Intercomparison of Mobility Particle Size Spectrometers

Project No.:	MPSS-2019-2-1
Principal Investigator:	Harald Flentje
Home Institution:	*Deutscher Wetterdienst -Hohenpeißenberg*
Participant:	Björn Briel

Candidate: MPSS Hohenpeißenberg
Made by: TROPOS HOMEMADE
Counter (SN): 70711210

Location of the quality assurance:	TROPOS Leipzig, lab 118
Comparison period:	May 20, 2019 – May 29, 2019

Last Intercomparison (with Project No.)*:*
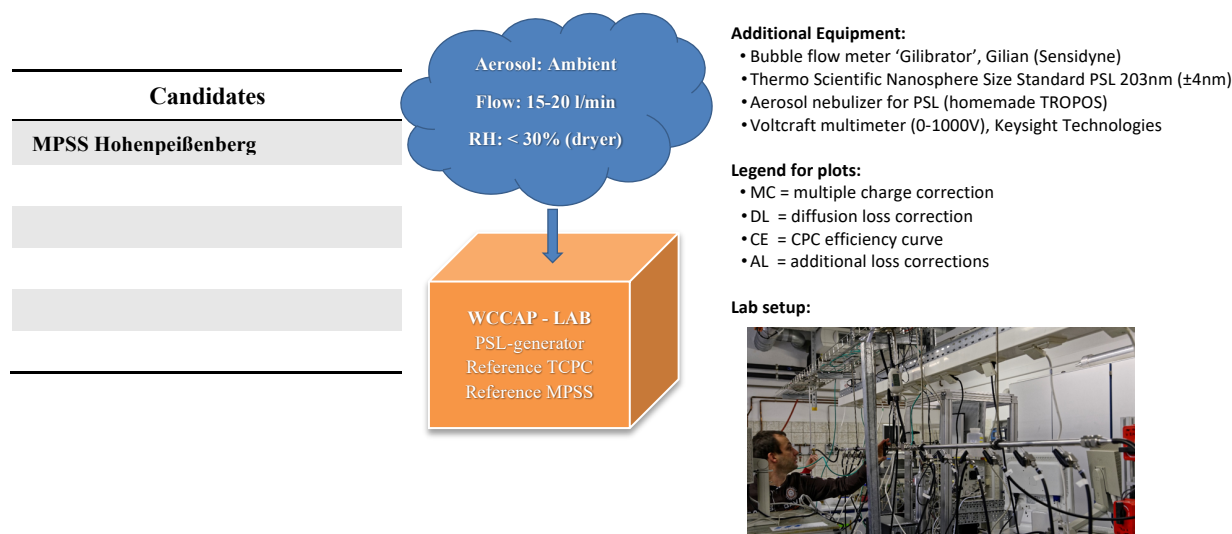
Summary of Intercomparison:

Pre-Status:

The candidate from DWD-Hohenpeißenberg MPSS participated in the ACTRIS workshop from May 20, 2019 to May 24, 2019 with the participant. The setup of the candidate was done on Monday, May 20th, afternoon. During the Pre-Status the candidate was running under the same settings, with their own TSI Kr.85 source, like on the Institute. The performance of the candidate showed a concentration 9% lower than the TROPOS Reference Instrument No.1. On Tuesday, May 21st, after the CPC-Workshop the MPSS was checked and the first part of maintenance was done. The performance of the CPC is shown in the report of the CPC-Workshop. The TSI CPC 3772 passed the CPC Workshop after maintenance. For more information, please look at the CPC-workshop report. During the workshop week, the whole candidate was checked and cleaned. More details are in the Tables for each night run. The participant was instructed and trained how to optimize his instrument. In addition, the station setup and quality assurance procedures were discussed.

Final-Status:

The final run took place from May 23 to May 24, 2019. Running the candidate using the new source Ni.63-DWD and the TROPOS Reference CPC No.4 the performance showed a concentration 9% lower than the TROPOS Reference Instrument No.1. The candidate passed the standards of ACTRIS and GAW conditions.

Laboratory Setup and Legend

Candidates

MPSS Hohenpeißenberg

Aerosol: Ambient

Flow: 15-20 l/min

RH: < 30% (dryer)

WCCAP - LAB
PSL-generator
Reference TCPC
Reference MPSS

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

Legend for plots:
- MC = multiple charge correction
- DL = diffusion loss correction
- CE = CPC efficiency curve
- AL = additional loss corrections

Lab setup:

TROPOS Reference Instruments No. 1 and No. 4

May 20 – May 21, 2019: Time Series, Particle Number Size Distribution and Correlation
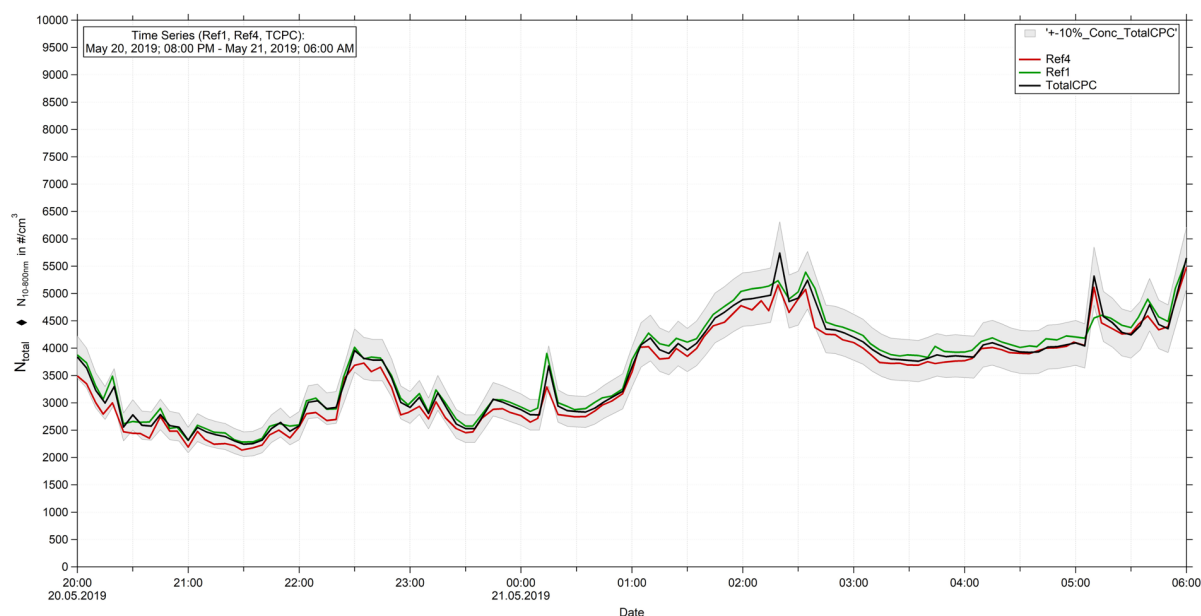

Figure 01: Time series (May 20, 2019 8 PM – May 21, 2019 6 AM) of the integrated particle number concentration ($N_{10-800nm}$) of the TROPOS Reference MPSS and total number concentration (N_{total}) of the Reference TSI-CPC Model 3010. Multiple charge correction, internal diffusion losses and CPC flow corrections are included.
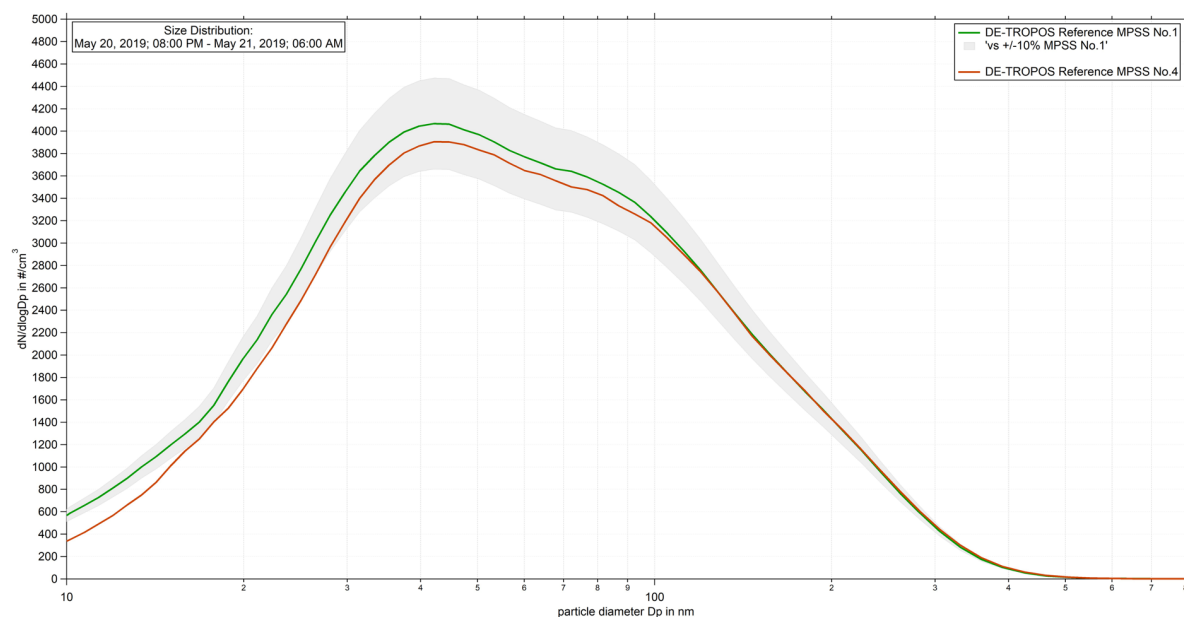
Figure 02: Comparison of mean particle number size distribution of TROPOS Reference MPSS No.1 against TROPOS Reference MPSS No.6 from May 20, 2019 8 PM – May 21, 2019 6 AM. Multiple charge correction, internal diffusion losses and CPC efficiency are included in different steps.
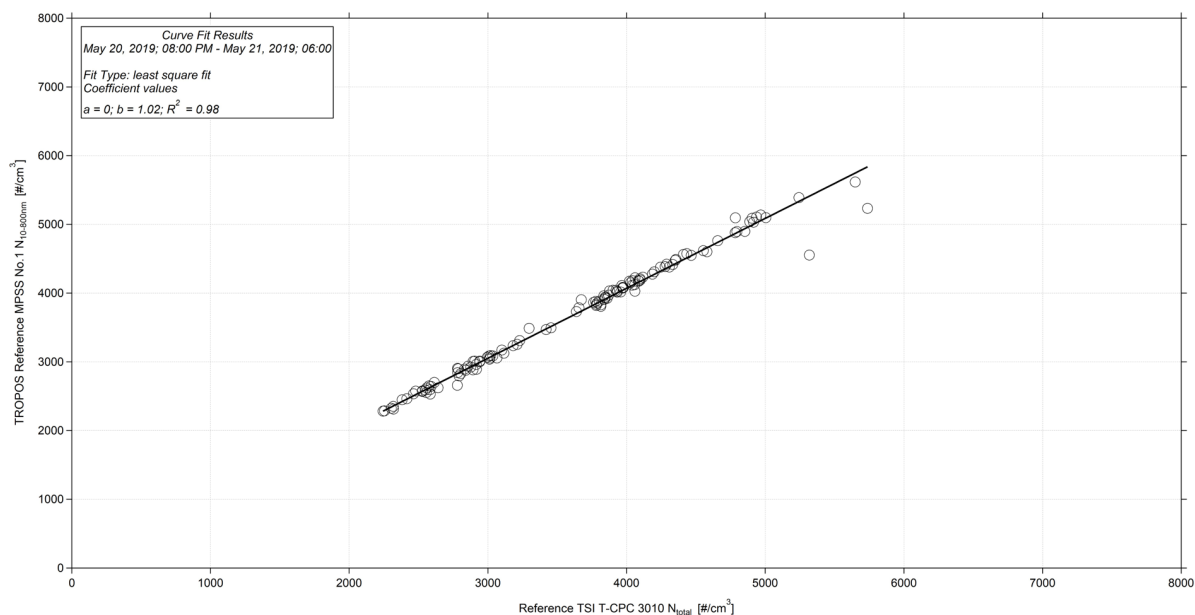

Figure 03: Linear regression between the number concentrations of the TROPOS Reference TSI T-CPC Model 3010 and TROPOS Reference MPSS No.1. Multiple charge correction, internal diffusion losses and CPC efficiency are included.
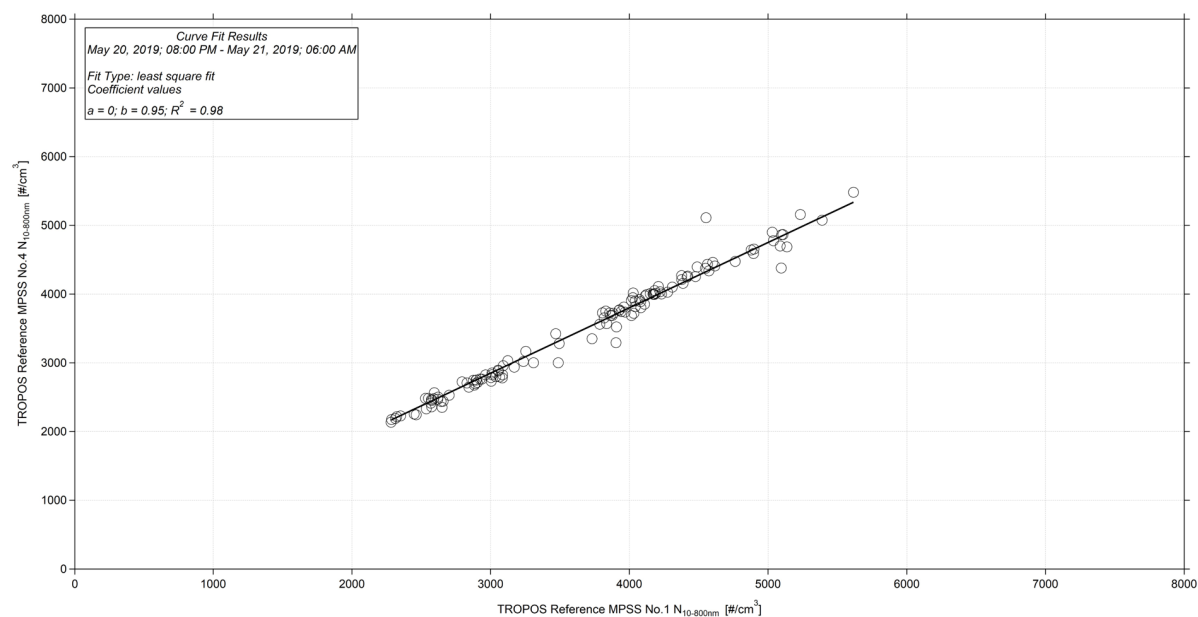
Figure 04: Linear regression between the number concentrations of the TROPOS Reference MPSS No.1 and TROPOS Reference MPSS No.6. Multiple charge correction, internal diffusion losses and CPC efficiency are included.
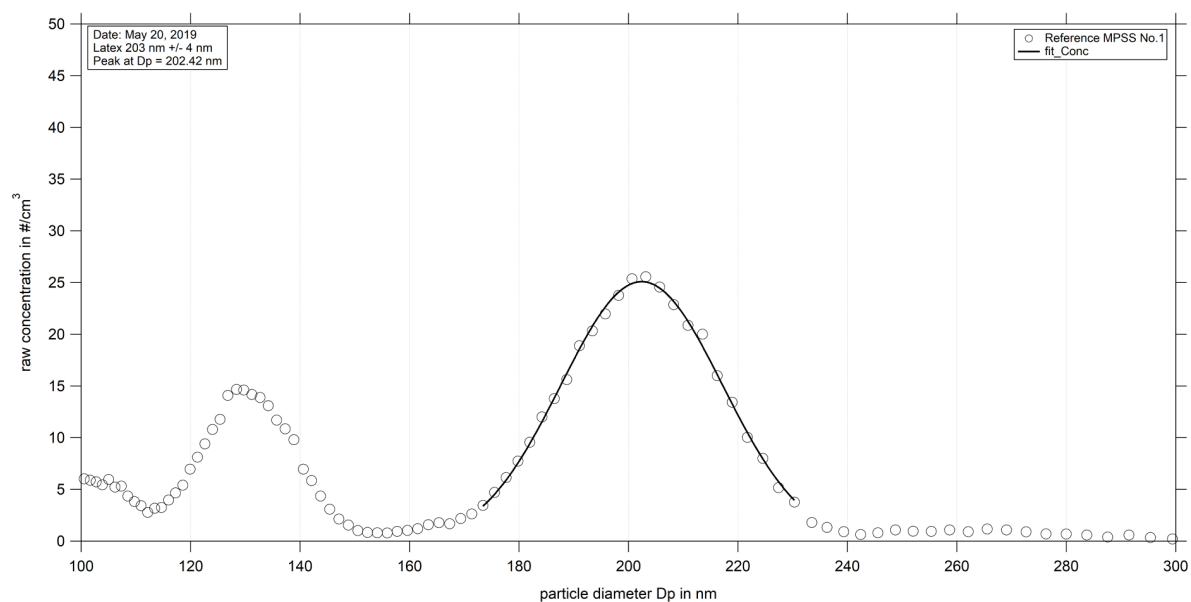
PSL Scan: Latex 203 nm +/- 4 nm

Figure 05: Measurement of latex 203 nm - Reference MPSS No.1: Particle size distribution (raw concentration) for latex 203 nm on May 20th 2019.
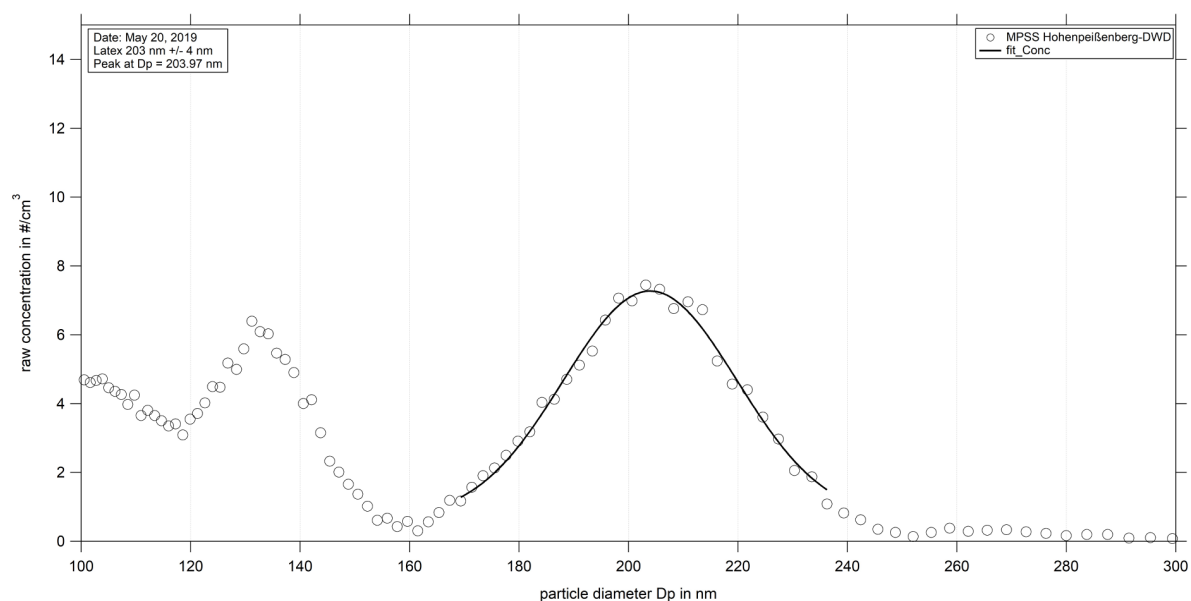
Figure 06: Measurement of latex 203 nm for the candidate DWD-Hohenpeißenberg MPSS: Particle size distribution for latex 203 nm on May 20th 2019 with a peak at 203.97 nm.

Pre-Status May 20 – 21, 2019

Instrument Settings, Time Series, Particle Number Size Distribution and Correlation

Table No. 1:

Instrument/ Components	info	SN	Date/Code	CPC-Status		HV-Status	
*Institute: **Deutscher Wetterdienst***							
Station: Hohenpeißenberg							
Date of checking list: **20.05.2019**							
MPSS/Classifier:	**TROPOS**			*ST*	**39.0**	*OFF*	
Firmware Classifier:	**TROPOS**			*CT*	**22.0**	*5 V*	**4.2**
Firmware Software:	**6.68**			*OT*	**40.0**	*1000 V*	**998**
DMA type:	**Vienna**		**160**	*CabT*	**33.2**	▮▮▮▮	
CPC model:	**TSI CPC 3772**	**70711210**		*AP*	**97.8**	*5 V*	**5.1**
Firmware CPC:	**2.16**			*OP*	**75.0**	*1000V*	**1000.1**
radioactive source:	**Kr.85**			*NP*	**2.7**	*250V*	**250**
Flow CPC (l/min):				*LC*		*5 V*	**5.1**
Flow Inlet (l/min):	**0.957**					*0*	**0.2**
Flow Display (l/min):							
Zero (#/cm³):	**0**						
Aerosol Nafion dryer	**MD-110-12E-S 072717-17-07**						
Sheath Nafion dryer	**ND0.7-72d**						
Maintenance							
Aerosol inlet:							
Aerosol Nafion dryer:							
Sheath Nafion dryer:							
Source:							
HV power supply:							
DMA:							
Aerosol/sheath RH/T- sensor:							
Pressure sensor:							
Filter:							
NI-card:							
CPC:							
Impactor:							
Setup settings over night:							

Instrument/ Components	info	Serial Number	Date/Code	CPC-Status		HV-Status	
Institute: **TROPOS**							
Station: **Reference Instrument No.1**							
Date of checking list: **May 20, 2019**							
MPSS/Classifier:	**TROPOS**	**No.1**		*ST*	**39.0**	*0 V*	**0**
Firmware Classifier:				*CT*	**22.0**	*5 mV*	**5.1**
Firmware Software:	**TROPOS 6.68**			*OT*	**40.0**	*800 mV*	**999.7**
DMA type:	**Hauke medium**		**142**	*CabT*	**27.3**	*200 mV*	**249.8**
CPC model:	**TSI 3772**	**3772141701**		*AP*	**98.5**	*0 V*	**0**
Firmware CPC:	**2.15**			*OP*	**72.1**		
Radioactive source:	**Kr.85**	**NER 8275**	**002/13**	*NP*	**2.8**		
Flow Inlet (l/min):	**1.009**			*LC*	**50**		
Zero (#/cm³):	**0**						

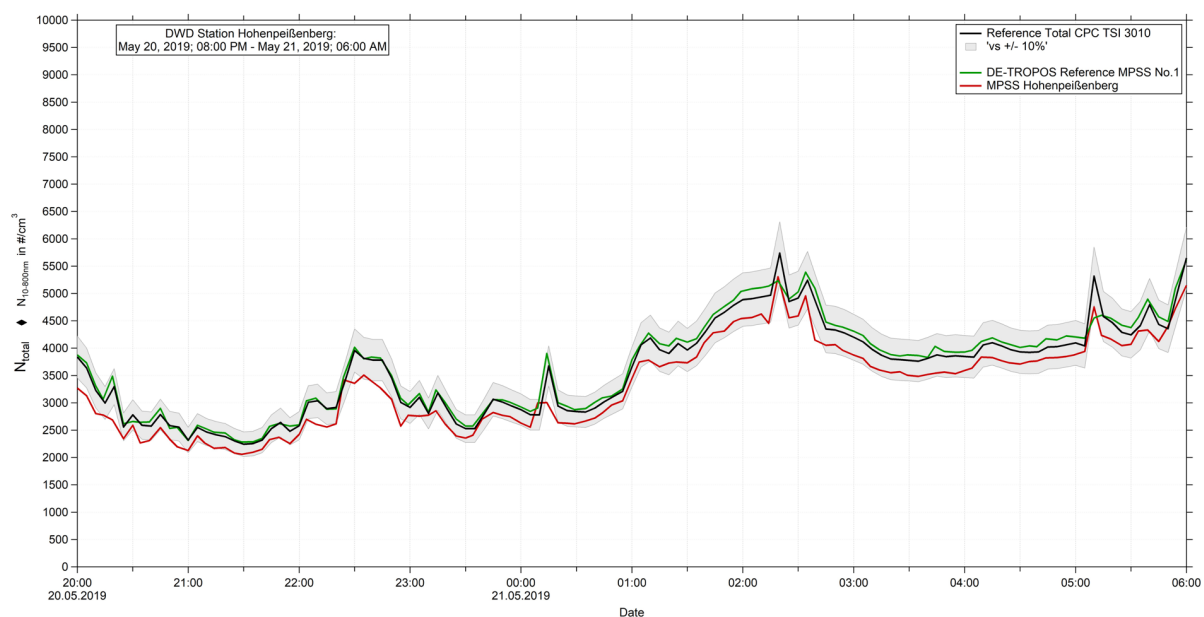| Institute: **TROPOS**						
Station: **Reference Total CPC**						
Date of checking list: **May 20, 2019**						
Instrument/ Components	info	Serial Number	Cut off	CPC-Status		
CPC model:	**TSI 3010**	**2337**	**D_{p50} 10 nm**	ST		
Firmware CPC:	**2.15**			CT		
Flow Inlet (l/min):	**1.001**			OT		
Zero (#/cm³):	**0**			CabT		
				AP		
				OP		
				NP		
				LC		

Figure 08: Time series (May 20, 2019 8 PM – May 21, 2019 6 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. Multiple charge correction, internal diffusion losses and CPC flow corrections are included. The candidate is running with the Kr.85 source.
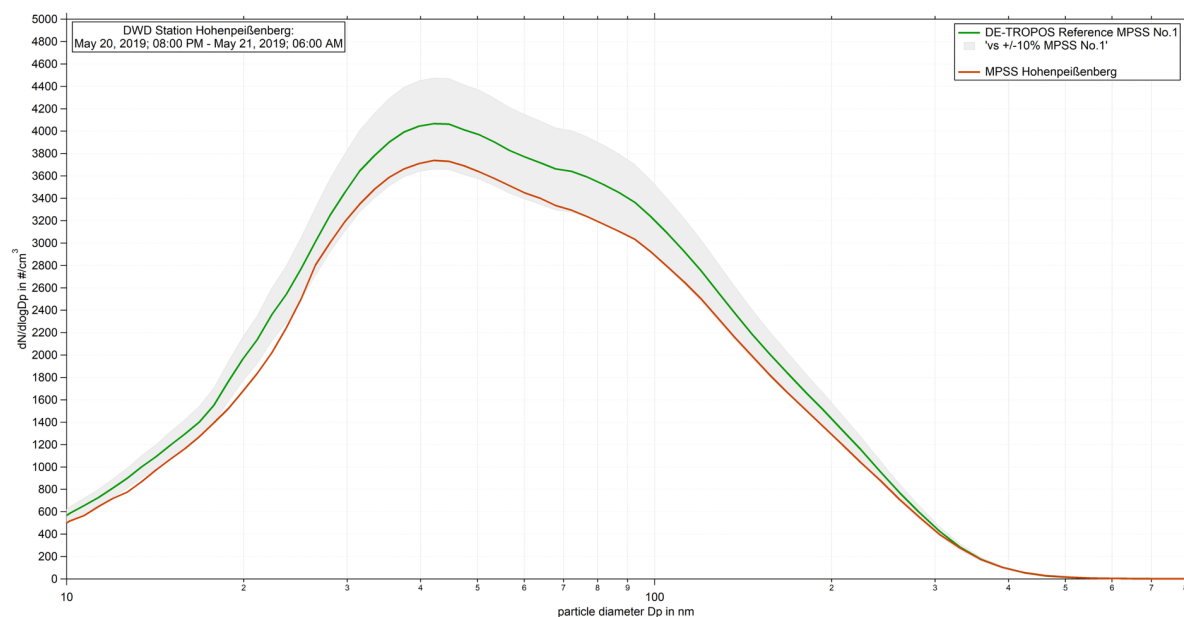
Figure 09: Comparison of mean particle number size distribution of TROPOS Reference MPSS No.1 against DWD-Hohenpeisenberg MPSS from May 20, 2019 8 PM – May 21, 2019 06:00 AM. Multiple charge correction, internal diffusion losses and CPC efficiency are included in different steps.
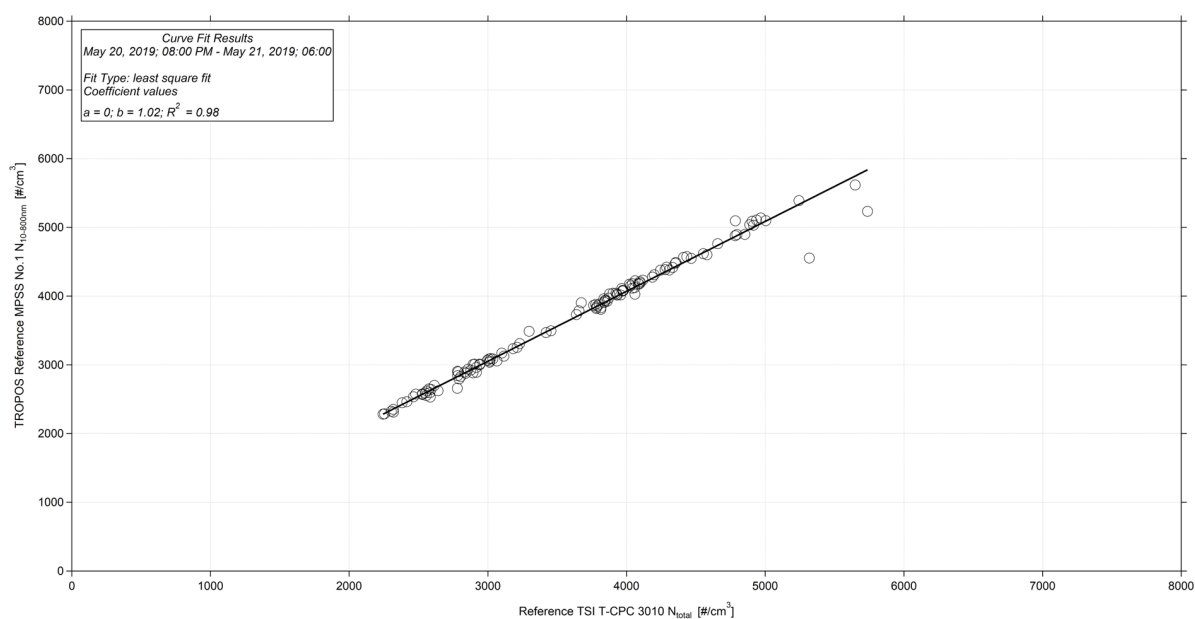

Figure 10: Linear regression between the number concentrations of the TROPOS Reference TSI T-CPC Model 3010 and TROPOS Reference MPSS No.1. Multiple charge correction, internal diffusion losses and CPC efficiency are included.
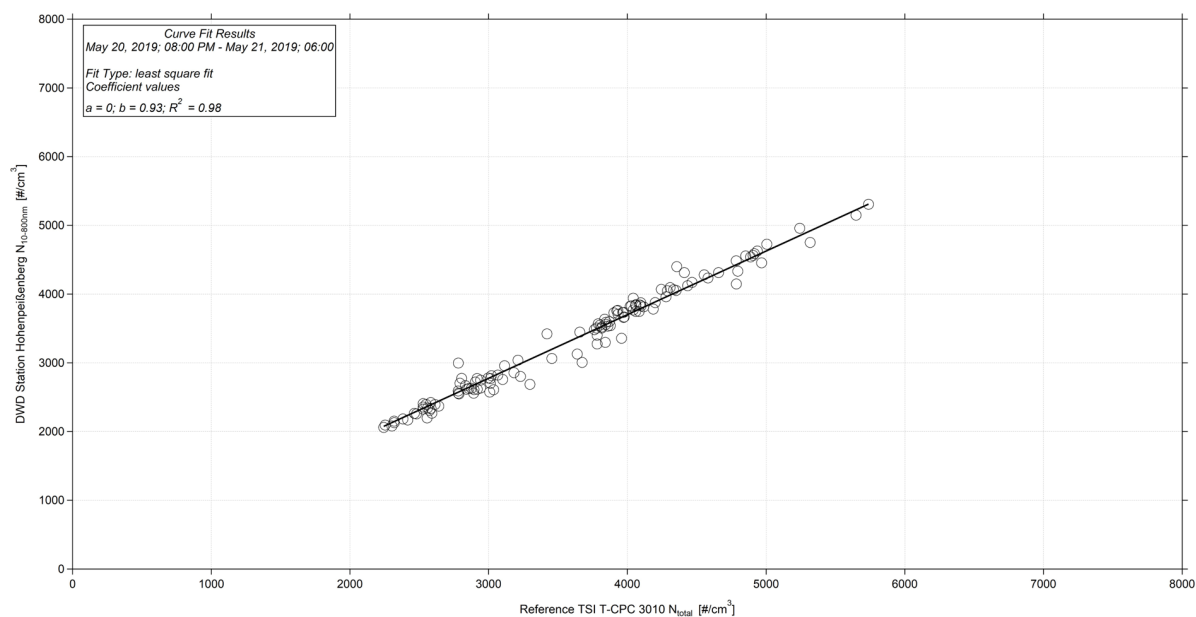
Figure 11: Linear regression between the number concentrations of the TROPOS Reference TSI T-CPC Model 3010 and DWD-Hohenpeißenberg MPSS. Multiple charge correction, internal diffusion losses and CPC efficiency are included.
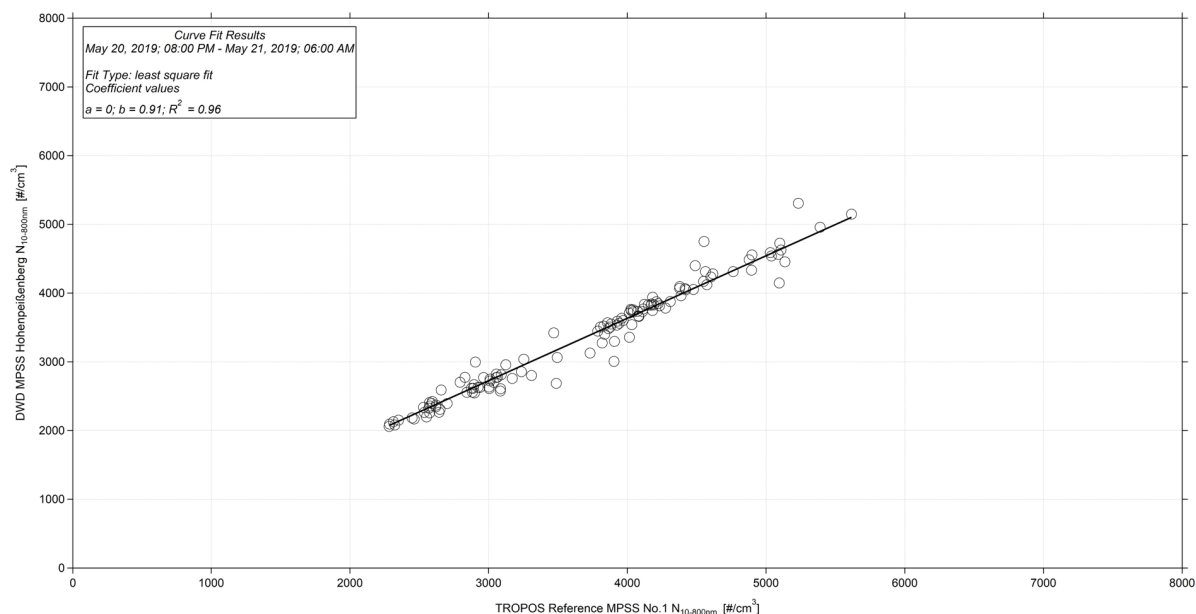

Figure 12: Linear regression between the number concentrations of the TROPOS Reference MPSS No.1 and DWD-Hohenpeißenberg MPSS. Multiple charge correction, internal diffusion losses and CPC efficiency are included.

Status May 21 – 22, 2018

Instrument Settings, Time Series, Particle Number Size Distribution and Correlation

Table No. 2:

Instrument/ Components	info	SN	Date/Code	CPC-Status		HV-Status	
Institute: **Deutscher Wetterdienst**							
Station: Hohenpeißenberg							
Date of checking list: **21.05.2019**							
MPSS/Classifier:	**TROPOS**			*ST*	**39.0**	*OFF*	
Firmware Classifier:	**TROPOS**			*CT*	**22.0**	*5 V*	**4.2**
Firmware Software:	**6.68**			*OT*	**40.0**	*1000 V*	**998**
DMA type:	**Vienna**		**160**	*CabT*	**33.2**	▉	
CPC model:	**TSI CPC 3772**	**70711210**		*AP*	**97.8**	*5 V*	**5.1**
Firmware CPC:	**2.16**			*OP*	**75.0**	*1000V*	**1000.1**
radioactive source:	**Kr.85**			*NP*	**2.7**	*250V*	**250**
Flow CPC (l/min):				*LC*		*5 V*	**5.1**
Flow Inlet (l/min):	**0.957**					*0*	**0.2**
Flow Display (l/min):							
Zero (#/cm³):	**0**						
Aerosol Nafion dryer	**MD-110-12E-S 072717-17-07**						
Sheath Nafion dryer	**ND0.7-72d**						
			Maintenance				
Aerosol inlet:							
Aerosol Nafion dryer:	**Instrument is running without nafion from 21.-22.05.19. Nafion -> check**						
Sheath Nafion dryer:							
Source:							
HV power supply:							
DMA:							
Aerosol/sheath RH/T- sensor:							
Pressure sensor:							
Filter:							
NI-card:							
CPC:	**CPC was dirty -> cleaning**						
Impactor:							
Setup settings over night:							

Instrument/ Components	info	Serial Number	Date/Code	CPC-Status		HV-Status	
Institute: **TROPOS**							
Station: **Reference Instrument No.1**							
Date of checking list: **May 21, 2019**							
MPSS/Classifier:	**TROPOS**	**No.1**		*ST*		*0 V*	
Firmware Classifier:				*CT*		*5 mV*	
Firmware Software:	**TROPOS 6.68**			*OT*		*800 mV*	
DMA type:	**Hauke medium**		**142**	*CabT*		*200 mV*	
CPC model:	**TSI 3772**	**3772141701**		*AP*		*0 V*	
Firmware CPC:	**2.15**			*OP*			
Radioactive source:	**Kr.85**	**NER 8275**	**002/13**	*NP*			
Flow Inlet (l/min):	**1.009**			*LC*			
Zero (#/cm³):	**0**						

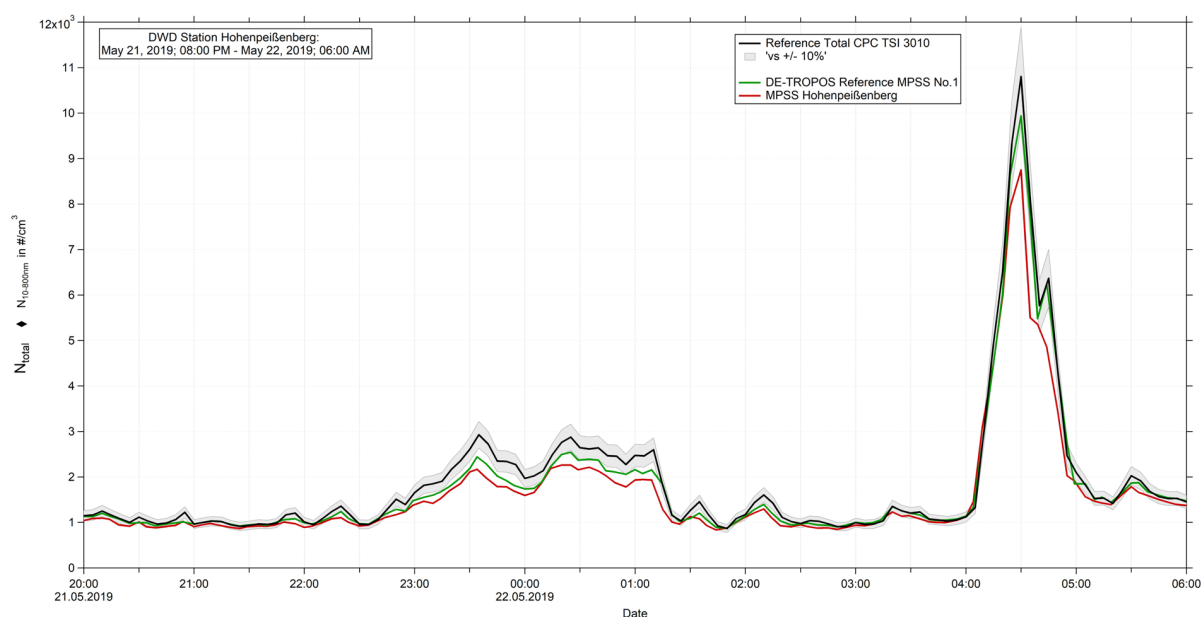| Institute: **TROPOS**					
Station: **Reference Total CPC**					
Date of checking list: **May 21, 2019**					
Instrument/ Components	info	Serial Number	Cut off	CPC-Status	
CPC model:	**TSI 3010**	**2337**	**D_{p50} 10 nm**	ST	
Firmware CPC:	**2.15**			CT	
Flow Inlet (l/min):	**1.001**			OT	
Zero (#/cm³):	**0**			CabT	
				AP	
				OP	
				NP	
				LC	

Figure 13: Time series (May 21, 2019 8 PM – May 22, 2019 6 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. Multiple charge correction, internal diffusion losses and CPC flow corrections are included. The candidate is running with the Kr.85 source.
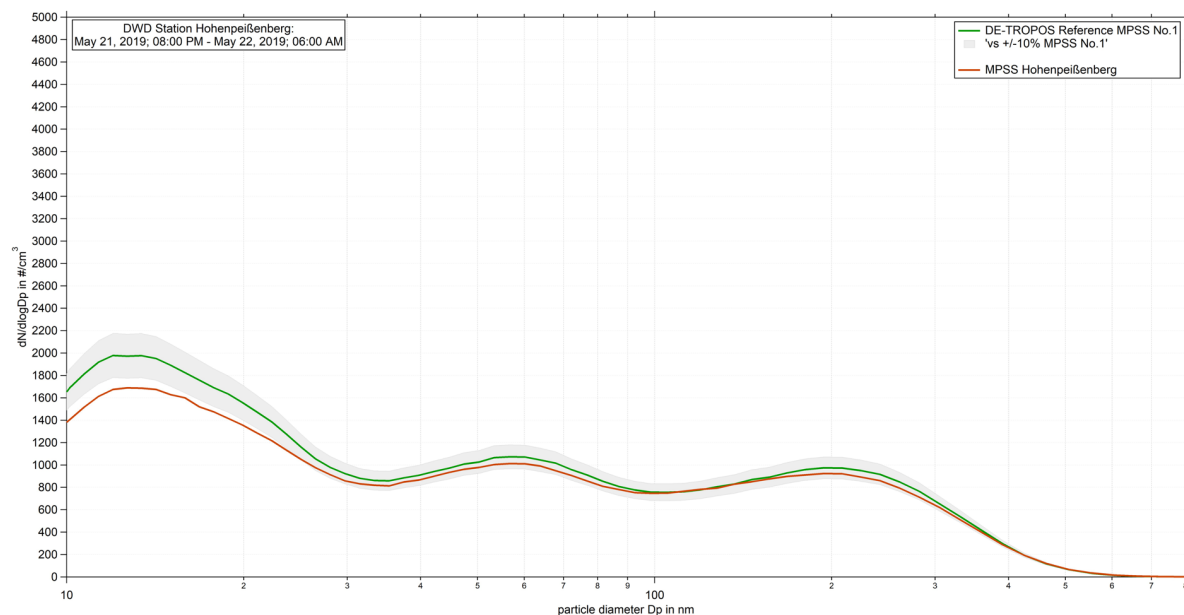
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Figure 14: Comparison of mean particle number size distribution of TROPOS Reference MPSS No.1 against DWD-Hohenpeisenberg MPSS from May 21, 2019 8 PM – May 22, 2019 06:00 AM. Multiple charge correction, internal diffusion losses and CPC efficiency are included in different steps.
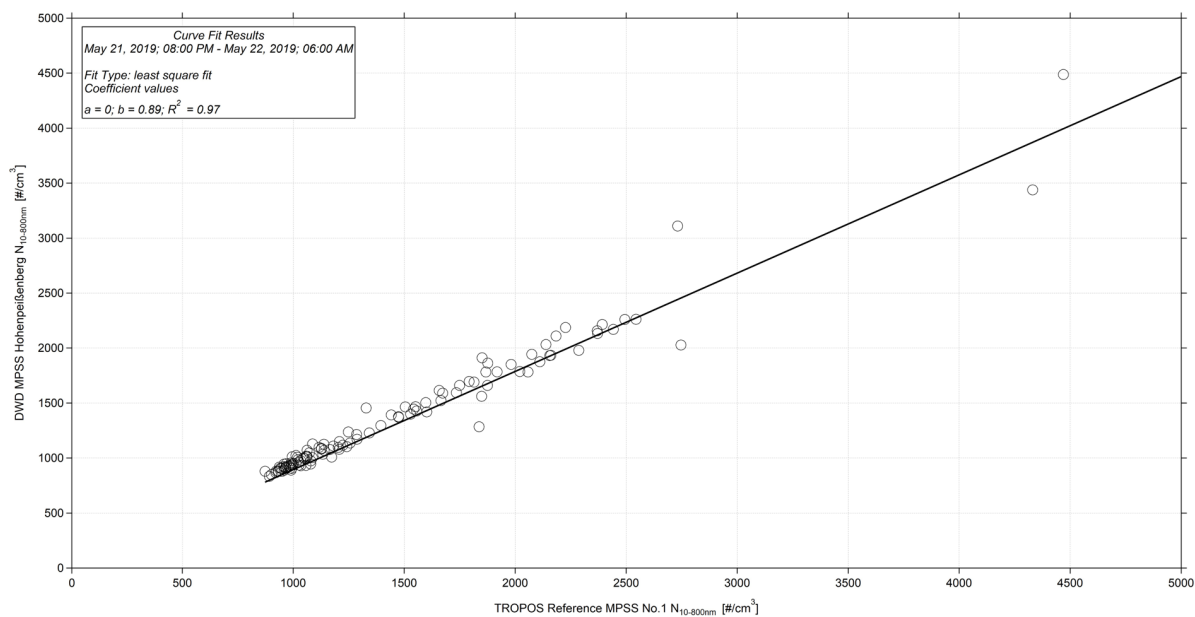

Figure 15: Linear regression between the number concentrations of the TROPOS Reference MPSS No.1 and DWD-Hohenpeißenberg MPSS. Multiple charge correction, internal diffusion losses and CPC efficiency are included

<u>Status May 22 – 23, 2019</u>

Instrument Settings, Time Series, Particle Number Size Distribution and Correlation

Table No. 2:

Institute: ***Deutscher Wetterdienst***							
Station: Hohenpeißenberg							
*Date of checking list: **22.05.2019***							
Instrument/ Components	*info*	*SN*	*Date/Code*	*CPC-Status*		*HV-Status*	
MPSS/Classifier:	**TROPOS**			*ST*	**39.0**	*OFF*	
Firmware Classifier:	**TROPOS**			*CT*	**22.0**	*5 V*	**5.7**
Firmware Software:	**6.68**			*OT*	**40.0**	*1000 V*	**1001.3**
DMA type:	**Vienna**		**160**	*CabT*	**33.2**		
CPC model:	**TSI CPC 3772**	**70711210**		*AP*	**97.8**	*5 V*	**5.0**
Firmware CPC:	**2.16**			*OP*	**75.0**	*1000V*	**1000.1**
radioactive source:	**Ni.63**			*NP*	**2.7**	*250V*	**249.8**
Flow CPC (l/min):				*LC*		*5 V*	**5.0**
Flow Inlet (l/min):	**1.021**					*0*	*0*
Flow Display (l/min):							
Zero (#/cm³):	**0**						
Aerosol Nafion dryer	**MD-110-12E-S 072717-17-07**						
Sheath Nafion dryer	**ND0.7-72d**						
Maintenance							
Aerosol inlet:							
Aerosol Nafion dryer:	**Instrument is running without nafion from 22.-23.05.19. Nafion**						
Sheath Nafion dryer:							
Source:	**Change Kr.85 to Ni.63**						
HV power supply:							
DMA:							
Aerosol/sheath RH/T- sensor:							
Pressure sensor:							
Filter:							
NI-card:							
CPC:	**CPC change >SN 70838335**						
Impactor:							
Setup settings over night:							

Institute: **TROPOS**							
Station: **Reference Instrument No.1**							
Date of checking list: **May 22, 2019**							
Instrument/ Components	*info*	*Serial Number*	*Date/Code*	*CPC-Status*		*HV-Status*	
MPSS/Classifier:	**TROPOS**	**No.1**		*ST*		*0 V*	**0.3**
Firmware Classifier:				*CT*		*4 mV*	**4.9**
Firmware Software:	**TROPOS 6.68**			*OT*		*800 mV*	**999.9**
DMA type:	**Hauke medium**		**142**	*CabT*		*200 mV*	**249.8**
CPC model:	**TSI 3772**	**3772141701**		*AP*		*0 V*	**0.3**
Firmware CPC:	**2.15**			*OP*			
Radioactive source:	**Kr.85**	**NER 8275**	**002/13**	*NP*			
Flow Inlet (l/min):	**1.012**			*LC*			
Zero (#/cm³):	**0**						

Institute: **TROPOS**					
Station: **Reference Total CPC**					
Date of checking list: **May 22, 2019**					
Instrument/ Components	info	Serial Number	Cut off	CPC-Status	
CPC model:	**TSI 3010**	**2410**	**D_{p50} 10 nm**	ST	
Firmware CPC:	**2.15**			CT	
Flow Inlet (l/min):	**1.008**			OT	
Zero (#/cm³):	**0**			CabT	
				AP	
				OP	
				NP	
				LC	

Figure 16: Time series (May 22, 2019 8 PM – May 23, 2019 6 AM) of the integrated particle number concentration ($N_{10\text{-}800nm}$) 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 Kr.85 source.
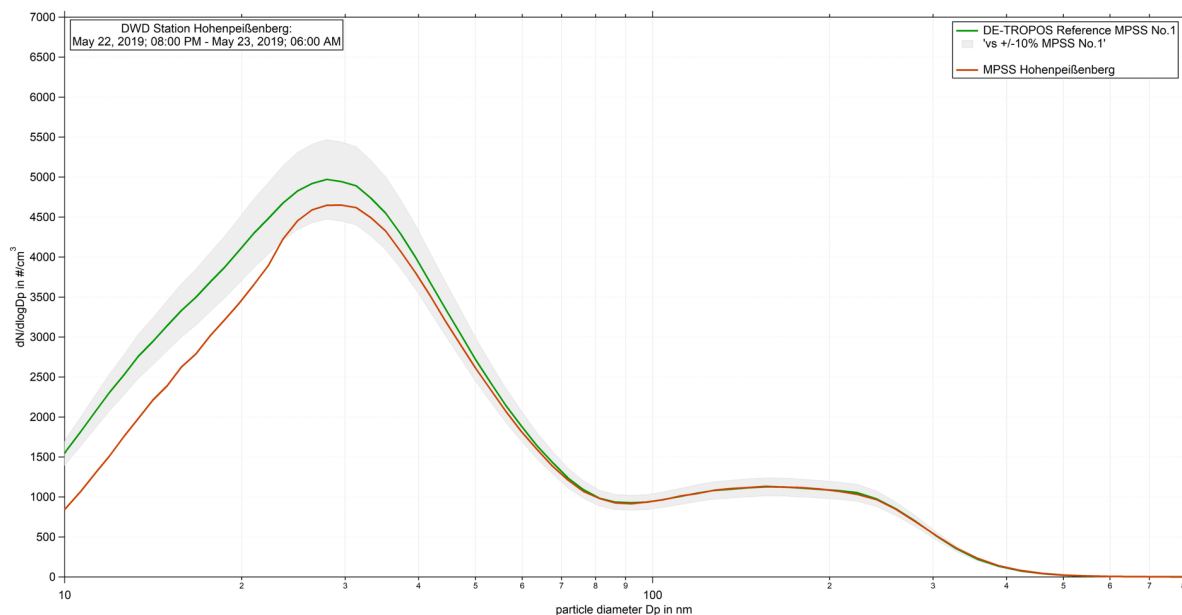
Figure 17: Comparison of mean particle number size distribution of TROPOS Reference MPSS No.1 against DWD-Hohenpeisenberg MPSS from May 22, 2019 8 PM – May 23, 2019 06:00 AM. Multiple charge correction, internal diffusion losses and CPC efficiency are included in different steps.
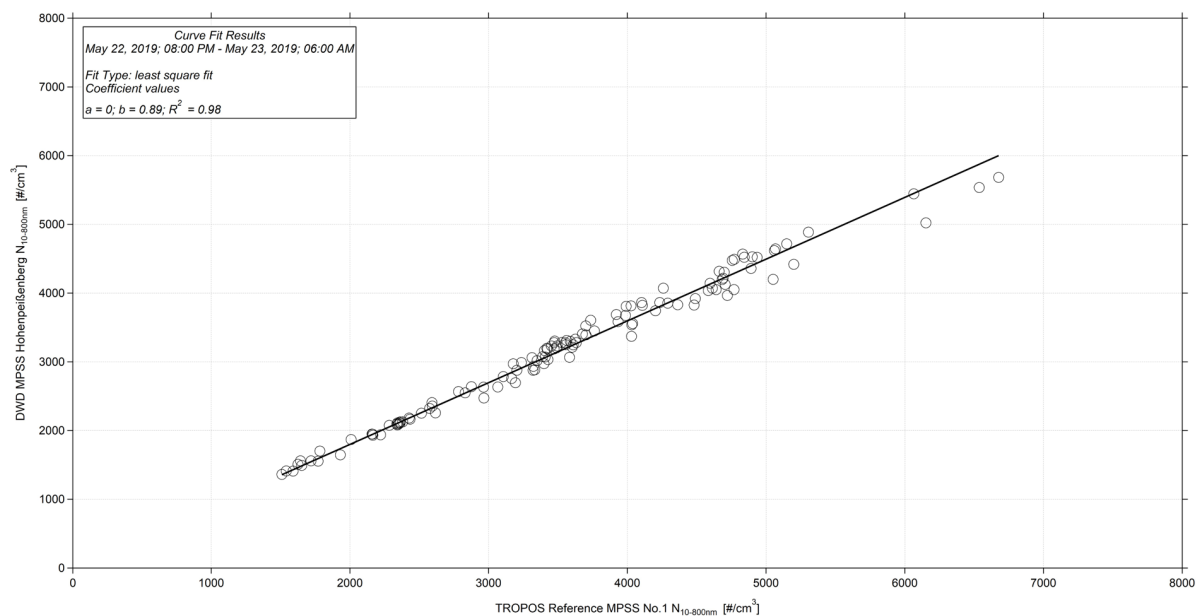

Figure 18: Linear regression between the number concentrations of the TROPOS Reference MPSS No.1 and DWD-Hohenpeißenberg MPSS. Multiple charge correction, internal diffusion losses and CPC efficiency are included.

Final-Status May 23 – 24, 2018

Instrument Settings, Time Series, Particle Number Size Distribution and Correlation

Table No. 3:

Institute: *Deutscher Wetterdienst*							
Station: Hohenpeißenberg							
Date of checking list: *23.05.2019*							
Instrument/ Components	info	SN	Date/Code	CPC-Status		HV-Status	
MPSS/Classifier:	**TROPOS**			ST	**39.0**	*OFF*	
Firmware Classifier:	**TROPOS**			CT	**22.0**	*5 V*	**5.7**
Firmware Software:	**6.68**			OT	**40.0**	*1000 V*	**1001.3**
DMA type:	**Vienna**		**160**	CabT	**33.2**		
CPC model:	**TSI CPC 3772**	**70711210**		AP	**97.8**	*5 V*	**5.0**
Firmware CPC:	**2.16**			OP	**75.0**	*1000V*	**1000.1**
radioactive source:	**Kr.85**			NP	**2.7**	*250V*	**249.8**
Flow CPC (l/min):				LC		*5 V*	**5.0**
Flow Inlet (l/min):	**1.021**					*0*	*0*
Flow Display (l/min):							
Zero (#/cm³):	**0**						
Aerosol Nafion dryer	**MD-110-12E-S 072717-17-07**						
Sheath Nafion dryer	**ND0.7-72d**						
		Maintenance					
Aerosol inlet:							
Aerosol Nafion dryer:		**Instrument is running with nafion from 23.-24.05.19. Nafion**					
Sheath Nafion dryer:							
Source:		**Source holder installed**					
HV power supply:							
DMA:							
Aerosol/sheath RH/T- sensor:							
Pressure sensor:							
Filter:							
NI-card:							
CPC:		**Running with TCPC**					
Impactor:							
Setup settings over night:							

Institute: **TROPOS**							
Station: **Reference Instrument No.1**							
Date of checking list: **May 23, 2019**							
Instrument/ Components	info	Serial Number	Date/Code	CPC-Status		HV-Status	
MPSS/Classifier:	**TROPOS**	**No.1**		ST		*0 V*	
Firmware Classifier:				CT		*5 mV*	
Firmware Software:	**TROPOS 6.68**			OT		*800 mV*	
DMA type:	**Hauke medium**		**142**	CabT		*200 mV*	
CPC model:	**TSI 3772**	**3772141701**		AP		*0 V*	
Firmware CPC:	**2.15**			OP			
Radioactive source:	**Kr.85**	**NER 8275**	**002/13**	NP			
Flow Inlet (l/min):	**1.02**			LC			
Zero (#/cm³):	**0**						

Institute: **TROPOS**						
Station: **Reference Total CPC**						
Date of checking list: **May 23, 2019**						
Instrument/ Components	*info*	*Serial Number*	*Cut off*	*CPC-Status*		
CPC model:	**TSI 3010**	**2410**	**D_{p50} 10 nm**	*ST*		
Firmware CPC:	**2.15**			*CT*		
Flow Inlet (l/min):	**1.01**			*OT*		
Zero (#/cm³):	**0**			*CabT*		
				AP		
				OP		
				NP		
				LC		

Figure 19: Time series (May 23, 2019 8 PM – May 24, 2019 6 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. Multiple charge correction, internal diffusion losses and CPC flow corrections are included. The candidate is running with the Kr.85 source.
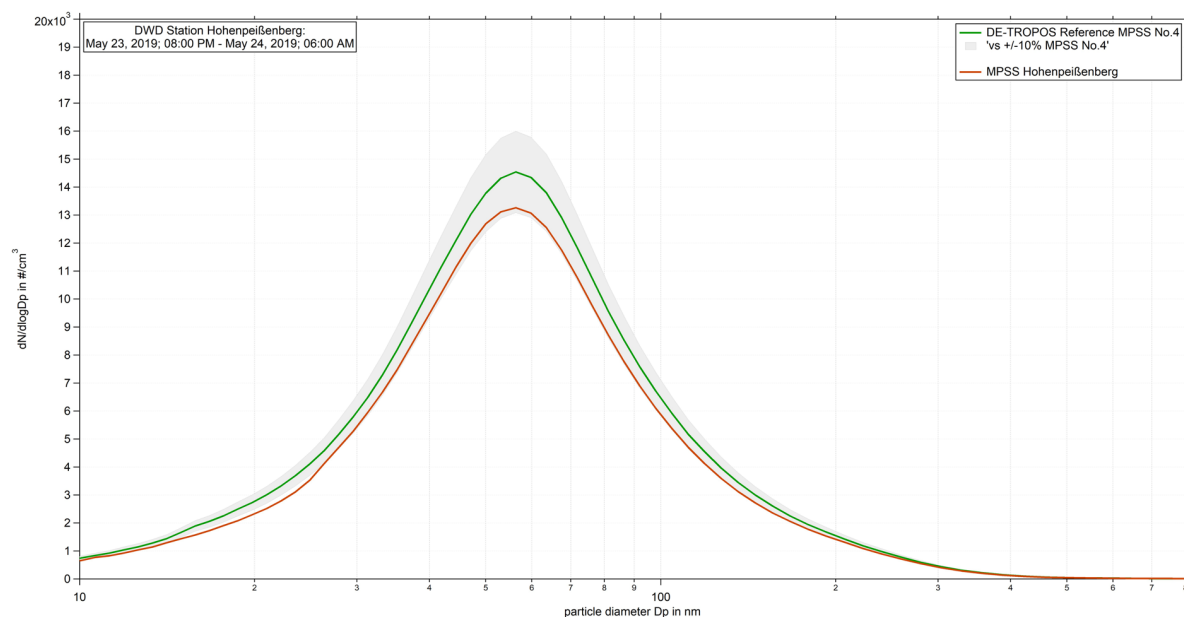
Figure 20: Comparison of mean particle number size distribution of TROPOS Reference MPSS No.1 against DWD-Hohenpeisenberg MPSS from May 23, 2019 8 PM – May 24, 2019 06:00 AM. Multiple charge correction, internal diffusion losses and CPC efficiency are included in different steps.
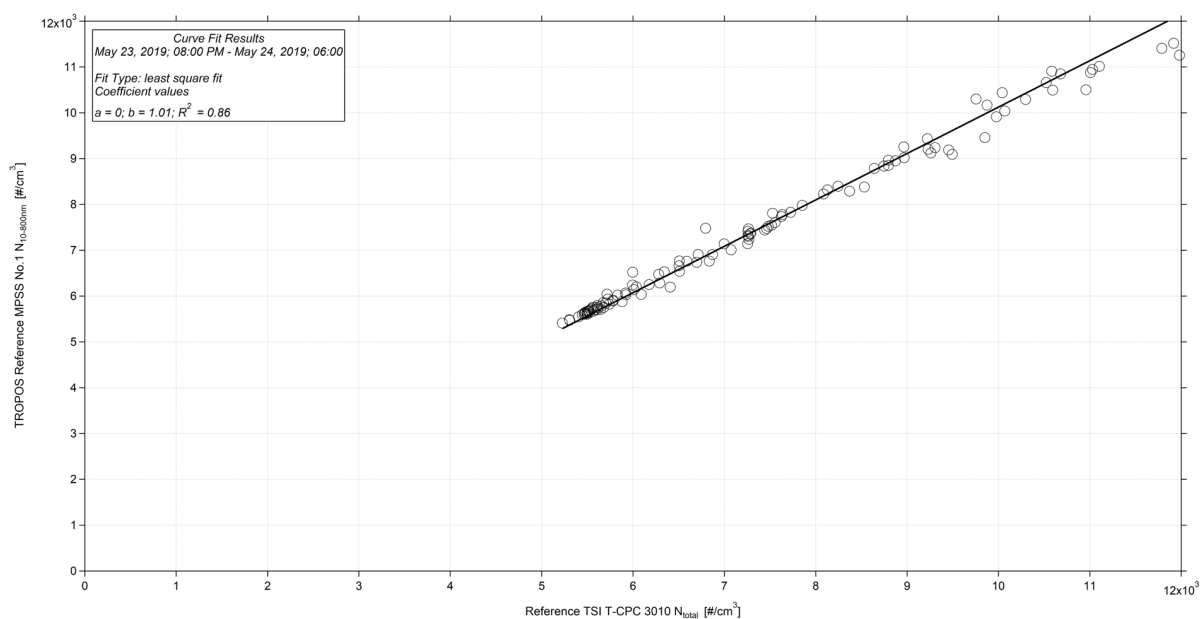

Figure 21: Linear regression between the number concentrations of the TROPOS Reference TSI T-CPC Model 3010 and TROPOS Reference MPSS No.4. Multiple charge correction, internal diffusion losses and CPC efficiency are included.
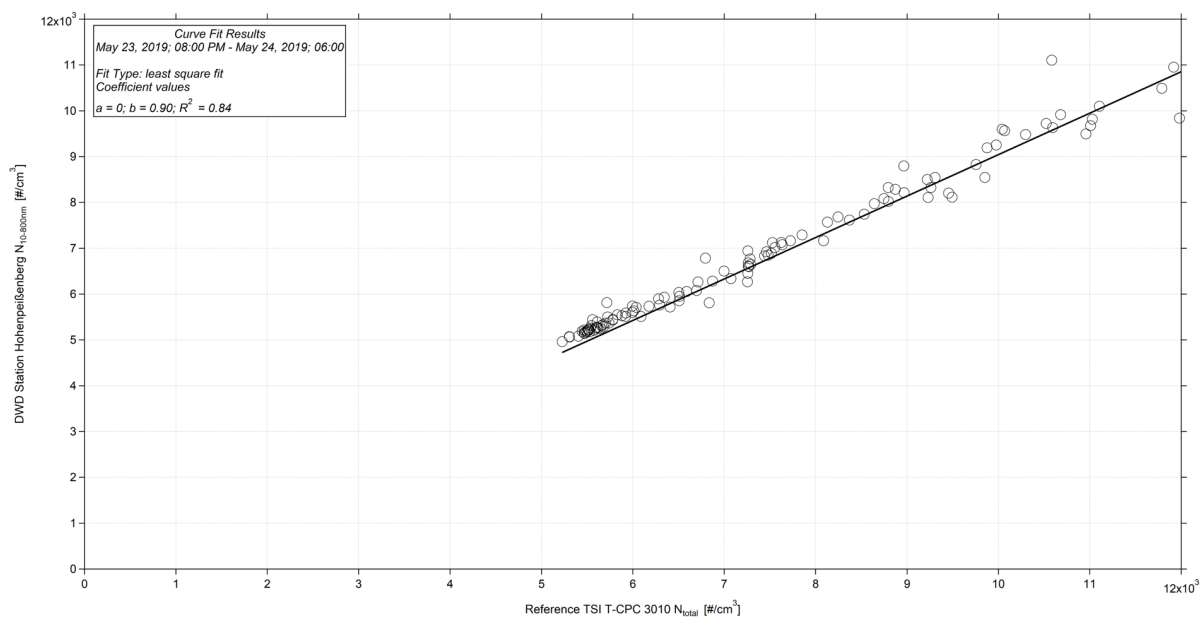
Figure 22: Linear regression between the number concentrations of the TROPOS Reference TSI T-CPC Model 3010 and DWD-Hohenpeißenberg MPSS. Multiple charge correction, internal diffusion losses and CPC efficiency are included.
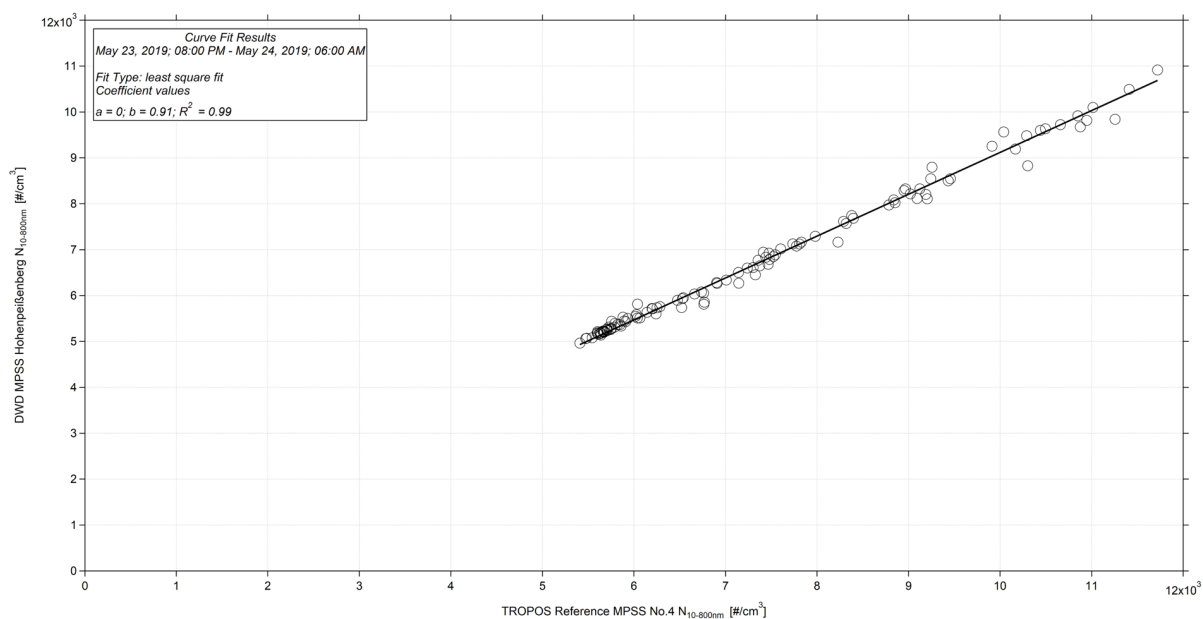

Figure 23: Linear regression between the number concentrations of the TROPOS Reference MPSS No.4 and DWD-Hohenpeißenberg MPSS. Multiple charge correction, internal diffusion losses and CPC efficiency are included.
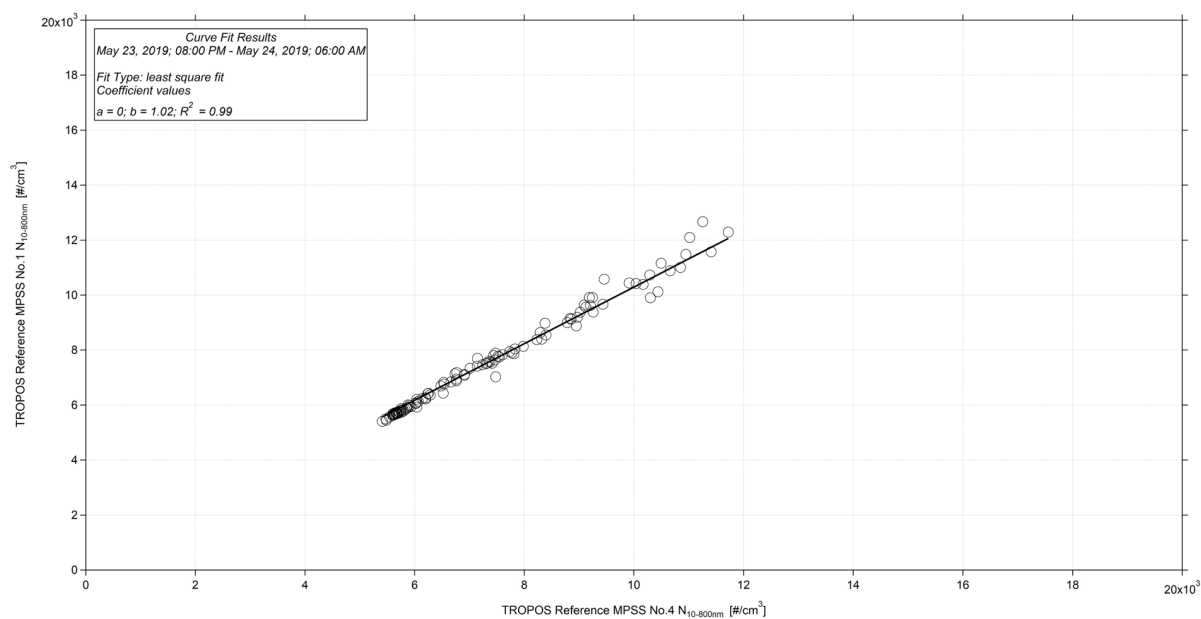
Figure 23: Linear regression between the number concentrations of the TROPOS Reference MPSS No.4 and TROPOS Reference MPSS No.1. Multiple charge correction, internal diffusion losses and CPC efficiency are included