meteoLCD Weblog

A weblog on climate, global change and climate measurements

« Climate trends at Diekirch, Luxembourg: part 2b (atmospheric CO2)
European Summer Temperatures since Roman Times »

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Climate trends at Diekirch, Luxembourg: part 2c (atmospheric CO2)

In this third and last part I will discuss the global trend in CO2 mixing ratio, the measurements of some EU measuring stations and our data at meteoLCD.

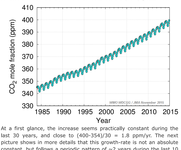
1. **The global situation**

CO2 and other atmospheric greenhouse gas concentrations can be found at many web sites, but I recommend two :

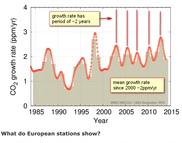
- the NOAA's Earth System Research Laboratory website which ! excellent FTP data finder. Its GLOBALVIEW site has a very inte movie showing how the seasonal amplitude of atmospheric CO2 swings when going from the South-Pole to the North-Pole (2001 to 2013): nearly constant yearly values at the South-Pole, and huge swings in the Northern hemisphere!

The following picture shows the 3 non-maritime reference stations that are closest to Diekirch:

- the WDGG (World Data Center for Greenhouse Gases), which is a Japanese website with links to many stations and miscellaneous visualization tools. From this site, let us look first at the **global** atmospheric CO2 trend, and the variations of the yearly growth rate.



At a first glance, the increase seems practically constant during the last 30 years, and close to (400-354)/30 = 1.8 ppm/yr. The next picture shows in more details that this growth-rate is not an absolute constant, but follows a periodic pattern of ~2 years during the last 10 years and a big variability from 1985 to 2000 (the hump in the middle is the finger-print of the big El-Nino of that year, where warmer oceans did not absorb as much CO2 as colder waters do).

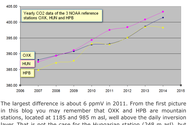


2. What do European stations show?

We will select (on WDGG) all European stations located in a rather small grid of latitudes [45, 50] and longitudes [5, 15 east] (the yellow rectangle pointed at by the blue arrow):

This plot shows that readings vary in an important manner, and that the global picture combined from these stations is far away from a smooth visible curve! We get a similar result if we select only the stations located in a 10°x 10° grid that covers Uccle (Belgium) and Diekirch:

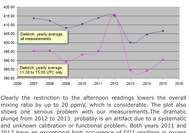
If we look at the yearly average results from the three NOAA reference stations mentioned above (HPB, OXK and HUN), the measurements lie rather close:



The largest difference is about 6 ppm/yr in 2011. From the first picture in this blog you may remember that OXK and HPB are mountain stations, located at 1185 and 985 m asl, well above the daily inversion layer. That is not the case for the Hungarian station (248 m asl), but the values you see on the plot are only a subset of the measurements. In a relatively well hidden remark, the scientist from Hegyhatsál write that they ignore all readings except those made between 11:30 and 15:00 UTC; during this period convective mixing is most important and the CO2 concentration is closer to a maritime or global background. I did not find their original data; the closeness of the HUN curve to the OXK and HPB plots clearly is a result of that pre-filtering.

3. The measurements in Diekirch

In Diekirch we publish all our measurements, but the next picture shows the effect of omitting all readings except those done from 11:30 to 15:00:



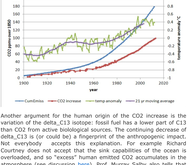
Clearly the restriction to the afternoon readings lowers the overall mixing ratio by up to 20 ppm/yr, which is considerable. The plot also shows that we have a problem with our measurements.The large plunge from 2012 to 2013 probably is an artefact due to a systematic and unknown calibration or functional problem. Both years, 2011 and 2012 have an exceptional high occurrence of Events with values in excess of 500 ppm/yr: usually there are about 200 occurrences (i.e. half hour periods) in a year, but during these 2 years we measured more than 500. That the lower plot also peaks at nearly the same value as the blue upper curve points to a problem.

A "consolation" is that the periods 2002 to 2012 and 2013 to 2015 show trends that are close to the global increase rate of ~2 ppm/yr/year:

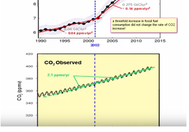
4. Conclusion

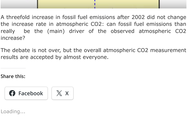
This 3 part series shows that CO2 measurements are not easy, are far from uniform, and that trends are difficult to find without extremely costly calibration procedures. Even the satellites circling the Earth have problems to measure CO2 mixing ratios with an accuracy of 0.1 ppm. If you look at the various CO2 series of ground stations, you may become horrified on the numerous malfunction and missing data periods. At Diekirch, we are a little player in the CO2 game, doing a difficult job on a shoe-string budget. Our atmospheric gas measurements are by far the most troublesome we do; that our long-time CO2 trends in CO2 increase are similar to those measured by the big guys is comforting, but does not allow us to make a blind eye on the numerous problems remaining.

A recurrent question is "what is the cause of the CO2 increase?". The usual answer is that our fossil fuel consumption is the main culprit, as both curves go well together. Ferdinand Engelbeen has a good discussion on this problem (link). The next picture from his website shows that CO2 concentration rises with (cumulative) emissions, but also that global temperature does not during all periods:



Another argument for the human origin of the CO2 increase is the variation of the delta_C13 isotope: fossil fuel has a lower part of C13 than CO2 from active biological sources. The continuing decrease of delta_C13 is (or could be) a fingerprint of the anthropogenic impact. Not everybody accepts this explanation. For example Richard Courtney does not accept that the sink capabilities of the ocean is overloaded, and so "excess" human emitted CO2 accumulates in the atmosphere (see discussion here). Prof. Murray Salby also tells that the CO2 increase is "natural" (see video). My late co-author Ernst-Georg Beck also was strongly convinced that warming regions of the North Atlantic are the **main** reason behind the atmospheric CO2 increase. Salby shows in his presentation this figure:





A threefold increase in fossil fuel emissions after 2002 did not change the increase rate in atmospheric CO2: can fossil fuel emissions than really be the (main) driver of the observed atmospheric CO2 increase?

The debate is not over, but the overall atmospheric CO2 measurement results are accepted by almost everyone.

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