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Refractivity fluctuations in space geodetic measurements – case study GPS carrier phase observations

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The incomplete knowledge of the atmospheric composition and dynamics along the signal path is still an accuracy limitation for parameter estimation based on space geodetic techniques. Besides the steady-state component (generally well described by empirical models), the dynamic processes in the atmosphere leads to fluctuations of the refractivity that are rarely considered during the analysis of space geodetic observations. Based on turbulence theory, we have previously proposed a new variance-covariance-model to account for the physical correlations of GPS phase observations induced by refractivity fluctuations in the troposphere.

In this paper, we analyse the sensitivity of the covariances with respect to the wind velocity and direction. We compare the empirical auto-correlation functions with those predicted by the model for different wind directions and velocities using the double-differenced phase data from a specially designed test network. We show that the geostrophic wind direction and velocity, which can be easily derived from isobaric maps or numerical weather models, are appropriate to explain the correlation and decorrelation processes. Consequently this new variance-covariance model contributes to model the complex processes in the lower atmosphere and to the adequate treatment of physical correlations between GPS observations in the GPS data analysis. The model is directly applicable to VLBI observations. Furthermore, it can be used as an adequate apriori model for the stochastic estimation of tropospheric wet delays.