Cloud Condensation Nuclei Comparisons from Surface and Aircraft Measurements in North Dakota

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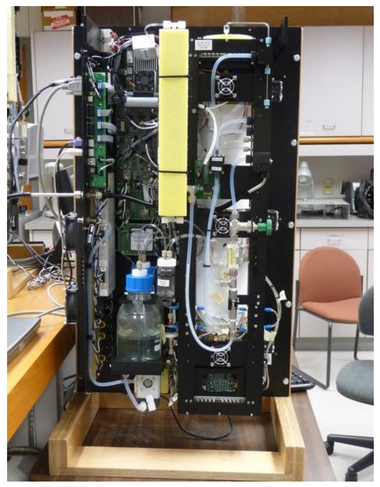
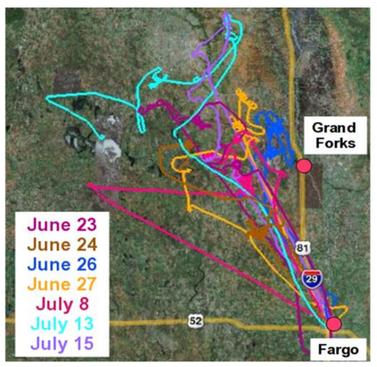
Objective

The objective is to determine how Cloud Condensation Nuclei (CCN) concentration change from the surface to clouds base and from day to day. Understanding when surface measurements can be used to predict cloud base CCN concentrations would allow long term, continuous, surface-based measurements to be used in many aerosol-cloud interaction studies.

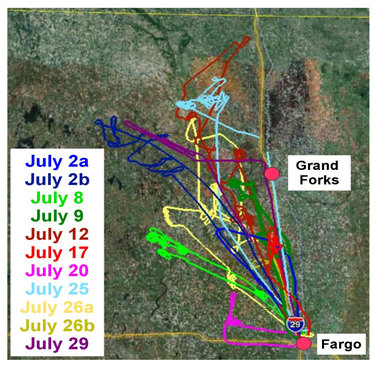
University of Wyoming's Cloud Condensation Nuclei Counter



Droplet Measurement Technologies Cloud Condensation Nuclei Counter

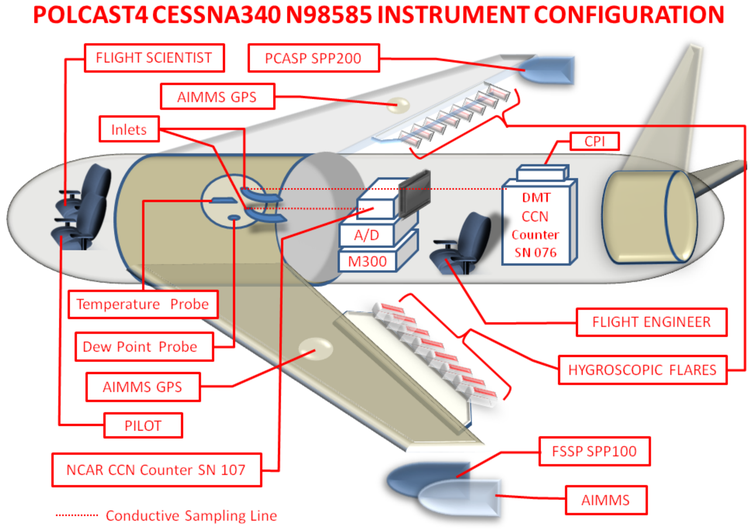


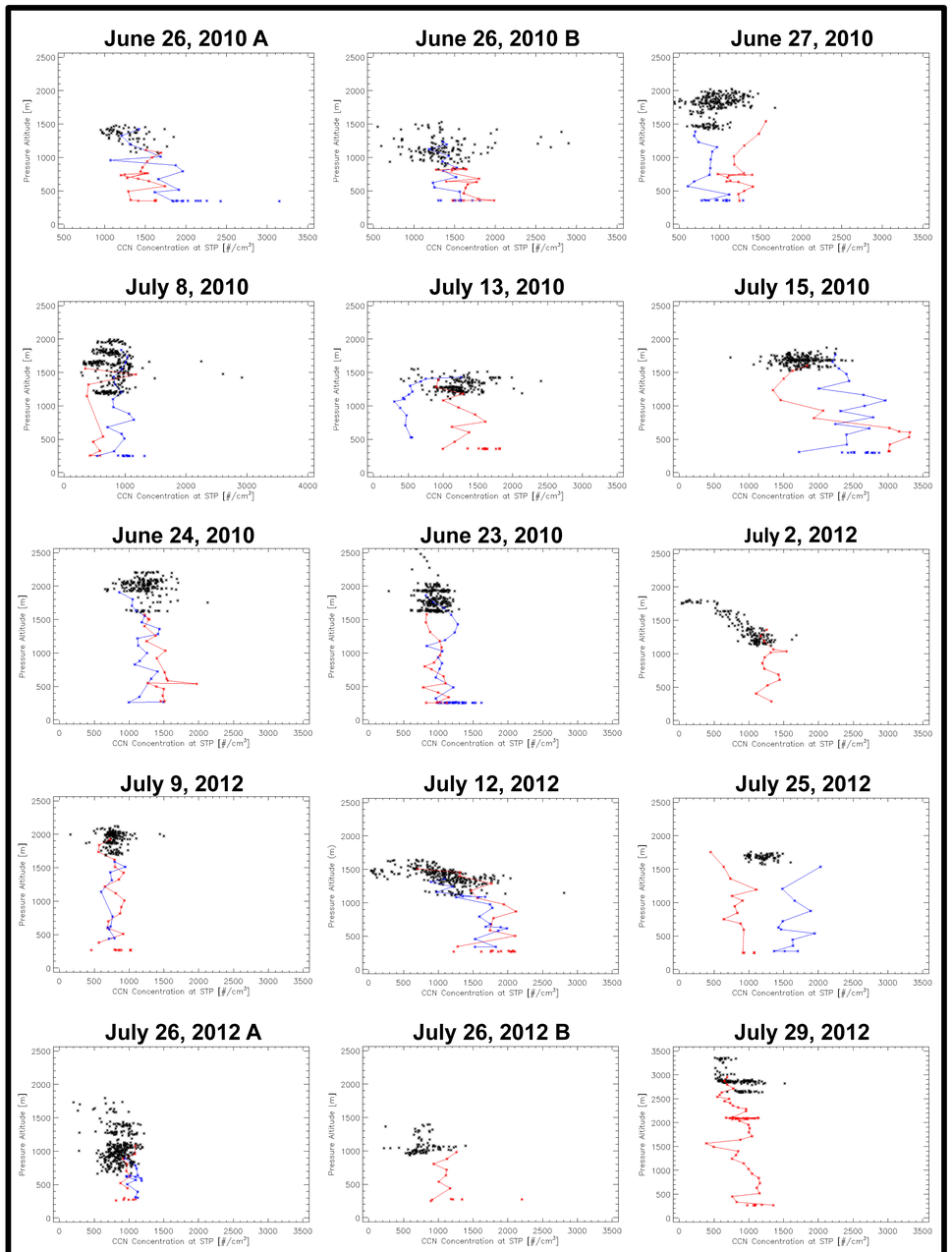
Aircraft flight paths during the 2010 POLCAST3 field project.



Aircraft flight paths during the 2012 PLCAST4 field project.

POLCAST4 CESSNA340 N98585 INSTRUMENT CONFIGURATION



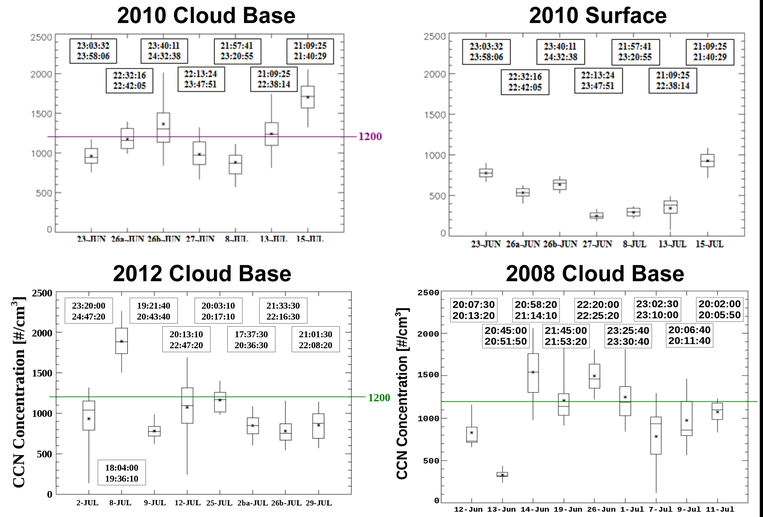


Comparison of Cloud Condensation Nuclei Concentrations at taxi (red stars), ascent (red lines), black stars (cloud base), and descent (blue lines) during the 2010 and 2012 POLCAST Campaign.

Date	Type	Start-time	Start-Time	End-Time	End Time
		SFM	HH:MM:SS	SFM	HH:MM:SS
23-Jun-10	Cloud Base	80180	22:16:20	88470	24:34:30
	Ascent	79680	22:08:00	80170	22:16:10
	Taxi	78700	21:51:40	79670	22:07:50
	Descent	88480	22:34:40	89100	24:45:00
26-Jun-10	Cloud Base	80630	22:23:50	82740	22:59:00
A	Ascent	80230	22:17:10	80630	22:23:50
	Taxi	79900	22:11:40	80240	22:17:20
	Descent	82750	22:59:10	83390	23:09:50
26-Jun-10	Cloud Base	84830	23:25:40	89500	24:51:00
B	Ascent	84510	23:28:30	84820	22:33:40
	Taxi	84130	23:22:10	84500	23:28:20
	Descent	89510	0:51:50	90200	25:03:20
27-Jun-10	Cloud Base	78120	21:42:00	85750	23:49:10
	Ascent	77770	21:36:10	78120	21:42:00
	Taxi	77330	21:28:50	84470	23:27:50
	Descent	85750	23:49:10	86330	23:58:50
8-Jul-10	Cloud Base	76190	21:09:50	85870	23:51:10
	Ascent	75670	21:01:10	76180	21:09:40
	Taxi	75300	20:55:00	75670	21:01:10
	Descent	75660	21:01:00	86270	23:57:50
13-Jul-10	Cloud Base	76100	21:08:20	82600	22:58:10
	Ascent	73280	20:21:20	73600	20:26:40
	Taxi	72900	20:15:20	73270	20:21:10
	Descent	82700	22:58:20	83120	23:05:20
15-Jul-10	Taxi	71890	19:58:10	72240	20:04:00
	Ascent	72240	20:04:00	72750	20:12:30
	Cloud Base	72750	20:12:30	79860	22:11:00
	Descent	79860	22:11:00	80300	22:18:20

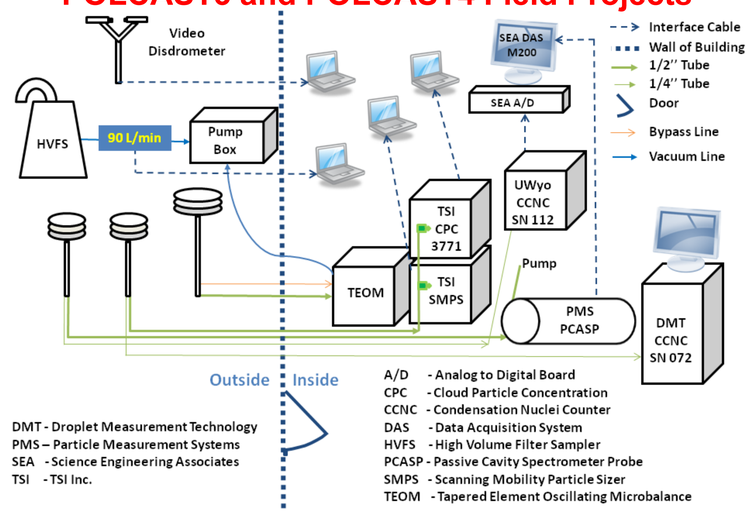
Date	Type	Start Time	Start Time	End Time	End Time
		SFM	MM:HH:SS	SFM	MM:HH:SS
2-Jul-12	Cloudbase	84000	23:20:00	89250	24:47:30
	Ascent	81650	22:40:50	82080	22:48:00
	Taxi	81440	22:37:20	81640	22:40:40
	Descent	89260	24:47:40	89610	24:53:30
8-Jul-12	Cloudbase	65040	18:04:00	70570	19:36:10
	Ascent	63600	17:40:00	63900	17:45:00
	Taxi	63528	17:38:48	63590	17:39:50
	Descent	70580	19:36:20	71800	19:56:40
9-Jul-12	Cloudbase	69700	19:21:40	74610	20:43:40
	Ascent	69200	19:13:20	69690	19:21:30
	Taxi	68940	19:09:00	69680	19:21:20
	Descent	74620	20:43:40	74990	20:49:50
12-Jul-12	Cloud Base	72790	20:13:10	82040	22:47:20
	Ascent	72460	20:07:40	72860	20:14:20
	Taxi	72068	20:01:08	72450	20:07:30
	Descent	82030	22:47:10	82630	22:57:10
25-Jul-12	Cloud Base	72190	20:03:10	73030	20:17:10
	Cloud Base	73710	20:28:30	75120	20:52:30
	Ascent	69350	19:15:50	69870	19:24:30
	Taxi	69082	19:11:22	69340	19:15:40
	Descent	77540	21:32:20	78000	21:40:00
26-Jul-12	Cloud Base	63450	17:37:30	74190	20:36:30
A	Ascent	63180	17:33:00	63440	17:37:20
	Taxi	62922	17:28:42	63180	17:33:00
	Descent	74200	20:36:40	74650	20:44:10
26-Jul-12	Cloud Base	77610	21:33:30	80190	22:16:30
B	Ascent	77350	21:29:10	77600	21:33:20
	Taxi	77153	21:25:53	77340	21:29:00
	Descent	N/A	N/A	N/A	N/A
29-Jul-12	Cloud Base	75690	21:01:30	79700	22:08:20
	Ascent	73390	20:23:10	75050	20:50:50
	Taxi	73184	20:19:44	73184	20:23:00
	Descent	N/A	N/A	N/A	N/A

Aircraft flight time intervals for the 2010 POLCAST3 and 2012 POLCAST4 field projects.



Statistical distributions made at cloud base and the surface in Grand Forks of the 30 s 1% supersaturation Cloud Condensation Nuclei (CCN) adjusted to standard temperature and pressure during the 2010 and 2012 POLCAST3 field project. The solid circle is the mean value, the horizontal 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 95th and 5th percentiles, respectively.

Surface Instrument Setup for the POLCAST3 and POLCAST4 Field Projects



DMT - Droplet Measurement Technology
PMS – Particle Measurement Systems
SEA - Science Engineering Associates
TSI - TSI Inc.

A/D - Analog to Digital Board
CPC - Cloud Particle Concentration
CCNC - Condensation Nuclei Counter
DAS - Data Acquisition System
HVFS - High Volume Filter Sampler
PCASP - Passive Cavity Spectrometer Probe
SMPS - Scanning Mobility Particle Sizer
TEOM - Tapered Element Oscillating Microbalance

Conclusions

Profiles show a well mixed CCN concentration layer between the surface and cloud base. This indicates that typically surface measurement can be used to infer cloud base properties. Day to day changes in CCN concentration are much larger than regional variations.

Future Work

The POLCAST4 2012 field project data will be analyzed, including the DMT CCN counter measurements.

Acknowledgement

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