REVIEW 1

Synergy of active and passive airborne observations for heating rates calculation during the AEROCLO-SA field campaign in Namibia

Mégane Ventura et al.

General comments to the Editor:

The submitted manuscript demonstrates the synergy of active LIDAR and passive polarimeter measurements for quantifying the vertical distribution of the heating rates caused by the light-absorbing, lofted layers of biomass burning aerosols over the cloud deck off the coast of Namibia, Africa. The active-passive synergistic method was applied to the airborne measurements of aerosols collected by OSIRIS polarimeter and lidar operated during the AEROCLO-sA campaign in September 2017. The radiative transfer code was used to calculate heating rates in the solar and thermal part of the spectrum. Authors find strong positive heating rate 2-5 K/day caused by aerosols lofted over clouds. The cooling effects of water vapor through infrared radiation is found to generally balance its warming effect from solar radiation. The heating rate calculations were validated against the altitude-resolved irradiance measurements taken during the sounding portion of the flights.

The scientific content presented in the paper effectively demonstrates the value and merit of the active-passive synergistic approach to quantify the aerosol absorption effects over the clouds—a seasonal phenomenon observed over several regions of the world, including the prime hotspot region of southeastern Atlantic Ocean. The methodology, sensors, datasets, results, and their interpretation/evaluation discussed in the paper look sound. The plots showing different sets of results are discussed appropriately in the text. The application of the presented synergistic method to the planned future sensors carrying lidar and polarimeter/image is also discussed towards the end of the paper.

I don't see any major flaw or concern on this paper that can send back the manuscript to a major revision. However, I have prepared a long list of specific suggestions and questions, included in this review, for authors to consider in the revision. I would suggest authors to proofread the revised article in terms of the language and structure for even more effective presentation.

I should be available re-review the revised submission.

Thanks for the review opportunity.

Reply to the reviewer's general comments:

We are grateful to the reviewer for his interest in our study and for his very detailed review of the article. We have done our best to take into account these suggestions for improvement and to answer the questions raised. Below are our responses, presented point by point.

Specific Comments to authors:

Abstract:

Line 12: "We present original results derived from the airborne observations acquired from the AErosol RadiatiOn and CLOud in Southern Africa (AEROCLO-sA) field campaign led in Namibia in August and September 2017".

Thanks, we modified this sentence in the abstract.

Line14: "…an airborne prototype.."

We corrected it.

While abstract mentions about the use of OSIRIS measurements, radiative transfer code, and meteorological parameters, it misses mentioning what aerosol and cloud measurements were actually used in the RT model to calculate the heating rate. This should be added to the abstract.

As you suggested, we modified the following sentence in the abstract:

"To calculate this parameter, we use a radiative transfer code and meteorological parameters provided by dropsondes"

For

"To calculate this parameter, we use a radiative transfer code, meteorological parameters provided by dropsondes and OSIRIS-retrieved aerosol optical thickness, size, and absorption above clouds."

Line 30: "…variable chemical, optical, and microphysical properties."

Thanks. We modified this sentence in the manuscript.

Line 37: "The aerosol radiative forcing estimates provided by climate model over the Southeast Atlantic Ocean show large discrepancies"

We modified this sentence.

Lines 45-48: These sentences can be re-written as, "Biomass burning aerosols are primarily composed of two components: black carbon and organic or brown carbon. The former strongly absorbs radiation across a wide spectral range, whereas the latter has relatively weaker absorption in the visible part of the spectrum but exhibits strong spectral dependence of absorption at the UV wavelengths."

When you write 'organic or brown carbon,' it implies to us that they are the same. However, brown carbon is a subset of organic carbon that exhibits light-absorbing properties, while most organic carbon in aerosols contributes primarily to scattering.

We chose to keep our initial sentence, as we believe it offers more comprehensive information.

Line 59: "Our study focuses…" Also these two sentences can be re-organized as, "This study focuses on quantifying the radiative impact of biomass burning aerosols and aims to estimate the profiles of atmospheric heating (or cooling) rates attributable to these particles. We use airborne measuerements acquired during the AErosols Radiation and CLOuds in southern Africa (AEROCLO-sA) campaign (Formenti et al., 2019) conducted over Namibia between 5 and 12th September 2017 with the French Falcon 20 environmental research aircraft of Safire."

We modified this sentence. Thanks.

Line 65: "..such as ORACLES…"

We modified it.

Line 78: SSA quantitatively describes the ability of aerosols to absorb or scatter the solar radiation.

We clarified our text by including your sentence.

Lines 79-80: I would not call it "To a lesser extent". Given the same state of aerosols (AOT, SSA, asymmetry parameter), the extent of the radiative forcing or heating rates is primarily determined by the brightness of the underlying clouds, which is a function of cloud optical depth. Please reconsider this statement.

We agree. We clarified this point in the manuscript as you suggested.

We changed the following sentence:

"To a lesser extent, the radiative properties of the underlying target (e.g., clouds) and the vertical profiles of the thermodynamical quantities (humidity and temperature) also need to be known."

For

"Given the same properties of aerosols (AOT, SSA and particles size), the extent of the heating rates is primarily determined by the brightness of the underlying clouds, which is a function of cloud optical depth. For accurate heating rate estimate, the vertical profiles of the thermodynamical quantities (humidity and temperature) also need to be known".

Lines 81-85: Author may consider citing Jethva et al. (2024), which uses UV-VIS-NIR satellite measurements from OMI and MODIS combined with AOT measurements from HSRL-2 lidar and 4STAR sunphotometer to derive UV-VIS-NIR spectral SSA over clouds in the SEA region. Satellite retrievals of SSA agree overall with the range measured by in-situ observations, and show relatively strongest (weakest) absorption in August (October).

Jethva, H. T., Torres, O., Ferrare, R. A., Burton, S. P., Cook, A. L., Harper, D. B., Hostetler, C. A., Redemann, J., Kayetha, V., LeBlanc, S., Pistone, K., Mitchell, L., and Flynn, C. J

(2024), Retrieving UV–Vis spectral singlescattering albedo of absorbing aerosols above clouds from synergy of ORACLES airborne and A-train sensors, Atmos. Meas. Tech., 17, 2335–2366, https://doi.org/10.5194/amt-17-2335-2024.

We included this recent study in the manuscript and added it in the list of references.

We included in our manuscript the information regarding the seasonal variability of the aerosol absorption.

We changed in the manuscript the following paragraph:

"Among the different results obtained under the recent international projects, one important common finding is that the absorption by BBA appears to be very high over SEA (Wu et al., 2020; Pistone et al., 2019; Chauvigné et al., 2021) with a column integrated SSA as low as ~0.85 (at 550 nm) or 0.80 (at 865 nm)."

For :

"Among the different results obtained under the recent international projects, one important common finding is that the absorption by BBA appears to be very high over SEA with maximum absorption in August and minimum absorption in October (Wu et al., 2020; Pistone et al., 2019; Chauvigné et al., 2021; Jethva et al., 2024) with a column integrated SSA as low as ~0.85 (at 550 nm) or ~0.80 (at 865 nm) in August".

Line 86-87: Author should consider citing following two papers on aerosol radiative effects over clouds.

Meyer K. G., S. E. Platnick, L. Oreopoulos, et al. 2013. "Estimating the direct radiative effect of absorbing aerosols overlying marine boundary layer clouds in the southeast Atlantic using MODIS and CALIOP." J. Geophys. Res. Atmos. 118 (10): 4801-4815 [10.1002/jgrd.50449] [Journal Article/Letter]

Zhang, Z.*, K. Meyer, H. Yu, S. Platnick, P. Colarco, Z. Liu, and L. Oreopoulos (2016), Shortwave direct radiative effects of above-cloud aerosols over global oceans derived from 8 years of CALIOP and MODIS observations, ACP, 16(5), 2877–2900, doi:10.5194/acpd-15-26357-2015.

Thanks, we added these two references in the introduction section of the manuscript and we updated our list of references.

Line 92: Jethva et al. (2014) should be corrected to Jethva et al. (2018).

We corrected it in the revised version of the manuscript.

Jethva H., O. Torres, C. Ahn and et al. 2018. "A 12-year long global record of optical depth of absorbing aerosols above the clouds derived from the OMI/OMACA algorithm." Atmospheric Measurement Techniques 11 (10): 5837-5864 [10.5194/amt-11-5837-2018] [Journal Article/Letter].

Line 98: CALIOP vertical profiles of extinction, if properly constrained, can provide altitude-dependent heating rates.

We added this sentence in the manuscript:

"If properly constrained, CALIOP vertical extinction profiles can provide altitude-dependent heating rates (Deaconu et al., 2019)."

Line 129: Define OSIRIS here, if it is not defined earlier in the text.

We now explain the acronym OSIRIS in the manuscript.

Line 125: Double dots (..).

Line 135: Some restructuring: "During the campaign, the air mass intercepted (or measured) by the on-board instruments were mainly transported from the in-land biomass burning source areas, emitting substantial amounts of carbonaceous aerosols transported over the southeastern Atlantic Ocean, as far as the Ascension Island. The airmass was then drifted to the southeast towards the Namibian coast due to the anticyclonic circulation located over South Africa".

Thanks, we included your revised sentence in the manuscript.

Low-pressure system rotates in clockwise direction in southern hemisphere. So, make sure that the cyclonic or anticyclonic movement is referenced to the southern hemisphere.

We confirmed that "anticyclonic movement" is the correct term.

Line 149: "…with the aircraft during specific flights". It would be desirable to mention the dates of these flights.

This information is already given in table 1. In table 1's legend:

"Sounding" indicates that an aircraft sounding (i.e., rapid descent of the aircraft) was performed during the flight."

So, aircraft soundings were performed on the 7th, 8th and 12th, as indicated in table 1.

Reviewer 2 also requested a modification of the 'aircraft soundings' term for "spiral descents" for sake of clarity. We have also addressed this feedback by incorporating the term "spiral descent" in the text.

Table 1: Add the wavelength of the AOT measurements (865 nm) in the respective column. Similarly, ABS should be labelled as the imaginary part of the refractive index. Please correct me, if wrong. Also, the wavelength of the ABS should be included in the table and text. AOT values of > 0.4 at 865 nm translate to AOT of > 1 at 500 nm.

We have implemented the changes to Table 1 as you recommended.

Line 78: Define OSIRIS the first time it was referred in the text.

OSIRIS acronym is now defined.

Line 184-185: It is assumed here that the LNG is a downward looking lidar.

Depending on field campaigns and objectives, LNG lidar was used for both upward and downward measurements on the F-20 aircraft.

We added this sentence in this manuscript for clarification:

"In our study, we use lidar LNG to depict the vertical profiles of aerosol extinction below the aircraft".

Line 189: Re-structuring: "Consequently, lidar data acquired for optically thick plumes at these wavelengths become less reliable in accurately determining the base altitude of the aerosol layer. On the other hand, the 1064-nm signal penetrates deeper into the aerosol layer due to significantly reduced attenuation, providing a better view of the depth of the aerosol layer. For this reason, we used LNG lidar data acquired at 1064 nm to accurately depict the aerosol extinction profile."

Thanks, we included this revised paragraph.

Line 194: "the extinction aerosol optical thickness". PLASMA resembles the 4-STAR sun photometer. Are there any major differences in the way both measure AOTs?

To my knowledge, the NASA 4-STAR sun-photometer can measure both AOT (by tracking the sun) and diffuse scattered light (through scan measurements), while PLASMA can currently only measure AOT in a similar manner to the 4-STAR.

Line 210: "600 m above the sea level".

Thanks, we modified it.

Line 213: What is the swath width of the OSIRIS instrument/retrievals?

We added two paragraphs in the manuscript:

-in the section 2.2:

"This instrument provides 20-meter resolution images for visible and near-infrared light (440-940 nm) and 60-meter resolution images for shortwave infrared light (940-2200 nm) at a 10-kilometer altitude."

-in the section 3.3.1:

"The aerosol retrieval is based on solar plane measurements and assumes spatial homogeneity over the entire OSIRIS visible image (an area of approximatively 20x10 km²). This procedure increases the sensitivity to aerosol properties, which are retrieved at this spatial resolution using an optimal estimation algorithm (Chauvigné et al., 2021)."

Line 229: Equation 1: This is simply the scaling of lidar extinction profile to match with the OSIRIS-retrieved AOTs. OSIRIS measured columnar AOT above the clouds, whereas the lidar measurements, according to Figure 7 (a & b), correspond to the atmospheric depth between cloud-top to 6-km. This leads to an assumption that the smoke aerosols are confined within these altitude range. Any amounts of aerosols above 6 km, therefore, are ignored in the analysis. This should be mentioned in the text.

We added this sentence in the manuscript:

"We also assume that the lidar accurately measures the base and top altitudes of the smoke layer, and that smoke aerosols are primarily confined within this range, typically between the cloud top and 6 km (see Figures 7a and 7b)."

Line 249: Which satellite/sensor total column O3 data was used here?

It was OMI data. We added this information in the text.

Line 257: Where Cp stands for…

Ok. We modified it.

Line 264: Optimal estimation method.

Thanks, we modified it.

Line 266-269: This is not understood. Both OSIRIS and GAME calculations ignore particles larger than one micron (radius or diameter?). How did author accounted for the aerosol optical properties to longer wavelengths?

This sentence: '… ignore particles larger than one micron…' was not clear.

We modified:

"The OSIRIS algorithm and GAME calculations assume both a simplified aerosol representation: the real part of the complex refractive index is constant (1.47) across the spectrum, the imaginary part is independent of wavelength, and particles larger than one micron are neglected"

For

"The OSIRIS algorithm and GAME calculations assume both a simplified aerosol representation: the real part of the complex refractive index is constant (1.47) across the spectrum and the imaginary part is independent of wavelength."

"A single lognormal particle size distribution is used for which the mean radius is retrieved whereas the variance is fixed (Chauvigné et al., 2021)".

How did author accounted for the aerosol optical properties to longer wavelengths?

"The previous aerosol model, assuming spectrally flat complex refractive index and a log-normal particles particle size distribution, is used to extrapolate the aerosol optical properties to longer wavelengths using Mie theory."

Line 280: MODIS cloud product of cloud effect radius histogram over the southeastern Atlantic Ocean shows peak around 12 microns, which is closer and near-consistent with the 10 microns assumed in this study. It is imperative to mention here that which cloud model is used here. Most likely, author is assuming water clouds. What droplet size distribution was assumed here? Modified GAMMA? Also, did author compare the Irradiance-based COT retrievals with those derived from OSIRIS algorithm? How well do they compare?

We added this sentence in the manuscript:

"A two-parameter gamma distribution was employed to describe the size distribution of cloud water droplets in the cloud layer situated below the aerosol layer. The effective radius and variance of the droplets were fixed at 10 microns and 0.1, respectively."

Also, did author compare the Irradiance-based COT retrievals with those derived from OSIRIS algorithm? How well do they compare?

A detailed comparison of cloud optical thicknesses retrieved by OSIRIS and measured by flux would require significant additional work, which is outside the scope of this article.

Line 322: "aerosol absorption optical depth of 0.03".

Here, this is not the aerosol absorption optical depth, 0.03 corresponds to the imaginary part of the complex refractive index of the particles.

We changed in the text the following sentence:

"Optical properties used were: Cloud Optical Thickness (COT) 11.69, Aerosol Optical Thickness (AOT) 0.43, and aerosol absorption 0.03"

For

"Optical properties used were: Cloud Optical Thickness (COT) 11.69, Aerosol Optical Thickness (AOT) 0.43, and imaginary part of the aerosol complex refractive index 0.03"

Line 325-327: spectrally neutral aerosol absorption: Does author mean the spectral imaginary part of the refractive index or aerosol absorption optical depth? In either case, assuming spectral neutral behavior might not be an appropriate assumption. Biomass burning aerosols are often rich in organics (brown carbon), which exhibits strong spectral absorption at shorter wavelengths. If it is not too much of work and computation, author is suggested to assume spectrally varying aerosol absorption optical depth assuming the Absorption Angstrom Exponent in the range 2.0-2.5, a typical range for biomass burning aerosols.

Spectrally neutral aerosol absorption refers to the imaginary part of the refractive index that is assumed spectrally neutral.

We clarified this point in the text.

We modified this sentence:

"For particles of the size range shown in table 1, and based on our assumption of spectrally neutral shortwave aerosol absorption (i.e., the aerosol absorption it is assumed to be the same across both the thermal infrared and solar spectrums)"

for

"For particles of the size range shown in table 1, and based on our assumption of spectrally neutral shortwave aerosol absorption (i.e., the aerosol absorption refers to the imaginary part of the complex refractive index and it is assumed to be the same across both the thermal infrared and solar spectrums)"

It looks like the aerosol absorption of 0.03 assumed in the simulation referred to the imaginary part of the refractive index.

You are right. It refers to the imaginary part of the refractive index.

Biomass burning aerosols are often rich in organics (brown carbon), which exhibits strong spectral absorption at shorter wavelengths. If it is not too much of work and computation, author is suggested to assume spectrally varying aerosol absorption optical depth assuming the Absorption Angstrom Exponent in the range 2.0-2.5, a typical range for biomass burning aerosols.

In a previous study (Siméon et al., 2021), we estimated the absorbing fraction of organic aerosols, specifically Brown Carbon (BrOC), within biomass burning plumes over the southeastern Atlantic Ocean to be between 2% and 3%. Although BrOC is not the primary constituent of organics and biomass burning aerosols, we recognize its non-negligible impact on aerosol optical properties. However, our previous work (Siméon et al., 2021) clearly indicates that soot carbon content, aerosol loading, and particle size are the primary factors controlling the aerosol optical properties and consequently their radiative impact over the region of interest. Therefore, accounting for brown carbon could be considered a refinement of our methodology that will be considered in further work. Including brown carbon (BrOC) in our calculation would be associated with a significant amount of work that is out of the scope of our study.

We mention this limitation in the manuscript:

We added in the manuscript:

"This assumption implies that our simulation neglects the contribution of brown carbon. Consequently, we assume here that soot exclusively governs the absorption properties of aerosols generated from biomass burning"

If it is not too much of work and computation, author is suggested to assume spectrally varying aerosol absorption optical depth assuming the Absorption Angstrom Exponent in the range 2.0-2.5, a typical range for biomass burning aerosols.

We already have an aerosol absorption optical depth that varies with the wavelength in our simulation.

Indeed, for a given spectrally flat imaginary refractive index, the aerosol absorption optical thickness spectral dependence is primarily control by particles size. Since we consider fine mode aerosol (mean radius of 0.1 microns) that shows a strong spectral dependence in terms of aerosol optical properties, the aerosol absorption optical depth already strongly depends on wavelength. Including BrOC will modulate the spectral dependence of the aerosol absorption.

Line 425-430: What was the variability in the COT retrievals during spiral descent? Since COT is retrieved at each change in altitude, these numbers should be handy and mentioned here.

We added this information in the manuscript:

"During the spiral descent, the majority of COT retrievals fall within the range of 8 to 14."

Could author remind here what wavelength range was considered to calculate solar and thermal heating rate, respectively?

This information is already given in the manuscript (see the section 3.2):

"The code considers 208 spectral intervals distributed between 0.2 and 3 µm for the solar spectrum. For thermal infrared, 115 intervals are used to cover the wavelength range from 4 microns to 47 microns"

For thermal IR range, fine mode smoke particles do not play a significant role; however, cloud properties (COT and effective radius) drive the heating/cooling rates. Does the blue curve in Figure 5 (f) use the improved cloud modeling (cloud retrievals at each change of altitude)?

We accounted for it but while this procedure may have some influence, our analysis of thermal infrared results indicates no significant impact. COT and cloud effective radius (and cloud top altitude) primarily influence the calculation of heating/cooling rates (and irradiances) within the cloud layer itself. This is primarily because we are examining spectrally integrated fluxes and heating/cooling rates (integrated from 4 to 47 microns). As water vapor absorption significantly impacts the thermal infrared spectrum, this is the knowledge of the water vapor profiles that is of paramount importance for our study.

We already mentioned this point: see "Note that this reasoning applies to measurements acquired in the solar spectrum, with measurements in the thermal infrared appear to unaffected or negligibly affected by this effect."

Line 464: "Despite heterogeneity in COT…"

Thanks, we included your suggestion.

Figure 6: It is interesting that there are seemingly three layers of aerosols identified in the solar heating rate. Could author confirm this with lidar and/or PLASMA AOT profile measurements?

No, there is only main layer of aerosols between 1 and 6 km for this case study Figures 8-e and 8-j further support this observation, demonstrating relatively homogeneous vertical distribution of aerosol radiative properties for the 12th September flight. While Figure 6 exhibits three distinct positive peaks in the solar heating rate profile, these are not attributed to atmospheric variations. Instead, they likely stem from spatial heterogeneity in cloud properties as measured during the spiral descent.

See the discussions in the manuscript in section 3.4 :

"Airborne irradiance measurements made above clouds during spiral descents are associated with different cloud targets. Thus, the heating rates calculated from the irradiance measurements considered in this study are related to variations in the radiative properties of the atmosphere and also to variations in the radiative properties of the underlying cloud layer. These rates cannot be considered as the "intrinsic" heating rates of the aerosol and atmospheric layers that we seek to calculate and quantify.

"However, by integrating target albedo variability into the simulations, the heating rates estimated from the measurements will become comparable to the simulated ones. Even if these latter do not reflect the intrinsic properties of the atmosphere, if our theoretical approach, namely the simulations, is able to reproduce the measured heating rates above cloud targets changing at each altitude level z, a fortiori, it will also be able to predict these rates if the cloud target remains fixed (simpler case). The direct comparison of measured and simulated irradiances acquired during the soundings will therefore be carried out in a validation perspective."

Line 499-500: "which are all found in all rate calculations (>10 K/day)." This is not understood.

OK. We modified.

Figure 7: About cloud formation, as mentioned in the text, at the top of aerosol layer for Sep 8th flight. Did author notice similar cloud layer during Sep 12th flight? Or the cloud layer is filtered out in the heating/cooling rates? There are drastic differences in the 1064-nm backscatter values between these two flights. Mentioning the averaged AOTs during these two flights here, for the high-altitude segments, would aid the reader in interpreting the results.

Did author notice similar cloud layer during Sep 12th flight?

Our observations during the 12th flight did not reveal any cloud formation at the top of the aerosol layer.

There are drastic differences in the 1064-nm backscatter values between these two flights. Mentioning the averaged AOTs during these two flights here, for the high-altitude segments, would aid the reader in interpreting the results.

This difference in the 1064-nm backscatter values can be attributed to variations in aerosol levels. Aerosol concentrations were significant during the 8th flight and moderated during the 12th flight. The AOT was respectively equal to 0.45 and 0.18 on average (at 865 nm) for the 8 and 12th flights respectively.

We added this paragraph in section 4.4.1:

"For 12th September, no cloud formation was observed at the top of the aerosol layer (see Figure 7b). Average AOT at 865 nm was 0.45 and 0.18 respectively on the 8th and 12th September, explaining the lower 1064-nm backscatter for the 12th September flight (see Figures 7a and 7b). Consistent key findings were observed for both flights. The specific results of the 8th September flight are discussed below."

Line 507: "fairly homogeneous values of the order of 4 to 5 K/day…"

Ok, we modified.

Figure 8: It appears that the plots for different days are ordered w.r.t highest to lowest heating rates. Please mention this in the text. Also, label the x-axis as heating rates for the plots shown at top. It is worth to mention the averaged COTs measured on these days in Table 3. It is assumed here that the heating rates are vertically integrated. Please clarify it in the text.

It appears that the plots for different days are ordered w.r.t highest to lowest heating rates. Please mention this in the text

We added in the manuscript:

The plots shown in Figure 8 are ranked by decreasing heating rate.

Also, label the x-axis as heating rates for the plots shown at top.

We improved figure 8 but we did not include this suggestion. This figure is already populated and this information is indicated in the text.

It is worth to mention the averaged COTs measured on these days in Table 3.

The COT values are aalready given in table 1.

It is assumed here that the heating rates are vertically integrated. Please clarify it in the text.

Ok. We added this sentence in the text to emphasize this point :

"The table 3 contains the vertically integrated values of the heating rates"

Line 578: "…observed during the September 2017 AEROCLO-sA airborne campaign"

Ok, thanks. We corrected it.

Line 616-620: This is a good point. The COT should also play somewhat significant role in heating rates, depending upon what range of COT is observed. Also, one needs the true COT below the aerosol layer, after aerosol attenuation correction, in order to accurately assess the role of COT in both radiative effects and heating rates.

Thanks.

Line 621: desert dust above the clouds not on a global scale, but regional scale, i.e., Saharan dust transport over the Atlantic, dust plumes over the Arabian Sea, and Asian desert dust over the clouds along the eastward transport pathways over the Pacific.

Right. We used now the word “regional”.

At the end, it is an excellent demonstrative study of how the synergy of active lidar and passive measurements brings new quantitative information on the effects of light-absorbing aerosols above the clouds.

Thank you again for your efforts in helping us improve the paper.

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