Intercomparison of Mobility Particle Size Spectrometers

Project No.:	MPSS-2019-5-2
Principal Investigator:	Christian Maier
Home Institution:	ZAMG Sonnenblick, Salzburg, Austria
Participant:	Christian Maier and Gerhard Schauer
Candidate:	MPSS ZAMG
Made by:	**TSI MPSS 3082 SN: 3082001549001**
Counter (SN):	**TSI UCPC 3775 SN: 3775155101**
Location of the quality assurance:	TROPOS Leipzig, lab 118
Comparison period:	October. 07, 2019 – October. 11, 2019
Last Intercomparison (with Project No.):	

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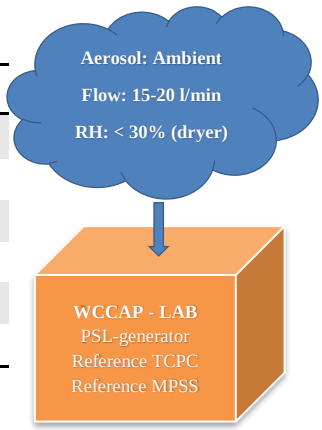
Summary of Intercomparison:

The TSI MPSS from ZAMG Sonnenblick participated in the WCCAP Workshop in October. The instrument arrived with all necessary parts in good condition to perform the intercomparison. There were no visible damages. The pre-status was performed in the same setup like on the station with a high and low flow mode 0.3/1.5 l/min (aerosol) and 2.5/13 l/min (sheath air). The candidate used a TSI 3775 butanol-based counter. The candidate showed a PSL peak at 209,91 nm instead of 203 nm and the particle number concentration integrated over the size range 10-800 nm is 30% lower than the Reference Instrument No.1 from TROPOS. Looking at the size distribution the candidate overestimates in the last part of the accumulation mode and underestimates the Aitken mode.
TROPOS, together with the participants, checked the whole system to optimize the performance of the measurements. There are problems in the particle selection over the DMA and undefined losses in the instrument. It is necessary to check and clean the whole instrument and run one night without the impactor, using a dummy. The instrument was cleaned and checked. Results are shown in the different night runs below. The final run was performed from 10.-11.10.2019 using the same settings as on the station. The overlap between the high and low flow is optimized but the instrument still underestimates the particle concentration in the Aitken mode. The station ZAMG is using their own software to run in the different flow mode settings. The candidate did not pass the standards of ACTRIS and GAW under the conditions wherein the TROPOS Reference CPC No.1 was used. The correlation against the Reference MPSS is still 20% lower in the final run. TROPOS recommends to send the whole classifier including DMA to TSI for maintenance.

Laboratory Setup and Legend

Candidates
MPSS ZAMG



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:

PSL Scan: Latex 203 nm +/- 4 nm

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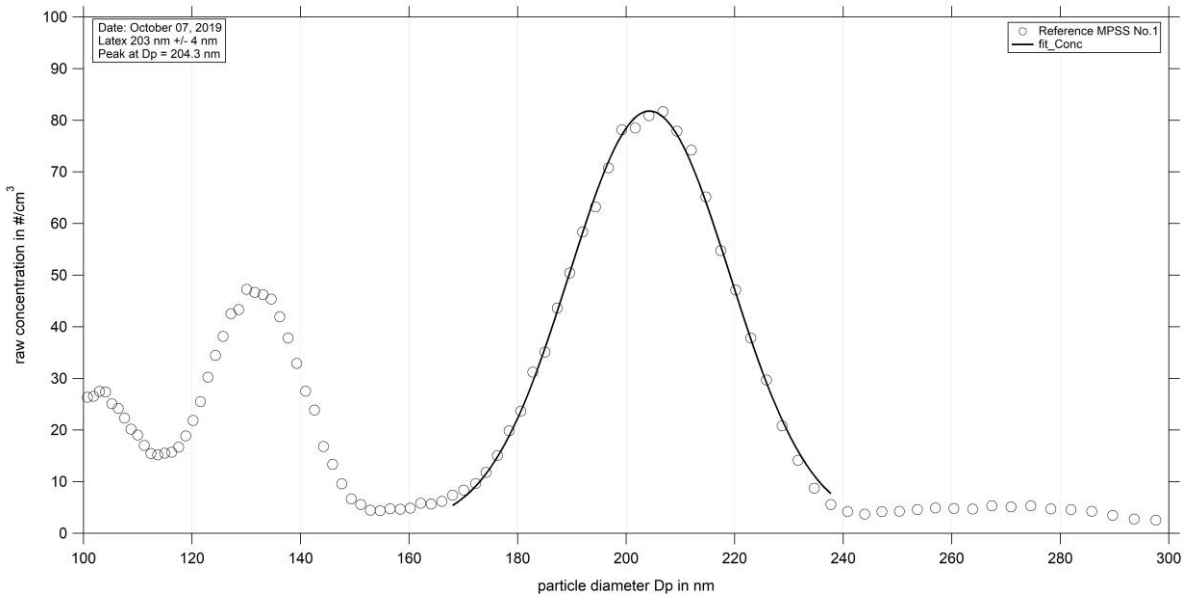

Figure 01: Measurement of latex 203 nm – TROPOS Reference MPSS No.1: Particle size distribution of latex 203 nm on October. 7th 2019. The flow ratio was 1.0 L/min aerosol and 5.0 L/min sheath air. Peak shows at 204.3 nm.

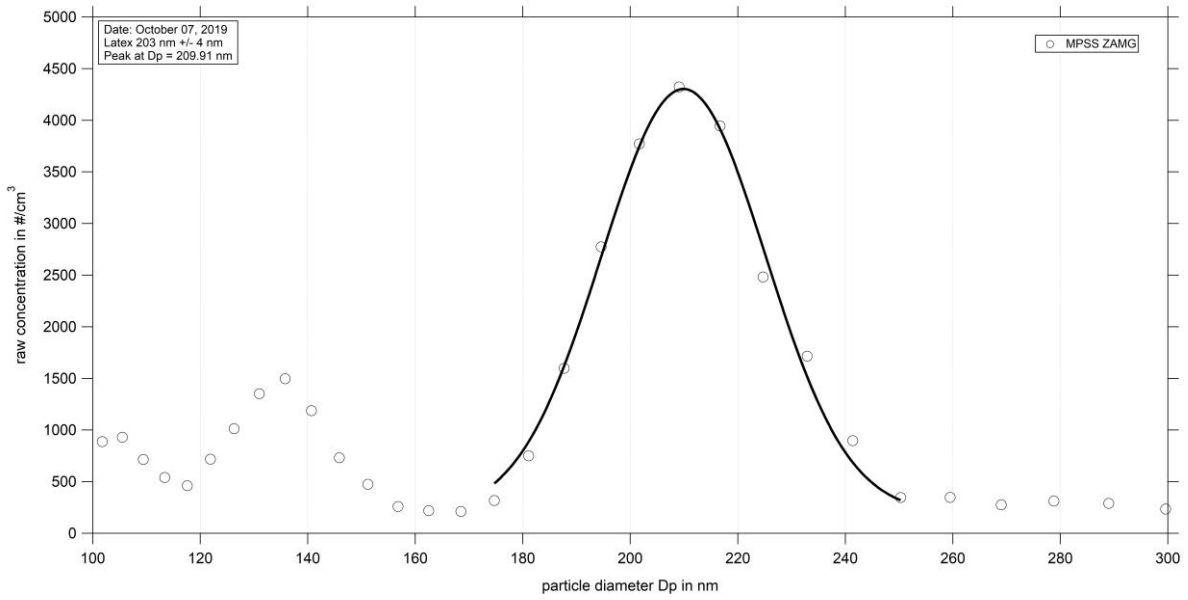

Figure 02: Measurement of latex 203 nm – MPSS-ZAMG: Particle size distribution of latex 203 nm on October. 7th 2019. Peak shows at 209.91 nm.

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Status October. 07 – 08, 2019

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

Table No. 1:

Institute: ***ZAMG***							
Station: Slazburg							
Date of checking list: ***07.10.2019***							
Instrument/ Components	*info*	*SN*	*Date/Code*	*CPC-Status*		*HV-Status*	
MPSS/Classifier:	**TSI 308200**	**3082001549001**	**Nov 2015**	*ST*	**39.0**	*OFF*	**-**
Firmware Classifier:	**-**		**-**	*CT*	**14.0**	*4mv*	**-**
Firmware Software:	**TSI AIM**		**9.0**	*OT*	**40.0**	*800mv*	**-**
DMA type:	**TSI 3081A00**	**3081A1550003**	**Dec. 2015**	*CabT*	**30.6**	*200mv*	**-**
CPC model:	**TSI UCPC 3775**	**3775155101**	**Dec. 2015**	*AP*	**100.1**	*0*	**-**
Firmware CPC:	**-**		**-**	*OP*	**85.0**		
radioactive source:	**TSI**	**-**	**Kr.85**	*NP*	**0.055**		
Flow CPC (l/min):	**Low 0.3 / high 1.5**			*LC*	**37mA**		
Flow Inlet (l/min):							
Sheath air flow (l/min):	**Low 2.5 / high 13.0**						
Zero (#/cm³):	**check**						
Maintenance							
Aerosol inlet:	**1.5 L/m on CPC**						
Aerosol Nafion dryer:	**No dryer**						
Sheath Nafion dryer:	**No dryer**						
Source:							
HV power supply:							
DMA:							
Aerosol/sheath RH/T- sensor:							
Pressure sensor:							
Filter:							
NI-card:							
CPC:							
Impactor:	**Yes: dummy impactor**						
Setup settings over night:	**Using the station conditions**						

Institute: **TROPOS**							
Station: **Reference Instrument No.1**							
Date of checking list: **October. 07, 2019**							
Instrument/ Components	*info*	*Serial Number*	*Date/Code*	*CPC-Status*		*HV-Status*	
MPSS/Classifier:	**TROPOS**	**No.1**		*ST*	**39.0**	*0 V*	**0**
Firmware Classifier:				*CT*	**22.0**	*5 mV*	**4.98**
Firmware Software:	**TROPOS 6.68**			*OT*	**40.0**	*800 mV*	**999.8**
DMA type:	**Hauke medium**		**142**	*CabT*	**28**	*200 mV*	**250.0**
CPC model:	**TSI 3772**	**3772141701**		*AP*	**100.1**	*0 V*	**0**
Firmware CPC:	**2.15**			*OP*	**78.0**		
Radioactive source:	**Kr.85**	**NER 8275**	**002/13**	*NP*	**2.8**		
Flow Inlet (l/min):	**1.007**			*LC*	**50**		
Zero (#/cm³):	**0**						
Institute: **TROPOS**							
Station: **Reference Total CPC**							
Date of checking list: **October. 07, 2019**							
Instrument/ Components	*info*	*Serial Number*	*Cut off*	*CPC-Status*			
CPC model:	**TSI 3010**	**2410**	**D_{p50} 10 nm**	*ST*			
Firmware CPC:				*CT*			
Flow Inlet (l/min):	**1.011**			*OT*			
Zero (#/cm³):	**0**			*CabT*			
				AP			
				OP			
				NP			
				LC			

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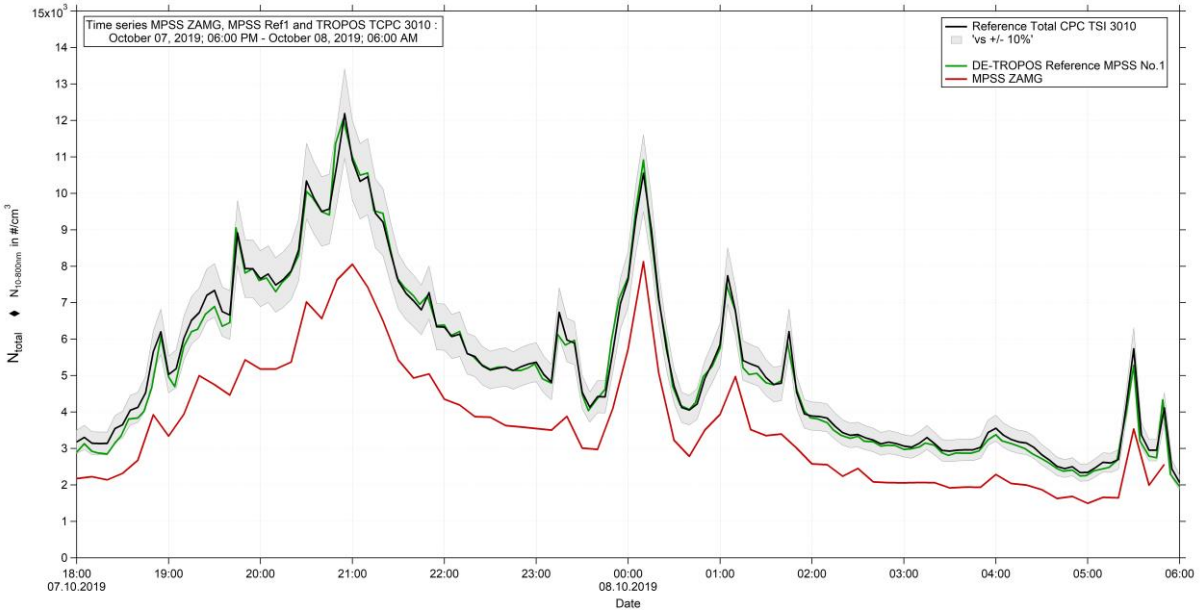

Figure 03: Time series (Oct. 07, 2019 6 PM – Oct. 08, 2019 6 AM) of the integrated particle number concentration ($N_{10\text{-}800nm}$) of the MPSS and total number concentration (N_{total}) of the Reference TSI-CPC Model 3010. Multiple charge correction, internal diffusion losses and CPC flow corrections are included. The candidate is running with the TSI Kr.85 source.

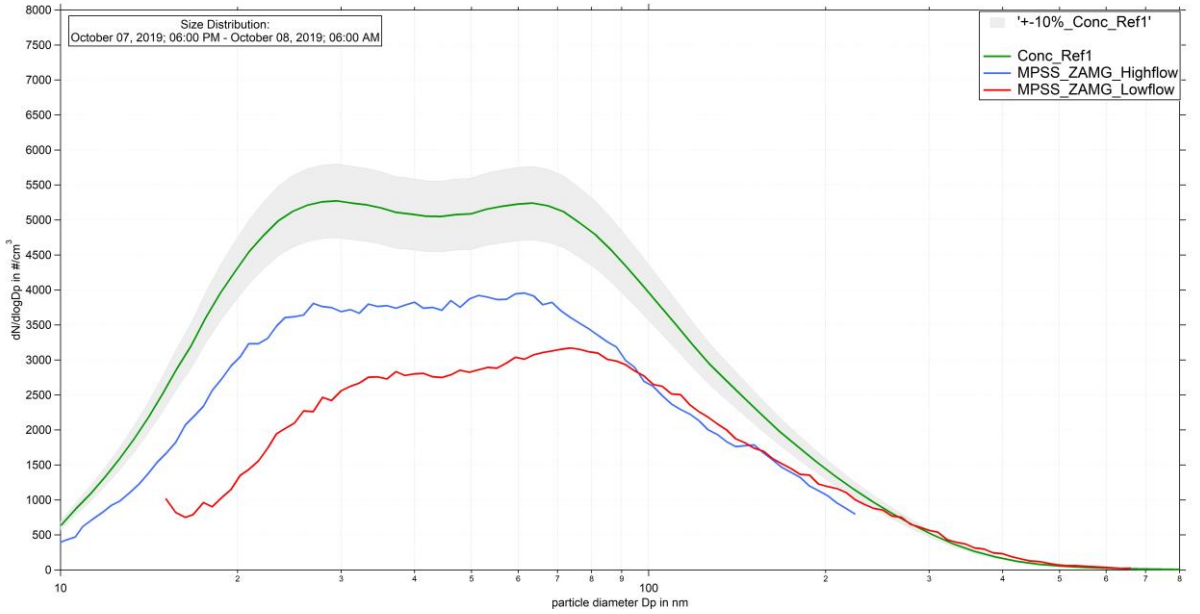

Figure 04: Comparison of mean particle number size distribution of TROPOS Reference MPSS No.1 against MPSS-ZAMG running with both high flow and low flow from Oct. 07, 2019 6 PM – Oct. 08, 2019 6 AM.

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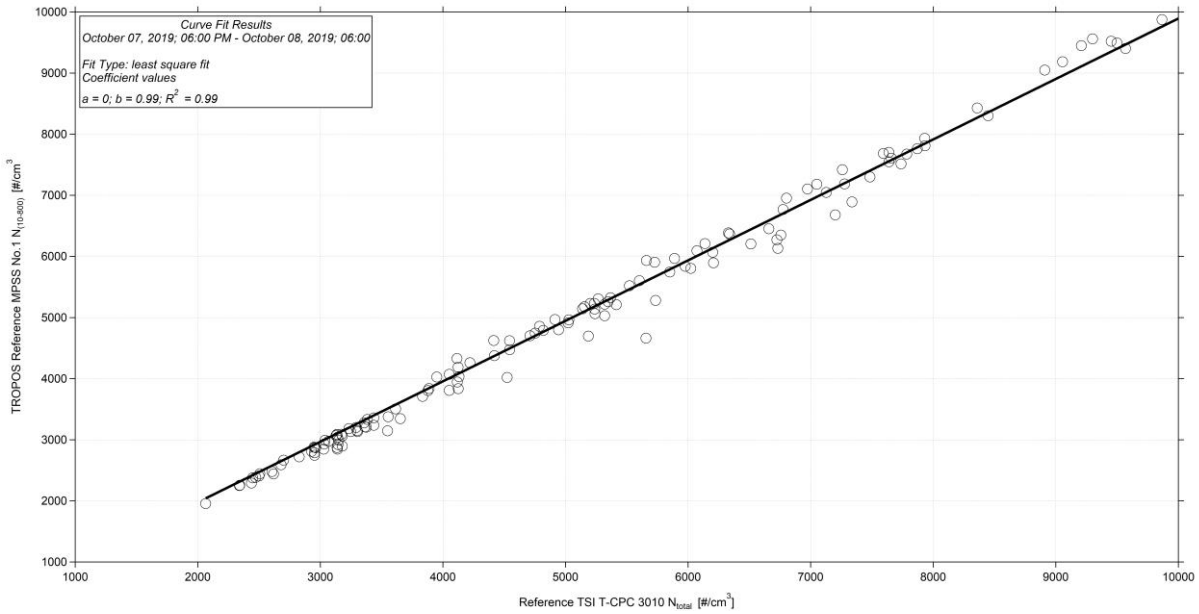

Figure 05: Linear regression between the number concentration of the TROPOS Reference TSI T-CPC Model 3010 and TROPOS Reference MPSS No.1.

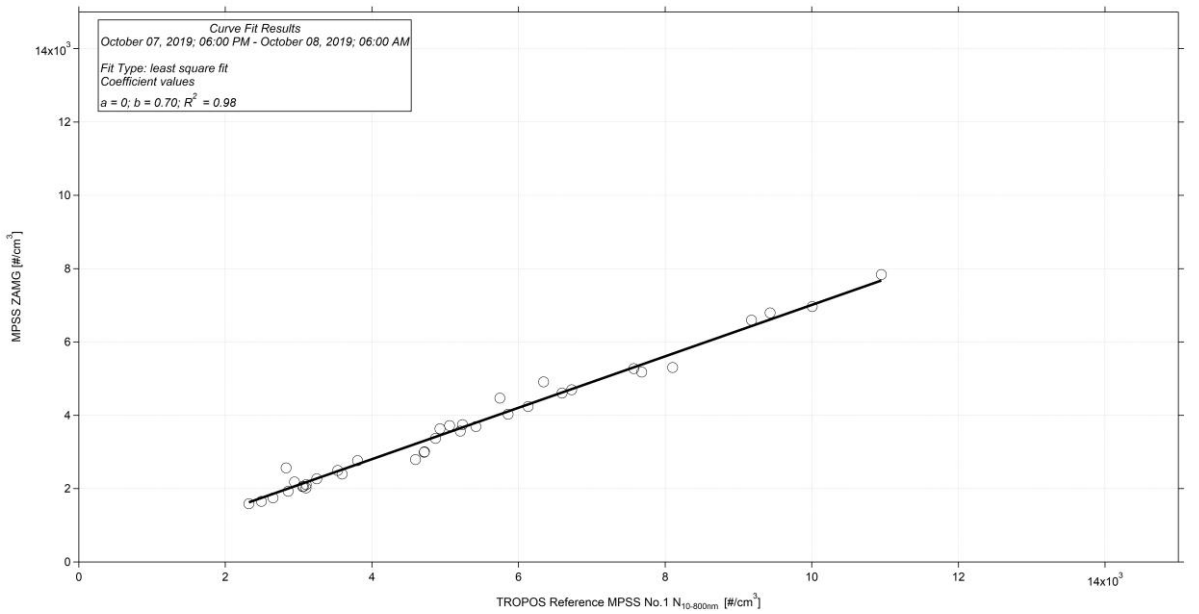

Figure 06: Linear regression between the number concentration of the TROPOS Reference MPSS No.1 (integrated number concentration N10-800nm) and MPSS ZAMG.

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Status October. 8 – 9, 2019

Instrument Settings, Time Series, Particle Number Size Distribution

Table No. 2:

Institute: ***ZAMG***							
Station: Slazburg							
Date of checking list: ***8.10.2019***							
Instrument/ Components	*info*	*SN*	*Date/Code*	*CPC-Status*		*HV-Status*	
MPSS/Classifier:	**TSI 308200**	**3082001549001**	**Nov 2015**	*ST*	**39.0**	*OFF*	**-**
Firmware Classifier:	**-**		**-**	*CT*	**22.0**	*4mv*	**-**
Firmware Software:	**TSI AIM**		**9.0**	*OT*	**40.0**	*800mv*	**-**
DMA type:	**TSI 3081A00**	**3081A1550003**	**Dec. 2015**	*CabT*	**35.4**	*200mv*	**-**
CPC model:	**TSI UCPC 3775**	**3775155101**	**Dec. 2015**	*AP*	**99.7**	*0*	**-**
Firmware CPC:	**-**		**-**	*OP*	**83.1**		
radioactive source:	**TSI**	**-**	**Kr.85**	*NP*	**2.7**		
Flow CPC (l/min):	**1.5**			*LC*	**43**		
Flow Inlet (l/min):	**1.5**						
Sheath air flow (l/min):	**15.0**						
Zero (#/cm³):	**check**						
Maintenance							
Aerosol inlet:	**-**						
Aerosol Nafion dryer:	**-**						
Sheath Nafion dryer:	**-**						
Source:	**-**						
HV power supply:	**-**						
DMA:	**DMA Opened and cleaned**						
Aerosol/sheath RH/T- sensor:	**-**						
Pressure sensor:	**-**						
Filter:	**-**						
NI-card:	**-**						
CPC:	**-**						
Impactor:	**-**						
Setup settings over night:	**-**						

Institute: **TROPOS**							
Station: **Reference Instrument No.1**							
Date of checking list: **Oct. 08, 2019**							
Instrument/ Components	*info*	*Serial Number*	*Date/Code*	*CPC-Status*		*HV-Status*	
MPSS/Classifier:	**TROPOS**	**No.1**		*ST*	**39.0**	*0 V*	**0**
Firmware Classifier:				*CT*	**22.0**	*5 mV*	**4.98**
Firmware Software:	**TROPOS 6.68**			*OT*	**40.0**	*800 mV*	**999.8**
DMA type:	**Hauke medium**		**142**	*CabT*	**27.3**	*200 mV*	**250.0**
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):	**1.017**			*LC*	**50**		
Zero (#/cm³):	**0**						

Institute: **TROPOS**					
Station: **Reference Total CPC**					
Date of checking list: **Oct. 08, 2019**					
Instrument/ Components	*info*	*Serial Number*	*Cut off*	*CPC-Status*	
CPC model:	**TSI 3010**	**2410**	**D_{p50} 10 nm**	*ST*	
Firmware CPC:				*CT*	
Flow Inlet (l/min):	**1.008**			*OT*	
Zero (#/cm³):	**0**			*CabT*	
				AP	
				OP	
				NP	
				LC	

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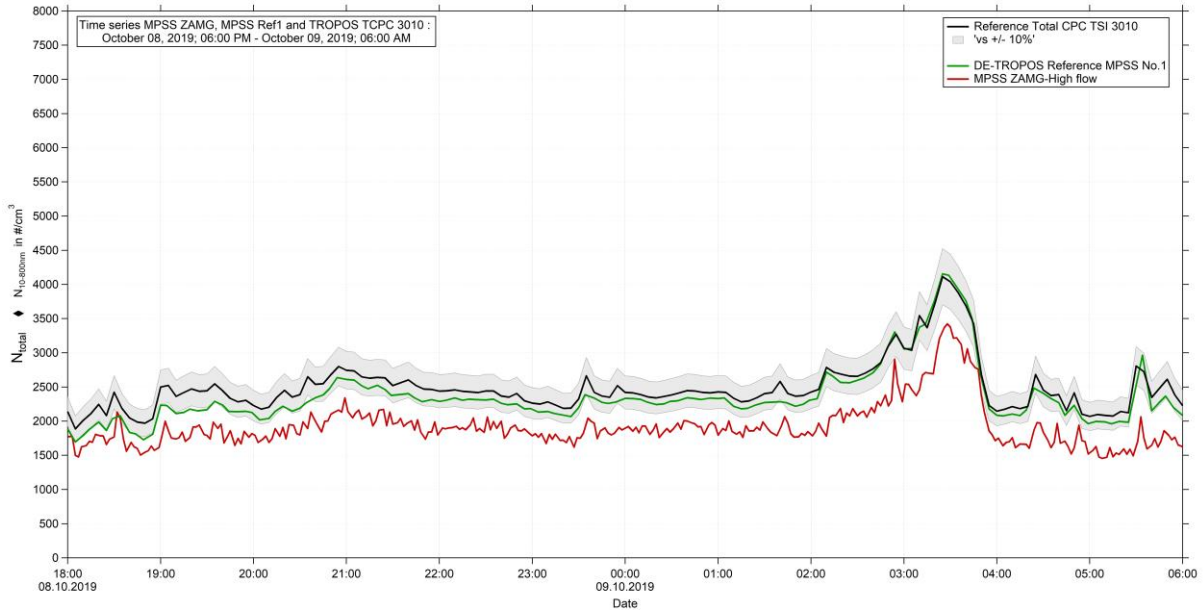

Figure 07: Time series between MPSS Ref1, MPSS ZAMG-High Flow and TCPC (Oct. 08, 2019 6 PM – Oct. 09, 2019 6 AM) of the integrated particle number concentration (N10-800nm) of the MPSS and total number concentration of the Reference TSI-CPC Model 3010. Multiple charge correction, internal diffusion losses and CPC flow corrections are included. The candidate is running with the TSI Kr.85 source.

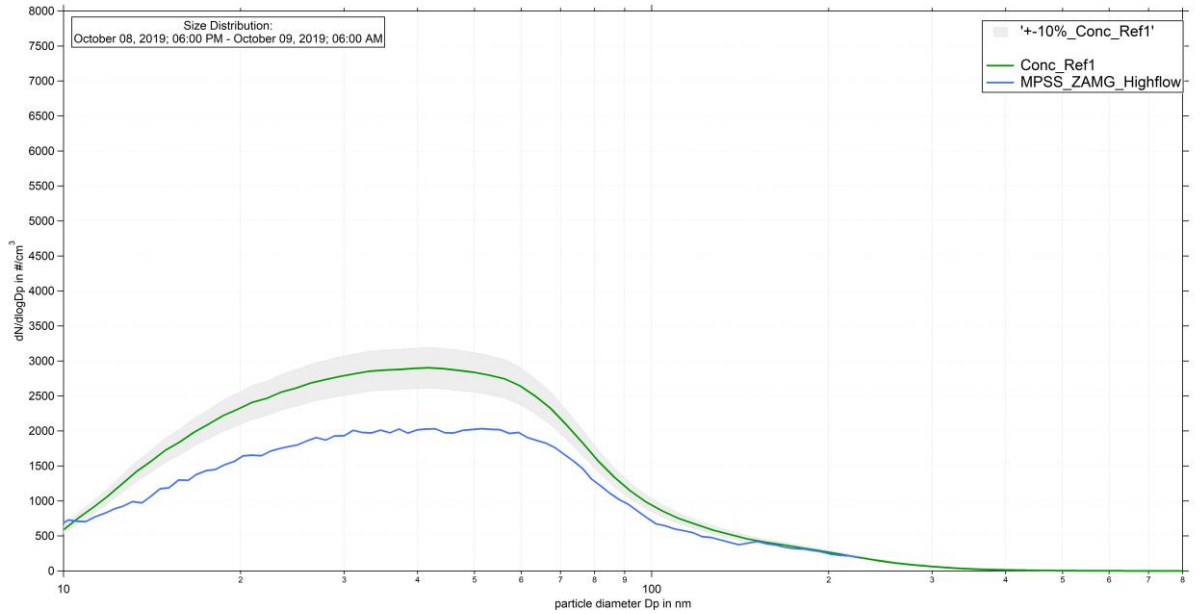

Figure 08: Comparison of mean particle number size distribution of TROPOS Reference MPSS No.1 against MPSS-ZAMG from Oct. 08, 2019 6 PM – Oct. 9, 2019 6 AM.

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Status Oct. 09 – 10, 2019

Table No. 3:

Institute: ***ZAMG***							
Station: Österreich							
Date of checking list: ***09.10.2019***							
Instrument/ Components	*info*	*SN*	*Date/Code*	*CPC-Status*		*HV-Status*	
MPSS/Classifier:	**TSI 308200**	**3082001549001**	**Nov 2015**	*ST*	**39.0**	*OFF*	**-**
Firmware Classifier:	**-**		**-**	*CT*	**22.0**	*4mv*	**-**
Firmware Software:	**TSI AIM**		**9.0**	*OT*	**40.0**	*800mv*	**-**
DMA type:	**TSI 3081A00**	**3081A1550003**	**Dec. 2015**	*CabT*	**35.4**	*200mv*	**-**
CPC model:	**TSI UCPC 3775**	**3775155101**	**Dec. 2015**	*AP*	**99.7**	*0*	**-**
Firmware CPC:	**-**		**-**	*OP*	**83.1**		
radioactive source:	**TSI**	**-**	**Kr.85**	*NP*	**2.7**		
Flow CPC (l/min):	**1**			*LC*	**43**		
Flow Inlet (l/min):	**1**						
Sheath air flow (l/min):	**5**						
Zero (#/cm³):	**check**						
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:	**UCPC changed to TSI CPC 3772**						
Impactor:	**-**						
Setup settings over night:							

Institute: **TROPOS**							
Station: **Reference Instrument No.1**							
Date of checking list: **Oct. 09, 2019**							
Instrument/ Components	*info*	*Serial Number*	*Date/Code*	*CPC-Status*		*HV-Status*	
MPSS/Classifier:	**TROPOS**	**No.1**		*ST*	**39.0**	*0 V*	**0**
Firmware Classifier:				*CT*	**22.0**	*5 mV*	**4.98**
Firmware Software:	**TROPOS 6.68**			*OT*	**40.0**	*800 mV*	**999.8**
DMA type:	**Hauke medium**		**142**	*CabT*	**27.3**	*200 mV*	**250.0**
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):	**1.017**			*LC*	**50**		
Zero (#/cm³):	**0**						

Institute: **TROPOS**					
Station: **Reference Total CPC**					
Date of checking list: **Oct. 09, 2019**					
Instrument/ Components	*info*	*Serial Number*	*Cut off*	*CPC-Status*	
CPC model:	**TSI 3010**	**2410**	**D_{p50} 10 nm**	*ST*	
Firmware CPC:				*CT*	
Flow Inlet (l/min):	**1.008**			*OT*	
Zero (#/cm³):	**0**			*CabT*	
				AP	
				OP	
				NP	

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Instrument Settings, Time Series, Particle Number Size Distribution

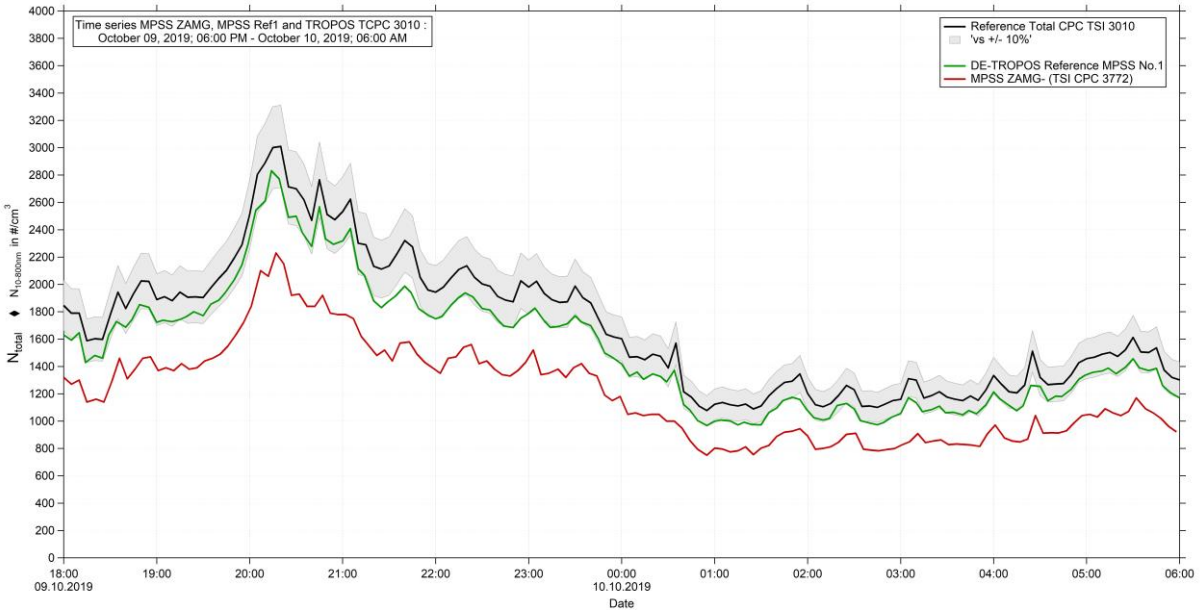

Figure 09: Time series between MPSS Ref1, MPSS ZAMG -with a TSI CPC 3772 instead of the original TSI UCPC from ZAMG- and TCPC (Oct. 09, 2019 6 PM – Oct. 10, 2019 6 AM) of the integrated particle number concentration (N10-800nm) of the MPSS and total number concentration of the Reference TSI-CPC Model 3010.

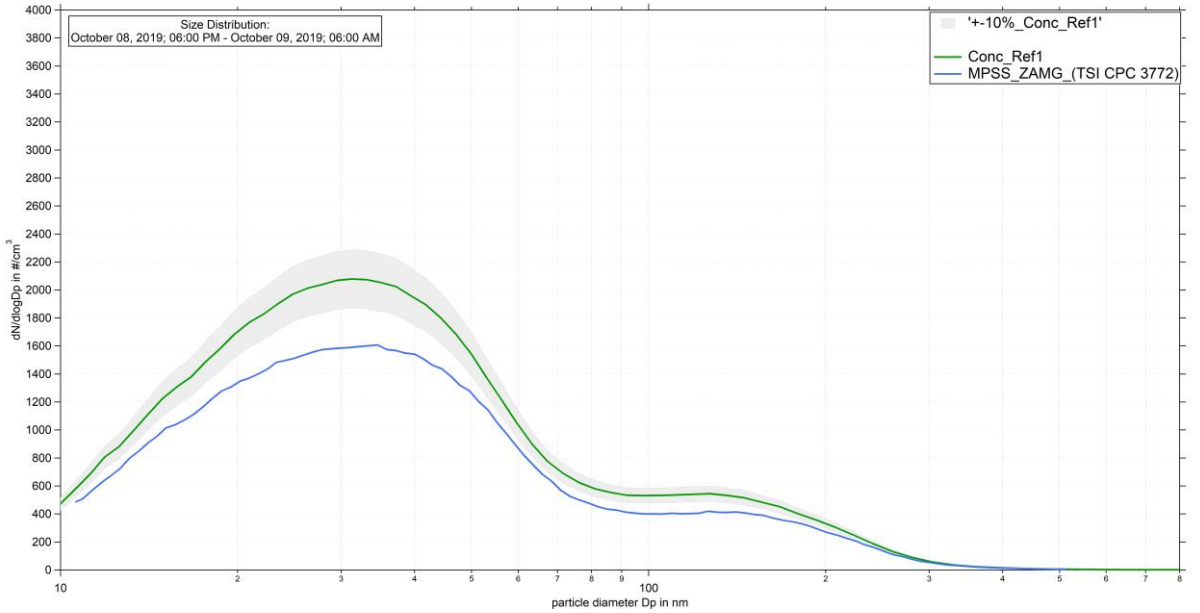

Figure 10: Comparison of mean particle number size distribution of TROPOS Reference MPSS No.1 against MPSS ZAMG from Oct. 09, 2019 6 PM – Oct. 10, 2019 6 AM.

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Status Oct. 10, 2019

Table No. 4:

Institute: ***ZAMG***							
Station: Österreich							
Date of checking list: ***10.10.2019***							
Instrument/ Components	*info*	*SN*	*Date/Code*	*CPC-Status*		*HV-Status*	
MPSS/Classifier:	**TSI 308200**	**3082001549001**	**Nov 2015**	*ST*	**39.0**	*OFF*	**-**
Firmware Classifier:	**-**		**-**	*CT*	**22.0**	*4mv*	**-**
Firmware Software:	**TSI AIM**		**9.0**	*OT*	**40.0**	*800mv*	**-**
DMA type:	**TSI 3081A00**	**3081A1550003**	**Dec. 2015**	*CabT*	**35.4**	*200mv*	**-**
CPC model:	**TSI UCPC 3775**	**3775155101**	**Dec. 2015**	*AP*	**99.7**	*0*	**-**
Firmware CPC:	**-**		**-**	*OP*	**83.1**		
radioactive source:	**TSI**	**-**	**Kr.85**	*NP*	**2.7**		
Flow CPC (l/min):	**Low 0.3 / high 1.5**			*LC*	**43**		
Flow Inlet (l/min):							
Sheath air flow (l/min):	**Low 2.5 / high 13.0**						
Zero (#/cm³):	**check**						
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:	**TSI CPC 3772 changed to original CPC from ZAMG**						
Impactor:	**-**						
Setup settings over night:							

Institute: **TROPOS**							
Station: **Reference Instrument No.1**							
Date of checking list: **Oct. 10, 2019**							
Instrument/ Components	*info*	*Serial Number*	*Date/Code*	*CPC-Status*		*HV-Status*	
MPSS/Classifier:	**TROPOS**	**No.1**		*ST*	**39.0**	*0 V*	**0**
Firmware Classifier:				*CT*	**22.0**	*5 mV*	**4.98**
Firmware Software:	**TROPOS 6.68**			*OT*	**40.0**	*800 mV*	**999.8**
DMA type:	**Hauke medium**		**142**	*CabT*	**27.3**	*200 mV*	**250.0**
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):	**1.017**			*LC*	**50**		
Zero (#/cm³):	**0**						

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

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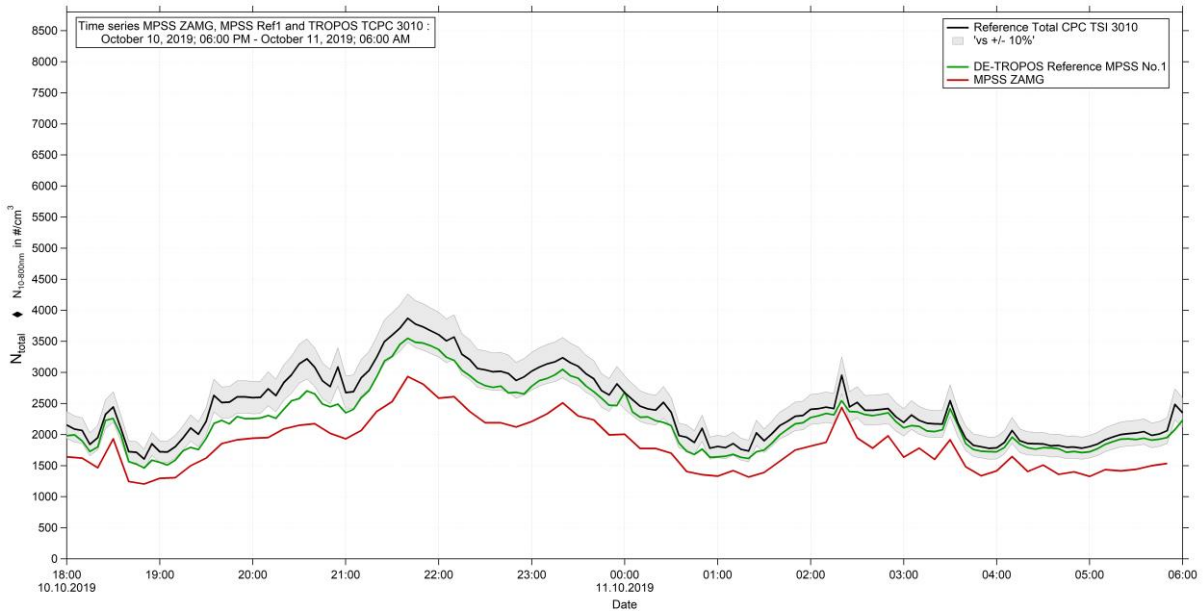

Figure 11: Time series between MPSS Ref1, MPSS ZAMG and TCPC (Oct. 10, 2019 6 PM – Oct. 11, 2019 6 AM) of the integrated particle number concentration (N10-800nm) of the MPSS and total number concentration of the Reference TSI-CPC Model 3010.

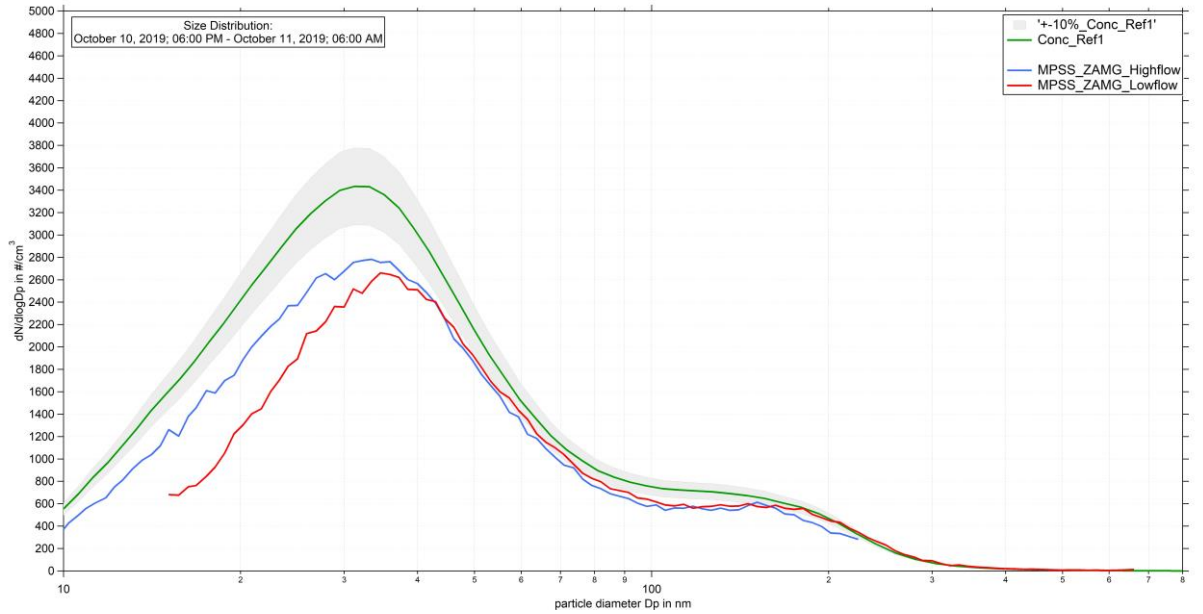

Figure 12: Comparison of mean particle number size distribution of TROPOS Reference MPSS No.1 against MPSS ZAMG from Oct. 10, 2019 6 PM – Oct. 11, 2019 6 AM.

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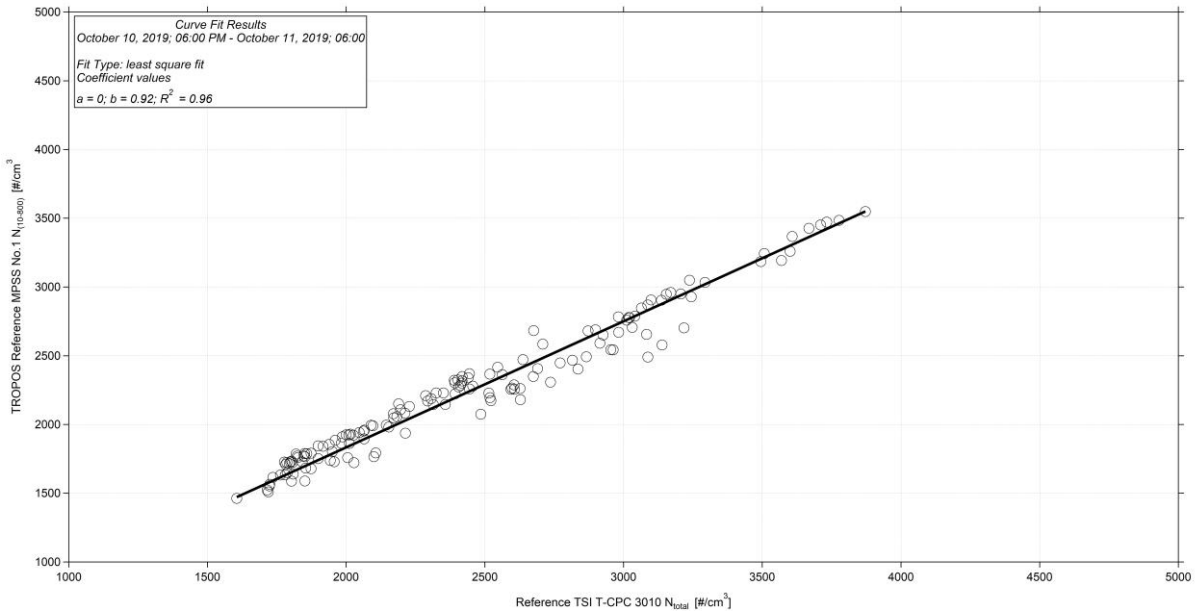

Figure 13: Linear regression between the number concentration of the TROPOS Reference TSI T-CPC Model 3010 and TROPOS Reference MPSS No.1.

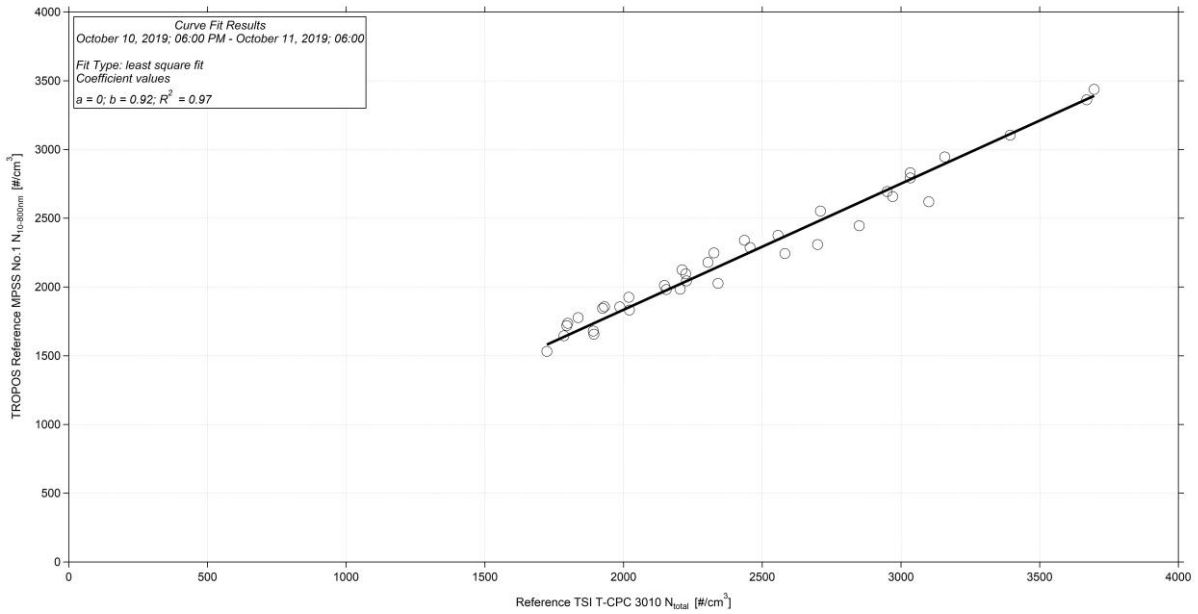

Figure 13: Linear regression between the number concentration of the TROPOS Reference TSI T-CPC Model 3010 and TROPOS Reference MPSS No.1. 20 minutes averages were done.

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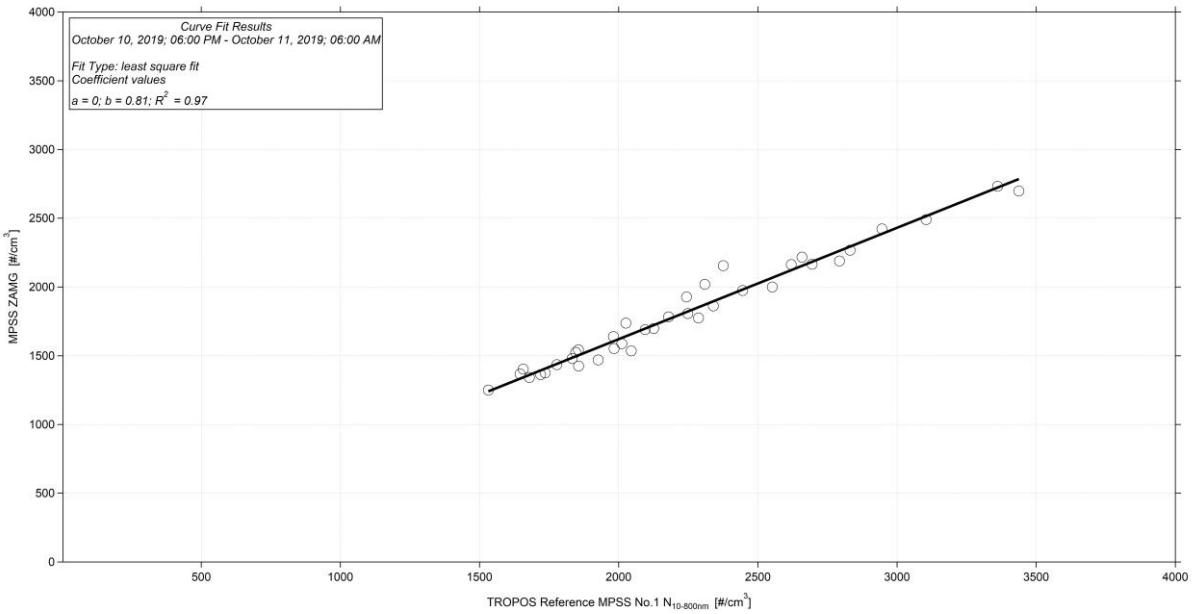

Figure 13: Linear regression between the number concentration of the MPSS ZAMG-Österriech and TROPOS Reference MPSS No.1. 20 minutes averages were done.

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