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Developing a gridded global radiation dataset for Germany

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Reference climate datasets are required for assessing the impacts of climate change on different economic sectors. Besides long time series of temperature, precipitation and humidity, also global radiation data are needed, e.g., as an input to hydrological models for assessing evapotranspiration or soil moisture. Furthermore, reference climate datasets are essential for the validation of climate simulations and for adjusting the bias of regional climate projections. Such reference datasets are developed for Germany within topic 1 “Adapting transport and infrastructure to climate change and extreme weather events” of the Network of Experts. Gridded datasets with a spatial resolution of 5 km x 5 km are developed for period 1951–2015 based on daily station time series.
Here, the approach of generating a global radiation dataset is introduced. The density of stations with global radiation measurements is – particularly in earlier decades – insufficient for the target resolution of the gridded dataset. Thus, sunshine duration measurements – providing a considerable higher station density – are employed in addition. Sunshine duration is converted into global radiation using the Ångström relationship. For this purpose, the study area is divided into six regions with similar climatological characteristics containing at least one station with simultaneous measurements of sunshine duration and global radiation. The Ångström coefficients describing the relationship between sunshine duration and global radiation are determined for period 1981–2010 for each of these six regions. Sunshine duration measurements are converted into global radiation data for the entire study period assuming that the relationship described by the Ångström coefficients is temporarily constant. The gridding of the resulting station based global radiation dataset is done in two steps by adding the interpolated residual field to a background field. The calculation of the background field is based on a digital elevation model and long-term monthly structures of the radiation field derived from a principal component analysis of the global radiation satellite data set CM-SAF. The interpolation of the differences between the measurements and the multiple linear regression results is done using inverse distance weighting.