

Intercomparison of Integrating Nephelometers and Extinction monitors Project No.: IN-2016-1-3

Basic Information:

Location of the quality assurance: TROPOS, lab 121

Delivery Date: 18.06.2016

Principal Investigator	Home Institution	Participant	Instrument
Martin Gysel	Paul Scherrer Institute	Günther Wehrle	TSI model 3563, SN 1043

1. Intercomparison summary

Status on arrival: No visual issues due to transportation etc.

Noise: The noise levels for wavelengths 550 and 700 nm are in the acceptable range with values between 0.17 and 0.23 Mm^{-1} . For wavelength 450 nm the noise is very high with values of 1.9 and 1.7 Mm^{-1} for total- and backscattering, respectively.

Inspection: Temperature and pressure sensors are okay. Values are similar to other instruments operated at the same conditions.
Metal splinters were found in the instrument inlet and light trap.

Comparison to reference nephelometer: Comparison the reference nephelometer shows that total and backscattering coefficients of the TSI nephelometer for the

wavelength 450 nm are about 20% too high. The deviations are probably caused by a bad calibration due to the high noise of the photomultiplier. The deviations for the other wavelengths (550 and 700 nm) are less than 3% for total and backscattering.

Other observation: The photomultiplier for the blue channels is very noisy. Changing the photomultiplier voltage did not show an improvement. The multiplier was tightly attached to the socket.

The instrument was disassembled for inspection. Cleaning of the optics (lenses and dichroic filters) did not solve the noise problem. The diffusor of the light source had a brownish colour.

After assembling the instrument showed problems with the chopper disc. Chopper disc and multipliers were temporarily replaced for testing.

Recommendations: Replace the photomultiplier for the blue channel, chopper disc unit diffusor.

Overall assessment: The status of the as it arrived at the workshop was that the green and red channels were giving good values. For the blue channels the values were higher by 20%. A check of previous calibration constants could give indications if data measured previous to the instrument can be corrected.

Due to replacement of many parts the instrument must be tested against another nephelometer. The nephelometer for inter-comparison should be a reference instrument or a nephelometer recently compared to a reference.

2. Details

Noise and background check.

The noise was determined from the standard deviation of a time series of 60 minutes with a temporal resolution of 1 minute. Test aerosol was filtered room air.

The zero value was determined from six zero measurements during an overnight measurement of ambient air.

Wavelength in nm	total scattering in Mm^{-1}			backscattering in Mm^{-1}		
	450	550	700	450	550	700
Zero value (average in Mm^{-1})	33.18	15.53	11.59	16.26	6.79	6.38
Noise (standard deviation in Mm^{-1})	1.90	0.23	0.23	1.70	0.17	0.19

Comparison to a reference nephelometer

The instrument TSI model 3563 SN 1043 was compared to the reference Nephelometer Aurora4000 SN 14-1408. Scattering coefficients were adjusted using the Ångström equation to the wavelength of TSI nephelometers.

	total scattering			backscattering		
Wavelength in nm	450	550	700	450	550	700
slope	1.21	0.99	0.97	1.23	0.98	0.99
R ²	0.64	0.92		0.06	0.23 ⁽¹⁾	0.16 ⁽¹⁾

⁽¹⁾ Low R² because of low aerosol concentrations (backscattering < 5 Mm⁻¹)

⁽²⁾ Values for the TSI Nephelometer are probably biased because of the high noise level for the blue channels during calibration.

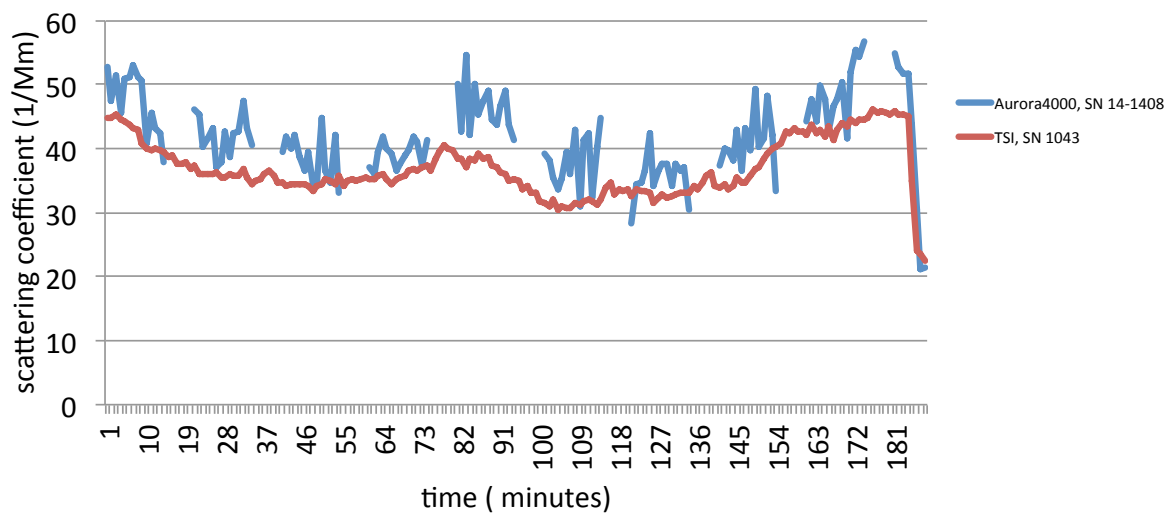


Figure 1: Comparison of TSI with Aurora4000. Show is total scattering for 450 nm.