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Atmospheric Chemistry and Physics Discussions

Interactive comment on "Multi-model dynamic climate emulator for solar geoengineering" *by* Douglas G. MacMartin and Ben Kravitz

Anonymous Referee #2

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The authors used model results from Geoengineering Model Intercomparison Project (GeoMIP) to test the linearity of the climate response to external forcings. The authors first constructed a climate emulator based on a convolution of impulse response function using results from GeoMIP G1 simulations involving abrupt changes in atmospheric CO2 and solar irradiance. Then the authors used the climate emulator to predict climate consequences of the GeoMIP G2 simulations involving gradual change in atmospheric CO2 and solar irradiance. For climate variables including temperature, precipitation, and annual mean Northern Hemisphere sea ice extent, the emulator does a good job in reproducing climate model simulated temporal evolution and spatial distribution. The use of impulse response function to emulate climate model results is not new. The novelty of this study is that it extends the application of impulse response function to the simulations involving both CO2 and solar forcing. This extension ad-

vances our understanding of climate response to external forcing, and in particular, climate response to solar geoengineering. The ms is well written. I recommend publication after the following issues are addressed:

1. The GeoMIP simulations are limited to a period of 50 years. Over longer timescales (several centuries), response from deep ocean dynamics would become important. Many aspects of ocean dynamics response (e.g., thermohaline circulation) are nonlinear. So the question is: To what extend the linear emulator would be valid in reproducing long-term climate response involving feedbacks from deep ocean dynamics?

2. A large part of the residual response of the hydrological cycle over land to solar geoengineering is due to the direct effect of increasing atmospheric CO2 on vegetation (stomatal, leaf area index, etc.), which cannot be offset by reduced solar forcing. Assumedly, this part of hydrological cycle response is nonlinear. This issue should be discussed.

3. The method used to emulate spatial pattern of temperature and precipitation is not clear. How EOFs were constructed, selected, and applied to generate the spatial pattern of climate change? These should be elaborated.

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