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Cloud Condensation Nuclei (CCN) activity of sub-micron aerosols during the Southwest Monsoon over a pristine site in the Western Ghats, India

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Aerosols, with their direct and indirect effects impacting the climate, have been established to significantly perturb Earth's radiative budget and hydrological cycle. The climate impact of aerosols is complex and multifaceted, with various factors influencing the combined net effect. The intricacies of aerosol effects, mainly through aerosol-cloud interactions, necessitate precise measurements to reduce the uncertainty in forecasting future climate fluctuations[1]. Studying their characteristics in pristine settings can provide an enhanced scientific understanding of aerosol impact in background conditions, as opposed to polluted ones[2]. With this motivation, we conducted a comprehensive field measurement campaign during the second phase of the COVID-induced lockdown in Munnar, a relatively clean high-altitude site in the Western Ghats of India. Munnar is surrounded by lush tea plantations and extensive forest reserves, and tea production and tourism are the major human activities in the area. However, suspended tourist activities due to the pandemic and frequent precipitation during monsoon enabled us to study the ambient aerosol characteristics in near-natural conditions[3]. This study presents results from the size-

resolved Cloud Condensation Nuclei (SR-CCN) measurements conducted along with aerosol size distribution and chemical composition at the Natural Aerosol and Bioaerosol High Altitude Laboratory (NABHA; 10.09 N, 77.06 E; 1605m asl) during the Southwest Monsoon season between June-October 2021. The median number concentration for 10–450nm particles was observed to be 533cm^{-3}, with 357$cm^{-3}$and 908cm^{-3} as first and third quartiles, respectively, similar to other pristine locations, such as Amazonia during the wet season[4]. The average non-refractory particulate matter (NR-PM_1) concentration was 2.28±1.81 μg/m^3 (mean ± one standard deviation). The SR-CCN measurements were carried out for set supersaturations between 0.1% and 0.85% for particles ranging between 20-350 nm in diameter. The critical dry diameter varied from 60 to 150nm for highest to lowest supersaturation, similar to previously reported studies elsewhere[4,5]. During the campaign, the efficiency spectra of CCN often reached unity despite organic aerosols dominating the submicron aerosol composition.

Further, hygroscopicity, a particle size and composition function, was investigated using the kappa-Köhler theory. The hygroscopicity parameter, kappa, derived from SR-CCN measurements(k_{CCN}) varied between 0.26 and 0.57. k_{CCN} did not exhibit much variation in the Aitken mode regime (60-80nm) but increased in the accumulation mode (100-160nm), suggesting higher hygroscopic fraction in larger (aged) particles. Assuming a linear mixing of organic and inorganic aerosols, chemically derived hygroscopicity (k_{chem}) was comparable to $k_{CCN,}$ following similar diurnal variation. Further details will be presented.

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