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Numerical computations of diffuse fraction of global irradiance on an hourly basis

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Solar Energy is the feedstock for various applications of renewable energy sources, thus, the necessity of using global tilted irradiance is acknowledged for the computations of the performance and monitoring of PV Parks and solar energy applications. In general, global tilted irradiance is computed as the sum of the beam component of direct irradiation on the tilted surface, diffuse tilted and reflected irradiance. These three components can be computed using only the values of Global horizontal and diffuse irradiance. However, although for some locations both global and diffuse irradiance are measured, in most locations, the data comprise measurements of only global horizontal irradiance, either measured on-site or determined from satellite data.

This research is based on a numerical analysis and the development of empirical correlations for the computation of the hourly diffuse fraction, based on the measurements of the clearness index. The solar altitude is included as a parameter in the computations in order to reduce the error in the computations, since it embraces the effect of the different time and date in the computations.

The derived numerical equations are presented in terms of the solar altitude in steps of 5 degrees and are validated using data from the meteorological station of Athalassa, Cyprus, for a ten year period (2001-2010). The statistical analysis from the comparison (in terms of R-squared and RMSE) showed better results for higher elevation angles, compared to the lower elevation angles that represent the early morning or late afternoon times.