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Comparison between measurements and model simulations of solar radiation at a high altitude site: case studies for the Izaña BSRN station

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A detailed comparison between estimated radiation from radiative transfer models and high-quality radiation observations have been performed for the global, direct and diffuse component of the radiation in order to know the main characteristics of the solar radiation behavior at the Izaña Baseline Surface Radiation Network (BSRN) station. The model simulations were calculated with the LibRadtran package using current available input parameters (i.e. total ozone, column water vapor, aerosol optical depth –AOD). Izaña is a high altitude (2.367 m. above sea level) Global Atmospheric Watch station.

In this work, selected cases corresponding to the most common atmospheric conditions at the Izaña station, were analyzed: (1) cloud-free conditions with the presence of a stratocumulus layer below the station level, and (2) African dust intrusions. Previously, a general sensitivity characterization of the LibRadtran model to changes in the main input parameters carried out. The sensitivity caused by changes in altitude, effective surface albedo, column water vapor, and AOD on global, direct and diffuse irradiances was analyzed. The model sensitivity tests showed that the factors that exert more influence on the simulated radiation components are the altitude and the AOD, with the local specific characteristic of the high "surface albedo" caused by the nearby quasi-permanent stratocumulus sea of clouds.

The results for the "cloud-free" case study and for solar zenith angles (SZA) lower than 70º, show an underestimation of the simulations for the global, direct and diffuse components. The relative differences were at most of 2.7%, 3.0% and 9.9% for the global, direct and diffuse components, respectively, with corresponding root mean square errors (RMSE) of 3.8%, 2.7% and 6.1%.

For the "dust intrusion" case study and for SZA lower than 70º, the simulations of the global and diffuse components are overestimated whereas the diffuse component is underestimated. The largest relative differences were -2.5%, 4.2% and -13.7% for the global, direct and diffuse components, respectively. The corresponding RMSE values were 1.8%, 7.7% and 9.4%, respectively.

The results in both case studies show a reasonably good agreement between simulations and measurements, being always within the instrumental error for the global and direct components, but not for the diffuse component. The discrepancies found for the diffuse component are due to the uncertainties of observations, and to the difficulty to evaluate the contribution of the actual surface albedo or "effective albedo" driven by a vast sea of clouds below the station level.
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