

We thank both reviewers for a comprehensive evaluation of the submitted paper. We have revised the paper in the manner noted in the original response, that is posted in the response to reviewer 2 of the discussion section of the original submission:

We thank both Reviewers for taking the time to carefully read our manuscript and provide valuable comments. We now understand the Reviewers' concerns regarding the length of the manuscript. If allowed to proceed, we propose to revise the manuscript by greatly reduce the length, as described below.

The revised manuscript would be built around four key figures:

- (New Figure 1): Comparison of AAWR and EffCS between the Baseline and AR6 Simulations (Original Fig. 3).
- (New Figure 2): Comparison of Equilibrium Climate Sensitivity (ECS) as the function of the pattern effect parameter α' (Original Fig. 5).
- (New Figure 3): Comparison of time-dependent probabilistic projections for the four SSP scenarios studied (Original Fig. 7).
- (New Figure 4): Comparison of Probability Distribution Functions (PDFs) for the end-of-century warming for the four SSP scenarios studied (Original Fig. 8).

The figures would be reduced to four, relative to the eight figures in the main body of the initial manuscript. Additionally, we propose moving Figs. 1 and 6 of the original manuscript to the supplement, and completely removing Figs. 2 and 4 of the original manuscript.

We also propose to revise and greatly shorten the text of the manuscript to better reflect the key results of our paper, given below, which we now realize was obscured by the length of the introductory material:

- Projected ERF provided in AR6 for the SSPs is much greater than in the prior SSP dataset, from the original (baseline) SSP database. This excess is due mainly to updates in the ERF formulations for CO₂ and CH₄. Further, for each SSP scenario, the projected ERF given by AR6 at the end of this century significantly exceeds the target radiative forcing associated with each given SSP scenario (original Fig 1, to be moved to Supplement).
- Historical GMST, when fit with the AR6 ERF datasets, corresponds to a *narrower* range of EffCS of 2.29 °C [1.54 °C to 3.11 °C] relative to EffCS inferred from the Baseline simulations 2.26 °C [1.45 °C to 4.37 °C]. (New Fig. 1)
- We provide new estimates of ECS using various values of the pattern effect parameter α' , and find a range for ECS of 3.24 [1.92 to 5.15 °C] for the AR6 best estimate of α' (New Fig. 2). This analysis is a notable advance relative to the McBride et al. (2021) paper.
- When the AR6 ERF datasets are used, the simulated GMST in the future is considerably higher than that for Baseline simulations, a direct consequence of the increase in projected ERF,

resulting in a less optimistic chance of achieving the 1.5C and 2.0C goal and upper limit of the Paris Agreement (New Fig. 4)

- Our AR6-based forecasts of GMST still provide a lower projected warming than is given by many of the CMIP6 ensemble members (New Fig. 4). We propose to update Fig. 7 of the original manuscript, such that we shall now include the minimum-, maximum and mean projections of time-dependent GMST projections from CMIP6, as our New Fig. 3.

Again, we sincerely appreciate both reviews and we hope we will be allowed to submit a revised, significantly shortened manuscript in response to these comments. The revised manuscript would rely heavily on the McBride et al. (2021) paper for our methodology, as suggested by both Reviewers.

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Below, we provide response to the detailed comments of each reviewer.

Reviewer 1:

Summary

The authors apply an existing multiple linear regression model to decompose the relative contribution of internal and external forcing factors to global mean surface temperature (GMST) change over the 20th and 21st century. They compare the influence of different assumptions about effective radiative forcing from various constituents (but primarily tropospheric aerosols) between two generations of the CMIP protocol (AR5, referred to as Baseline, and AR6). The authors show that their MLR model reproduces the majority of features of the GMST response, and the effective climate sensitivity, simulated by a range of previous simplified and comprehensive modelling efforts. They use this information to provide probabilistic estimates of GMST remaining below Paris targets (1.5C and 2.0C).

Major comments

The paper is well researched, and well written; the figures are clear and communicate the main findings of the analysis. I believe that the conclusions reached are appropriate based on the methods and evidence presented. However, I cannot recommend publication of this manuscript for the following reasons.

First, this reviewer found that the authors have not adequately communicated what are the primary novel contributions of the research. On the contrary, in virtually all cases in the results sections, the authors highlight that their results are consistent with previous studies. This holds true for previous studies using simplified or intermediate-complexity models, and comprehensive modelling like CMIP6. This is a very well-studied field over the past decade, and the authors must articulate clearly how this research advances the discipline beyond what the myriad of previous studies has done.

We have revised the paper to focus, much more clearly, on the “primary novel contributions” of our research. The new abstract reads as follows:

We provide a reduced complexity climate model (RCM) evaluation of how the IPCC WG1 Sixth Assessment Report (AR6) updates to the time series of the future atmospheric concentrations of GHGs, the effective radiative forcing (ERF) of GHGs, and the ERF of tropospheric aerosols (ERF_{AER}) affect attributable anthropogenic warming rate, climate sensitivity, and the likelihood of achieving either the goal (1.5°C) or upper limit (2°C) global warming thresholds of the Paris Agreement. This evaluation is conducted for four selected Shared Socioeconomic Pathway (SSP) scenarios: SSP1–1.9, SSP1–2.6, SSP4–3.4, and SSP2–4.5. Throughout, we compare and contrast these AR6 updates to the state of knowledge that existed prior to the publication of AR6, and provide probabilistic model simulations based on an evaluation of the impact in the uncertainty of ERF_{AER} and climate feedback. Our most important findings are that the rate of human-induced warming between 1975 and 2014 is $0.18 [0.13 \text{ to } 0.21]^{\circ}\text{C decade}^{-1}$ within the AR6 framework (range reflects the 5th and 95th percentiles), which is considerably lower than values found by many Earth System Models (ESMs) that participated in Phase 6 of the Coupled Model Intercomparison Project (CMIP6). Effective Climate Sensitivity (EffCS) inferred from the historical Global Mean Surface Temperature (GSMT) record was found to be $2.29 [1.54 \text{ to } 3.11]^{\circ}\text{C}$ using the ERF datasets from AR6 as model inputs. Upon adoption of the AR6 best estimate for the pattern effect (that is, $0.5 \text{ W m}^{-2}^{\circ}\text{C}^{-1}$), we find values for Equilibrium Climate Sensitivity (ECS) of $3.24 [1.92 \text{ to } 5.15]^{\circ}\text{C}$, which is quite similar to the AR6 assessment of $3.0 [2.0 \text{ to } 5.0]^{\circ}\text{C}$ for ECS. The hallmark of our RCM is the ability to conduct large (here, 160,000 member) ensemble forecasts of global warming. These calculations show that AR6 updates to the ERF of GHGs and aerosols result in a considerable decline in the likelihood of limiting warming to either 1.5 or 2°C , compared to prior knowledge, for the same future emissions scenarios of GHGs. The likelihood of limiting global warming to 2.0°C by end-of-century is found to be 100%, 85%, 40%, and 8%, for the SSP1–1.9, SSP1–2.6, SSP4–3.4, and SSP2–4.5 scenarios, respectively, based on the AR6 ERF datasets. Similarly, the ensembles run using the AR6 updates yield likelihoods of 70%, 32%, 3%, and 0% of limiting warming to 1.5°C by end-of-century, for the same four SSPs.

Second, while the authors must be commended on their attention to detail and the depth of the research undertaken, the manuscript is much too long considering the paucity of new results being presented. At times it felt like a PhD thesis; for example, Section 2.3 provides many textbook-level definitions of ERF for various atmospheric constituents, and Section 2.5 describes every assumption for the inputs of the regression model in intricate detail. This raised the question of who exactly is the target audience for this work? Since the aim is to publish in ESD, there should be an assumption that interested readers will have sufficient background knowledge in climate change science to trust that emissions inventories, sources of natural/internal climate variability etc. are properly referenced and incorporated without the need for such a detailed assessment here. Potentially important and relevant previous literature was also excluded; for example, see:

<https://iopscience.iop.org/article/10.1088/1748-9326/6/4/044022/meta>

We have taken this comment to heart in the revised version of the paper. We have tried our best to focus the text on the important, new aspects of the study in the revised manuscript.

The original submission lacked a citation to the Foster and Rahmstorf 2011 paper noted by the reviewer, as well as Lean and Rind (2008), Lean and Rind (2009), and Zhou and Tung (2013). We have added the following sentence to Section 2:

The MLR component of the model is responsible for quantifying the influence of various natural factors on the GMST in a manner similar to other MLR-based analyses of the climate system (Lean and Rind, 2008, 2009; Foster and Rahmstorf, 2011; Zhou and Tung, 2013)

and we have added the following sentence to Section 2.2.1:

Our method for the evaluation of AAWR is similar to earlier, MLR based studies (Lean and Rind, 2008, 2009; Foster and Rahmstorf, 2011; Zhou and Tung, 2013), except that we quantitatively account for the impact of the uncertainty in the RF of aerosols and the strength of climate feedback on the possible range of AAWR.

Our consideration of the uncertainties in the RF of tropospheric aerosols, the strength of climate feedback, as well as ocean heat export is a unique feature of our quantitative evaluation of the possible range in AAWR, which is considerably wider than most other evaluations.

Third, the linear modelling framework itself does not appear to be a new contribution (e.g., McBride et al. 2021). Therefore, it is somewhat surprising that potentially important limitations of the linear model approach are not investigated or advanced in this research. For example, on L513 the authors describe needing to include a third constraint (consistency with recent observed temperature trends) in order to yield solutions that match the GMST time series over the recent past. Given the importance of ERF_CO2 and ERF_AER on the GMST predictions from the EM-GC model, this suggests a probable role for nonlinear interactions between aerosol and CO2 forcing that the current model cannot capture. It would have been interesting to see this commented on, if not addressed, in the research.

The use of the chi-squared recent metric, which appeared on line 513 of the original submission, is a model element that was described in Section 2.1 of McBride et al. This metric is needed because the uncertainty associated with measurements of GMST is quite large.

The sentence in the original submission that had read:

The χ^2_{RECENT} metric is used because without this constraint, some solutions with values of $\chi^2_{\text{ATM}} \leq 2$ have a visually poor simulation of the rise in GMST over the past 4 to 5 decades (McBride et al., 2021).

has been changed to read:

The χ^2_{RECENT} metric is used because without this constraint, some solutions with values of $\chi^2_{\text{ATM}} \leq 2$ have a visually poor simulation of the rise in GMST over the past 4 to 5 decades, due to the large uncertainty associated with early measurements of ΔT (McBride et al., 2021).

The most important non-linear component of our analysis is the possibility that climate feedback has changed over time. This possibility is examined, in great detail, within Section 3.3.6 of McBride et al. (2021). We have added the following sentence to Section 2.2.2 of the revised paper:

The projections of ΔT shown in Section 3 assume that the climate feedback parameter, λ_z , is constant over time. Support for this assumption is given by the temporal invariance of the residual between measured and modeled values of ΔT , over the past century and a half, as shown in Fig. 14 of McBride et al. (2021). If the true value of λ_z varies over time, as has been suggested based on analysis of CMIP5 (Marvel et al., 2018; Rugenstein et al., 2020) and CMIP6 (Dong et al., 2020; Salvi et al., 2023), then the analysis conducted by McBride et al. (2021) indicates that our end-of-century projections of global warming could be biased low by a few tenths of the degree Celsius. Regardless, the primary contributor to the uncertainty in end-of-century warming is the imprecise knowledge of ERF_{AER} .

Fourth, one of the major findings of the research highlighted by the authors is the apparent increase in warming rate under the AR6 assumptions compared to pre-AR6 (baseline). However, on L502 the authors state that the 6% higher climate sensitivity in AR6 comes from applying the published formula for ERF_{CO_2} from AR6 that is larger than the pre-AR6 formula provided by Myhre et al. (1998). Therefore, it appears that the increased warming rate is "baked-in" to the EM-GC model, rather than an emergent property, making the findings of more warming and a lower probability of remaining below the Paris targets largely unsurprising.

The 6% larger value of ERF_{CO_2} in AR6 compared to Baseline has no substantial impact on our numerical evaluation of either AAWR or end-of-century warming, because both quantities depend on the time rate of change of radiative forcing. This 6% increase does not alter any of the slopes of the ERF terms.

The increased warming we find for the AR6 framework, relative to the Baseline framework, is a consequence of the larger rise in total anthropogenic ERF, ERF_{ANTH} , from the middle of the prior century to the end of this century. This change in slope is driven largely by AR6 versus AR5 assessments of aerosol cooling as well as AR6 updates to end-of-century atmospheric concentrations of CO_2 and CH_4 .

We have added the following sentence to end of Section 2.1.3:

One final, important difference between the two frameworks is the steeper rise in ERF_{ANTH} between about 1960 and present within AR6 compared to Baseline, which is attributable to an assessed best value of much stronger aerosol cooling over the latter part of the prior century in AR6 relative to the Baseline (Fig. S1g).

and the following two sentences to Section 3.2:

Median projections of ΔT_{2100} within the AR6 framework are about 0.2 °C (SSP1–1.9, SSP1–2.6), 0.3 °C (SSP4–3.4), and 0.4 °C (SSP2–4.5) greater than found using the Baseline framework. This difference originates from the fact that projected ERF at the end of the century is higher in the AR6 framework than in Baseline, for all four SSPs, which is driven by higher end-of-century atmospheric concentrations of CO₂ and CH₄ in AR6 (Fig. S1i).

to clarify these points.

Minor comments:

-L23: The overlap of the baseline and AR6 confidence intervals suggests that the statistical evidence for an increase in the mean is rather weak.

We agree. The comparison of the AR6 and Baseline framework values for AAWR is now omitted from the abstract. Rather, in the new abstract noted above, we focus on a comparison of our value of AAWR over the time period 1975 to 2014, to that inferred from free running ESMs over this same time period. The relevant new sentence in the new abstract is:

Our most important findings are that the rate of human-induced warming between 1975 and 2014 is 0.18 [0.13 to 0.21] °C decade⁻¹ within the AR6 framework (range reflects the 5th and 95th percentiles), which is considerably lower than values found by many Earth System Models (ESMs) that participated in Phase 6 of the Coupled Model Intercomparison Project (CMIP6).

-L119 and L122: do the authors mean to say adopted, rather than adapted?

Thanks! The word “adapted” is not used in the revised paper.

-L152: Can the authors provide the proportions for the different effects in this attribution? Are CO₂ concentrations the dominant effect?

The issue of higher ERF due to GHGs is now addressed in a meticulous fashion in Sections 2.1.1 (Atmospheric Concentrations of Greenhouse Gases) and Sections 2.1.2 (Radiative Forcing of Greenhouse Gases), as well as Fig. S1. It is challenging to rank CO₂ or CH₄ as being most important, since for some of the SSPs the change in ERF due to CO₂ is larger than the change due to CH₄, and vice-versa for the other SSPs. So, we have written:

The middle row of Fig. S1 compares time series of ERF due to CO₂, CH₄, and N₂O, for the Baseline (dotted lines) and AR6 (solid lines) frameworks. The results shown in this middle row reflect the AR6 updates to both the ERF and the future atmospheric abundances of GHGs. Values of ERF are higher in the AR6 framework compared to Baseline, with particularly large increases found for the ERFs of CO₂ and CH₄ for the SSP4–3.4 and SSP2–4.5 scenarios. Finally, Fig. S1h compares ERF due to all GHGs, for the Baseline and AR6 frameworks. The largest increase in ERF, among the four SSP scenarios considered, is found for SSP4–3.4 and

SSP2–4.5, with end-of-century increases of 0.6 and 1.0 W m⁻², respectively. A similar qualitative conclusion was reached by Fredriksen et al. (2023), who contrasted projections of ERF from CMIP5 models with those from CMIP6 models, and found that CMIP6 models project higher levels of ERF by the end of the century relative to CMIP5 models.

-L205: Can the authors comment on why the ERF_{AER} value changes by so much (15% larger) when the time period is shortened by only 5 years (ending in 2014)?

We have added the following text to explain the change of ERF_{AER} in AR6, relative to AR5:

It is beyond the scope of this paper to delve deeply into the cause of the differences between the AR5 and AR6 estimates of ERF_{AER}. It is somewhat surprising that the AR6 update to the best estimate of ERF_{AER} in the year 2019 exhibits more cooling than the AR5 best estimate that reflected conditions out to 2011, because individual time series of ERF_{AER} in both AR5 and AR6 (Fig. S1g) exhibit a considerable decline in the absolute value of ERF_{AER} over the 2011 to 2019 period of time. This decline was driven by successful efforts to reduce the emissions of aerosol precursors, by various entities throughout the world, due to the public health concerns of aerosols (Smith and Bond, 2014; Fu et al., 2021). The primary reason for larger aerosol cooling in the AR6 best estimate of ERF_{AER}, despite the 8-year extension in end year, is the nearly factor of two increase in the assessed value of cooling due to the aerosol indirect effect from AR5's best estimate of -0.45 [0.0 to -1.2] W m⁻² to the AR6 best estimate of -0.84 [-0.25 to -1.45] W m⁻². A significant decline in the best estimate of black carbon warming in AR6 (0.11 [-0.20 to 0.42] W m⁻²) compared to AR5 (0.4 W m⁻² [0.05 to 0.80] W m⁻²) also contributes to the decline in the absolute value of ERF_{AER} in AR6, compared to AR5. There are other updates in the AR6 approach for ERF_{AER}, as summarized in Sect. 7.3.3 of Forster et al. (2021).

-L235: This paragraph is very unclear. What is the single best estimate ERF_{AER} time series? What portion of the difference is highlighted?

This longer new paragraph, starting on line 172 of the revised paper, replaces the two sentence paragraph that indeed was unclear in the original submission:

Time series of ERF_{AER} are vitally important inputs to our EM–GC. A hallmark of our approach is to span a wide range of possible time series of ERF_{AER}, as well as a model parameter λ_z that represents the sum of all climate feedbacks, retaining for further analysis the members of this ensemble that satisfy three goodness-of-fit constraints, to the: 1) 170-year GMST record; 2) GMST record over the past 8 decades (formally, 1940 to 2019); 3) the ocean heat content record that begins in 1955. Further details of this ensemble approach are given in Sect. 2.1 of McBride et al. (2021). Figure S2 illustrates our approach for generating an ensemble of ERF_{AER} time series for the SSP2–4.5 scenario, within the AR6 framework. The solid black line shows the AR6 assessed best value of the time series of ERF_{AER}. An ensemble is created by scaling this time series by various constant multiplicative factors, with the color scheme chosen to highlight the numerical value of ERF_{AER} in 2019. A similar approach is used for the Baseline

framework, relying upon time series of ERF_{AER} obtained from the aforementioned PICR website, as detailed in Sect. 2.5 and Fig. S7 of McBride et al. (2021). While one can envision a more sophisticated approach that allows for the alteration of the shape of ERF_{AER} , in addition to the magnitude, the actual ERF_{AER} responds quickly to changes in precursor emissions due to the short lifetime of tropospheric aerosols. Generally, historical aerosol precursor emissions are fairly well known (e.g. Hoesly et al. (2018)). The more sophisticated approach of Smith and Bond (2014), which relied upon a RF parametrization tied to the emission of sulfate, black carbon, and organic carbon aerosols, resulted in an ensemble of time series for ERF_{AER} that exhibit nearly the same shape, with quite different peak cooling.

-L690: Why did the authors elect to not examine a business-as-usual/ high emission scenario like SSP5-8.5?

As in McBride et al. (2021), we focus on the most prominent (that is, Tier 1 or Tier 2) SSPs that have the potential to allow society to meet the goal (1.5 °C warming) or upper limit (2 °C warming) of the Paris Agreement, plus the SSP2-4.5 scenario, which actually mirrors the current RF of climate by the three major GHGs most closely than other SSPs. The relevant text at the end of the Introduction reads as follows:

Here, we examine four policy-relevant SSP scenarios: SSP1-1.9, SSP1-2.6, SSP2-4.5, and SSP4-3.4 from Tier 1 and Tier 2 of the ScenarioMIP protocol (O'Neill et al., 2016). These were chosen because SSP2-4.5 is the SSP scenario most consistent with recent trends in the anthropogenic emissions of GHGs and aerosols (Meinshausen et al., 2024), while the other three SSPs we have chosen all offer more aggressive means for climate mitigation than the SSP2-4.5 scenario.

-L855: This conclusion is challenging, because the agreement between EM-GC outputs and the observed GMST timeseries is explicitly built in to the EM-GC model, whereas for the majority of CMIP6 models they are freely running through the 20th Century. Whether this reduces the value of those simulations is a matter for debate; perhaps a more nuanced view is that it affects the types of questions that one should ask of the CMIP-class models.

The sentence in question, in the original submission, read as follows:

Our work highlights the importance of ensuring that CMIP6 models used for policy purposes succeed in reproducing observed trends in GMST.

This sentence has been removed from the revised paper.

We do draw attention to the so-called “hot model” problem of ESMs in two places within section 3.2, where it is now stated:

Numerous studies have similarly concluded that many of the ESMs central to CMIP6 tend to provide estimates of the rate of global warming due to human activity (that is, AAWR) that exceeds empirically based estimates of AAWR (Tokarska et al., 2020b; Nijssen et al., 2020;

McBride et al., 2021, Chylek et al., 2024), which Hausfather et al. (2022) have termed the “hot model problem”.

as well as:

Figure 4 shows the PDF of ΔT_{2100} found with EM–GC for the four SSP scenarios, using the AR6 and Baseline frameworks. The height of the bars corresponds to the probability of ΔT_{2100} being in the range defined by the width of each column. Figure 4 also shows PDFs derived from a CMIP6 ESM ensemble, as detailed by McBride et al., (2021). As expected, based on the “hot model problem” described above, our projections of ΔT_{2100} within both the Baseline and AR6 frameworks fall on the lower end of the projections from the CMIP6 ensemble. Furthermore, the EM–GC based PDF for the AR6 framework tends to be shifted towards higher values of ΔT_{2100} than found for Baseline, with a smaller tail, behaviors that are consistent with higher end of century RF of the climate within the AR6 framework (Fig. S1i), as well as the ability to fit the climate record with higher values of climate feedback (model parameter λ_2) in the Baseline framework (Fig. 1).

Reviewer 2:

In this manuscript, the authors use the Empirical Model of Global Change (EM-GC) to explore how updates to effective radiative forcing, as reported in the IPCC Sixth Assessment Report (AR6), influence the following climate metrics: effective climate sensitivity, the rate of attributable anthropogenic warming, and projections of future warming. The manuscript concludes with an assessment of how these updates affect the likelihood of meeting the climate policy goals set by the 2015 Paris Agreement.

I was genuinely excited to see the EM-GC used in this context, and I believe this study has the potential to make a meaningful contribution to the literature. The research question is both timely and important, and I encourage the authors to continue developing this work. However, in its current form, the manuscript faces some structural challenges and clarity issues that make it difficult to fully appreciate the significance of the results. I would strongly encourage the authors to revise and resubmit, as I believe that with improvements, this paper could become a valuable addition to the field.

Much thanks for these kind words. Our revised document is much shorter, 567 lines, than the original submitted document, which had been 870 lines.

While I did not feel that a detailed, line-by-line review was appropriate at this stage, I would like to share a few broader comments that I hope will be helpful in guiding the revision.

At times, the manuscript reads like a blend of two distinct papers — part literature review, part research article. I recognize and appreciate the substantial effort the authors have put into the background material, and the breadth of the literature covered is impressive. That said, I feel that the extensive background somewhat overshadows the more novel and exciting aspects of the authors' analysis. I would recommend streamlining the background, particularly in the methods and data sections, and relying more heavily on citations to established work, which would allow the new contributions to stand out more clearly.

We have fully followed this suggestion.

I think referencing prior EM-GC literature more explicitly could help improve clarity in the model description. For example, Section 2.4 closely resembles McBride et al. (2021), and equations (1)–(4) appear to be the same as those in that manuscript. Could the authors clarify whether these equations are indeed unchanged, or if they have been modified in this study? Providing that clarification will help situate the current work within the existing EM-GC framework and highlight any new developments more effectively.

The equations are the same. As such, we have omitted the model equations from the revision. The original submission included 7 equation in Main, and 4 in Supplement. The revised paper has 2 equations in Main, and 3 in Supplement.

Another question that arose when reading this manuscript was how do the authors deal with the issue with the ERF of aerosols in the AR6 analysis (see Zelinka 2023). Did the authors account for or

correct for this basis their analysis? A comment of if/how the authors address this should be included in the manuscript or discussed as a potential limitation of the study.

We have decided to continue to base the analysis of ERF of aerosols on the AR6 time series, in part because the Zelinka et al. (2023) paper focuses mainly on the AR6 assessment of Δ ERF between 1750 and 2000, and between 1750 and 2014. Much of our paper is based on the 1750 to 2019 time period central to many ERF estimates of AR6. We have added the following new paragraph to section 2.1.3 of the revised paper:

Recently, Zelinka et al. (2023) pointed out two coding errors in the Smith et al. (2020) paper that influenced the AR6 evaluation of ERF_{AER} . These two errors largely cancel for the evaluation of ERF_{AER} . The Zelinka et al. (2023) best estimate and standard deviation of ERF_{AER} , over 1750 to 2014, is $-1.09 \pm 0.24 \text{ W m}^{-2}$, which is slightly less aerosol cooling than the AR6 estimate of $-1.3 [-0.6 \text{ to } -2.0] \text{ W m}^{-2}$ for the same time period. Given the “medium confidence” associated with the assessed value of ERF_{AER} noted in Chapter 7 of AR6 (Forster et al., 2021), the lack of evaluation of ERF_{AER} by Zelinka et al. (2023) for the 1750 to 2019 time period that is central to our study, and the focus within Zelinka et al. (2023) on the evaluation of the various components of ERF_{AER} for contemporary periods of time rather than the historical evolution of ERF_{AER} , we have decided to use the AR6 historical time series for aerosol cooling as presented in the assessment.

I appreciate the authors' effort and I am confident that with thoughtful revisions, this work can make a valuable impact. I look forward to seeing a future version of this manuscript and the contributions it will bring to our field.

Thanks for these kind words. We look forward to your comments on the revised manuscript.