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Observations of Ice Nucleating Particles Over the Red Sea, Arabian Sea, Arabian Gulf and Mediterranean During AQABA

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A limited understanding of the ice microphysical processes that govern cloud radiative properties, lifetime, and phase-partitioning challenges the ability of models across all scales to simulate the surface energy budget. Ice nucleating particles (INPs) trigger heterogeneous ice formation above the homogeneous freezing point ($\sim$ -38 ˚C), influencing the number, shape and size of in-cloud ice crystals, and consequent processes such as riming, splintering, and water vapor uptake by ice. Though mineral dust is considered to be the dominant source of INPs in many parts of the world, evidence from modeling, field and laboratory studies indicates that unique parameterizations of marine INPs are necessary to improve simulated cloud microphysics, particularly in remote ocean regions. However, due to limited understanding of the biological and physicochemical controls of marine INP emissions, and a historical dearth of observations over the oceans, marine INP populations remain a challenge to constrain. While the contributions of mineral dusts to continental INP populations are well documented, few observations exist near major source regions in the Middle Eastern "dust belt". Consequently, the degree to which existing dust INP parameterizations are representative of nascent dust is unknown, as are the effects of atmospheric and chemical processing on ice nucleation potential of these particles.

This study will characterize the INP spectra of nascent dust near major "dust belt" source regions and thereby address critical gaps in our understanding of boundary layer concentrations of immersion freezing INPs (n_{INP}) in previously undocumented regions of the Red Sea, Arabian Sea, Arabian Gulf and Mediterranean. Daily aerosol membrane filters and seawater samples were collected during the Air Quality and Climate Change in the Arabian Basin (AQABA, June – August 2017) ship campaign for off-line measurements of n_{INP} and assessment of the seawater INP source potential. To characterize INP identity, the size, heat-lability and organic contribution of INPs was investigated through filtration, heat and peroxide digestion. Lastly, in support of previous studies that implicate microbes or their decomposition products as constituents of both marine and dust INP populations, relationships between fluorescent aerosol particles and n_{INP} are investigated using the Spectral Intensity Bioaerosol Sensor (SIBS), an on-line LIF (light-induced fluorescence) instrument that provides size and fluorescence properties of individual particles.