TROPOS
Leibniz Institute for Tropospheric Research

ACTRiS

Intercomparison of Mobility Particle Size Spectrometers

Project No.: OSIA-2016-1-1

Basic information:

Location of the quality assurance: Hyytiälä, SMEAR2 station

Delivery date of reference instrument: May 23, 2016

Setup in the container: May 23, 2016

Comparison period: May 23, 2016 – May 26, 2016

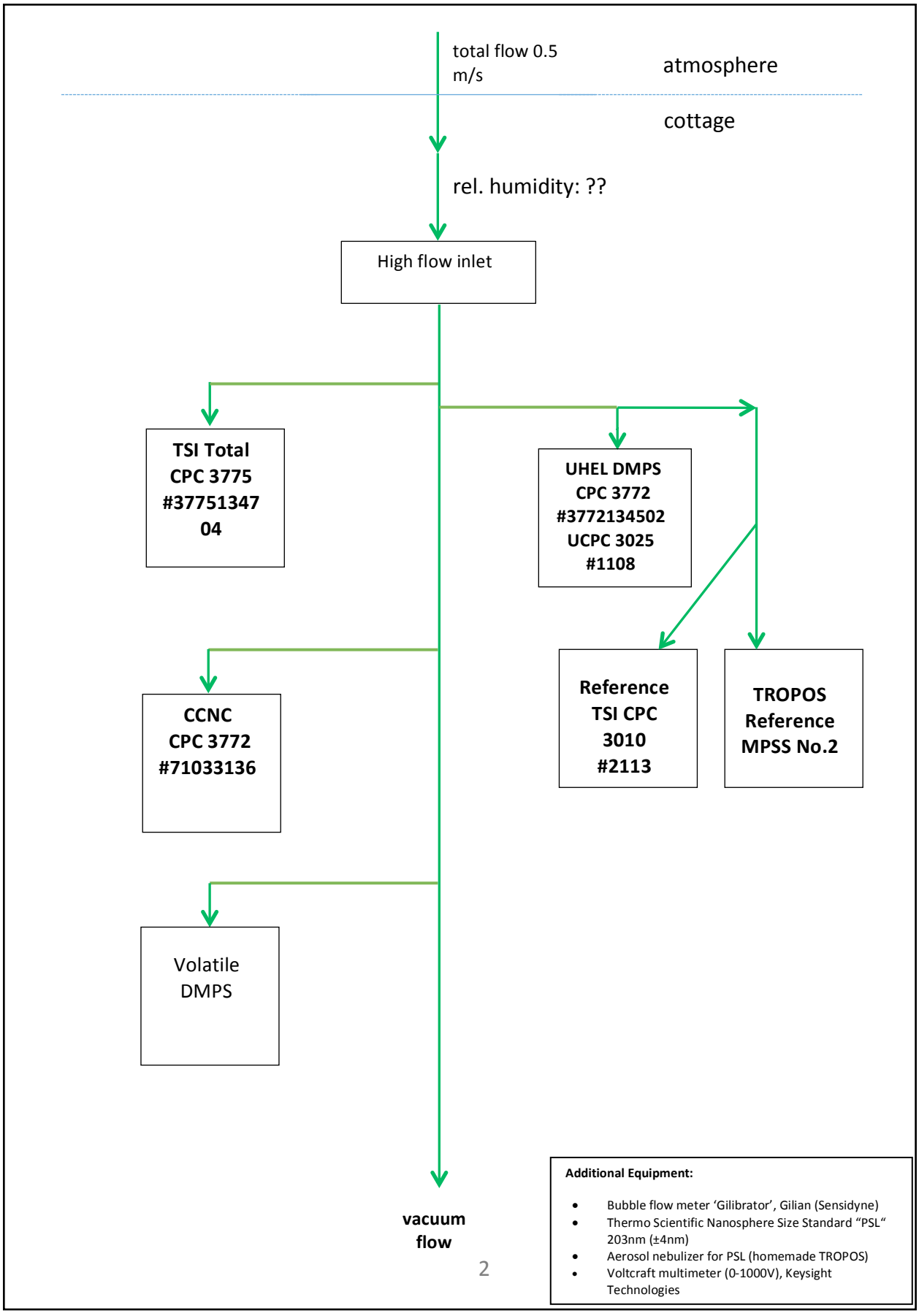
Principal Investigator	Home Institution	Participant	Instrument
	UHEL		FI-UHEL Hyytiälä Homemade DMPS TSI CPC Model 3772 SN : 3772134502 TSI UCPC Model 3025 SN : 1108 TSI Total CPC Model 3775 SN : 3775134704

Summary of Intercomparison:

Final status:

The UHEL DMPS Hyytiälä passed the quality standards of ACTRIS and GAW.

Intercomparison setup



List of Components

	Specification	Reference MPSS No.2	UHEL DMPS Hyytiälä	UHEL DMPS Hyytiälä
Company		TROPOS	UHEL	UHEL
Software		TROPOS 6.1	UHEL	UHEL
CPC		Model 3772 SN: 70835059	Model 3772 SN : 70835059	Model 3025 SN : 1108
Flow ratio		1.0 : 5.0	1.0 : 5.0	4.0 : 20.0
Source		Kr85	C14	C14
HV cassette		positive	positive	Positive
DMA		Hauke medium	Hauke medium	Hauke short
Flow meas.	Aerosol	✓	✓	✓
Dryer		✓		
RH sensor	Inlet	✓	✓	✓
T sensor		✓	✓	✓
RH sensor	Sheath air	✓	✓	✓
T sensor		✓	✓	✓
Dryer		✓	✓	✓
p sensor		✓	✓	✓

CPC Status total CPC SN: 2113

Institute CPC	Variable	Status	Comments
TROPOS **Total CPC 3010, #2113**	Power	okay	
	Laser	okay	
	Flow	okay	
	Liquid level	okay	

CPC Status Reference Instrument No.2

Institute	CPC	Variable	Status	Comments
TROPOS	Reference Instrument No.2, 3772 #70835059	Saturator Temp	39.1°C	
		Condenser Temp	22.0°C	
		Optics Temp	40.0°C	
		Cabinet Temp	36.1°C	
		Ambient Pressure	99.4 kPa	
		Orifice Pressure	53.9 kPa	
		Nozzle Pressure	2.7 kPa	
		Laser Current	48 mA	

CPC Status DMPS Hyytiälä

Institute	CPC	Variable	Status	Comments
UHEL	DMPS Hyytiälä, 3772 #3772134502	Saturator Temp	39.0°C	
		Condenser Temp	17.0°C	
		Optics Temp	40.0°C	
		Cabinet Temp	42.2°C	
		Ambient Pressure	98.8 kPa	
		Orifice Pressure	64.3 kPa	
		Nozzle Pressure	2.9 kPa	
		Laser Current	41 mA	

UCPC Status DMPS Hyytiälä SN: 1108

Institute	CPC	Variable	Status	Comments
UHEL	DMPS Hyytiälä, 3025 #1108	Power	okay	
		Laser	okay	
		Flow	okay	
		Liquid level	okay	

CPC Status Total CPC Hyytiälä

Institute	CPC	Variable	Status	Comments
UHEL	TCPC Hyytiälä, 3775 #3775134704	Saturator Temp	39.0°C	
		Condenser Temp	14.0°C	
		Optics Temp	40.0°C	
		Cabinet Temp	37.0°C	
		Ambient Pressure	98.9 kPa	
		Orifice Pressure	52.6 kPa	
		Nozzle Pressure	0.073 kPa	
		Laser Current	34 mA	

CPC Status CCNC Hyytiälä

Institute	CPC	Variable	Status	Comments
UHEL	CCNC Hyytiälä, 3772 #71033136	Saturator Temp	39.0°C	
		Condenser Temp	15.0°C	
		Optics Temp	43.1°C	!!!
		Cabinet Temp	50.0°C	!!!
		Ambient Pressure	99.4 kPa	
		Orifice Pressure	0.0 kPa	!!!
		Nozzle Pressure	2.0 kPa	
		Laser Current	41 mA	

Status of the Candidate

Components and zero check, 25.05.2016; 08:30 to 25.05.2016;08:50

Institute	Instrument	Components	Flow		Zero	
TROPOS	Ref2	MPSS	**1.039**	l/min	2	# cm^{-3}
TROPOS	Ref	Total CPC 3010	**1.046**	l/min	0	# cm^{-3}
UHEL		DMPS CPC	**1.052**	l/min	0	# cm^{-3}
UHEL		DMPS UCPC	**3.916**	l/min	0	# cm^{-3}
UHEL		Total CPC 3775	**1.470**	l/min		# cm^{-3}
UHEL		CCNC CPC 3772	**0.987**	l/min		

High voltage calibration

Institute	System	[V]	0 V	4 mV	80 mV	800 mV
TROPOS	Reference MPSS No.2	**final**	**0.0**	**4.99**	**99.6**	**999.1**

Latex 203nm ±4nm (pressure 987 hPa, 23.0°C) ->> 23.05.2016: 10:40 – 11:00

Institut	System		Latex 203 [nm]	slope
TROPOS	Reference MPSS No.2	**final**	**203.69**	**-**

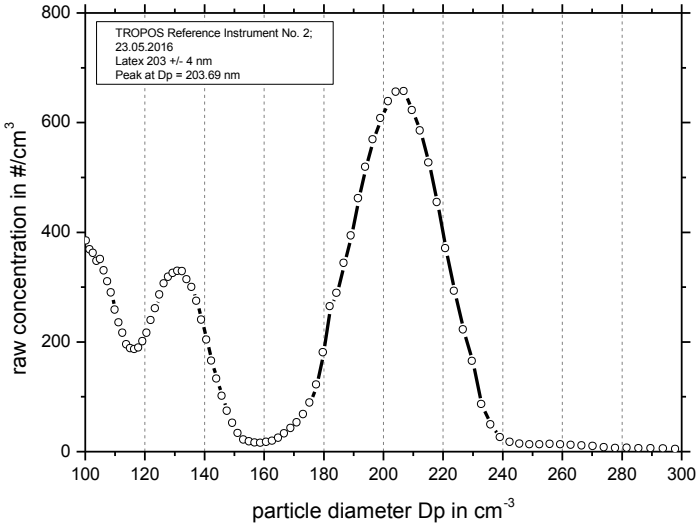


Figure 01: Measurement of latex 203 nm: Particle size distribution (raw concentration) for latex 203 nm on May 23rd, 2016 for the TROPOS Reference Instrument No. 2.

Latex 203nm ±4nm (pressure 980 hPa, 23.0°C) ->> 24.05.2016: 10:45 – 11:00

Institut	System		Latex 203 [nm]	slope
UHEL	DMPS Hyytiälä	**final**	**207.90**	**-**

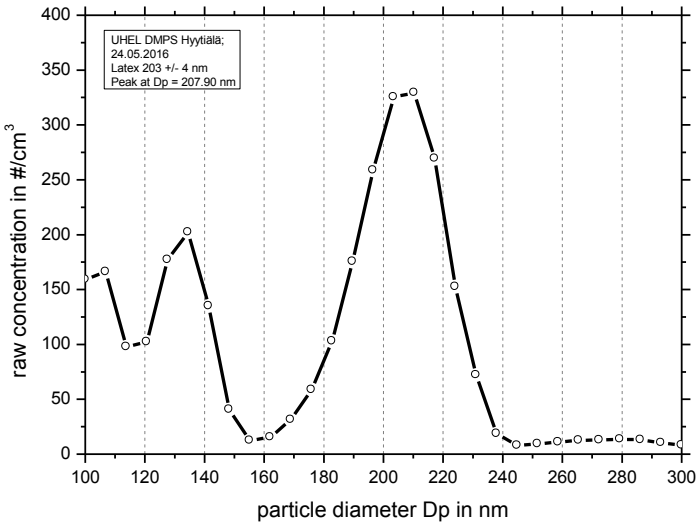


Figure 02: Measurement of latex 203 nm: Particle size distribution (raw concentration) for latex 203 nm on May 23rd, 2016 for the UHEL DMPS Hyytiälä.

Time Series

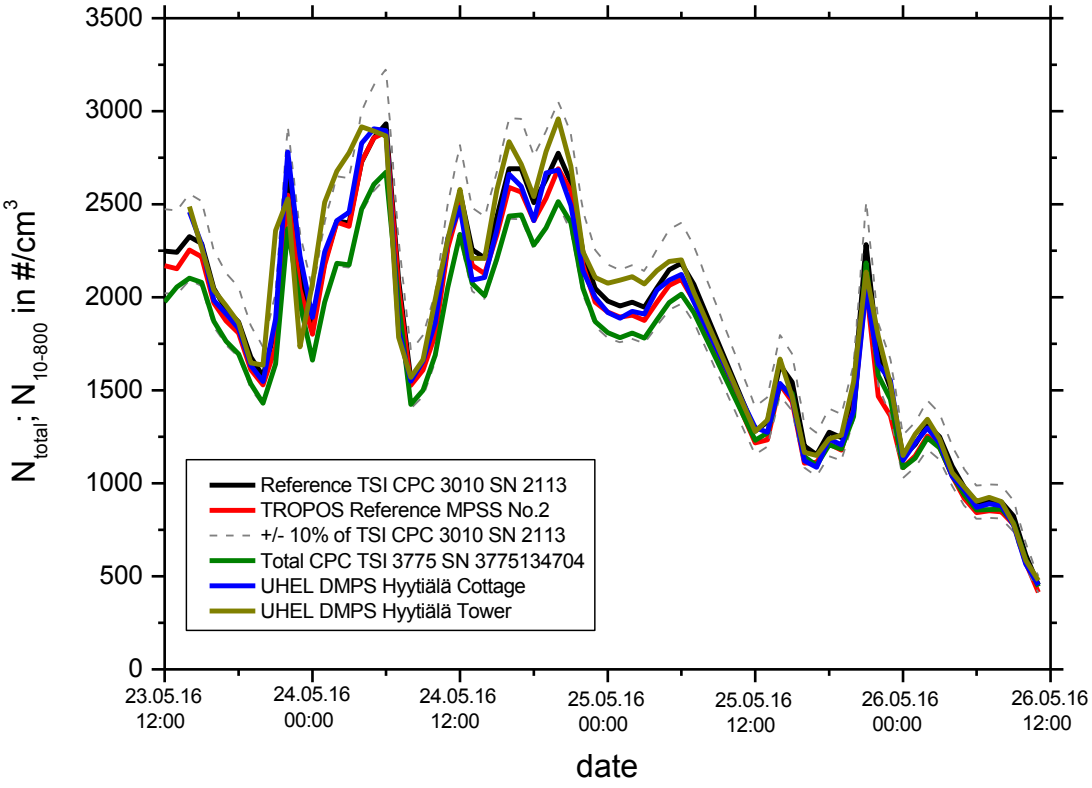


Figure 03: Time series (May 23, 2016 12:00 pm – May 26, 2016 11:00 am) of the integrated particle number concentration ($N_{10\text{-}800nm}$) of the different mobility particle size spectrometers and total number concentration (N_{total}) of the Total CPC 3010 and 3775.

Particle Number Size Distribution

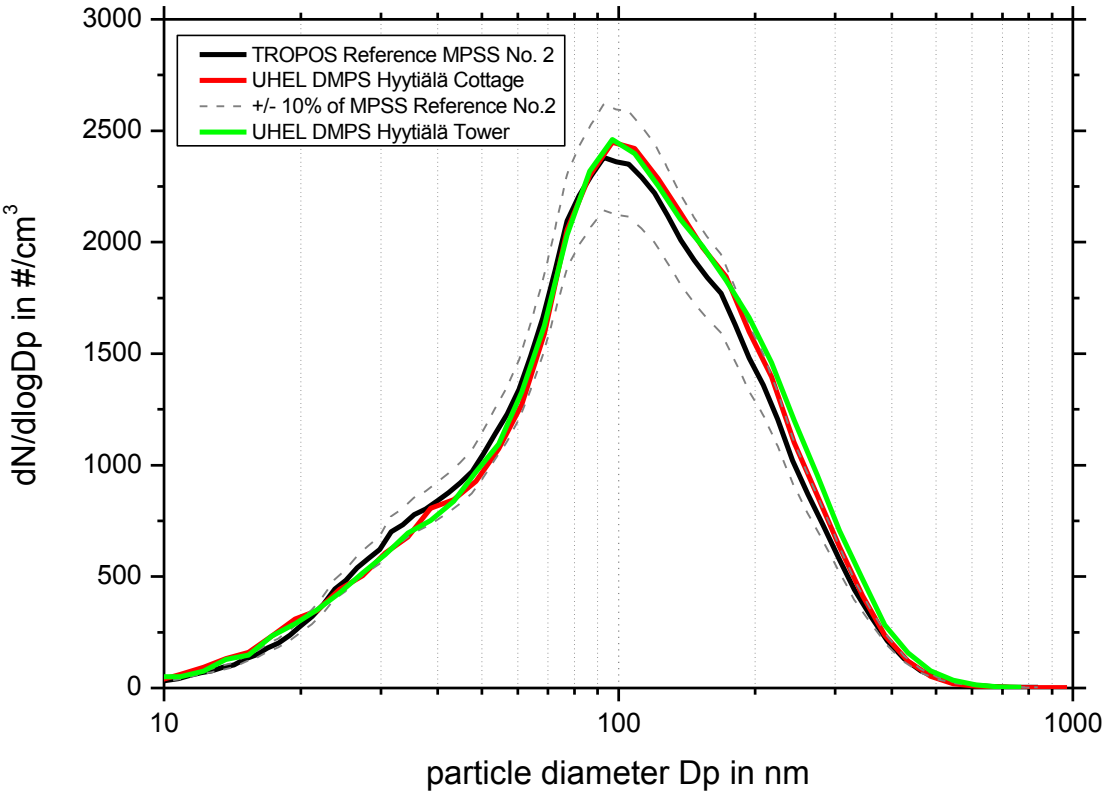


Figure 03: Comparison of mean particle number size distribution of TROPOS Reference MPSS No.2, UHEL DMPS Hyytiälä Cottage (red) and UHEL DMPS Hyytiälä Tower (green) from May 23, 2016 12:00 pm until May 26, 2016 10:00 am. The inversion for the MPSS Reference No. 2 was performed using TROPOS software. Multiple charge correction, internal diffusion losses and CPC efficiency are included. The inversion for the UHEL DMPS Hyytiälä was performed by Pasi Aalto, including multiple charge correction, internal losses and CPC efficiency.

Correlation

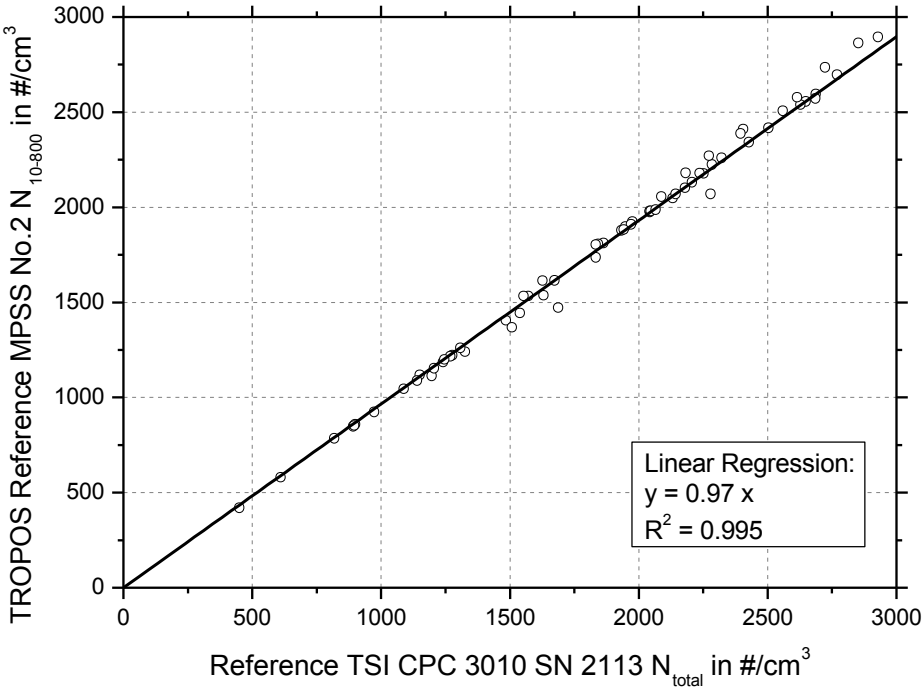


Figure 04: Linear regression between the number concentrations of the Reference TSI CPC 3010 SN 2113 and TROPOS Reference MPSS No.2. Multiple charge correction, internal diffusion losses and CPC flow corrections are included.

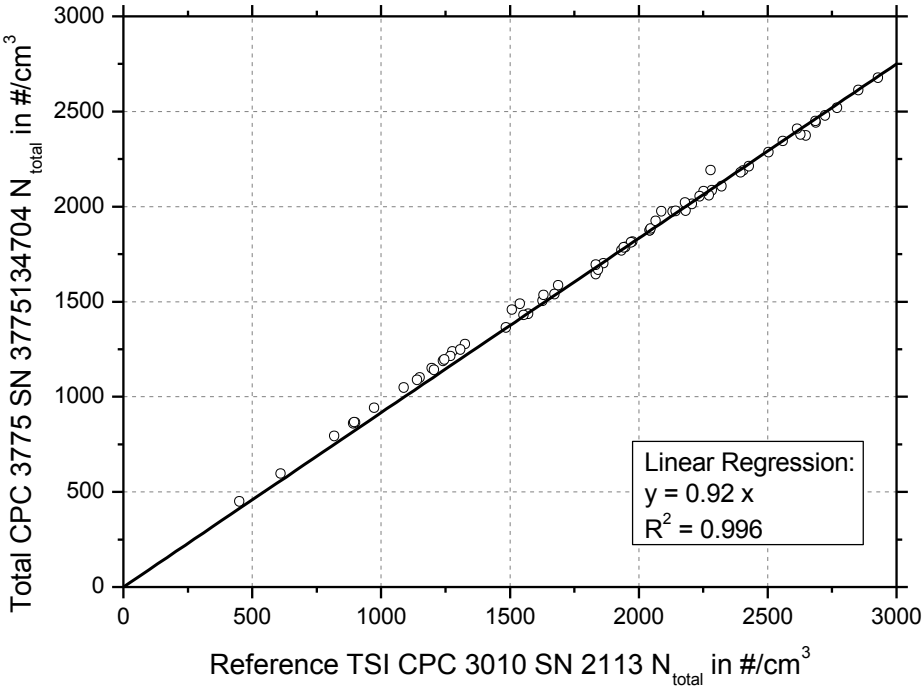


Figure 05: Linear regression between the number concentrations of the Reference TSI CPC 3010 SN 2113 and Total CPC 3775 SN 3775134704. CPC flow corrections are included.

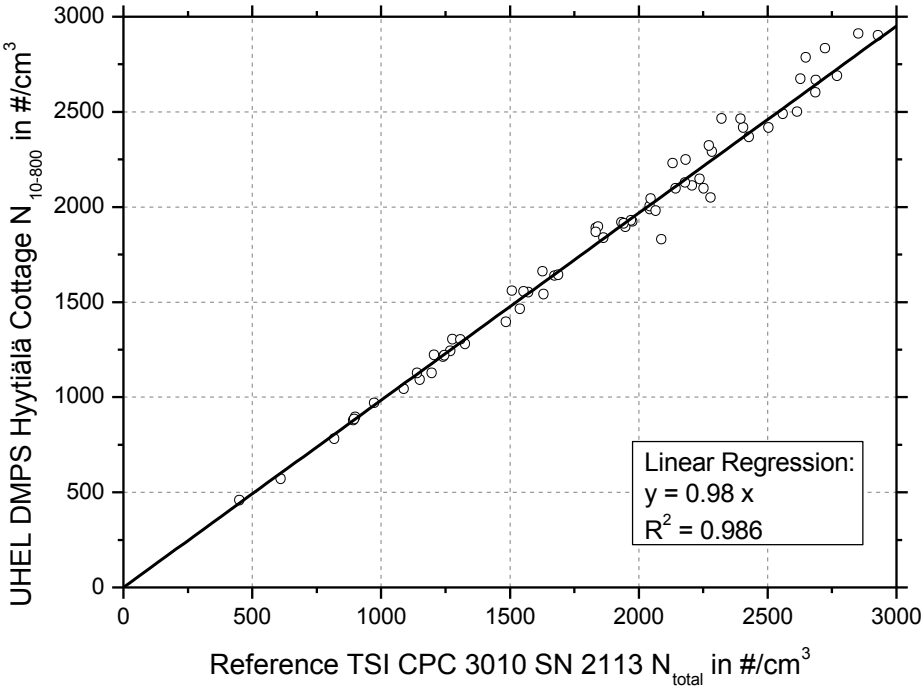


Figure 06: Linear regression between the number concentrations of the Reference TSI CPC 3010 SN 2113 and UHEL DMPS Hyytiälä Cottage. Multiple charge correction, internal diffusion losses and CPC flow corrections are included.

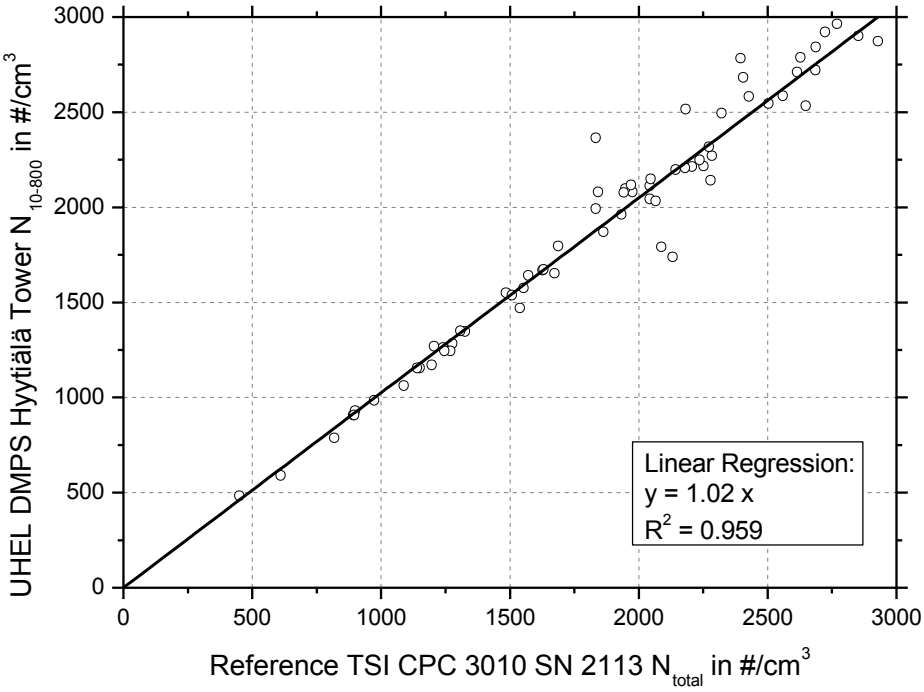


Figure 07: Linear regression between the number concentrations of the Reference TSI CPC 3010 SN 2113 and UHEL DMPS Hyytiälä Tower. Multiple charge correction, internal diffusion losses and CPC flow corrections are included.

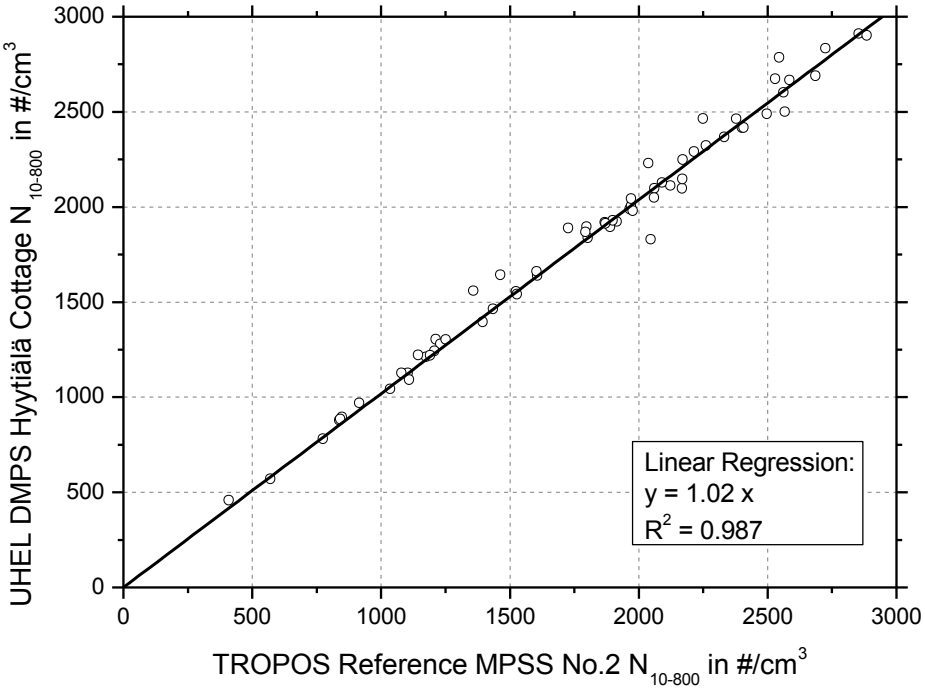


Figure 08: Linear regression between the number concentrations of the TROPOS Reference MPSS No.2 and UHEL DMPS Hyytiälä Cottage. Multiple charge correction, internal diffusion losses and CPC flow corrections are included.

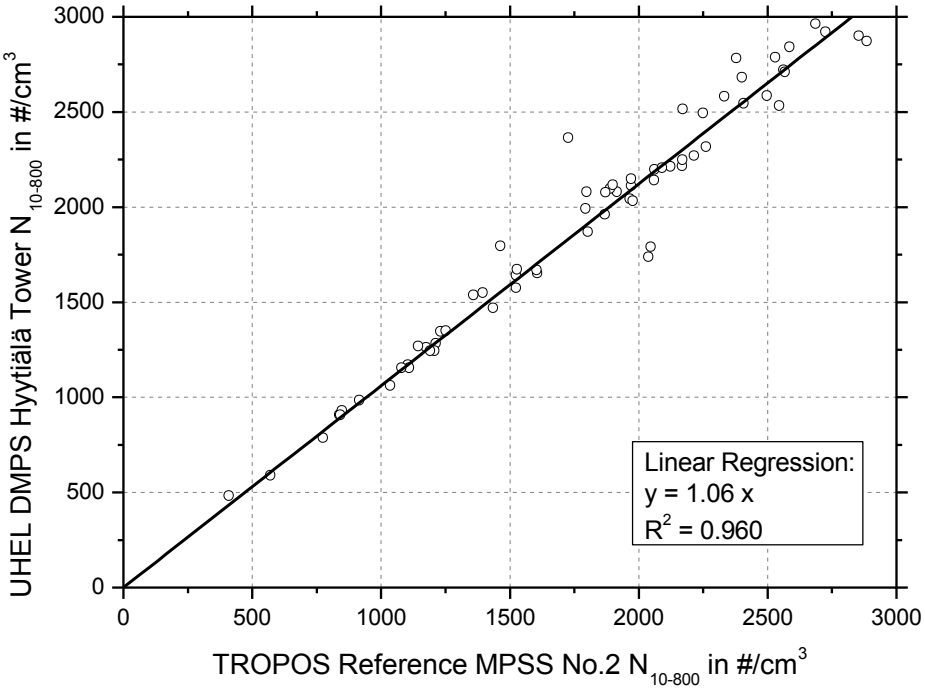


Figure 09: Linear regression between the number concentrations of the TROPOS Reference MPSS No.2 and UHEL DMPS Hyytiälä Tower. Multiple charge correction, internal diffusion losses and CPC flow corrections are included.

Primary flow standard:

A Gilibrator is used as primary flow standard at SMEAR 2. This Gilibrator is available for routine flow checks. Both flow cells have been verified against the GAW reference Gilibrator during the audit. Results of this inter comparison are shown in figure 10.

	TROPOS	**SMEAR2**
	SN 0303865-S	**SN 1105063-S**
flow rate	255	257
in ml/min	493	496
	1008	1027
	1532	1545
	1996	2031
	TROPOS	**SMEAR2**
	SN 0801012-H	**SN 1106007-H**
flow rate	2778	2813
in ml/min	3601	3641
	4220	4191
	5305	5269
	10480	10480
	20500	20110

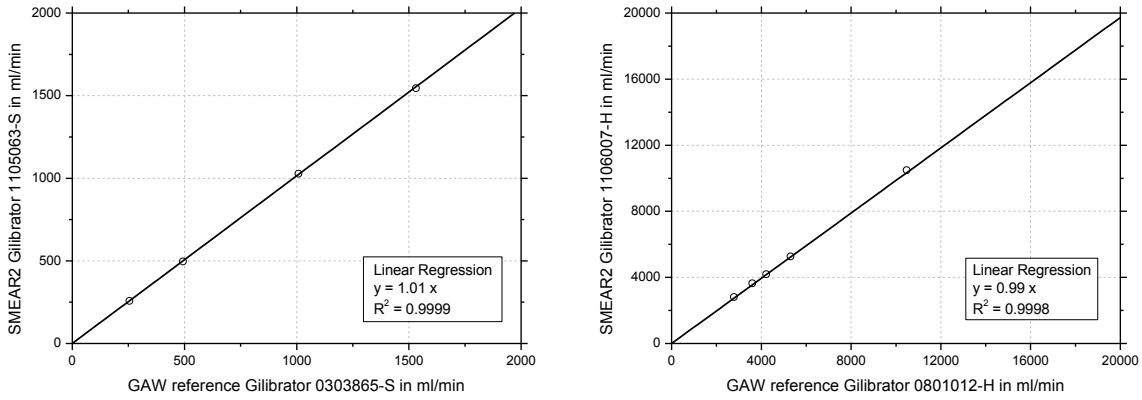


Figure 10: Comparison of SMEAR2 flow cells with GAW reference flow cells.

Comparison of Condensation Particle Counters

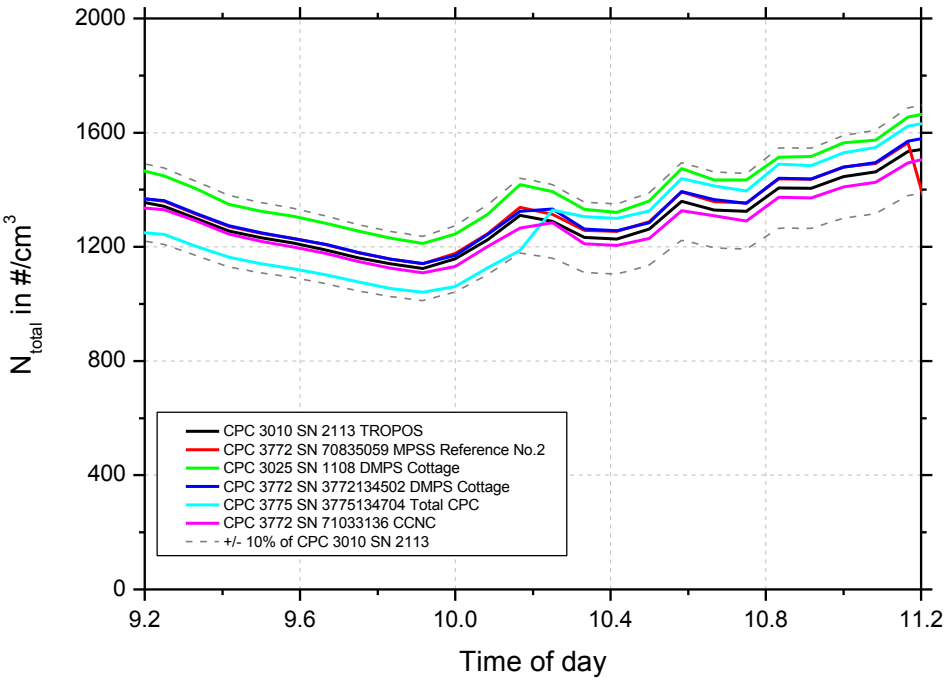


Figure 11: Time series (May 25, 2016 9:15 am – May 25, 2016 11:15 am) of total number concentration (N_{total}) for 6 Condensation Particle Counters.

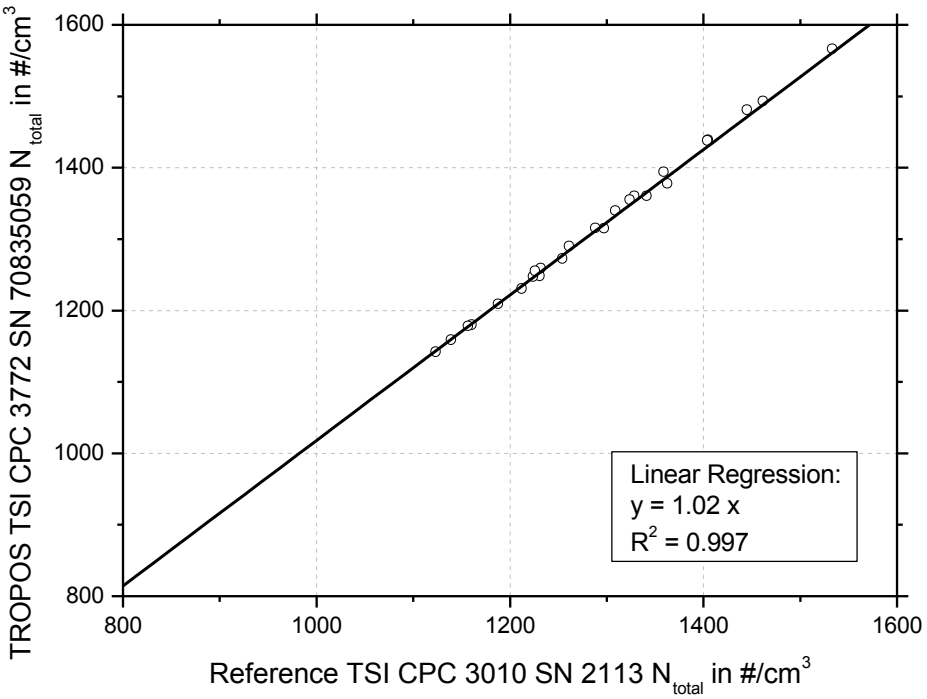


Figure 12: Linear regression between the number concentrations of the Reference TSI CPC 3010 SN 2113 and TROPOS TSI CPC 3772 SN 70835059. CPC flow corrections are included.

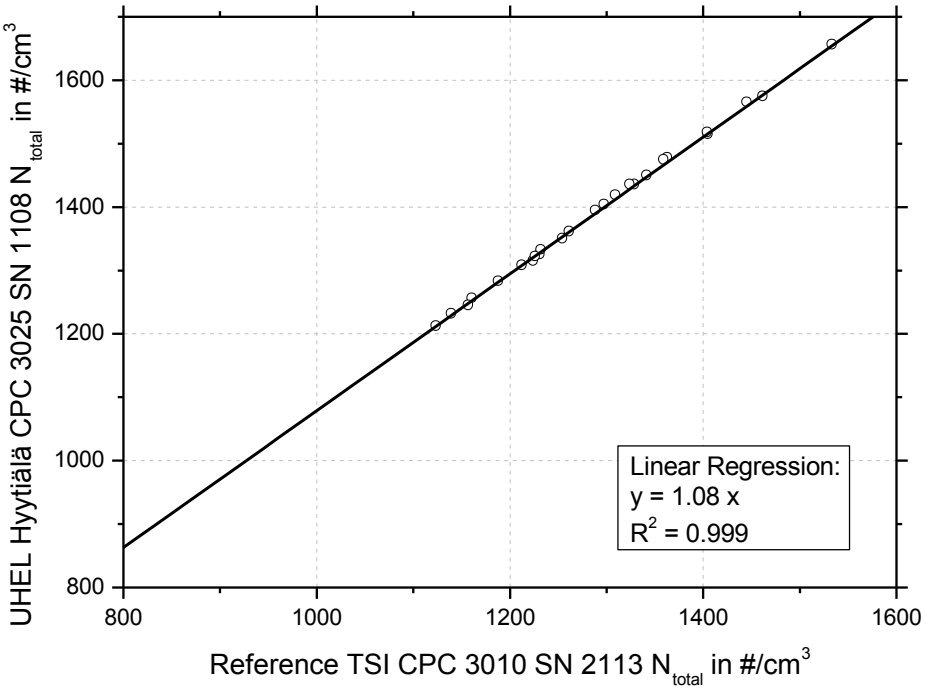


Figure 13: Linear regression between the number concentrations of the Reference TSI CPC 3010 SN 2113 and UHEL Hyytiälä CPC 3025 SN 1108. CPC flow corrections are included.

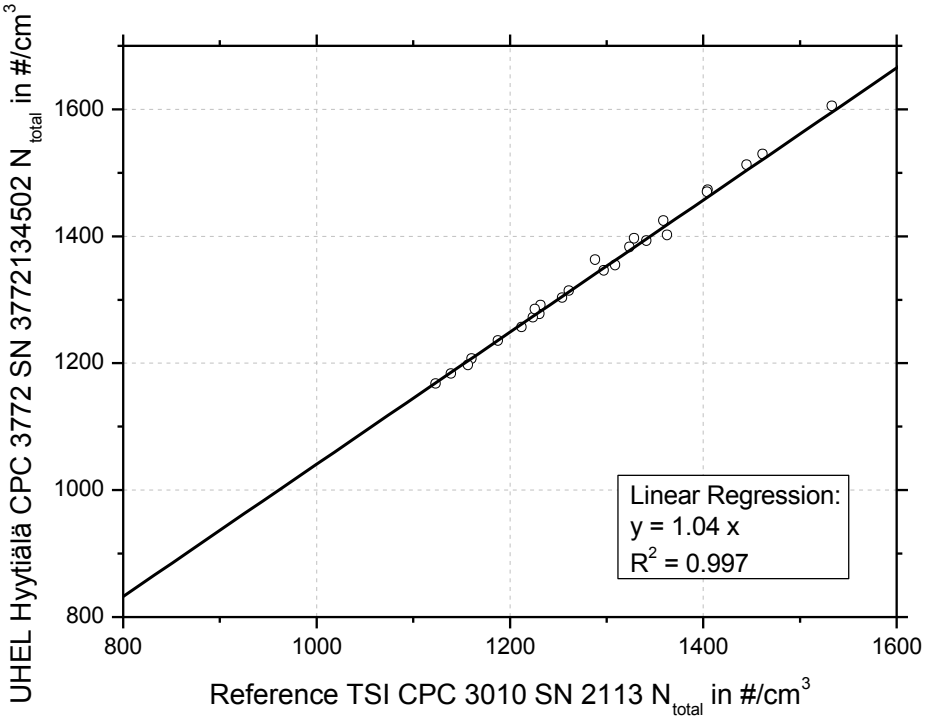


Figure 14: Linear regression between the number concentrations of the Reference TSI CPC 3010 SN 2113 and UHEL Hyytiälä CPC 3772 SN 3772134502. CPC flow corrections are included.

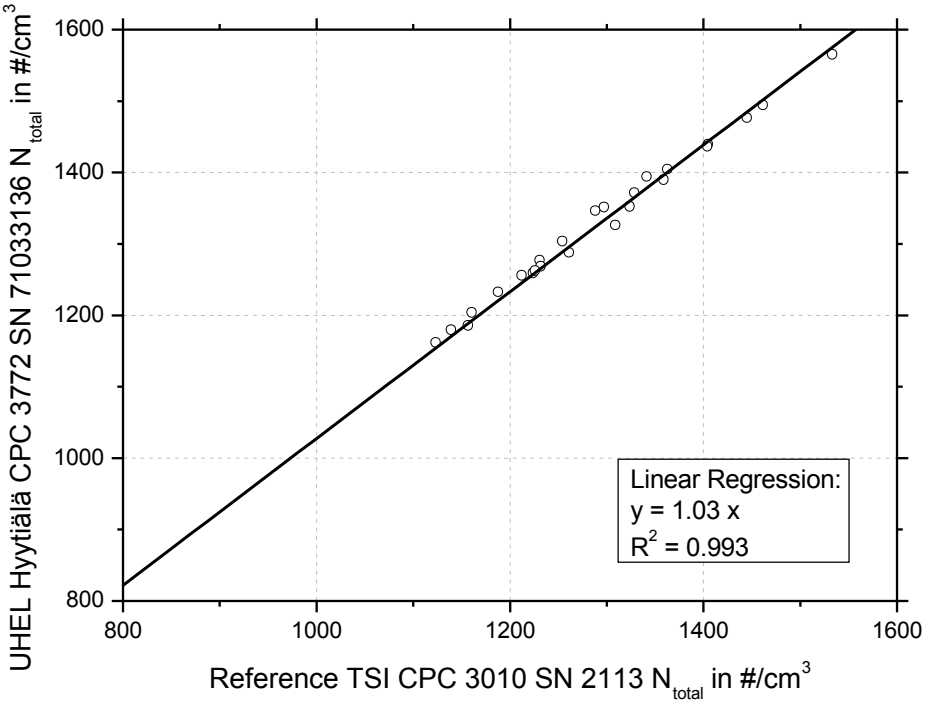


Figure 15: Linear regression between the number concentrations of the Reference TSI CPC 3010 SN 2113 and UHEL Hyytiälä CPC 3772 SN 71033136. CPC flow corrections are included.

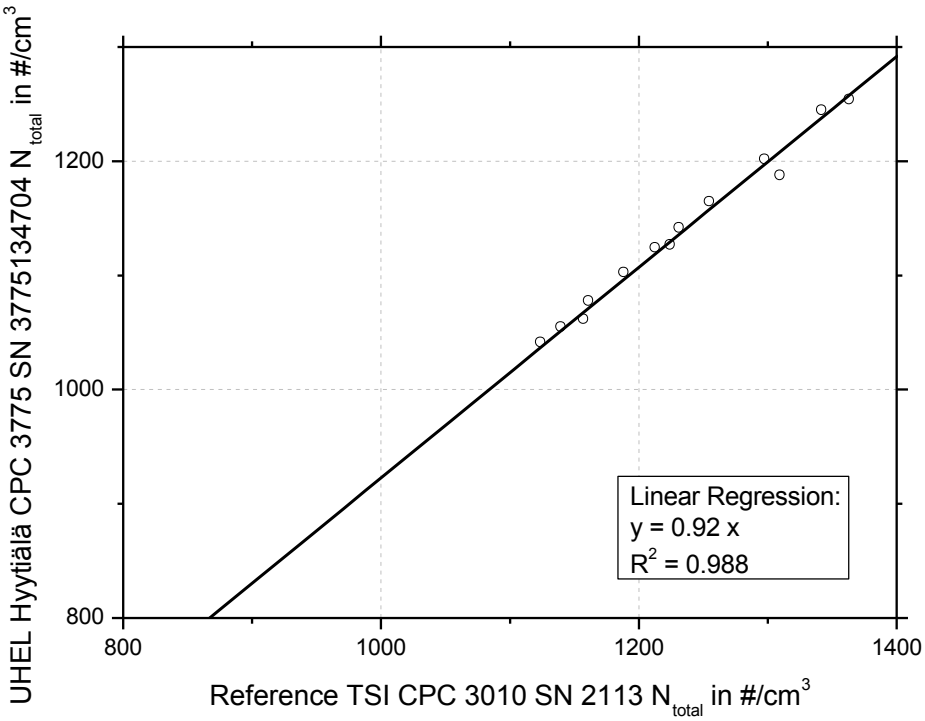


Figure 16: Linear regression between the number concentrations of the Reference TSI CPC 3010 SN 2113 and UHEL Hyytiälä CPC 3775 SN 3775134704, including the diffusion dryer. CPC flow corrections are included.

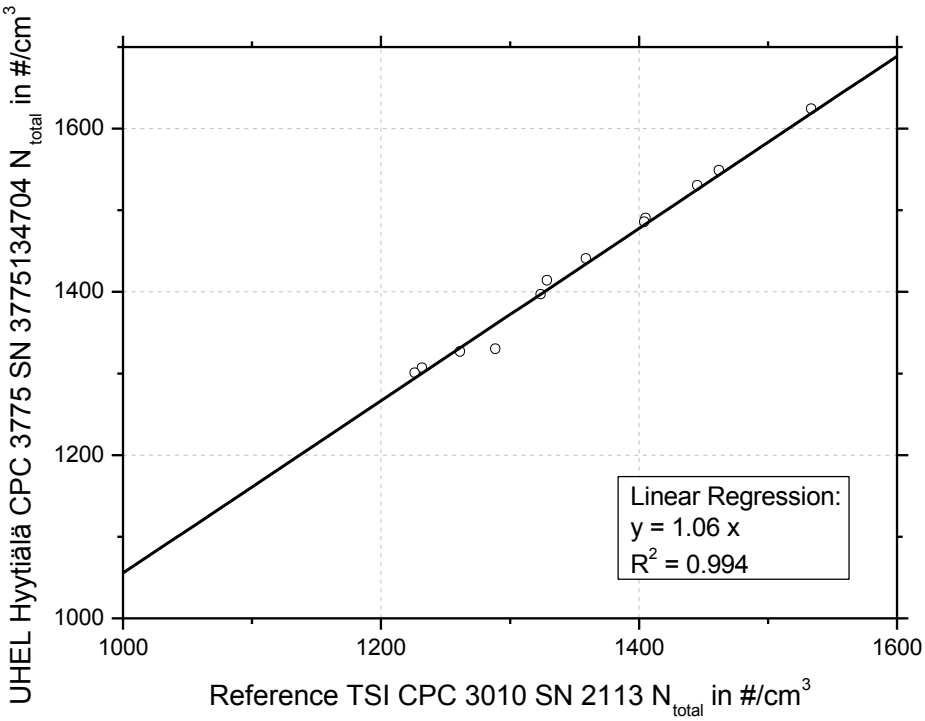


Figure 17: Linear regression between the number concentrations of the Reference TSI CPC 3010 SN 2113 and UHEL Hyytiälä CPC 3775 SN 3775134704, without diffusion dryer. CPC flow corrections are included.