Intercomparison of Mobility Particle Size Spectrometers

Project No.:	*MPSS-2018-6-5*
Principal Investigator:	*Jason Southgate, Ian Marshall*
Home Institution:	*Ricardo Energy & Environment, Particle Measurement Center*
Participant:	*online*
Candidate:	**UK-Ricardo Energy**
Made by:	**TSI**
Counter (SN):	**Classifier 3082001610001, CPC 3750 SN3750180502**
Software:	**CPC Firmware: 1.0.7; AIM: 10.3**
Location of the quality assurance:	TROPOS Leipzig, lab 118
Comparison period:	September 17, 2018 – September 21, 2018
Last Intercomparison (with Project No.):	

Summary of Intercomparison:

Pre-Status:
The candidate from UK-Ricardo Energy & Environment participated in the ACTRIS workshop from September 17, 2018 to September 21, 2018 with the participant. On Monday, September 17th, the setup was done in the TROPOS Lab 118. The candidate was running under the same settings, with their own TSI X-ray source, like on the Institute. The performance of the candidate showed a concentration 15% lower than the TROPOS Reference Instrument No.1. One of the reasons was evident during the CPC workshop which took place on September 18th. The CPC showed a concentration 10% lower than the electrometer in the plateau at 40 nm. For more information, please see the CPC-workshop report. The CPC was cleaned and checked again but it was not possible to

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increase the plateau at 40 nm to 1. TROPOS recommended Ricardo Energy & Environment to send the TSI CPC Model 3772 SN3750180502 for maintenance back to TSI.

Final-Status:
The final run took place from Sep. 20 to Sep. 21, 2018. Running the candidate using the original source TSI X-ray and consider the 10% of the TSI CPC the performance showed a concentration 8% lower than the TROPOS Reference Instrument No.1. However, using the correction factor of the CPC-workshop yielded a concentration well within the standards. Therefore, considering the CPC-correction factor, the candidate passed the standards of ACTRIS and GAW. Nonetheless, TROPOS highly recommends Ricardo Energy & Environment to send the CPC for maintenance back to TSI.

Information about the instruments:

Date of check: September 17, 2018

List of Components		TROPOS Reference MPSS No.1	Candidate
Position		Line 1.2	Line 1.3
Company		TROPOS	TSI
Software		TROPOS V6.68	TSI with AIM 10.3
CPC-MPSS		TSI CPC, Model 3772	TSI 3750 with Firmware 1.0.7
CPC-total		TSI CPC, Model 3010	-
flow ratio		1.0 : 5.0	10 : 1.0
source		Kr.85	TSI x-ray
HV power supply		Positive	Positive
DMA		Hauke medium	TSI 3082
aerosol dryer		✓	-
aerosol RH- sensor		✓	-
aerosol T-sensor		✓	-
sheath RH-sensor		✓	-
sheath T-sensor		✓	-
Sheath dryer		✓	-
pressure sensor		✓	✓
info			Impactor 0.071

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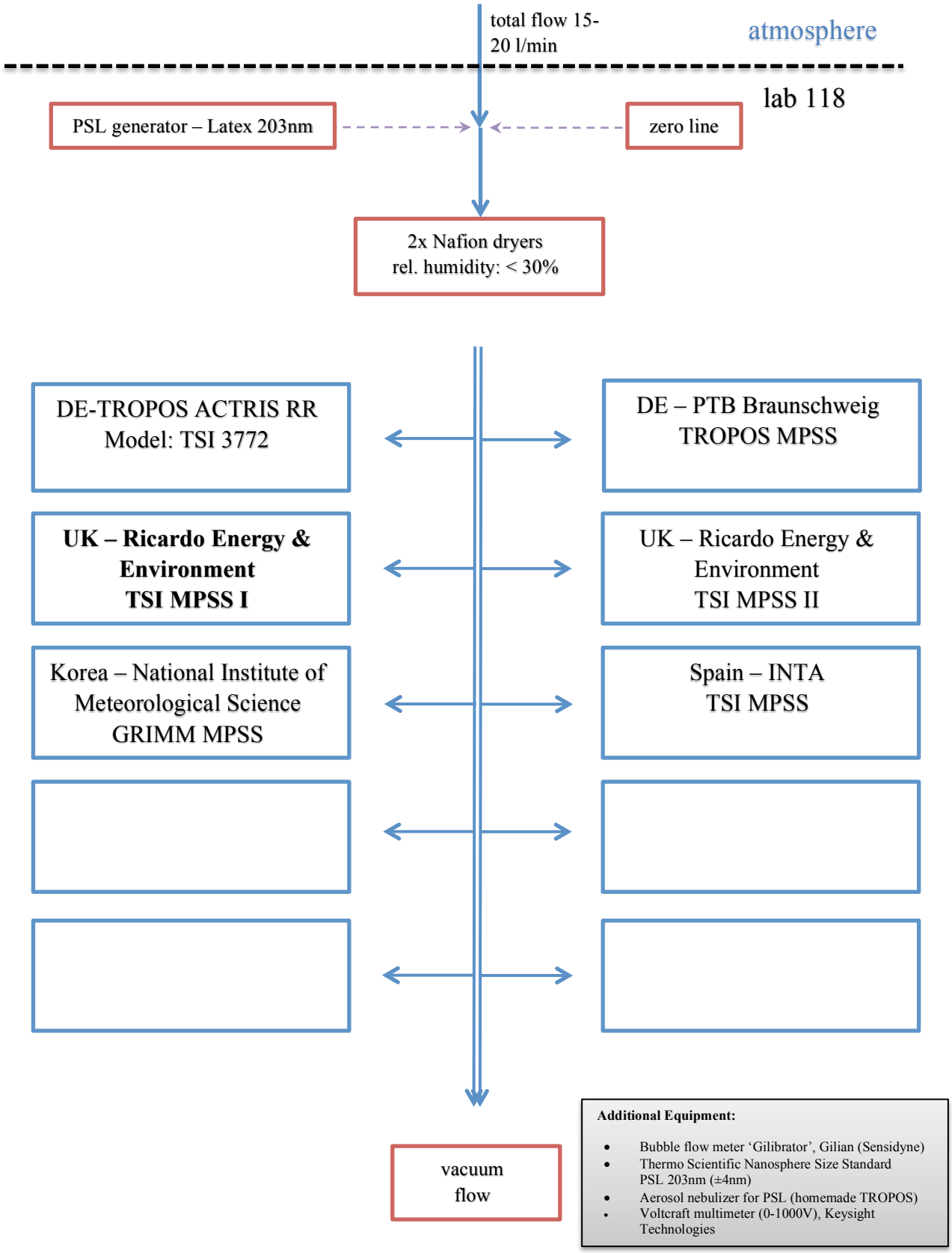
Laboratory setup:



Additional Equipment:

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

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Status of the instruments:

Date of system checks:

date	17.09.2018		unit
total CPC flow	-	-	l/min
aerosol flow (total)	0.960	-	l/min
Zero MPSS	0	-	#/cm³
Zero total CPC	-	-	#/cm³
PSL 203 nm	no data	-	nm

HV check	17.09.2018		unit
5.3	4.7		V
10.3	9.7		V
500.4	499.5		V
1000.3	998.5		V

Special Information regarding the Candidate - Date of check: September 17, 2018

Was it necessary to:	yes/no (date)	old part (ID/SN)	new part (ID/SN)	information
clean the aerosol inlet	no	-	-	checked
change aerosol Nafion dryer	no	-	-	-
change sheath Nafion dryer	no	-	-	-
check source	no	-	-	Changed to see differences
change HV power supply	no	-	-	checked
clean/change DMA	no	-	-	Checked/cleaned
change aerosol RH/T-sensor	no	-	-	-
change sheath RH/T-sensor	no	-	-	-
change pressure sensor	no	-	-	-
change inlet Nafion dryer (500)	no	-	-	-
Change Total filter	-	-	-	-
NI-card	no	-	-	-

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PSL Scan and calibration: Latex 203 nm +/- 4 nm

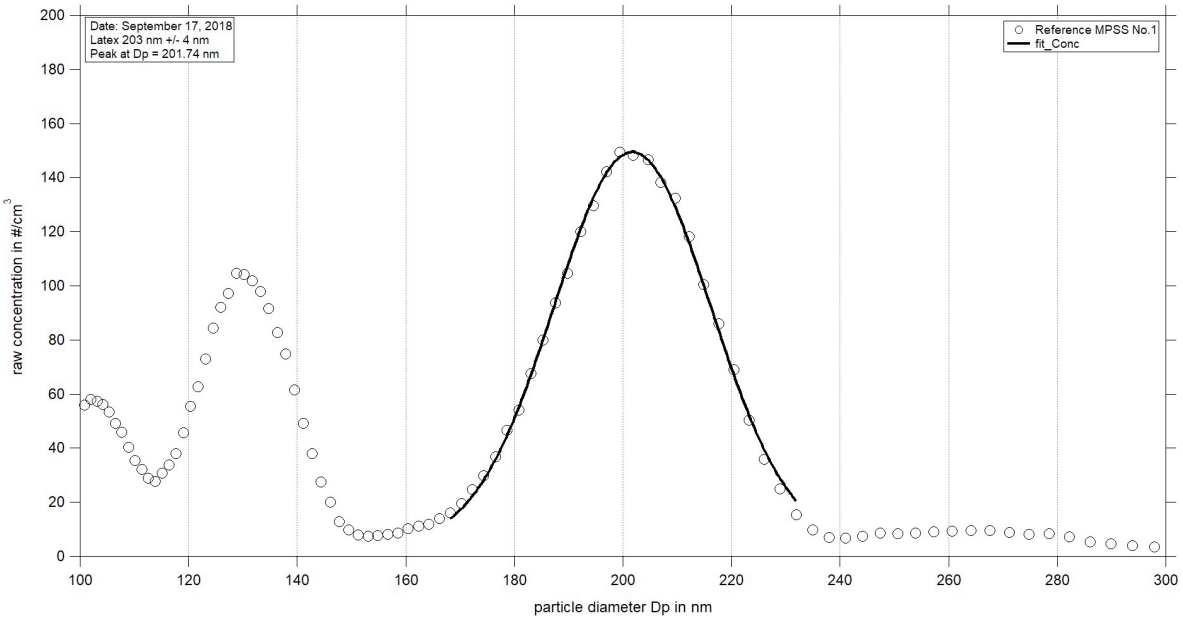

Figure 01: Measurement of latex 203 nm - Reference MPSS No.1: Particle size distribution (raw concentration) for latex 203 nm on September 17th 2018.

Pre-Status Sept. 17 – 18, 2018 with X-ray: Time Series, Particle Number Size Distribution and Correlation

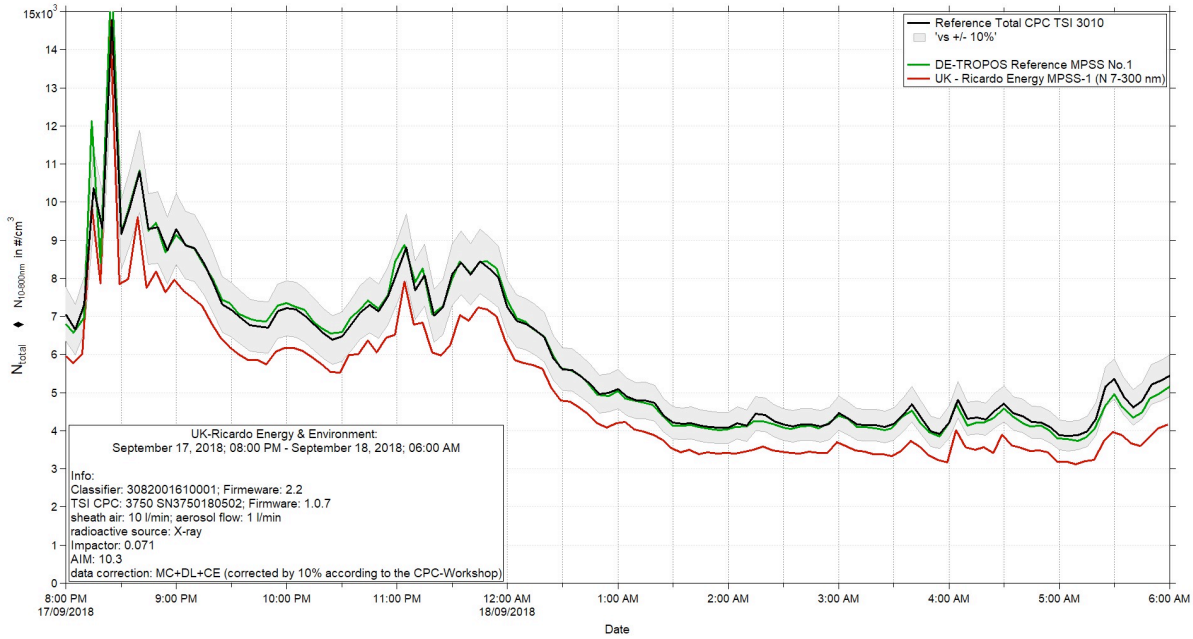

Figure 02: Time series (September 17, 2018 8 PM – September 18, 2018 6 AM) of the integrated particle number concentration ($N_{10\text{-}800nm}/N_{7\text{-}300nm}$) of the MPSS and total number concentration (N_{total}) of the Reference TSI-CPC Model 3010.

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Multiple charge correction, internal diffusion losses and CPC flow corrections are included. The candidate is running with the TSI X-ray source.

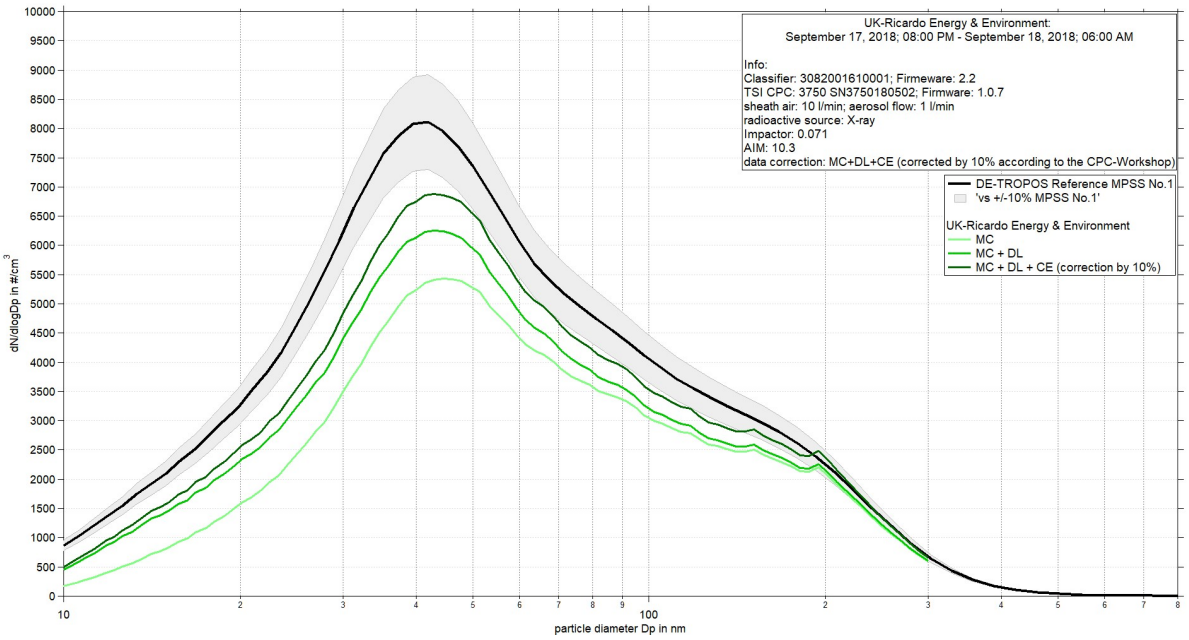

Figure 03: Comparison of mean particle number size distribution of TROPOS Reference MPSS No.1 against UK-Ricardo Energy & Environment from September 17, 2018 8 PM – September 18, 2018 6 AM. Multiple charge correction, internal diffusion losses and CPC efficiency are included in different steps.

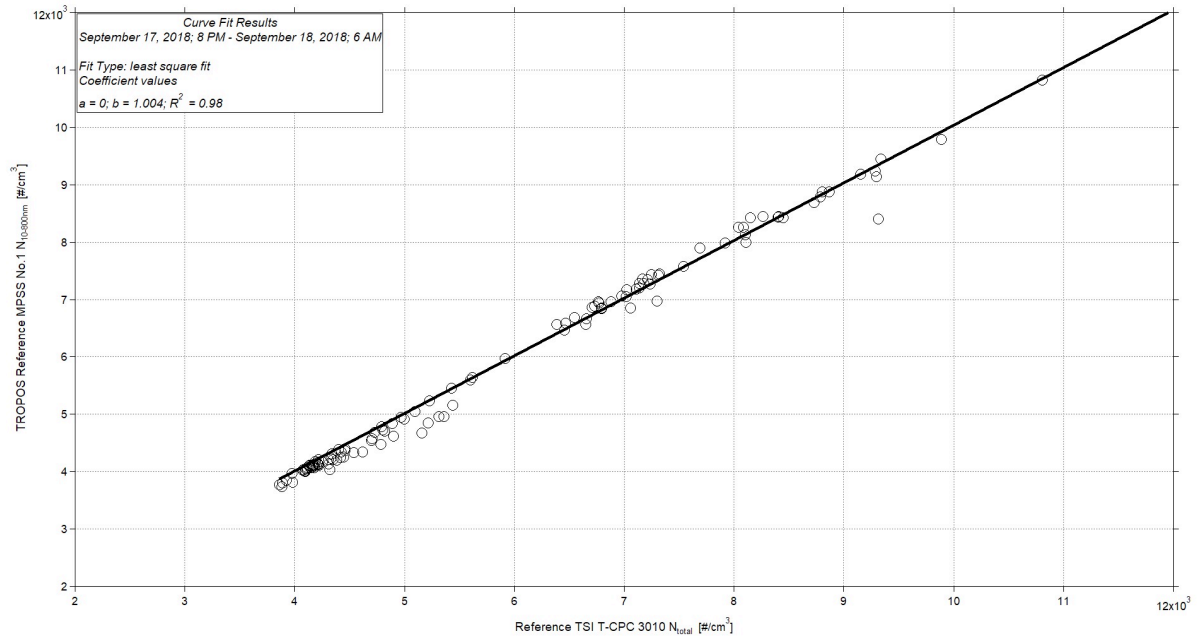

Figure 04: Linear regression between the number concentrations of the TROPOS Reference TSI T-CPC Model 3010 and TROPOS Reference MPSS No.1. Multiple charge correction, internal diffusion losses and CPC efficiency are included.

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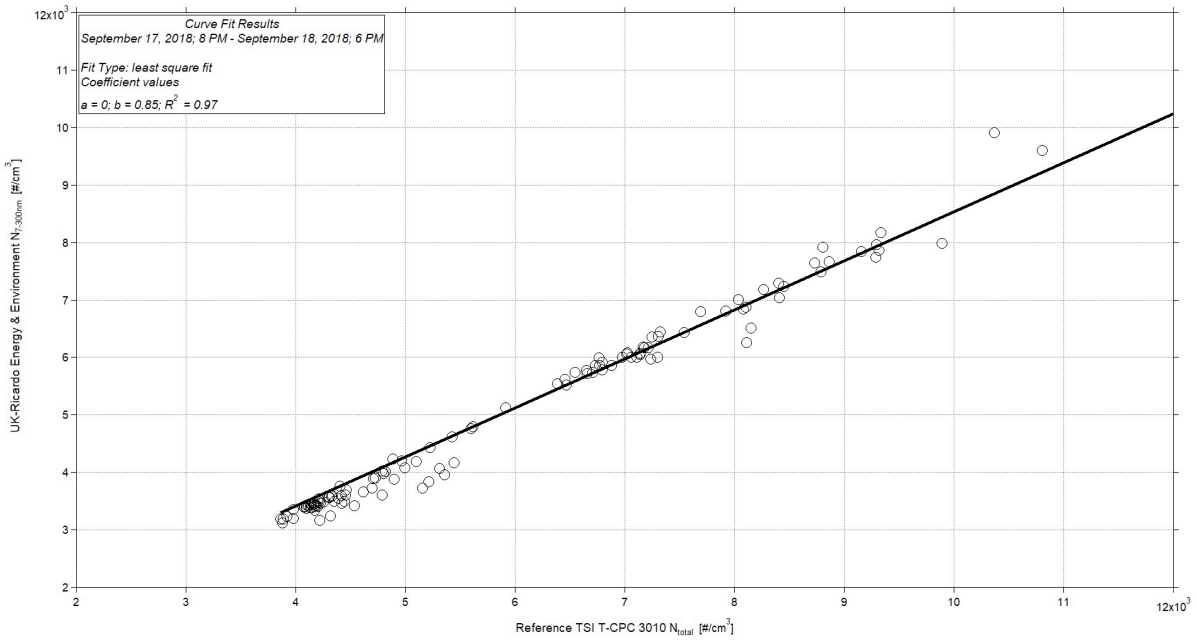

Figure 05: Linear regression between the number concentrations of the TROPOS Reference TSI T-CPC Model 3010 and UK-Ricardo Energy & Environment. Multiple charge correction, internal diffusion losses and CPC efficiency are included.

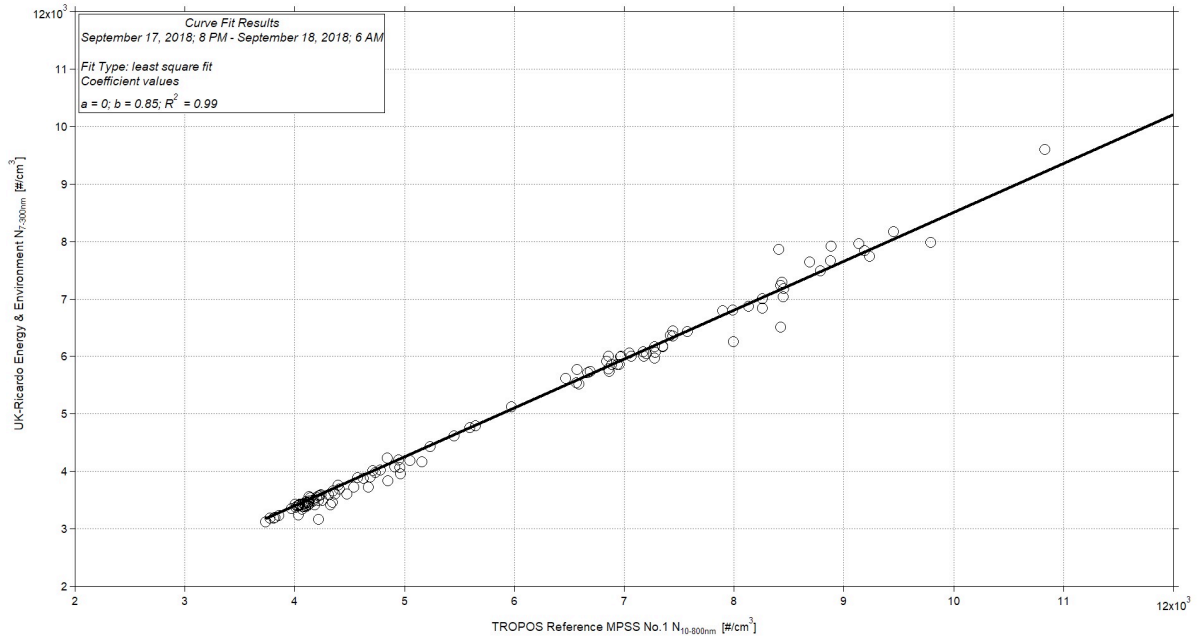

Figure 06: Linear regression between the number concentrations of the TROPOS Reference MPSS No.1 and UK-Ricardo Energy & Environment. Multiple charge correction, internal diffusion losses and CPC efficiency are included.

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Status Sept. 18 – 19, 2018 with X-ray: Time Series, Particle Number Size Distribution and Correlation

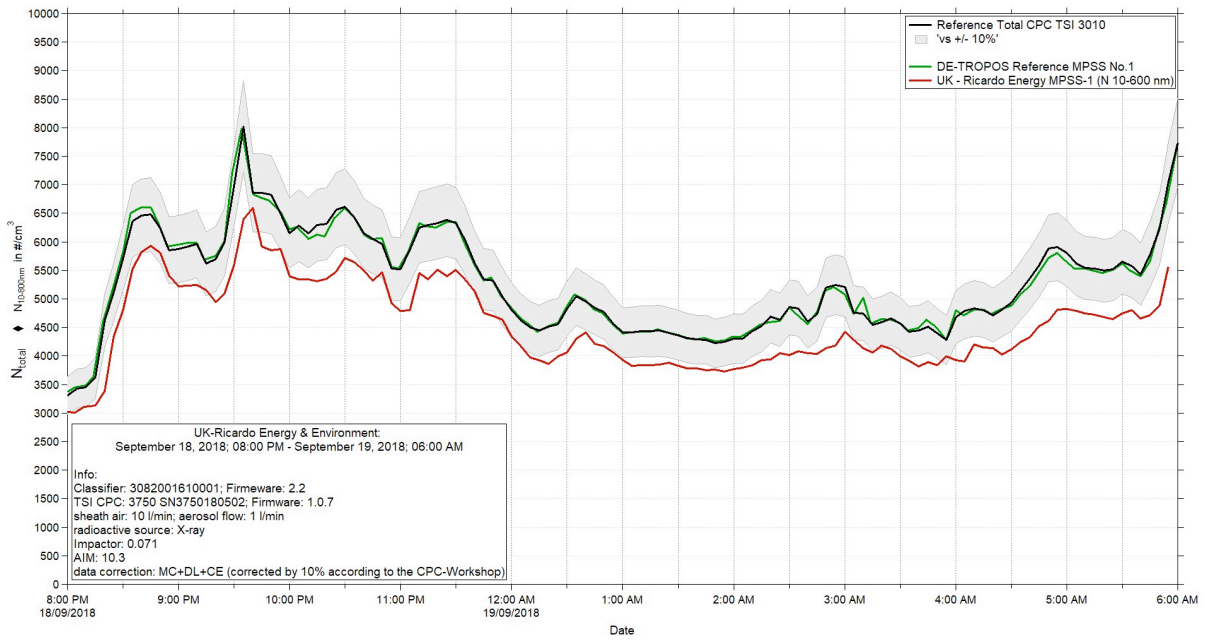

Figure 07: Time series (September 18, 2018 8 PM – September 19, 2018 6 AM) of the integrated particle number concentration ($N_{10\text{-}800nm}/N_{10\text{-}600nm}$) of the MPSS and total number concentration (N_{total}) of the Reference TSI-CPC Model 3010. Multiple charge correction, internal diffusion losses and CPC flow corrections are included. The candidate is running with the TSI X-ray source.

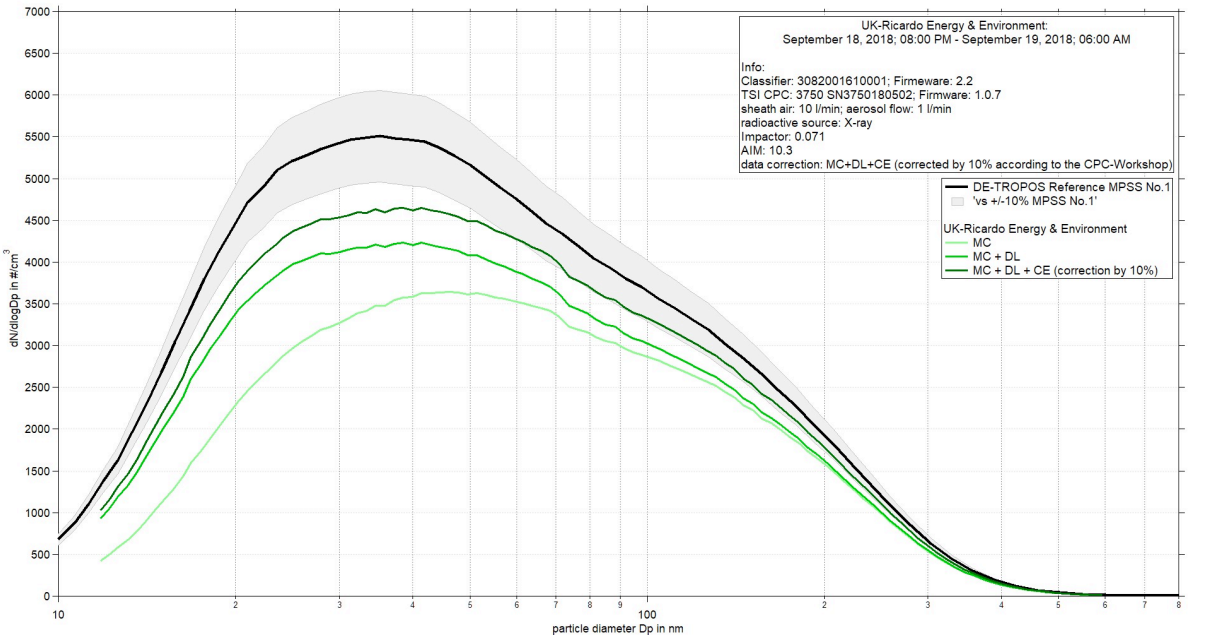

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Figure 08: Comparison of mean particle number size distribution of TROPOS Reference MPSS No.1 against UK-Ricardo Energy & Environment from September 18, 2018 8 PM – September 19, 2018 6 AM. Multiple charge correction, internal diffusion losses and CPC efficiency are included in different steps.

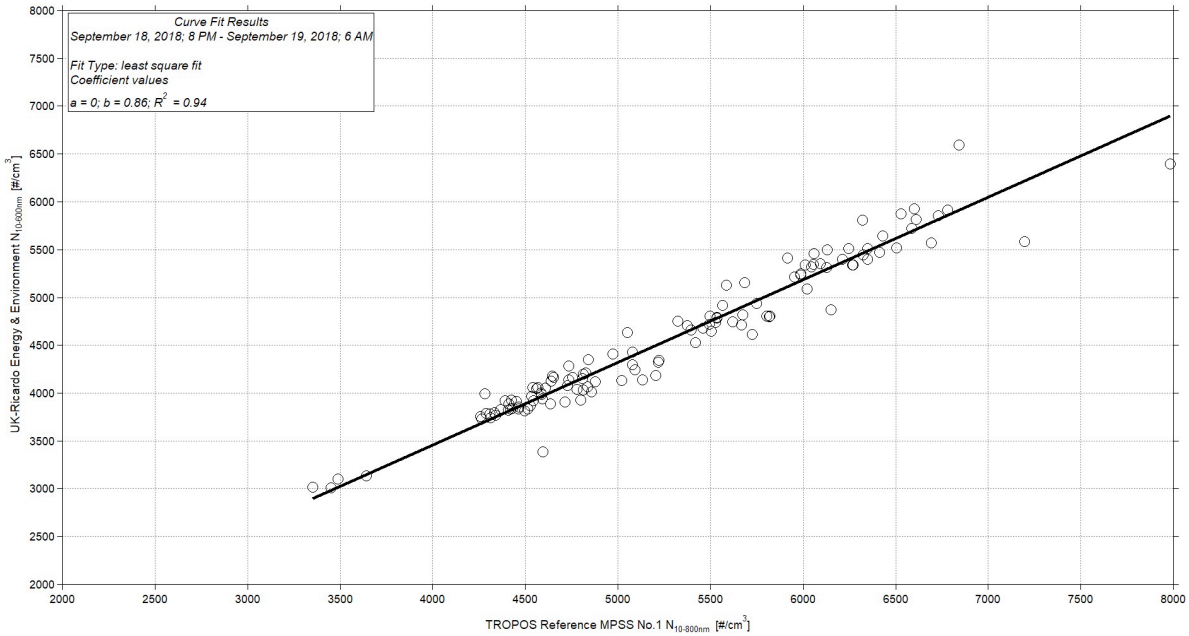

Figure 09: Linear regression between the number concentrations of the TROPOS Reference MPSS No.1 and UK-Ricardo Energy & Environment. Multiple charge correction, internal diffusion losses and CPC efficiency are included.

Status Sept. 19 – 20, 2018 with X-ray: Time Series, Particle Number Size Distribution and Correlation

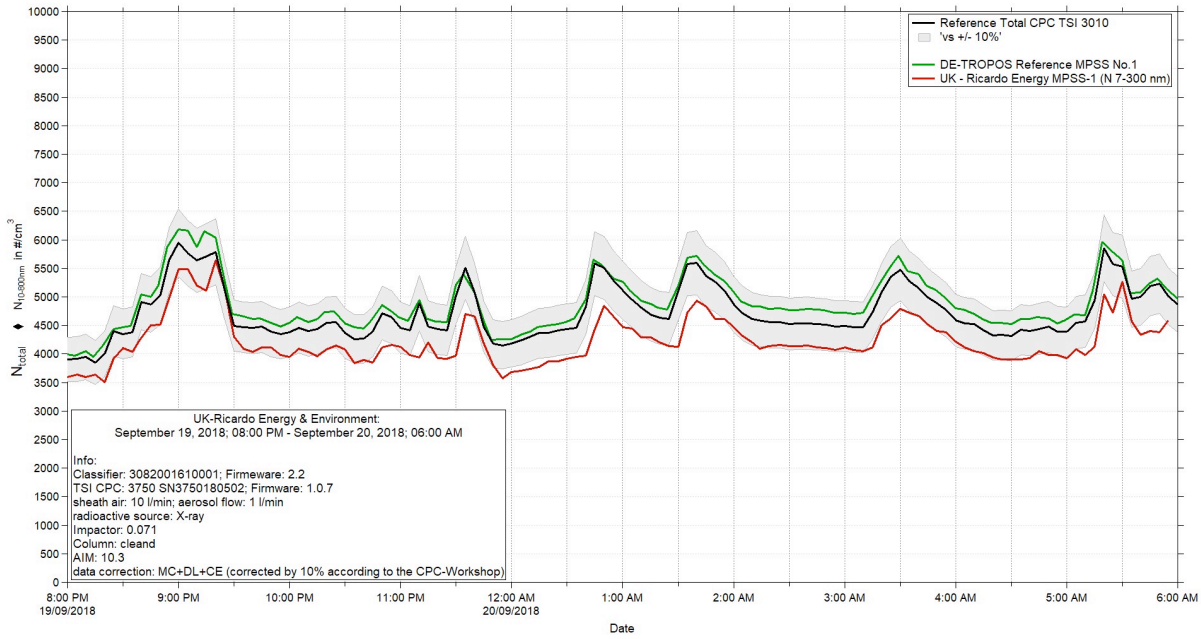

Figure 10: Time series (September 19, 2018 8 PM – September 20, 2018 6 AM) of the integrated particle number concentration ($N_{10\text{-}800nm}/N_{7\text{-}300nm}$) of the MPSS and total number concentration (N_{total}) of the Reference TSI-CPC Model 3010. Multiple charge correction, internal diffusion losses and CPC flow corrections are included. The candidate is running with the TSI X-ray source.

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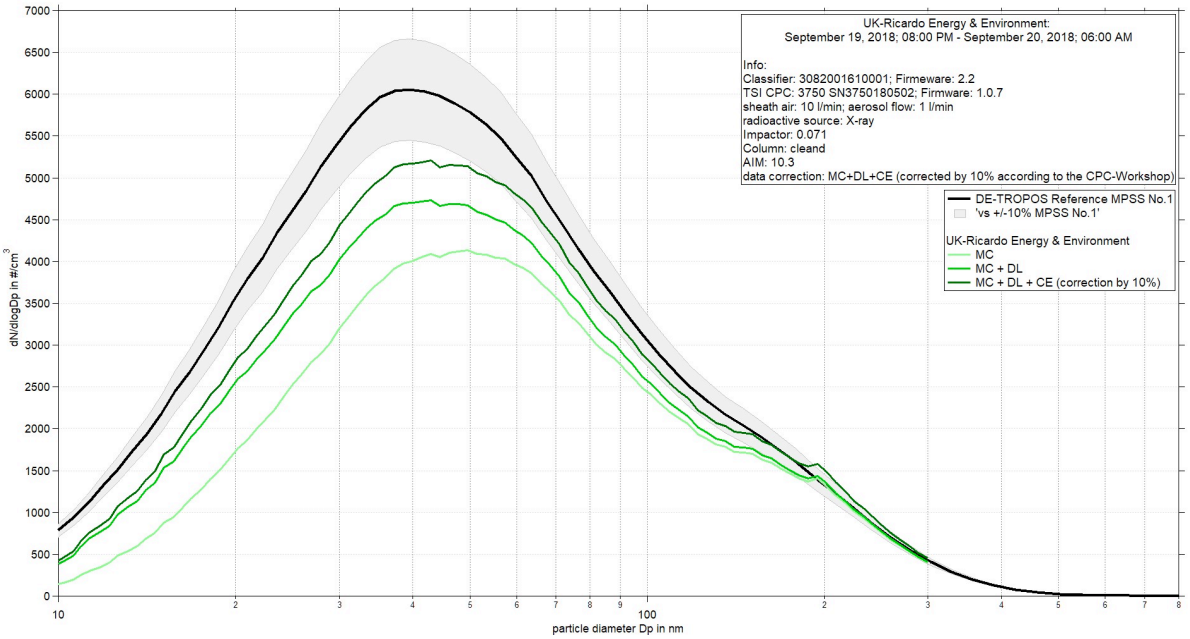

Figure 11: Comparison of mean particle number size distribution of TROPOS Reference MPSS No.1 against UK-Ricardo Energy & Environment from September 19, 2018 8 PM – September 20, 2018 6 AM. Multiple charge correction, internal diffusion losses and CPC efficiency are included in different steps.

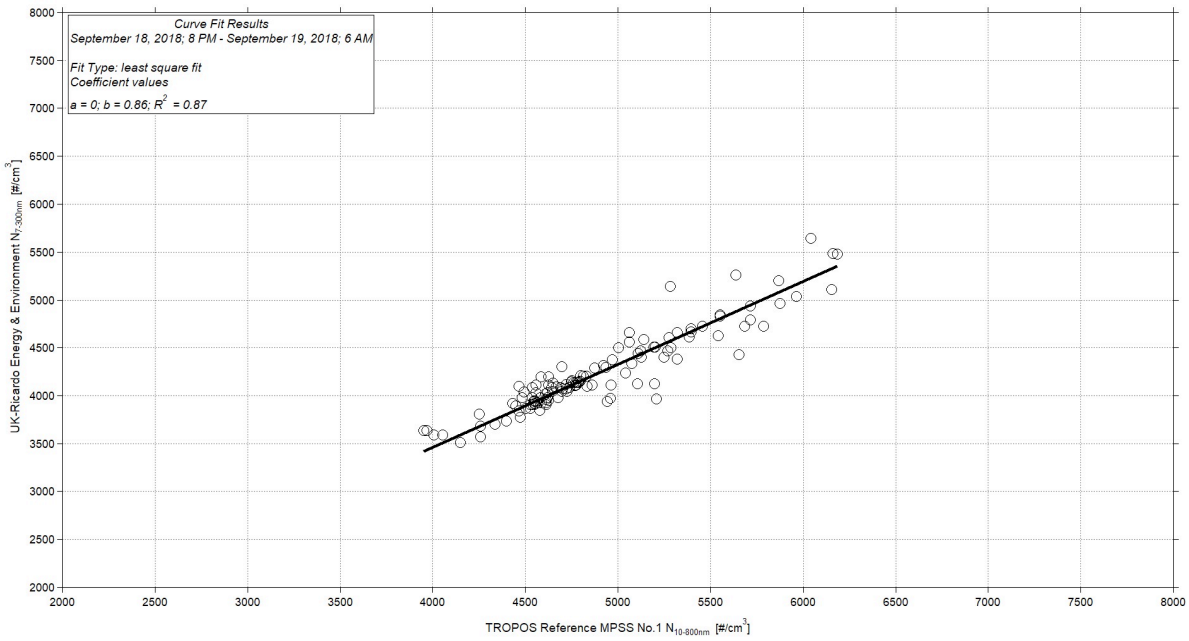

Figure 12: Linear regression between the number concentrations of the TROPOS Reference MPSS No.1 and UK-Ricardo Energy & Environment. Multiple charge correction, internal diffusion losses and CPC efficiency are included.

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Final-Status Sept. 20 – 21, 2018 with X-ray: Time Series, Particle Number Size Distribution and Correlation

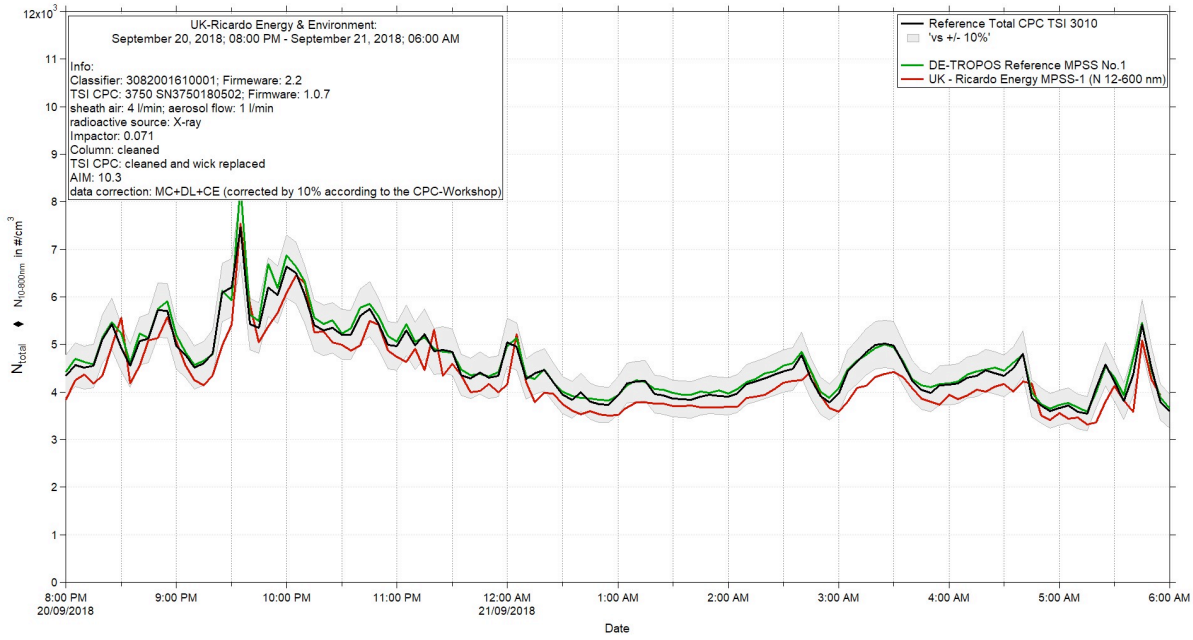

Figure 13: Time series (September 20, 2018 8 PM – September 21, 2018 6 AM) of the integrated particle number concentration ($N_{10\text{-}800nm}/N_{12\text{-}600nm}$) of the MPSS and total number concentration (N_{total}) of the Reference TSI-CPC Model 3010. Multiple charge correction, internal diffusion losses and CPC flow corrections are included. The candidate is running with the TSI X-ray source.

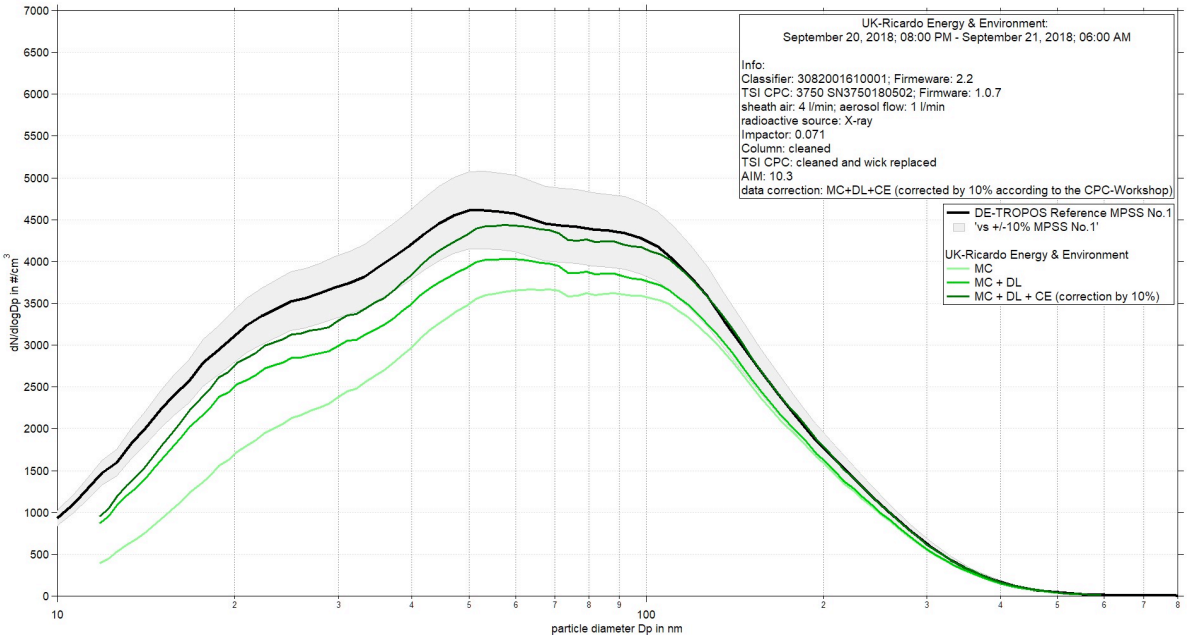

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Figure 14: Comparison of mean particle number size distribution of TROPOS Reference MPSS No.1 against UK-Ricardo Energy & Environment from September 20, 2018 8 PM – September 21, 2018 6 AM. Multiple charge correction, internal diffusion losses and CPC efficiency are included in different steps.

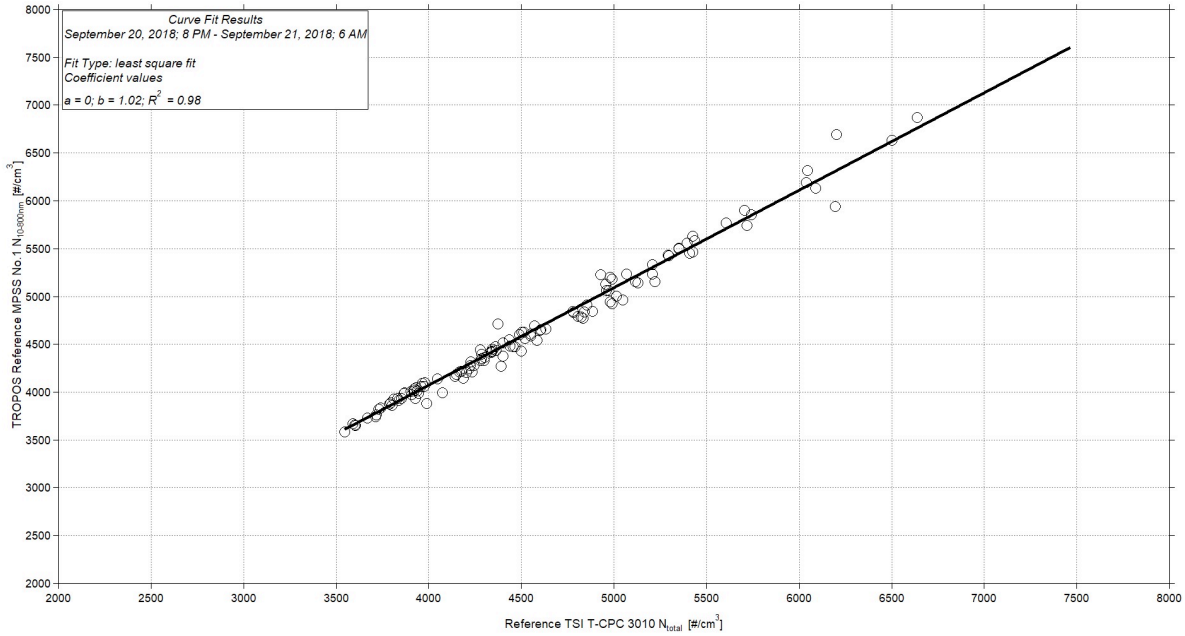

Figure 15: Linear regression between the number concentrations of the TROPOS Reference TSI T-CPC Model 3010 and TROPOS Reference MPSS No.1. Multiple charge correction, internal diffusion losses and CPC efficiency are included.

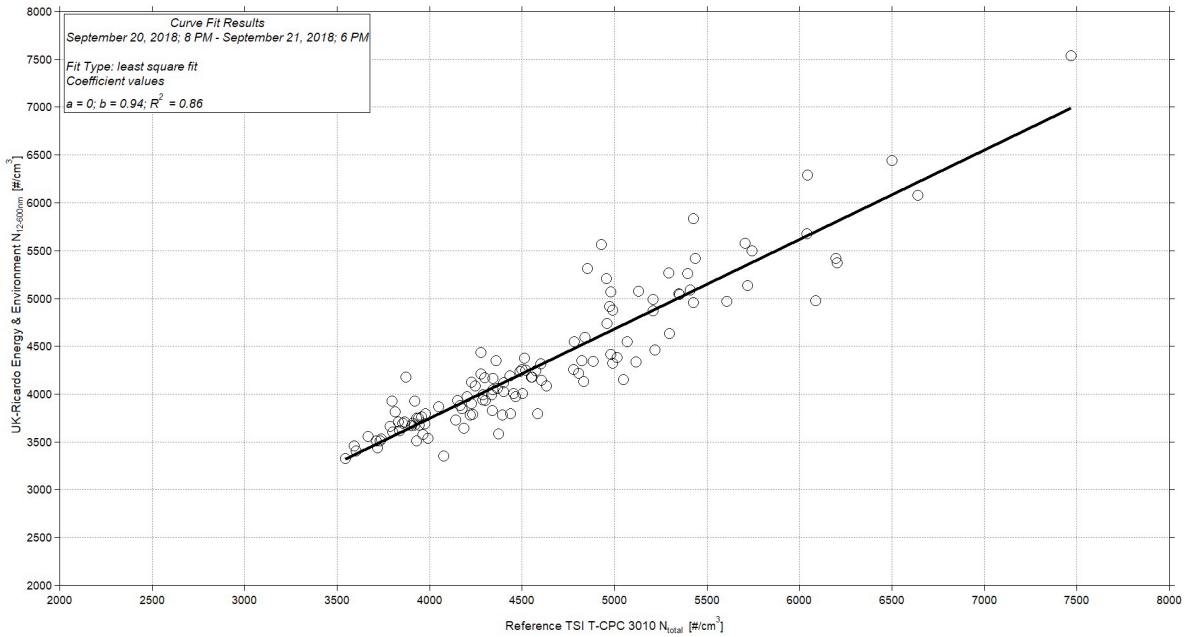

Figure 16: Linear regression between the number concentrations of the TROPOS Reference TSI T-CPC Model 3010 and UK-Ricardo Energy & Environment. Multiple charge correction, internal diffusion losses and CPC efficiency are included.

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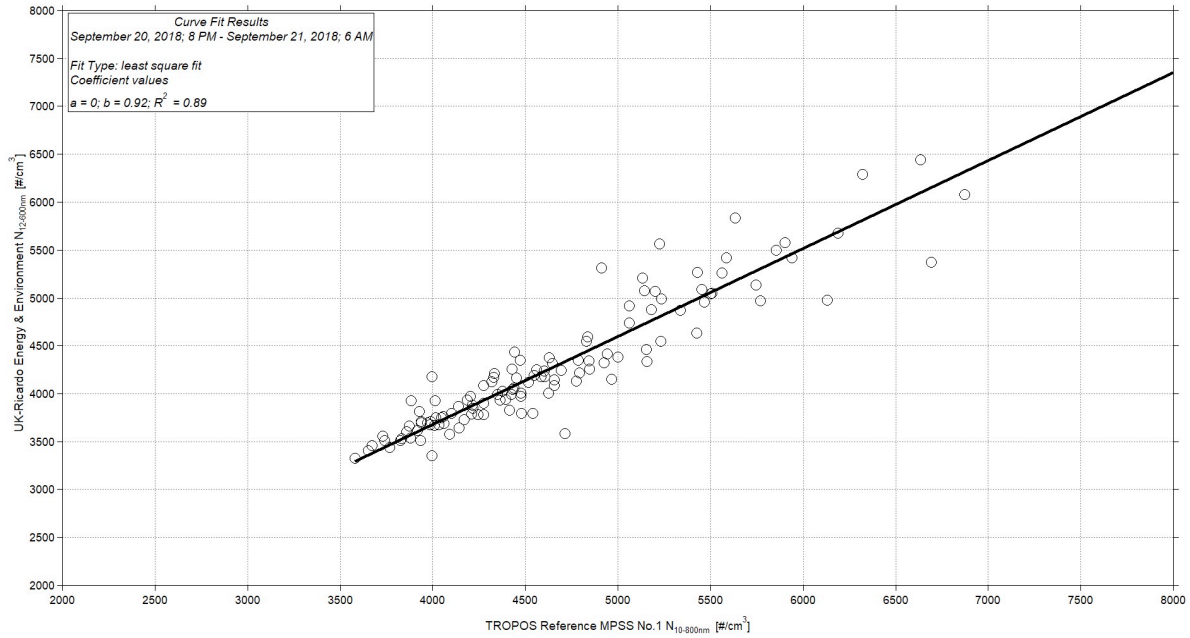

Figure 17: Linear regression between the number concentrations of the TROPOS Reference MPSS No.1 and UK-Ricardo Energy & Environment. Multiple charge correction, internal diffusion losses and CPC efficiency are included.

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