Comment on egusphere-2022-713
Anonymous Referee #2

Referee comment on "Impacts of estimated plume rise on PM$_{2.5}$ exceedance prediction during extreme wildfire events: A comparison of three schemes (Briggs, Freitas, and Sofiev)" by Yunyao Li et al., EGUsphere, https://doi.org/10.5194/egusphere-2022-713-RC2, 2022

Summary:

This paper used an offline CMAQ model with three different plume rise schemes to discuss the impact of injection plume height on local and downwind aerosols’ chemical composition as well as the photochemical processes. The paper clearly explains the basic settings of the CMAQ model and the different input parameters in three plume models.

This work has compared the predicted AOD among three plume models to illustrate their different prediction performance in the source and downwind area, while a detailed comparison between VIIRS observed AOD and modeled AOD is expected to further validate the model prediction accuracy. This work has made the comparison of PM exceedance regions between the model prediction and the AirNow observation on Aug 20, 2020. The result shows good consistency.

The analysis of the plume models’ impacts on photochemistry mainly focuses on the photolysis of NO$_2$. We expect more observation evidence on NO$_2$ concentration to validate the model prediction. The relationship between NO$_2$ concentration or photolysis rate and other species concentration which have adverse effects on human health (e.g., ozone) needs to be further established.

General comments:
Introduction:

Authors explained the different parameters used in three schemes for plume height estimates. We expect the authors to explain how the later-published schemes of plume height simulation improve the modeling accuracy, in general. Also, what is the limitation of each model.

Method:

The CMAQ model domain has a spatial resolution of 12 km × 12 km. The scale of an wildfires in the western US is normally smaller than the spatial resolution of the defined CMAQ domain (Biomass burning emission is a 0.1 degree product). Please provide the dimension information (or related information) of the studied fire to explain the choice of domain resolution.

In section 2.1 Experiment Design, authors have mentioned the reaction pathway from VOCs to SOA. However, in the result analysis part, section 3.2, the contribution of SOA in the total OM has not been mentioned. The potion of OM in the total PM2.5 seems to be completely regarded as the primary emission. Combining primary OA and SOA together may introduce errors in the further discussion on particle/gas transport issue.

Results:

Figure 5 plots the specific chemical component of PM2.5 against the distance (km) from the source point. Is this distance along certain smoke transport pathway? If so, which specific pathway you chose to sample the modeled concentration of different species.

Specific comments:

Line 48: PM2.5 definition: Particle’s aerodynamic diameter is less than 2.5 μm

Line 48: “47%” in mass or other types of measure?
Line 62: “Irregular large point sources”. What does this terminology mean? The boundary of the source is irregular? Then why is a point source?

Line 78: the unit of “3720”. Daily, hourly cases?

Line 156: What’s the result of this reason?

Line 209: Define “ABL” before using it

Line 225: Is “OM” here the same as organic carbon you defined in section 2.1, which only refers to primary organic carbon?

Line 226: Clarify that the composition of PM2.5 in this section is surface PM2.5, or PM2.5 under PBL, or column PM2.5. Line 232 mentioned “surface PM2.5”, and the conclusion of this section is “integrated over all vertical layer”.

Figure 4: The negative sign before the longitude is unnecessary

Line 249: Unify the representation of longitude: either 115° W or -115° throughout the paper

Figure 6: The comparisons between VIIRS AOD and modeled results may be needed to demonstrate the prediction accuracy of different plume models.

Line 286: Thicker smoke in this study doesn’t necessarily mean higher AOD. Thicker smoke somehow may be attributed to a diluted plume because of the different plume height modeled by different schemes. A basic assumption in this study is the primary biomass burning emissions among three models are similar (or identical).

**Typos or other improvement suggestions:**
Line 25: lower case “western”

Line 46: two “annual”

Line 63: Start a new sentence to declare the second limitation of Briggs scheme.

Line 69: Please provide the reference of Siberia study

Line 69: “height”

Line 72: Suggest start a new sentence here.

Line 162: “from... from...” redundancy

Line 185: lower case

Line 263: lower case

Figure 6: Increase the tick font size of the colorbar

Line 296: The difference ratios in NO2 is higher than the ones of AOD can only prove the concentration of NO2 is not linearly proportional to AOD.

Line 297: The reaction rate of NO2 (for this NO2 -> NO + O reaction) is the product of <NO2_IUPAC10> and the concentration of NO2. The comparison of reaction rates between different plume schemes is needed to support your conclusion.

Figure 7: Increase the tick font size of the colorbar
Other comments

Line 67: This sentence means Sofiev scheme used the MISR observed plume height to determine the modeled plume height. I am a bit confused about it (Line 67 - 69).

Line 76: Please provide the reference of the burned area. (I remembered the burned area in the western US in 2020 is high but below 10 million acres. The entire US is larger than 10 million acres)