact of the increased spatial resolution on local heavy rain forecast.