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Towards a better understanding of the model spread in aerosol forcing

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The radiative forcing of anthropogenic aerosol is important for understanding climate change. However, the uncertainty in anthropogenic aerosol forcing is large, despite decades of research on aerosols and their effect on climate. The reasons for the associated model spread in aerosol forcing are numerous, but their relative importance is largely unclear due to the model complexity. In this presentation, we see how a deliberate reduction of the model complexity aids improving our understanding of the effective radiative forcing of anthropogenic aerosol (ERF). We investigate the impact on ERF from uncertainties that remain when we pretend to know the spatio-temporal distribution of anthropogenic aerosols and their properties. For doing so, we present an ensemble of atmosphere-only experiments of a selection of contemporary climate models (Fiedler et al., 2018a, in review). All five models use the same prescribed anthropogenic aerosol optical properties and an associated effect on clouds from the new observationally informed simple-plumes parameterisation MACv2-SP for use in CMIP6 (Fiedler et al., 2017, Stevens et al., 2017). The highlights of the results are (1) a strong impact of year-to-year variability internal to the models on estimating the ERF, (2) a small change in the global mean ERF between the mid-1970s and the mid-2000s, despite the substantially different spatial distribution of anthropogenic aerosol, and (3) a persistently large model diversity in clouds on the macro- and micro-scale. In the future, MACv2-SP will be used for CMIP6 experiments, e.g., in the radiative forcing model inter-comparison project (RFMIP), and for other scientific endeavours, e.g., decadal climate predictions. These projects will make use of MACv2-SP's time series of anthropogenic aerosol for the past (Stevens et al., 2017) and for the projections into the future, based on CMIP6 emission scenarios (Fiedler et al., 2018b, in review).

Publications

Fiedler, et al. (2018a) Anthropogenic aerosol forcing - insights from multi-estimates from aerosol-climate models with reduced complexity, Atmos. Chem. Phys. Discuss., doi:10.5194/acp-2018-639, in review.

Fiedler, et al. (2018b) First forcing estimates from the future CMIP6 scenarios of anthropogenic aerosol optical properties and an associated Twomey effect, Geosci. Model Dev. Discuss., doi:10.5194/gmd-2018-244, in review.

Fiedler, et al. (2017) On the sensitivity of the anthropogenic aerosol forcing to model-internal variability and parameterizing a Twomey effect, J. Adv. Mod. Earth Syst., 9, doi:10.1002/2017MS000932.

Stevens, et al. (2017) Simple Plumes: A parameterization of anthropogenic aerosol optical properties and an associated Twomey effect for climate studies, Geosci. Model Dev. 10, 433-452, doi:10.5194/gmd-10-433-2017.