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Regional validation of the solar irradiance tool SolaRes in clear-sky conditions, with a focus on the aerosol module
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General Comments:

This manuscript compares the solar irradiance under clear sky conditions simulated by the SolaRes (solar resource estimation tool) at two sites with ground-based solar irradiance observations, evaluating the impact of different cloud-screening procedures and the incorporation of aerosol optical characteristics from different sources on the simulation results. The study indicates that SolaRes performs well in the study area when using AERONET AOT. The research content aligns with the publication scope of the Atmospheric Measurement Techniques journal, and **publication is recommended after revisions**.

Thank you for your comments. Please find our answers below each of the comment (in bold).

Specific Comments:

1) The English grammar and structure of the manuscript need further improvement. Excessive forward and backward references make the article difficult to read. The abstract contains a lot of content but does not clearly explain the purpose of the research.

English grammar has been revised in this new version, as well as the abstract and many parts of the manuscript, as can be seen in the version with corrections.

We removed some "**forward and backward references**" for clarity. We also hpe that the changes improve the structure.

2) When assessing the impact of aerosol optical properties on the simulated results in the manuscript, the aerosol scattering phase function and single scattering albedo (SSA) are derived from different aerosol models. Due to the influence of various factors such as aerosol size distribution, chemical composition, hygroscopicity, morphology, etc., and their values vary with altitude, a thorough analysis of the corresponding errors should be conducted.

To resolve the radiative transfer, optical properties are required, as the aerosol scattering and absorbing properties. Some of the required aerosol optical properties can be delivered by measurements, as aerosol optical thickness by AERONET. However, measurements rarely provide all necessary optical properties at all wavelengths. Strategies are then required to extrapolate the measurements. One approach is to estimate the microphysical properties reproducing the measurements, which are then used to compute any required optical properties, as done here with the 2-model mixing approach.

As SolaRes is fed with aerosol optical properties and not microphysical properties, we judge that a thorough analysis of the errors caused by microphysical properties (which are the size distribution, the refractive index (describing the chemical nature), the shape, …) is out of the scope of the paper. Anyway, some sensitivity studies are performed based on optical properties.

A sensitivity study of DNI is presented in a proceeding paper by Elias et al. [2019], and the main factor in DNI is AOT and a secondary factor is the Angstrom exponent. Witthuhn et al. [2021] show that the main contributor to RMSE in both GHI and DNI is AOT.

In the paper we show the influence of AOT by showing scores in different seasons (Section 5), and by using the CAMS source instead of AERONET (Section 6.3). Moreover, in the response of reviewer #1, we also show the sensitivity of the comparison scores to the AOT range. With the Garcia cloud-screening method, MBD and RMSD in GHI are -0.6% and 1.6%, respectively, for AOT < 0.2, and increase to -1.3% and 2.2%, respectively, for AOT>0.2.

In the paper, we also show that exploiting the spectral AOT (giving the Angstrom exponent) to model aerosols in SolaRes allows to sufficiently constrain the aerosol size distribution, given the good comparison scores in DNI and GHI, and that the AERONET-inverted model does not significantly improve the performance in DNI (Section 6.2).

We also show the influence of the aerosol single scattering albedo (SSA) by changing the aerosol models (Section 6.1), and it is significant in DifHI. For example MBD in DifHI varies from 2,2% to 12.3% when the large-α model changes from continental clean to urban (small- α model being desert dust).

The vertical profile of aerosol extinction has no influence on DNI, as it depends on the accumulated atmospheric extinction along the path, and has little influence on DifHI.

3) The two sites used by the authors for evaluation are relatively similar and both belong to regions with low aerosol loading, thus their representativeness is limited. If observational data from other sites with different aerosol concentrations and sources could be included, it would contribute to a better assessment of the application of SolaRes.

The answer here is equal to the answer to a comment by reviewer #1:

Our region of study, northern France is significantly influenced by anthropogenic aerosol sources, and particulate pollution episodes (Chebaicheb et al., 2023), especially those producing nitrates (Drugé et al., 2019) with a diversity of local and regional origins (Potier et al., 2021).

Aerosol variability is large at Lille and Palaiseau, with standard deviation in aerosol optical thickness (AOT) and in the Angstrom exponent (α) reaching 70% and 30%, respectively. The mean AOT level is moderate with an annual average of 0.14 at 500 nm (Table 3), close to the European average according to Gueymard and Yang [2020], based on AERONET, which is larger than the average in North America. According to the Köppen–Geiger climate classification, both sites are affected by a climate similar to western Germany [Witthuhn et al., 2021], and similar to England, Ireland, Belgium, Netherlands (Cfb). The annual averages at Lille and Palaiseau are also close to the Cfb average [Gueymard and Yang, 2020]. AOT is 0.16 in spring-summer at Lille, the 90th percentile over a year is 0.32. There are a number and a variety of recorded aerosol events (as volcanic plumes, Derimian et al., 2012, Boichu et al., 2016), including heavy regional pollution events. For example in March 2014 in Lille and Palaiseau (Dupont et al., 2016, Favez et al., 2021), measured AOD reached values up to 0.9, such that this can be classified as a severe aerosol pollution event, and such kind of events are recurrently observed in spring over this part of Europe.

Moreover, these two sites are appropriate to test the cloud-screening techniques, as the cloud influence is strong and highly variable in the region.

We consequently judge that these sites are good candidates to validate SolaRes in variable clear-sky conditions. But we agree that these sites are not fully representative of the global variability in terms of aerosol properties, it is why we chose to specify "regional validation" in the title. This article can be considered as a first step of a larger and comprehensive validation process of SolaRes, focusing on typical aerosol conditions of northern Europe in clear-sky conditions. Among our perspectives, we will consider additional aerosol conditions (in type and load) over other continents and also provide all-sky conditions evaluation of the algorithm.

The DNI approach (inspired from ASoRA) was already validated at Ouarazate, in Morocco, nearer the desert dust sources [Elias et al., 2021] than both Lille and Palaiseau.

A paragraph is added in Section 2 to justify the choice of these 2 sites.

Chebaicheb, H., Joel F. de Brito, Gang Chen, Emmanuel Tison, Caroline Marchand, et al.. Investigation of four-year chemical composition and organic aerosol sources of submicron particles at the ATOLL site in northern France. Environmental Pollution, 2023, 330, pp.121805. 10.1016/j.envpol.2023.121805 . Hal-04146486.

Drugé, T., Nabat, P., Mallet, M., and Somot, S.: Model simulation of ammonium and nitrate aerosols distribution in the Euro-Mediterranean region and their radiative and climatic effects over 1979–2016, Atmos. Chem. Phys., 19, 3707–3731, https://doi.org/10.5194/acp-19-3707-2019, 2019.

Gueymard, C. A., D. Yang, Worldwide validation of CAMS and MERRA-2 reanalysis aerosol optical depth products using 15 years of AERONET observations, Atmospheric Environment, 225, 2020, 117216, https://doi.org/10.1016/j.atmosenv.2019.117216.

Potier, E., Waked, A., Bourin, A., Minvielle, F., Péré, J., Perdrix, E., Michoud, V., Riffault, V., Alleman, L., and Sauvage, S.: Characterizing the regional contribution to PM10 pollution over northern France using two complementary approaches: Chemistry transport and trajectory-based receptor models, Atmospheric Research, 223, 1–14, https://doi.org/https://doi.org/10.1016/j.atmosres.2019.03.002, 2019.

4) Line 793: "Small/larger aerosol model" is not a common expression.

We propose to name these 2 categories of aerosol model as large- α and small-α, α standing for the Angstrom exponent, instead of "small" and "larger", respectively.