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What is the impact of different VLBI analysis setups of the tropospheric delay on precipitable water vapor trends?

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The quality of the parameters estimated by global navigation satellite systems (GNSS) and very long baseline interferometry (VLBI) are distorted by erroneous meteorological observations applied to model the propagation delay in the electrically neutral atmosphere. For early VLBI sessions with poor geometry, unsuitable constraints imposed on the a priori tropospheric gradients is a source of additional hassle of VLBI analysis. Therefore, climate change indicators deduced from the geodetic analysis, such as the long-term precipitable water vapor (PWV) trends, are strongly affected. In this contribution we investigate the impact of different modeling and parameterization of the propagation delay in the troposphere on the estimates of long-term PWV trends from geodetic VLBI analysis results. We address the influence of the meteorological data source, and of the a priori non-hydrostatic delays and gradients employed in the VLBI processing, on the estimated PWV trends. In particular, we assess the effect of employing temperature and pressure from (i) homogenized in situ observations, (ii) the model levels of the ERA Interim reanalysis numerical weather model and (iii) our own blind model in the style of GPT2w with enhanced parameterization, calculated using the latter data set. Furthermore, we utilize non-hydrostatic delays and gradients estimated from (i) a GNSS reprocessing at GeoForschungsZentrum Potsdam, rigorously considering tropospheric ties, and (ii) direct ray-tracing through ERA Interim, as additional observations. To evaluate the above, the least-squares module of the VieVS@GFZ VLBI software was appropriately modified. Additionally, we study the noise characteristics of the non-hydrostatic delays and gradients estimated from our VLBI and GNSS analyses as well as from ray-tracing. We have modified the Theil-Sen estimator appropriately to robustly deduce PWV trends from VLBI, GNSS, ray-tracing and direct numerical integration in ERA Interim. We disseminate all our solutions in the latest Tropo-SINEX format.