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Power-law behaviour of GPS phase observations reflecting atmospheric turbulence

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It is commonly known, that the uncertainty of GPS derived results, like e.g., tropospheric zenith delays or station coordinates, tends to be too optimistic. One possible explanation is that the stochastic model is still incomplete since physical correlations induced by atmospheric fluctuations are not modelled. In this contribution we treat the atmospheric fluctuations by turbulence theory. To deal with non-stationary effects, structure functions D(r) are used, where r is the spatial distance between two stations. The power-law for D(r) is 5/3 and 2/3 for r, considering the three-dimensional and the two-dimensional situation, respectively.

A GPS experiment was specially designed to study the physical correlations of GPS phase observations. Time series were computed for undifferenced GPS phase observation of the ionosphere-free linear combination as well as double differenced L1 observations yielding to the required structure functions. Besides the temporal variation of the power-law exponent, the impact of the receiver satellite geometry is studied with special emphasis on the break point of the 3d to 2d turbulent process. It is shown that an increase of the temporal or spatial separation between the ray paths of GPS observations decreases the degree of correlation and thus the exponent.