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Spatio-temporal consistency of the stochastic component of the ZTD time series over Europe

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Abstract. We use a unique atmospheric dataset over Europe provided by the EUREF Permanent GNSS Network (EPN) in the form of Zenith Total Delay (ZTD) time series. We use solutions provided by the ASI (Agenzia Spaziale Italiana Centro di Geodesia Spaziale, Italy) and GOP (Geodetic Observatory Pecny, Czech Republic) analysis centers and the combined product of EPN Repro-2 solution; different processing options are applied to these solutions. We show that the trends and seasonal amplitudes of the ZTD time series are only slightly affected by changing the processing strategy, while the temporal patterns of autoregressive noise present in the stochastic component are reduced in favor of white noise during the combination procedure. Although combination reduces the stochastic properties for individual stations, the change in stochastic character does not affect the correlations and spatial patterns determined between stations. We demonstrate that the ZTD residuals for different locations are strongly spatially correlated with the spatial correlation between station pairs being time-varying. We find clear annual oscillations in the time series of correlation coefficients for stations up to 1,000 km apart. We use empirical orthogonal functions and prove that for all four solutions they are generated by the same sets of stations and are strongly correlated with each other in the time domain. To search for possible contributions of non-tidal atmospheric loading to the ZTD residuals, we compute differences from two GOP solutions that differ only in the unmodeled, non-tidal atmospheric loading and cross-compare them with temporal and spatial responses of non-tidal atmospheric loading residuals. We show that the similarity between the ZTD differences and the non-tidal atmospheric loading is only apparent for unusual loading events, such as significant interannual signals or large seasonal peaks.