Polarimetric Cloud Analysis and Seeding Test 3: Cloud Micro-physical Data Analysis

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Motivation

- The Polarimetric Cloud Analysis and Seeding Test 3 (POLCAST3) experiment is a continuation of the 2006 & 2008 field programs.
- Research the use of hygroscopic seeding flares for possible use in the North Dakota weather modification program.



June 15, 2010 Flight

June 19, 2010 Flight

Research Objectives

- Characterization of hygroscopic seeding effects stratified by aerosol and Cloud Condensation Nuclei (CCN) concentrations using statistical analysis of a randomized experiment.
- Evaluated the use of the Weather Research and Forecasting (WRF) model in predicting North Dakota convection.
- Sample the cloud micro-physical properties of seeded and unseeded clouds.
- Determine if surface measurements could be used to estimate cloud base CCN concentrations.

Measurement Components

Polarimetric Radar

Seeding Aircraft

Model



Ataset: d03 RIP: rip dbz st: 23.00 h flectivity () Valid: 2300 UTC Mon 19 Jul 10 (1800 CDT Mon 19 Jul 10) at height = 2.00 km





MAINTENANG

VIONICS

NACKEN

Cloud-physics Aircraft

Surface Measurements





Comparison between radar returns from the Weather and Research Forecasting (WRF) model 24 hr forecast and NorthPol observation for June 25, 2010 at 0 Z. The bottom plots show the MODE tool 30 dBZ cloud cells.

Model/Radar Comparison



Histogram plot comparing the forecasted and observed number of cells in different size ranges. The forecasts are from 3 km resolution runs of the Weather and Research Forecasting (WRF) model with 0 Z initialization. The observations are from the NorthPol radar. The ten cases presented are from June and July of 2010 and have forecast lead times of between 14 and 28 hours. The radar data was interpolated to the 3-km domain of the model

POLCAST3 Aircraft Flights



Seeding Aircraft

Cloud-physics Aircraft

Instrumentation

Seeding Aircraft

Cloud-physics Aircraft





Surface Station





Performance Checks:

Data System Screen Shot



Injection Tube



Syringe with SF_c

Base Voltage ~0.9 volts

Fluctuation < 2 mV



The Cloud Droplet Probe (CDP) mean droplet diameter versus the King Probe Hot Wire Probe Liquid Water Content (LWC) for aircraft flights during POLCAST3 near Grand Forks, North Dakota. Only measurements with CDP concentrations about 140 cm⁻³ are presented.



Mean Droplet Diameter [µm]

The Cloud Droplet Probe (CDP) mean droplet diameter versus the height above cloud base for aircraft flights during POLCAST3 near Grand Forks, North Dakota. Only measurements with CDP concentrations about 140 cm⁻³ are presented.





An Electrostatic Classifier was used to size select 100 nm diameter particles from a poly-dispersed, ammonium sulfate, aerosol size distribution generated with a nebulizer and dried using a diffusional dryer. The 100 nm particles were sampled from a mixing chamber concurrently by the both CCN counters and a TSI Model 3775 Condensation Particle Counter (CPC).



Lab CCN Comparison October 14, 2010 October 7, 2010



Lab comparison between both Cloud Condensation Nuclei (CCN) counters used during POLCAST3.

Cloud Base



Statistical distributions near cloud base of 30 s 1 % supersaturation Cloud Condensation Nuclei (CCN) adjusted to standard temperature and pressure during the 2010 POLCAST3 field project conducted near Grand Forks, North Dakota. The solid circle is the mean value, 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.

Surface



23-JUN 26a-JUN 26b-JUN 27-JUN 8-JUL 13-JUL 15-JUL

Statistical distributions made at the surface in Grand Forks of the 30 s 1% supersaturation Cloud Condensation Nuclei (CCN) adjusted to standard temperature and pressure during the 2010 POLCAST3 field project. The solid circle is the mean value, 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.

POLCAST3 CCN Comparison



Comparison between the mean Cloud Condensation Nuclei (CCN) concentration made at the surface in Grand Forks and cloud based CCN concentration for the POLCAST3 data set.

Conclusions

- Cloud base Cloud Condensation Nuclei (CCN) concentrations were approximately 1200 #/cm³ which is similar to POLCAST2.
- The number of cells from the 24 hr forecast of the Weather Research and Forecasting (WRF) model agrees well with radar observations.
- July 15 cloud observation show slower droplet growth with height than other days and also has the highest CCN concentrations.
- Initial analysis show that surface CCN measurements are lower than cloud base observations.

POLCAST3 Team

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Questions

For more information: http://aerosol.atmos.und.edu



Statistical distributions near cloud base of the 30 s Cloud Condensation Nuclei (CCN), 1 Hz cloud droplet and 1 Hz Passive Cavity Aerosol Spectrometer Probe (PCASP) aerosol measurements for flights during the 2008 POLCAST2 field project. All concentrations are adjusted to standard temperature and pressure conditions. The solid circle is the mean value, 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.

SF₆ **Detector Components**



System response time, without aircraft inlet, is 29 seconds.

Electron Capture Detector



- Device for detecting atoms and molecules in a gas through the attachment of electrons via electron capture ionization.
- Electron absorbing analyte molecules capture electrons and hence reduce the current.
- The analyte concentration is proportional to the degree of electron capture.

Can make measurements pesticides and CFCs at levels of ppt and hence has revolutionizing our understanding of the atmosphere chemistry.

Electron Affinity



How is electron affinity of elements related to the electron affinity of molecules like O_2 , H_2O , SF_6 and CFCs?