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Title: Analysis of In-situ Observations Made during the POLCAST Field Projects

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Abstract: The North Dakota Atmospheric Resource Board has funded a series (2006, 2008, 2010, and 2012) of field projects, called Polarimetric Cloud Analysis and Seeding Test (POLCAST), to research the effectiveness of hygroscopic cloud seeding. The main objective of POLCAST is to understand the effects of conducting cloud-base hygroscopic seeding on convective clouds in North Dakota. Due to varying day-to-day conditions, it is important to measure the key atmospheric parameters of cloud condensation nuclei (CCN) concentration, cloud base temperature, cloud base height, and cloud microphysical properties during weather modification research projects. These key atmospheric parameters are important to natural precipitation formation; hence, scientists should stratify their analysis of randomized seeding using these measurements.

The 2012 field campaign made aircraft-based and surface-based CCN measurements using the University of Wyoming (UWyo) and Droplet Measurement Technologies (DMT) CCN counters. The DMT CCN counter measured at three different supersaturations (0.2 %, 0.3 %, and 0.6 %) and the UWyo CCN counter measured at 0.6 % supersaturation. Careful calibrations of both CCN counters provide consistent measurements. Cloud base CCN concentrations, at ambient supersaturation of 0.6 %, have a day-to-day variation from a minimum of 800 #/cm^3 to a maximum of 2,500 #/cm^3. Day-to-day variations in CCN concentration are larger than changes in concentration across North Dakota on a single day. Furthermore, daily variations are larger than the uncertainty in the CCN measurements.

Analysis of the 2008, 2010, and 2012 POLCAST aircraft measurements indicate that North Dakota has the following atmospheric hygroscopic seeding conditions: 1) daily cloud base CCN concentrations from 300 – 2,500 #/cm^3, 2) daily cloud base temperatures from 4 – 20 ^{0}C, and 3) daily cloud base heights of 1.0 – 2.5 km. Combining these measurements with our current theoretical understanding of hygroscopic seeding indicates that North Dakota is suitable for operational hygroscopic seeding.