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Filling gaps in urban temperature observations by debiasing ERA5 reanalysis data

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Gaps in urban meteorological time series are a widely known phenomenon, occurring in all sorts of urban datasets, ranging from crowd-sourced data till urban climate networks. These gaps cause a problem, since they complicate the analysis and further use of the dataset. Various gap-filling techniques exist to tackle gaps in meteorological time series, including the debiasing of ERA5 reanalysis data. Unfortunately, the evaluation of these ERA5 debiasing techniques are often performed separately and limited to rural locations. Since the ERA5 bias is highly pronounced for urban locations, a good understanding of the performances of the debiasing techniques with respect to urban data is crucial to obtain accurate gap-filling estimates.

To gain a better insight into the most optimal gap-filling techniques for urban temperature time series, we compared five techniques, including three different debiasing techniques that employ a learning period and time window to take into account the seasonal and diurnal characteristics of the ERA5 temperature bias. The evaluation, which is performed by filling manually constructed gaps, shows that small gaps are ideally filled by linear interpolation, while for larger gaps the best performance is obtained through the ERA5 debiasing techniques. For urban locations, the results indicate that it is crucial to correct for the ERA5 bias. We also investigated the most optimal length and placement of the learning period and time window, although the settings of these parameters do not seem to have a significant impact on the gap-filling performance. Based on these results, we designed a gap-filling algorithm that efficiently fills a series of gaps in urban temperature time series by selecting the most optimal gap-filling procedure for each gap. This newly designed algorithm is able to successfully reproduce the urban heat island effect, although a small over- or underestimation might occur.