EGU22-8985
https://doi.org/10.5194/egusphere-egu22-8985
EGU General Assembly 2022

Simulation of climate change due to reducing emission of each anthropogenic aerosol component by region using a coupled atmosphere-ocean model

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The Summary for Policymakers of the Working Group I of the 6th assessment report of the Intergovernmental Panel for Climate Change (IPCC) contained a diagram of the contribution of the global mean change in surface air temperature from the preindustrial to the present climate by the composition of the short-lived climate forces (SLCFs) including aerosols. However, it was estimated by a two-layer energy budget emulator with effective radiative forcing obtained from a model inter comparison project, AerChemMIP. Although the effects of total anthropogenic aerosols have been included in the past, present, and future simulations by climate models, it is essential to estimate and analyze climate change by composition of SLCFs using coupled atmosphere-ocean models in the next step. For example, the amount of temperature change varies significantly with CO_2 concentration even when the reduced amount of anthropogenic SO_2 emissions and then the instantaneous radiative forcing are the same (Takemura, 2020, doi:10.1038/s41598-020-78805-1). In this study, sensitivity experiments to reduce anthropogenic emissions of SO_2, organic matter, and black carbon to zero for each of the 12 regions of the world are simulated using a coupled atmosphere-ocean aerosol model MIROC-SPRINTARS and the results are analyzed in comparison with the experiment under standard emissions. Similar experiments are conducted for biomass burning aerosols from several regions. In the simulations, well-mixed greenhouse gas concentrations are set in two patterns, 2015 and 2060 for SSP3-7.0. The same set of simulations using an atmospheric general circulation model with prescribed sea surface temperature and sea ice are conducted for calculating the effective radiative forcing and rapid adjustment due to each anthropogenic aerosol. This set of experiments also aims to generate scientific knowledge to explore the optimal path for emission reductions of SLCFs and use it in policy making. The project S-20 of the Ministry of the Environment of Japan is also conducting experiments to reduce emissions of SLCFs other than aerosols, as well as experiments to reduce SLCFs emissions using a global cloud-resolving model NICAM. Conducting similar experiments with other climate models and comparing them will enable us to better understand the climate impact of SLCFs with uncertainty.