Reviewer #1 Comments

We thank the reviewer for her constructive comments. We are unsure as to what the reviewer means by the highlights and check marks in the supplied comment document. We reviewed the wording and science in the lines around the check marks and found no issues with grammar or scientific content. We thus make no changes to the lines with the highlights or check marks (unless specific comments were added in the nearby margins), but we are happy to address any other comments or suggestions that the reviewer may have regarding said un-marked highlights or check marks.

Comment: Line 23: (in reference to "… wildfire aerosol plumes are more radiatively neutral…") Due to compensating effects in the VIS and IR?

Response: Thank you for the question. That is correct: we suspect that the dense smoke plumes are more radiatively neutral than previously understood because the reduction in upwelling longwave flux related to the TIR cooling offsets some of the increase in upwelling shortwave flux associated with the high albedo of the dense smoke.

Comment: Line 169: (at elevations nearly 3000 ft below O05). Metric system

Response: Thank you for catching this error. We have changed "… at elevations nearly 3000 ft below O05." to "… at elevations nearly 1 km below O05."

Comment: Section 2.7: What is used for the IR biomass burning aerosol optical properties?

Response: Thank you for the question. The purpose of our SBDART simulations is only to test if enhanced concentrations of gas constituents (water vapor, carbon dioxide, methane, etc.) could be responsible for the observed TOA thermal IR cooling, so we conducted our simulations by only adjusting the amounts of water vapor and gas constituents in the profile. Smoke aerosol plumes are not included in the SBDART runs. This is also because observational-based aerosol optical properties are needed. However, we do not have reliable aerosol observations to constrain the SBDART simulations.

Comment: Section 3.2, lines 322 – 335: Also hydrogen cyanide (HCN) could be a contributor. This was the case for the Indonesian fires of 2015 (see for example [link to eumetsat tech report])

Response: Thank you for the comment. Hydrogen cyanide certainly could be a contributor. However, no observed data for HCN are available for the study case. Also, we do not observe significant HCN signals at nighttime (Section 3.4). We revised the paper by adding the following text:

"Note that high concentrations of hydrogen cyanide (HCN) were found for the 2015 Indonesian Fires (Park et al., 2021). However, no observational HCN concentration data are available to confirm the presence of high concentrations of HCN for this study case. Also, if absorption by HCN within the smoke plume plays a significant role in the TIR cooling signal for this study case, we would observe cooling signals within the smoke plume at night, but as we show later in Section 3.4, no significant cooling signal is observed in the plume region at night. We thus expect the impact of HCN to be marginal in this case, but leave further analysis of the impacts of HCN on the Dixie Fire smoke plume to a future study."

Comment: Lines 386 – 387 (in reference to "… possibly caused by shadowing induced by the smoke plume.") Does this mean that the smoke acts like a cloud in the VIS but not in the IR? Does this depend on the plume height?

Response: Thank you for the comment. That is correct: our hypothesis is that the sub-micron sized smoke particles act like a cloud in the visible and scatter/absorb significant amounts of sunlight, causing strong shadowing effects on the surface and cooling the surface and column beneath the smoke. However, due to the drastic decrease in smoke optical depth at the IR spectrum, the smoke plumes are likely transparent to IR radiation.

Given the scope of this study, in that we studied just one of these dense smoke plume cases, we are limited in our ability to study if the strength of the IR cooling signal is related to the plume height. Further study is needed to investigate this with the inclusion of lidar observations, which are not available for this study.

Comment: Line 470: I would suggest at looking at the Indonesian fires of 2015 – those were extensive and would provide a nice testbed for this hypothesis. GOES data will not be usable over that region but MeteoSat-9 can provide some insight along with the polar orbiting satellites.

Response: Thank you very much for the suggestion. We agree that expanding the analysis to other wildfire cases (including the Indonesian fires of 2015) is an interesting and necessary next step. However, such a step would require extensive additions to this paper, which is already long as it is. Thus, we choose to keep this paper as a first look at the observable smoke-induced TIR cooling phenomenon and leave the application of this hypothesis to other wildfire cases for a future study.