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Earth System Dynamics
Discussions

Interactive comment on "The response of terrestrial ecosystem carbon cycling under different aerosol-based radiation management geoengineering" *by* Hanna Lee et al.

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We appreciate the reviewer's support and comments. The suggestions were very helpful and we revised the manuscript according to the suggestions made by the reviewer.

General comments: 1. The authors investigated the spatial patterns of precipitation changes caused by RM applications, but gave only a little information on the spatial patterns of other variables affecting C cycle. As recently suggested by Zhang et al. (2019), vegetation at different latitudes show different sensitivities to aerosol-caused temperature changes. In Line 168-170, the authors indicated stronger cooling effect of RM in tropics than high latitudes. How is this pattern different from the RCP4.5 sce-

nario? It would be interesting to compare and discuss. If possible [optional], to quantify this impact using sensitivity as in Zhang et al. (2019) or a few offline simulations on the land surface model will be able to distinguish the impacts of temperature (probably other factors) and CO2 fertilization and provide more insightful understanding of RM impacts. 2. Similar to the previous point, I would also check if the downward solar radiation at land surface has different patterns among the 3 RM methods, especially in tropical forests, because some studies indicate radiation-limiting vegetation in these regions (e.g. Nemani et al., 2003). 3. The authors suggested that the diffuse radiation is not so important regulating NPP in Line 160. To justify this, the authors need to clarify whether and how the model distinguish diffuse and direct radiation in the Model description section. Also, I recommend the authors to use total downward surface radiation and diffuse radiation fraction rather than direct and diffuse radiation because the previous way can more clearly distinguish the effect of aerosol-caused dimming and increase in diffuse light.

»The first three comments are related and we address them together here. While investigating the reviewer's comments, we recognized that we made a serious under-investigation of radiation changes in our manuscript. We have investigated changes in radiation and its effects more in depth. We now added additional paragraph describing the patterns of direct and diffuse radiation change (see sections 2.1-2.3).

We realize that the statement we previously made 'the diffuse radiation is not so important regulating NPP in Line 160' was incorrect and now revised it in the main text. In the CLM, both direct and diffuse radiation is used in the computation of photosynthesis and as diffuse radiation is used in both sunlit and shaded leaves, it is indeed more efficient in the overall photosynthetic process as pointed out by several studies. We greatly appreciate the reviewer by pointing out this mistake and giving us the opportunity to correct it.

The reviewer suggested us to investigate sensitivity of photosynthesis using sensitivity test shown in Zhang et al. (2019). We investigated Zhang et al. (2019) and the method

used in this study and decided to keep the analysis as correlation instead of sensitivity. We decided that correlation is a more effective metric to show in our study as it is a more direct comparison of changes between the two variables. Since our study deals with different model experiments using the same model, correlation is simpler and direct method to show how different environmental changes affect photosynthesis. The correlation plot in our study does exhibit some regions to be sensitive to changes in temperature and radiation. It is important to note here that the main goal of our study is to compare how different RM applications affect global biome NPP and C storage. Since we are using the same model, looking into sensitivity in different regions is slightly out of the scope of the study as it does not influence a great deal in comparing different methods of RM and how the different methods manifest in the NPP.

After investigating the changes in direct radiation, diffuse radiation, temperature, and precipitation, we are still convinced that changes in precipitation is the largest driver of changes in NPP under the three RM methods applied. The increases in diffuse radiation may positively influence the rate of photosynthesis, however, the large decrease in precipitation under some of the RM methods applied in our study has greater impact on photosynthesis. We think that this is still a very important investigation made under the suggestion of the reviewer and we truly appreciate this comment. As admitted by the authors in Zhang et al. (2019) study, some of these environmental variables covary. For instance, it is common that where direct radiation is reduced precipitation increases due to increased cloud formation. This is very difficult to partition and may need separate simulations to quantify it. The sensitivity change in various regions under RM is still an interesting topic, but this could better be addressed using experiments conducted using different models. We think this could be an interesting research topic for another study but is a bit out of the scope for this paper that focuses on comparing the impacts of applying three different RM methods.

4. It is not clear whether SI1 is the spatial pattern of temporal correlation, or the pattern of spatial correlation calculated in groups of nearby grids? The later correlation

might indicate mainly the response of PFT distribution to precipitation regime given the coarse resolution of the model. In the manuscript, to investigate the response of the vegetation to precipitation changes, the temporal correlation (partial correlation to control temperature and radiation) is more reasonable.

»We believe the reviewer is addressing SI2 (now SI3) instead of SI1 in this comment. The results in SI2 is simply drawn from a distribution of PFT used in our model. Perhaps the confusion comes from the title of the figure. We appreciate the reviewer's comment for us to clarify this. We have now revised the title to 'Spatial pattern of temporal correlation between the simulated results between RCP8.5 and the RM methods based on RCP8.5 scenario. The variables shown are FVR-NPP, TSA-NPP, precipitation-NPP in each grid of the model mean over the 2070-2100 period.'

Other comments: Line 153 "large overall". Also to be consistent in tense. For instance, Line 153 used "is" but Line 155 used "was"

»Revised to be consistent and as suggested.

Line 189-191: Not clear, need to be rephrased

»Revised.

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