EGU21-10410
https://doi.org/10.5194/egusphere-egu21-10410
EGU General Assembly 2021

Challenges in constructing a source function for high-temperature marine INPs

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Sea spray emissions are an important source for ice nucleating particles (INPs) over remote ocean regions. Over the past years, our understanding of marine organic surfactants acting as INPs has advanced a lot. However, there are still significant knowledge gaps regarding the role of larger marine biogenic particles (e.g. polymers, diatom fragments, protists and bacteria) which are potentially the drivers of episodically observed high INP concentrations.
In this study, we use a combination of ARM (Atmospheric Radiation Measurement) observations and output from E3SM (Energy Exascale Earth System Model) simulation runs to investigate the impact of larger marine biogenic particles acting as INPs. We use heterotrophic bacteria and nanogels (polymeric particles) as two hypothesized classes of marine INPs which can get transported across the sea-air interface. Based on the offline-calculated concentrations of these ice nucleating entities in the ocean surface layer, we conduct sensitivity studies to estimate INP concentration ranges, relying on current knowledge of enrichment factors and ice nucleation activities (e.g., n_s values from McCluskey et al. (2018)). In comparison to observations of episodic high INP concentrations, our estimated concentrations are consistently lower. However, one of the main conclusions of our study is that large uncertainties regarding the links between ocean biology, organic matter in sea spray and ice nucleation properties, remain. Therefore, comprehensive observational datasets, including sea spray size distributions, aerosol and INP compositions, and ice nucleation efficiencies of individual marine species, are needed.