

## ***Interactive comment on “Improved retrieval of direct and diffuse downwelling surface shortwave flux in cloudless atmosphere using dynamic estimates of aerosol content and type: application to the LSA-SAF project” by X. Ceamanos et al.***

### **Anonymous Referee #1**

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"Improved retrieval of direct and diffuse downwelling surface shortwave flux in cloudless atmosphere using dynamic estimates of aerosol content and type: Application to the LSA-SAF project" describes and assesses in detail a novel algorithm to derive surface shortwave radiation parameters from satellite observations, taking into account a combination of aerosols. This work is very significant, as direct and diffuse downwelling surface radiation fluxes are very useful in a number of meteorological and climate modelling activities. The method presented here appears to bring a large improvement in the quality of remotely observed DSSF, and the distinction between direct and diffuse

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fluxes, even though it is more sensitive to the aerosol load and errors are thus higher, are a definite plus. These results will be useful and used in a number of observing and modelling activities. They are also a novel and intelligent way of making use of the MACC-II reanalysis and near-real time aerosol products. The new products that are proposed (direct and diffuse surface downwelling fluxes, atmospheric radiative forcing of specific gases or aerosol species) are extremely appealing.

The SIRAMix algorithm is clearly explained, and the paper is overall well organized and easily readable. No major scientific shortcomings were spotted. The validation method (vs simulated observations, observations and state of the art algorithms) is sound. The sensitivity study brings more insight to the product and also to its limitations. A few remarks, comments and questions are listed below. A (non-exhaustive) list of minor corrections is also added.

- The proximity of this work to the modelling of the aerosol direct effect could be mentioned or discussed somewhere. This could place this work in a broader perspective and make more explicit the link between aerosol modelling and the method presented here. This could also provide more validation tools.
- Line 27 : "This outcome (ie the fact that the MACC-II aerosol forecasts are less accurate than the analysis) will be taken into account in the forthcoming implementation of SIRAMix in the operational production chain of the LSA-SAF project". How do the authors propose to address this issue?
- In section 2 line 194 : does there exist any reference for this formula?
- Line 293 : MACC-II provides forecasts up to 5 days ahead. There are 11 aerosol prognostic variables (and not 9) : for both OM and BC both the hydrophilic and the hydrophobic components are taken into account
- Lines 303-305 : the forecast time(s) concerned here should be mentioned
- Lines 318 - 325 : What is the impact of this height correction on AOD and on direct,

C1181

diffuse and global DSSF? While this step is necessary due to the wide difference in resolution between the MACC-II products and the satellite pixel, the vertical repartition of aerosols that is used in this algorithm (ie exponential decrease with height), while certainly adequate on a climatological range, can at times differ a lot to the observed or analysed aerosol load. This height correction algorithm could be a source of errors for the whole proposed method, for regions with a marked orography, since it was shown in section 3 that results are very sensitive to AOD. As the authors already use MACC-II products in their algorithm, wouldn't it be possible to also use the same products to assess dynamically the aerosol decrease as a function of height above the ground? This point would perhaps deserve more discussion.

- line 450 : the physical link between the errors on diffuse and direct fluxes should perhaps be more clearly explicated. Also, it appears that the positive bias (as compared to in situ observations and Mc Clear values) for the SIRAMix diffuse DSSF is more important than the negative bias of the SIRAMix direct DSSF, resulting in an overall small positive bias for the SIRAMix global DSSF. Is there any explanation for this?

- line 520 : a possible explanation of the higher RMSE for Tamanrasset and Sede Boqer (in addition to the fact that the aerosol load is generally much higher than other stations) is that the aerosol assimilation system of the MACC-II products uses MODIS observations of total AOD which are not available over deserts. This can affect the quality of the aerosol analysis over desertic areas.

- line 580 : the agreement between the global estimate of aerosol SRF provided by SIRAMix and study that provides local values over North Korea is not enough to validate the aerosol SRF product. There exists many papers and studies trying to quantify and model the aerosol direct effect that could help provide a broader validation.

Specific correction propositions (not exhaustive) :

- line 6 constant instead of unchanging

C1182

- line 10 : composed instead of constituted

- line 11 : "real" is optimistic. Observed or analysed would maybe fit better?

- line 19 : improve rather than decrease

- line 26 : issue instead of outcome

- line 35 : absence rather than lack

- line 36 : The latter particles

- line 39-40 : "On the other hand" is not necessary

- line 59 : In particular usually doesn't start a sentence. "A static climatological aerosol load doesn't match the variability of aerosols in space and time"

- line 61 : "...doesn't describe accurately enough the usual mixture..." instead of "...is not correct in front of the usual mixture..."

- line 66 "In front of" is not necessary. This sentence should be rewritten

- line 94 : existent instead of existing

- line 95 : "The upgrade consists of..."

- line 97 : "the abundance of which may vary with time and space". This part is not strictly necessary

- line 97 : "As explained"

- line 112 : Even though I see what you mean by "horizontally" (it refers to the surface and not the radiative flux), the term is misleading and should probably be removed.

- line 116-117 : this sentence should probably be move to the beginning of the section

- line 132-133 : ", on  $\mu_0$ ..., and on the factor  $v(t)$ ". Why not write  $\cos(\theta_0)$  in the formulae?

C1183

- line 170 : computed instead of calculated, single scattering rather than singly scattered
- line 173 : idem
- line 269 : to monitor the aerosols
- line 291 : there was also the MACC project in between GEMS and MACC-II
- line 299 : made available
- line 301 : delayed mode
- line 350 : "minor" should probably be removed
- lines 391-392 : "assesses the sensitivity of SIRMix to the variability of inputs" fits perhaps better
- lines 400-405 : while the difference between experiments 5 and 6 is clear when you go to the corresponding sections, it is not very clear as explained in these two bullet points. The sentence describing experiment 6 should probably be rewritten
- line 413 : "shows a comparison" instead of "compares"
- line 460 : "As can be seen"

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