



EGUsphere, referee comment RC1
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Comment on egusphere-2022-80

Anonymous Referee #1

Referee comment on "Dynamical perturbation of the stratosphere by a pyrocumulonimbus injection of carbonaceous aerosols" by Giorgio Doglioni et al., EGUsphere,
<https://doi.org/10.5194/egusphere-2022-80-RC1>, 2022

This paper describes a simulation of a large stratospheric smoke plume injected by an intense pyroCb event in Canada. Emphasis is placed on the successful simulation of a stratospheric anticyclone induced by diabatic heating within the plume. Radiative interactions of aerosols (coupling with meteorology) facilitate a realistic anticyclone that is comparable with observations in previous studies. This work represents a major advancement in aerosol modeling with radiative coupling, and is the most detailed simulation to date of the SWIRL (Smoke With Induced Rotation and Lofting) phenomenon. I therefore recommend publication after addressing the comments below.

General comments

While it is VERY impressive that GEOS was able to simulate a realistic SWIRL, I did have some difficulty reconciling the results with real-world observations. I became heavily dependent on looking at the work by Lestrelin et al. Readers will want a quick way to compare the timing, magnitude, and location of the simulated SWIRL with what actually happened. It's okay to reference Lestrelin for some of this, but I think you need to have at least one direct comparison in the current manuscript. For example, can you add a second panel to Figure 2 highlighting the actual path and timing of the observed SWIRL? Is it the same path as Figure 6 in Lestrelin et al? How does the location and altitude of the observed SWIRL on 23 Aug compare with the simulation?

This analysis focuses on the SWIRL at lower latitudes. Did the observed SWIRL stall for 7 days such as in the simulation? Do you know why the GEOS simulations were unable to identify the other SWIRLS identified by observations (e.g., Lestrelin et al)? Is it simply a function of differences in meteorology caused by the free running simulation? Some

discussion of this is likely warranted.

Additionally, the discussion in Section 3.1 should include a bit more information on the limitations of using a free running simulation. Basically, provide a 1-2 sentence summary of what is in the Appendix. Perhaps make it clear that the replay mode is a good proxy for the observed plume, but you have to use free running methods here for reasons X, Y, Z.

In summary, I was a bit lost on how I could quickly compare the SWIRL simulation results with real-world observations. It's okay if the simulated plume takes a radically different path from the obs, but you'll need to explain that in the context of the free running simulation type used here. Basically, that subtle changes in ambient meteorology (e.g., relying forecast fields) can have a significant effect on plume transport. That's a limitation of doing a study like this, but it's the only way without adding much more complicated ensemble work or something similar. Some of this is already provided in certain parts of the manuscript, but a little reorganization would help, especially making these aspects more clear early on.

Specific Comments

Abstract line 1: Better to say that the PNE took place during the "evening and nighttime hours". The most intense pyroCbs developed before sunset.

Lines 33-35: Note: The PNE actually had 7 individual pyroCbs, including the 5 identified by Peterson et al 2018 and two more that occurred after sunset identified by Fromm et al 2021. The majority of the smoke likely reached the stratosphere via the 4 largest pyroCbs highlighted by Peterson et al 2018.

Fromm, M. D., G. P. Kablick, D. A. Peterson, R. A. Kahn, V. J. B. Flower, and C. J. Seftor (2021), Quantifying the Source Term and Uniqueness of the August 12, 2017 Pacific Northwest PyroCb Event, *Journal of Geophysical Research: Atmospheres*, 126(13), e2021JD034928, doi:<https://doi.org/10.1029/2021JD034928>.

Lines 120-121: double negative is confusing. Perhaps use something like: "These criteria constrain PV anomalies to those associated with the presence of high carbonaceous aerosol concentrations."

Figure 2: perhaps mark the PNE source region for reference?

Line 164: change "Caribbeans" to "Caribbean Sea"

Lines 251-254: This is a long and slightly confusing sentence. Please revise and/or clarify.

Fig. 9e and d are referenced before Fig. 9a and b?

Line 274: fix "(9f)"

Fig. 9c. Caption states that the three curves are averages, but the legend uses "TOT" and "AER HR". This is confusing. There is enough space to make a more descriptive legend here.

Line 300: confusing sentence

Line ~305 to the end: This ending text might be better suited for a separate section called something like "discussion and limitations". The preceding text covers the actual conclusions I think. You could then end with a "big picture" paragraph highlighting the advance this study makes in plume modeling and future directions.