Calibration workshop on Cloud Condensation Nucleus Counters

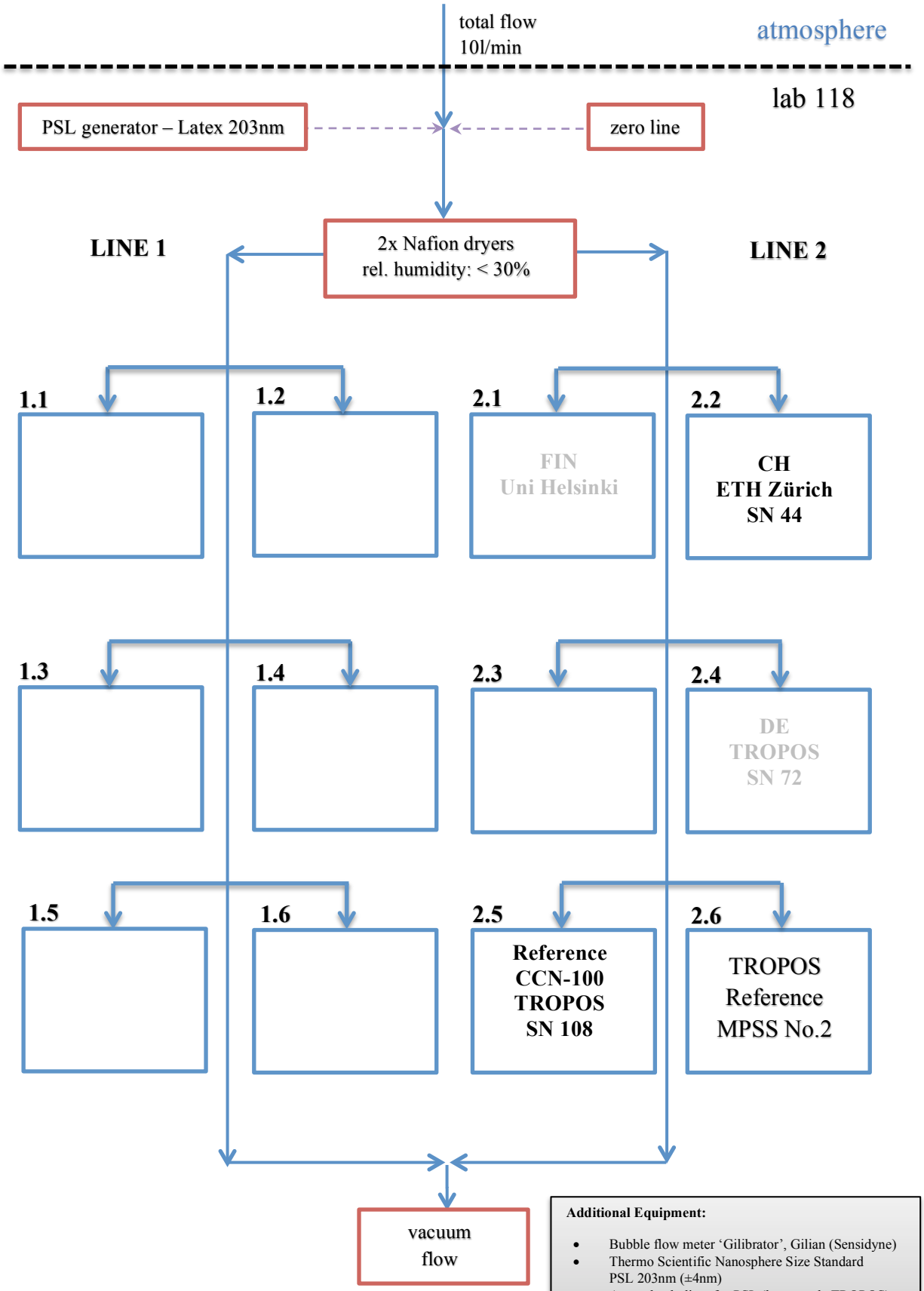
Project No.:	***CCNC-2016-1-4***
Principal Investigator:	*Amewu Antoinette Mensah*
Home Institution:	*Switzerland, ETH*
Participant:	*Franz Friebel, Nadine Borduas*
Candidate:	**CCN-100**
Made by:	DMT
Counter (SN):	CCN-100, SN 0507-44
Software:	DMT 5.0.6
Location of the quality assurance:	TROPOS Leipzig, lab 118
Comparison period:	October 24, 2016 – October 28, 2016
Last Intercomparison (with Project No.):	

Summary of Intercomparison

Pre-Status:
The instrument arrived with participant. The column was wetted and a pre-status measurement was done on ambient aerosol. During the Pre-Status, the performance of the system showed relative differences of -2.0% to +7.5% compared with the TROPOS Reference Instrument SN108 for supersaturation between 0.1% and 1.0%. The system was operated with a flow of 500ml.

Final Status:
The new parameters for flow and supersaturation calibration were set. During the Final Status the performance of the system showed relative differences of -8.3% to +12.5% compared with the TROPOS Reference Instrument SN108 for supersaturation between 0.1% and 1.0%. The candidate passed the quality standards of ACTRIS and GAW.

Laboratory setup:



Additional Equipment:

- Bubble flow meter 'Gilibrator', Gilian (Sensidyne)
- Thermo Scientific Nanosphere Size Standard PSL 203nm (±4nm)
- Aerosol nebulizer for PSL (homemade TROPOS)
- Voltcraft multimeter (0-1000V), Keysight Technologies

Supersaturation calibration protocol (Ammonium Sulfate Particle, size selected by TROPOS Reference MPSS No.2)

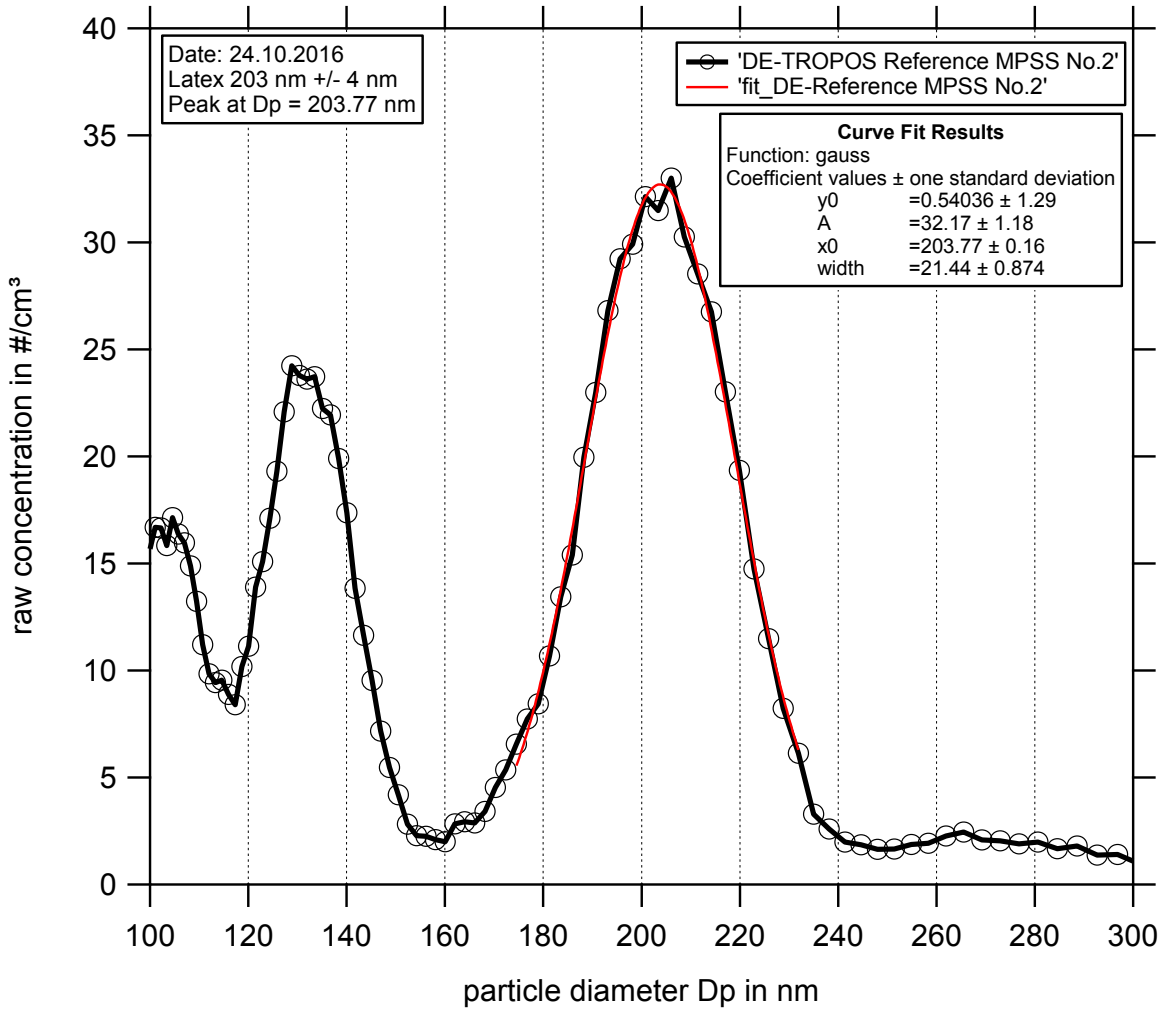


Figure 01: Measurement of latex 203 nm: Particle size distribution (raw concentration) for latex 203 nm on October 24rd, 2016.

Pre-status settings:

Date of check: 24.10.2016

Calibration tab settings	ETH DMT-CCN-100
Sample slope	64.251
Sample y-intercept	-146.36
Sheath slope	1091.6
Sheath y-intercept	-2486.2
Temp gradiet slope	17.553
Temp gradient intercept	1.0247

Zero-test with filter: passed (< 0.02 particles cm-3)

Candidate against TROPOS CCN-100 SN 108 during the pre-status: Time Series

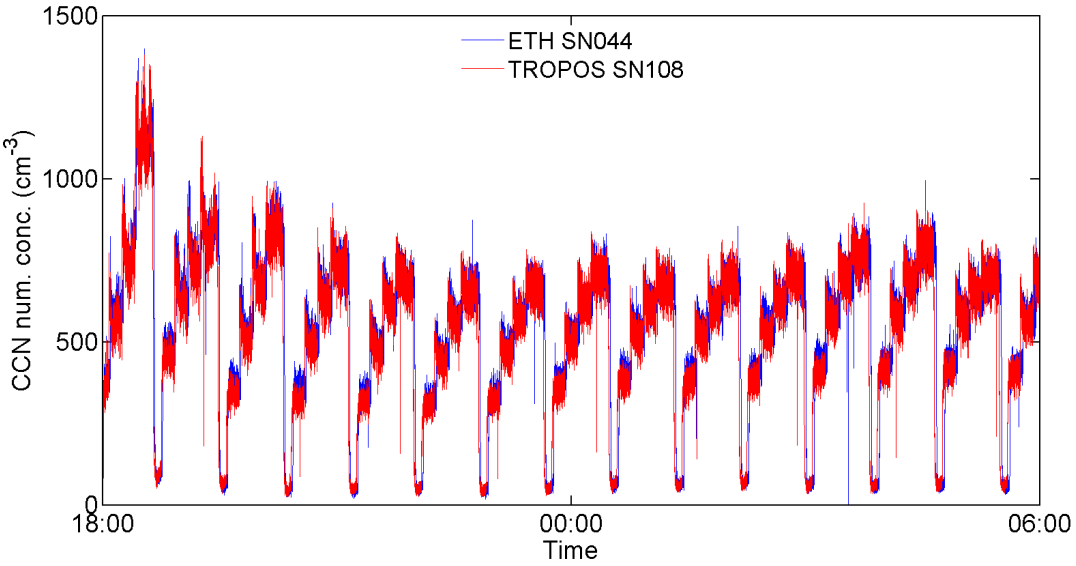


Figure 02: Time series (Oct 24, 2016 06:00 pm – Oct 25, 2016 06:00 am) of the Candidate vs. TROPOS CCN-100 SN-108.

Candidate against TROPOS CCN-100 SN 108 during the pre-status: average over supersaturation

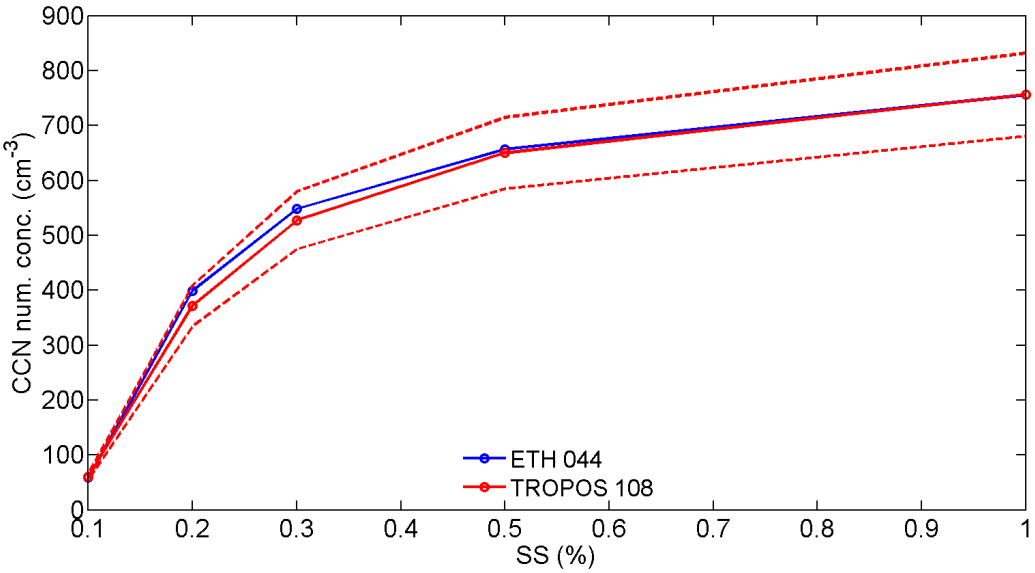


Figure 03: Average (Oct 24, 2016 06:00 pm – Oct 25, 2016 06:00 am) of the Candidate vs. TROPOS CCN-100 SN-108.

Flow calibration protocol (Bubble flow meter 'Gilibrator', Gilian (Sensidyne))

	Old	New	Old	New
Sample Slope	64.251	59.639	Sheath Slope	1091.6	1121.1
Sample intercept	-146.36	-132.8	Sheath intercept	-2486.2	-2576.4

Sample Calibration Without Sheath				
Valve Set (V)	Sample Volt (V)	Sheath '	Measured Total Flow (mlpm)	
2.2	2.56		20.49	18.12256
2.3	2.98		44.52	45.10798
2.4	3.81		93.84	98.43631
2.35	3.38		70.2	70.80838
2.25	2.74		29.78	29.68774

Sheath Calibration					
Valve Set (V)	Sample Volt (V)	Sheath '	Measured Total Flo	Sample Calcu (mlpm)	Sheath Flow (mlpm)
2.6	2.49	2.51	249.7	15.74111	233.95889
2.65	2.54	2.54	285.6	18.72306	266.87694
2.75	2.63	2.6	370.4	24.09057	346.30943
2.85	2.75	2.67	455	31.24725	423.75275
2.95	2.86	2.75	539.4	37.80754	501.59246
3.05	2.98	2.82	628.4	44.96422	583.43578
3.2	3.2	2.94	778	58.0848	719.9152

	input total Flow
before	503.9
after	506.4

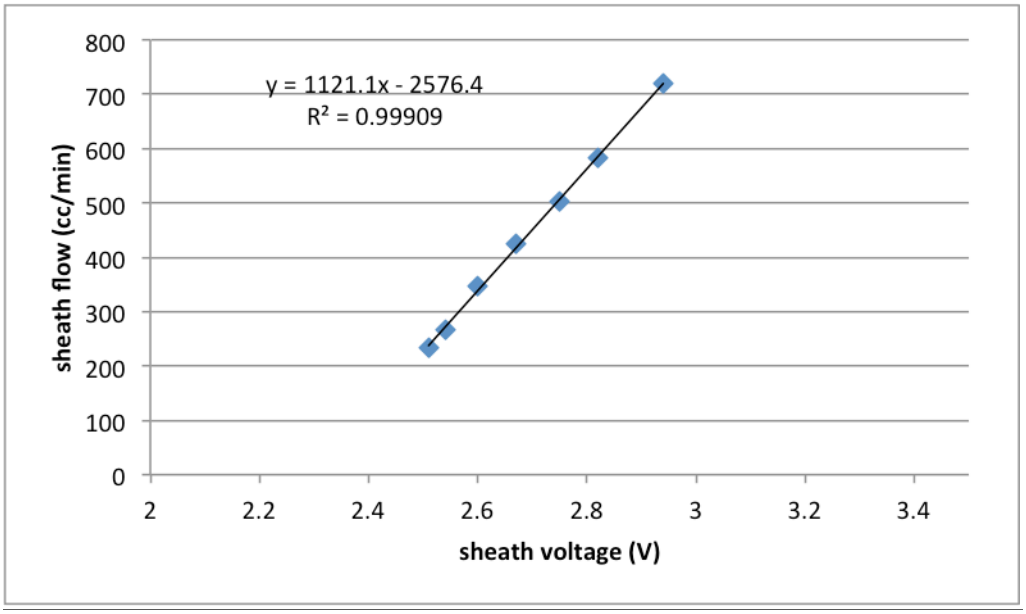


Figure 04: Sheath flow calibration

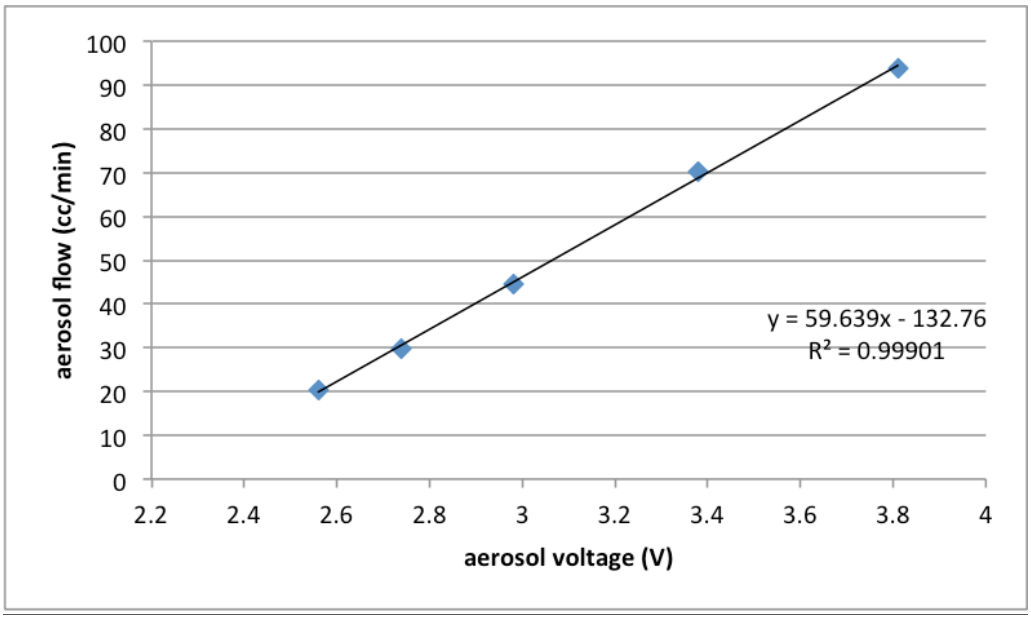
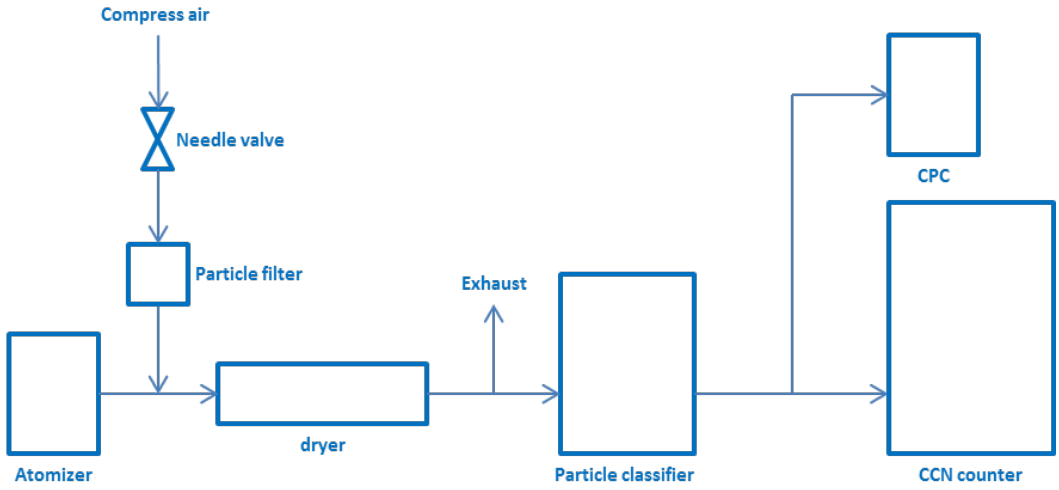


Figure 05: Aerosol flow calibration.

Calibration of Supersaturation-ΔT in CCN chamber

Experiment setup:



- Solution: ammonium sulfate 0.05 mol/L.
- Particle classifier was operated in diameter-scanning mode.
- Size-resolved activation ratio of ammonium sulfate particles was measured at 6 ΔT.
- Size-resolved activation ratio curves were fitted with 2 error functions, and critical diameter was taken as the centre diameter of the second error function (Fig. 05).
- Equivalent supersaturation at each pre-selected ΔT was derived from the fitted critical diameter based on a lookup-table according to the Standardized protocol for CCN measurements WP3-NA3 / D3.11.
- Calibration parameters was derived by a linear fit of equivalent supersaturation and ΔT (Fig. 06).

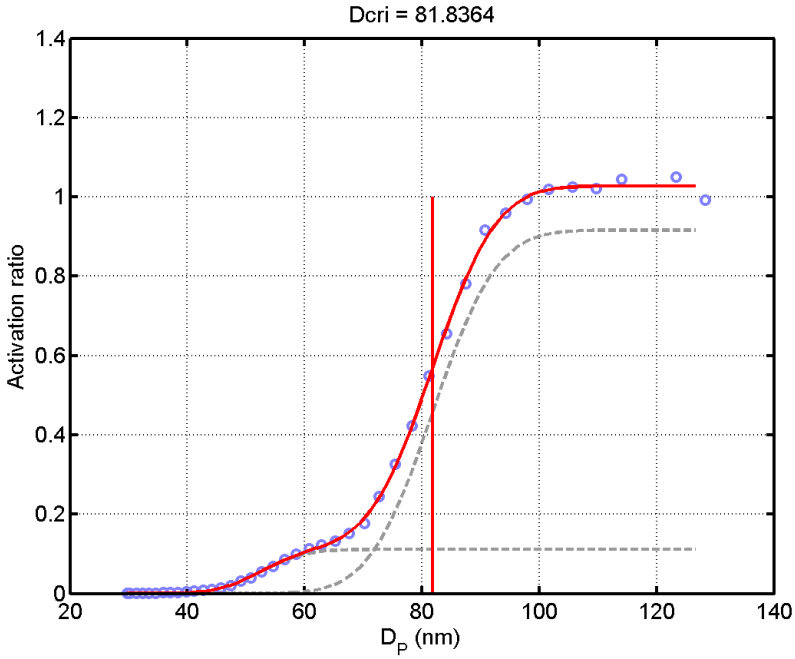


Figure 06: Example for activation curve of ammonium sulfate. Size selection was done with ref2 of WCCAP. The red line gives the sum of two sigmoid fits which are fitted to the measurements data. The grey lines give the fration of doubly charged particles and the fit corrected for the doubly charged particles. The red vertical line gives the position of the determined critical diameter.

Table 01: Result of the supersaturation calibration.

deltaT	SS	Dcrit	T
14.3449	0.900788698	30.48135665	29.89780867
14.3449	0.924454506	30.18477847	28.63902847
14.3449	0.921814417	30.23946728	28.64036133
10.57423	0.644749993	38.13179716	27.69563351
10.57423	0.611016347	39.45835622	27.6955341
8.06045	0.450415702	48.16204817	26.80744163
8.06045	0.443796394	48.61910194	26.81108873
5.54667	0.298278629	62.96130205	26.09650548
5.54667	0.292431067	63.7673257	26.10022458
4.28978	0.197822854	82.11867139	25.88553774
4.28978	0.198119151	82.03871692	25.88600284
4.28978	0.198880134	81.83640395	25.88633555
3.03289	0.085033256	142.4107042	25.29760202
3.03289	0.085668811	141.7202669	25.30030603

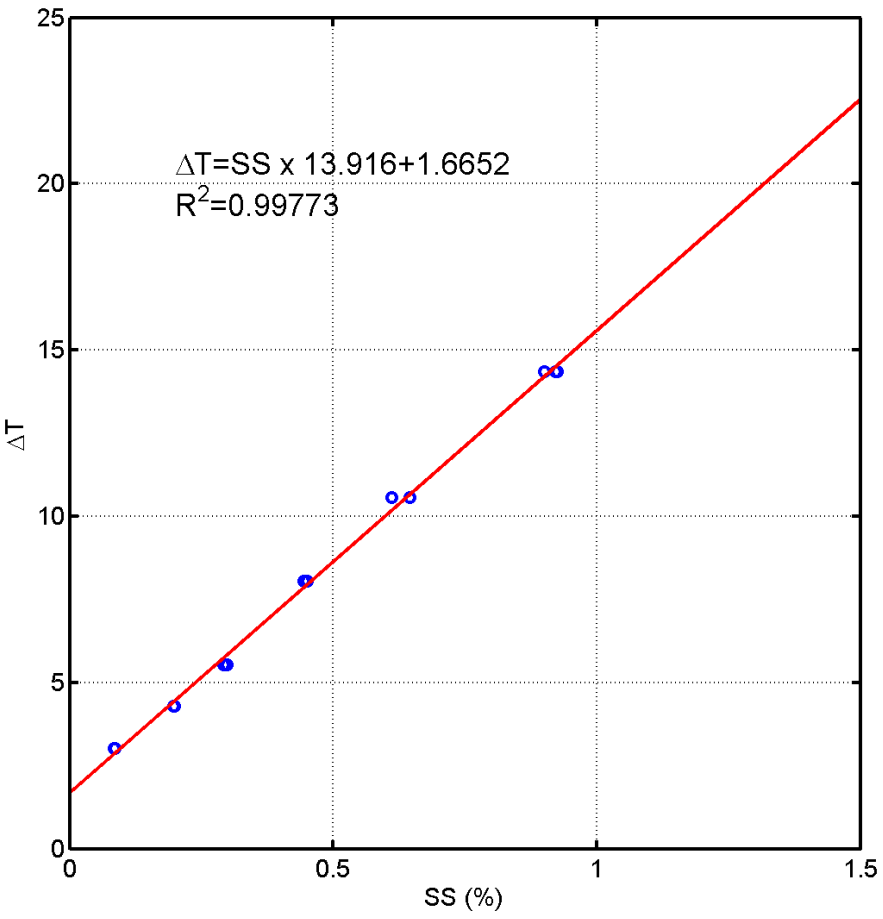


Figure 07: New supersaturation calibration coefficients.

Final Status of the Candidate: time series

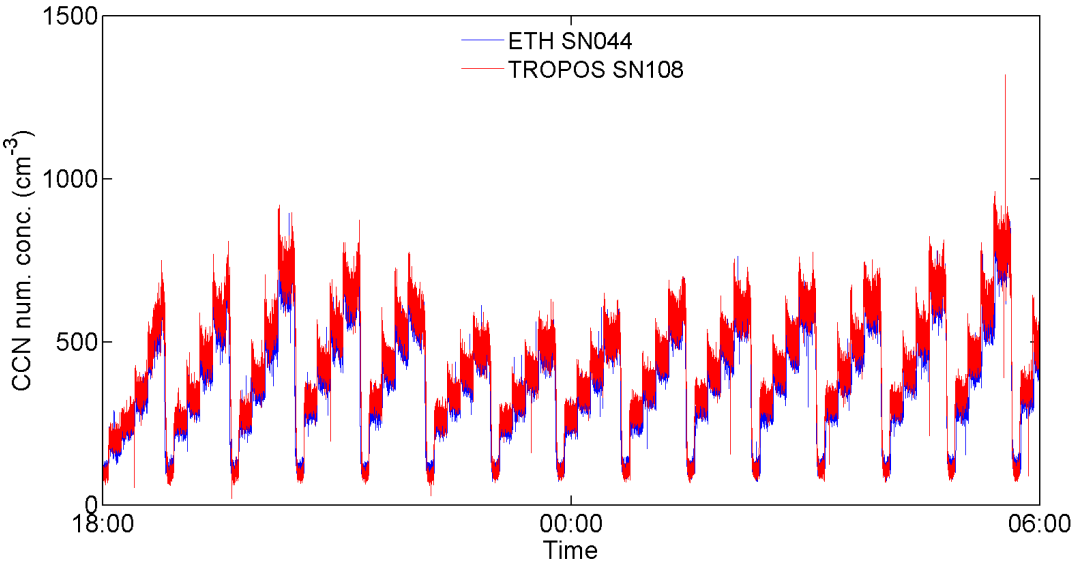


Figure 08: Time series (Oct 26, 2016 06:00 pm – Oct 27, 2016 06:00 am) of the Candidate vs. TROPOS CCN-100 SN-108.

Final Status of the Candidate: average over supersaturation

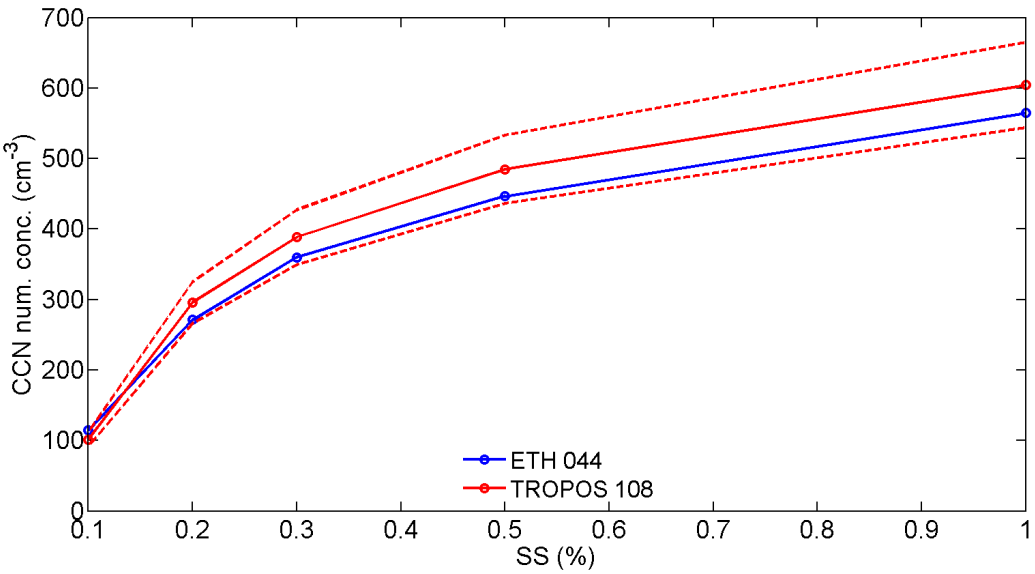


Figure 09: Average of activated particles vs. supersaturation (Oct 26, 2016 06:00 pm – Oct 27, 2016 06:00 am) of the Candidate vs. TROPOS CCN-100 SN-108.