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Atmospheric Chemistry and Physics Discussions

Interactive comment on "Harnessing Stratospheric Diffusion Barriers for Enhanced Climate Geoengineering" *by* Nikolas O. Aksamit et al.

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Anonymous Referee 1

Thank you for your comments and suggestions. They have greatly added to the clarity of the manuscript.

Line 28, missing citation

Thank you. We have added the missing citation.

Line 44, missing comma (turbulence coherence and mixing → turbulence, coherence and mixing)

Corrected, thank you.

Line 63, says figure 4 but I think mean to reference figure 2.

Corrected, thank you.

Line 145, the definition of DBS. It appears to be non-dimensional. Is that correct?

Yes, this is non-dimensional.

Line 147, there are typos in the definition of $T_{t0}(x0)$, the superscript of T and the first argument of D. The definition should be, ... , Given the importance of this definition, I suggest not having it as an in-line equation; give it its own equation line. Lines 151 and 153, typo in the superscript of F

Thank you for catching these superscript typos. They are now corrected.

Figure 3. This figure was a bit confusing. It took some time to realize that the background grayscale in the upper left figure was related to DBSBW whereas in the upper right it was DBSFW. Also, why is it in a log scale, ln(DBS)/2t, and what is t? The advection time-scale, so 7 days? What are the units of this log scale? Inverse days?

Correct, the timescale is inverse days. The logscale provides a better visualization of the structures present in the DBS field, instead of only showing a few ridges. This presentation is adapted from the standard approaches of presenting non-diffusive analog, FTLE fields. The figure has also been updated for clarity.

Lines 176-185, This section seems to describe the identification of DBS-informed injection sites. But it does not appear to be automated. Does this involve a human-in-the-loop for each month during the two decade simulation time? Could this procedure be automated to optimize some cost function, such as the main two metrics given?

This process is in fact automated. The algorithm is as follows 1: Calculate DBS_{BW} and DBS_{FW}. 2: Extract attracting ridges as connected components of DBS_{BW} field above a fixed threshold via flood-fill algorithms. 3: Find seven largest ridges, and identify all points that are closer to each ridge than any other ridge. 3a:If we cannot find seven unique ridges, use as many unique ridges as we can, and separate ridges into intersections with latitude bands. Find points closest to our 7 subdivided ridges. 4: In the neighborhood of each ridge, identify the point with the highest DBS_{FW} value.

This could indeed be optimized, and would possibly improve the results, especially for the case when we cannot find 7 unique connected components, or by using adjacent isentropes. At this stage, a true optimization would be a significant undertaking as it would require many more CESM2 simulations. This is already the bottleneck, and why we have chosen this DBS method to begin with.

This algorithm is now included in Table 1.

Figure 5, the subplot labels (a),(b), etc are too small to see. The curves in the lower two plots are not labeled.

Thank you. This figure has been updated for clarity.

Figure 7, DBS vs. Airport DBS: look very similar. How much did the airport restriction actually affect the choice of injection sites?

12 of the 28 injection sites were changed upon applying the airport restriction. During this process, a given injection location was changed anywhere between 600 and 18,000 km. Considering we are moving injection locations halfway around the world, it speaks to the ability of DBS to highlight locations of strong dispersion as the results with the airport restriction can still outperform the fixed locations.

line 308, it says Figure 8, but I think this is about Figure 9. C2

Corrected, thank you.

Figure 10, does larger effective aerosol radius correlate to more coagulation? I am assuming this is the case but it was not stated.

Yes this is now explicitly stated in Line 440.

While it is good to see the mean distance quantity and entropy, how much of an effect are these things having on the actual reduction in global temperature? Sure the DBS informed location sites will spread out more and coagulate less and it is clear that will reduce the temperature but is not clear by how much. Would be helpful to know.

We agree that some aggregate measure of the net effect would be useful. The simulations are not long enough to capture steady state responses of temperature. Instead, we include information on the top-of-atmosphere radiative flux changes in a new Table 2, which, in this setup, are good estimates of radiative forcing (Hansen et al., 1997). This can serve as a proxy for temperature change (Gregory et al., 2004).

References:

Hansen, J., M. Sato, and R. Ruedy, 1997: Radiative forcing and climate response. J. Geophys. Res., 102, 6831-6864, doi:10.1029/96JD03436. Gregory, J. M., Ingram, W. J., Palmer, M. A., Jones, G. S., Stott, P. A., Thorpe, R. B., … Williams, K. D. (2004). A new method for diagnosing radiative forcing and climate sensitivity. Geophysical Research Letters, 31(3), 2–5. https://doi.org/10.1029/2003GL018747

Please also note the supplement to this comment:
https://acp.copernicus.org/preprints/acp-2020-696/acp-2020-696-AC1-supplement.pdf

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