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How uncertainty distorts the climate of precipitation grids – And how one can avoid it

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Interpolation of precipitation from rain gauges is usually associated with considerable uncertainty, particularly at short time scales (e.g. daily precipitation). It seems desirable to choose analysis methods that provide estimates with small (minimal) expected errors. Unfortunately, minimizing errors in the presence of large uncertainty entails conditional biases, which compromise the climatological characteristics of the resulting grid: Fields are, in general, too smooth, wet-areas are overestimated and extremes underestimated. The biases directly affect the utility of precipitation grids, such as for hydrological modelling, climate model evaluation, and trend analysis, as has been highlighted in the literature. An explicit account of uncertainty by means of probabilistic precipitation analysis, i.e. with ensembles, can avoid these limitations.

In a first part, this contribution aims at explaining and illustrating the sketched chain of effects from uncertainty and optimal estimation to climatological deterioration. To this end interpolation experiments will be conducted with surrogate, stochastically generated precipitation fields. The experiments illustrate, for example, how biases in extremes relate to local station density and to the scale nature of precipitation. They also pinpoint to worrying artefacts caused by temporal variations in station density. In a second part, the presentation illustrates how a probabilistic (ensemble) analysis can avoid these limitations. The method is applied to high-resolution rain-gauge data over the territory of Switzerland to yield 50-member ensembles of daily precipitation fields on a 1-km grid. The members exhibit more realistic fine-scale structures with local extremes between measurements. The ensemble dataset will also be used to illustrate the magnitude of uncertainties in precipitation gridding.

This presentation is meant to share a recent learning step of the author. The arguments are not new, basically, but they are often overlooked in the métier, or confused with notions like “effective resolution” or “representativity error”. To advance our craft, it is worth reviewing, now and then, some of the principles behind our tools.