

Instrument Inter-Comparison Report

Instrument	
Type	Three Wavelength Particle Soot Absorption Photometer
Serial Number	121
Institution	NILU
Contact	Markus Fiebig

Instrument inter-comparison	
Organization	Leibniz Institute for Tropospheric Research (TROPOS) World Calibration Centre for Aerosol Physics (WCCAP)
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Workshop/Time frame	ACTRIS 2 Absorption Photometer Workshop, 21-25 Sep. 2015

Report	
Status	final
Date	2015-12-28

1. Summary

Flow: The reference temperature and pressure of the instruments mass flow meter are not part of the data. The instruments mass flow mass compared to a reference flow meter. The mass flow compared well to the reference mass flow at room conditions. If concentrations are given at STP ($T=0^{\circ}\text{C}$ and $p=1013.25$) conditions, the mass flow must be corrected by a factor of 1.08.

Noise: The noise for all three wavelengths is low and amounts about 0.27 1/mm for one minute averages.

Zero filter test: A one hour zero measurement shows mean values of 0.036 1/Mm. The error of the mean is in the same order of magnitude. This indicates that there could be a small leak in the instruments.

Comparison to reference absorption: The absorption coefficients at 450 and 530 nm agree well to the reference absorption with slopes of the regression lines of 0.99 and 0.97. Differences at 660 nm (slope about 1.17) are due to the low concentration during the ambient combined with an unstable background correction of the reference absorption setup at 660 nm.

Recommendations: If the automatic loading and spot size correction is used, be aware that the parameters in the systems settings do not follow the parameters in the original Bond correction.
Regular zero measurement to check for possible leak.

Overall assessment: The instrument meets the requirements.

2. Instrument configuration

Configuration parameters
Instrument serial number: 121 Radiance Research Version 2.03 Amplivier settings: Blue: lvl 15, lvl 25, Green: lvl 25, lvl 25, Red: lvl 10 lvl 12 zero flow = .0 Bond correction: $B1999 \ b/b0/(Tr*B+A)$, $A=0.866$, $B=1.317$ Filter area = $18.77 \text{ mm}^2 \rightarrow$ spot diameter 4.88 mm

3. Technical checks

Flow check							
Date	System Flow	Measured flow				Reference flow meter	Flow correction factor (to STP)
	Mass flow	Volume flow	Ambient T and P		Mass flow [slpm] STP (0°C, 1013.25hPa)		
	Q_{PSAP} [slpm]	Q [lpm]	T [°C]	P [hPa]			
17. Sep	1.04	1.27	23	986	1.14	Gilibrator TROPOS-T	1.09
25. Sep	1.15	1.38	22	1005	1.25	Gilibrator TROPOS-T	1.07

The flow meter in the PSAP measures the mass flow. The reference temperature and pressure of the mass flow is not specified. For data evaluation the flow was measured and a correction factor was derived to related the instrument mass flow to a STP flow with $T_0=0^\circ\text{C}$ and $P_0=1013.25 \text{ hPa}$.

Spot size				
Date	Measured diameter [mm]	Instrument setting [mm]	Area correction factor [mm ²]	Comments
23. Sep	5 ± 0.1	4.88	1.05 ± 0.04	sharp
25. Sep	5 ± 0.1	4.88	1.05 ± 0.04	sharp

Noise: Results of 67 minutes measurements with particle free air.			
Wavelength [nm]	450	530	520
Minutes	67	67	67
Mean [1/Mm]	0.032	0.036	0.040
Standard dev. [1/Mm]	0.272	0.258	0.250
Error of the mean [1/Mm]	0.034	0.031	0.028

The noise level (single standard deviation) for one minute averages of about 0.27 1/Mm is within the expected range of values. The average absorption for all wavelength was about 0.04 1/Mm. This indicates a possible small leak. A leak was not found and the O-rings of the filter holder were in proper conditions. Measurements were repeated with different filters for zero-air with similar results. The leakage is small compared to the error of the mean! Anyway, the instrument should be checked regularly for leaks.

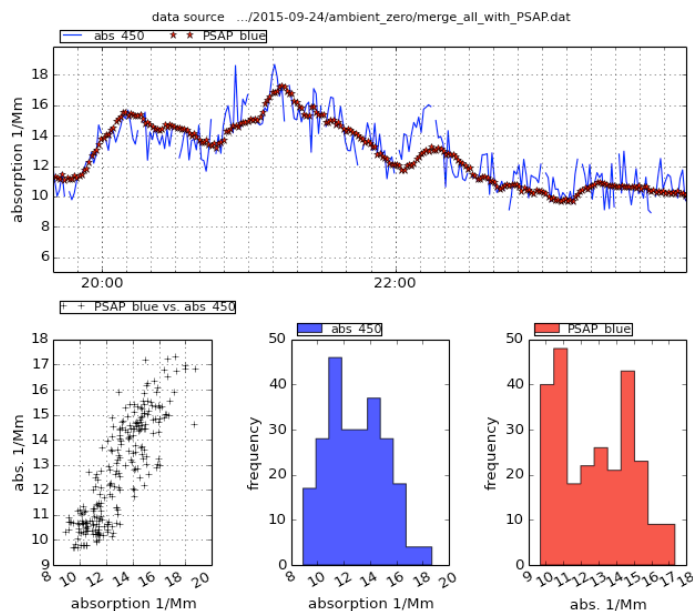
4. Data evaluation

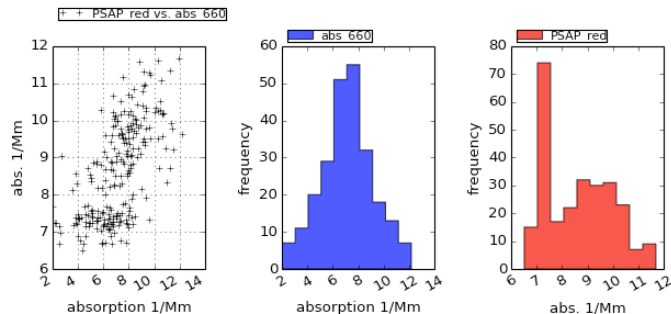
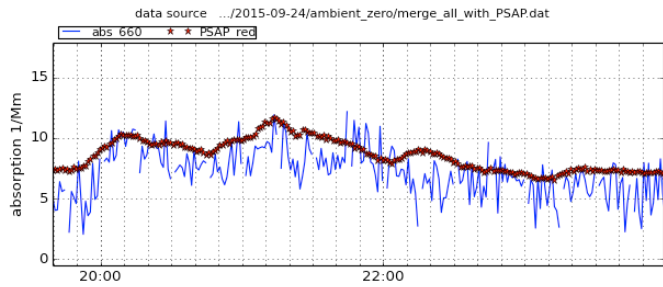
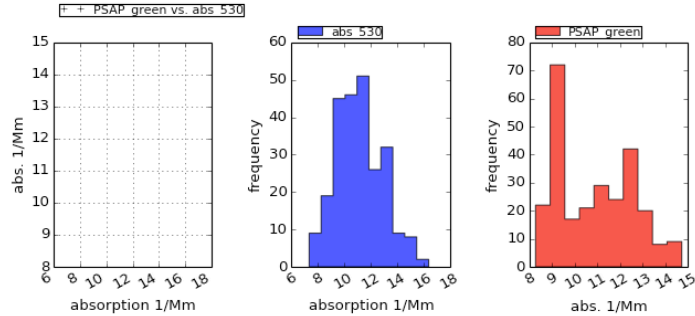
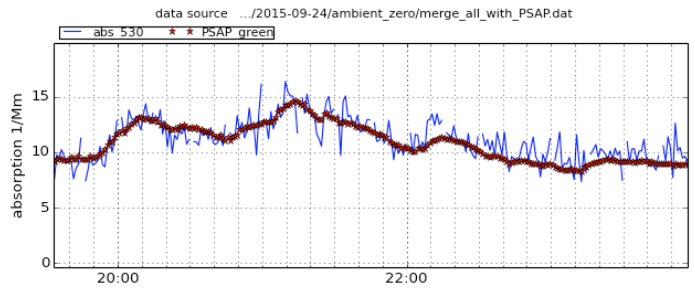
The automatic loading and spot size correction is turned off. Note, the loading correction parameters and reference spot size differ from values given in Bind et al. (1999).

Post processing of data was done following the procedure given in Bond et. (1999). Post-processing includes: a) spot size correction, b) flow correction to STP, C) loading correction, and d) scattering correction.

Absorption coefficient derived from PSAP (SN121) were compared to absorption coefficients determined from the reference Multi-wavelength absorption setup.

5. Results





Figures: Time series and scatter plots of absorption coefficients from PSAP SN121 and the Reference multi-wavelength absorption.

Table: Comparison of absorption coefficients from PSAP (SN121) and the Multi-wavelength absorption reference			
Wavelength [nm]	450	530	520
Slope	0.988 ± 0.006	0.974 ± 0.006	1.179 ± 0.016
R ²	0.727	0.663	0.396