

## Intercomparison of Mobility Particle Size Spectrometers

*Project No.:* MPSS-2017-6-2

*Principal Investigator:* Felix Lüönd

*Home Institution:* METAS

*Participant:* Felix Lüönd

*Candidate:* **CH-METAS**

*Made by:* **TSI**

*Counter (SN):* TSI CPC Model 3775, SN: 70701277

*Software:* TSI Software V9.1

*Location of the quality assurance:* TROPOS Leipzig, lab 118

*Comparison period:* November 13, 2017 – November 17, 2017

*Last Intercomparison (with Project No.):*

**Summary of Intercomparison:***Pre-Status:*

The instrument arrived with participant. The instrument was running with the TSI Software Version 9.1 on the classifier and for data evaluation. During the Pre-Status, we found different results by using different TSI software versions. Therefore, we used also the TROPOS evaluation software to apply each correction e.g. flow, diffusion losses, CPC efficiency, and DMA. The PSL check showed a shifted peak to 208.95 nm. It was not possible to change the sheath air settings. More details are shown in the plots below.

*Final-Status:*

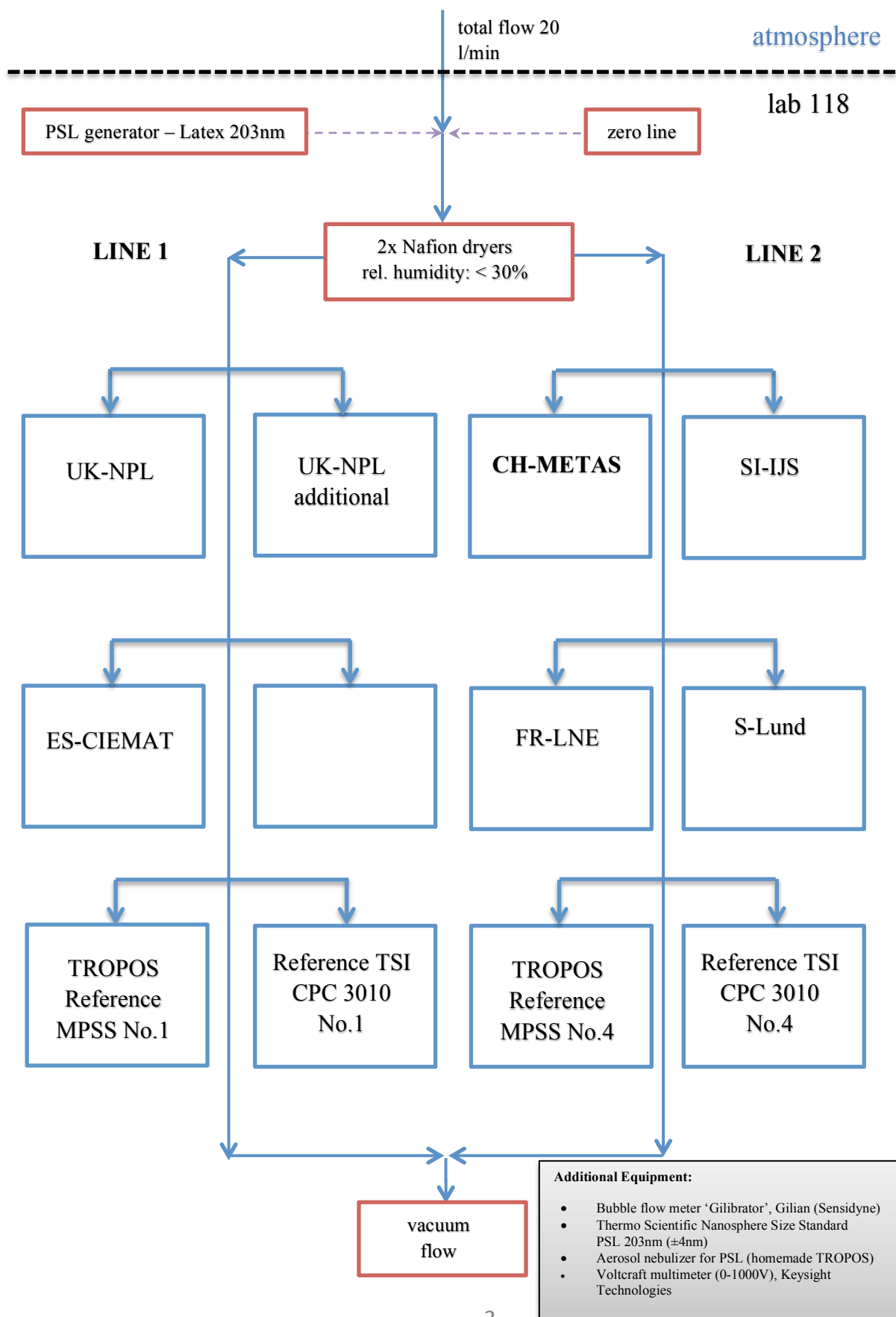
During the Final-Status, the performance of the system showed a concentration 4% lower than the TROPOS Reference Instrument No.4 when using the TROPOS evaluation software and 2% lower when using the TSI evaluation software. The candidate used the recalibrated TSI CPC model 3775 and their own Kr.85 source. The candidate passed the quality standards of ACTRIS and GAW.

**Information about the instruments:**

**Date of check: November 13, 2017**

<i>List of Components</i>	TROPOS Reference MPSS No.1	TROPOS Reference MPSS No.4	Candidate
<i>Position</i>	Line 1	Line 2	Line 2
<i>Company</i>	TROPOS	TROPOS	TSI 3080; SN:71201060
<i>Software</i>	TROPOS	TROPOS	TSI V9.1
<i>CPC-MPSS</i>	TSI CPC, Model 3772	TSI CPC, Model 3772	TSI CPC, Model 3775
<i>CPC-total</i>	TSI CPC, Model 3010	TSI CPC, Model 3010	-
<i>flow ratio</i>	1.0 : 5.0	1.0 : 5.0	0.3 : 3.0
<i>source</i>	Kr.85	Ni.63	Kr85
<i>HV power supply</i>	Positive	Positive	negative
<i>DMA</i>	Hauke medium	Hauke medium	TSI 3081
<i>aerosol dryer</i>	✓	✓	
<i>aerosol RH- sensor</i>	✓	✓	
<i>aerosol T-sensor</i>	✓	✓	
<i>sheath RH-sensor</i>	✓	✓	
<i>sheath T-sensor</i>	✓	✓	
<i>Sheath dryer</i>	✓	✓	
<i>pressure sensor</i>	✓	✓	
<i>info</i>			

## Laboratory setup:



## Status of the instruments:

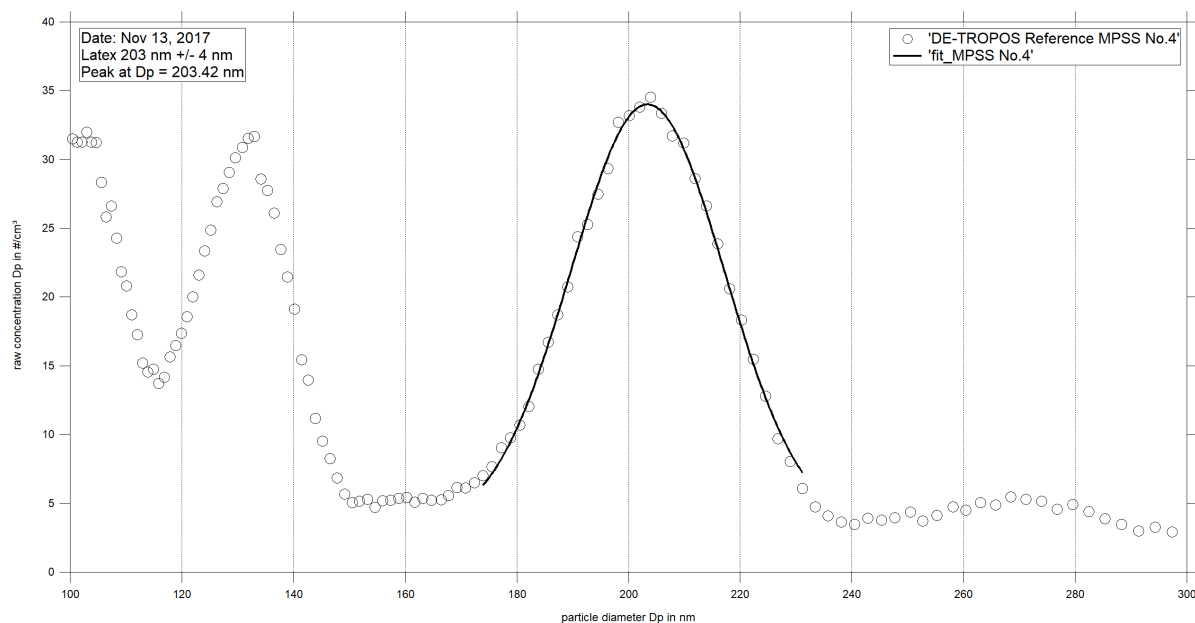
### Date of system checks:

<i>date</i>	13.11.2017	10.10.2017	11.10.2017	13.10.2017	unit
<i>total CPC flow</i>	-	-	-	-	l/min
<i>aerosol flow (DMA)</i>	-	-	-	-	l/min
<i>aerosol flow (UDMA)</i>	-	-	-	-	l/min
<i>aerosol flow (total)</i>	0.303	-	0.301	0.303	l/min
<i>Zero MPSS</i>	0	-	0	0	#/cm <sup>3</sup>
<i>Zero total CPC</i>	-	-	-	-	#/cm <sup>3</sup>
<i>PSL 203 nm</i>	208.95	-			nm
<i>HV check</i>	okay	-	okay	-	V

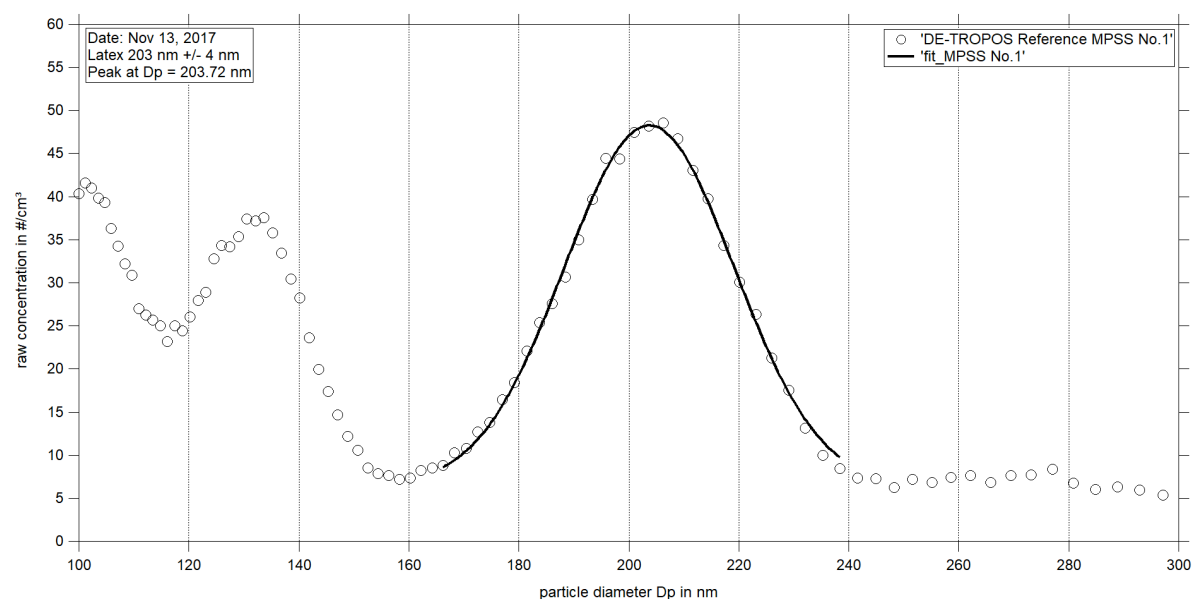
### Special Information regarding the Candidate:

<i>Was it necessary to:</i>	yes/no (date)	old part (ID/SN)	new part (ID/SN)	information
<i>clean the aerosol inlet</i>	No	-	-	replace capillary
<i>change aerosol Nafion dryer</i>	No	-	-	-
<i>change sheath Nafion dryer</i>	No	-	-	-
<i>check source</i>	No	-	-	-
<i>change HV power supply</i>	No	-	-	-
<i>clean/change DMA</i>	Yes	-	-	Check okay
<i>change aerosol RH/T-sensor</i>	No	-	-	-
<i>change sheath RH/T-sensor</i>	No	-	-	-
<i>change pressure sensor</i>	No	-	-	-
<i>change inlet Nafion dryer (500)</i>	No	-	-	-
<i>Change Total filter</i>	No	-	-	-

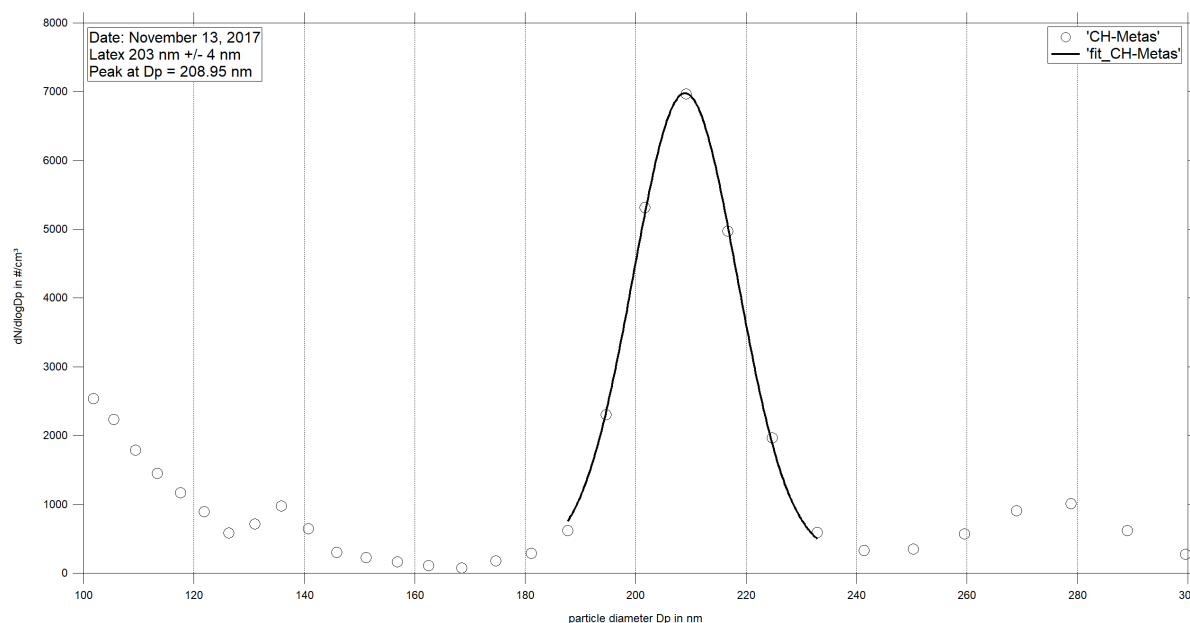
## PSL Scan and calibration: Latex 203 nm $\pm$ 4 nm



**Figure 01:** Measurement of latex 203 nm: Particle size distribution (raw concentration) for latex 203 nm on Nov 13<sup>rd</sup>, 2017.

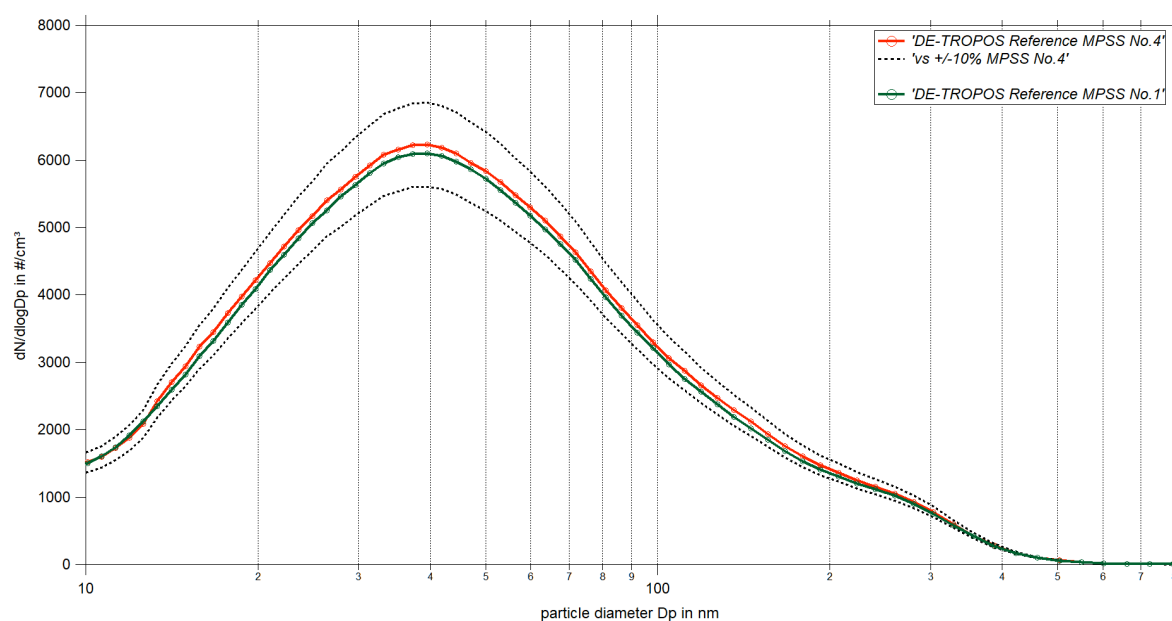


**Figure 02:** Measurement of latex 203 nm: Particle size distribution (raw concentration) for latex 203 nm on Nov 13<sup>rd</sup>, 2017.



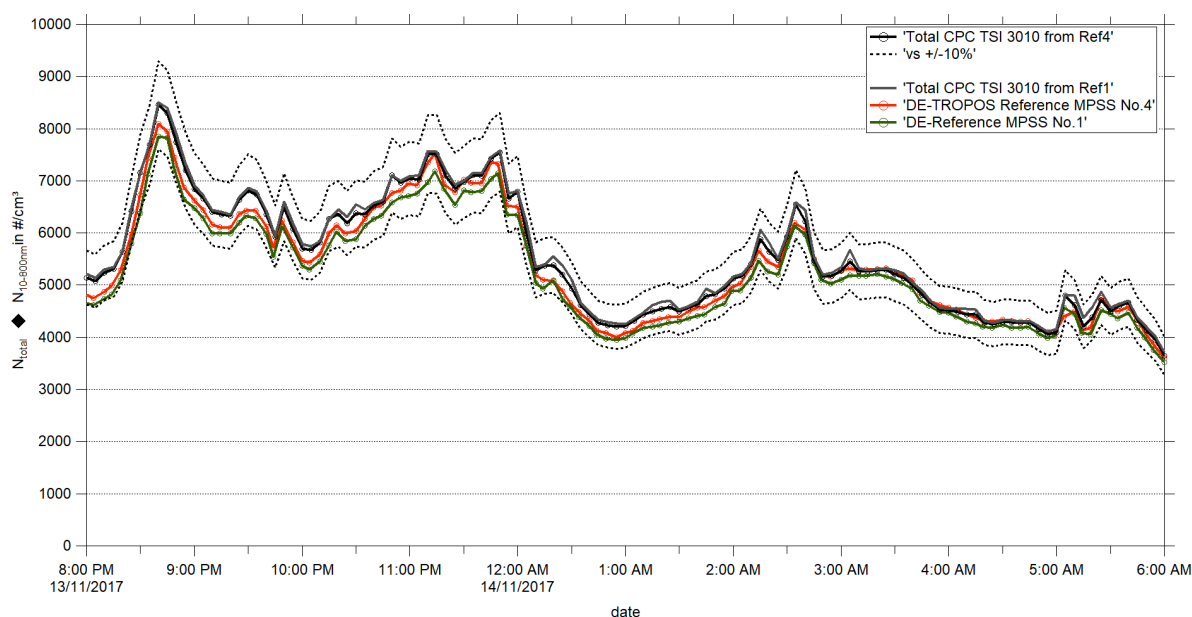
**Figure 03:** Measurement of latex 203 nm: Particle size distribution (raw concentration) for latex 203 nm on November 13<sup>rd</sup>, 2017.

### Pre-Status of the TROPOS Reference Instruments: Particle Number Size Distribution



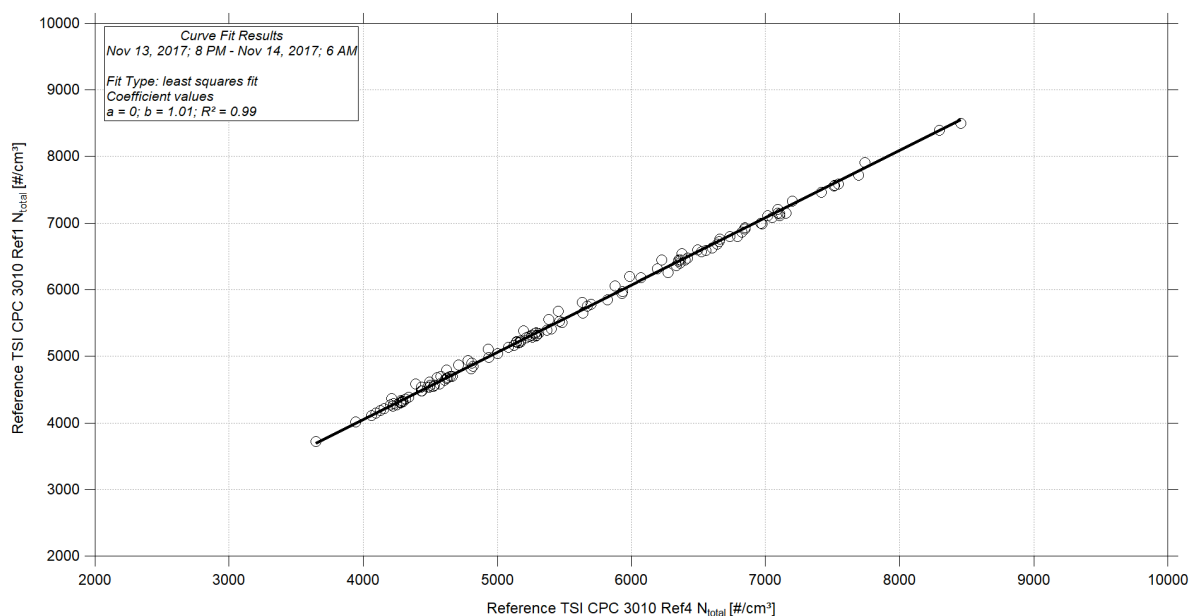
**Figure 04:** Comparison of mean particle number size distribution of TROPOS Reference MPSS No.4 against TROPOS Reference MPSS No.1 from November 13, 2017 08:00 PM – November 14, 2017 06:00 AM. Multiple charge correction, internal diffusion losses and CPC efficiency are included.

## Pre-Status of the TROPOS Reference Instruments: Time Series

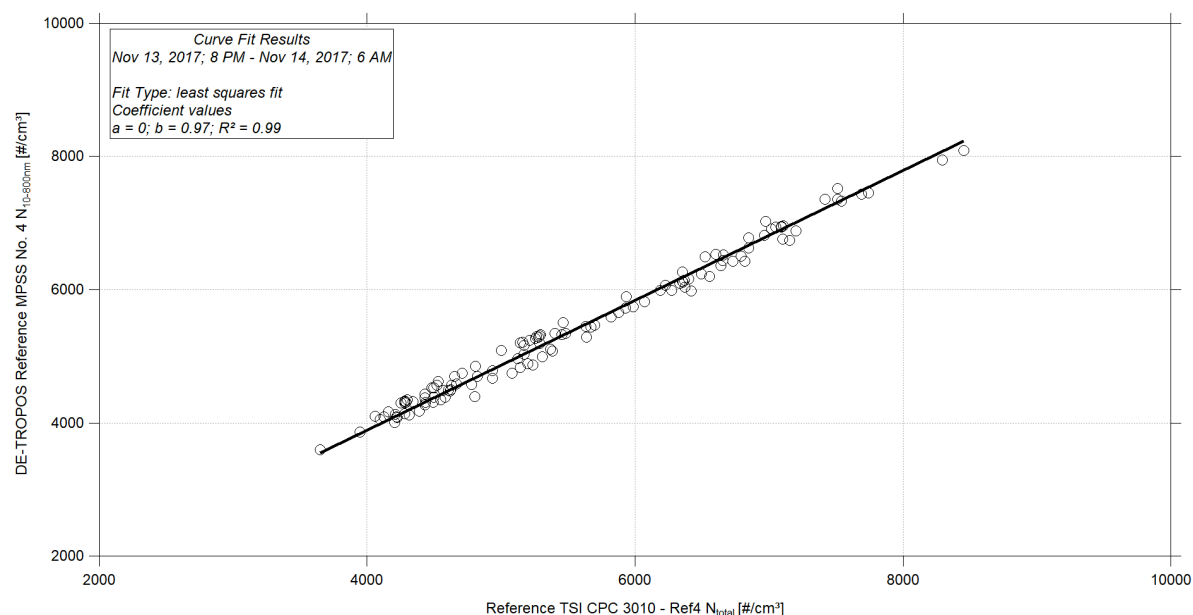


**Figure 05:** Time series (November 13, 2017 08:00 PM – November 14, 2017 06:00 AM) of the integrated particle number concentration ( $N_{10-800nm}$ ) of the MPSS and total number concentration ( $N_{total}$ ) of the Reference TSI-CPC Model 3010. The inversion for the candidate was performed using TSI software. Multiple charge correction, internal diffusion losses and CPC flow corrections are included.

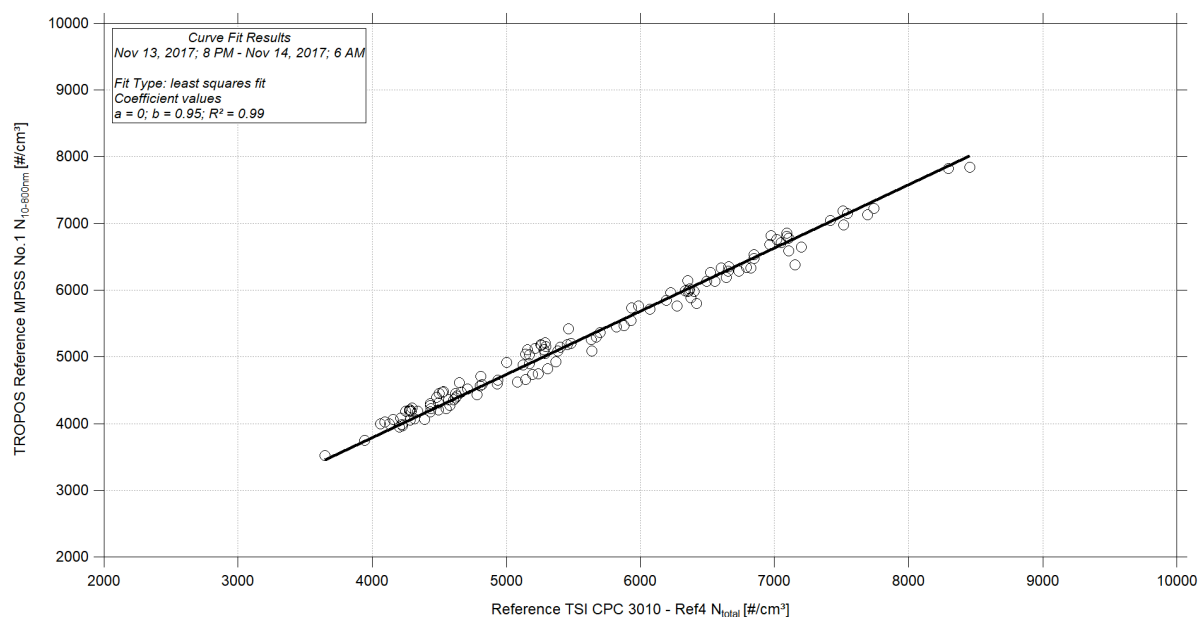
## Pre-Status of the TROPOS Reference Instruments: Correlation



**Figure 06:** Linear regression between the number concentrations of the TROPOS Reference TSI CPC Model 3010 Ref4 and TROPOS Reference TSI CPC Model 3010 Ref1. CPC flow and coincidence corrections are included.

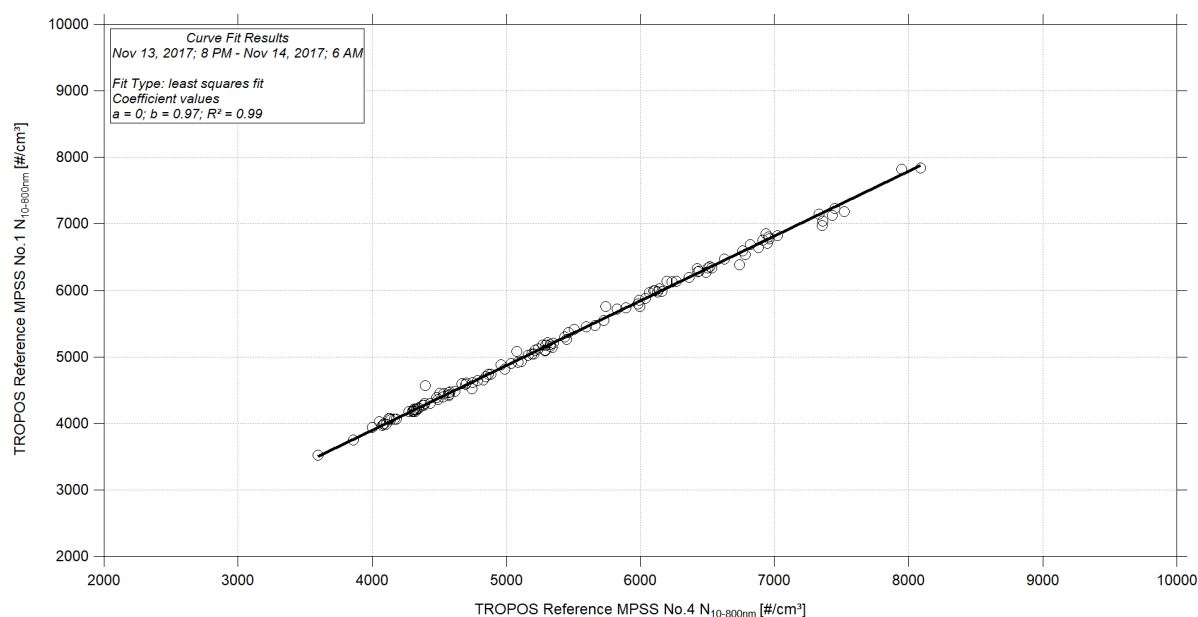


**Figure 07:** Linear regression between the number concentrations of the TROPOS Reference TSI CPC Model 3010 Ref4 and TROPOS Reference MPSS No.4. Multiple charge correction, internal diffusion losses and CPC flow corrections are included.



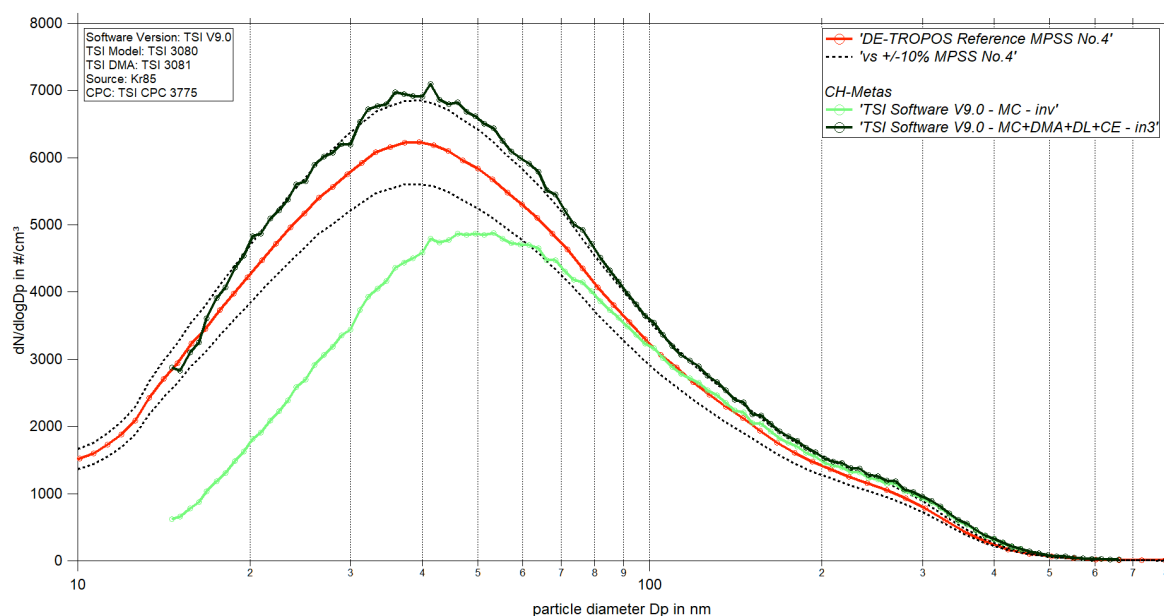
**Figure 08:** Linear regression between the number concentrations of the TROPOS Reference TSI CPC Model 3010 Ref4 and TROPOS Reference MPSS No.1. Multiple charge correction, internal diffusion losses and CPC flow corrections are included.



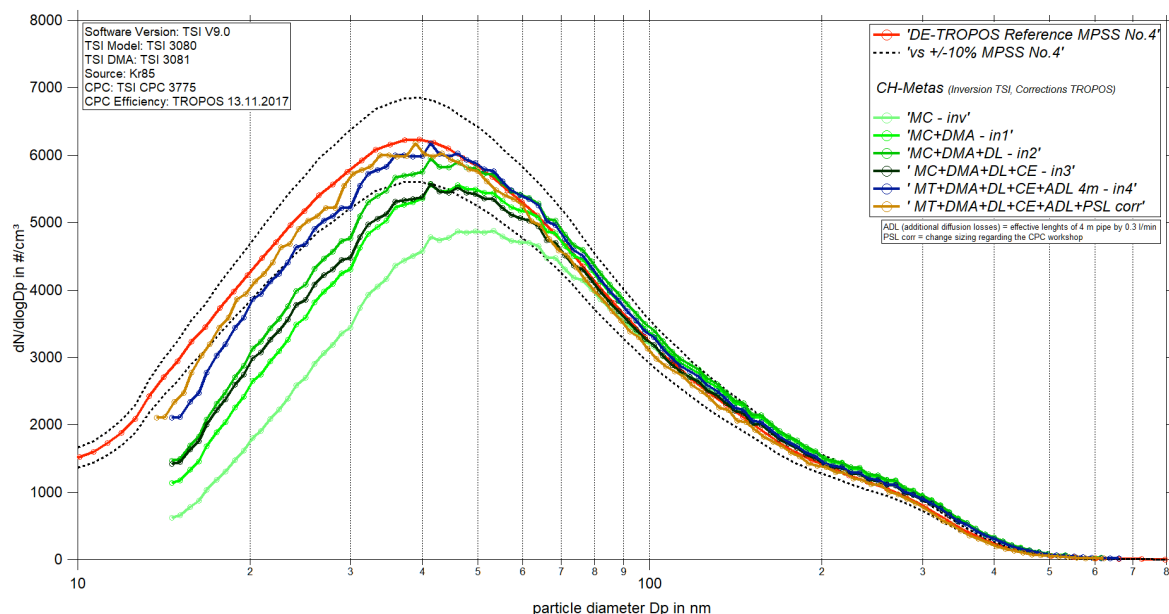


**Figure 09:** Linear regression between the number concentrations of the TROPOS Reference MPSS No.4 and TROPOS Reference MPSS No.1. Multiple charge correction, internal diffusion losses and CPC flow corrections are included.

## Pre-Status of the Candidate: Particle Number Size Distribution

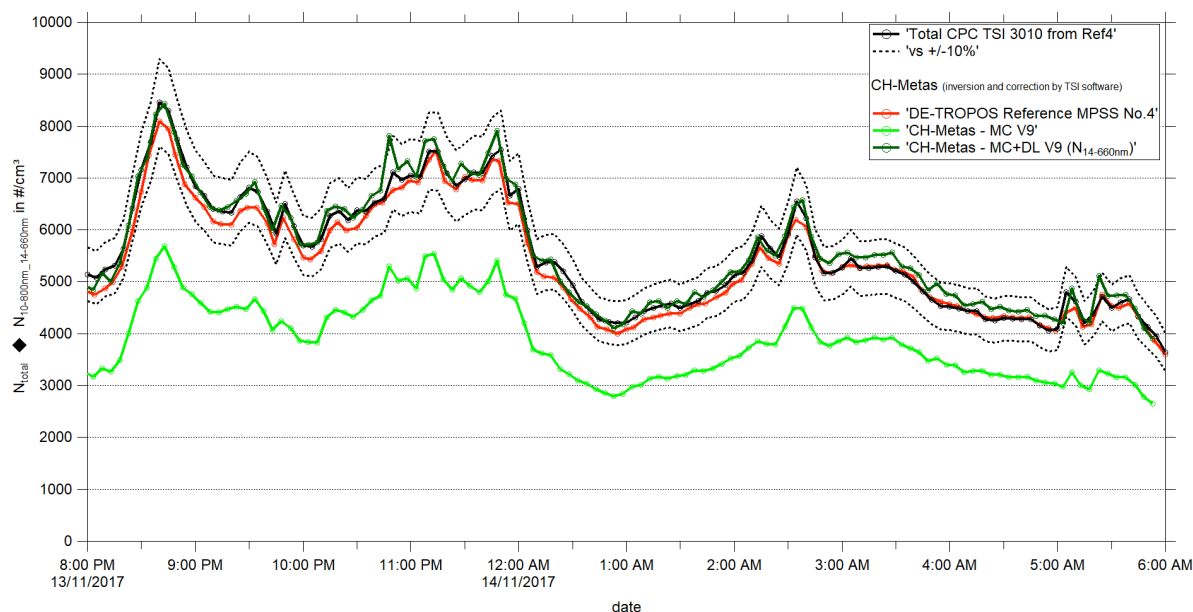


**Figure 10:** Comparison of mean particle number size distribution of TROPOS Reference MPSS No.4 against CH-Metas from November 13, 2017 08:00 PM – November 14, 2017 06:00 AM. Multiple charge correction, internal diffusion losses and CPC efficiency are included. TSI Software V9.0 – inv includes only the multiple charge correction. TSI Software V9.0 – in3 includes all corrections from TSI.

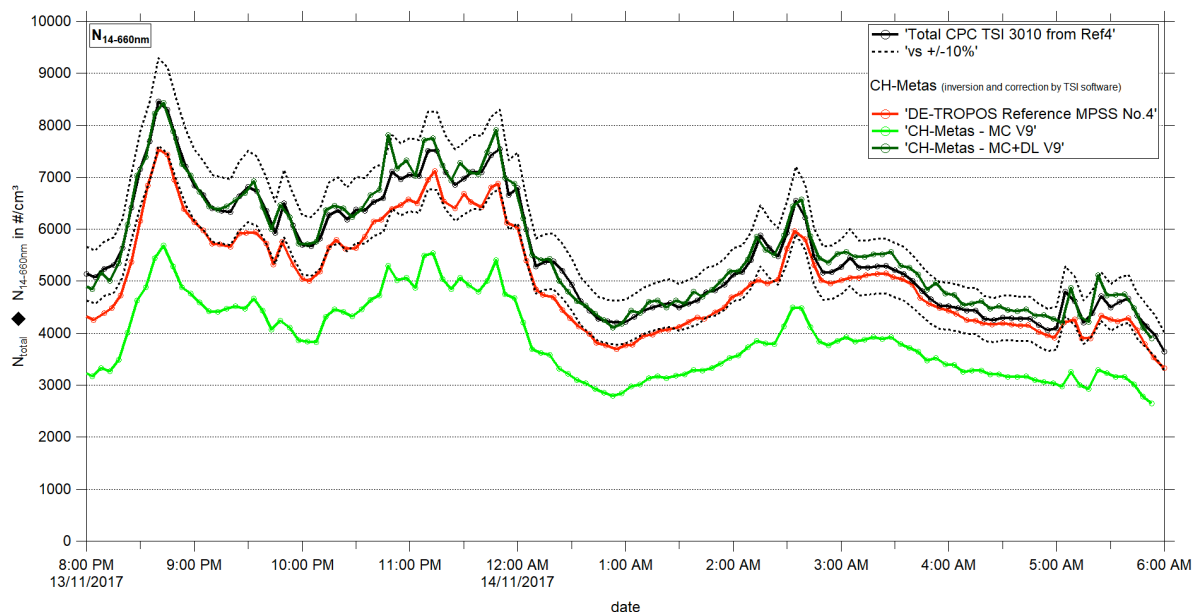


**Figure 11:** Comparison of mean particle number size distribution of TROPOS Reference MPSS No.4 against CH-Metas from November 13, 2017 08:00 PM – November 14, 2017 06:00 AM. All corrections, excluding the multiple charge correction, which is done by TSI software, are calculated by using the TROPOS software.

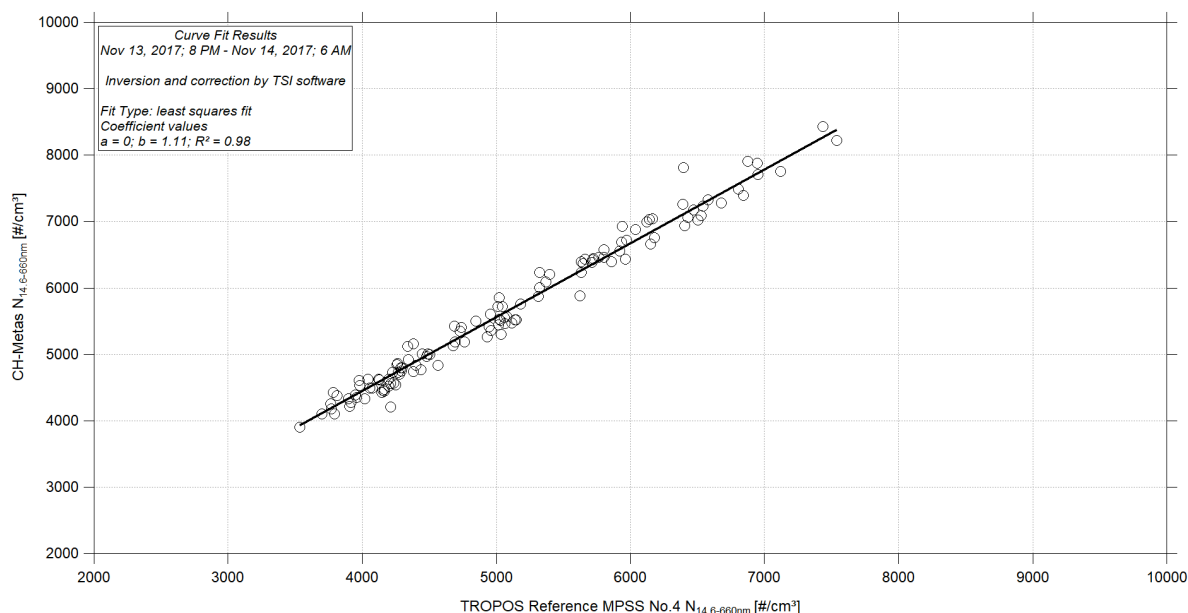
## Pre-Status of the Candidate: Time Series and Correlation



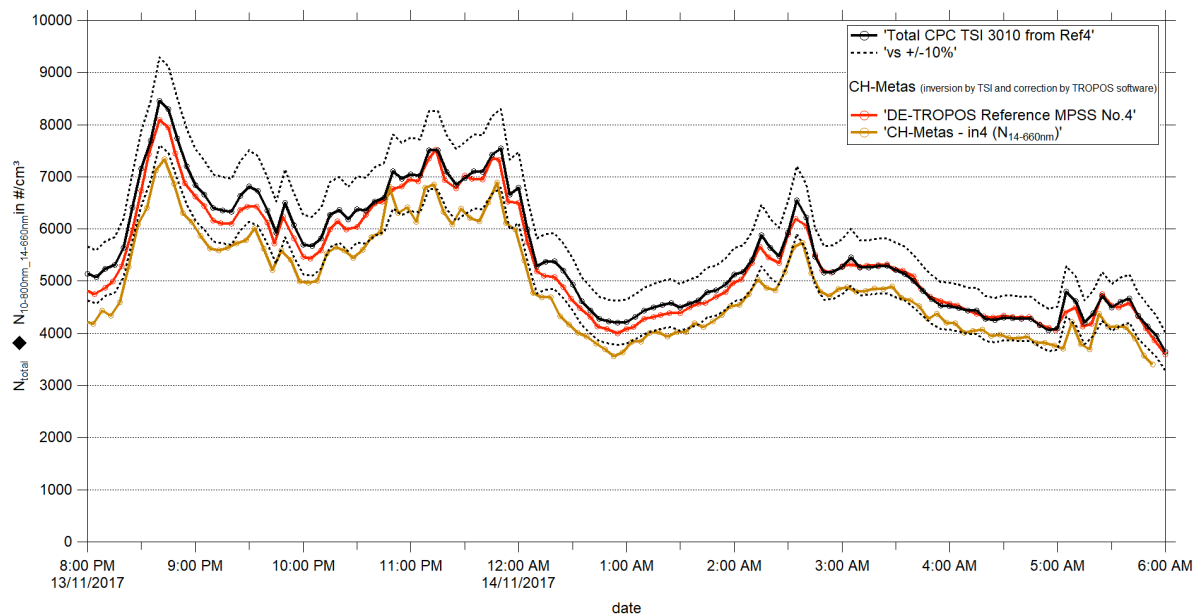
**Figure 12:** Time series (November 13, 2017 08:00 PM – November 14, 2017 06:00 AM) of the integrated particle number concentration ( $N_{10-800nm}$ ;  $N_{14.6-660nm}$ ) of the MPSS and total number concentration ( $N_{total}$ ) of the Reference TSI-CPC Model 3010. The inversion and corrections for the candidate was performed using TSI software. Multiple charge correction, internal diffusion losses and CPC flow corrections are included.



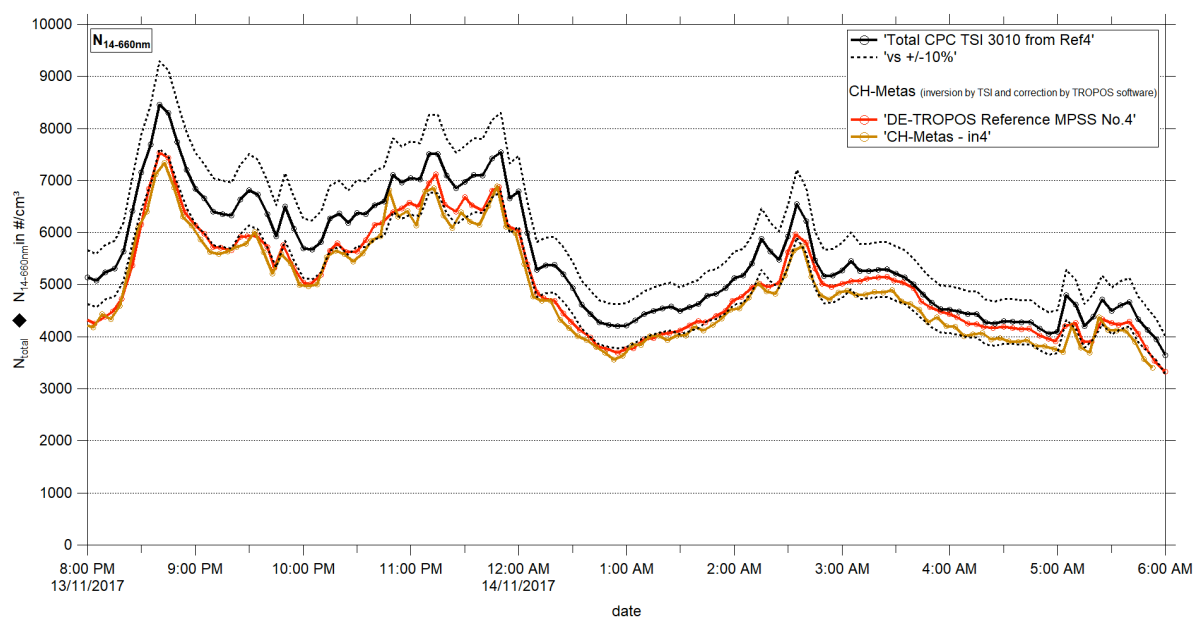
**Figure 13:** Time series (November 13, 2017 08:00 PM – November 14, 2017 06:00 AM) of the integrated particle number concentration ( $N_{14,6-660nm}$ ) of the MPSS and total number concentration ( $N_{total}$ ) of the Reference TSI-CPC Model 3010. The inversion and corrections for the candidate was performed using TSI software. Multiple charge correction, internal diffusion losses and CPC flow corrections are included.



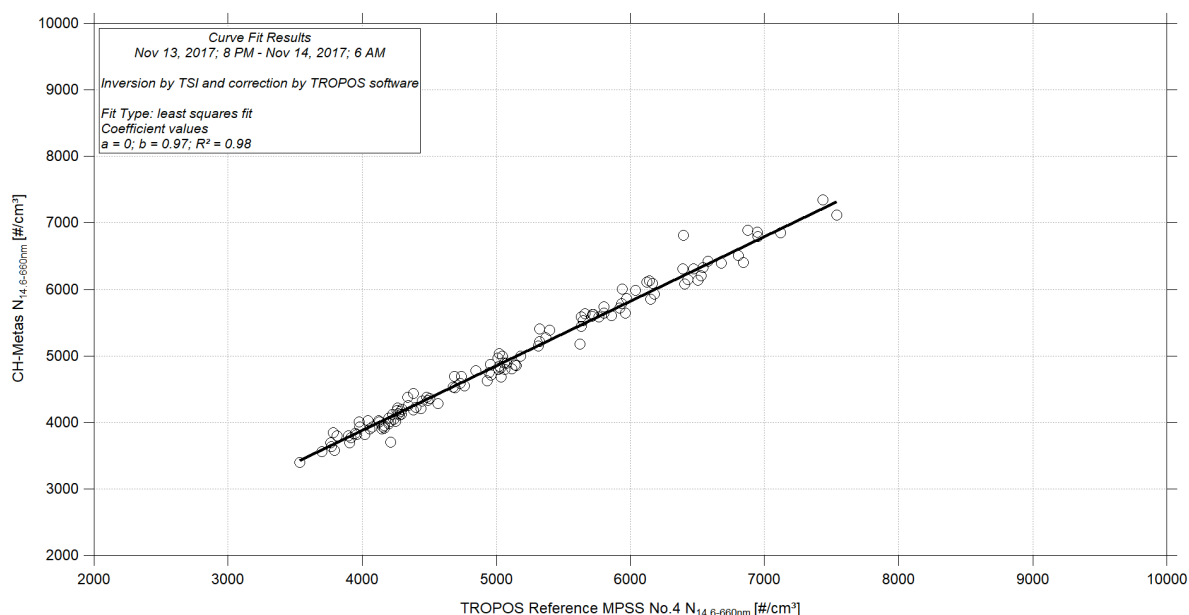
**Figure 14:** Linear regression between the number concentrations of the TROPOS Reference MPSS No. 4 and CH-Metas. The inversion and corrections for the candidate was performed using TSI software. Multiple charge correction, internal diffusion losses and CPC flow corrections are included.



**Figure 15:** Time series (November 13, 2017 08:00 PM – November 14, 2017 06:00 AM) of the integrated particle number concentration ( $N_{10-800\text{nm}}$ ;  $N_{14.6-660\text{nm}}$ ) of the MPSS and total number concentration ( $N_{\text{total}}$ ) of the Reference TSI-CPC Model 3010. The inversion for the candidate was performed using TSI software. Internal diffusion losses, CPC efficiency and CPC flow corrections are included and performed using TROPOS software.

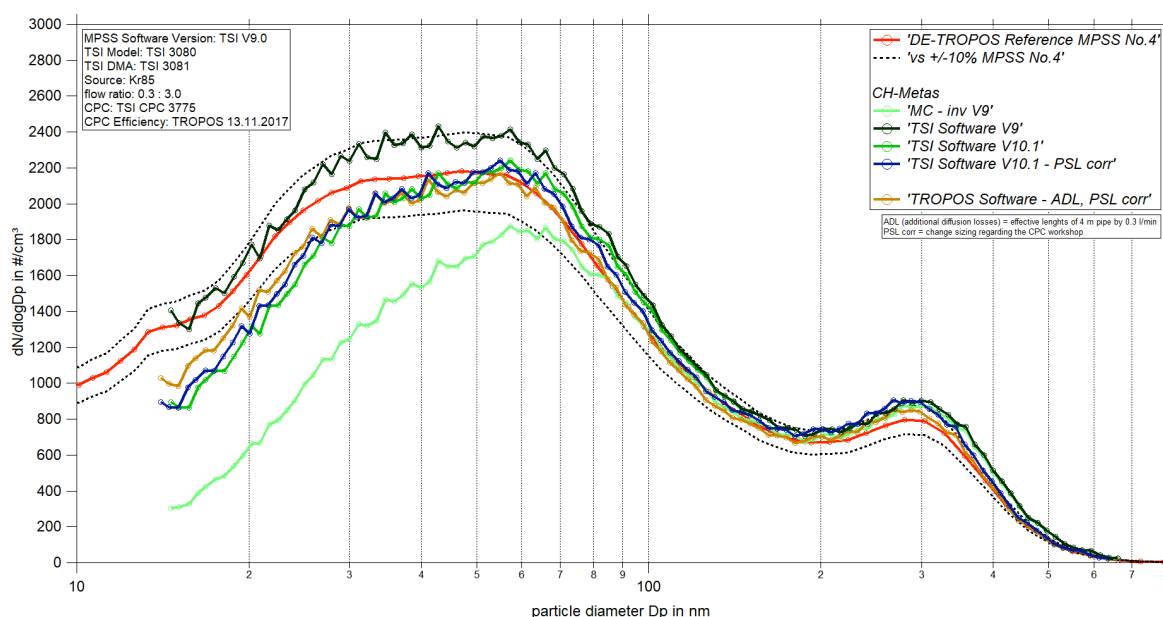


**Figure 16:** Time series (November 13, 2017 08:00 PM – November 14, 2017 06:00 AM) of the integrated particle number concentration ( $N_{14.6-660\text{nm}}$ ) of the MPSS and total number concentration ( $N_{\text{total}}$ ) of the Reference TSI-CPC Model 3010. The inversion for the candidate was performed using TSI software. Internal diffusion losses, CPC efficiency and CPC flow corrections are included and performed using TROPOS software.



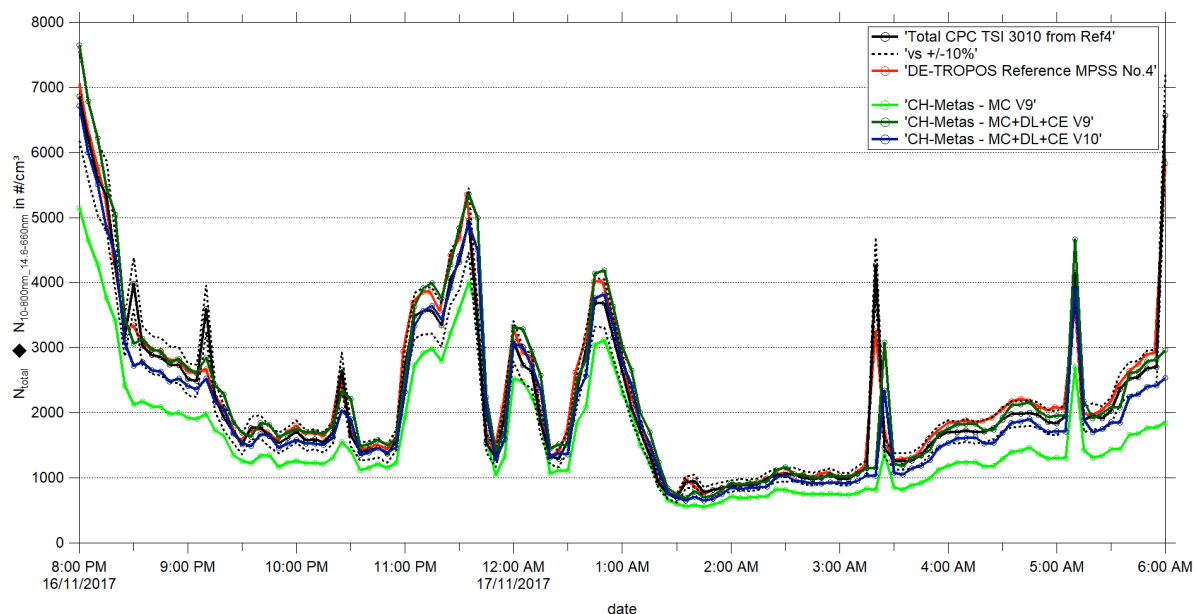
**Figure 17:** Linear regression between the number concentrations of the TROPOS Reference MPSS No. 4 and CH-Metas. The inversion for the candidate was performed using TSI software. Internal diffusion losses, CPC efficiency and CPC flow corrections are included and performed using TROPOS software.

## Final-Status of the Candidate: Particle Number Size Distribution

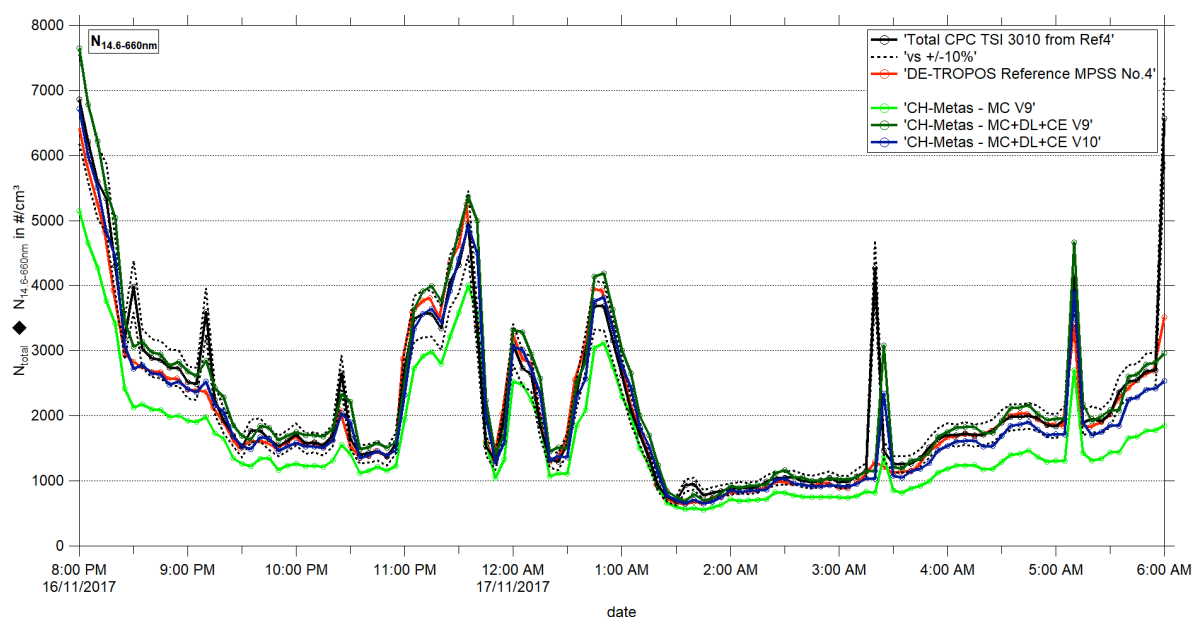


**Figure 18:** Comparison of mean particle number size distribution of TROPOS Reference MPSS No.4 against CH-Metas from November 16, 2017 08:00 PM – November 17, 2017 06:00 AM. Multiple charge correction, internal diffusion losses and CPC efficiency are included by different software version.

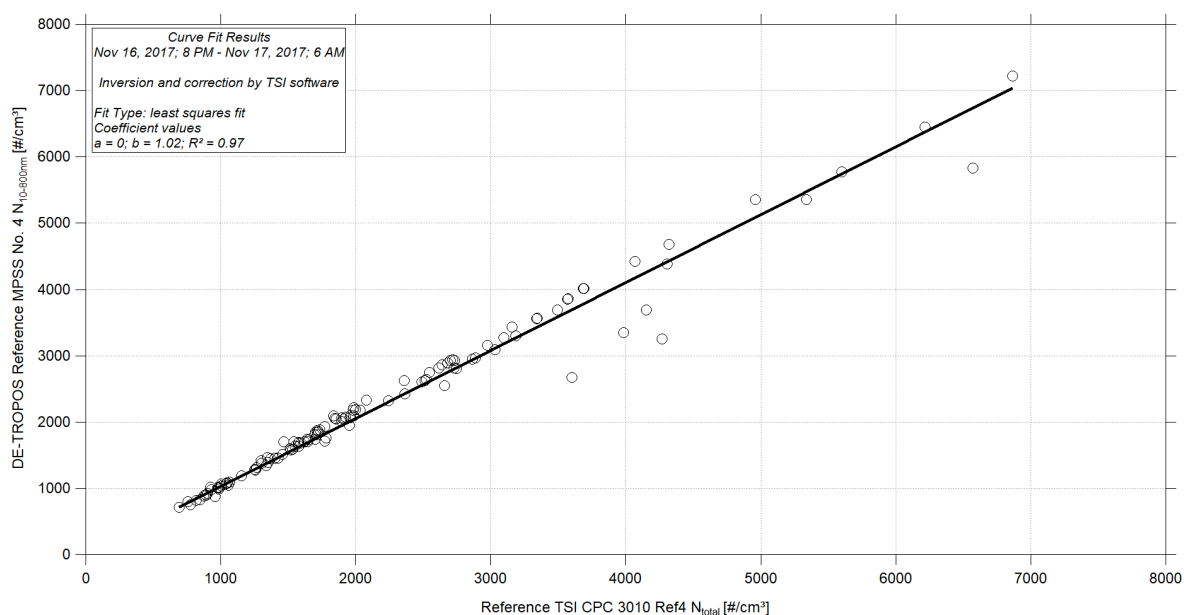
## Final-Status of the Candidate: Time Series and Correlation



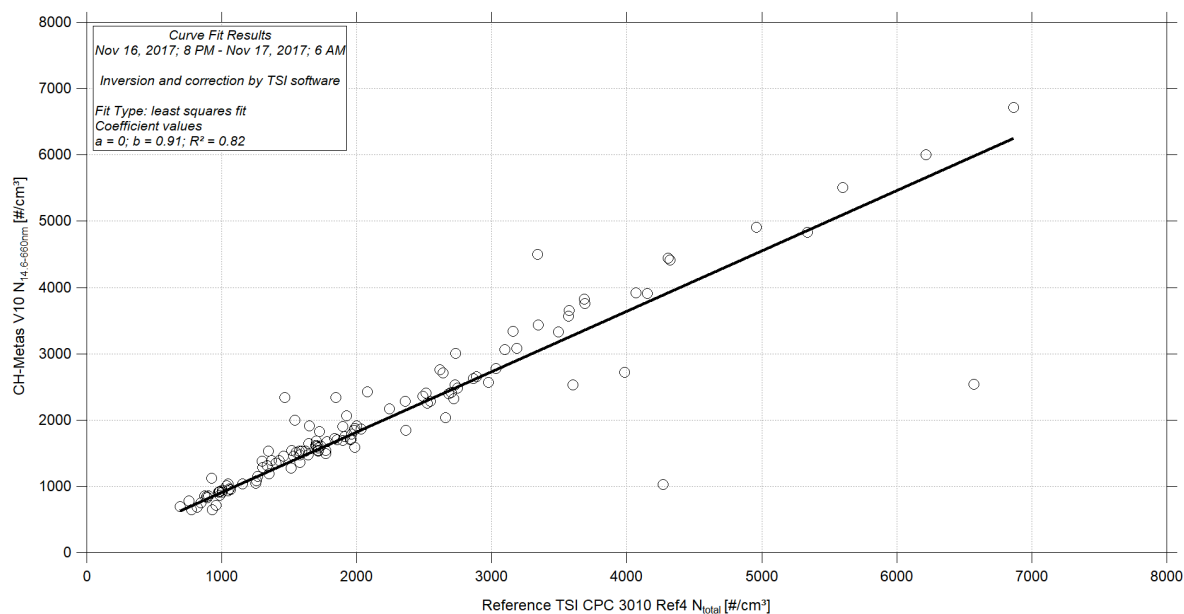
**Figure 19:** Time series (November 16, 2017 08:00 PM – November 17, 2017 06:00 AM) of the integrated particle number concentration ( $N_{10-800nm}$ ;  $N_{14-660nm}$ ) of the MPSS and total number concentration ( $N_{total}$ ) of the Reference TSI-CPC Model 3010. The inversion and correction for the candidate was performed using TSI software.



**Figure 20:** Time series (November 16, 2017 08:00 PM – November 17, 2017 06:00 AM) of the integrated particle number concentration ( $N_{14-660nm}$ ) of the MPSS and total number concentration ( $N_{total}$ ) of the Reference TSI-CPC Model 3010. The inversion and correction for the candidate was performed using TSI software.

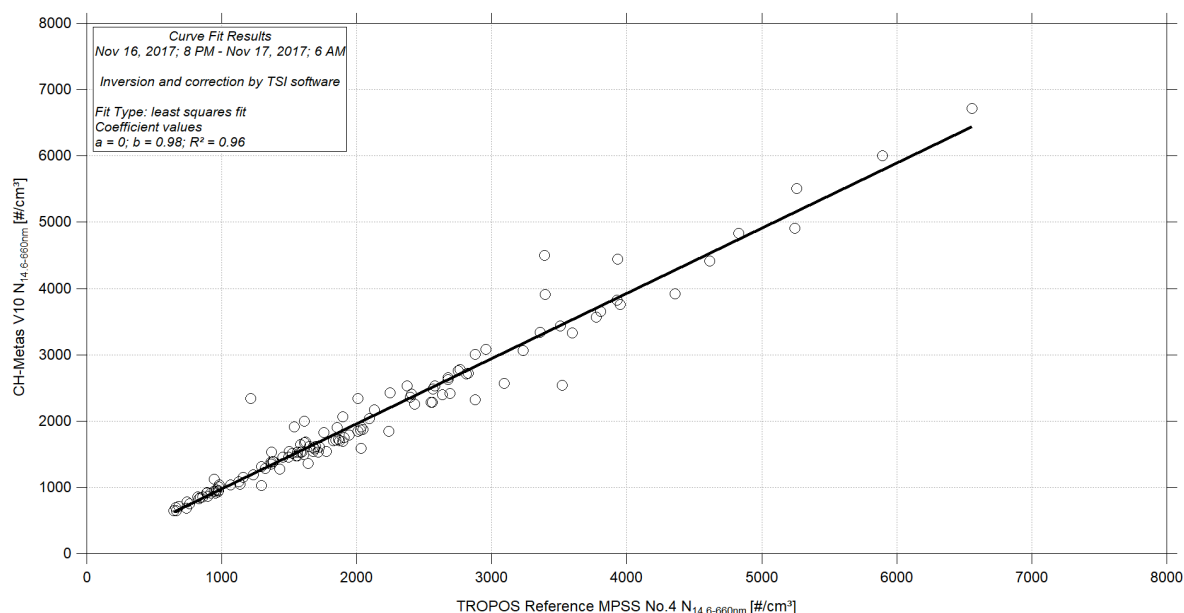


**Figure 21:** Linear regression between the number concentrations of the TROPOS Reference TSI CPC Model 3010 Ref4 and TROPOS Reference MPSS No.4 (November 16, 2017 08:00 PM – November 17, 2017 06:00 AM). Multiple charge correction, internal diffusion losses and CPC flow corrections are included.

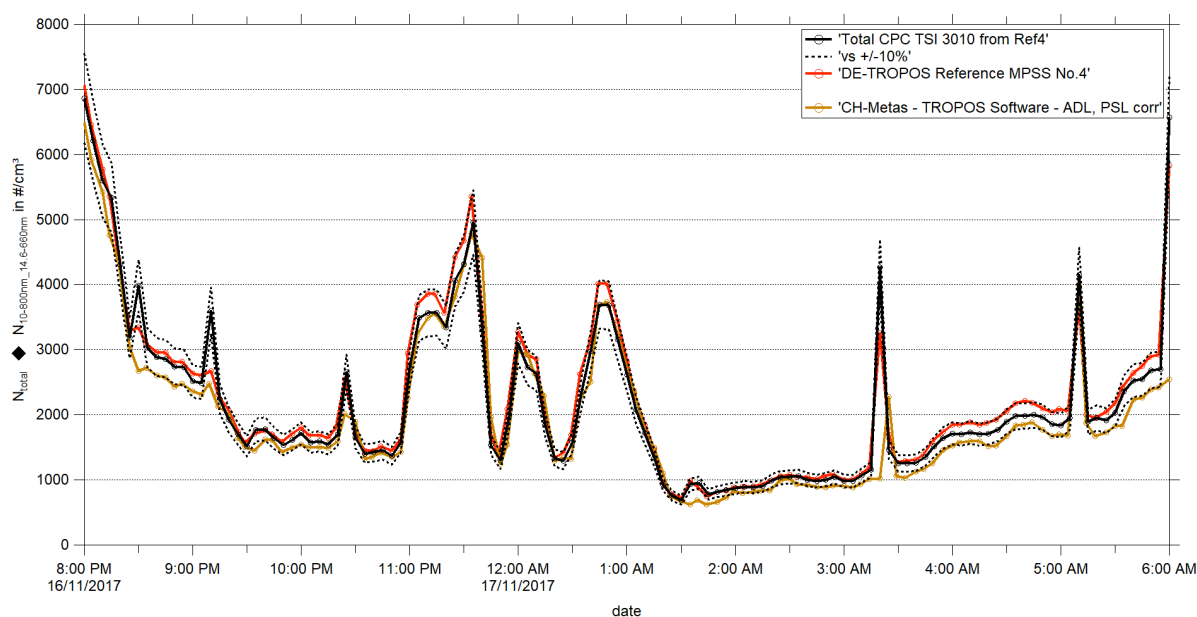


**Figure 22:** Linear regression between the number concentrations of the TROPOS Reference TSI CPC Model 3010 Ref4 and CH-Metas V10 (November 16, 2017 08:00 PM – November 17, 2017 06:00 AM). The inversion and corrections for the candidate was performed using TSI software.



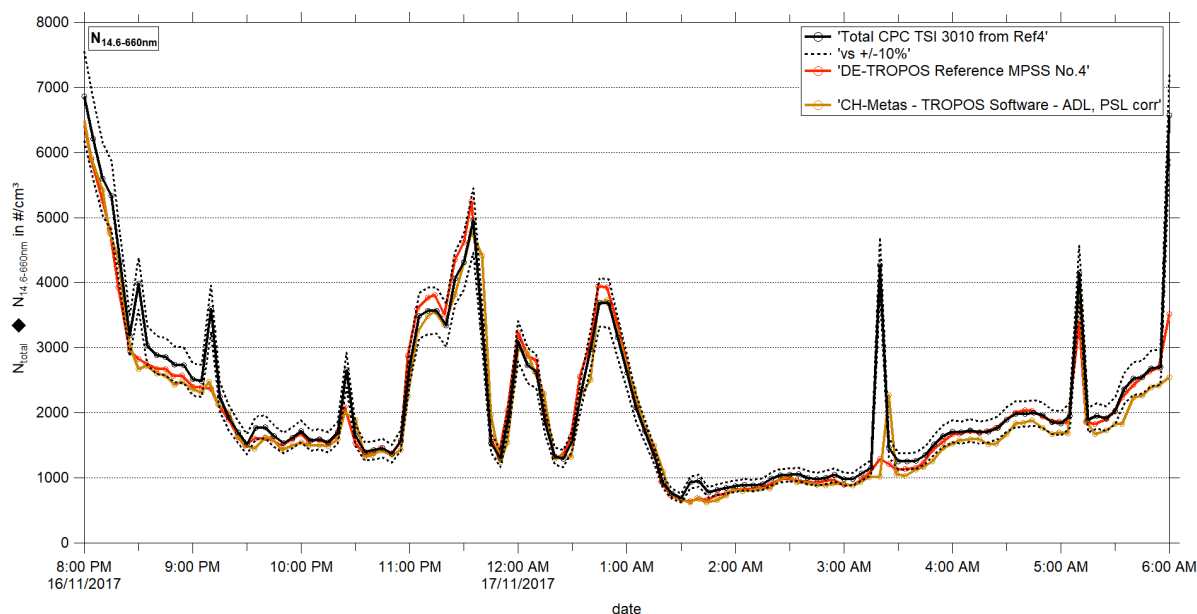


**Figure 23:** Linear regression between the number concentrations of the TROPOS Reference MPSS No.4 and CH-Metas V10 (November 16, 2017 08:00 PM – November 17, 2017 06:00 AM). The inversion and corrections for the candidate was performed using TSI software.

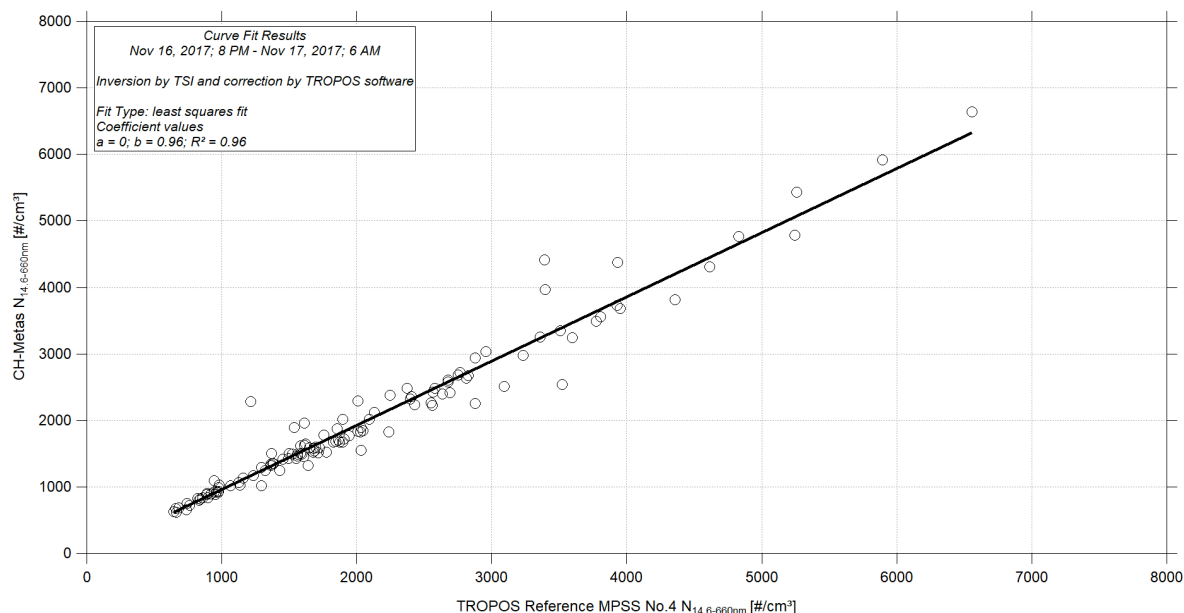


**Figure 24:** Time series (November 16, 2017 08:00 PM – November 17, 2017 06:00 AM) of the integrated particle number concentration ( $N_{10-800nm}$ ;  $N_{14-660nm}$ ) of the MPSS and total number concentration ( $N_{total}$ ) of the Reference TSI-CPC Model 3010. The inversion for the candidate was performed using TSI software. Internal diffusion losses, CPC efficiency and CPC flow corrections are included and performed using TROPOS software.





**Figure 25:** Time series (November 16, 2017 08:00 PM – November 17, 2017 06:00 AM) of the integrated particle number concentration ( $N_{14,6-660nm}$ ) of the MPSS and total number concentration ( $N_{total}$ ) of the Reference TSI-CPC Model 3010. The inversion for the candidate was performed using TSI software. Internal diffusion losses, CPC efficiency and CPC flow corrections are included and performed using TROPOS software.



**Figure 26:** Linear regression between the number concentrations of the TROPOS Reference MPSS No.4 and CH-Metas - TROPOS software in4 (November 16, 2017 08:00 PM – November 17, 2017 06:00 AM). The inversion for the candidate was performed using TSI software. Internal diffusion losses, CPC efficiency and CPC flow corrections are included and performed using TROPOS software.