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# Beyond optimal estimation: An ensemble spatial precipitation analysis and its application for area-mean extremes in Switzerland

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A major limitation of traditional interpolation of precipitation from rain gauges is that estimates are subject to conditional bias. This commonly manifests itself in too smooth fields, too many wet-days, and too few heavy precipitation events. Conditional bias and attendant scale ambiguities are an aggravating difficulty in applications. Most importantly, they compromise climate applications with a focus on extremes, such as the inference of extreme return levels for area-mean precipitation. The ultimate reason for conditional bias is that interpolations are optimal estimators, aiming for the single estimate with the smallest expected error. Remedy requires shifting away from the one single best estimate to an ensemble of possible realizations, characterizing, together, the involved interpolation uncertainty.

This contribution starts by illustrating the connection between conditional bias and optimal estimation, using idealized interpolation experiments. We then introduce, as alternative to optimal estimation, an ensemble technique that delivers a set of precipitation fields (realisations), consistent with the available rain-gauge observations. Our development extends conditional simulation techniques that were previously proposed. Results will be presented from an application for daily precipitation over the territory of Switzerland and over a period of more than 50 years. Compared to the classical single estimate analysis, ensemble members exhibit more realistic fine-scale structures and yield local extremes between measurements. The ensemble dataset lends itself for the derivation of extreme return levels of area-mean precipitation for river catchments. Results from such an application will be illustrated for a hydrological partitioning of Switzerland. The estimated return levels exhibit plausible spatial variations and dependencies on catchment area. We also provide insight into the relative contribution of interpolation errors and limited observation period to the uncertainty in the estimated return levels.