Audit Report

Station name:	Pha Din, Vietnam 21°34'16''N 103°31'0''E
Date:	July 4, 2016
Auditor:	Prof. Dr. Alfred Wiedensohler (WMO-GAW-WCCAP, TROPOS, Germany)
Responsible people:	Mr. Günther Wehrle (PSI, Switzerland)

First of all, I would like to thank the people of the Vietnam Met Office in Hanoi and the people from the regional office for the great hospitality, hosting me for three days. Especially, I would like to thank Vang A. Phia (head of station) and Vang A. Tuang (deputy head of station). Furthermore, I would like to thank Valentin Graf from the Swiss Met Office and Günther Wehrle von PSI for their support here in Vietnam.

Group photo taken during the audit day July 4, 2016

Pha Din Station

General Conclusion:

The GAW station Pha Din is in a very good condition in terms of the aerosol measurement program.

World Calibration Centre
for Aerosol Physics

General Comment:

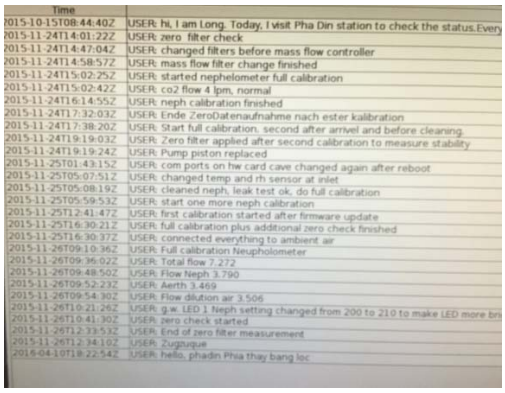
PSI has set up together with the Vietnam Met Office a very good aerosol package, however, there are two issue, which have to be clarified.

1. The inlet configuration might not be optimum for cloud events.
2. The activity of the station personnel needs to be improved

More:

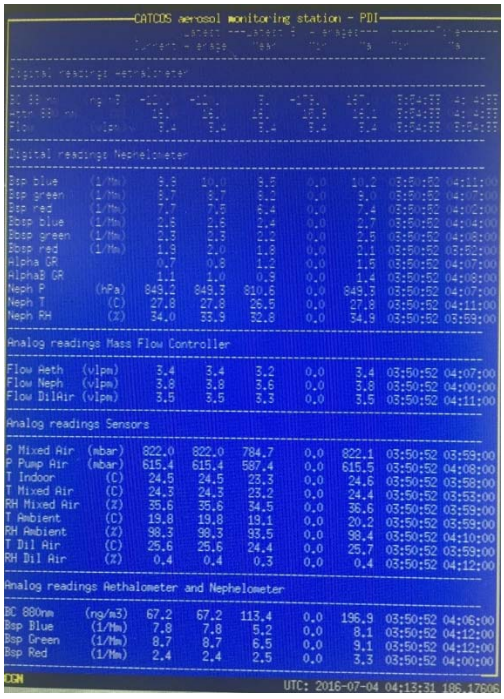
Manuals for instruments are not available on site. A digital logbook for all aerosol-related activities is available, however no logbook entries have been done by the station personnel. Last entries were done by PSI people in Nov. 2015.

Picture about the whole set-up are shown below:



Time	
2015-10-15T08:44:40Z	USER: hi, I am Long. Today, I visit Pha Din station to check the status.Every
2015-11-24T14:01:22Z	USER: zero filter check
2015-11-24T14:47:04Z	USER: changed filters before mass flow controller
2015-11-24T14:58:57Z	USER: mass flow filter change finished
2015-11-24T15:02:25Z	USER: started nephelometer full calibration
2015-11-24T15:02:42Z	USER: co2 flow 4 lpm, normal
2015-11-24T16:14:55Z	USER: neph calibration finished
2015-11-24T17:32:03Z	USER: Ende ZeroDatenaufnahme nach ester kalibration
2015-11-24T17:38:20Z	USER: Start full calibration, second after arrivel and before cleaning
2015-11-24T19:19:03Z	USER: Zero filter applied after second calibration to measure stability
2015-11-24T19:19:24Z	USER: Pump piston replaced
2015-11-25T01:43:15Z	USER: com ports on hw card cave changed again after reboot
2015-11-25T05:07:51Z	USER: changed temp and rh sensor at inlet
2015-11-25T05:08:19Z	USER: cleaned neph, leak test ok, do full calibration
2015-11-25T05:59:53Z	USER: start one more neph calibration
2015-11-25T12:41:47Z	USER: first calibration started after firmware update
2015-11-25T16:30:21Z	USER: full calibration plus additional zero check finished
2015-11-25T16:30:37Z	USER: connected everything to ambient air
2015-11-26T09:19:36Z	USER: Full calibration Neupholometer
2015-11-26T09:36:02Z	USER: Total flow 7.272
2015-11-26T09:48:50Z	USER: Flow Neph 3.790
2015-11-26T09:52:23Z	USER: Aerth 3.469
2015-11-26T09:54:30Z	USER: Flow dilution air 3.506
2015-11-26T10:21:26Z	USER: g.w. LED 1 Neph setting changed from 200 to 210 to make LED more bri
2015-11-26T10:41:30Z	USER: zero check started
2015-11-26T12:33:53Z	USER: End of zero filter measurement
2015-11-26T12:34:10Z	USER: Zurguque
2016-04-10T18:22:54Z	USER: hello, phadin Phia thay bang loc

Logbook of the Pha Din station



CATOS aerosol monitoring station - PDI

Digital readings Nephelometer

Bsp blue	(1/Mm)	9.9	10.0	9.5	0.0	10.2	03:50:52 04:11:00
Bsp green	(1/Mm)	8.7	8.7	8.2	0.0	9.0	03:50:52 04:07:00
Bsp red	(1/Mm)	7.7	7.8	8.4	0.0	7.4	03:50:52 04:02:00
Bbsp blue	(1/Mm)	2.6	2.6	2.4	0.0	2.7	03:50:52 04:04:00
Bbsp green	(1/Mm)	2.3	2.3	2.2	0.0	2.5	03:50:52 04:08:00
Bbsp red	(1/Mm)	1.9	2.0	1.8	0.0	2.1	03:50:52 03:52:00
Alpha GR		0.7	0.8	1.2	0.0	1.5	03:50:52 04:07:00
AlphaB GR		1.1	1.0	0.9	0.0	1.4	03:50:52 04:08:00
Neph P	(hPa)	849.2	848.3	820.6	0.0	849.3	03:50:52 04:07:00
Neph T	(C)	27.8	27.8	26.5	0.0	27.8	03:50:52 04:11:00
Neph RH	(%)	34.0	33.9	32.8	0.0	34.9	03:50:52 03:59:00

Analog readings Mass Flow Controller

Flow Aeth	(vlpm)	3.4	3.4	3.2	0.0	3.4	03:50:52 04:07:00
Flow Neph	(vlpm)	3.8	3.8	3.6	0.0	3.8	03:50:52 04:00:00
Flow DilAir	(vlpm)	3.5	3.5	3.3	0.0	3.5	03:50:52 04:11:00

Analog readings Sensors

P Mixed Air	(mbar)	822.0	822.0	784.7	0.0	822.1	03:50:52 03:59:00
P Pump Air	(mbar)	615.4	615.4	587.4	0.0	615.5	03:50:52 04:08:00
T Indoor	(C)	24.5	24.5	23.3	0.0	24.6	03:50:52 03:58:00
T Mixed Air	(C)	24.3	24.3	23.2	0.0	24.4	03:50:52 03:53:00
RH Mixed Air	(%)	35.6	35.6	34.5	0.0	36.6	03:50:52 03:59:00
T Ambient	(C)	19.8	19.8	19.1	0.0	20.2	03:50:52 03:59:00
RH Ambient	(%)	98.3	98.3	93.5	0.0	98.4	03:50:52 04:10:00
T Dil Air	(C)	25.6	25.6	24.4	0.0	25.7	03:50:52 03:59:00
RH Dil Air	(%)	0.4	0.4	0.3	0.0	0.4	03:50:52 04:12:00

Analog readings Aethalometer and Nephelometer

BC 880nm	(ng/m3)	67.2	67.2	113.4	0.0	196.9	03:50:52 04:06:00
Bsp Blue	(1/Mm)	7.8	7.8	5.2	0.0	8.1	03:50:52 04:12:00
Bsp Green	(1/Mm)	8.7	8.7	6.5	0.0	9.1	03:50:52 04:12:00
Bsp Red	(1/Mm)	2.4	2.4	2.5	0.0	3.3	03:50:52 04:00:00

UTC: 2016-07-04 04:13:31 186.17608

Current measurements of the Pha Din station

Indoor aerosol splitter and T/RH sensor of the aerosol set-up

Aerosol set-up

Audit Recommendations:

- The manuals of the instruments must be available at the station.
- We suggest strongly that the station personnel follows the operation procedures written by PSI and use the logbook.

Reference flow meter:

Type of reference flow meter:	The mini-BUCK Calibrator (electronic bubble flow meter)
Serial number:	A30441
Last calibrated:	2013

Audit recommendations:

No further recommendation

Aerosol inlet:

Inlet:	TSP
Material:	conductive tubing (last 1.5m), rest copper line
Vertical:	10 m
Horizontal:	1.5 m
Bends	1
Inlet tube:	Outer diameter: 12 mm Inner diameter: 10 mm
Flow rate:	10.7 l/min
Calculated Reynolds number:	1216 → ok
Aerosol drying by dilution:	standard: 7.2 l/min ambient + 3.5 l/min dry air, dry air added 10cm downstream of inlet head

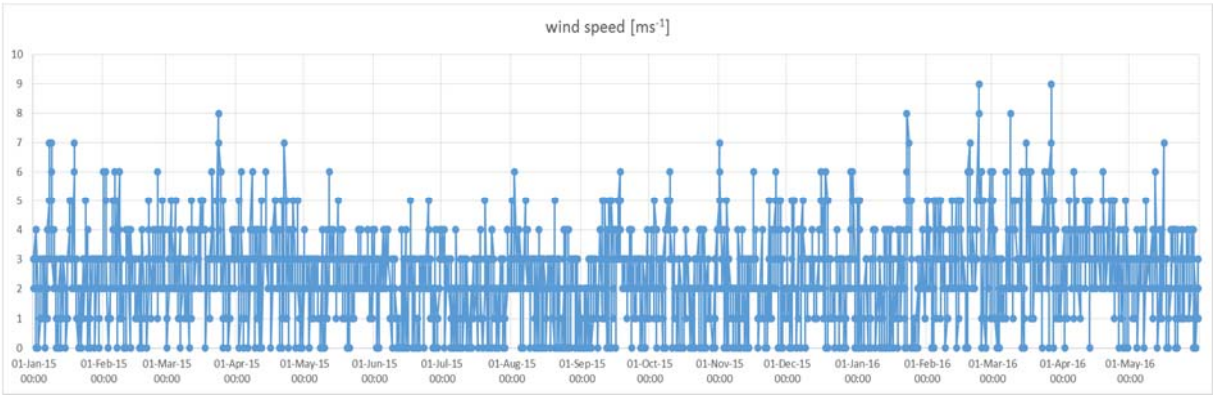
Present condition:

Indoor aerosol RH:	35%
T ambient:	19.2°C
RH ambient:	99%
Dew point T:	19.2°C
Dilution flow rate:	3.7 l/min

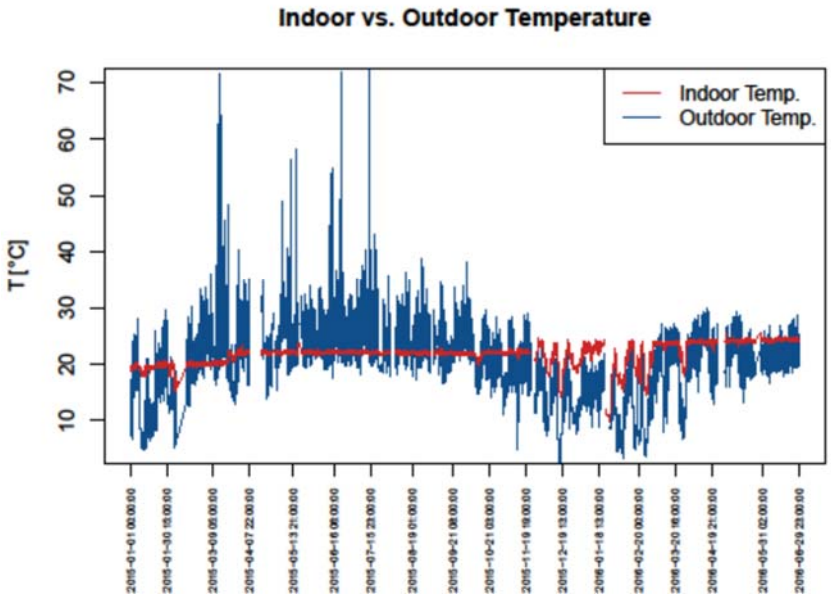
Inlet Configuration:

Pha Din aerosol inlet mast

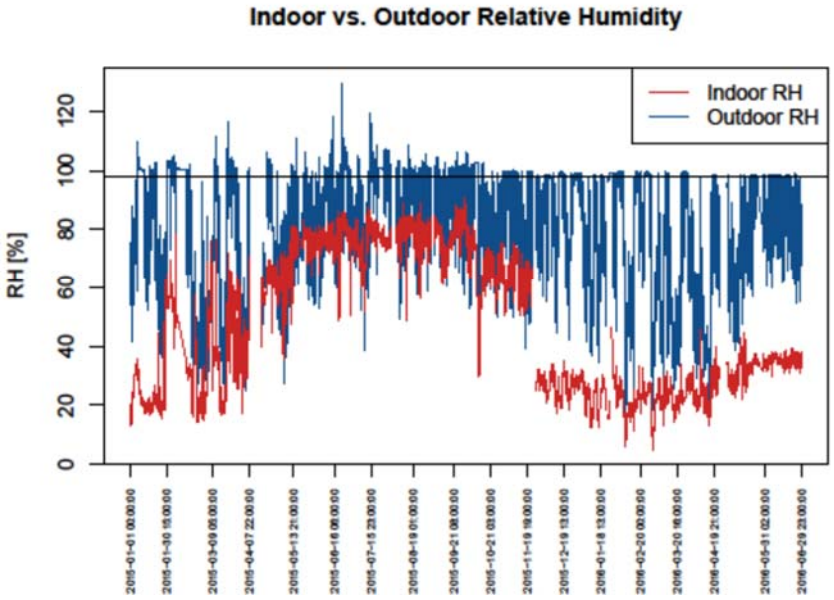
Actual TSP inlet, showing the insect screen



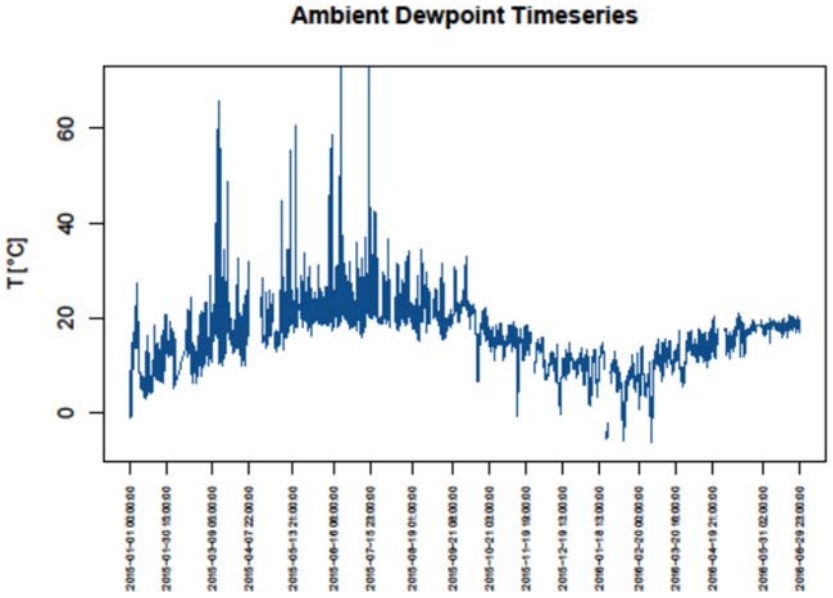
Time series of the wind speed (6 h resolution) at the Pha Din station in 2015



Time series outdoor & indoor temperature Pha Din station



Time series outdoor & relative humidity of the mixed aerosol flow measured in the aerosol splitter in side of Pha Din station



Time series dew point temperature Pha Din station

Comments:

The station is according to the Mr. Günther Wehrle and Dr. Nicolas Bukowiecki (PSI) frequently in cloud. The CATCOS team of PSI decided during planning phase in 2011 that a TSP inlet should be used. In the WMO-GAW report following is recommended:

„Sampling sites that are frequently in clouds or fog (e.g. mountain sites) should use whole air inlets to sample cloud or fog droplets as well as aerosols. This air should be dried rapidly to avoid inertial particle losses."

The TSP inlets probably works as a whole air inlets, although no heated inlet is employed. The wind velocity seems never to exceed 10 m/s over all seasons, meaning that the stopping distance is never larger than 3 cm in the worst case, even for a 20µm droplet (stopping distance = 3x relaxation time x wind velocity). The droplets would make it into the sampling cone, which is 6 cm in diameter at the top.

Another problem might be caused by the insect screen with about 50% porosity, which may cause impacts of cloud droplets. The effect on aerosol particle properties such as the particle light scattering and absorption coefficients is difficult to estimate. It might be that a part of the cloud droplet are not taken into the dilution flow. The consequence might be that that the particle light scattering and absorption coefficients are measured too low during cloud periods. Since there is no independent cloud detector or particle number size spectrometer, data cannot be flagged for the cloud periods.

Looking at the time series of T, RH and T_{dew}, there was a problem with the RH/T sensor at the TSP inlet until fall 2015. Additionally, there was a technical failure of the compressor, leading to high aerosol relative humidity inside of the instruments. This seems to have been solved after the visit of PSI people in fall 2015. The data afterwards seem to be reliable.

Coming back to cloud problem, the RH sensor at the inlet can be used to identify the period of cloud events. PSI should estimate the effect on a possible change of the aerosol particle parameters by looking at the data before and after cloud events (excluding time periods in this analysis when there was precipitation)

Audit Recommendation:

- The inlet configuration might be not optimum due to the insect screen. Data should be checked for cloud events and possible be flagged, if the aerosol particle properties are influenced.

- As a minor issue, I suggest to change possibly the copper tubing to stainless steel at the lower end of the mast.

Particle light absorption coefficient:

Instrument:	Filter-based absorption photometer
Type:	Aethalometer AE31
Serial number:	1145
Wavelengths:	370, 450, 571, 615, 660, 880 and 950 nm
Firmware version:	985d8
Data format:	dataline
Last calibrated:	before installation at PSI, no information presently
By:	PSI people
Nominal flow rate:	3.4 l/min
Measured flow rate at 822 hPa, 24°C:	3.6 l/min
Flow rate indicated on front panel:	3.4 l/min
Indicated concentration with absolute filter:	0.0 g/m^3
Nominal filter change:	60% transmission → ok
Condition of instrument:	visually, the instrument is an excellent condition
Data submitted to data centre:	Data are submitted by PSI people to the WDCA, according to PSI. Please check the data for the time periods of high instrument RH

Audit Recommendation:

No further recommendation

Particle light scattering coefficient:

Instrument:	Integrating nephelometer
Type:	Ecotech Aurora 3000
Serial number:	12-0248 (built in 2012)
Wavelengths:	635, 525, 450 nm
Firmware version:	Version 1.14
Gases for span check:	CO_2
Last zero check:	every36 h (zero adjustment)
Last span check:	Nov. 2015
By:	Mr. Günther Wehrle
Nominal flow rate:	3.8 l/min
Measured flow rate:	3.9 l/min at 822 hPa, 24°C
Indicated concentration with absolute filter:	0.0 Mm^{-1}

Condition of instrument:	Visually, the instrument seems to be in an excellent condition
Data submitted to data centre:	Yes, data are submitted by PSI people to the WDCA (HYMENET is being trained to handle the submission in the future), according to PSI. Please check if the data for the time periods of high indoor RH

Comments:
The instrument was not calibrated with CO2 by the station personnel since the last visit of PSI people in Nov. 2015. The recommended calibration frequency should not be longer than 3 month, which is also given in the operation procedure written by PSI.
The station personnel did not do a calibration during the audit. According to PSI, the station personnel has performed a calibration directly after the audit.

Audit Recommendation:

- The station personnel must perform the CO2 calibration for the integrating nephelometer every three month.
- The system needs to be changed to a daily Zero Check
- The aerosol flow should be measured frequently and the values should be also written into the logbook.