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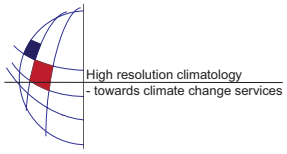

Assessment of performances of sun zenith angle and altitude parameterisations of atmospheric radiative transfer for spectral surface downwelling solar irradiance

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Satellite-derived assessments of surface downwelling solar irradiance are more and more used by engineering companies in solar energy. Performances are judged satisfactory for the time being. Nevertheless, requests for more accuracy are increasing, in particular in the spectral definition and in the decomposition of the global radiation into direct and diffuse radiations. One approach to reach this goal is to improve both the modelling of the radiative transfer and the quality of the inputs describing the optical state. Within their joint project Heliosat-4, DLR and MINES ParisTech have adopted this approach to create advanced databases of solar irradiance succeeding to the current ones HelioClim and SolEMi.
Regarding the model, we have opted for libRadtran, a well-known model of proven quality. As many similar models, running libRadtran is very time-consuming when it comes to process millions or more pixels or grid cells. This is incompatible with real-time operational process. One may adopt the abacus approach, or look-up tables, to overcome the problem. The model is run for a limited number of cases, covering the whole range of values taken by the various inputs of the model. Abaci are such constructed. For each real case, the irradiance value is computed by interpolating within the abaci. In this way, real-time can be envisioned. Nevertheless, the computation of the abaci themselves requires large computing capabilities. In addition, searching the abaci to find the values to interpolate can be time-consuming as the abaci are very large: several millions of values in total. Moreover, it raises the extrapolation problem of parameter out-of-range during the utilisation of the abaci.
Parameterisation, when possible, is a means to reduce the amount of computations to be made and subsequently, the computation effort to create the abaci, the size of the abaci, the extrapolation and the searching time. It describes in analytical manner and with a few parameters the change in irradiance with a specific variable. The communication discusses two parameterisations found in the literature. One deals with the solar zenith angle, the other with the altitude. We assess their performances in retrieving solar irradiance for 32 spectral bands, from 240 nm to 4606 nm. The model libRadtran is run to create data sets for all sun zenith angles (every 5 degrees) and all altitudes (every km). These data sets are considered as a reference. Then, for each parameterisation, we compute the parameters using two irradiance values for specific values of angle (e.g., 0 and 60 degrees) or altitude (e.g., 0 and 3 km). The parameterisations are then applied to other values of angle and altitude. Differences between these assessments and the reference values of irradiance are computed and analysed.
We conclude on the level of performances of each parameterisation for each spectral band as well as for the total irradiance. We discuss the possible use of these parameterisations in the future method Heliosat-4 and possible improvements.
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