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Source attribution of cloud condensation nuclei in the south-east Atlantic

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Aerosol-cloud interactions (ACI) present the largest uncertainty to anthropogenic perturbations of the climate system. Cloud condensation nuclei (CCN), specifically, are a key pathway of aerosol effects on cloud microphysics. CCN can be activated as cloud droplets, which directly impacts their concentration, and further influences other cloud properties. Therefore, a better understanding of CCN sources and their impact on clouds provides the foundation for understanding ACI.

The south-east Atlantic is a unique area where stratocumulus and shallow cumulus clouds dominate all year around. It is also influenced by some of the largest biomass burning sources on Earth. The persistence of clouds alongside abundant aerosols makes it an ideal location for the investigation of aerosols and clouds interactions. The flight measurements of the CLARIFY, ORACLES and AEROCLO-SA campaigns provide invaluable constraints on aerosol and cloud properties in the south-east Atlantic.

In this work, we combine simulations using the UK Earth System Model (UKESM) with CLARIFY and ORACLES aircraft measurements to investigate sources of CCN, their contribution to the cloud droplet number budgets of shallow clouds and ultimately to the effective radiative forcing associated with aerosol-cloud interactions (ERF_{aci}) in the south-east Atlantic.

Our results demonstrate that anthropogenic aerosols are the most significant source of CCN at low and medium supersaturations, whereas, at very high supersaturations, where the critical activation diameters lie within Aitken mode, secondary organic aerosols (SOA) contribute most of the near-surface CCN. Sea-salt surprisingly merely contribute the CCN for all supersaturations, while biomass burning aerosols only have an influence on CCN at low supersaturations.

Interestingly, the cloud droplet number concentration (CDNC) shows a different response from CCN. The SOA only slightly increased the CDNC, while the largest source of CDNC is the total nucleation, which has a significant influence on CDNC near the continent. Sea salt, however, decreased somewhat CDNC away from the continent.

Based on these sensitivity studies we will present an attribution of ERF_{aci} to different aerosol sources and formation pathways.