# Statistical Analysis of Cloud Base Cloud Condensation Nuclei (CCN), Temperature, Altitude, along with Rainfall in Summer-Time North Dakota

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### Objective

- Comparing statistical distributions of cloud base CCN, cloud base temperature and cloud base altitude to check for similarities in precipitation processes between seed and non-seed cases.
- Measuring rainfall during 2008, 2010, and 2012 and comparing to the normal amount to determine if the years are 'typical'.

St. Thomas Station JND Radar Grand Forks Station ayville Station Fargo Fargo

North Dakota convective cloud targets (circles) for POLCAST field projects; blue for 2008, green for 2010 and yellow for 2012. The black circle represents a 100 km radius from the UND radar (red pin). North Dakota Agricultural Weather Network (NDAWN) stations are shown as yellow pins.



Results of Mann-Whitney U Statistical test on POLCAST data from 2008, 2010, and 2012 for environmental properties. Statistical analysis of data from flights during The exact significance value (2-sided) is POLCAST of cloud base environment properties of used to determine if the cases are seed (red) and non-seed (blue) cases for 2008, randomly distributed across the seed and 2010, and 2012 combined. The error bars (above non-seed. If the exact significance value and below) represent one standard deviation of the is greater than the critical value, the null mean. hypothesis is accepted.

### Methodology

The Mann-Whitney U Statistical test is used to compare the independent of means two samples (seed and non-seed). The null hypothesis is that the distributions of the two sample groups is identical with a 50:50 chance that a value selected from one is greater than a selection from the other group. The test uses the following equation:

$$U = n_1 n_2 + \frac{n_2 (n_2 + 1)}{2} - \sum_{i=n_1+1}^{n_2} R_i$$

U=Mann-Whitney U test  $n_1 =$ Sample size one  $n_2 = Sample size two$  $R_i = Rank$  of the sample size

The Test statistic (provided below) is compared to a table of critical values. The critical value varies depending on the number of samples in each group and the significance level of interest. The significance level (2-sided) is 0.05. For  $n_1=19$   $n_2=18$  the critical value is 106.

Property	Test Statistic	Exact Significance
Mean Cloud Base CCN Concentration	154.5	0.621
Mean Cloud Base Temperature	153.5	0.599
Mean Cloud Base Pressure	158.5	0.707

3.0 2.5 2.0 1.5 1.0 0.0 3.0 2.5 2.0 1.5 1.0	6/1
$0.5 \\ 0.0 \\ 3.0 \\ 2.5 \\ 2.0 \\ 1.5 \\ 1.0 \\ 0.5 \\ 0.0 $	6/1
	3.0 2.5 2.0 1.0 0.0 3.0 2.5 2.0 1.5 0.0 1.5 0.0 0.5 0.0

Cumulative rainfall from NDAWN of June and July daily averages between 1200 – 1800 local time.

Board.

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## Conclusions

The distributions of environmental properties indicate that the seed and non seed cases are indications of a random distribution.

The Mann-Whitney nonparametric statistical test resulted in a significance of 0.621 for CCN and 0.599 for temperature. The large significant values means that the distribution of the cloud base environmental factors are similar across seed and non-seed cases.

The value of the Mann-Whitney U Statistic for the CCN (154.5) and temperature (153.5) is greater than the critical value (106), therefore the null hypothesis that the two samples (seed and non-seed) are from the same population is accepted. June and July for 2008, 2010, and 2012 are typical in the amount of rainfall Eastern North Dakota

## **Future Work**

Compare North Dakota statistics to published statistics from other locations. Compare the number of rainfall events between 1200-1800 local time at each NDAWN and see if 2008, 2010, and 2012 are 'typical'.

Acknowledgement The POLCAST projects are funded by the North Dakota Atmospheric Resource