The response of extreme variability in the Arctic stratosphere to 4xCO_2 concentrations in CMIP6 models

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Sudden stratospheric warmings (SSWs) and stratospheric final warmings (SFWs) are the most important phenomena of the wintertime Arctic stratosphere. They also constitute one of the clearest examples of stratosphere-troposphere coupling. Given their impact on the troposphere, several previous studies have focused on the possible impact of increasing CO_2 concentrations on these events, but without reaching a robust conclusion across them. Several factors might explain this lack of robustness in the results, notably the availability of short data record or the consideration of moderate CO_2 forcing. Part of these limitations may now be overcome thanks to the new simulations of the Coupled Model Intercomparison Project, Phase 6 and in particular, to the long daily data requirements of the DynVarMIP project in preindustrial and quadrupled CO_2 forcing simulations.

In this work, we use this new model output to investigate the response, if any, of extreme variability in the Arctic stratosphere to 4xCO_2 forcing. The results of many models predict that the SSW frequency is sensitive to increase in CO_2 loading, but there is a large disagreement across models on the sign of this change. Regarding the SSW impact on the troposphere, the response over the North Atlantic remain unchanged, but the signal over the Pacific is more uncertain, with some indications that there might be a larger mean response under 4xCO_2 scenario. Finally, the models show robust changes to the seasonal cycle in the stratosphere. Specifically, we find an earlier formation of the vortex in Autumn and a delay in the date of SFWs, resulting in a longer duration of the polar vortex and so, of the season of stratosphere-troposphere coupling.

Keywords: sudden stratospheric warmings, climate change

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