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Spatio-temporal representativeness of ground-based downward solar radiation measurements

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Surface solar radiation (SSR) is most directly observed with ground based pyranometer measurements. Besides measurement uncertainties, which arise from the pyranometer instrument itself, also errors attributed to the limited spatial representativeness of observations from single sites for their large-scale surrounding have to be taken into account when using such measurements for energy balance studies. In this study the spatial representativeness of 157 homogeneous European downward surface solar radiation time series from the Global Energy Balance Archive (GEBA) and the Baseline Surface Radiation Network (BSRN) were examined for the period 1983-2015 by using the high resolution (0.05°) surface solar radiation data set from the Satellite Application Facility on Climate Monitoring (CM-SAF SARAH) as a proxy for the spatiotemporal variability of SSR.

By correlating deseasonalized monthly SSR time series form surface observations against single collocated satellite derived SSR time series, a mean spatial correlation pattern was calculated and validated against purely observational based patterns. Generally decreasing correlations with increasing distance from station, with high correlations ($R^2 = 0.7$) in proximity to the observational sites ($\pm 0.5°$), was found. When correlating surface observations against time series from spatially averaged satellite derived SSR data (and thereby simulating coarser and coarser grids), very high correspondence between sites and the collocated pixels has been found for pixel sizes up to several degrees. Moreover, special focus was put on the quantification of errors which arise in conjunction to spatial sampling when estimating the temporal variability and trends for a larger region from a single surface observation site. For 15-year trends on a $1°$ grid, errors due to spatial sampling in the order of half of the measurement uncertainty for monthly mean values were found.