The Cryosphere Discuss.,
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Interactive comment on "Brief Communication: The significance for the IPCC targets of 1.5 °C and 2.0 °C temperature rise for an ice-free Arctic" *by* Jeff K. Ridley and Edward W. Blockley

Anonymous Referee #3

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The submitted paper discusses the response of Arctic Sea ice September coverage at global mean temperatures of 1.5 or 2 degrees Celcius above pre-industrial, the targets referred to in the Paris climate agreement.

In contrast to previous studies, which have focussed on scenarios which achieve these targets through greenhouse gas mitigation alone, the present study considers joint mitigation and solar radiation management (SRM) to achieve global mean temperature goals.

The study is potentially interesting, but does not address the most interesting issue which could potentially be discerned from this dataset: is there a difference in the

projected avoided sea-ice loss which can be obtained through solar radiation management, compared to greenhouse gas mitigation alone?

Firstly - the authors have considered only one target in their geo-engineering experiment: the global mean temperature, and the authors have used globally uniform sulphate distributions to represent their SRM. It has long been noted that such compensation of uniform sulphate increase, whose effect peaks in the tropics combined with increased CO2, whose effect peaks at the pole - results in significant warming at the poles relative to the CO2 mitigation case (Ricke 2010). This would imply that the author's estimates of ice distribution at 1.5 or 2 degrees are likely to show more loss than a pure mitigation case. This is undiscussed in the paper - and is a central point.

Moreover, recent studies have highlighted that targeted injection patterns can mitigate the polar warming effect (Kravitz 2017, Modak 2013) by increasing choosing injection sites which increase the relative sulphate loading over the poles or summer hemisphere. Even if the authors' model is not capable of resolving interactive aerosols, a non-uniform sulphate loading distribution could quantify the efficacy of such approaches for sea ice conservation.

A clear possibility here is to quantify minimum sea ice cover not just as a function of global mean temperature - but as a function of forcing type and transient forcing history (is there any detectable lag in the response of sea ice to falling temperatures as the sulphate loading is increased?).

This is an interesting dataset, but it has been interpreted as a straightforward assessment of climate at 1.5 and 2 degrees, although there are strong reasons to believe that the geoengineered climates considered here would be unlike those observed at global mean temperatures of 1.5 or 2 degrees during a conventional RCP. The paper should acknowledge this, and consider more deeply how climate targets achieved using SRM differ from those achieved using mitigation.

Minor Issues:

The injection quantities use information derived from the multi-model mean - which is a piece of information which would not be known in the real world. This should be acknowldged

There are multiple typos. Please proof read before resubmission.

Ricke, K. L., Morgan, M. G., & Allen, M. R. (2010). Regional climate response to solar-radiation management. Nature Geoscience, 3(8), 537.

Kravitz, Ben, Douglas G. MacMartin, Michael J. Mills, Jadwiga H. Richter, Simone Tilmes, JeanâĂŘFrancois Lamarque, Joseph J. Tribbia, and Francis Vitt. "First simulations of designing stratospheric sulfate aerosol geoengineering to meet multiple simultaneous climate objectives." Journal of Geophysical Research: Atmospheres 122, no. 23 (2017).

Modak, A., and G. Bala. "Sensitivity of simulated climate to latitudinal distribution of solar insolation reduction in SRM geoengineering methods." Atmos Chem Phys Discuss 13 (2013): 25387-25415.

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