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How accurately can the aerosol forcing be diagnosed using present day observations?

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Much of the uncertainty in anthropogenic forcing of climate change comes from uncertainties in the radiative forcing due to aerosol-cloud interactions (RFaci). As aerosols serving as cloud condensation nuclei can have a strong influence on the cloud droplet number concentration (CDNC), previous studies have used the observed sensitivity of CDNC to aerosol properties as an emergent constraint on the strength of the RFaci. However, recent studies have suggested that this sensitivity in the present-day atmosphere is not the same as the sensitivity in the pre-industrial atmosphere, making it unsuitable for use as a constraint on the strength of the RFaci.

In this study, we investigate a variety of methods and aerosol proxies in a selection of global aerosol-climate models to examine to what extent present-day aerosol-cloud relationships can be used to diagnose the RFaci. Using a simple linear sensitivity of the CDNC to aerosol perturbations, especially in clean regions, can result in large errors. However, we show that if suitable choices of aerosol proxy and spatial scale are made and if non-linearities in the sensitivity are accounted for, it is possible to diagnose the anthropogenic change in CDNC and so the RFaci using present day aerosol-cloud relationships and knowledge of the anthropogenic aerosol perturbation.