



## Assessment of angular distribution model of radiance: a comparison of the CIE model output with radiation transfer calculations.

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The angular distribution of solar downwelling at Earth surface is of interest namely for emerging applications such as in building design and management (energy efficiency, visual and thermal comfort).

The operational service of CAMS Radiation, named McClear, is a webservice providing the three solar downwelling irradiance components global, diffuse, direct normal on the ground under clear sky conditions from CAMS data with good accuracy ((Lefèvre et al., 2013), (Gschwind et al., 2019)). In preparation to the extension of McClear capabilities, we consider the CIE modelling approach (Darula and Kittler, 2002) as a natural option because it is widely used in the literature. The CIE modelling approach consists in the product of two functions: (1) the scattering function that relates the relative radiance of a sky feature to its angular distance from the sun and (2) the gradation function that explains the variation of the radiance with the angular distance of a sky element to the zenith angle. The basic assumption behind this approach is that the distribution of the radiation in the sky vault can be decomposed in these two functions. As a preliminary to the extension of McClear service, we would like to test the validity of this assumption. For this purpose, we have selected the Perez model (Perez et al., 1993, 1990) that is based on the CIE approach and show good performances (Alshaibani et al., 2020; Darula and Kittler, 2002).

We compared the downwelling angular solar radiance at the surface of the Earth calculated by the Perez model and by the Radiative Transfer Model libRadtran a software package used for radiative transfer calculations such as the distribution of the spherical radiance and irradiance (Mayer and Kylling, 2005) also used as basis of McClear irradiance model. In this comparison, we consider several meteorological situations with different atmospheric composition in ozone, water vapor, aerosols loads, etc., but also with different Sun-Earth geometry and different bidirectional reflectance distribution function (BRDF) of the ground. This investigation was beneficial to evaluate the domain of validity of the CIE approach assumption. We described the methodology, discuss the results in view of the targeted application. and we provide some idea for an alternative to the CIE approach to extend McClear in a radiance model.

