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Decomposing the aerosol radiative forcing in atmospheric models

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The aerosol radiative forcing is the most uncertain human forcer of the climate system, with much of this uncertainty coming from the aerosol impact on cloud properties. Previous studies have typically found larger radiative forcings in model based studies when compared to observational studies. Although the small temporal and spatial scales of clouds leads to difficulties simulating them and the aerosol impact, biases in the observations of clouds and aerosols can lead to uncertainties in the observational estimates, such that it is not clear these methods are more reliable.

In this work, we demonstrate a method to decompose the aerosol radiative forcing in models that more closely replicates observations-based techniques. Displaying a close agreement to the accurate partial radiative perturbations method, the decomposition shows that observations and models estimate similar values for the Twomey effect (RFaci). Although cloud adjustments remain a large source of uncertainty, by separating them, they are shown to be of a similar magnitude to the current observational uncertainty. We also demonstrate that the ratio of the forcing from cloud adjustments to the RFaci is independent of the aerosol perturbation, leading to improved methods for constraining the aerosol radiative forcing from aerosol cloud interactions.