Intercomparison of Mobility Particle Size Spectrometers

Project No.: *MPSS-2019-4-1*

Principal Investigator: Jean-François Doussin

Home Institution: *CNRS LISA*

Participant:

Candidate:	CNRS LISA
Made by:	**TSI MPSS 3080 SN: 8414**
Counter (SN):	**TSI CPC 3772 SN: 3772134401**

Location of the quality assurance: TROPOS Leipzig, lab 118

Comparison period: Sept. 16, 2019 – Sept. 19, 2019

Last Intercomparison (with Project No.):

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Summary of Intercomparison:

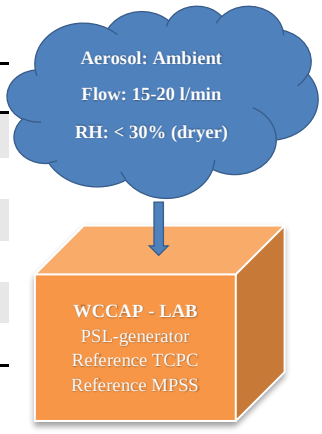
The TSI MPSS from CNRS LISA participated in the WCCAP Workshop in September with the following participants: Mathieu Cazaunau and Aline Gratien.
The instrument arrived with all necessary parts in good condition to perform the intercomparison. There were no visible damages. The pre-status was performed in the same setup like on the station with a flow of 0.2 l/min (aerosol) and 2.0 l/min sheath air. Using a TSI 3772 counter with usually 1 l/min, the flow was decreaesd over a splitter with a total filter and needle valve. The candidate showed a PSL peak at 203 nm and the particle number concentration integrated over the size range 20-800 nm is 10% higher than the Reference Instrument No.1 from TROPOS.
It was not possible to run the candidate with a higher flow than 2.0 l/min in any setup cases and PSL performance. It was necessary to open the DMA and clean it. TROPOS found out that the laminarity net in the head of the DMA was broken. It was not possible to reach a laminar flow inside the DMA. TROPOS replaced the net and the participants cleaned the DMA. The classifier was check with a flow ratio 1.0: 5.0 l/min and without an impactor. Results are shown in the different night runs below.
The final run was performed from 18.-19.09.2019 using different data evaluation cases:

- *TSI AIM software version 9.0 including all TSI corrections*
- *TROPOS software using the inverted data from TSI (MC) without any other corrections. Afterwards we included step by step the diffusion loss corrections (DL) and CPC efficiency curve (CE) from the cpc workshop on 17.09.2019.*

The candidate showed with the TSI AIM software a slightly higher concentration against the Reference Instrument No.1. The software is overcorrecting the small particles with the internal corrections from TSI. Looking at the evaluation with the TROPOS software using the measured effective lengths and the measured CPC efficiency curve from 17.09.2019, the candidate is in the range required by WCCAP for the particle size from 25 nm and larger. For smaller particles the instrument has significant losses which can be due to the DMA. TROPOS recommends CNRS LISA to change the laminarity net to a new one and polish the DMA.

Laboratory Setup and Legend

Candidates
CNRS LISA



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:

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PSL Scan: Latex 203 nm +/- 4 nm

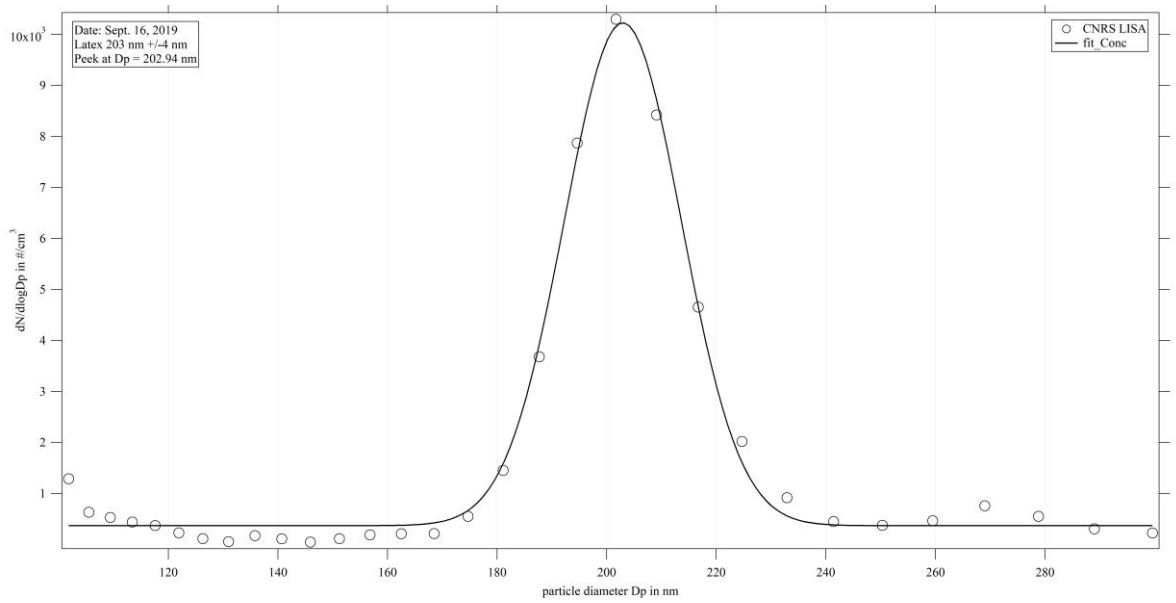

Figure 01: Measurement of latex 203 nm – CNRS LISA: Particle size distribution of latex 203 nm on Sept. 16th 2019. The flow ratio was 0.2 L/min aerosol and 2.0 L/min sheath air.

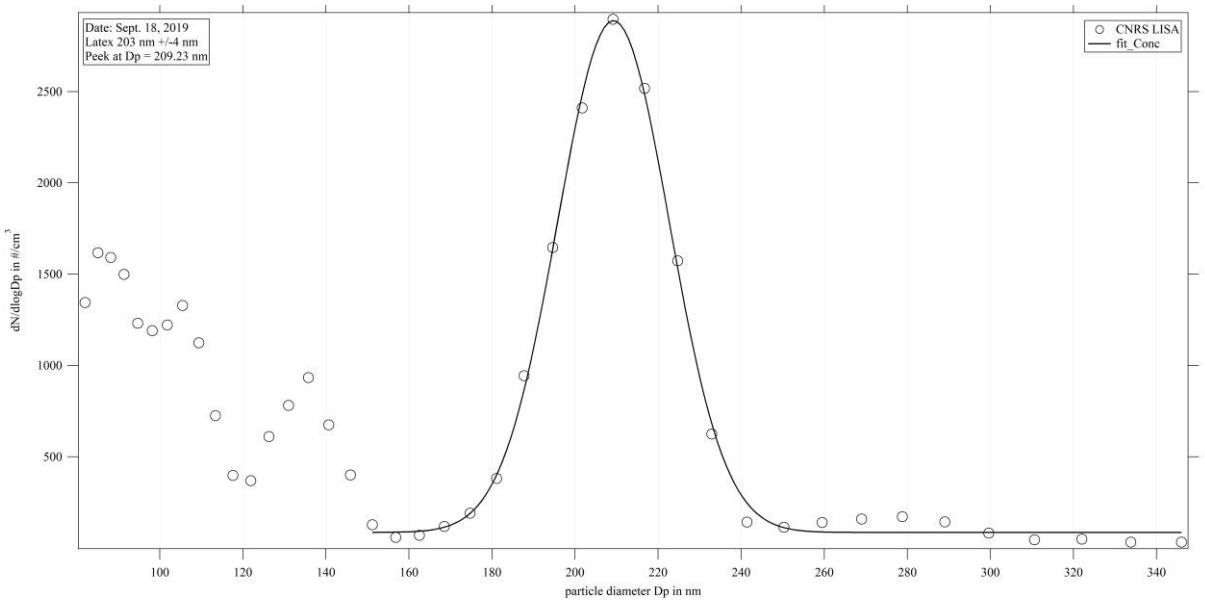

Figure 02: Measurement of latex 203 nm – CNRS-LISA: Particle size distribution of latex 203 nm on Sept. 18th 2019. The flow ratio was 1.0 L/min aerosol and 5.0 L/min sheath air.

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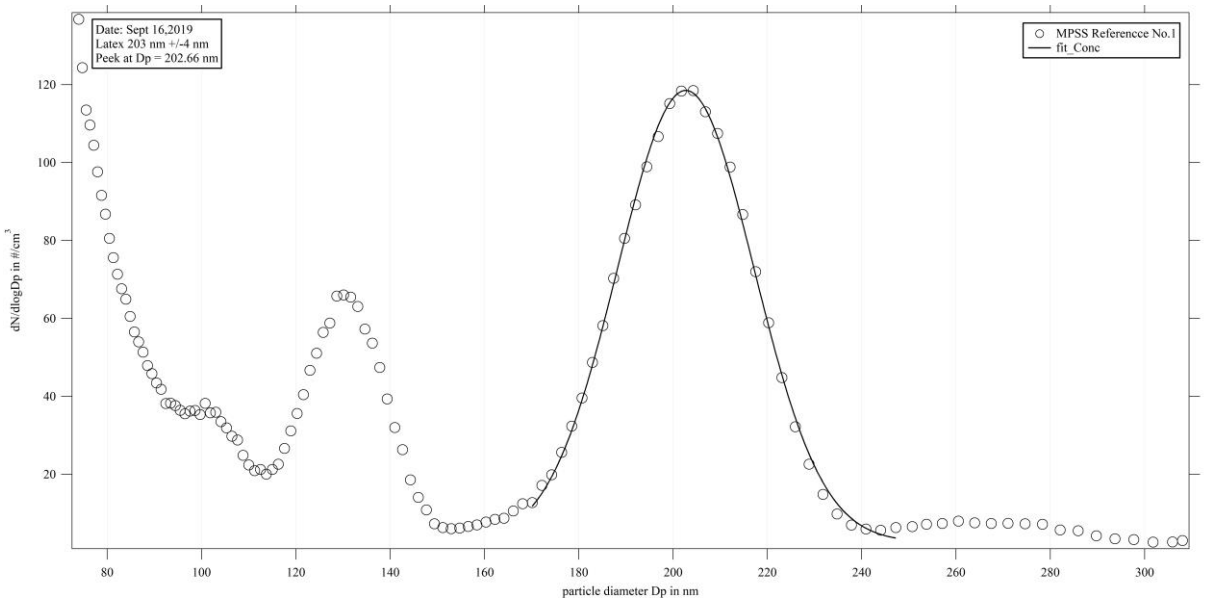

Figure 03: Measurement of latex 203 nm – Reference MPSS No.1: Particle size distribution of latex 203 nm on Sept. 16th 2019. The flow ratio was 1.0 L/min aerosol and 5.0 L/min sheath air.

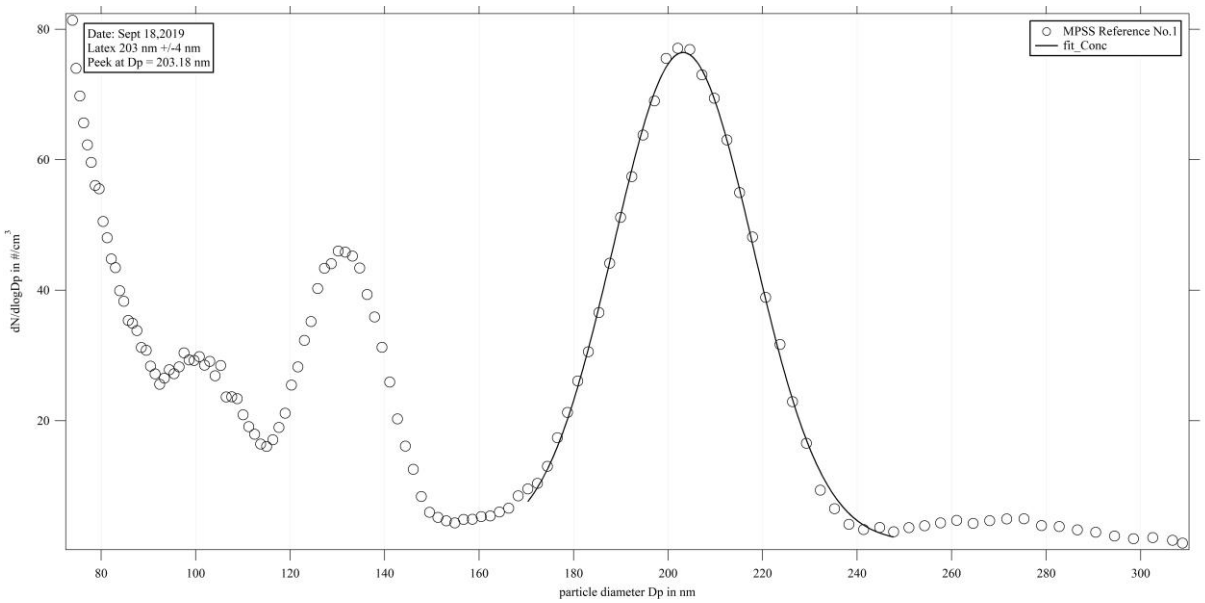

Figure 04: Measurement of latex 203 nm – Reference MPSS No.1: Particle size distribution of latex 203 nm on Sept. 18th 2019. The flow ratio was 1.0 L/min aerosol and 5.0 L/min sheath air.

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Status Sept. 16 – 17, 2019

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

Table No. 1:

Institute: ***CNRS LISA***							
Station: France							
Date of checking list: ***16.09.2019***							
Instrument/ Components	*info*	*SN*	*Date/Code*	*CPC-Status*		*HV-Status*	
MPSS/Classifier:	**TSI 3080**	**8414**	**Oct 2003**	*ST*	**39.0**	*OFF*	**-**
Firmware Classifier:	**-**		**-**	*CT*	**22.0**	*4mv*	**-**
Firmware Software:	**TSI AIM**		**9.0**	*OT*	**40.0**	*800mv*	**-**
DMA type:	**TSI 3081**	**1423**	**Nov. 2003**	*CabT*	**35.4**	*200mv*	**-**
CPC model:	**TSI CPC 3772**	**3772124401**	**Oct. 2013**	*AP*	**99.7**	*0*	**-**
Firmware CPC:	**-**		**-**	*OP*	**83.1**		
radioactive source:	**TSI**	**-**	**Kr.85**	*NP*	**2.7**		
Flow CPC (l/min):	**1.0**			*LC*	**43**		
Flow Inlet (l/min):	**0.2**						
Sheath air flow (l/min):	**2.0**						
Zero (#/cm³):	**3**						
Maintenance							
Aerosol inlet:	**Run with 0.2 l/min over splitter**						
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**						
Setup settings over night:	**Using the station conditions**						

Institute: **TROPOS**							
Station: **Reference Instrument No.1**							
Date of checking list: **Sept. 16, 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: **Sept. 16, 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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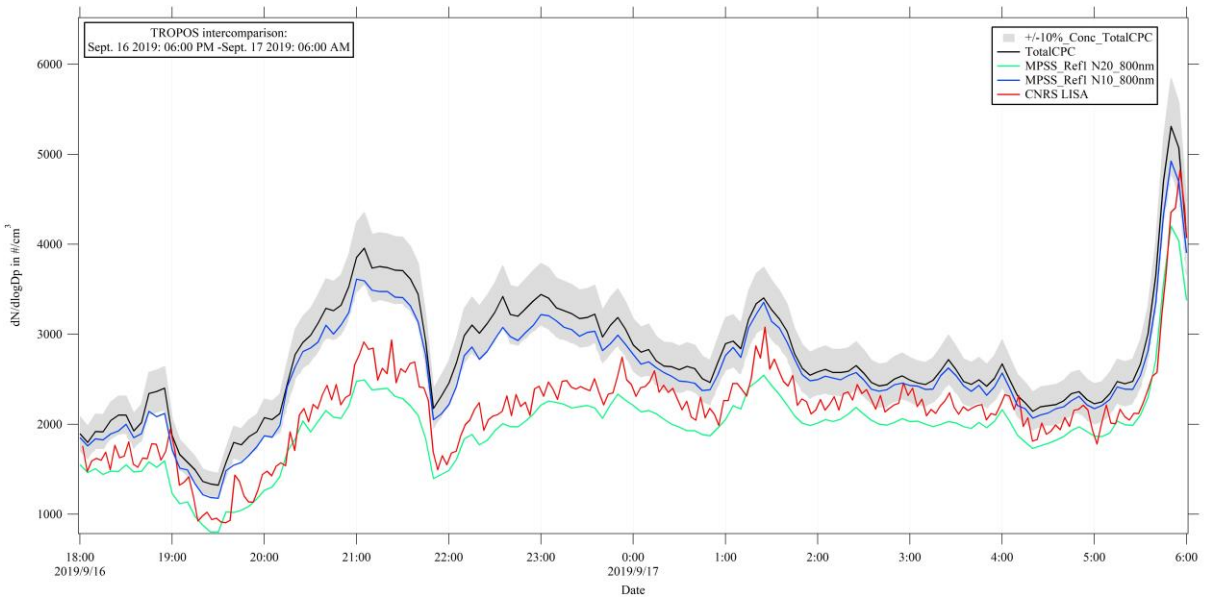

Figure 05: Time series (Sept. 16, 2019 6 PM – Sept. 17, 2019 6 AM) of the integrated particle number concentration ($N_{10/20-800nm}$) of the MPSS and total number concentration (N_{total}) of the Reference TSI-CPC Model 3010. Multiple charge correction, internal diffusion losses and CPC flow corrections are included. The candidate is running with the TSI Kr.85 source.

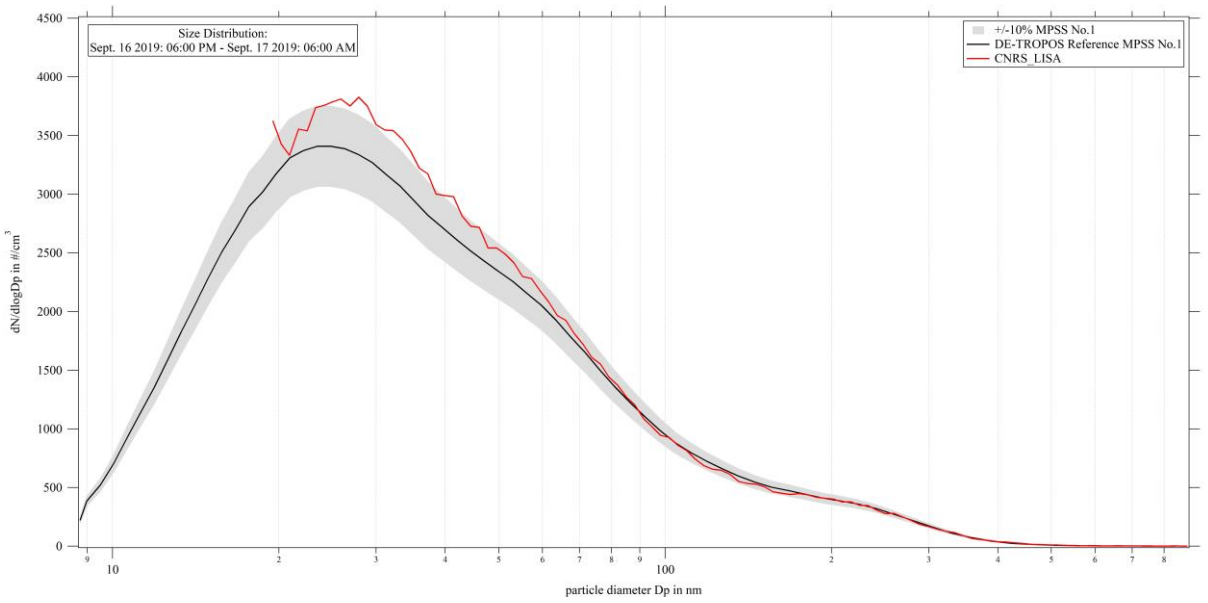

Figure 06: Comparison of mean particle number size distribution of TROPOS Reference MPSS No.1 against CNRS LISA from Sept. 16, 2019 6 PM – Sept. 17, 2019 6 AM.

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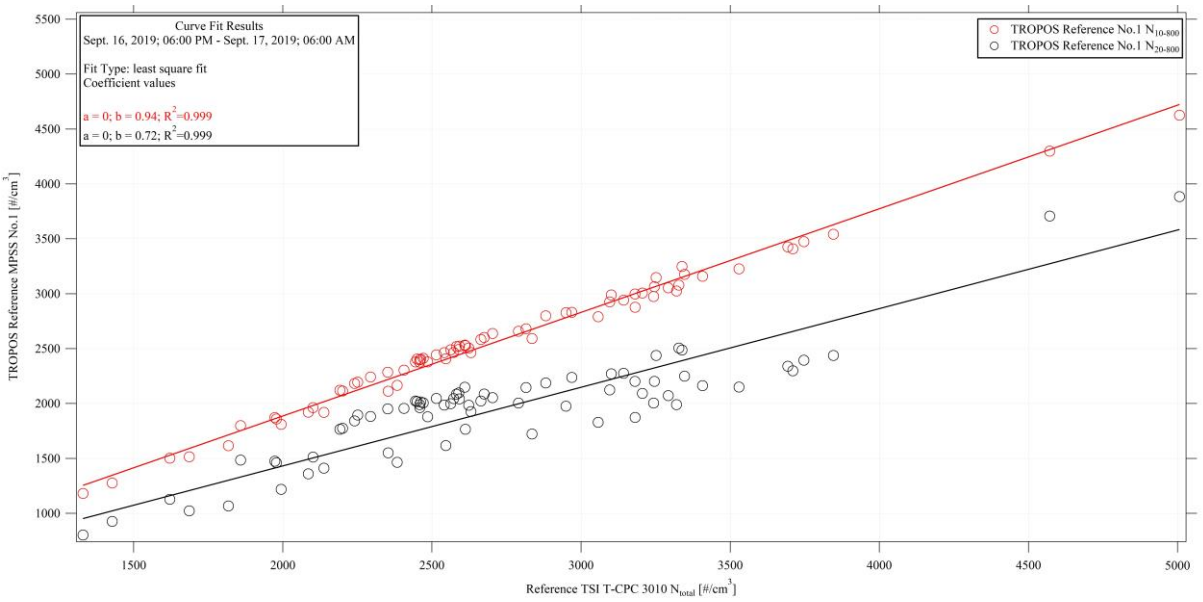

Figure 07: Linear regression between the number concentration of the TROPOS Reference TSI T-CPC Model 3010 and TROPOS Reference MPSS No.1.

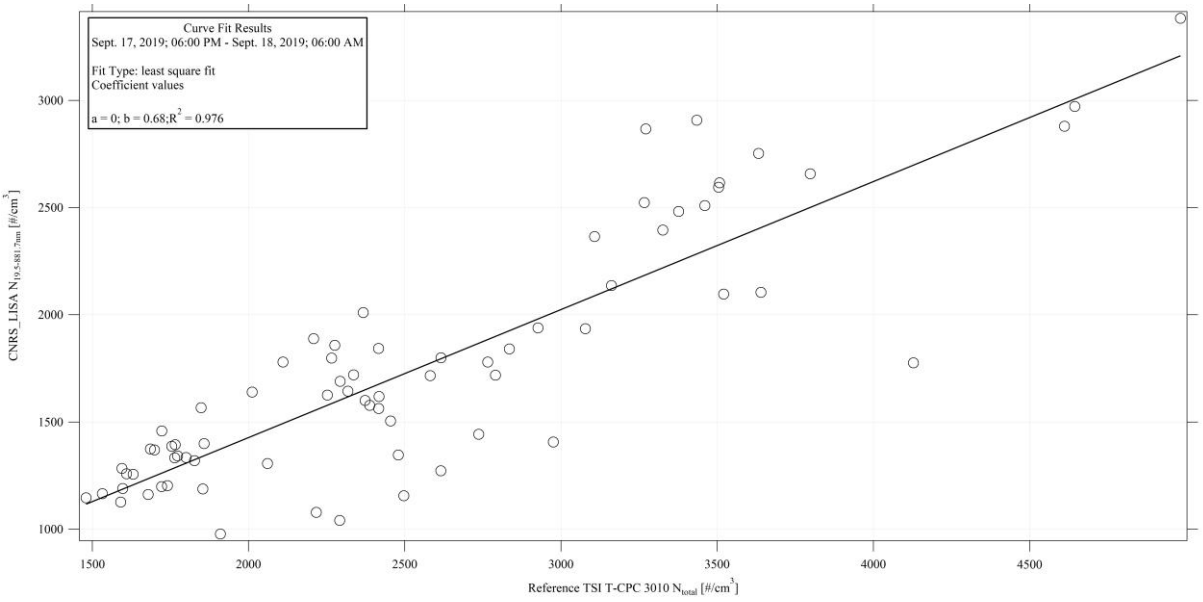

Figure 08: Linear regression between the number concentration of the TROPOS Reference TSI T-CPC Model 3010 and CNRS LISA.

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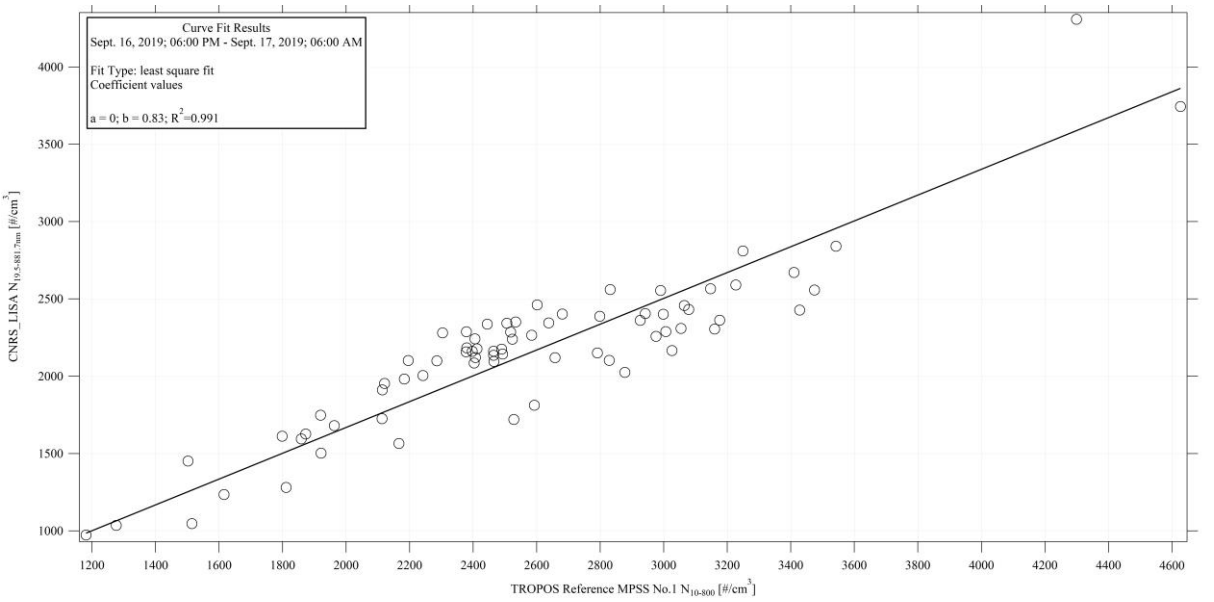

Figure 09: Linear regression between the number concentration of the TROPOS Reference MPSS No.1 (integrated number concentration N10-800nm) and CNRS LISA.

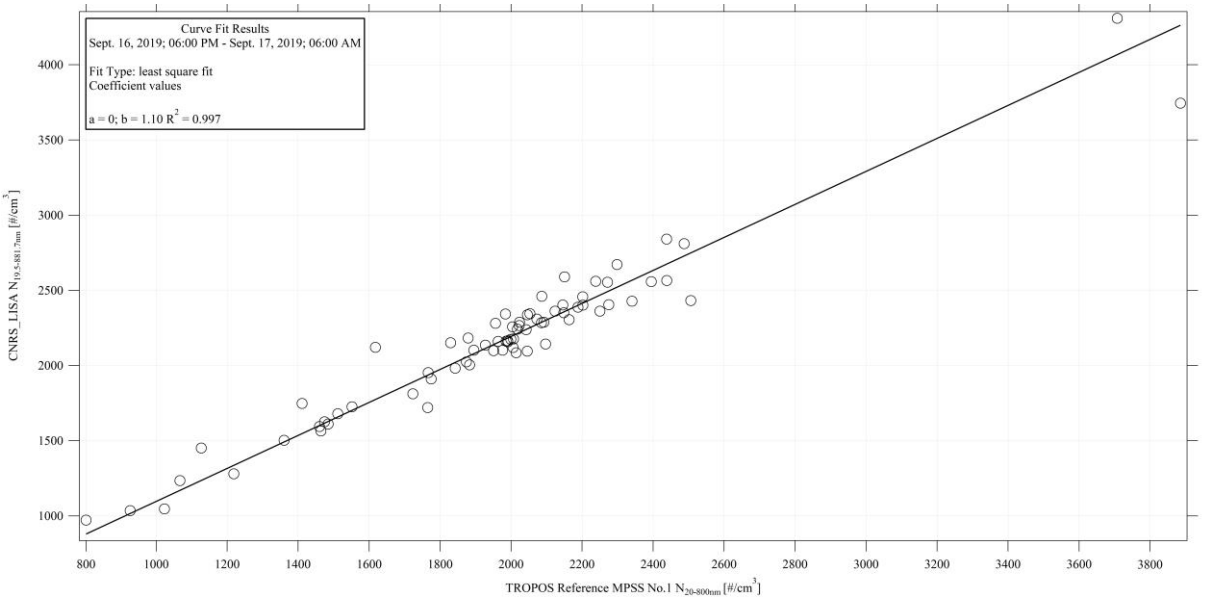

Figure 10: Linear regression between the number concentration of the TROPOS Reference MPSS No.1 (integrated number concentration N20-800nm) and CNRS LISA.

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Status Sept. 17 – 18, 2019

Table No. 2:

Institute: ***CNRS LISA***							
Station: France							
Date of checking list: ***17.09.2019***							
Instrument/ Components	*info*	*SN*	*Date/Code*	*CPC-Status*		*HV-Status*	
MPSS/Classifier:	**TSI 3080**	**8414**	**Oct 2003**	*ST*	**39.0**	*OFF*	**-**
Firmware Classifier:	**-**		**-**	*CT*	**22.0**	*4mv*	**-**
Firmware Software:	**TSI AIM**		**9.0**	*OT*	**40.0**	*800mv*	**-**
DMA type:	**TSI 3081**	**1423**	**Nov. 2003**	*CabT*	**35.4**	*200mv*	**-**
CPC model:	**TSI CPC 3772**	**3772124401**	**Oct. 2013**	*AP*	**99.7**	*0*	**-**
Firmware CPC:	**-**		**-**	*OP*	**83.1**		
radioactive source:	**TSI**	**-**	**Kr.85**	*NP*	**2.7**		
Flow CPC (l/min):	**1.0**			*LC*	**43**		
Flow Inlet (l/min):	**0.2**						
Sheath air flow (l/min):	**2.0**						
Zero (#/cm³):	**3**						
Maintenance							
Aerosol inlet:	**Run with 0.2 L/min over splitter**						
Aerosol Nafion dryer:	**No dryer**						
Sheath Nafion dryer:	**No dryer**						
Source:	**No change**						
HV power supply:	**No change**						
DMA:	**No change**						
Aerosol/sheath RH/T- sensor:	**No sensor**						
Pressure sensor:	**Using TSI sensor over impactor**						
Filter:	**No change**						
NI-card:	**No change**						
CPC:	**No change**						
Impactor:	**With impactor**						
Setup settings over night:	**Use same AIM settings like 16.-17.09.2019**						

Institute: **TROPOS**							
Station: **Reference Instrument No.1**							
Date of checking list: **Sept. 17, 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: **Sept. 17, 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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Instrument Settings, Time Series, Particle Number Size Distribution and Correlation

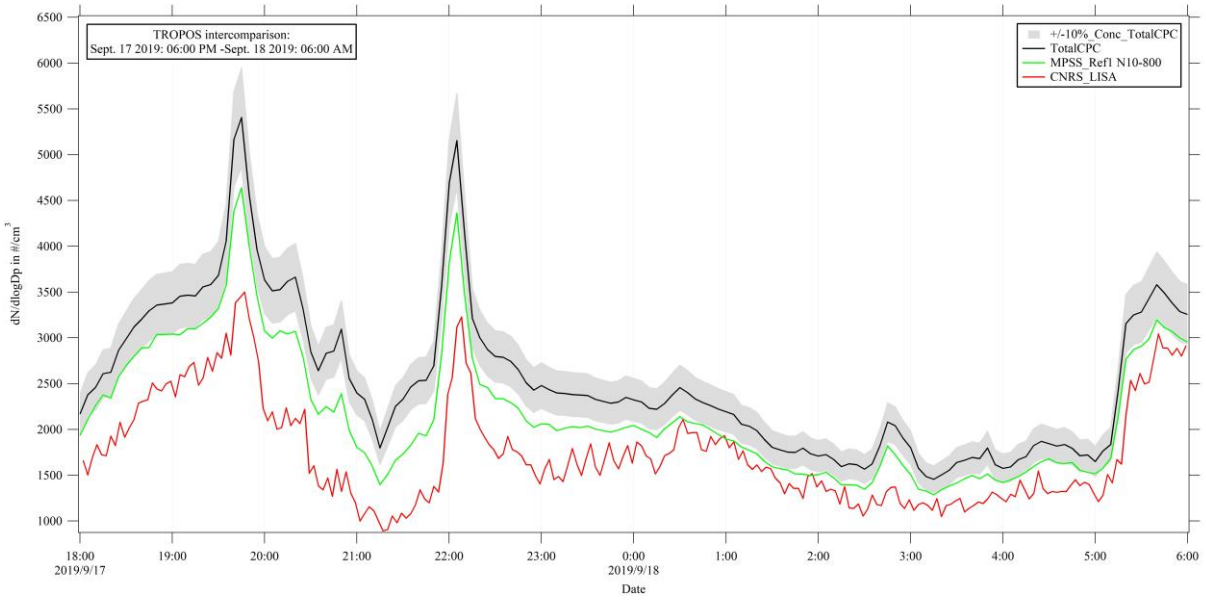

Figure 11: Time series between MPSS Ref1, CNRS LISA and TCPC (Sept. 17, 2019 6 PM – Sept. 18, 2019 6 AM) of the integrated particle number concentration (N10-800nm) of the MPSS and total number concentration of the Reference TSI-CPC Model 3010. Multiple charge correction, internal diffusion losses and CPC flow corrections are included. The candidate is running with the TSI Kr.85 source.

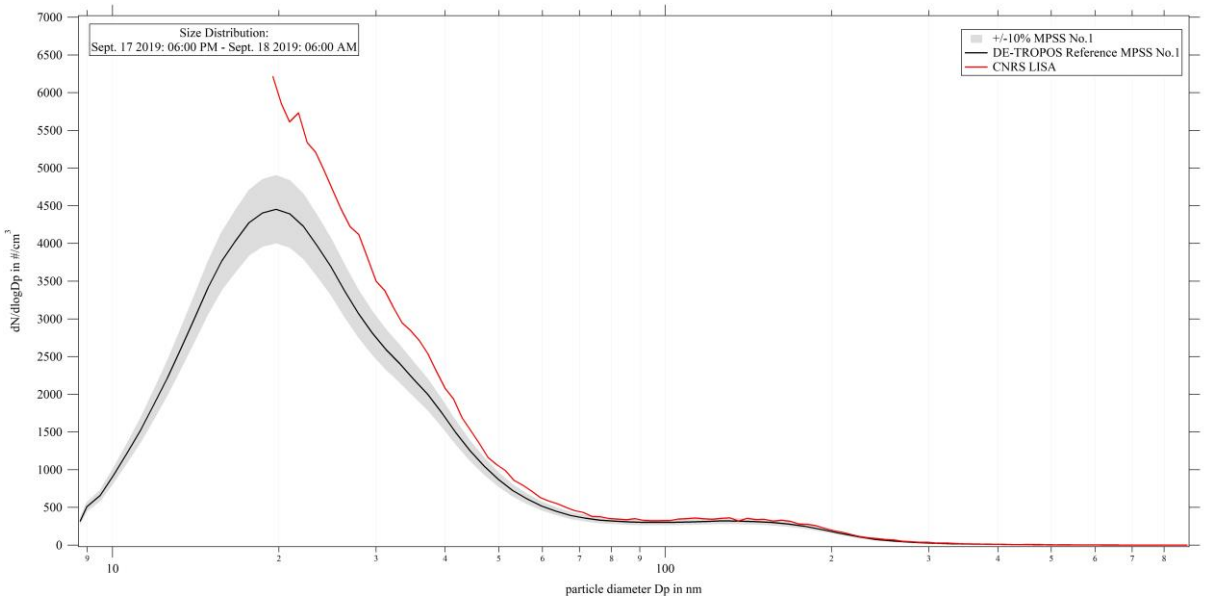

Figure 12: Comparison of mean particle number size distribution of TROPOS Reference MPSS No.1 against CNRS LISA from Sept. 17, 2019 6 PM – Sept. 18, 2019 6 AM.

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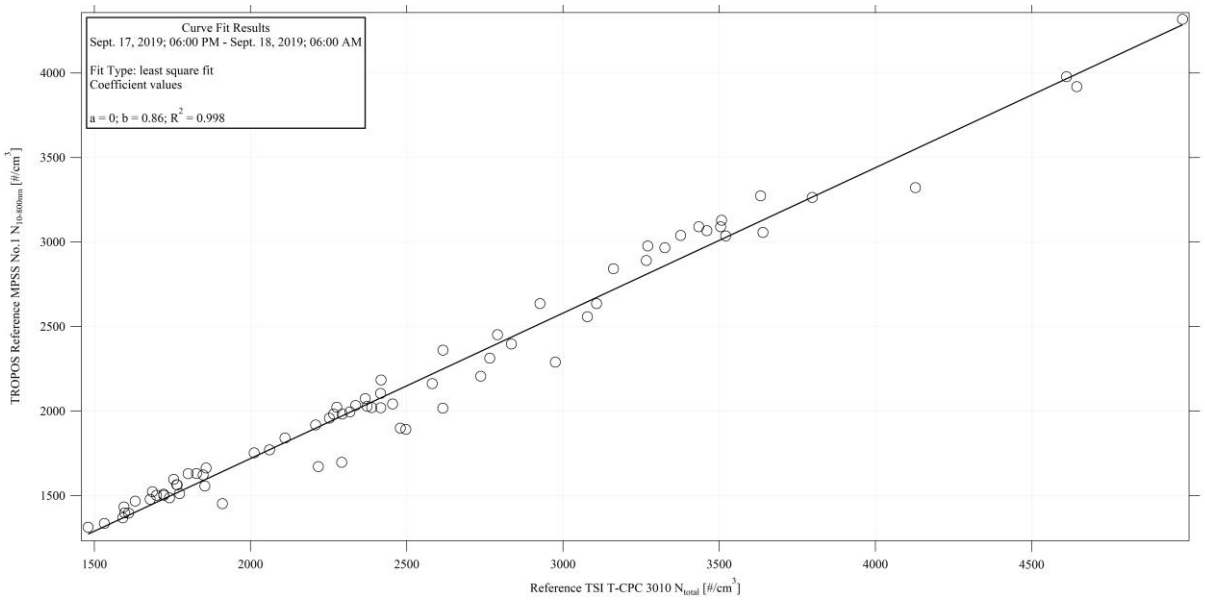

Figure 13: Linear regression between the number concentration of the TROPOS Reference TSI T-CPC Model 3010 and TROPOS Reference MPSS No.1.

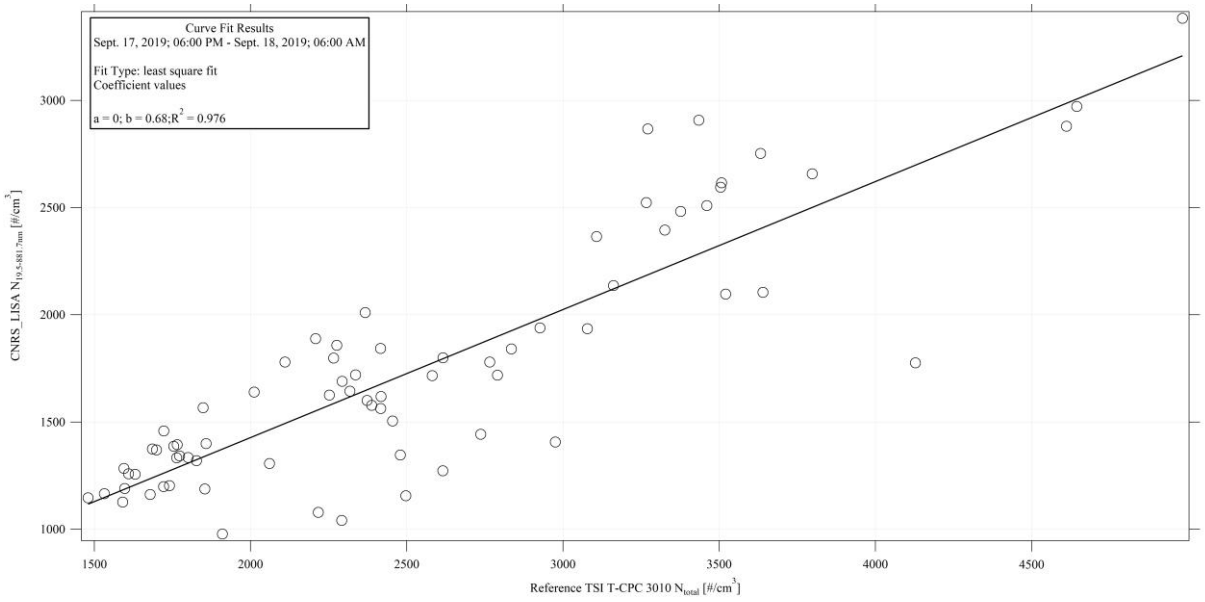

Figure 14: Linear regression between the number concentration of the TROPOS Reference TSI T-CPC Model 3010 and CNRS LISA.

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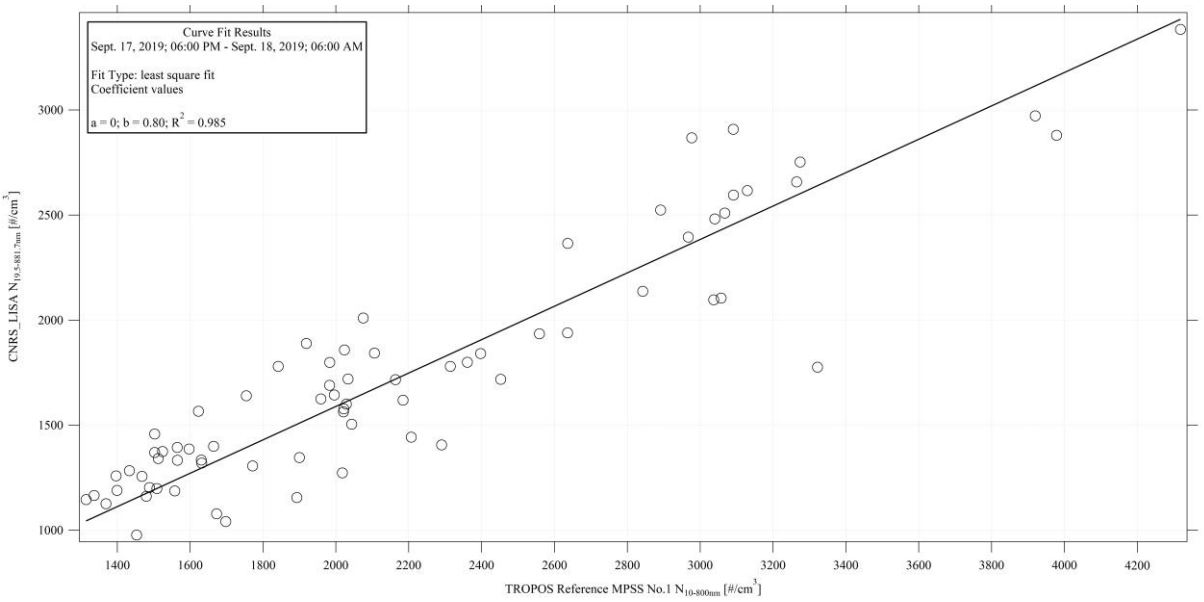

Figure 15: Linear regression between the number concentration of the TROPOS Reference MPSS No.1 (integrated number concentration N10-800nm) and CNRS LISA.

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Status Sept. 18 – 19, 2019

Table No. 3:

Institute: ***CNRS LISA***							
Station: France							
Date of checking list: ***18.09.2019***							
Instrument/ Components	*info*	*SN*	*Date/Code*	*CPC-Status*		*HV-Status*	
MPSS/Classifier:	**TSI 3080**	**8414**	**Oct 2003**	*ST*	**39.0**	*OFF*	**-**
Firmware Classifier:	**-**		**-**	*CT*	**22.0**	*4mv*	**-**
Firmware Software:	**TSI AIM**		**9.0**	*OT*	**40.0**	*800mv*	**-**
DMA type:	**TSI 3081**	**1423**	**Nov. 2003**	*CabT*	**35.4**	*200mv*	**-**
CPC model:	**TSI CPC 3772**	**3772124401**	**Oct. 2013**	*AP*	**99.7**	*0*	**-**
Firmware CPC:	**-**		**-**	*OP*	**83.1**		
radioactive source:	**TSI**	**-**	**Kr.85**	*NP*	**2.7**		
Flow CPC (l/min):	**1.0**			*LC*	**43**		
Flow Inlet (l/min):	**1.0**						
Sheath air flow (l/min):	**5.0**						
Zero (#/cm³):	**0**						
Maintenance							
Aerosol inlet:	**DMA is directly connected to the CPC**						
Aerosol Nafion dryer:	**No dryer**						
Sheath Nafion dryer:	**No dryer**						
Source:	**No change**						
HV power supply:	**No change**						
DMA:	**Cleaned and repair filter**						
Aerosol/sheath RH/T- sensor:	**No sensor**						
Pressure sensor:	**Using TSI sensor over impactor**						
Filter:	**No change**						
NI-card:	**No change**						
CPC:	**No change**						
Impactor:	**without impactor**						
Setup settings over night:							

Institute: **TROPOS**							
Station: **Reference Instrument No.1**							
Date of checking list: **Sept. 18, 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: **Sept. 18, 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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Instrument Settings, Time Series, Particle Number Size Distribution and Correlation

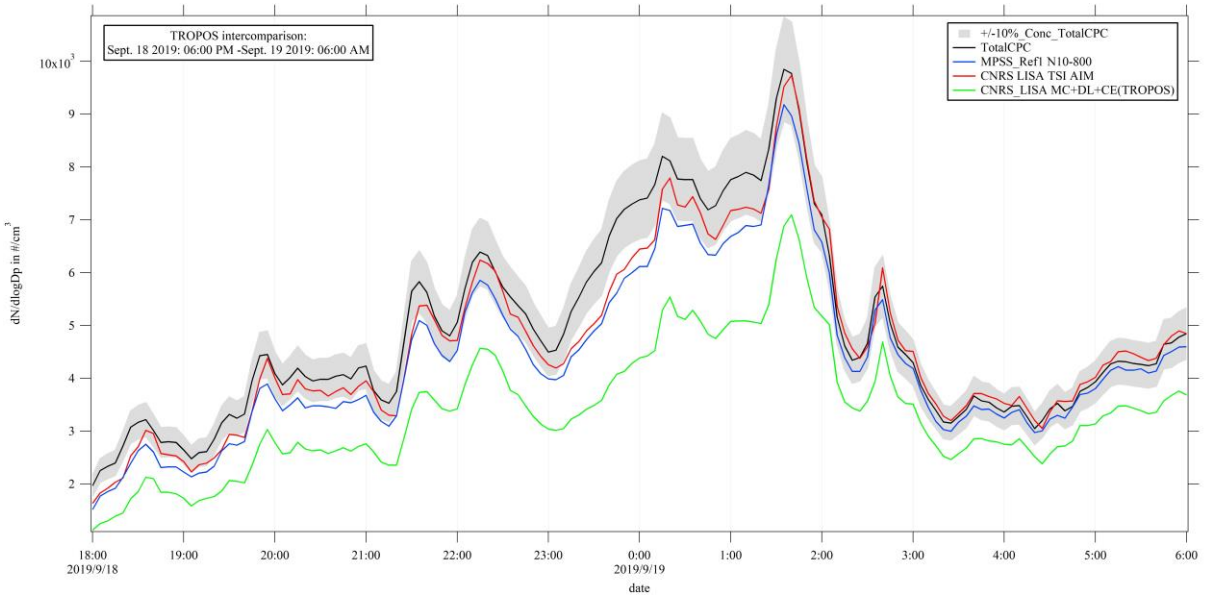

Figure 16: Time series between MPSS Ref1, CNRS LISA and TCPC (Sept. 18, 2019 6 PM – Sept. 19, 2019 6 AM) of the integrated particle number concentration (N10-800nm) of the MPSS and total number concentration of the Reference TSI-CPC Model 3010. s

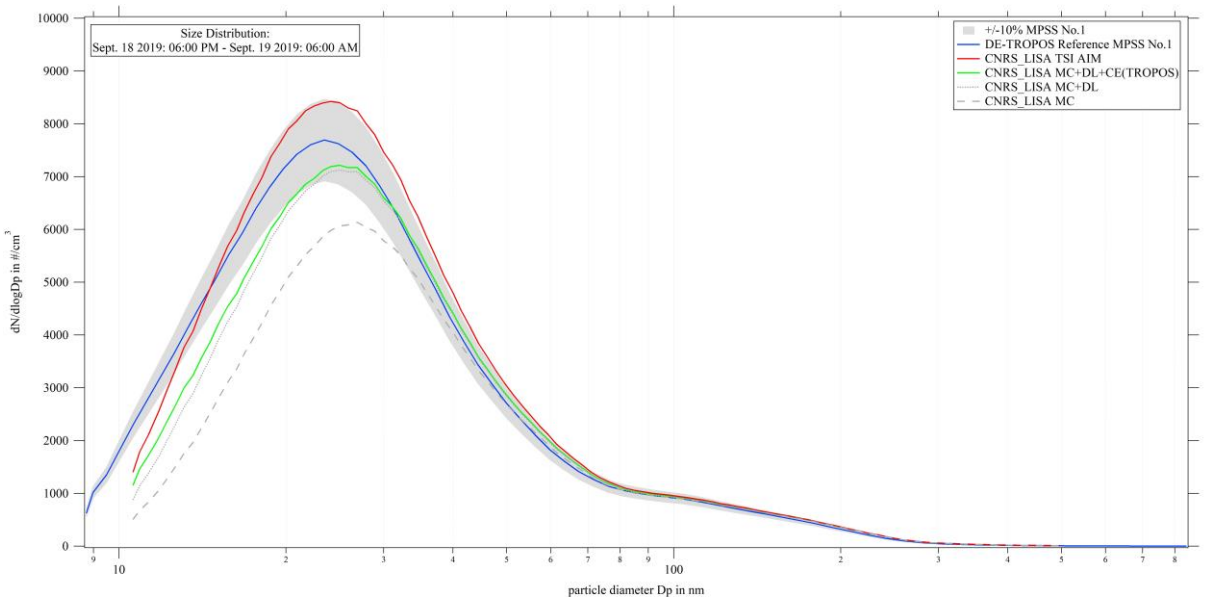

Figure 17: Comparison of mean particle number size distribution of TROPOS Reference MPSS No.1 against CNRS LISA from Sept. 18, 2019 6 PM – Sept. 19, 2019 6 AM.

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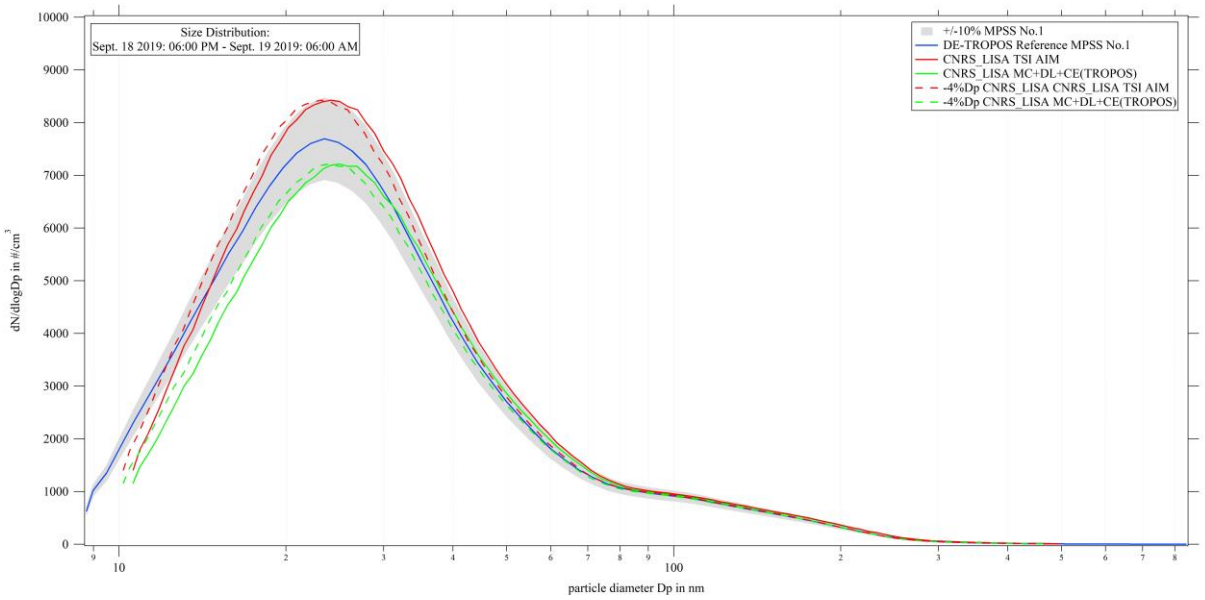

Figure 18: Comparison of mean particle number size distribution of TROPOS Reference MPSS No.1 against CNRS LISA (Dp was corrected according to PSL tests) from Sept. 18, 2019 6 PM – Sept. 19, 2019 6 AM.

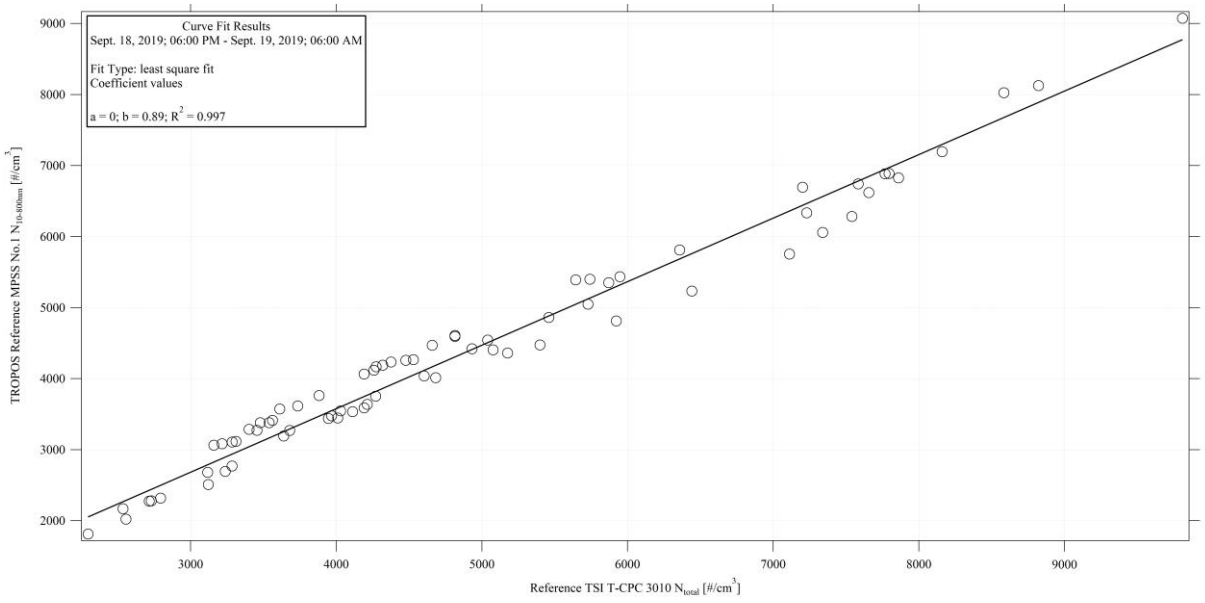

Figure 19: Linear regression between the number concentration of the TROPOS Reference TSI T-CPC Model 3010 and TROPOS Reference MPSS No.1.

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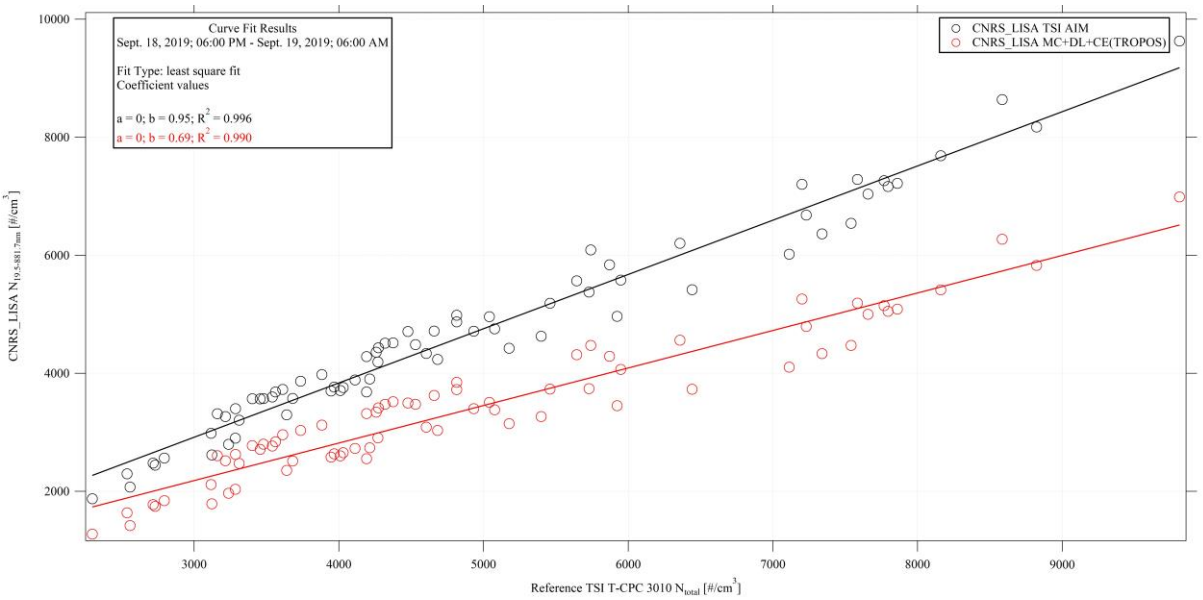

Figure 20: Linear regression between the number concentration of the TROPOS Reference TSI T-CPC Model 3010 and CNRS LISA.

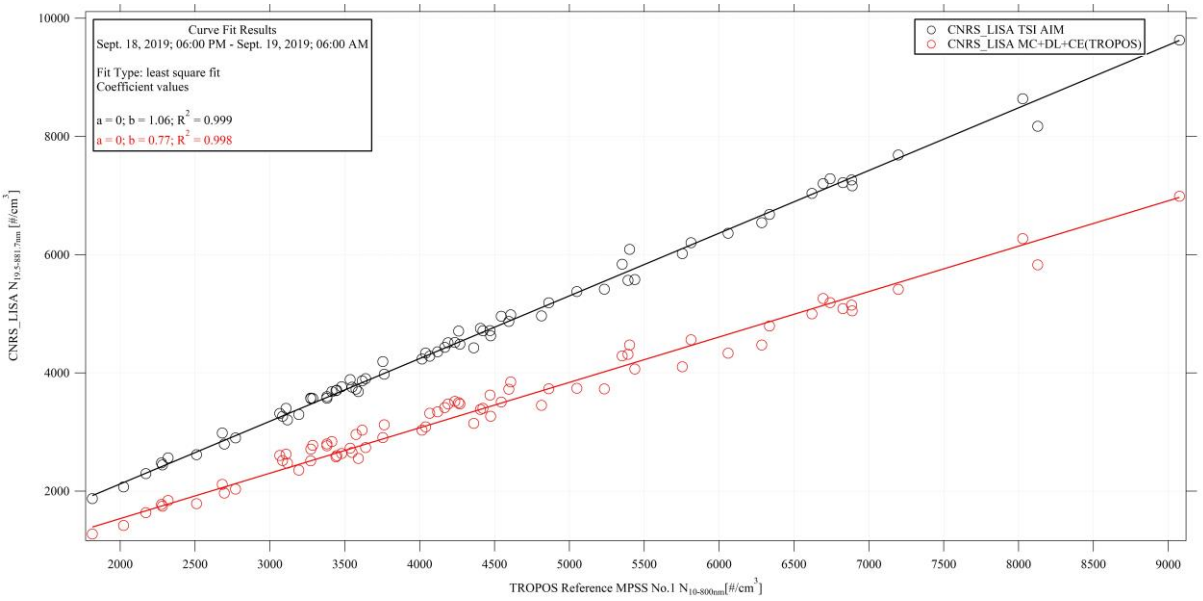

Figure 21: Linear regression between the number concentration of the TROPOS Reference MPSS No.1 (integrated number concentration N10-800nm) and CNRS LISA.

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Status Sept. 19, 2019

Table No. 4:

Institute: ***CNRS LISA***							
Station: France							
Date of checking list: ***19.09.2019***							
Instrument/ Components	*info*	*SN*	*Date/Code*	*CPC-Status*		*HV-Status*	
MPSS/Classifier:	**TSI 3080**	**8414**	**Oct 2003**	*ST*	**39.0**	*OFF*	**-**
Firmware Classifier:	**-**		**-**	*CT*	**22.0**	*4mv*	**-**
Firmware Software:	**TSI AIM**		**9.0**	*OT*	**40.0**	*800mv*	**-**
DMA type:	**TSI 3081**	**1423**	**Nov. 2003**	*CabT*	**35.4**	*200mv*	**-**
CPC model:	**TSI CPC 3772**	**3772124401**	**Oct. 2013**	*AP*	**99.7**	*0*	**-**
Firmware CPC:	**-**		**-**	*OP*	**83.1**		
radioactive source:	**TSI**	**-**	**Kr.85**	*NP*	**2.7**		
Flow CPC (l/min):	**1.0**			*LC*	**43**		
Flow Inlet (l/min):	**0.2**						
Sheath air flow (l/min):	**2.0**						
Zero (#/cm³):	**0**						
Maintenance							
Aerosol inlet:	**Run with 0.2 L/min over splitter**						
Aerosol Nafion dryer:	**No dryer**						
Sheath Nafion dryer:	**No dryer**						
Source:	**No change**						
HV power supply:	**No change**						
DMA:	**-**						
Aerosol/sheath RH/T- sensor:	**No sensor**						
Pressure sensor:	**Using TSI sensor over impactor**						
Filter:	**No change**						
NI-card:	**No change**						
CPC:	**No change**						
Impactor:	**with impactor**						
Setup settings over night:							

Institute: **TROPOS**							
Station: **Reference Instrument No.1**							
Date of checking list: **Sept. 18, 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: **Sept. 18, 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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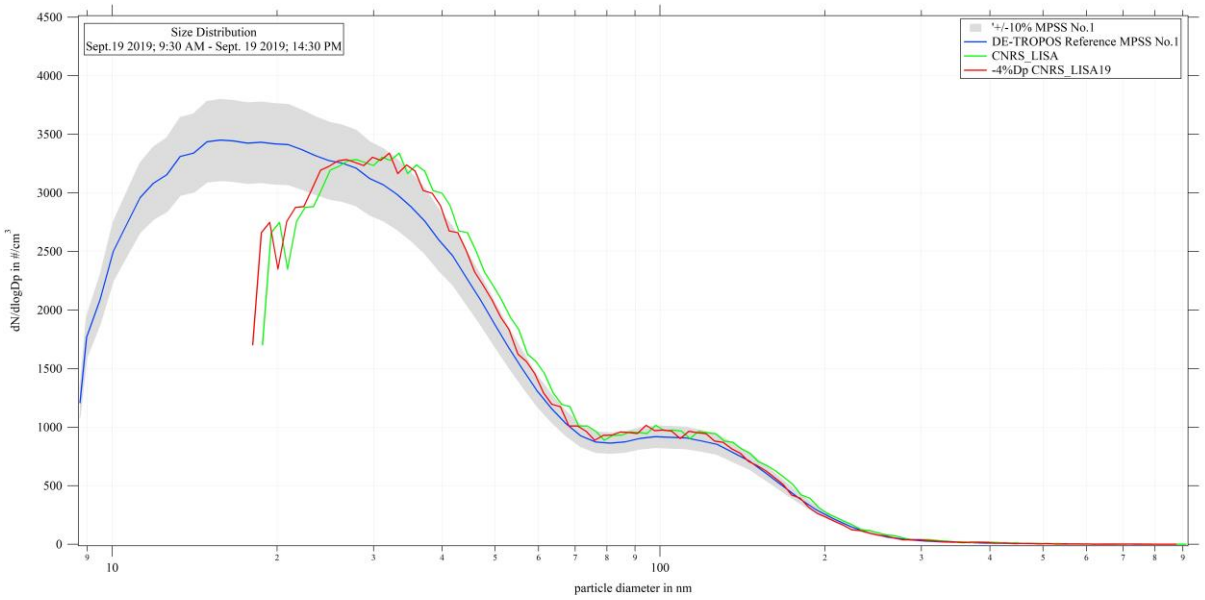

Figure 22: Comparison of mean particle number size distribution of TROPOS Reference MPSS No.1 against CNRS LISA from Sept. 19, 2019 9:30 AM – Sept. 19, 2019 14:30 PM. After fixing the DMA, the following PSL calibration (203 nm) of instrument showed a peak at 209 nm. The red line shows a 4% correction in the sizing.

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