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Which effective solar zenith angles to use for hourly irradiation measurements?

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Time-series of in situ or satellite-derived measurements of hourly irradiation on horizontal surface are increasingly available. In many cases, such data are input to numerical procedures that can be performed only if a solar zenith angle can be associated to each measurement. Currently, only time stamp is given for each measurement; no angle is given. The solar zenith angle is greatly varying within 1 h and cannot be considered as constant. In this context, there is a practical request from companies, academics, researchers...: what is the best practice for computing this angle? The work presented here compares the performances of several existing practices and makes recommendations keeping in mind the practical aspects faced by practitioners, companies, academics, researchers... High-quality 1 min measurements of global, diffuse and direct collected by the BSRN station in Carpentras in France, are aggregated to yield hourly irradiation, and used to assess the performances. It is found that several practices may be used to compute in a satisfactory way the effective solar zenith angle. The most accurate results are obtained if one may obtain corresponding irradiation values that should be observed under clear-sky conditions. The McClear Service available at <http://www.soda-pro.com> is one Web service providing such estimates of cloud-free irradiation for several summarizations, from 1 min to 1 month. If one may not obtain such cloud-free estimates, then the most accurate results are obtained from using irradiation at the top of atmosphere. Performances show a tendency to decrease during sunrise and sunset hours.