Statistical Analysis of Aerosol, Cloud Condensation Nuclei (CCN), Cloud Base Temperature and Pressure in Summer-Time North Dakota

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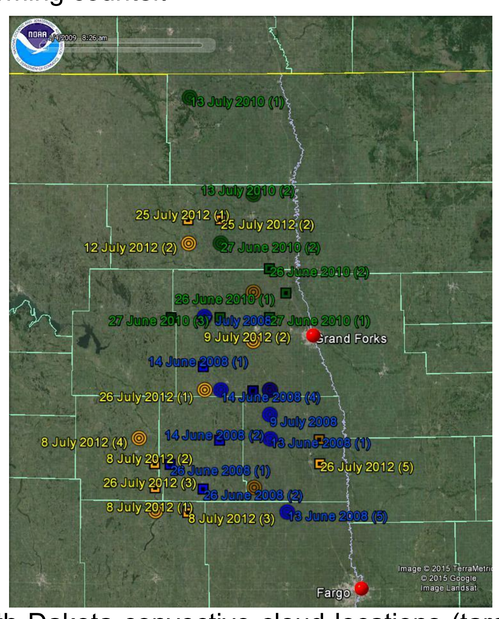
Objective

Surface based convective clouds in similar environments will have similar precipitation formation processes. Comparing statistical distributions of important environmental properties can be used to check that there are similarities in precipitation processes between two different areas or between observations and models. The POLCAST data set is analyzed to determine the distribution of important environmental properties.

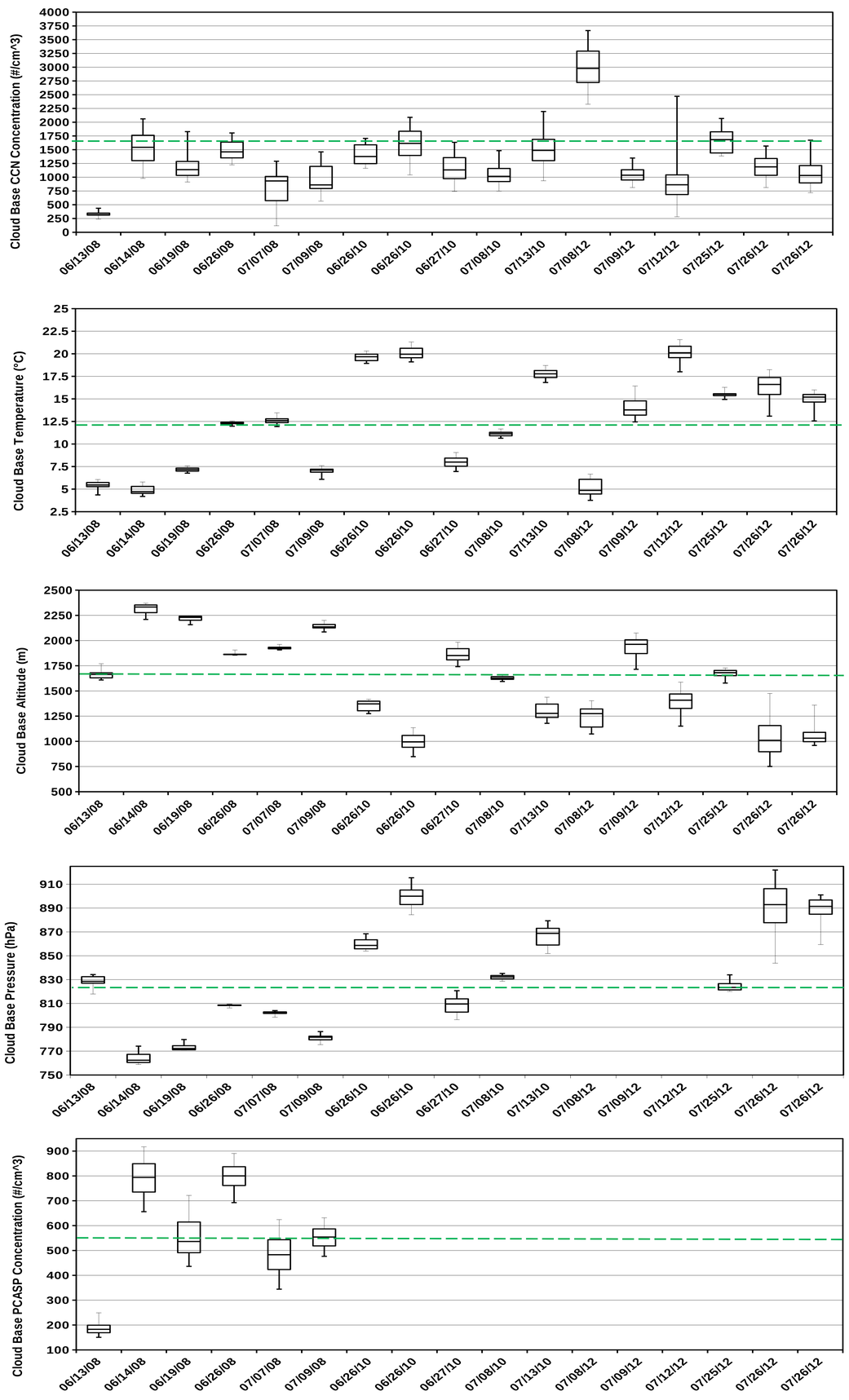
Date	Start Time (sfm)	End Time (sfm)	CCN Concentration (#/cm^3)
06/13/2008	74,727	75,086	331 ± 63
06/14/2008	75,513	76,441	1,541 ± 350
06/19/2008	78,322	78,771	1,205 ± 290
06/26/2008	80,411	80,710	1,499 ± 211
07/07/2008	82,973	83,392	784 ± 390
07/09/2008	72,402	72,671	975 ± 342
06/26/2010	81,136	81,725	1,408 ± 193
06/26/2010	86,804	88,357	1,588 ± 352
06/27/2010	80,003	85,699	1,156 ± 282
07/08/2010	81,447	81,895	1,054 ± 231
07/13/2010	76,164	81,493	1,506 ± 394
07/08/2012	65,064	70,540	3,003 ± 429
07/09/2012	69,728	74,608	1,052 ± 214
07/12/2012	72,796	82,032	1,503 ± 629
07/25/2012	73,714	75,091	1,676 ± 231
07/26/2012	63,461	74,176	1,190 ± 242
07/26/2012	77,613	80,186	1,072 ± 314

Start and end flight times in seconds from midnight (sfm) along with the mean CCN concentration for each flight day. CCN measurements were taken using a University of Wyoming counter.



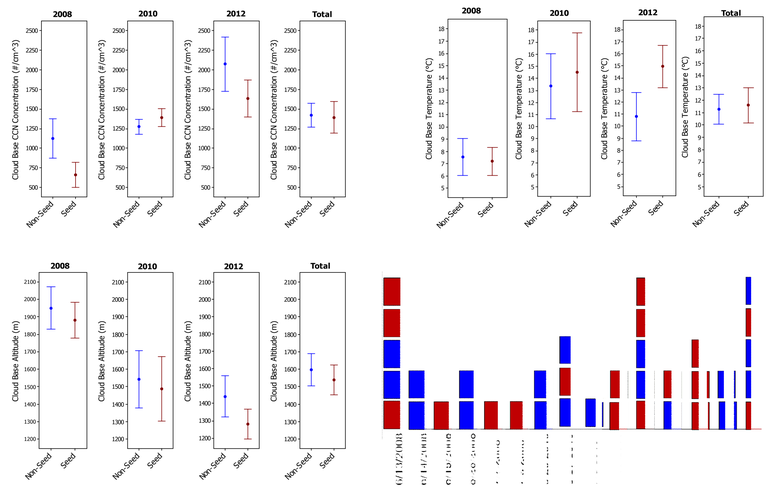
North Dakota convective cloud locations (targets) for 2008, 2010, and 2012. The circles represent hygroscopic seed cases and squares represent non-seed cases.

Analysis



Statistical distributions of environmental properties measured by aircraft at cloud base during summers of 2008, 2010, and 2012 in North Dakota. The 50th percentile is the horizontal line in the middle of the box. The top of the box is the 75th percentile, bottom of the box is the 25th percentile. The top whisker is the 95th percentile and the bottom whisker is the 5th percentile. The overall median value is shown as a dotted green line. The bottom two plots have some missing data due to instrument issues.

Non-Seed Seed



Summertime North Dakota measurements of cloud base environment properties for 2008, 2010, 2012, and all combined years. The bars (above and below) represent one standard deviation of the mean. Measurements are from the POLCAST field projects where hygroscopic seeding was evaluated. Red represents hygroscopic seed cases and blue represents non-seed cases. The bottom right plot shows the ordering of target(s), with the first target on the bottom.

Conclusions

- In North Dakota, the median cloud base CCN concentration is 1400 #/cm^3, cloud base temperature is 12 ℃, cloud base pressure altitude is 1600 m, cloud base pressure is 825 hPa, and 2008 cloud base PCASP concentration is 550 #/cm^3 for surface based convective clouds.
- Cloud Condensation Nuclei Concentration varies more day to day than across North Dakota in a single day.
- The distributions of environmental properties indicate that the seed and non seed cases are similar likely due to being randomly distributed.

Future Work

- Use the Mann-Whitney statistical test to confirm that the seed and non-seed data sets are from the same population.
- Compare the measured environmental statistics with WRF model statistics for 2010 and 2012.
- Compare North Dakota statistics to published statistics from other locations.

Acknowledgement

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