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Aerosol and CCN in southwest Saudi Arabia

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As part of an ongoing study of the microphysical and dynamical controls on precipitation in southwest Saudi Arabia, a number of surface and aircraft-based instruments were used in summer / fall 2009 to measure the size distribution, hygroscopic properties, and cloud droplet nucleation efficiency of the local aerosol. Submicron size distributions were measured using differential mobility analyzers both on the ground and on board the aircraft, while an aerodynamic particle sizer and a forward scattering spectrometer probe were used to measure the supermicron size distributions on the ground and from on board the aircraft, respectively. Identical continuous flow cloud condensation nuclei counters were used to measure CCN spectra at the surface and aloft and a humidified tandem differential mobility analyzer was operated on the ground to measure size-resolved hygroscopicity. The aerosol in this arid environment is characterized by a persistent accumulation mode having hygroscopic and CCN efficiency properties consistent with a sulfate-rich aged aerosol. The particles in that background aerosol are generally sufficiently large and hygroscopic to activate at those supersaturations expected in the convective clouds responsible for most of the regional precipitation, which consequently acts as a lower bound on the resulting cloud droplet concentrations. Though the concentration, size distribution, and properties of the submicron aerosol generally changed very slowly over periods of several hours, abrupt $\sim$doubling in concentration almost always accompanied the arrival of the sea breeze front that began along the Red Sea. Interestingly, the hygroscopicity and the shape of the size distribution differed little in the pre- and post-sea breeze air masses. The dust-dominated coarse mode typically contributed significantly more to the aerosol mass concentration than did the submicron mode and likely controlled the ice nuclei concentration, though no direct measurements were made to confirm this. Results of routine flight patterns designed to examine the spatial, vertical, and day-to-day variability of the aerosol will be presented and the link between the aerosol at the surface and aloft will be quantified. This presentation will emphasize the regional character of the aerosol and will assess its influence on cloud microphysics.