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Estimating the effective spatio-temporal resolution of integrated water vapor trends based on VLBI, GNSS, and weather model data

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How far apart can two space geodetic sites be located to consider the integrated water vapor (hereinafter IWV) trends as equal, from a statistical viewpoint? How to do efficient feature selection with a given IWV time series? To address these questions, we utilize spatio-temporal variations of long-term IWV trends that were estimated employing very long baseline interferometry (VLBI), Global Navigation Satellite Systems (GNSS), and numerical weather prediction data (ERA5 reanalysis). We estimate coefficients for several spatial covariance functions; Hirvonen's model proves to be the most precise for our area of interest, Greater Europe. We find that the effective spatial resolution is around 56 km (for error level (p) < 0.05). Our investigations indicate that among else, altitude and proximity to the ocean are key factors affecting the IWV trend decorrelation lengths. We find good agreement between the spatially varying decorrelation lengths and established climate classification systems such as the latest Köppen-Geiger model. Moreover, the IWV trend variation as a function of data span and temporal resolution has been investigated. We find that varying the temporal resolution from one hour up to 30 days does not yield a statistically significant difference ($p < 0.05$) in the IWV trend and its uncertainty, provided the inherent autocorrelation is factored in and the data span remains. We also find that given the IWV time series length, the spread calculated from the estimated trends varying the start point of the time series, follows an exponential decrease $\sigma(\Delta t) = 22\Delta t^{-1.7} + 0.008$.