

# meteoLCD Weblog

A weblog on climate, global change and climate measurements

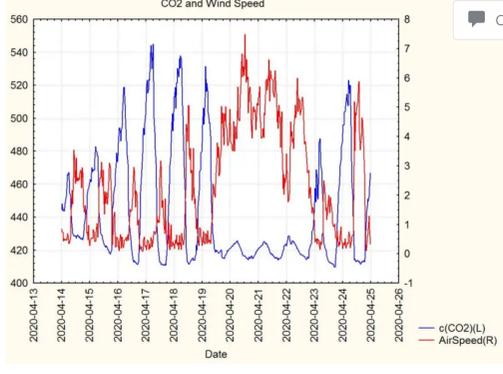
« On wind, CO2 and other gases (1/3)

On wind, CO2 and other gases (3/3) »

## On wind, CO2 and other gases (2/3)

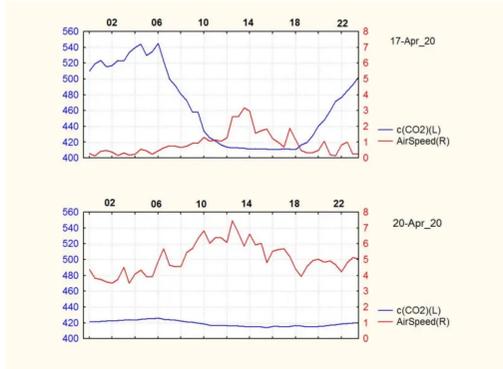
In this 2nd part we will take a deeper look into CO2 variations, wind speed, ground ozone and solar irradiance. I will settle down on the 11 days period from 14 to 24 April 2020 inclusive. The data are fed into STATISTICA, and graphs are made in that software.

### 2. CO2 and wind speed over the 11 days, and a zoom on two days



This plot shows the dampening of daily CO2 peaks during the 3 day period where wind speed was higher 24 hours around: the CO2 peaks plunge from about 540 to less than 430 ppm, practically by one fifth! This windy period stops the 23th April and the 24th we are back to a 520 ppm morning peak. The 3 days low period covers Monday, Tuesday and Wednesday, i.e. days which despite lockdown have certainly more traffic than what happens during the weekends (Saturday, Sunday: 18 & 19 April)

Let us take a look at two days, the Friday 17th April belonging to the low-wind period, and the Monday 20th April where the wind blows strong.



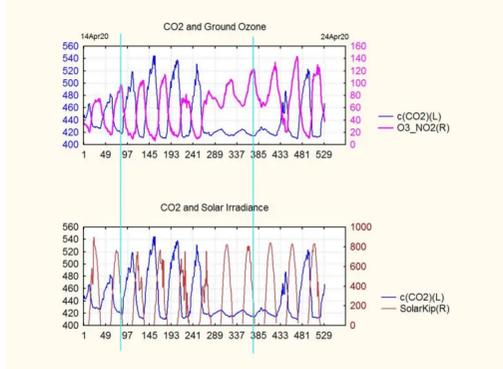
I choose the same scales on both figures, which allows a better visual appreciation: compared to the upper graph, CO2 levels seem practically flat during the windy period.

**Conclusion #1:** CO2 levels at Diekirch are mostly lowered by air movements, which dilute the CO2 concentration through a higher mixing of the near-ground air.

Attention: this is a preliminary conclusion; we know that photosynthesis is the big CO2 killer, and uses it as the building blocks for making plant matter. So we must also look at solar activity (irradiance, energy per day ...) to check if our CO2 slump is not simply the result of a stronger photosynthesis.

### 3. CO2, ground ozone and solar irradiance

But let us look first how another gas that we measure at meteoLCD varies during the same period: ground O3. The next combined graph shows how CO2 and O3 vary together, and how CO2 and solar irradiance change.

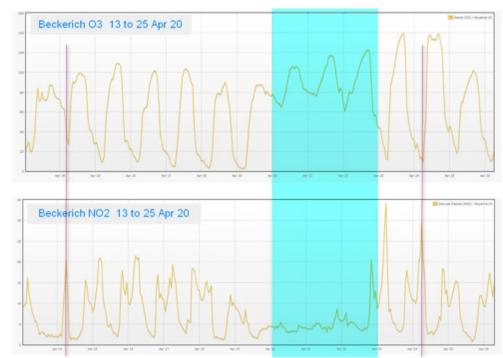


#### 3.1 First the O3 problem:

During the "non-wind" periods O3 levels plunge to near-zero at the morning hours, whereas they remain relatively high during the windy days. Exactly the opposite what we see with CO2! The 2 turquoise lines show CO2 minima and O3 maxima happen at the same time during late-afternoon.

Now we know that nightly O3-patterns differ markedly between city and rural locations. In a city with its ongoing 24/24 traffic, O3 destroying emissions of NO remain efficient, and, in the absence of UVB radiation which creates O3, rapidly lowers O3 concentration. The opposite happens at rural stations: no night traffic, no NO emissions, no hugely important destruction of O3: especially when night temperatures remain high, O3 minimum levels do not fall back to say 10 ug/m3, but stay at 60-80 ug/m3.

Let us check this using the measurements made at Beckerich, a semi-rural village similar to Diekirch regarding traffic: 2 peaks per day of in- and outgoing traffic for the foreigners working in Luxembourg, and a moderate traffic level during the rest of the day. This is nicely shown in the following picture:



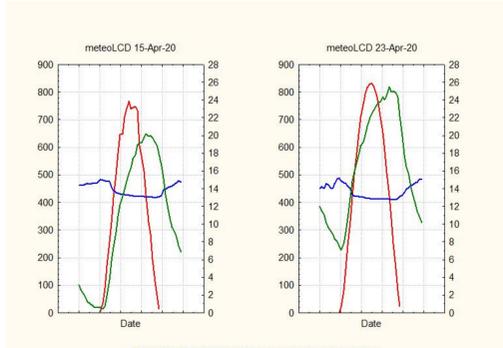
The upper plot shows the O3 concentration, and the lower the NO2, which we will use as a proxy for NO. The two red vertical lines show the morning NO2 peaks and the corresponding O3 lows. If one looks carefully, two NO2 peaks per day can be seen. The highlighted section corresponds to the windy days (remember that these are working days!): NO2 levels remain very low, and so do not bring down O3 concentration to near zero!

**Conclusion #2:** NO2 levels respond to wind speed as does CO2; more wind means more dilution and lower levels. O3 concentrations do not! Not all atmospheric gases are impacted by higher wind speed in the same manner!

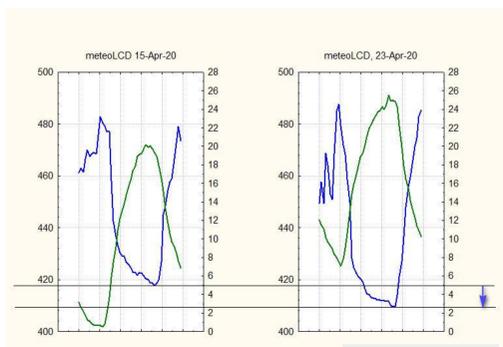
#### 3.2. And now solar irradiance and temperature in more detail:

Can we see the influence of solar irradiance (and air temperature) during low-wind days? Intuitively one would expect stronger air movements by convection when solar irradiance (and air temperature) is higher. So the morning CO2 minima should be lower during sunnier and warmer days.

First a plot showing CO2, solar irradiance and air temperature for the two "wind-poor" days of 15th and 23rd April



Clearly solar irradiance and air temperature is higher on the second day: so this 23th April air convection movements as well as photosynthesis will both be higher. To have a clearer picture, let us retain only CO2 and air temperature:



The CO2 minimum is 8 ppm lower on the warmer and sunnier day. We can not dissociate the two CO2 lowering causes, convection and photosynthesis; suffice to say that the lowering of 8 ppm has to be compared with the peaks which are more than 100 ppm lower during windy compared to wind-still days... a difference of one magnitude!

**Conclusion #3:** The huge CO2 lowering effect during windy days is caused by increased air movements. The variations caused by photosynthesis and air convection are much smaller.

(to be continued with 3rd and last part)

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