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Are remote-sensing retrieved aerosol radiative properties a suitable proxy for cloud condensation nuclei?

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Aerosol-cloud interactions arguably remain the single greatest uncertainty among anthropogenic perturbations of the climate system. The large uncertainties associated with their representation in global aerosol climate models have emphasised the need for observational studies. In-situ measurements provide a detailed description of aerosol and cloud microphysical properties, providing strong observational constraints on aerosol cloud interactions. However, their spatio-temporal sampling is sparse so that "observational" estimates of global aerosol cloud interactions generally rely on co-located satellite retrievals of aerosol radiative properties and cloud properties.

In this study I will critically evaluate the suitability of remote-sensing retrieved aerosol radiative properties, such as aerosol optical depth (AOD), aerosol index (AI) and aerosol fine mode optical depth, as proxy for cloud condensation nuclei (CCN).

This analysis based on the fully self-consistent calculation of aerosol radiative properties and CCN in the aerosol climate model ECHAM-HAM. Correlating simulated aerosol radiative properties with CCN at a range of supersaturations (sampling different sizes/composition of the aerosol spectrum) highlights limitations in the suitability of AOD and AI as proxy for CCN. These discrepancies arise from a range of factors, including the limited representativeness of column-integrated aerosol radiative properties for surface or cloud-base CCN as well as the effects of humidity growth of aerosols, affecting AOD/AI but not CCN. Simulated correlations show a strong regional variability, with significant implications for "observational" estimates of aerosol cloud interactions from remote-sensing as well as in-situ data.