

Suitability of Atmospheric Conditions in North Dakota for Conducting Effective Hygroscopic Cloud Seeding

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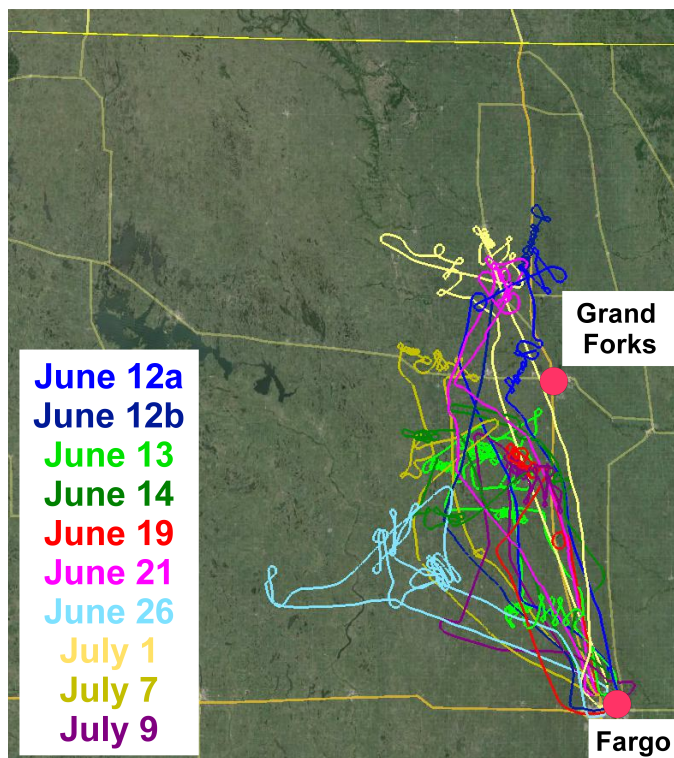
National Center for Atmospheric Research - RAL

Paul Kucera and Duncan Axisa

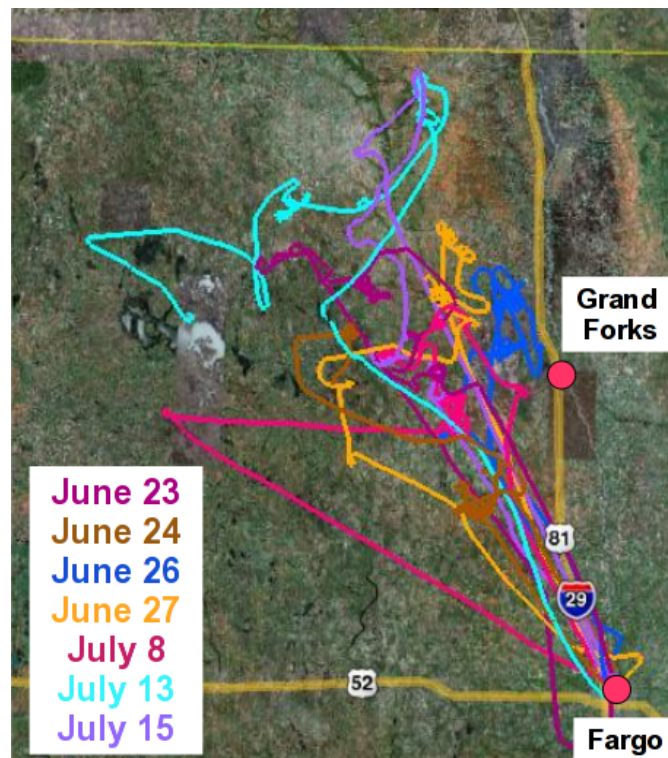
Weather Modification Inc.

POLCAST Objectives

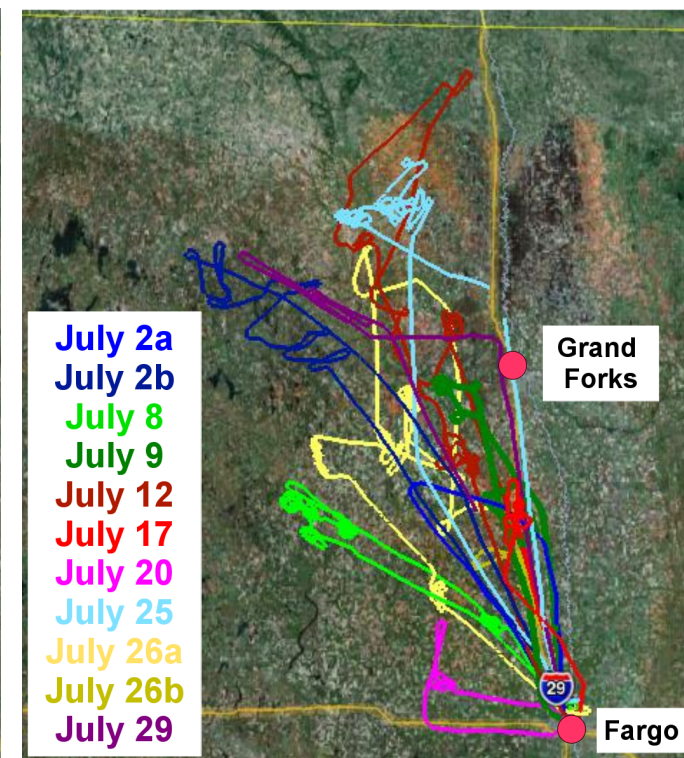
- Conduct a randomized statistical evaluation of hygroscopic seeding in North Dakota.
- Understand the atmospheric conditions under which hygroscopically seedable clouds develop precipitation in North Dakota



Flight paths during 2008.

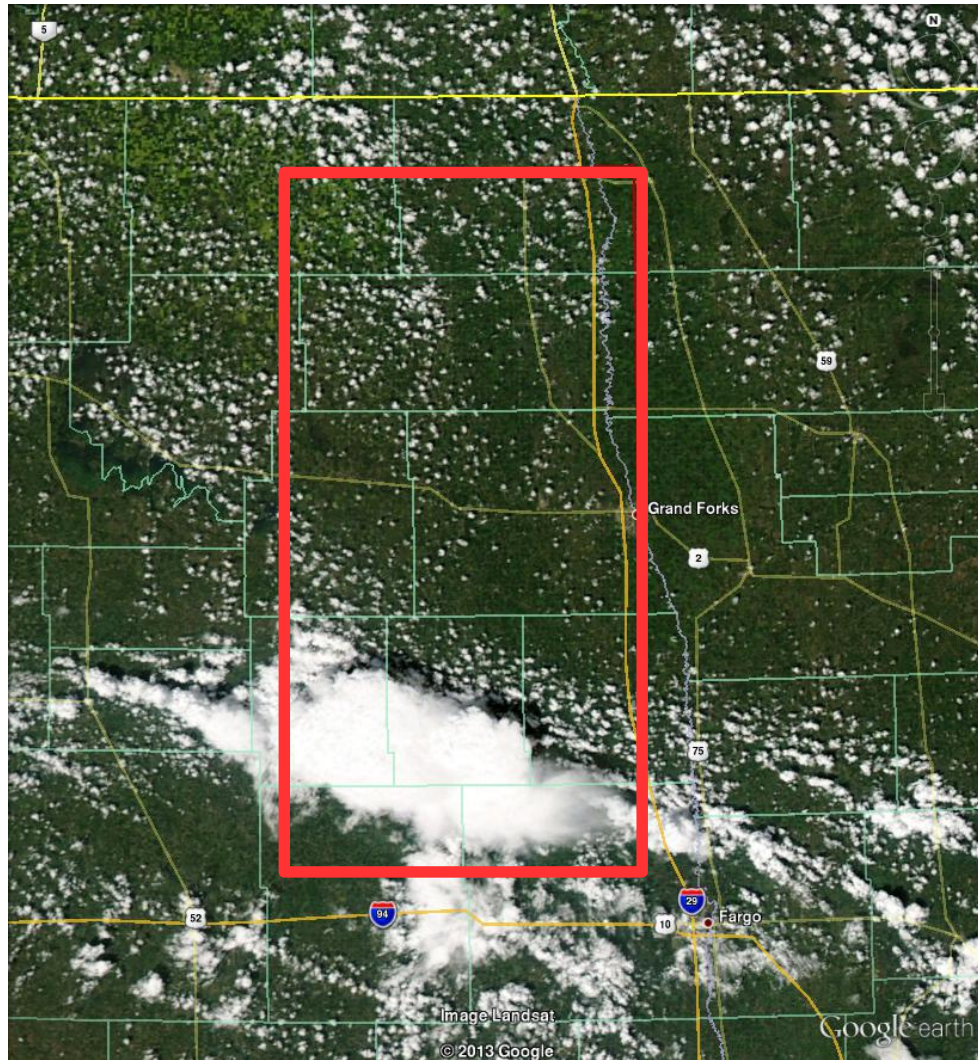


Flight paths during 2010.

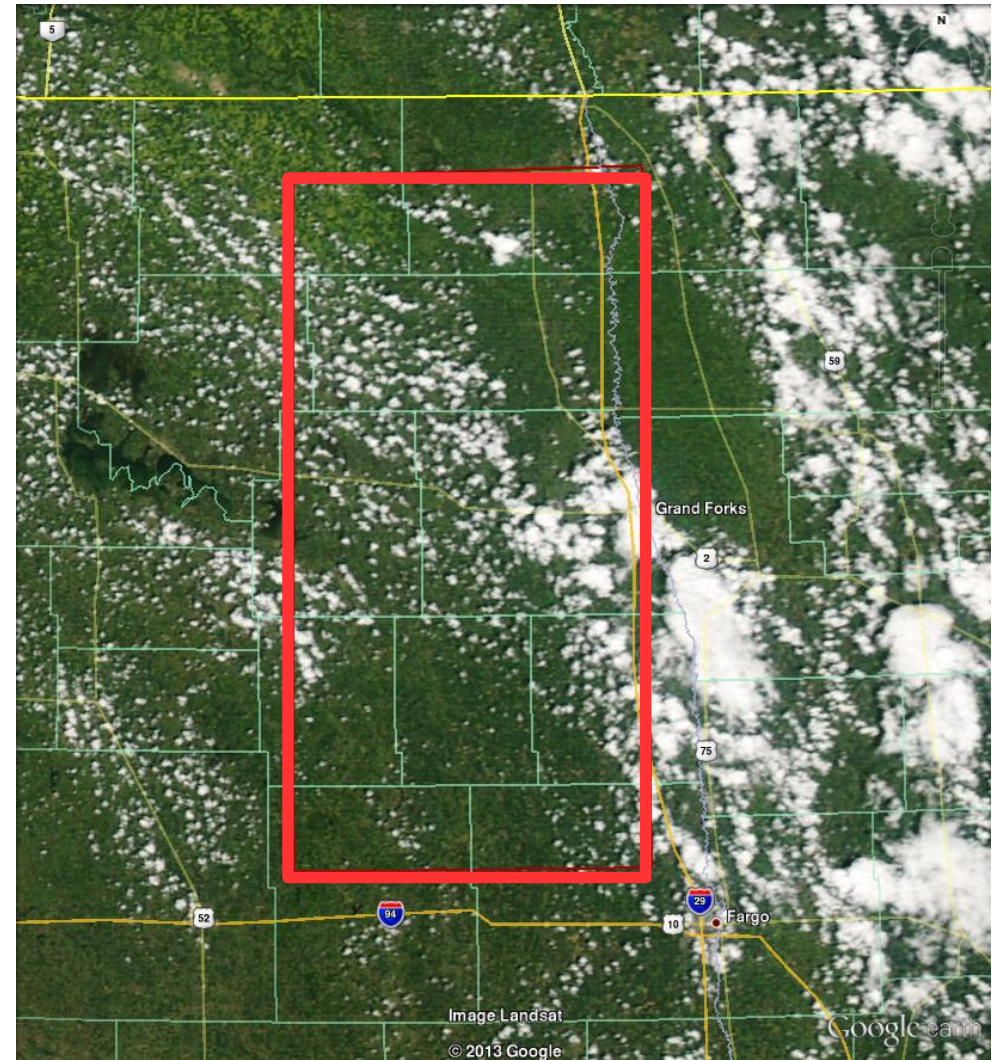


Flight paths during 2012.

North Dakota Project Area

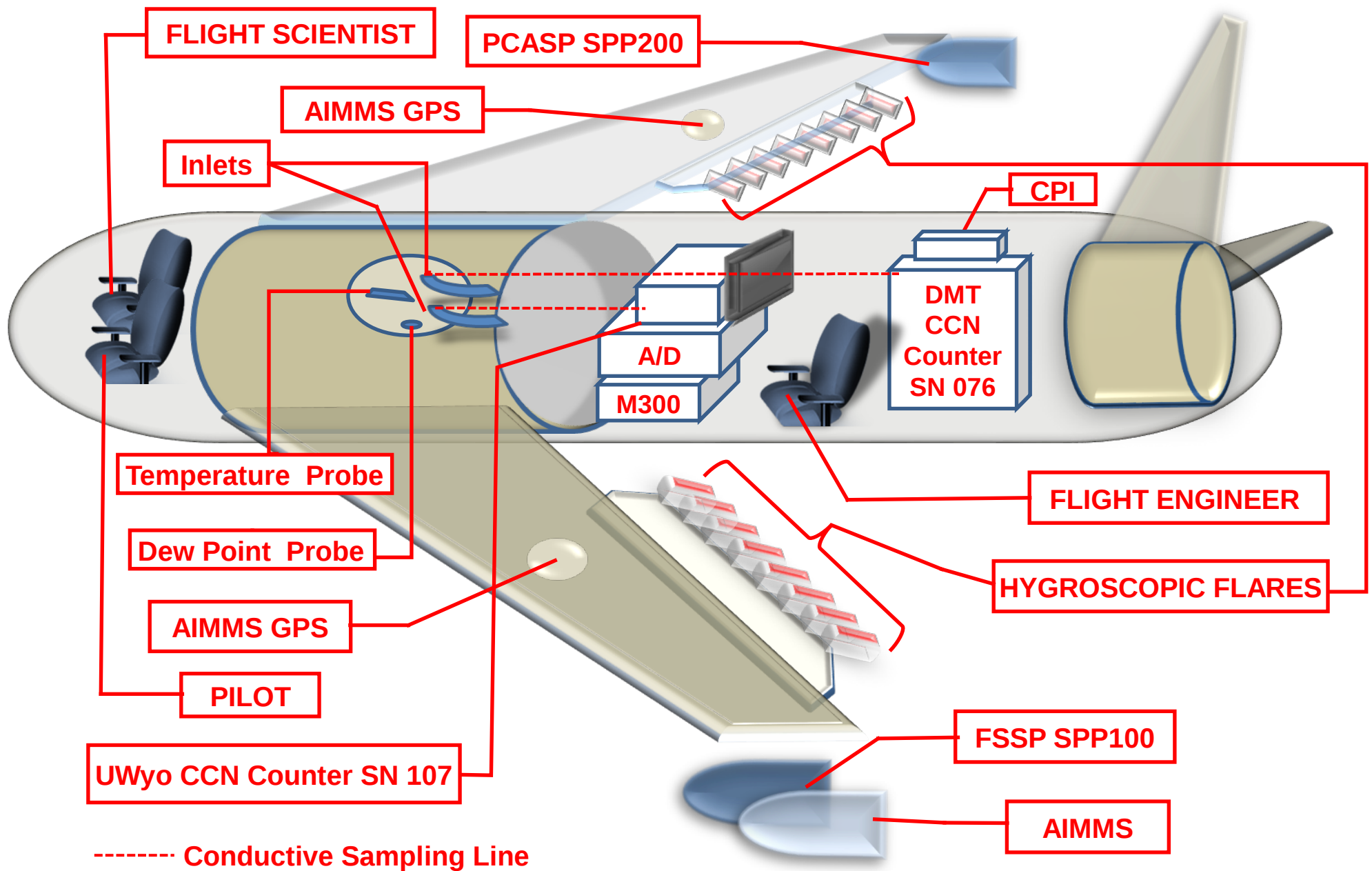


July 8, 2012



July 9, 2012

2012 Cessna 340 Configuration

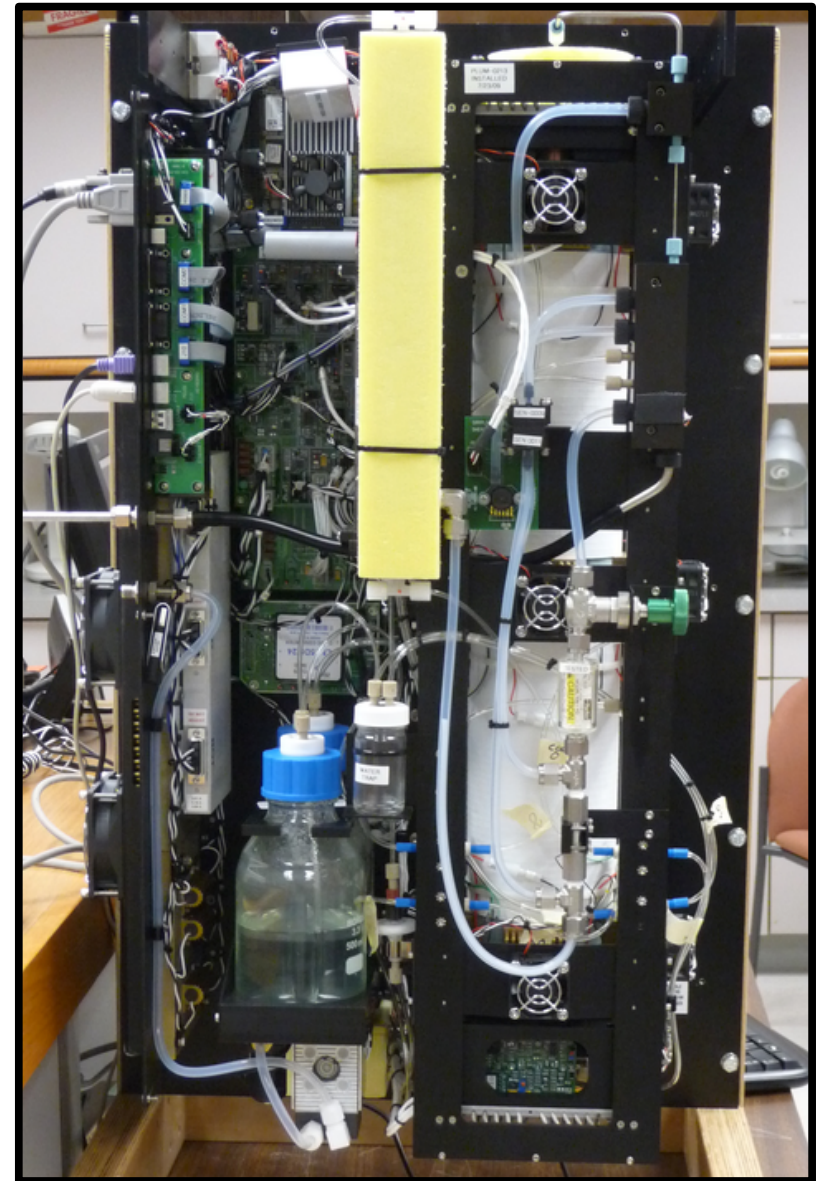


Cloud Condensation Nuclei (CCN) Counter



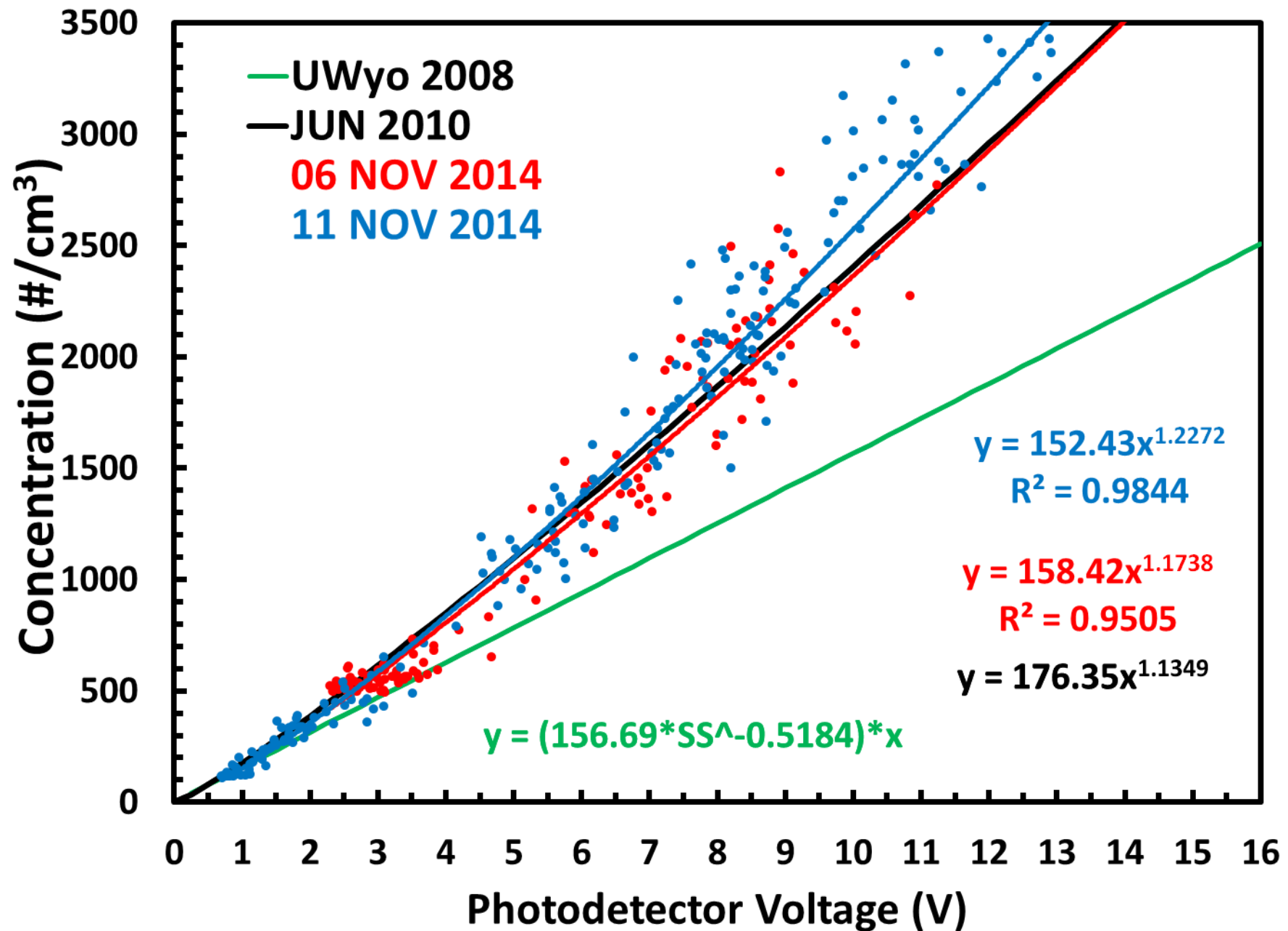
**University of Wyoming (UWyo)
CCN Counter**

**Droplet Measurement Technologies
(DMT) CCN Counter**

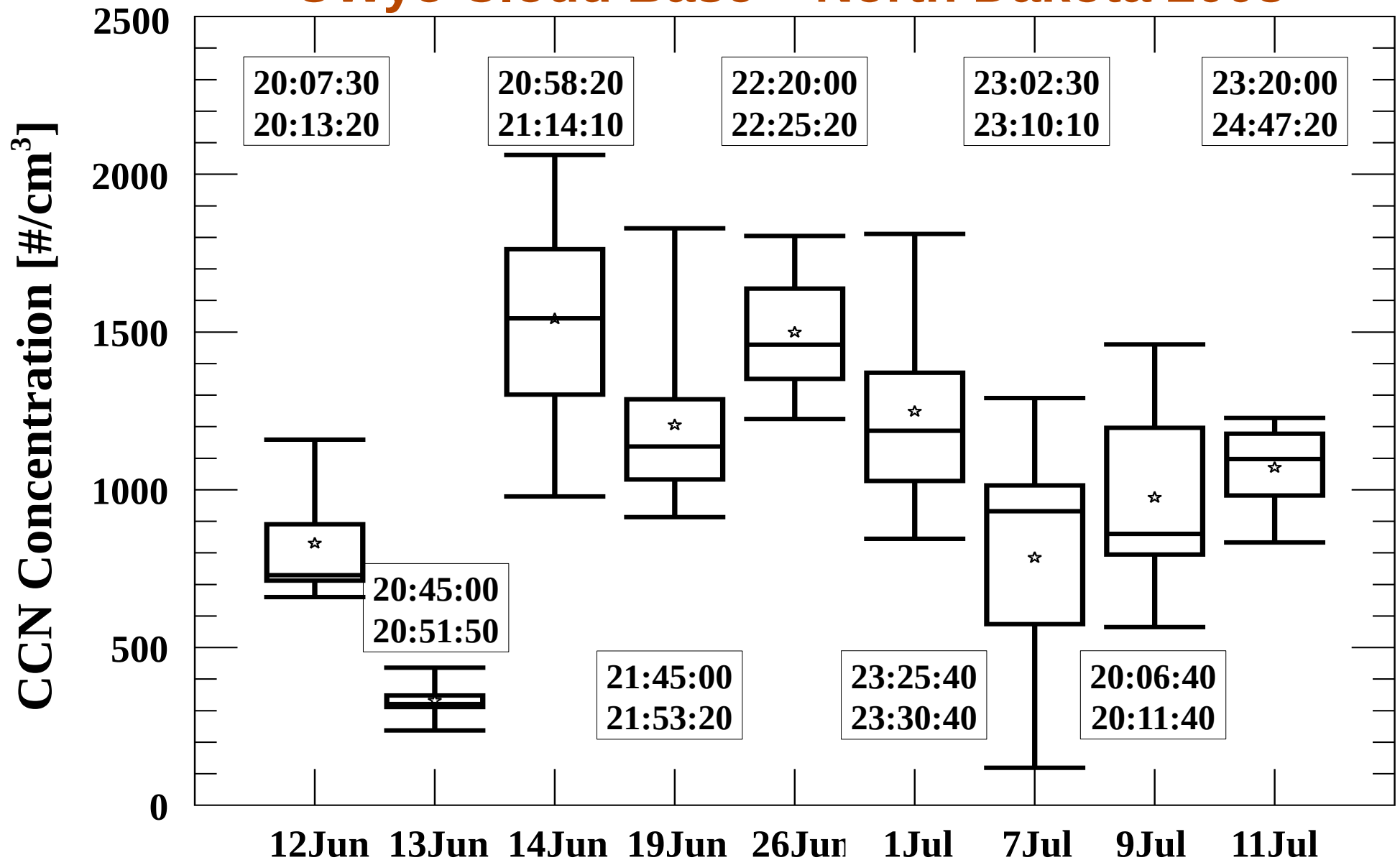


What is the cloud base concentration?

Uwyo CCN Counter (SN 107) Calibration

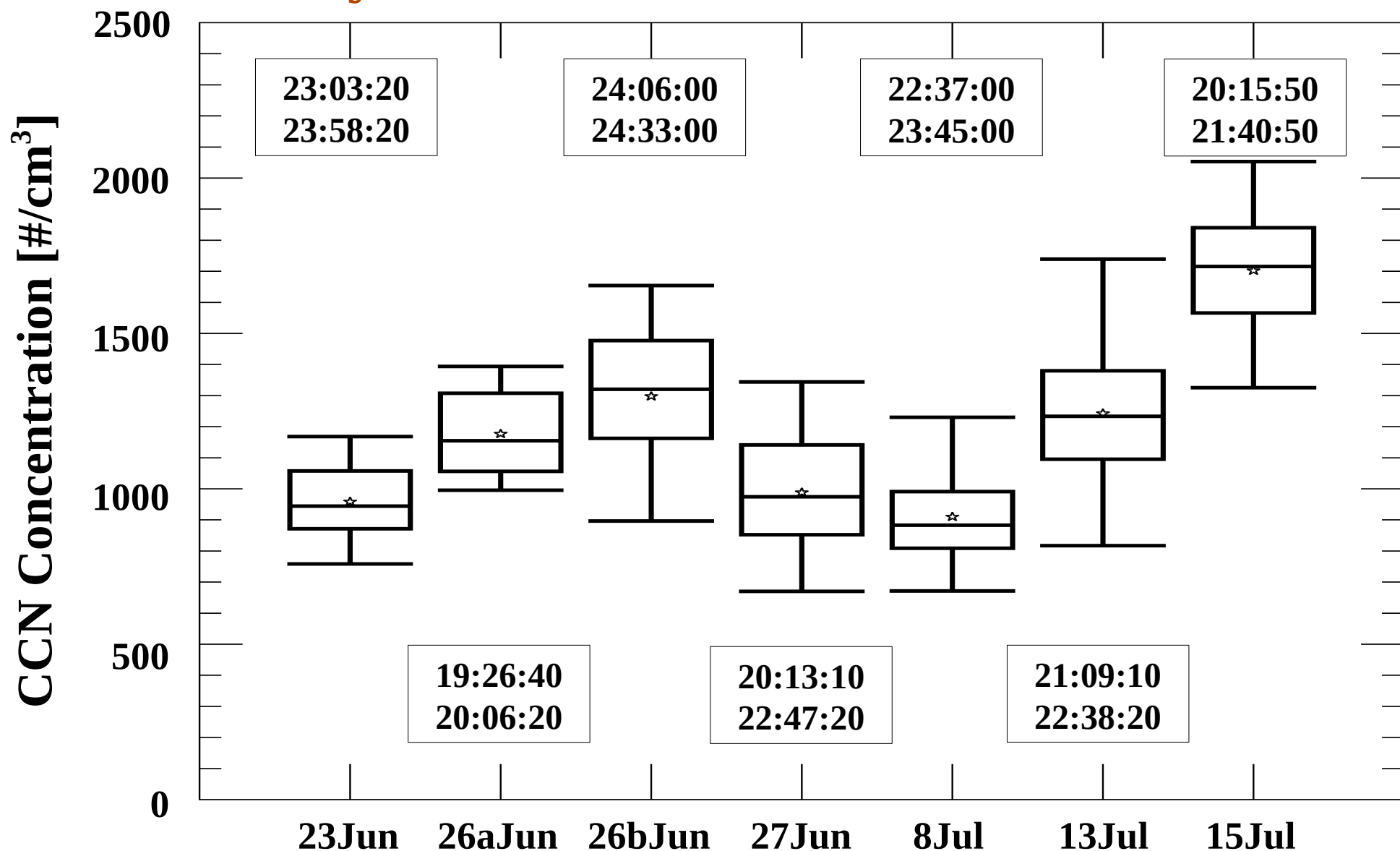


UWyo Cloud Base – North Dakota 2008



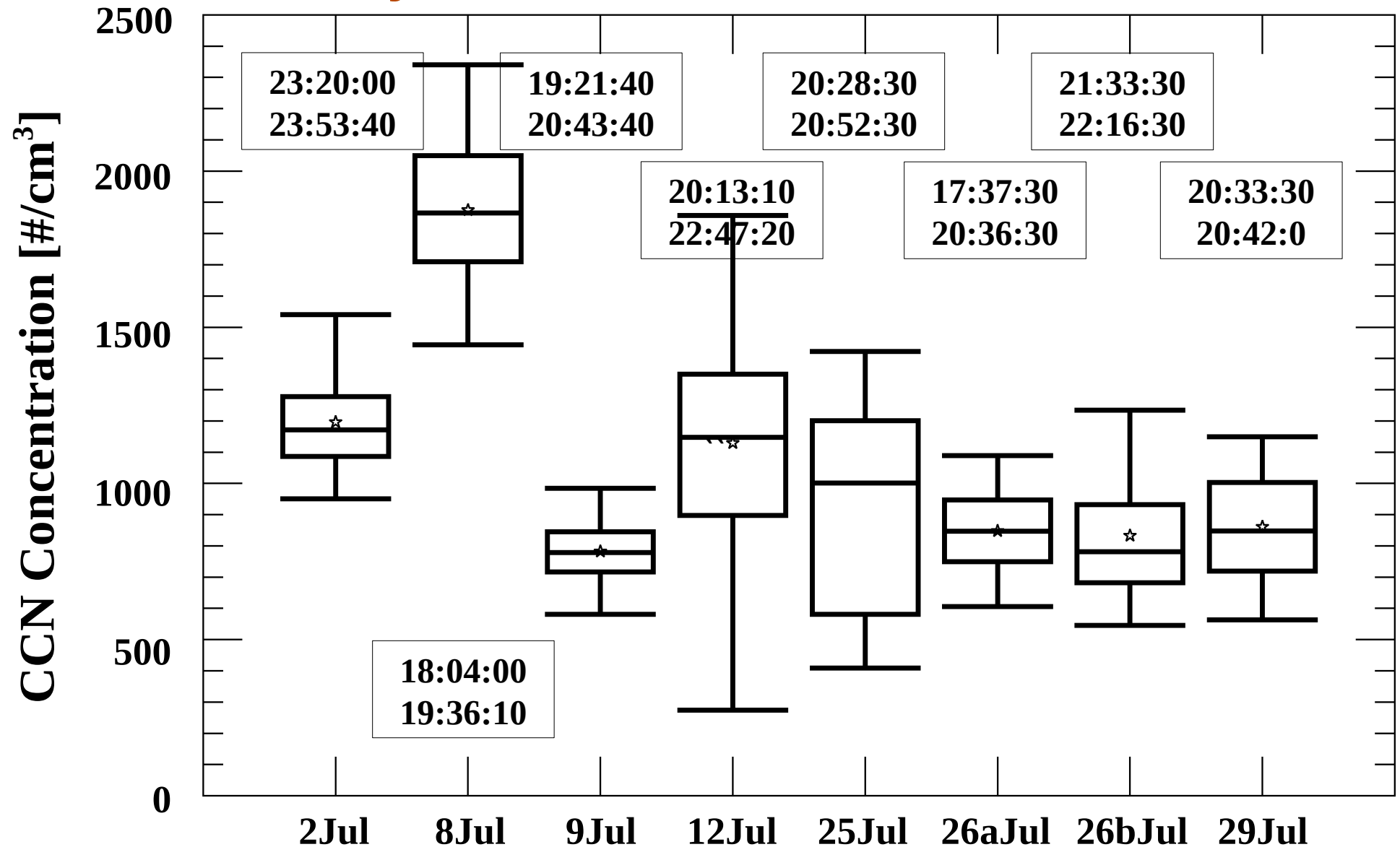
Statistical distributions near cloud base of 30 s, 0.6 % ambient supersaturation Cloud Condensation Nuclei (CCN) adjusted to standard temperature and pressure. Measurements are using the University of Wyoming (Uwyo) CCN counter. Star symbols are means, horizontal line is the 50th percentile, top of the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

UWyo Cloud Base - North Dakota 2010



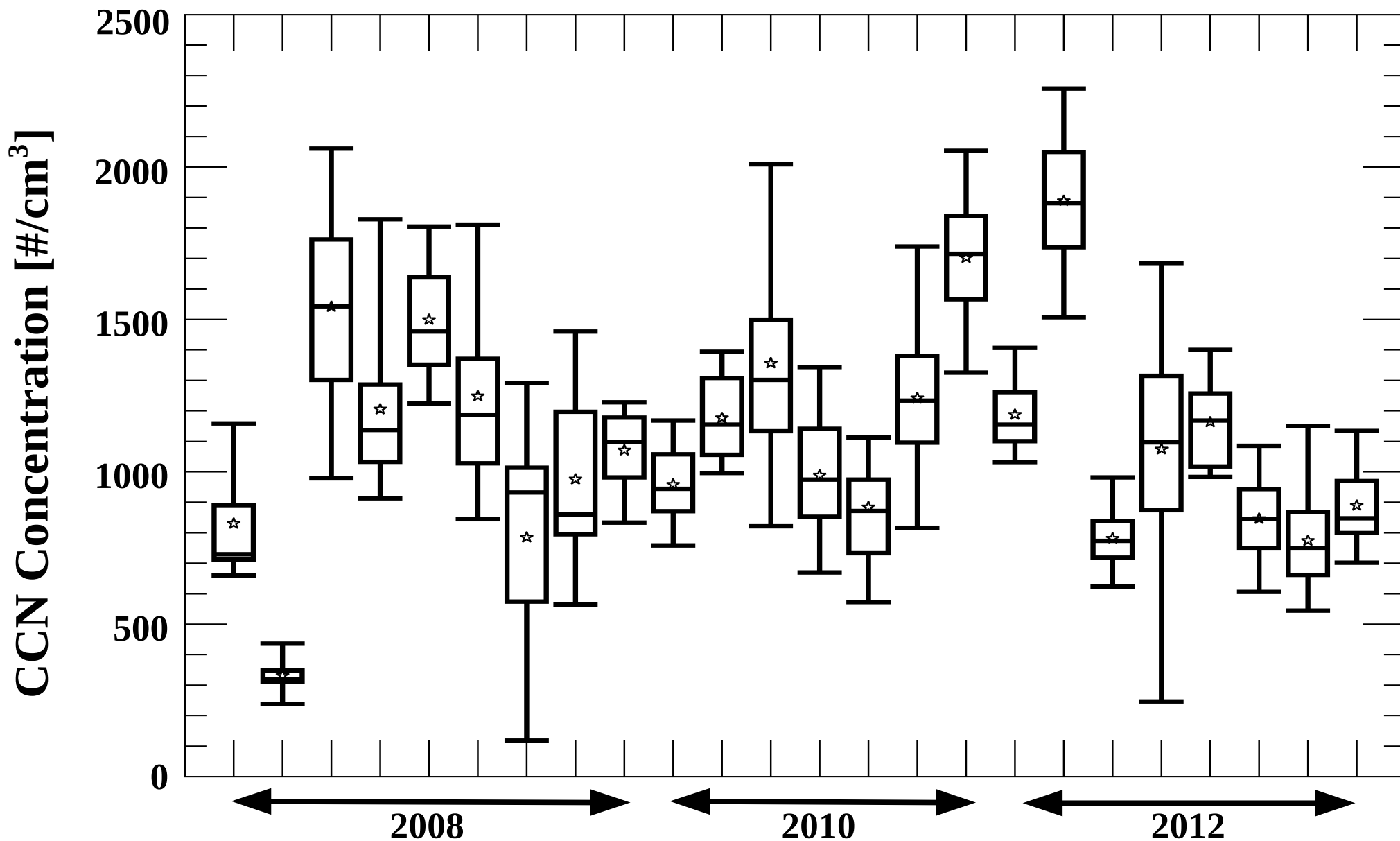
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UWyo Cloud Base – North Dakota 2012



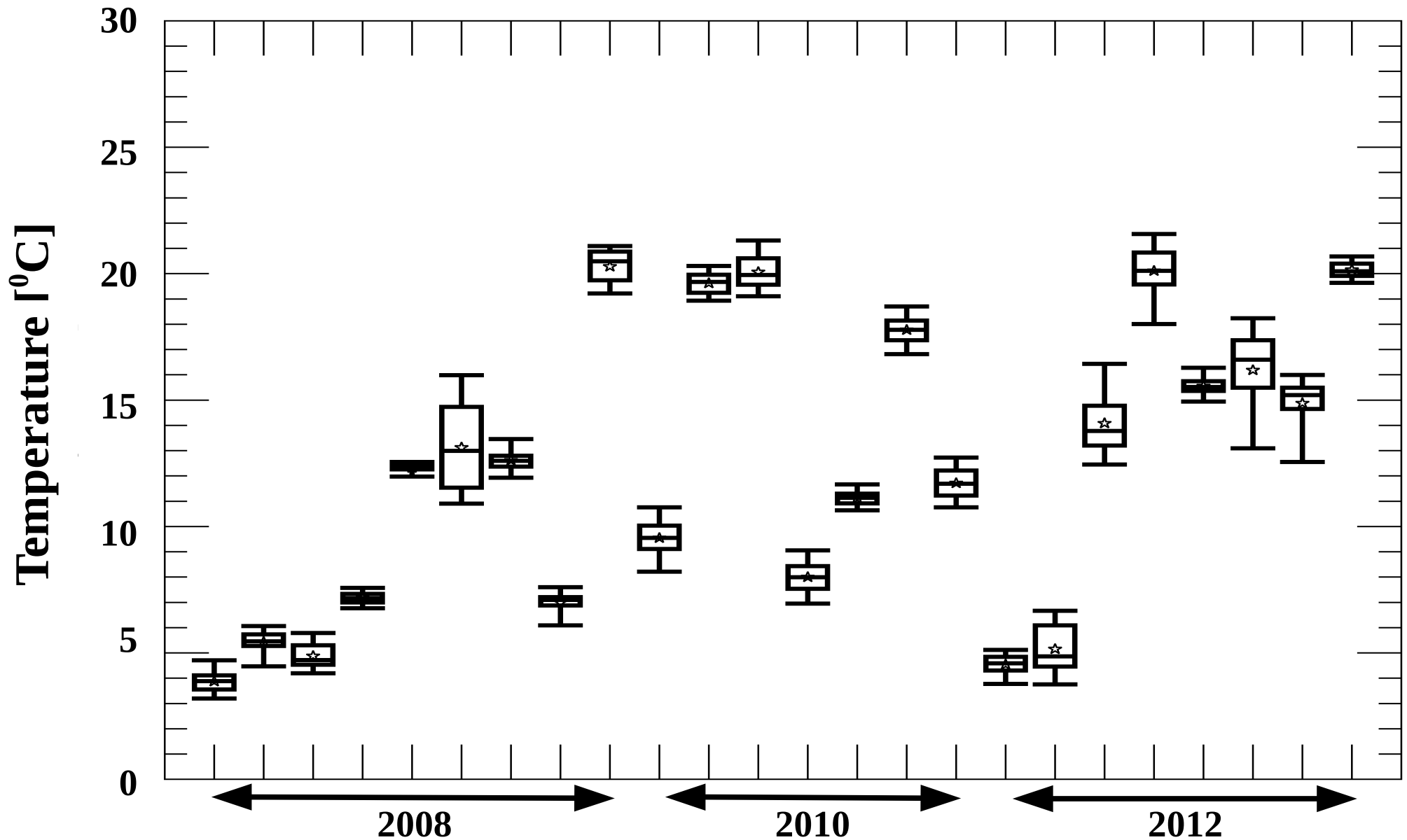
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CCN Concentration – North Dakota 2008, 2010, 2012



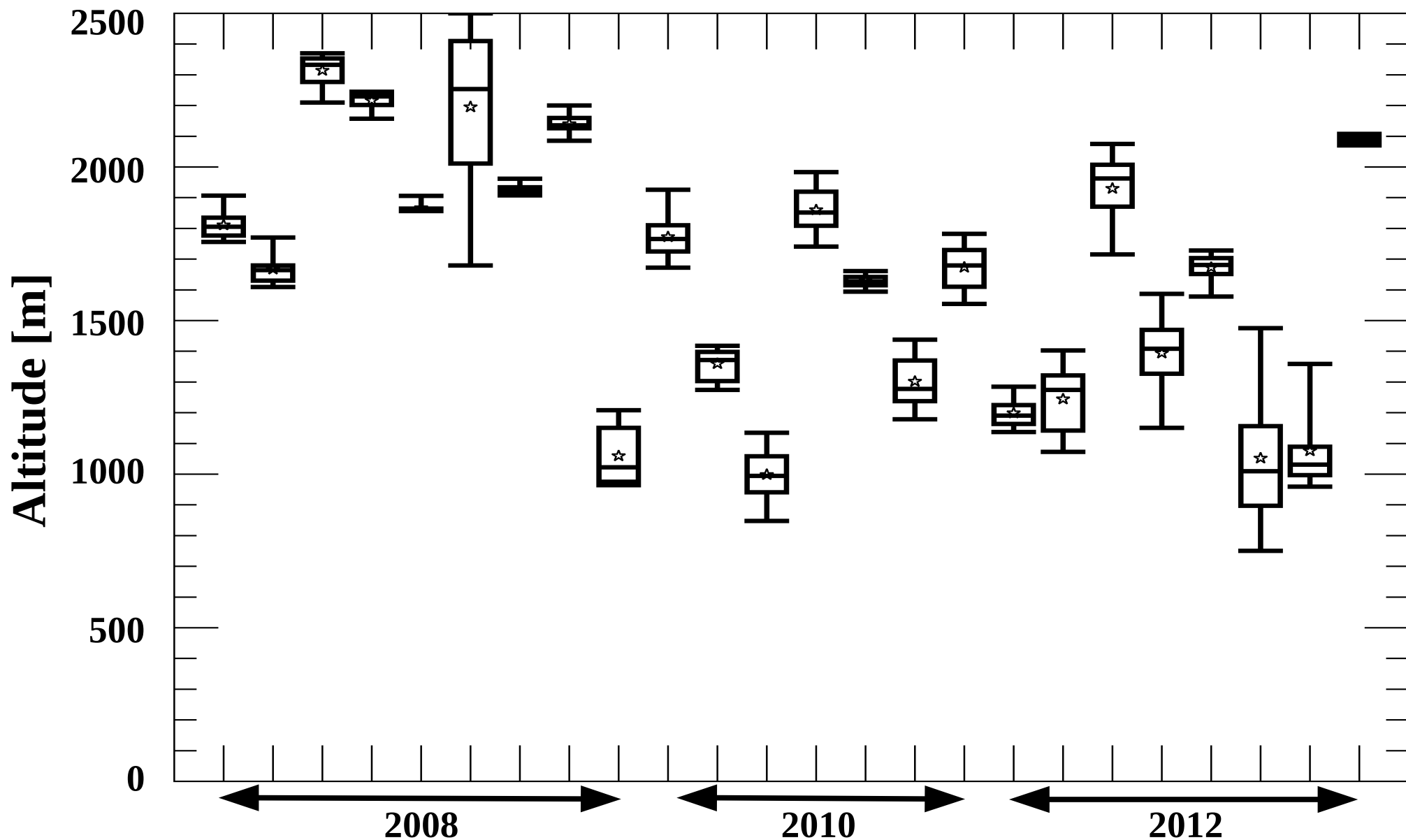
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Cloud Base Temperature – North Dakota 2008, 2010, 2012



Statistical distributions near cloud base of ambient temperature [°C]. 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.

Cloud Base Altitude – North Dakota 2008, 2010, 2012



Statistical distributions of cloud base height [m]. 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.

Conclusions

- Lots of care must be taken when processing airborne measurements.
- Statistical distribution on several days and during several seasons are important to understanding atmospheric conditions.
- Summer North Dakota Hygroscopic Seeding Conditions
 - 300 – 3,000 $\text{\#}/\text{cm}^{-3}$ cloud condensation nuclei
 - 4 – 20 $^{\circ}\text{C}$ cloud base temperature
 - 1,000 – 2,500 m cloud base altitude

Future Work

- Complete CCN calibration work.
- Article on the suitability of North Dakota for hygroscopic cloud seeding.

Questions

