General comments

This paper addresses an important question regarding the uncertainty – and associated causes – of emissions scenarios over Africa, and the consequent uncertainty in health and climate responses. The method is introduced clearly, and the results are presented in a sensible manner overall, with appropriate conclusions drawn. Overall, this paper is a nice contribution to the field and will aid in the understanding of future plausible emissions trajectories over Africa.

However, the ease of interpretation of the study's results could be decently improved with some modifications to the paper. Below are some general overview comments, with more specific line-by-line comments underneath (some of which relate to the overview comments). On the basis of these suggested changes to the presentation of the study, and in the context of the sensible methodology and important results, I recommend this study be accepted subject to minor revisions.

Some sections of the results would benefit from expansion and clarification (especially the health results), potentially at the expense of parts of the emissions results, if space is short. Sections 3.1 and 3.2 should be condensed, with key narratives drawn out, and presented in a way which is easier to follow and absorb. Section 3.2 is currently better in this regard, but could still benefit from improvement. This could involve reducing the amount of information presented. On the contrary, the health results in section 3.4 could be expanded, as they only contain 2 paragraphs and no in-text reference to figure 7. The relative effect of aging vs overall population growth isn't discussed in this section, but is of interest in interpreting the results.

Several of the figures could also be substantially improved in their presentation. Figures 3 and 4 are somewhat squashed, and the maps in figure 5 should be enlarged. There are specific comments on figures below.

Line-by-line comments

Introduction

L10: the abstract doesn't mention the fact that baseline emissions vary in their sectoral split, which is an important result.

L39: is this the sensitivity to local emissions reductions? Or remote?

L42: it's worth mentioning the semi-direct burnoff effect too.

L46: it's probably worth referring to IPCC AR6 on this too – as the definitive and more recent summary; or even the Indicators of Global Climate Change studies for more recent, and IPCC-consistent, analysis https://essd.copernicus.org/articles/16/2625/2024/.

L52: "more" recent than what? The prior references? I think it would be clearer to drop this word. Also perhaps quickly clarify this is the global burden.

L60-63: this might imply these changes are similar between scenarios – so perhaps worth caveating here to note the future uncertainty in this (which you of course go on to explore).

L74: I think it's worth explicitly noting the increased understanding in both history (from inventories) and future plausible trends (from scenarios).

L75: I think "anticipated development" should be rephrased – "accelerating development"? I think a brief noting of the wide spatial variation across the continent in any concept of development would be useful too.

L82: it might look unwieldy but you should repeat "SSP" within the scenario names e.g. SSP3-7.0, since these are the exact names.

L81-90: this paragraph is a bit hard to parse; I think you could drop the specifics of the 10 emissions pathways as you detail them in the methods, and it isn't essential at this point to know what they are. Similarly with details of the variables for evaluation. This paragraph should just be a brief overview of the method; no need for this much specificity.

L95: more detailed representation compared to what?

L98: "observed and satellite data" might imply the satellite data isn't observed? Just a quick rephrasing needed for clarity.

L104: "between 2050 and 2015-2018" – switch these around I think for ease of reading; should be "from past to future".

Methods

L108: worth defining WHO, and also for reproducibility a brief explanation of those minor adjustments, in the supplement.

L114: not sure it's worth stating your overall method again here.

Figure 1: I think the SSA is referring to the country boundaries being a different colour, but this isn't obvious. It would be best to just have the border round the actual region be distinct, and not the internal borders. Also clarify somewhere that sub-Saharan = West + East + Central + South (if I've understood that right).

L122: see above on SSP scenario names. It would probably be better to list the scenarios in 3 bullet points, maybe 1 for each source ie SSPs, ECLIPSE, UNEP? Use specific names – perhaps shorthand ones – and use these throughout the paper.

L127: what is the resolution of these new emissions? How does this vary across the emissions inventories?

L146: "[to provide emissions] for 2018 and 2050" – would suggest this, for clarity

L148: "be developed, in contrast" – this comma should be a full stop or semi colon.

L150: ", like advances" – would replace "like", maybe "such as"?

L160: would use semi-colons to separate this list, for clarity.

L164: "SSPs" to "SSP"

L165: do you not need a paragraph on the ECLIPSE emissions? Or is the info in the first paragraph of this section sufficient (I think it could be expanded to explain the motivation of

these emissions)? In any case, I would put this info in separate paragraphs, in the order in which you introduce the scenarios at the start of this section, to aid the reader. I think you need to be clearer on which species are included in each inventory – do they all give the same?

L168: Don't need "The" at the start.

L178: would drop the word "recently"; as long as it's the documentation for the model you used, this doesn't matter, and 2018 is debatable as recent in a fast-moving field!

L180: can you say roughly which fields are initialised in the model?

L180: I think this should be a new section, on "Experiments" – since you have information on the simulations, rather than just the model itself. Readers looking for the experimental setup won't necessarily expect it to be in the model documentation section.

L191: technically 2015 is the first "future" year for the SSPs, right? So maybe drop the bit in brackets.

L194: this 2% is not just due to the different time period, but also the inventories themselves, right? This strengthens your justification for using different baseline years.

L195: info on this should just be in Section 2.4.

L200: "[and] ammonium". Is the fine-mode defined with an upper level at 2.5um? i.e. giving exactly PM2.5? This is important to clarify.

L203: need "-" between "population weighted"

L204: I would drop the 2015, 2016, 2018 as you have already described this; just refer to something like "respective baselines" or even just "baselines".

L206: population isn't an output from ISIMIP "simulations"; it's an input – so just clarify that.

L207: minor point but just say 1 degree resolution – you didn't specify lat and lon in the 0.5 deg population above.

L209: I'm not sure what this sentence means – the model could be ran in 1 degree resolution? I'm not sure how that shows the downscaling works well?

L212: how did you assign gridcells to countries, when borders will cut across gridcells? Just need to clarify the method used.

L214: "SSP population" not "SSPs.. ". This approach seems sensible, as you have the population data for SSPs but presumably there aren't the same for the others, but it's worth briefly exploring the sensitivity to this – since this is an inconsistency in the other scenarios. i.e. do you get the same overall results if you just use SSP2 for the SSPs as well?

L243: what does level 3 mean? If not relevant, can leave out.

L244: see above for consistency in resolution formatting.

L251: not sure about using "our" here – maybe clarify the research group? No strong opinion on this though.

L252: reference for the recent GBD study?

How do you deal with the uncertainty in this function? Do you take draws? What about the low concentration threshold below which there is no impact? There also should be something brief on how this function was made, and its applicability for Africa.

L262: this paragraph is a bit harder to follow; I would define the terms first and then expand on them. The use of a 25km2 grid needs more justification – where does this come from? Is it meaningful to downscale the CTM results to this extent, or would it be better to upscale?

L275: 5km2 is a typo?

L277: this use of SSP2 was mentioned above, without this justification; this should be included in that earlier part, with a reference.

Results

L283: why "sub-Saharan"? This is the same as all the non-north Africa regions I guess? I think Figure 1 could be improved to be more clear on this. There is a lot of variation in North Africa too, so I think you undersell yourself by focusing on a subset of the continent here.

Figure 2: Is "ECL6" a duplication? It's not distinct from others, and there are 11 scenarios in the legend but you mention using 10 above. SAF = Sub-Saharan Africa? That needs defining somewhere; if you are going to use that then you can include it in figure 1. But maybe it's worth just writing it out in full like the other regions. Note in the caption that the y scales vary between regions. It's interesting that CEDSv21 is lower than 17, right? Also that formatting "CEDSv21" is different from the main text.

L294: SSP245 and SSP585? Also check formatting – it was SSP2-4.5 earlier. Just be consistent.

L300: I don't think Wells et al., 2024 focused on SSP585 – they mention SO2 emissions in SSP119 being driven by industry, which is relevant to your next sentence, but this reference to BC in SSP585 is worth checking. That next sentence isn't quite right either – SO2 emissions increase to mid-century in SAF in SSP119 and SSP585, before decreasing; you might be saying this already but worth clarifying for sure.

L308: would simplify by saying "the ECLIPSE scenarios"; generally, this section could do with a bit of tightening up just to simplify and aid the reader. Currently it's a bit overwhelming and hard to take in all the detail; the reader would take away more if there was less info. Figure out the key trends you want to highlight, and consider dropping some others.

L310: to 2050 right?

L318: needs a reference here; also worth noting this dynamic (reducing warming SLCPs but not SO2) earlier when you introduce the scenarios.

L337: "the SSP370" – needs rephrasing. Again, lots of information in this bit which the reader may struggle to absorb (speaking from experience!).

L361: could do with explaining exactly why it's important for accurate sectoral information (i.e. IAM consistency?).

Figures 3+4: these are a nice way of showing this, but these need some work. The figures are currently squashed making them harder to read. Maybe you could have one comparative

stacked bar chart for each region instead of the 3 pie charts? Like the supplement. But maybe that won't work. List the "increasing scenarios" in the caption, not just the main text.

L376: "the SSP585"

Section 3.2 has some really nice material, and is clearer than the previous section. E.g. the last paragraph, L367-9, L388-90 are clear; it's great when you can put these differences in their broader context. This still needs some work though to condense out the key narratives you want to get across. In general you should briefly say what the supplementary figures show as well as the conclusions drawn from them. You slip into discussing "the SSPs" when you are only looking at SSP370 in this bit, right? Need to be careful on that.

L437: this sounds like you're referring to prior analysis; ned to be clear these are your results.

L439: define MAE, RMSE. Maybe make the point here that there is some disagreement between the observations? And set your results in that context.

Figure 5: this needs tidying up too; the maps are small and the plot could be better formatted. Maybe use a discrete scale to make it easier to read roughly what each value is.

Again, you should introduce the figures in the text with roughly what they show, so the reader doesn't have to jump to the figure straight away to get the picture.

Figure 6: you should use the same regional colour scheme as in the maps for these lines; I think you've used close colours but they're not exactly the same. Maybe it would be worth adding a second panel showing the percentage changes, as these are not the same as the magnitude ones and also tell an interesting story?

L468: "exposure [increase]"?

L483: you need to show that this is the case – see suggestion for figure 6 above.

L486: this is nice – relating your results to the underlying drivers.

L492: you use "MFR" here instead of "ECL6 MFR" – it's fine to have shorthand (and maybe this would be a good thing to use throughout) but need to be consistent. If you use shorthand names, then define them when you introduce the scenarios – see the suggested in the intro about bullet points for these scenarios.

L494: don't use PM as shorthand for PM2.5; you need to write it out in full if this is the metric we are looking at.

L511: "s partially due" -> primarily due, right?

L512: "Western African" - Western Africa's? also, need to be clear this is SSP370 (right?), as there is wide variation in the figure you refer to.

Section 3.4: this section was a bit of an anticlimax – this is one of your main results, and it's only 2 paragraphs! Figure S13 is really interesting, showcasing the different drivers of these changes – and that these are fairly consistent across regions, with some important scenario and regional differences. Figure 7 is great (though the colours don't seem quite the same as figure 6, and the order is different, which should just be fixed), but you don't refer to it in the text at all! Though you do quote data from it.

L531: I don't think this conclusion about baseline concentrations follows, unless you make an argument based on the functional form of the response function? The population increase would drive increases regardless of the baseline, all else being equal.

Figure 7: are these error bars from the response function?

"3.5 Anthropogenic aerosol-inducing radiative forcing" – aerosol-induced?

L542: "s between 2050 and 2015, 2016 or 2018," – again, just say baseline, and go from present to future.

L544: should note again here that this is only the 1st cloud effect, not the 2nd (lifetime) one. also just name again the method/model used.

L551: clarify regional-mean is SAF.

L559: "emissions of changes" -> "changes of emissions"?

L552: before you go into detail here, just state the overall result: you generally find a small warming effect due to reduced concentrations, with cooling from the increase in 2 scenarios.

L584: "CEDS is not updated to 2022" – not sure when this sentence was written but CEDS is available to 2022 now; maybe just note a general delay in inventories?

L636: "significant weakening of aerosol radiative forcing by 2100 across all scenarios" – is this true spatially, e.g. in Africa? Or just globally?

L640: you should bring in CMIP6 studies on aerosol forcing e.g. https://acp.copernicus.org/articles/21/853/2021/ - to display the inter-model variability.

L649: "found that BC absorbs short-wave radiation," – careful with your phrasing when it comes to describing other studies; they didn't show this effect (ie for the first time); they look at the implications of this effect.

It's worth noting in the discussion that your method will miss climate driven PM2.5 changes, though these shouldn't be very large. Also you should note that while you explore uncertainty in emissions, your use of one model means the uncertainty in model response – concentrations and forcing - is not explored.

L709: this is the first time you've mentioned aging as a cause of this increase – how important is this cf the general population increase? If it's important, then your earlier presentation of results as being driven by population change should be clarified to note this is not just a numerical population increase, but also the aging effect.

L714: "projected to reduce excess deaths" – should be clear this is just the tendency of these effects, not the overall effect (which is driven by population)