Thank you for your positive review of our manuscript. We appreciate the comments and technical suggestions you provided. Below we have provided responses (in boldface) to each of the specific comments and technical corrections. Line numbers refer to the original manuscript.

Summary:

This paper proposes a new approach to study heating rate profiles on the South-eastern Atlantic region, well-known for the influence of extreme biomass-burning episodes. This study is essential to understand drivers of the heating rate in this region. Even if there are some reorganisations of titles and subtitles to apply, authors well explain the method by: 1) detail the calculation of the usually analysed heating rate as well as its dependency on atmospheric absorbers, 2) analyse applications to spirals and radiation walls during the ORACLES-2016 and 2017 experiments, and 3) demonstrate the necessity of the HRE to reduce variability trained by aerosol extinction and incoming solar flux. The description of the method is precise and clear, and authors well explained the limitations of the method.

The results and analyses are interesting for aerosol impact studies in the South-eastern Atlantic region and the method may bring promising information if adapted to other area or to satellite measurements. This is why the study well fit with the journal scope and I would recommend for publication after considering following specific comments and technical corrections.

Specific comments:

1. The study is based on several measurement technics which allow to reduce assumptions and obtain accurate retrievals. However, combining in-situ and remote sensing measurements obtained from different flight patterns drives several issues which have to be considered to discuss the results. This is what I would expect more information and discussions on:
    - - Altitudes of measurements for each case for both 4STAR and HSRL measurements. As example, does P-3 exceed 12 km height during measurements?

    Within the radiation walls, the 4STAR measurements are made along the BOL leg, ranging between 1.0 to 1.6 km for the cases included in our analysis. HSRL measurements are made at the TOL, which ranged between 5.1 to 7.1 km. We chose not to include this information explicitly since it was a requirement that the aerosol layer be fully captured by the HSRL measurement. For radiation walls where these criteria were not met, the case was disqualified for further analysis. The text has been updated starting at line 248 as followed to explicitly state this:

    "This requires a) aerosol optical properties and water vapor profile (both obtained from a spiral retrieval and held constant), b) the SSFR-measured albedo spectra, the AOD spectra and column ozone retrievals from 4STAR, all measured from the BOL leg of the radiation wall, and c) aerosol extinction profiles at 532 nm of the full aerosol layer measured by HSRL-2 from the TOL leg (Table 2). Cases for which these criteria were not met were excluded from analysis."

- Distances and times between combined spirals and walls. This may be included on Table 3.

We have included the UTC range for the spirals in Table 2 so the times can be compared. The distance between walls and spirals is visualized in Figure 1. As noted on lines 257-258, our goal was to examine the heating rate dependence on the scene variability without knowing the albedo and AOD spectra underlying a *specific* aerosol extinction profile. We therefore assessed the dependence statistically by considering the albedo variability and the AOD. The underlying assumption of course is that there are no changes in key parameters (aerosol intensive properties) over the timeframe

- Spectral ranges and resolutions for each instrument. This may be included on Table 1.

The table has been updated as follows:

Property	Instrument(s)	Method	Reference
SSA_λ	SSFR/4STAR	Retrieval	Cochrane et al., 2019; Cochrane et al., 2021
g_λ	SSFR/4STAR	Retrieval	Cochrane et al., 2019; Cochrane et al., 2021
AOD_λ	4STAR (wavelength range: 350-1650 nm)	Measurement	Dunagan et al., 2013; Shinozuka et al., 2013; LeBlanc et al., 2020
$Albedo_\lambda$	SSFR (wavelength range: 350-2100 nm)	Measurement	Pilewskie et al., 2003; Schmidt and Pilewskie, 2012; Cochrane et al., 2019; Cochrane et al., 2021
Aerosol extinction profile (532 nm)	HSRL (wavelengths: 355 nm, 532 nm)	Measurement	Hair et al., 2008; Burton et al., 2018
Water Vapor Profile	P-3 Hygrometer (EdgeTech Model 137 aircraft hygrometer)/ 4STAR	Measurement	Segal-Rosenheimer et al., 2014; Pistone et al., 2021
Column Ozone	4STAR	Measurement	Segal-Rosenheimer et al., 2014

2. The application of the method to the two experiments allows to note the stability of the HRE in the region at the biomass-burning period since the aerosol and water vapor sources are expected to be seasonal. However, as authors well explained, the method is applied at very specific atmosphere conditions and is only applicable to similar aircraft measurements

conditions. In order to facilitate comparison study, I would expect more details and discussions on the parameter variations. As example:

- - Figure 6a and 6b would benefit from additional information on AOD and cloud albedo variations along the wall. Link with Figure 7c may be more discussed since it could explain the reason of aerosol heating rate variations.

Figures 6a and 6b along with their caption have been updated to include the AOD and cloud albedo information:

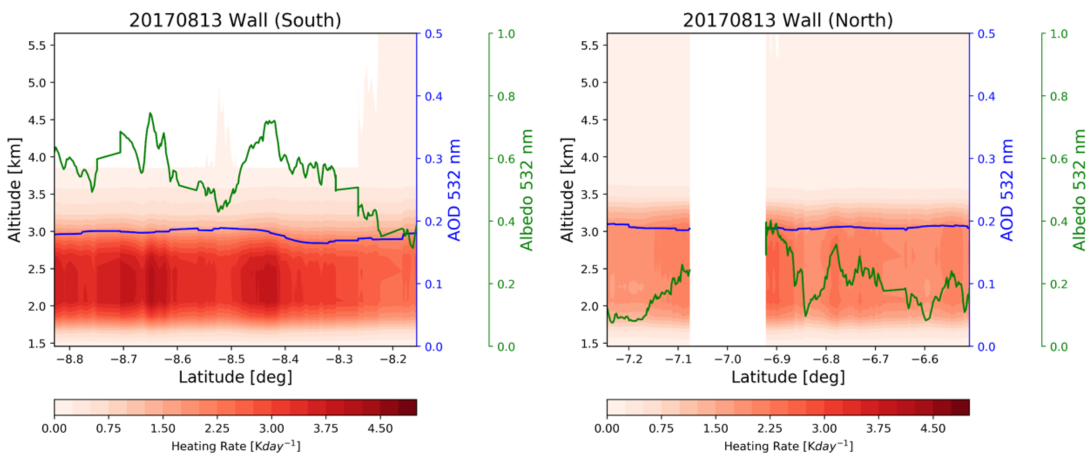


Figure 6. Heating rate curtains calculated using HSRL-2 measured extinction for the 20170813 radiation wall (shown here in separate plots: North (right) and South (left)). Peak heating of ~4.8 K/day occurs between 2 and 3 km. The underlying albedo, shown at 532 nm in green, is significantly higher on the left plot than the right (i.e., further south), contributing to higher aerosol heating rates. The AOD, shown at 532 nm in blue, does not vary significantly across the wall. Missing results between -7.08 and -6.51 are due to in-cloud sampling that replaced above-cloud albedo measurements and serve as the break point between North and South ends of the wall.

- - Measured parameters on Figure 10 should be highlighted, for example with filled dots. From there, the heating rate efficiency from each spiral will be shown.

  While Figure 10 also uses the same color code as Figure 8, we do not want to give the impression that the HRE values are the true HRE from the spirals. Rather, Figure 10 shows a set of calculations based on the AOD and vertical distribution of the aerosol in each spiral case with constant SSA, albedo, or SZA values (depending on a, b, and c Figures). If we included filled points, they would most likely NOT align with the case-specific HRE value because when we showed the dependence of HRE on parameter (e.g., albedo), we pegged all of the other parameters (e.g., AOD, SZA) to fixed values across all cases, indicated as dashed lines in all three panels. Therefore, we do not include this label on Figure 10.

- \- Figure 9 well demonstrates the stability of HRE for the two main aerosol layers between 2 and 4.5 km. More discussion on these features are expected.

  Beginning at line 352, we included the following additional text in the discussion of Figure 9:

  "Figure 9 shows an example of the vertical profile of the aerosol heating rate, extinction, and HRE, which clearly shows that the HRE for the aerosol two sub-layers (at 2 km and 4.5 km) is rather stable, and comparable between the two layers, despite the variable extinction and heating rate profiles."

- \- Additional figure with the asymmetric coefficients on Figure 10 will also give relevant information of aerosol particles size impacts on HRE by considering that coarse mode particles are not well represented in the used spectral range.

  Indeed, the impact of the coarse mode on the HRE is not conveyed in these plots. However, the asymmetry parameter range was too small in our case to make meaningful statements about the size distribution. To illustrate this, we include a figure from an earlier paper (Cochrane et al., 2021) below:

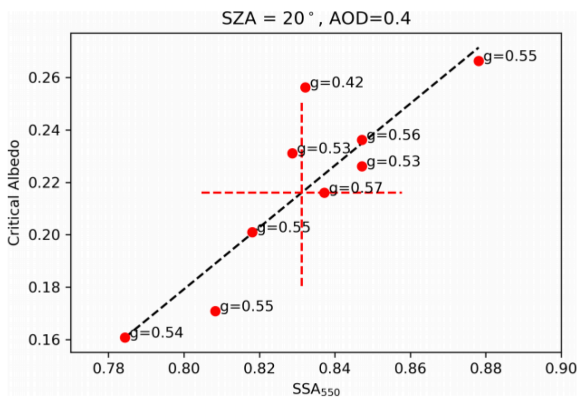


Figure 7. Critical albedo as a function of mid-visible SSA. The red dashed cross shows the case-average α_{crit}.

It shows that the SSA by far dominates the radiative impact of the aerosol (here visualized in terms of the critical albedo, a quantity related to the TOA radiative effect); the asymmetry parameter (labels on the individual cases) is not useful to explain any of the variability that is not explained by the SSA.

Technical corrections:

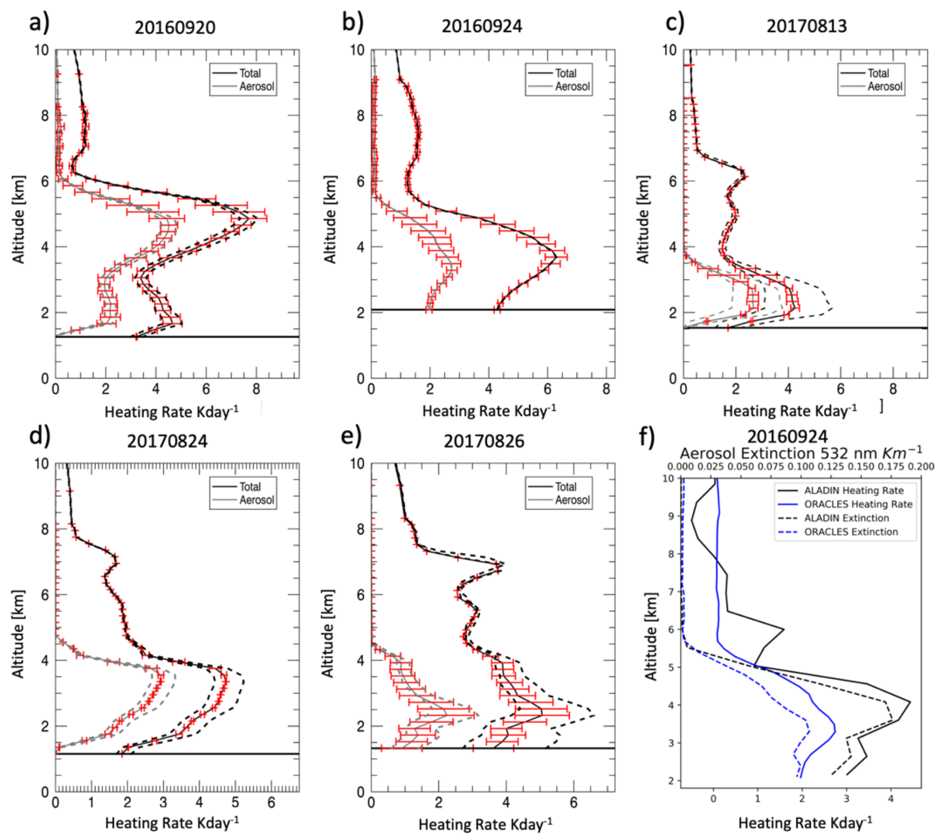
1) Equations (2) to (5) need to be rewritten:

- Please, detail the meaning of (x).
x is the location, z is the height. This has been included on line 275.

- In order to obtain $R_\lambda(x)$ = 1 at 532 nm, equation (3) shouldn't be:

$$AOD_\lambda' = AOD_\lambda'^{\,4STAR} * \frac{AOD_{532}^{HSRL}(x)}{AOD_{532}'^{\,4STAR}} \; ?$$

Thank you for pointing out this error. We have corrected equation (3) and re-ran the heating calculations it applies to. Figures 6 and 7 have been updated to reflect the new calculations. New Figure 6 is shown in response to comment #2. New Figure 7 shown below:



- Used terms have to be consistent between equations. AOD_{532}^{HSRL} instead of AOD_{HSRL}.

This has been corrected.

2) Figures 3 is discussed earlier than Figure 2 in the text. Please exchange them.

This has been corrected.

3) Figure 7 format should be consistent between panels:

- Only mention the wall's date as title.
- [km] on y-axis.
- [k/day] and [Km^{-1}] on x-axis on Figure 7f.

Figure 7 has been updated as shown above.

4) Figure 8a values seem to correspond to cloud albedo and not SSA as Figure 8b and values on the text. Please also correct the legend.

To convey as much information as possible, Figure 8a points are intentionally labeled by their corresponding 550 nm albedo values while Figure 8b points are labeled by the SSA (described in the figure caption.) The legend indicates that the dashed line is an additional calculation performed using the mean SSA from all cases. The text has been corrected at line 328.

5) Figure 8: please change y-axis with Aerosol and water vapor Heating Rate instead of on the title.

Figure 8 has been updated as follows:

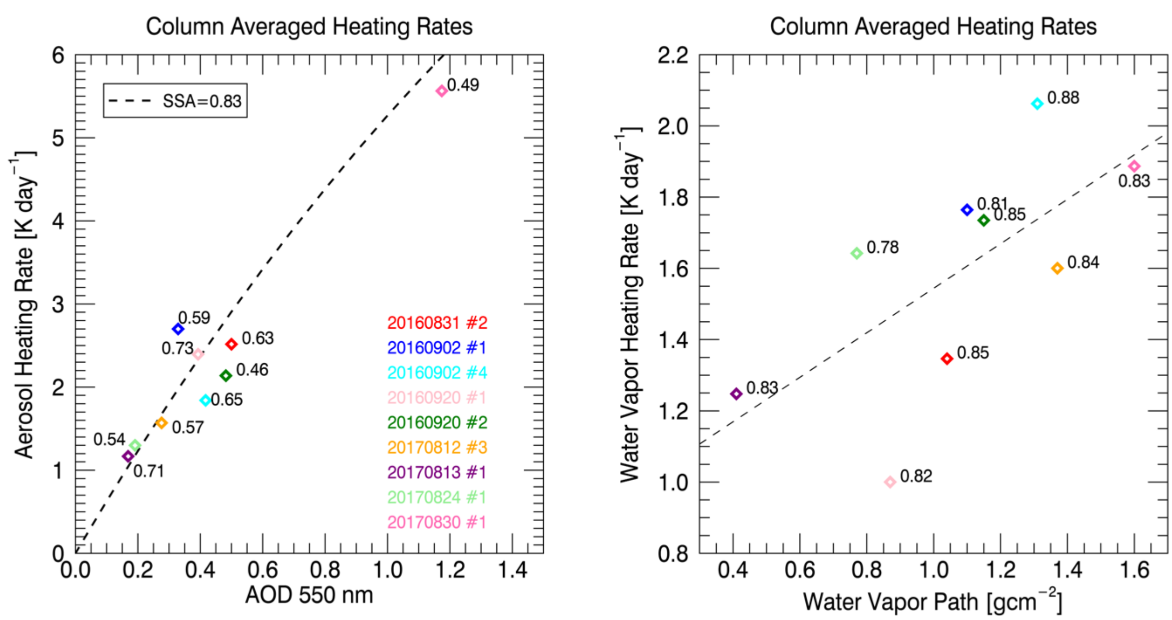


Figure 8. a) Aerosol heating rate as a function of AOD at 550 nm. Column-averaged values from each spiral case are shown as colored points labeled by their 550 nm albedo value. The black dashed line indicates RTM calculations using mean SSA (0.83, 550 nm) and albedo (0.6, 550 nm) from all cases, and a range of AOD spectra (ranging from 0 to 1.4 at 550 nm). b) Water vapor heating rate as a function of the water vapor path. The grey dashed line is a simple linear fit to highlight the dependence. Cases are labeled by the 550 nm SSA value. The color-coding in both a) and b) is denoted by the legend on a).

6) Please, add the coloured code used on Figure 8 and 10 on Table 2.

The color code has been added to Figure 8 as shown above. While Figure 10 also uses the same color code, we do not want to give the impression that the HRE values are the true HRE from the spirals. Rather, Figure 10 shows a set of calculations based on the AOD and vertical distribution of the aerosol in each spiral case with constant SSA, albedo, or SZA values (depending on a, b, and c Figures). If we included filled points, they would most likely NOT align with the case-specific HRE value because when we showed the dependence of HRE on parameter (e.g., albedo), we pegged all of the other parameters (e.g., AOD, SZA) to fixed values across all cases, indicated as dashed lines in all three panels. Therefore, we do not include this label on Figure 10.

7) Table 2, why values are expressed at 500 nm and not at 550 or 532 nm as in the whole paper? These values have to be comparable to Table 3 values as well.

Table 2 was adapted from the Cochrane et al., 2021 paper in which the optical properties were retrieved for each of the spiral cases. We have updated the table to report the 532 nm values.

8) line 338: the sentence is not needed.

We would prefer to keep this sentence as it highlights the importance of water vapor heating in conjunction with aerosol heating.