2nd ACTRIS intercomparison workshop for mobility particle size spectrometers and condensation particle counters

ACTRIS partners and associate partner who did not participate with their instrument in the workshop in Sept. Oct. 2013 have been invited for a second workshop from May 12 to 16, 2014.

In the following, the participating ACTRIS partner and associate partner institutes as well as the individual participants are listed. Separate reports for each instrument are given as well.

Participant list

ACTRIS intercomparison workshop: Condensation Particle Counters and Mobility Particle Size Spectrometers		
Participant list ACTRIS WP3 workshop May 12 - May 16, 2014 - TROPOS, Leipzig		
First name	**Family Name**	**Institution**
Nicolas	Bukowiecki	Paul Scherrer Institut (PSI)
Radovan	Krejci	Department of Applied Environmental Science (ITM)
Brendan	Kelly	National University of Ireland, Galway (NUIC)
Francisco Javier	Gomez	Centro de Investigaciones Energéticas, Medioambientales Tecnológicas (CIEMAT)
Angela	Marinoni	Institute of Atmospheric Sciences and Climate (ISAC)
Vidmantas	Ulevicius	Center for Physical Sciences and Technology (KTL)
Nadezda	Zikova	Institute of Chemical Process Fundamentals (ICPF)
Ludwig	Ries	Umwelt Bundesamt (Schneefernerhaus)
Alfred	Wiedensohler	Leibniz Institute for Tropospheric Research (TROPOS)
Kay	Weinhold	Leibniz Institute for Tropospheric Research (TROPOS)
Thomas	Tuch	Leibniz Institute for Tropospheric Research (TROPOS)
Anja	Schmidt	Leibniz Institute for Tropospheric Research (TROPOS)

Intercomparison of TSI SMPS CIEMAT

Basic information

Location of the quality assurance:	TROPOS, lab: 118
Delivery date:	May 12, 2014
Setup in the laboratory:	May 12, 2014
Comparison period:	May 12, 2014 – May 16, 2014
Instrument:	TSI SMPS
TROPOS Reference Instrument:	TROPOS Reference Instrument No. 1 TROPOS Reference Instrument No. 3
Total CPC:	TROPOS Reference CPC No.1; SN: 3772112101 TROPOS Reference CPC No.3; SN: 3772111903
Additional equipment:	
Involved people:	F. J. Gomez-Moreno (fj.gomez@ciemat.es)

Summary of second intercomparison:

From May 12, 2014 to May 16, 2014, the CIEMAT TSI SMPS participated in the TROPOS ACTRIS Workshop. The workshop consisted of an entrance test and a final run. In addition to the overnight ambient measurements, we had numerous high voltage checks, zero- and PSL-measurements. The report is divided into three sections. The first section shows the laboratory setup and the PSL measurement. After that, we show for each run the time series of the particle number concentration, the particle number size distribution, and correlation plots. If anything was written in the log book, so we added this also in this report. As reference standards, we used CPCs model TSI 3772 for total particle number concentration and two TROPOS mobility particle size spectrometer. The particle counters have been calibrated against a calibrated TSI electrometer 3068 B with the serial number 70838596.

For the PSL-calibrations, we used Latex particle with a nominal size of 203 nm +/- 4 nm. The latex particles have been generated with an aerosol nebulizer. The sheath air flow rate of the candidate system was calibrated to match the latex particle size, if possible. The CIEMAT TSI SMPS showed in the PSL-measurements a particle diameter of 202.9 nm. Both the zero check and the high-voltage calibration passed the requirements in the final run. When we look at the time series and particle number size distributions the system showed all the time a lower concentration then the Reference Instrument. Also the TROPOS inversion + diffusion correction can´t solve the problem. In the final run the CIEMAT TSI SMPS is out of the 10%. The CIEMAT TSI SMPS didn´t pass the second ACTRIS Workshop.

Log book:

May 12, 2014

-> Setup of all instruments in laboratory 118

11:00 am -> CPC workshop
- 04:00 pm (local time)

-> High voltage calibration of Ref1 and Ref3

-> Measured flows: CPC 1 : 1.040 l/min
CPC 3 : 1.029 l/min
Ref 1 : 1.018 l/min
Ref 3 : 0.9999 l/min

-> DMA HV source calibration:
The fit gives: y=0.997x + 2.63, R^2=1
This means 0.23% of deviation

-> Zero test, a very good zero

-> Flow rate calibrations: CPC inlet: 300.1 cm3/min, N=6
SMPS inlet (no impactor): 297.4 cm3/min, N=4
Impactor inlet: 284.6, N=6

04:15 pm -> a total zero

05:03 pm -> Latex 203 nm

05:31 pm -> end of latex

05:31 pm -> new zero check

05:34 pm -> stop

05:56 pm -> start ambient aerosol measurement

06:00 pm -> restart system due to a problem with the computer

06:08 pm -> start ambient aerosol measurement

No drier working in the SMPS

May 13, 2014

-> the systems concentration is 50% of the real values

-> check the sheath flow rate to see if there is any leak: with the mass flowmeter in the DMA sheath inlet: 2.90 l/min; in the DMA excess outlet: 2.90 l/min

-> Sampling flow rate (Gilibrator): 284.9 cm^3/min, N=6

-> Latex measurements x2

-> remove the pre-impactor and the driers, flow rate: 301.6, N=5. Change in the tube, now it is 90 cm long.

-> Latex measurements x2, the concentration is similar to ref.3!!

-> the pre-impactor is installed again to see what happens

-> Latex measurements x2, the concentration is similar to previously, the problem is in the drier

-> Zero only the impactor

04:15 pm	-> start ambient aerosol measurement

<u>May 14, 2014</u>

The results from the night are still far from where they should be.

11:00 am	-> change the CPC, we install the PSI CPC, also a 3775. Measure ambient air

Much better results, now the difference is around the 20%

We remove the CPC3775 and install a CPC3772 working at 0.3 l/min, using a T, a valve and a filter, the flow rate through the valve is 0.702 l/min

05:30 pm	-> it is observed that the additional flow rate is not stable. It is 0.747 l/min, It is fitted again to 0.6995 l/min
06:25 pm	-> the flow is not stable, it is oscillating
06:30 pm	-> The T is removed and the SMPS works at 1:10. Measure ambient air

<u>May 15, 2014</u>

-> The computer stopped at 3:50 am so we take the period 6:30 am - 3:45 am.

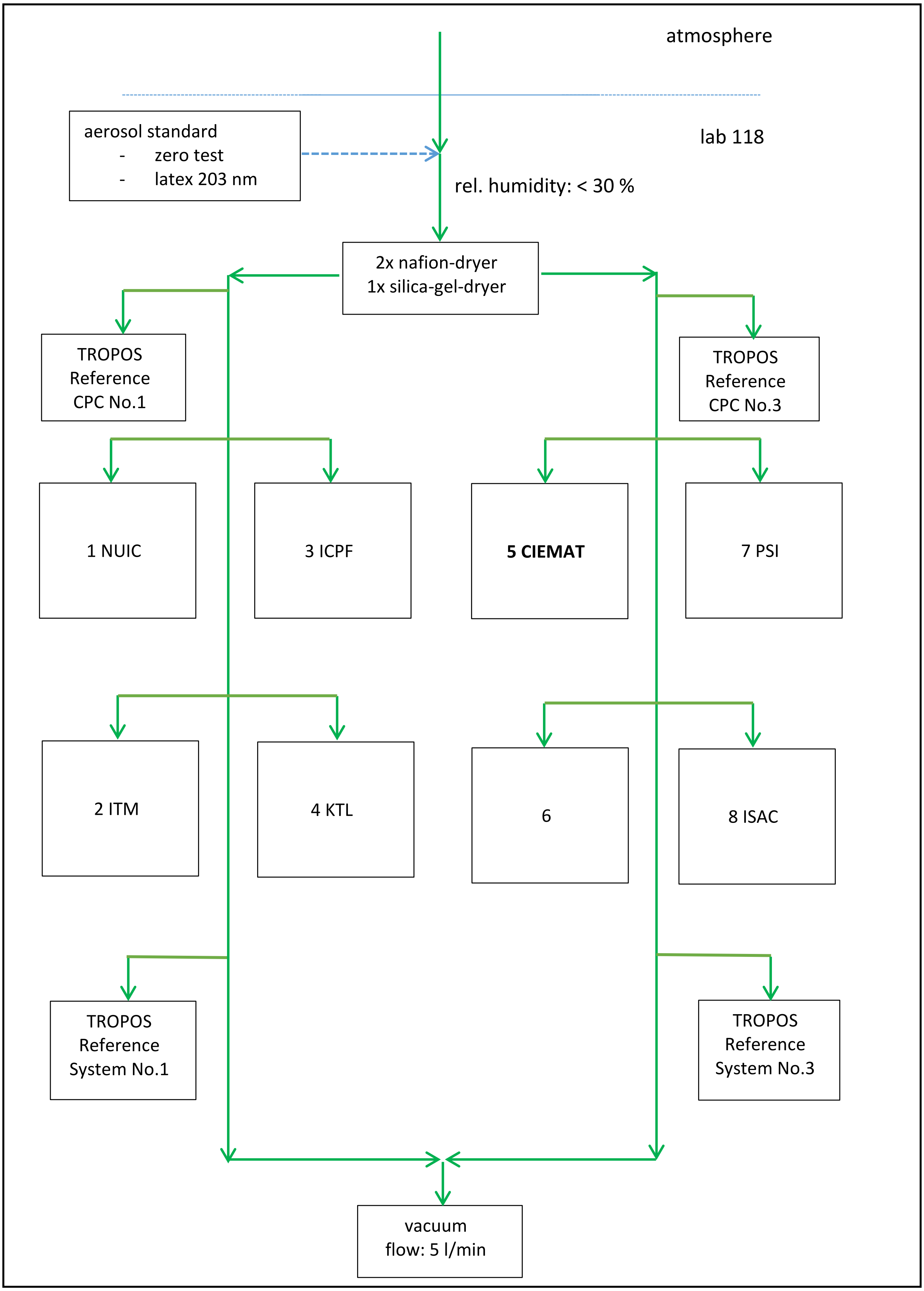
-> The results for that period are similar to measurements from the prior day. The difference, 20%, is similar to the problem that PSI had because of the radioactive source. Possibly, CIEMAT's problem as well?

11:30 am	-> An Am source is installed instead of the Kr-85 one. The CPC3772 is still installed

The results are somewhat better, around 5%, but still far from the right value, 17% less

05:50 pm -> Change the Am source by a Kr-85 one, different to the first one used. We remove the CPC3772 and use our CPC3775. The flow rates used are 0.3:3

Laboratory setup



CPC Efficiency

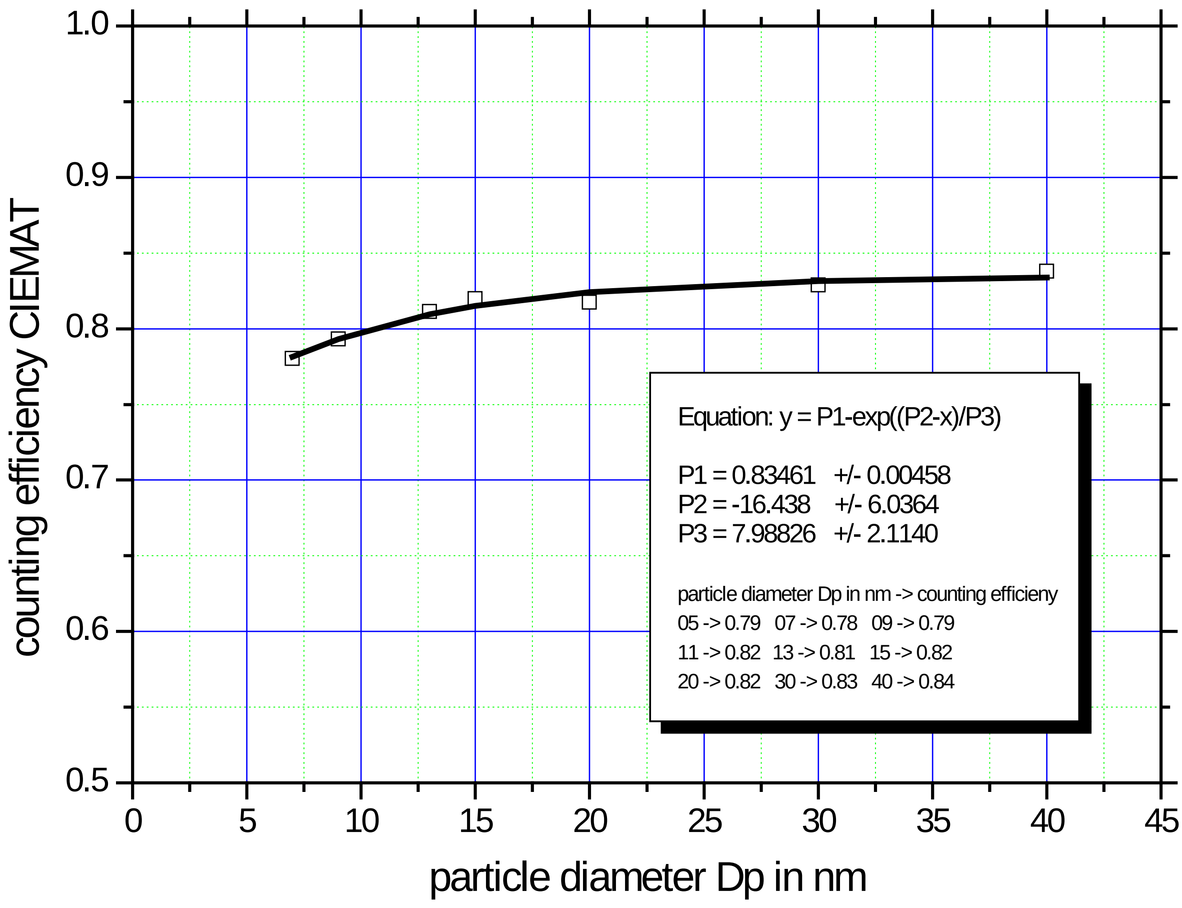


Fig.1. CPC efficiency curve. Based on Electrometer TSI 3068B. Serial number: 70838596

Latex 203 nm

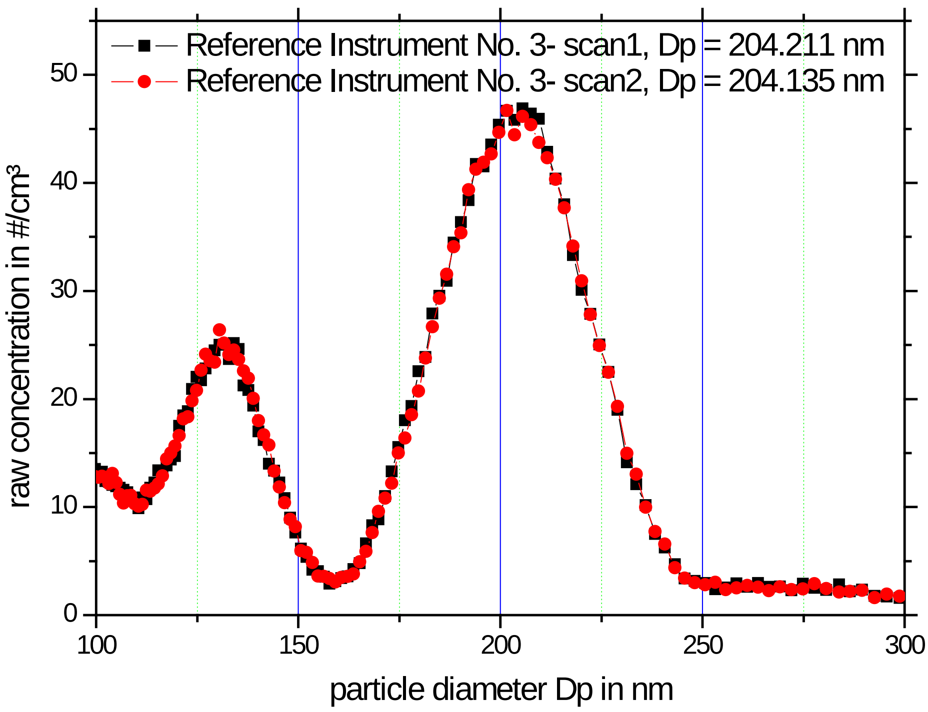


Fig.2. Measurement of latex 203 nm for TROPOS reference instrument No.3: Particle size distribution (raw concentration) for latex 203 nm on May 12, 2014 between 05:10 pm and 05:25 pm.

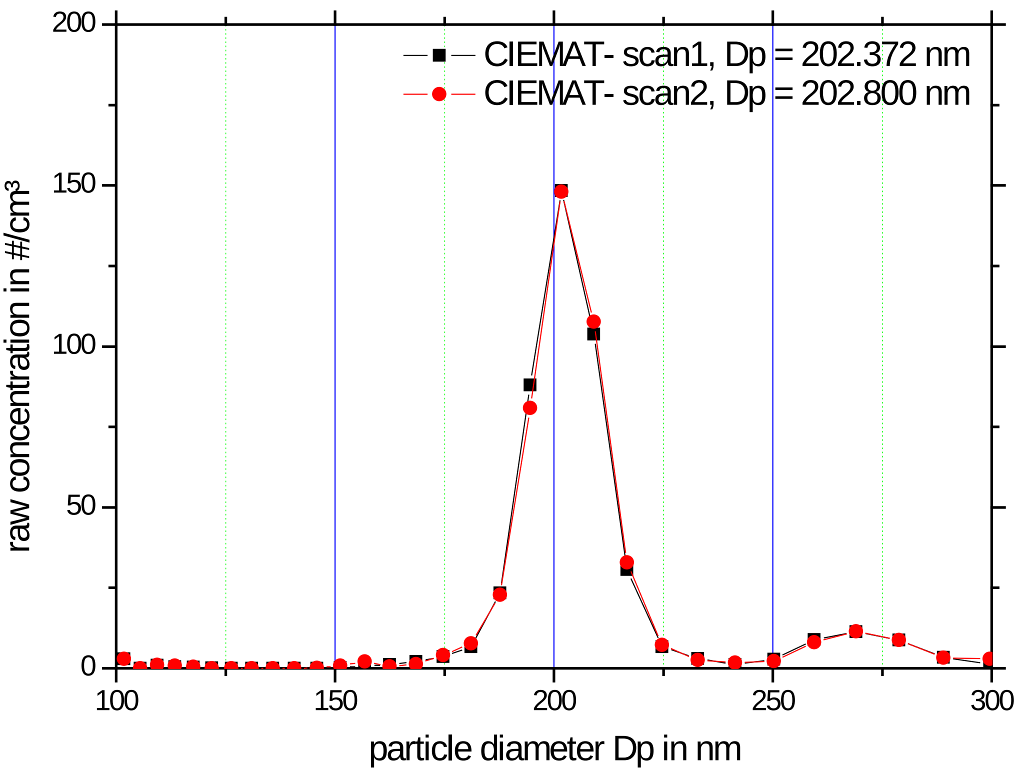


Fig.3. Measurement of latex 203 nm for instrument SMPS CIEMAT: particle size distribution (raw concentration) for latex 203 nm on May 12, 2014 between 05:03 pm and 05:31 pm.

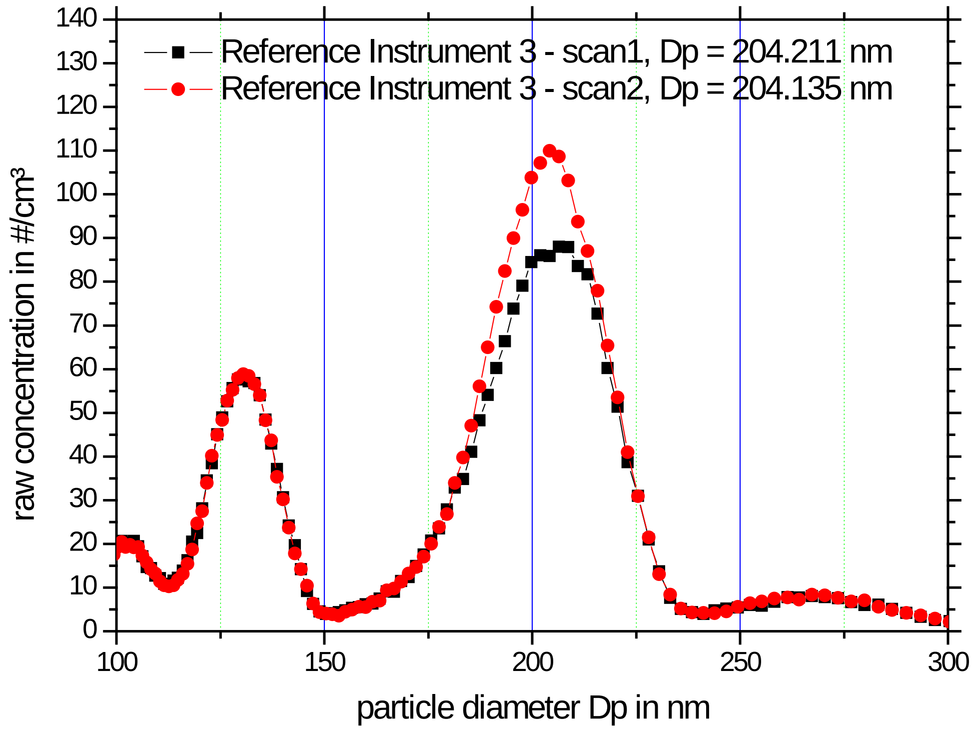


Fig.4. Measurement of latex 203 nm for TROPOS reference instrument No.3: Particle size distribution (raw concentration) for latex 203 nm on May 13, 2014 between 03:15 pm and 03:55 pm.

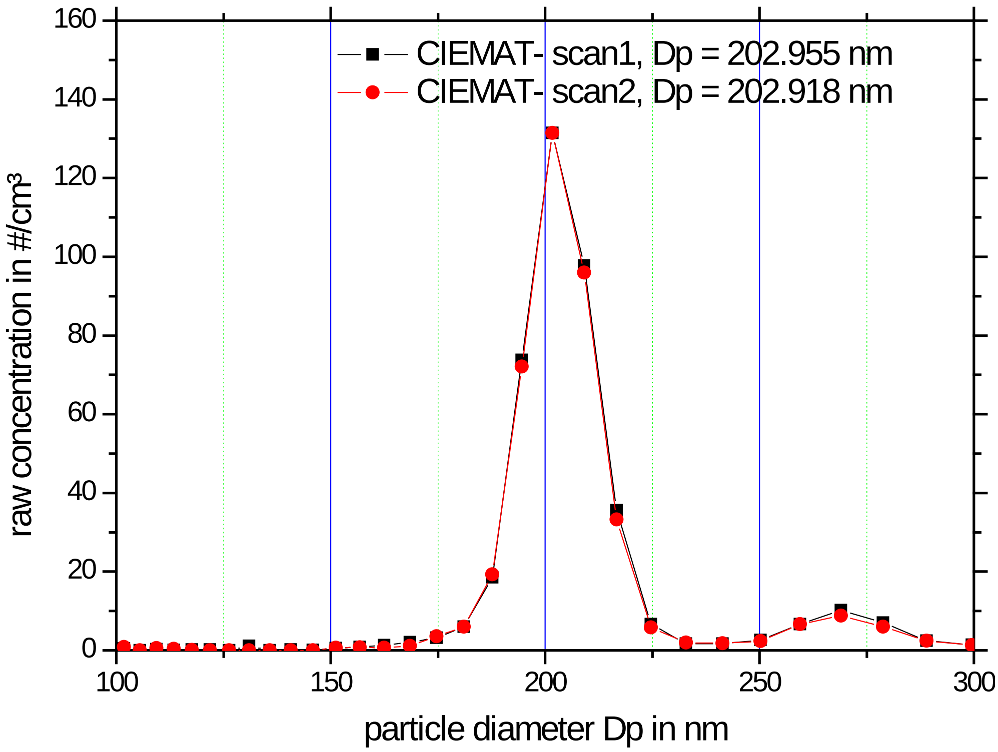


Fig.5. Measurement of latex 203 nm for instrument SMPS CIEMAT: particle size distribution (raw concentration) for latex 203 nm on May 13, 2014 between 03:15 pm and 03:55 pm.

A: first run (May 12, 2014 06:00 pm – May 13, 2014 08:00 am)

1. Correlation of reference instruments

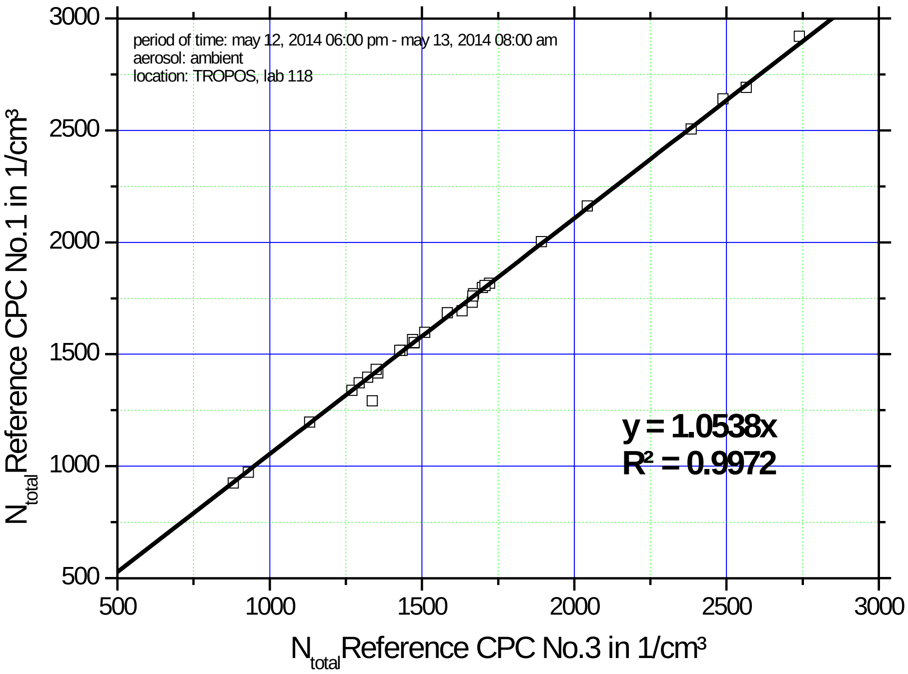


Fig.6. Linear regression between the number concentrations of the TROPOS reference CPC No.1 and the TROPOS reference CPC No.3. Multiple charge correction, internal diffusion losses and flow corrections are included.

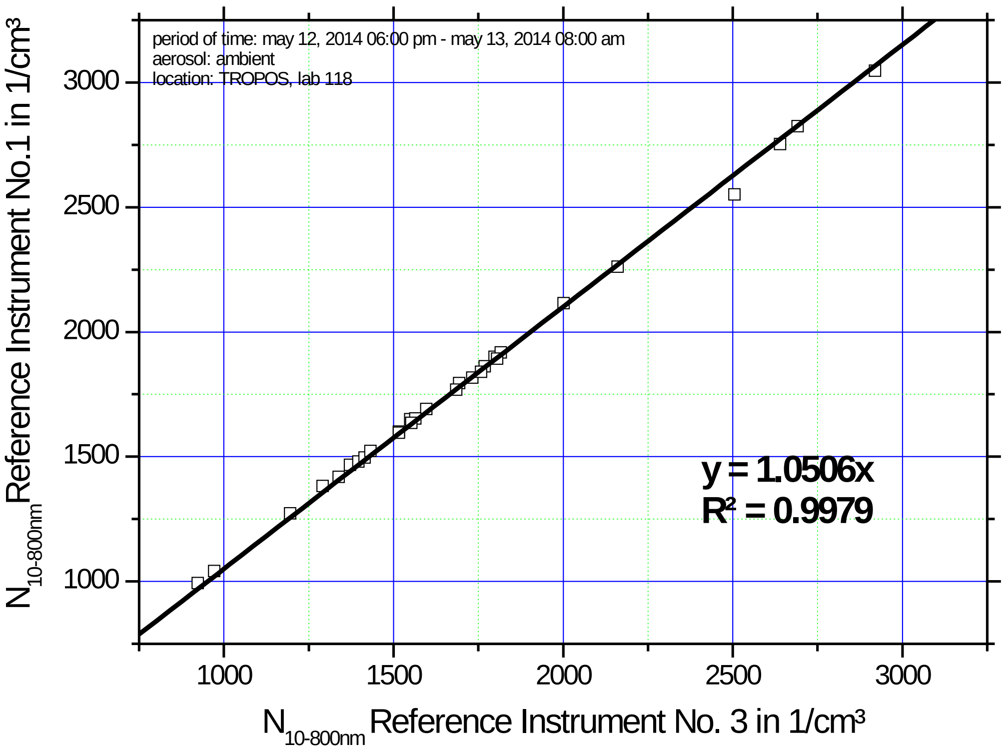


Fig.7. Linear regression between the number concentrations of the TROPOS reference instrument No.1 and the TROPOS reference instrument No.3. Multiple charge correction, internal diffusion losses and flow corrections are included.

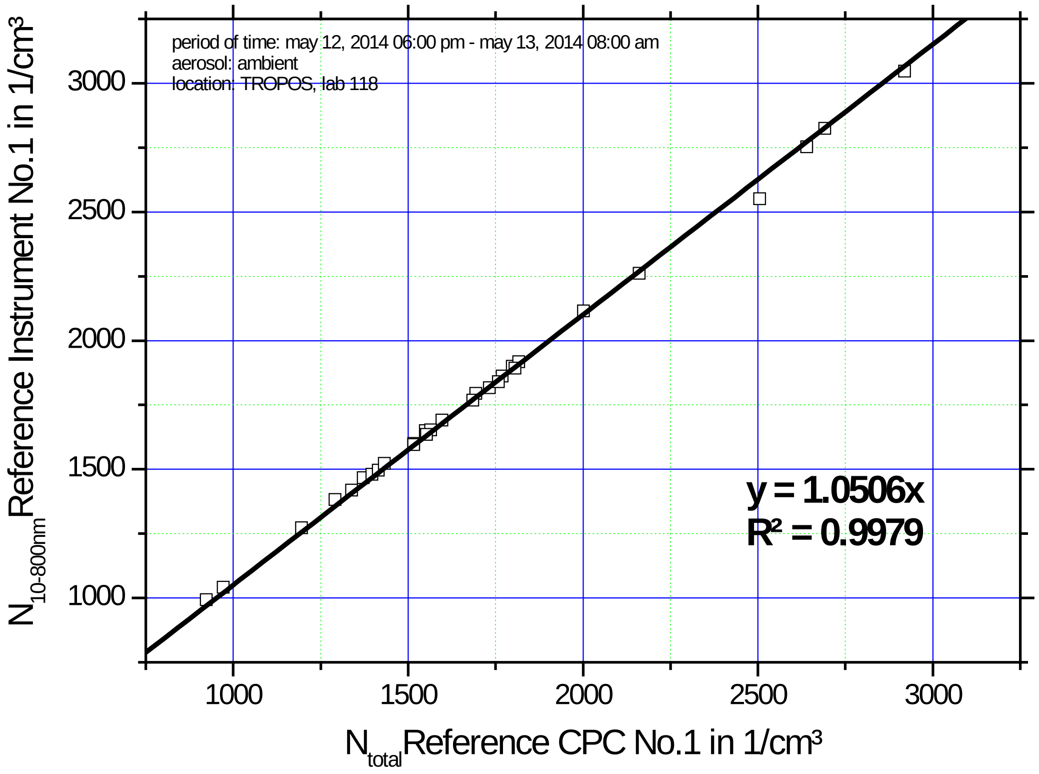


Fig.8. Linear regression between the number concentrations of the TROPOS reference instrument No.1 and TROPOS reference CPC No.1. Multiple charge correction, internal diffusion losses and flow corrections are included.

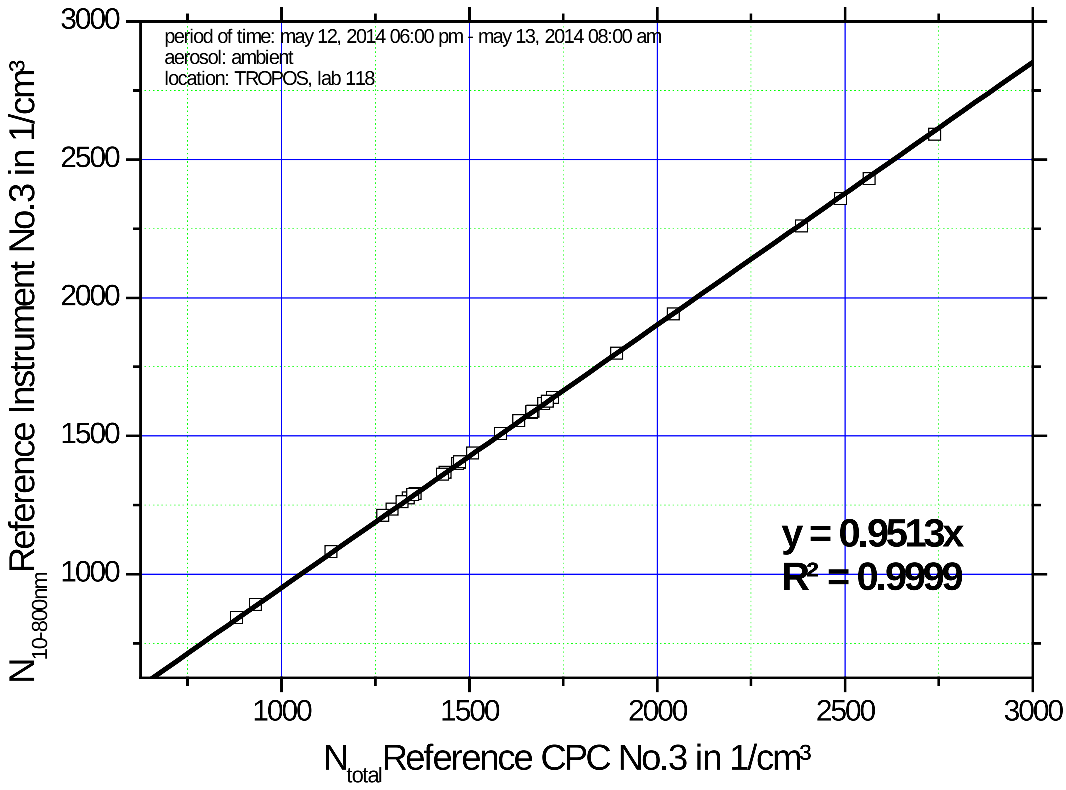


Fig.9. Linear regression between the number concentrations of the TROPOS reference instrument No.3 and TROPOS reference CPC No.3. Multiple charge correction, internal diffusion losses and flow corrections are included.

2. Time series

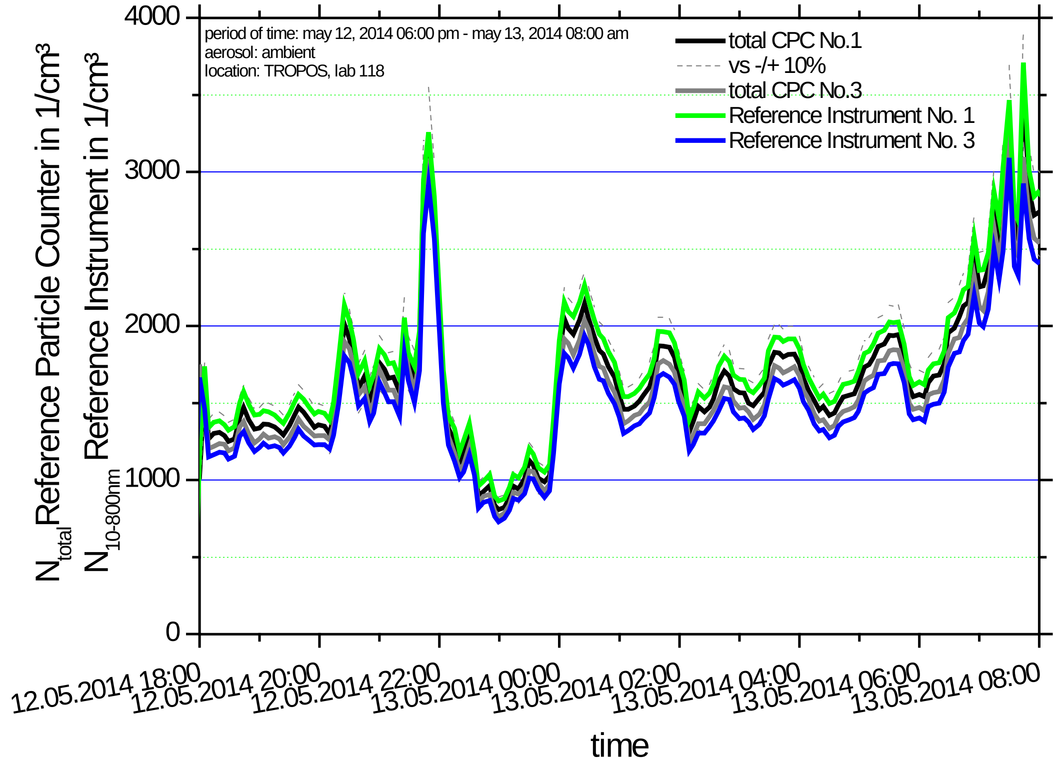


Fig.10. Time series (May 12, 2014 06:00 pm – May 13, 2014 08:00 am) of the integrated particle number concentration (N 10-800nm). Multiple charge correction, internal diffusion losses and flow corrections are included.

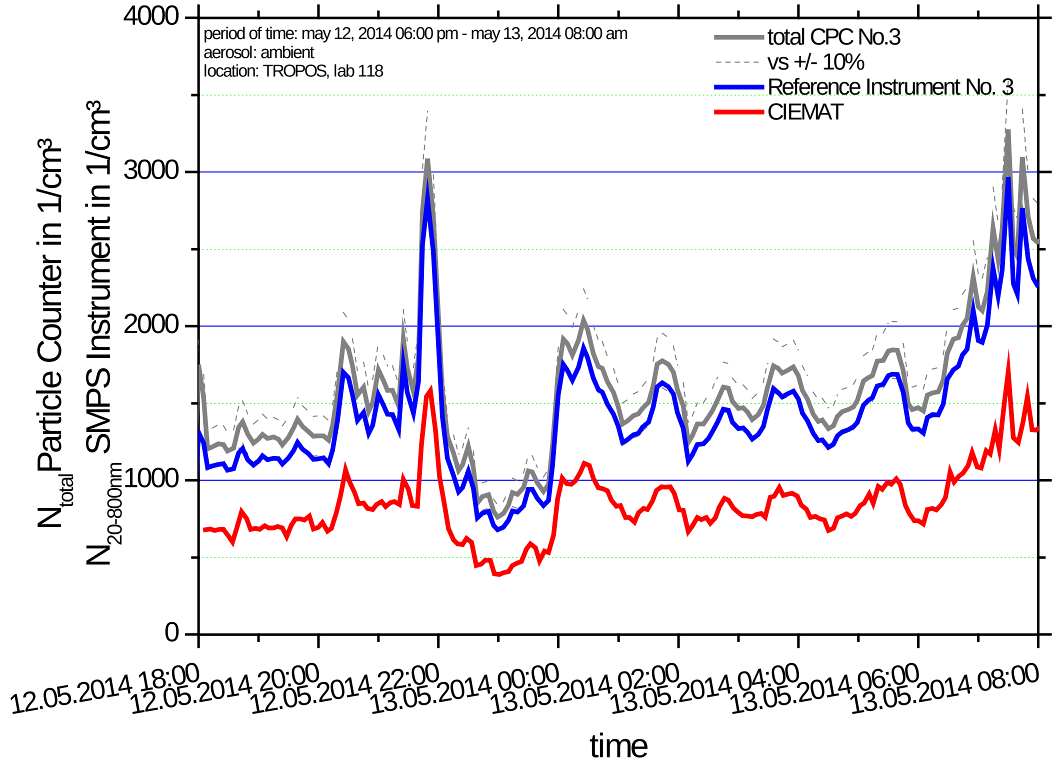


Fig.11. Time series (May 12, 2014 06:00 pm – May 13, 2014 08:00 am) of the integrated particle number concentration (N 20-800 nm) of SMPS CIEMAT and TROPOS reference instrument No.3. Multiple charge correction and internal diffusion losses are included.

3. Correlation of SMPS CIEMAT

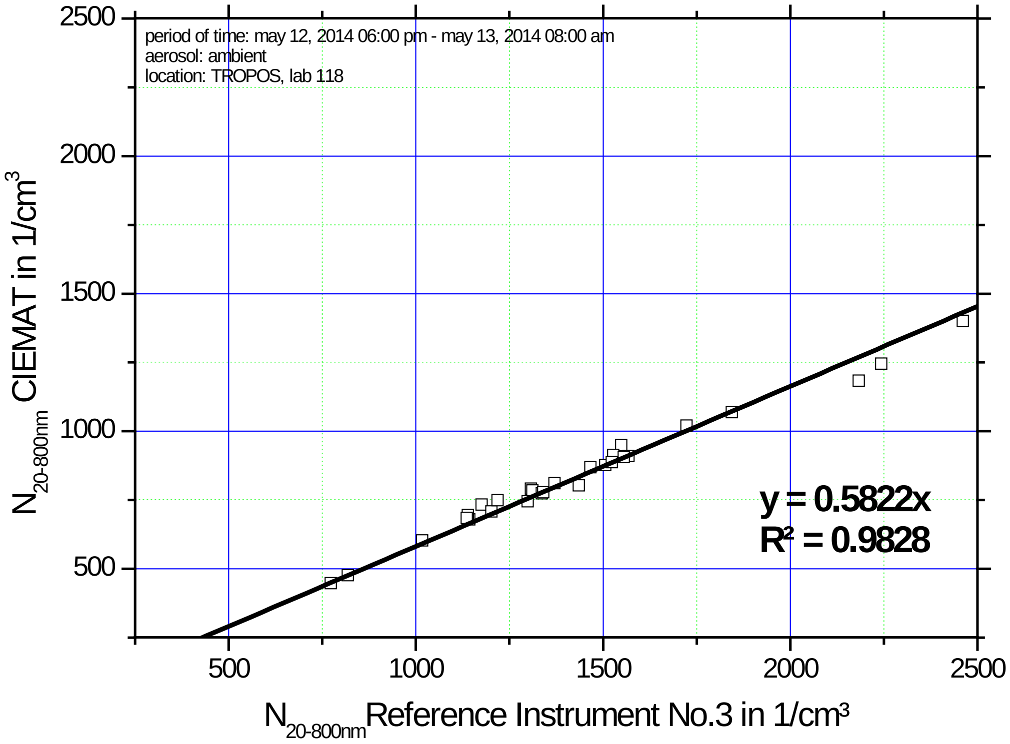


Fig.12. Linear regression between the number concentrations of the TROPOS reference instrument No.3 and SMPS CIEMAT. Multiple charge correction and internal diffusion losses are included.

4. Size distribution

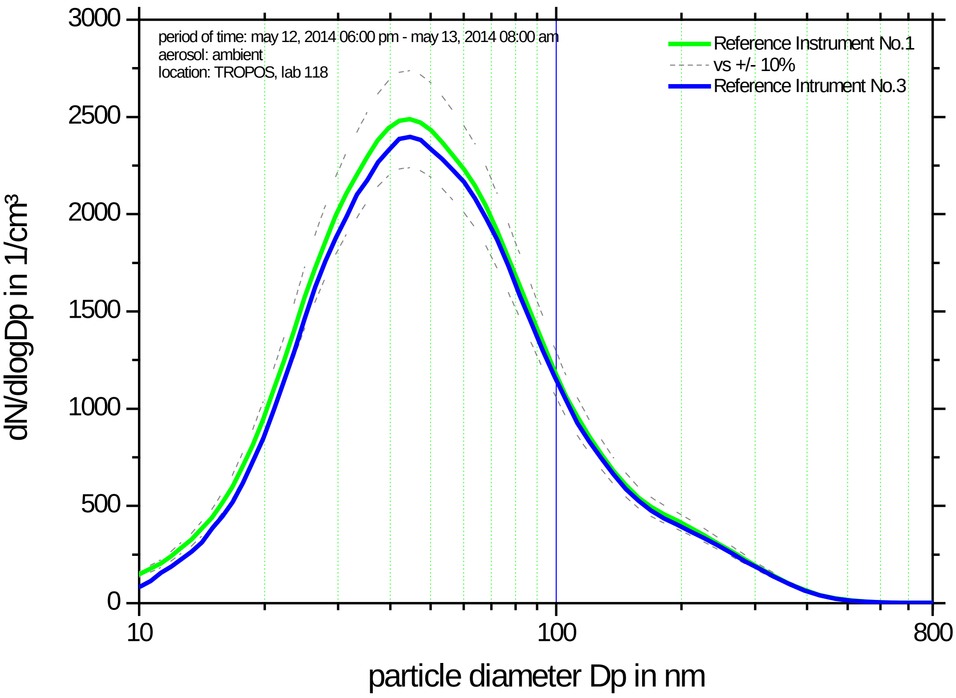


Fig.13. Comparison of mean particle number size distribution of the reference instruments between May 12, 2014 06:00 pm and May 13, 2014 08:00 am. Multiple charge correction, internal diffusion losses and CPC efficiency are included (.in2).

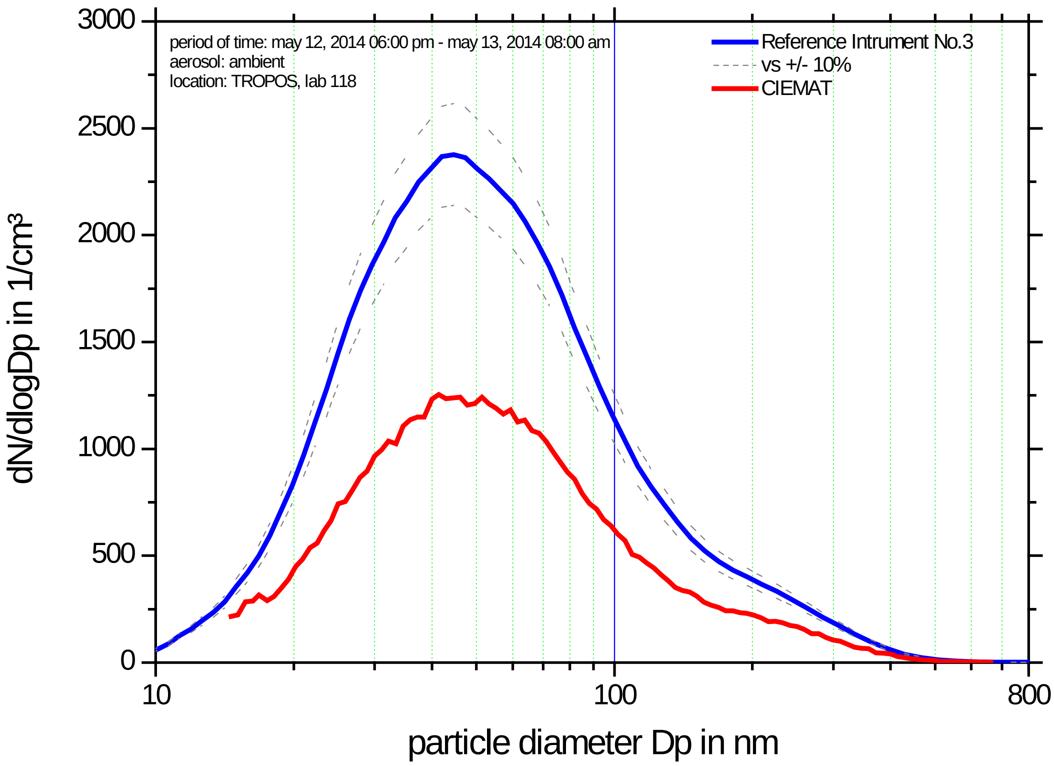


Fig.14. Comparison of mean particle number size distribution of SMPS CIEMAT and TROPOS reference instrument No.3 between May 12, 2014 06:00 pm and May 13, 2014 08:00 am. Multiple charge correction and internal diffusion losses are included (.in1).

B: second run (May 13, 2014 05:00 pm – May 14, 2014 07:00 am)

1. Correlation of reference instruments

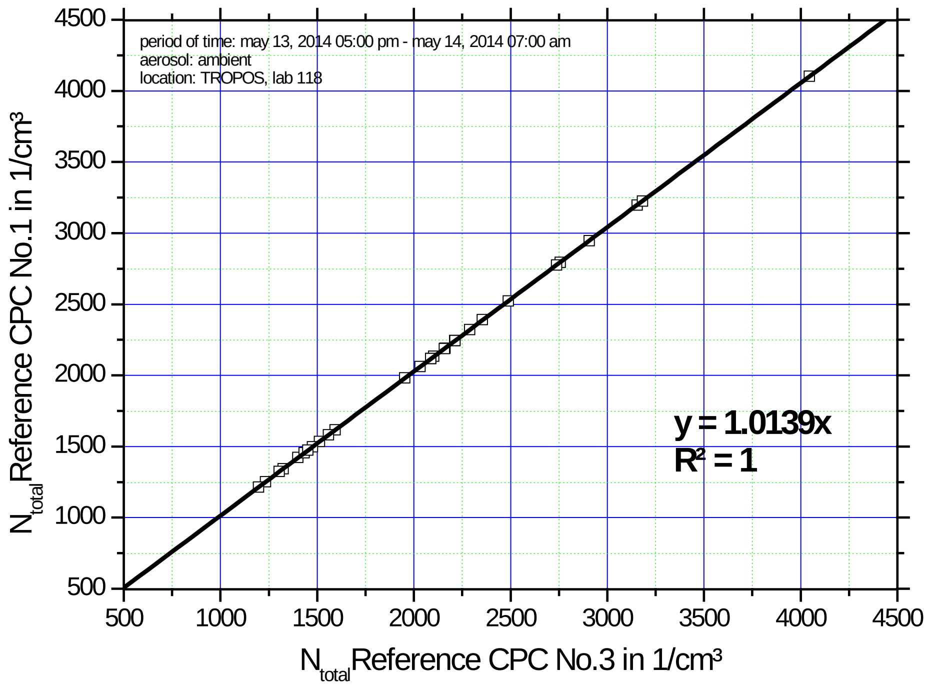


Fig.15. Linear regression between the number concentrations of the TROPOS reference CPC No.1 and the TROPOS reference CPC No.3. Multiple charge correction, internal diffusion losses and flow corrections are included.

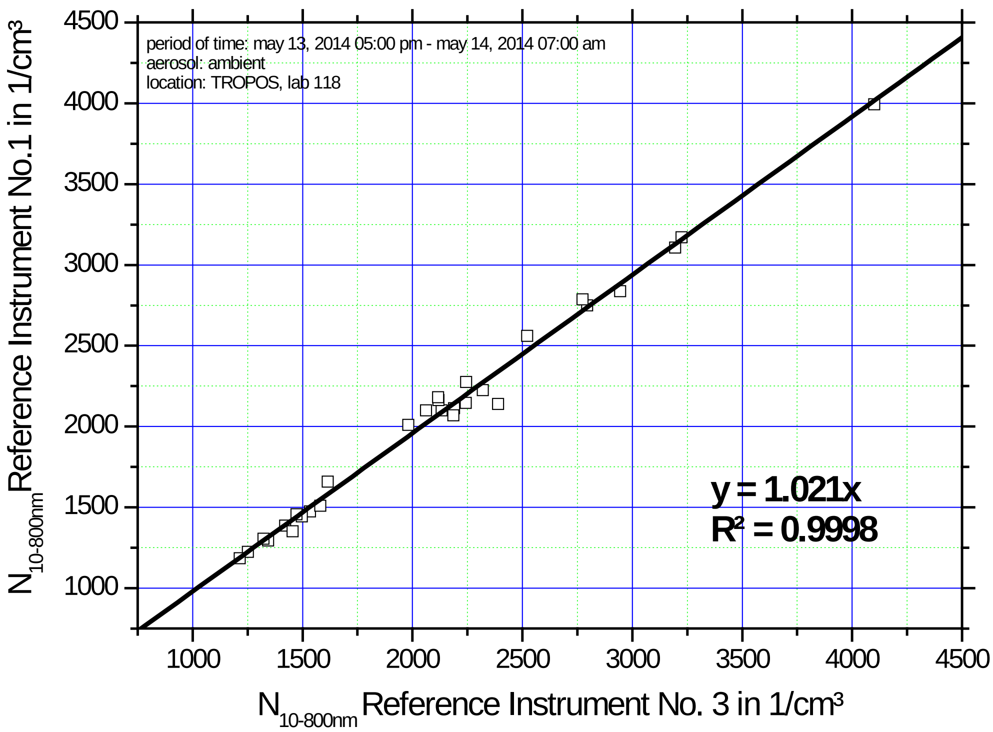


Fig.16. Linear regression between the number concentrations of the TROPOS reference instrument No. 1 and the TROPOS reference instrument No. 3. Multiple charge correction, internal diffusion losses and flow corrections are included.

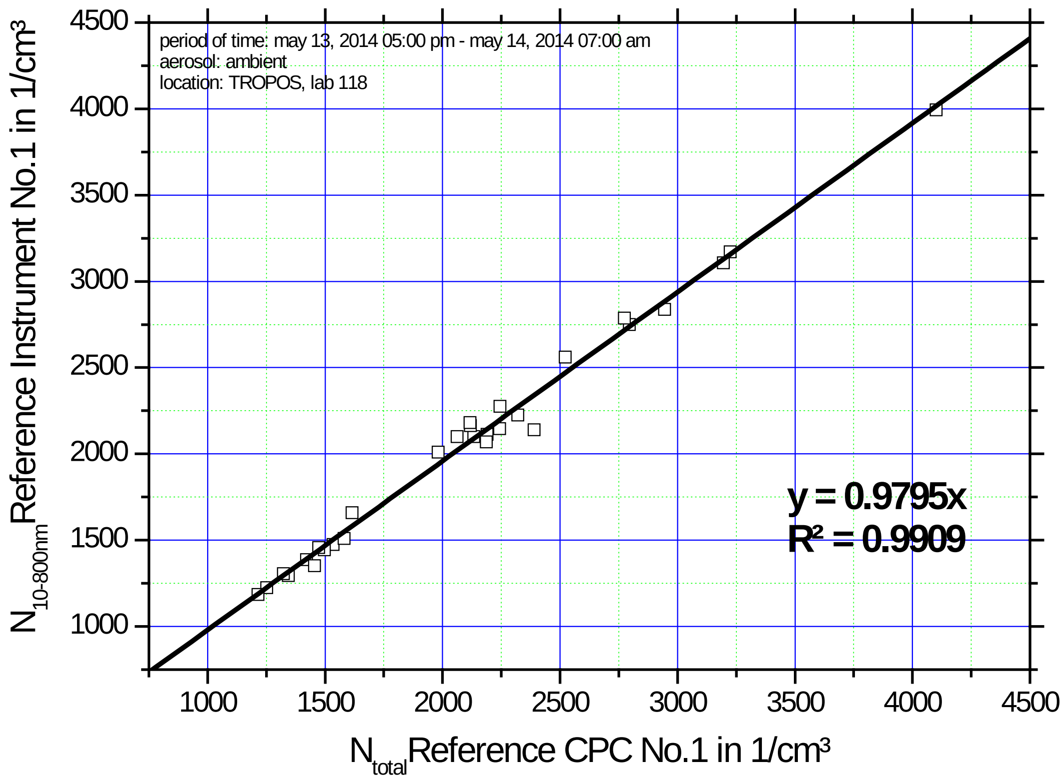


Fig.17. Linear regression between the number concentrations of the TROPOS reference instrument No. 1 and TROPOS reference CPC No.1. Multiple charge correction, internal diffusion losses and flow corrections are included.

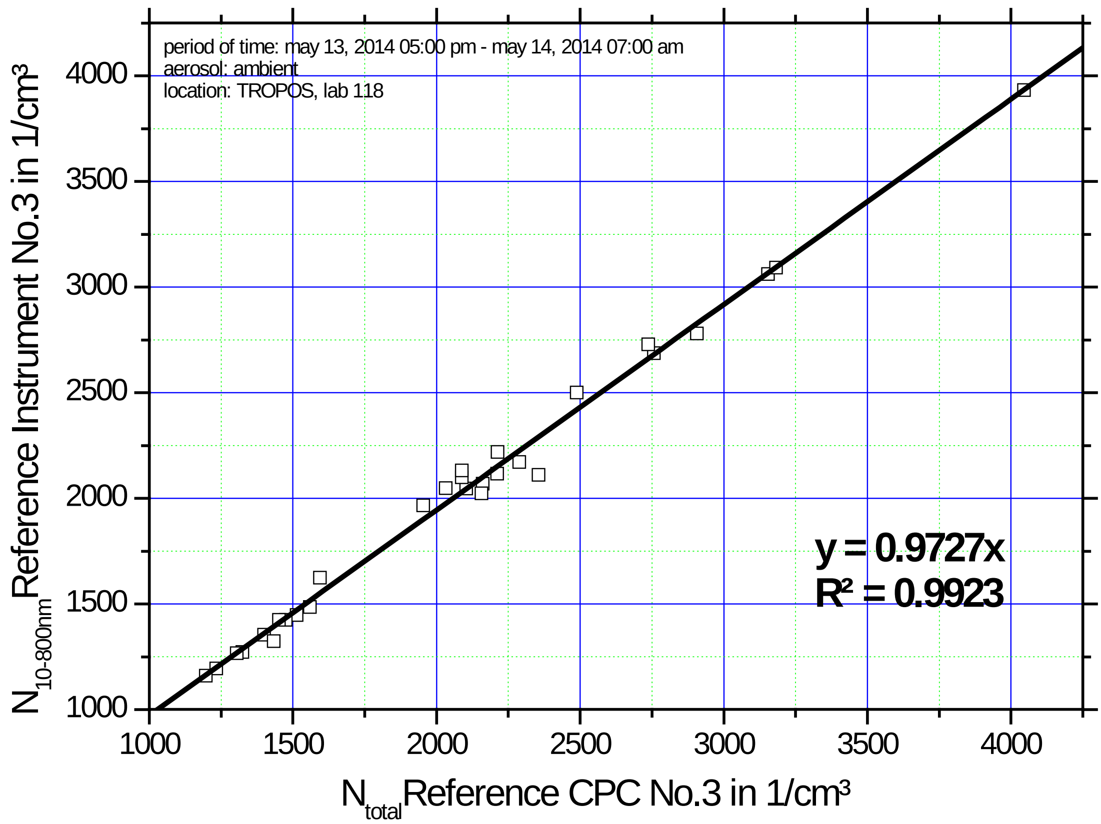


Fig.18. Linear regression between the number concentrations of the TROPOS reference instrument No. 3 and TROPOS reference CPC No.3. Multiple charge correction, internal diffusion losses and flow corrections are included.

2. Time series

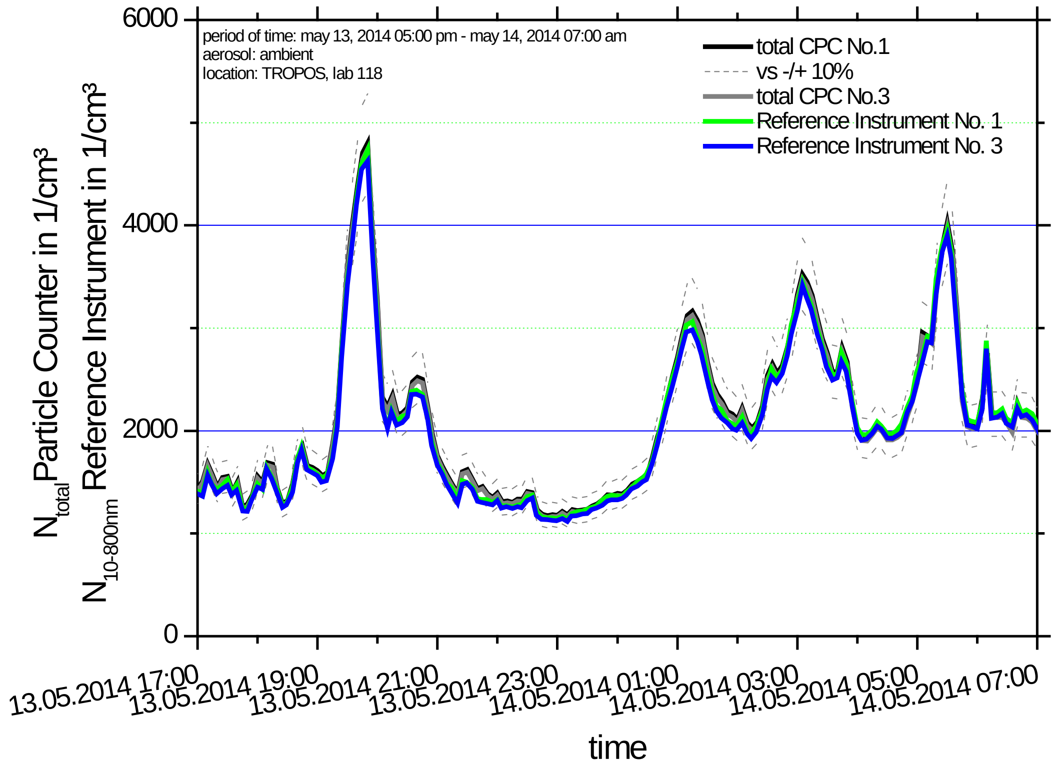


Fig.19. Time series (May 13, 2014 05:00 pm – May 14, 2014 07:00 am) of the integrated particle number concentration (N 10-800nm). Multiple charge correction, internal diffusion losses and flow corrections are included.

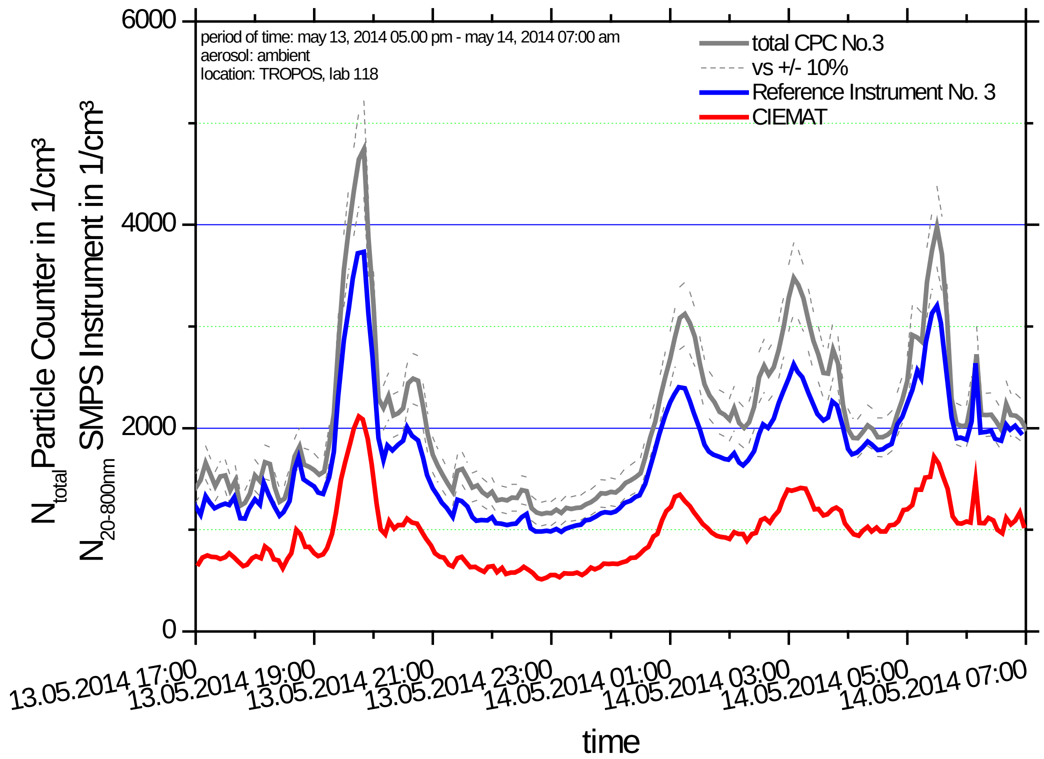


Fig.20. Time series (May 13, 2014 05:00 pm – May 14, 2014 07:00 am) of the integrated particle number concentration (N 20-800nm) of SMPS CIEMAT and TROPOS reference instrument No.3. Multiple charge correction and internal diffusion losses are included.

3. Correlation of SMPS CIEMAT

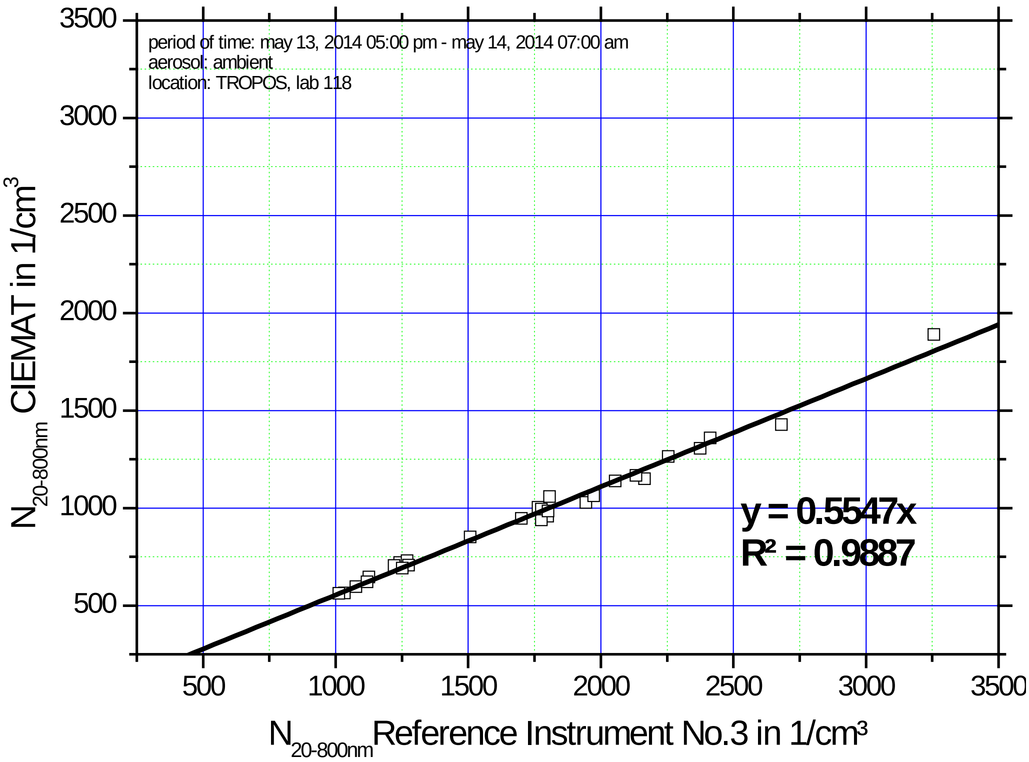


Fig.21. Linear regression between the number concentrations of the TROPOS reference instrument No. 3 and SMPS CIEMAT. Multiple charge correction and internal diffusion losses are included.

4. Size distribution

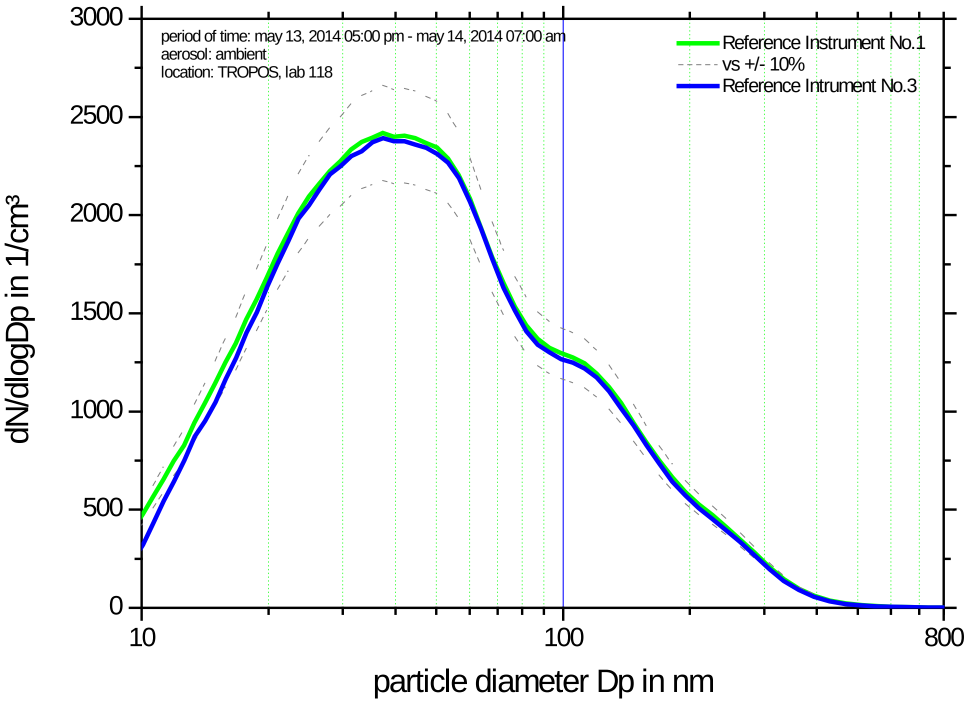


Fig.22. Comparison of mean particle number size distribution between May 13, 2014 05:00 pm and May 14, 2014 07:00 am. Multiple charge correction, internal diffusion losses and CPC efficiency are included (.in2).

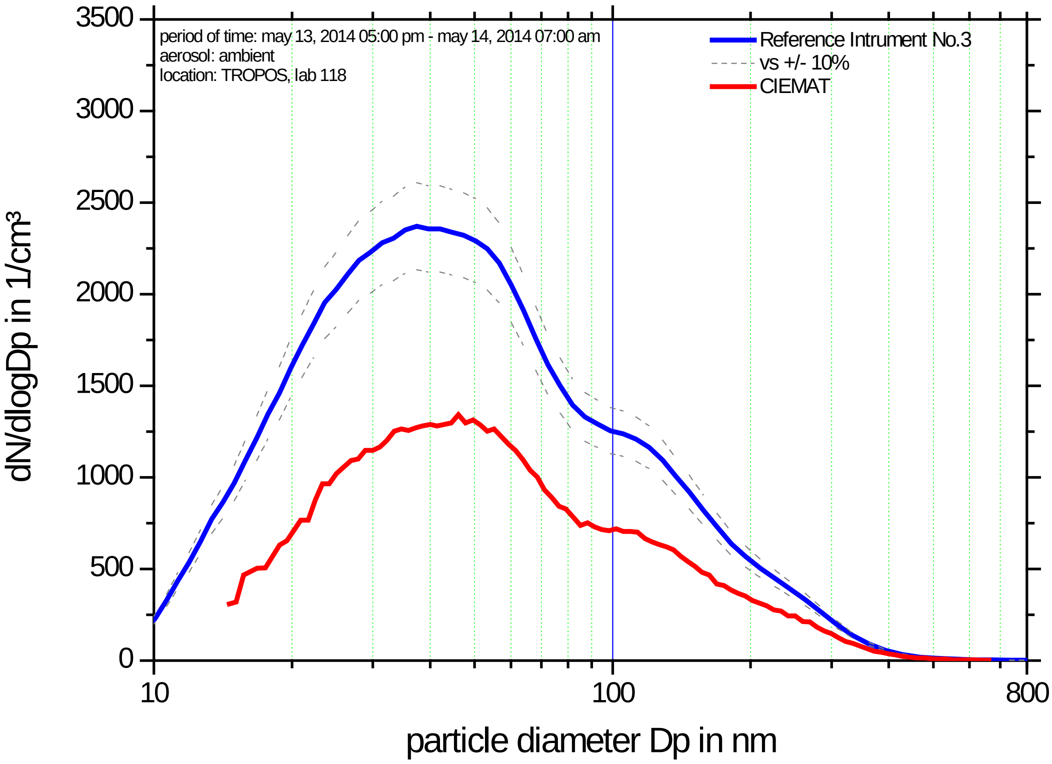


Fig.23. Comparison of mean particle number size distribution of SMPS CIEMAT and TROPOS reference instrument No.3 between May 13, 2014 05:00 pm and May 14, 2014 07:00 am. Multiple charge correction and internal diffusion losses are included (.in1).

C: third run (May 14, 2014 07:00 pm – May 15, 2014 07:00 am)

1. Correlation of reference instruments

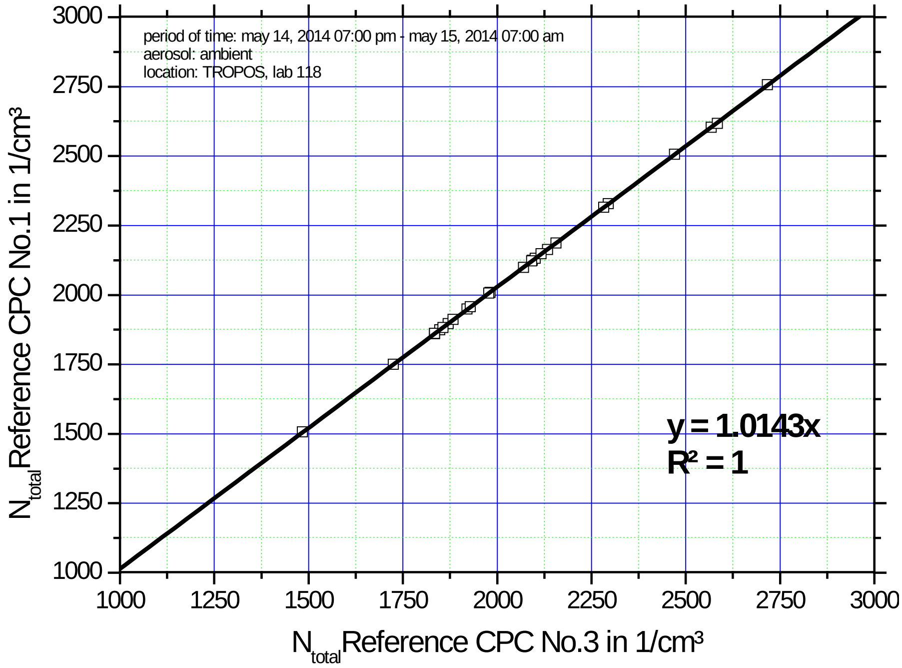


Fig.24. Linear regression between the number concentrations of the TROPOS reference CPC No.1 and the TROPOS reference CPC No.3. Multiple charge correction, internal diffusion losses and flow corrections are included.

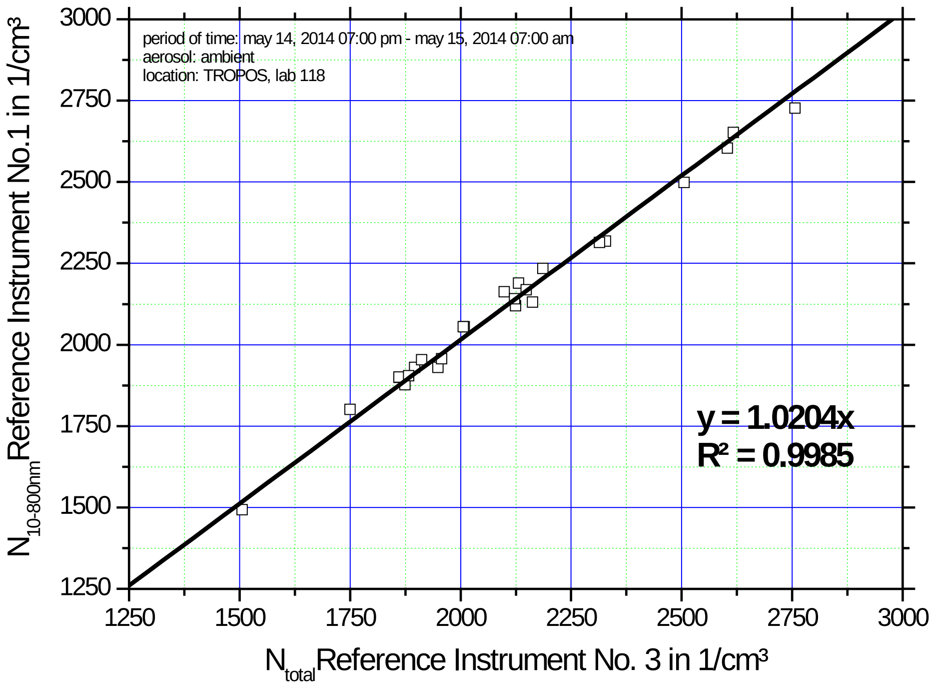


Fig.25. Linear regression between the number concentrations of the TROPOS reference instrument No. 1 and the TROPOS reference instrument No. 3. Multiple charge correction, internal diffusion losses and flow corrections are included.

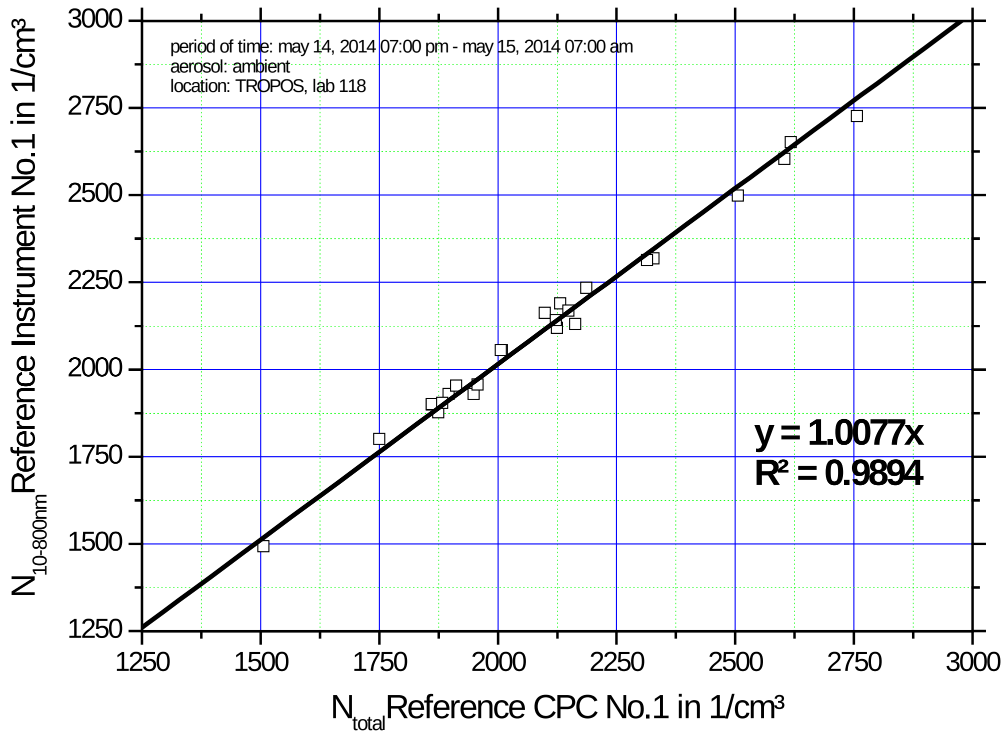


Fig.26. Linear regression between the number concentrations of the TROPOS reference instrument No. 1 and TROPOS reference CPC No.1. Multiple charge correction, internal diffusion losses and flow corrections are included.

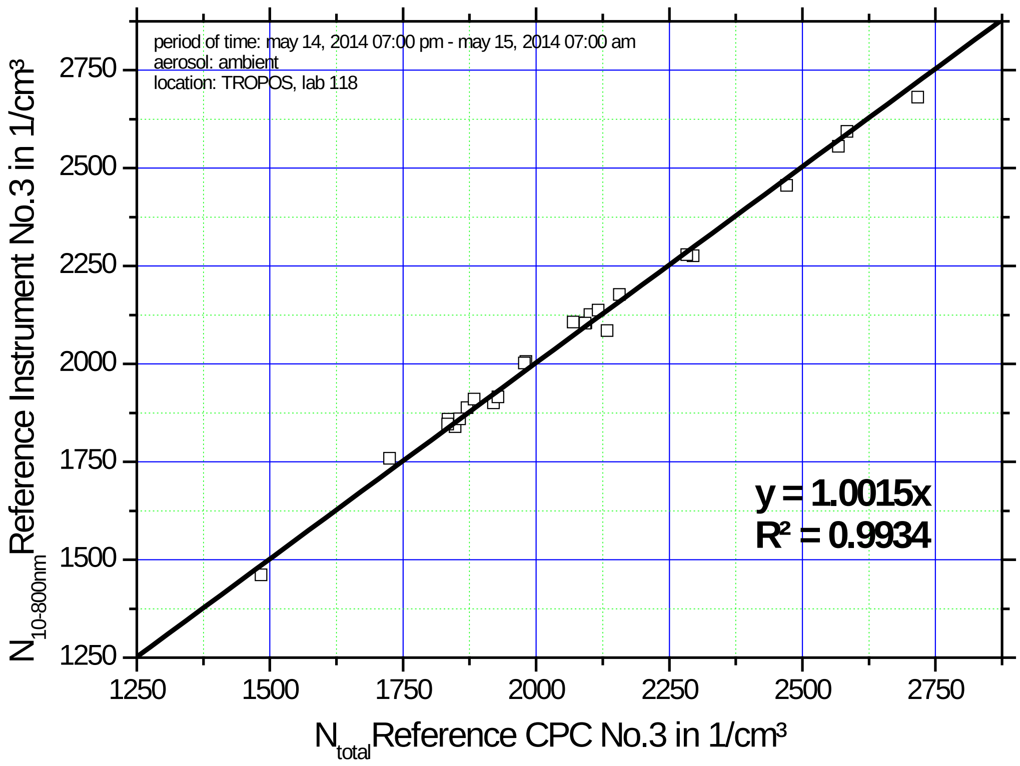


Fig.27. Linear regression between the number concentrations of the TROPOS reference instrument No. 3 and TROPOS reference CPC No.3. Multiple charge correction, internal diffusion losses and flow corrections are included.

2. Time series

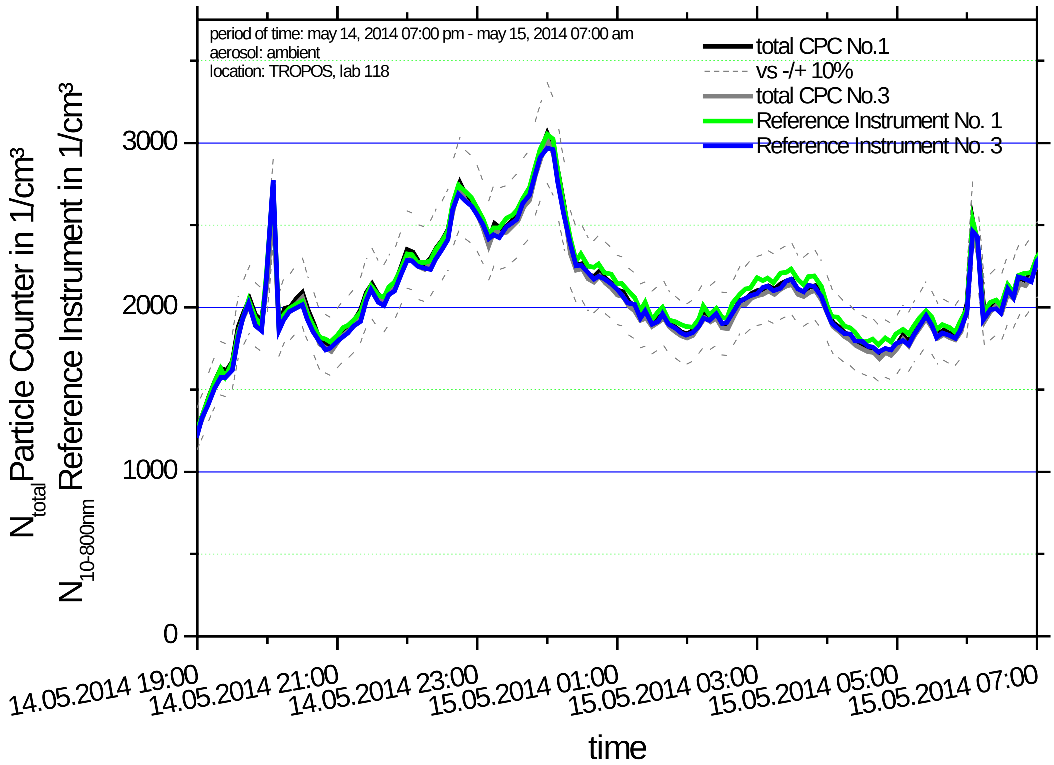


Fig.28. Time series (May 14, 2014 07:00 pm – May 15, 2014 07:00 am) of the integrated particle number concentration (N 10-800nm). Multiple charge correction, internal diffusion losses and flow corrections are included.

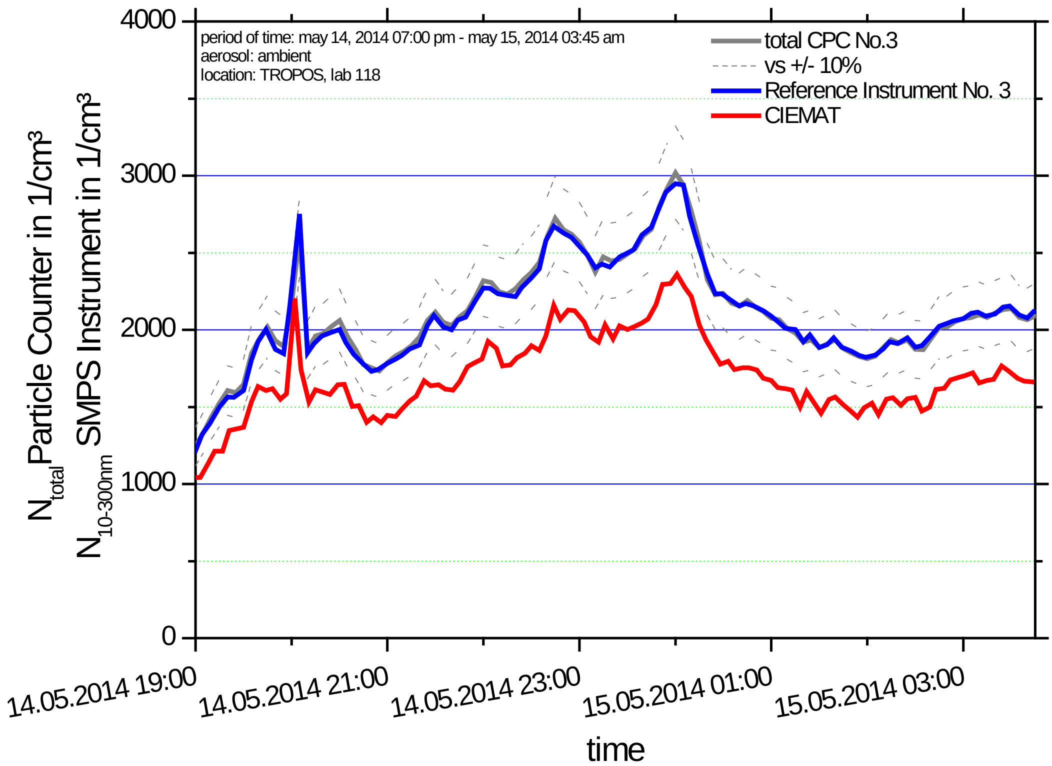


Fig.29. Time series (May 14, 2014 07:00 pm – May 15, 2014 03:45 am) of the integrated particle number concentration (N 10-300nm) of SMPS CIEMAT and TROPOS reference instrument No.3. Multiple charge correction and diffusion losses are included.

3. Correlation of SMPS CIEMAT

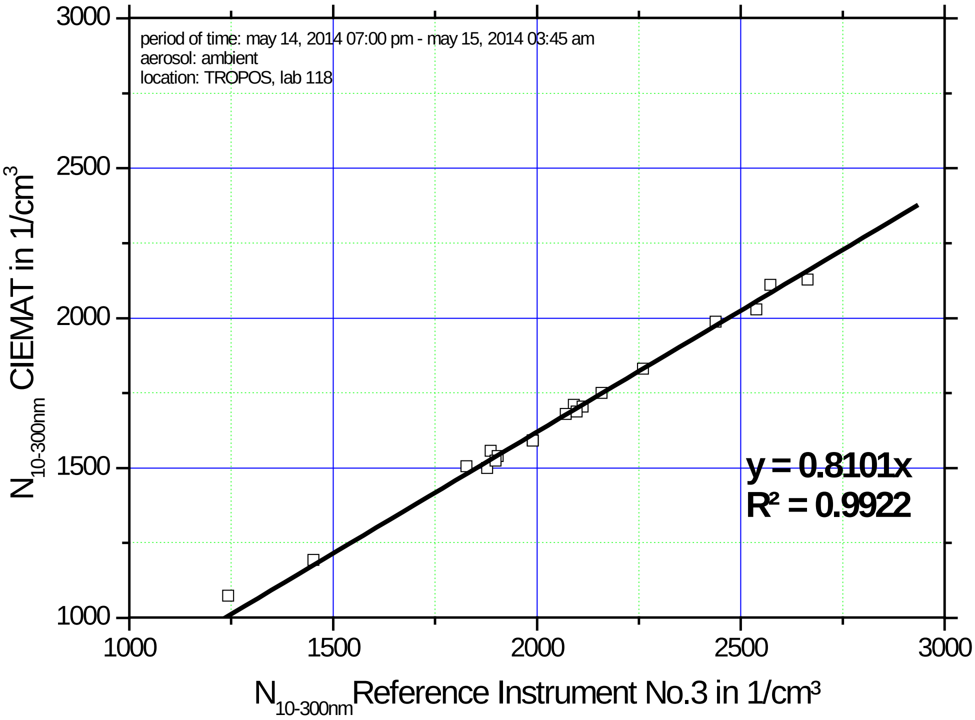


Fig.30. Linear regression between the number concentrations of the TROPOS reference instrument No.3 and SMPS CIEMAT. Multiple charge correction and internal diffusion losses are included.

4. Size distribution

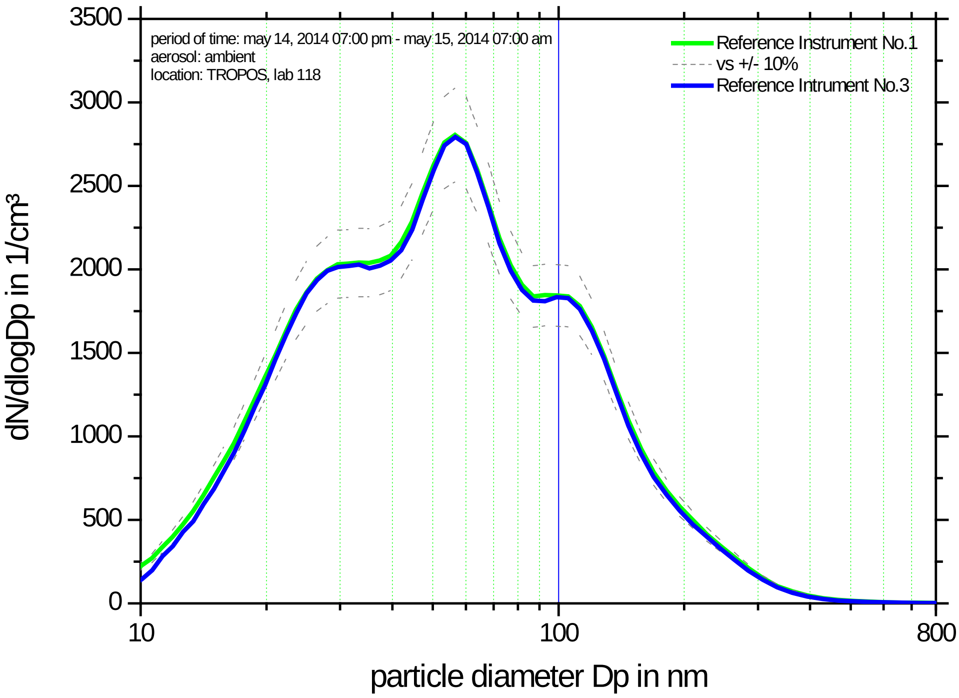


Fig.31. Comparison of mean particle number size distribution between May 14, 2014 07:00 pm and May 15, 2014 07:00 am. Multiple charge correction, internal diffusion losses and CPC efficiency are included (.in2).

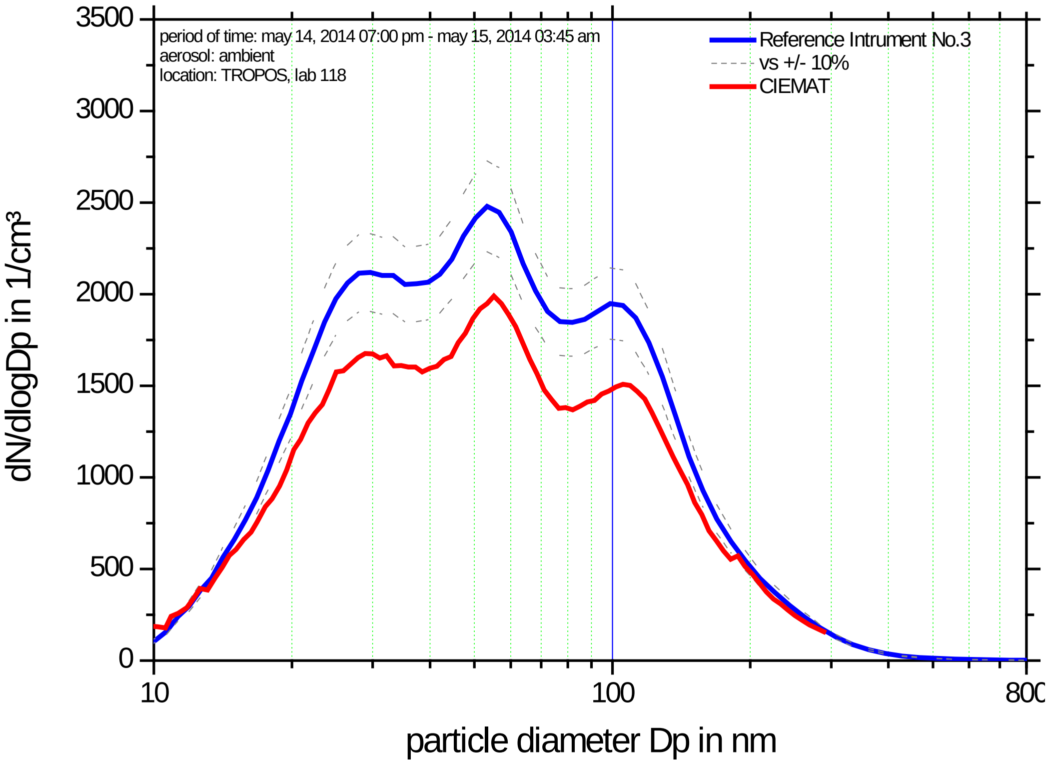


Fig.32. Comparison of mean particle number size distribution of SMPS CIEMAT and TROPOS reference instrument No.3 between May 14, 2014 07:00 pm and May 15, 2014 03:45 am. Multiple charge correction and internal diffusion losses are included (.in1).

D: fourth run (May 15, 2014 08:00 pm – May 16, 2014 06:00 am)

1. Correlation reference instruments

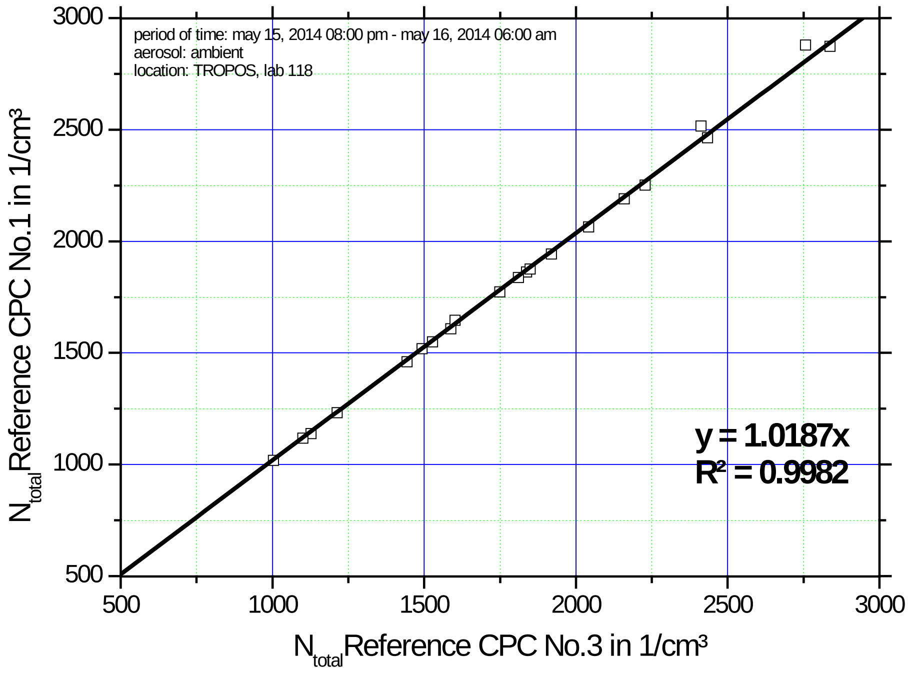


Fig.33. Linear regression between the number concentrations of the TROPOS reference CPC No.1 and the TROPOS reference CPC No.3. Multiple charge correction, internal diffusion losses and flow corrections are included.

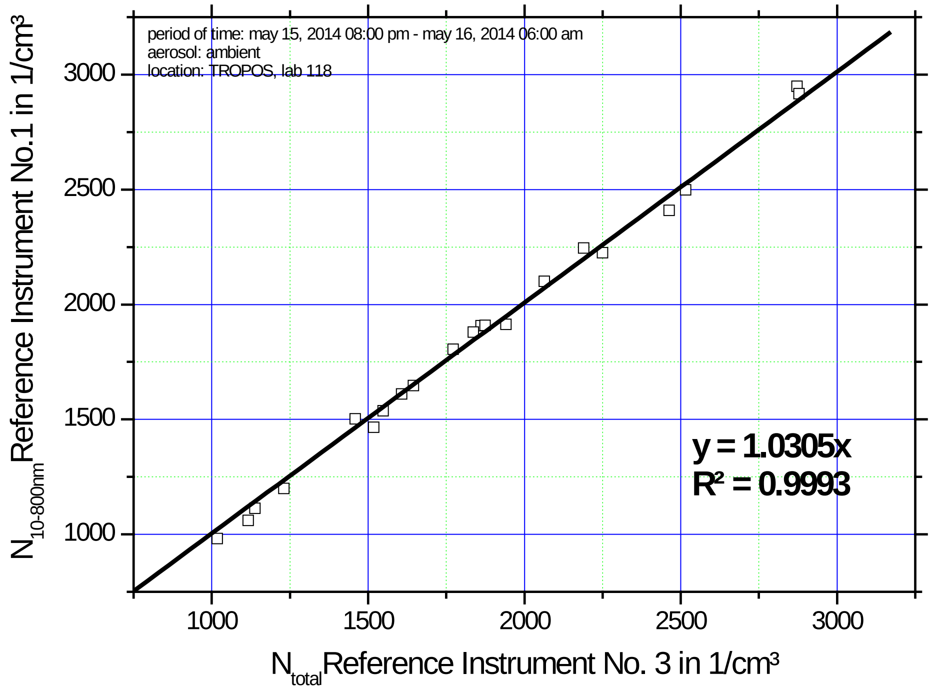


Fig.34. Linear regression between the number concentrations of the TROPOS reference instrument No. 1 and the TROPOS reference instrument No. 3. Multiple charge correction, internal diffusion losses and flow corrections are included.

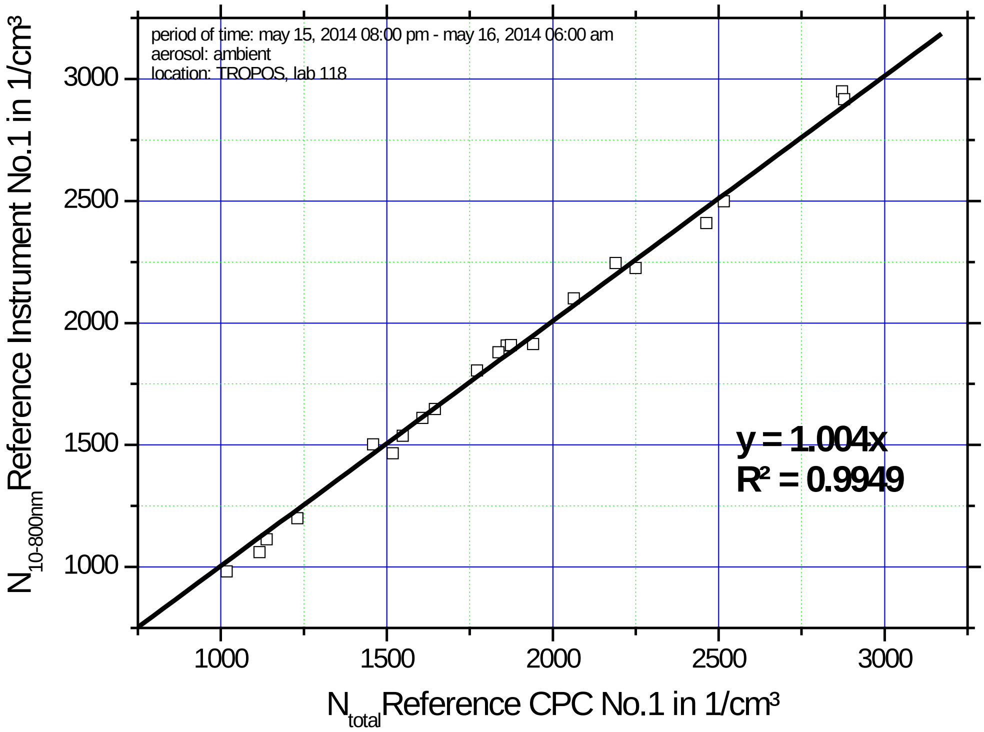


Fig.35. Linear regression between the number concentrations of the TROPOS reference instrument No. 1 and TROPOS reference CPC No.1. Multiple charge correction, internal diffusion losses and flow corrections are included.

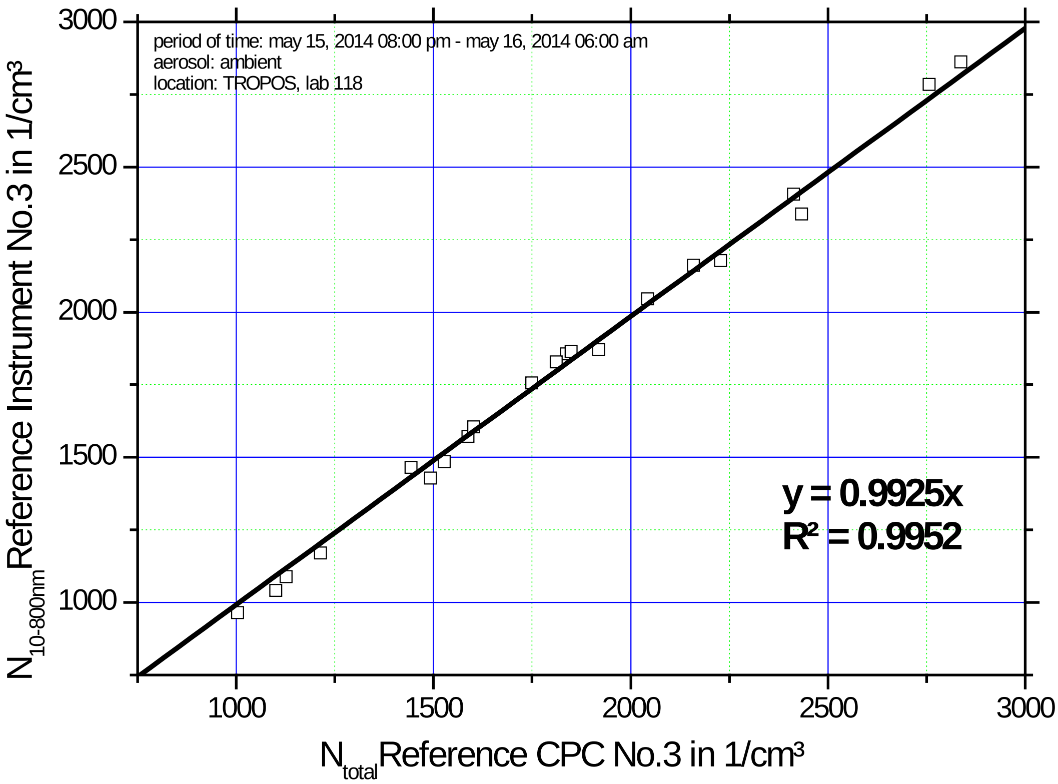


Fig.36. Linear regression between the number concentrations of the TROPOS reference instrument No. 3 and TROPOS reference CPC No.3. Multiple charge correction, internal diffusion losses and flow corrections are included.

2. Time series

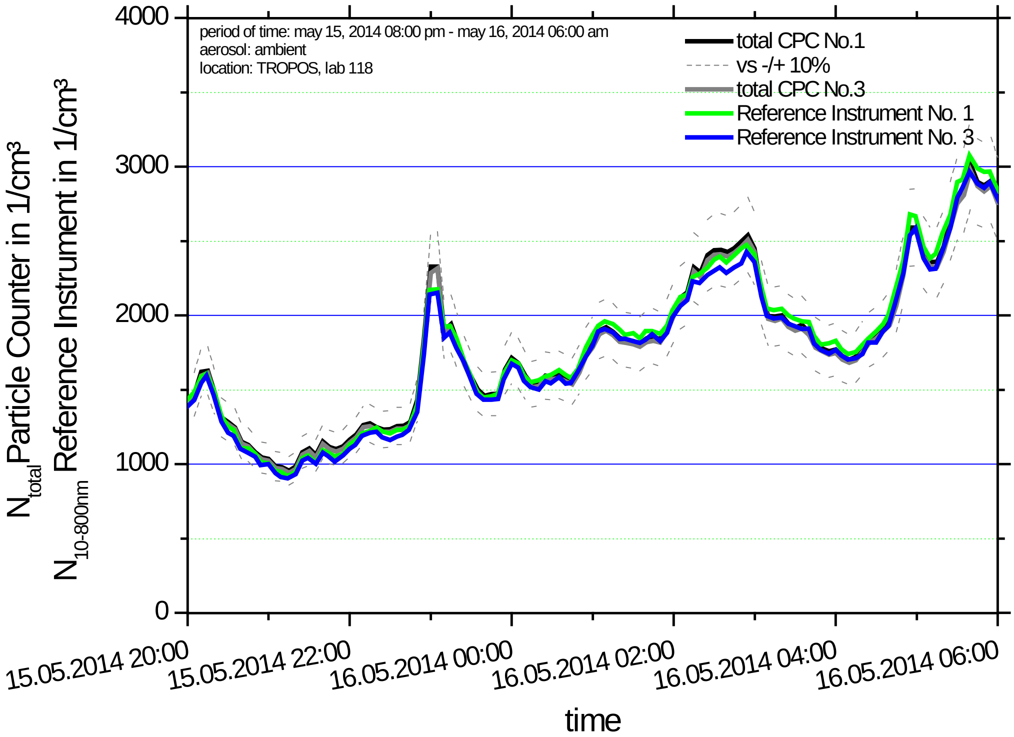


Fig.37. Time series (May 15, 2014 08:00 pm – May 16, 2014 06:00 am) of the integrated particle number concentration (N 10-800nm). Multiple charge correction, internal diffusion losses and flow corrections are included.

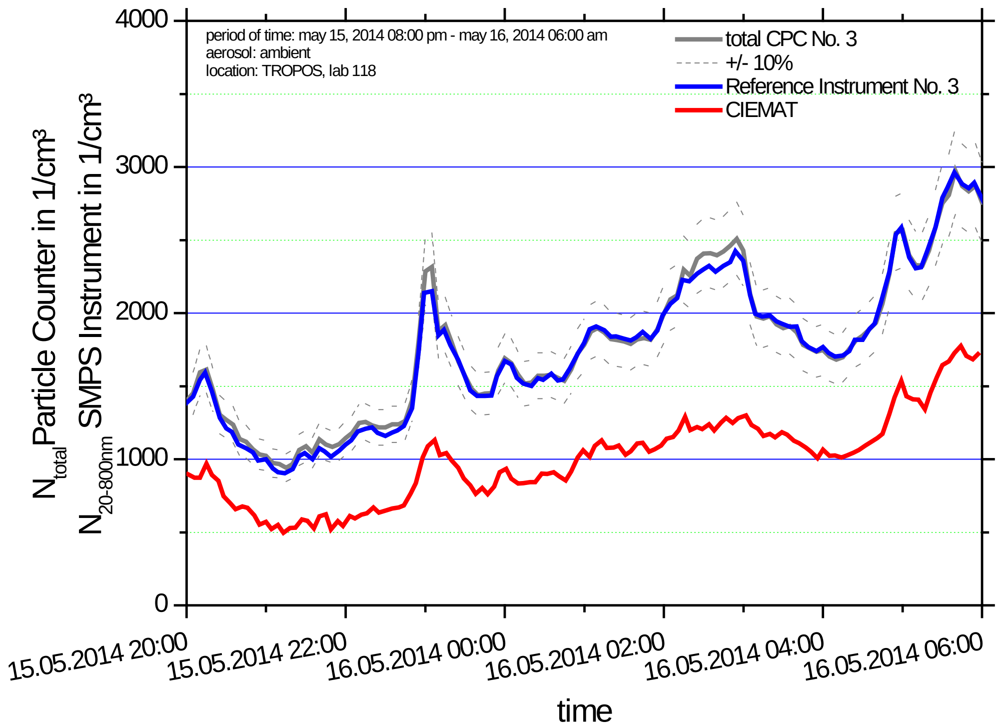


Fig.38. Time series (May 15, 2014 08:00 pm – May 16, 2014 06:00 am) of the integrated particle number concentration (N 20-800nm) of SMPS CIEMAT and TROPOS reference instrument No.3. Multiple charge correction, internal diffusion losses and flow corrections are included.

3. Correlation of SMPS CIEMAT

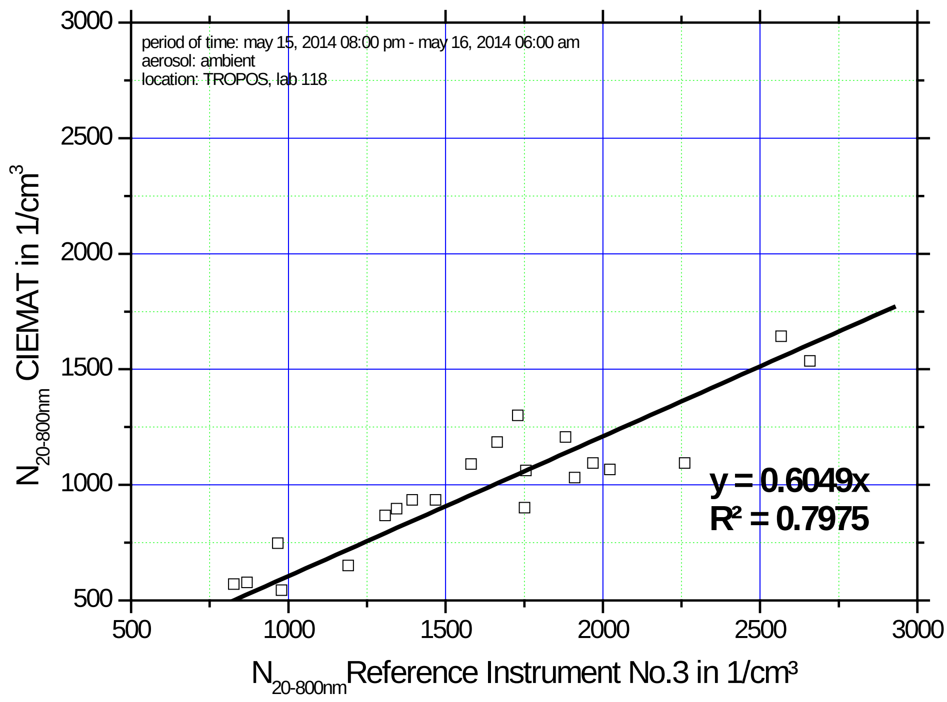


Fig.39. Linear regression between the number concentrations of the TROPOS reference instrument No.3 and SMPS CIEMAT. Multiple charge correction, internal diffusion losses and flow corrections are included.

4. Size distribution

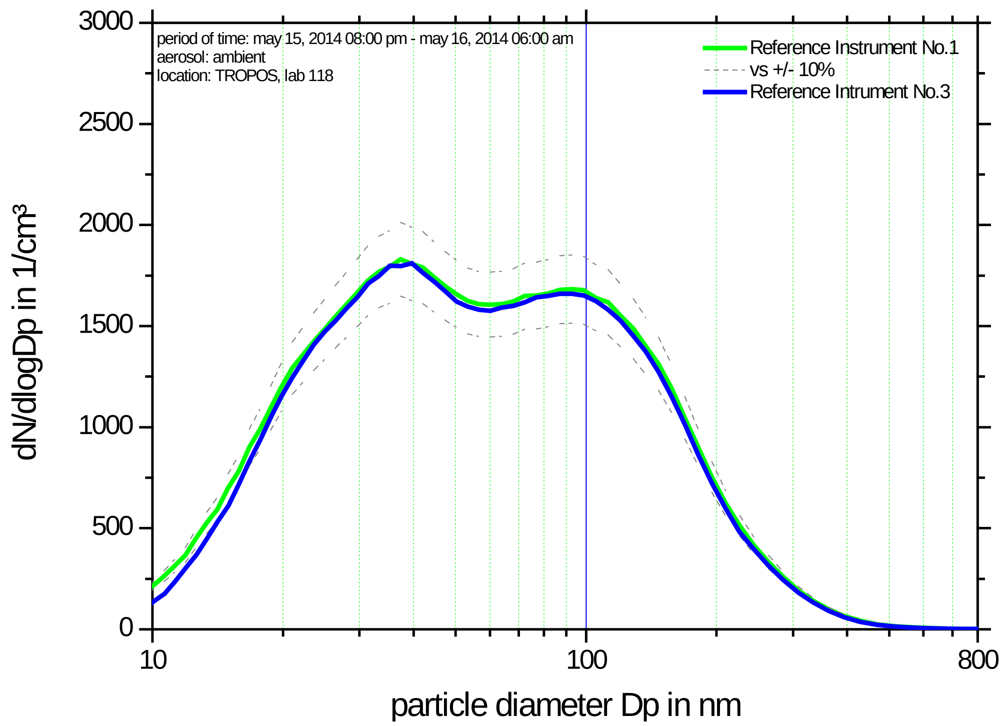


Fig.40. Comparison of mean particle number size distribution between May 15, 2014 08:00 pm and May 16, 2014 06:00 am. Multiple charge correction, internal diffusion losses and CPC efficiency are included (.in2).

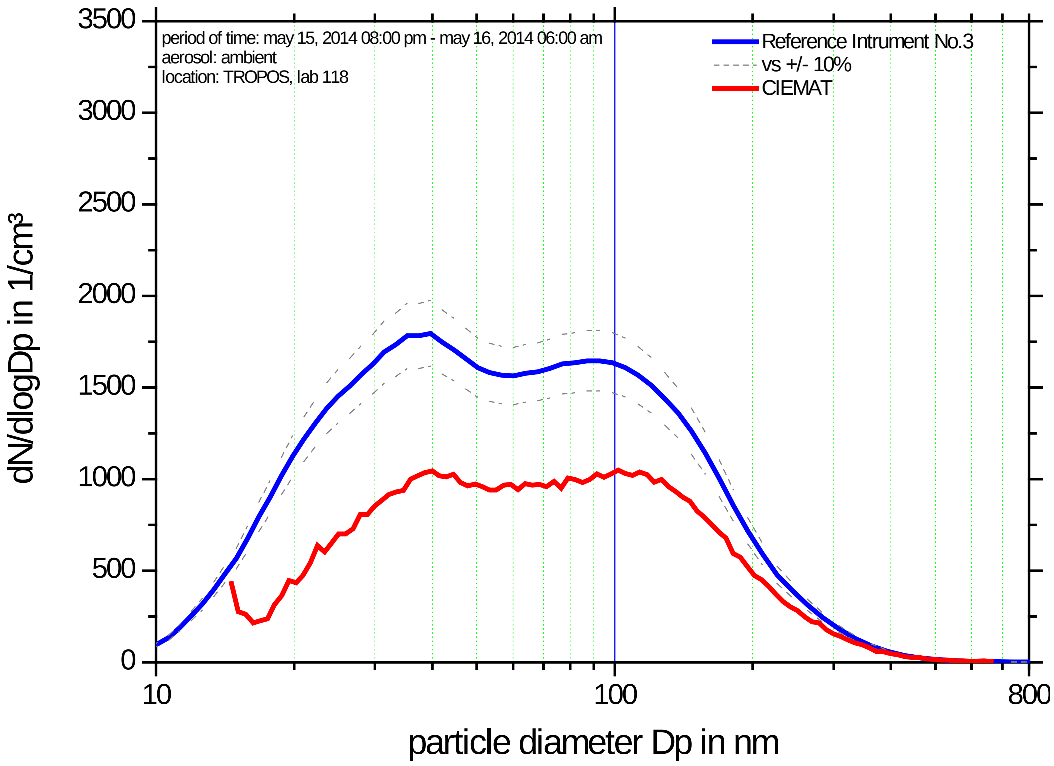


Fig.41. Comparison of mean particle number size distribution of SMPS CIEMAT and TROPOS reference instrument No.3 between May 15, 2014 08:00 pm and May 16, 2014 06:00 am. Multiple charge correction, internal diffusion losses and CPC efficiency are included (.in2).

Intercomparison of TROPOS SMPS ICPF

Basic information

Location of the quality assurance:	TROPOS, lab: 118
Delivery date:	May 12, 2014
Setup in the laboratory:	May 12, 2014
Comparison period:	May 12, 2014 – May 16, 2014
Instrument:	TROPOS SMPS
TROPOS Reference Instrument:	TROPOS Reference Instrument No. 1 TROPOS Reference Instrument No. 3
Total CPC:	TROPOS Reference CPC No.1; SN: 3772112101 TROPOS Reference CPC No.3; SN: 3772111903
Additional equipment:	
Involved people:	Nadezda Zikowa (zikova@icpf.cas.cz)

Summary of second intercompasison:

From May 12, 2014 to May 16, 2014 the Kosetice TROPOS SMPS participated the TROPOS ACTRIS Workshop. The workshop consisted of an entrance test and a final run. In addition to the overnight ambient measurements, we had numerous high voltage checks, zero- and PSL-measurements. The report is divided into three sections. The first section shows the laboratory setup and the PSL measurement. After that, we show for each run the time series of the particle number concentration, the particle number size distribution, and correlation plots. If anything was written in the log book, so we added this also in this report. As reference standards, we used CPCs model TSI 3772 for total particle number concentration and two TROPOS mobility particle size spectrometer. The particle counters have been calibrated against a calibrated TSI electrometer 3068 B with the serial number 70838596.

For the PSL-calibrations, we used Latex particle with a nominal size of 203 nm +/- 4 nm. The latex particles have been generated with an aerosol nebulizer. The sheath air flow rate of the candidate system was calibrated to match the latex particle size, if possible. The Kositice TROPOS SMPS showed in the PSL-measurements a particle diameter of 203.8 nm. Both the zero check and the high-voltage calibration passed the requirements in the final run. If we look at the final ambient measurement run, the Kosetice TROPOS SMPS is in the 10%. The Kosetice TROPOS SMPS passed the ACTRIS Workshop.

Log book:

<u>May 12, 2014</u>

	-> Setup of all instruments in laboratory 118
11:00 am - 04:00 pm	-> CPC workshop
	-> High voltage calibration of Ref1 and Ref3
	-> Measured flows: CPC 1 : 1.040 l/min CPC 3 : 1.029 l/min Ref 1 : 1.018 l/min Ref 3 : 0.9999 l/min
01:00 pm	-> SMPS ICPF is started (without CPC)
01:05 pm	-> HV check: 5m .. 6.40 V 10m .. 12.45 V 20m .. 24.8 V 80m .. 98.8 V 200m.. 247V 5m .. 6.7 V 0 .. 0.4 V original values -0.006 .. 0 10 .. 10 0.995 .. 1
01:57 pm	-> zero check (not original CPC, without additional resistance) CPC connected via black hosing
02:03 pm	-> switched to HEPA 02:05 pm 4 #/ccm 02:10 pm 0 #/ccm
02:13 pm	-> CPC disconnected
02:34 pm	-> HC check: 0 0.2 5m 6.30 10m 12.7 20m 24.9 80m 99.2 200m 249 800m 997 5m 6.3 new regression curve -0.0065 0 9.998 10 1.003 1
02:57 pm	-> calibrated CPC 3772 connected
03:36 pm	-> aerosol flow check 1.03 l/min
03:43 pm	-> zero check with HEPA in front of system

03:40 pm 30 #/ccm
03:45 pm 1 #/ccm

03:52 pm -> zero check for the whole sampling line
03:50 pm 0 #/ccm

04:10 pm -> change to latex, temperature 23 C degree, pressure 995 hPa
automatic program not working, changed manually
04:27 pm sampling switched to latex (203 nm); peak at about 204 / 205 nm

05:06 pm -> change to measurement mode

05:10 pm -> ambient measurement

(changed the pressure to 1000 hPa and the temp to 23)

06:10 pm -> ambient measurement

<u>May 13, 2014</u>

02:38 pm -> change to latex, p: 995 hPa, T: 23 °C , again partly manually

02:48 pm -> 203 nm latex sampling started; 204 nm peak

05:12 pm -> carbon hose changed to 70 cm long one

03:21 pm -> change to normal mode, latex scan continuation, p: 1000 hPa, T: 23 °C

03:50 pm ->change to zero (half of the scan)

-> scan 3189 #/ccm

03:55 pm -> scan 7.4 #/ccm
DMA voltage off

04:00 pm -> scan 1 #/ccm

04:05 pm -> scan 0 #/ccm

04:11 pm -> change to ambient and DMA voltage on again

<u>May 14, 2014</u>

02:48 pm -> measurement stopped; radioactive source removed and replaced;
Americium source installed instead

02:52 pm -> start of the measurement, zero check (HEPA in front of the carbon hose)

02:55 pm -> scan 1 #/ccm

03:00 pm -> leak

03:13 pm -> plumbing for the radioactive source replaced and improved
zero scan again
15:10 scan 173 #/ccm
15:15 scan 0 #/ccm
15:20 scan 0 #/ccm

03:25 pm -> change to ambient measurement; comparison period with Ref1 03:30 pm - 05:30 pm

05:44 pm -> downloaded data

09:30 pm	-> overnight ambient scan with americium source

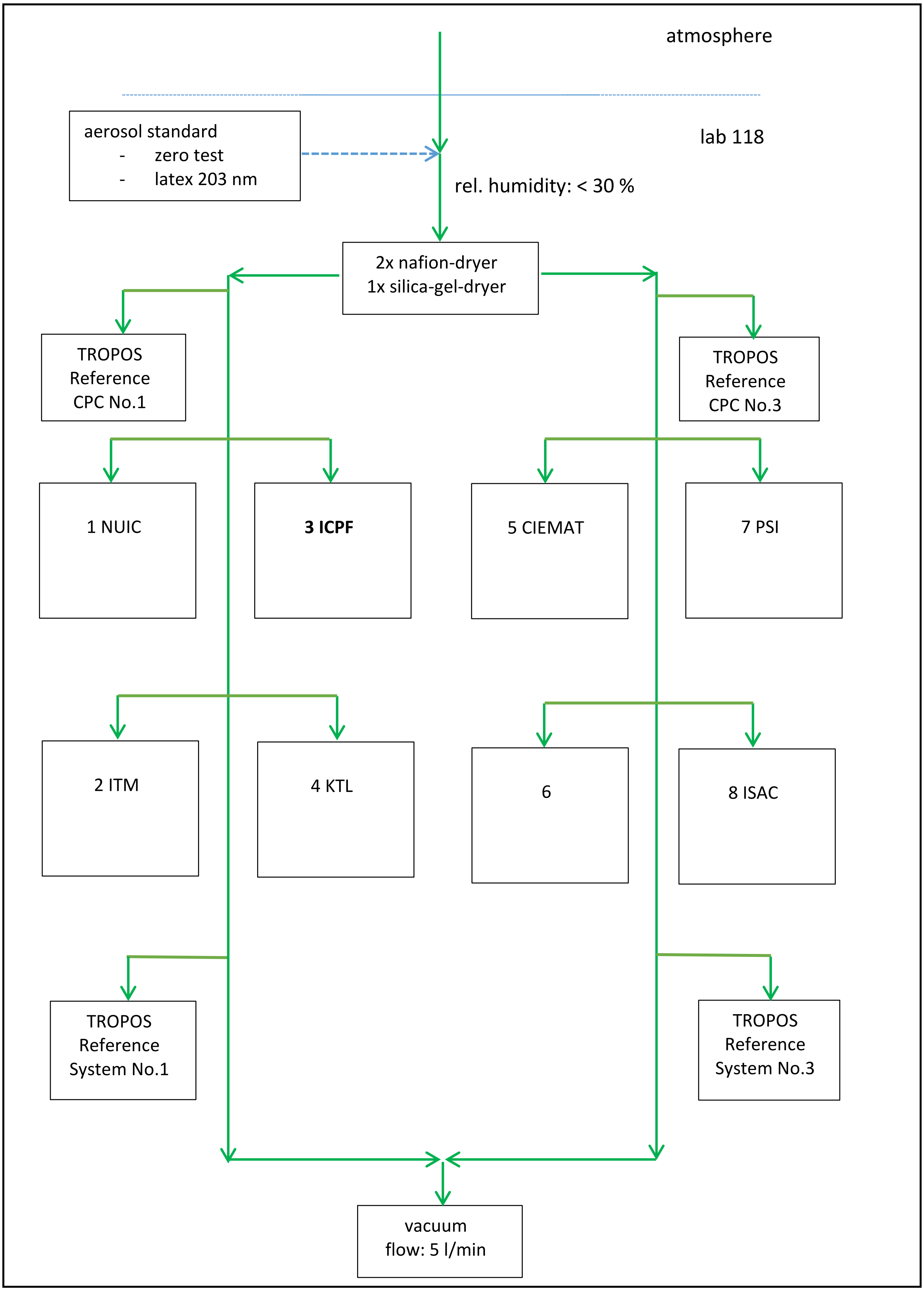
<u>May 15, 2014</u>

11:25 am	-> system stopped, americium source removed; sampling line switched to HEPA; CPC OFF, computer OFF
03:23 pm	-> computer ON, CPC ON; another americium source was given into the system nafion dryer added back to the system; longer carbon hose added - 92 cm length switched sampling line to common inlet
03:30 pm	-> change sampling to HEPA on the SMPS inlet CPC status still not OK - low saturator temperature
03:35 pm	-> zero scan 0 #/ccm
03:40 pm - 05:35 pm	-> comparison measurement TROPOS source, OBK nafion, 92 cm carbon hose
05:35 pm	-> measurement stopped, sampling switched to room, americium removed and krypton placed back into system
05:36 pm	-> sampling from the common inlet change to HEPA in front of the SMPS 253 #/ccm - 0 #/ccm data from ref1 downloaded
05:45 pm	-> overnight measurement started with nafion and krypton source = original set-up
06:10 pm	-> change of the nafion for another TROPOS one, remove the switch to HEPA; change back to americium source
06:18 pm	-> sampling from the common inlet 06:20 pm - 07:50 pm comparison
08:30 pm	-> nafion removed - probable leak in the sheath flow? ; radioactive source replaced back to krypton; sampling changed to common sampling line

<u>May 16, 2014</u>

08:50 am	-> data downloaded; switched to room air; sheath flow nafion bypassed
08:55 am	-> zero scan; 1520 -> 0
09:26 am	-> switch to sampling line
09:30 am - 11:00 am	-> comparison
09:50 am	-> comparison stopped, switch to room air, another nafion added
09:55 am	-> krypton, larger nafion into aerosol flow, sheath nafion back to system
10:00 am - 11:30 am	-> comparison

Laboratory setup



CPC Efficiency

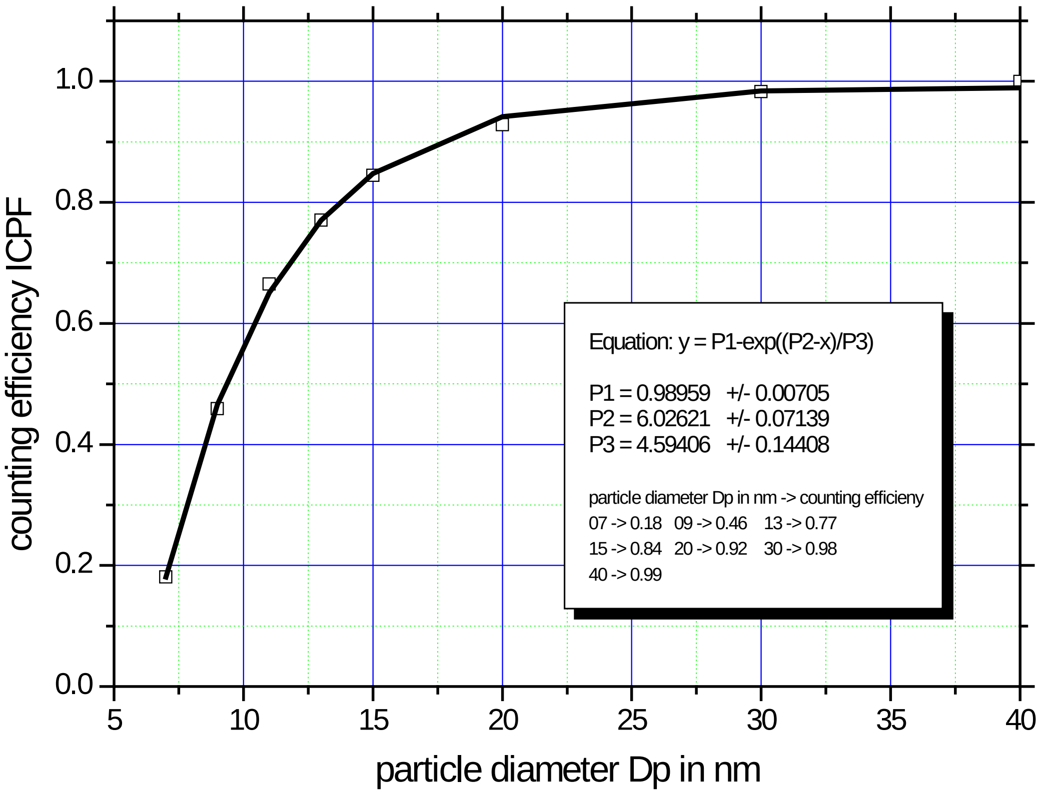


Fig.1. CPC efficiency curve. Based on Electrometer TSI 3068B. Serial number: 70838596

Latex 203 nm

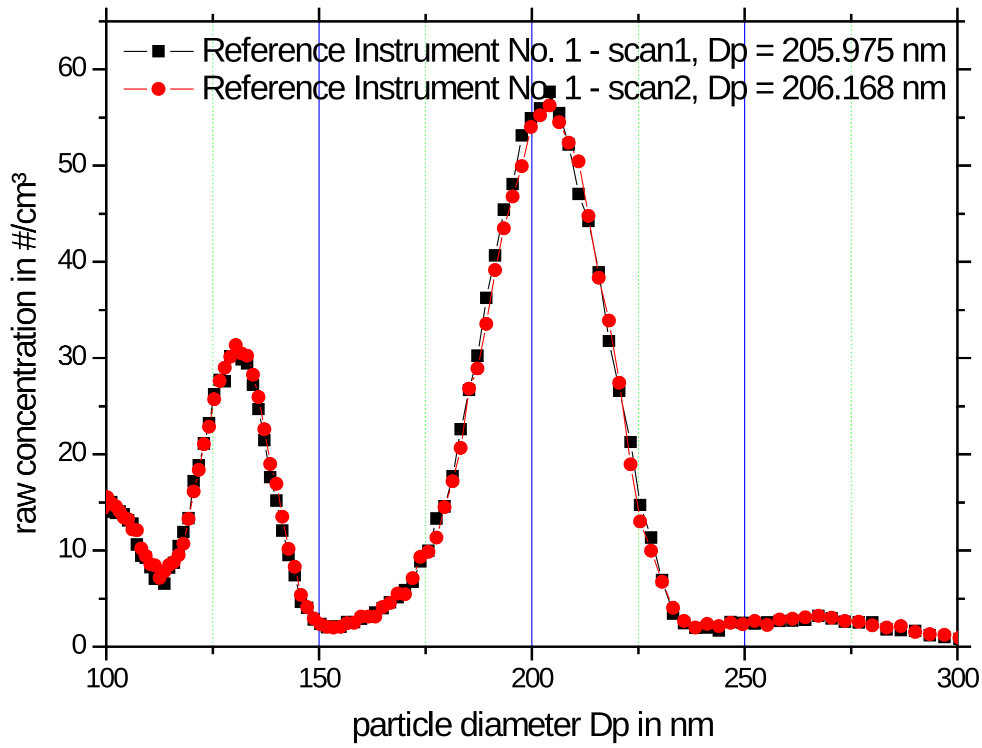


Fig.2. Measurement of latex 203 nm for TROPOS reference instrument No.1: Particle size distribution (raw concentration) for latex 203 nm on May 12, 2014 between 04:28 pm and 05:08 pm.

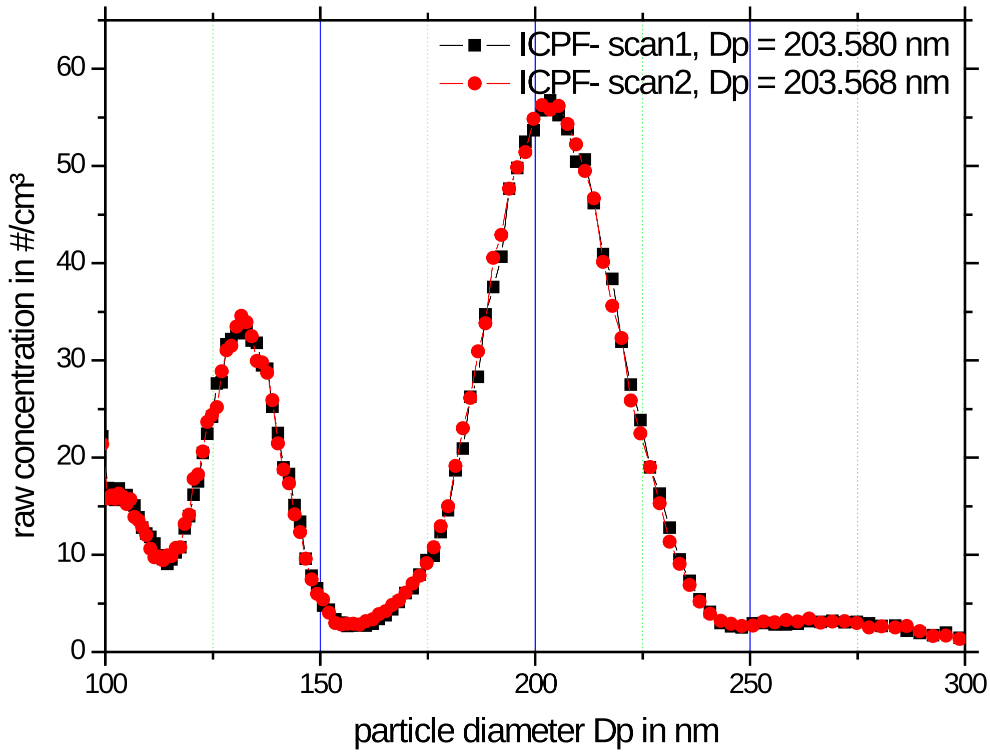


Fig.3. Measurement of latex 203 nm for instrument SMPS ICPF: particle size distribution (raw concentration) for latex 203 nm on May 12, 2014 between 04:27 pm and 05:06 pm.

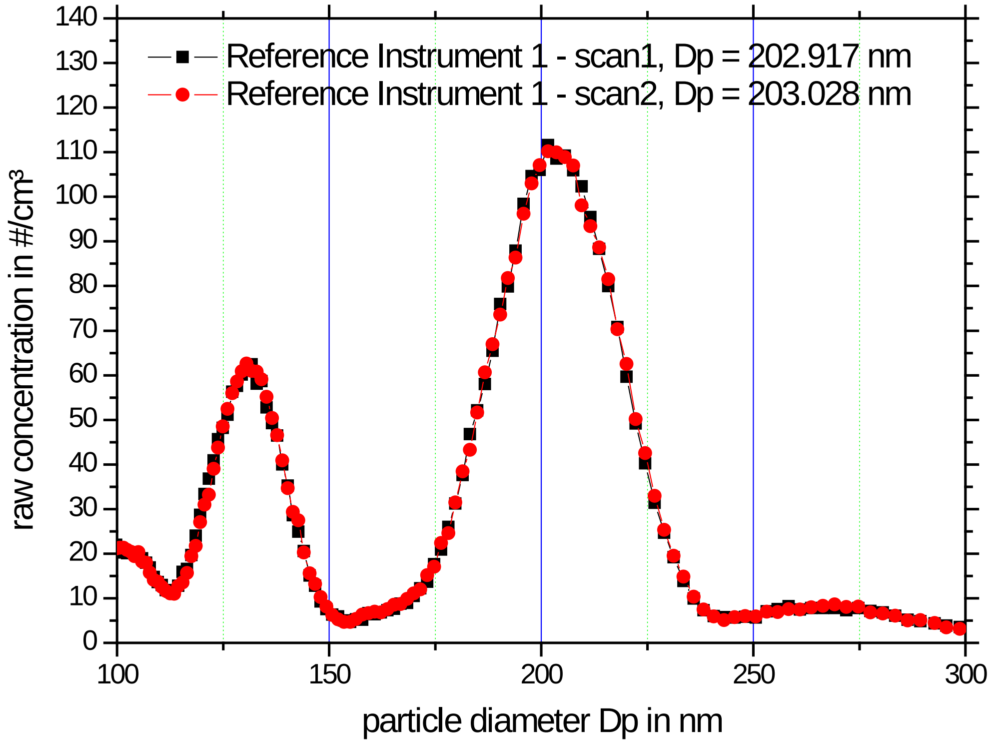


Fig.4. Measurement of latex 203 nm for TROPOS reference instrument No.1: Particle size distribution (raw concentration) for latex 203 nm on May 13, 2014 between 03:13 pm and 03:39 pm.

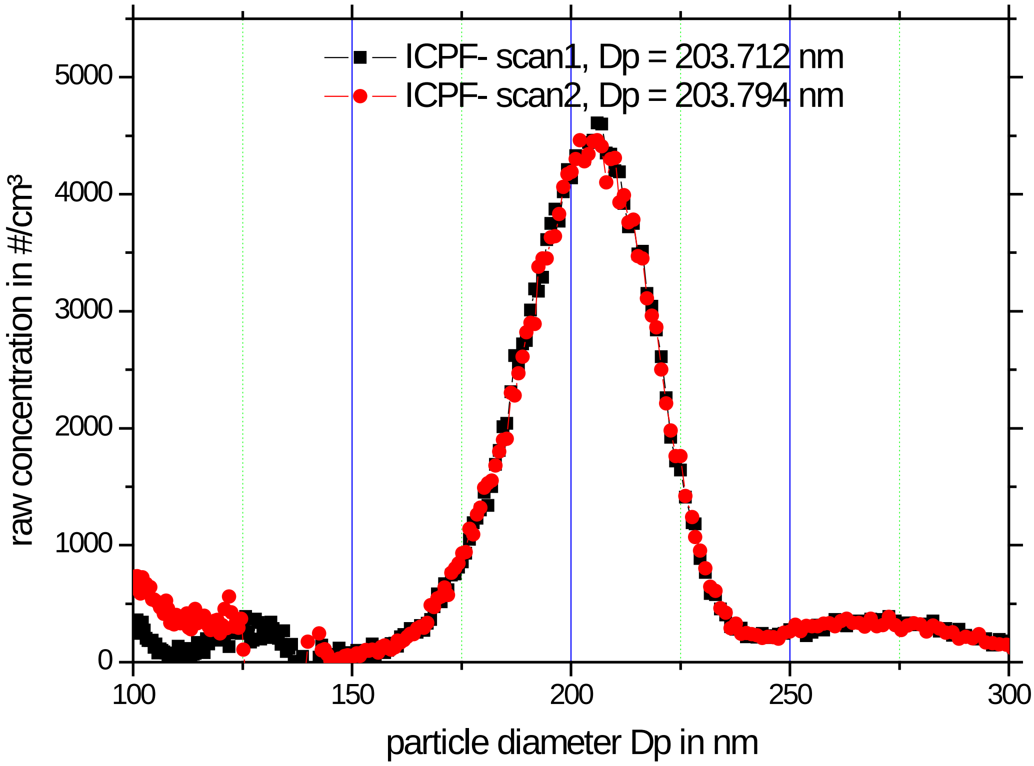


Fig.5. Measurement of latex 203 nm for instrument SMPS ICPF: particle size distribution (raw concentration) for latex 203 nm on May 13, 2014 between 03:21 pm and 03:49 pm.

A: first run (May 12, 2014 06:00 pm – May 13, 2014 08:00 am)

1. Correlation of reference instruments

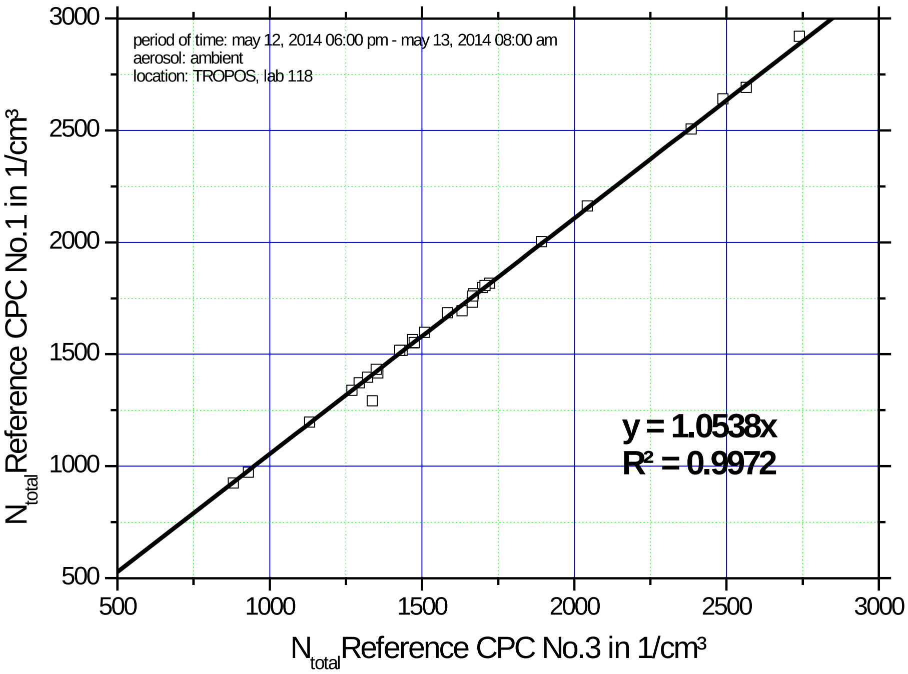


Fig.6. Linear regression between the number concentrations of the TROPOS reference CPC No.1 and the TROPOS reference CPC No.3. Multiple charge correction, internal diffusion losses and flow corrections are included.

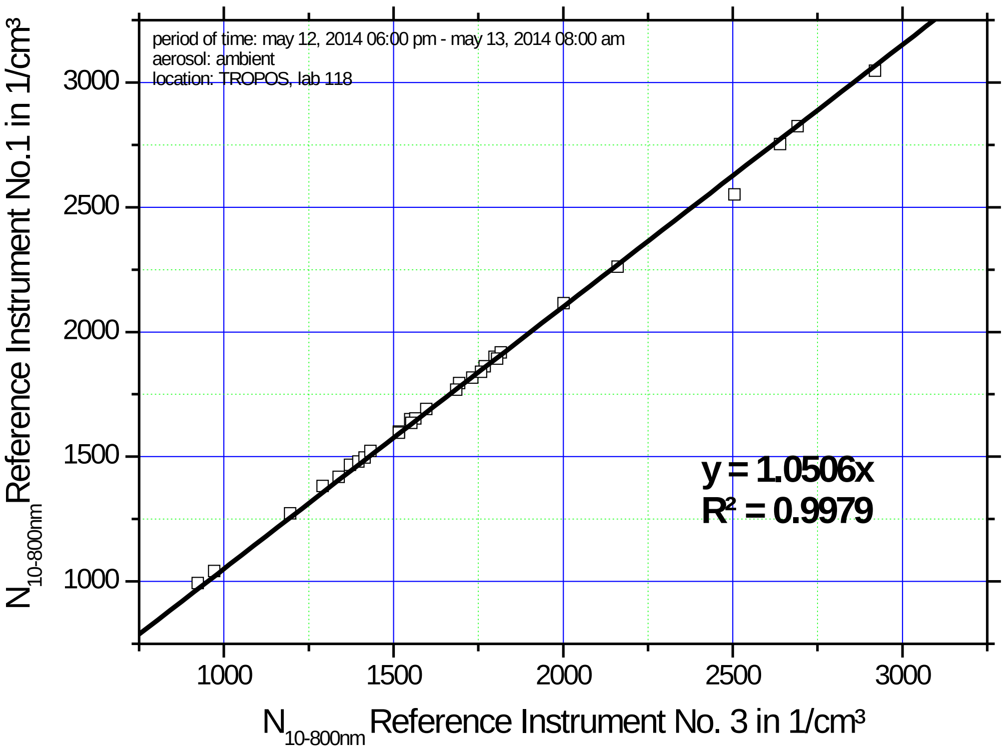


Fig.7. Linear regression between the number concentrations of the TROPOS reference instrument No.1 and the TROPOS reference instrument No.3. Multiple charge correction, internal diffusion losses and flow corrections are included.

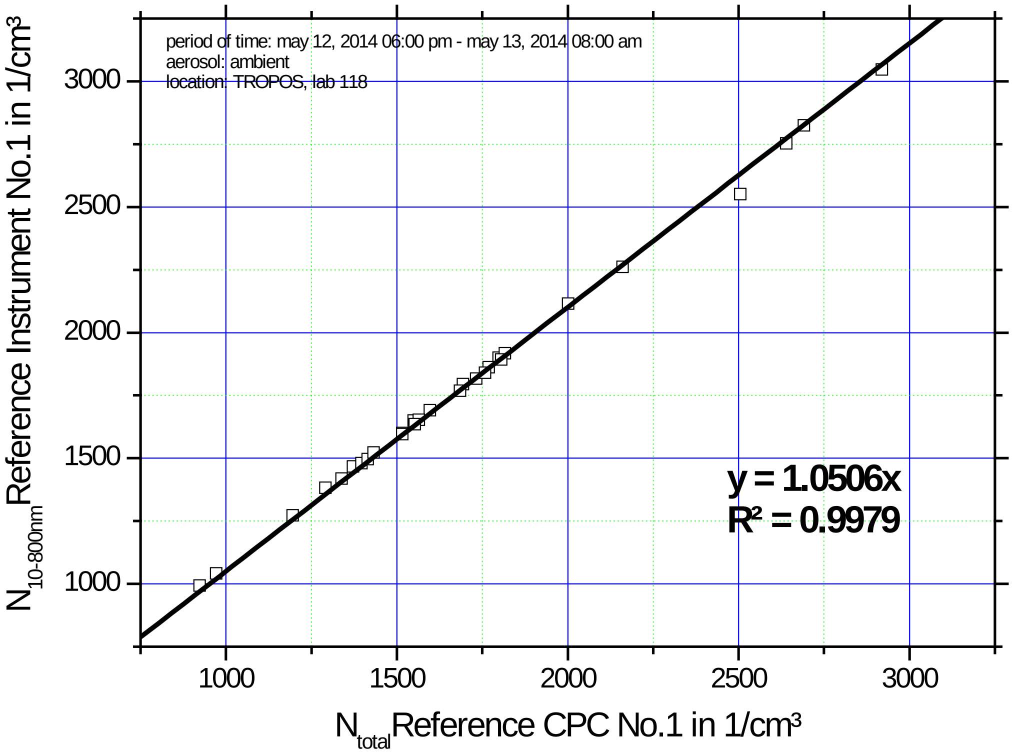


Fig.8. Linear regression between the number concentrations of the TROPOS reference instrument No.1 and TROPOS reference CPC No.1. Multiple charge correction, internal diffusion losses and flow corrections are included.

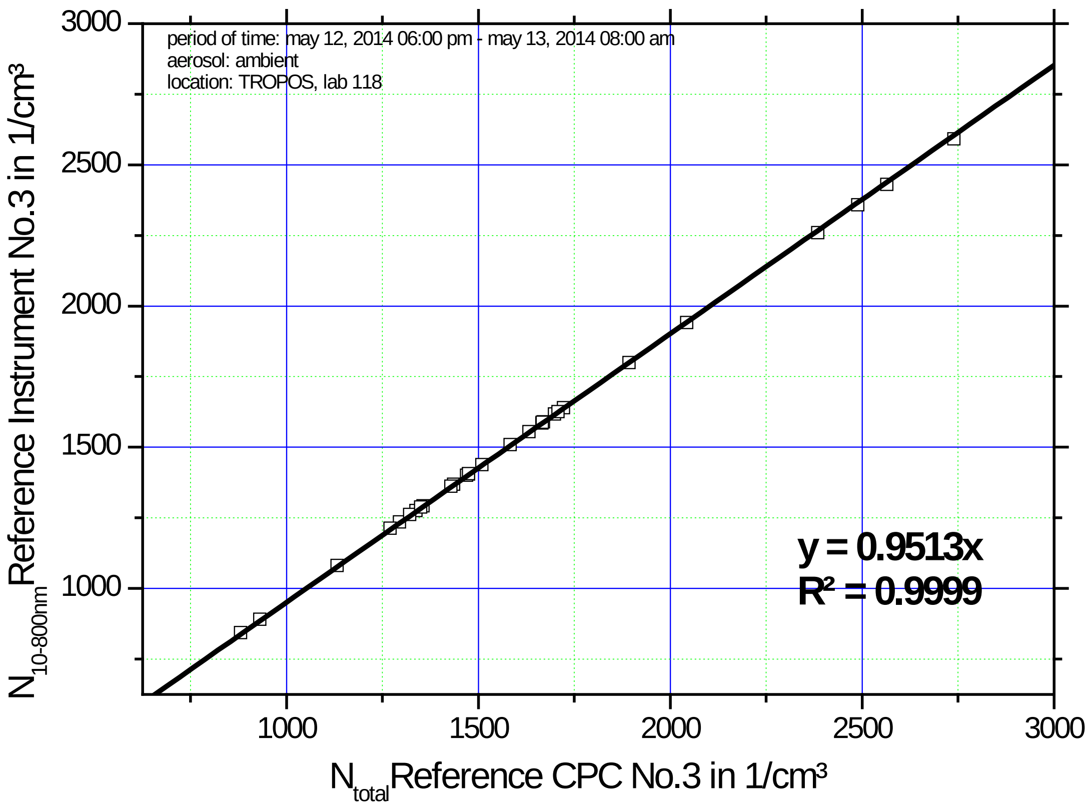


Fig.9. Linear regression between the number concentrations of the TROPOS reference instrument No.3 and TROPOS reference CPC No.3. Multiple charge correction, internal diffusion losses and flow corrections are included.

2. Time series

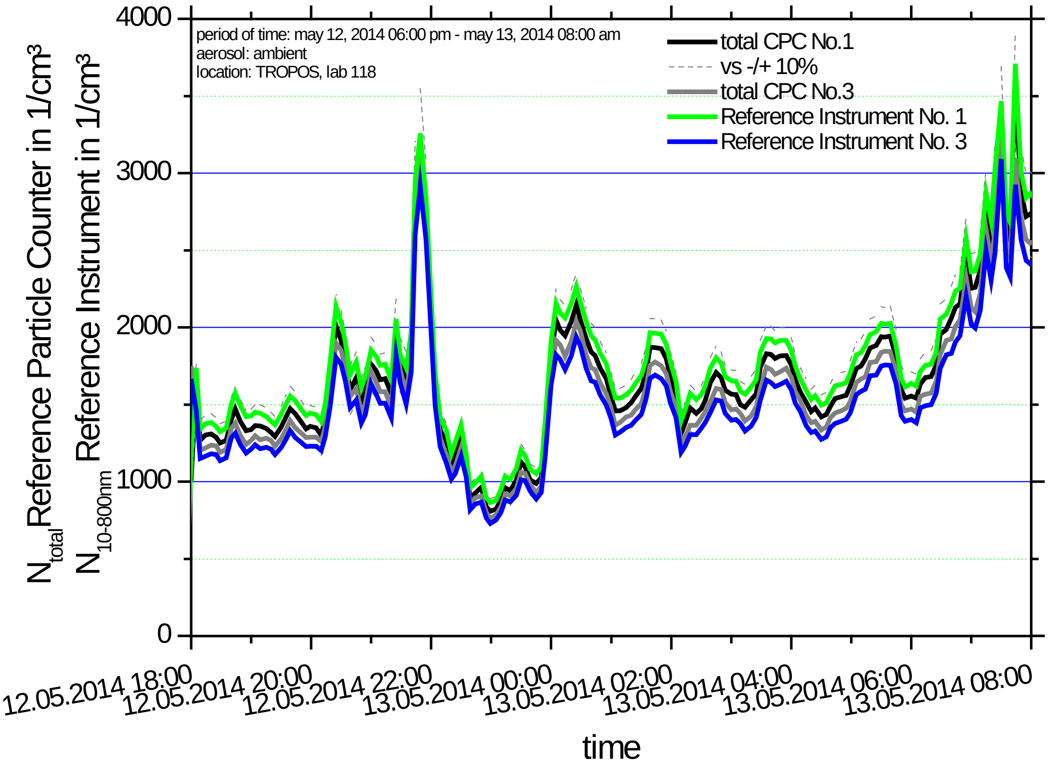


Fig.10. Time series (May 12, 2014 06:00 pm – May 13, 2014 08:00 am) of the integrated particle number concentration (N 10-800nm). Multiple charge correction, internal diffusion losses and flow corrections are included.

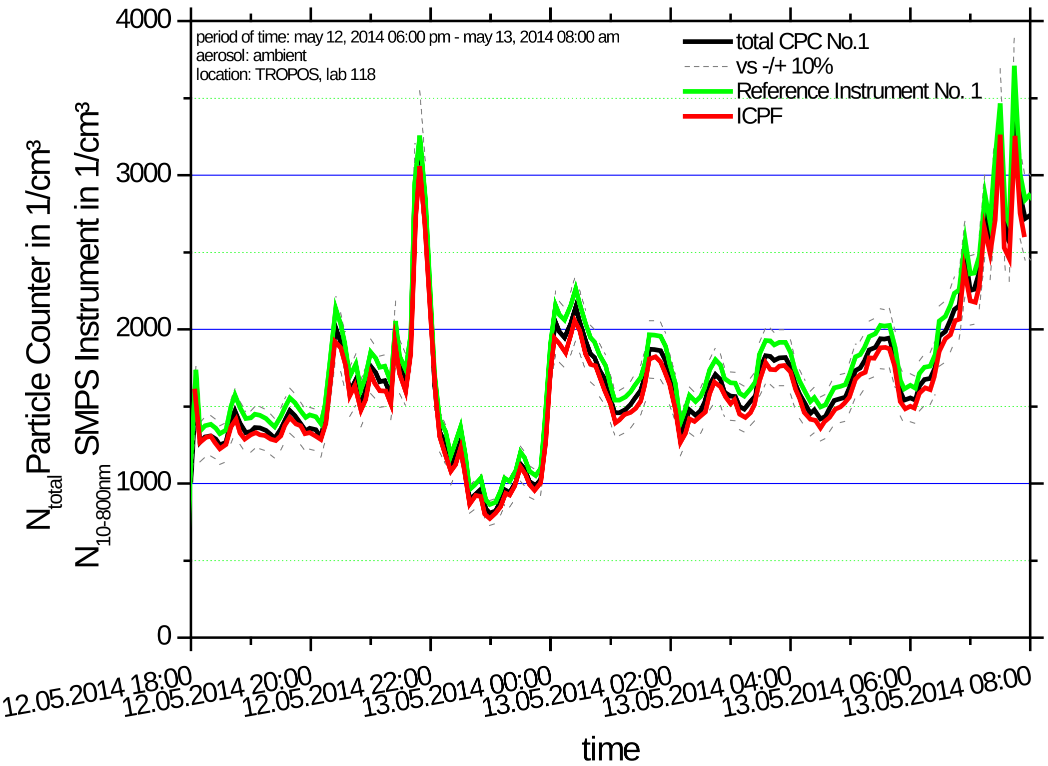


Fig.11. Time series (May 12, 2014 06:00 pm – May 13, 2014 08:00 am) of the integrated particle number concentration (N 10-800nm) of SMPS ICPF and TROPOS reference instrument No.1. Multiple charge correction and internal diffusion losses are included.

3. Correlation of SMPS ICPF

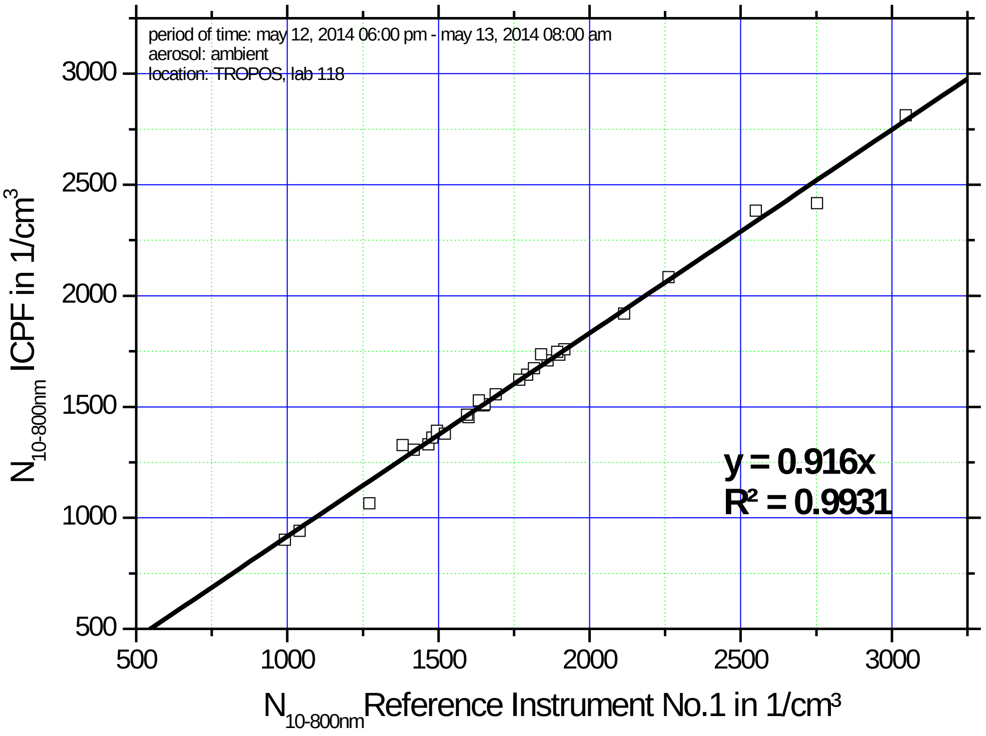


Fig.12. Linear regression between the number concentrations of the TROPOS reference instrument No.1 and SMPS ICPF. Multiple charge correction and internal diffusion losses are included.

4. Size distribution

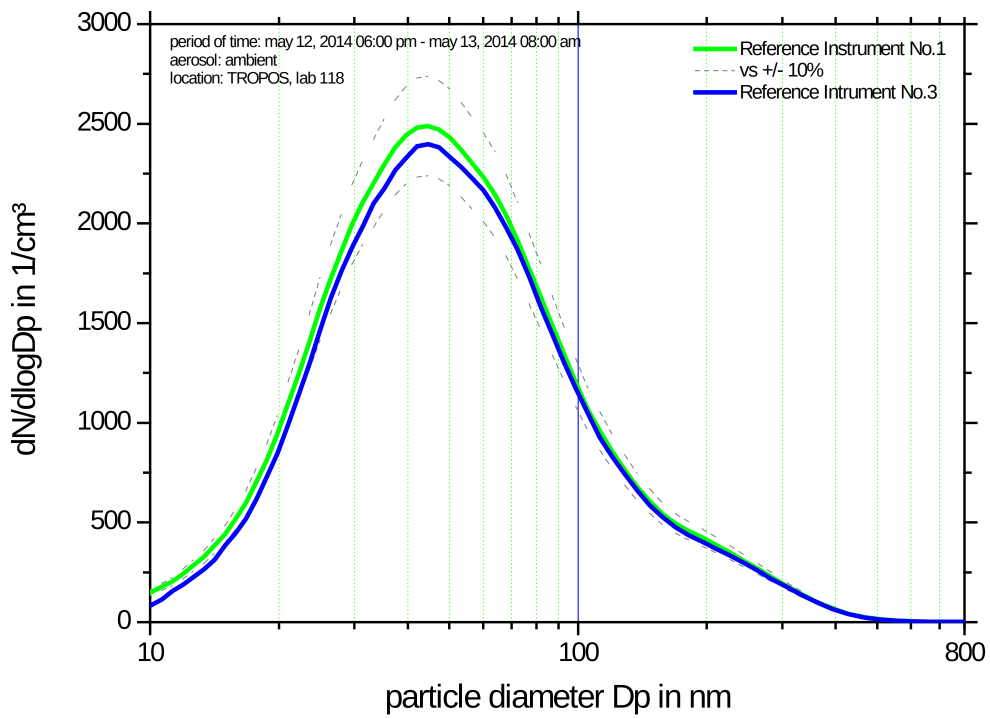


Fig.13. Comparison of mean particle number size distribution of the reference instruments between May 12, 2014 06:00 pm and May 13, 2014 08:00 am. Multiple charge correction, internal diffusion losses and CPC efficiency are included (.in2).

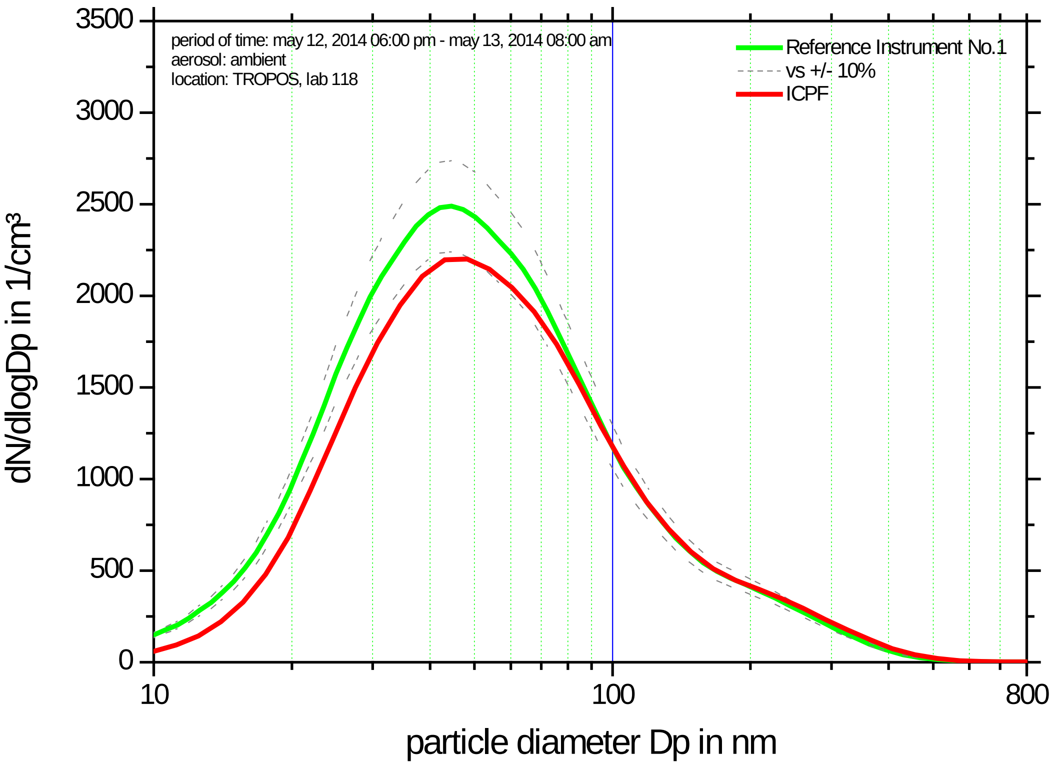


Fig.14. Comparison of mean particle number size distribution of SMPS ICPF and TROPOS reference instrument No.1 between May 12, 2014 06:00 pm and May 13, 2014 08:00 am. Multiple charge correction, internal diffusion losses and CPC efficiency are included (.in2).

B: second run (May 13, 2014 05:00 pm – May 14, 2014 07:00 am)

1. Correlation of reference instruments

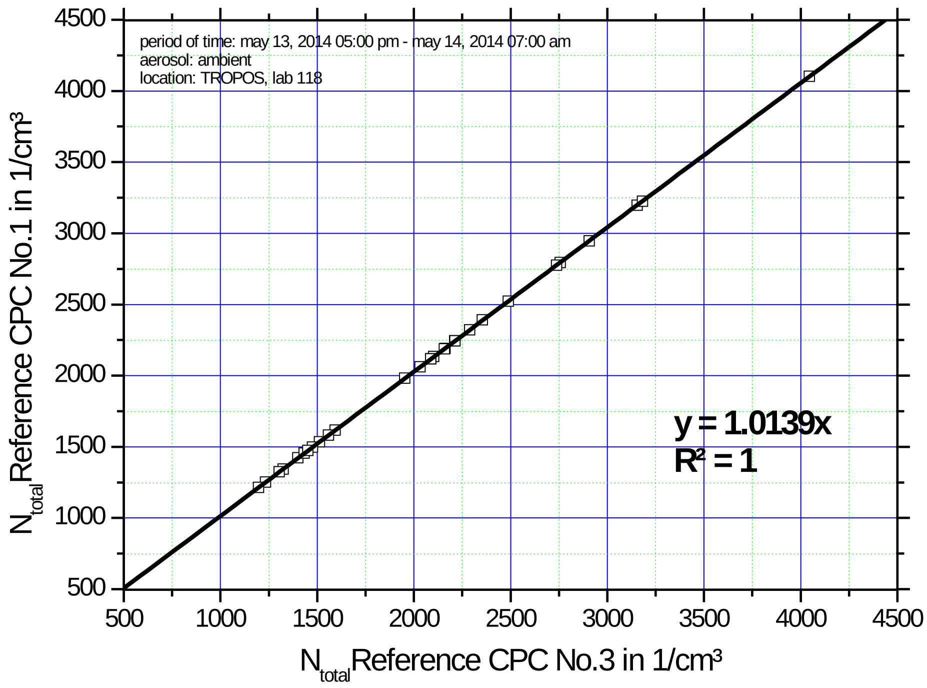


Fig.15. Linear regression between the number concentrations of the TROPOS reference CPC No.1 and the TROPOS reference CPC No.3. Multiple charge correction, internal diffusion losses and flow corrections are included.

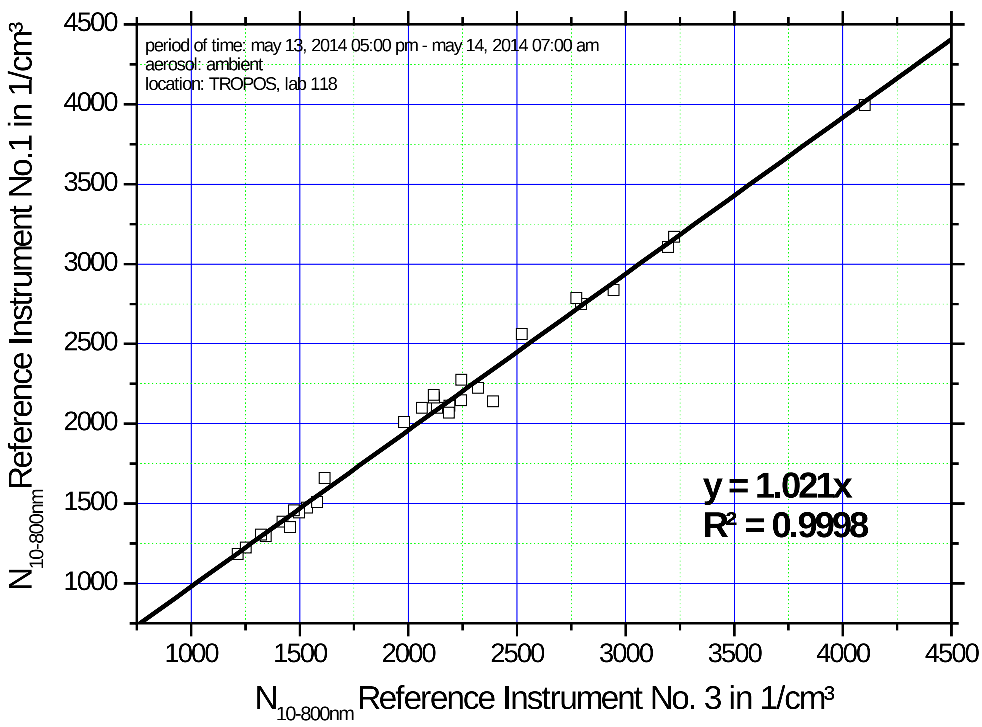


Fig.16. Linear regression between the number concentrations of the TROPOS reference instrument No. 1 and the TROPOS reference instrument No. 3. Multiple charge correction, internal diffusion losses and flow corrections are included.

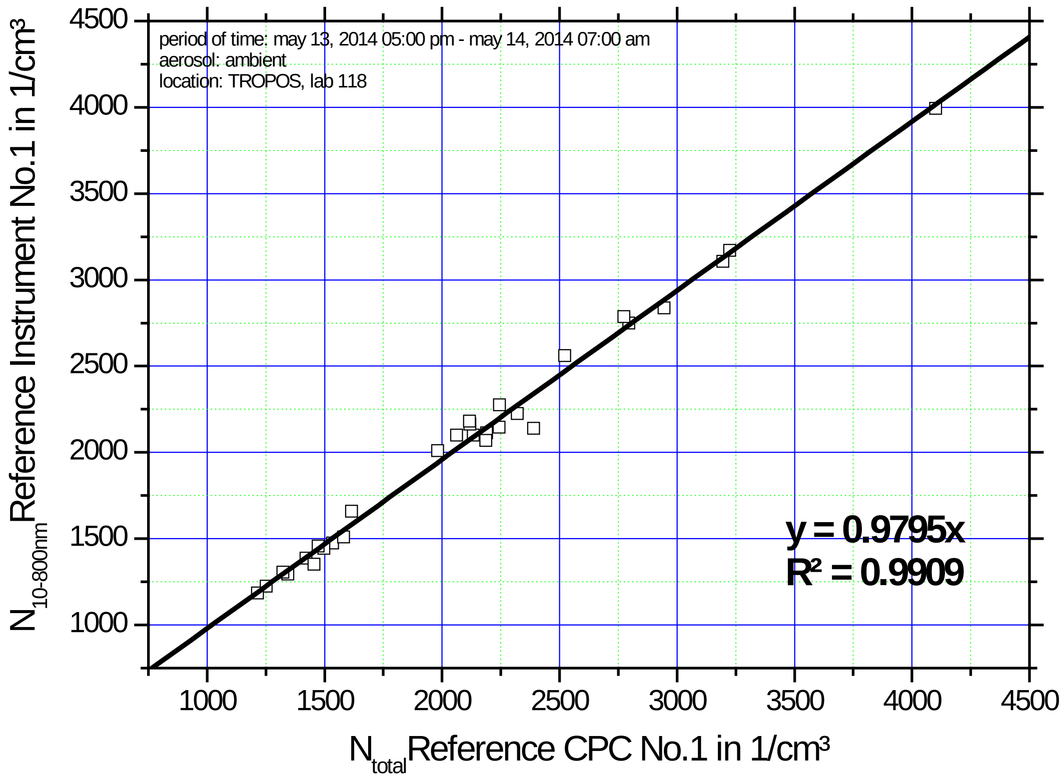


Fig.17. Linear regression between the number concentrations of the TROPOS reference instrument No. 1 and TROPOS reference CPC No.1. Multiple charge correction, internal diffusion losses and flow corrections are included.

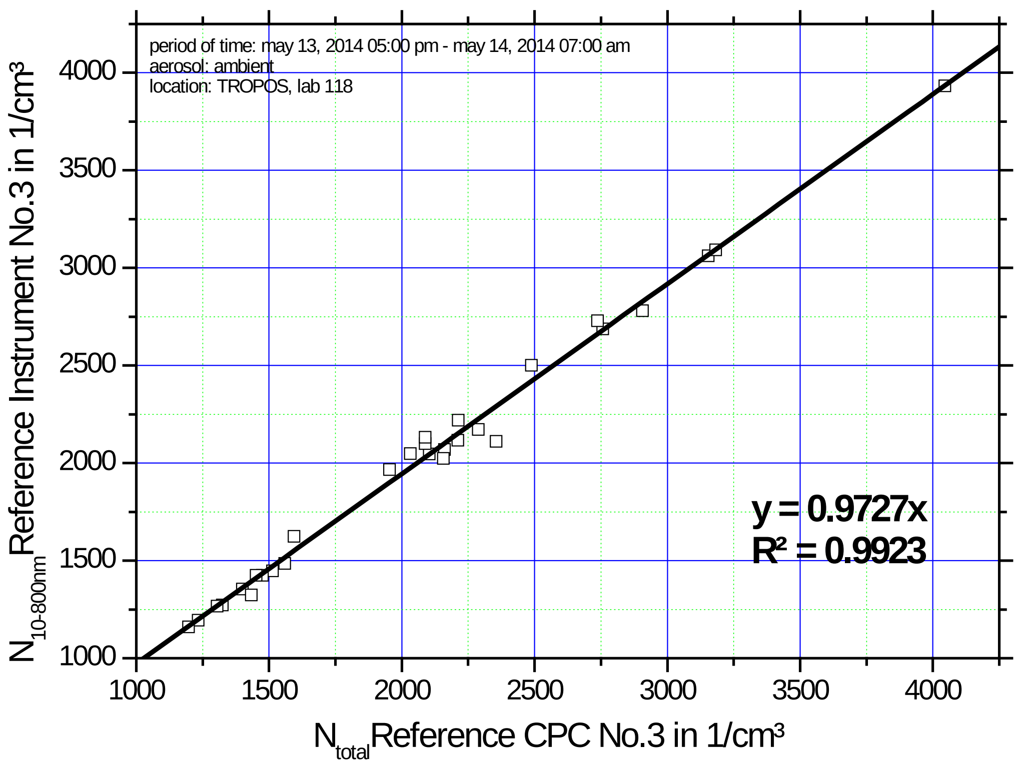


Fig.18. Linear regression between the number concentrations of the TROPOS reference instrument No. 3 and TROPOS reference CPC No.3. Multiple charge correction, internal diffusion losses and flow corrections are included.

2. Time series

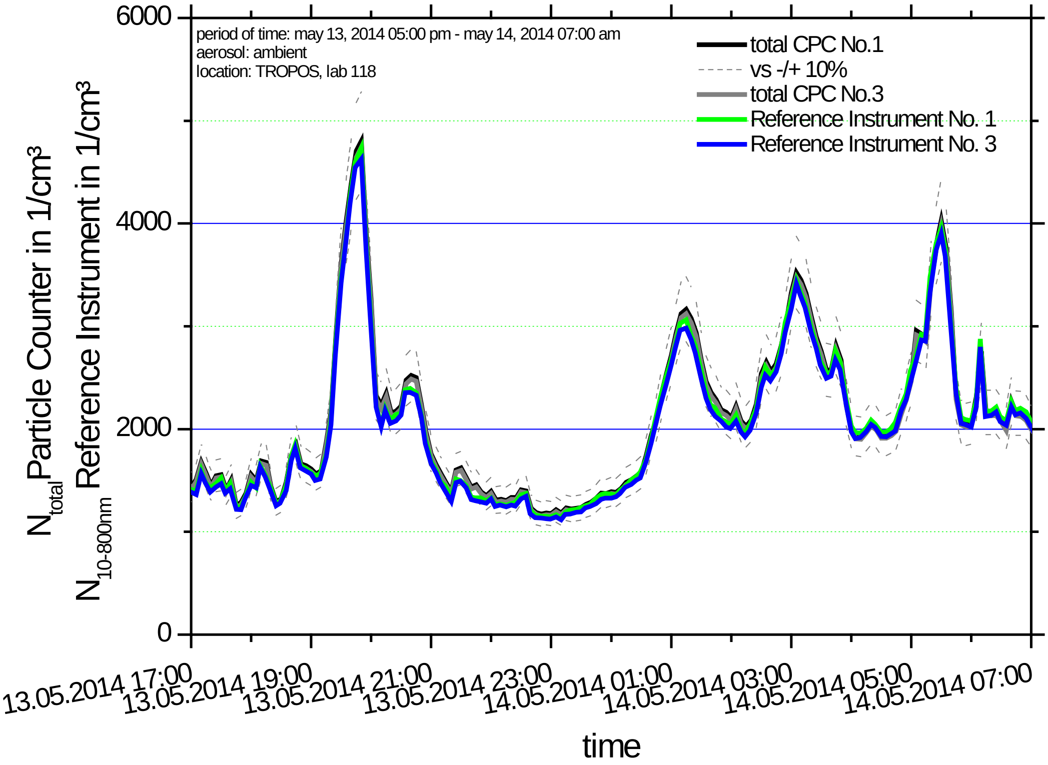


Fig.19. Time series (May 13, 2014 05:00 pm – May 14, 2014 07:00 am) of the integrated particle number concentration (N 10-800nm). Multiple charge correction and internal diffusion losses are included.

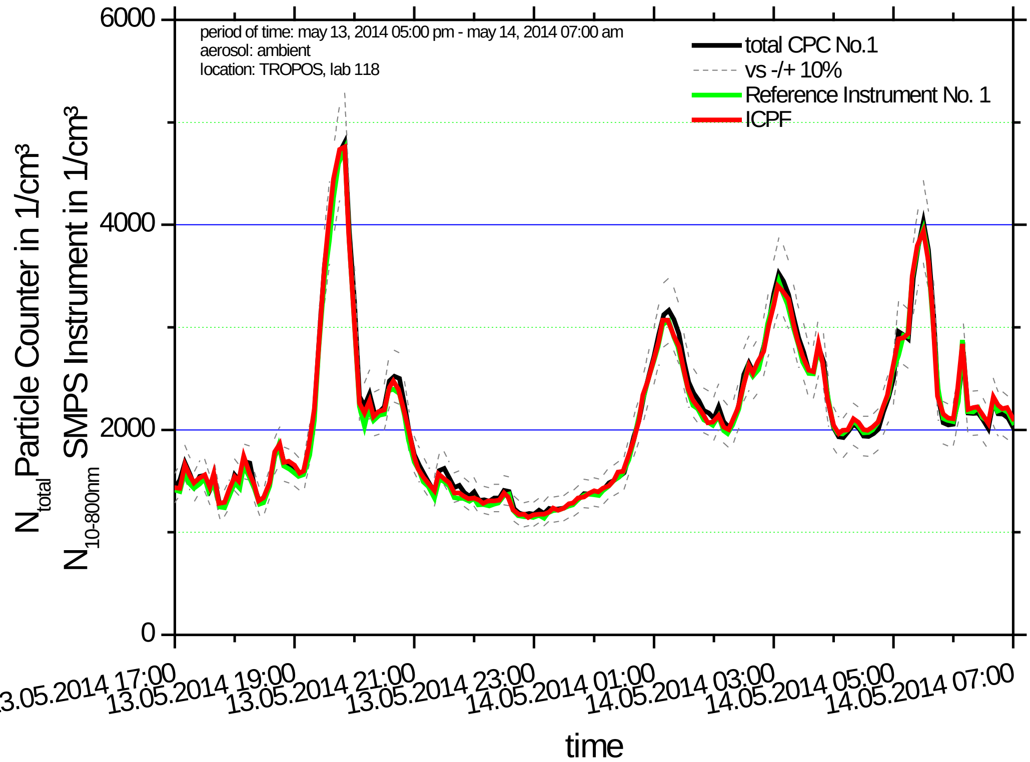


Fig.20. Time series (May 13, 2014 05:00 pm – May 14, 2014 07:00 am) of the integrated particle number concentration (N 20-800nm) of SMPS ICPF and TROPOS reference instrument No.1. Multiple charge correction and internal diffusion losses are included.

3. Correlation of SMPS ICPF

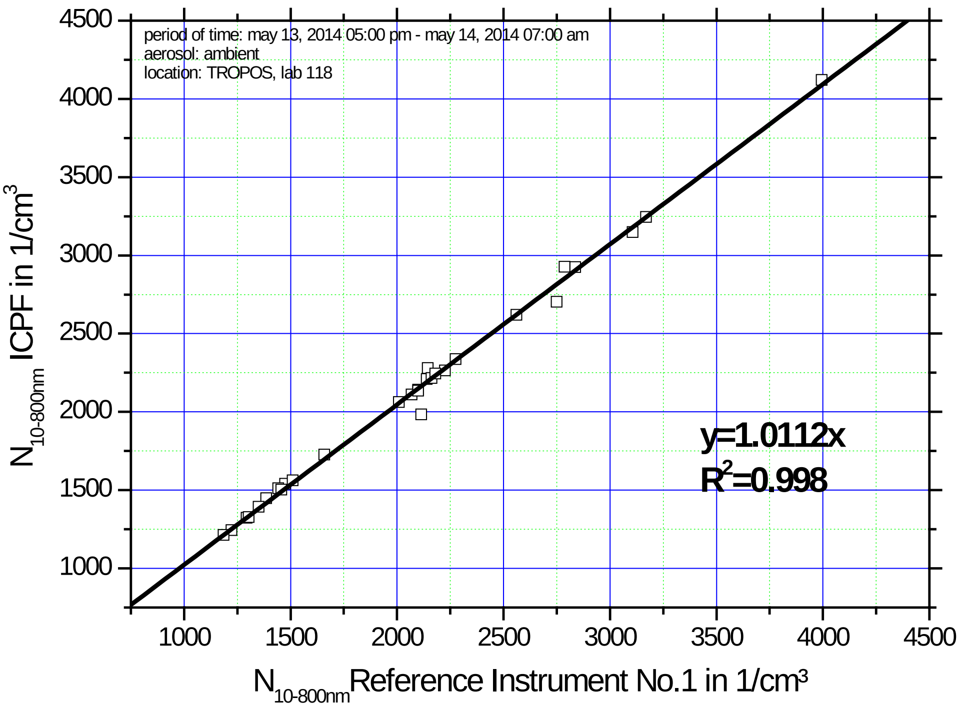


Fig.21. Linear regression between the number concentrations of the TROPOS reference instrument No. 1 and SMPS ICPF. Multiple charge correction and internal diffusion losses are included.

4. Size distribution

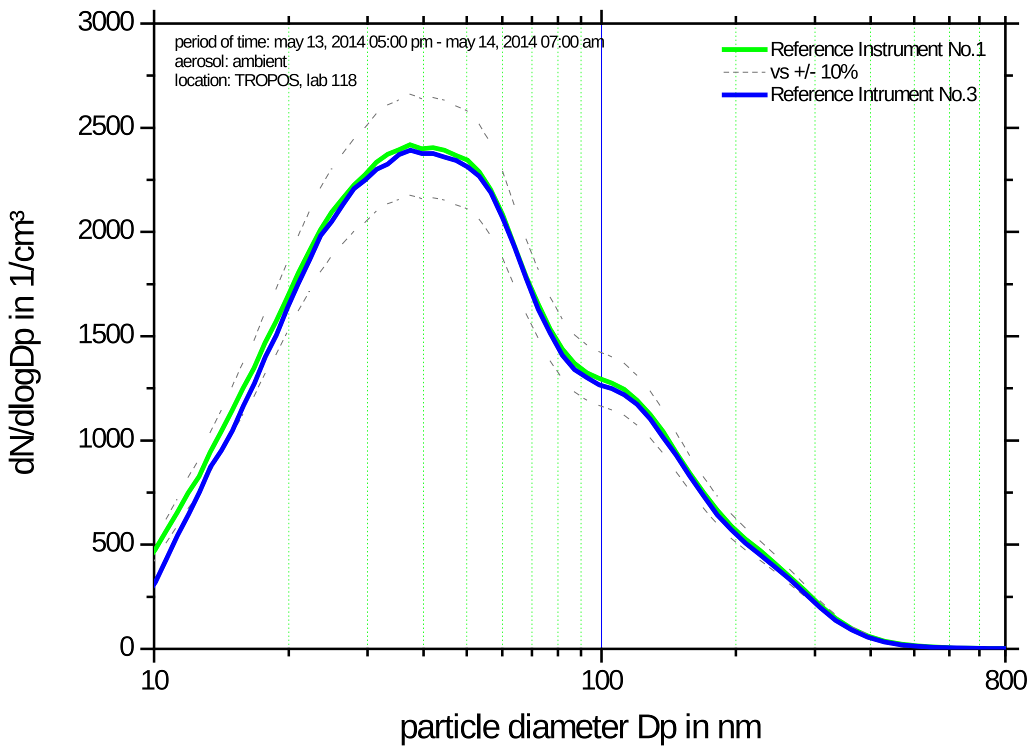


Fig.22. Comparison of mean particle number size distribution between May 13, 2014 05:00 pm and May 14, 2014 07:00 am. Multiple charge correction, internal diffusion losses and CPC efficiency are included (.in2).

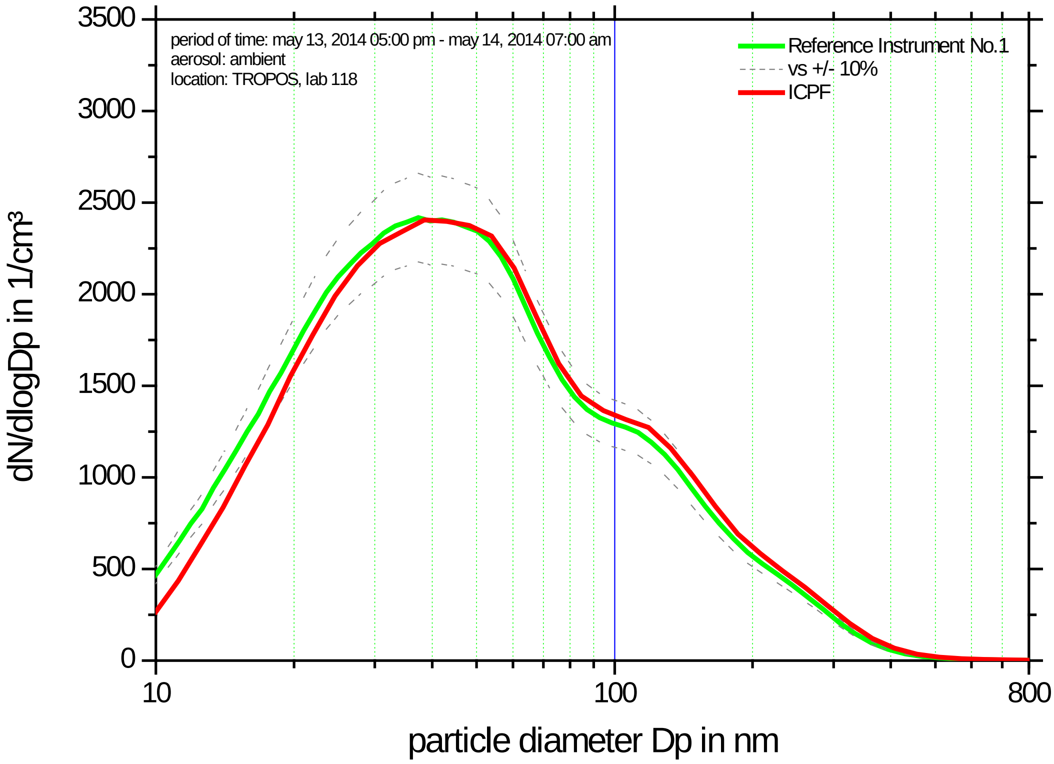


Fig.23. Comparison of mean particle number size distribution of SMPS ICPF and TROPOS reference instrument No.1 between May 13, 2014 05:00 pm and May 14, 2014 07:00 am. Multiple charge correction, internal diffusion losses and CPC efficiency are included (.in2).

C: third run (May 14, 2014 07:00 pm – May 15, 2014 07:00 am)

1. Correlation of reference instruments

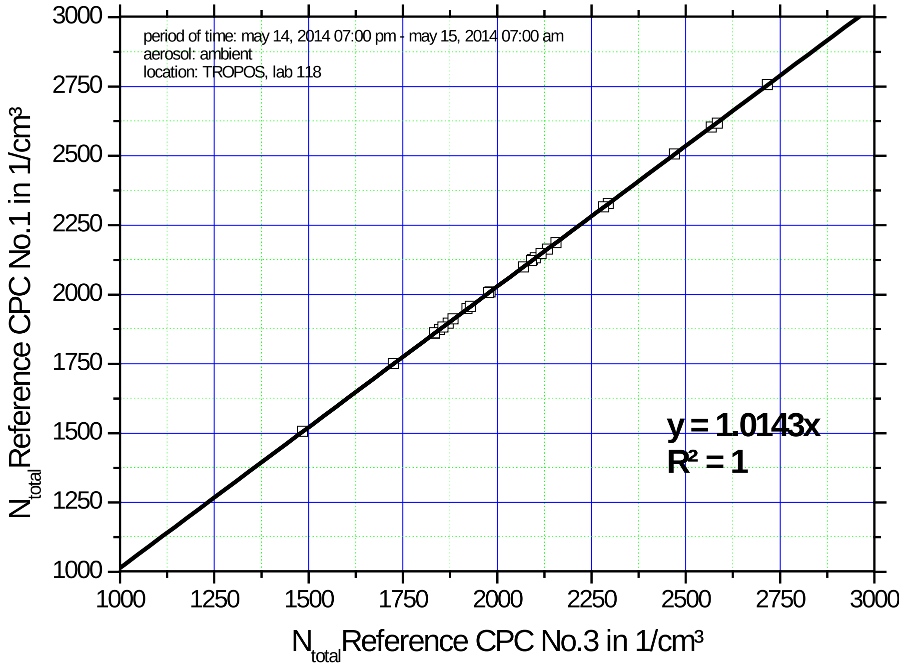


Fig.24. Linear regression between the number concentrations of the TROPOS reference CPC No.1 and the TROPOS reference CPC No.3. Multiple charge correction, internal diffusion losses and flow corrections are included.

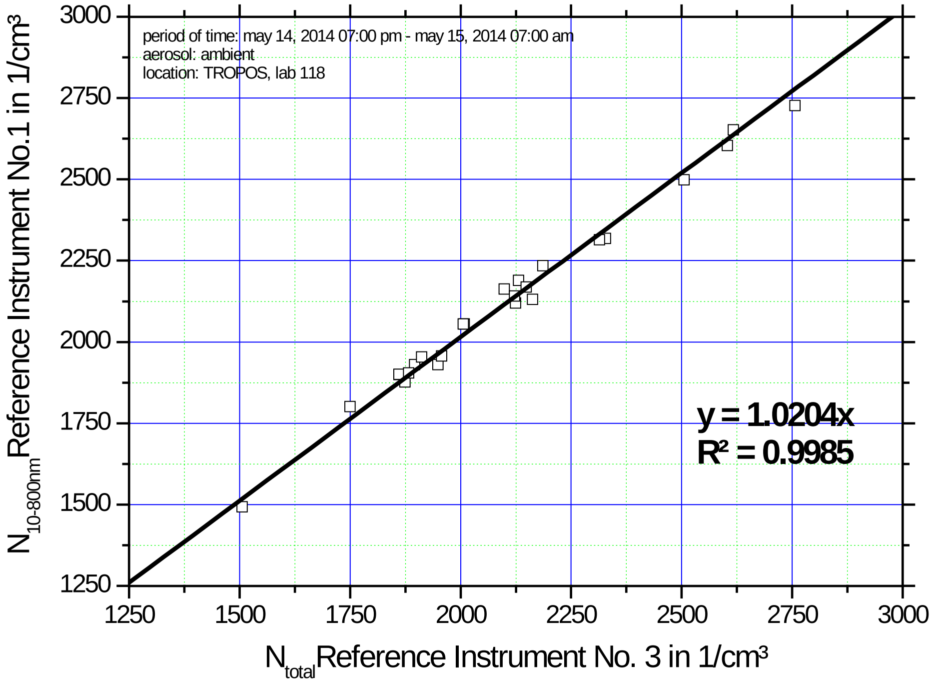


Fig.25. Linear regression between the number concentrations of the TROPOS reference instrument No. 1 and the TROPOS reference instrument No. 3. Multiple charge correction, internal diffusion losses and flow corrections are included.

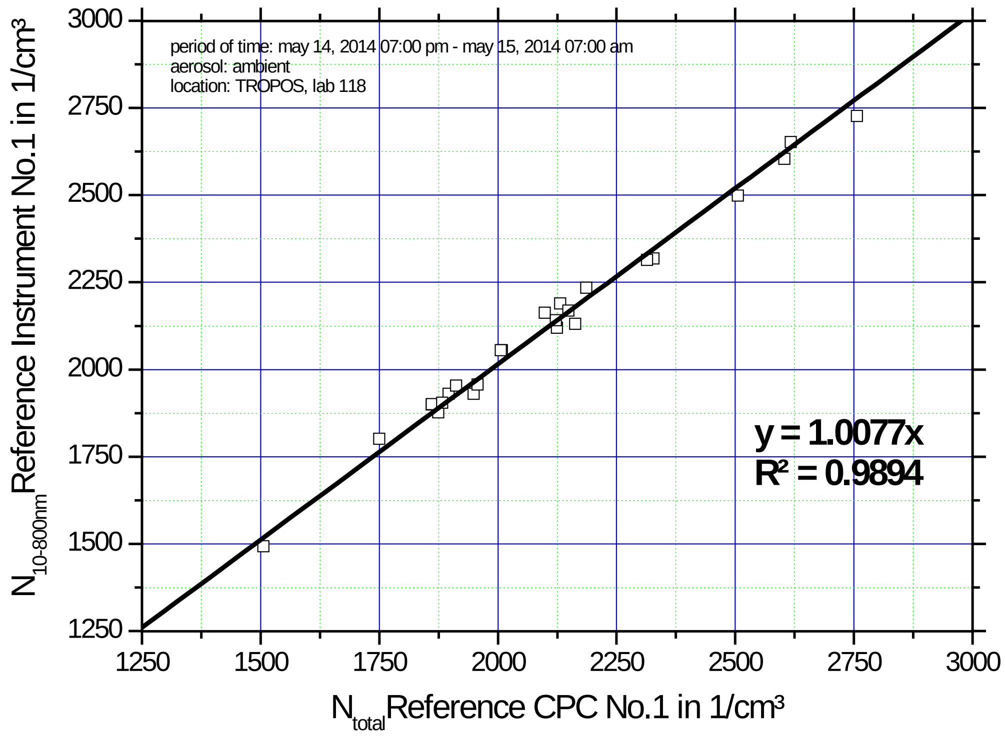


Fig.26. Linear regression between the number concentrations of the TROPOS reference instrument No. 1 and TROPOS reference CPC No.1. Multiple charge correction, internal diffusion losses and flow corrections are included.

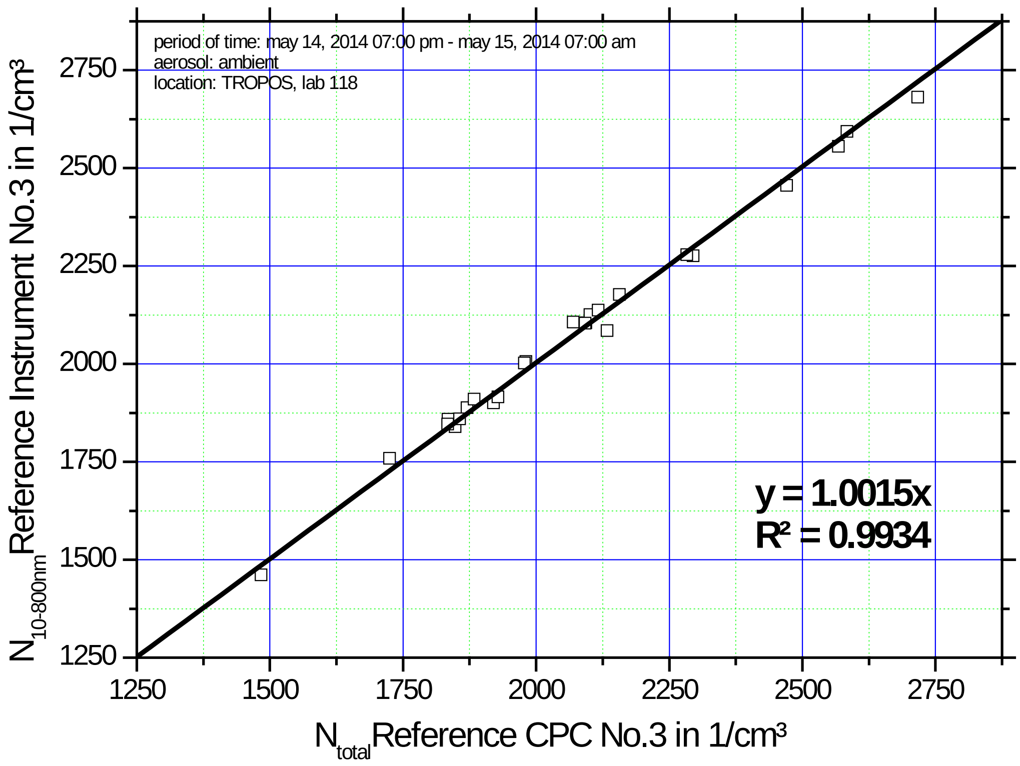


Fig.27. Linear regression between the number concentrations of the TROPOS reference instrument No. 3 and TROPOS reference CPC No.3. Multiple charge correction, internal diffusion losses and flow corrections are included.

2. Time series

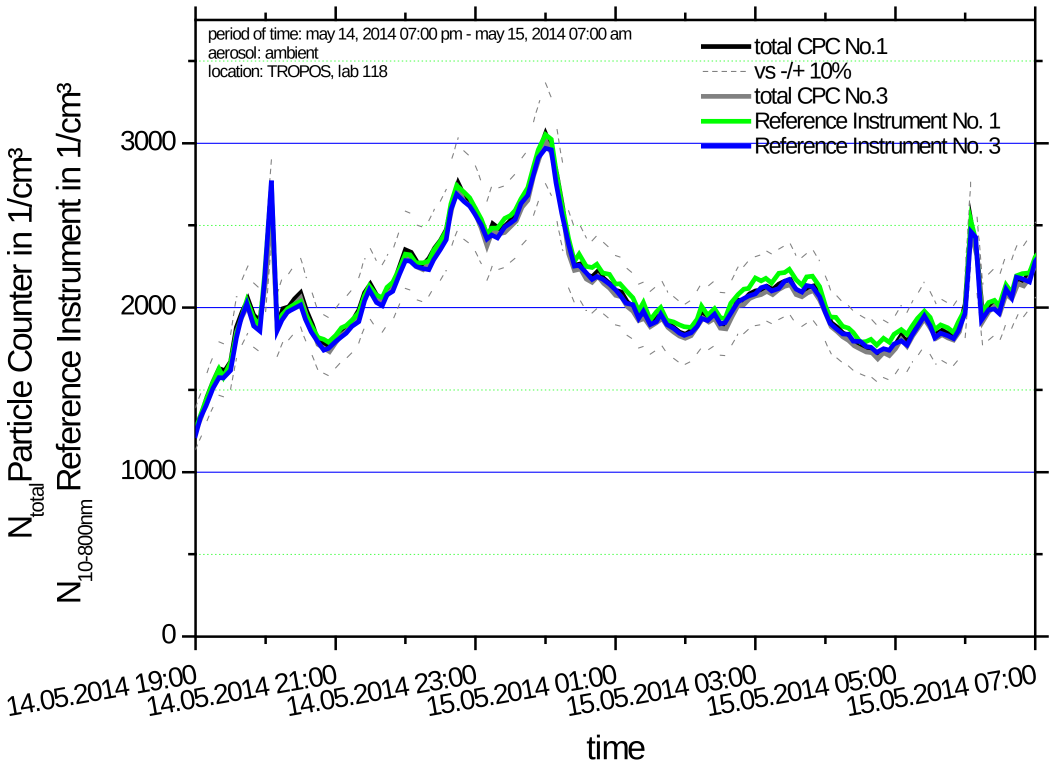


Fig.28. Time series (May 14, 2014 07:00 pm – May 15, 2014 07:00 am) of the integrated particle number concentration (N 10-800nm). Multiple charge correction, internal diffusion losses and flow corrections are included.

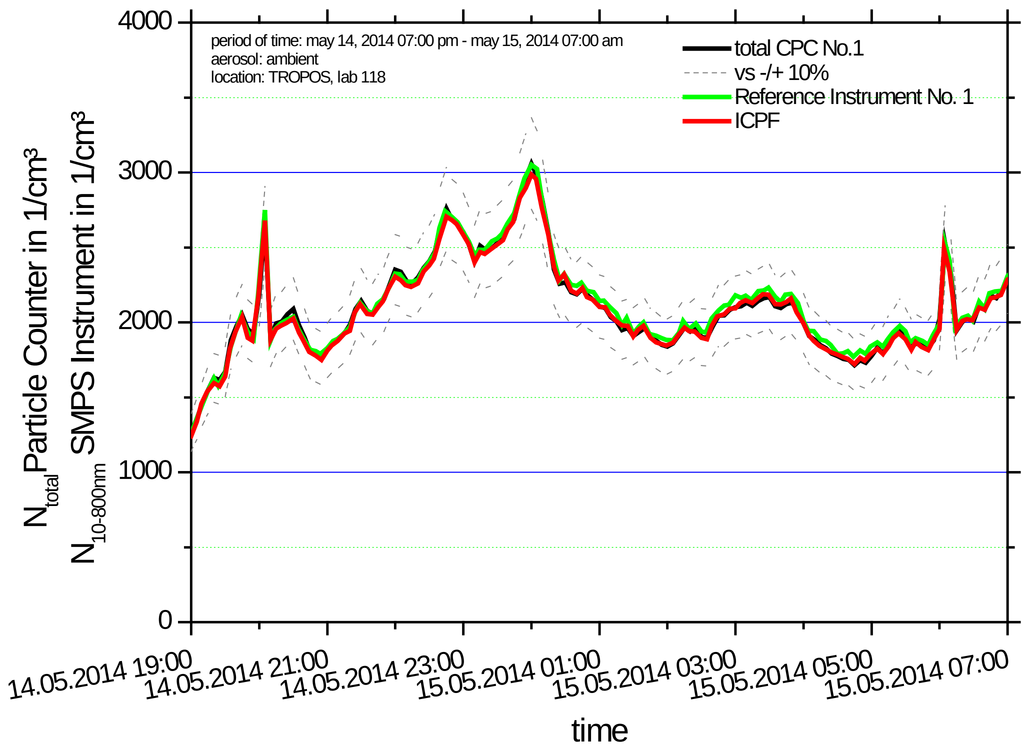


Fig.29. Time series (May 14, 2014 07:00 pm – May 15, 2014 07:00 am) of the integrated particle number concentration (N 20-800nm) of SMPS ICPF and TROPOS reference instrument No.1. Multiple charge correction and internal diffusion losses are included.

3. Correlation of SMPS ICPF

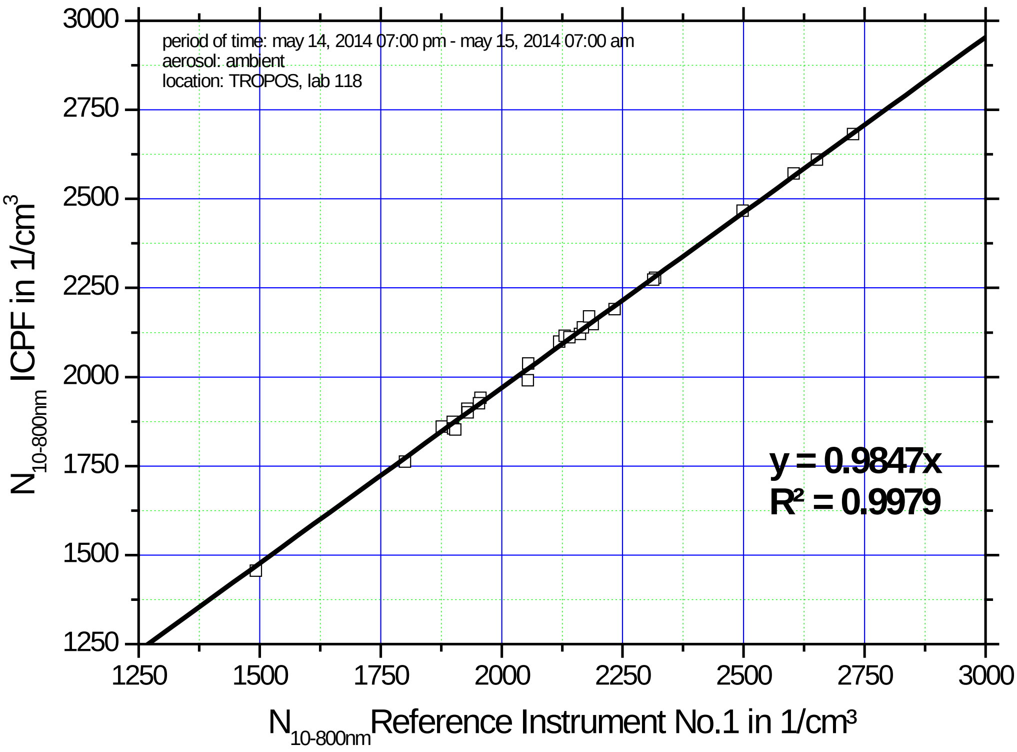


Fig.30. Linear regression between the number concentrations of the TROPOS reference instrument No.1 and SMPS ICPF. Multiple charge correction and internal diffusion losses are included.

4. Size distribution

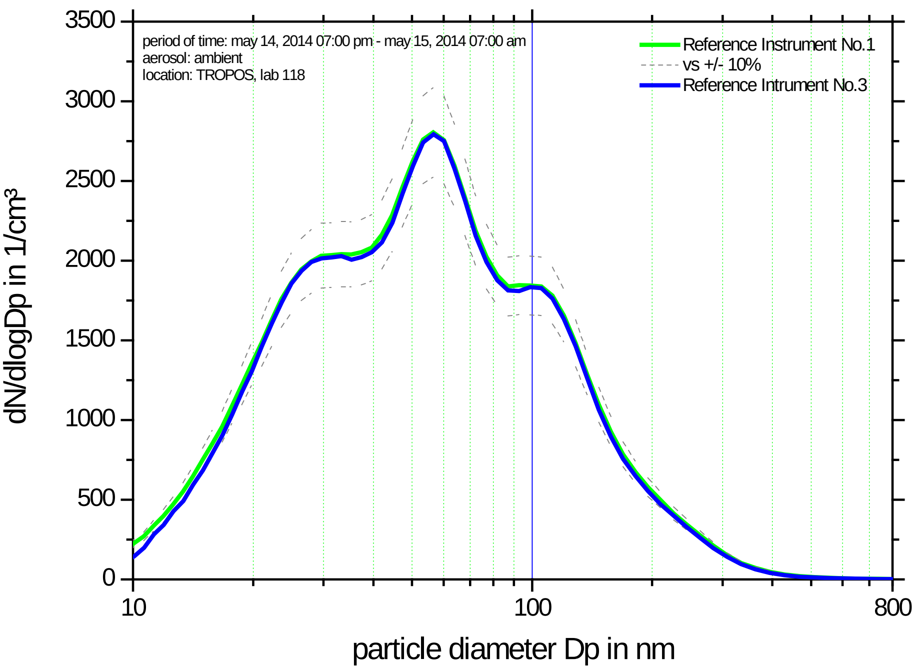


Fig.31. Comparison of mean particle number size distribution between May 14, 2014 07:00 pm and May 15, 2014 07:00 am. Multiple charge correction, internal diffusion losses and CPC efficiency are included (.in2).

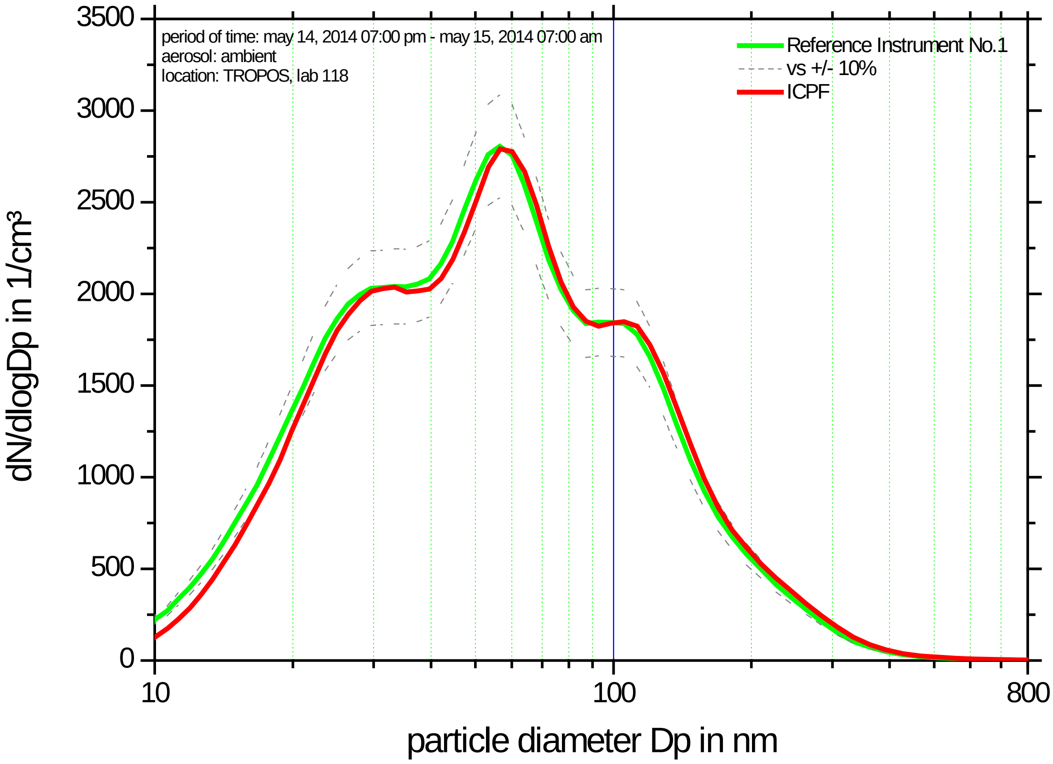


Fig.32. Comparison of mean particle number size distribution of SMPS ICPF and TROPOS reference instrument No.1 between May 14, 2014 07:00 pm and May 15, 2014 07:00 am. Multiple charge correction, internal diffusion losses and CPC efficiency are included (.in2).

D: fourth run (May 15, 2014 08:00 pm – May 16, 2014 06:00 am)

1. Correlation reference instruments

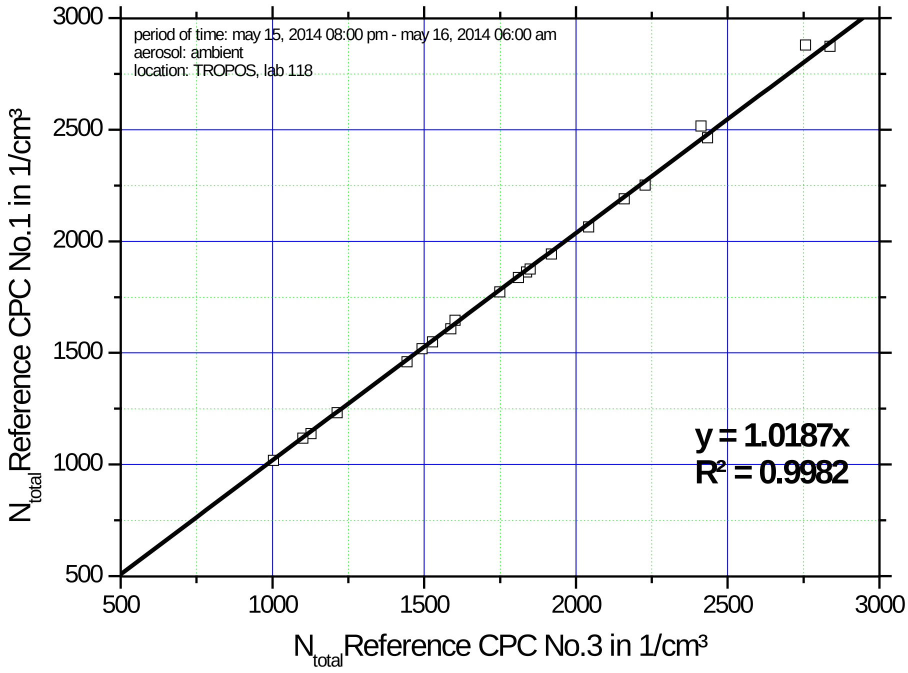


Fig.33. Linear regression between the number concentrations of the TROPOS reference CPC No.1 and the TROPOS reference CPC No.3. Multiple charge correction, internal diffusion losses and flow corrections are included.

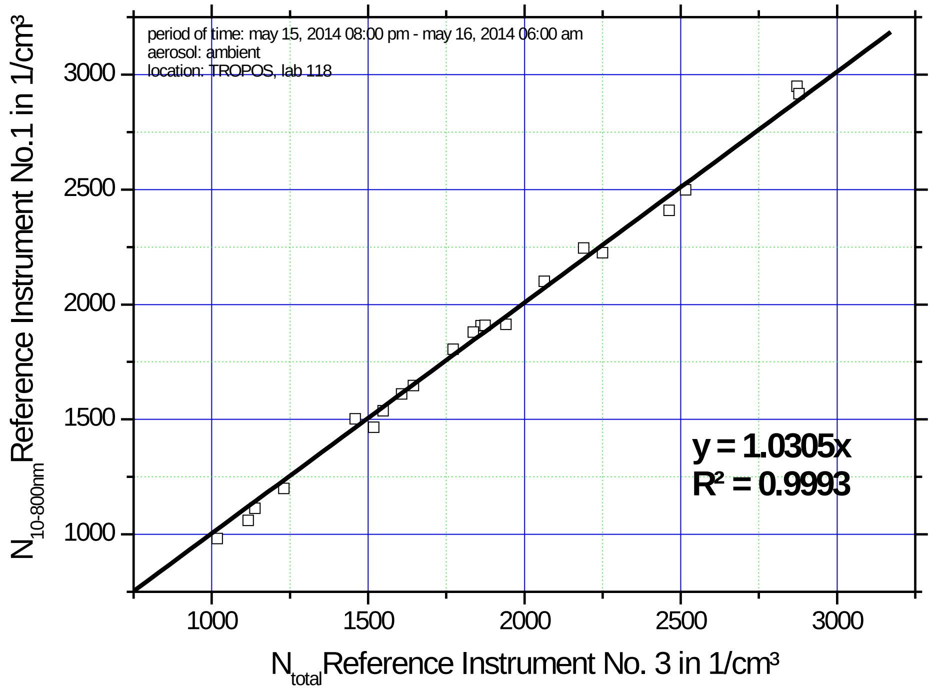


Fig.34. Linear regression between the number concentrations of the TROPOS reference instrument No. 1 and the TROPOS reference instrument No. 3. Multiple charge correction, internal diffusion losses and flow corrections are included.

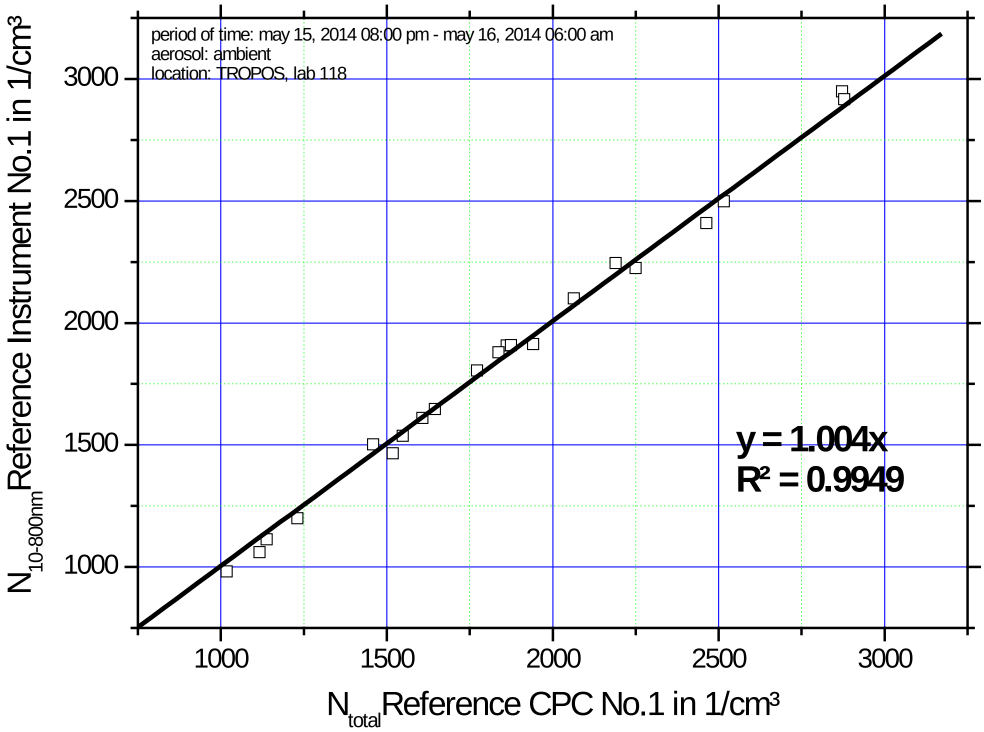


Fig.35. Linear regression between the number concentrations of the TROPOS reference instrument No. 1 and TROPOS reference CPC No.1. Multiple charge correction, internal diffusion losses and flow corrections are included.

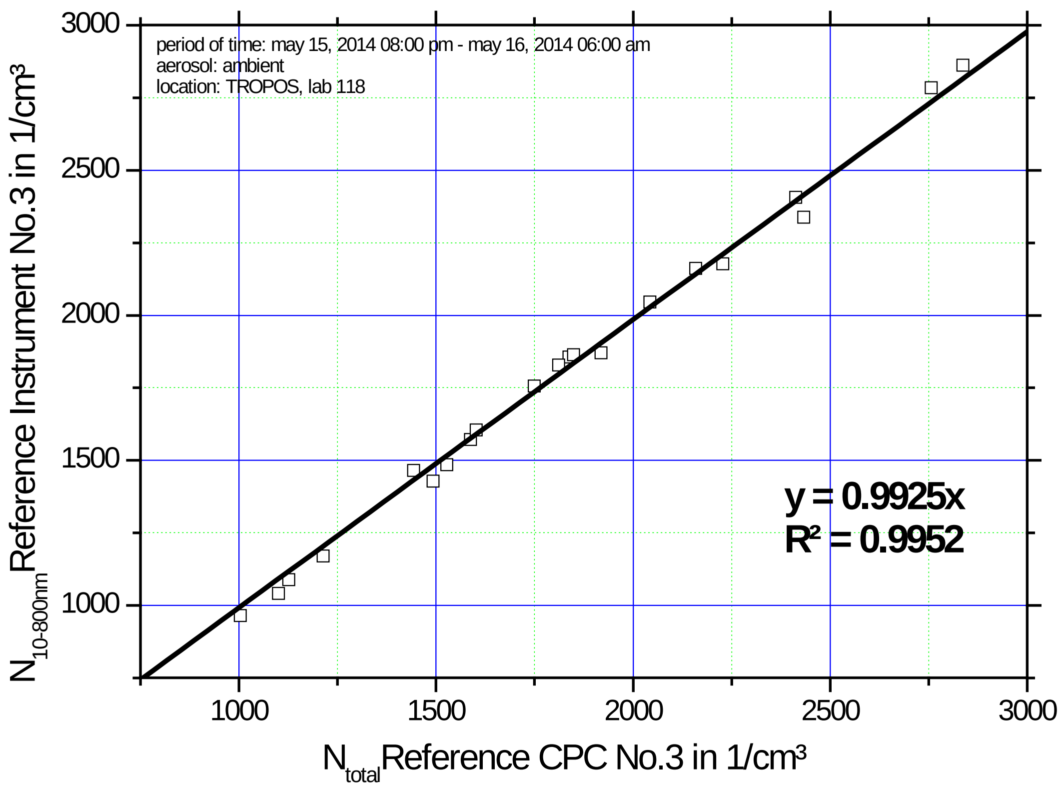


Fig.36. Linear regression between the number concentrations of the TROPOS reference instrument No. 3 and TROPOS reference CPC No.3. Multiple charge correction, internal diffusion losses and flow corrections are included.

2. Time series

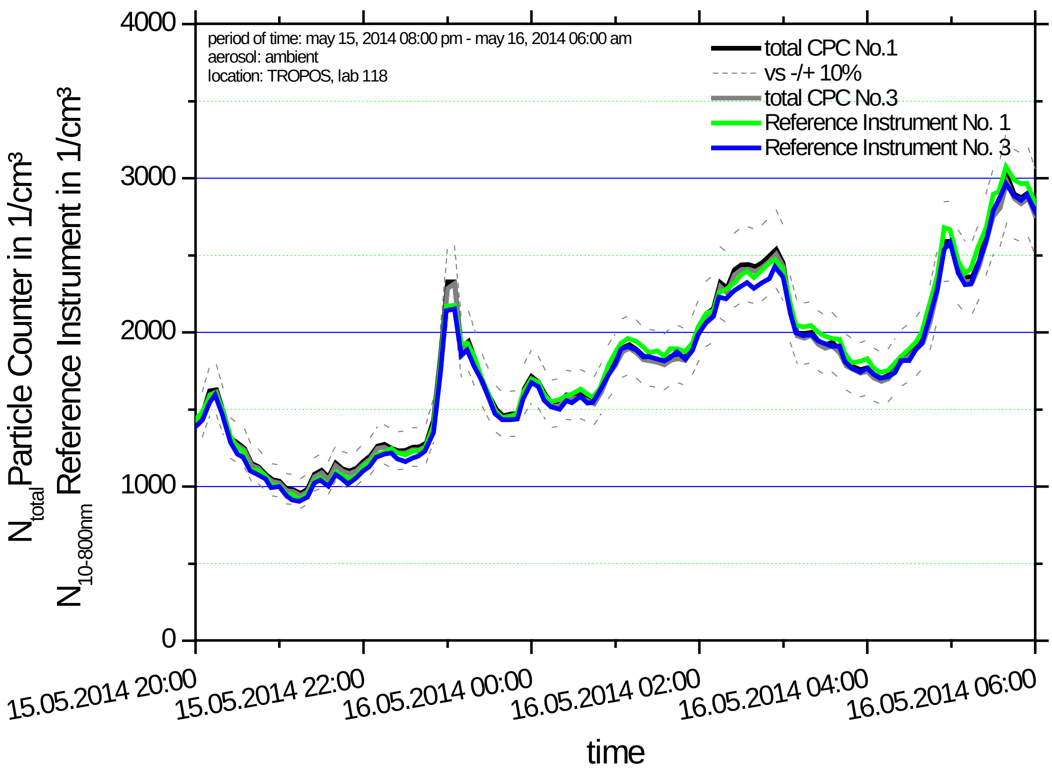


Fig.37. Time series (May 15, 2014 08:00 pm – May 16, 2014 06:00 am) of the integrated particle number concentration (N 10-800nm). Multiple charge correction, internal diffusion losses and CPC efficiency are included.

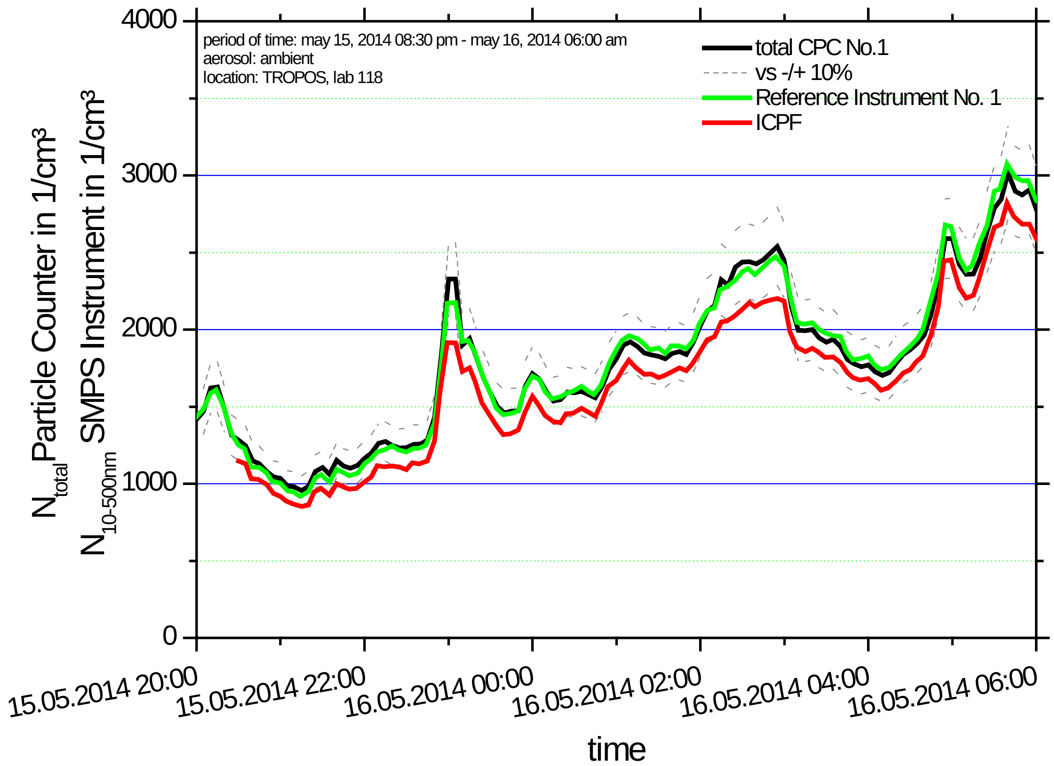


Fig.38. Time series (May 15, 2014 08:00 pm – May 16, 2014 06:00 am) of the integrated particle number concentration (N 10-800nm) of SMPS ICPF and TROPOS reference instrument No.1. Multiple charge correction and internal diffusion losses are included.

3. Correlation of SMPS ICPF

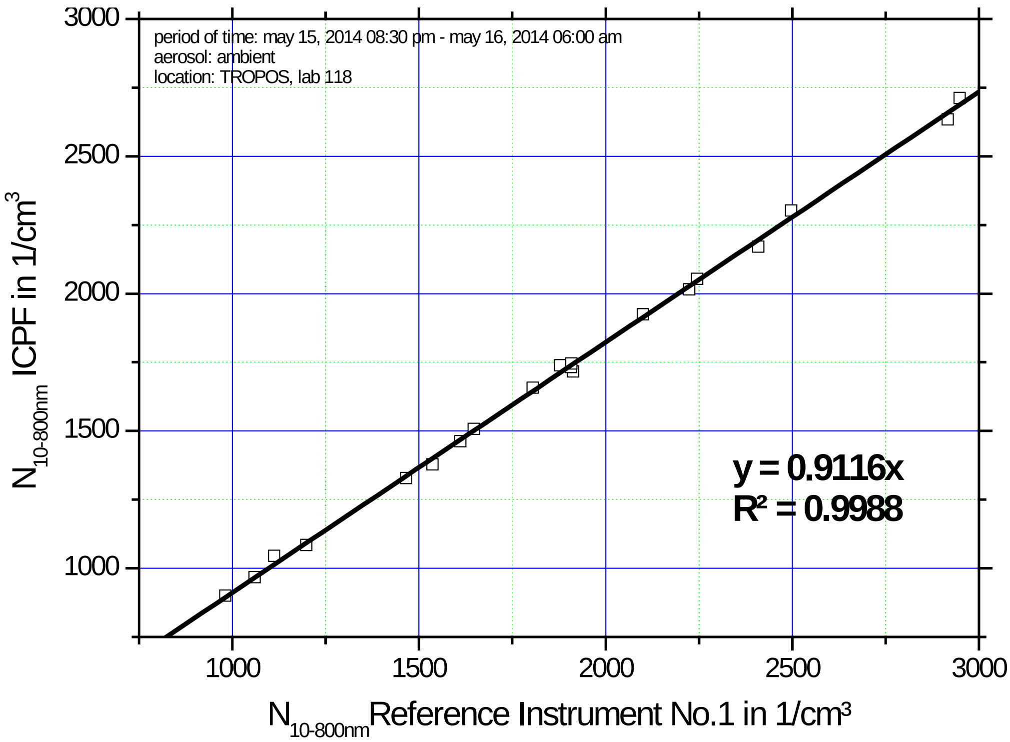


Fig.39. Linear regression between the number concentrations of the TROPOS reference instrument No.1 and SMPS ICPF. Multiple charge correction and internal diffusion losses are included.

4. Size distribution

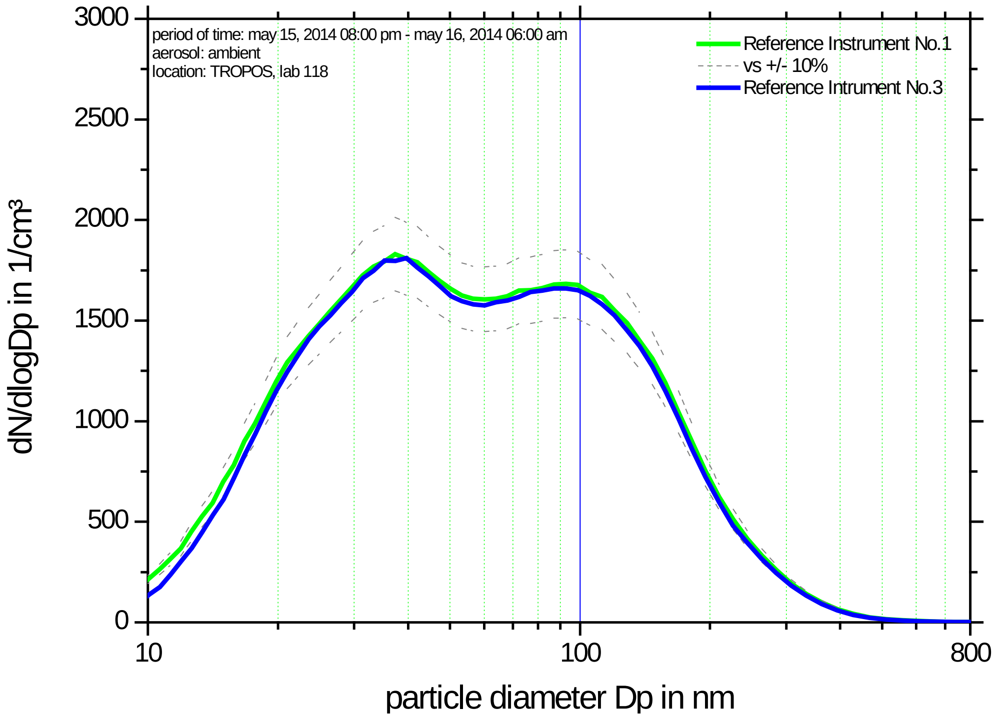


Fig.35. Comparison of mean particle number size distribution between May 15, 2014 08:00 pm and May 16, 2014 06:00 am. Multiple charge correction, internal diffusion losses and CPC efficiency are included (.in2).

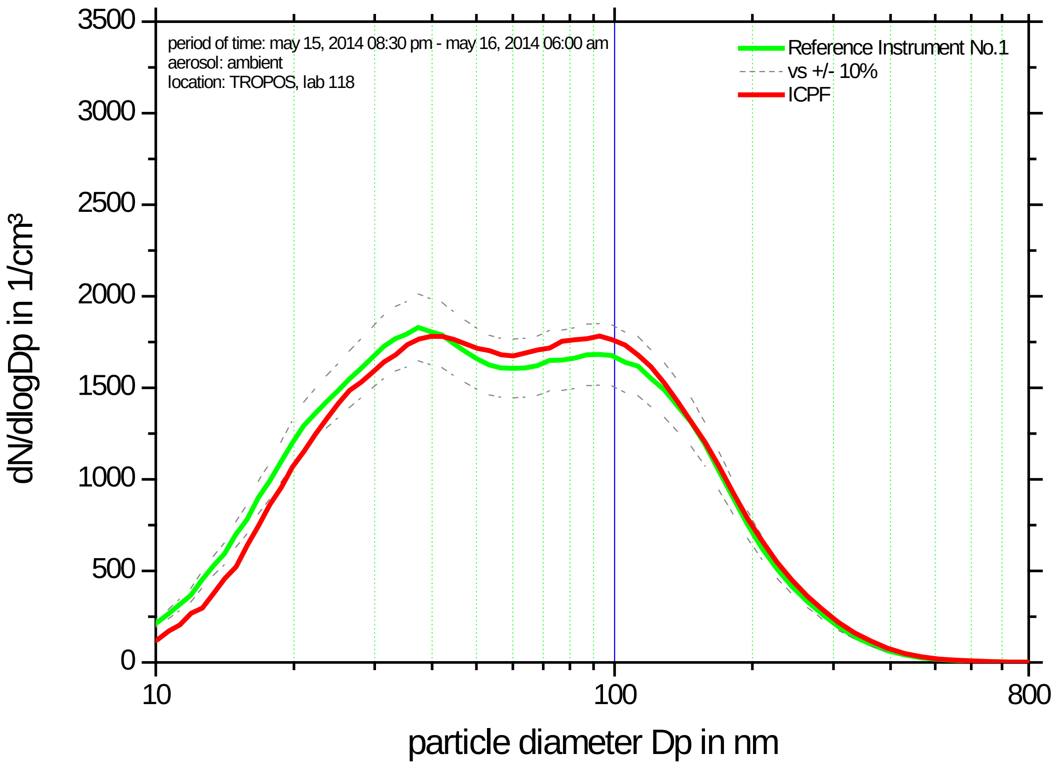


Fig.35. Comparison of mean particle number size distribution of SMPS ICPF and TROPOS reference instrument No.1 between May 15, 2014 08:30 pm and May 16, 2014 06:00 am. Multiple charge correction, internal diffusion losses and CPC efficiency are included (.in2).

Intercomparison of TROPOS MTC DMPS ISAC

Basic information

Location of the quality assurance:	TROPOS, lab: 118
Delivery date:	May 12, 2014
Setup in the laboratory:	May 12, 2014
Comparison period:	May 12, 2014 – May 16, 2014
Instrument:	MTC DMPS
TROPOS Reference Instrument:	TROPOS Reference Instrument No. 1 TROPOS Reference Instrument No. 3
Total CPC:	TROPOS Reference CPC No.1; SN: 3772112101 TROPOS Reference CPC No.3; SN: 3772111903
Additional equipment:	
Involved people:	Angela Marinoni (A.Marinoni@isac.cnr.it)

Summary of second intercomparison:

From May 12, 2014 to May 16, 2014 the ISAC TROPOS MTC DMPS participated the TROPOS ACTRIS Workshop. The workshop consisted of an entrance test and a final run. In addition to the overnight ambient measurements, we had numerous high voltage checks, zero- and PSL-measurements. The report is divided into three sections. The first section shows the laboratory setup and the PSL measurement. After that, we show for each run the time series of the particle number concentration, the particle number size distribution, and correlation plots. If anything was written in the log book, so we added this also in this report. As reference standards, we used CPCs model TSI 3772 for total particle number concentration and two TROPOS mobility particle size spectrometer. The particle counters have been calibrated against a calibrated TSI electrometer 3068 B with the serial number 70838596.

For the PSL-calibrations, we used Latex particle with a nominal size of 203 nm +/- 4 nm. The latex particles have been generated with an aerosol nebulizer. The sheath air flow rate of the candidate system was calibrated to match the latex particle size, if possible. The TROPOS MTC DMPS showed in the PSL-measurements a particle diameter of 200.2 nm. Both the zero check and the high-voltage calibration passed the requirements in the final run. If we look at the final ambient measurement run, the TROPOS MTC DMPS is in the 10%. The DMPS-System was controlled the whole time with a blower from TROPOS! The TROPOS MTC DMPS passed the ACTRIS Workshop.

Log book:

<u>May 12, 2014</u>

	-> DMPS installed, ground problems solved avoiding use of USB ports in T-RH probes. System connected to ground
11:00 am - 04:00 pm	-> CPC workshop
	-> High voltage calibration of Ref1 and Ref3
	-> Measured flows: CPC 1 : 1.040 l/min CPC 3 : 1.029 l/min Ref 1 : 1.018 l/min Ref 3 : 0.9999 l/min
	-> Check flow of DMPS: CPC = 1.001 lpm Aerosol flow = 0.998 lpm Aerosol flow (CPC disconnected) = 0.01 lpm
05:05 pm	-> start latex measurements (3 scans)
05:30 pm	-> zero air measurement
06:07 pm	-> Change range 10-800 nm, measurements overnight

<u>May 13, 2014</u>

03:01 pm	-> LATEX 203 nm measurement
	-> Check voltages: 1.3 mV measured between PC and DMS (still problem of ground present in the system)
03:47 pm	-> stop latex, start zero air
04:28 pm	-> improvement in the ground connection (2 additional point connected at same potential)
04:37 pm	-> stop soft. Acquisition from 7 to 800 nm (the inversion is run only from 3rd bin)

<u>May 14, 2014</u>

Measurements stopped at 02:49 am, because of no voltages in the DMA (V problem)

02:45 pm	-> check sheath flow = 5.2 l/min, while TSI flowmeter show 5.00 l/min Installation of external power supply, adjusted at 5.00 l/min
	Check with latex, peak between 198.7 nm and 205 nm. -> Measured equivalent length:

TSI black tube 70 cm
Source: 1m
Source to DMA: 27 cm
Bend 15 cm
DMA: 4.6 m
DMA to CPC: 20 cm
Bend 15 cm
Total : 7.07 m

04:34 pm -> start measurements overnight

Measurement stopped at 12:00 am, because of voltage problems

May 15, 2014

New cpc.loss insert in the software.
Problem with in2 inverted data (too high).
Raw data ISAC are 3% higher with respect to Ref 3 TROPOS, while CPC should count 0.9% less.

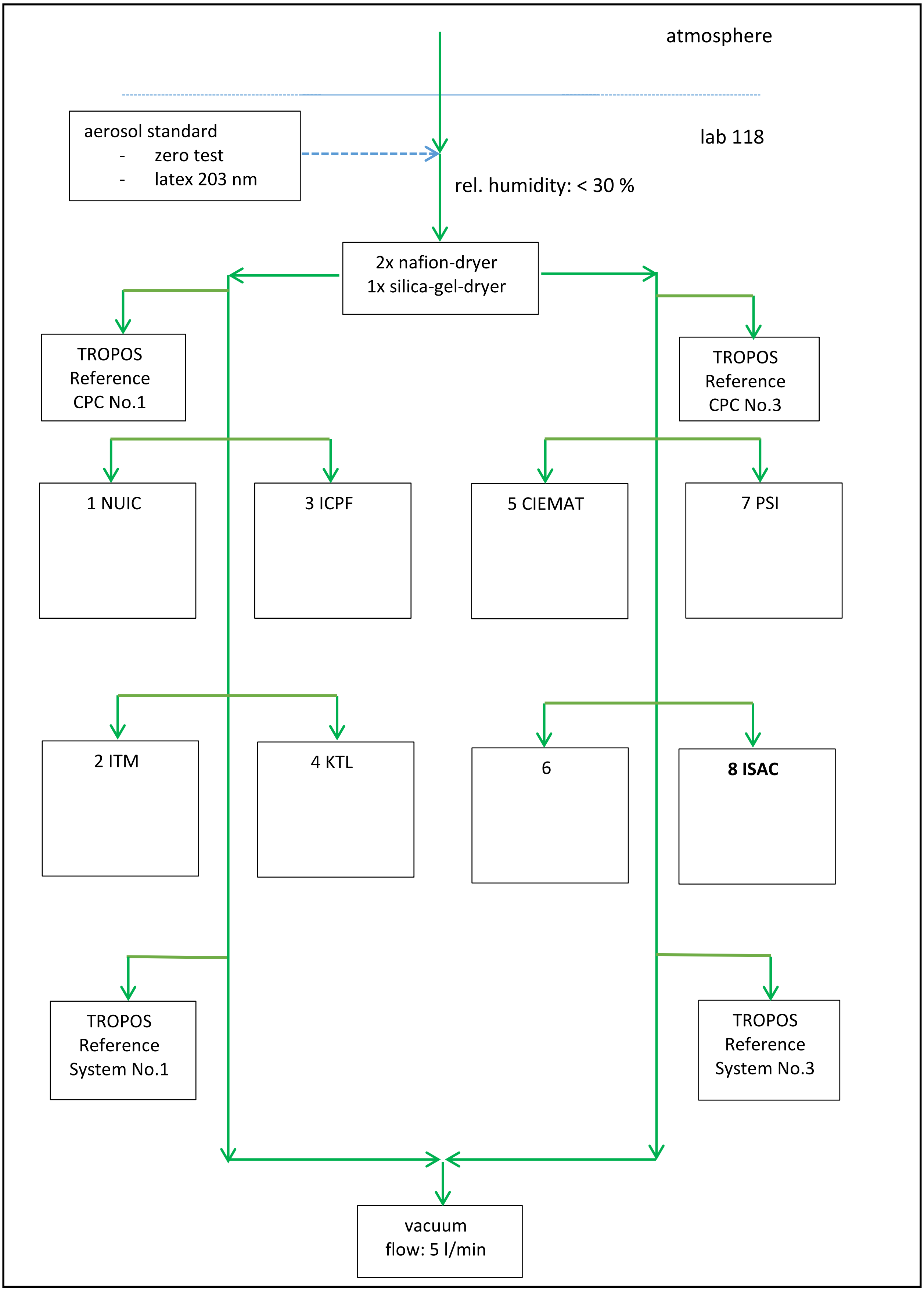
08:30 pm -> zero measurement (perfect at 0!)
Is there a problem in DMA slit?

09:06 pm -> start ambient measurement overnight

May 16, 2013

Measurement stopped at 03:14 am, because of windows update and computer restart.
New CPC efficiency measurement (99% at 40 nm)
With new CPC efficiency in2 inversion problem solved.

Laboratory setup



CPC Efficiency

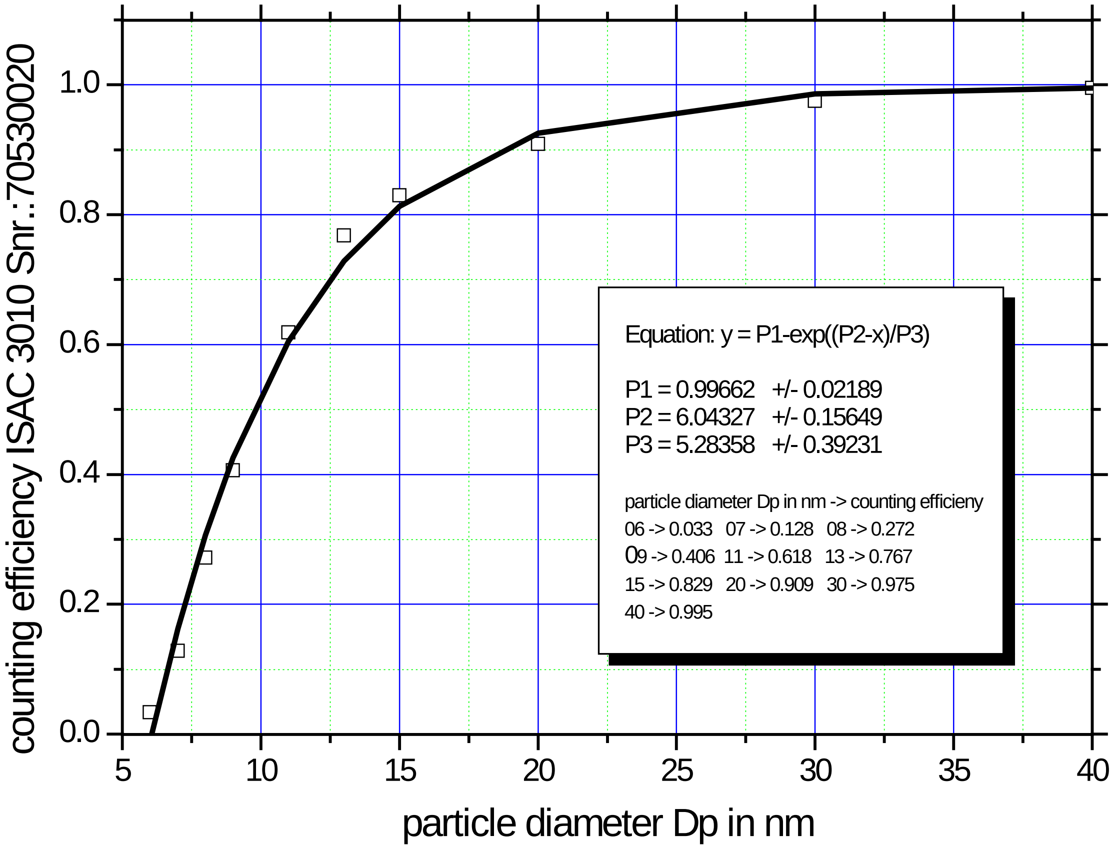


Fig.1. CPC efficiency curve. Based on Electrometer TSI 3068B. Serial number: 70838596

Latex 203 nm

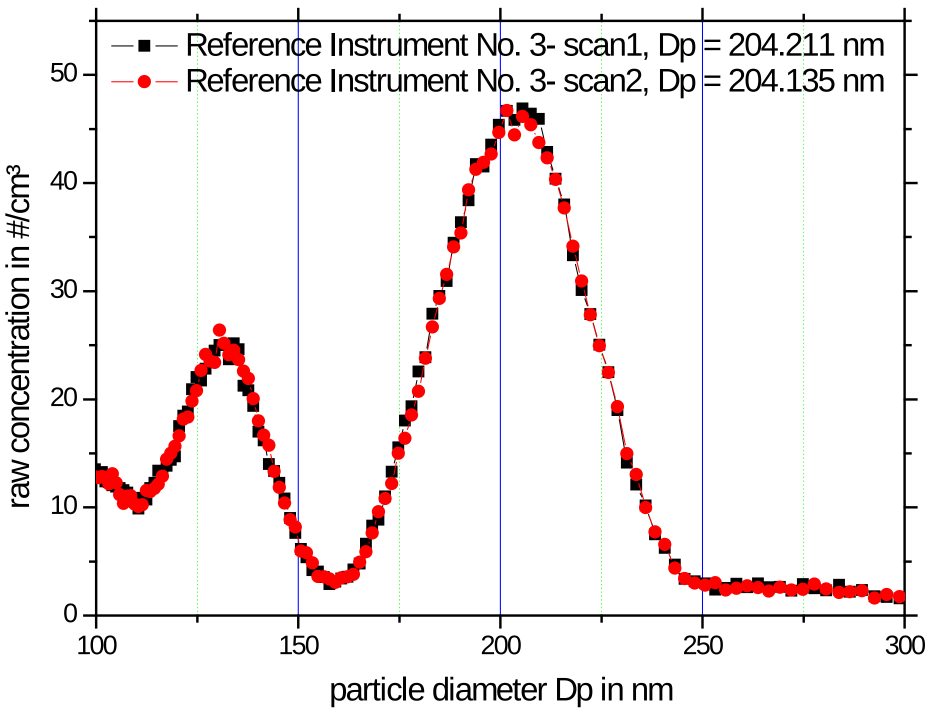


Fig.2. Measurement of latex 203 nm for TROPOS reference instrument No.3: Particle size distribution (raw concentration) for latex 203 nm on May 12, 2014 between 05:10 pm and 05:25 pm.

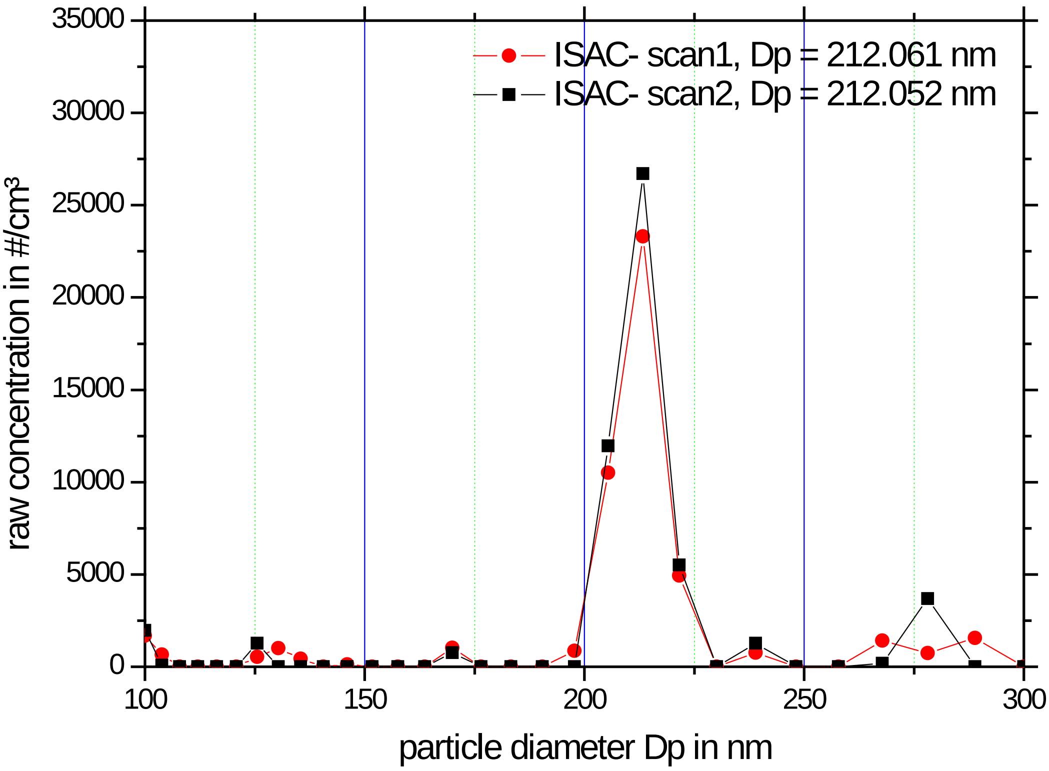


Fig.3. Measurement of latex 203 nm for instrument DMPS ISAC: particle size distribution (raw concentration) for latex 203 nm on May 12, 2014 between 04:27 pm and 05:06 pm.

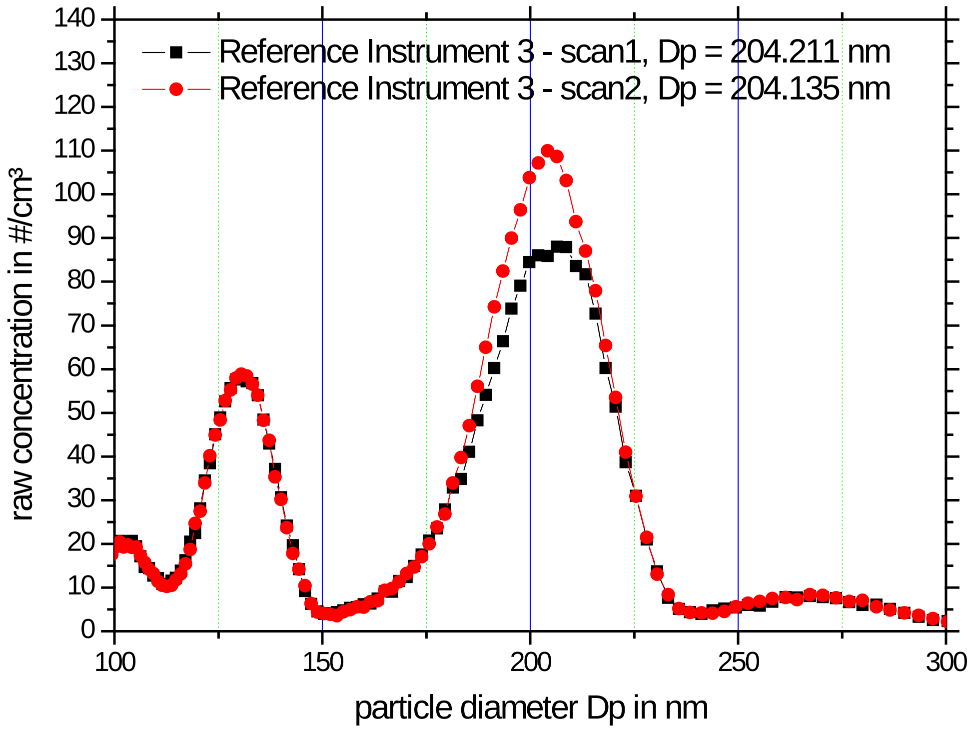


Fig.4. Measurement of latex 203 nm for TROPOS reference instrument No.3: Particle size distribution (raw concentration) for latex 203 nm on May 13, 2014 between 03:13 pm and 03:39 pm.

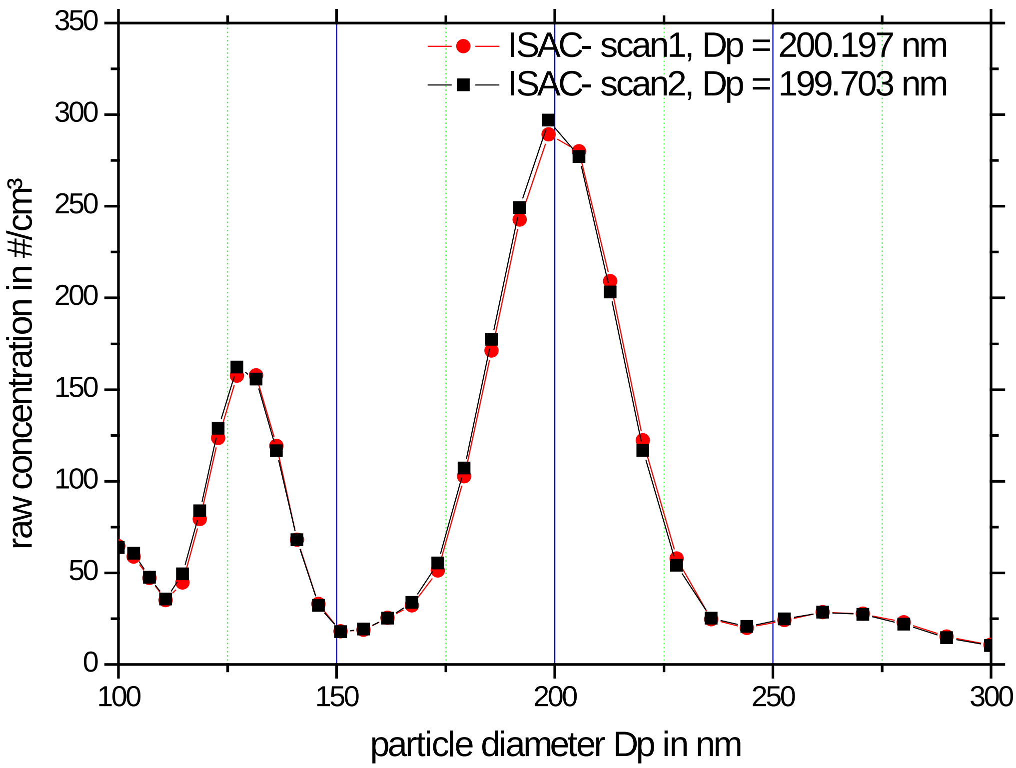


Fig.5. Measurement of latex 203 nm for instrument DMPS ISAC: particle size distribution (raw concentration) for latex 203 nm on May 14, 2014 between 03:01 pm and 03:47 pm.

A: first run (May 12, 2014 06:00 pm – May 13, 2014 08:00 am)

1. Correlation of reference instruments

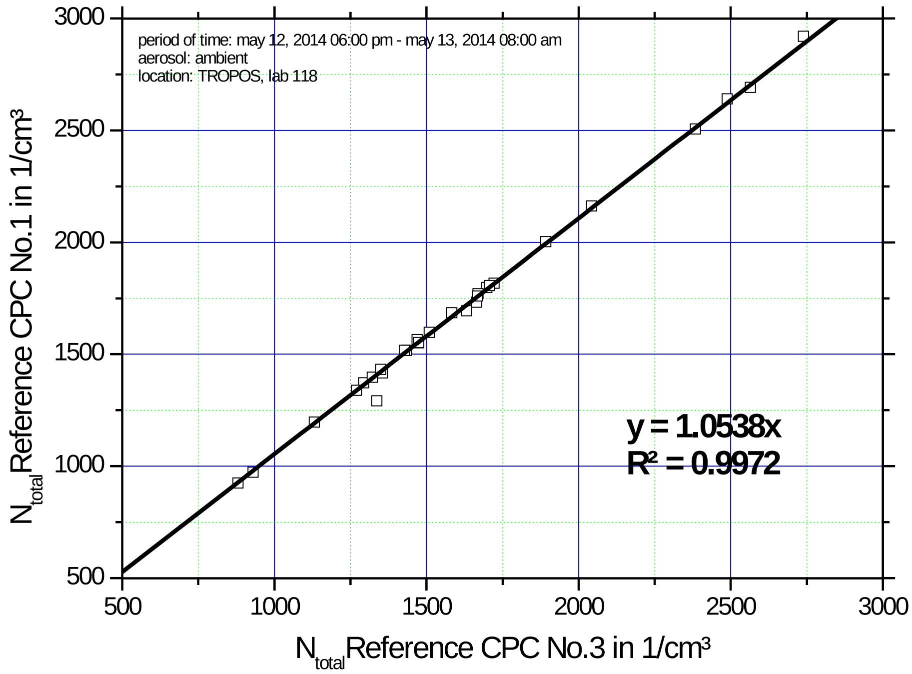


Fig.6. Linear regression between the number concentrations of the TROPOS reference CPC No.1 and the TROPOS reference CPC No.3. Multiple charge correction, internal diffusion losses and flow corrections are included.

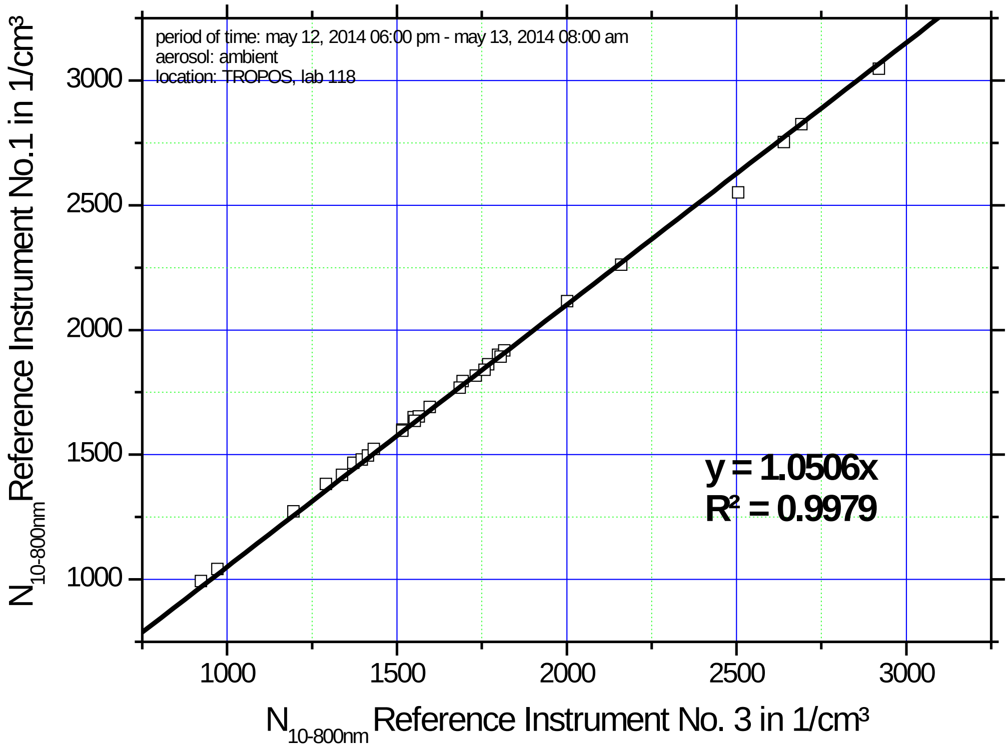


Fig.7. Linear regression between the number concentrations of the TROPOS reference instrument No.1 and the TROPOS reference instrument No.3. Multiple charge correction, internal diffusion losses and flow corrections are included.

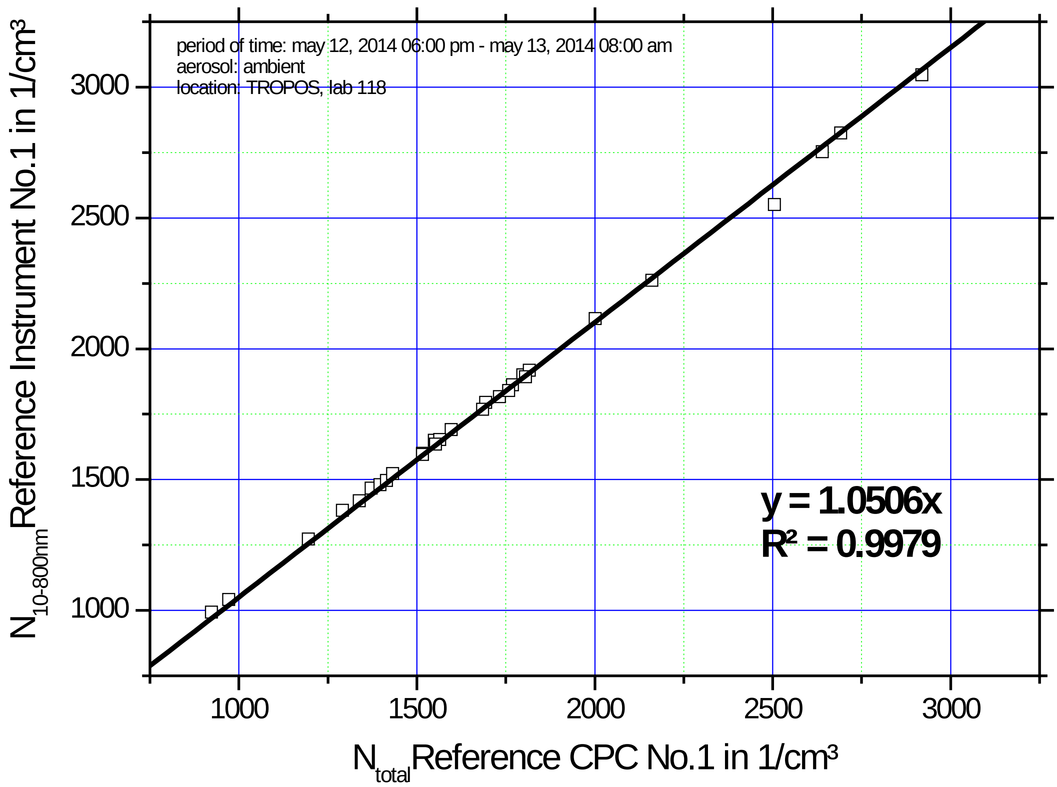


Fig.8. Linear regression between the number concentrations of the TROPOS reference instrument No.1 and TROPOS reference CPC No.1. Multiple charge correction, internal diffusion losses and flow corrections are included.

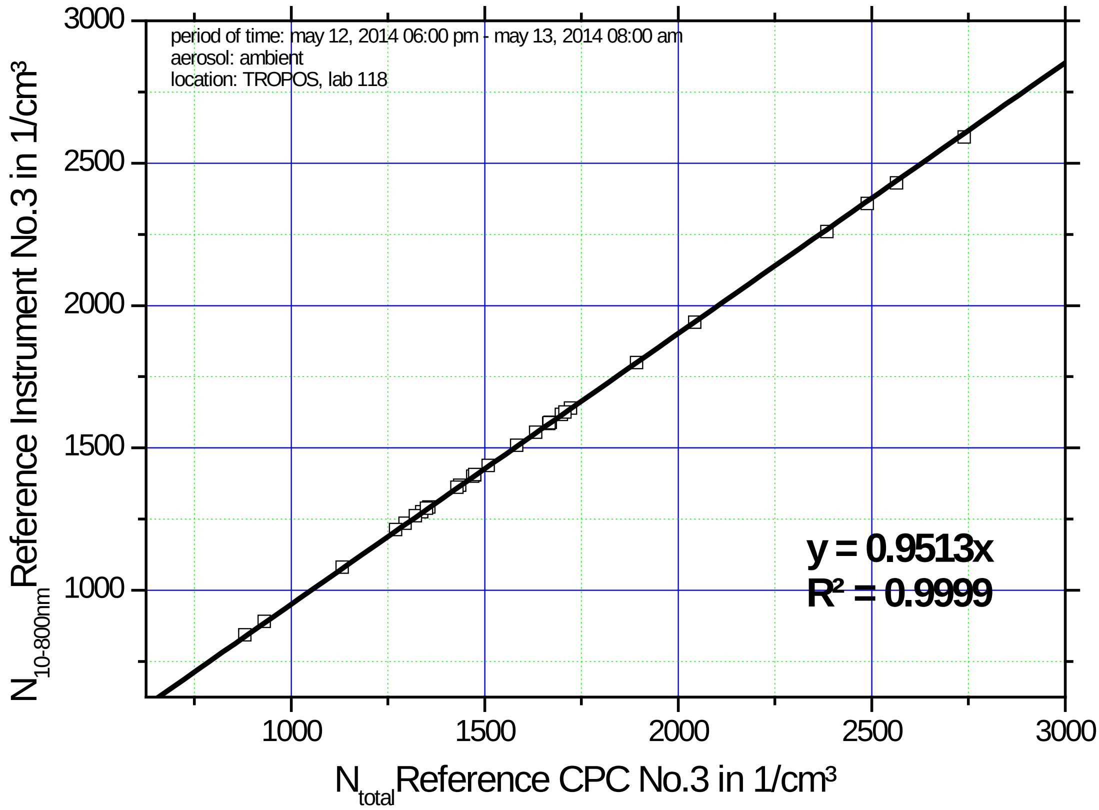


Fig.9. Linear regression between the number concentrations of the TROPOS reference instrument No.3 and TROPOS reference CPC No.3. Multiple charge correction, internal diffusion losses and flow corrections are included.

2. Time series

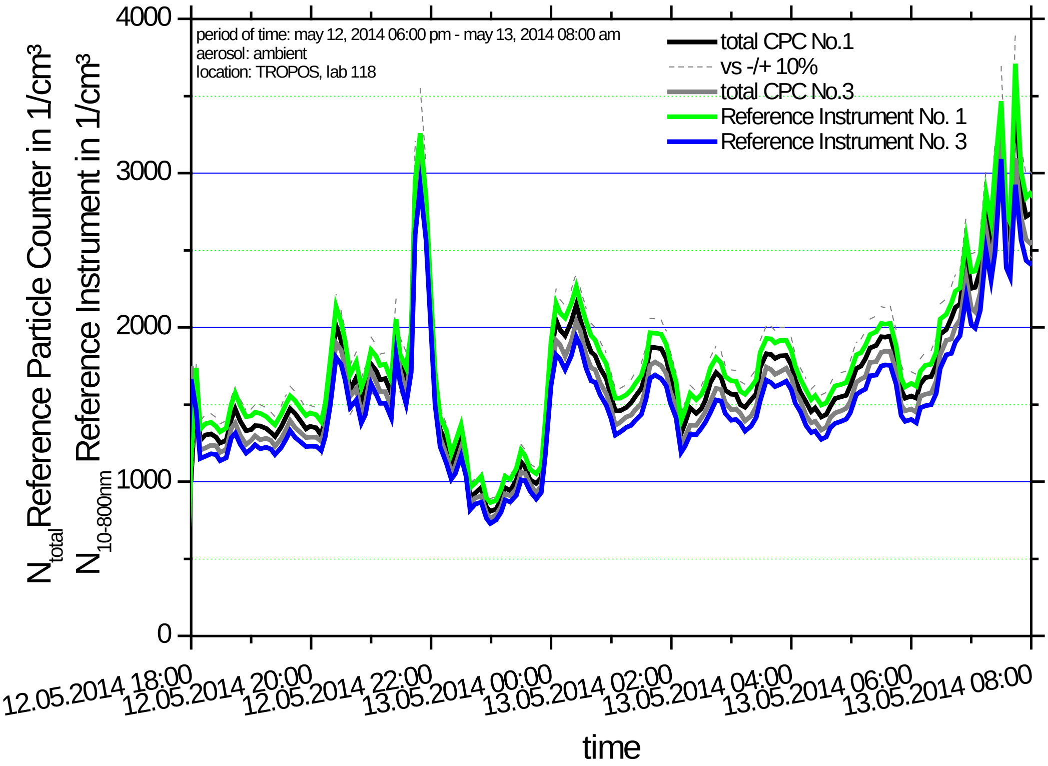


Fig.10. Time series (May 12, 2014 06:00 pm – May 13, 2014 08:00 am) of the integrated particle number concentration (N 10-800nm). Multiple charge correction, internal diffusion losses and flow corrections are included.

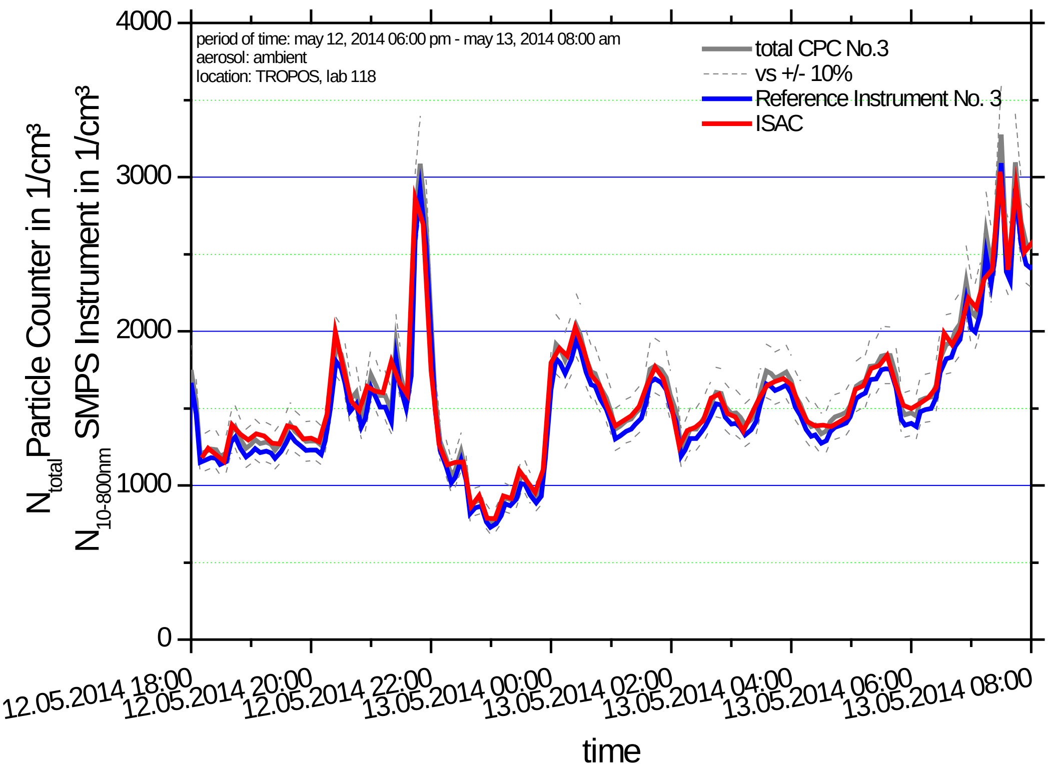


Fig.11. Time series (May 12, 2014 06:00 pm – May 13, 2014 08:00 am) of the integrated particle number concentration (N 10-800 nm) of DMPS ISAC and TROPOS reference instrument No.3. Multiple charge correction and internal diffusion losses are included.

3. Correlation of DMPS ISAC

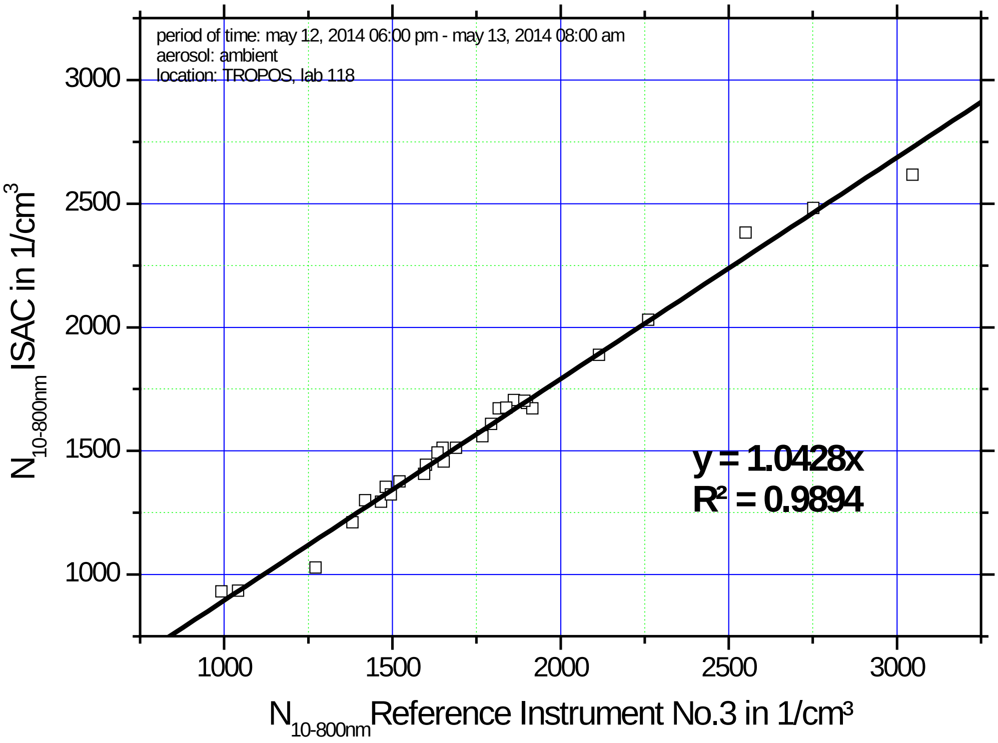


Fig.12. Linear regression between the number concentrations of the TROPOS reference instrument No.3 and DMPS ISAC. Multiple charge correction and internal diffusion losses are included.

4. Size distribution

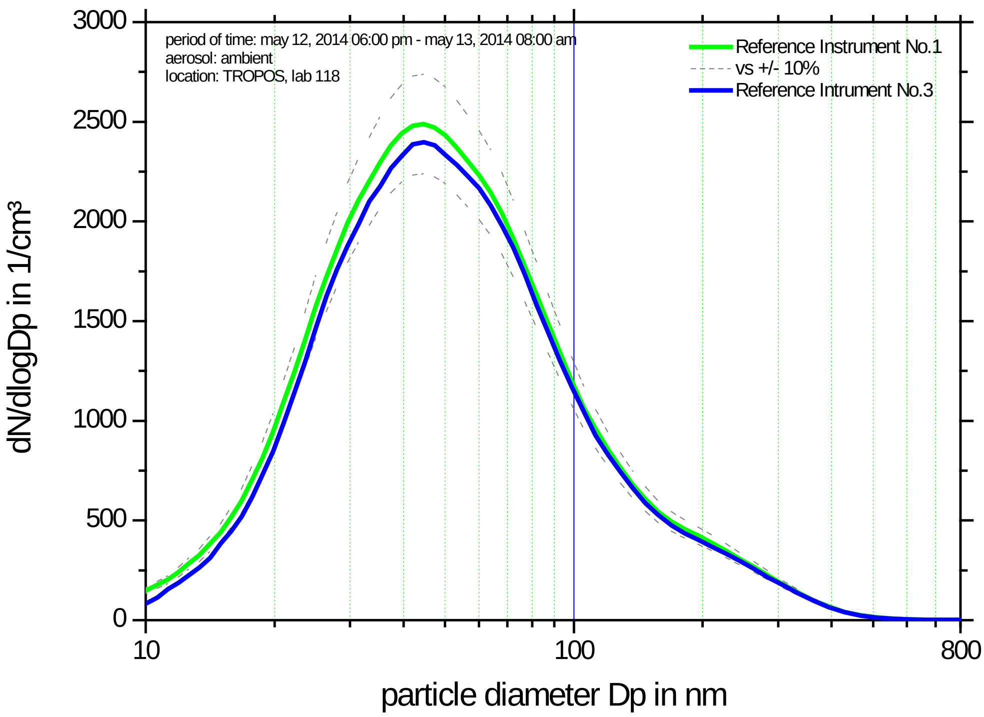


Fig.13. Comparison of mean particle number size distribution of the reference instruments between May 12, 2014 06:00 pm and May 13, 2014 08:00 am. Multiple charge correction, internal diffusion losses and CPC efficiency are included (.in2).

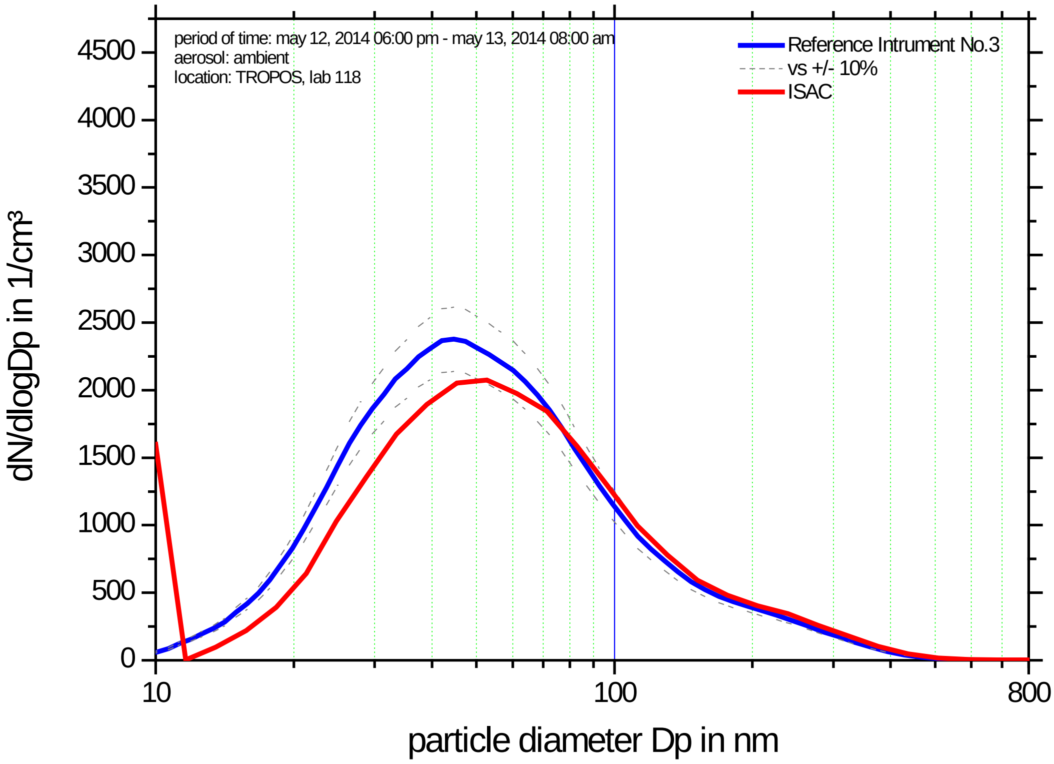


Fig.14. Comparison of mean particle number size distribution of DMPS ISAC and TROPOS reference instrument No.3 between May 12, 2014 06:00 pm and May 13, 2014 08:00 am. Multiple charge correction and internal diffusion losses are included (.in1).

B: second run (May 13, 2014 05:00 pm – May 14, 2014 07:00 am)

1. Correlation of reference instruments

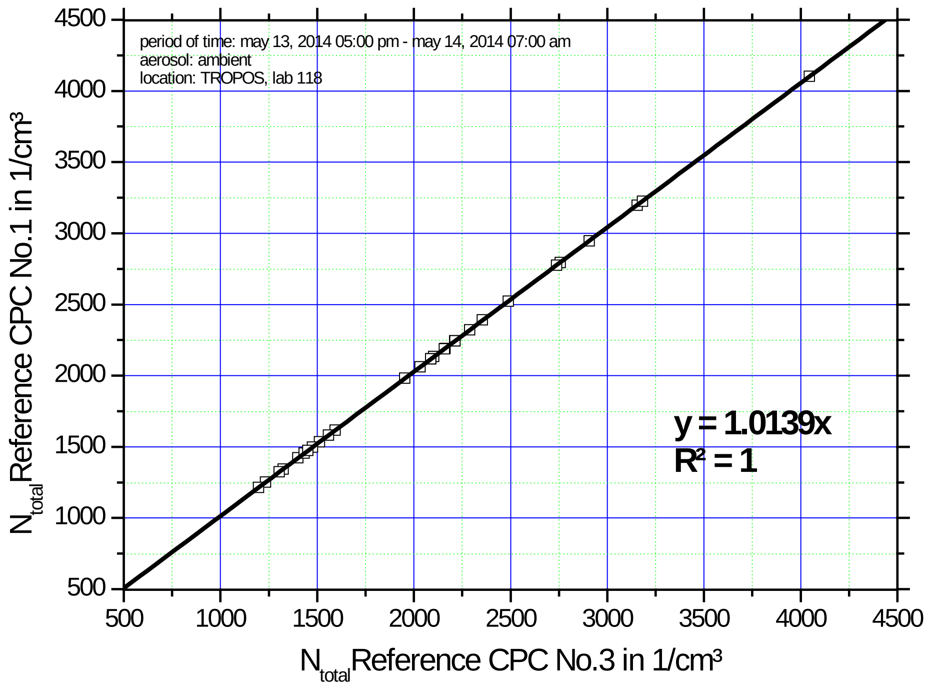


Fig.15. Linear regression between the number concentrations of the TROPOS reference CPC No.1 and the TROPOS reference CPC No.3. Multiple charge correction, internal diffusion losses and flow corrections are included.

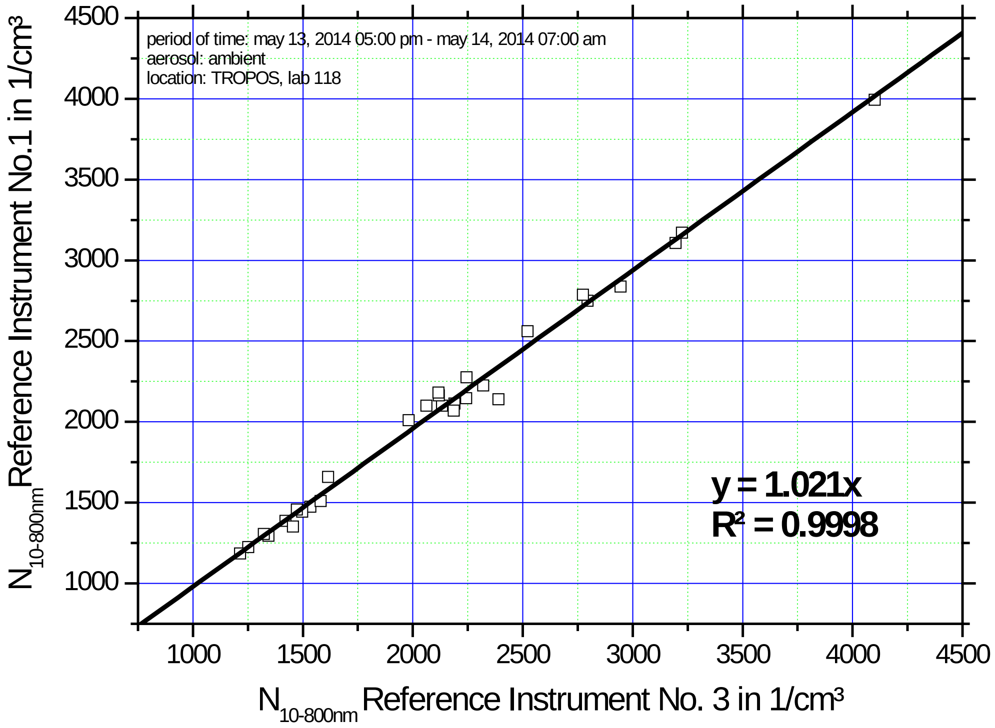


Fig.16. Linear regression between the number concentrations of the TROPOS reference instrument No. 1 and the TROPOS reference instrument No. 3. Multiple charge correction, internal diffusion losses and flow corrections are included.

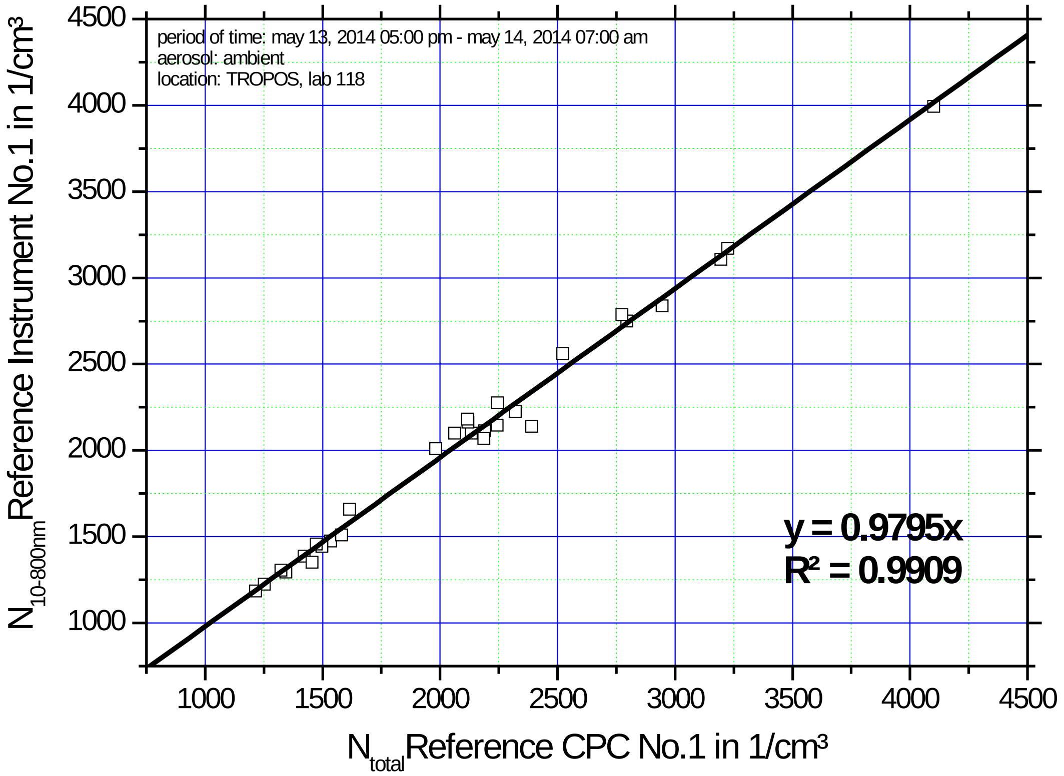


Fig.17. Linear regression between the number concentrations of the TROPOS reference instrument No. 1 and TROPOS reference CPC No.1. Multiple charge correction, internal diffusion losses and flow corrections are included.

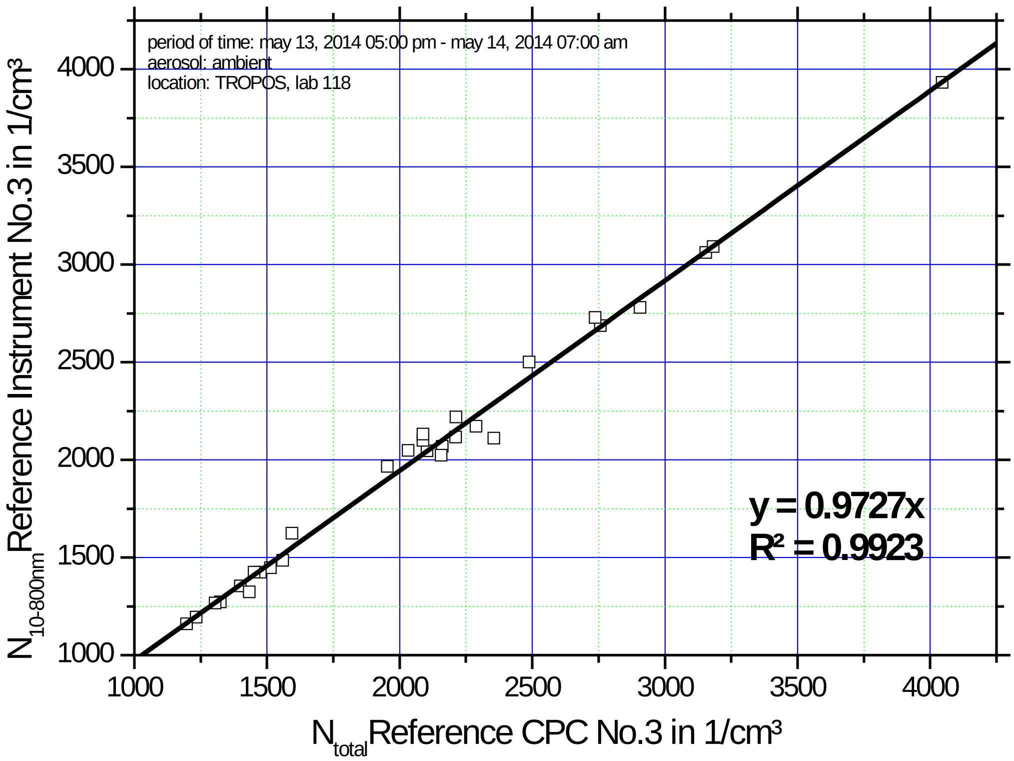


Fig.18. Linear regression between the number concentrations of the TROPOS reference instrument No. 3 and TROPOS reference CPC No.3. Multiple charge correction, internal diffusion losses and flow corrections are included.

2. Time series

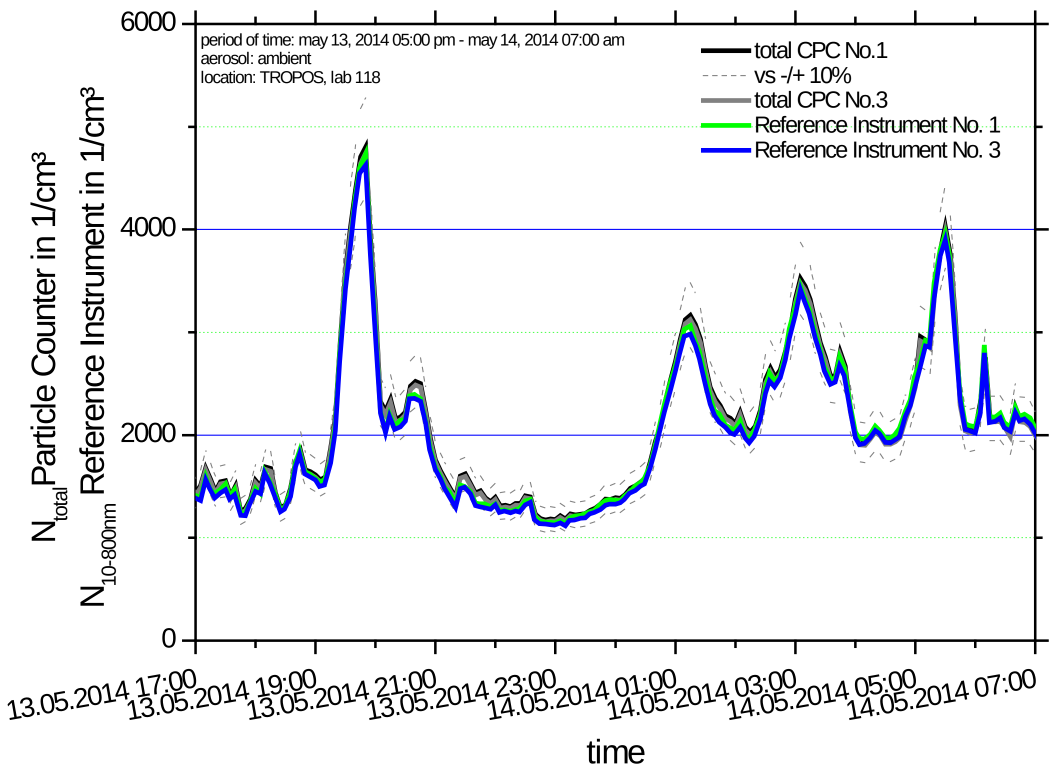


Fig.19. Time series (May 13, 2014 05:00 pm – May 14, 2014 07:00 am) of the integrated particle number concentration (N 10-800nm). Multiple charge correction and internal diffusion losses are included.

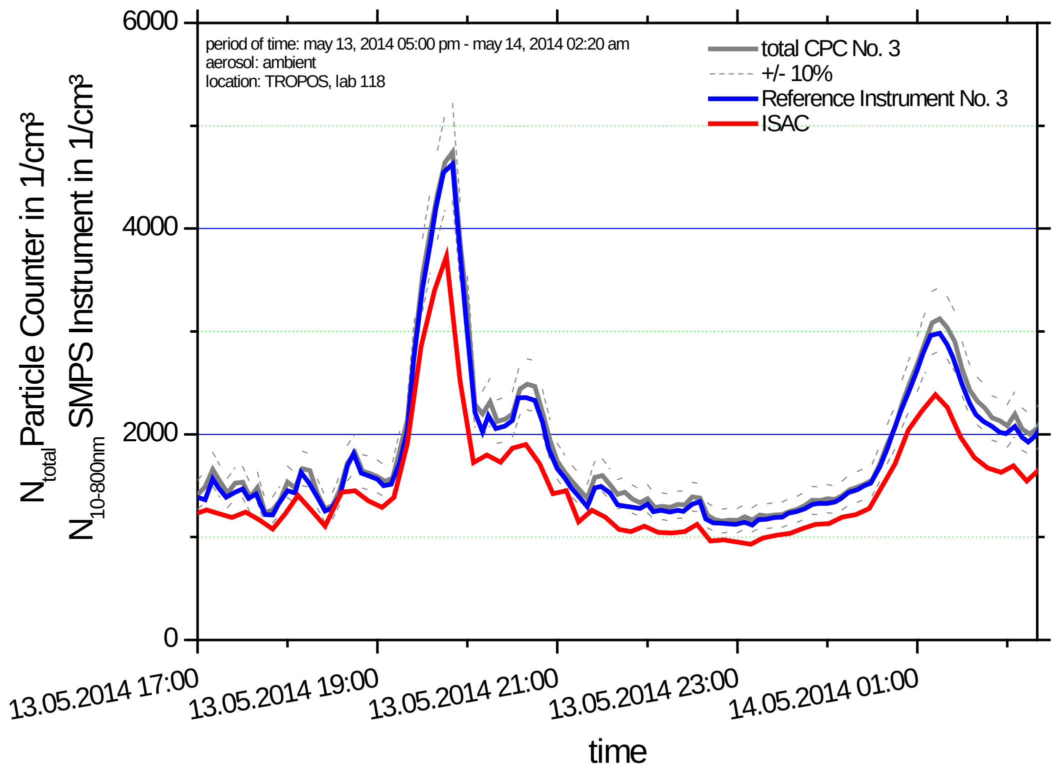


Fig.20. Time series (May 13, 2014 05:00 pm – May 14, 2014 02:20 am) of the integrated particle number concentration (N 10-800nm) of DMPS ISAC and TROPOS reference instrument No.3. Multiple charge correction and internal diffusion losses are included.

3. Correlation of DMPS ISAC

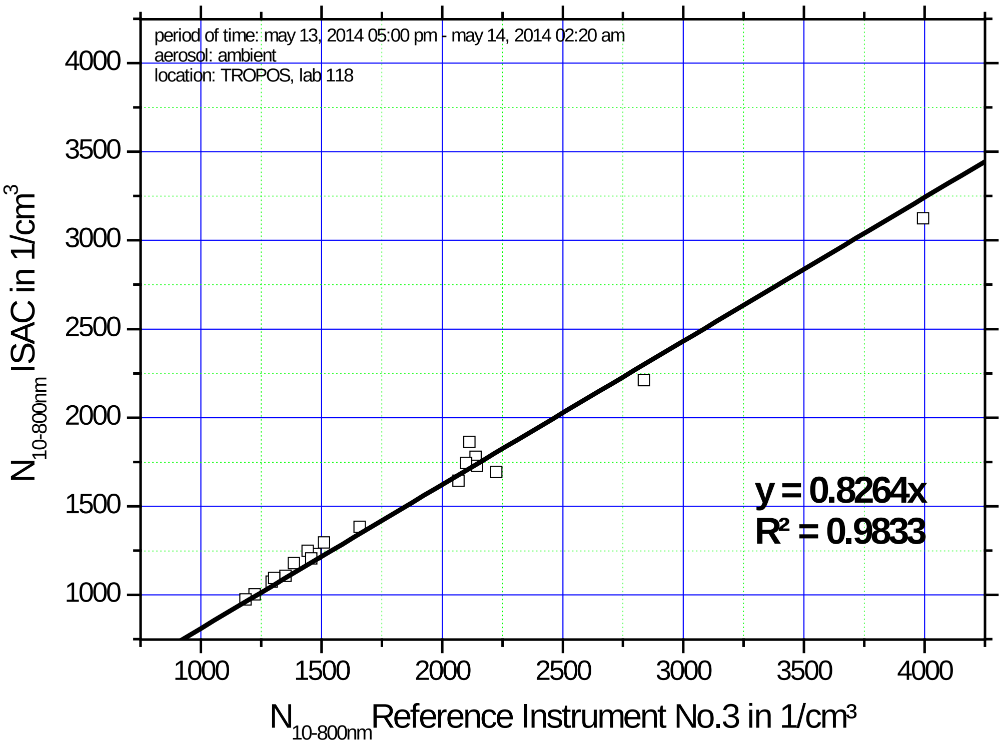


Fig.21. Linear regression between the number concentrations of the TROPOS reference instrument No. 3 and DMPS ISAC. Multiple charge correction and internal diffusion losses are included.

4. Size distribution

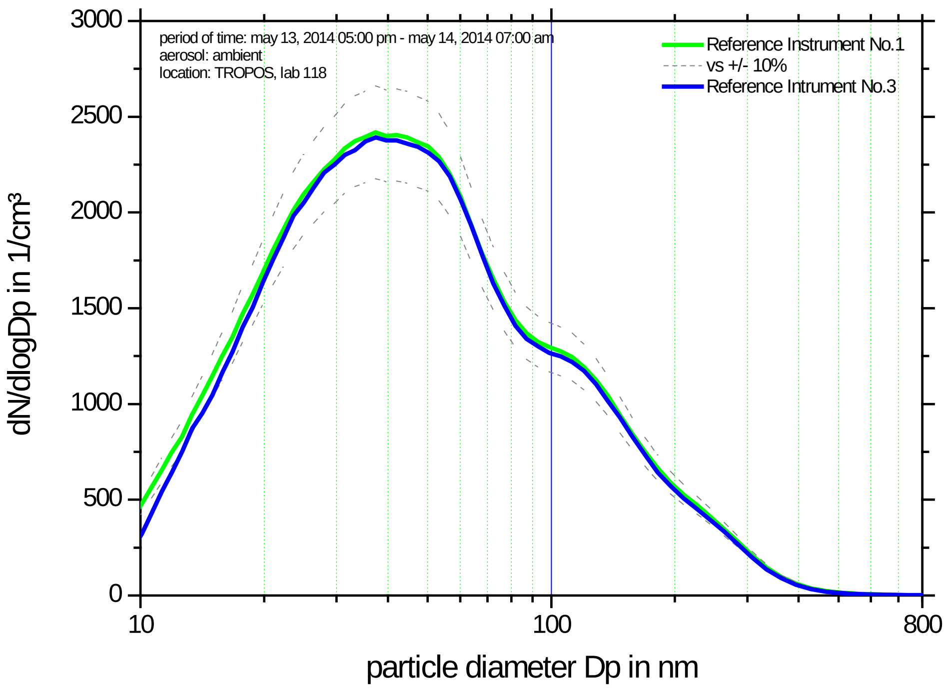


Fig.22. Comparison of mean particle number size distribution between May 13, 2014 05:00 pm and May 14, 2014 07:00 am. Multiple charge correction, internal diffusion losses and CPC efficiency are included (.in2).

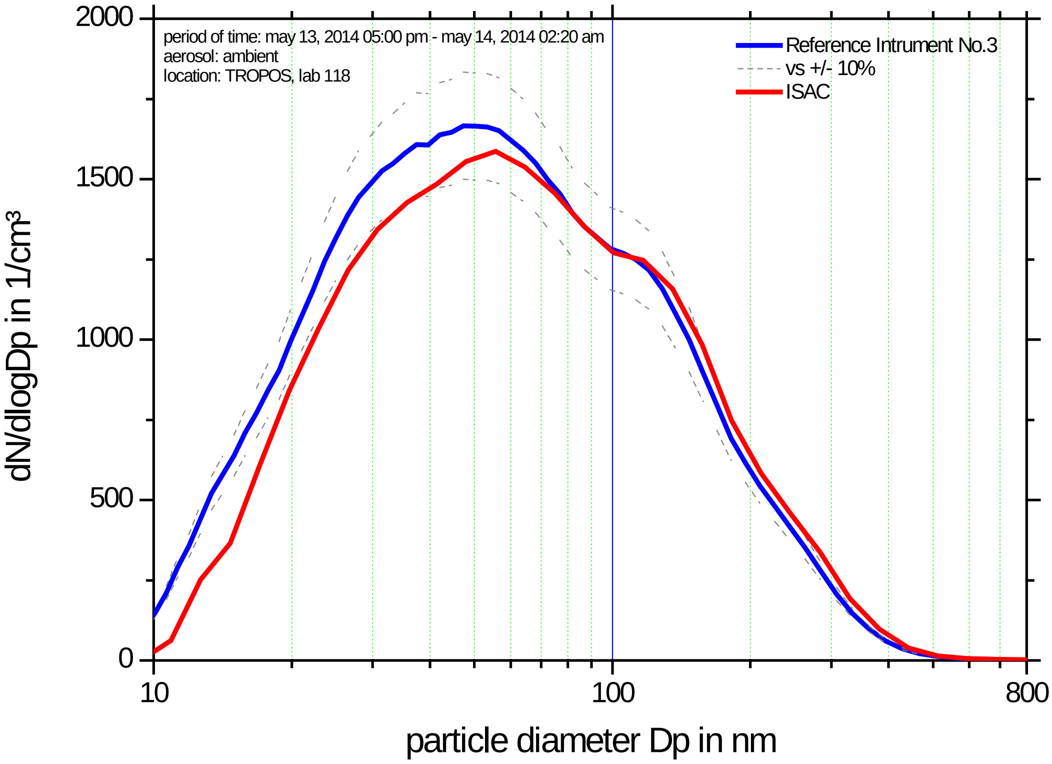


Fig.23. Comparison of mean particle number size distribution of DMPS ISAC and TROPOS reference instrument No.3 between May 13, 2014 05:00 pm and May 14, 2014 02:20 am. Multiple charge correction is included (.in0).

C: third run (May 14, 2014 07:00 pm – May 15, 2014 07:00 am)

1. Correlation of reference instruments

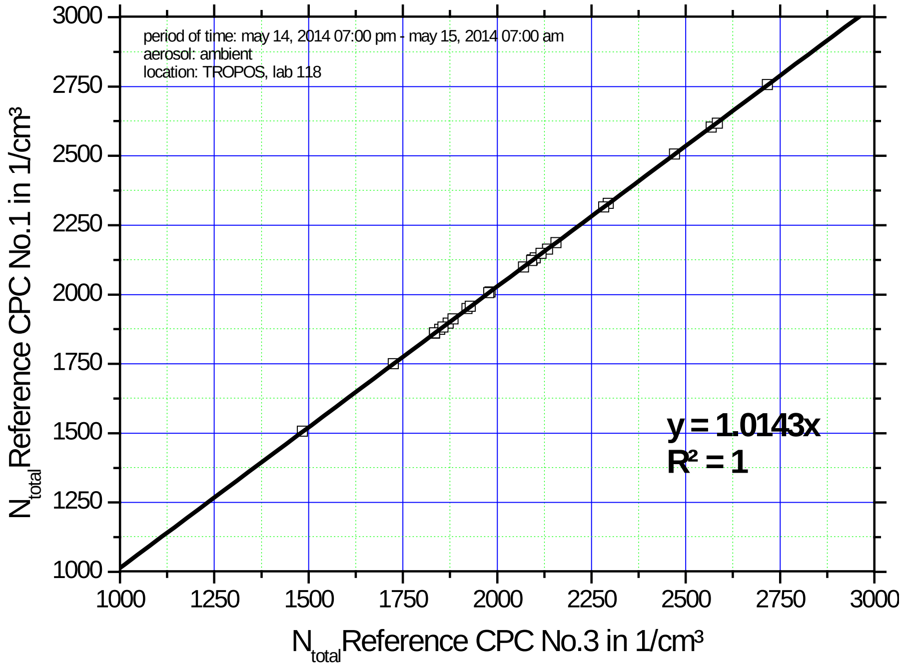


Fig.24. Linear regression between the number concentrations of the TROPOS reference CPC No.1 and the TROPOS reference CPC No.3. Multiple charge correction, internal diffusion losses and flow corrections are included.

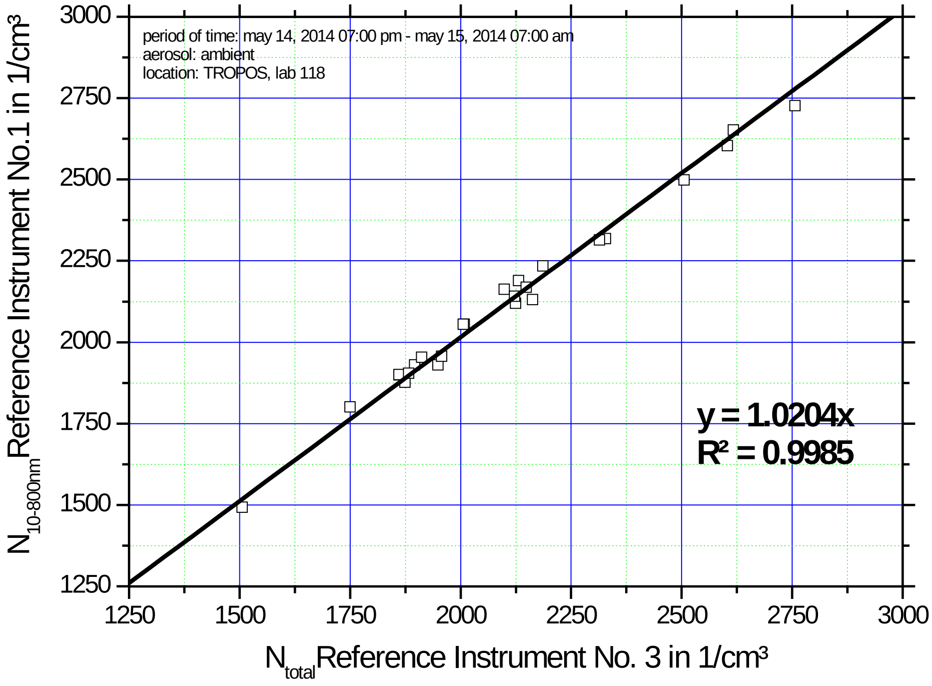


Fig.25. Linear regression between the number concentrations of the TROPOS reference instrument No. 1 and the TROPOS reference instrument No. 3. Multiple charge correction, internal diffusion losses and flow corrections are included.

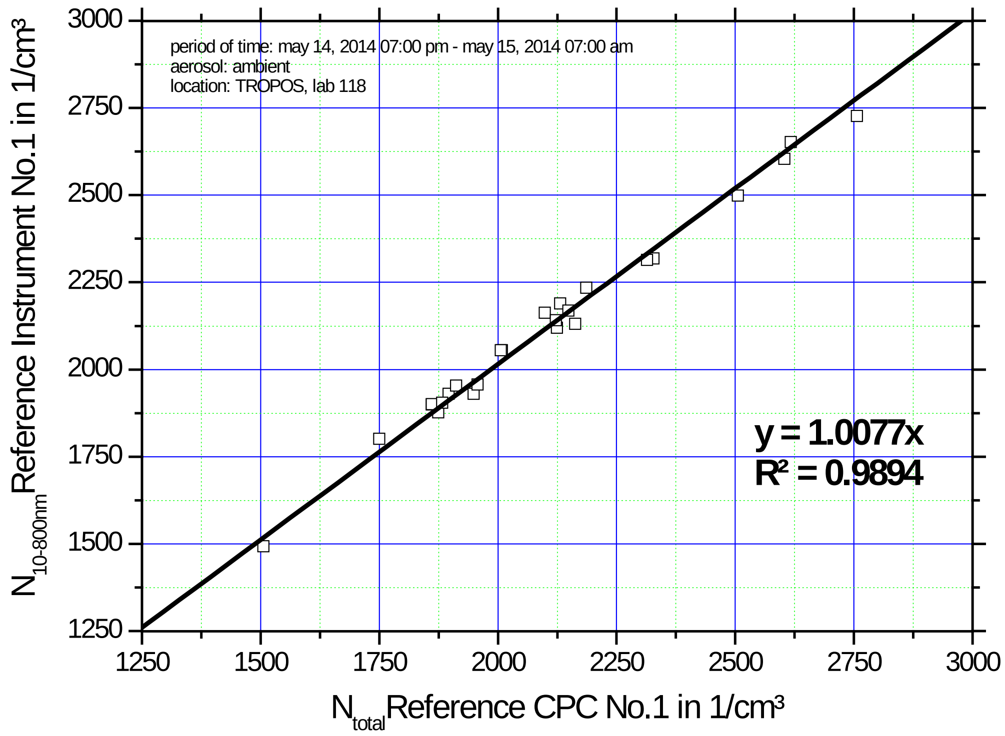


Fig.26. Linear regression between the number concentrations of the TROPOS reference instrument No. 1 and TROPOS reference CPC No.1. Multiple charge correction, internal diffusion losses and flow corrections are included.

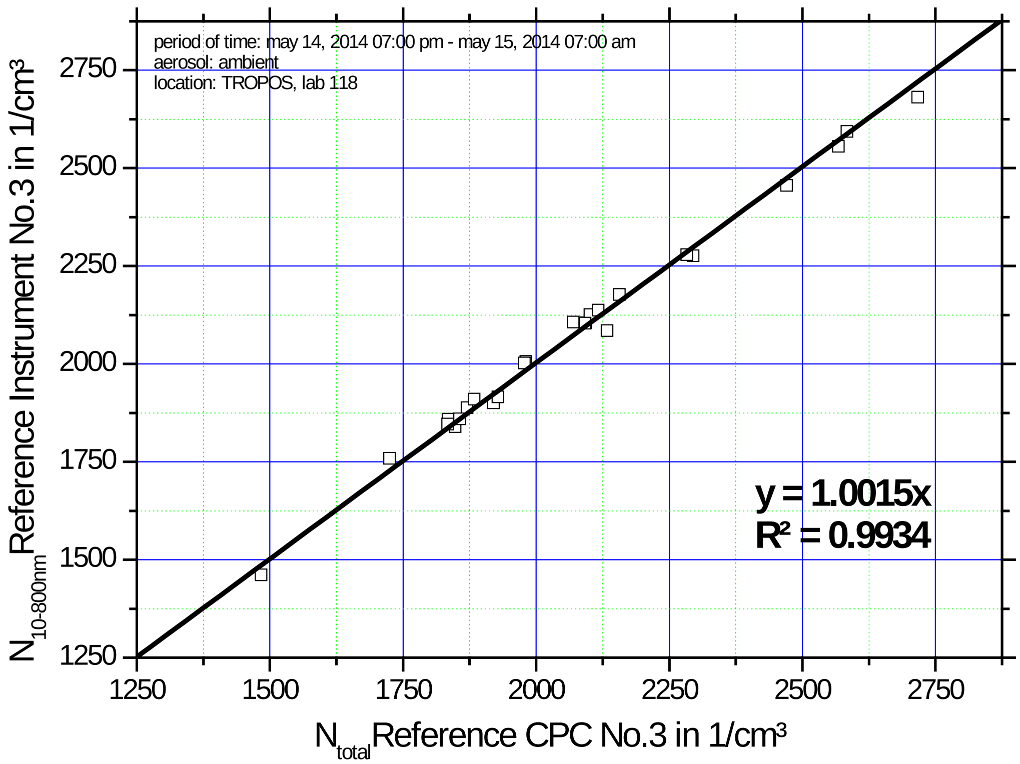


Fig.27. Linear regression between the number concentrations of the TROPOS reference instrument No. 3 and TROPOS reference CPC No.3. Multiple charge correction, internal diffusion losses and flow corrections are included.

2. Time series

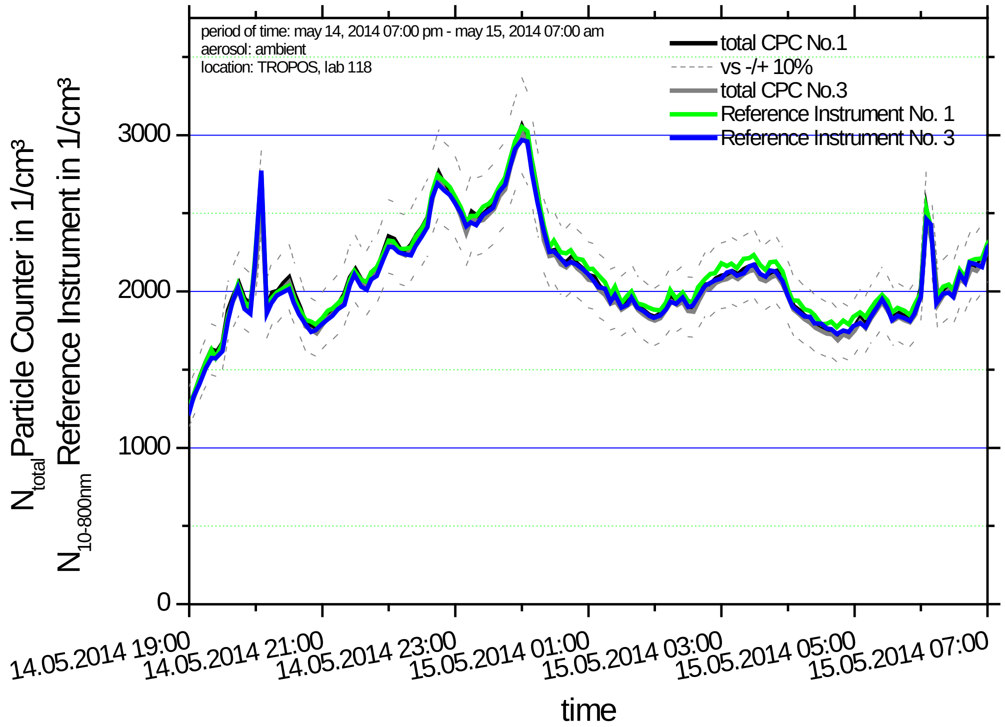


Fig.28. Time series (May 14, 2014 07:00 pm – May 15, 2014 07:00 am) of the integrated particle number concentration (N 10-800nm) of the integrated particle number concentration (N 10-800nm). Multiple charge correction internal diffusion losses and flow corrections are included.

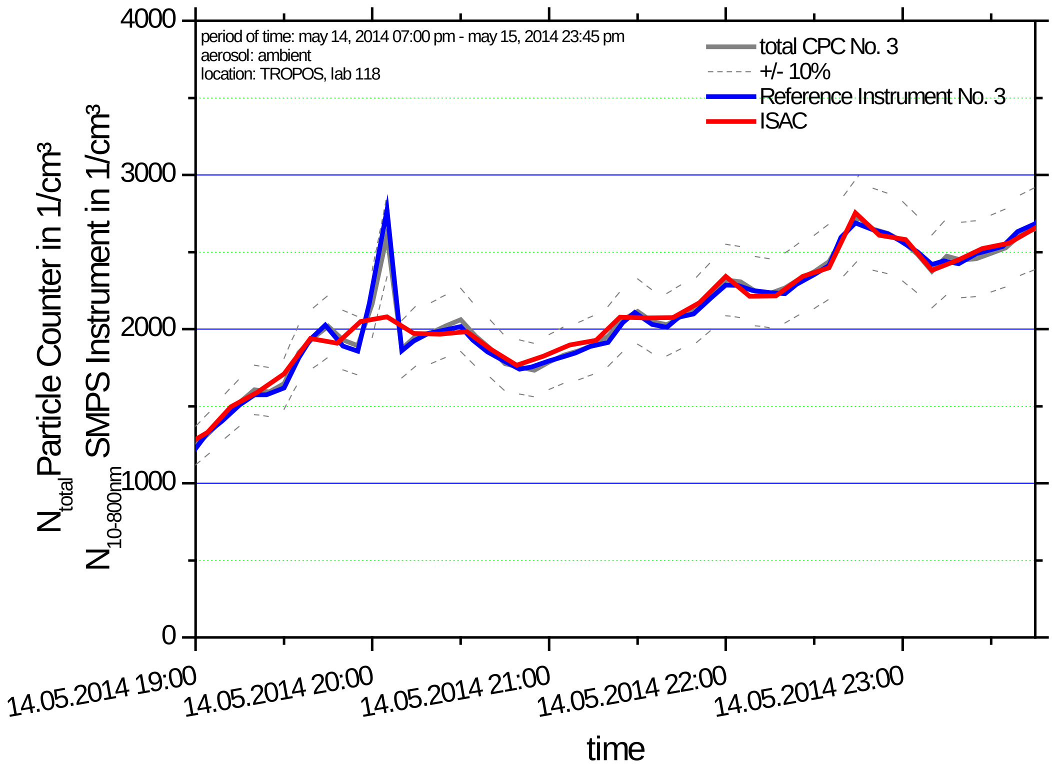


Fig.29. Time series (May 14, 2014 07:00 pm – 11:45 pm) of the integrated particle number concentration (N 10-800nm) of DMPS ISAC and TROPOS reference instrument No.3. Multiple charge correction and internal diffusion losses are included.

3. Correlation of SMPS ISAC

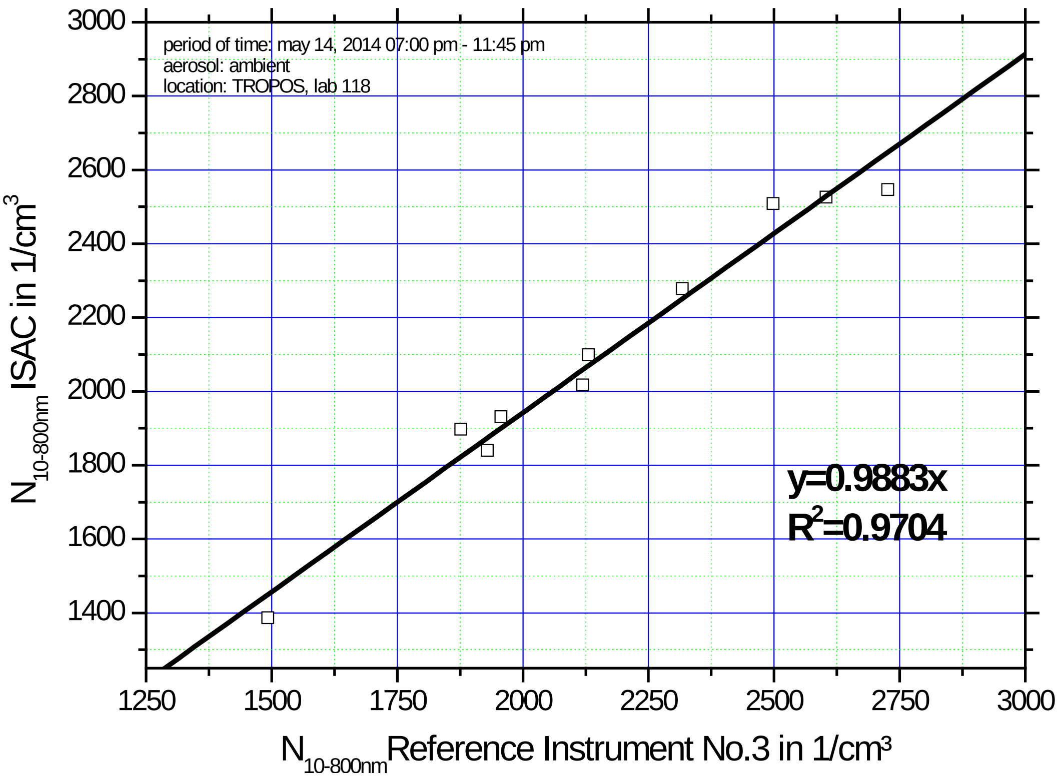


Fig.30. Linear regression between the number concentrations of the TROPOS reference instrument No.3 and DMPS ISAC. Multiple charge correction and internal diffusion losses are included.

4. Size distribution

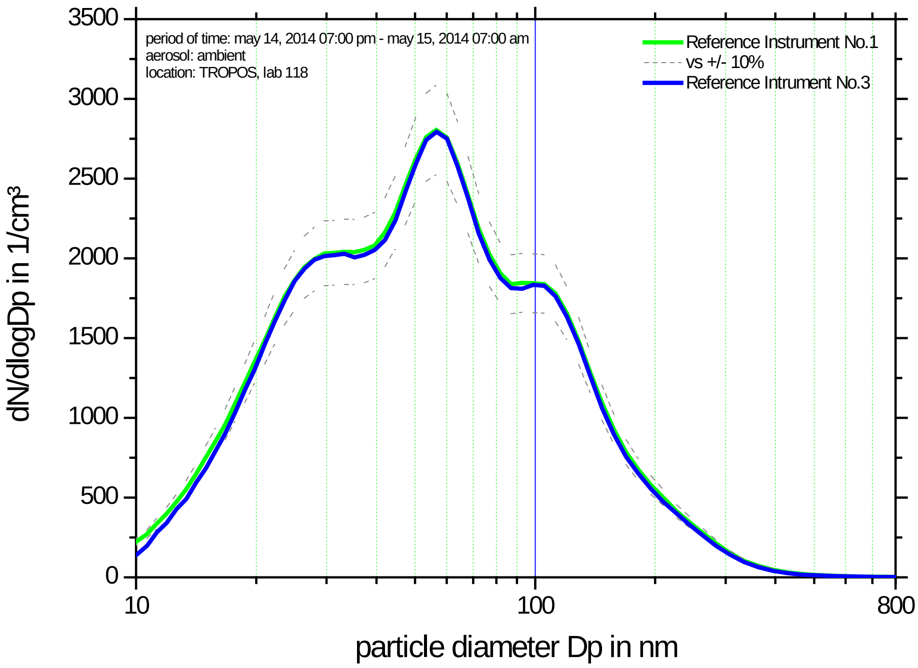


Fig.31. Comparison of mean particle number size distribution between May 14, 2014 07:00 pm and May 15, 2014 07:00 am. Multiple charge correction, internal diffusion losses and CPC efficiency are included (.in2).

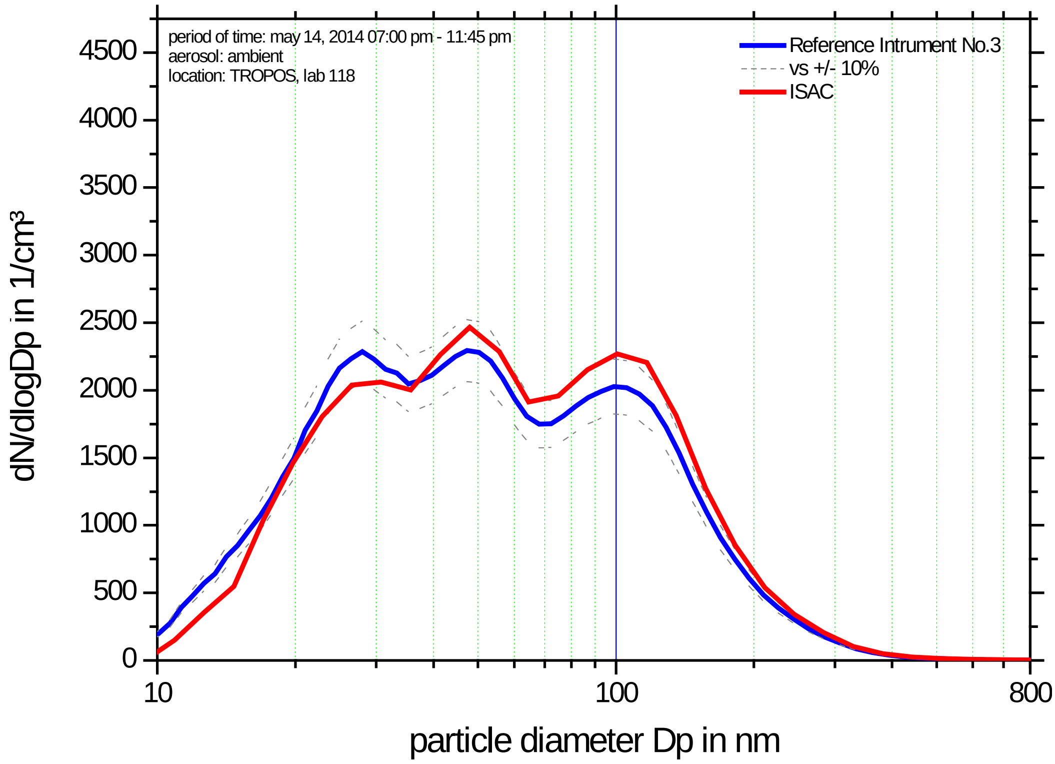


Fig.32. Comparison of mean particle number size distribution of DMPS ISAC and TROPOS reference instrument No.3 on May 14, 2014 between 07:00 and 11:45 pm. Multiple charge correction, internal diffusion losses and CPC efficiency are included (.in2).

D: fourth run (May 15, 2014 08:00 pm – May 16, 2014 06:00 am)

1. Correlation reference instruments

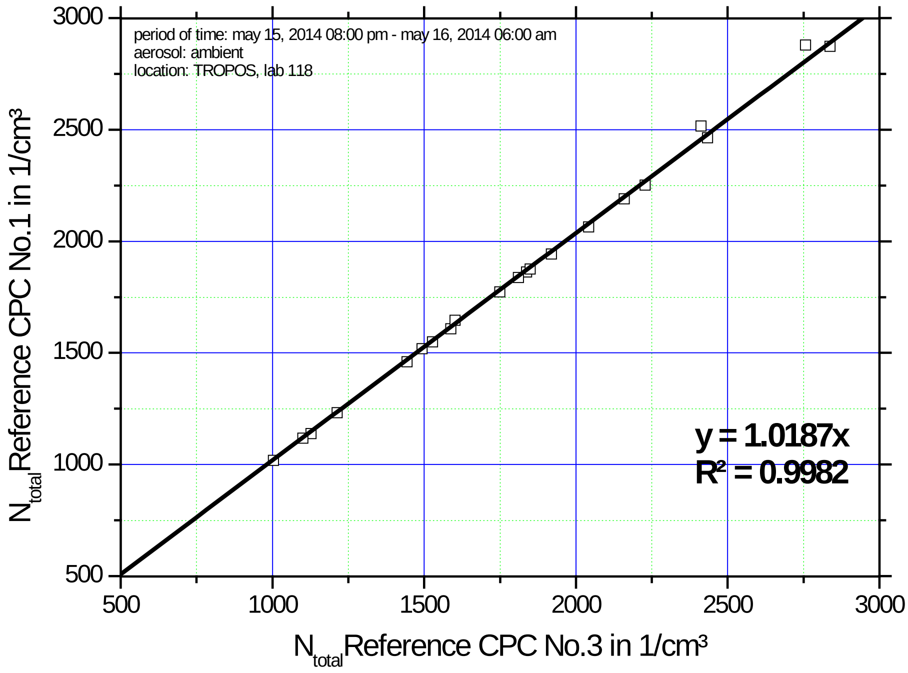


Fig.33. Linear regression between the number concentrations of the TROPOS reference CPC No.1 and the TROPOS reference CPC No.3. Multiple charge correction, internal diffusion losses and flow corrections are included.

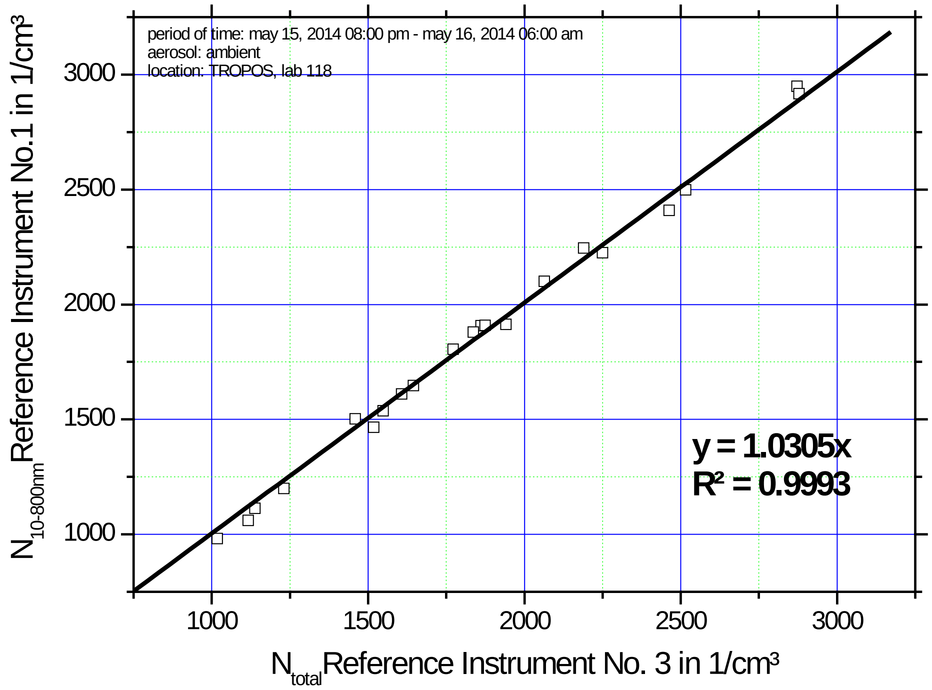


Fig.34. Linear regression between the number concentrations of the TROPOS reference instrument No. 1 and the TROPOS reference instrument No. 3. Multiple charge correction, internal diffusion losses and flow corrections are included.

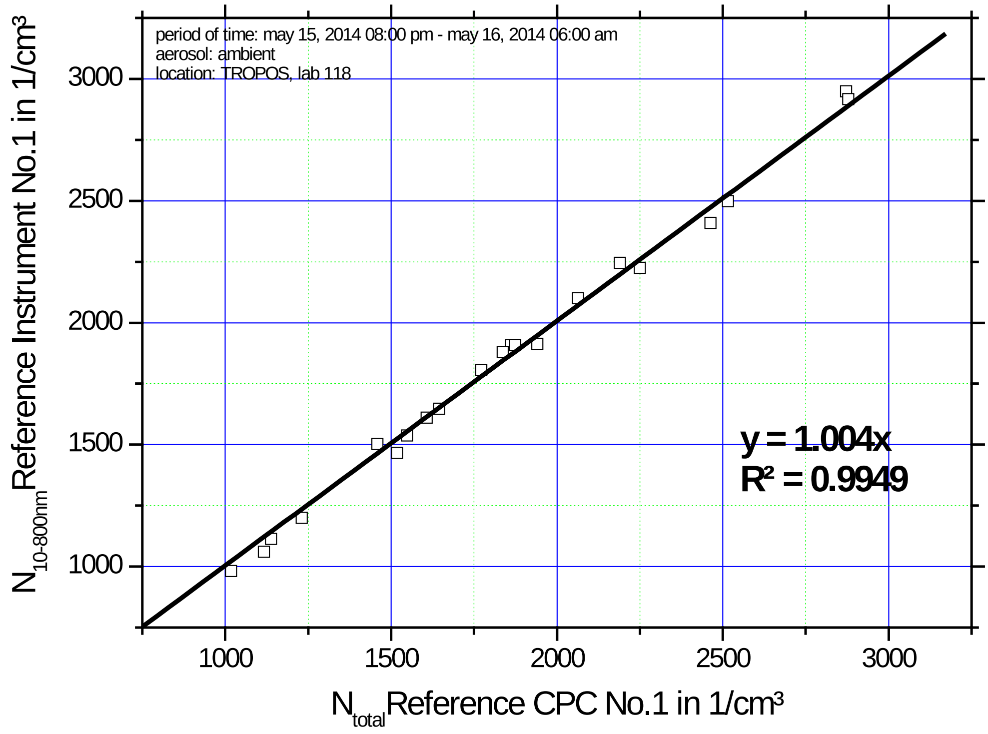


Fig.35. Linear regression between the number concentrations of the TROPOS reference instrument No. 1 and TROPOS reference CPC No.1. Multiple charge correction, internal diffusion losses and flow corrections are included.

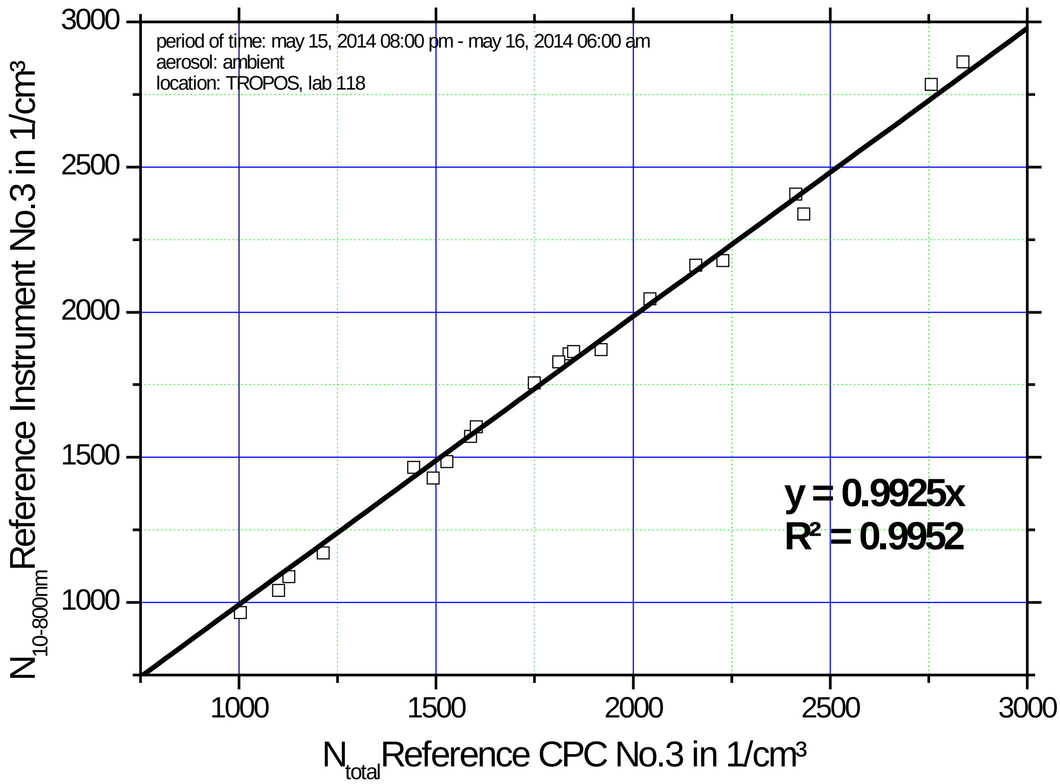


Fig.36. Linear regression between the number concentrations of the TROPOS reference instrument No. 3 and TROPOS reference CPC No.3. Multiple charge correction, internal diffusion losses and flow corrections are included.

2. Time series

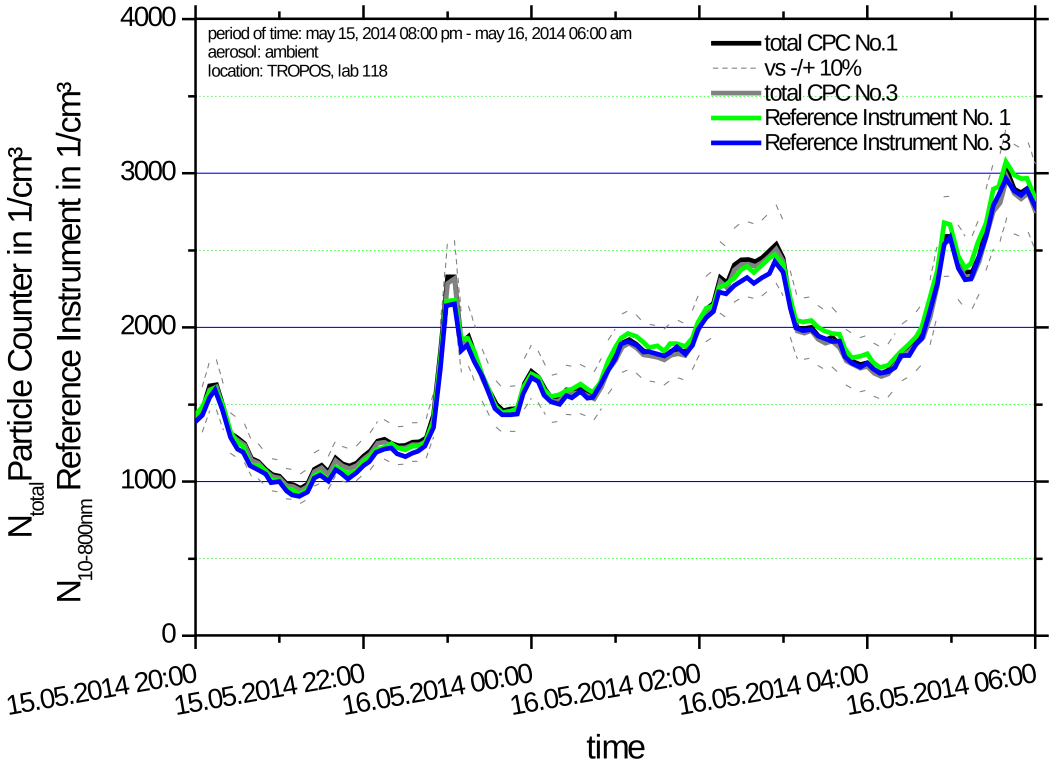


Fig.37. Time series (May 15, 2014 08:00 pm – May 16, 2014 06:00 am) of the integrated particle number concentration (N 10-800nm). Multiple charge correction, internal diffusion losses and flow corrections are included.

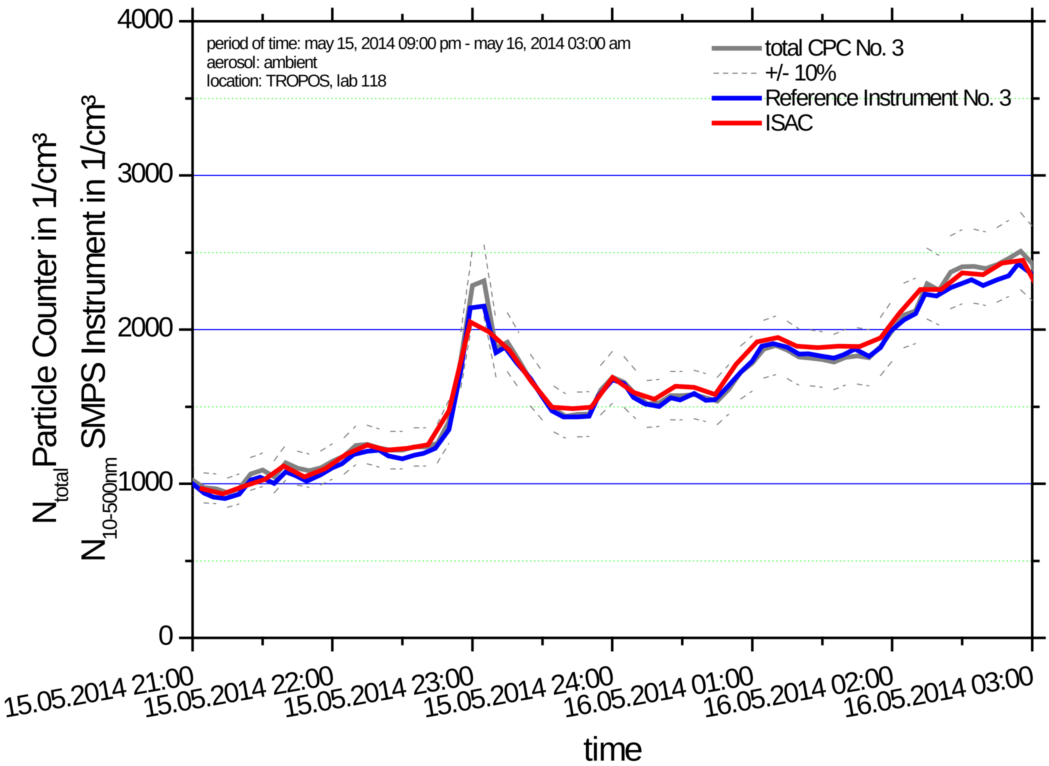


Fig.38. Time series (May 15, 2014 09:00 pm – May 16, 2014 03:00 am) of the integrated particle number concentration (N 10-800nm) of DMPS ISAC and TROPOS reference instrument No.3. Multiple charge correction and internal diffusion losses are included.

3. Correlation of SMPS ISAC

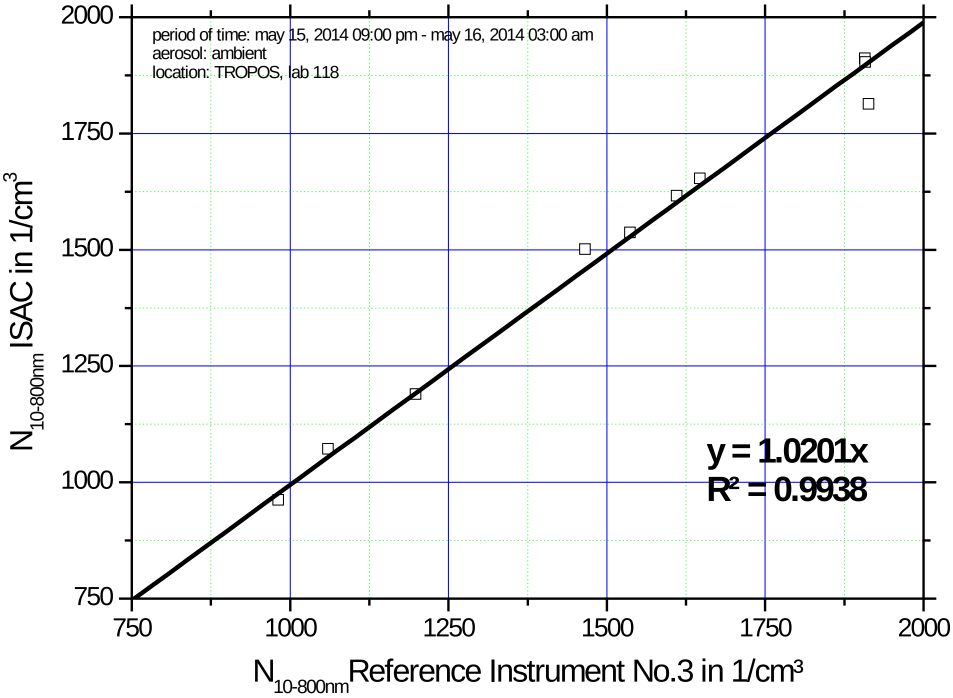


Fig.39. Linear regression between the number concentrations of the TROPOS reference instrument No.3 and DMPS ISAC. Multiple charge correction, internal diffusion losses and flow corrections are included.

4. Size distribution

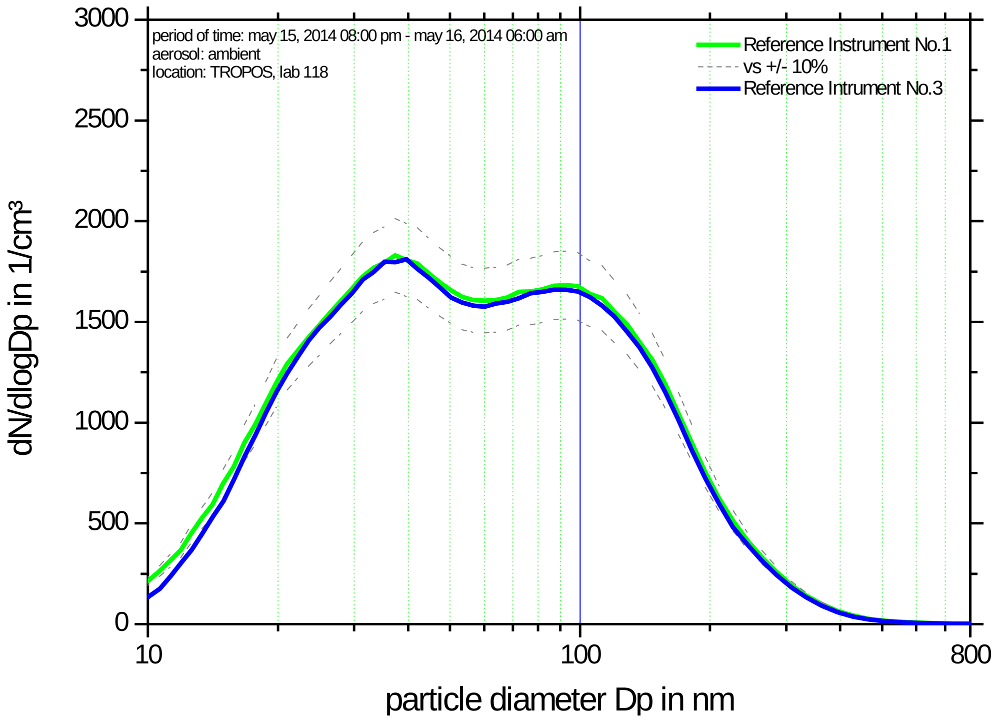


Fig.35. Comparison of mean particle number size distribution between May 15, 2014 08:00 pm and May 16, 2014 06:00 am. Multiple charge correction, internal diffusion losses and CPC efficiency are included (.in2).

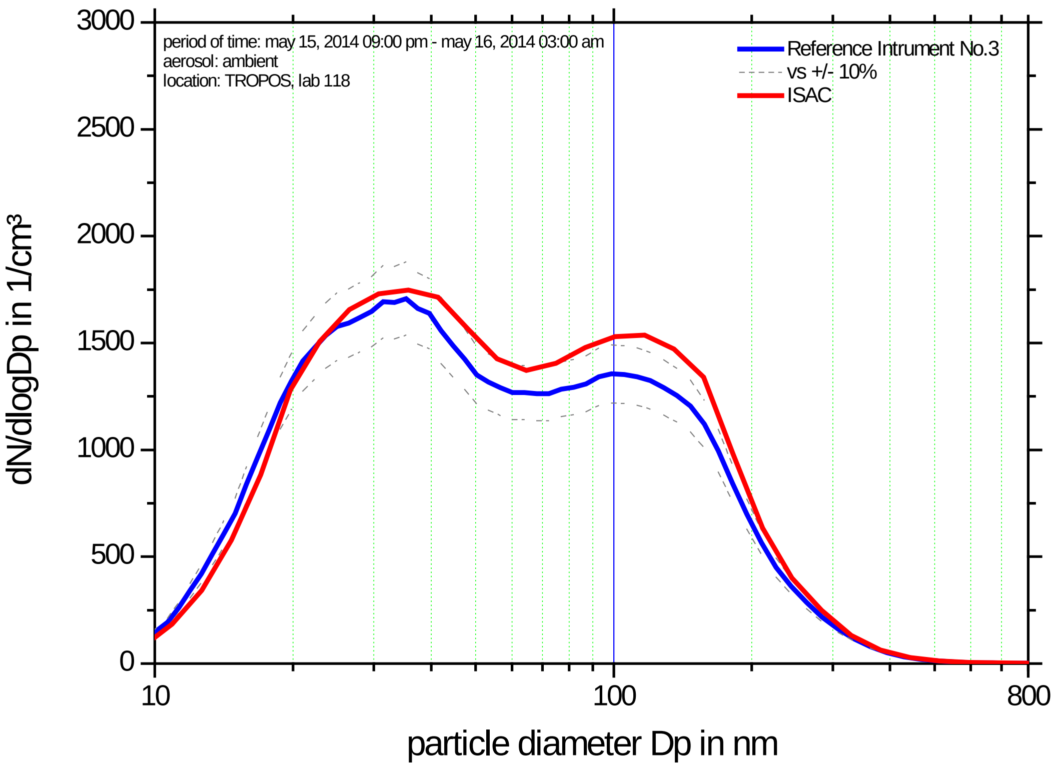


Fig.35. Comparison of mean particle number size distribution of DMPS ISAC and TROPOS reference instrument No.3 between May 15, 2014 09:00 pm and May 16, 2014 03:00 am. Multiple charge correction, internal diffusion losses and CPC efficiency are included (.in2).

Intercomparison of DMPS ITM

Basic information

Location of the quality assurance:	TROPOS, lab: 118
Delivery date:	May 12, 2014
Setup in the laboratory:	May 12, 2014
Comparison period:	May 12, 2014 – May 16, 2014
Instrument:	DMPS
TROPOS Reference Instrument:	TROPOS Reference Instrument No. 1 TROPOS Reference Instrument No. 3
Total CPC:	TROPOS Reference CPC No.1; SN: 3772112101 TROPOS Reference CPC No.3; SN: 3772111903
Additional equipment:	
Involved people:	Radovan Krejci (radek@itm.su.se)

Summary of second intercomparison:

From May 12, 2014 to May 16, 2014 the ITM DMPS participated successfully the TROPOS ACTRIS Workshop. The workshop consisted of an entrance test and a final run. In addition to the overnight ambient measurements, we had numerous high voltage checks, zero- and PSL-measurements. The report is divided into three sections. The first section shows the laboratory setup and the PSL measurement. After that, we show for each run the time series of the particle number concentration, the particle number size distribution, and correlation plots. If anything was written in the log book, so we added this also in this report. As reference standards, we used CPCs model TSI 3772 for total particle number concentration and two TROPOS mobility particle size spectrometer. The particle counters have been calibrated against a calibrated TSI electrometer 3068 B with the serial number 70838596.

For the PSL-calibrations, we used Latex particle with a nominal size of 203 nm +/- 4 nm. The latex particles have been generated with an aerosol nebulizer. The sheath air flow rate of the candidate system was calibrated to match the latex particle size, if possible. The ITM DMPS showed in the PSL-measurements a particle diameter of 202.9 nm. Both the zero check and the high-voltage calibration passed the requirements in the final run. If we look at the final ambient measurement run, the ITM DMPS is in the 10%. The ITM DMPS passed the ACTRIS Workshop.

May 12, 2014

-> Setup of all instruments in laboratory 118

11:00 am - 04:00 pm	-> CPC workshop
	-> High voltage calibration of Ref1 and Ref3
	-> Measured flows: CPC 1 : 1.040 l/min CPC 3 : 1.029 l/min Ref 1 : 1.018 l/min Ref 3 : 0.9999 l/min
06:30 pm	-> start ambient measurement

May 13, 2014

	-> Overnight run particle size distribution shows an oversize by 12% (sheath flow is 10.15 l/min; aerosol flow is 1 l/min)
	-> start overnight ambient measurement

May 14, 2014

	-> overnight result shows: now sheath flow decreased even more to 8.5 l/min and size distribution had to be shifted by 2 bins
11:00 am - 01:30 pm	-> ambient measurement: Sheath flow 11.2 l/min entered to DMA schedule (real sheath flow 10.05). At 11.2 sheath flow we did size properly Latex, but - overestimate size distr.
06:20 pm	-> start overnight ambient measurement

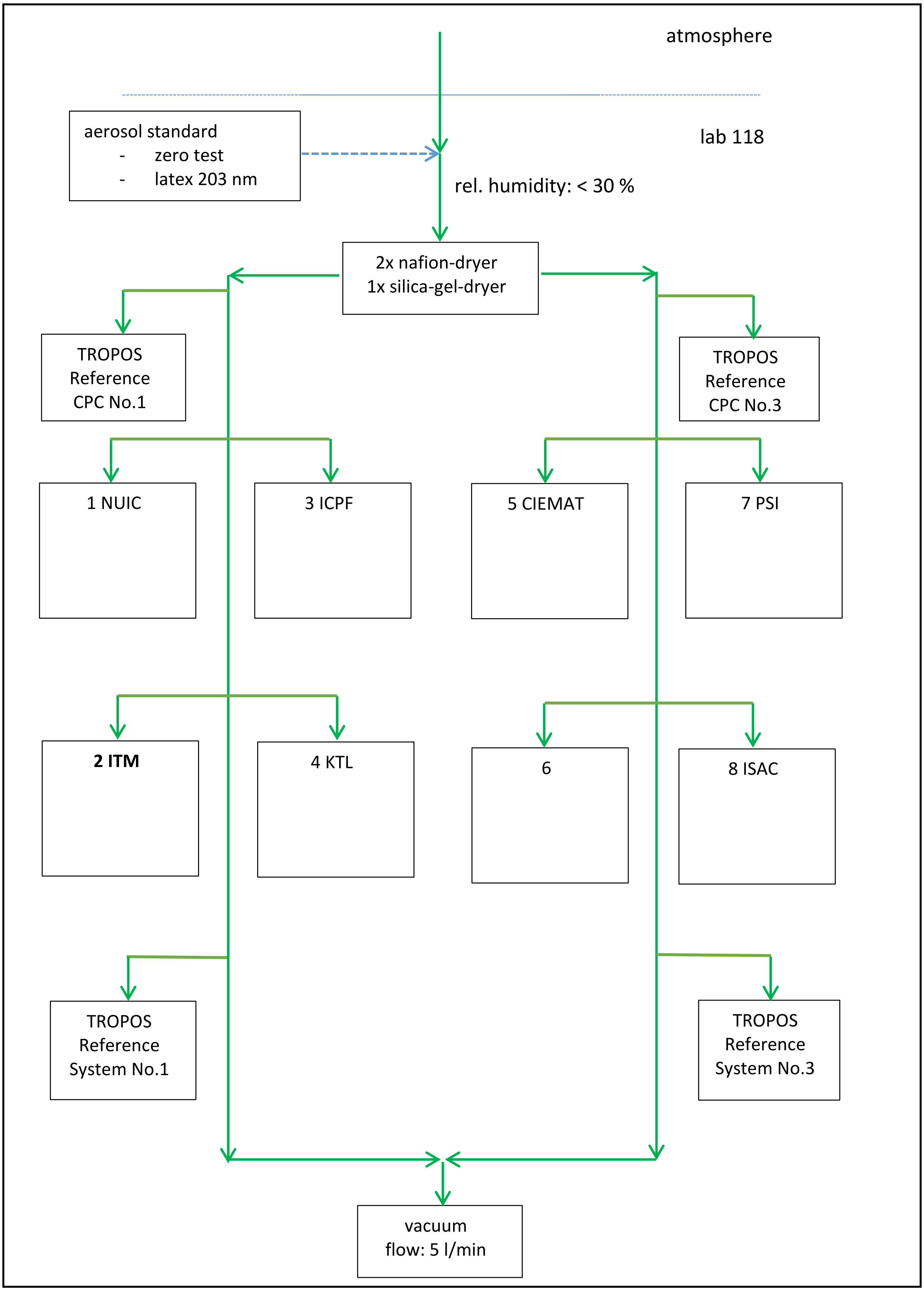
May 15, 2014

09:20 am	-> end of ambient measurement. Run stills shows oversizing. Solve problem by shifting size distribution to the left by one bin.
08:50 pm	-> start overnight ambient measurement

May 16, 2014

09:25 am	-> stop ambient measurement

Laboratory setup



<u>CPC Efficiency</u>

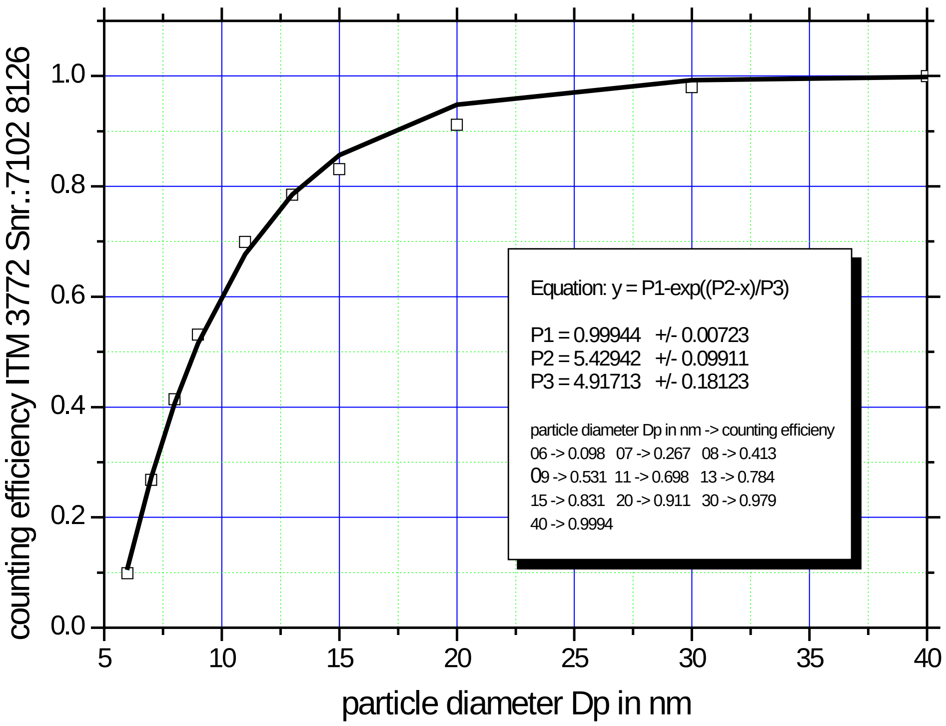


Fig.1. CPC efficiency curve. Based on Electrometer TSI 3068B. Serial number: 70838596

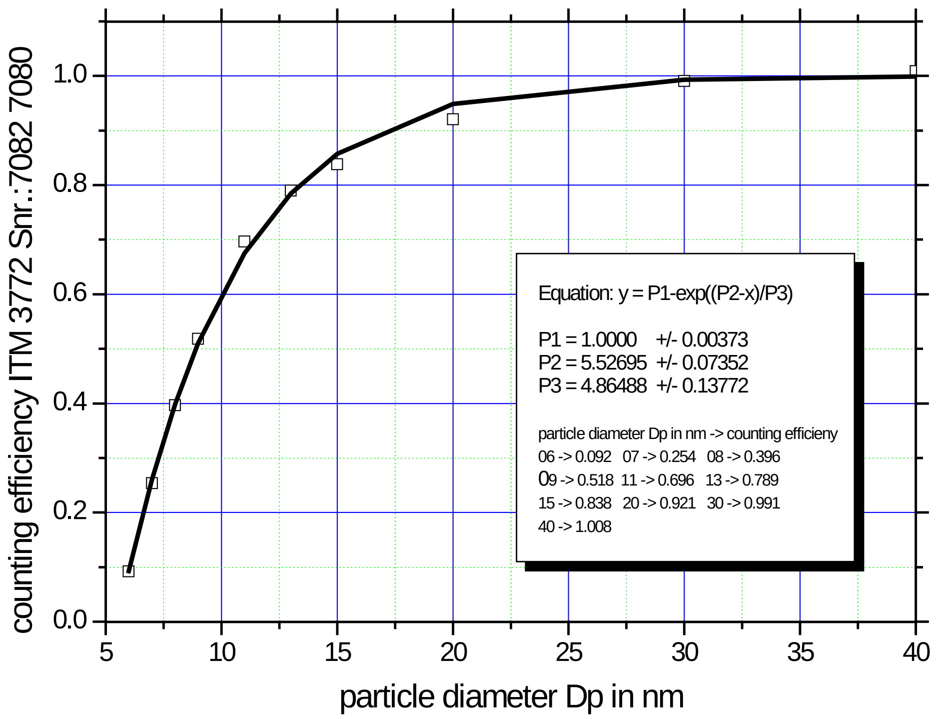


Fig.2. CPC efficiency curve. Based on Electrometer TSI 3068B. Serial number: 70838596

Latex 203 nm

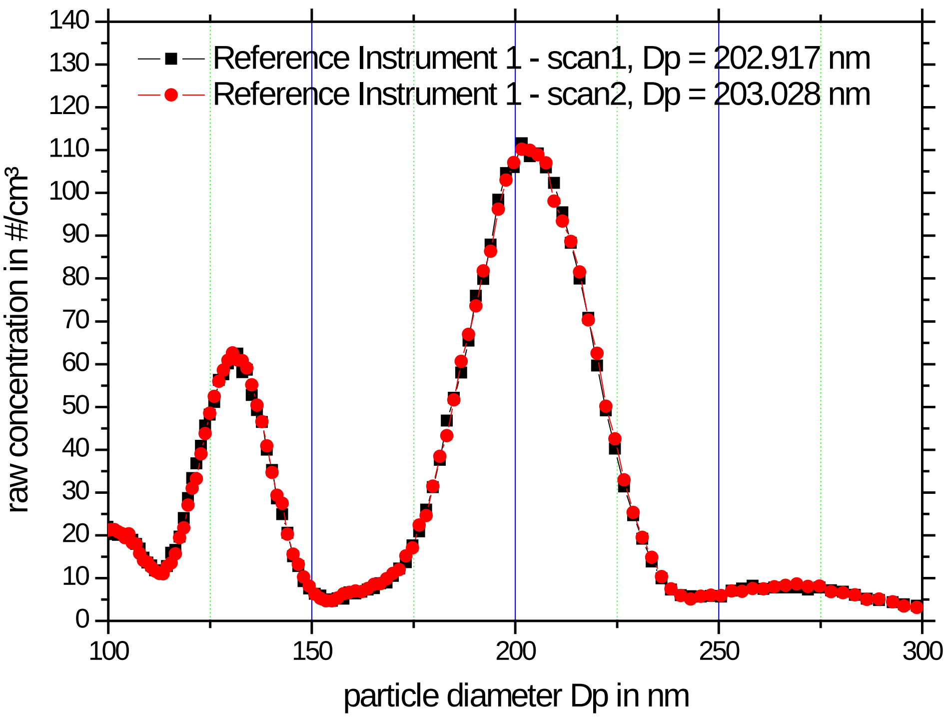


Fig.3. Measurement of latex 203 nm for TROPOS reference instrument No.1: Particle size distribution (raw concentration) for latex 203 nm on May 13, 2014 between 03:13 pm and 03:39 pm.

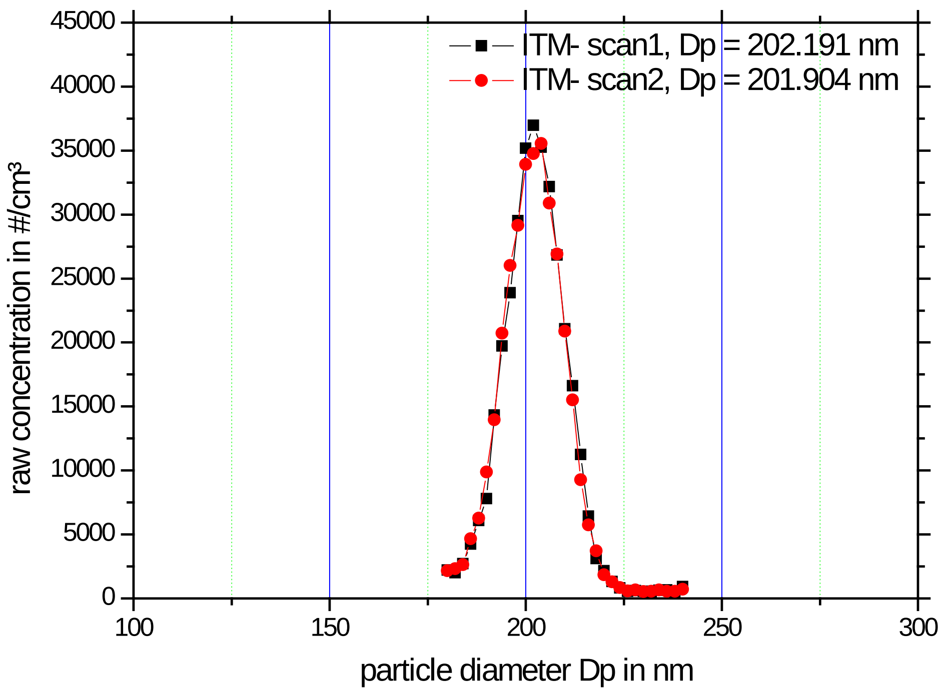


Fig.4. Measurement of latex 203 nm for instrument SMPS ITM: particle size distribution (raw concentration) for latex 203 nm on May 13, 2014 between 03:21 pm and 03:49 pm.

A: first run (May 12, 2014 06:00 pm – May 13, 2014 08:00 am)

1. Correlation of reference instruments

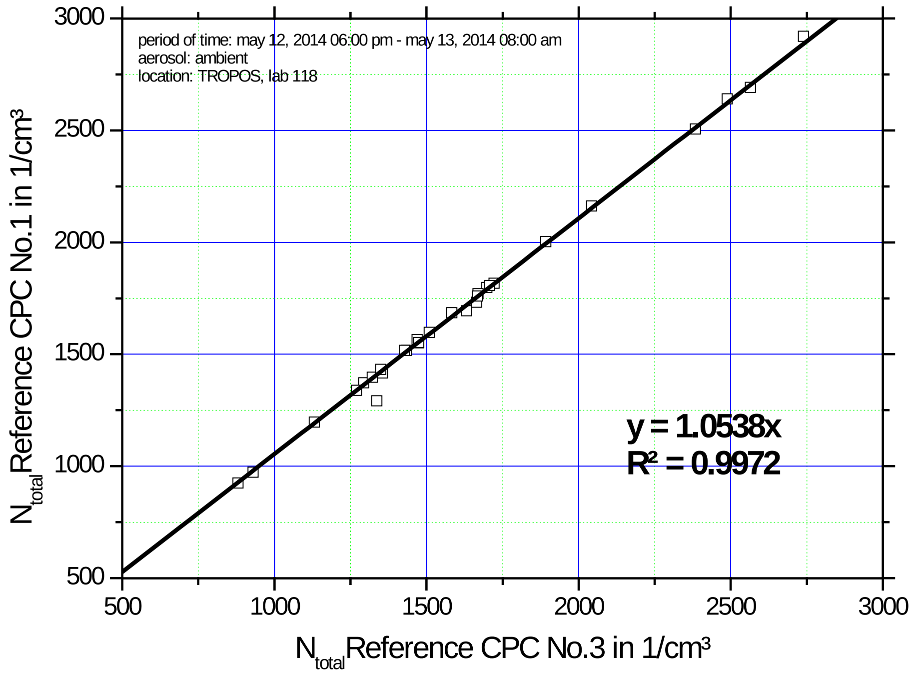


Fig.5. Linear regression between the number concentrations of the TROPOS reference CPC No.1 and the TROPOS reference CPC No.3. Multiple charge correction, internal diffusion losses and flow corrections are included.

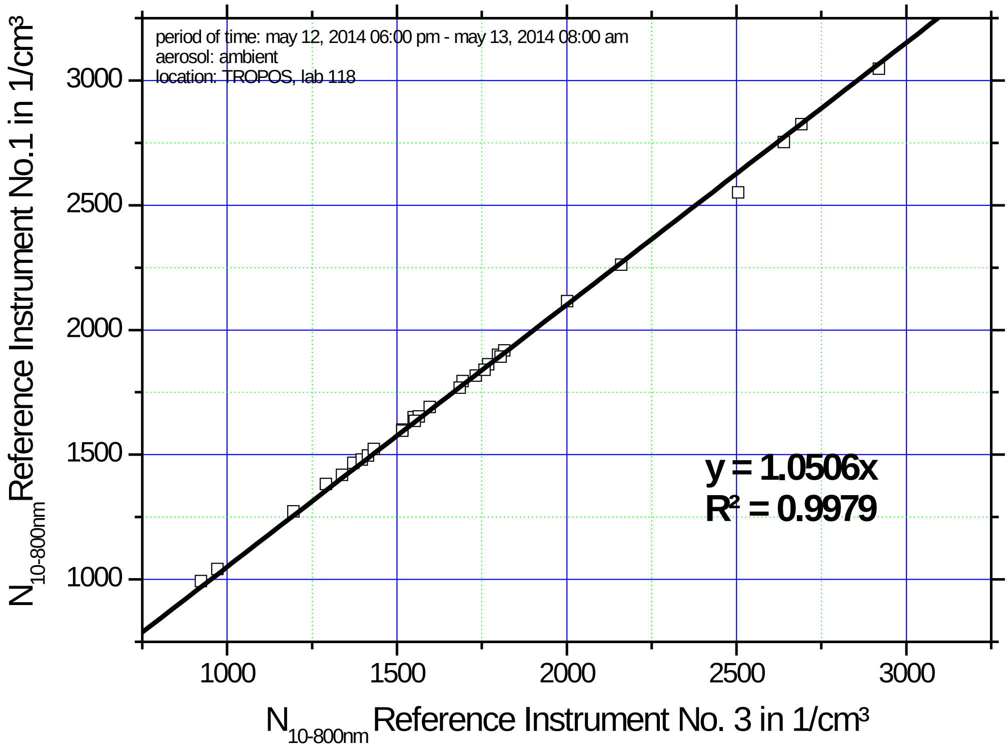


Fig.6. Linear regression between the number concentrations of the TROPOS reference instrument No.1 and the TROPOS reference instrument No.3. Multiple charge correction, internal diffusion losses and flow corrections are included.

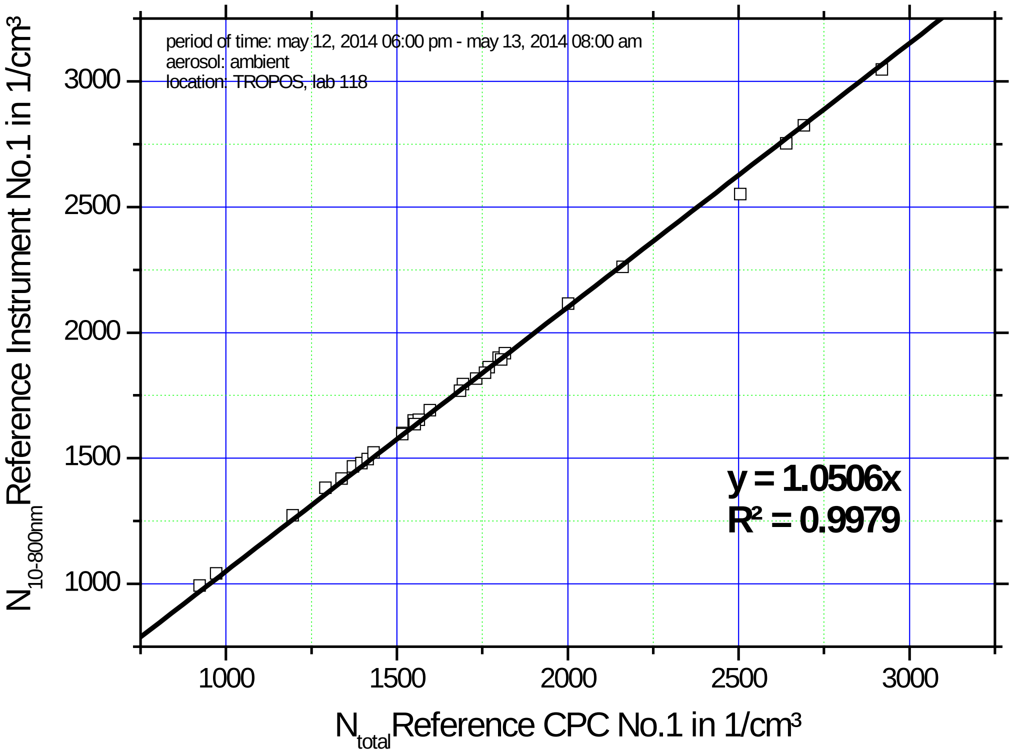


Fig.7. Linear regression between the number concentrations of the TROPOS reference instrument No.1 and TROPOS reference CPC No.1. Multiple charge correction, internal diffusion losses and flow corrections are included.

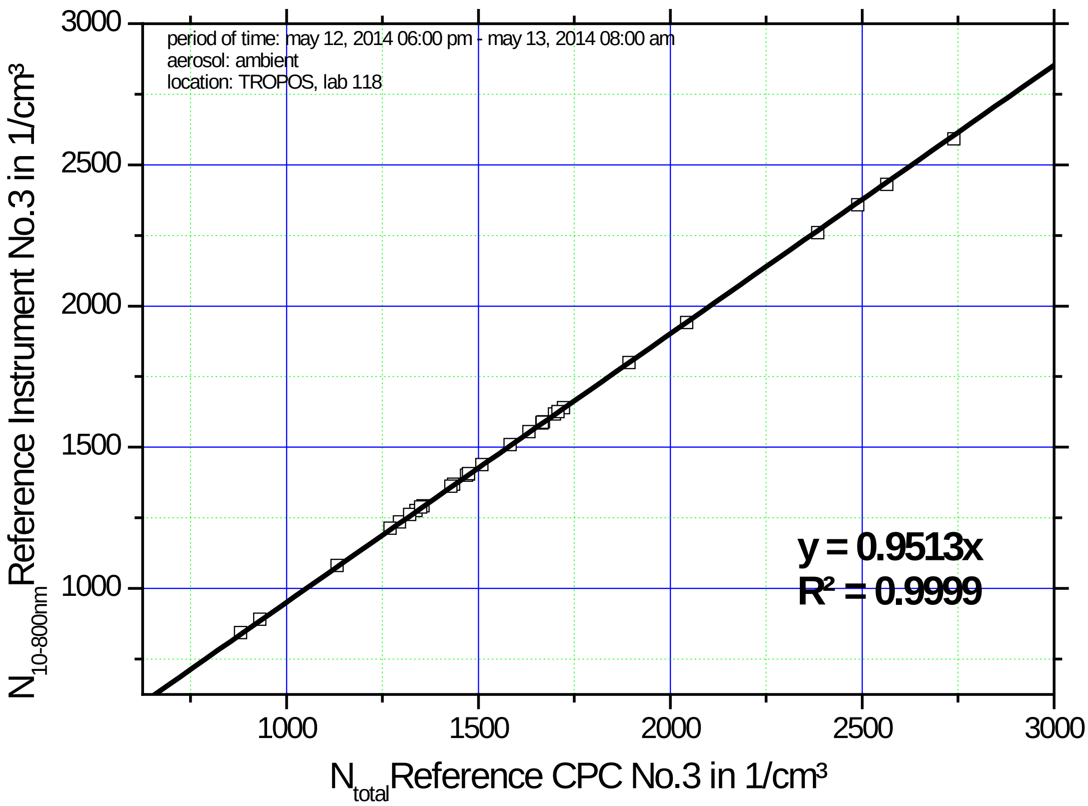


Fig.8. Linear regression between the number concentrations of the TROPOS reference instrument No.3 and TROPOS reference CPC No.3. Multiple charge correction, internal diffusion losses and flow corrections are included.

2. Time series

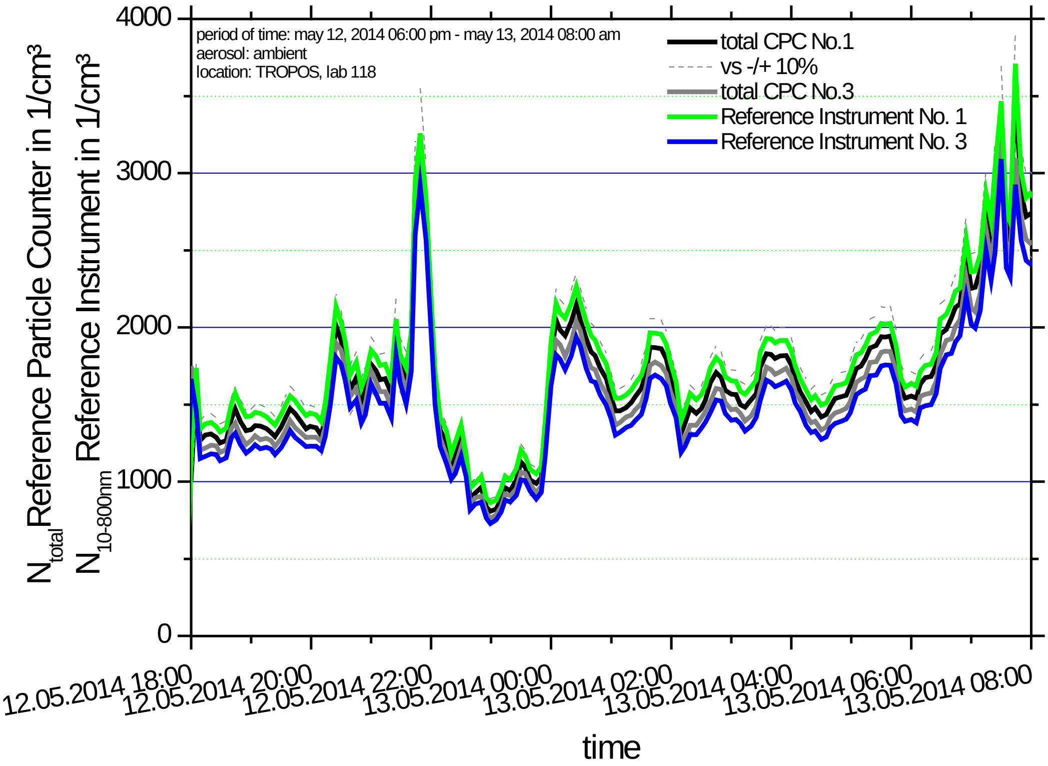


Fig.9. Time series (May 12, 2014 06:00 pm – May 13, 2014 08:00 am) of the integrated particle number concentration (N 10-800nm). Multiple charge correction, internal diffusion losses and flow corrections are included.

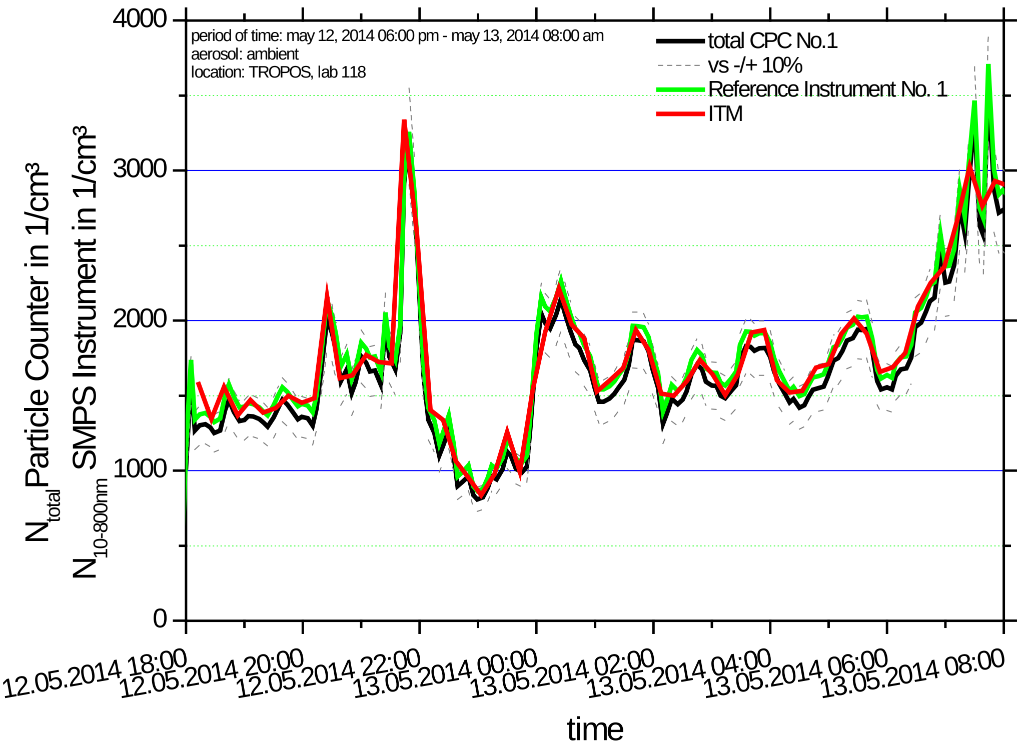


Fig.10. Time series (May 12, 2014 06:00 pm – May 13, 2014 08:00 am) of the integrated particle number concentration (N 10-800nm) of SMPS ITM and TROPOS reference instrument No.1. Multiple charge correction and internal diffusion losses are included.

3. Correlation of SMPS ITM

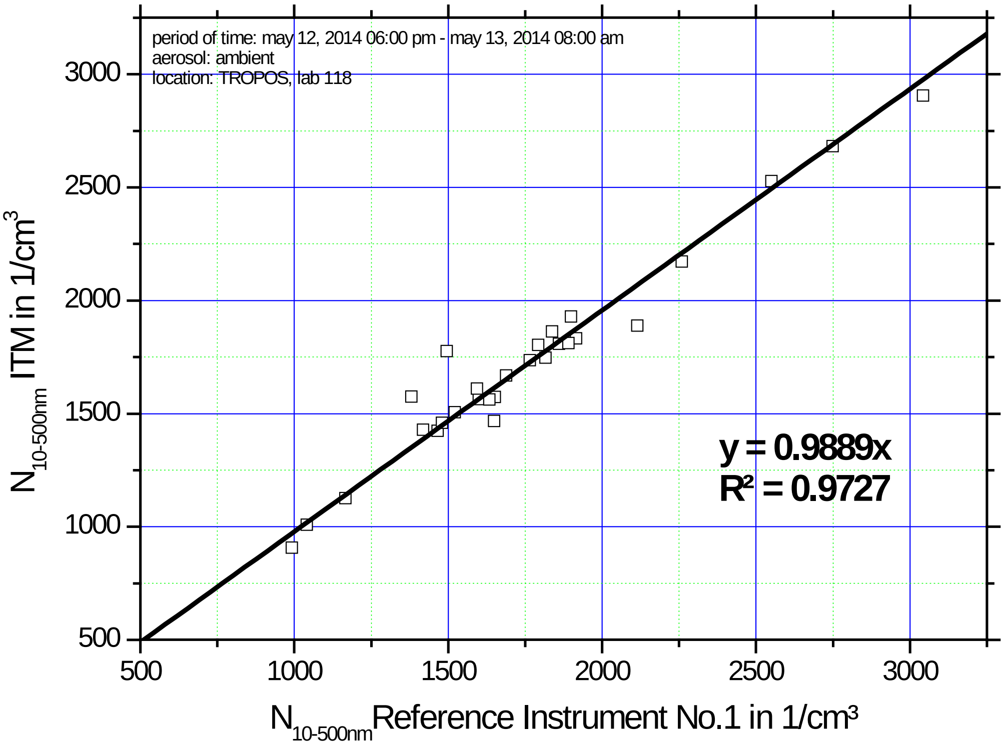


Fig.11. Linear regression between the number concentrations of the TROPOS reference instrument No.1 and SMPS ITM. Multiple charge correction and internal diffusion losses are included.

4. Size distribution

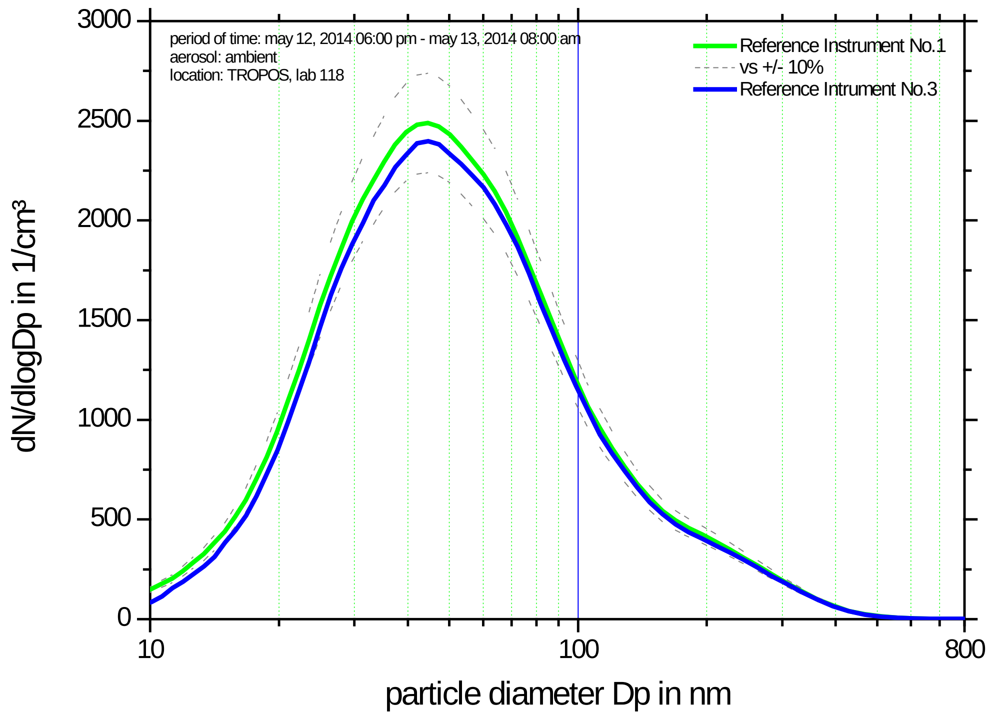


Fig.12. Comparison of mean particle number size distribution of the reference instruments between May 12, 2014 06:00 pm and May 13, 2014 08:00 am. Multiple charge correction, internal diffusion losses and CPC efficiency are included (.in2).

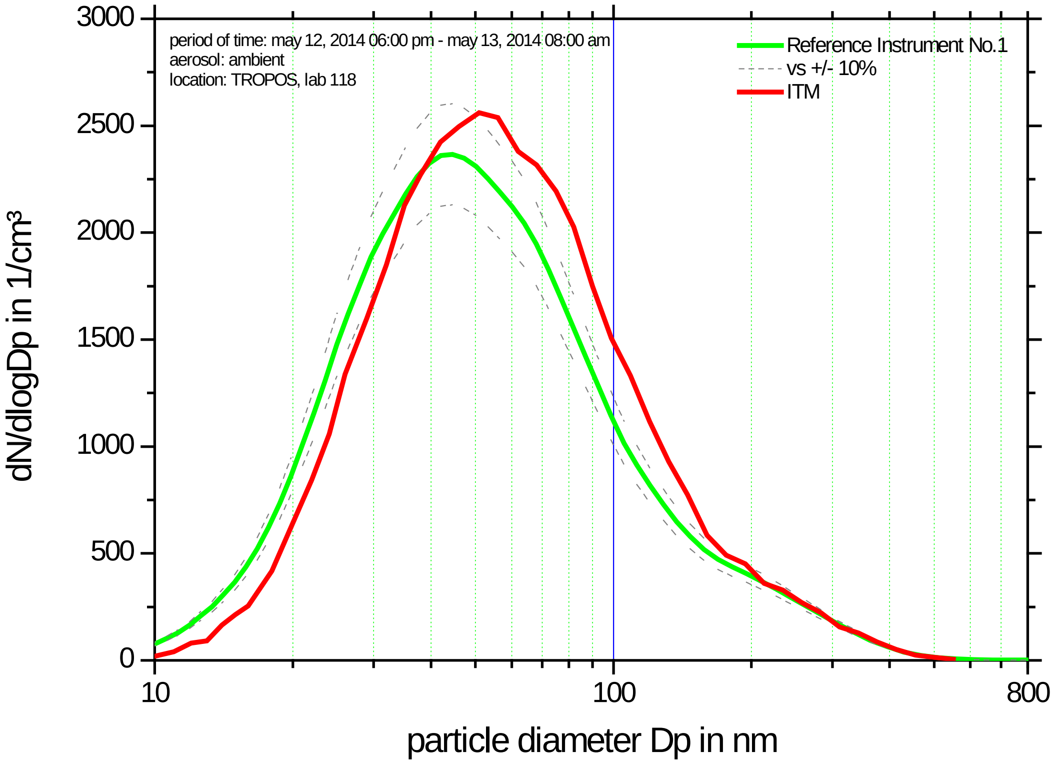


Fig.13. Comparison of mean particle number size distribution of SMPS ITM and TROPOS reference instrument No.1 between May 12, 2014 06:00 pm and May 13, 2014 08:00 am. Multiple charge correction and internal diffusion losses (.in1).

B: second run (May 13, 2014 05:00 pm – May 14, 2014 07:00 am)

1. Correlation of reference instruments

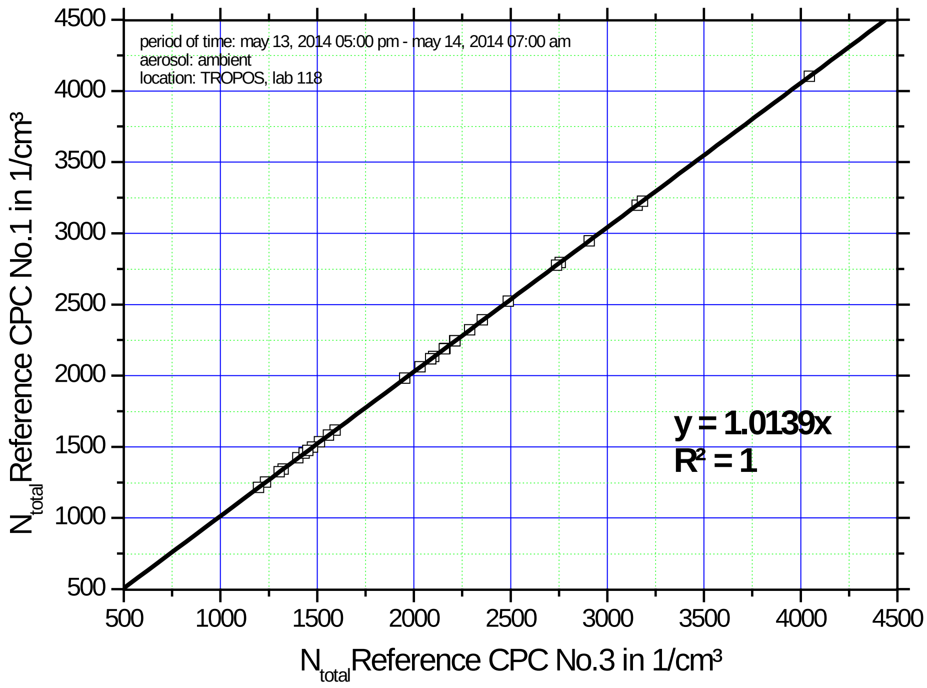


Fig.14. Linear regression between the number concentrations of the TROPOS reference CPC No.1 and the TROPOS reference CPC No.3. Multiple charge correction, internal diffusion losses and flow corrections are included.

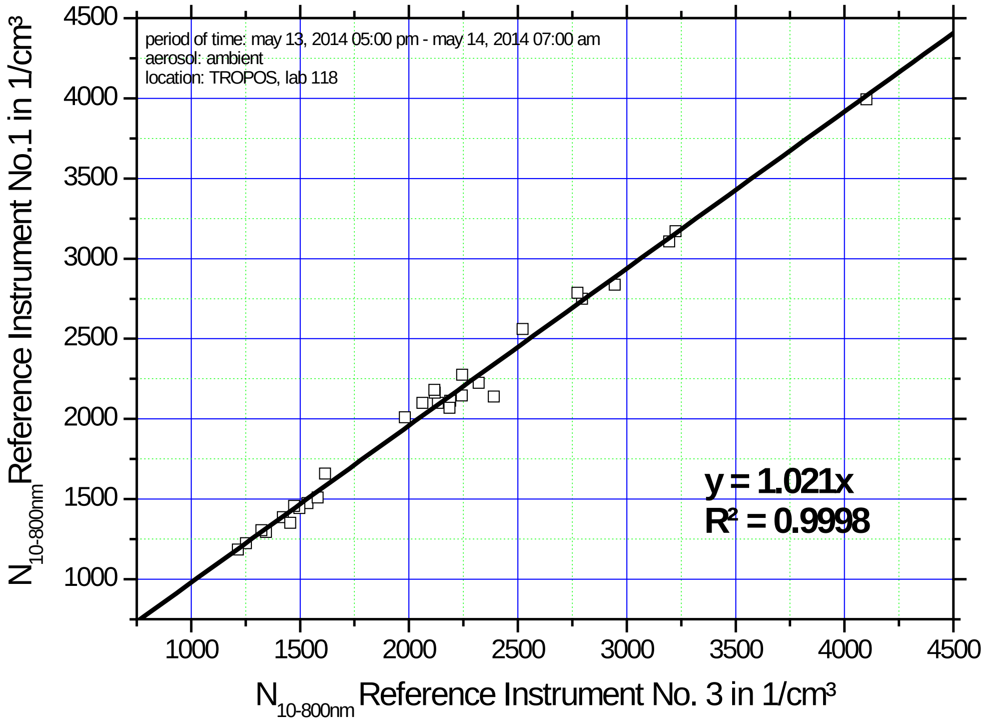


Fig.15. Linear regression between the number concentrations of the TROPOS reference instrument No. 1 and the TROPOS reference instrument No. 3. Multiple charge correction, internal diffusion losses and flow corrections are included.

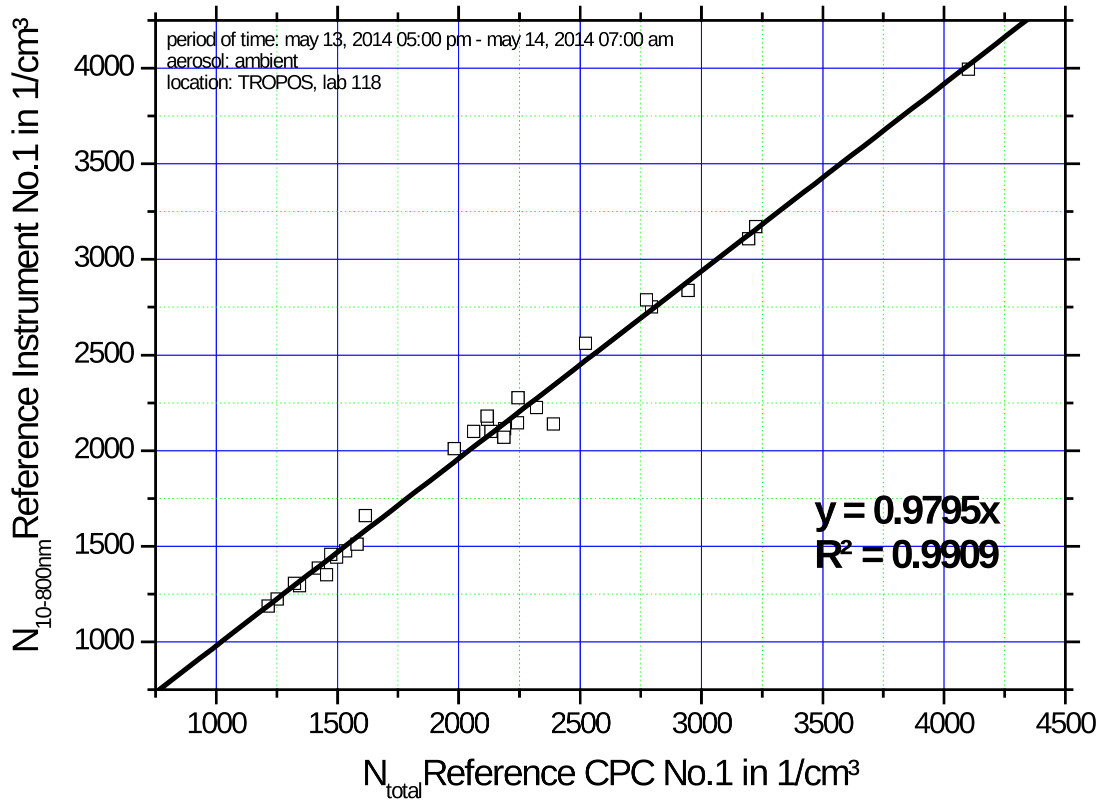


Fig.16. Linear regression between the number concentrations of the TROPOS reference instrument No. 1 and TROPOS reference CPC No.1. Multiple charge correction, internal diffusion losses and flow corrections are included.

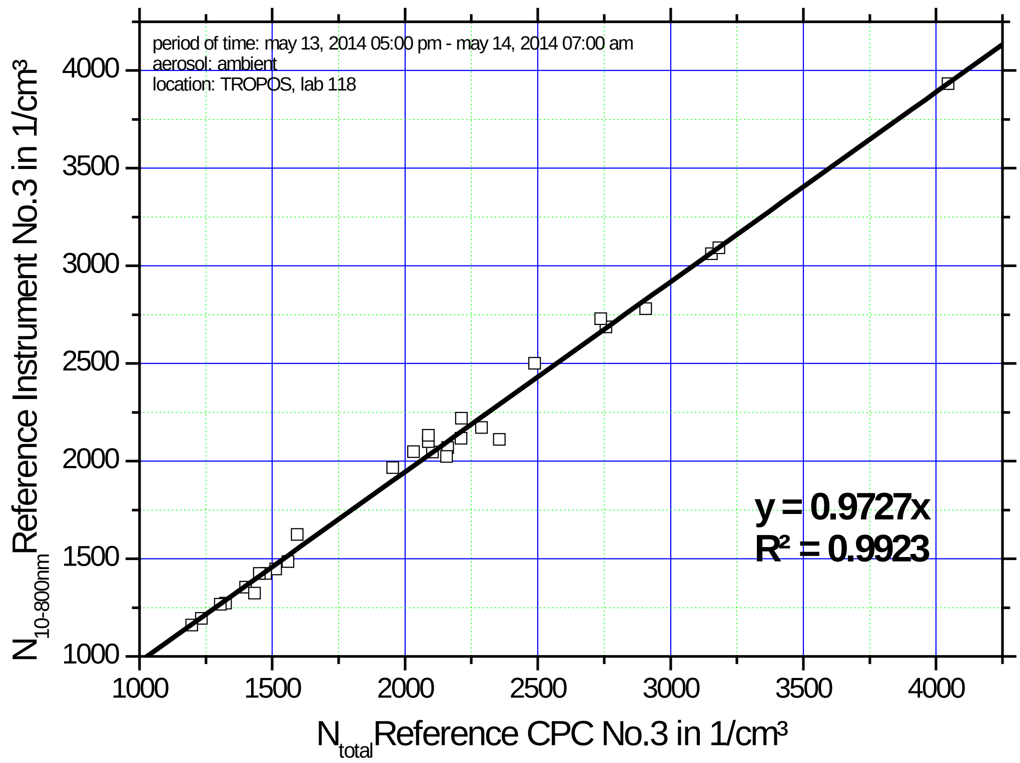


Fig.17. Linear regression between the number concentrations of the TROPOS reference instrument No. 3 and TROPOS reference CPC No.3. Multiple charge correction, internal diffusion losses and flow corrections are included.

2. Time series

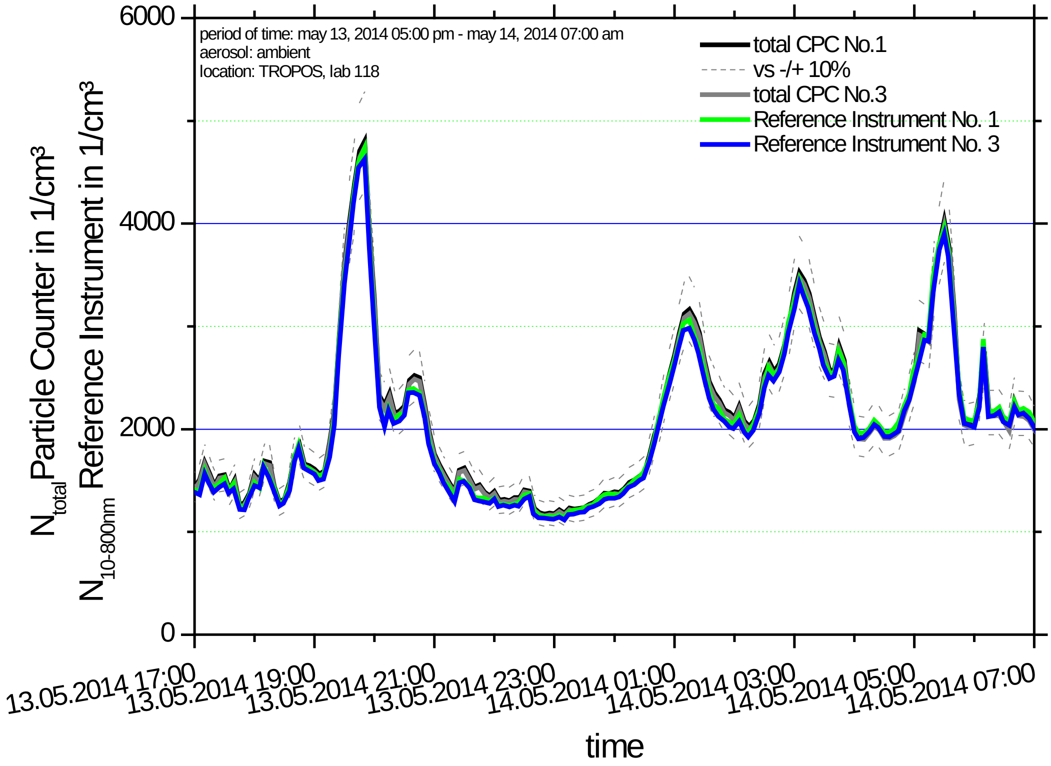


Fig.18. Time series (May 13, 2014 05:00 pm – May 14, 2014 07:00 am) of the integrated particle number concentration (N 10-800nm). Multiple charge correction, internal diffusion losses and flow corrections are included.

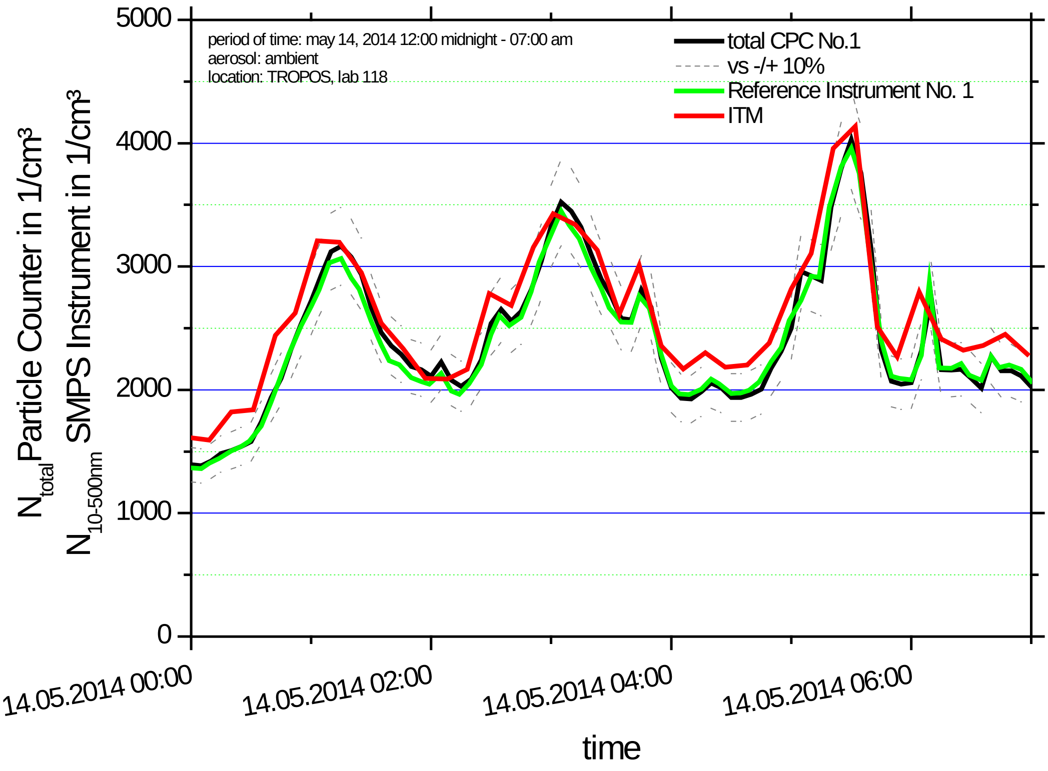


Fig.19. Time series (May 14, 2014 12:00 midnight - 07:00 am) of the integrated particle number concentration (N 10-500nm) of SMPS ITM and TROPOS reference instrument No.1. Multiple charge correction and internal diffusion losses are included.

3. Correlation of SMPS ITM

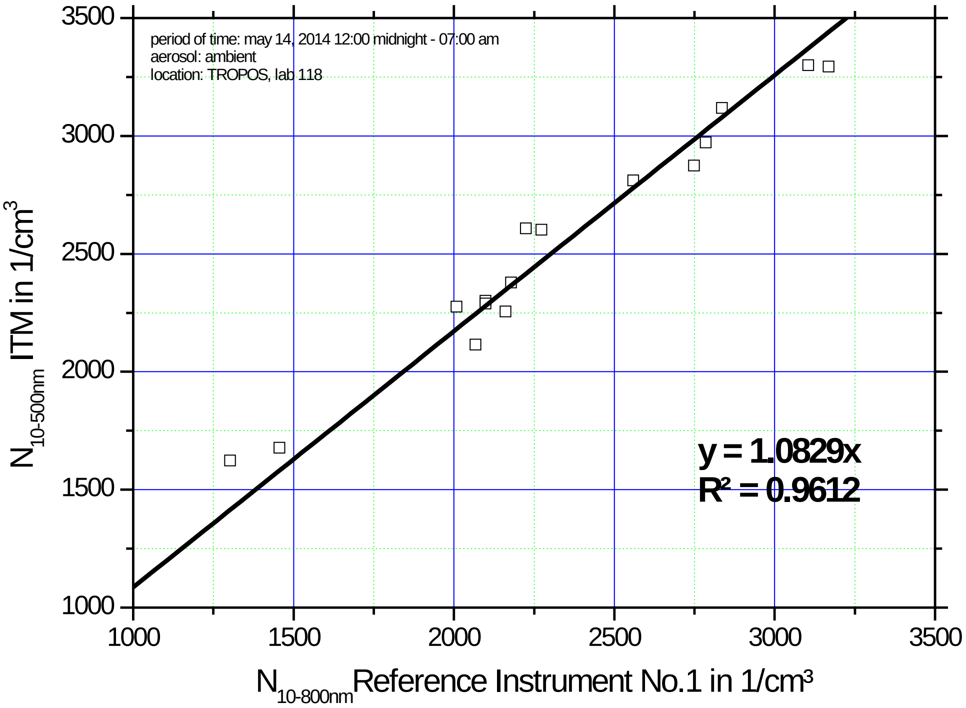


Fig.20. Linear regression between the number concentrations of the TROPOS reference instrument No.1 and SMPS ITM. Multiple charge correction and internal diffusion losses are included.

4. Size distribution

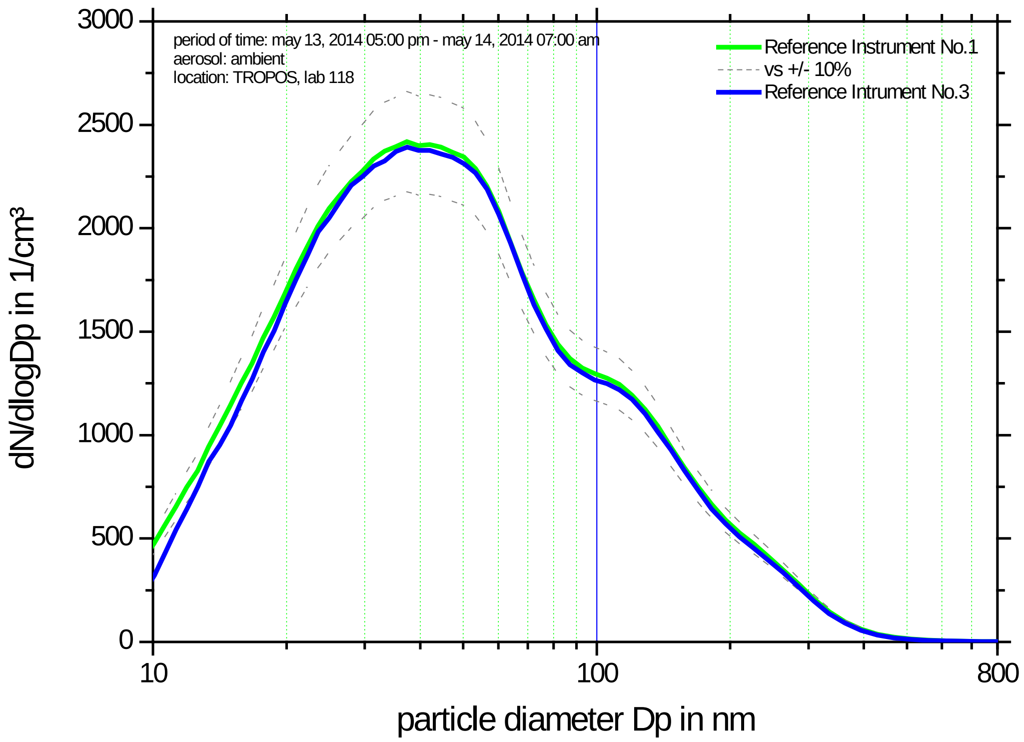


Fig.21. Comparison of mean particle number size distribution between May 13, 2014 05:00 pm and May 14, 2014 07:00 am. Multiple charge correction, internal diffusion losses and CPC efficiency are included. (.in2).

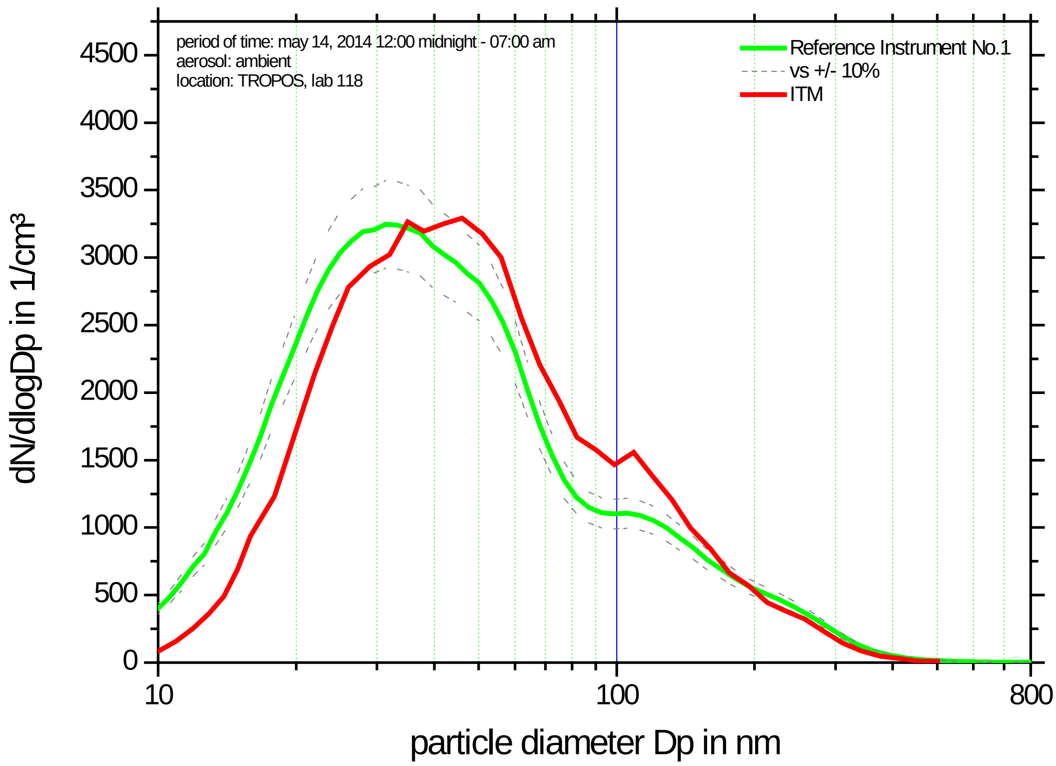


Fig.22. Comparison of mean particle number size distribution of SMPS ITM and TROPOS reference instrument No.3 between May 14, 2014 midnight and May 14, 2014 07:00 am. Multiple charge correction as included (.in0).

C: third run (May 14, 2014 07:00 pm – May 15, 2014 07:00 am)

1. Correlation of reference instruments

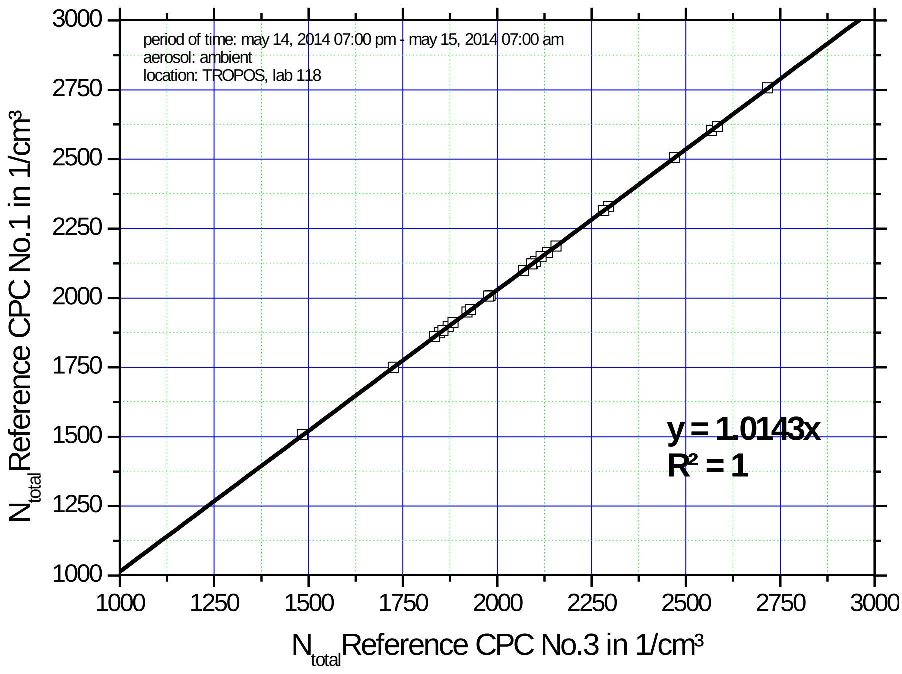


Fig.23. Linear regression between the number concentrations of the TROPOS reference CPC No.1 and the TROPOS reference CPC No.3. Multiple charge correction, internal diffusion losses and flow corrections are included.

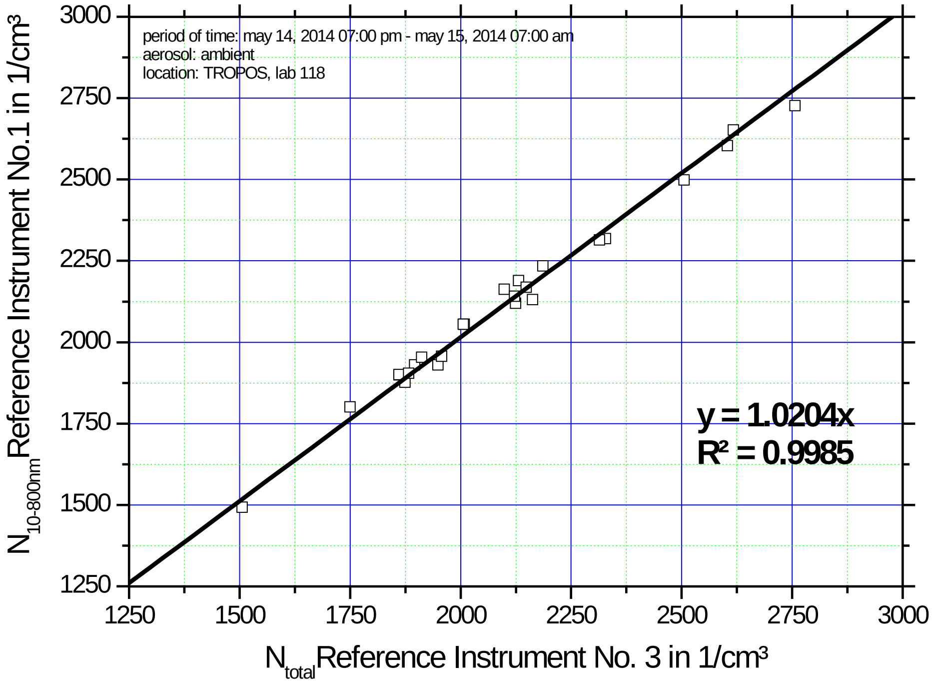


Fig.24. Linear regression between the number concentrations of the TROPOS reference instrument No. 1 and the TROPOS reference instrument No. 3. Multiple charge correction, internal diffusion losses and flow corrections are included.

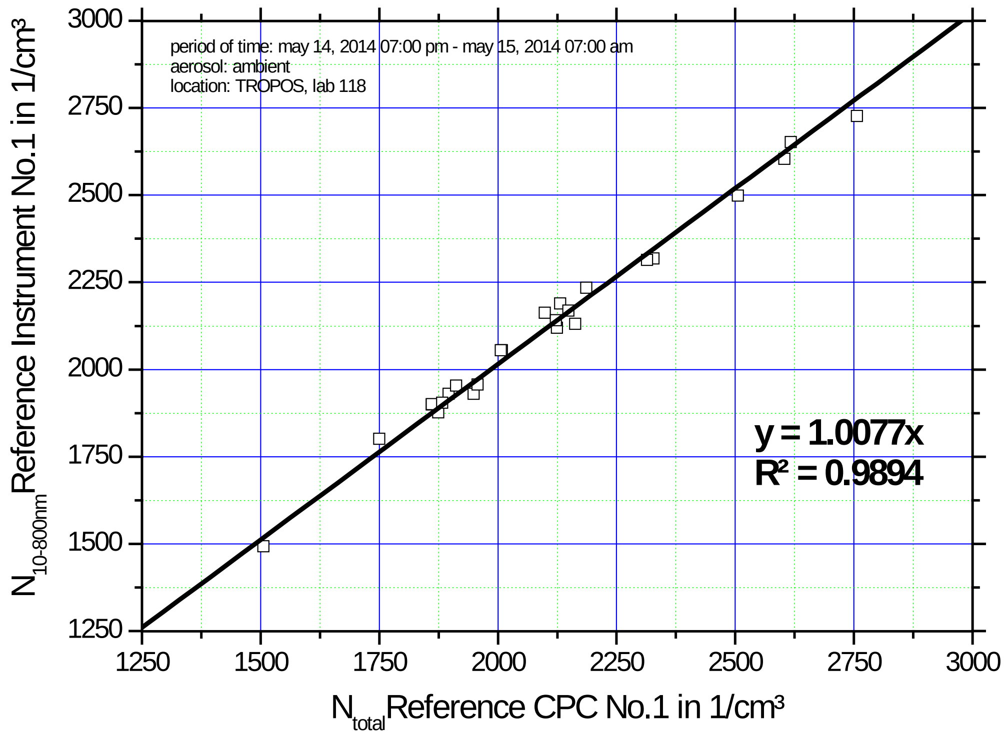


Fig.25. Linear regression between the number concentrations of the TROPOS reference instrument No. 1 and TROPOS reference CPC No.1. Multiple charge correction, internal diffusion losses and flow corrections are included.

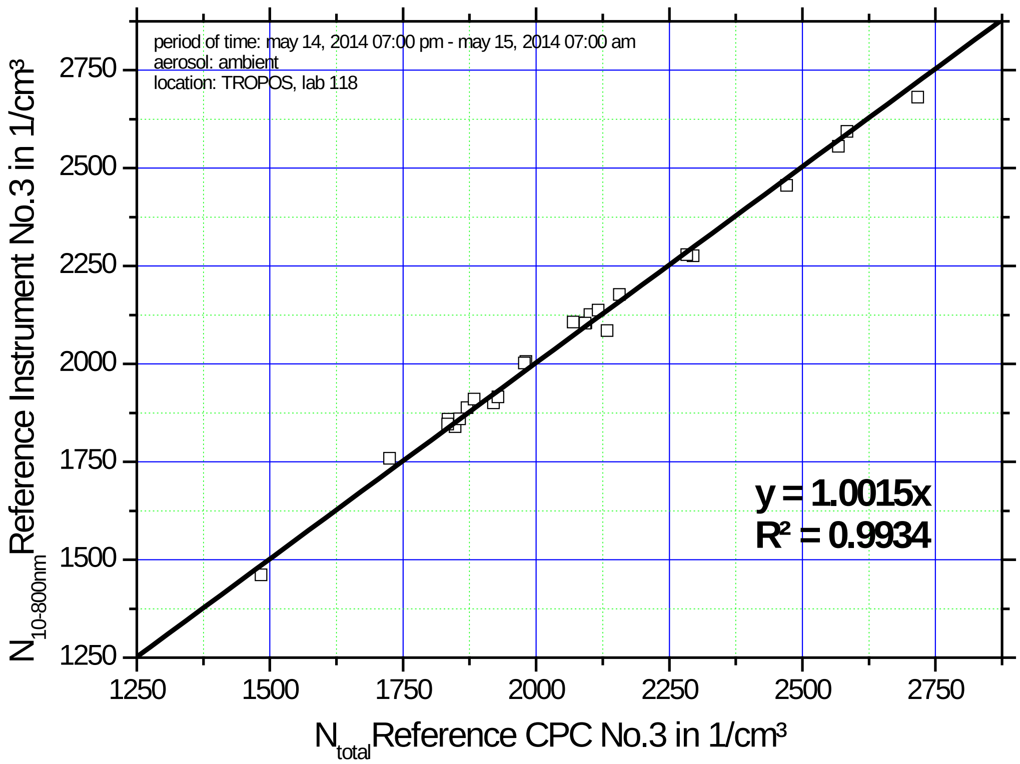


Fig.26. Linear regression between the number concentrations of the TROPOS reference instrument No. 3 and TROPOS reference CPC No.3. Multiple charge correction, internal diffusion losses and flow corrections are included.

2. Time series

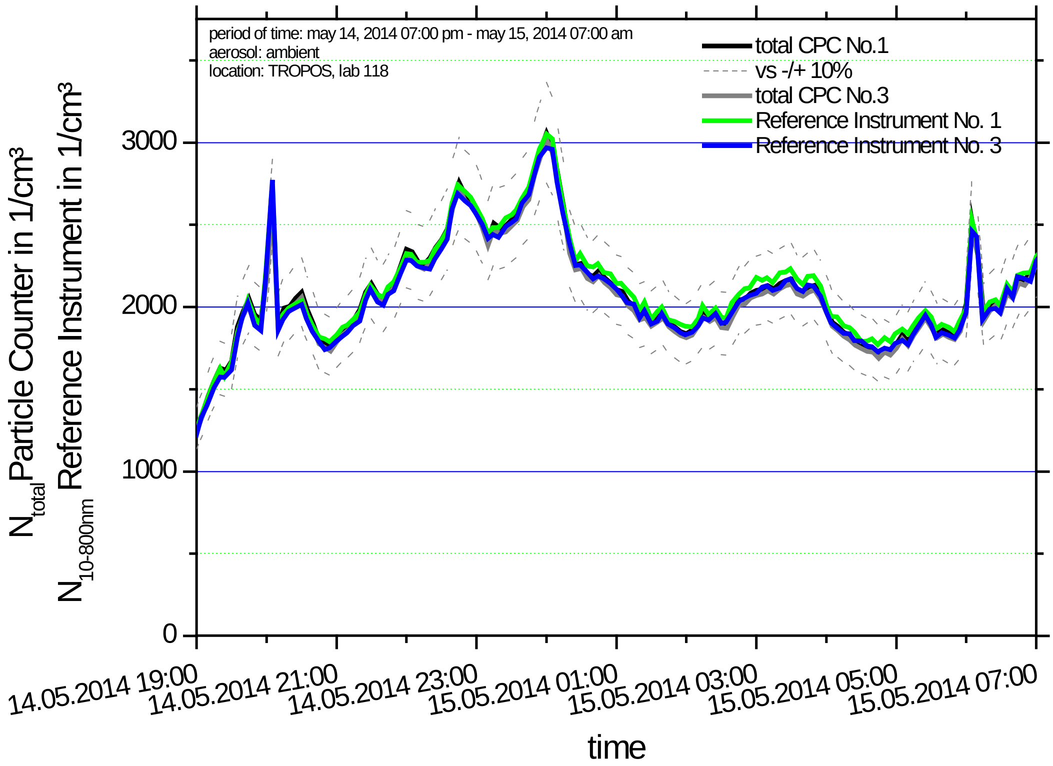


Fig.27. Time series (May 13, 2014 05:00 pm – May 14, 2014 07:00 am) of the integrated particle number concentration (N 10-800nm). Multiple charge correction, internal diffusion losses and flow corrections are included.

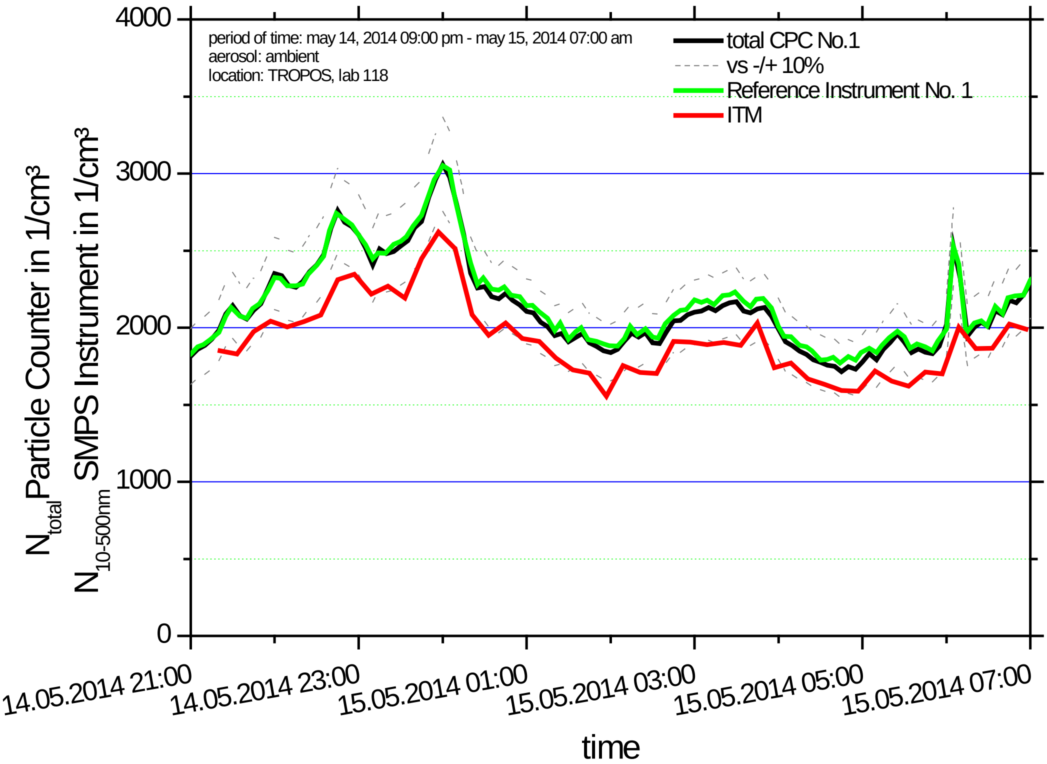


Fig.28. Time series (May 14, 2014 09:00 pm – May 15, 2014 07:00 am) of the integrated particle number concentration (N 10-500nm) of SMPS ITM and TROPOS reference instrument No.1. Multiple charge correction and internal diffusion losses are included.

3. Correlation of SMPS ITM

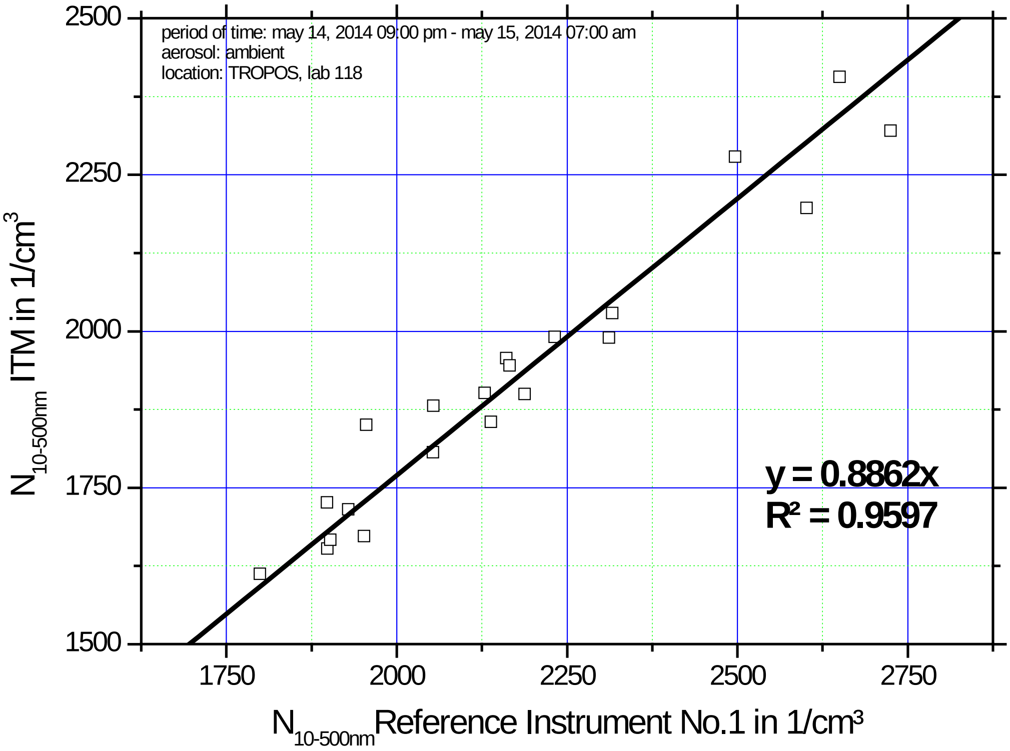


Fig.29. Linear regression between the number concentrations of the TROPOS reference instrument No.1 and SMPS ITM. Multiple charge correction and internal diffusion losses are included.

4. Size distribution

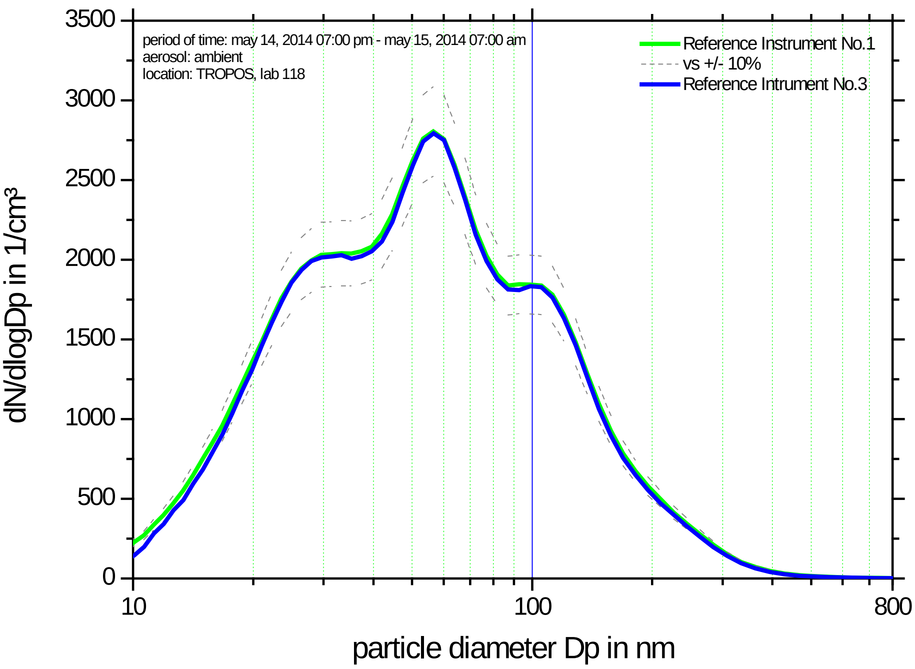


Fig.30. Comparison of mean particle number size distribution between May 14, 2014 07:00 pm and May 15, 2014 07:00 am. Multiple charge correction, internal diffusion losses and CPC efficiency are included (.in2).

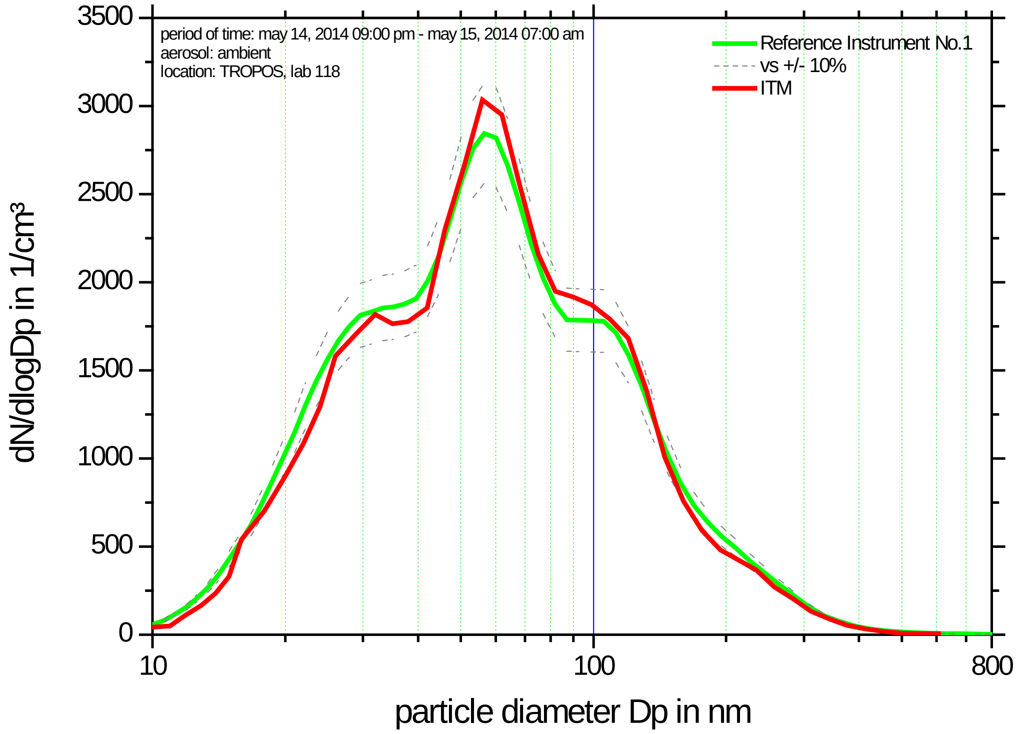


Fig.31. Comparison of mean particle number size distribution of SMPS ITM and TROPOS reference instrument No.3 between May 14, 2014 09:00 pm and May 15, 2014 07:00 am. Multiple charge correction, internal diffusion losses and CPC efficiency are included (.in2).

D: fourth run (May 15, 2014 08:00 pm – May 16, 2014 06:00 am)

1. Correlation reference instruments

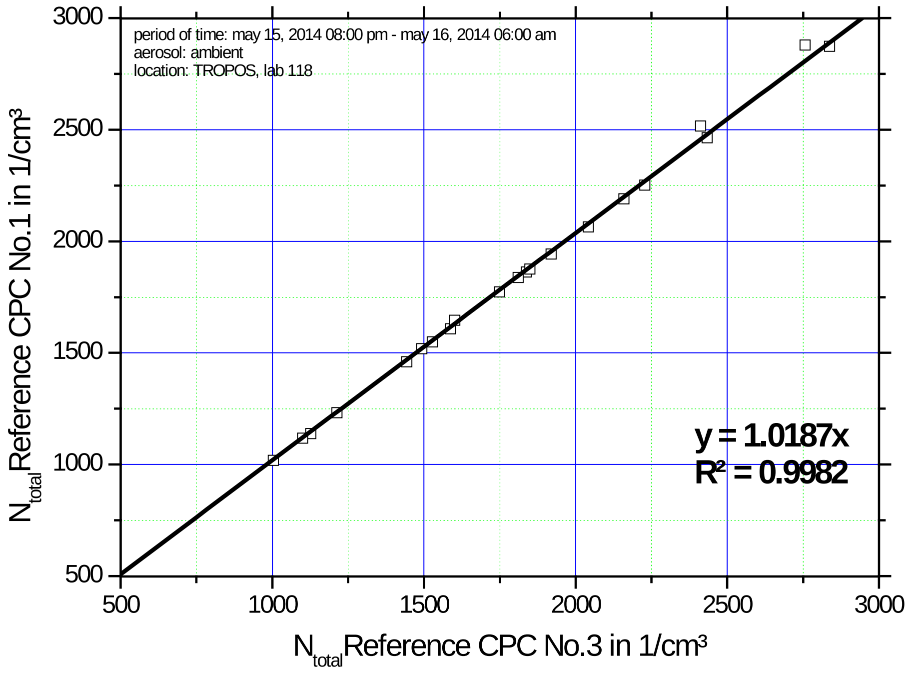


Fig.32. Linear regression between the number concentrations of the TROPOS reference CPC No.1 and the TROPOS reference CPC No.3. Multiple charge correction, internal diffusion losses and flow corrections are included.

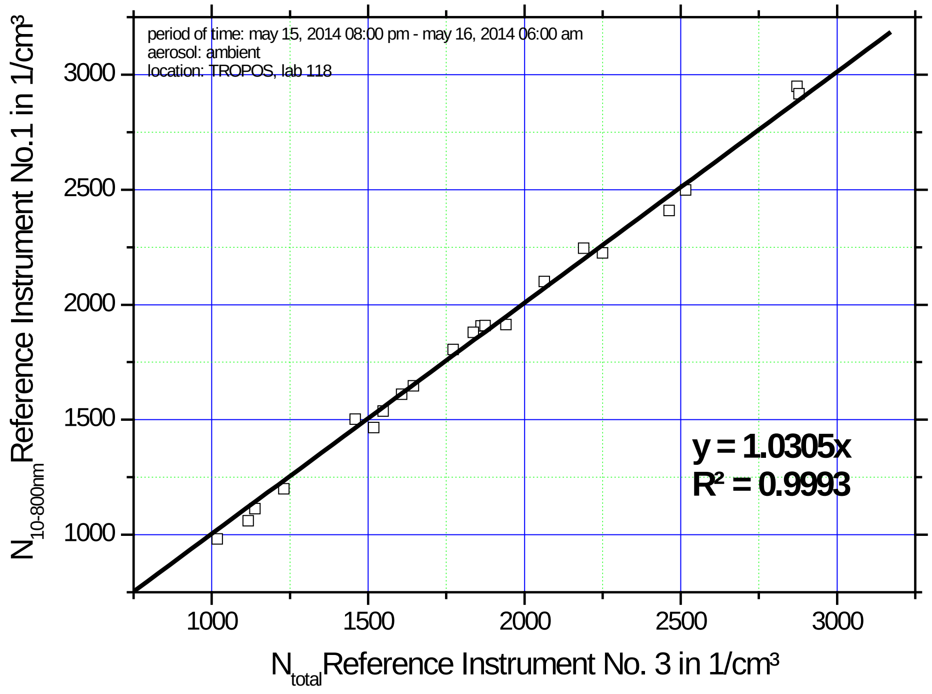


Fig.33. Linear regression between the number concentrations of the TROPOS reference instrument No. 1 and the TROPOS reference instrument No. 3. Multiple charge correction, internal diffusion losses and flow corrections are included.

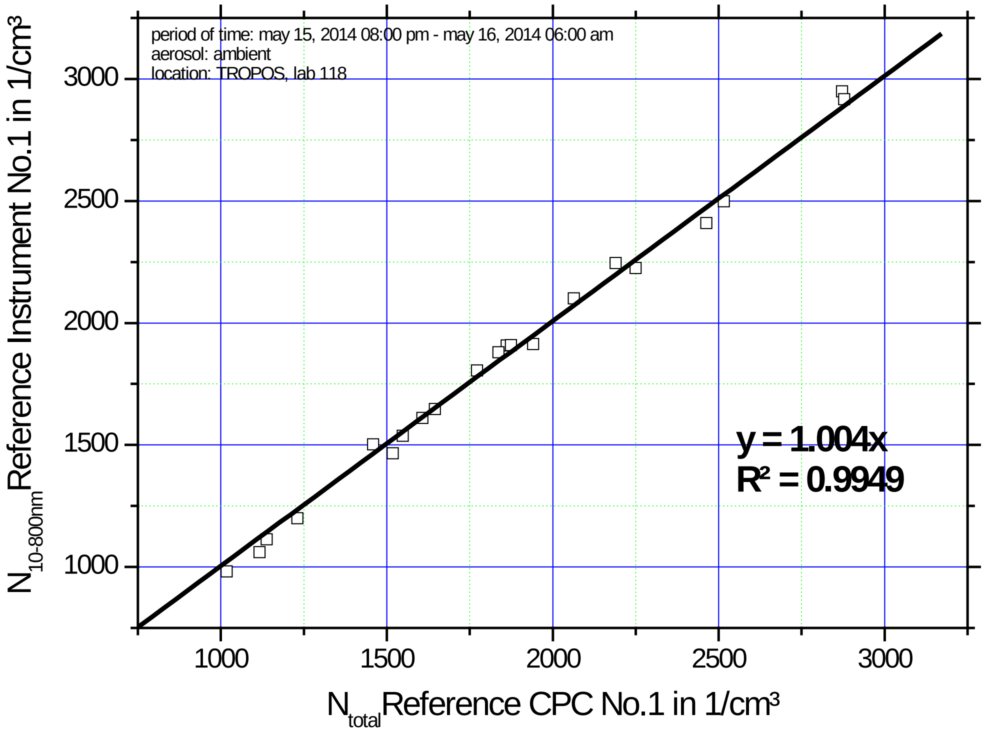


Fig.34. Linear regression between the number concentrations of the TROPOS reference instrument No. 1 and TROPOS reference CPC No.1. Multiple charge correction, internal diffusion losses and flow corrections are included.

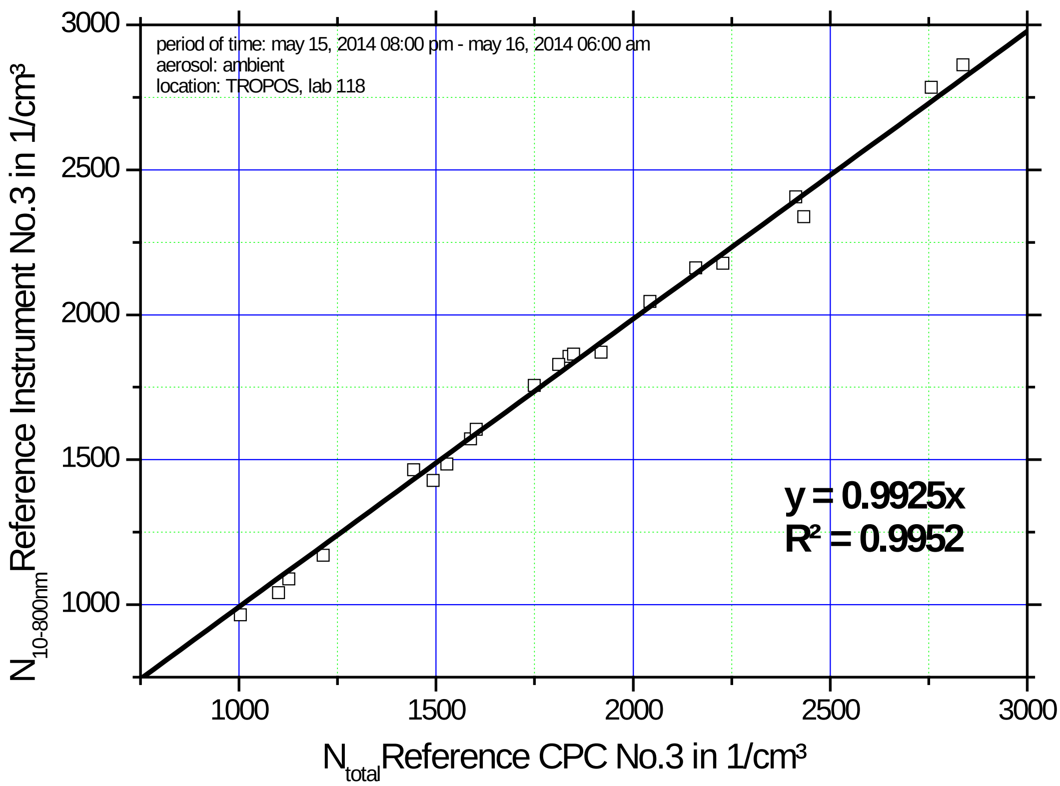


Fig.35. Linear regression between the number concentrations of the TROPOS reference instrument No. 3 and TROPOS reference CPC No.3. Multiple charge correction, internal diffusion losses and flow corrections are included.

2. Time series

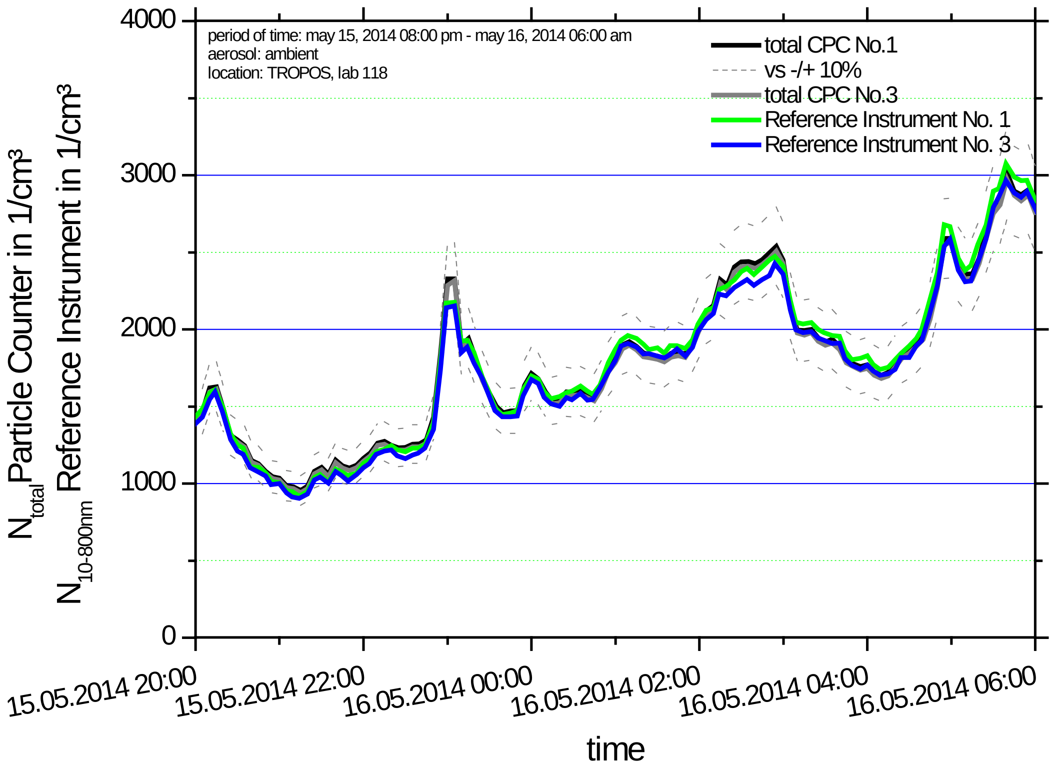


Fig.36. Time series (May 15, 2014 08:00 pm – May 16, 2014 06:00 am) of the integrated particle number concentration (N 10-800nm). Multiple charge correction, internal diffusion losses and flow corrections are included.

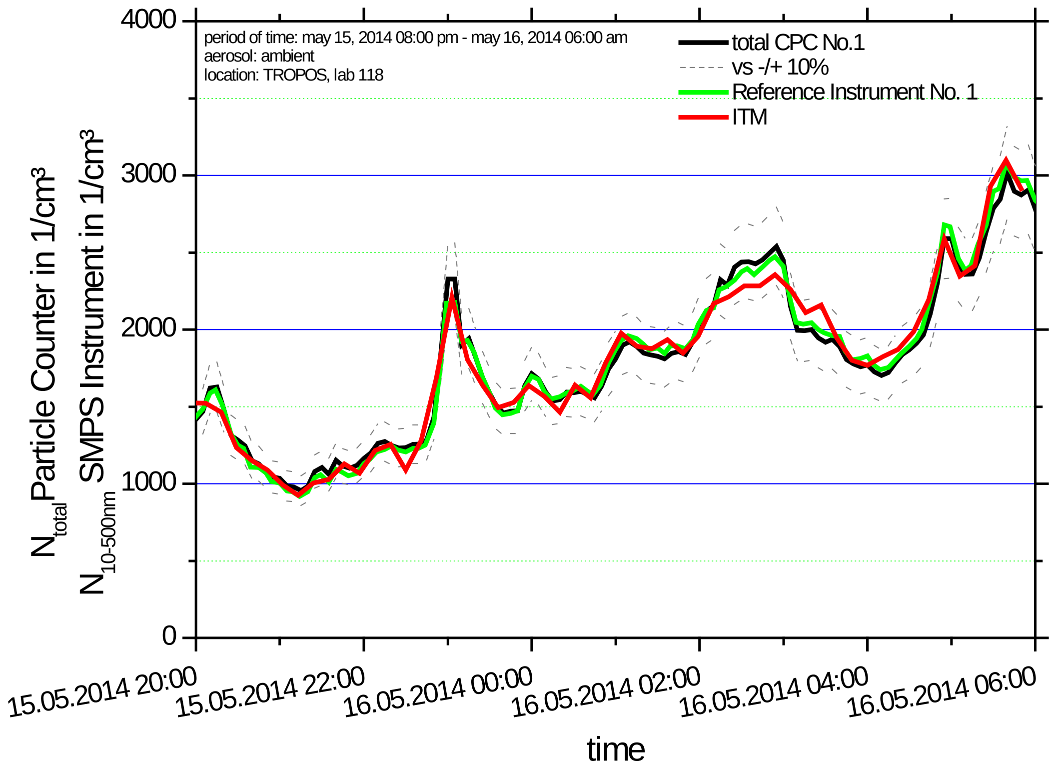


Fig.37. Time series (May 15, 2014 08:00 pm – May 16, 2014 06:00 am) of the integrated particle number concentration (N 10-500nm) of SMPS ITM and TROPOS reference instrument No.1. Multiple charge correction and diffusion losses are included.

3. Correlation of SMPS ITM

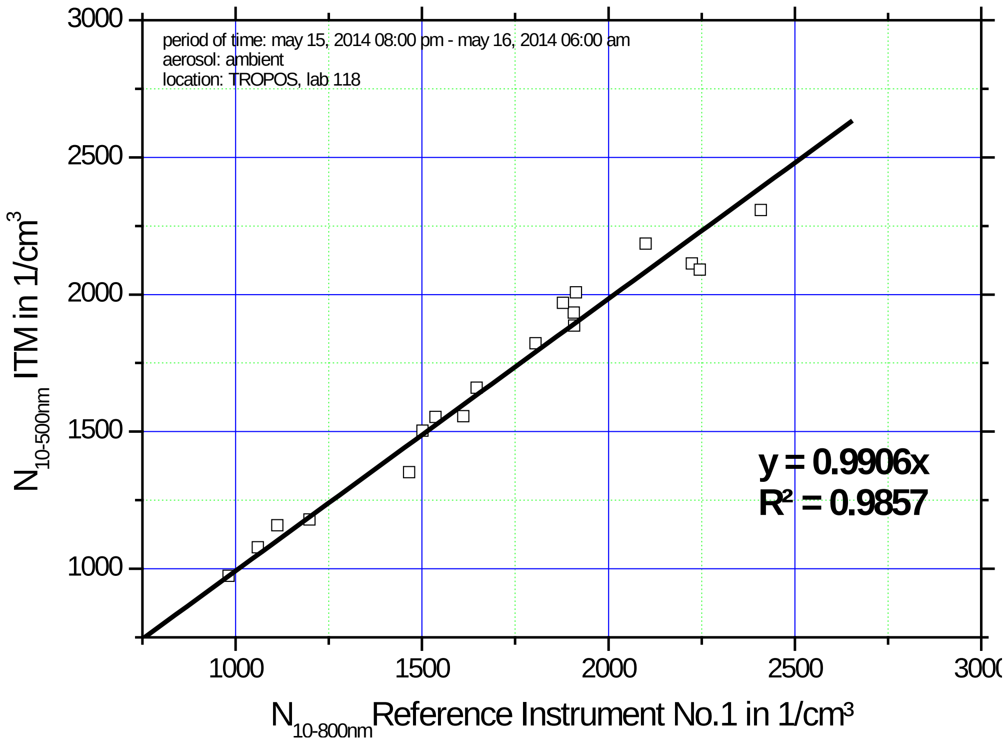


Fig.38. Linear regression between the number concentrations of the TROPOS reference instrument No.1 and SMPS ITM. Multiple charge correction, internal diffusion losses and flow corrections are included.

4. Size distribution

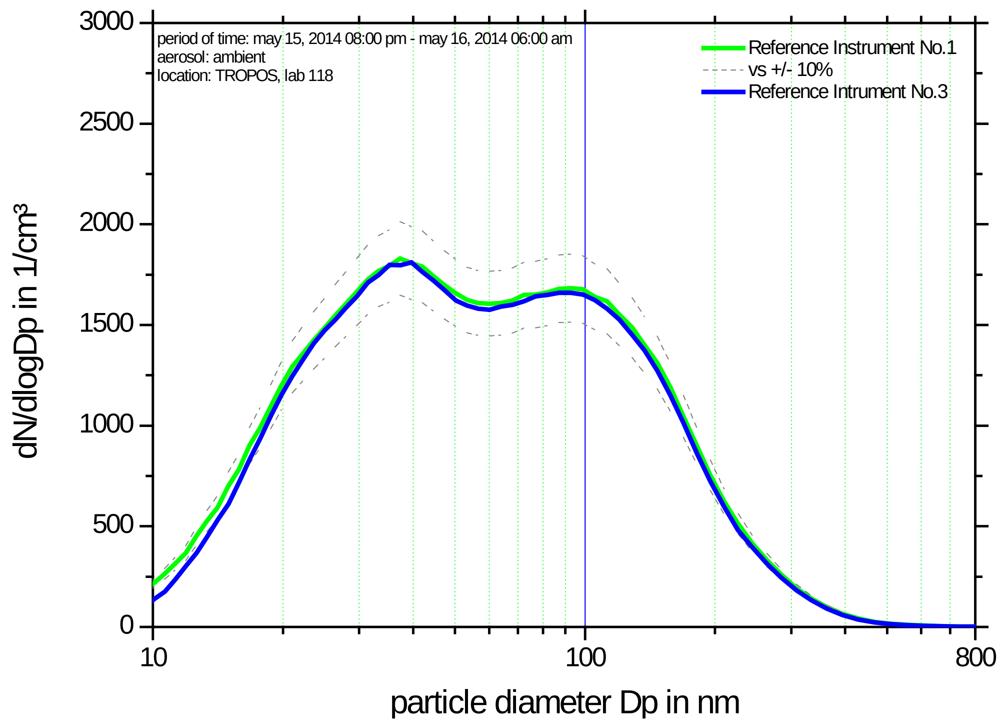


Fig.39. Comparison of mean particle number size distribution between May 15, 2014 08:00 pm and May 16, 2014 06:00 am. Multiple charge correction, internal diffusion losses and CPC efficiency are included (.in2).

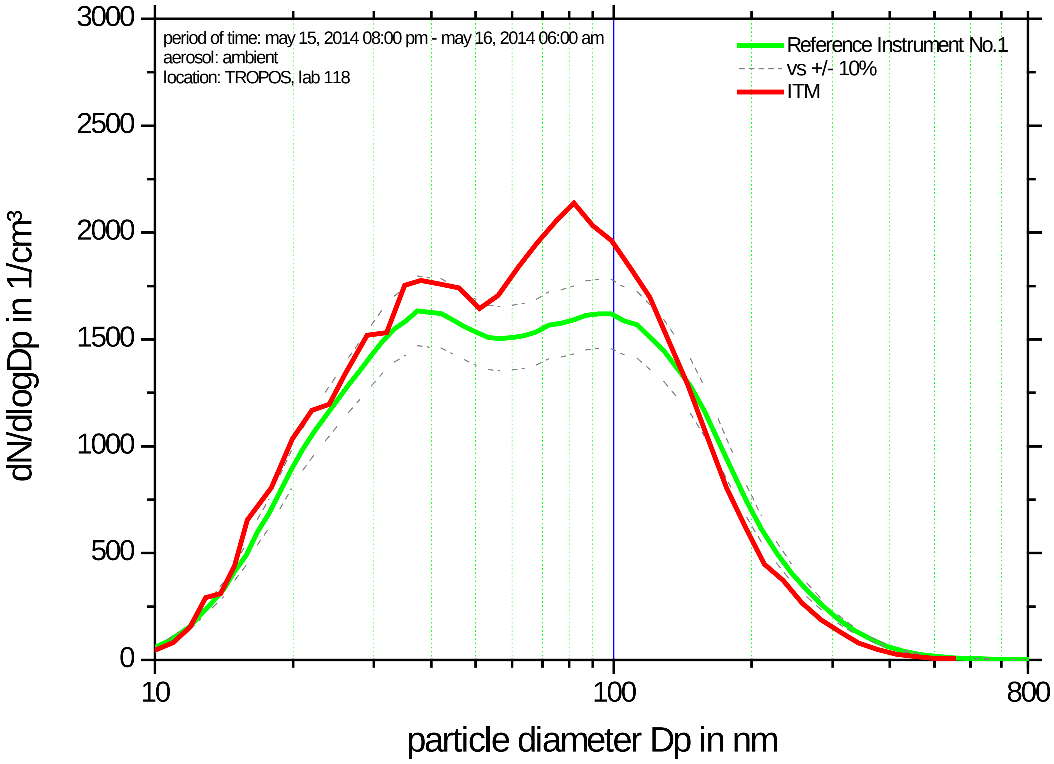


Fig.40. Comparison of mean particle number size distribution of SMPS ITM and TROPOS reference instrument No.3 between May 15, 2014 08:00 pm and May 16, 2014 06:00 am. Multiple charge correction is included (.in0).

Intercomparison of TROPOS SMPS KTL

Basic information

Location of the quality assurance:	TROPOS, lab: 118
Delivery date:	May 09, 2014
Setup in the laboratory:	May 12, 2014
Comparison period:	May 12, 2014 – May 16, 2014
Instrument:	TROPOS SMPS
TROPOS Reference Instrument:	TROPOS Reference Instrument No. 1 TROPOS Reference Instrument No. 3
Total CPC:	TROPOS Reference CPC No.1; SN: 3772112101 TROPOS Reference CPC No.3; SN: 3772111903
Additional equipment:	
Involved people:	Vadimas Dudoitis (vadimas.dudoitis@ftmc.lt)

Summary of second intercomparison:

From May 12, 2014 to May 16, 2014 the KTL TROPOS SMPS participated successfully the TROPOS ACTRIS Workshop. The workshop consisted of an entrance test and a final run. In addition to the overnight ambient measurements, we had numerous high voltage checks, zero- and PSL- measurements. The report is divided into three sections. The first section shows the laboratory setup and the PSL measurement. After that, we show for each run the time series of the particle number concentration, the particle number size distribution, and correlation plots. If anything was written in the log book, so we added this also in this report. As reference standards, we used CPCs model TSI 3772 for total particle number concentration and two TROPOS mobility particle size spectrometer. The particle counters have been calibrated against a calibrated TSI electrometer 3068 B with the serial number 70838596.

For the PSL-calibrations, we used Latex particle with a nominal size of 203 nm +/- 4 nm. The latex particles have been generated with an aerosol nebulizer. The sheath air flow rate of the candidate system was calibrated to match the latex particle size, if possible. The KTL TROPOS SMPS showed in the PSL-measurements a particle diameter of 203.5 nm. Both the zero check and the high-voltage calibration passed the requirements in the final run. If we look at the final ambient measurement run, the KTL TROPOS SMPS is in the 10%. The KTL TROPOS SMPS did not pass the ACTRIS Workshop.

Log book:

May 12, 2014

	-> Setup of all instruments in laboratory 118
11:00 am - 04:00 pm (local time)	-> CPC workshop
	-> High voltage calibration of Ref1 and Ref3
	-> Measured flows: CPC 1 : 1.040 l/min CPC 3 : 1.029 l/min Ref 1 : 1.018 l/min Ref 3 : 0.9999 l/min
03:45 pm - 04:05 pm	-> Zero test
04:15 pm - 05:05 pm	-> Settings changed. Pressure changed to 994 hPa For 200 nm PSL particle test.
04:15 pm - 05:05 pm	-> Construction changed. CPC exhaust to vacuum line is removed. Problem detected. There was a problem with CPC, because the exhaust was connected to vacuum, which is not good for this type of CPC, it runs with the pump directly from inlet to exhaust.
04:15 pm - 17:05 pm	-> From PSL particle test we find that sheath flow in SMPS isn't correct. Apply correction for SMPS sheath flow. Sheath flow calibration curve is corrected from 4.8x to 5.4x
05:05 pm - 05:25 pm	-> Settings changed. SMPS starts measuring PSL particles correctly (PSL theoretical size - 204 nm) after adjusting the system.
05:25 pm - 05:30 pm	-> Settings changed. SMPS switched from the zero test to normal measurement mode (pressure changed to 1000 hPa, temperature to 15 C).
05:30 pm - 06:03 pm	-> Zero test. Less than 5 particles/cm3 measured. Zero test passed.
06:05 pm - 12:00 am	-> Ambient aerosol measurement. Day 1.

May 13, 2014

12:00 am - 02:55 pm	-> Ambient aerosol measurement. Day 2 part 1.
03:20 pm - 04:15 pm	-> Settings changed. PSL particle measurement. Peak registered at 203 nm.
04:15 pm - 12:00 am	-> Ambient aerosol measurement. Day 2 part 2.

May 14, 2014

12:00 am - 02:30 pm	-> Ambient aerosol measurement. Day 3 part 1.

02:40 pm - 02:45 pm	-> Construction changed. Nafion dryer on the inlet removed. Measurements before, Preila CPC shows relevantly higher cooler temperature than it should be.
02:45 pm - 04:05 pm	-> Testing without nafion dryer. For 1 hour.
04:05 pm - 04:15 pm	-> Stop measurements without nafion dryer. Concentration is still lower than the reference system.
04:15 pm - 04:20 pm	-> Construction changed. Remove the cover lid from CPC for more efficient cooling temperature.
04:20 pm - 05:25 pm	-> SMPS measurement of ambient aerosol running with CPC Preila without cover lid and without inlet nafion dryer.
05:25 pm - 05:25 pm	-> Construction changed. Stopped measurements with Preila CPC lid uncovered and without nafion dryer. Switching SMPS off for change of CPCs. From Preila CPC to CPC TSI 3760A.
06:12 pm 06:16 pm	-> CPC TSI 3760A is connected to SMPS.
06:16 pm - 06:19 pm	-> Settings changed. SMPS settings changed for the new CPC. Use TSI 3010 model settings06n the dashboard. Flow ratio - 1:5.
06:19 pm - 06:20 pm	-> Checked aerosol flow rate before the start. It is set to 1.00 LPM.
06:20 pm - 12:00 am	-> Ambient aerosol measurement. Day 3 part 2.

<u>May 15, 2014</u>

12:00 am - 09:20 am	-> Ambient aerosol measurement. Day 4 part 1.
09:20 am - 09:35 am	-> Settings changed. The inner sheath flow loop was changed into external loop through the mass flowmeter.
09:35 am - 09:40 am	-> Construction changed. SMPS measures aerosol from the room.
09:40 am - 10:00 am	-> Sheath flow goes through the external loop. 5.00 LPM on the system represents 4.64 LPM on the flowmeter. Before the settings changed for external loop, the flowmeter showed 4.00 LPM.
09:40 am - 10:00 am	-> Settings changed. Aersol changed from the room into the ambient aerosol.
10:00 am - 10:10 am	-> Construction changed. Zero test measurement with Hepa filter directly attached to CPC inlet. Ended Zero test. No leaks detected.

10:10 am - 10:33 am	-> Settings changed. Corrected sheath flow calibration curve from 5.6x (4.64 LPM) to 5.78x (4.50 LPM) and spotted that it decreased the sheath flow. So the opposite has to be done
10:33 am - 10:35 am	-> Settings changed. The sheath flow calibration curve changed from 5.78x (4.50 LPM) to 5.25x (5.00 LPM).
10:35 am - 10:40 am	-> SMPS measures ambient aerosol on external sheath loop. The flow is 4.97 LPM to 4.92 LPM.
10:40 am - 11:00 am	-> Normalized flow rate in the external loop is 5.00 LPM. The results from the SMPS "looks" the same as in the reference system.
11:00 am - 11:10 am	-> Construction changed. Switched from the external sheath flow loop to the inner sheath flow loop.
11:10 am - 03:05 pm	-> Ambient aerosol measurement with SMPS CPC TSI 3760A. Day 4 part 2.
03:05 pm - 03:20 pm	-> Construction changed. Interrupt measurements and place the nafion dryer at the aerosol inlet back.
03:20 pm - 06:20 pm	-> Ambient aerosol measurement with SMPS CPC TSI 3760A with inlet nafion dryer.
06:20 pm - 08:00 pm	-> Construction changed. Switched off SMPS. Changed CPC TSI 3760A to Preila CPC.
06:20 pm - 08:00 pm	-> Settings changed. A lot of variation in CPC parameter change were conducted. It's obvious that PREILA CPC was estimating too many particles, both in the nanosize range as in the large particle range. Something wrong with the pump which blows air into nafion dryer. So the pump for nafions was switched off.
08:13 pm - 08:27 pm	-> Settings changed. CPC flow rate in the SMPS dashboard was changed to 0.03 LPM. Nothing happened
08:27 pm - 08:42 pm	-> Construction changed. Disconnect SMPS and connect CPC directly inline for comparison to REF1 CPC.
08:42 pm - 08:50 pm	-> Settings/Construction changed. Connect SMPS back in line and change settings back to normal.
08:50 pm - 12:00 am	-> Ambient aerosol measurement with SMPS PREILA CPC with inlet nafion dryer. Day 4 part 4.

<u>May 16, 2014</u>

12:00 am - 09:25 am	-> Ambient aerosol measurement with SMPS PREILA CPC with inlet nafion dryer. Day 5 part 1.
09:00 am - 09:25 am	-> Construction changed. Switch the inner SMPS sheath flow loop to external and measured the flow rate.
09:25 am	-> Construction changed. SMPS switched off.

Other details

Time zone (GMT+02:00).

About the flows:

CPC flowrate at the inlet 1.06 LPM. CPC flow splits to aerosol flow - 0.026 LPM

The line flow in the tube was 10 LPM and the aerosol particles from the line were sucked by SMPS system only.

Sheath flow 5.00 LPM. Mixing ratio of sheath and aerosol flows - 5:1

DMA HV can be calibrated by

Measurement & Automation Explorer > Data Neighborhood > Ni-Daqmx Global Virtual Channels > DMA HV.

Sheath flow can be calibrated by

Measurement & Automation Explorer > Data Neighborhood > Ni-Daqmx tasks > tsk dma loop flow.

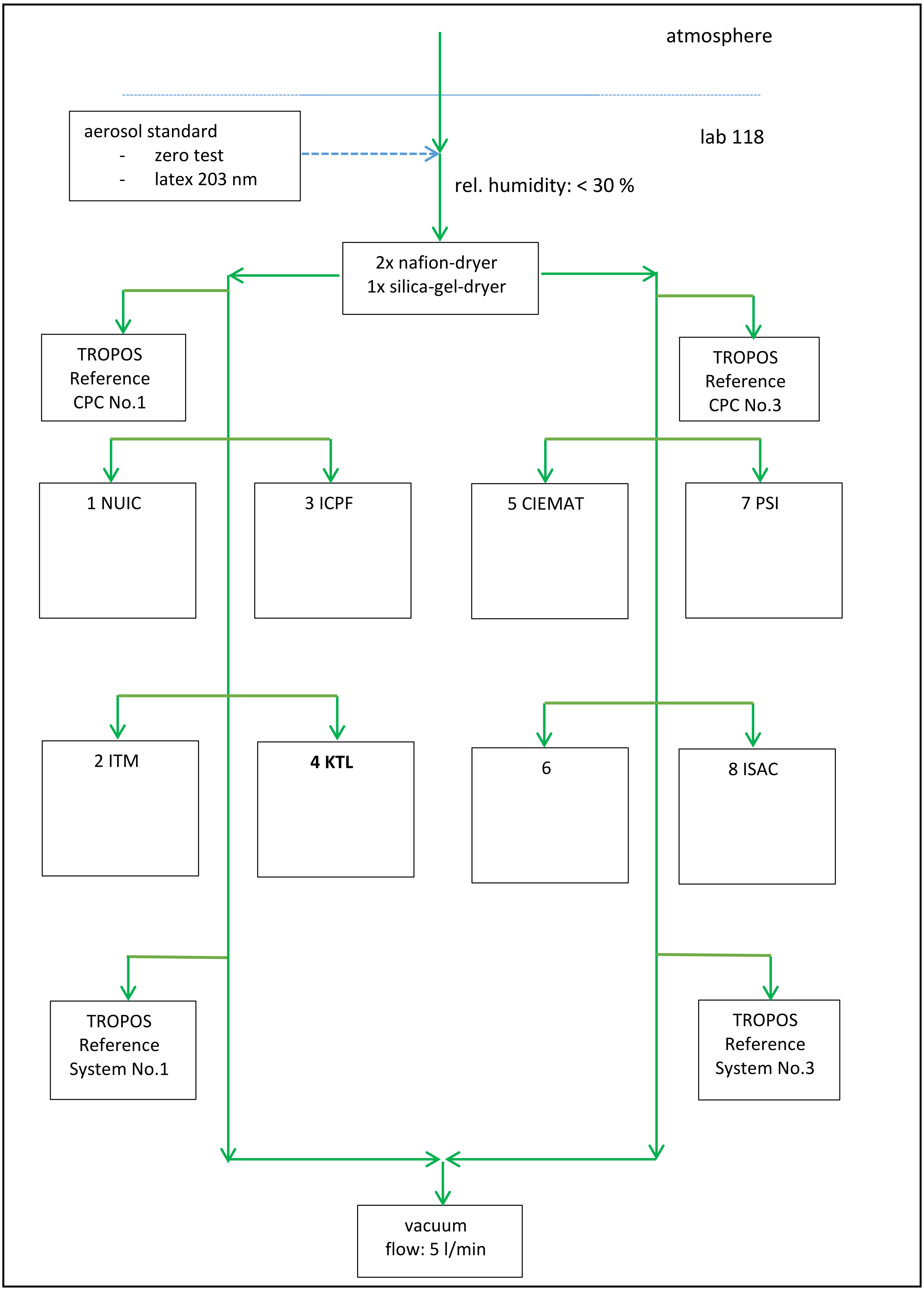
CPC settings:

Heater T43
Cooler T 10
Integration time 1
Division constant 341

HV calibration. Scaling factor 1250. Example: 4 mV * 1250 = 5.00 V

Set point, mV	Experimental value, V	Theoretical value (mV * 1250), V
0	4.65	0.03
4	9.59	4.83
10	17.23	12.36
80	105.2	199.9
200	256.4	249.9
800	1013	1000

Laboratory setup



CPC Efficiency

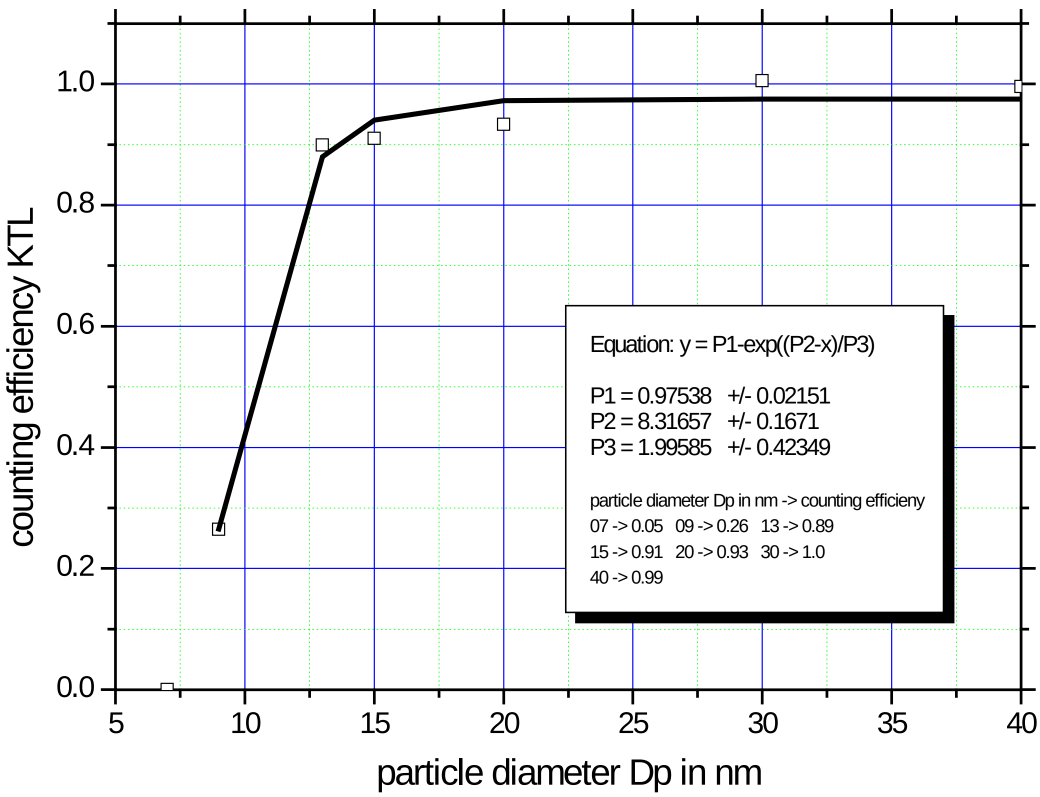


Fig.1. CPC efficiency curve. Based on Electrometer TSI 3068B. Serial number: 70838596

Latex 203 nm

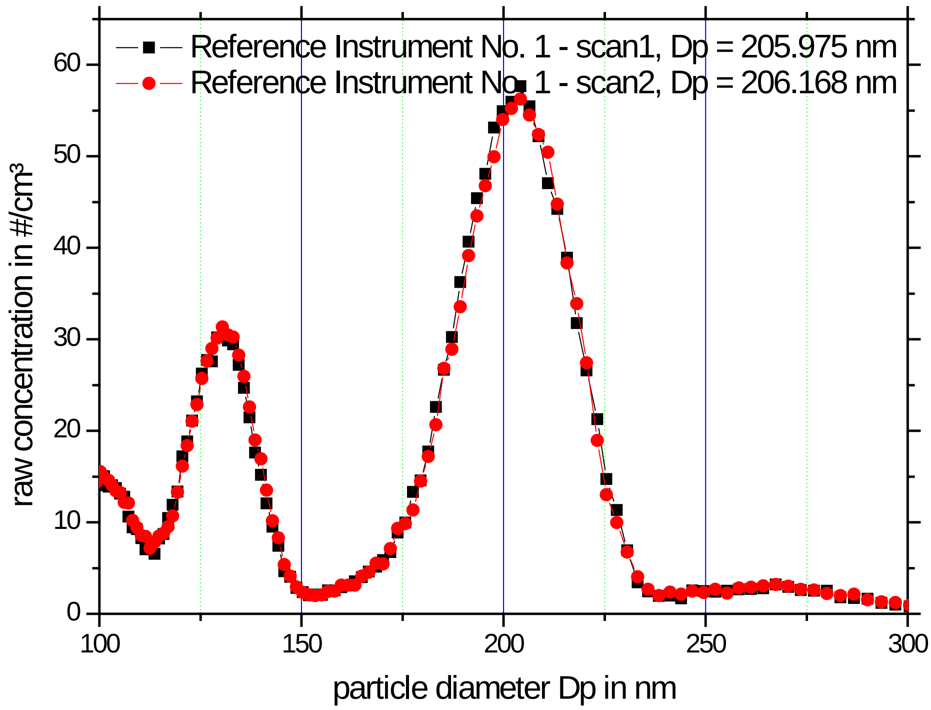


Fig.2. Measurement of latex 203 nm for TROPOS reference instrument No.1: Particle size distribution (raw concentration) for latex 203 nm on May 12, 2014 between 05:10 pm and 05:25 pm.

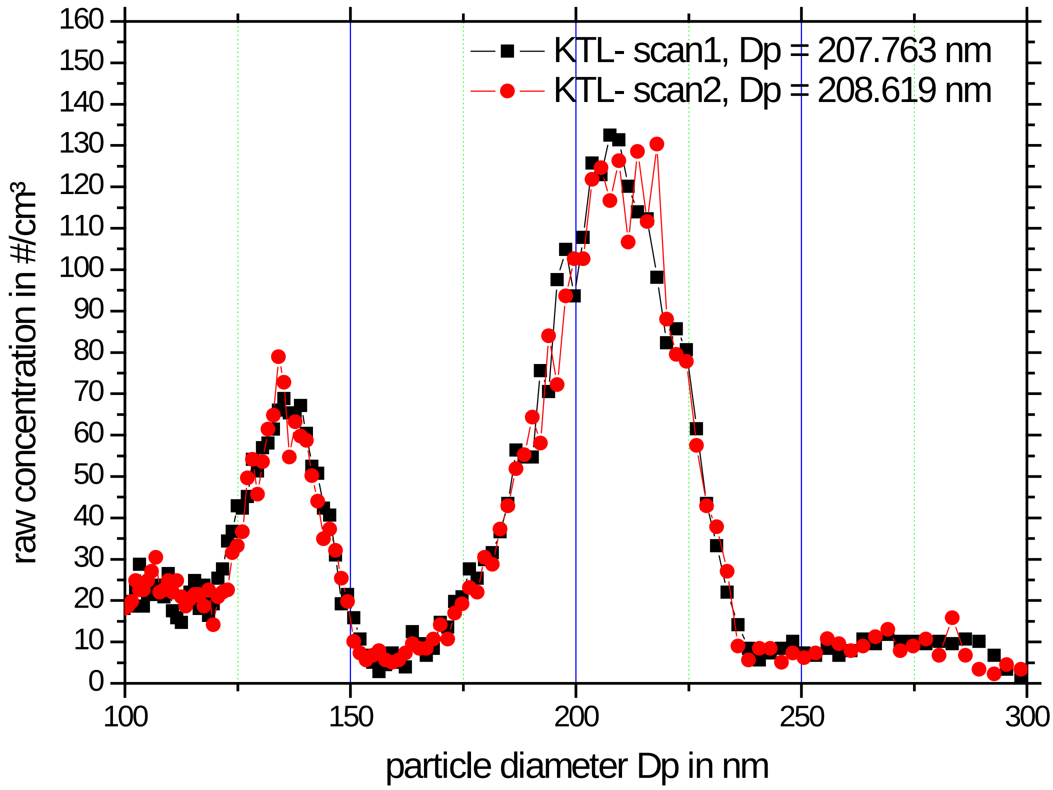


Fig.3. Measurement of latex 203 nm for instrument SMPS KTL: particle size distribution (raw concentration) for latex 203 nm on May 12, 2014 between 04:30 pm and 05:00 pm.

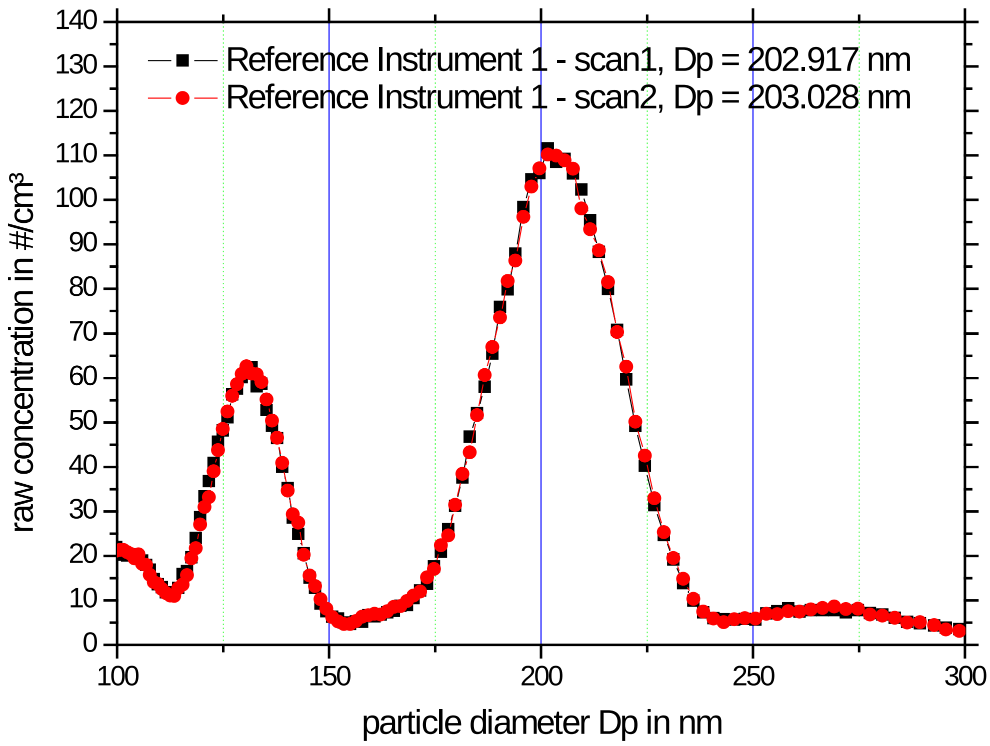


Fig.4. Measurement of latex 203 nm for TROPOS reference instrument No.1: Particle size distribution (raw concentration) for latex 203 nm on May 13, 2014 between 03:15 pm and 03:55 pm.

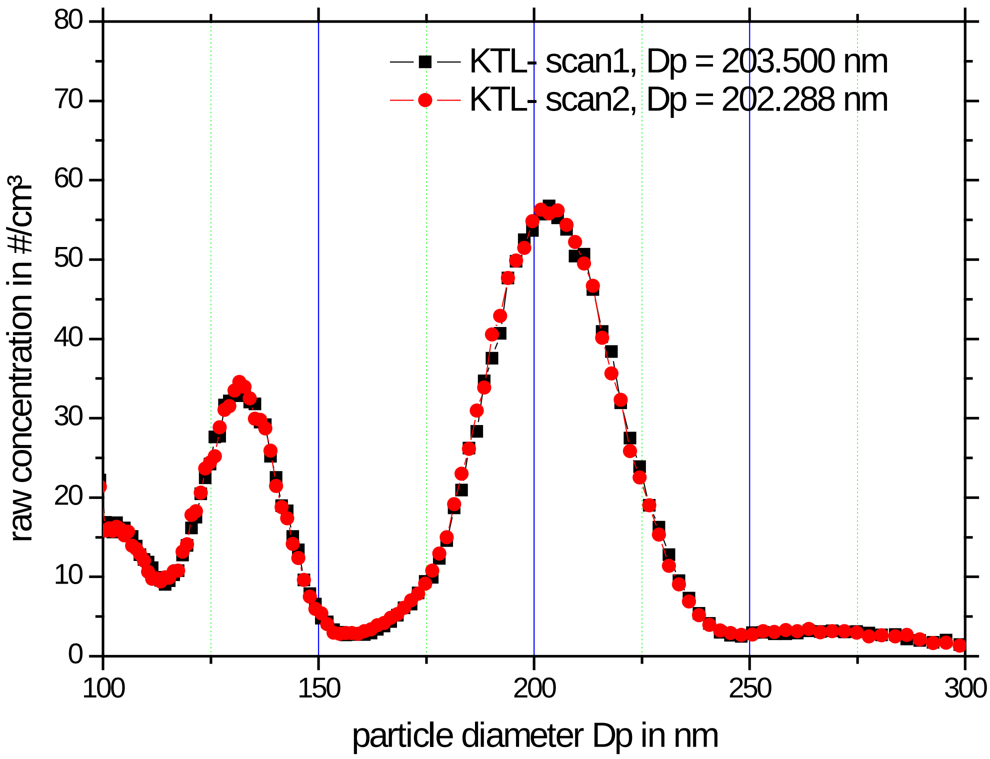


Fig.5. Measurement of latex 203 nm for instrument SMPS KTL: particle size distribution (raw concentration) for latex 203 nm on May 13, 2014 between 03:15 pm and 03:55 pm.

A: first run (May 12, 2014 06:00 pm – May 13, 2014 08:00 am)

1. Correlation of reference instruments

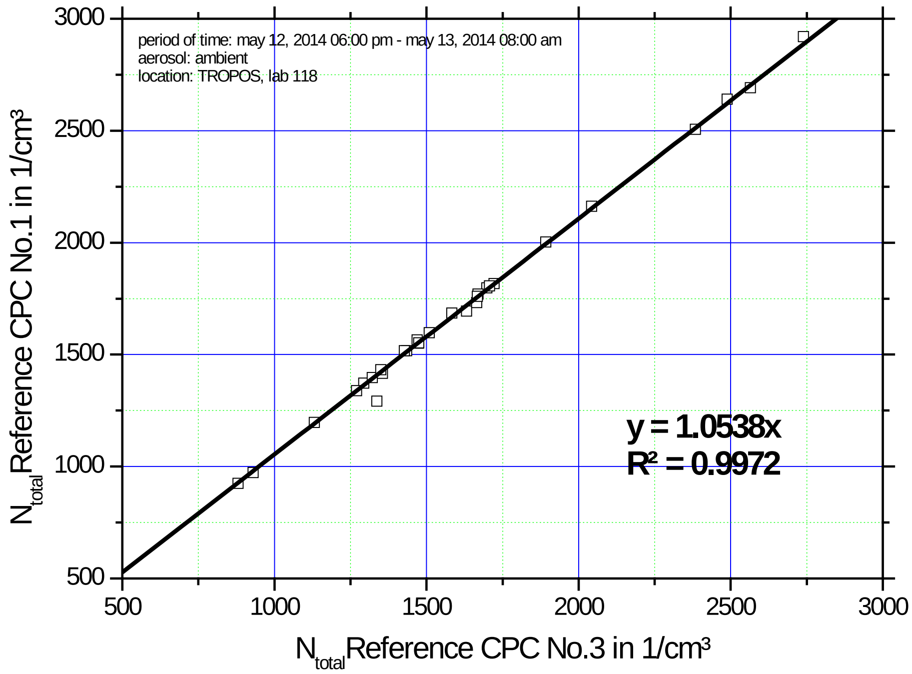


Fig.6. Linear regression between the number concentrations of the TROPOS reference CPC No.1 and the TROPOS reference CPC No.3. Multiple charge correction, internal diffusion losses and flow corrections are included.

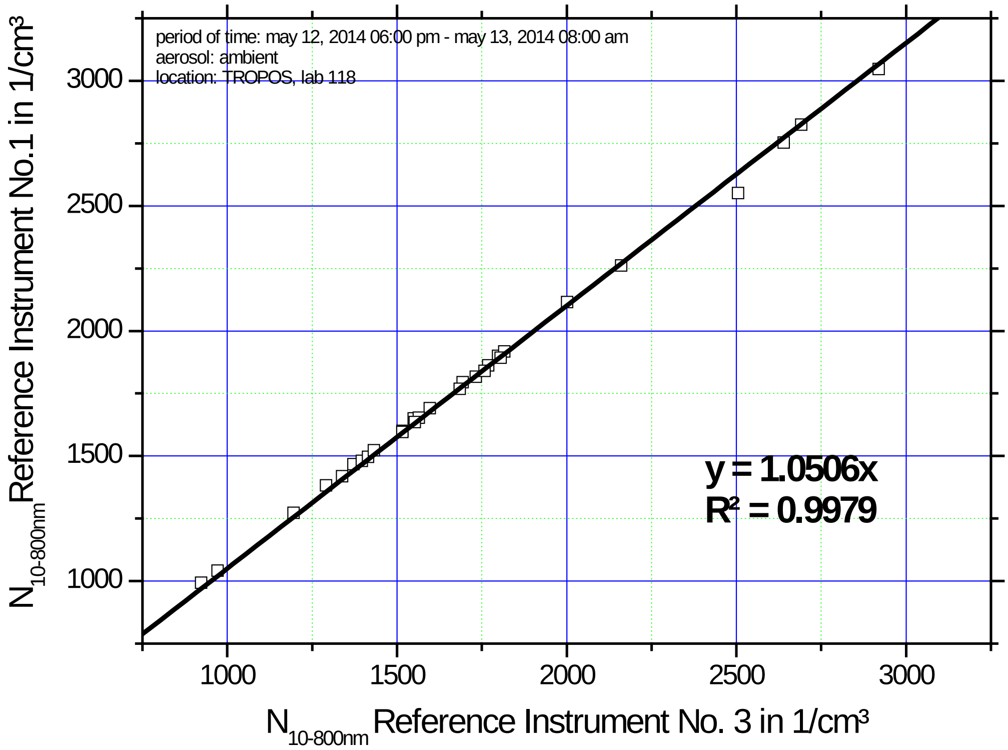


Fig.7. Linear regression between the number concentrations of the TROPOS reference instrument No.1 and the TROPOS reference instrument No.3. Multiple charge correction, internal diffusion losses and flow corrections are included.

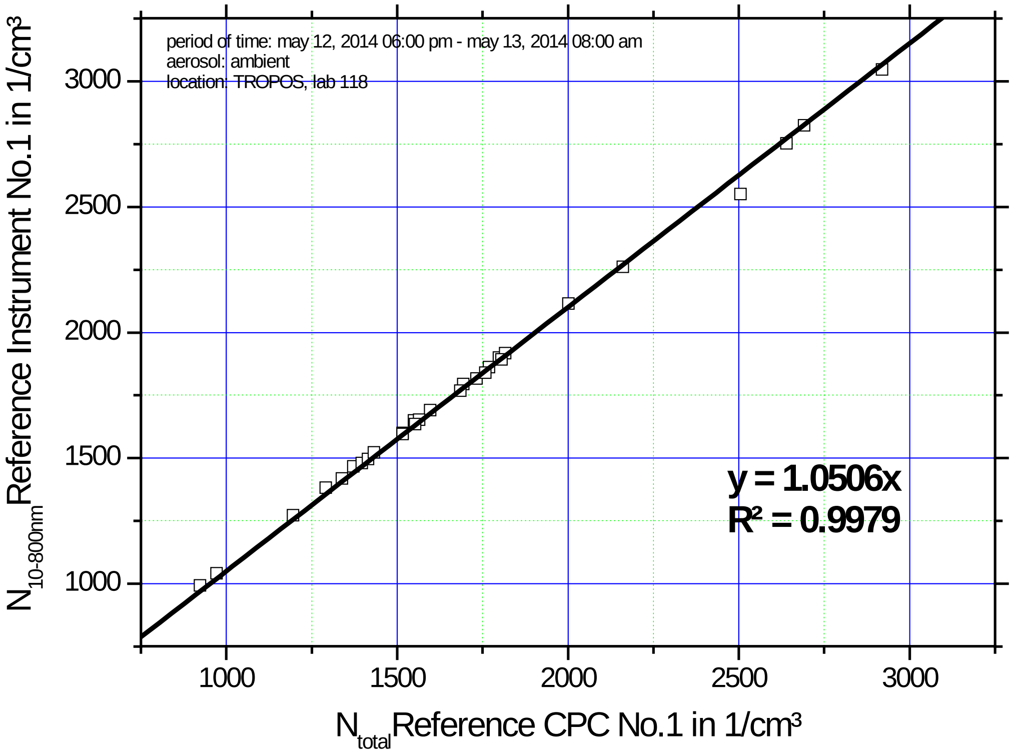


Fig.8. Linear regression between the number concentrations of the TROPOS reference instrument No.1 and TROPOS reference CPC No.1. Multiple charge correction, internal diffusion losses and flow corrections are included.

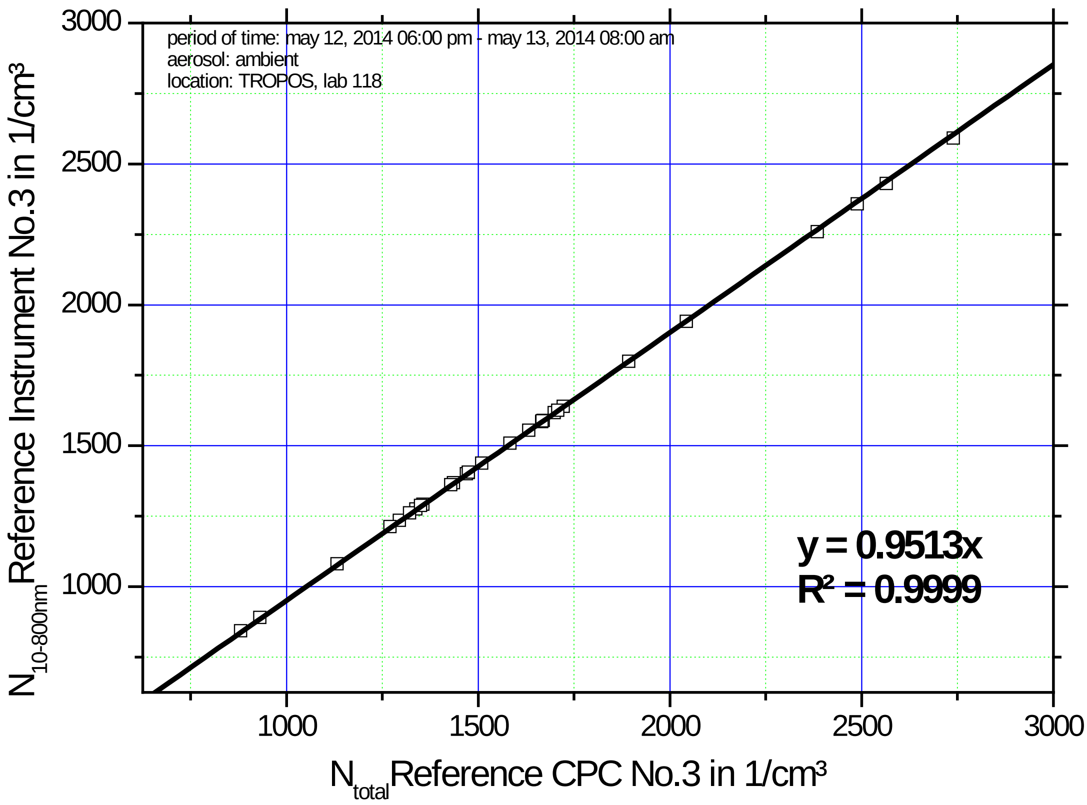


Fig.9. Linear regression between the number concentrations of the TROPOS reference instrument No.3 and TROPOS reference CPC No.3. Multiple charge correction, internal diffusion losses and flow corrections are included.

2. Time series

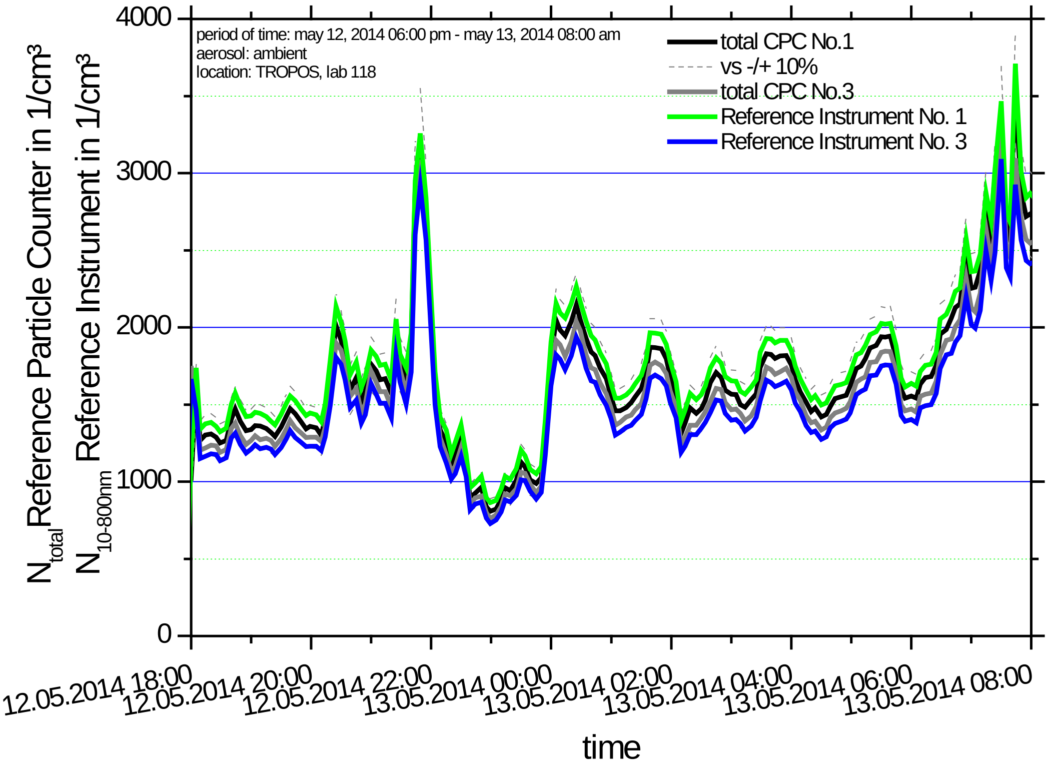


Fig.10. Time series (May 12, 2014 06:00 pm – May 13, 2014 08:00 am) of the integrated particle number concentration (N 10-800nm). Multiple charge correction, internal diffusion losses and flow corrections are included.

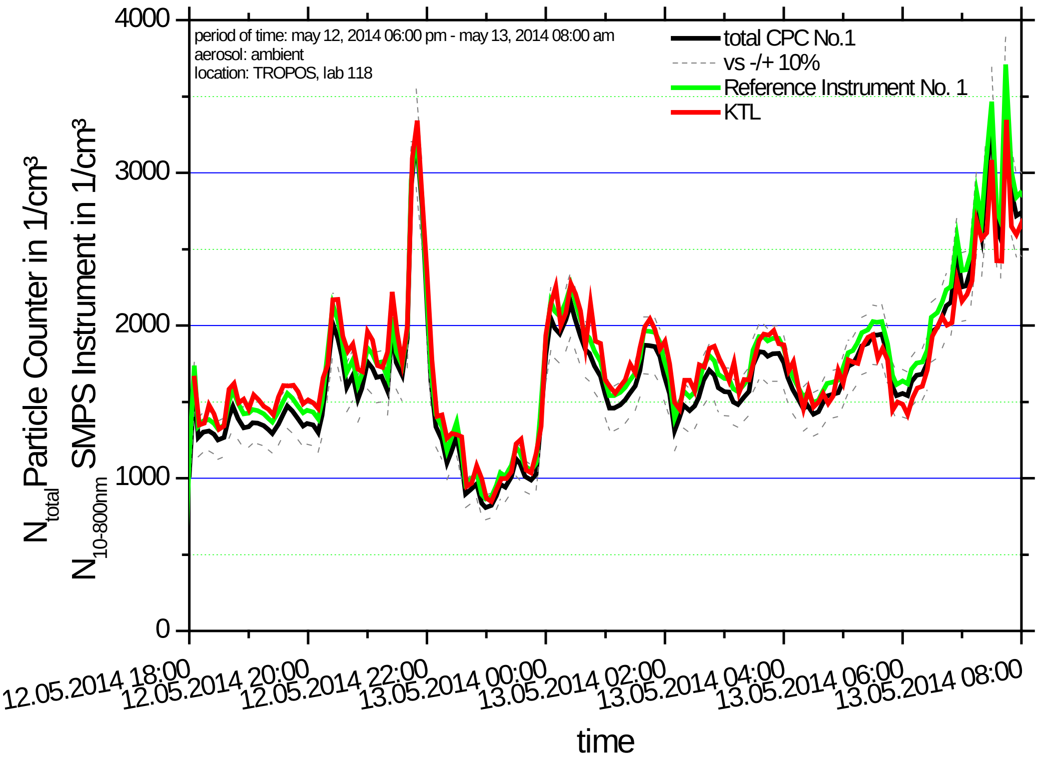


Fig.11. Time series (May 12, 2014 06:00 pm – May 13, 2014 08:00 am) of the integrated particle number concentration (N 10-800nm) of SMPS KTL and TROPOS reference instrument No.1. Multiple charge correction and internal diffusion losses are included.

3. Correlation of SMPS KTL

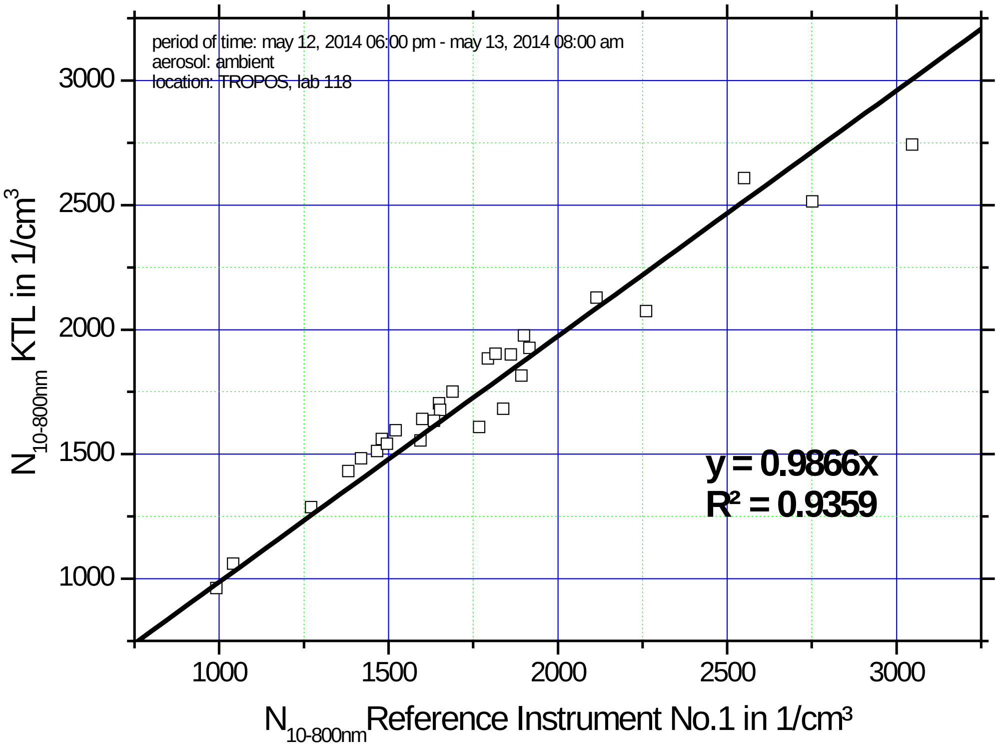


Fig.12. Linear regression between the number concentrations of the TROPOS reference instrument No.1 and SMPS KTL. Multiple charge correction and internal diffusion losses are included.

4. Size distribution

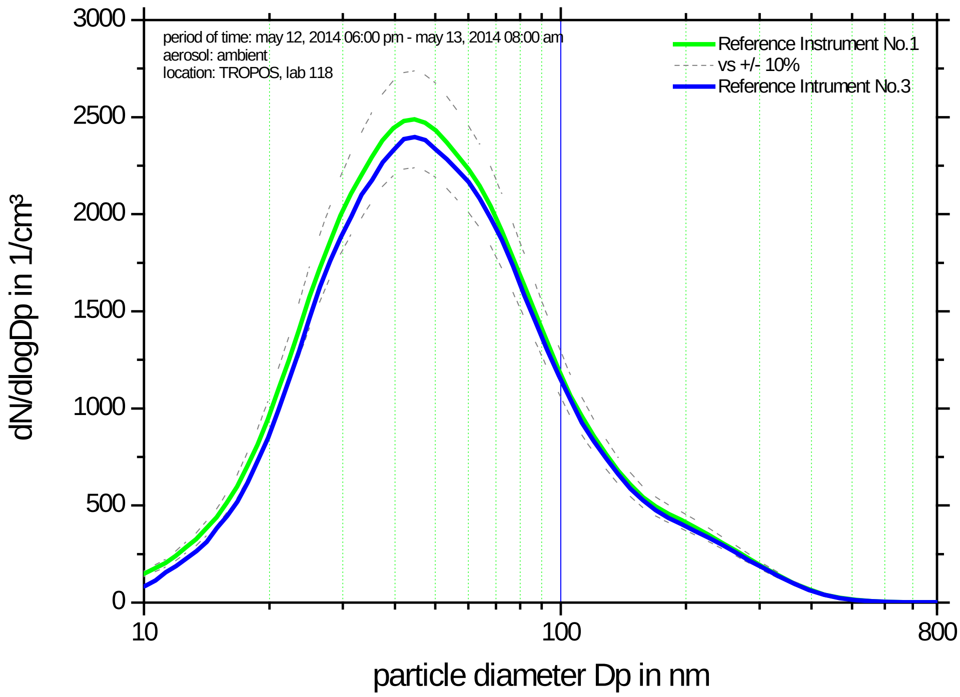


Fig.13. Comparison of mean particle number size distribution of the reference instruments between May 12, 2014 06:00 pm and May 13, 2014 08:00 am. Multiple charge correction, internal diffusion losses and CPC efficiency are included (.in2).

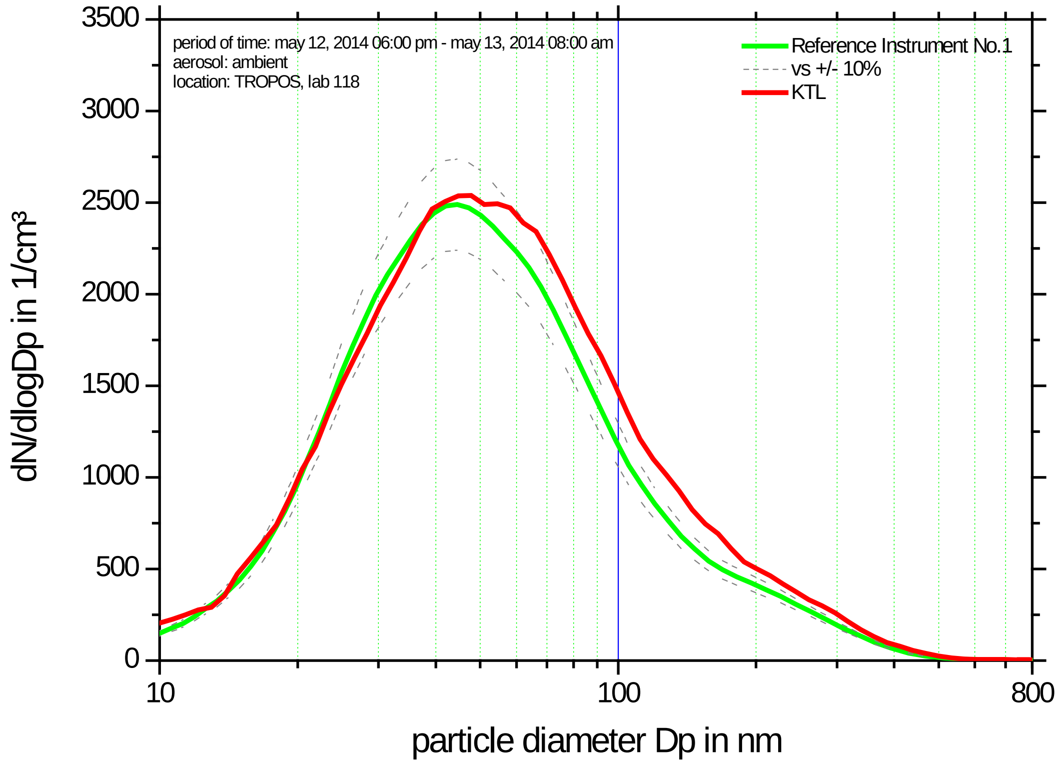


Fig.14. Comparison of mean particle number size distribution of SMPS KTL and TROPOS reference instrument No.1 between May 12, 2014 06:00 pm and May 13, 2014 08:00 am. Multiple charge correction and internal diffusion losses are included (.in1).

B: second run (May 13, 2014 05:00 pm – May 14, 2014 07:00 am)

1. Correlation of reference instruments

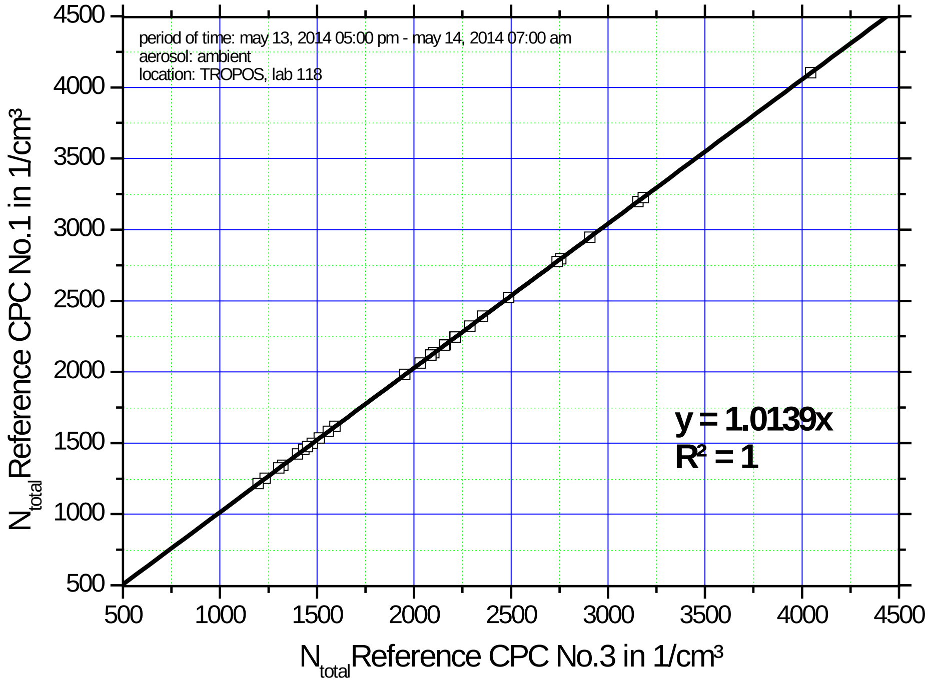


Fig.15. Linear regression between the number concentrations of the TROPOS reference CPC No.1 and the TROPOS reference CPC No.3. Multiple charge correction, internal diffusion losses and flow corrections are included.

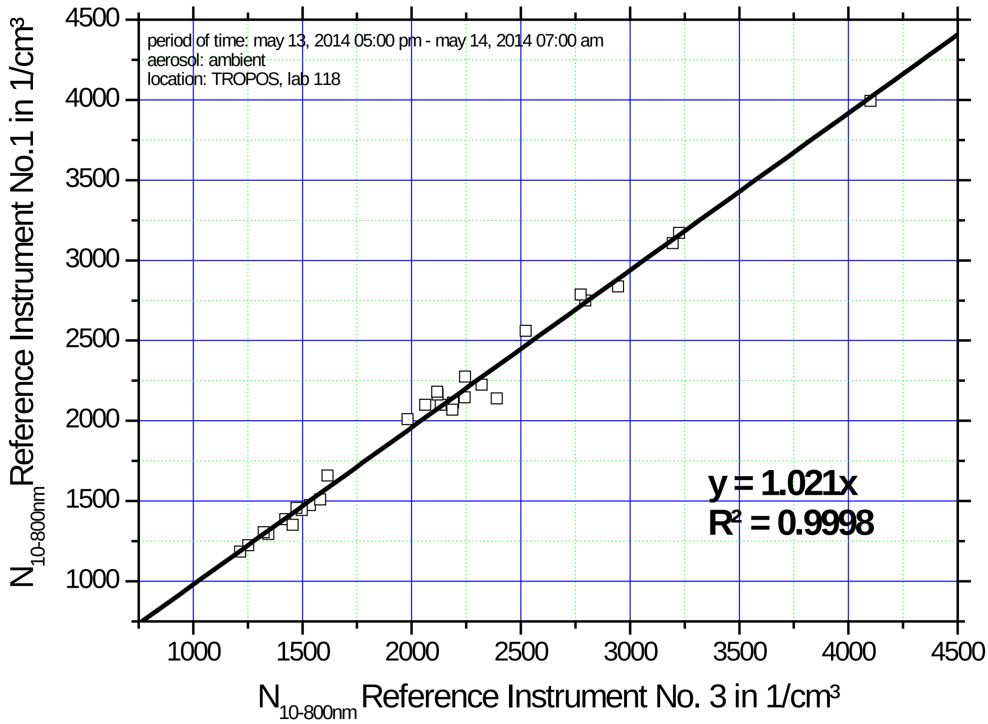


Fig.16. Linear regression between the number concentrations of the TROPOS reference instrument No. 1 and the TROPOS reference instrument No. 3. Multiple charge correction, internal diffusion losses and flow corrections are included.

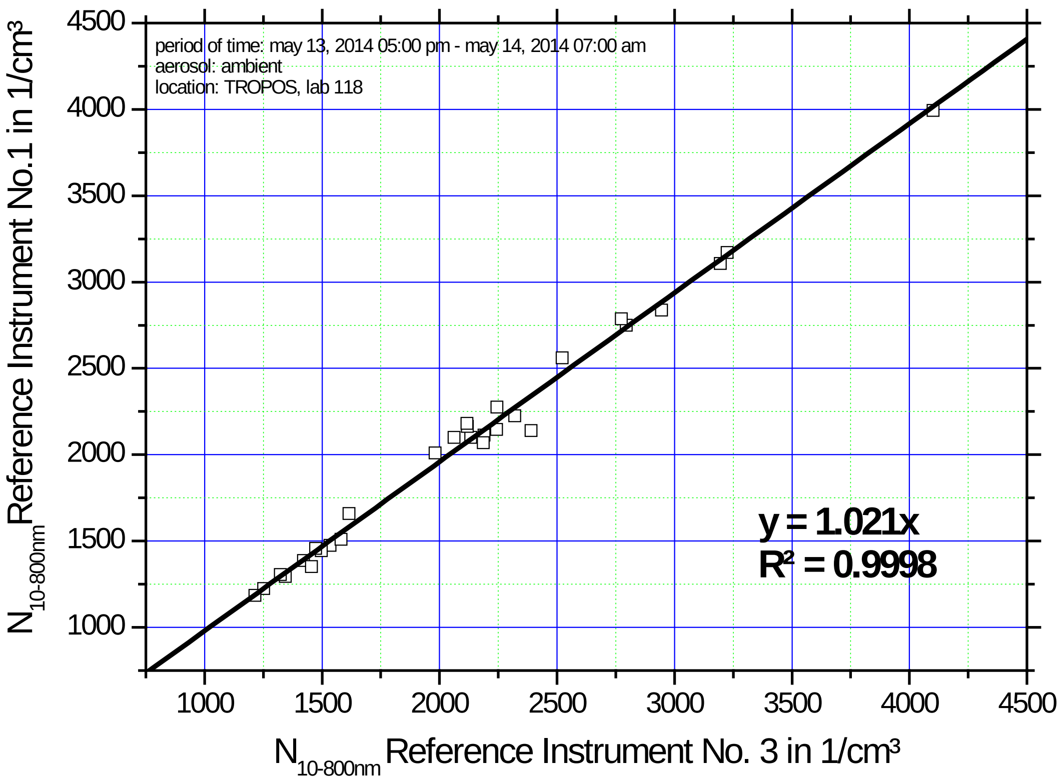


Fig.17. Linear regression between the number concentrations of the TROPOS reference instrument No. 1 and TROPOS reference CPC No.1. Multiple charge correction, internal diffusion losses and flow corrections are included.

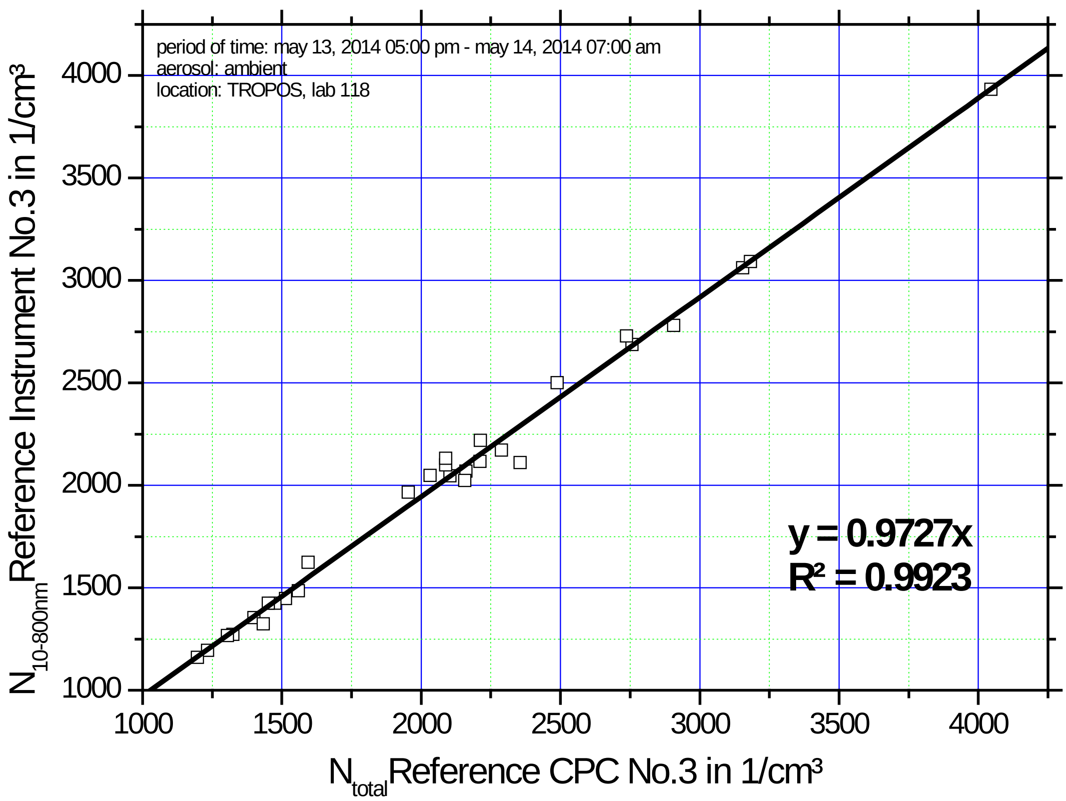


Fig.18. Linear regression between the number concentrations of the TROPOS reference instrument No. 3 and TROPOS reference CPC No.3. Multiple charge correction, internal diffusion losses and flow corrections are included.

2. Time series

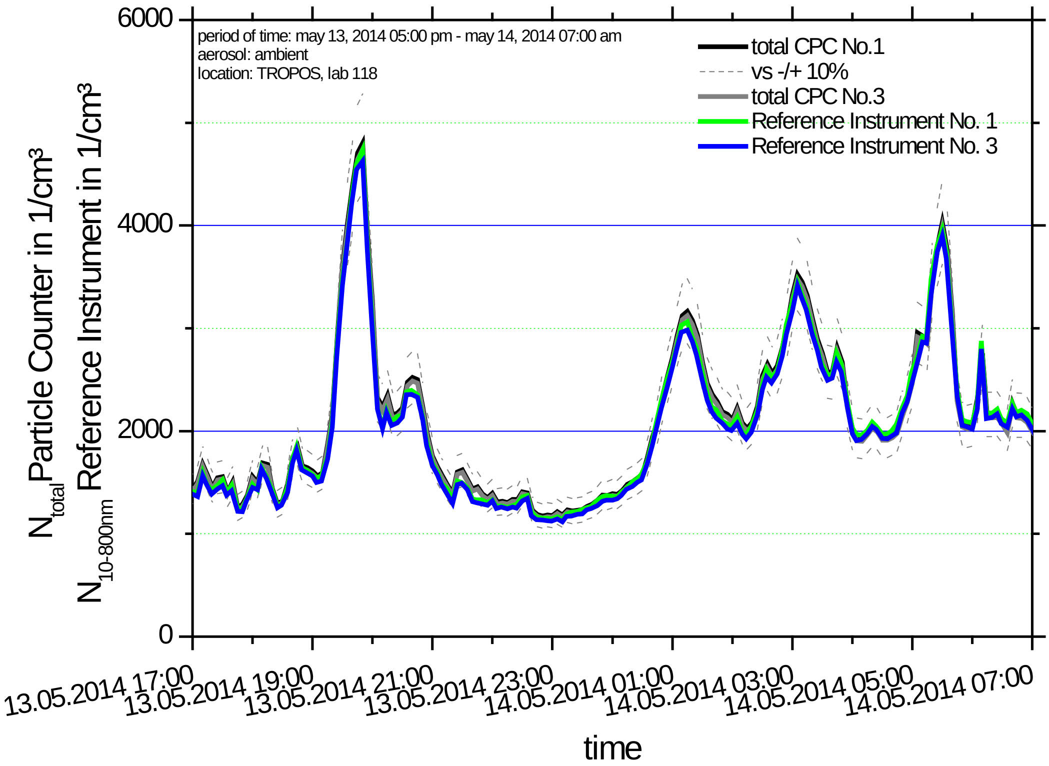


Fig.19. Time series (May 13, 2014 05:00 pm – May 14, 2014 07:00 am) of the integrated particle number concentration (N 10-800nm). Multiple charge correction and internal diffusion losses are included.

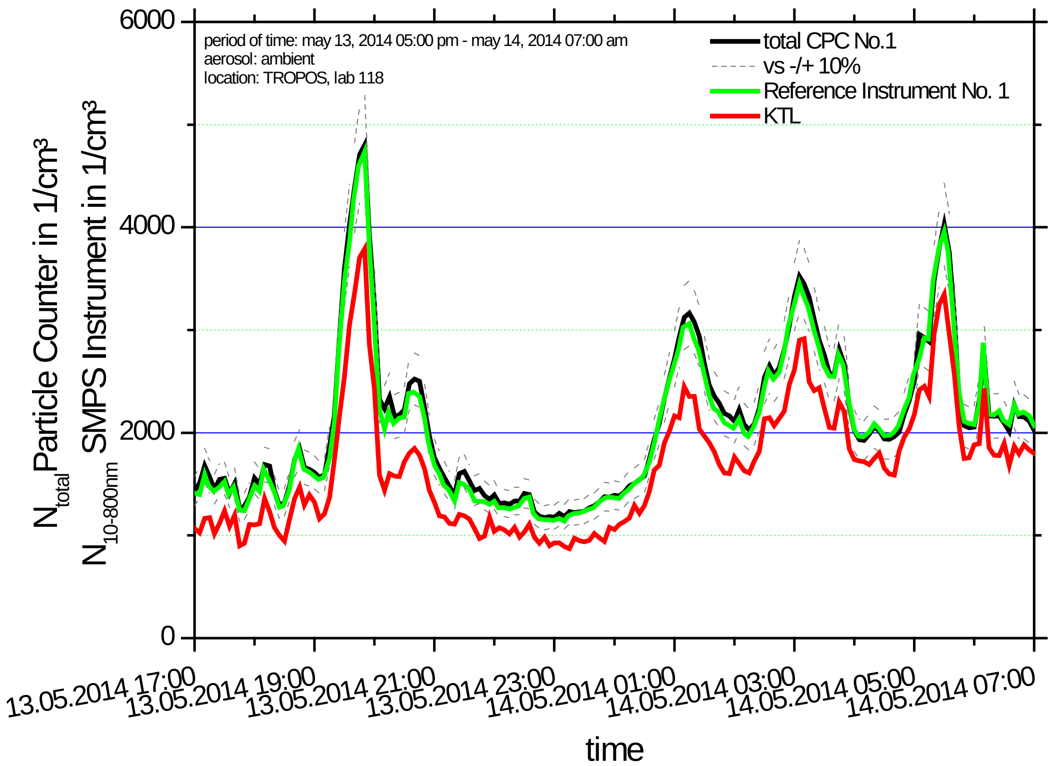


Fig.20. Time series (May 13, 2014 05:00 pm – May 14, 2014 07:00 am) of the integrated particle number concentration (N 10-800nm) of SMPS KTL and TROPOS reference instrument No.1. Multiple charge correction and internal diffusion losses are included.

3. Correlation of SMPS KTL

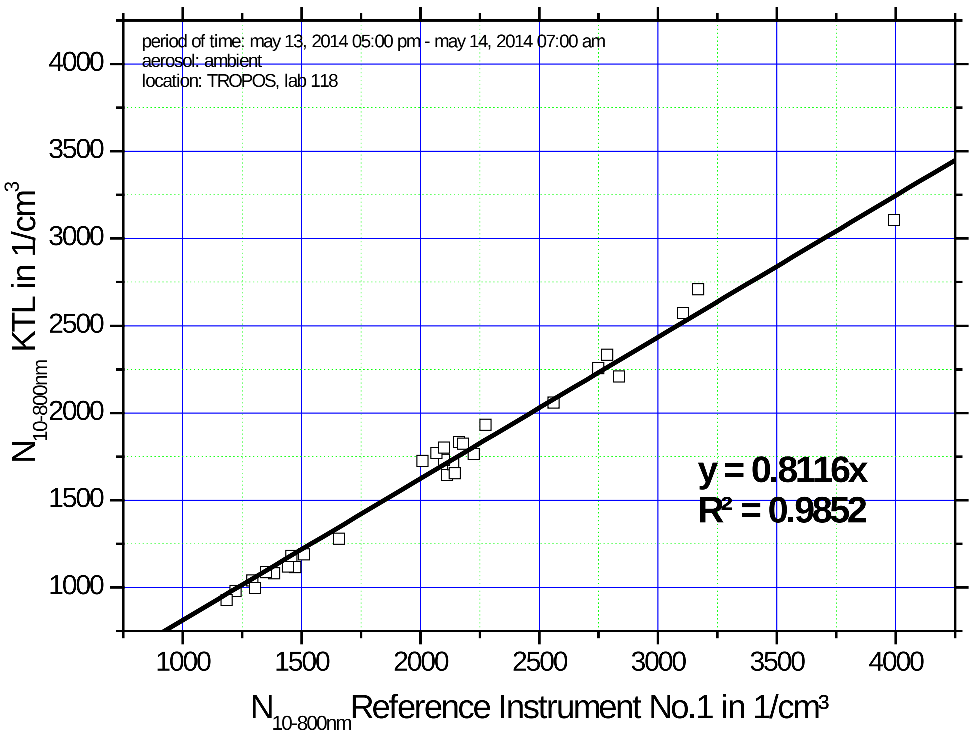


Fig.21. Linear regression between the number concentrations of the TROPOS reference instrument No.1 and SMPS KTL. Multiple charge correction and internal diffusion losses are included.

4. Size distribution

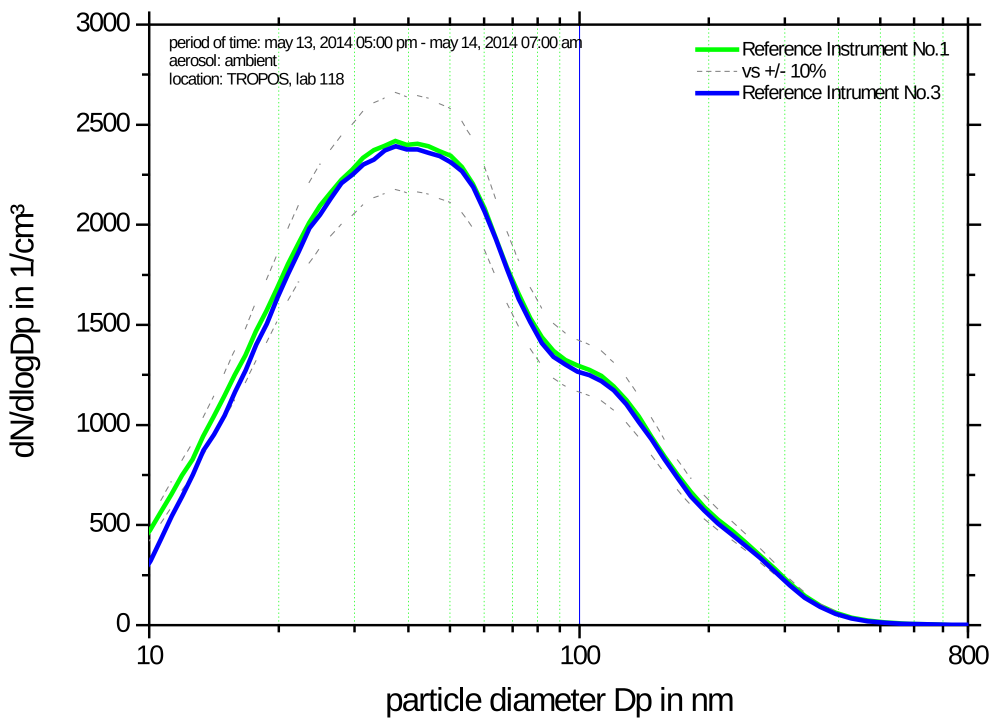


Fig.22. Comparison of mean particle number size distribution between May 13, 2014 05:00 pm and May 14, 2014 07:00 am. Multiple charge correction, internal diffusion losses and CPC efficiency are included (.in2).

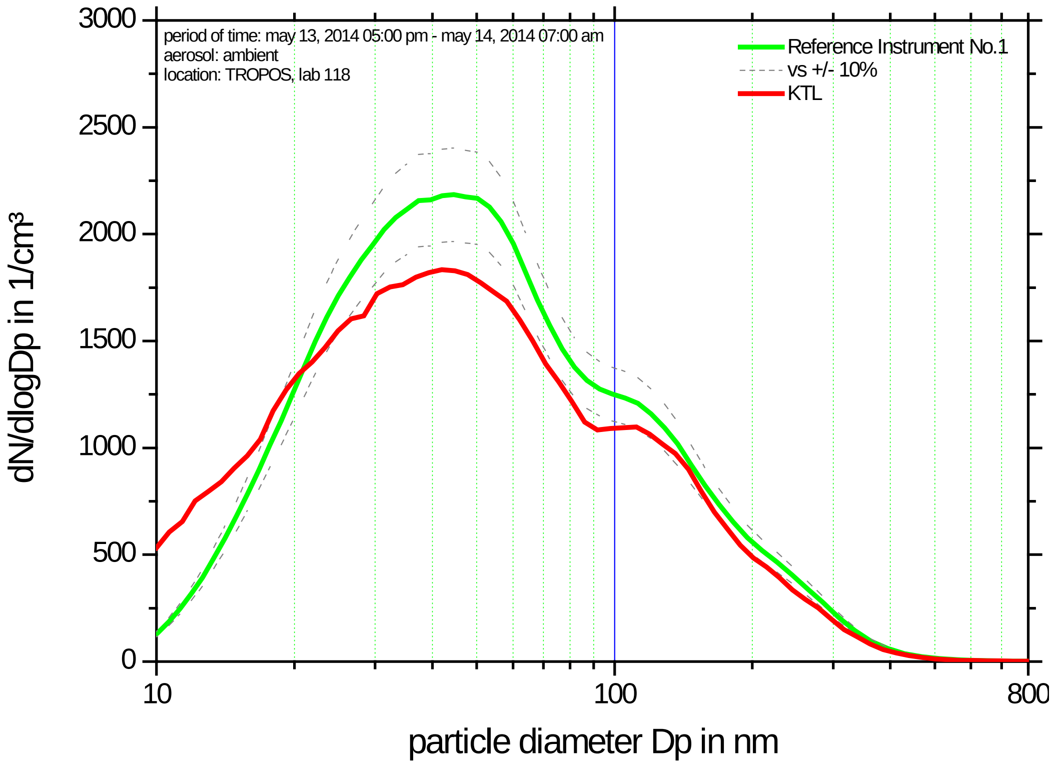


Fig.23. Comparison of mean particle number size distribution of SMPS KTL and TROPOS reference instrument No.1 between May 13, 2014 05:00 pm and May 14, 2014 07:00 am. Multiple charge correction is included (.in0).

C: third run (May 14, 2014 07:00 pm – May 15, 2014 07:00 am)

1. Correlation of reference instruments

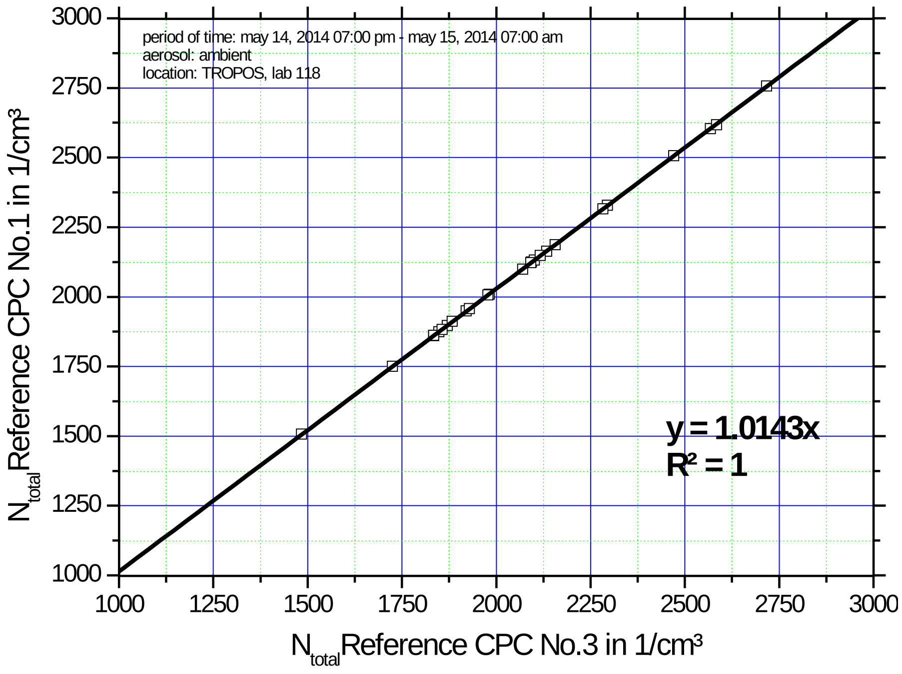


Fig.24. Linear regression between the number concentrations of the TROPOS reference CPC No.1 and the TROPOS reference CPC No.3. Multiple charge correction, internal diffusion losses and flow corrections are included.

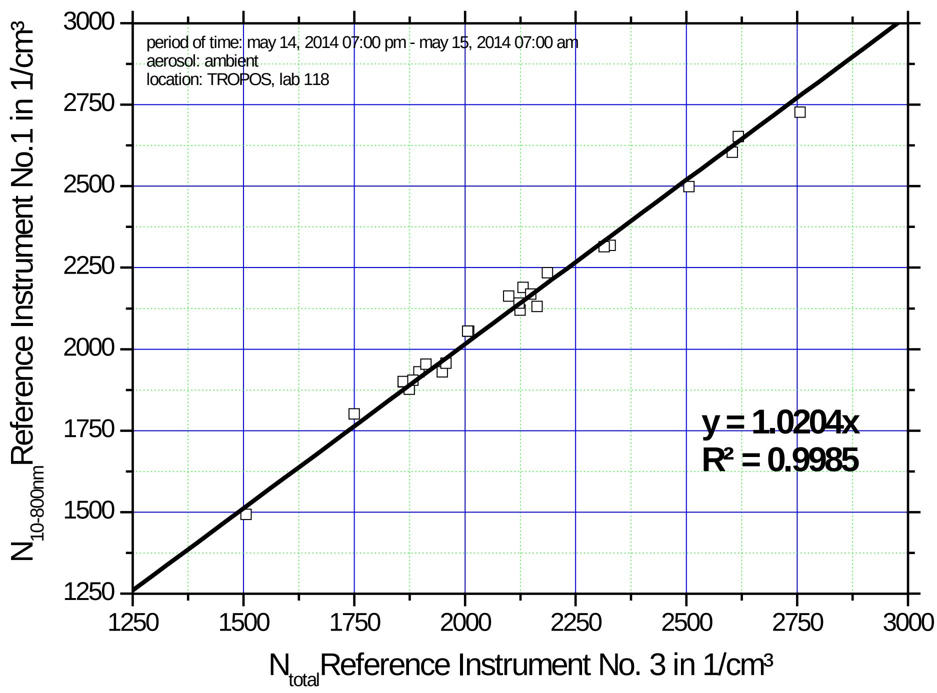


Fig.25. Linear regression between the number concentrations of the TROPOS reference instrument No. 1 and the TROPOS reference instrument No. 3. Multiple charge correction, internal diffusion losses and flow corrections are included.

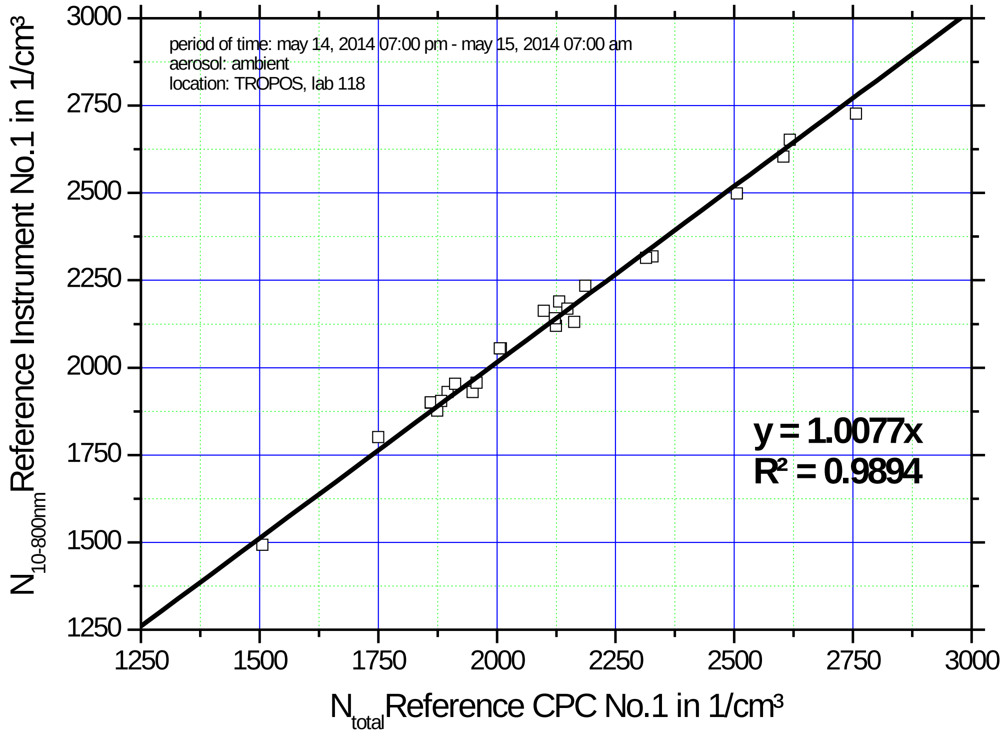


Fig.26. Linear regression between the number concentrations of the TROPOS reference instrument No. 1 and TROPOS reference CPC No.1. Multiple charge correction, internal diffusion losses and flow corrections are included.

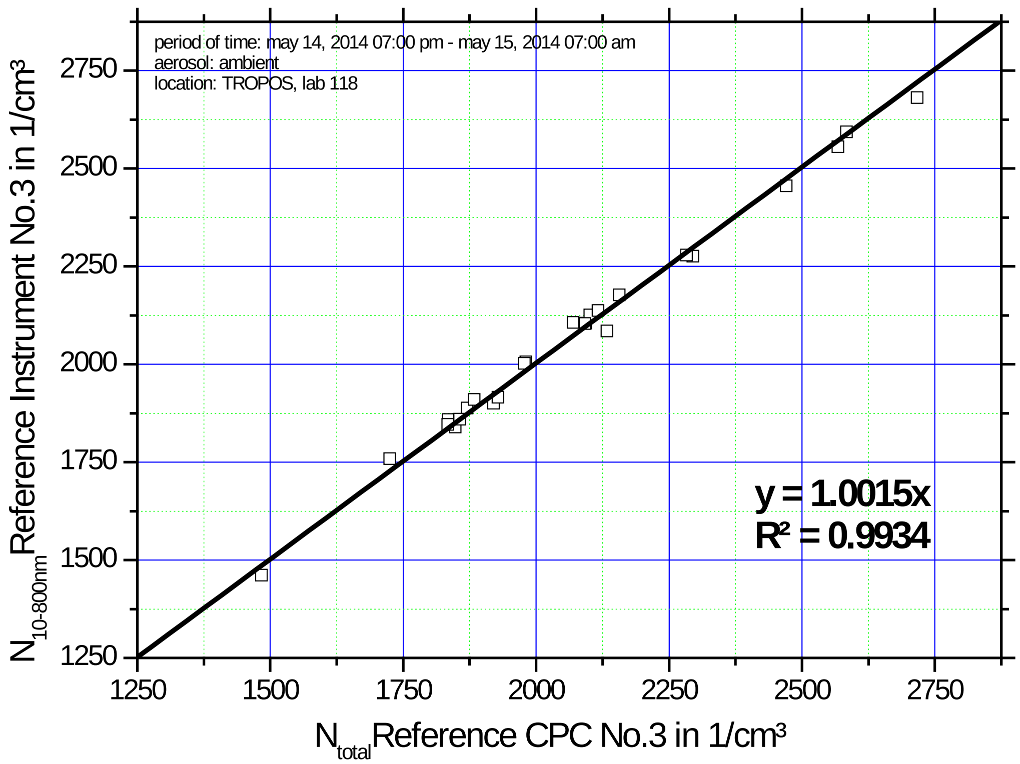


Fig.27. Linear regression between the number concentrations of the TROPOS reference instrument No. 3 and TROPOS reference CPC No.3. Multiple charge correction, internal diffusion losses and flow corrections are included.

2. Time series

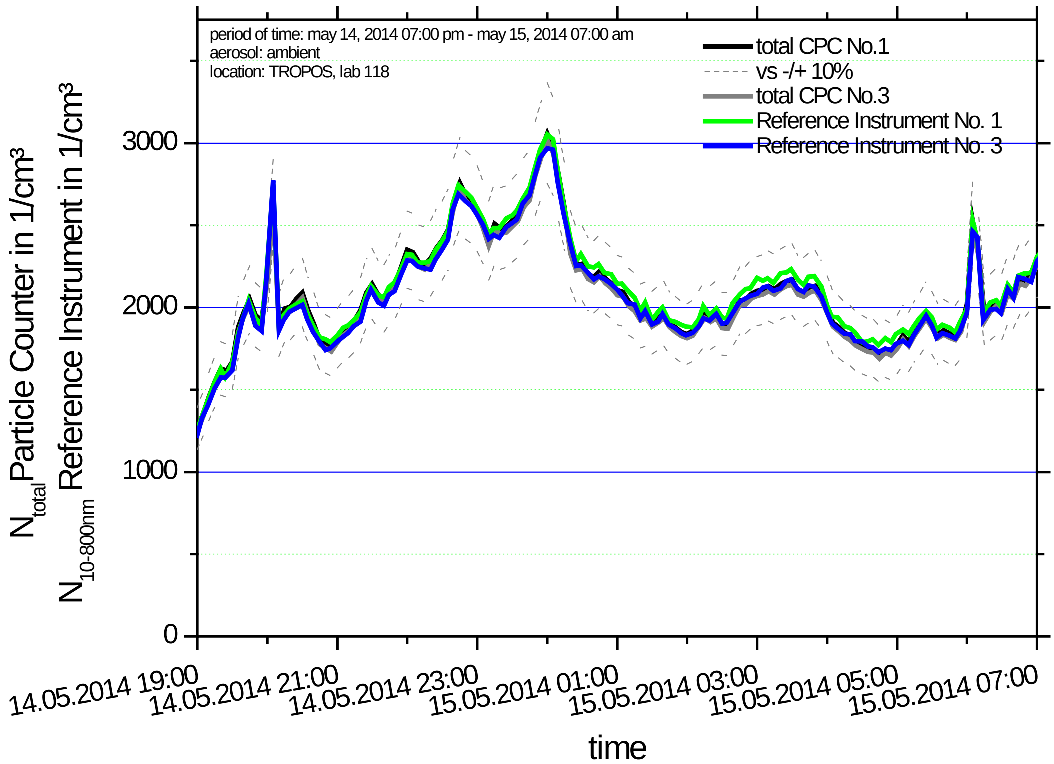


Fig.28. Time series (May 14, 2014 07:00 pm – May 15, 2014 07:00 am) of the integrated particle number concentration (N 10-800nm). Multiple charge correction, internal diffusion losses and floe corrections are included.

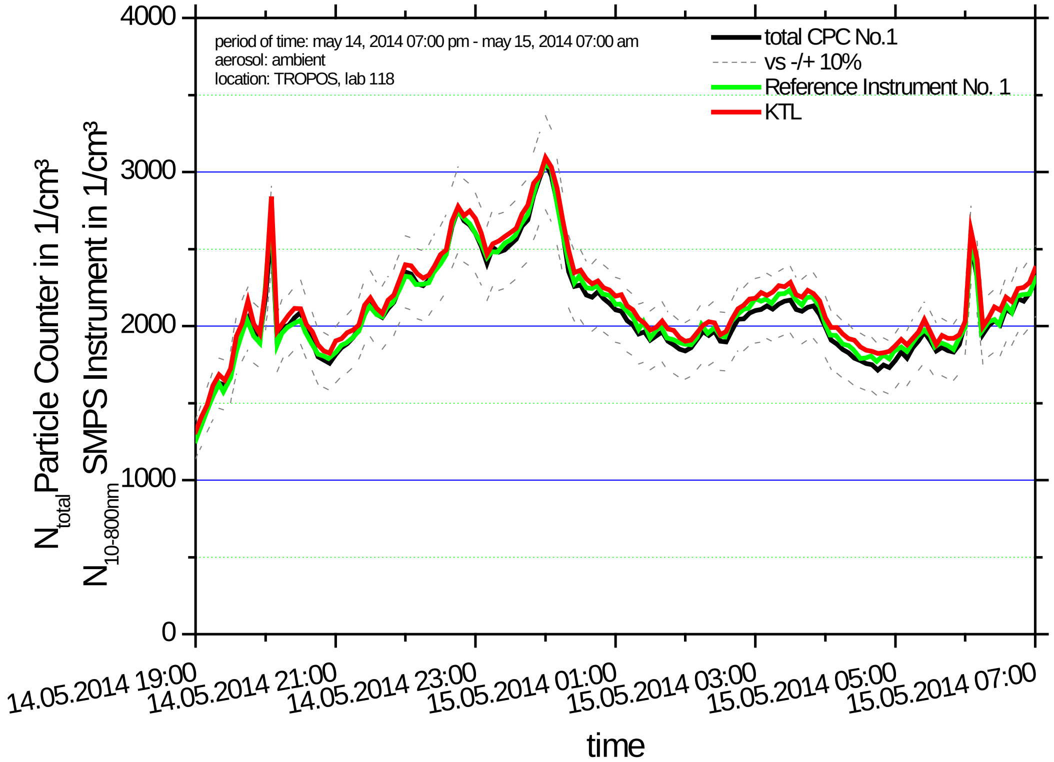


Fig.29. Time series (May 14, 2014 07:00 pm – May 15, 2014 07:00 am) of the integrated particle number concentration (N 10-800nm) of SMPS KTL and TROPOS reference instrument No.1. Multiple charge correction and internal diffusion losses are included.

3. Correlation of SMPS KTL

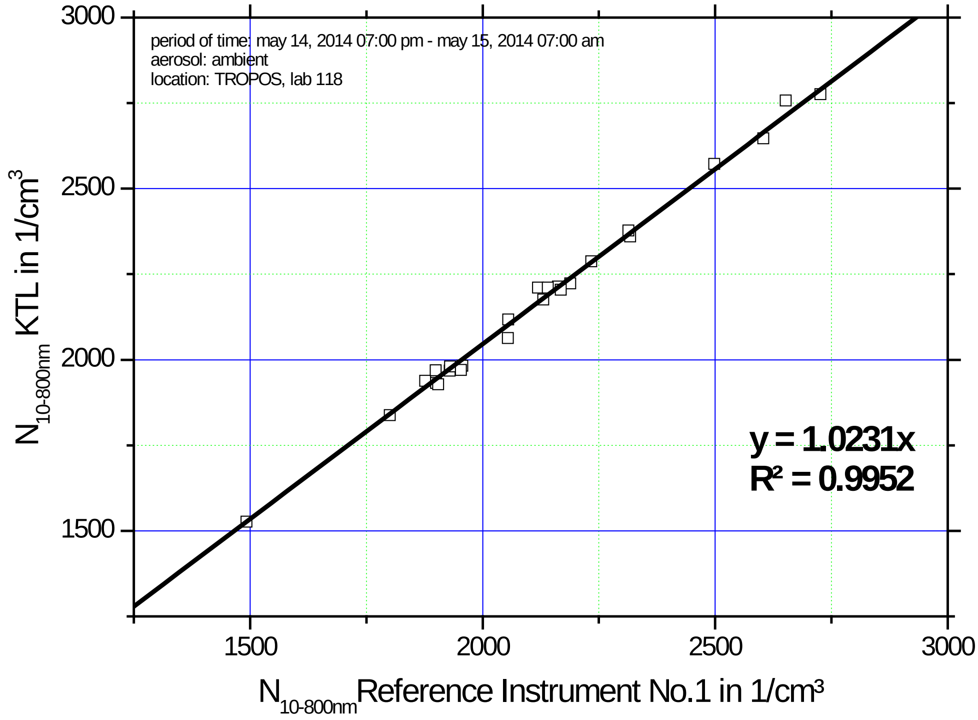


Fig.30. Linear regression between the number concentrations of the TROPOS reference instrument No.1 and SMPS KTL. Multiple charge correction and internal diffusion losses are included.

4. Size distribution

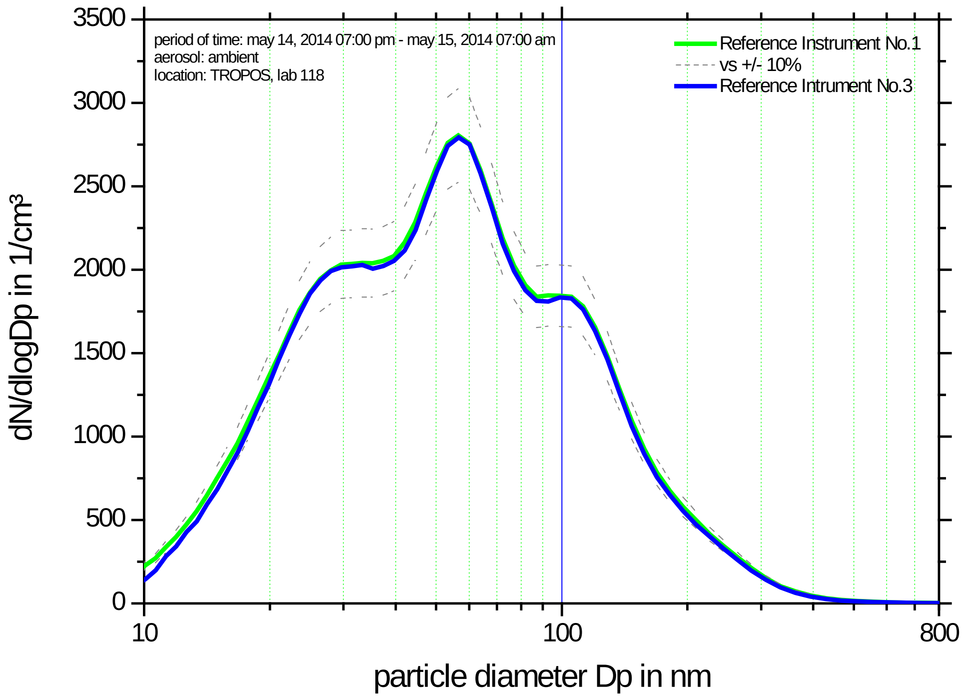


Fig.31. Comparison of mean particle number size distribution between May 14, 2014 07:00 pm and May 15, 2014 07:00 am. Multiple charge correction, internal diffusion losses and CPC efficiency are included (.in2).

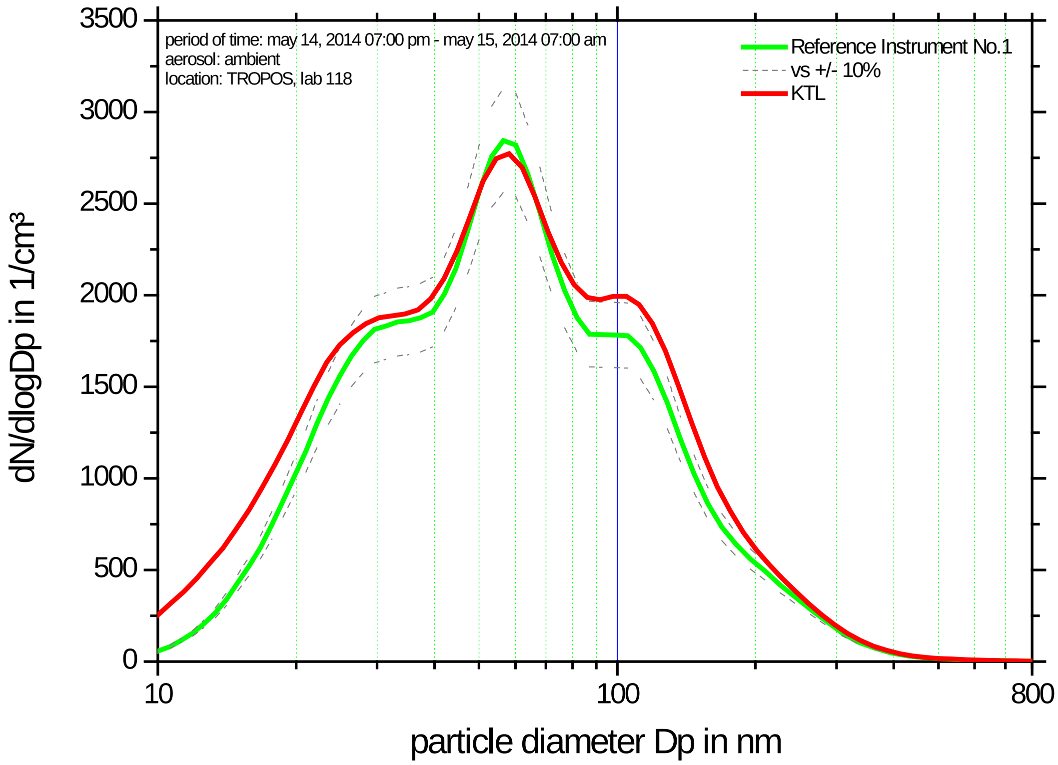


Fig.32. Comparison of mean particle number size distribution of SMPS KTL and TROPOS reference instrument No.1 between May 14, 2014 07:00 pm and May 15, 2014 07:00 am. Multiple charge correction is included (.in0).

D: fourth run (May 15, 2014 08:00 pm – May 16, 2014 06:00 am)

1. Correlation reference instruments

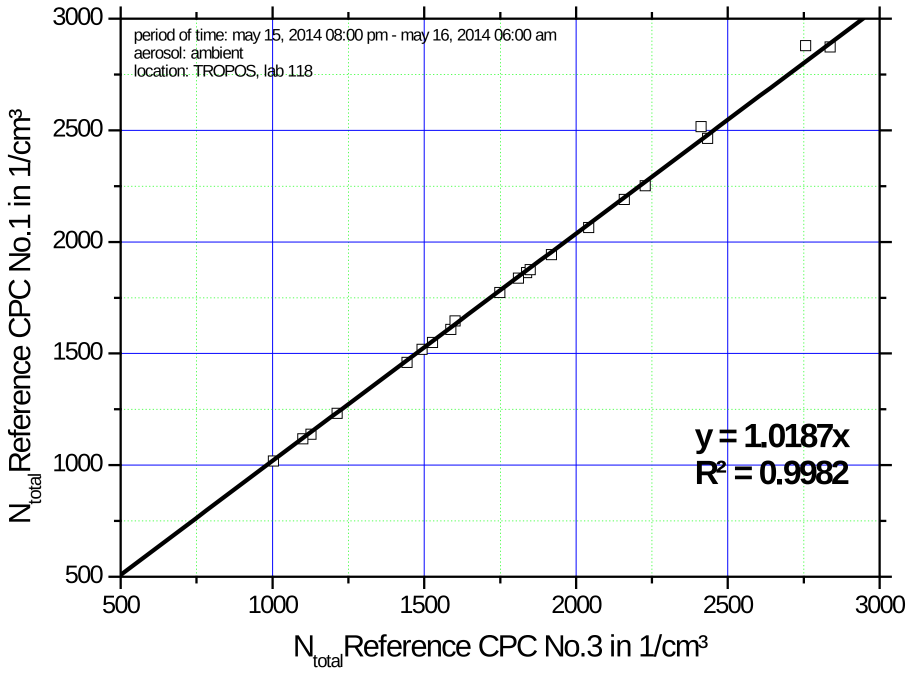


Fig.33. Linear regression between the number concentrations of the TROPOS reference CPC No.1 and the TROPOS reference CPC No.3. Multiple charge correction, internal diffusion losses and flow corrections are included.

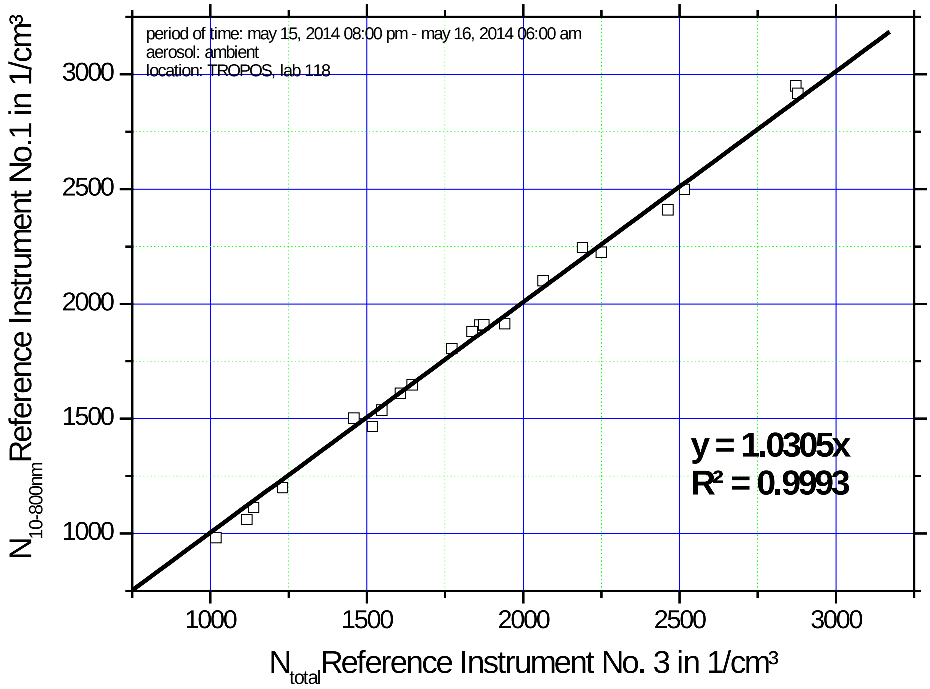


Fig.34. Linear regression between the number concentrations of the TROPOS reference instrument No. 1 and the TROPOS reference instrument No. 3. Multiple charge correction, internal diffusion losses and flow corrections are included.

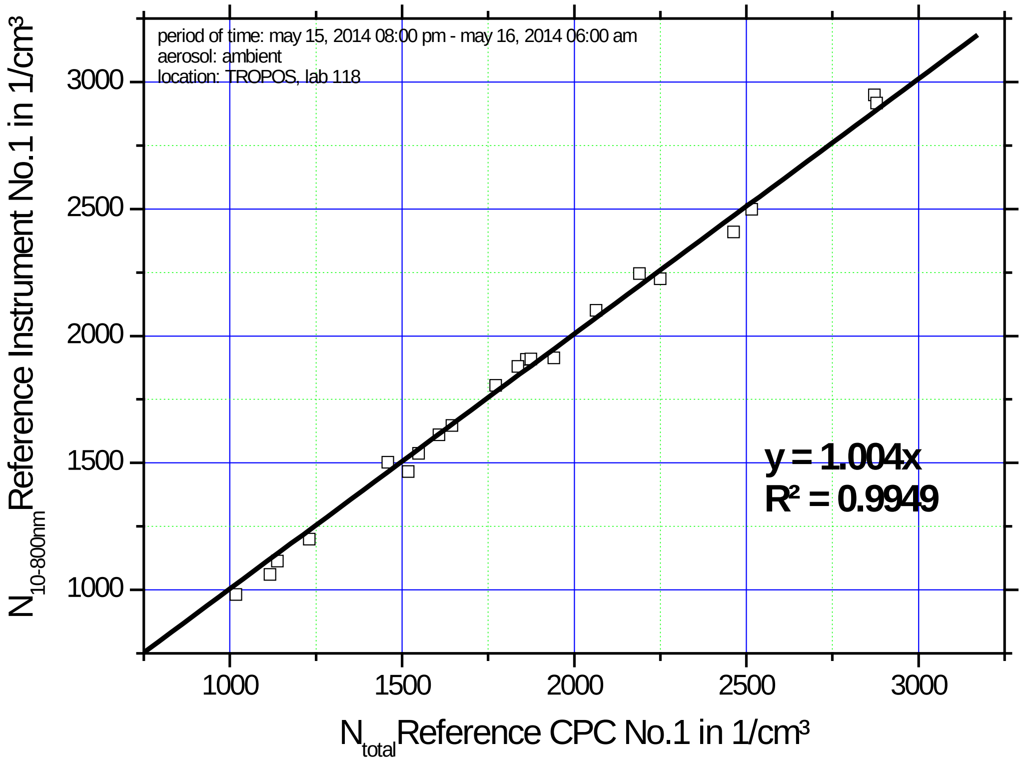


Fig.35. Linear regression between the number concentrations of the TROPOS reference instrument No. 1 and TROPOS reference CPC No.1. Multiple charge correction, internal diffusion losses and flow corrections are included.

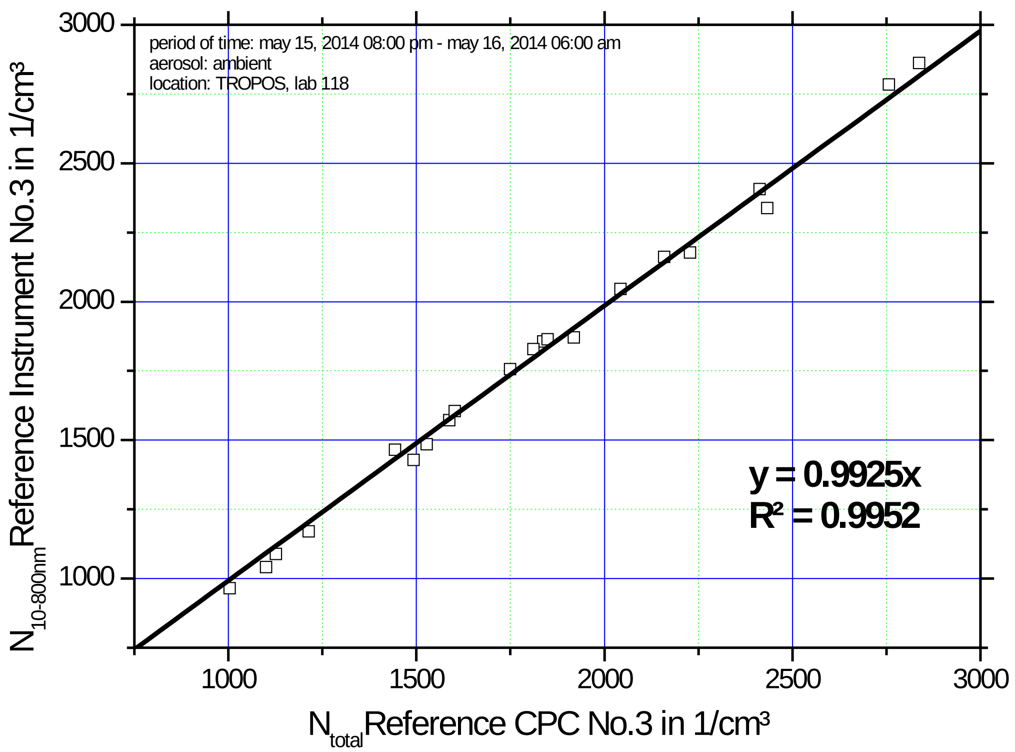


Fig.36. Linear regression between the number concentrations of the TROPOS reference instrument No. 3 and TROPOS reference CPC No.3. Multiple charge correction, internal diffusion losses and flow corrections are included.

2. Time series

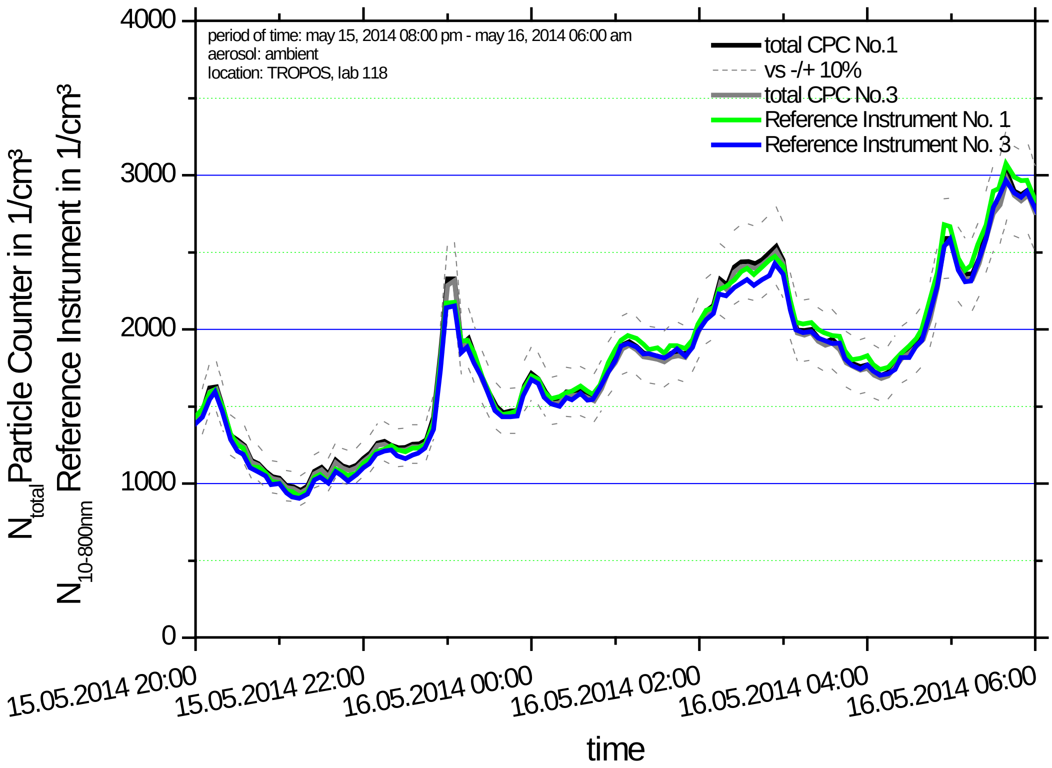


Fig.37. Time series (May 15, 2014 08:00 pm – May 16, 2014 06:00 am) of the integrated particle number concentration (N 10-800nm). Multiple charge correction and diffusion losses are included.

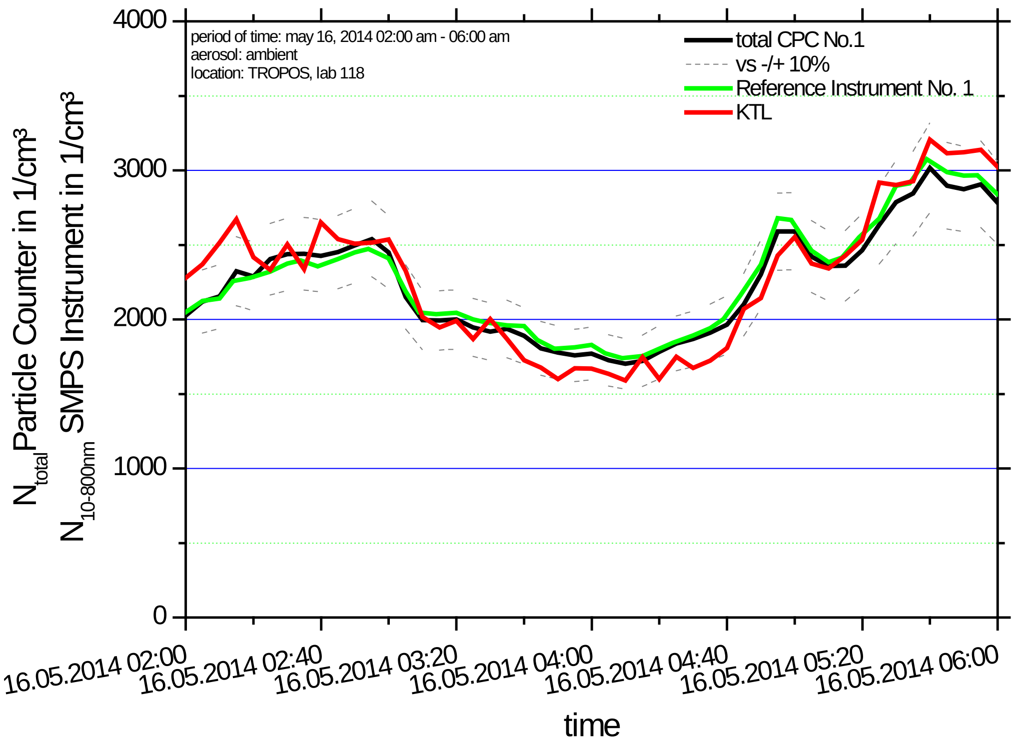


Fig.38. Time series (May 16, 2014 02:00 am – 06:00 am) of the integrated particle number concentration (N 10-800nm) of SMPS KTL and TROPOS reference instrument No.1. Multiple charge correction, diffusion losses and CPC efficiency are included.

3. Correlation of SMPS KTL

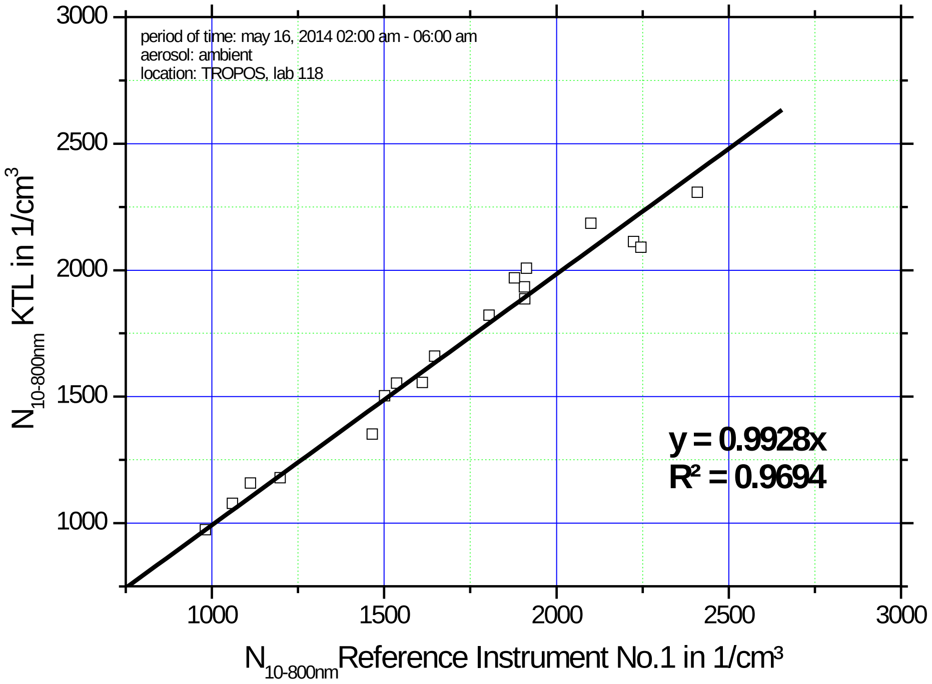


Fig.39. Linear regression between the number concentrations of the TROPOS reference instrument No.1 and SMPS KTL. Multiple charge correction and internal diffusion losses are included.

4. Size distribution

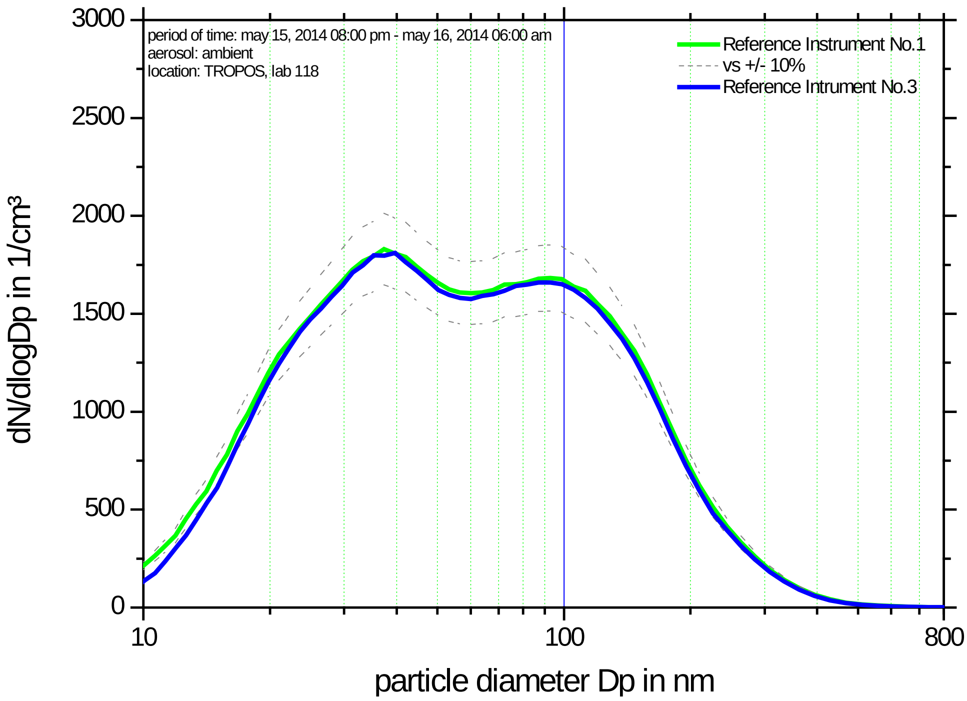


Fig.35. Comparison of mean particle number size distribution between May 15, 2014 08:00 pm and May 16, 2014 06:00 am. Multiple charge correction, internal diffusion losses and CPC efficiency are included (.in2).

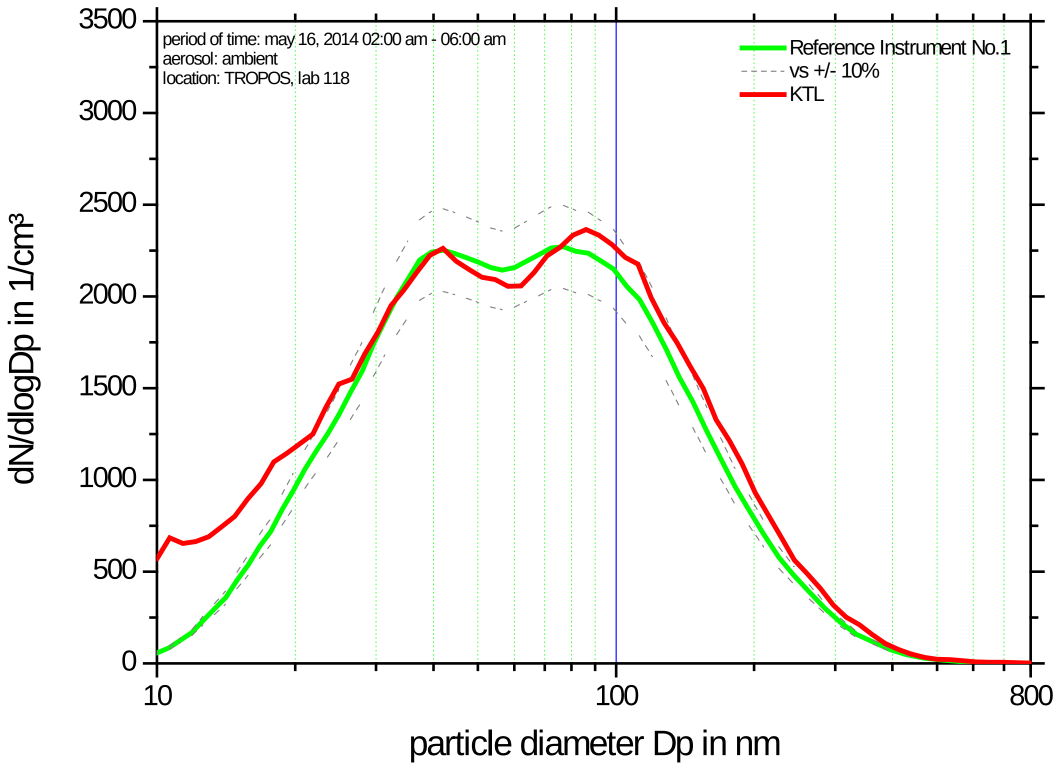


Fig.35. Comparison of mean particle number size distribution of SMPS KTL and TROPOS reference instrument No.1 on May 16, 2014 between 02:00 am and 06:00 am. Multiple charge correction, internal diffusion losses and CPC efficiency are included.

Intercomparison of SMPS NUIC

<u>Basic information</u>

Location of the quality assurance:	TROPOS, lab: 118
Delivery date:	May 12, 2014
Setup in the laboratory:	May 12, 2014
Comparison period:	May 12, 2014 – May 16, 2014
Instrument:	
TROPOS Reference Instrument:	TROPOS Reference Instrument No. 1 TROPOS Reference Instrument No. 3
Total CPC:	TROPOS Reference CPC No.1; SN: 3772112101 TROPOS Reference CPC No.3; SN: 3772111903
Additional equipment:	
Involved people:	Brendan Kelly (brendan.kelly@nuigalway.ie)

<u>Summary of second intercomparison:</u>

From May 12, 2014 to May 16, 2014 the NUIC SMPS participated successfully the TROPOS ACTRIS Workshop. The workshop consisted of an entrance test and a final run. In addition to the overnight ambient measurements, we had numerous high voltage checks, zero- and PSL-measurements. The report is divided into three sections. The first section shows the laboratory setup and the PSL measurement. After that, we show for each run the time series of the particle number concentration, the particle number size distribution, and correlation plots. If anything was written in the log book, so we added this also in this report. As reference standards, we used CPCs model TSI 3772 for total particle number concentration and two TROPOS mobility particle size spectrometer. The particle counters have been calibrated against a calibrated TSI electrometer 3068 B with the serial number 70838596.

For the PSL-calibrations, we used Latex particle with a nominal size of 203 nm +/- 4 nm. The latex particles have been generated with an aerosol nebulizer. The sheath air flow rate of the candidate system was calibrated to match the latex particle size, if possible. The NUIC SMPS showed in the PSL-measurements a particle diameter of 203.5 nm. Both the zero check and the high-voltage calibration passed the requirements in the final run. If we look at the final ambient measurement run, the NUIC SMPS is not in the 10%. The NUIC SMPS did not pass the ACTRIS Workshop.

Log book:

<u>May 12, 2014</u>

-> Setup of all intruments in laboratory 118

11:00 am - 04:00 pm (local time) -> CPC workshop

-> Highvoltage calibration of Ref1 and Ref3

-> Measured flows: CPC 1 : 1.040 l/min
CPC 3 : 1.029 l/min
Ref 1 : 1.018 l/min
Ref 3 : 0.9999 l/min

-> Column arrived Monday afternoon. Set up NUIC system with TROPOS radioactive source.

-> Obtained LabView error that I had not seen before while trying to start measurement. After some googling, I found that the NI MAX database had to be rebuilt and used the information at the following link to do this:
http://digital.ni.com/public.nsf/allkb/2C7480E856987FFF862573AE005AB0D9?OpenDocument

-> Eventually had system running for 203nm test and for overnight run

<u>May 13, 2014</u>

-> System had hung up at 10:15 pm of the previous evening. I started system - had to use task manager to restart LabView. I had to then write scripts to get the required data for the comparison - would try to sort hanging problem later. Two 203nm tests were run on Tuesday plus a zero test.

<u>May 14, 2014</u>

-> Continued with scripts and data work today and tried some more tricks to get rid of this hanging problem.

<u>May 15, 2014</u>

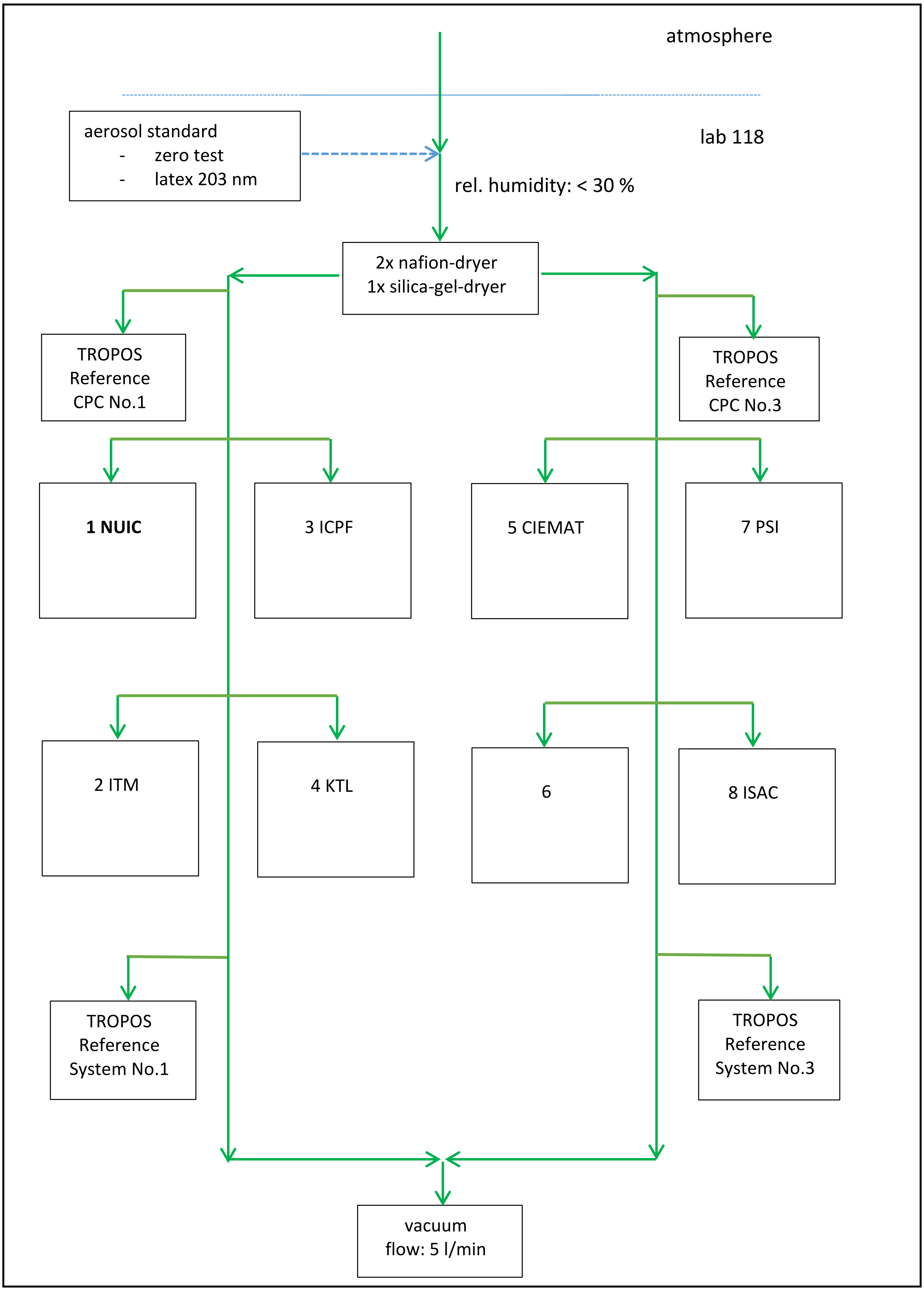
-> Because of the offset that appeared on the previous nights run, I decided to perform a full High Voltage calibration - paying particular attention to the low end of range. It appeared to me that the HV out doesn't move from lowest set value until the first 15 transitions of 1200 transition loop have executed - even though the HV seems capable during calibration. Did the full calibration (twice) and was just about (late finish) ready for overnight run.

<u>May 16, 2014</u>

-> Obtained a decent enough run overnight - to nearly completely coincide with selected comparison time. Have to work this data when I get back to Galway - need to pack instrumentation. Also had Kay set up 203nm test for me again - and obtained a couple of runs.

I was plagued with system hanging for unknown reason - something that did not happen for the previous 4 weeks deployed at Mace Head - the system had a full software upgrade 5 weeks prior to workshop. No useful debug information was to hand and many things were tried - particularly, in relation to preventing the system (or usb subsystem) going into sleep mode. In the end, decided to write LabView code to detect when program is not running - and restart LabVIEW and program.

Laboratory setup



CPC Efficiency

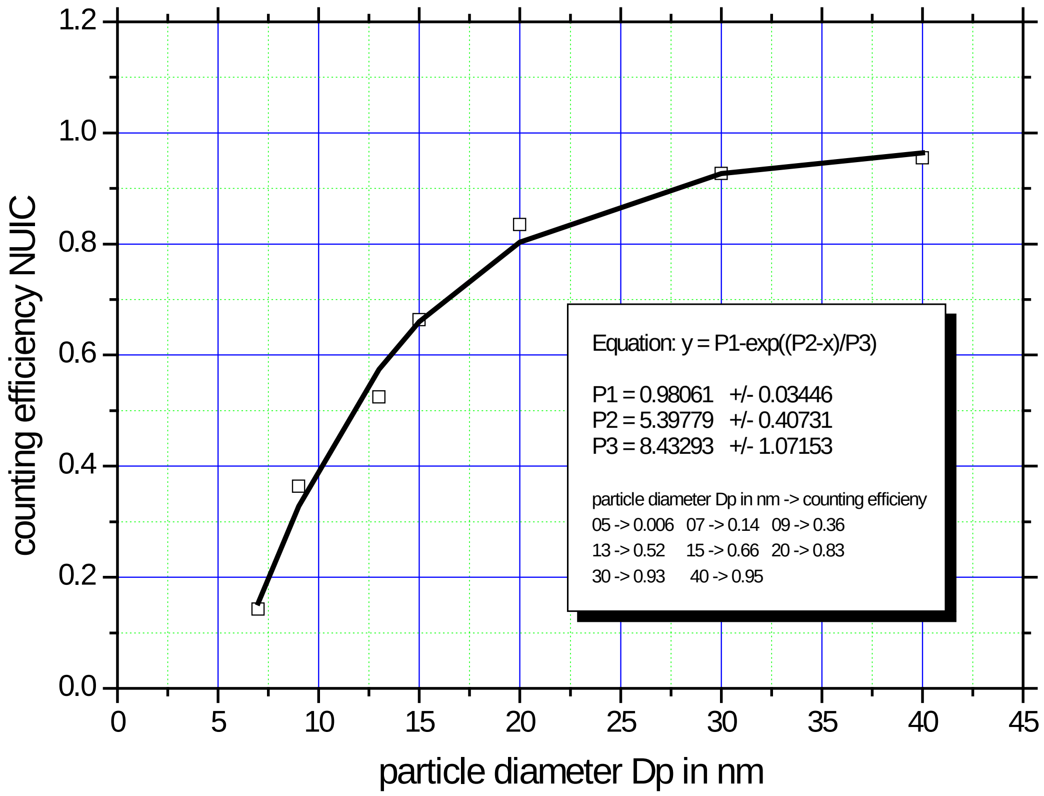


Fig.1. CPC efficiency curve. Based on Electrometer TSI 3068B. Serial number: 70838596

Latex 203 nm

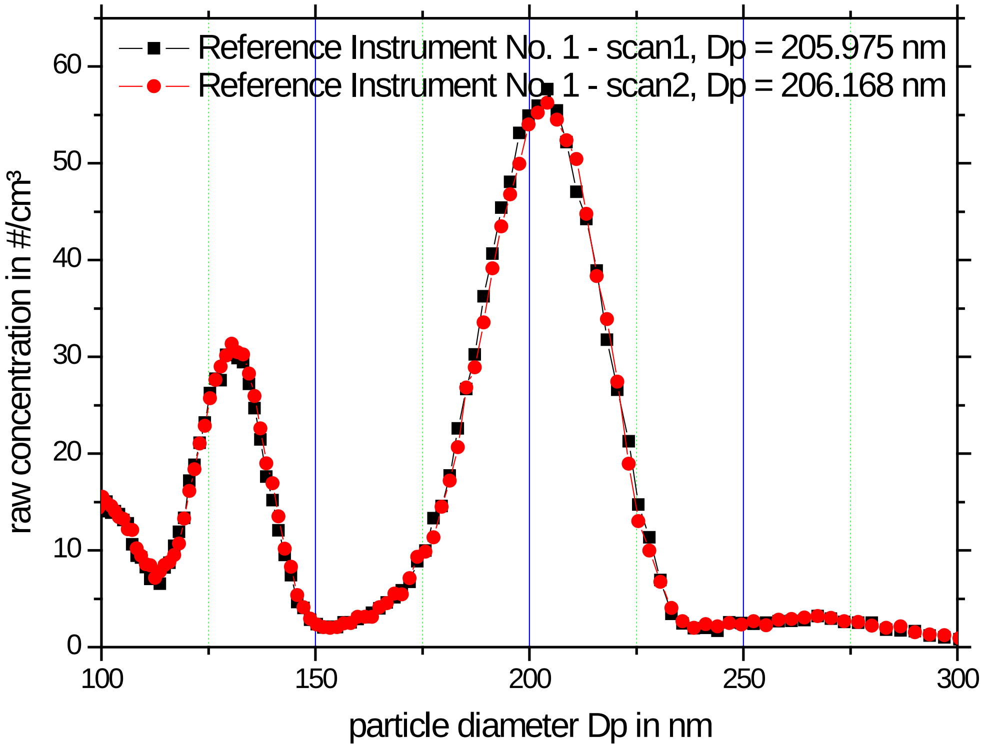


Fig.2. Measurement of latex 203 nm for TROPOS reference instrument No.1: Particle size distribution (raw concentration) for latex 203 nm on May 12, 2014 between 05:10 pm and 05:25 pm.

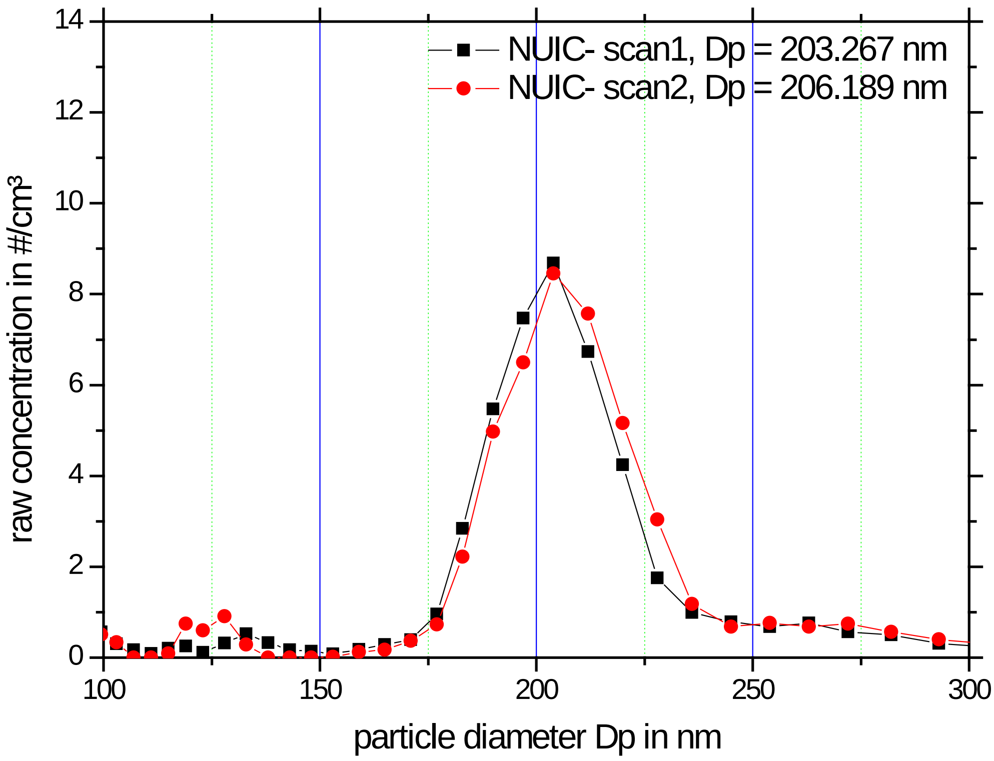


Fig.3. Measurement of latex 203 nm for instrument SMPS NUIC: particle size distribution (raw concentration) for latex 203 nm on May 12, 2014 between 05:09 pm and 05:25 pm.

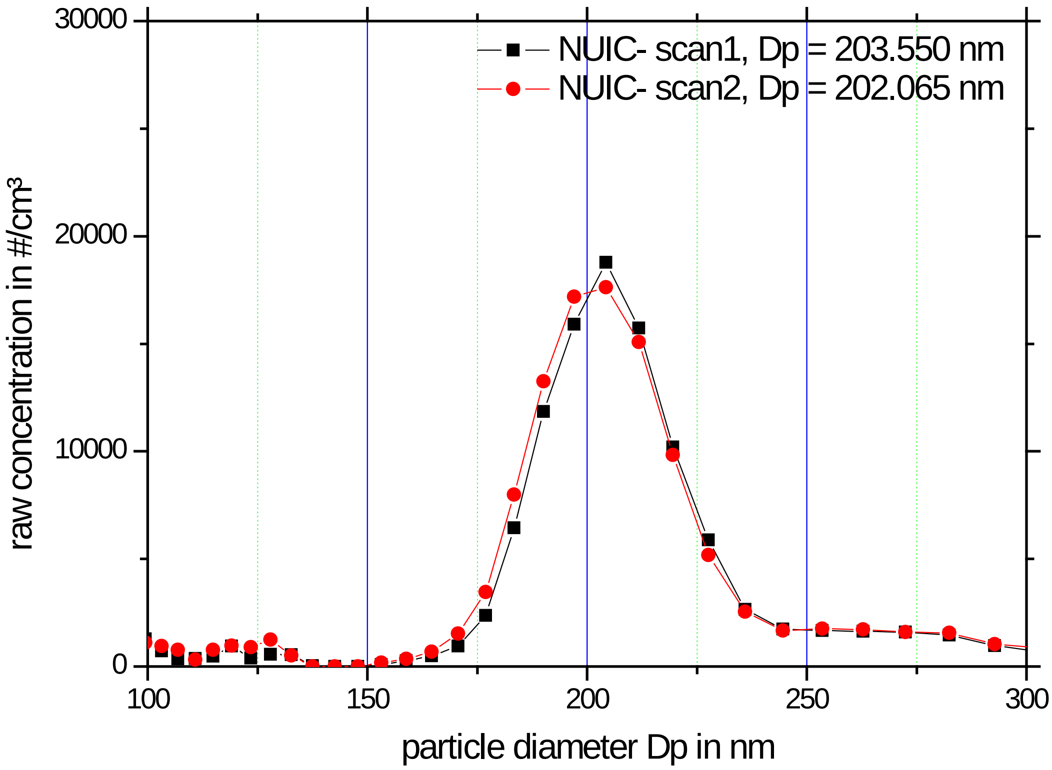


Fig.4. Measurement of latex 203 nm for instrument SMPS NUIC: particle size distribution (raw concentration) for latex 203 nm on May 16, 2014.

A: first run (May 12, 2014 06:00 pm – May 13, 2014 08:00 am)

1. Correlation of reference instruments

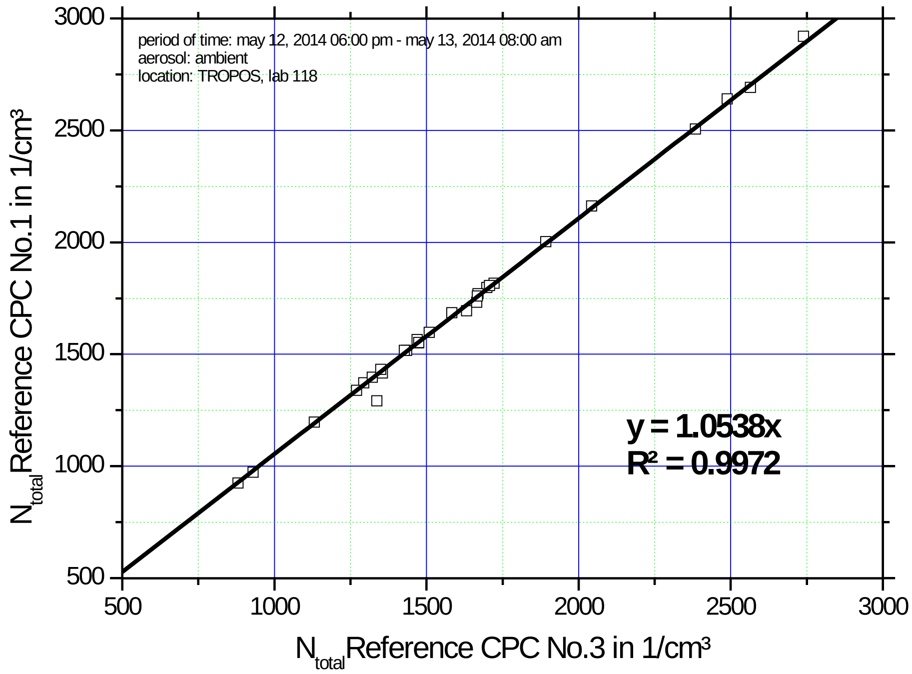


Fig.5. Linear regression between the number concentrations of the TROPOS reference CPC No.1 and the TROPOS reference CPC No.3. Multiple charge correction, internal diffusion losses and flow corrections are included.

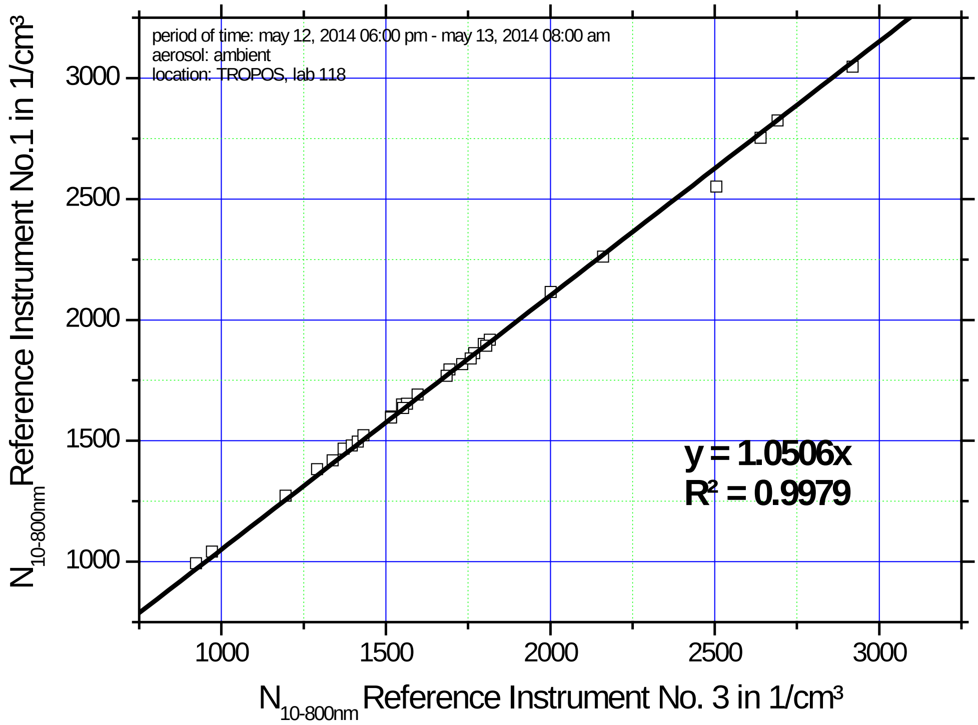


Fig.6. Linear regression between the number concentrations of the TROPOS reference instrument No.1 and the TROPOS reference instrument No.3. Multiple charge correction, internal diffusion losses and flow corrections are included.

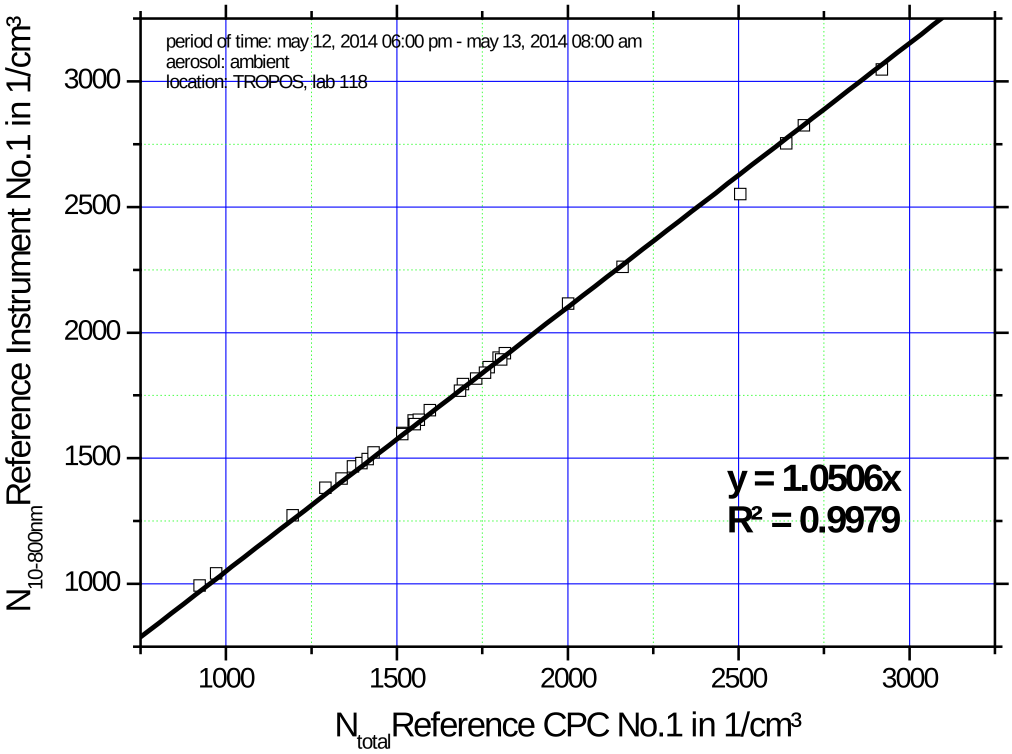


Fig.7. Linear regression between the number concentrations of the TROPOS reference instrument No.1 and TROPOS reference CPC No.1. Multiple charge correction, internal diffusion losses and flow corrections are included.

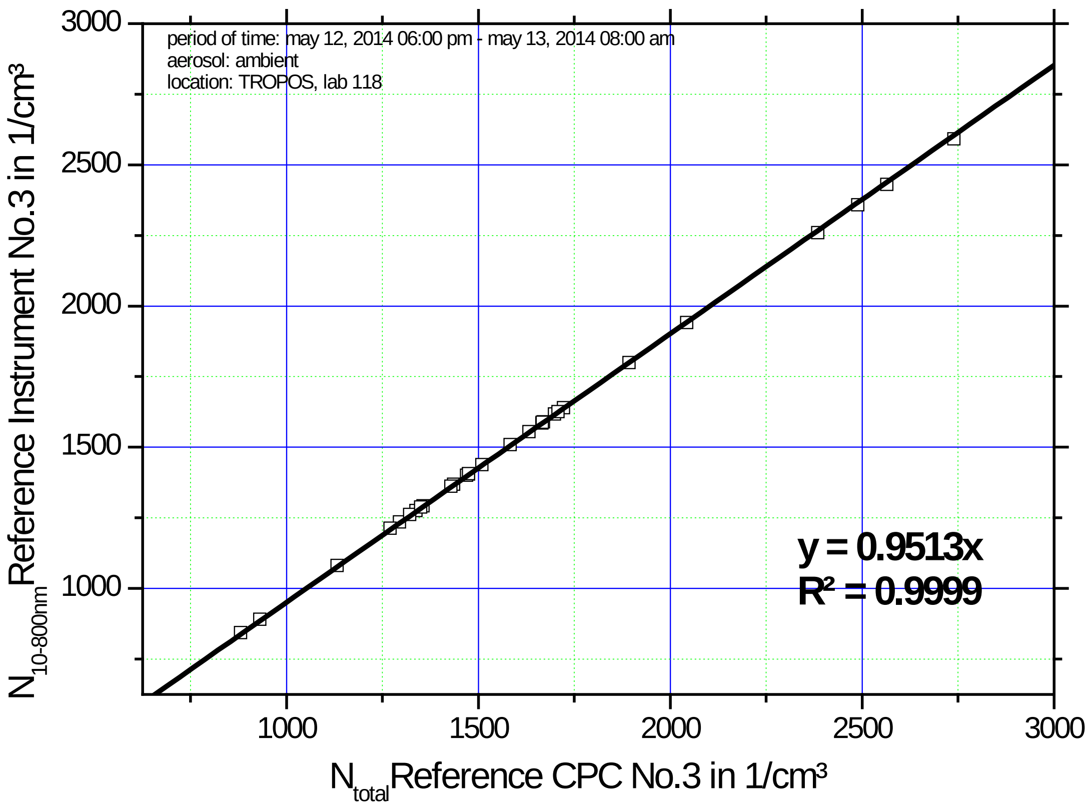


Fig.8. Linear regression between the number concentrations of the TROPOS reference instrument No.3 and TROPOS reference CPC No.3. Multiple charge correction, internal diffusion losses and flow corrections are included.

2. Time series

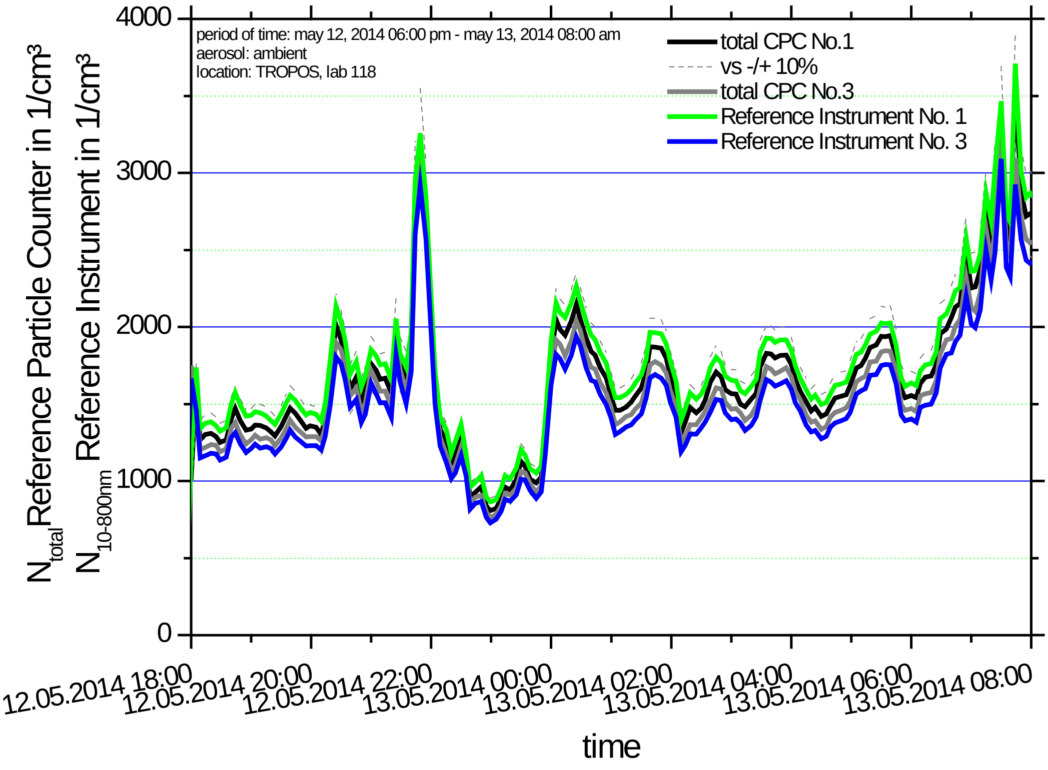


Fig.9. Time series (May 12, 2014 06:00 pm – May 13, 2014 08:00 am) of the integrated particle number concentration (N 10-800nm). Multiple charge correction, internal diffusion losses and flow corrections are included.

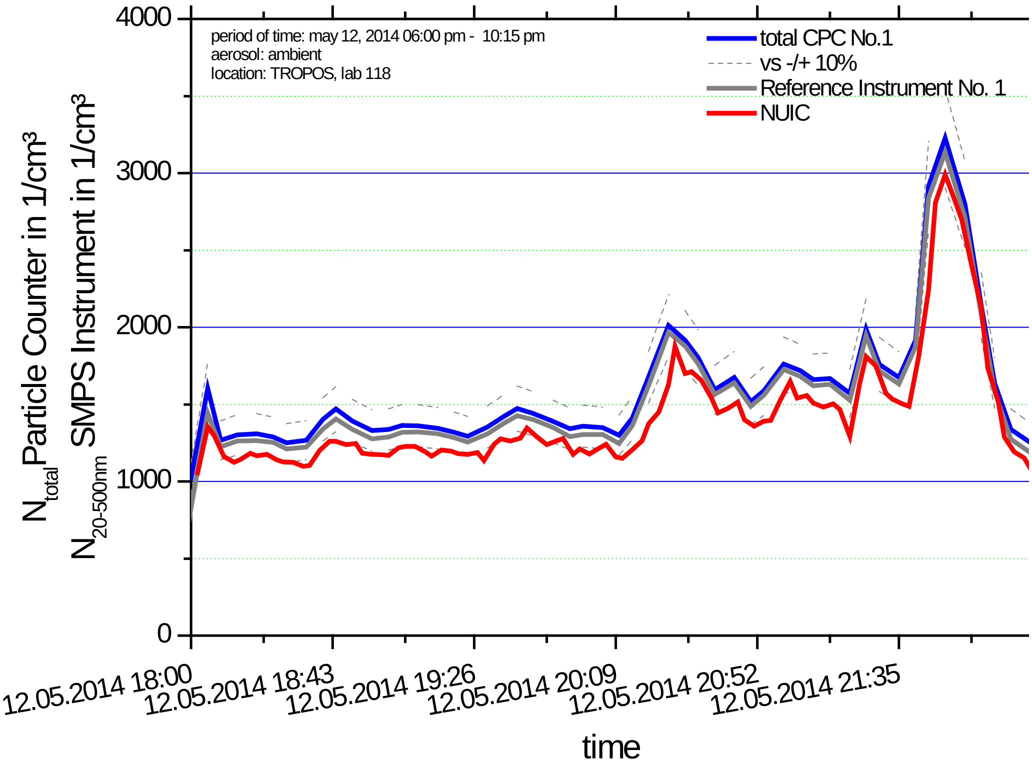


Fig.10. Time series (May 12, 2014 06:00 pm – 10:15 pm) of the integrated particle number concentration (N 20-500 nm) of SMPS NUIC and TROPOS reference instrument No.1. Multiple charge correction and internal diffusion losses are included.

3. Correlation of SMPS NUIC

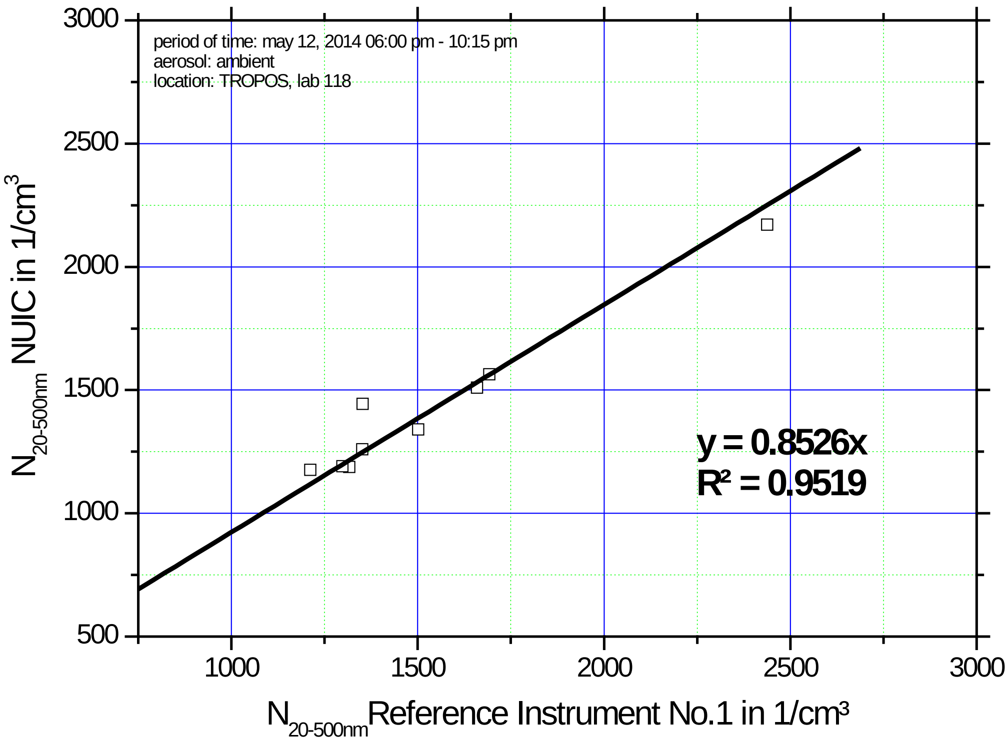


Fig.11. Linear regression between the number concentrations of the TROPOS reference instrument No.1 and SMPS NUIC. Multiple charge correction and internal diffusion losses are included.

4. Size distribution

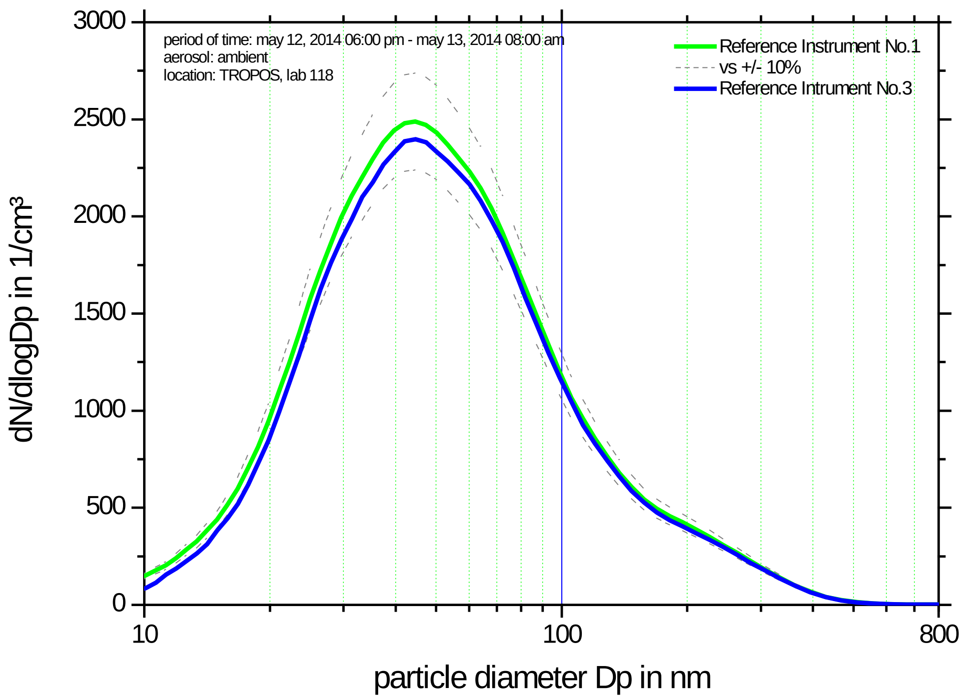


Fig.12. Comparison of mean particle number size distribution of the reference instruments between May 12, 2014 06:00 pm and May 13, 2014 08:00 am. Multiple charge correction, internal diffusion losses and CPC efficiency are included (.in2).

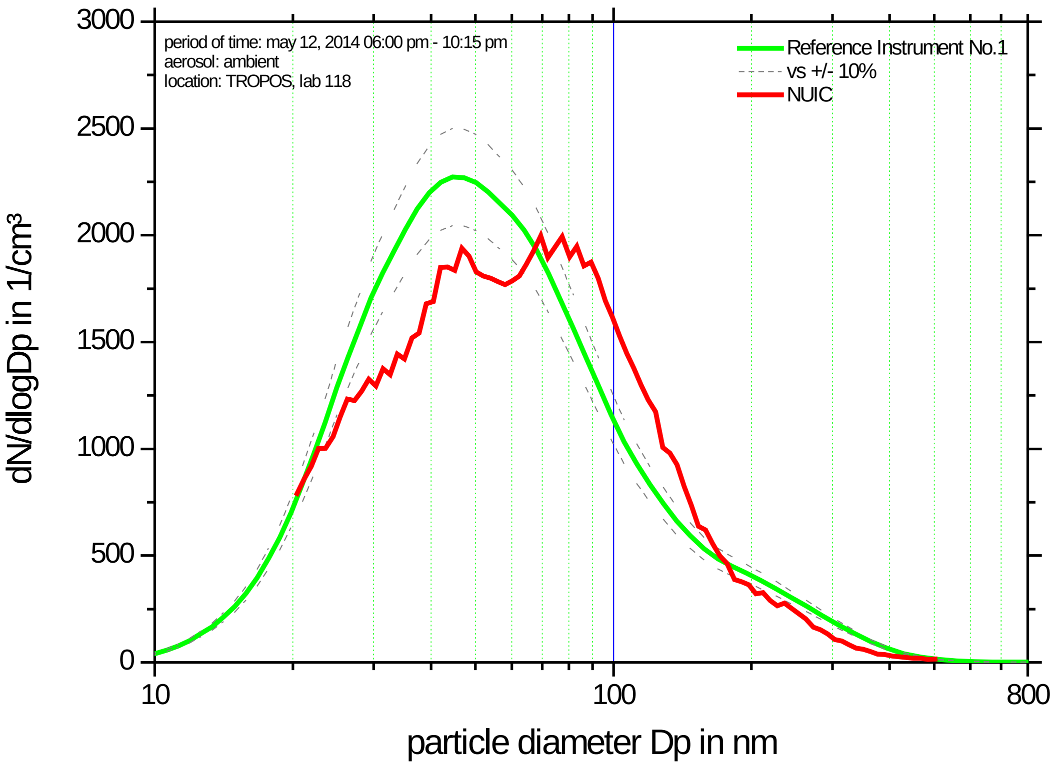


Fig.13. Comparison of mean particle number size distribution of SMPS NUIC and TROPOS reference instrument No.1 on May 12, 2014 between 06:00 pm and 10:15 pm. Multiple charge correction is included (.in0).

B: second run (May 14, 2014 10:00 am – 02:30 pm)

1. Correlation of reference instruments

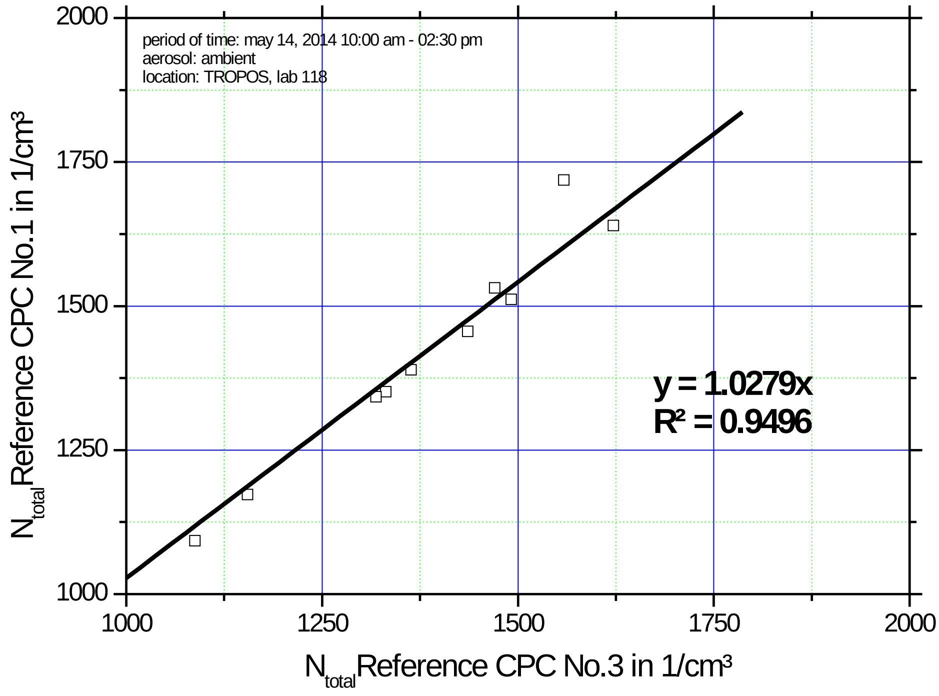


Fig.14. Linear regression between the number concentrations of the TROPOS reference CPC No.1 and the TROPOS reference CPC No.3. Multiple charge correction, internal diffusion losses and flow corrections are included.

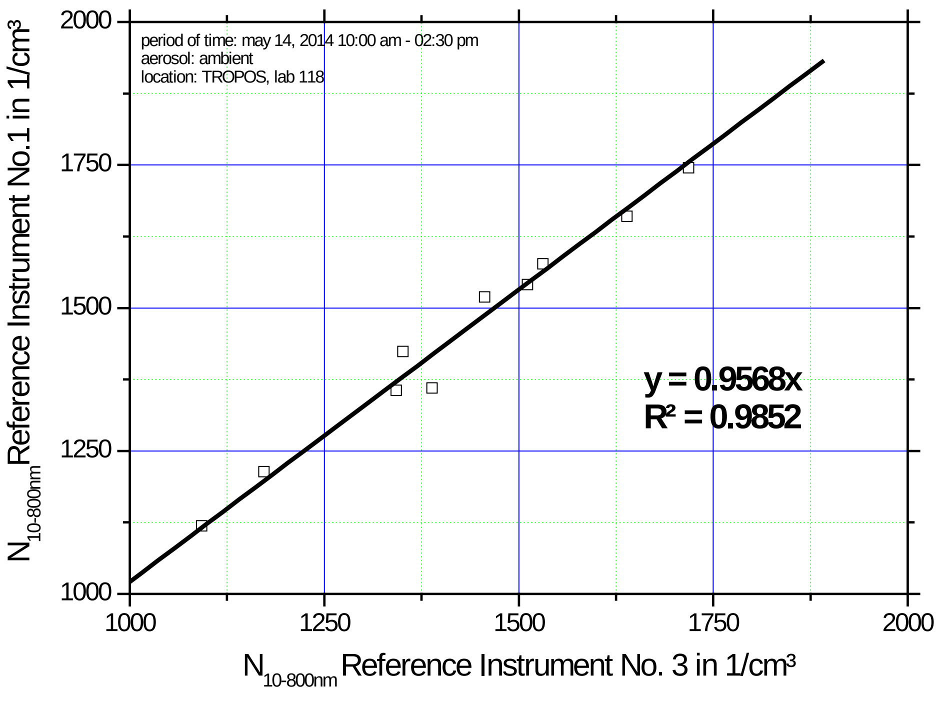


Fig.15. Linear regression between the number concentrations of the TROPOS reference instrument No. 1 and the TROPOS reference instrument No. 3. Multiple charge correction, internal diffusion losses and flow corrections are included.

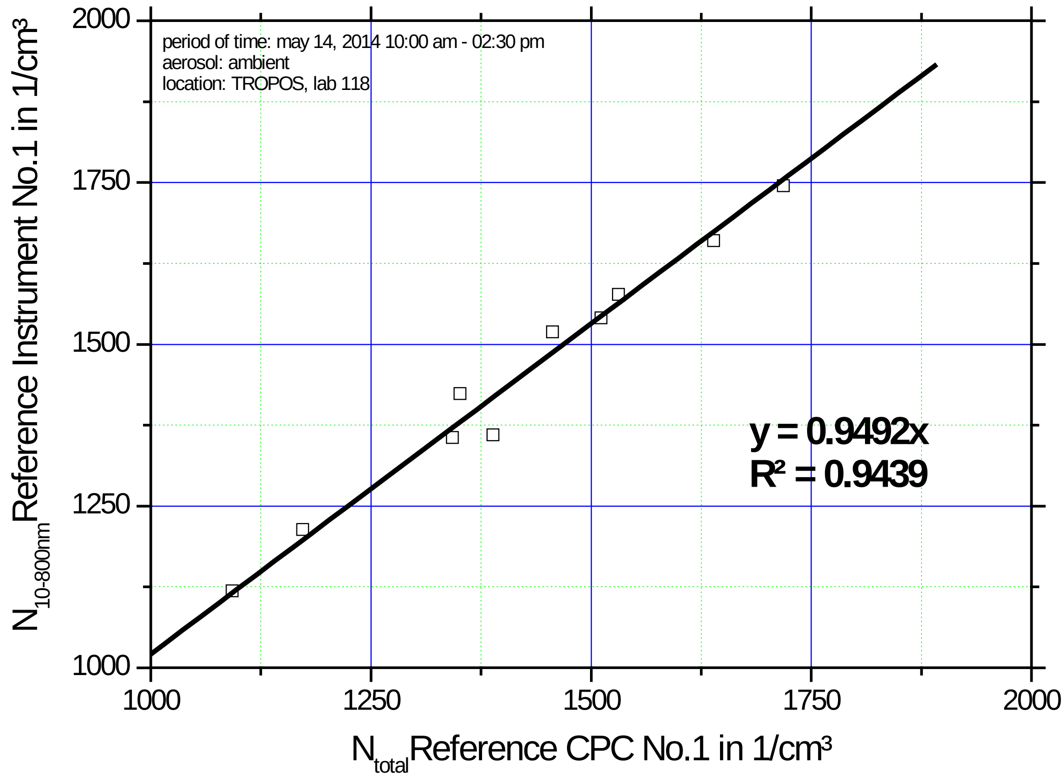


Fig.16. Linear regression between the number concentrations of the TROPOS reference instrument No. 1 and TROPOS reference CPC No.1. Multiple charge correction, internal diffusion losses and flow corrections are included.

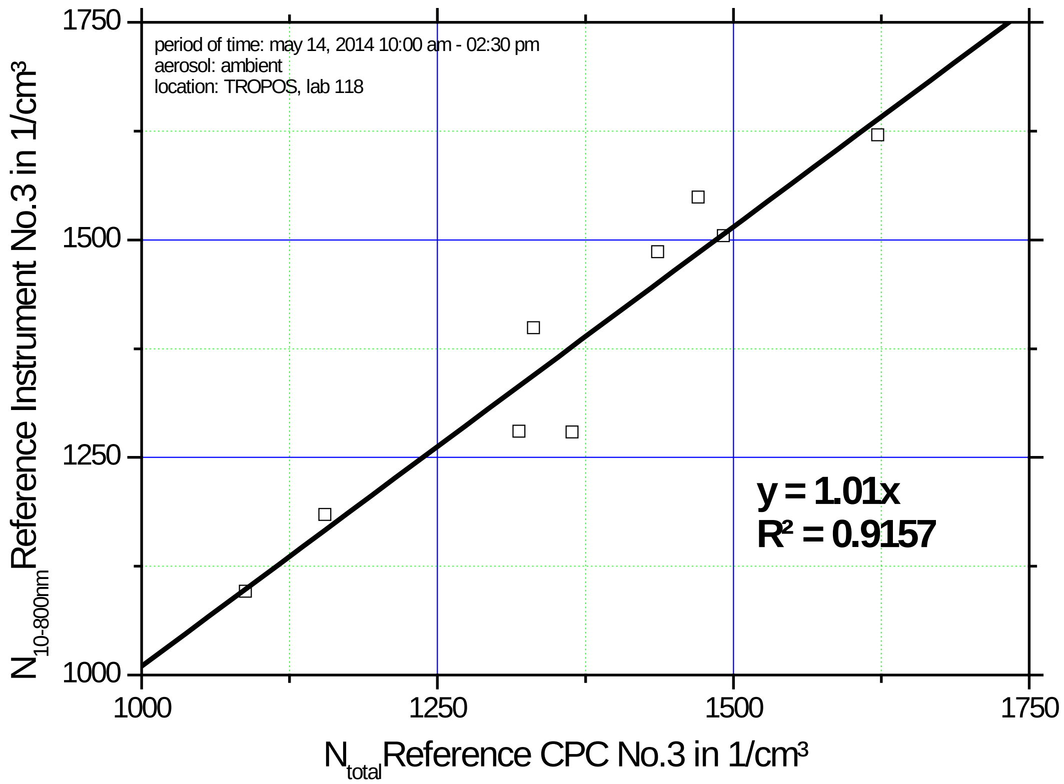


Fig.17. Linear regression between the number concentrations of the TROPOS reference instrument No. 3 and TROPOS reference CPC No.3. Multiple charge correction, internal diffusion losses and flow corrections are included.

2. Time series

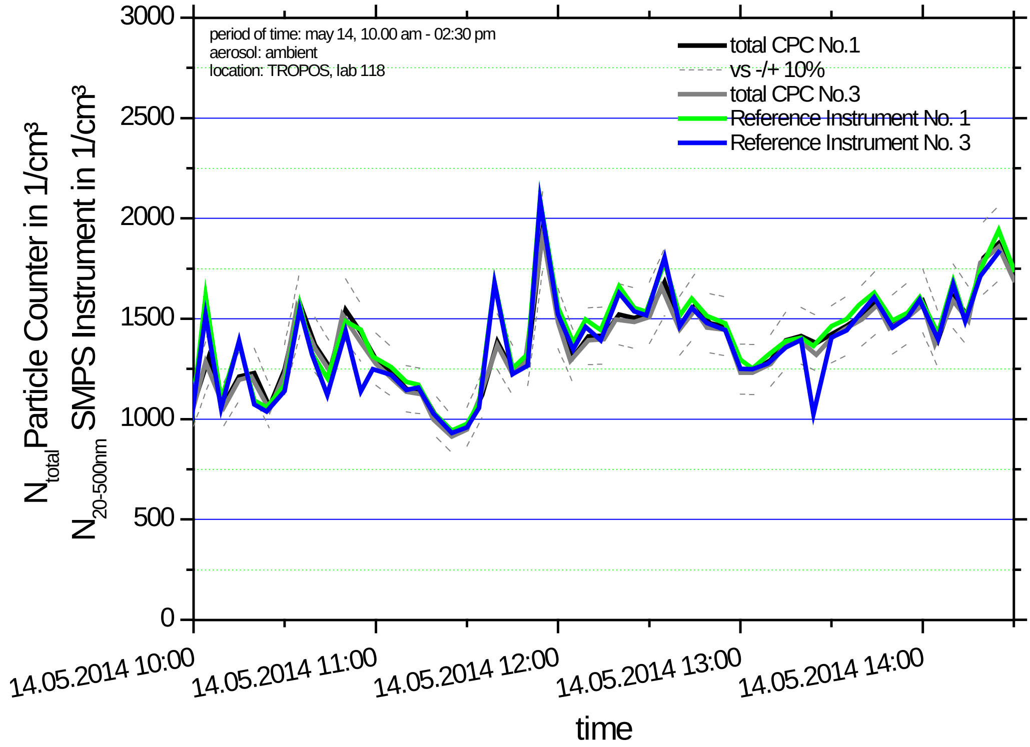


Fig.18. Time series (May 14, 2014 10:00 am – 02:30 pm) of the integrated particle number concentration (N 10-800nm). Multiple charge correction, internal diffusion losses and flow corrections are included.

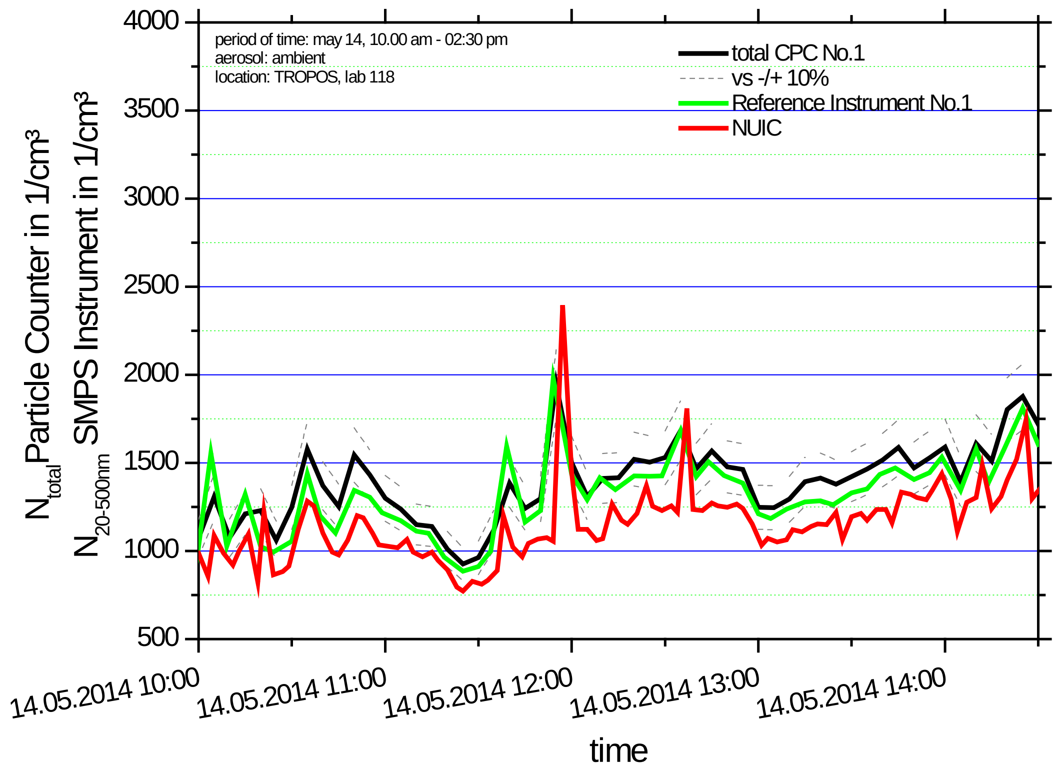


Fig.19. Time series (May 14, 2014 10:00 am – 02:30 pm) of the integrated particle number concentration (N 20-500nm) of SMPS NUIC and TROPOS reference instrument No.1. Multiple charge correction and internal diffusion losses are included.

3. Correlation of SMPS NUIC

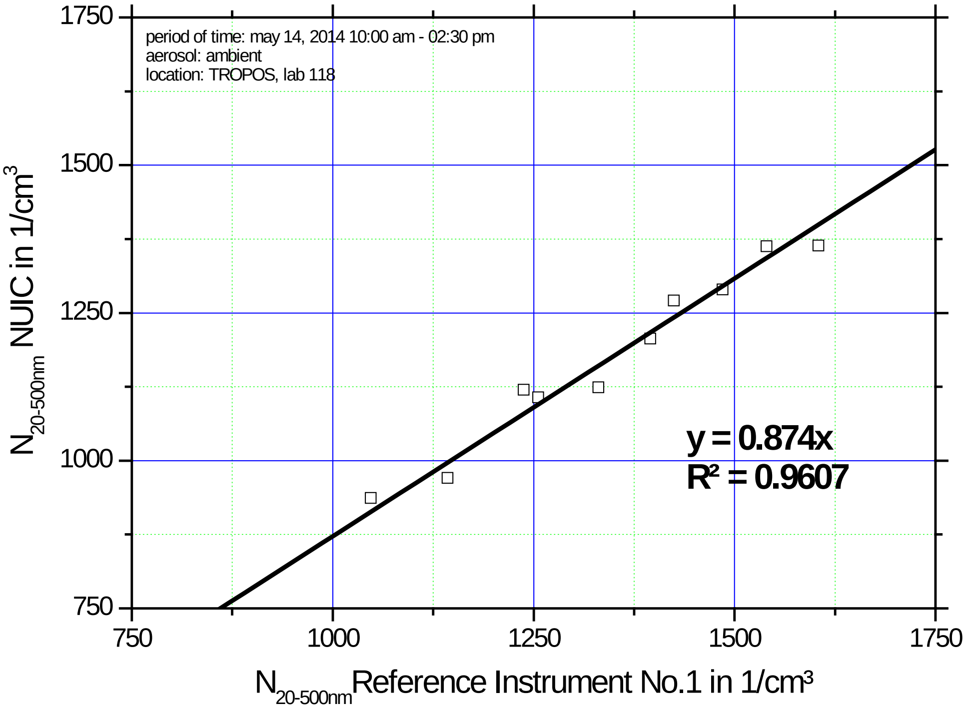


Fig.20. Linear regression between the number concentrations of the TROPOS reference instrument No.1 and SMPS NUIC. Multiple charge correction and internal diffusion losses are included.

4. Size distribution

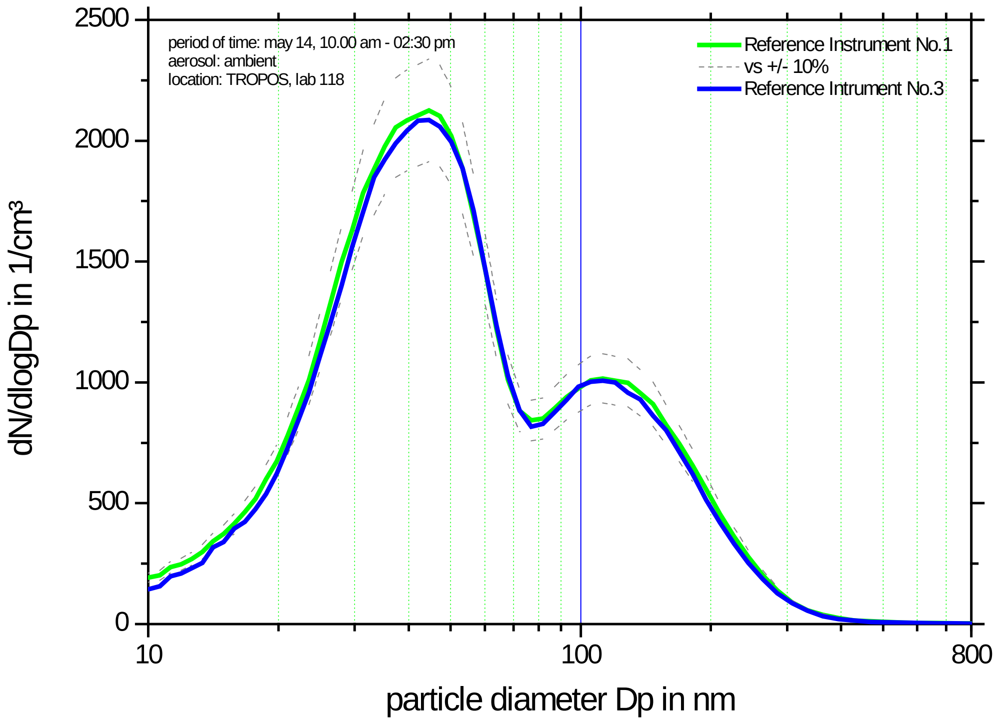


Fig.21. Comparison of mean particle number size distribution between May 13, 2014 10:00 am and May 14, 2014 02:30 pm. Multiple charge correction, internal diffusion losses and CPC efficiency are included (.in2).

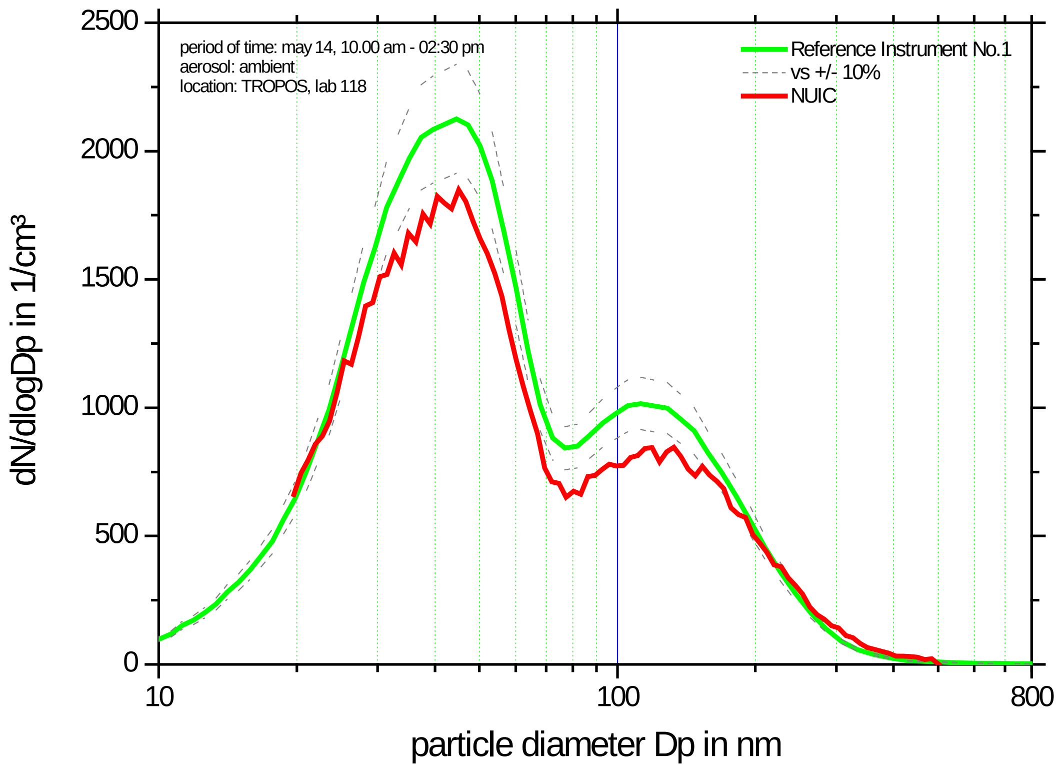


Fig.22. Comparison of mean particle number size distribution of SMPS NUIC and TROPOS reference instrument No.1 on May 14, 2014 between 10:00 am and 02:30 pm. Multiple charge correction and internal diffusion losses are included (.in1).

C: third run (May 14, 2014 07:00 pm – May 15, 2014 07:00 am)

1. Correlation of reference instruments

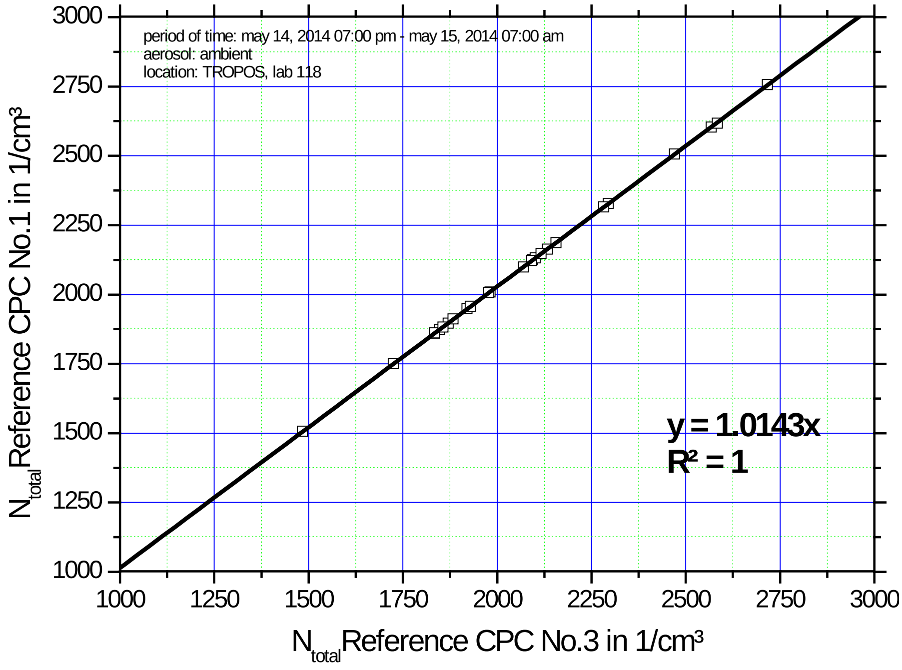


Fig.23. Linear regression between the number concentrations of the TROPOS reference CPC No.1 and the TROPOS reference CPC No.3. Multiple charge correction, internal diffusion losses and flow corrections are included.

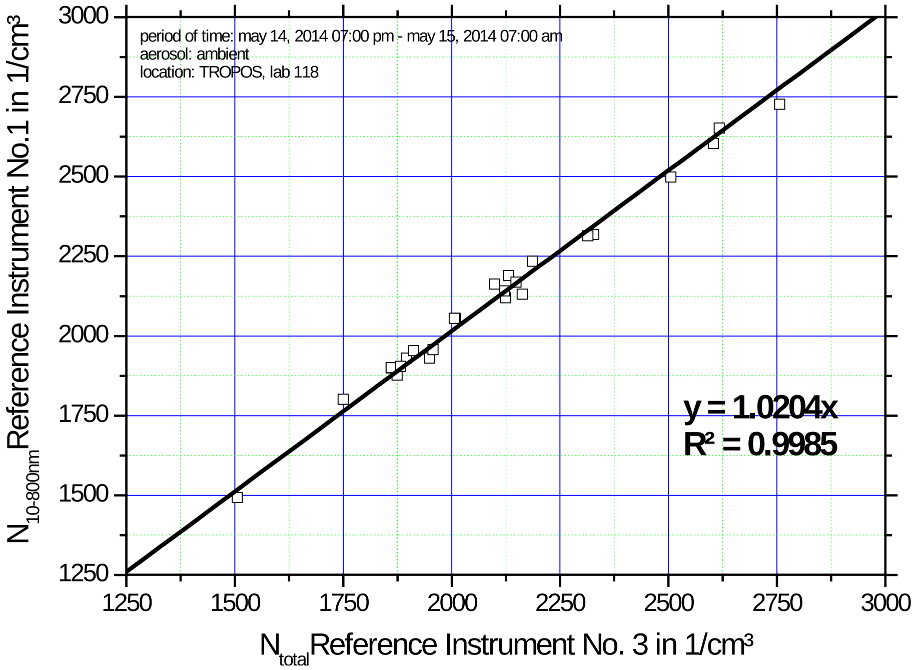


Fig.24. Linear regression between the number concentrations of the TROPOS reference instrument No. 1 and the TROPOS reference instrument No. 3. Multiple charge correction, internal diffusion losses and flow corrections are included.

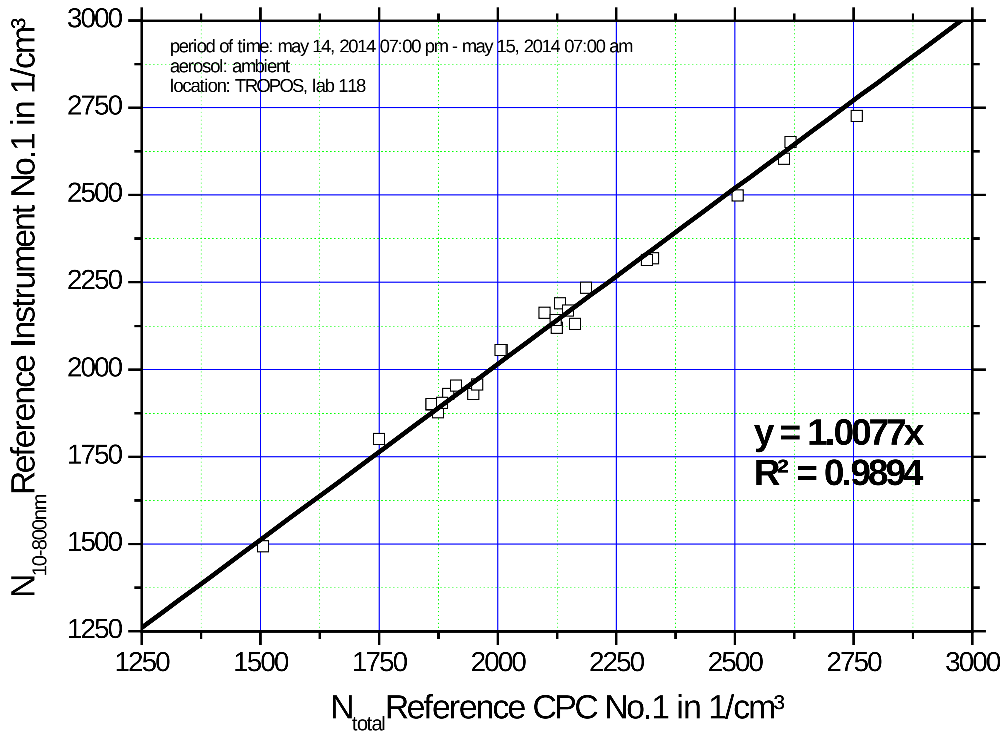


Fig.25. Linear regression between the number concentrations of the TROPOS reference instrument No. 1 and TROPOS reference CPC No.1. Multiple charge correction, internal diffusion losses and flow corrections are included.

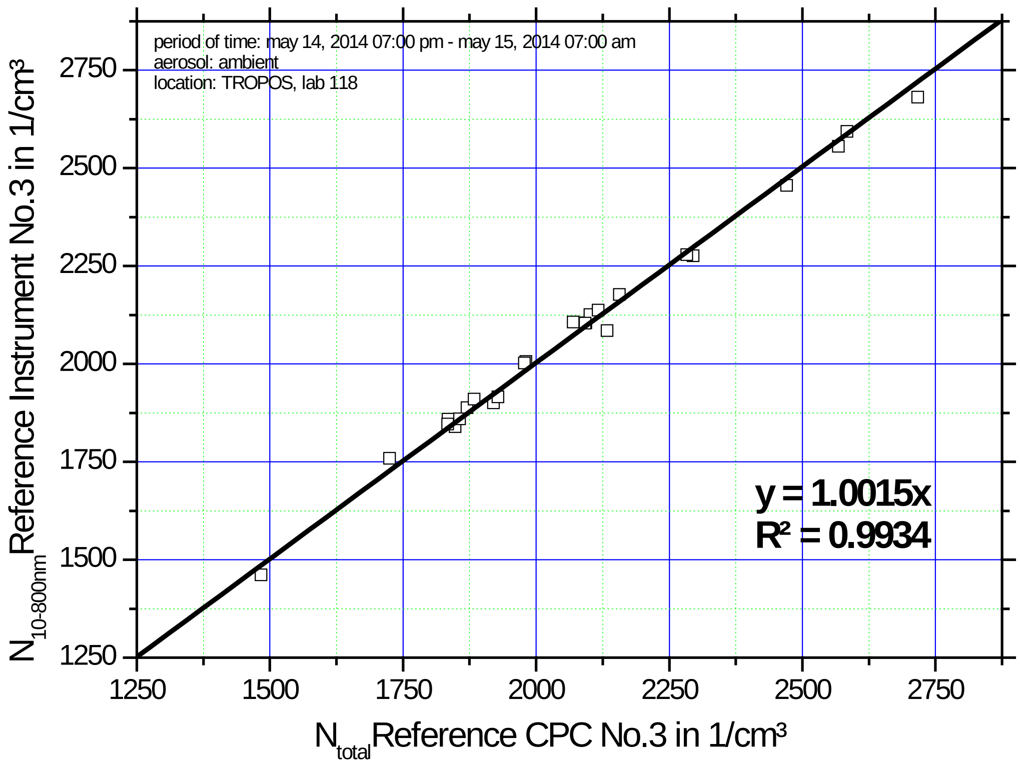


Fig.26. Linear regression between the number concentrations of the TROPOS reference instrument No. 3 and TROPOS reference CPC No.3. Multiple charge correction, internal diffusion losses and flow corrections are included.

2. Time series

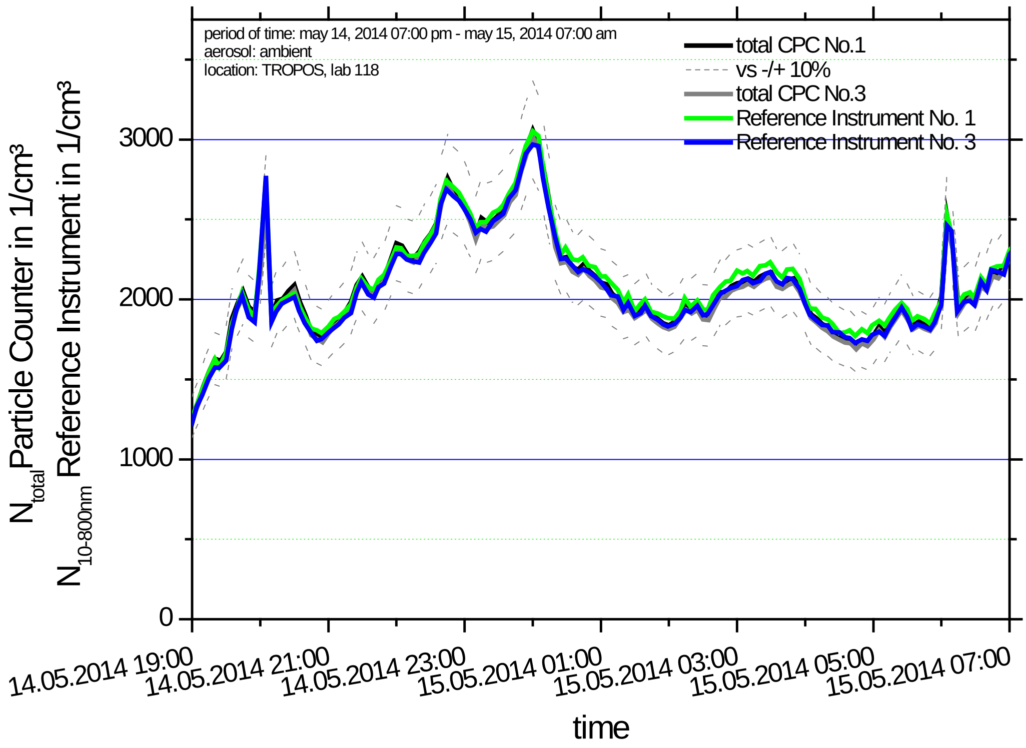


Fig.27. Time series (May 14, 2014 07:00 pm – May 15, 2014 07:00 am) of the integrated particle number concentration (N 10-800nm). Multiple charge correction, internal diffusion losses and CPC efficiency are included.

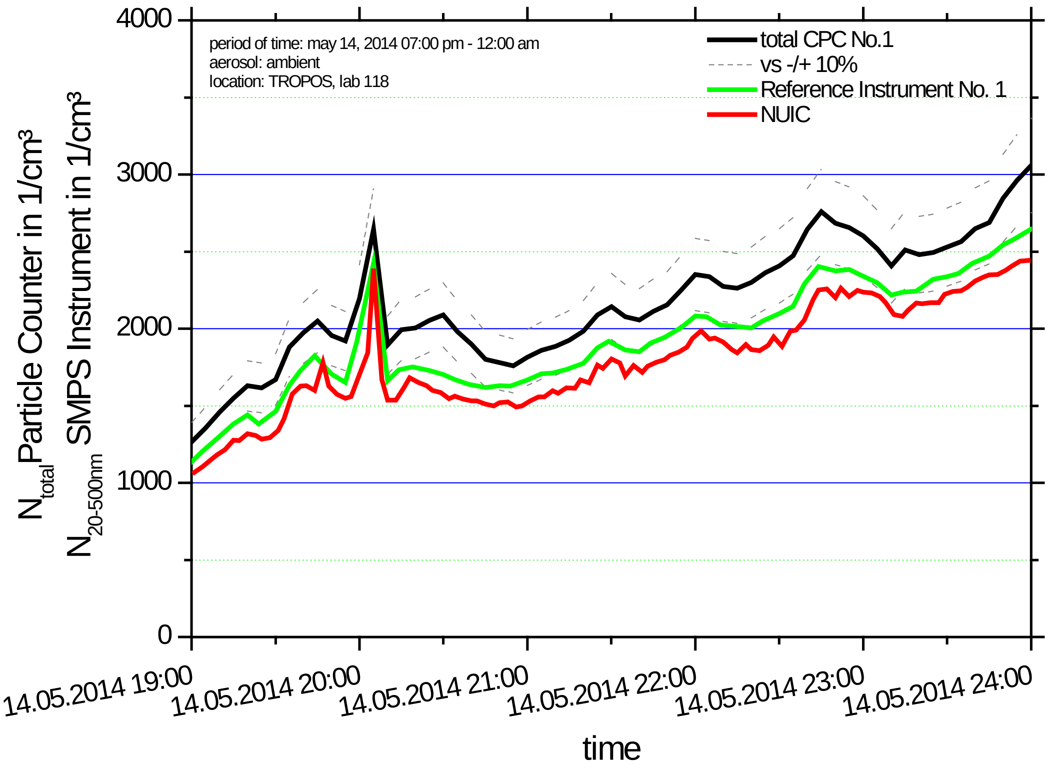


Fig.28. Time series (May 14, 2014 07:00 pm – May 15, 2014 12:00 am) of the integrated particle number concentration (N 20-500nm) of SMPS NUIC and TROPOS reference instrument No.1. Multiple charge correction and internal diffusion losses are included.

3. Correlation of NUIC

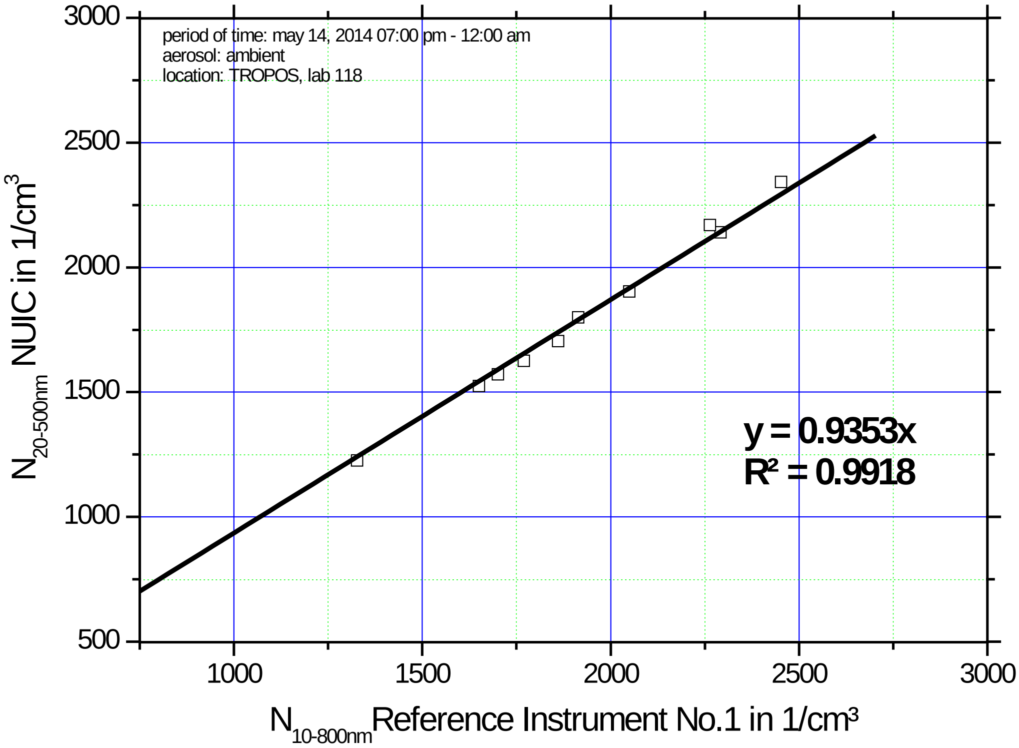


Fig.29. Linear regression between the number concentrations of the TROPOS reference instrument No.1 and SMPS NUIC. Multiple charge correction and internal diffusion losses are included.

4. Size distribution

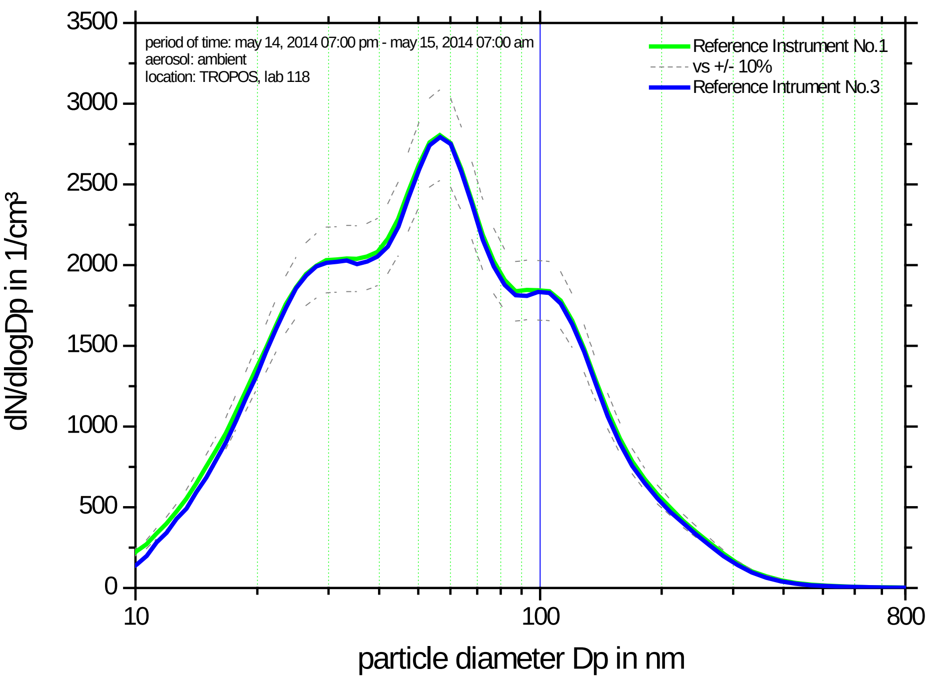


Fig.30. Comparison of mean particle number size distribution between May 14, 2014 07:00 pm and May 15, 2014 07:00 am. Multiple charge correction, internal diffusion losses and CPC efficiency are included (.in2).

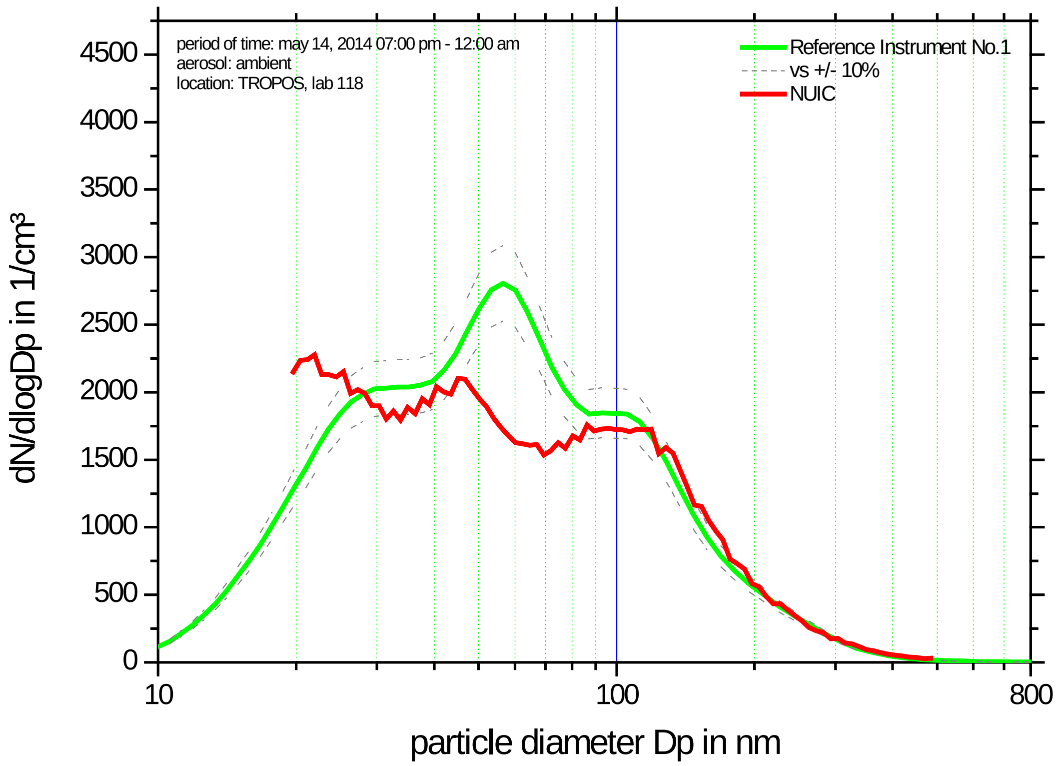


Fig.31. Comparison of mean particle number size distribution of SMPS NUIC and TROPOS reference instrument No.1 between May 14, 2014 07:00 pm and May 15, 2014 12:00 am. Multiple charge correction and internal diffusion losses are included (.in1).

D: fourth run (May 15, 2014 08:00 pm – May 16, 2014 06:00 am)

1. Correlation of reference instruments

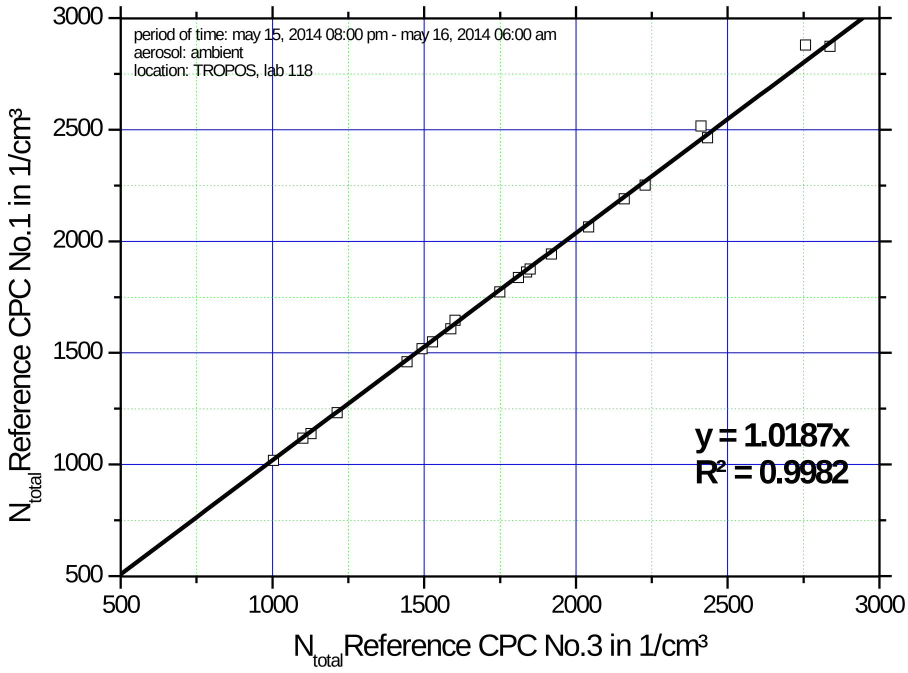


Fig.32. Linear regression between the number concentrations of the TROPOS reference CPC No.1 and the TROPOS reference CPC No.3. Multiple charge correction, internal diffusion losses and flow corrections are included.

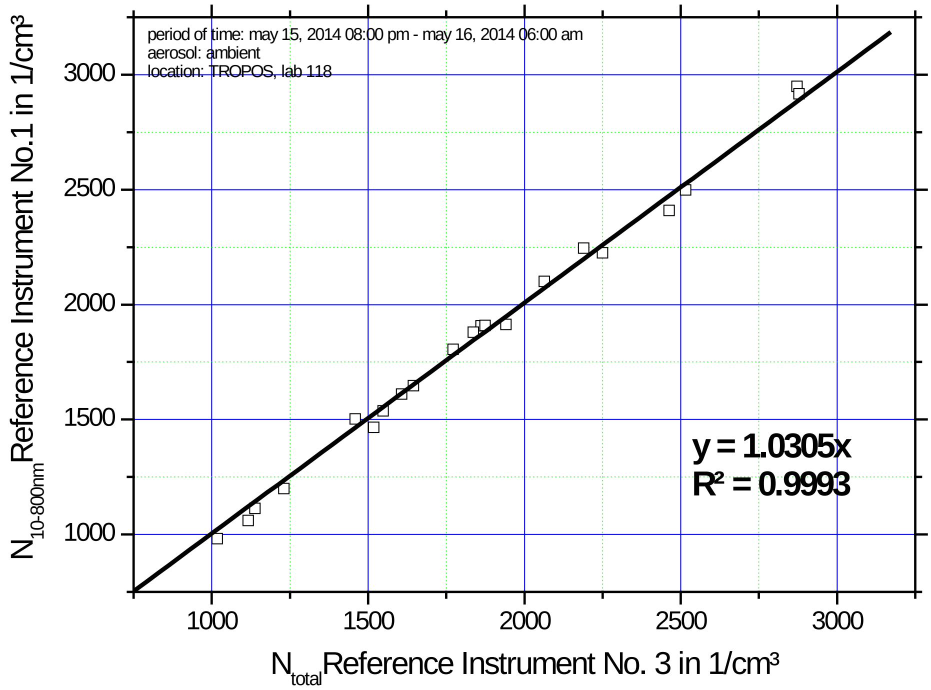


Fig.33. Linear regression between the number concentrations of the TROPOS reference instrument No. 1 and the TROPOS reference instrument No. 3. Multiple charge correction, internal diffusion losses and flow corrections are included.

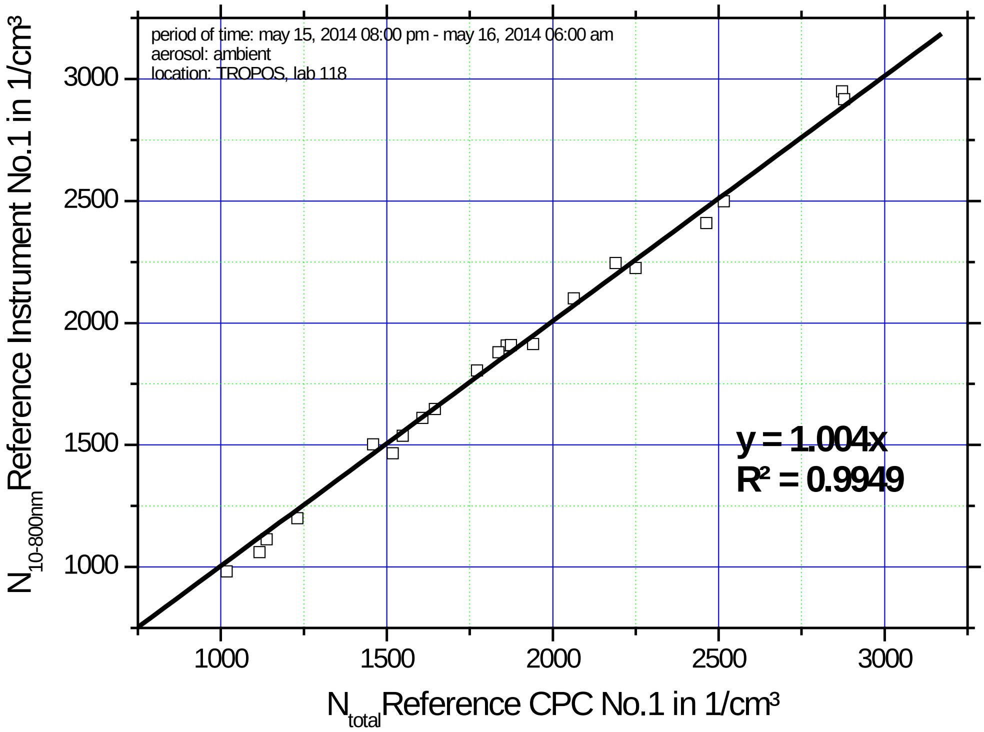


Fig.34. Linear regression between the number concentrations of the TROPOS reference instrument No. 1 and TROPOS reference CPC No.1. Multiple charge correction, internal diffusion losses and flow corrections are included.

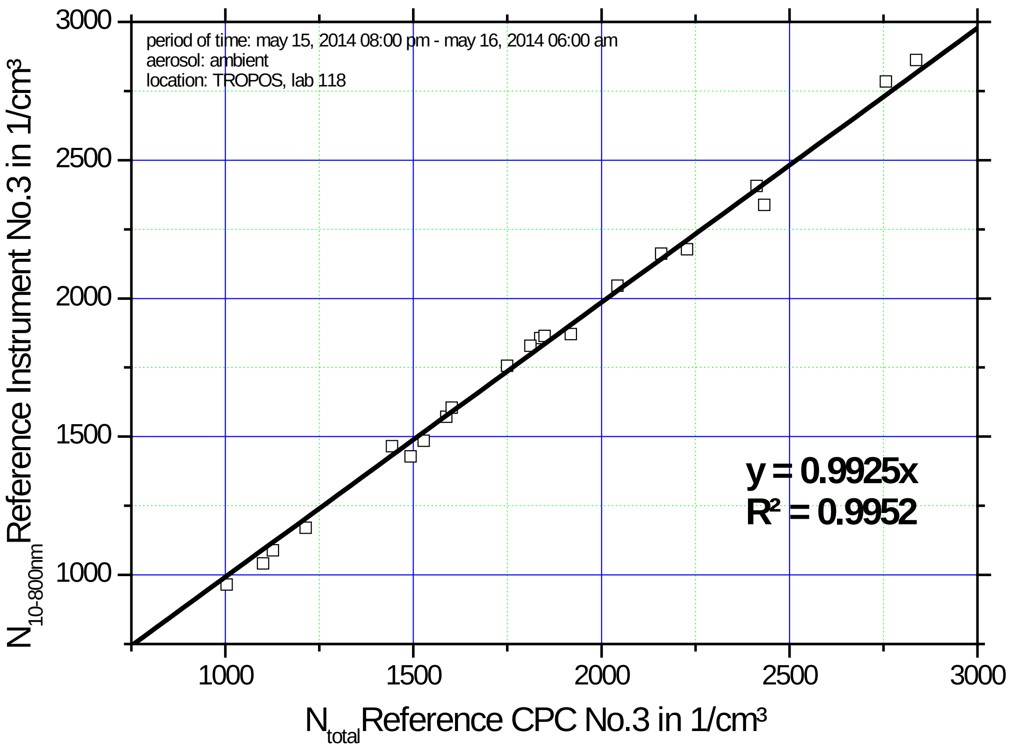


Fig.35. Linear regression between the number concentrations of the TROPOS reference instrument No. 3 and TROPOS reference CPC No.3. Multiple charge correction, internal diffusion losses and flow corrections are included.

2. Time series

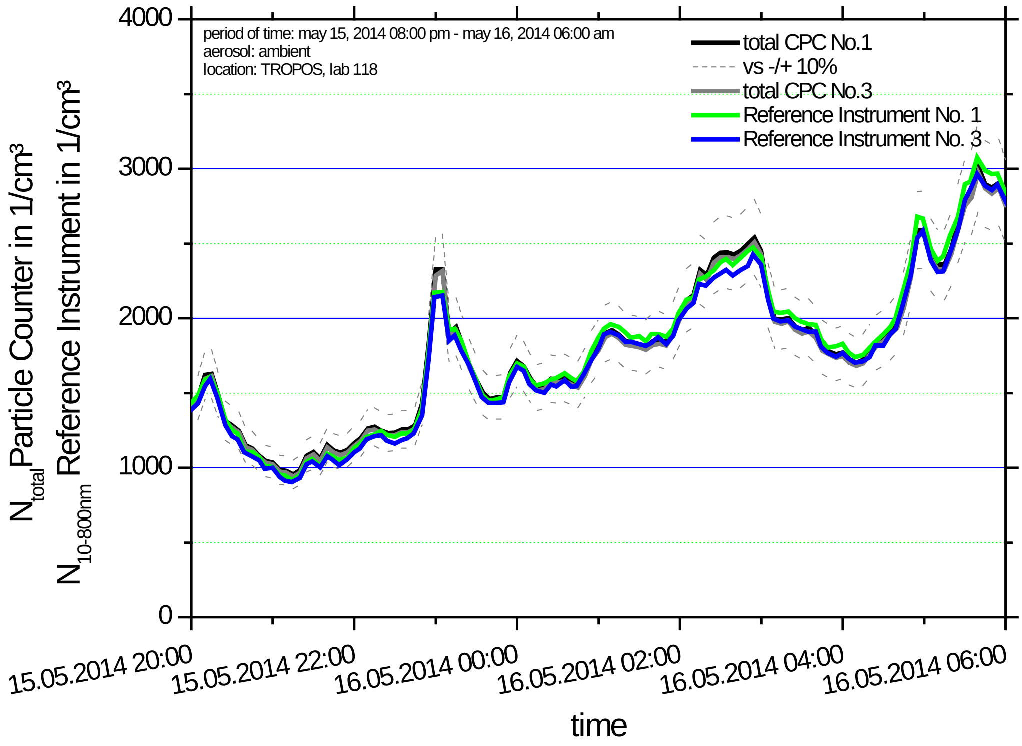


Fig.36. Time series (May 15, 2014 08:00 pm – May 16, 2014 06:00 am) of the integrated particle number concentration (N 10-800nm). Multiple charge correction, internal diffusion losses and CPC efficiency are included.

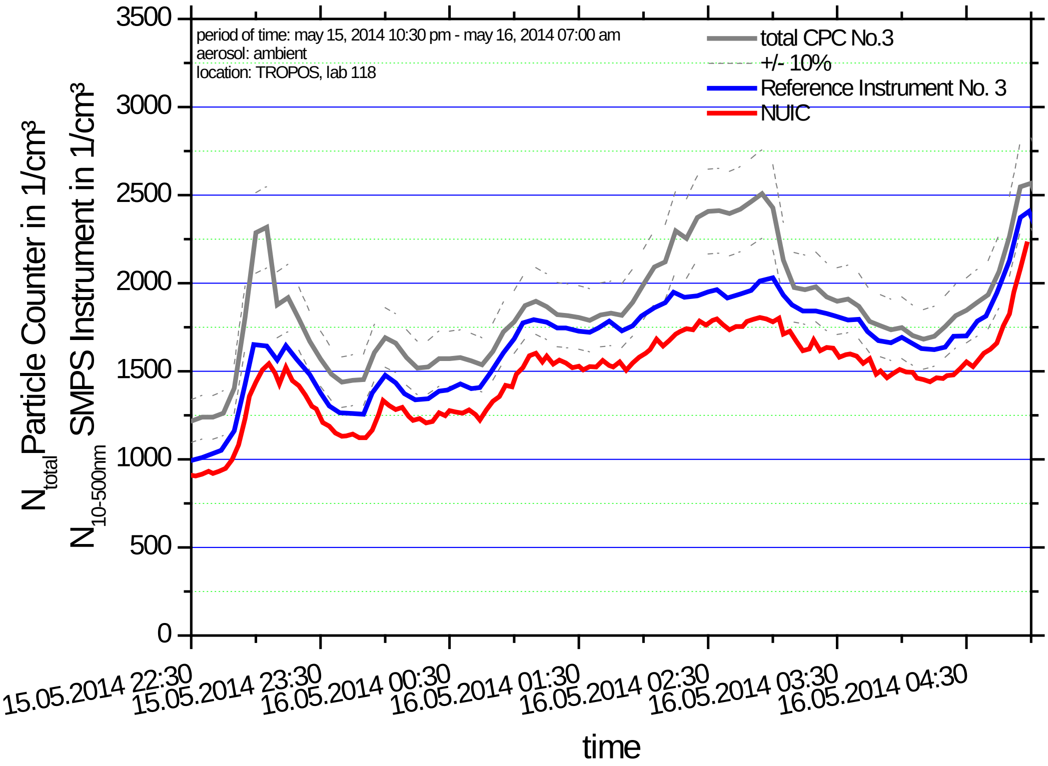


Fig.37. Time series (May 15, 2014 10:30 pm – May 16, 2014 07:00 am) of the integrated particle number concentration (N 20-500nm) of SMPS NUIC and TROPOS reference instrument No.1. Multiple charge correction and internal diffusion losses are included.

3. Correlation of NUIC

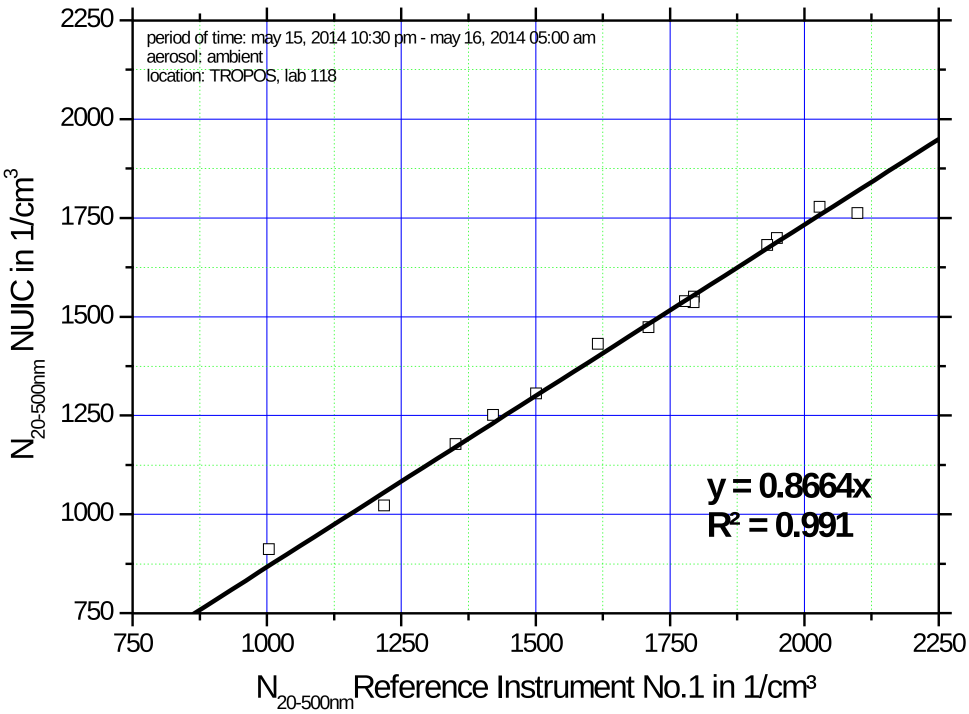


Fig.38. Linear regression between the number concentrations of the TROPOS reference instrument No.1 and SMPS NUIC. Multiple charge correction and internal diffusion losses are included.

4. Size distribution

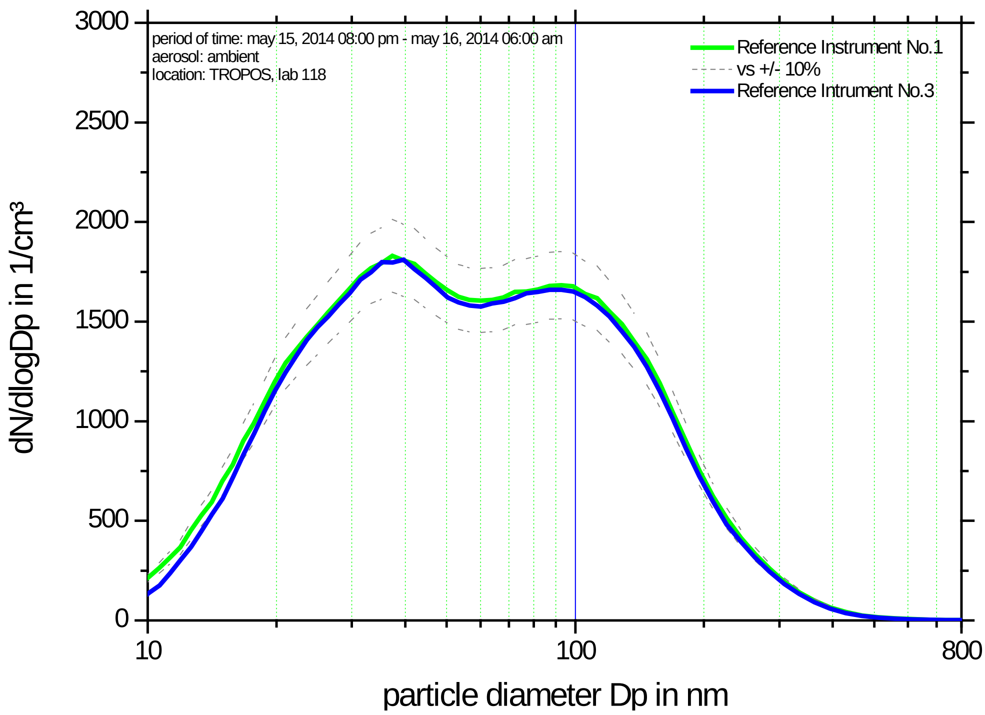


Fig.39. Comparison of mean particle number size distribution between May 15, 2014 08:00 pm and May 16, 2014 06:00 am. Multiple charge correction, internal diffusion losses and CPC efficiency are included (.in2).

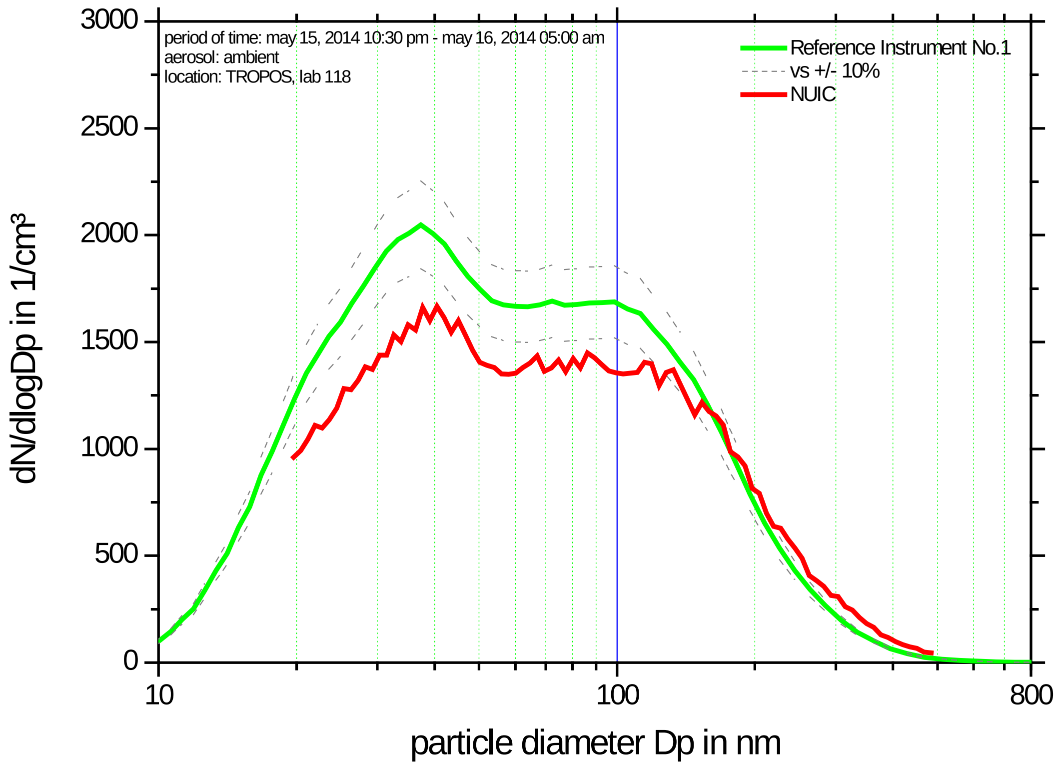


Fig.40. Comparison of mean particle number size distribution of SMPS NUIC and TROPOS reference instrument No.1 between May 15, 2014 10:30 pm and May 16, 2014 05:00 am. Multiple charge correction and internal diffusion losses are included (.in1).

Intercomparison of SMPS PSI

Basic information

Location of the quality assurance:	TROPOS, lab: 118
Delivery date:	May 12, 2014
Setup in the laboratory:	May 12, 2014
Comparison period:	May 12, 2014 – May 16, 2014
Instrument:	
TROPOS Reference Instrument:	TROPOS Reference Instrument No. 1 TROPOS Reference Instrument No. 3
Total CPC:	TROPOS Reference CPC No.1; SN: 3772112101 TROPOS Reference CPC No.3; SN: 3772111903
Additional equipment:	
Involved people:	Nicolas Buckowiecki (nicolas.bukowiecki@psi.ch)

Summary of second intercomparison:

From May 12, 2014 to May 16, 2014 the PSI SMPS participated successfully the TROPOS ACTRIS Workshop. The workshop consisted of an entrance test and a final run. In addition to the overnight ambient measurements, we had numerous high voltage checks, zero- and PSL-measurements. The report is divided into three sections. The first section shows the laboratory setup and the PSL measurement. After that, we show for each run the time series of the particle number concentration, the particle number size distribution, and correlation plots. If anything was written in the log book, so we added this also in this report. As reference standards, we used CPCs model TSI 3772 for total particle number concentration and two TROPOS mobility particle size spectrometer. The particle counters have been calibrated against a calibrated TSI electrometer 3068 B with the serial number 70838596.

For the PSL-calibrations, we used Latex particle with a nominal size of 203 nm +/- 4 nm. The latex particles have been generated with an aerosol nebulizer. The sheath air flow rate of the candidate system was calibrated to match the latex particle size, if possible. The PSI SMPS showed in the PSL-measurements a particle diameter of 202.1 nm. Both the zero check and the high-voltage calibration passed the requirements in the final run. If we look at the final ambient measurement run, the PSI SMPS is in the 10%. The PSI SMPS passed the ACTRIS Workshop.

Log book:

Settings:

Closed loop system regulated to 3 l/min volumetric flow

CPC 3775 0.3 l/min

Long DMA TSI style home made

NO PM1 impactor for the workshop (normally present at JFJ)

<u>May 12, 2014</u>

11:08 am (local time)	-> Setup in laboratory 118; Neutralizer: Kr-85 from TROPOS
11:00 am - 04:00 pm	-> CPC workshop
	-> Highvoltage calibration of Ref1 and Ref3
	-> Measured flows: CPC 1 : 1.040 l/min CPC 3 : 1.029 l/min Ref 1 : 1.018 l/min Ref 3 : 0.9999 l/min
12:37 pm	-> Connect 3010 from TROPOS to check for leaks ->Test TROPOS zero filter at CPC inlet: 0 Counts -> Connect zero filter at SMPS inlet (SMPS pump running): read 6-s count buffer: Between 0 and 4 counts per 6 seconds; 0.04 cm-3
01:11 pm	-> Connect our 3775
01:25 pm	-> Connect to intercomparison line
03:33 pm	-> Change time to local time (from UTC to UTC+2)
04:18 pm	-> Zero check on entire inlet branch
04:47 pm	-> Check all connections for leaks, loosened and retightened some swagelocks; some of the zero scans are influenced by this
04:53 pm	-> again
05:07 pm	-> Change line to PSL 203 nm; Mode is in 202.4 size bin; 2 scans
05:26 pm	-> change to a blue balston filter directly at the SMPS inlet
05:41 pm	-> Replace tubing between CPC and DMA, it had visible holes!
05:42 pm	-> Zero; first scan better, then?
06:00 pm	-> start ambient measurement

06:09 pm -> open line between pump and DMA for a few seconds; throw away this scan

May 13, 2014

10:00 am -> Zero filter in front of the SMPS

02:42 pm -> Flow checks; Gilibrator Italy; SMPS before Kr Source: 0.314; At CPC inlet: 0.310
-> Mass flow meter TSI:
DMA out: 3.10 , 25.6 degC, 995 mbar
DMA in: 3.07, 26.2 deg C. 995 mbar

03:03 pm -> start PSL measurement

03:12 pm -> scans were done with lab air on accident; now PSL is measured

03:50 pm -> start ambient measurement

May 14, 2014

11:05 am -> Exchange CPC with CPC from CIEMAT (they want to test ours)

01:34 pm -> Change back to our CPC

01:35 pm -> Change Kr source; New source: 370 MBq Kr-85

02:40 pm -> Change FUG to positive

02:49 pm -> start measuring with positive FUG (IFT 95120), same model as ours except polarity

04:21 pm -> start ambient measurement

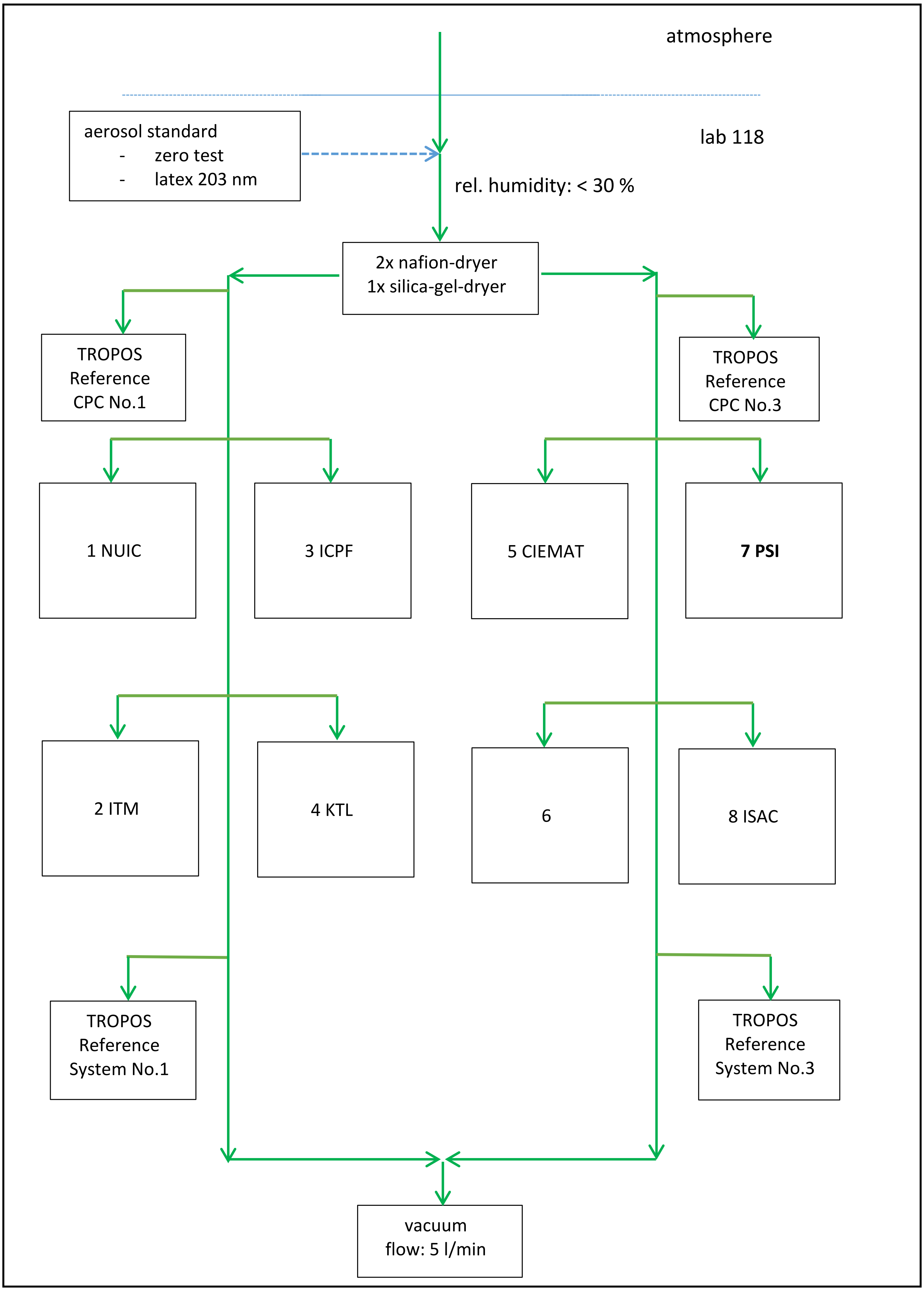
05:24 pm -> change back to Negative FUG

05:32 pm -> start measurement with negative FUG

May 15, 2014

03:15 pm -> End of measurements

Laboratory setup



CPC Efficiency

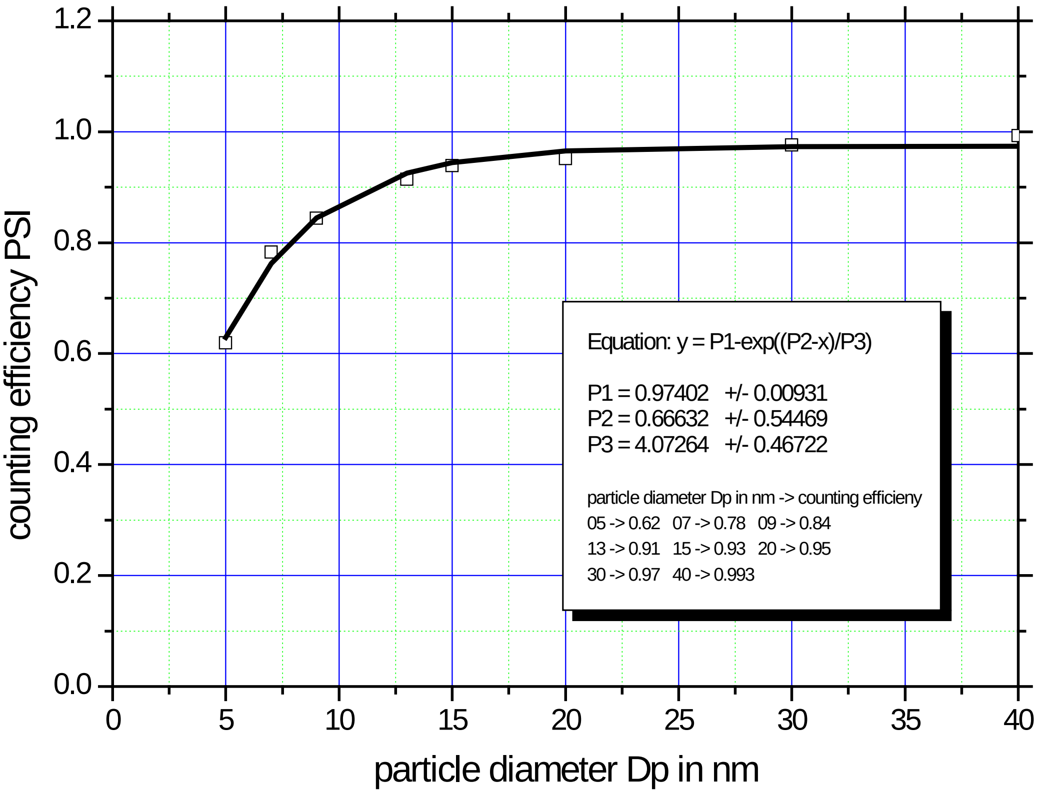


Fig.1. CPC efficiency curve. Based on Electrometer TSI 3068B. Serial number: 70838596

Latex 203 nm

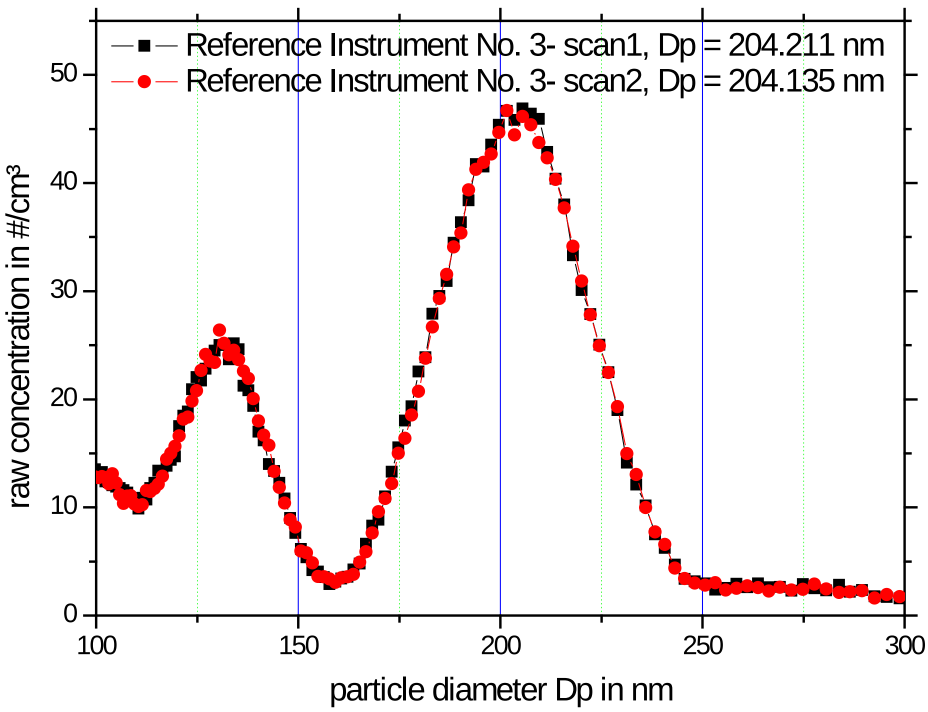


Fig.2. Measurement of latex 203 nm for TROPOS reference instrument No.3: Particle size distribution (raw concentration) for latex 203 nm on May 12, 2014 between 05:10 pm and 05:25 pm.

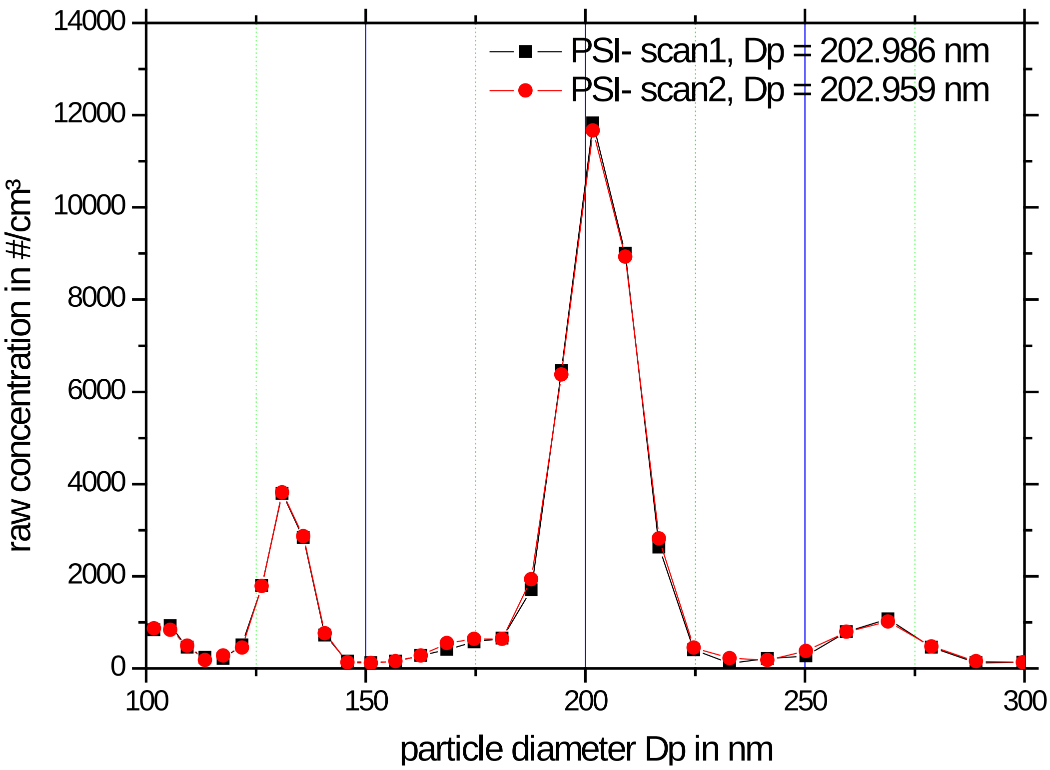


Fig.3. Measurement of latex 203 nm for instrument SMPS PSI: particle size distribution (raw concentration) for latex 203 nm on May 12, 2014 between 05:09 pm and 05:25 pm.

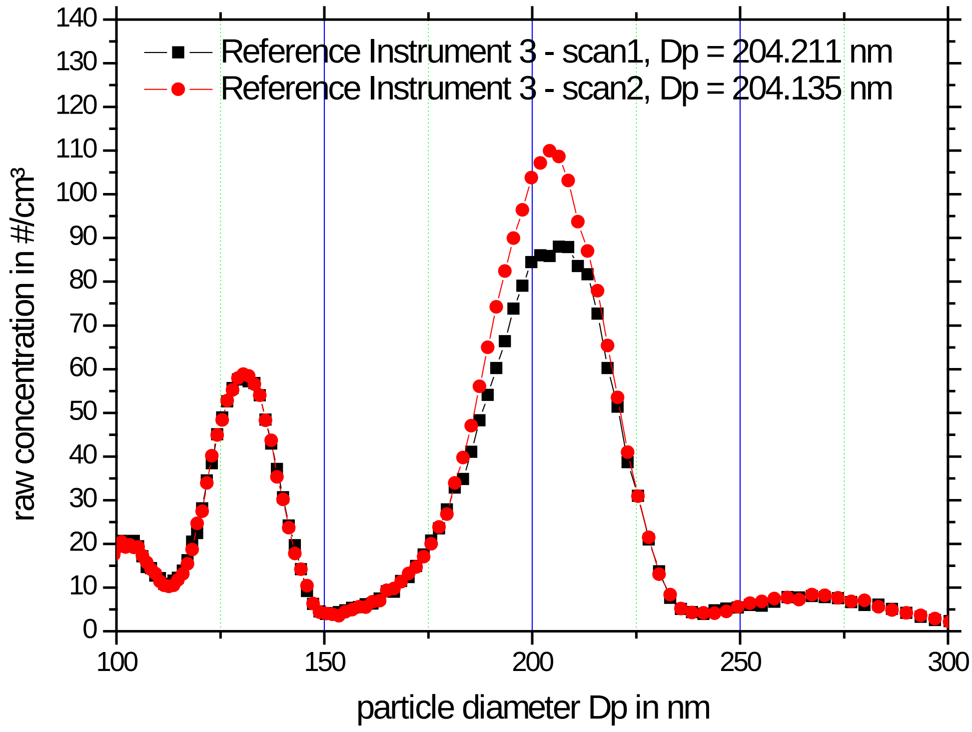


Fig.4. Measurement of latex 203 nm for TROPOS reference instrument No.3: Particle size distribution (raw concentration) for latex 203 nm on May 13, 2014 between 03:15 pm and 03:55 pm.

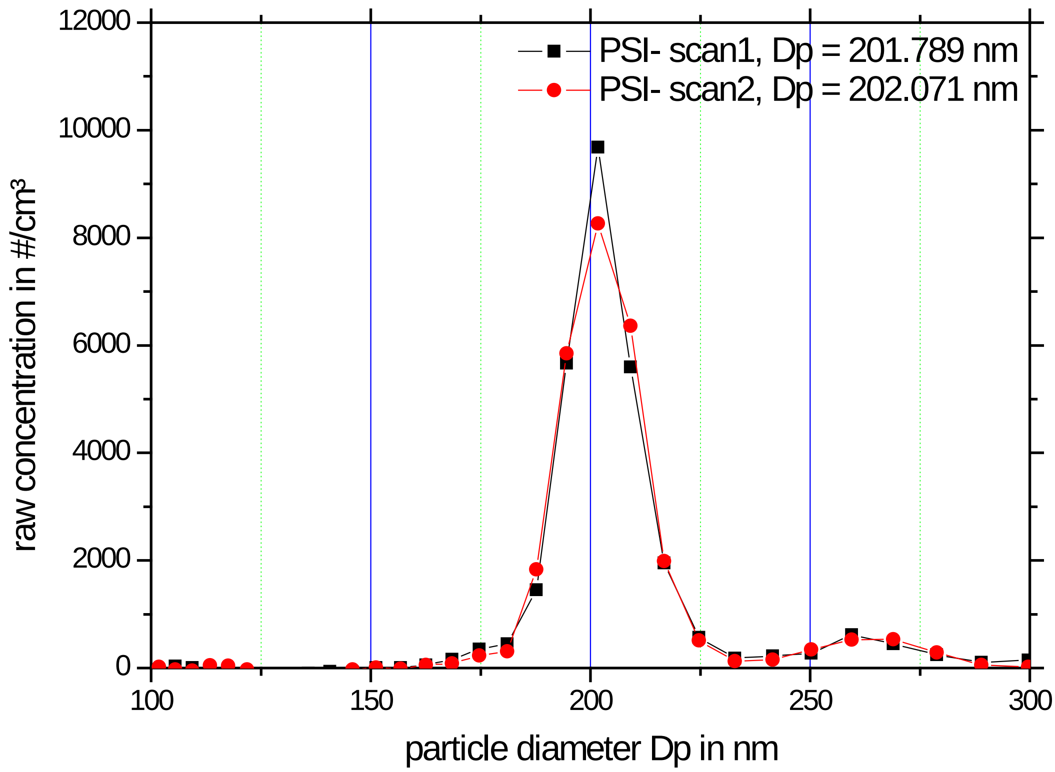


Fig.5. Measurement of latex 203 nm for instrument SMPS PSI: particle size distribution (raw concentration) for latex 203 nm on May 13, 2014 between 03:15 pm and 03:55 pm.

A: first run (May 12, 2014 06:00 pm – May 13, 2014 08:00 am)

1. Correlation of reference instruments

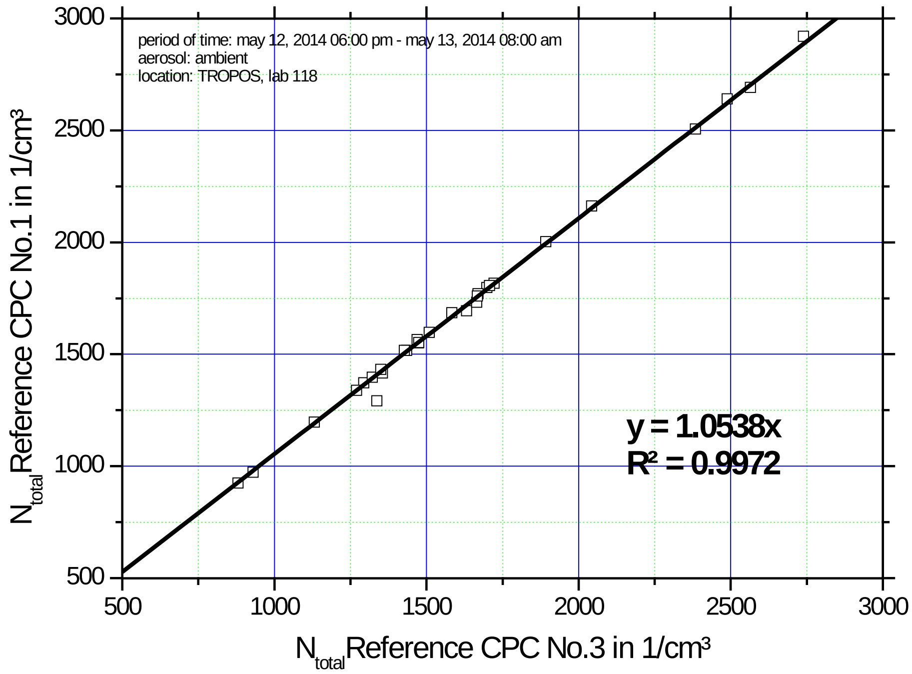


Fig.6. Linear regression between the number concentrations of the TROPOS reference CPC No.1 and the TROPOS reference CPC No.3. Multiple charge correction, internal diffusion losses and flow corrections are included.

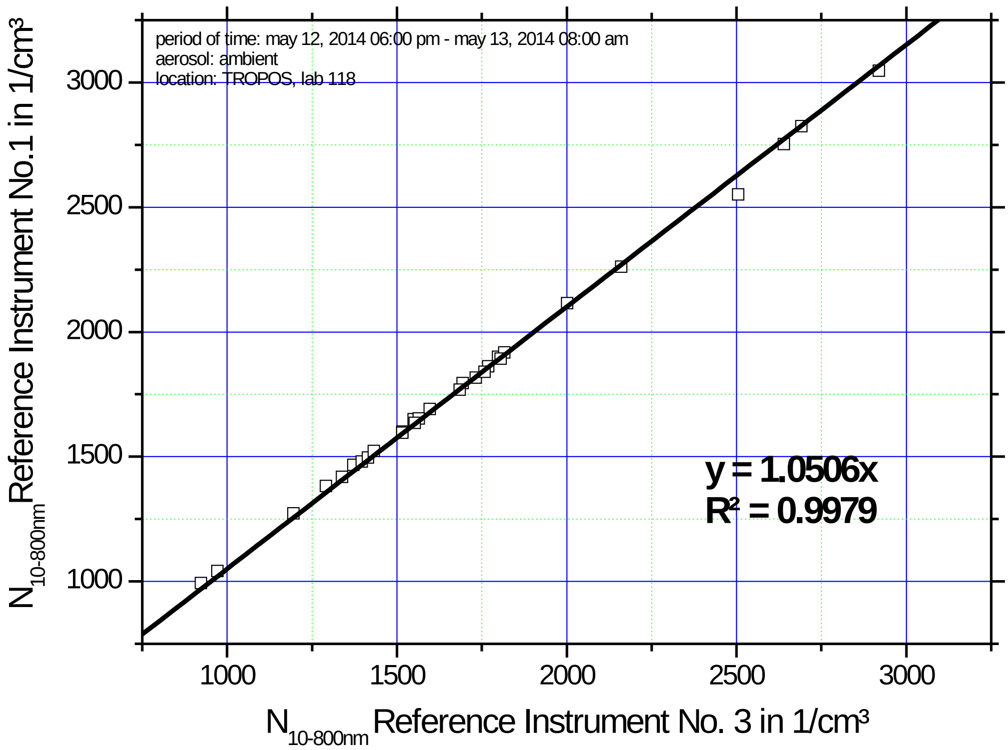


Fig.7. Linear regression between the number concentrations of the TROPOS reference instrument No.1 and the TROPOS reference instrument No.3. Multiple charge correction, internal diffusion losses and flow corrections are included.

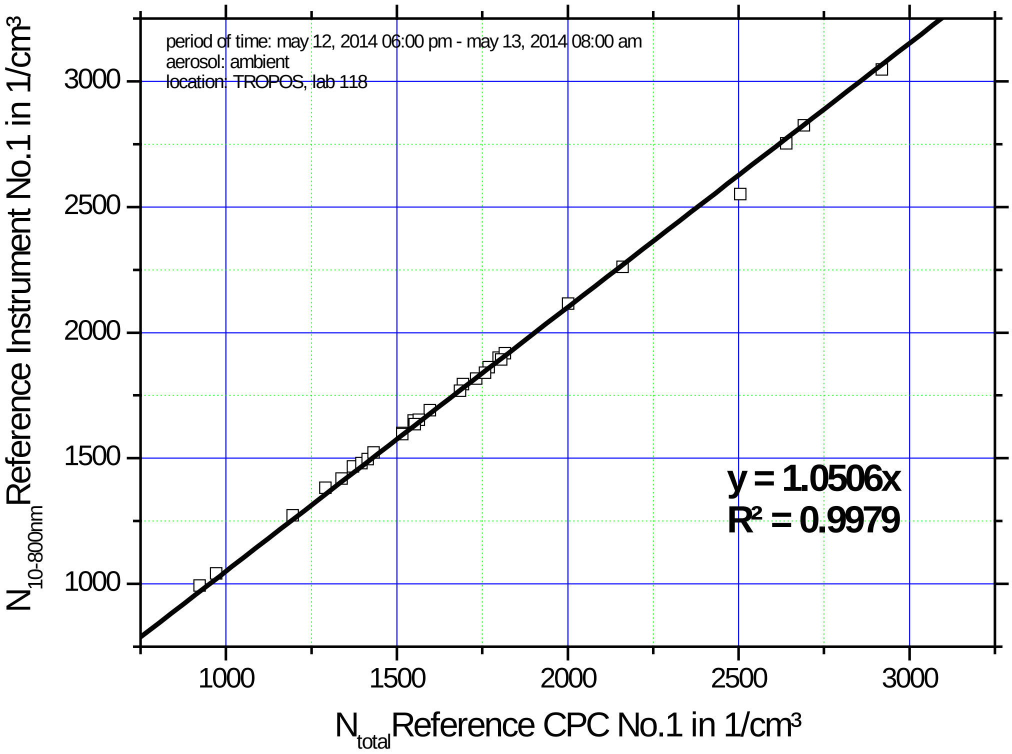


Fig.8. Linear regression between the number concentrations of the TROPOS reference instrument No.1 and TROPOS reference CPC No.1. Multiple charge correction, internal diffusion losses and flow corrections are included.

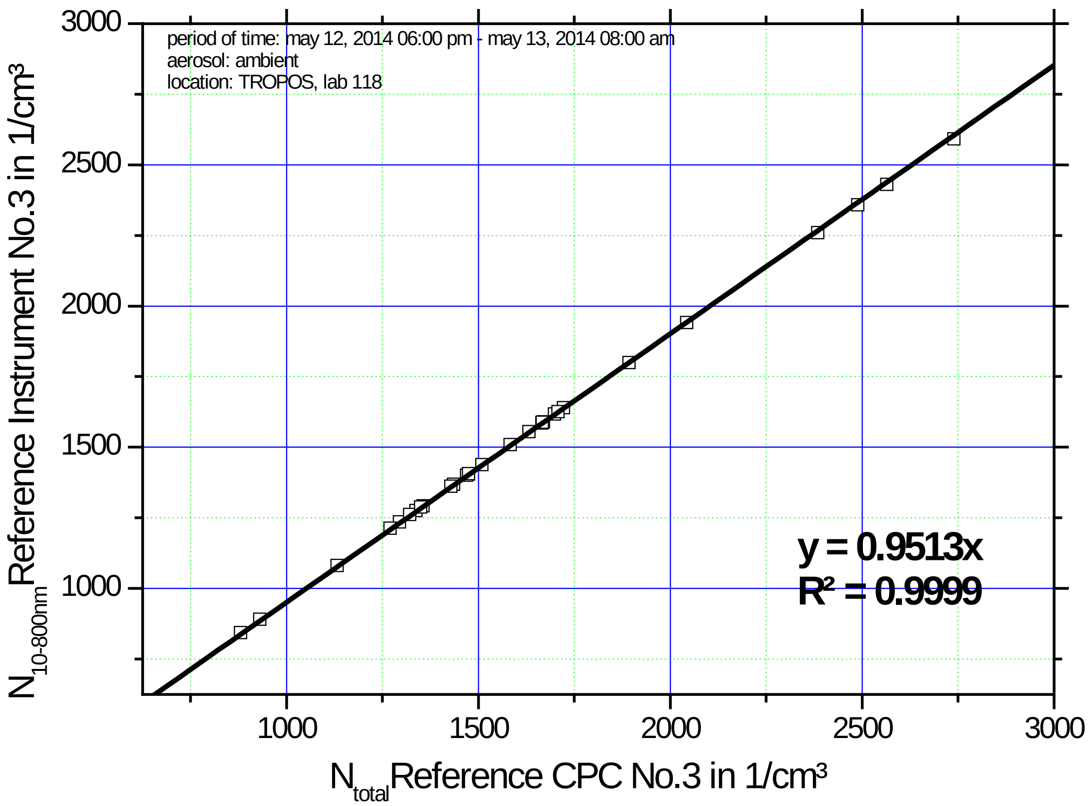


Fig.9. Linear regression between the number concentrations of the TROPOS reference instrument No.3 and TROPOS reference CPC No.3. Multiple charge correction, internal diffusion losses and flow corrections are included.

2. Time series

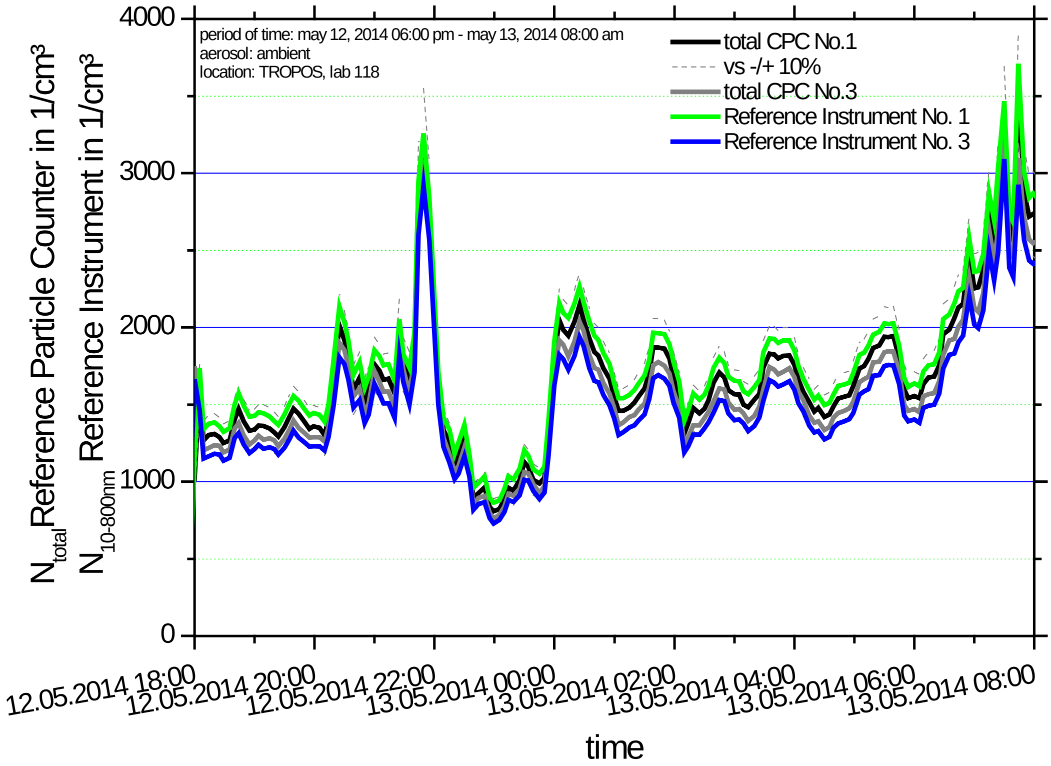


Fig.10. Time series (May 12, 2014 06:00 pm – May 13, 2014 08:00 am) of the integrated particle number concentration (N 10-800nm). Multiple charge correction, internal diffusion losses and flow corrections are included.

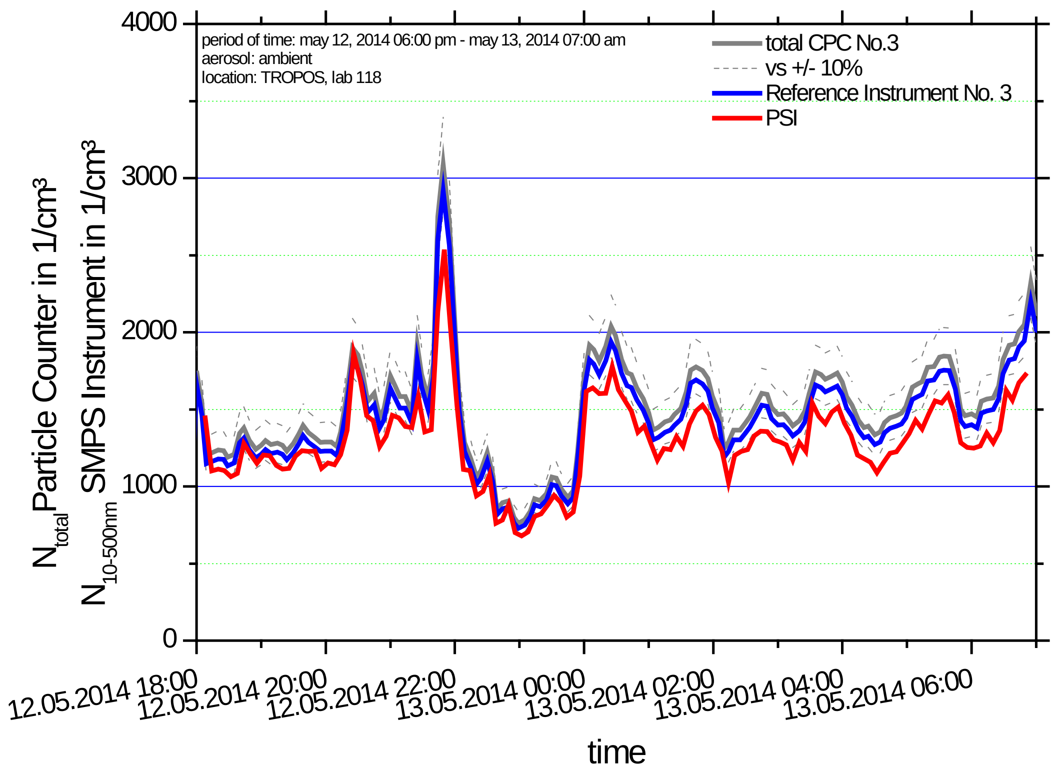


Fig.11. Time series (May 12, 2014 06:00 pm – May 13, 2014 08:00 am) of the integrated particle number concentration (N 10-500 nm) of SMPS PSI and TROPOS reference instrument No.3. Multiple charge correction and internal diffusion losses are included.

3. Correlation of SMPS PSI

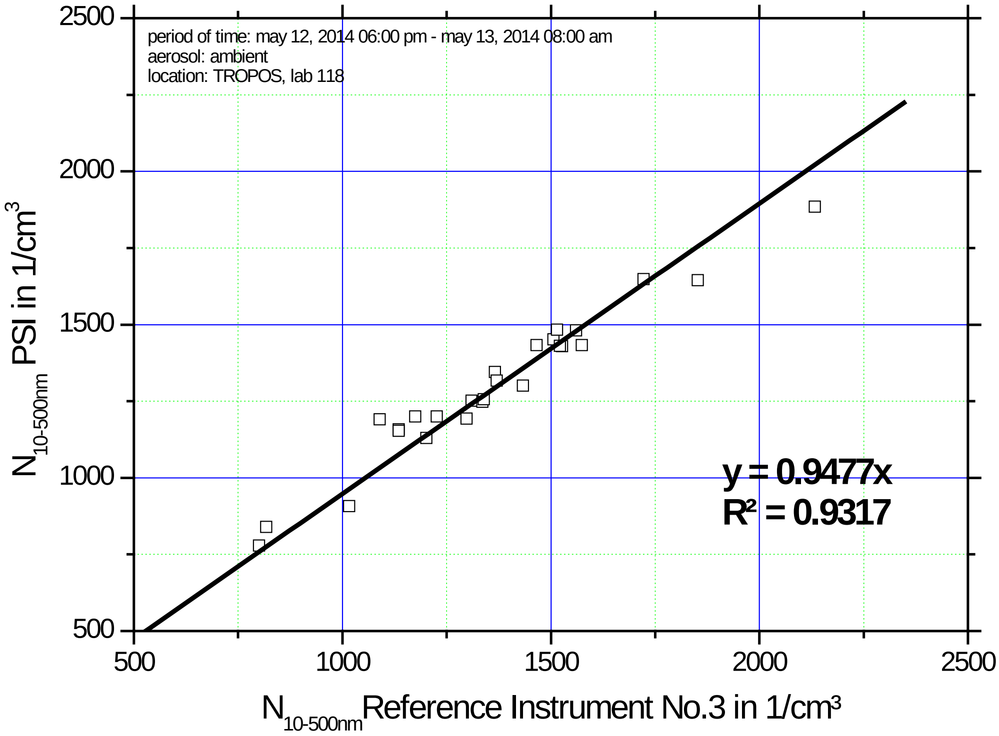


Fig.12. Linear regression between the number concentrations of the TROPOS reference instrument No.3 and SMPS PSI. Multiple charge correction and internal diffusion losses are included.

4. Size distribution

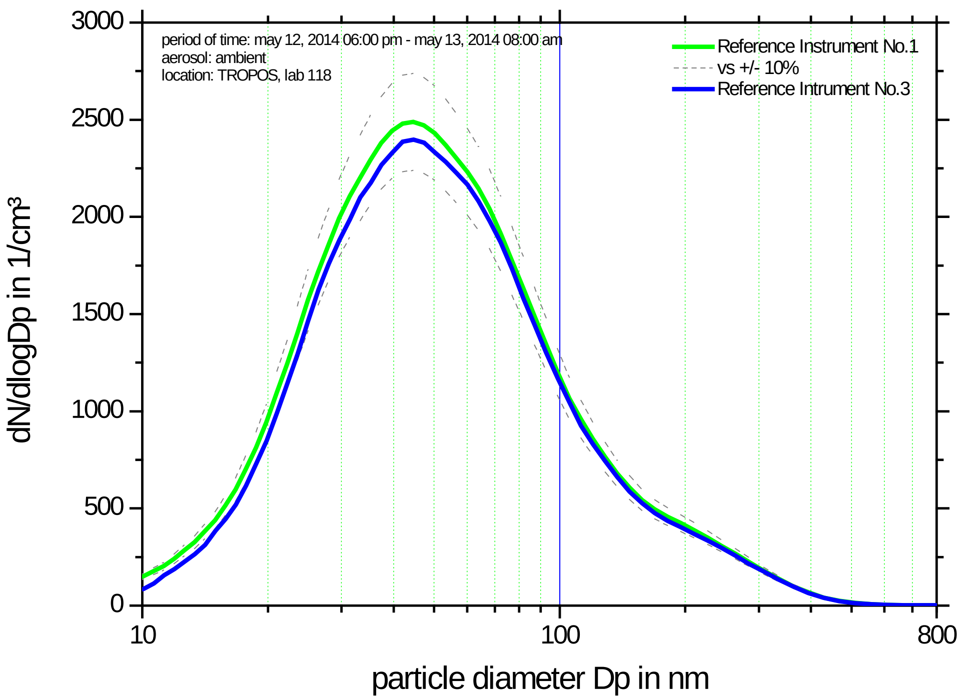


Fig.13. Comparison of mean particle number size distribution of the reference instruments between May 12, 2014 06:00 pm and May 13, 2014 08:00 am. Multiple charge correction, internal diffusion losses and CPC efficiency are included (.in2).

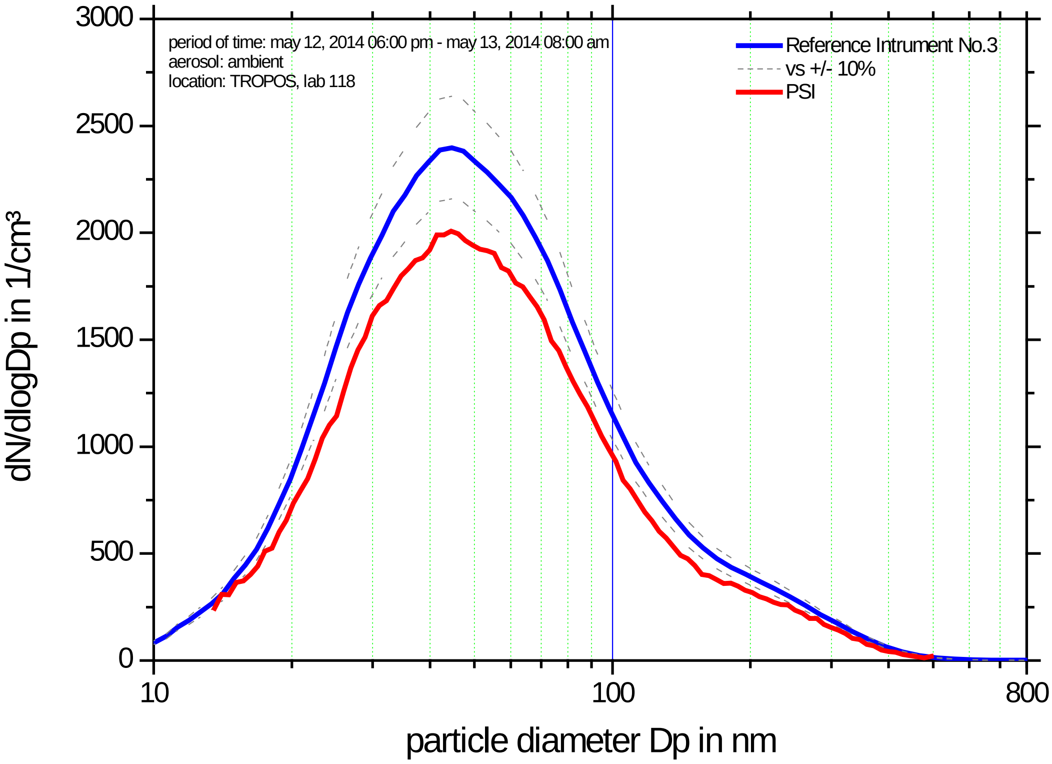


Fig.14. Comparison of mean particle number size distribution of SMPS PSI and TROPOS reference instrument No.3 between May 12, 2014 06:00 pm and May 13, 2014 08:00 am. Multiple charge correction, internal diffusion losses and CPC efficiency are included (.in2).

B: second run (May 13, 2014 05:00 pm – May 14, 2014 07:00 am)

1. Correlation of reference instruments

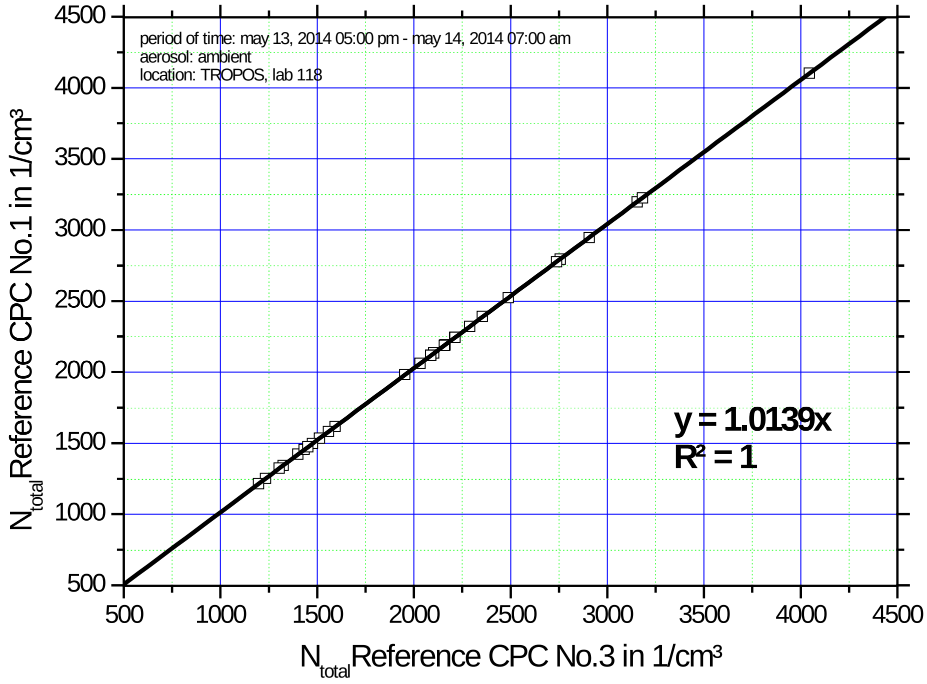


Fig.15. Linear regression between the number concentrations of the TROPOS reference CPC No.1 and the TROPOS reference CPC No.3. Multiple charge correction, internal diffusion losses and flow corrections are included.

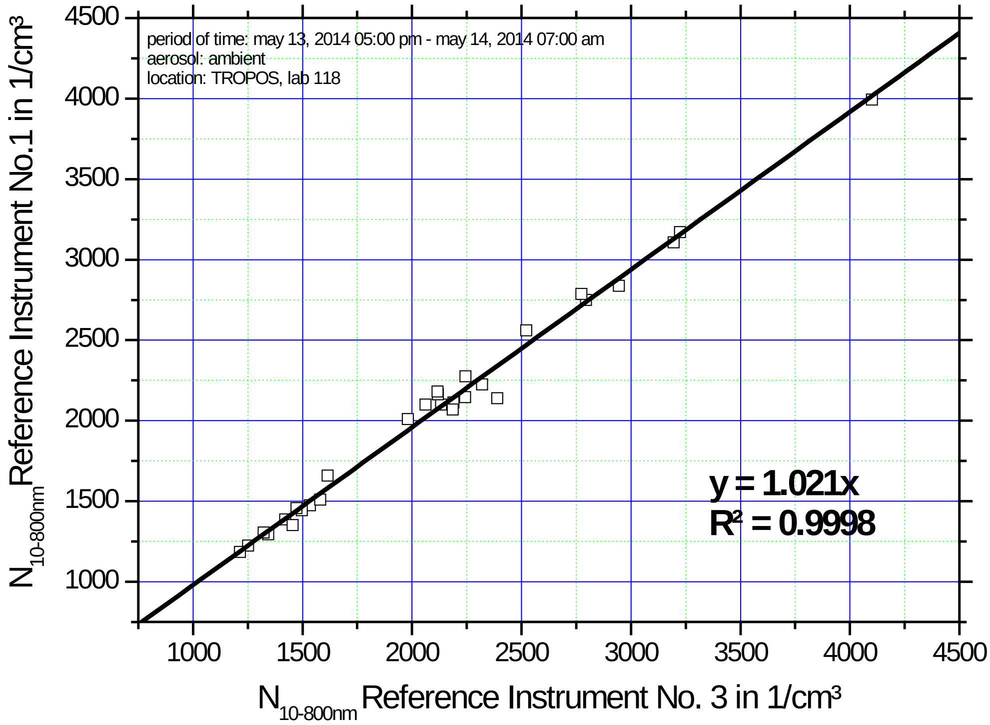


Fig.16. Linear regression between the number concentrations of the TROPOS reference instrument No. 1 and the TROPOS reference instrument No. 3. Multiple charge correction, internal diffusion losses and flow corrections are included.

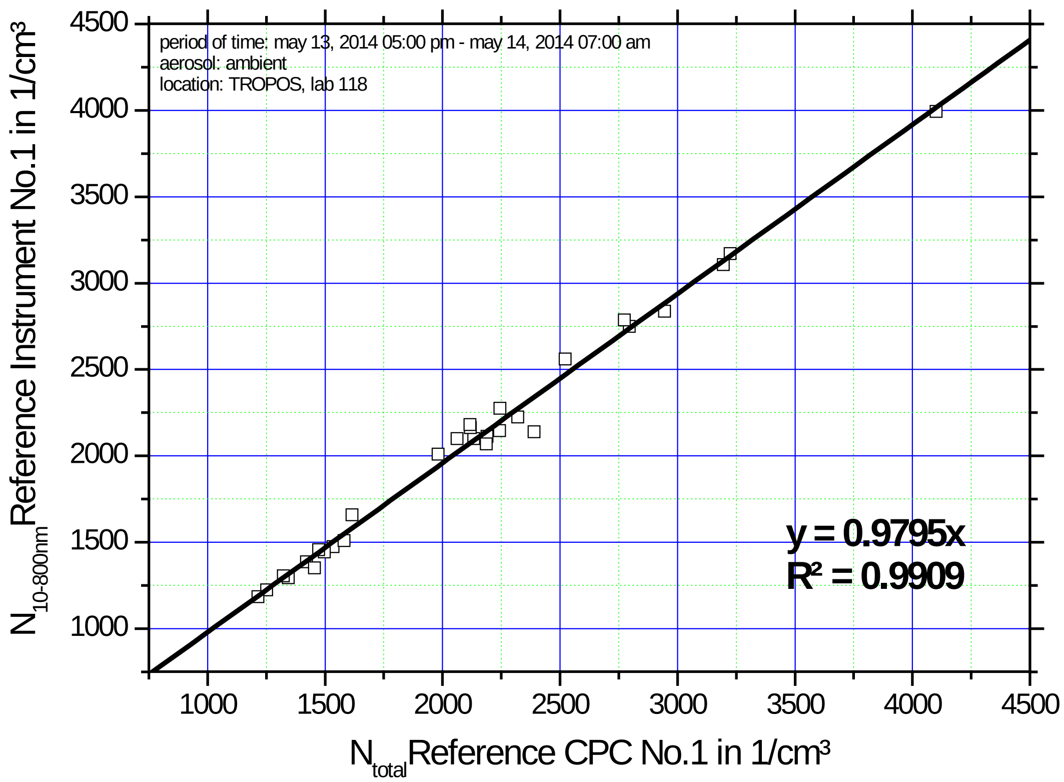


Fig.17. Linear regression between the number concentrations of the TROPOS reference instrument No. 1 and TROPOS reference CPC No.1. Multiple charge correction, internal diffusion losses and flow corrections are included.

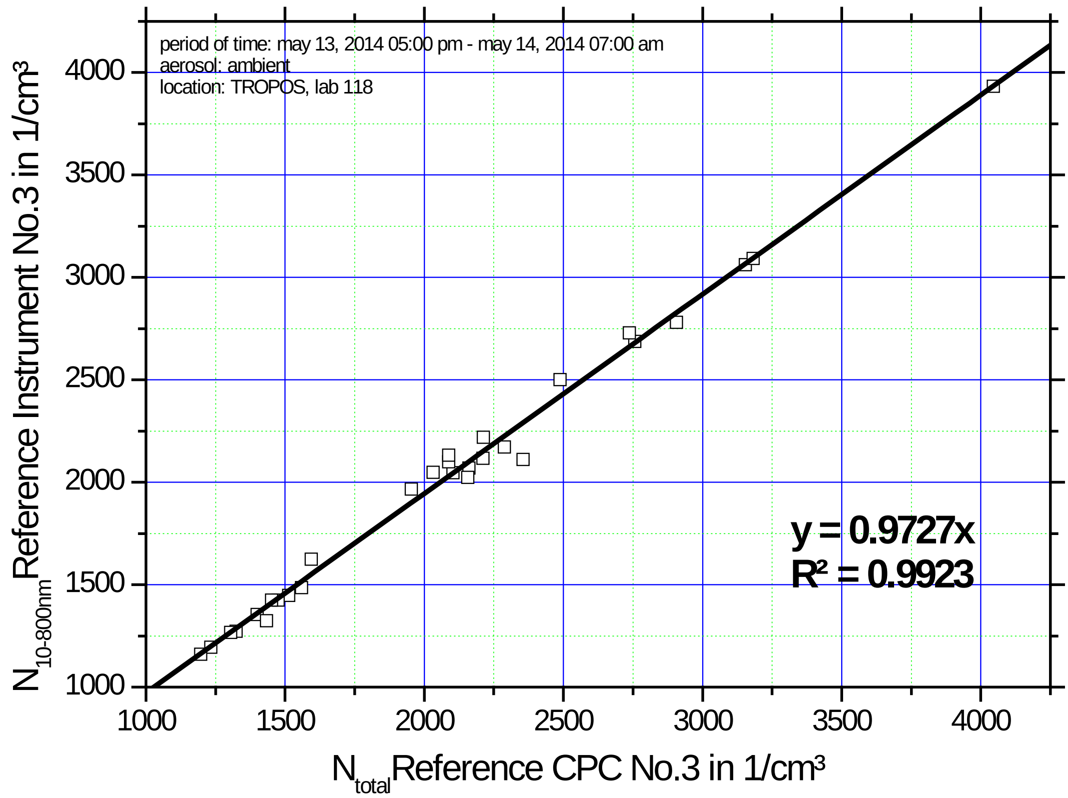


Fig.18. Linear regression between the number concentrations of the TROPOS reference instrument No. 3 and TROPOS reference CPC No.3. Multiple charge correction, internal diffusion losses and flow corrections are included.

2. Time series

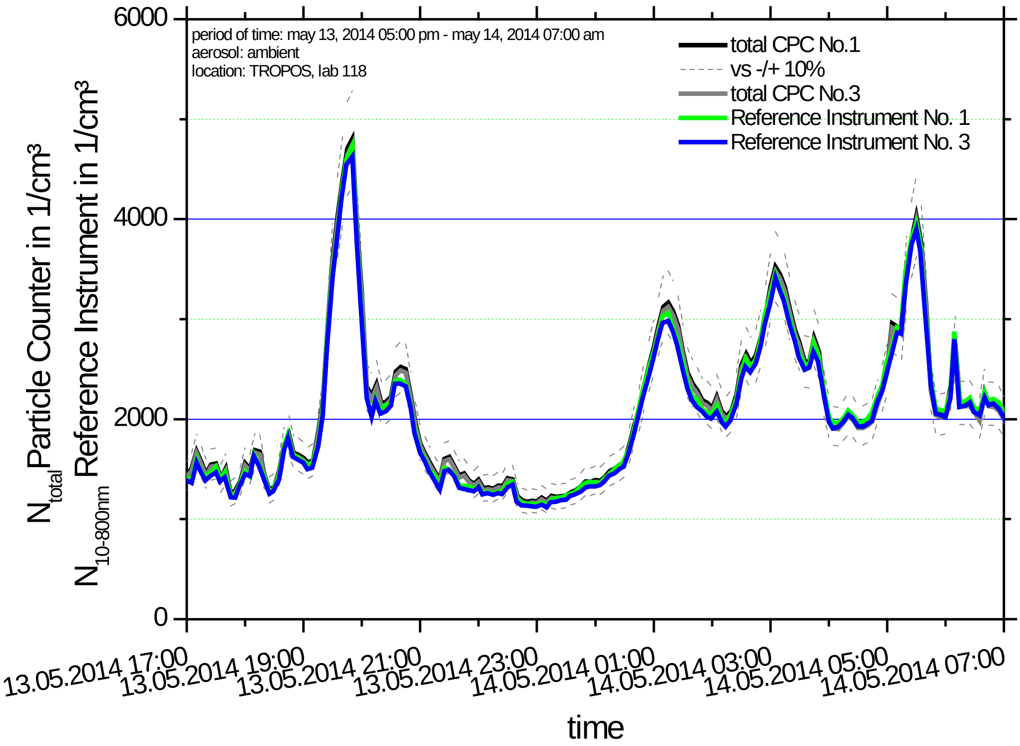


Fig.19. Time series (May 13, 2014 05:00 pm – May 14, 2014 07:00 am) of the integrated particle number concentration (N 10-800nm). Multiple charge correction, internal diffusion losses and flow correction are included.

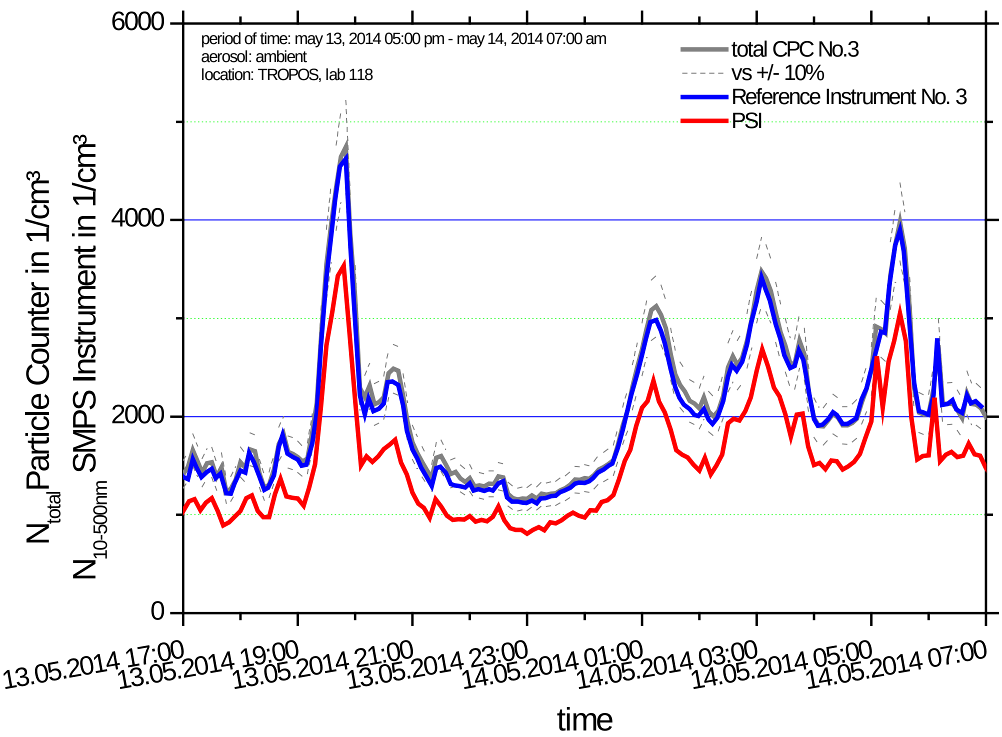


Fig.20. Time series (May 13, 2014 05:00 pm – May 14, 2014 07:00 am) of the integrated particle number concentration (N 10-500nm) of SMPS PSI and TROPOS reference instrument No.3. Multiple charge correction and internal diffusion losses are included.

3. Correlation of SMPS PSI

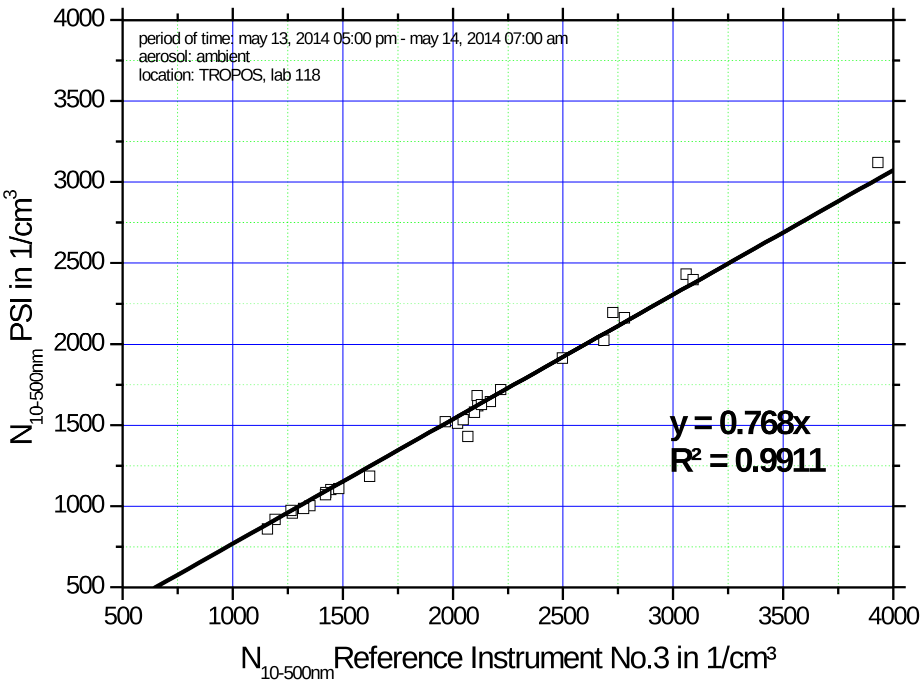


Fig.21. Linear regression between the number concentrations of the TROPOS reference instrument No. 3 and SMPS PSI. Multiple charge correction and internal diffusion losses are included.

4. Size distribution

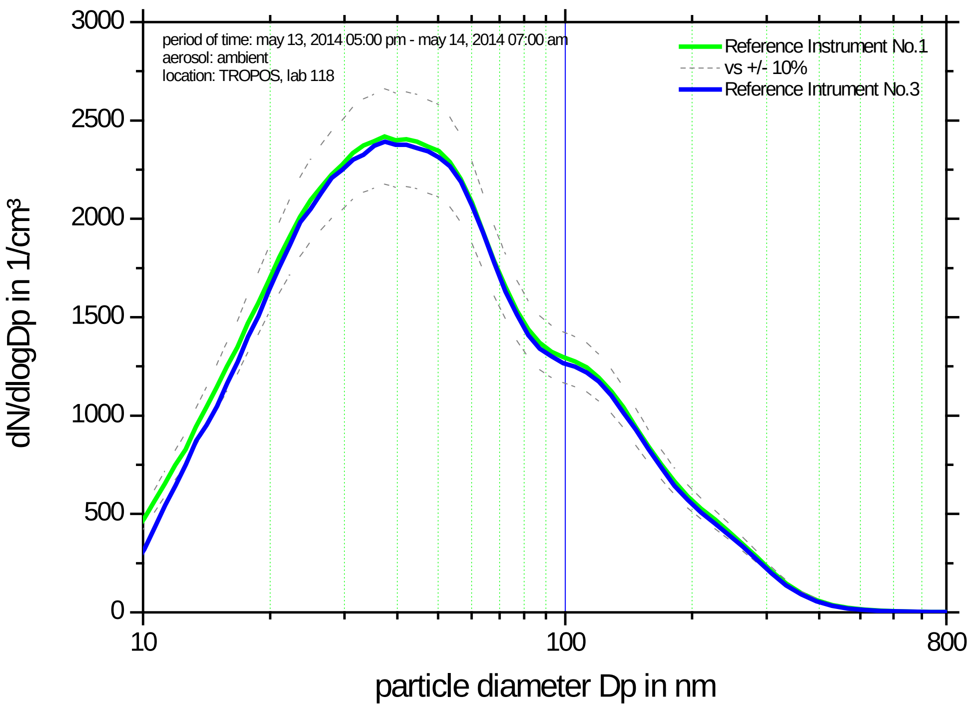


Fig.22. Comparison of mean particle number size distribution between May 13, 2014 05:00 pm and May 14, 2014 07:00 am. Multiple charge correction, internal diffusion losses and CPC efficiency are included (.in2).

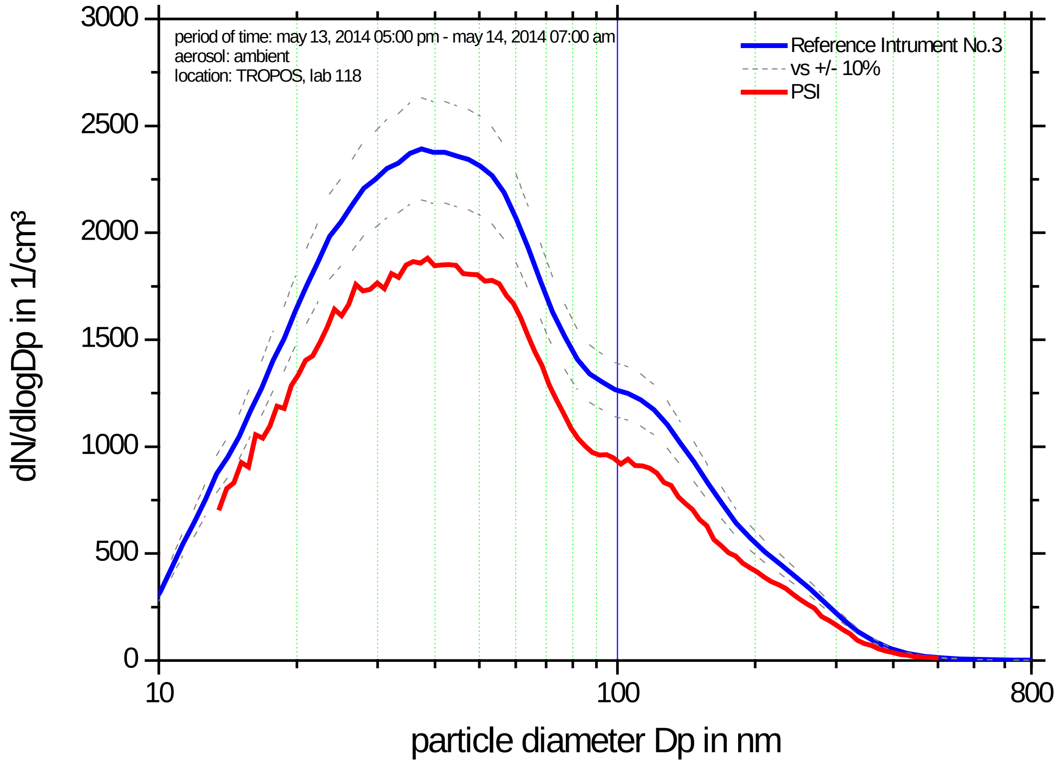


Fig.23. Comparison of mean particle number size distribution of SMPS PSI and TROPOS reference instrument No.3 between May 13, 2014 05:00 pm and May 14, 2014 07:00 am. Multiple charge correction, internal diffusion losses and CPC efficiency are included (.in2).

C: third run (May 14, 2014 07:00 pm – May 15, 2014 07:00 am)

1. Correlation of reference instruments

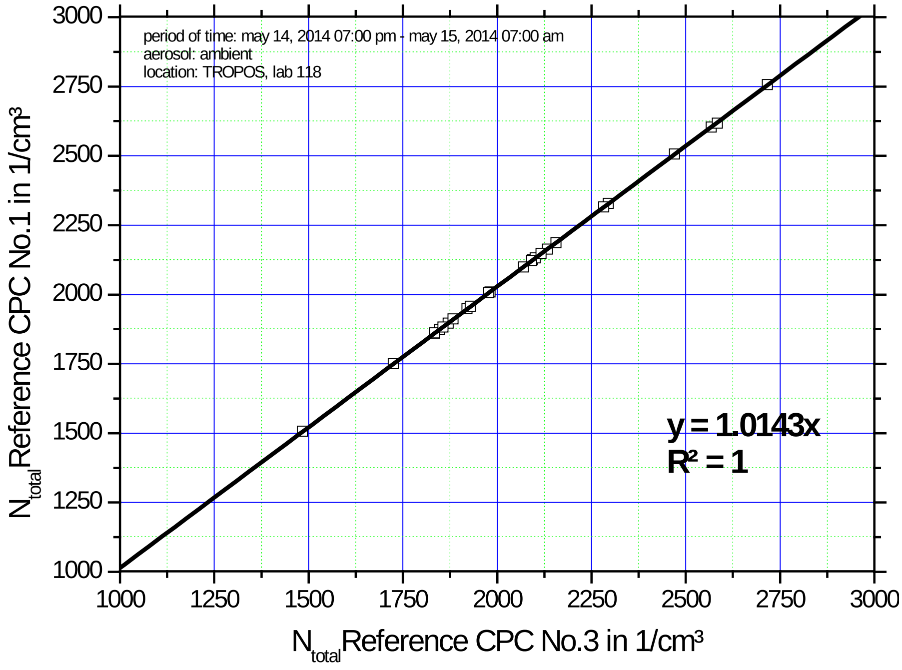


Fig.24. Linear regression between the number concentrations of the TROPOS reference CPC No.1 and the TROPOS reference CPC No.3. Multiple charge correction, internal diffusion losses and flow corrections are included.

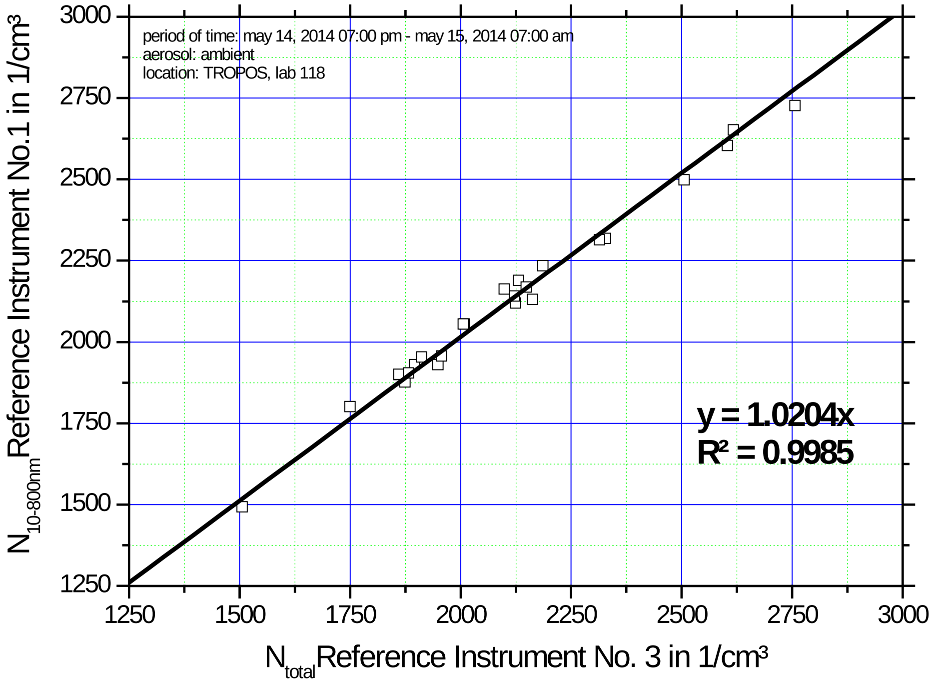


Fig.25. Linear regression between the number concentrations of the TROPOS reference instrument No. 1 and the TROPOS reference instrument No. 3. Multiple charge correction, internal diffusion losses and flow corrections are included.

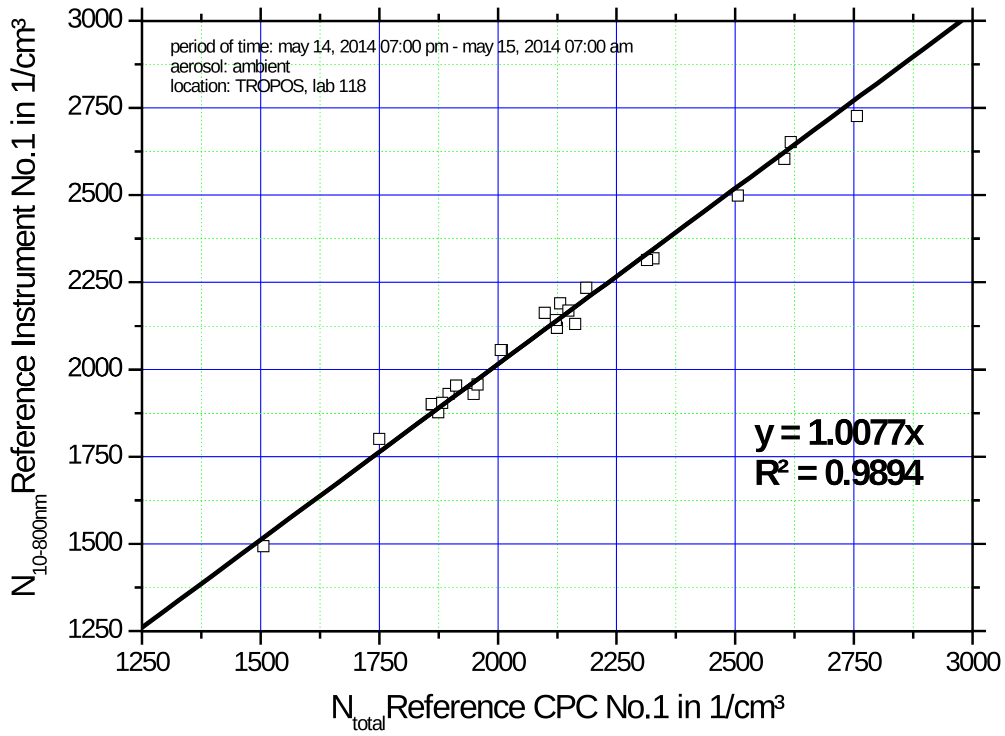


Fig.26. Linear regression between the number concentrations of the TROPOS reference instrument No. 1 and TROPOS reference CPC No.1. Multiple charge correction, internal diffusion losses and flow corrections are included.

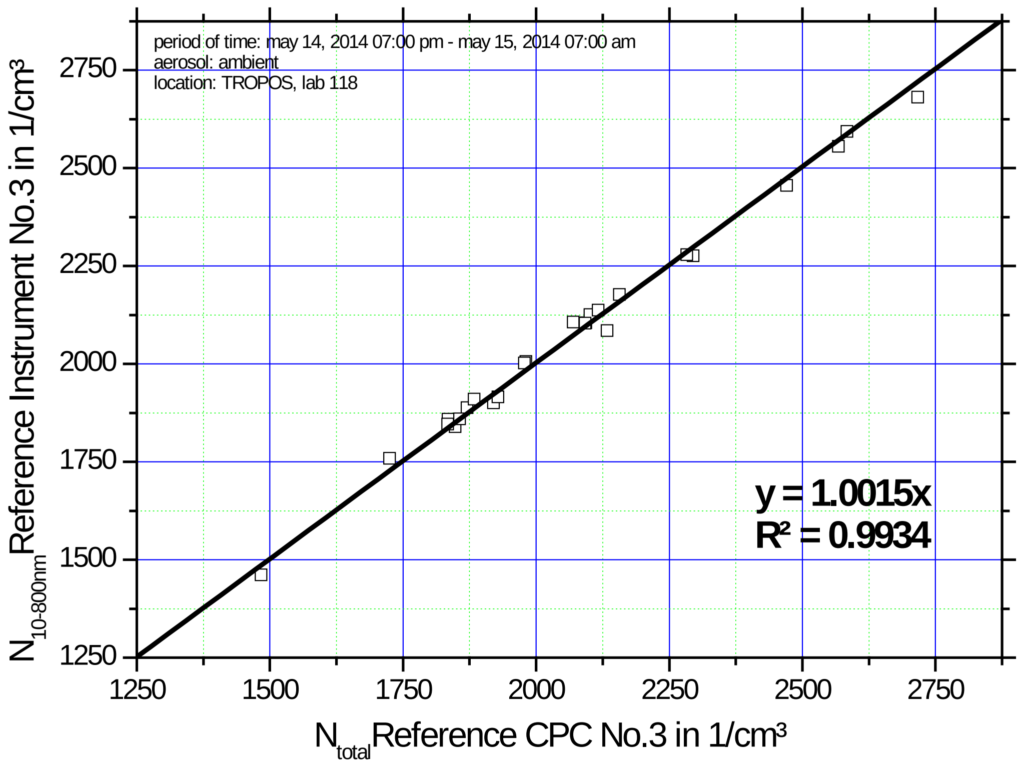


Fig.27. Linear regression between the number concentrations of the TROPOS reference instrument No. 3 and TROPOS reference CPC No.3. Multiple charge correction, internal diffusion losses and flow corrections are included.

2. Time series

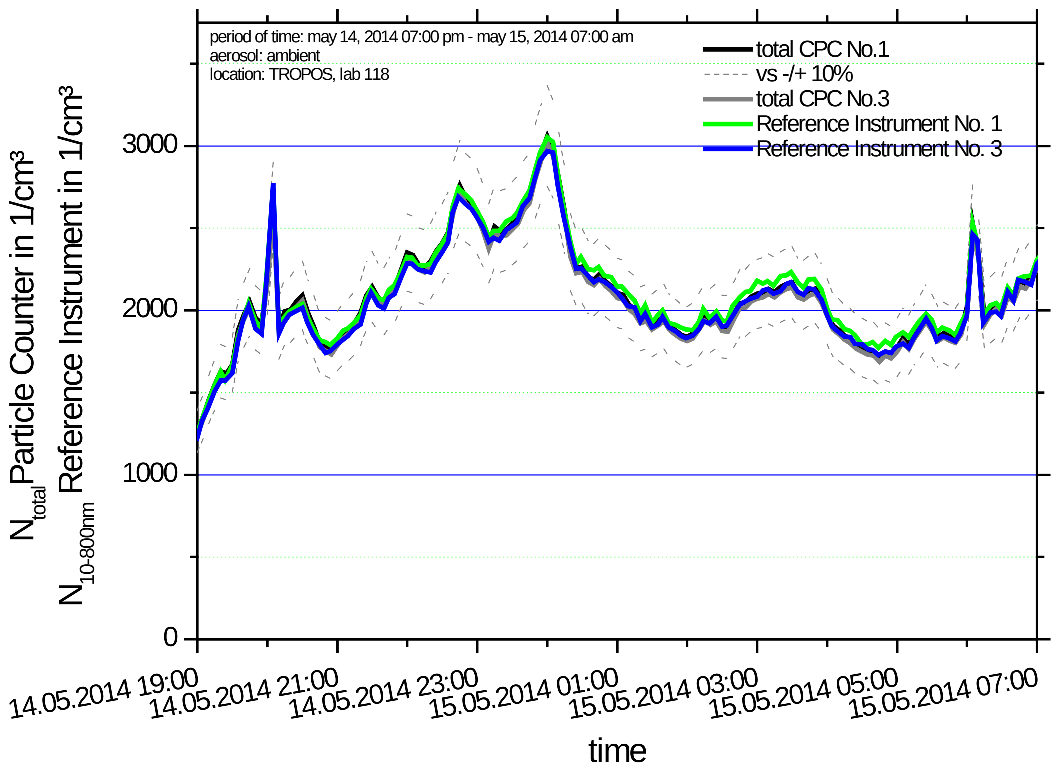


Fig.28. Time series (May 14, 2014 07:00 pm – May 15, 2014 07:00 am) of the integrated particle number concentration (N 10-800nm). Multiple charge correction, internal diffusion losses and flow correction are included.

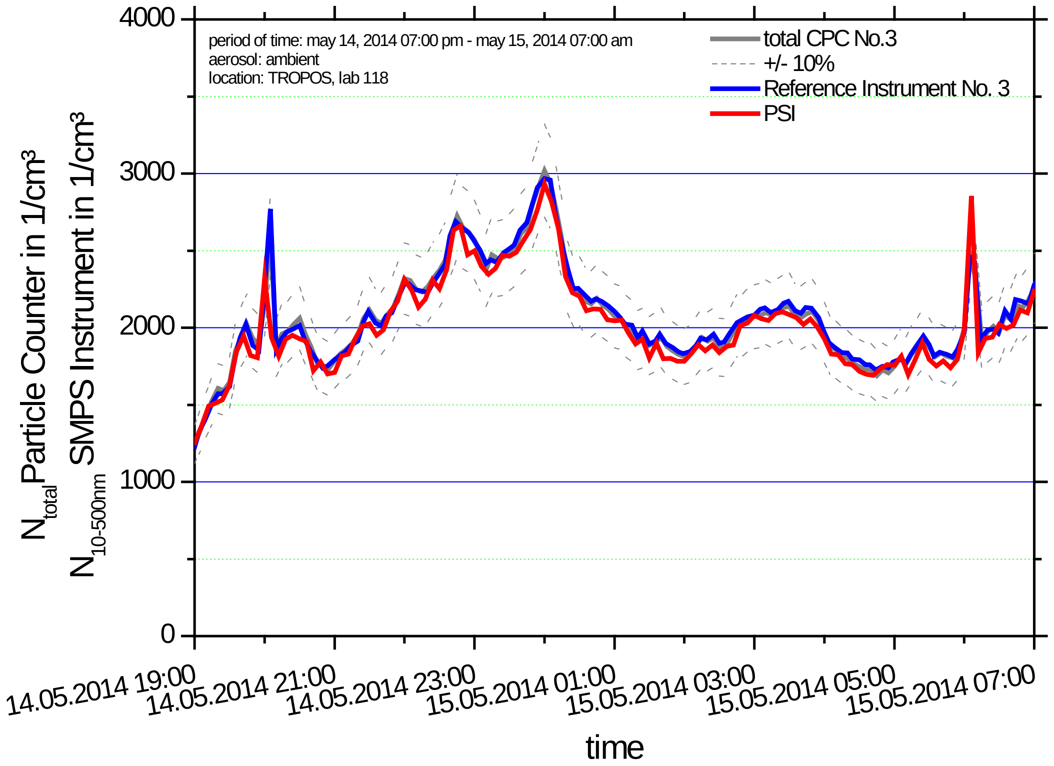


Fig.29. Time series (May 14, 2014 07:00 pm – May 15, 2014 07:00 am) of the integrated particle number concentration (N 10-500nm) of SMPS PSI and TROPOS reference instrument No.3. Multiple charge correction and internal diffusion losses are included.

3. Correlation of SMPS PSI

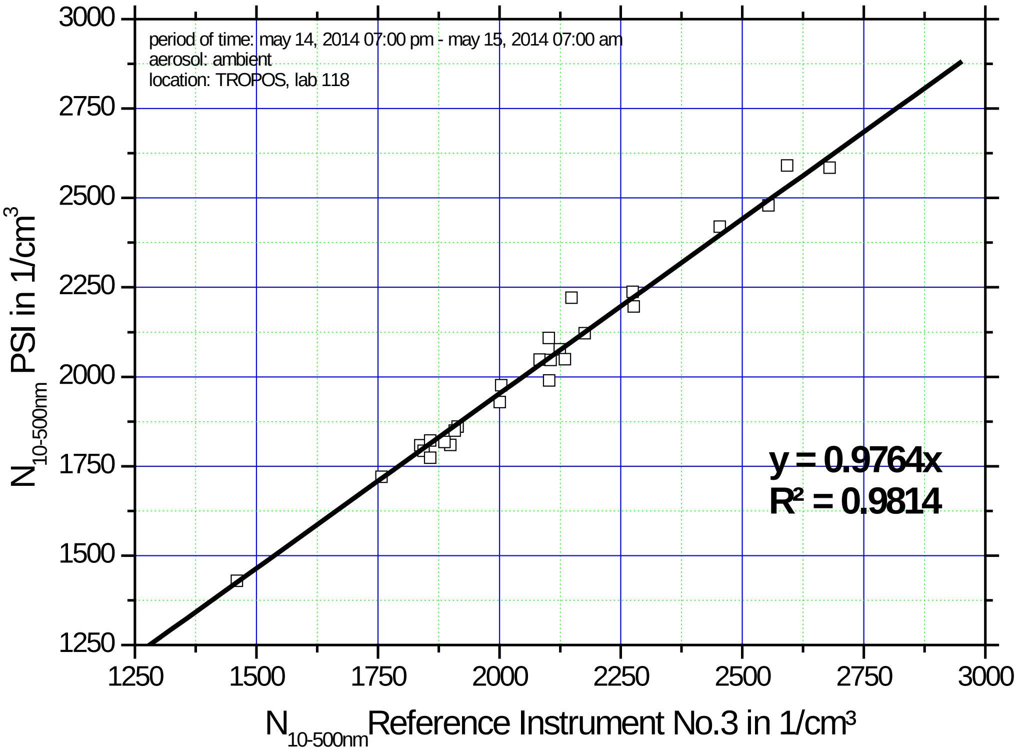


Fig.30. Linear regression between the number concentrations of the TROPOS reference instrument No.3 and SMPS PSI. Multiple charge correction and internal diffusion losses are included.

4. Size distribution

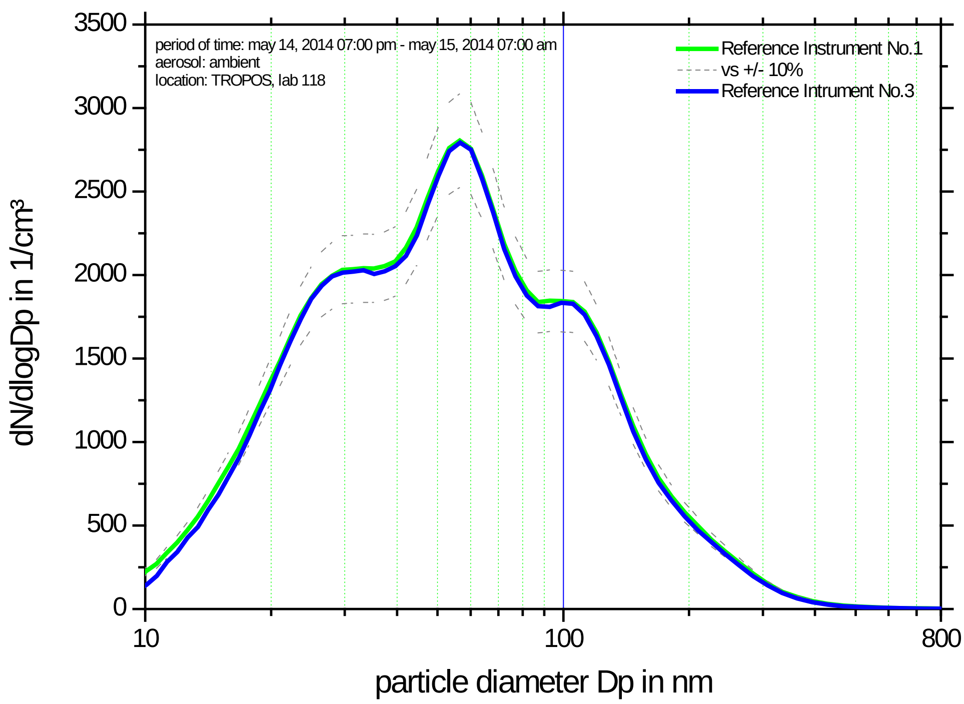


Fig.31. Comparison of mean particle number size distribution between May 14, 2014 07:00 pm and May 15, 2014 07:00 am. Multiple charge correction, internal diffusion losses and CPC efficiency are included (.in2).

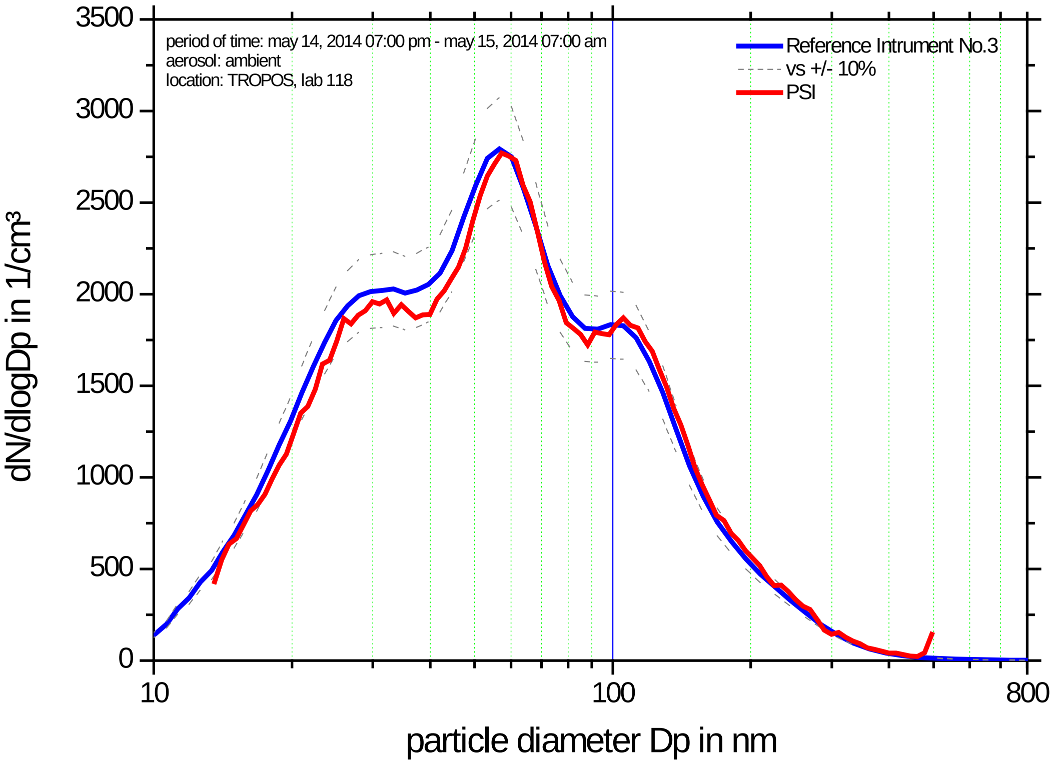


Fig.32. Comparison of mean particle number size distribution of SMPS PSI and TROPOS reference instrument No.3 between May 14, 2014 07:00 pm and May 15, 2014 07:00 am. Multiple charge correction, internal diffusion losses and CPC efficiency are included (.in2).

Intercomparison of TSI-SMPS Zugspitze

Basic information

Location of the quality assurance:	TROPOS, lab: 118
Delivery date:	June 13, 2014
Setup in the laboratory:	June 30, 2014
Comparison period:	July 03, 2014 – July 07, 2014
Instrument:	TSI-SMPS Zugspitze
TROPOS Reference Instrument:	TROPOS Reference Instrument No. 3
Total CPC:	TROPOS Reference CPC 3772; SN: 3772111903
Additional equipment:	aerosol nebulizer for latex calibration
Involved people:	Thomas Tuch, Kay Weinhold

Summary:

From June 30, 2014 to July 07, 2014, the instrument TSI SMPS Zugspitze participated the TROPOS ACTRIS Workshop. The system was rebuilt to the newest ACTRIS standard in hardware and software. The TSI Instrument is controlled by LabView-Software from TROPOS.

For the PSL-calibrations, we used Latex particle with a nominal size of 203 nm +/- 4 nm. The latex particles have been generated with an aerosol nebulizer. The sheath air flow rate of the candidate system was calibrated to match the latex particle size, if possible. The TSI SMPS Zugspitze showed in the PSL-measurements a particle diameter of 201.88 nm. Both the zero check and the high-voltage calibration passed the requirements in the final run. If we look at the final ambient measurement run, the TSI SMPS Zugspitze is in the 10%. The TSI SMPS Zugspitze passed the ACTRIS Workshop.

Log book:

June 16, 2014 – June 30, 2014

- mechanical group - > update from TSI-SMPS
- electronic group – update from TSI-SMPS
- check Kr.85

July 01, 2014

11:08 am -> Setup in laboratory 118; Neutralizer: Kr-85 from TROPOS
01:00 pm -> Problems with the positive HV -> contact TSI Company

July 03, 2014

09:00 am -> HV check, zero check
10:00 am -> configuration TSI-SMPS

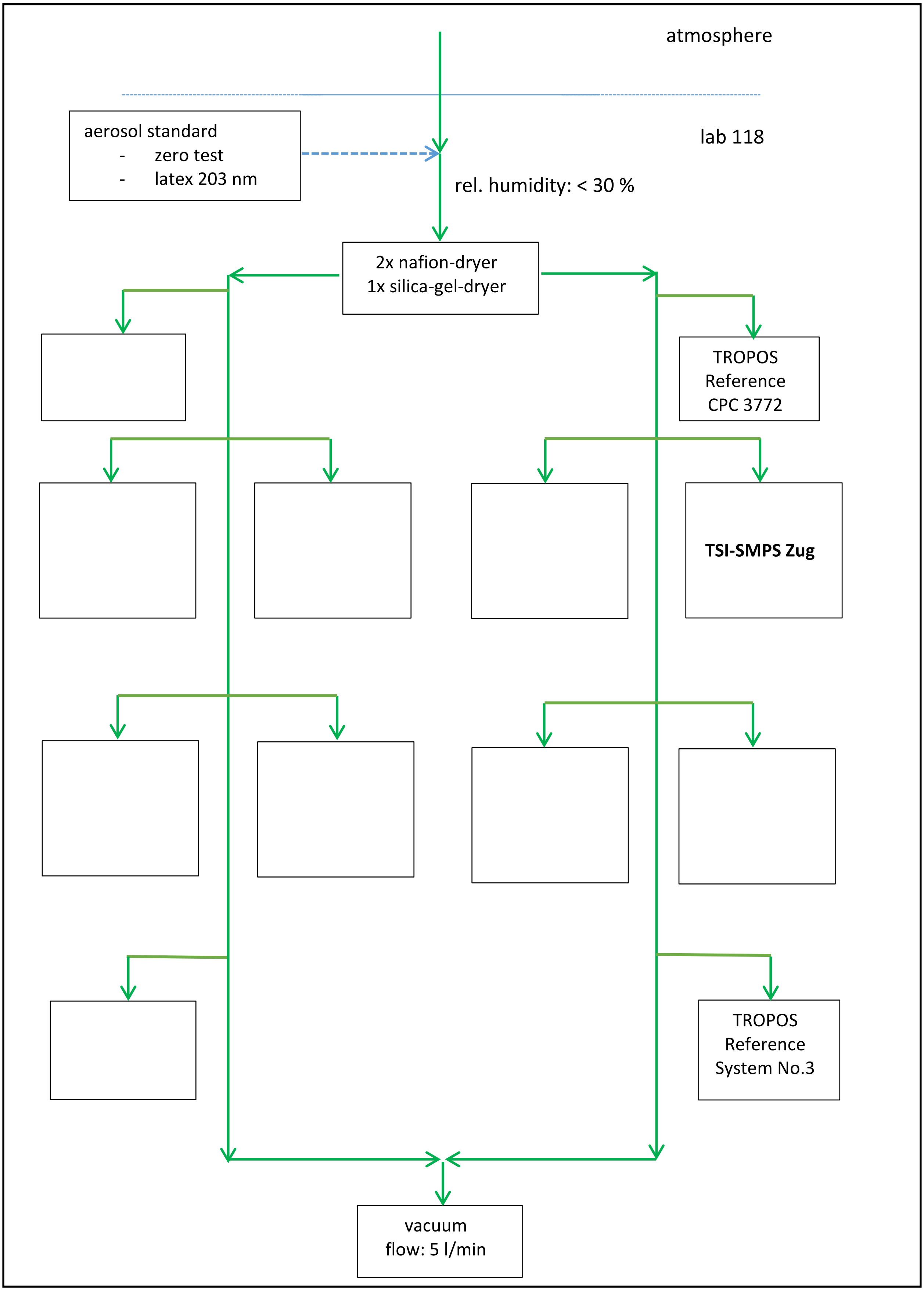
July 04, 2014

July 04, 06:00 pm – July 07, 06:00 am -> intercomparison over 3 days

July 07, 2014

09:00 am -> finish workshop

Laboratory setup



1. Latex 203 nm

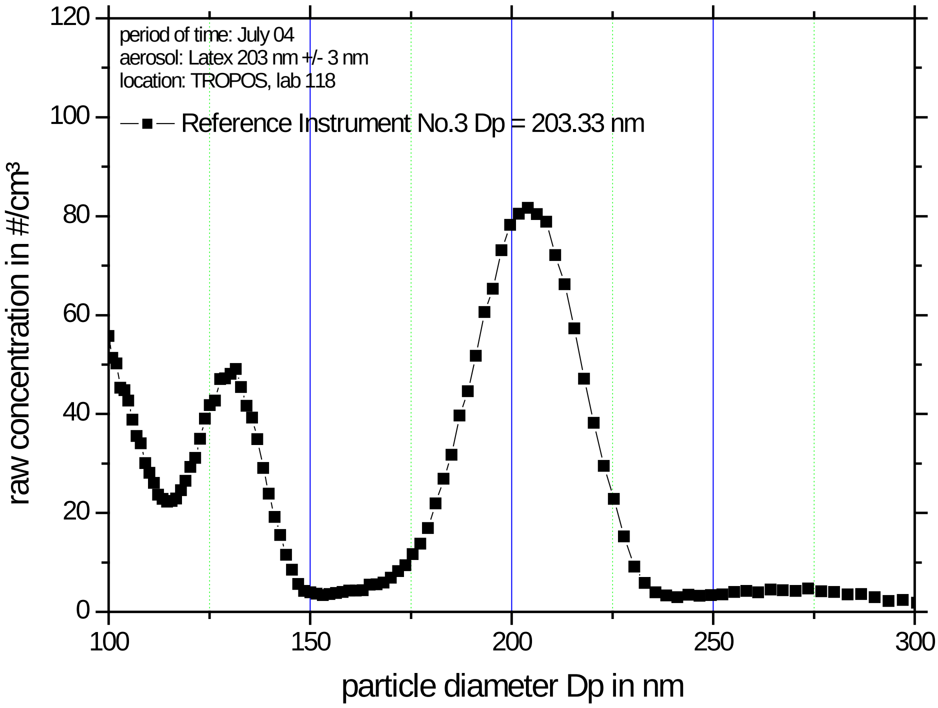


Fig.1. Measurement of latex 203 nm for TROPOS reference instrument No.3: Particle size distribution (raw concentration) for latex 203 nm nm on July 04.

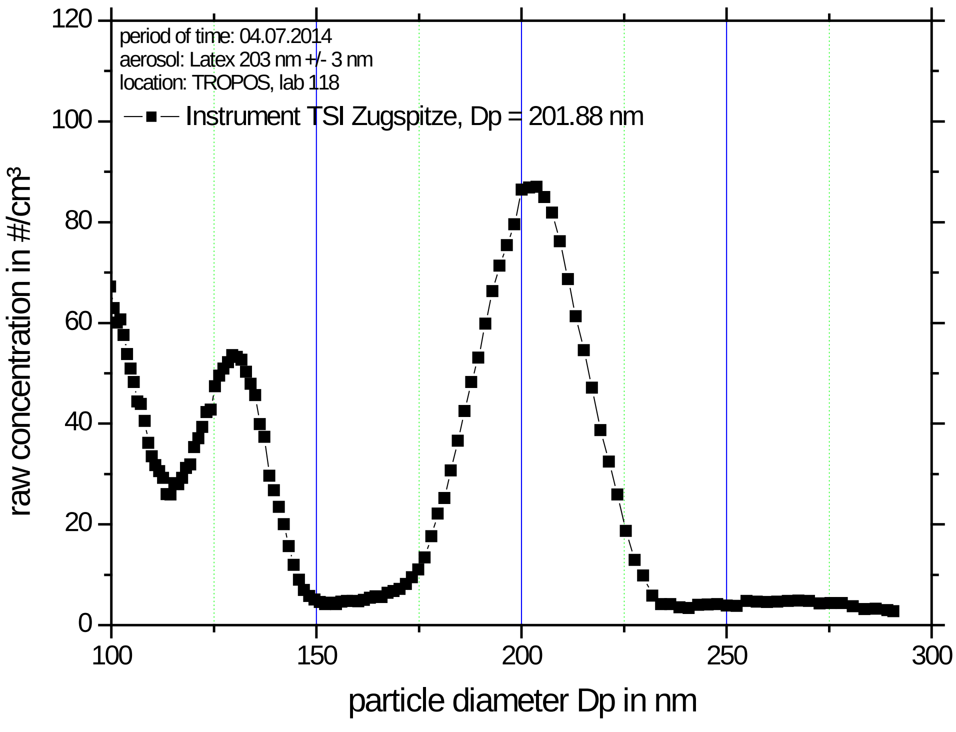


Fig.2. Measurement of latex 203 nm for instrument TSI Zugspitze: particle size distribution (raw concentration) for latex 203 nm on July 04.

2. Time series

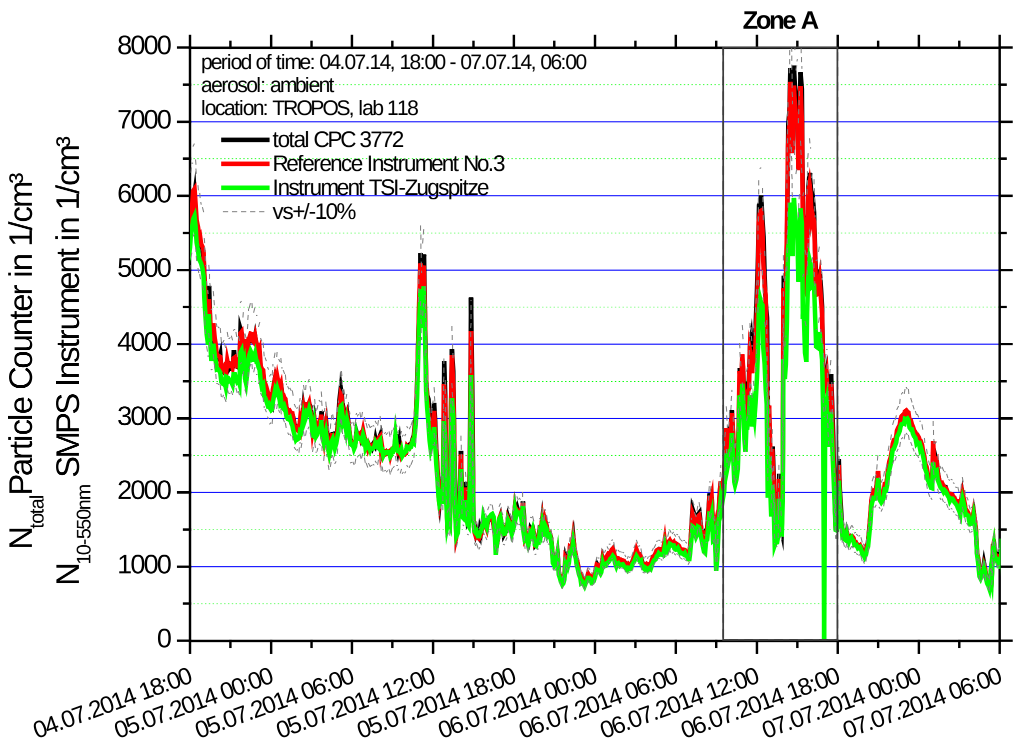


Fig.3. Time series (July 04, 2014 06:00 pm – July 07, 2014 06:00 am) of the integrated particle number concentration (N 10-550nm). Multiple charge correction, internal diffusion losses and flow corrections are included.

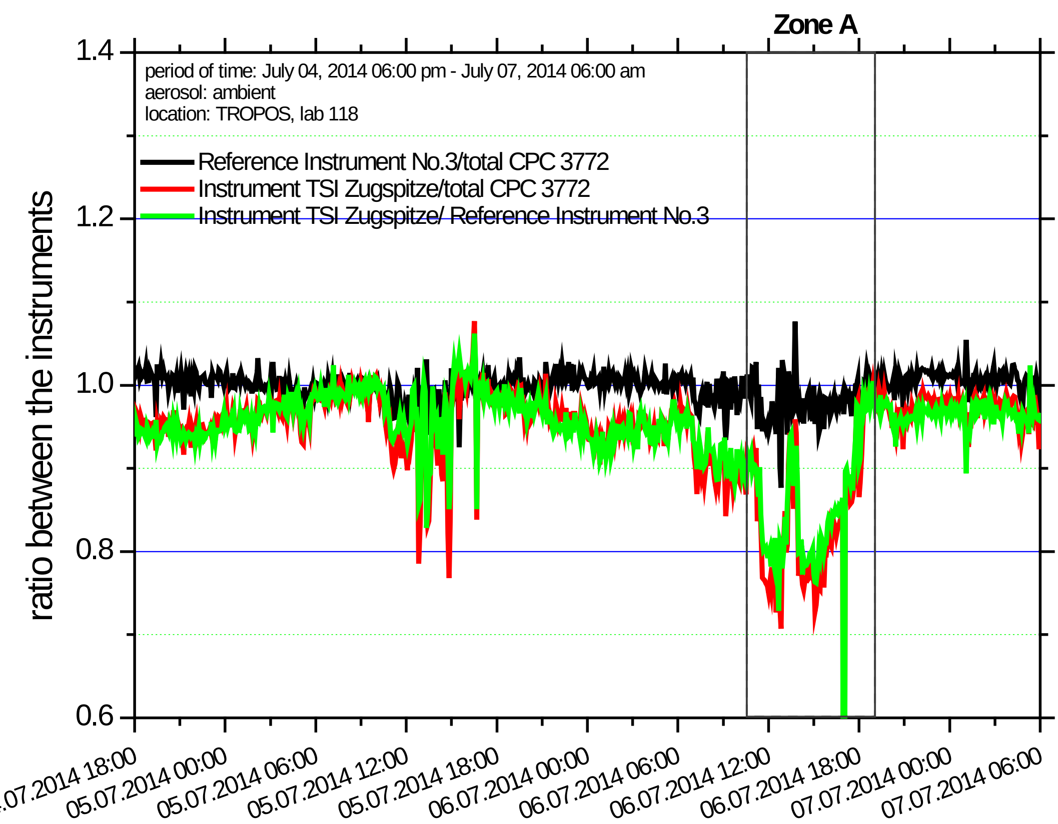


Fig.4. Ratio between particle number concentrations (N10-550nm) of TROPOS Reference SMPS No.3, Instrument TSI Zugspitze and total CPC 3772.

<u>3. Correlation without zone A</u>

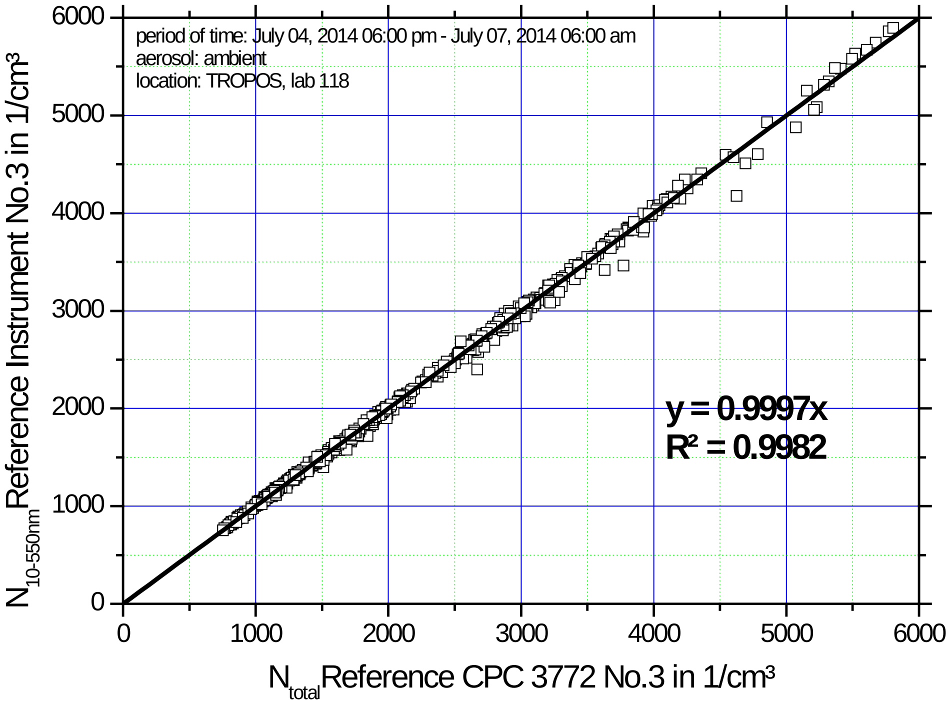


Fig.5. Linear regression between the number concentrations of the TROPOS reference CPC No.3 and the Reference Instrument No.3. Multiple charge correction, internal diffusion losses and flow corrections are included. Without zone A.

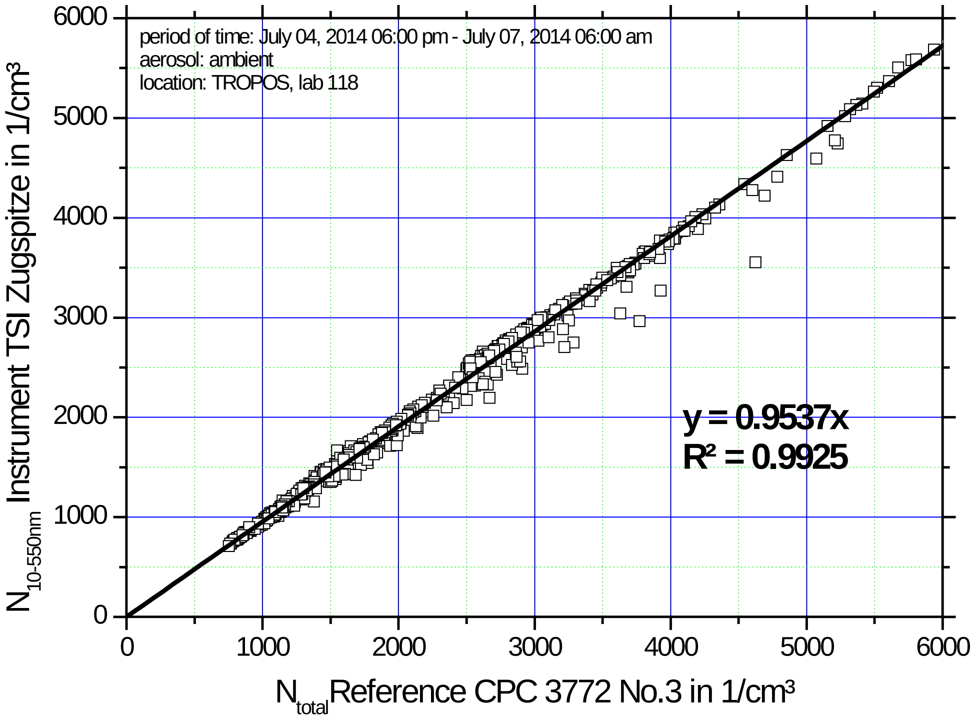


Fig.6. Linear regression between the number concentrations of the TROPOS reference CPC No.3 and the Instrument TSI Zugspitze. Multiple charge correction, internal diffusion losses and flow corrections are included. Without zone A.

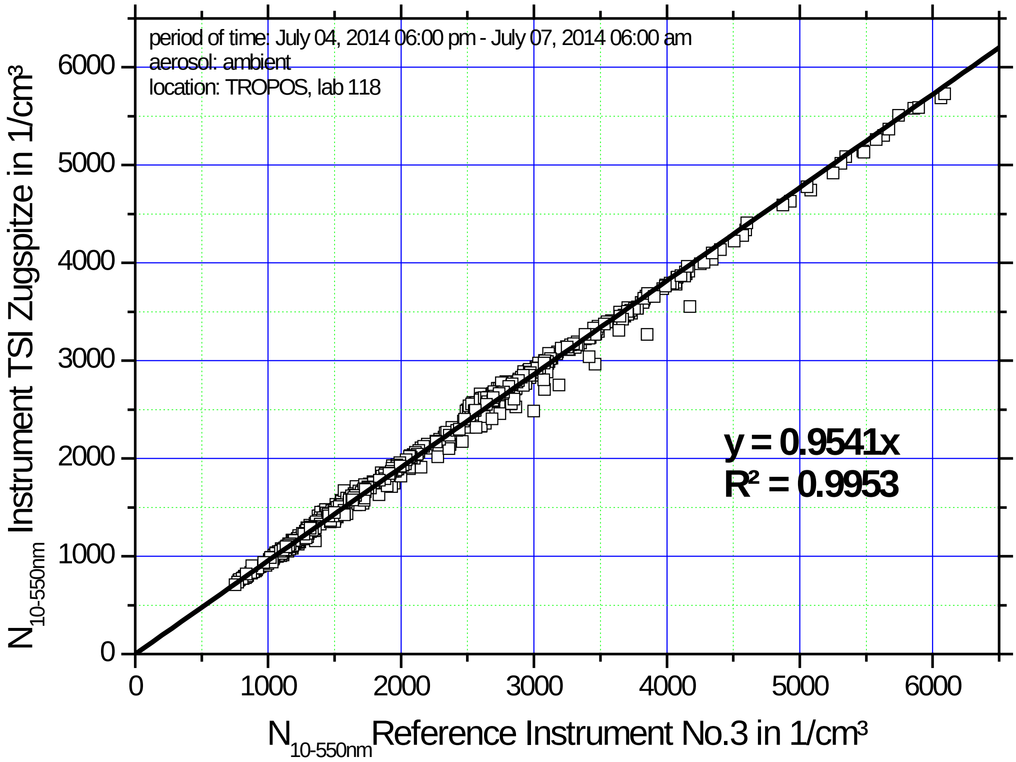


Fig.7. Linear regression between the number concentrations of the Reference Instrument No.3 and the Instrument TSI Zugspitze. Multiple charge correction, internal diffusion losses and flow corrections are included. Without zone A.

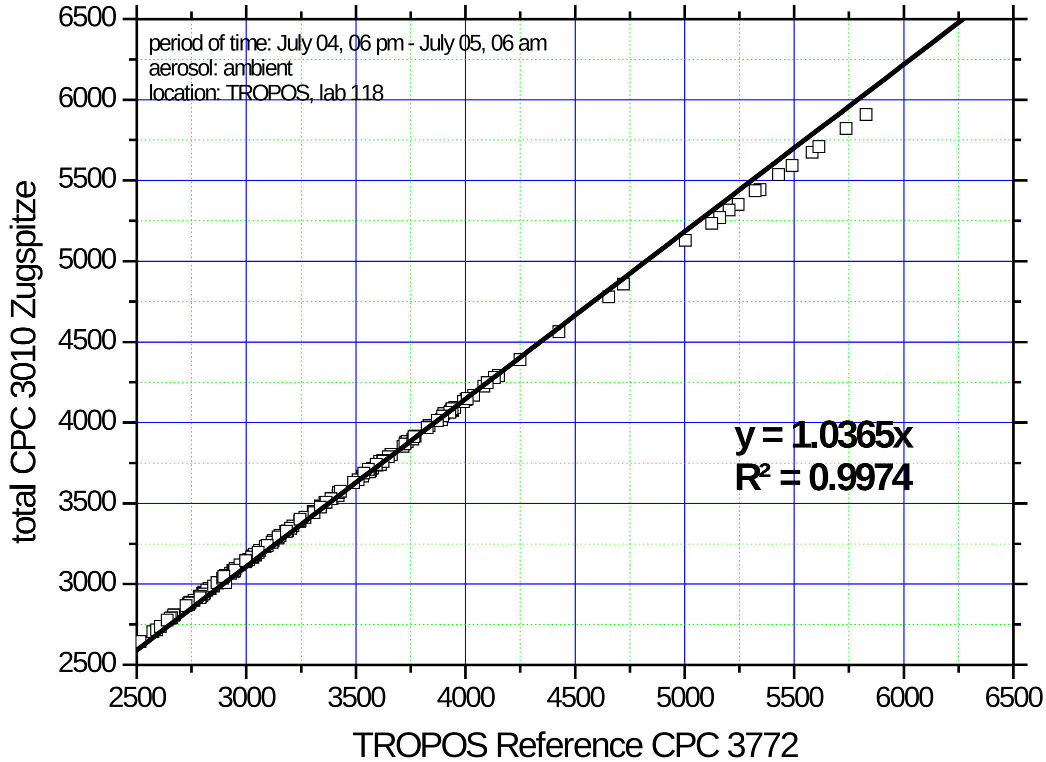


Fig.8. Linear regression between the TROPOS Reference CPC 3772 and total CPC 3010 Zugspitze.

4. Size distribution without zone A

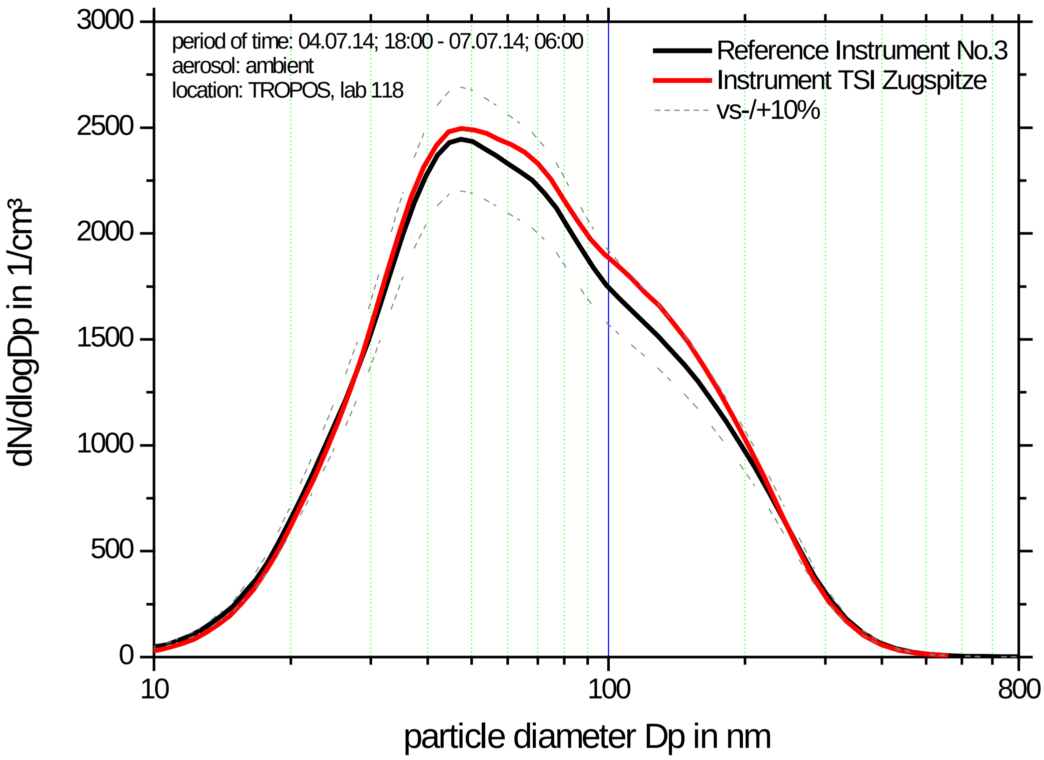


Fig.9. Comparison of mean particle number size distribution of the reference instruments between July 04, 2014 06:00 pm and July 07, 2014 06:00 am. Multiple charge correction, internal diffusion losses and CPC efficiency are included (.in2). Without zone A.