Intrinsic random functions for mitigation of atmospheric effects in ground based radar interferometry

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Abstract. The potential benefits of terrestrial radar interferometry (TRI) for deformation monitoring are overshadowed by the influence of changing meteorological conditions contaminating the potentially highly precise measurements with spurious deformations. This is the case especially when the measurement setup includes long distances between instrument and objects of interest and the topography affecting atmospheric refraction is complex. These situations are typically encountered with geo-monitoring in mountainous regions, e.g. with glaciers, landslides or volcanoes.

We propose and explain an approach for the mitigation of atmospheric influences based on the theory of intrinsic random functions of order k (IRF-k) generalizing existing approaches based on ordinary least squares estimation of trend functions. This class of random functions retains convenient computational properties allowing for rigorous statistical inference while still permitting to model stochastic spatial phenomena which are non-stationary in mean and variance. We explore the correspondence between the properties of the IRF-k and the properties of the measurement process. Drifts in variance are linked to the additive nature of atmospheric effects along the propagation path and to the irregularity of the terrain.

In an exemplary case study, we find that our method reduces the time needed to derive reliable estimations of glacial movements from 12h down to 2h. We relate the estimated error variance of the results to details of our measurement campaign like roughness of terrain, altitude differences and involved distances thus indicating how this method is expected to perform when applied under different conditions.