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Title: Observations of In-situ Cloud Condensation Nuclei and Satellite Cloud Droplet Effective Radius during the POLCAST4 Field Project in North Dakota

Authors: David Delene[1], Mariusz Starzec[1], Cody Troop[1] and Darin Langerud[2]

[1]Department of Atmospheric Sciences, University of North Dakota
[2]North Dakota Atmospheric Resource Board

Abstract: Research to understand the effectiveness of hygroscopic cloud seeding has been conducted with a series (2006, 2008, 2010, and 2012) of field projects, called the Polarimetric Cloud Analysis and Seeding Test (POLCAST). The project's main objective is to understand the effects of conducting cloud base hygroscopic seeding on convective clouds in North Dakota. Between 23 June and 3 August 2012, cloud seeding and in-situ measurements were made using a Cessna 340 aircraft to understand the physical processes involved in precipitation formation. Some atmospheric aerosols (particles) serve as Cloud Condensation Nuclei (CCN), which nucleate the formation of cloud droplets. The properties of cloud droplets affect cloud formation, cloud radiative properties, cloud longevity, and influence precipitation processes. Cloud droplet properties are directly tied to CCN properties, which can vary greatly under different atmospheric conditions and from region to region. However, most cloud models and parameterizations rely on a few observations taken in a few locations to determine CCN properties and hence cloud droplet properties. To understand cloud processes and stratify cloud seeding targets, detailed aerosol and cloud observations are required.

During the 2012 field campaign, aircraft-based CCN measurements were made 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 measured at 0.6 % supersaturation. 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 2700 #/cm^3. While half of the daily observations show agreement between the UWyo and DMT CCN counter, the other half of the daily observations show the DMT CCN concentration is significantly higher.

Satellite-based measurements of cloud microphysical parameters, such as droplet effective radius, are useful in understanding the possible effect of different cloud base CCN concentrations. Satellite-derived effective radius is a weighted mean radius of all the droplets within an observed region. Cloud top effective radius is measured by the Moderate Resolution Imaging Spectroradiometer (MODIS) instrument on-board the Aqua and Terra polar orbiting satellites. Filtering MODIS effective radius using cloud top temperature allows statistics to be obtained of clouds at similar stages of development. Effective radius summary statistics are compared to the below-cloud aerosol concentration to develop a relationship between aerosols and cloud droplet effective radius. This relationship can then be used to parameterize and test models**.** Determination of days with high CCN concentration and low effective radius is important since theory indicates that the effectiveness of hygroscopic seeding increases on these days. The relatively high CCN concentrations in North Dakota indicate that the location should allow for effective hygroscopic seeding.