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Spatial representativeness of ground-based solar radiation measurements estimated from high-resolution Meteosat data

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The validation of gridded surface solar radiation (SSR) data often relies on the comparison with ground-based in-situ measurements. This poses the question on how representative a point measurement is for a larger-scale surrounding. We use the high-resolution (0.03°) SIS MVIRI data from the Satellite Application Facility on Climate Monitoring (CM SAF) to study the spatial sub-grid variability in all-sky surface solar radiation (SSR) over Europe, Africa, and parts of South America as covered by the Meteosat disk. This is done for the CERES EBAF 1° standard grid and two equal-angle grids of 0.25° and 3° resolution. Furthermore, we quantify the spatial representativeness of numerous surface sites from the BSRN and the GEBA for their site-centered larger surroundings varying in size from 0.25° to 3°, as well as with respect to the given standard grids. These analyses are done on a climatological annual and monthly mean basis over the period 2001–2005.

The annual mean sub-grid variability (mean absolute deviation) in the 1° standard grid over European land is on average 1.6% (2.4 Wm^{-2}), with a maximum of up to 10% in Northern Spain (Hakuba et al. 2013). As expected, highest sub-grid variability is found in mountainous and coastal regions. The annual mean representation error of point values at 143 surface sites in Europe with respect to their 1° surrounding and the 1° standard grid is on average 2% (3 Wm^{-2}). For larger surroundings of 3°, the representation error increases to 3% (4.8 Wm^{-2}), which is of similar order as the measurement accuracy of in-situ observations. Most of the sites can thus be considered as representative for their larger surroundings of up to 3°, which holds also true for the majority of BSRN sites located in Africa and South America. This representation error can be reduced if site-specific correction factors are applied or when multiple sites are available in the same grid cell, i.e. three more sites reduce the error by 50%. Overall, the sub-grid variability and representativeness of BSRN sites in Africa and South America are of similar magnitude and do not significantly exceed the findings (in %) for Europe.

Reference:
Hakuba, M.Z., Folini, D., Sanchez-Lorenzo, A., and Wild, M. 2013: Spatial representativeness of ground-based solar radiation measurements, J. Geophys. Res., 118, 8585–8597, doi:10.1002/jgrd.50673.