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

David Delene¹, Mariusz Starzec¹, Cody Troop¹ and Darin Langerud²

¹Department of Atmospheric Sciences University of North Dakota

²North Dakota Atmospheric Resource Board

Objective

• Determine the relationship between cloud base Cloud Condensation Nuclei (CCN) and satellite retrials of cloud effective radius in a developing cumulus cloud field.



View from Seeding Aircraft on July 8, 2012



View of Cumulus Cloud on July 12, 2012

Aerosol Importance

- Scatter and Absorb Radiation
- Media for Chemical Reactions
- Serve as Cloud

Condensation Nuclei CCN)





Software

Airborne Data Processing and Analysis (ADPAA)

- Open-source software
- Quality control and assurance checks
- Contains a compilation of scripts that can be used on a variety of airborne instruments by different users
- Allows for direct comparison of data sets



CCN Counter Lab Calibration Setup



POLCAST4 Surface Measurements: Clifford Hall 601



POLCAST4 CESSNA340 N98585 INSTRUMENT CONFIGURATION



Aircraft Flight Tracks



Cessna 340 flight paths during the 2012 POLCAST 4 field project. Aircraft was based out of Fargo, North Dakota and conducted sampling and seeding in eastern North Dakota.

UWyo Cloud Base - North Dakota 2012



Statistical distributions near cloud base of 30 s, 0.6 % ambient supersaturation Cloud Condensation Nuclei (CCN) adjusted to standard temperature and pressure. Measurements are using the University of Wyoming (Uwyo) CCN counter. Star symbols are means, horizontal line is the 50th percentile, top of the box is the 75th percentile, bottom of the box is the 25th percentile, and the top and bottom of the whiskers are the 95th and 5th percentiles, respectively.



Time series (64,835 – 65,555 sfm) of raw (1 Hz) measurements from the Droplet Measurement Technologies (DMT) Cloud Condensation Nuclei counter. The insert shows a cycle of unadjusted (chamber) supersaturation. Spikes within the red circles indicate sampling of seeding material.

DMT Cloud Base – North Dakota 2012



Statistical distributions near cloud base of 30 s, 0.6 % ambient supersaturation Cloud Condensation Nuclei (CCN) adjusted to standard temperature and pressure. Measurements are using the Droplet Measurement Technology (DMT) CCN counter. Star symbols are means, horizontal line is the 50th percentile, top of the box is the 75th percentile, bottom of the box is the 25th percentile, and top and bottom of the whiskers are the 95th and 5th percentiles, respectively.

2012 Surface Measurements, DMT Counter 10 min Samples (30 s means) at 0.6 %



2012 Surface Measurements, DMT Counter 10 min Samples (30 s means) at 0.6 % **Aircraft Flight Periods**



DMT Surface – North Dakota 2012



Statistical distributions near cloud base of 30 s, 0.6 % supersaturation (ambient, DMT Counter) Cloud Condensation Nuclei (CCN) adjusted to standard temperature and pressure during the 2012 POLCAST4 field project. Star symbols are mean values, the horizontal line is the 50th percentile, the top of the box is the 75th percentile, the bottom is the 25th percentile, and the top and bottom of the whiskers are the 95th and 5th percentiles, respectively.

July 2012 - North Dakota



Satellite Processing

- Use MODIS instrument retrievals of effective radius from the Aqua polar orbiting satellite.
- Observations are cropped to the North Dakota aircraft sampling region.
- Cloud top temperature is used to subset the effective radius data set so only developing cumulus clouds of similar heights are retained.

MODIS Visible Images



July 8, 2012 July 9, 2012

★ Grand Forks, North Dakota

North Dakota Project Area





July 8, 2012

July 9, 2012

Effective Radius



July 8, 2012

Mean: 21.1 (um) Mean Deviation: 3.3 (um) Standard Deviation: 5.1 (um) Skewness: 0.35

July 9, 2012

Mean: 16.9 (um) Mean Deviation: 4.0 (um) Standard Deviation: 5.0 (um) Skewness: 0.60

Conclusions

- Lots of care must be taken when processing CCN counter data.
- Measurements from the DMT and UWyo CCN counters show general agreement.
 - Implies that 2008/2010 UWyo CCN concentration are comparable to other projects that use the DMT counter.
- Surface DMT CCN measurements are high compared to cloud base measurement.
 - Implies affects of local sources.

Future Work

- The processing of supersaturation spectrum fits have been completed but still working on the analysis.
- Additional work is required to remove periods influenced by local sources.

• Additional work is need to process the satellite data to obtain effective radius.

Acknowledgments



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Questions