Audit/Twinning Report

Station name:	Danum Valley
Date:	November 26 -30 2017
Auditor:	Dr. Thomas Tuch (WMO-GAW-WCCAP, TROPOS)
Responsible station staff:	Maznorizan Bt Mohamad, Mohan Kumar A/L Sammathuria

Figure 1: Group photo taken during the audit

Summary:

Data from GAW global stations in the tropical rain forest are rare and would be of great interest for the scientific community for the prediction of global climate change. Valid data from the Danum Valley global GAW station used in models predicting the rate of global warming in this area can help local governments to mitigate effect of global warming in their countries.

Danum Valley station is operated by well-trained personal. The staff has demonstrated their skills to solve problems during the audit. Unfortunately, none of the aerosol instruments and other instruments has been working during the audit due to failures, which could not be repaired on-site. Some of these instrument failures did already occur more than two years earlier.

1) The Multi-Angle-Absorption Photometer (MAAP), which determines the BC mass concentration and particle light scattering coefficient, was affected by a lightning stroke in November 2015. Replacement of the motherboard in December 2015 did not solve the problem. Obviously, there seems to an additional problem with this instrument, which caused another failure of the motherboard. There are no data from the MAAP since November 2015.
2) The TEOM, measuring the PM10 particle mass concentration, failed to transmit data in July 2017. A replacement motherboard was installed during the audit. With this motherboard data transmission was possible, however, the heating of the sensor inlet of the instrument does not work. Measurements are therefore currently not possible.
3) The Integrating Nephelometer, measuring the particle light scattering and backscattering coefficient, failed May 16, 2017 with a backscatter driver failure. Measurements from this date are unusable.
4) The adsorption dryer connected to the air compressor (needed to produce dry air) failed in October 2017. Currently the aerosol inlet dryer operated with compressed air at a dew point temperature of 7°C, which allows drying the aerosol to about 45% rH. With a required maximum rH of the aerosol of 40% r.H. this adsorption dryer (Boge DAZ 5-2) needs to be replaced as soon as possible.
5) A "new" used Windows 7 PC was configured for data acquisition during the audit. Unfortunately, this PC seems to have problems with the internet connection.

These problems could not be solved on-site by the station personal. They have been reported to the head office in KL immediately after their occurrences.

There are currently additional problems affecting the operation of the station.

1) Only one out of three power generators is currently working to provide power to the station.
2) The UPS system has been removed from the station without replacement.
3) The lightning protection system is still not sufficient.
4) The sun-tracker for AOD measurements is broken and has been removed from the station.
5) The low-flow CO2 analyzer is broken beyond repair.
6) The automatic weather station is currently not working.

Furthermore, there has been no submission of data to the Data Center for the years 2013, 2014, 2015 and 2016.

We wish to thank the staff of the Danum Valley GAW station for their great hospitality during the audit. We hope that current problems with the instrumentation at the station can be solved soon and are looking forward to receive data from this station at the database in the near future.

Detailed observations and recommendations:

Station infrastructure:

Currently two of three generators providing power to the station are broken. It is planned to replace the broken generators in 2019. The uninterrupted power supply has been removed from the station. We suggest installing at least an UPS capable of running the measurement instruments during a short power failure. Instrument failure due to lightning strokes is a frequent problem at Danum Valley. An upgrade of the lightning protection system is scheduled for 2019-

Documentation:

Summary sheets are available for the status of all instruments and have been filled for every visit of the station. Furthermore, individual logbooks are available for all instruments. Every question regarding instruments during the audit could be answered within short time. Summary sheets are send to the headquarters in Kuala Lumpur after each station visit. All instrument manuals are on site.

Documentation at Danum Valley GAW station is excellent.

There has been no submission of data to the Data Center for the years 2013, 2014, 2015 and 2016.

Data for one year should be submitted to the data center by end of May of the following year.

Primary flow standard:

Flow calibrators type BIOS defender 510H #129597 and 520L #128767 are primary flow standards at the station. BIOS instrument measurements are in good agreement with measurement using the WCCAP reference flow cell.

The primary flow standards are suitable for a GAW station.

Data acquisition:

During the audit a "new" used PC has been set up running Windows 7 replacing the old Windows XP computer. All software has been installed on this machine including the software for near real time data submission of MAAP data to EBAS. Because the aerosol instruments did not run and communicate with any computer during the audit Teamviewer was installed to configure the software remotely from Leipzig after instrument repair. Unfortunately, this new computer has problems with the Internet connection. It is currently only sometimes online during the routine visits at the station.

Recommendation: Replace the "new" PC by a really new one using the current using the hard disk of the current "new" PC.

Aerosol inlet:

The aerosol inlet at Danum Valley has been designed at TROPOS. It features two custom made Nafion dryers. The PM10 inlet head was found to be relatively clean inside (Figure 2).

Figure 2: PM10 inlet at Danum Valley

The exterior of the inlet has been cleaned during the audit.

The compressor providing dry air to the Nafion dryers is in good working condition. It reaches a compressed air dew point temperature of 7 deg. C (Figure 3).

Figure 3: Status of the compressor at Danum Valley.

The secondary dryer (Boge DAZ 5-2) is broken. This dryer provides dry air to the Nafion dryers at a compressed air dew point temperature of less than -20 deg. C. This dryer has reached the end of its typical lifetime. Spare parts for repair would cost about the same as a new device.

The secondary dryer was bypassed during the audit. Furthermore, the compressed air flow to the Nafion dryers was increased from 1 l/min to 16 l/min. With these changes, the humidity of the aerosol could be reduced to about 45% rH. GAW recommendations require an aerosol rH below 40%.

Recommendation: Replace the secondary (https://www.boge.com/en/products/adsorption-dryers-heatless-regeneration) dryer by a new device.

MAAP:

The MAAP (SN 39) had failed after a lightning stroke in November 2015. The motherboard of the device has been replaced in December 2015.

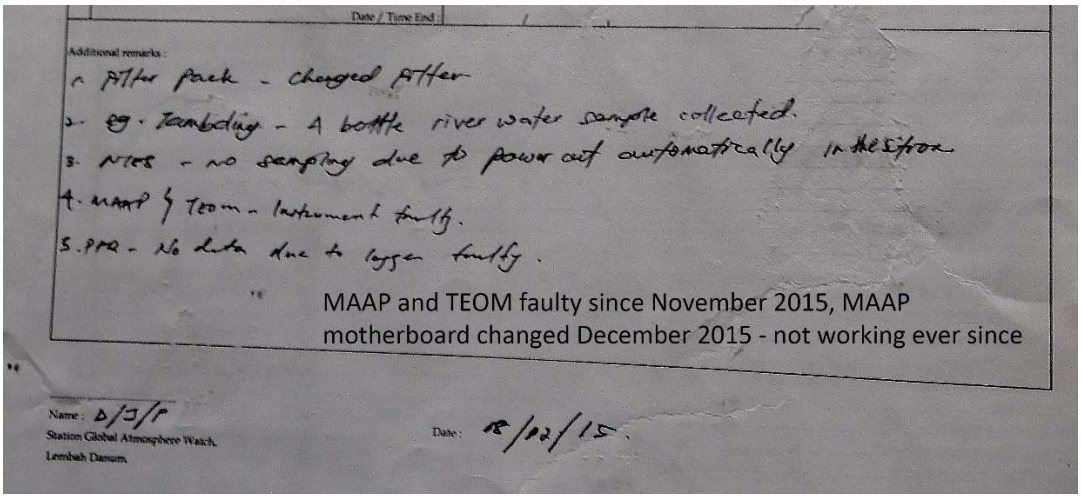


Figure 4: MAAP failure notice in the logbook.

After replacement of the motherboard of the instrument, the display of the unit did only show erroneous characters. Communication over the serial port of the instrument was not possible. A new display unit has been ordered but did never arrive at the station. We discovered during the audit that the failure of the instrument is not only due to the display but also obviously again to a broken motherboard. The serial port chip of the motherboard driving both the serial I/O and the display was extremely hot and showed some color change. It seems that there is more than one component of the instrument broken. The instrument should be repaired by the manufacturer due to multiple instrument problems.

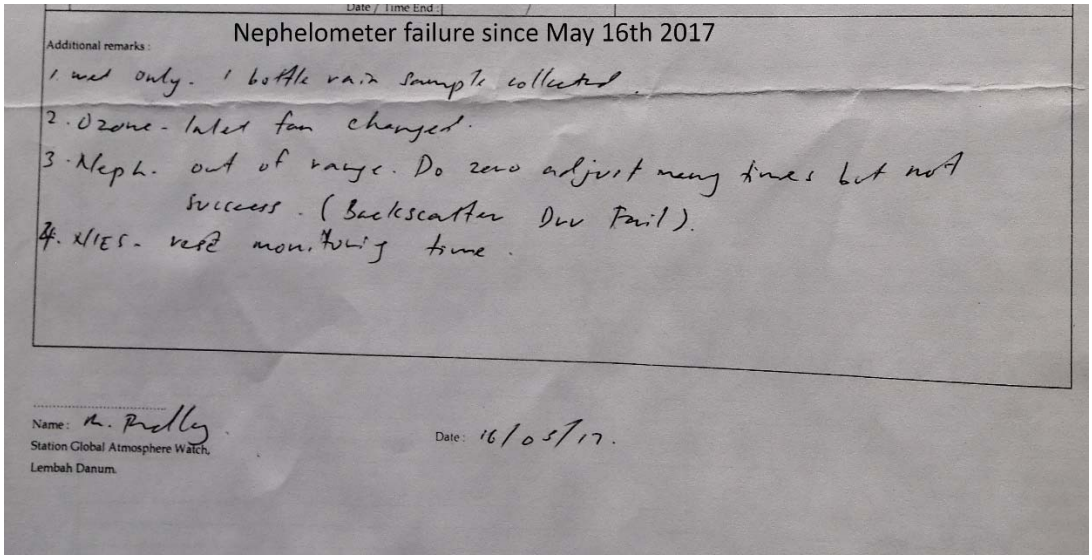
MAAP data are unusable/non-existent after November 2015.

Recommendation: Send the MAAP to the manufacturer for factory repair.

Further checks of the instruments could not be performed due to instrument failure.

Nephelometer:

The backscatter shutter of the Nephelometer Ecotech Aurora 3000 (SN 11-1011) did fail on May 16th 2017 (Figure 5). As result, the instrument could not be calibrated after this date. Data of the instrument cannot be used after May 16th.



Nephelometer failure since May 16th 2017

Additional remarks :

1 wet only. 1 bottle rain sample collected.

2. Ozone - Inlet fan changed.

3. Neph. out of range. Do zero adjust many times but not success. (Backscatter Dev Fail).

4. NIES - reset monitoring time.

Name : R. Reddy

Station Global Atmosphere Watch,

Lembah Danum.

Date : 16/05/17.

Figure 5: Nephelometer failure notice in the logbook.

The instrument was opened to investigate the error. The motor of the backscatter shutter is broken. The light source with the backscatter shutter needs to be send to the manufacturer for repair.

With the instrument open we found the measurement cell heavily polluted. Furthermore the backup batteries have not been replaced for several years. These batteries should be replaced at least once per year to avoid damage to the instrument (Figure 6).

The Nephelometer measurement cell was cleaned by the station staff during the audit. Cleaning of the measurement cell should be performed at least once per year or whenever wall scatter signals increase significantly. (Figure 7)

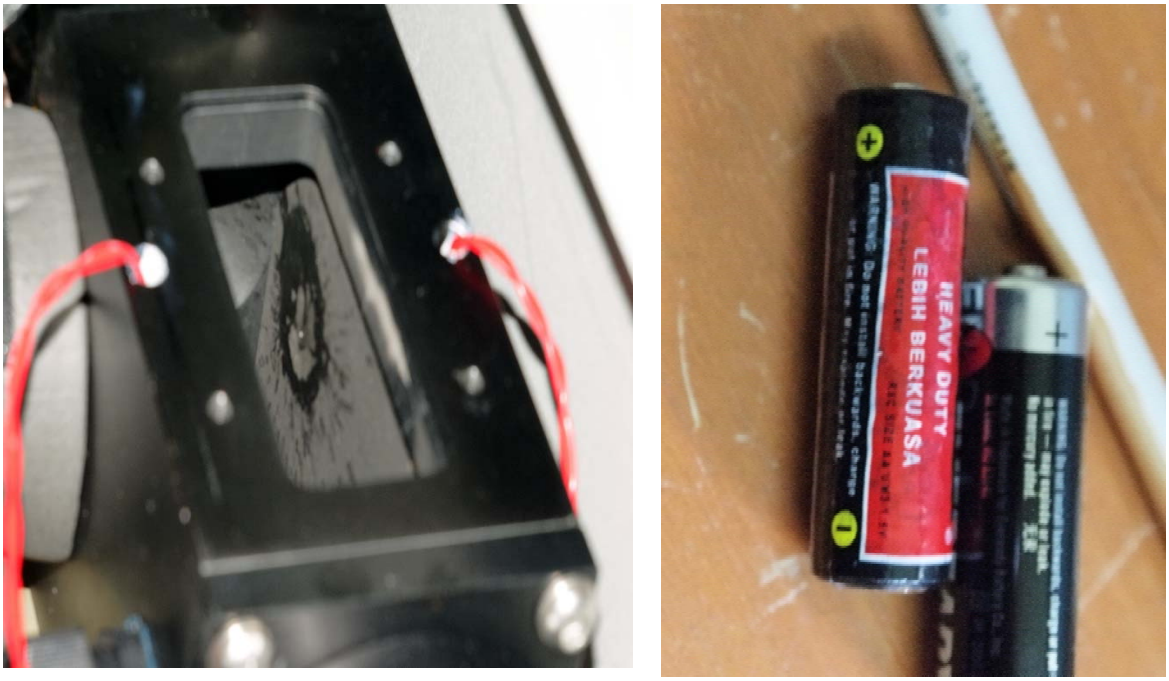


Figure 6: Dirty measurement cell and broken backup batteries of the Nephelometer.

Figure 7: Nephelometer cleaning.

New software for the Nephelometer has been developed during the audit based on the existing software by Sascha Pfeifer. This was necessary because the old software did not work correctly with the newest LabView version.

Nephelometer data are unusable beginning from May 16th 2017.

Recommendations:

1) **The Nephelometer cell should be checked and cleaned (if necessary) on an annual basis.**
2) **The backscatter shutter needs to be repaired by the manufacturer.**

TEOM:

The TEOM SN 140AB214609703 was running upon arrival at the station. Data communication was, however, again not possible due to a problem with the serial port of the instrument. This failure was first observed in July 2017. The motherboard of the TEOM control unit was replaced by an existing spare part during the audit(Figure 8).

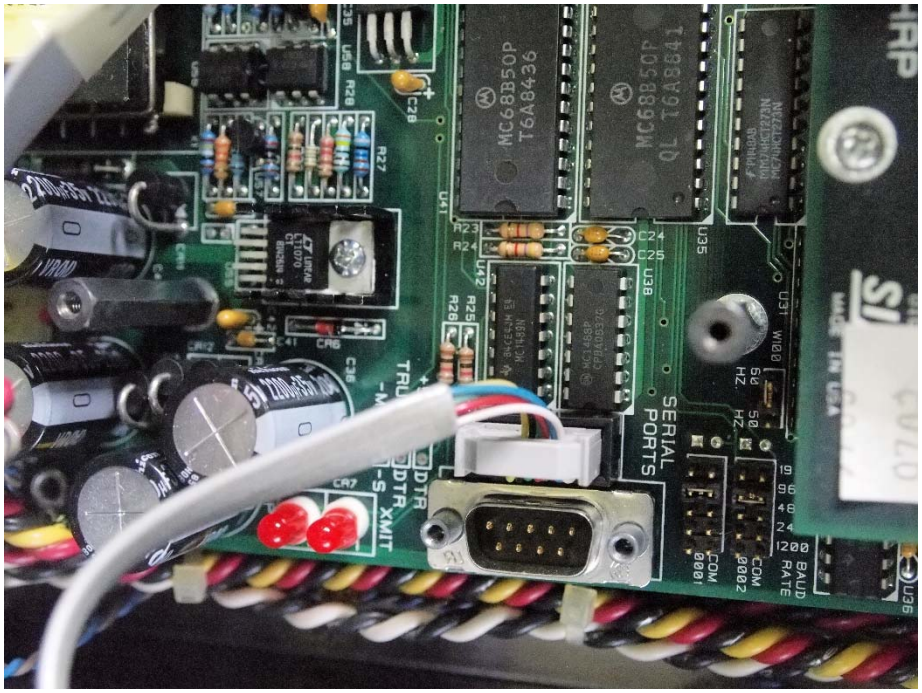


Figure 8: TEOM motherboard with internal serial connector.

After change of the motherboard, the instrument was able to communicate via serial port. With this board heating of the TEOM sensor unit did not work. The instrument could therefore not stabilize into measurement mode.

There are spare TEOM control units available at the headquarters in Kuala Lumpur. One of these units should replace the broken control unit at Danum Valley. Note that all operation parameters need to be transferred from the broken instrument to the replacement unit.

TEOM data are not available starting July 2017.

Recommendation: The broken control unit should be replaced by a spare control from Kuala Lumpur.

Conclusion:

During this audit, all aerosol instruments were broken. We hope that they will be repaired soon. Station power supply and lightning protection need to be upgrade/repaired in the near future to avoid further instrument damage.

We would appreciate visiting a fully operational Danum Valley global GAW station in winter 2018/19 again.