« Plume Labs Flow sensor… first impressions.
A test of inexpensive LLS fine particle sensors »

Plume Labs Flow: a round-trip record

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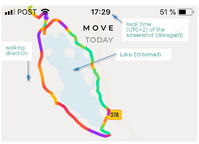
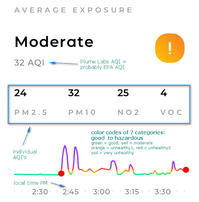
In this blog I report a first round-trip made with the flow-sensor attached to my belt and my iphone recording the flow's readings.

The picture shows the FLOW in its charging cradle and its packaging. The leather buckle is to attach the device to a backpack, a belt or otherwise. The dimensions of the noiseless, silent FLOW are height = 90mm (or 140mm with the leather buckle), base 40mm x 25mm, weight = 70 g. There seems to be a miniature, inaudible fan inside. More info here and here.

1. **Introductory comments**

The trip was made the 13th October 2018 afternoon in fine weather, blue sky, moderate temperature of 27°C, low wind, low humidity. I started at the parking near the entrance of the Echternach lake, and returned to the same point. Here a first screen-shot made at home later in the afternoon from the iphone displaying the Flow app:





The trip started at approx. 2:45 local time (12:45 UTC); the green line left to the red start point corresponds to the trip in the car from my home to the lake. The AQI of 32 represents the average of the total move (so probably including the green part at the left). Let me remember that the AQI from a set of pollutants is the specific AQI of the pollutant having the highest AQI (it is NOT an average or weighted sum of all the sub-AQI's!). If you are confused, please re-read my 5 part series on AQI .

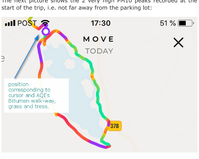
Dwelling deep into Plume Labs poor explanations of their AQI (which sometimes they label PAQI), I presume that they use more or less the AQI breakpoints defined by EPA, i.e. the EAQI. So if you want to know the concentration of a relevant pollutant, you must use the following EPA table in reverse, going from AQI to concentration:

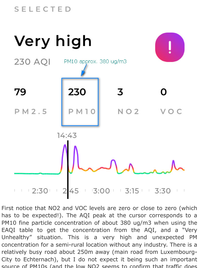
These Breakpoints…							EPA 2015 AQI's	…equal this AQI	…and this category
O_3 8-hour (ppm)	O_3 1-hour	$PM_{2.5}$ (µg/m³) 24-hour	PM_{10} (µg/m³) 24-hour	CO 8-hour	SO_2 (ppb) 24-hour	SO_2 (ppb) 1-hour	AQI		
0.000-0.054	-	0.0 - 12.0	0 - 54	0.0 - 4.4	0 - 35		0 - 50	Good	
0.055-0.070	-	12.1 - 35.4	55 - 154	4.5 - 9.4	36 - 75	54 - 100	51 - 100	Moderate	
0.071-0.085	0.125-0.164	35.5 - 55.4	155 - 254	9.5 - 12.4	76 - 185	101 - 360	101 - 150	Unhealthy for Sensitive Groups	
0.086-0.105	0.165-0.204	55.5 - 150.4	255 - 354	12.5 - 15.4	186 - 304*	361 - 649	151 - 200	Unhealthy	
0.106-0.200	0.205-0.404	150.5 - 250.4*	355 - 424	15.5 - 30.4	305 - 604*	650 - 1249	201 - 300	Very unhealthy	
(*)	0.405-0.504	250.5 - 350.4*	425 - 504	30.5 - 40.4	605 - 804*	1250 - 1649	301 - 400	Hazardous	
(*)	0.505-0.604	350.5 - 500.4*	505 - 604	40.5 - 50.4	805 - 1004*	1650 - 2049	401 - 500	Hazardous	

The Plume Labs plot uses the same 7 categories and the same colors as EPA does.

2. The extraordinary PM10 peaks at the start.

The next picture shows the 2 very high PM10 peaks recorded at the start of the trip, i.e. not far away from the parking lot:

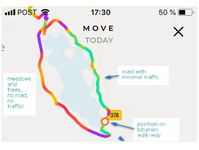


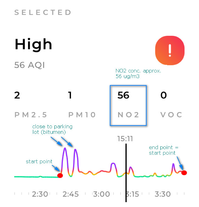


First notice that NO2 and VOC levels are zero or close to zero (which has to be expected!). The AQI peak at the cursor corresponds to a PM10 fine particle concentration of about 380 ug/m3 when using the EAQI table to get the concentration from the AQI, and a "Very Unhealthy" situation. This is a very high and unexpected PM concentration for a semi-rural location without any industry. There is a relatively busy road about 250m away (main road from Luxembourg-City to Echternach), but I do not expect it being such an important source of PM10s (and the low NO2 seems to confirm that traffic does not play a role here). The surrounding of the lake is mostly meadow and forest on the West side (left), and meadows on the East side (right); the wind was more or less blowing from the West. There is a small road (label 378) on the East side of the lake with practically zero traffic. So we have here something close to a mystery, as some comparisons made at home with 3 other sensors do not shows an exaggeration in PM10's by the Flow ? Are the PM10's of natural origin, as dust blown over by some wind gusts from the dry meadows?

3. Unsuspected NO2 peak

The next picture shows a curious NO2 peak at the last third part of the trip:





The cursor corresponds to a position close to a small parking lot and a picnic area with 3 public barbecues, one of them being active (and smelly!). My best guess is that the plumes from this barbecue caused the higher NO2 concentration of about 56 ug/m3. The small peak right of the cursor at 3:15 (15:15) is caused by higher PM2.5 (AQI 118, about 38 ug/m3), not NO2, possibly also related to barbecuing.

So it seems plausible that the Flow sensor correctly recorded a footprint of the nuisances caused by an open barbecue burning charcoal.

4. Conclusions

The Flow app is a nice feature, but I do have some serious complains:

1. **why does the app not show in addition to the AQIs the concentrations of the pollutants ?** There are so many different AQIs (EAQI, Chinese CAQI, European EAQI etc…) that simply stating that the AQI is a qualifier of the pollution is not enough.

2. why does the app not show or download the data, as they must be stored in some part in the smartphone's memory?

3. why does Plume Labs not give technical details on the sensors used in the device? How are its readings influenced by humidity and temperature?

There is an avalanche of low-cost sensors on the market, and one should not expect too much regarding accuracy. I made some short comparisons with three other PM sensors in my office (two SDS011, and a SNDWAY SW-825), using the Flow ? for the flow AQI's, a typical situation for PM2.5 concentration is ug/m3 is: FLOW = 0.6, SW-825 = 3, SDS011 = 3.6 and 2.6.

The FLOW PM2.5 AQI was 2.5 which would correspond to 0.6 ug/m3.

These big relative differences are not shocking, as the absolute differences are small, and one should not expect identical measurements even from a batch of same model sensors. But as a general rule I suggest to take the readings of all these sensors with some healthy skepticism. That being said, the FLOW is a very sexy device and easy to use.

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