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Extracting gridded probability density functions for precipitation intensity from point measurements

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A common complication arising in comparisons of modeled data, e.g. from regional climate models or re-analysis, to measurements, e.g. rain gauge data collected at a single position, is that the resolutions do not match. Thereby, a direct comparison of the probability density functions of precipitation rates is not possible, since the gridded data represent an average over an area and a time interval while the point data represent only a temporal average. The spatial resolution of the point data can be considered "infinitely high". This especially constitutes an obstacle in statistical downscaling approaches such as statistical bias correction, or the proper assessment of extremes as computed by climate models.

It is well known from the Taylor hypothesis that considerable spatio-temporal information about a dynamical process, such as the eddies of the atmospheric flow, is already contained in a point measurement. Applying the Taylor hypothesis to the statistical distribution functions of precipitation intensity, we show that a gridded spatio-temporal process can be approximated very well by the zero-dimensional analog, i.e. the statistics at a single point. All that needs to be done is to use a coarser temporal resolution for the point timeseries, when comparing to the gridded data, i.e. much better results can be achieved when coarsening the resolution of the point data. The remaining question is, how to extract the proper "scale-adapted" temporal resolution in practice, when only an observed point timeseries and some gridded model data sets are available. We show that this is indeed possible by use of the model alone. Indeed, we find that models which misrepresent precipitation intensity, still serve well in producing proper scale-adaptation, i.e. the model is sufficient in representing larger-scale atmospheric dynamics even though precipitation formation is misrepresented. Our results may have relevance to improved statistical downscaling as well as the assessment of model produced extremes, in particular in data sparse regions where dense measurement networks are not available.