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Spatial rainfall downscaling based upon Local Singularity Analysis and Kriging

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In this work a conceptually simple stochastic spatial downscaling method, based upon the techniques of local singularity analysis (LSA) and ordinary kriging (OK) interpolation, is proposed and tested. The method is suited for generation of gridded fine-resolution rainfall estimates and comprises two steps: (1) LSA is employed to extrapolate finer resolution rainfall samples disjointly located at the centre of the pixels of the rainfall data at the original resolution; (2) OK is then employed to interpolate these samples and generate a complete rainfall field at the desired spatial resolution. The LSA and OK estimation errors are then used to model the overall downscaling uncertainty and to stochastically generate realisations of the finer-resolution rainfall field. The proposed method is tested using as case study four storm events (two stratiform and two convective ones) observed in London (UK) between January 2015 and January 2016 and for which fine resolution radar rainfall estimates were available. For the selected storm events, downscaling is conducted from 1600 m to 400 m resolution. Furthermore, the results of the proposed method are compared against those obtained with the well-known log-Poisson multifractal downscaling model. The proposed downscaling method was shown to be able to generate fine-resolution rainfall fields which reproduce well both fine scale rainfall structures and values not initially observed at coarser resolutions, while also preserving the spatial variability and global statistics of rainfall fields. As compared to the log-Poisson downscaling, the proposed method generally displays a better quantitative performance (with lower root mean square errors) and leads to more spatially structured rainfall fields which display a higher correlation with the fine resolution observations. The conceptual simplicity and performance features of the proposed downscaling method make it suitable for a range of hydro meteorological applications.