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Decoupling the effects of clear atmosphere and clouds to simplify calculations of the broadband solar irradiance at ground level

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Abstract. In the case of infinite plane-parallel single- and double-layered cloud, the solar irradiance at ground level computed by a radiative transfer model can be approximated by the product of the irradiance under clear atmosphere and a modification factor due to cloud properties and ground albedo only. Changes in clear-atmosphere properties have negligible effect on the latter so that both terms can be calculated independently. The error made in using this approximation depends mostly on the solar zenith angle, the ground albedo and the cloud optical depth. In most cases, the maximum errors (95th percentile) on global and direct surface irradiances are less than 15 W m^{-2} and less than 2 – 5% in relative value. These values are similar to those recommended by the World Meteorological Organization for high-quality measurements of the solar irradiance. Practically, the results mean that a model for fast calculation of surface solar irradiance may be separated into two distinct and independent models, possibly abacus-based, whose input parameters and resolutions can be different, and whose creation requires less computation time and resources than a single model.

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