We would like to thank the anonymous referee for his comments mentioning different points listed below. The reviewer's comments are in black, and the answers are in red. New information and explanations in the new version of the article are italicized.

Anonymous Referee 2

This paper is an important advance in providing better radiative transfer schemes in climate models. The redo of ARPEGE-Climate with longwave thermal IR scattering for large dust aerosols represents new work and is timely. The authors did a very nice job in presenting overall, with only minor English language issues. The authors can clean up some of the language issues and clarify the issue of monthly climatologies. The other problem is with the diagnostics that remove clouds ('clear sky') from a self-consistent climate model but assume that surface temperatures and water vapor are unchanged. These diagnostics should be removed or justified.

New information on the definition of clear-sky and all-sky diagnostics has been added to section 2.2: *"The various radiative diagnostics provided in this study have been computed in all-sky conditions and in clear-sky ones, as classically done. In clear-sky conditions, only clouds are removed, surface temperatures and water vapor remaining unchanged."*

Besides, we acknowledge the disadvantage of the clear-sky diagnostics is that they do not take into account the effects of water vapor, which is important for LW radiative budget. Therefore, this point has been clearly mentioned and Table 1 has been simplified, the results obtained under clear-sky conditions have been put in appendix.

Overall the paper is well written, an important contribution, and nearly ready to publish.

L35-48: This discussion is important here and should do a better job of helping the reader understand the basic physics of the atmosphere and radiative transfer:

- the 8-12 micron window is so well known because H2O and other gases blanket the longer wavelengths and shorter wavelengths; it has nothing to do with the aerosol properties.

We agree with the reviewer's comment. The following sentence has been modified in the text: *"Both Dufresne et al. (2002) and Sicard et al. (2014) underlined that the LW aerosol RF is maximum at wavelengths between 8 and 13 µm, as expected, while Sicard et al. (2014) indicated that large particles have a non-negligible effect in the 17 to 22 µm range at the TOA."*

- it would be nice to discuss what size aerosols need to be to affect this IR window (> 2 microns?), including a discussion of their Q vs effective radius here.

The impact of aerosol size on LW radiation is discussed in the fourth paragraph of the introduction, where we provide information from several publications. Regarding their Q, dust particles are generally weakly hygroscopic, and their ability to absorb water decreases with increasing size (Kumar et al. 2011).

L119: Since you do not calculate the scattering phase function for the aerosols, you are limited to RRTMG's two-stream scattering, which causes heating biases (at least in the uv-vis) over bright albedo regions (Hsu and Prather, 2021, Assessing uncertainties and approximations in solar heating of the climate system. JAMES, 13, e2020MS002131. doi: 10.1029/2020MS002131). Interestingly enough Hsu & Prather did not do LW scattering but only solar. There is nothing that can be done about the use of 2-stream here alas. The other 4+ stream RT codes are at GFDL and CCC.

Thank you for this interesting information. A sentence has been added to the text: *"The use of two-stream scattering in RRTM could also cause some heating biases in the UV and visible spectrum (Hsu and Prather, 2021).*

L153: I am confused as to whether you used AERONET to evaluate the monthly climatology used in your LWAS calculations or to evaluate the daily TACTIC results used to get the monthly means – that would make more sense, then you can use daylight only model data. Can you please evaluate the issues of diurnal aliasing with your TACTIC model? ARPEGE-Climat is using a climatology – right? Also, is the monthly climatology different for each year?

In this article, AERONET data are used to evaluate the 3D monthly climatology of aerosol concentrations used in the LWAS and NOLWAS simulations. The 10-year simulation using TACTIC, on which this climatology is based, was also evaluated with AERONET data in a previous article (Drugé et al. 2022). The issues of diurnal aliasing with our TACTIC model were notably mentioned in our previous article (Drugé et al. 2022). The climatology used here is the same for all years, but evolves monthly over the course of the year.

L162-165: This algorithm is a bit confusing, please make it clear what was done.

In order to have the most accurate comparison with the model, we decided to keep only AERONET monthly data with at least eight daily values to derive the mean of each month, and for a given month we keep only the stations with at least 3 monthly values over the 2000-2020 period. This data selection process has been clarified in the text.

L172. Since dust, esp. large dust, is non-spherical, please comment on the errors resulting form Mie assumption as opposed to using T-matrix or PingYang's ice crystal codes to get the scattering phase function.

Several studies, such as Bellouin et al. 2004 or Colarco et al. 2014, have shown that considering dusts as spherical in climate models has little impact on the DRE at the TOA. This information is given at the end of the fourth paragraph of the introduction.

L173: Glad to see new work on the RI of aerosols.

L218: I thought that the ARPEGE-Climat model being used here for LW scattering is just using an aerosol pre-calculated climatology – what does this r value mean – it should be daily, not monthly means I would expect. If you are evaluating the TACTIC run to generate the climatology, then this discussion needs to be revised.

Correlation coefficients are calculated here to assess the monthly AOD simulated by the ARPEGE-Climat model, which effectively uses a 3D monthly climatology of aerosol concentrations, against the monthly climatology of AERONET AOD data.

L238: "several meteorological fields" You have only one or two meteorological fields (with and without LWAS). Maybe you mean diagnostics? or quantities?

Yes, we're talking about diagnostics here.

L243: These 4 months "cover" or "span" the period of max AOD, they do not "correspond" to it – the latter implies that they are the four months of max AOD.

Done. The sentence has been modified.

L245: "clear-sky" conditions are artificial and only in a model, what is the purpose here? You should focus on "all-sky" conditions. Also you need the full climate response in ARPEGE since the surface T is changing. This discussion is odd – who cares if it is more significant in clear-sky? We are talking climate and monthly mean aerosols!

We have reoriented slightly our study which now focuses mainly on results under “all-sky” conditions. We have simplified our Table 1 but we kept the “clear-sky” section in Appendix as our results under “clear-sky” conditions show that the LW scattering of coarse aerosols has a direct impact on radiation. Furthermore, this distinction between “all-sky” and “clear-sky” is also often used in the scientific literature, so we thought it would be useful to provide this information, at least in the appendix.

L255: Here is the climate response – excellent.

L260: Very interesting climatic shift due to the LWAS, how significant is the change in high cloud (Fig 5) or convective rain – I did not notice any discussion of ensembles or climate variability?

In this study, the significance of changes between the two simulations (LWAS and NOLWAS) is tested using a Student's t-test (0.05 level). Indeed, a larger study, with several climate models or an ensemble of simulations would be very useful and interesting to support or not the different results of this study.

L304: How robust are these differences to issues of climate variability, and would having an interactive aerosol calculation (vs. monthly mean) change these results? e.g. large dust aerosol loading depends on wind shear, lack of cirrus, etc? Also the wind/rain biases in L334.

This study is based on the analysis of simulations carried out over a period of 30 years, which makes it possible to obtain robust and significant results despite climate variability. Having an interactive aerosol calculation could modify these results. Indeed, as these results are obtained with aerosol AOD averaged over the month, AOD peaks are not taken into account. Use an interactive aerosol scheme would make it possible to study the impact of aerosol scattering in the LW spectrum during strong wind events generating high dust AOD loads, or during heat waves, etc.

Correcting for wind and rain biases in the model would also provide a better estimate of the impact of aerosol LW scattering. In the northern part of the region studied in this study, a correction of these biases would result in a less strong AOD and therefore potentially smaller impacts and vice versa in the southernmost part of this region. It is important to note, however, that the strongest effects are not always co-localized with the strongest AODs.

L313: Does ecRad actually do 3D RT? (pardon my ignorance here)

The 3D effects of clouds are not taken into account in our simulations for reasons of computing cost. However, this option is available in ecRad with the SPARTACUS solver.

Table 1. The extensive comparison of All-sky vs Clear-sky is becoming too artificial. For SW, this is fine because water vapor does not affect much. Clouds are clearly correlated with the water vapor and hence just removing clouds without including their effect on water is misleading.

Table 1 has been simplified and the results obtained under clear-sky conditions have been put in Appendix. Moreover, new information and limitations on clear-sky and all-sky diagnostics have been added to section 2.2.

Figure 3. A lot of the colored signal here appears to be statistically not significant w.r.t. climate noise. There are some hatched areas, but most of your square are not. For Figure 4, the radiation is clearly significant, but the T is not.

In fact, not all diagnostics are affected in the same way by taking into account the LW diffusion of aerosols. These differences are discussed in the article. In addition, other diagnostics (LW heating rate, vertical velocity, temperature and specific humidity vertical profiles) have also been added and discussed in this study.

One odd question: does you model include LW scattering by cirrus and stratus? Can you comment on that impact (which would seem to be bigger issue than dust)?

Yes, the LW scattering by clouds is taken into account in our model. Cloud longwave scattering is frequently omitted in the radiation schemes of atmospheric models, even if it can increase longwave cloud radiative effect by around 10% globally (Costa and Shine, 2006).

150 Please finish the Dufresne 2002 reference by adding: 'doi:10.1175/1520-0469(2002)059<1959:LSEOMA>2.0.CO;21, 2002'

Done.