



## **Role of climate model dynamics in estimated climate responses to anthropogenic aerosols**

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The scatter in regional impacts of aerosols remain large between different global circulation models (GCMs). It remains unclear to which degree the differences in models arise from different aerosol microphysics versus the differences in the atmospheric response. We carry out experiments of equilibrium climate response to modern day anthropogenic aerosols using a simplified representation of anthropogenic aerosol optical properties and aerosol-cloud interactions, MACv2-SP, in two independent climate models (NorESM1 and ECHAM6). In this study, we demonstrate that eliminating differences in model aerosol or radiative forcing fields results in close agreement in simulated globally averaged temperature and precipitation responses in the studied GCMs. Significant differences remain between the two GCMs regional temperature responses around the Arctic circle and the equator and precipitation responses in the tropics. The correlation coefficient of regional temperature response in these model experiments with MACv2-SP aerosols is 0.81, for precipitation correlation is 0.41. We compare the obtained equilibrium temperature and precipitation responses with prescribed MACv2-SP aerosols in ECHAM6 and NorESM1 against those equilibrium climate responses from four fully coupled climate models (CESM1, GISS, HadGEMS2, and NorESM1) with intrinsic aerosol schemes but the same aerosol emissions. Surprisingly, the simplified representation of anthropogenic aerosols does not improve the obtained correlation coefficients between different GCMs. The lack of improvement in correlation coefficients implies that the spatial distribution of regional climate responses is not improved via homogenizing the aerosol descriptions in the models. Rather, differences in the atmospheric dynamic responses dominate the differences in regional climate responses. Hence, further improvements in the model aerosol descriptions can be expected to have a limited value in improving our understanding of regional aerosol climate impacts, unless the dynamical cores of the climate models are improved as well.