Sea Spray as an Obscured Source for Marine Cloud Nuclei

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Abstract

Sea spray aerosols (SSAs) make up a substantial proportion of aerosols in the global atmosphere and have a large impact on cloud formation and atmospheric radiative balance. Although SSA has the highest cloud condensation nuclei (CCN) activation potential, the majority of its population, residing in sub-micrometre sizes, are often obscured by non-sea-spray CCN. Moreover, greater sea-spray nuclei availability can even suppress sulphate aerosol activation where sea salt nuclei indirectly control sulphate nuclei activation into cloud droplets and could potentially lead to changes in the albedo of marine boundary layer clouds by as much as 30%. Recent laboratory studies and/or statistical developments in deriving sea spray aerosol number typically only account for 30% of the real sea spray nuclei over remote oceans. Here we demonstrate that SSA distributions can be derived from a unique five-year dataset of aerosol microphysics and hygroscopicity (water uptake ability) over the North Atlantic Ocean. This approach utilizes the distinctive ultra-high hygroscopicity signature of inorganic sea salt and enables to identify the sub-micrometre sea spray down to 35 nm diameter with high time and size resolution. In stark contrast to previous studies, the hygroscopicity coupled multimodal fitting approach yields SSA-derived CCN as much as 500% in excess of previous statistical estimates depending on the wind speed and cloud supersaturation. Another promising method in deriving sea spray nuclei number and size distribution is based on positive matrix factorisation (PMF) technique applied to ambient aerosol microphysics and bulk PM1 sea salt mass concentration as an external constraint, again revealing copious Aitken mode sea spray particles. Our results suggest the contribution of SSA to global CCN, particularly Aitken mode SSA, has probably been seriously overlooked.

Early Career Scientist

NO, I am not an early career scientist.

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