

I am very grateful to the authors for their hard work in addressing both my and the second reviewer's comments from the previous revision. In particular the inclusion of uncertainty estimates throughout, and more precise description of the model configuration and experimental setup, have made the manuscript much more informative. I have a few wording suggestions on some of the revised text detailed below, where in a couple of places I feel the authors may not have completely addressed my original points. Subject to these minor additional changes being made though, I would be pleased to recommend the manuscript for publication in Atmospheric Chemistry and Physics.

(In the below comments, line numbers refer to the clean version of the manuscript)

Minor comments:

- L17-L18: "*instantaneous environmental perturbations*" – they're not instantaneous; they are rapid adjustments. In place of the first two sentences, the authors could maybe say something like: "Fire emissions influence radiation, climate, and ecosystems through aerosol radiative effects. These can drive rapid atmospheric and land surface adjustments which feed back to affect fire emissions" or something along those lines.
- L19-L21: "*Here, we quantify the impacts of fire aerosols on climate through direct, indirect, and albedo effects based on the two way simulations using a well-established chemistry-climate-vegetation model*" – the authors have not completely addressed my main concern here that the abstract is misleading; once again I would assert that the current study does not exactly quantify the impacts on climate; it quantifies the aerosol radiative forcing and rapid adjustments/fast response. The abstract needs to be clear and unambiguous about this throughout – readers should not have to dig in the main text to work this out. Instead of this sentence, the authors could maybe say something like: "Here, we quantify the impacts of fire aerosols on radiative forcing and the fast atmospheric response through direct, indirect, and albedo effects, based on two-way simulations using a well-established chemistry-climate-vegetation model". Or alternatively, "Here, we quantify the impacts of fire aerosols on climate through direct, indirect, and albedo effects based on atmosphere-only simulations using the GISS-E2 model coupled to an interactive vegetation and wildfire scheme". Or something similar.
- L34-L39: Same goes for the short summary – currently there no changes to the short summary to indicate that the manuscript only reports the rapid adjustment/fast response from atmosphere-only simulations. It still talks about the impact of fire aerosols on climate and the impact on temperature and precipitation without providing the context that this is not the full coupled climate response. Like the abstract, the short summary should stand on its own and not be ambiguous or misleading without further context. As with the previous comment, I suggest modifying it to say something like: "We quantify the impacts of fire aerosols on climate through direct, indirect, and albedo effects. In atmosphere-only simulations we find global fire aerosols cause cooling of surface air temperature and inhibition of precipitation over many land regions. These fast atmospheric perturbations further reduce regional leaf area index and lightning ignitions..." etc.

- L65-L67: *“Aerosol radiative effect is the instantaneous radiative impact on energy balance of climate system, representing the fast adjustment or response before changing global mean surface air temperature (TAS)”* - Remove the word ‘instantaneous’; the authors should be precise with language and stick to the accepted terminology. It’s not instantaneous, it’s the fast/rapid response and the radiative forcing being diagnosed is the effective radiative forcing (if I have understood correctly, please tell me if I’m wrong though!). This is not the same as the instantaneous radiative forcing, which has a specific meaning. References to the ‘instantaneous’ radiative impact are therefore potentially confusing. I would also say *“fast atmospheric adjustment...”* in L66 (rather than just ‘fast adjustment’) just to be even clearer for readers that are less familiar with the literature, what is being allowed to adjust whilst GMST is kept fixed.
- L85-L86: *“Impact of fire-induced instantaneous climatic perturbations to fire activities on the global scale have not been fully assessed”* – again, it’s not instantaneous. The standard terminology is either rapid adjustments or fast (atmosphere-only) response. Change to: *“The impacts of fire-induced rapid adjustments on fire activity at the global scale have not been fully assessed”* or something similar.
- L96: *“quantify the feedback of fire-induced instantaneous climate effects to fire emissions”* – same thing again, this is not the usual terminology and it’s not actually instantaneous. Replace ‘instantaneous climate effects’ with ‘rapid adjustments’ or ‘fast/atmosphere-only climate responses’.
- (From author response to a previous comment) *“The differences between YF and NF include the emissions of both primary aerosols and aerosol precursor gases (such as NO<sub>x</sub>, SO<sub>2</sub>, NH<sub>3</sub>). In the revised paper, we clarified as follows: “The fire emissions include both primary aerosols and trace gases, the latter of which react with other species to form the secondary aerosols. These particles could be transported across the globe by the three-dimensional atmospheric circulation and eventually removed through either dry or wet deposition.” (Lines 227-230) and “For YF simulations, fire-induced aerosols including primarily emitted and secondarily formed are dynamically calculated based on fire parameterization (see section 2.3) and atmospheric transport.” (Lines 238-240).”* – this hasn’t entirely answered my original question, which was: what about trace gas emissions which aren’t aerosol precursors? The model description mentions other gas-phase chemistry including NO<sub>x</sub>, CO, and CH<sub>4</sub>, all of which have radiative impacts either directly themselves, or via impacts on tropospheric ozone. I’m still unclear on whether these emissions were also perturbed, and whether there are therefore also impacts on radiative forcing from these gas-phase species and ozone perturbations. I agree they will likely be small compared to the aerosol forcing and so I don’t have a problem with the rest of the paper focusing on aerosol radiative effects, but I would still like to clarify whether these gas species are perturbed and in principle contribute to the radiative forcing that is diagnosed directly and/or via feedbacks on ozone, or is it only the aerosol changes which affect the radiation scheme?
- L186 – L187: *“Natural and anthropogenic ignition determines whether the fire can actually occur. If ignition is zero, the resulting fire emissions will be zero...”*. To me, this reads quite oddly now. You could say ‘ignition rate’ (singular), or else I would put it back to ‘ignitions’ (plural) like it was before (and then make sure the surrounding sentences are consistent

with this). I.e. either: “Natural and anthropogenic ignition rate determines whether fires can actually occur. If the ignition rate is zero, the resulting fire emissions will be zero...”, or else: “Natural and anthropogenic ignitions determine whether a fire can actually occur. If there are zero ignitions, the resulting fire emissions will be zero...” or something along these lines.

- L187-L188 and L193-L194: “*Natural ignition source  $I_N$* ” and “*The number of anthropogenic ignition source  $I_A$* ” – these should probably be “The natural ignition rate  $I_N$ ” and “The anthropogenic ignition rate  $I_A$ ” respectively.
- L223: “*has been validated based on global observations (Pechony and Shindell, 2009)*” – could potentially also reference the Hantson et al. (2020) FireMIP paper (<https://doi.org/10.5194/gmd-13-3299-2020>) here, since this intercompares and validates multiple global fire models including the INFERNO model which is essentially another implementation of the Pechony and Shindell (2009) scheme.
- L240-L241: “*These fire emissions cause radiative perturbations and the consequent changes in climatic variables, which feedback to influence fire emissions*” – change to “These fire emissions cause radiative perturbations and consequent fast atmospheric adjustments, which feedback to influence fire emissions” or something similar.
- L254: “*last 20-year averaged*” -> ‘last 20 years averaged’ or ‘last 20-year average being analysed’
- L254: “*Two-tail student t-test is performed*” -> ‘A two-tailed Student’s t-test is performed’
- Section 2.4: I am grateful to the authors for now including  $\pm$  standard deviation values after all the global mean or sum values. However the methods section also needs to be updated so that the reader knows what the  $\pm$  values correspond to (apologies if it does say somewhere and I’ve missed it; I couldn’t see in obviously Section 2.4 though). Without stating this, readers will likely assume that it corresponds to the same 90% confidence interval as is used for shading in the figures.
- L331: “*3.4 Climate feedback to fire aerosol radiative effect*” – suggest changing this to: “3.4 Fast response feedback on fire emissions” or something similar, since as far as I can tell this section doesn’t actually discuss the feedback on aerosol radiative forcing, rather it discusses the feedback on fire emissions.
- L340: “*the joint the impacts of fire-aerosol-induced instantaneous climatic change*” – c.f. previous comment about L85; replace ‘instantaneous climate effects’ with ‘rapid adjustments’ or ‘fast/atmosphere-only climate responses’.
- Data availability (L430-L434): No information is given on the availability of the simulation output being analysed here; please add this
- L643: “*through fire-climate interactions*” – maybe change this to “due to the fast response feedback” or something similar, so that the caption is easy to interpret even without reading the main text for additional context