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Towards a global mean partitioning of solar absorption

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In a previous study, we have estimated the mean-state partitioning of absorbed solar radiation over Europe through the combination of surface-based and space-born observations of solar radiation, which yielded best estimates of European land annual mean surface and atmospheric absorption of 117 $\pm$6 Wm^{-2} (42 $\pm$2 % of TOA incident irradiance) and 65 $\pm$3 Wm^{-2} (23 $\pm$1 %). The fractional atmospheric absorption of 23% was found to be largely unaffected by variations in latitude and season. Here, we extend this study to the global scale, again by combining in-situ measurements of surface solar radiation (BSRN, GEBA) with satellite-based surface albedo (MODIS), and top-of-atmosphere net incoming solar radiation (CERES EBAF, 1° grid).

Preliminary results are in line with the European mean with fractional atmospheric absorption of around 22-24% found in various regions of the globe where direct observations are available. The partitioning as represented by the CERES EBAF dataset is validated against our reference dataset and supports the finding of a spatially and seasonally fairly robust fractional atmospheric absorption, making it a potentially useful quantity for first order validation of global climate models.

To obtain best possible reference estimates and associated uncertainties, we study the spatial representativeness of the point observations for their collocated 1° CERES EBAF grid cells, using a high-resolution satellite-derived surface solar radiation product (CM SAF). This product is spatially limited, hence only regions covered by the METEOSAT disk can be analyzed with respect to sub-grid variability and point representativeness. The so-called spatial sampling errors and associated uncertainty are of similar magnitude as the uncertainty of monthly mean pyranometer measurements.

Other sources of uncertainty arise mostly from the measurements themselves, in particular surface albedo and ground-based solar radiation. Uncertainties due to the multiplicative combination of spatially averaged surface solar radiation and surface albedo estimates, and the spatial representativeness of the point observations are either negligibly small or can be corrected for.