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A peek at ground-ozone

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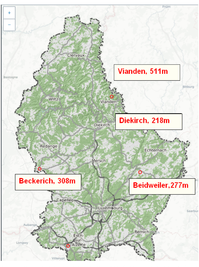
Attention: this comment has being updated the 06Oct20: previous comparison with the 6 months values was erroneous. :

A useful exercise is always to compare our meteoLCD ground ozone measurements (here) with those of the official administration for air quality (here).

Since 3 Jan. 2017 we use the miniature CAIRSENS O3&NO2 sensor for our ozone measurements (technical specs here). The NO2 readings are normally well below the lower limit of detection of 20 ppb of this instrument, so that its readings can be taken as ozone concentration (in ppb, multiplying by the conversion factor 2 gives a result in ug/m3 at standard conditions). The Administration of Environment uses expensive Horiba sensors in its stations and the readings are given in ug/m3. The 3rd April 2018, the first Cairsens O3&NO2 has been replaced by a follower.

1. **The official stations of Vianden, Beckerich and Beidweiler.**

We will compare our measurements made during the week of the 29th September 2019 with those of the three stations of Beckerich, Beidweiler and Vianden:



As Luxembourg is a very tiny country, the distances between Diekirch and the other 3 stations are small: Diekirch-Vianden = 8km, Diekirch-Beidweiler = 19km, Diekirch-Beckerich = 25km (rounded to the km).

Regarding traffic we have a very clear situation: Vianden has very low traffic, and is surrounded by a large forest area; the measuring station is situated between the two basins of the pumped water storage SEO facility. Beidweiler has some morning and evening traffic peak from people driving for work into Luxembourg and also a certain amount going opposite into the Moselle region or Trier in Germany. Beckerich surely has the most morning and evening work related traffic, and being on a main road (but not a highway) to Arlon in Belgium, also more traffic during the day. This situation is similar to that in Diekirch, where there are traffic peaks in the morning and evening hours and a continuous background over the day.

Here a picture of the O3 measurements of these 3 stations:

I added a horizontal line defining the lowest nightly measurements: Clearly Vianden shows the typical situation of a rural station, where there is no nightly traffic whose NO emissions are rapidly bringing down the O3 levels. Its peak values also are the highest, as this is a location with very pristine and clear air (so no much UV8 attenuation here), and with a large natural supply of ozone precursor gases as isoprenes and terpenes emitted by the surrounding trees.

Beidweiler is an intermediate: the night lows are close to 20 ug/m3 and the peak values are lower than those of Vianden. Finally Beckerich has the lowest night O3 levels, going down to about 5 ug/m3; its peak readings also are distinctly inferior to those of Vianden and Beidweiler (please pay attention that on the graphs the vertical scales are not the same!)

Now I can not refrain to make a comment: I am issuing since at least 20 years. From its location, it is clear that Vianden **must** have the highest **natural** O3 levels during warm periods (all stations not mentioned here are city stations). Why is it than that the Administration of Environment uses every year the Vianden values to declare an ozone emergency and limit traffic speed on the highways, with the argument that Vianden is **representative** for Luxembourg! Nothing could be father from truth: most people in Luxembourg live in/near Luxembourg-City and to the South, in regions that are a far shot from the pristine Vianden situation. I guess that an environmental agency must justify its existence by launching scary messages from time to time ; I am more than willing to change my opinion if I get one single good argument justifying its choice that I consider a political, and not scientific one.

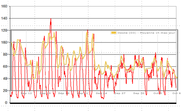
3. Comparing Diekirch to the three other stations

The next figure shows for every station (brown curve) an overplot with our Cairsens measurements (in red):

Simple inspection would suggest that Beckerich and Diekirch are the most similar: same night-time low due to ongoing traffic, same highs and lows with a possible overshoot of the highest readings. Beidweiler ranks second and Vianden makes for some head scratching: the night-time readings are quite different, but all the high readings are very close.

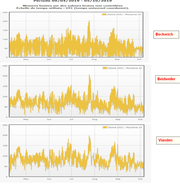
In my opinion, our Cairsens (this is the second sensor as each one has a life-span of a year) has a span that might be slightly to high, even if its calibration certificate was nearly perfect. During high ozone events, we had several times readings exceeding 200 ug/m3, when the other stations were distinctly below.

Let us have a look at the last month (09 Sep to the morning of the 06 Oct) overlaying the Diekirch and Vianden plots:



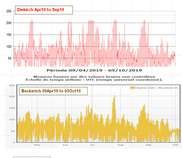
This looks not too bad, but clearly the ozone sensor in Vianden had some problems, shown by the brown straight lines which point to an interpolation of missing data. Do also not ignore that this graphical overplot is really rough, so one should not put too much emphasis on slightly misaligned peaks.

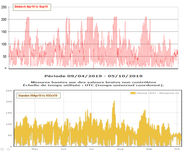
Now lets look at the past 6 months. The official station correspond rather well one to another:



We find approximately the same situation as in the short week long series from above.

Here now a comparison between Diekirch and Beckerich, and in the next picture Diekirch and Vianden:





Visually this is not too bad! We have the same peaks and lows, with a possible overshoot in the Cairsens readings during the highest O3 periods.

4. Conclusion

This short comparison has shown a quite good agreement between our Cairsens measurements and the Horibas during the last week, month and even 6 months periods. Do not forget that the price difference between the Cairsens and the Horiba is enormous. The Cairsens is one of a new generation of sensors that are made to be affordable, calibrated for a full year of operation, and meant to be replaced after that year.

The O3&NO2 Cairsens sensor has a special patented filter that must be changed every 4 months or so. This change will be made asap.

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