Response to Referee 1

Overview:

This paper analyzed changes in surface air temperature over China in response to stratospheric aerosol injection (SAI) geoengineering. The authors did so by analyzing existing G4 multi-model SAI simulations from the Geoengineering Model Intercomparsion project. The authors used the method of Kashimura et al. (2017) to decompose SAI-induced changes in shortwave radiation into components of solar reduction, albedo change, cloud cover change, and water vapor change. Using this method, the authors further examined spatial pattern of surface shortwave radiation change and its contributors over China.

Major Comments:

(1) This paper itself is straightforward and scientifically sound. However, it lacks scientific insight. I see little new scientific findings this paper offers. It essentially applies an existing method and uses existing multi-model dataset to a regional study. To put it in another way, if similar studies are done for another country/region, does it merit another publication?

Response: We intend to establish a relationship between changes in surface shortwave radiation and temperature under SAI forcing in the original manuscript. However, as you and Referee 3 suggested, this consideration lacks new scientific findings and has duplication with previous studies. In the revision, we try to diagnose the SAI-induced temperature change over China by using the surface energy balance equation based on Lu and Cai (2009) (Lines 136–166). The method proposed by Kashimura et al. (2017) is only used to diagnose the downward shortwave radiation change under clear sky conditions (Lines 153–166). Results indicate that the SAI-induced temperature change over China is dominated by the robust decreases in downward clear-sky radiation fluxes and associated with the cloud effective forcing and surface albedo feedback changes. The spatial pattern of temperature response over China is mainly related to the shortwave radiative effect of clouds and surface albedo feedback. The physical processes which drive the temperature change have also been discussed in the revision (Lines 265–300). Taken together, we believe that these analyses provide new scientific findings.

Specific comments:

(1) Lines 31-32: Recent reports such as IPCC special reports on 1.5 degree warming treat CDR and SRM separately and no longer lump them together as geoengineering.

Response: This sentence has been rewritten as you suggested (Lines 34–36).

(2) Lines 51-52: SAI does not necessarily reduce precipitation. It only reduces global mean precipitation if SAI is used to compensate GHG-induced global mean warming.

Response: This sentence has been rewritten in the revision for clarity (Lines 60–62).

(3) Lines 58-59: Possible ozone depletion due to SAI is not a result of SAI induced cooling.

Response: The possible ozone depletion is mainly caused by the SAI-induced heterogeneous chemistry change (Tilmes et al., 2008). This sentence has been rewritten for accuracy (Lines 66–68).

(4) Line 66: It is important to note that volcanic eruptions are just imperfect analog of SAI.

Response: As you suggested, the volcanic eruption is not a perfect analog of SAI. The sulfate aerosols from massive volcanic eruptions only last for 2–3 years, while the SAI-induced aerosols are continuously replenished for decades or centuries. The relevant explanation has been added to the revision (Lines 82–84).

(5) Lines 70-76: It is not clear what is the novelty of this study. The authors state that no previous studies have analyzed effect of SAI on surface air temperature over China. However, this is a very weak justification of the novelty of this study. What new scientific insight we can obtain from this study? In other words, if someone writes another paper, stating that no

previous study has focused on surface air temperature response over another region/country, can it be justified for publication?

Response: Following your comment, firstly, we have emphasized the importance of analyzing the effect of SAI on surface air temperature over China in the revision (Lines 75–79). As an important region in combating climate change, China's attitude to SAI is crucial to the international geoengineering research community. Considering the combined effect of the Tibetan Plateau and the East Asian monsoon, the climate over China would be strongly influenced by SAI geoengineering. It is therefore worth investigating how SAI affects the climate over China.

Secondly, we have changed the research method in the revision. The diagnosis based on surface energy budget quantifies the effect of downward energy fluxes changes on surface air temperature over China under SAI forcing. The related physical processes are also discussed in the revision (Lines 265–300).

(6) Lines 108-113: Everything stated in this paragraph is self-evident.

Response: This paragraph has been completely rewritten in the revision for clarity (Lines 129–135).

(7) Lines 114: Is it necessary to repeat the method and equations of Kashimura et al. (2017) in detail? What is new here?

Response: As you suggested, the detailed introduction of this method is redundant. This part has been shortened in the revision (Lines 153–166).

(8) Line 222: Why surface cooling increases upward LW radiation?

Response: The original "increases" should be "decreases" here. The discussion about upward radiations has been removed in the revision.

Reference:

Kashimura, H., Abe, M., Watanabe, S., Sekiya, T., Ji, D., Moore, J. C., Cole, J. N., and Kravitz, B.: Shortwave radiative forcing, rapid adjustment, and feedback to the surface by sulfate geoengineering: Analysis of the Geoengineering Model Intercomparison Project G4 scenario, Atmos. Chem. Phys., 17, 3339–3356, https://doi.org/10.5194/acp-17-3339-2017, 2017.

Lu, J., and Cai, M.: Seasonality of polar surface warming amplification in climate simulations. Geophys. Res. Lett., 36, L16704, https://doi.org/10.1029/2009GL040133, 2009.

Tilmes, S., Müller, R., and Salawitch, R.: The sensitivity of polar ozone depletion to proposed geoengineering schemes, Science, 320, 1201–1204, https://doi.org/10.1126/science.1153966, 2008.