

The authors appreciate the effort from the reviewer and acknowledge his/her contribution to improving this manuscript. The replies are provided in red.

Reviewer 2

The manuscript titled “Assessment of light-adsorbing carbonaceous aerosol origins and properties at the ATOLL site in Northern France” appertains, by using the INTERPLAY integrated multi-step approach (with back trajectories and emission inventories, in-situ measurements), sources (shipping, vehicular, residential heating, industrial) of BC and BrC and their lifecycles, focusing on effect of aging processes on optical properties of BrC.

The manuscript is well structured and written, the research question is properly outlined and clearly addressed. Also, the methodology is exhaustively explained and consistent with the main objectives. References are appropriate and key studies included. The topic and the submitted study is very interesting, for the experimental integrated approach, and complete in discussing obtained results.

In my opinion, the study is valuable and could have a very good research sound for the research community, needing only some little refinements.

Thank you.

General comments

The applied approach is innovative, with uncertainties discussed in the conclusions, and easily scalable, being based on available/easily accessible data.

Apart from mentioning previous studies performed at ATOLL site and in Paris, are there other European sites with same measurements types to be compared? Please, report some of them and discuss results. The authors could have a look at these papers, about other sites belonging to the ACTRIS network: <https://doi.org/10.1016/j.atmosres.2017.10.004> & <https://doi.org/10.1016/j.atmosres.2020.104976>

The following sentence has been added including the reference for a recent review on multiple European sites on L.201:

“Those values are within other European cities, with BC (i.e. the sum of BC_{ff} and BC_{wb}) ranging from 0.7 to 1.7 $\mu\text{g m}^{-3}$, generally following an increasing trend from north to south (Savadkoohi et al., 2023).”

Line 163: according to which criterion is a minimum contribution of 20% of the total integrated BC chosen? Please provide references, in case some studies applied it before.

The threshold of 20% was used to find a balance between a representative number of points (at least 70 back trajectories) for the main sources. Increased percentage (e.g. 30%) has strongly affected the statistics without any meaningful impact on the obtained results for the most abundant sources. The test of the thresholds has been added in the supplementary information (Table S1).

Minor revisions

- The first and last statements of the abstract are almost equal. Delete one of them.

We propose to modify the last sentence, focusing particularly on the region of study, as:

“The results from this study allows for an improved understanding of sources and atmospheric dynamics of light-absorbing carbonaceous aerosols in northern France, being crucial for both source abatement strategies as well as a better assessment of their climate impact.”

- Regarding lifecycle of LAC, take a look at “Liu, D., He, C., Schwarz, J.P. et al. Lifecycle of light-absorbing carbonaceous aerosols in the atmosphere. npj Clim Atmos Sci 3, 40 (2020). <https://doi.org/10.1038/s41612-020-00145-8>”

We thank the reviewer for suggesting the inclusion of this interesting and updated review about LACs. It is now part of the references in the main text.

- Check citation style throughout the text (i.e., missing commas).

The correction has been done.

- Line 124: why are not world-historical trend of emission inventory extended until 2019 (study period)?

The latest version of EDGAR only covers up to 2018, indeed not fulfilling our entire period, but without any meaningful expected changes in 2019.

- Does France include Lille or not in the pie-charts of the Figures 2b and 3a, 3b?

No, France includes the contribution of the whole territory except for the contribution of Lille. This specification has been added to the description in figures 2b, 3a, 3b.

“...note that France does not include Lille’s contribution...”

- Line 260: Figure S7 is wrongly indicated as Figure S5.

The correction has been done.

- Line 335-336: sentence to be re-phrase.

The sentence between 335-336 was modified as following:

“This fraction is comparable to Athens (24%), despite their higher total absorption at 370 nm (15.9 Mm^{-1}) (Liakakou et al., 2020), and marked differences in weather conditions and heating fuel usage compared to Lille (Rehfeldt et al., 2020).”

- Line 371-372: re-phrase the sentence for missing verb.

The sentence has been corrected as such:

“Relative contributions from residential and traffic emitted less than 24 hrs (fresh) and more than 24hrs (aged) before reaching the ATOLL site **were analyzed concerning**: (a) the mass loading of BC; (b) the light absorption coefficient of BrC calculated at 470 nm...”

- Figure S1: check incorrect figure numbering and caption.

The numbering and caption have been corrected accordingly.

- Figure S7 could be moved as Figure S6.

The correction has been done.