

# meteoLCD Weblog

A weblog on climate, global change and climate measurements

« [Future and extinction fear](#)      [An interesting day for Ozone and CO2](#) »

## One year of fine particle measurements by Airvisual Pro at meteoLCD



Airvisual Pro installed in the Stevenson hut the 26th Dec. 2018

### 1. Introduction

During the year 2018 I decided to introduce fine particle measurements at [meteoLCD](#). During many months I built several PM measurement systems based on the Chinese SDS011 sensor made by [inovafit](#), with data logging done by a Raspberry Pi. All these new sensors are of the LLS type (LLS = Laser Light Scattering), where ambient air is sucked into a chamber by a little fan and exposed in that chamber to the light emitted by a solid-state laser. The scattered light is analysed by a photodiode, and the result is a count of particles in suspension, classified in two categories (< 2.5 um for PM 2.5 and < 10 um for PM 10). The counts are converted into a mass (ug/m3) by the inbuilt controller, assuming a certain combination of substances of known density. Clearly this easy to built system has some weak points: the most important is humidity, and it has been shown that above a certain level of relative humidity (about 75%) the condensation of water vapor on the particles inflates the count and so the mass reading. A second weak point are the changing conditions of air flow due to a varying atmospheric pressure and/or wind. Professional, expensive sensors like the [Horiba APDA-371](#) avoid these problems by drying the incoming air, maintaining precise conditions of airflow and air pressure, and using a much more expensive and complicated principle of beta radiation weakening (BAM principle). I wrote two preliminary articles on comparing low-cost LLS sensors with a Horiba at the Beidweiler station, which I suggest to read [here](#) and [here](#).

### 2. The Airvisual Pro

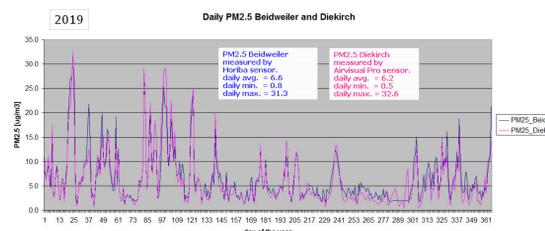
The Airvisual Pro is a stylish LLS-type sensor made by the Swiss company [iQAir](#) (actual price ca. 460 €). It measures temperature, rel. humidity, CO2 concentration, PM2.5 and PM10. The instrument can be integrated into a cloud managed by iQAir, so that hourly data are always available on the internet (see our data [here](#)). Communication with the outside is exclusively by WiFi (there is no RJ45 connector), which was sort of a problem at meteoLCD. We first used a Devolo Powerline system with the AP located in the hub (visible in the above picture below the translucent base plate). This system was unstable, even when we switched to a AVM powerline system which uses the 3 line wires (neutral, line and ground). So finally I laid an RJ45 cable up into the Stevenson hut, and installed a WiFi access point directly beneath the Airvisual Pro. This solved the problem of intermittent connection failures.

The correction of the humidity influence consist in dividing the raw readings by a growth-factor  $GW = a + (b \cdot RH^2) / (1 - RH)$  where RH is the relative humidity (number between 0..1),  $a=1$  and  $b= 0.25$ . This formula has been suggested by several authors (see my prior papers for the references), and first tests have shown that this compensation for humidity is an absolute must.

### 3. One full year of data

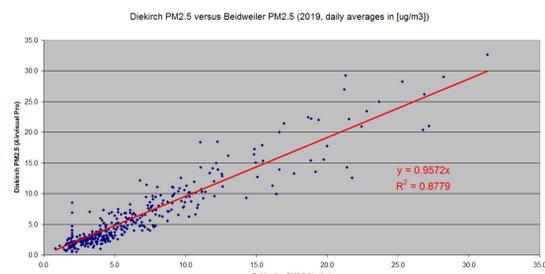
We now have a full year of hourly data to compare the Airvisual Pro readings with those of the official Beidweiler station LU0105A located less than 20 km from Diekirch. The Beidweiler data have been downloaded from the "discomap"-site of the EEA, and I used the E1a series (the validated E2a series are not yet available). The E1a data are somewhat irregular in the ongoing time (lines do not always follow increasing time), and there are many missing data (often a couple of hours, but some much longer periods). The time-stamp probably is local time, as is the time-stamp of the Airvisual Pro file. Missing values have been replaced by repeating the last correct reading before the interruption. As all hourly data are raveled into daily averages, the impact of this action is tolerable.

So here is a plot showing the daily PM2.5 readings for the full year 2019:



First, look at the peaking values, which are absolutely synchronous: practically all the peaks and lows coincide in time. The yearly averages, minima and maxima also are very close for both series.

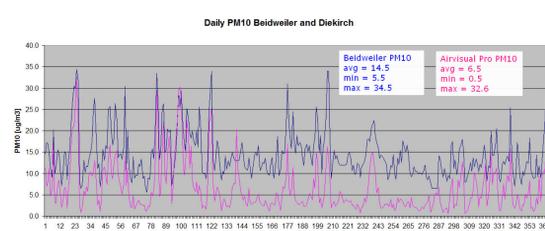
The next plot shows the Airvisual Pro readings versus the Beidweiler ones:



The goodness of the fit (forced to 0) is  $R^2 = 0.88$ , quite acceptable! A calibration factor to apply to the Airvisual Pro PM 2.5. readings would be a multiplier of  $1/0.88 = 1.14$  (always rounded to the nearest integer). Not forcing the trend-line through the origin does not change these results.

### 4. The PM 10 readings

The Airvisual Pro seems to have a problem with the PM10 category, as these readings are very similar to the PM 2.5, and considerably too low, as shown by the next plot:



I have no explication to this for the moment.

### 5. Conclusion

This first year-long series of PM measurements with the Airvisual Pro shows that it is exceptional accurate in its PM 2.5 measurements, compared to the hugely more expensive Horiba APDA\_371.

The Airvisual Pro, despite being exposed in the open in a well ventilated Stevenson hut (natural ventilation) and high humidity levels, worked without a single break-down for the full year

The year long communications with the Airvisual cloud worked flawlessly; this cloud makes it easy to store and consult the uploaded data. For understandable security reasons, accessing these data is reserved to the subscriber, and not the general public.

An Excel file holding all relevant data and plots can be found [here](#). Please give proper credit when citing these data.

Share this:



Loading...

### Related

[A test of inexpensive LLS fine particle sensors](#)  
November 9, 2018

[Lockdown and no PM improvement! \(1\)](#)  
April 13, 2020

[AQI: air quality confusion \(1\)](#)  
May 20, 2018  
With 6 comments

This entry was posted on January 23, 2020 at 14:31 and is filed under Uncategorized. You can follow any responses to this entry through the [RSS 2.0](#) feed. You can [leave a response](#), or [trackback](#) from your own site.

### One Response to “One year of fine particle measurements by Airvisual Pro at meteoLCD”

[Lock-down and no PM improvement! | meteoLCD Weblog Says:](#)  
April 13, 2020 at 16:56 | Reply

[...] an Airvisual Pro instrument from iQAir, Beidweiler uses an Horiba (you might re-read this article here for more [...])

Leave a comment