Intercomparison of Mobility Particle Size Spectrometers

Project No.: MPSS-2015-1-1

Basic information:

Location of the quality assurance: TROPOS, lab: 118

Delivery date: October 05, 2015

Setup in the laboratory: October 15, 2015

Comparison period: December 17, 2015 – December 18, 2015

Principal Investigator	Home Institution	Participant	Instrument
Raymond Ellul	Atmospheric Research Group Geosciences department University Gozo Campus Mgarr Road, Xewkija, Gozo. Malta	David Munaò	Malta TROPOS-MPSS: home-made TSI CPC Model 3772 # 71021256

Summary of Intercomparison:

Pre-status:
The Malta TROPOS-MPSS was completely disassembled. Therefore, an initial status check was not possible.

Final status:
The Malta TROPOS-MPSS passed the quality standards of ACTRIS and GAW.

A Malta TROPOS-MPSS with TSI-CPC Model 3772 (S/N: 71021256) was sent to TROPOS under flowing conditions:

- The Malta TROPOS-MPSS was completely disassembled. Therefore, an initial status check was not possible.
- shipped without radioactive source → during the workshop we used a TSI-Kr85 source from TROPOS
- CPC-Workshop: The CPC 3772 reached 100% efficiency at 30 nm. The Dp50 is at 7.6 nm. The CPC efficiency curve corresponds to the standard.
- All Nafion dryers (ND.07-66, ND.07-67, ND.07-68, MD-110-12E-S 1610210-7) were in a bad condition, because of contamination by sea salt. All of them have to be replaced with new ones.

Figure 01: Status of the nafion membrane. The nafion membrane is completely damaged from the sea salt and it is also broken in two pieces.

- The whole aerosol inlet (head, inlet, splitter) have been delivered to the electronic and mechanic workshop. The PM10 head and splitter were cleaned. All tubes and fittings were replaced by new ones.

Figure 02: Status of the PM10 head. There was heavy corrosion on the supporting screws and ring. Screws and aluminium net were replaced.

Figure 03: Splitter and SS piping. The splitter was sand blasted and the piping and fitting were replaced.

- Before mounting the whole Malta TROPOS-MPSS back, each part of the rack and fittings were cleaned and checked. Both the electronic box and the A/C unit have been inspected by the electronic group to make sure that everything is in proper order. All the aerosol lines have been wet cleaned in a sonic bath with a water based

solution (distilled water + isopropanol + commercial surfactant), rinsed with distilled water and dried by means of compressed air. All the nylon ferrules were replaced with new ones in the mounting phase.

- The DMA has been opened and inspected. A visible passivation layer has been observed in the negative electrode, as well as on the positive one. This thin corrosion layer is due to the salty environment in which the system is working. The mechanical workshop cleaned the DMA, mechanically removing the passivation layer from the electrodes.

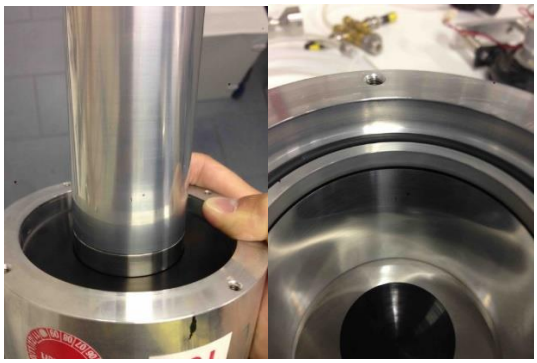


Figure 04: DMA status: The DMA was opened and completely cleaned.

- The three HEPA filters installed in the Malta TROPOS-MPSS have been opened and serviced. Filter holders have been wet cleaned and the inner filters and o-rings were replaced with new ones. HEPA filters have been tested for leaks against a TROPOS CPC 3772 (SN 70835059) with the Zero count method.
- After two weeks, the Malta TSI-CPC Model 3772 showed counts. After 1 ½ hours, the size distribution on both ends showed high concentration. After changing the CPC to another MPSS, we got the same results. A technical check in TROPOS was not successful. The CPC was sent to TSI-Company for repair. After 3 weeks we got the CPC back, but there was no change, the same results were obtained. After a second check by TSI, which took another3 weeks, we got the CPC back, repaired.
- Software update: The Malta TROPOS-MPSS got the latest version of the TROPOS software 6.5 under WIN7. The OPSS and the MAAP were checked and tested with the newest software based on LabView.
- The Malta TROPOS-MPSS was calibrated: High voltage and PSL with Latex 203 nm.
- Discussion with the provider about the setup in the future: The whole inlet has been revised, to optimize the aerosol lengths for each instrument and, as much as possible, protect all the components against sea salt. This is realized by implementing a PM1 before the main nafion dryer, MPSS, MAAP. The OPSS is operating after the PM10 head together with a nafion dryer. The whole Malta setup complies with the standards of ACTRIS and GAW.

List of Components

	Specification	Reference MPSS No.1	TROPOS-MPSS Malta
Position (Line)		1.6	1.4
Company		TROPOS	TROPOS
Software		TROPOS 5.7	TROPOS 6.5
CPC		Model 3772	Model 3772
Flow ratio		1.0 : 5.0	1.0 : 5.0
Source		Kr85	Kr85 (TSI)
HV cassette		positive	positive
DMA		Hauke medium	Hauke medium
Flow meas.	Aerosol	✓	✓
Dryer		✓	✓
RH sensor	Inlet	✓	✓
T sensor		✓	✓
RH sensor	Sheath air	✓	✓
T sensor		✓	✓
Dryer		✓	✓
p sensor		✓	✓

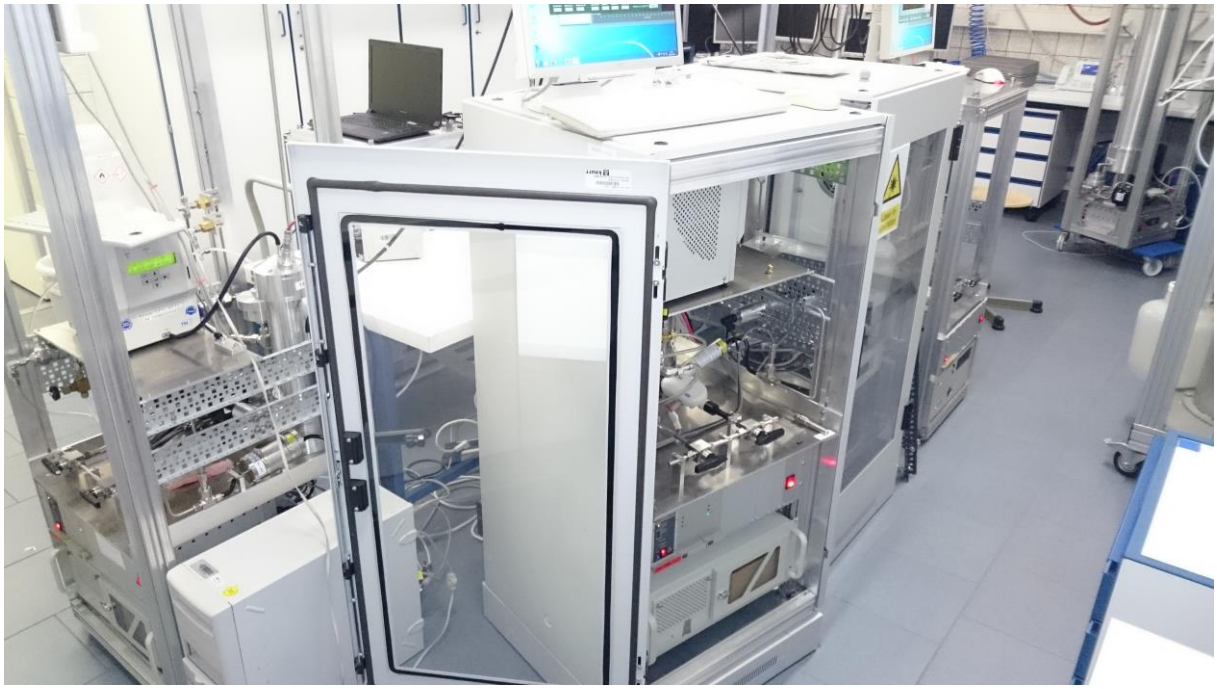
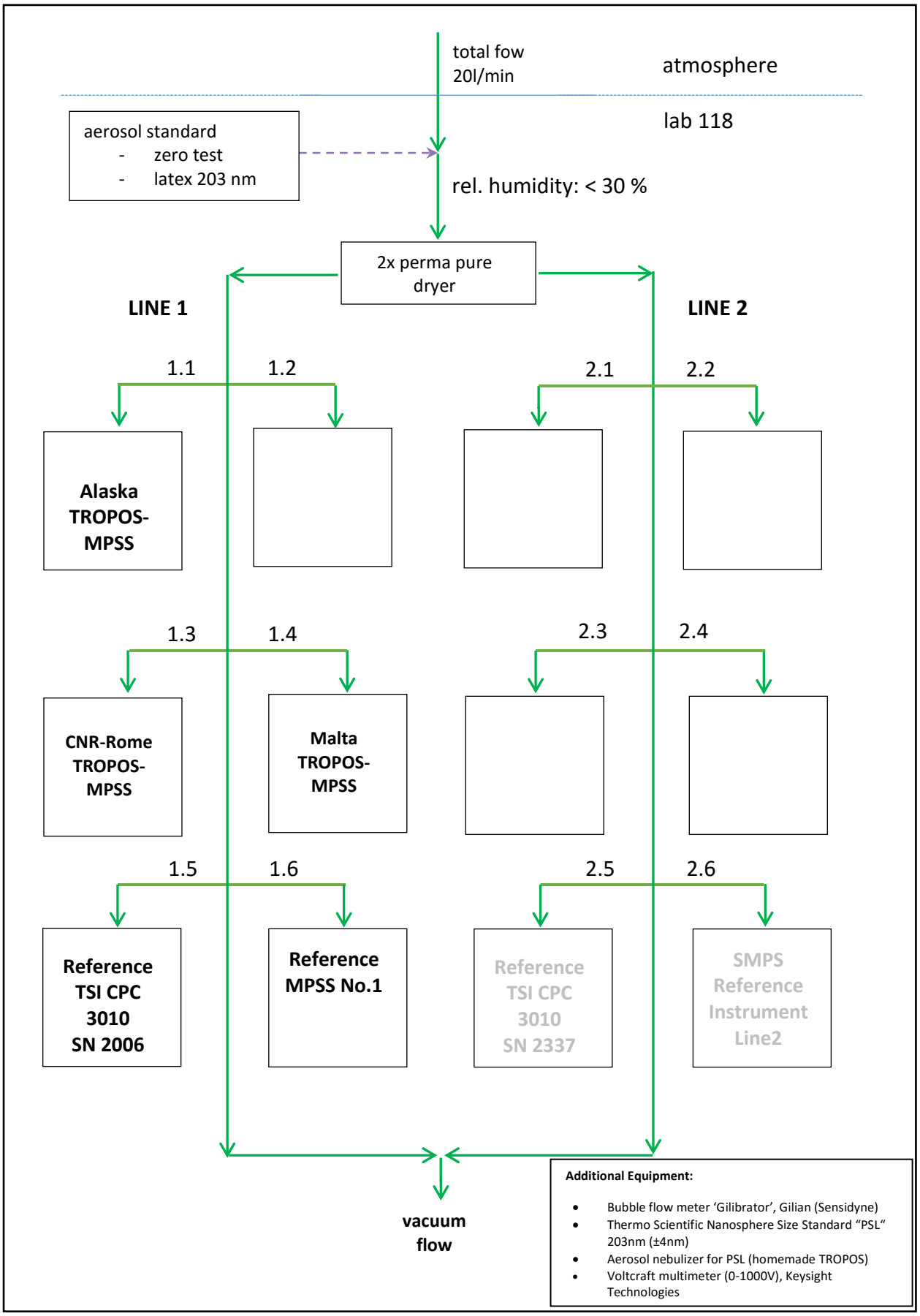


Figure 05: Setup of the Malta TROPOS-MPSS in the TROPOS lab 118.

Laboratory setup



Pre-Workshop-Status of Reference Instruments in TROPOS

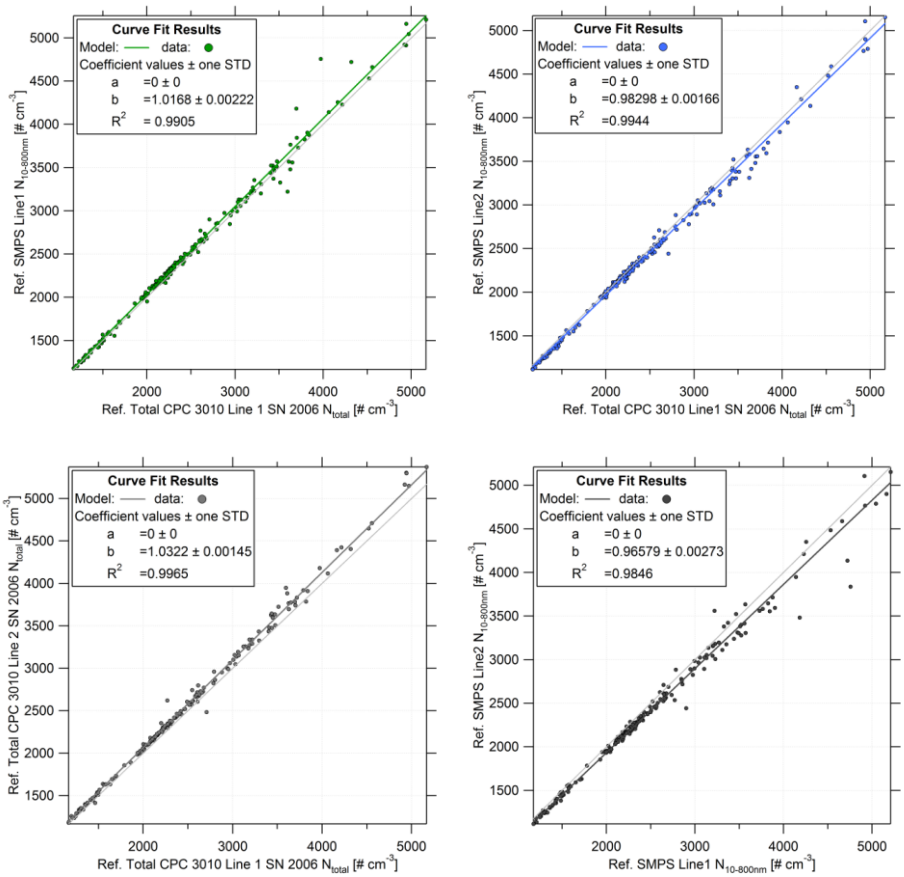


Figure 06: Correlations of the TROPOS Reference MPSS systems and the Reference TSI CPCs Model 3010 of both lines (see laboratory setup). Multiple charge, internal diffusion loss and CPC flow corrections are included.

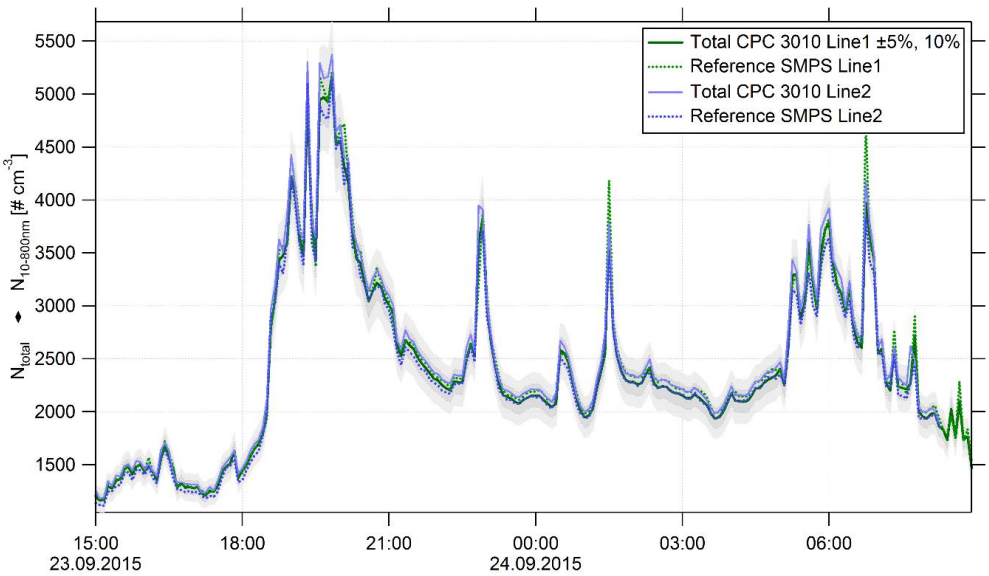


Figure 07: Intercomparison between the two Lines. For each Line there is a TROPOS Reference MPSS and a Reference TSI CPC Model 3010, which are calibrated against an electrometer. Multiple charge, internal diffusion loss and CPC flow corrections are included.

Final Status of the Candidate (17.12.2015 – 18.12.2015)

Components and zero check

Institut	System	Components	CPC Model + Serial No.	Line	Flow		Zero	
TROPOS	Ref1	MPSS	3772 SN 71011009	1.6	**1.032**	l/min	0	# cm^{-3}
TROPOS		Total CPC	3010 SN 2006	1.5	**1.041**	l/min	0	# cm^{-3}
UOM	Malta	TROPOS-MPSS	3772 SN 71021256	1.4	**1.030**	l/min	0	# cm^{-3}

High voltage calibration

Institut	System	[V]	0 V	5 mV	80 mV	800 mV
TROPOS	Reference MPSS No.1	Pre-status	-	-	-	-
		final	**0.00**	**6.2**	**99.9**	**1000**
UOM	MPSS Malta	Pre-status	-	-	-	-
		final	**0.00**	**6.3**	**100**	**1000**

Latex 203nm ±4nm (pressure 1007 hPa, 23.0°C)

Institut	System		Latex 203 [nm]	slope
TROPOS	Reference MPSS No.1	Pre-status		
		final	**203.0**	**4.89**
UOM	MPSS Malta	Pre-status	-	-
		final	**203.0**	**4.95**

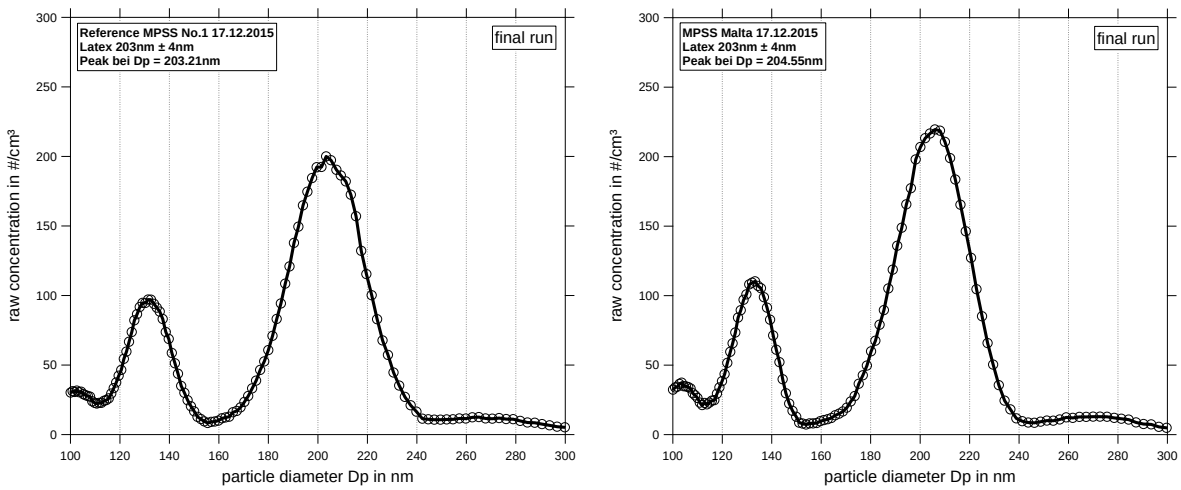


Figure 08: Measurement of latex 203 nm: Particle size distribution (raw concentration) for latex 203 nm on December 17, 2015.

Time Series

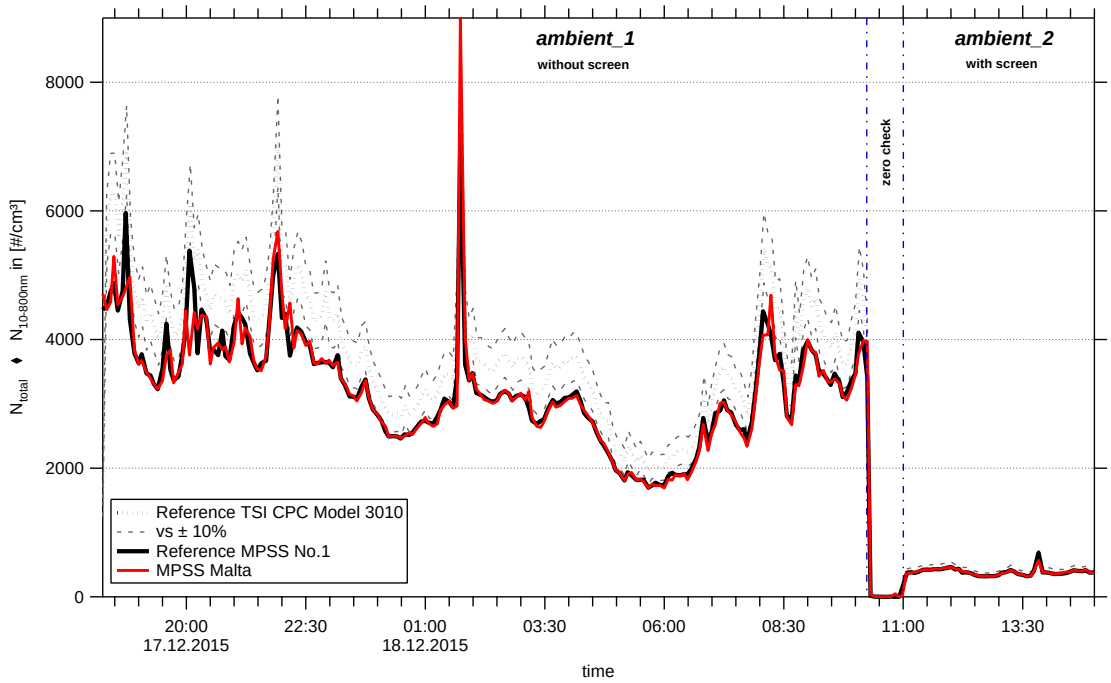


Figure 9: Time series (December 17, 2015 18:00 pm – December 18, 2015 15:00 pm) of the integrated particle number concentration ($N_{10\text{-}800nm}$) of the MPSS and total number concentration (N_{total}) of the reference TSI-CPC Model 3010. The inversion was performed using TROPOS software. Multiple charge correction, internal diffusion losses and CPC flow corrections are included.

Particle Number Size Distribution

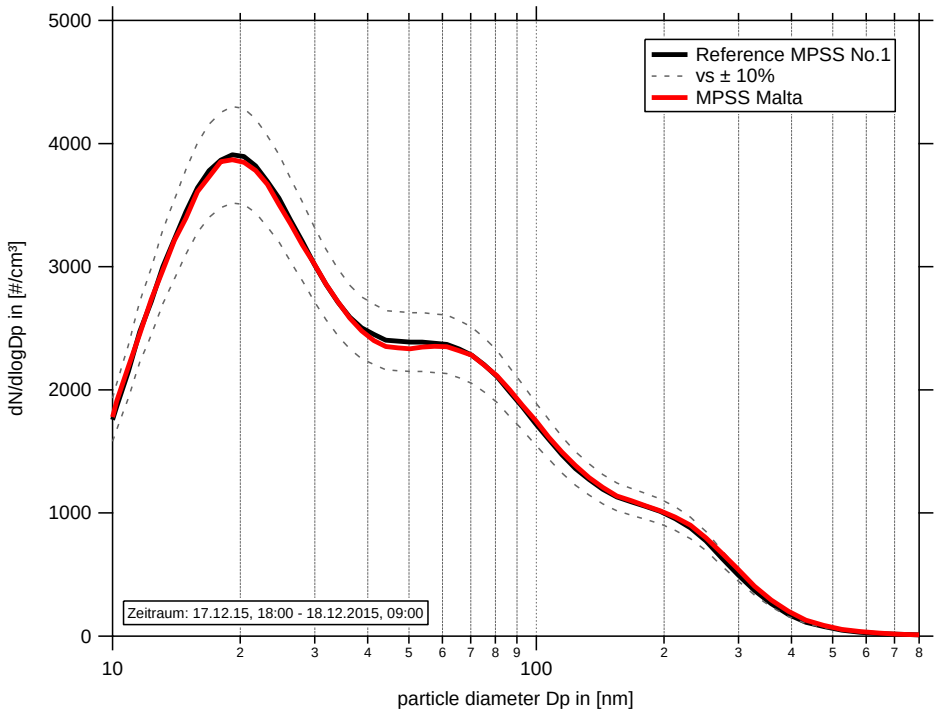


Figure 10: Comparison of mean particle number size distribution of Malta TROPOS-MPSS and TROPOS reference instrument No.1 from December 17, 2015 18:00 pm until December 18, 2015 09:00 am. The inversion was performed using TROPOS software. Multiple charge correction, internal diffusion losses and CPC efficiency are included.

Ambient_1: without screen

Correlation between the total CPCs Model 3010 and TROPOS Reference MPSS No.1

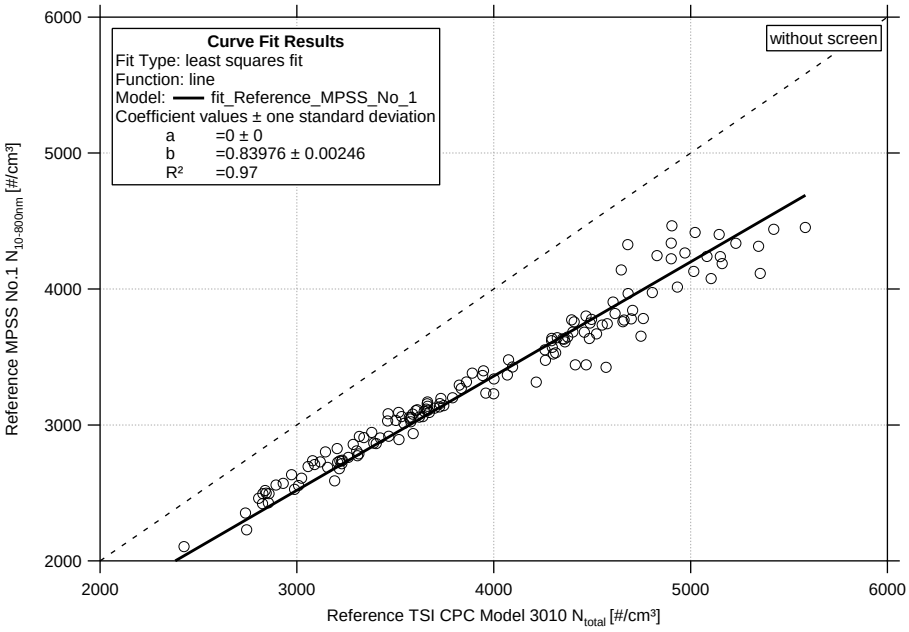


Figure 11: Linear regression between the number concentrations of the TROPOS Reference MPSS No.1 and TROPOS Reference TSI CPC Model 3010. Multiple charge correction, internal diffusion losses and CPC flow corrections are included.

Correlation between the TROPOS Reference TSI CPC Model 3010 and MPSS Malta

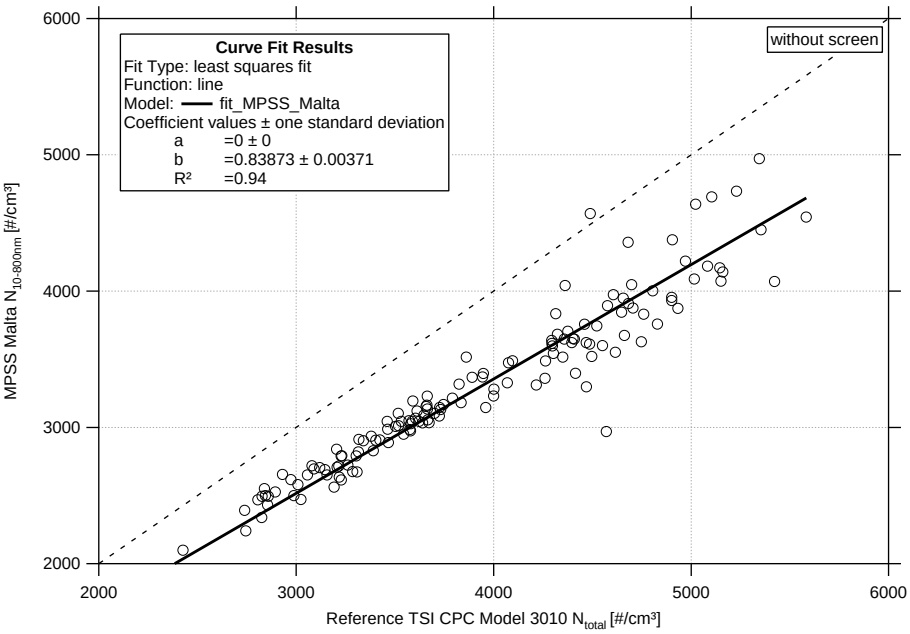


Figure 12: Linear regression between the number concentrations of the MPSS Malta and TROPOS Reference TSI CPC Model 3010. Multiple charge correction, internal diffusion losses and CPC flow corrections are included.

Correlation between the TROPOS Reference MPSS No.1 and MPSS Malta

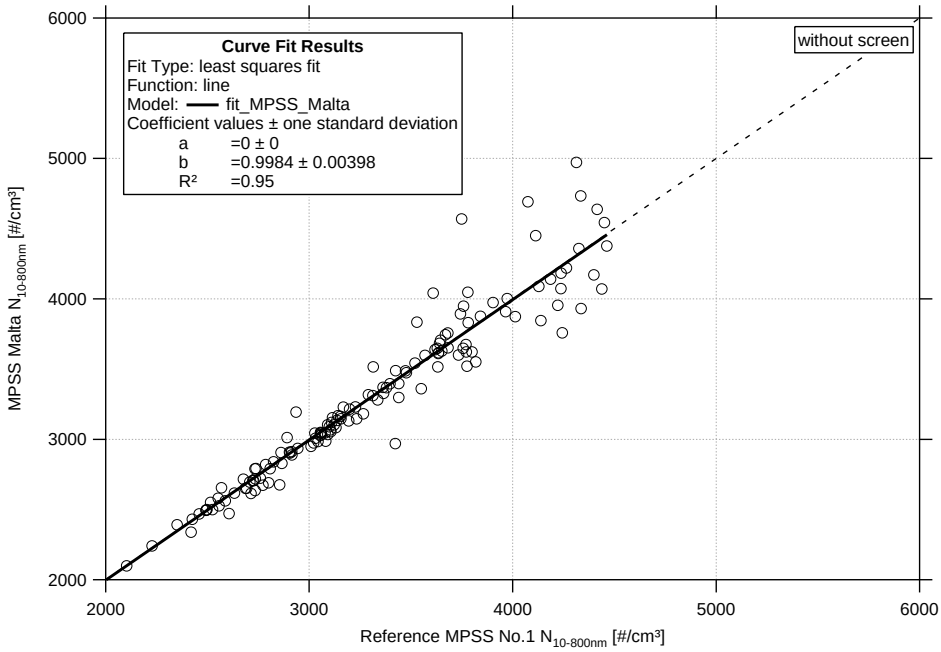


Figure 13: Linear regression between the number concentrations of the MPSS Malta and TROPOS Reference MPSS No.1. Multiple charge correction, internal diffusion losses and CPC flow corrections are included.

Ambient_2: with screen

Correlation between the total CPCs Model 3010 and TROPOS Reference MPSS No.1

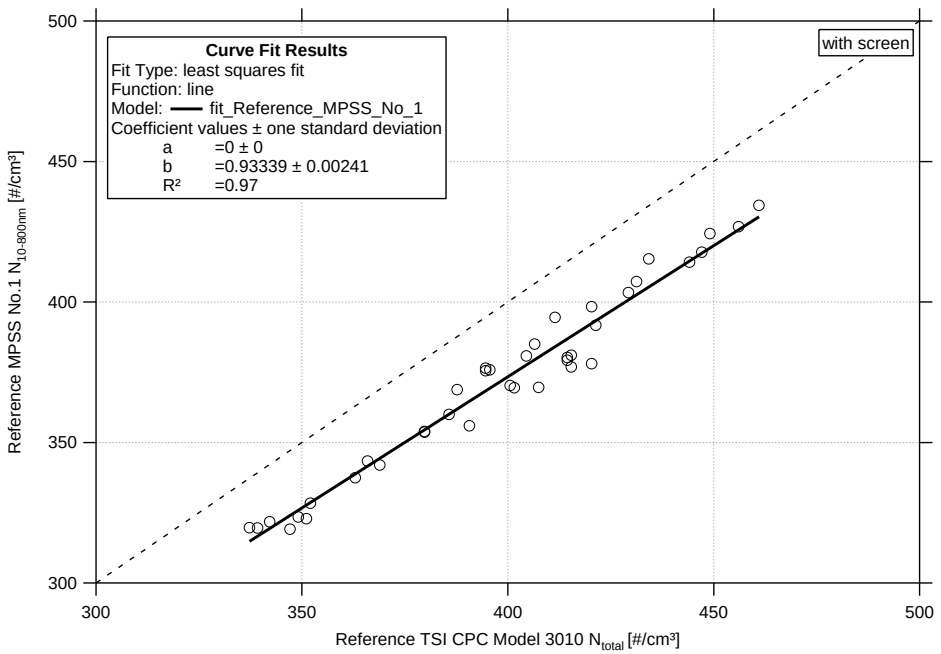


Figure 14: Linear regression between the number concentrations of the TROPOS Reference MPSS No.1 and TROPOS Reference TSI CPC Model 3010. Multiple charge correction, internal diffusion losses and CPC flow corrections are included.

Correlation between the TROPOS Reference TSI CPC Model 3010 and MPSS Malta

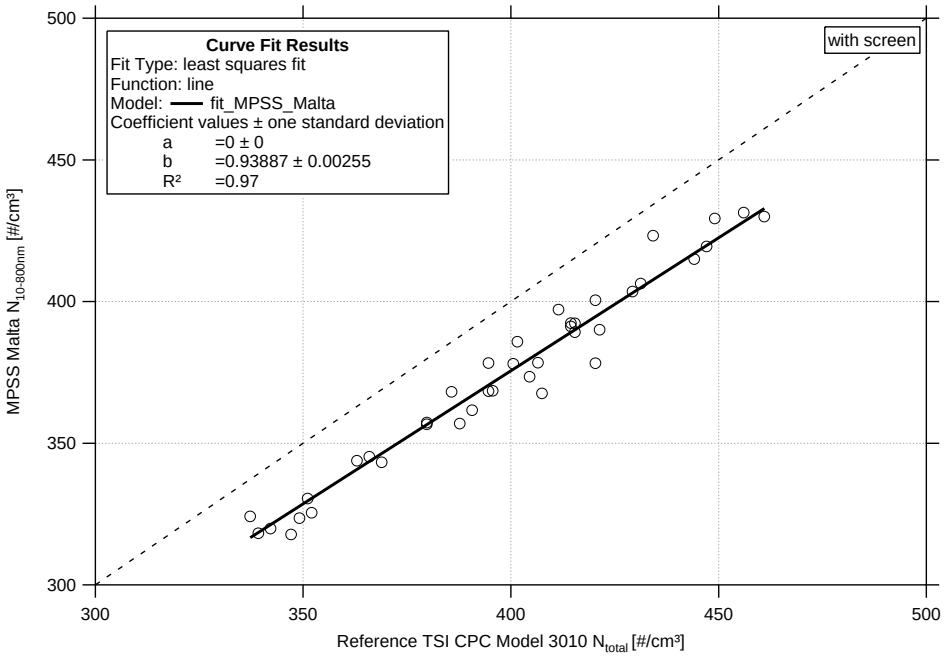


Figure 15: Linear regression between the number concentrations of the MPSS Malta and TROPOS Reference TSI CPC Model 3010. Multiple charge correction, internal diffusion losses and CPC flow corrections are included.

Correlation between the TROPOS Reference MPSS No.1 and MPSS Malta

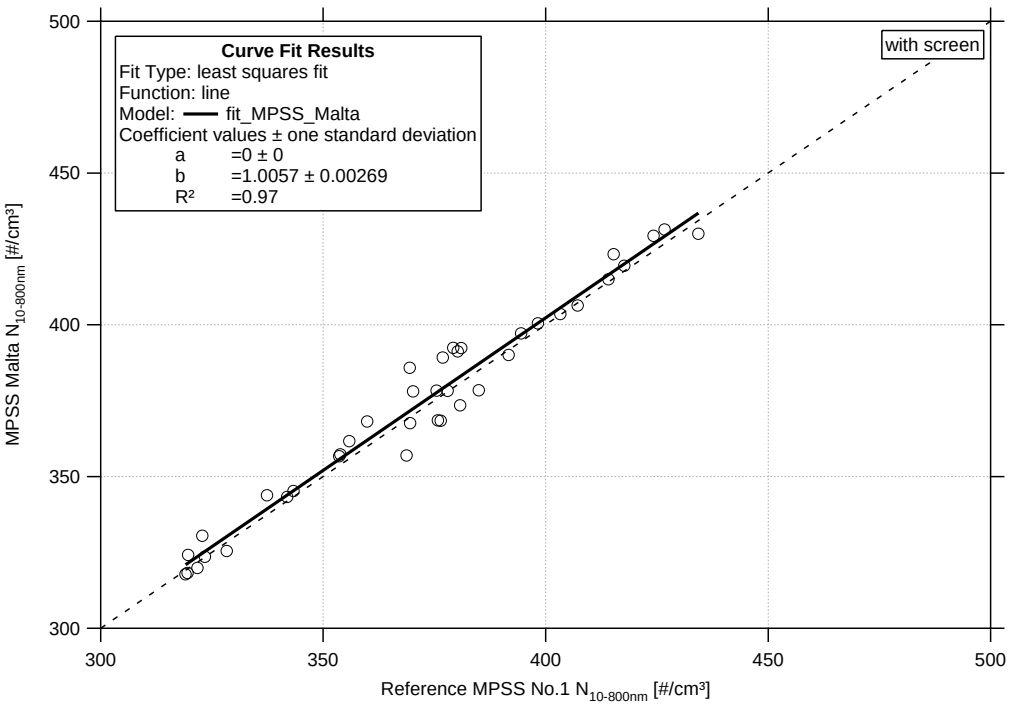


Figure 16: Linear regression between the number concentrations of the MPSS Malta and TROPOS Reference MPSS No.1. Multiple charge correction, internal diffusion losses and CPC flow corrections are included.