Dear authors,

Comment 1: Thanks for clarifying that your method already addresses the concern raised by the referee. Unfortunately, the sentence you added to the manuscript for clarity does not detail your reasoning behind your method as nicely as your response. (Also, "The ratios of fire-sourced O_3 concentrations and the total O_3 concentrations during historical and different climate scenarios were not invariable, which were estimated by GEOS-Chem based on different meteorological conditions and emission scenarios" is grammatically confusing, I think you mean "..., but were estimated...").

Response: Thank for editor's suggestions. The sentence has been changed into "In future simulations of fire-sourced MDA8 O_3 concentrations, we did not apply the historical ratio of fire-sourced O_3 to total O_3 concentrations to future scenarios directly, but used the GEOS-Chem model to calculate the ratios of fire-sourced O_3 to total O_3 concentrations under four future climate scenarios" (Line 174-177).

Comment 2: Please add a suitable version of this response of yours to the method description to make it clear to the reader why you did what you did: "It would be unscientific and problematic to assume a fixed ratio of fire-generated O_3 to total O_3 from historical periods and extrapolate it unchanged into future scenarios. Instead, we employed a machine learning approach to calibrate total O_3 concentrations under future scenarios. The proportion of fire-related O_3 within the total O_3 in these future scenarios was simulated using the GEOS-Chem model. For instance, the ratio of fire-related O_3 and the total O_3 in SSP1-2.6 scenario was calculated based on the simulated fire-sourced O_3 concentrations divided by simulated O_3 concentrations (from all of the sources) in this scenario. For the four different climate scenarios considered, the contribution of wildfires varies significantly—a factor we thoroughly accounted for in our modeling. However, directly validating future fire-sourced O_3 concentrations remains challenging. Instead, we performed indirect validation using historical data, such as with K^+ and levoglucosan tracers, which demonstrated strong performance. Thus, the ratios of fire-sourced O_3 concentrations and the total O_3 concentrations during historical and different climate scenarios were not invariable, but were estimated by GEOS-Chem based on different meteorological conditions and emission scenarios" .

Response: Thank for editor's suggestions. We have added the basic principle and detailed correction method in the revised version. "In the third/final stage, the calibrated MDA8 O_3 concentrations based on previous two-stage models were utilized to optimize the fire-sourced MDA8 O_3 concentrations. Due to uncertainties in the GFED and anthropogenic emission inventories, as well as in the chemical mechanisms, the simulated total and fire-sourced MDA8 O_3 concentrations often deviate substantially from ground-based observations. Therefore, it is essential to use the calibrated MDA8 O_3 concentrations from the previous two stages rather than the originally simulated values to adjust the fire-sourced O_3 levels. However, the magnitude of the error between the simulated fire-sourced O_3 concentrations and the actual values cannot be directly quantified. Based on previous studies (McDuffie et al., 2021), we assumed that the ratio of simulated fire-sourced O_3 concentration to simulated total O_3 concentration from the GEOS-Chem model was equivalent to the ratio of optimized fire-sourced O_3 concentration to calibrated total O_3 concentration. The detailed equations

are summarized as follows:

$$O_{3\_opt\_fire} = O_{3\_cal\_total} \times (O_{3\_chem\_fire} / O_{3\_chem\_total}) \quad (2)$$

where $O_{3\_opt\_fire}$ is optimized wildfire-induced MDA8 O_3 concentration in the final stage. $O_{3\_cal\_total}$ is calibrated total MDA8 O_3 concentration. $O_{3\_chem\_fire}$ is simulated wildfire-induced MDA8 O_3 concentration using GEOS-Chem model. $O_{3\_chem\_total}$ is simulated total MDA8 O_3 concentrations using GEOS-Chem model.

In future simulations of fire-sourced MDA8 O_3 concentrations, we did not apply the historical ratio of fire-sourced O_3 to total O_3 concentrations to future scenarios directly, but used the GEOS-Chem model to calculate the ratios of fire-sourced O_3 to total O_3 concentrations under four future climate scenarios.

The modelling accuracy of fire-induced MDA8 O_3 cannot be evaluated directly, whereas the modelling performance of total MDA8 O_3 concentrations could be assessed. Some typical statistical indices (supporting information) were applied to evaluate the modelling accuracy of this model on the basis of the ground-level observations. For the accuracy of fire-sourced MDA8 O_3 estimate, we used some fire fingerprints (K^+ and levoglucosan) to assess their relationships with O_3 concentrations. This method could also examine whether the assumption of in the stage 3 was right and suitable to our study" has been added in the revised version (Section 2.2).

Best regards,
Eva Pfannerstill