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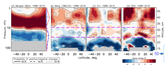
New scare: decline of lower stratospheric ozone

There is a new paper by William T. Ball (ETH Zürich) et al.(21 co-authors!!) titled "**Evidence for a continuous decline in lower stratospheric ozone offsetting ozone layer recovery**" published in Atmospheric Chemistry and Physics (6 Feb 2018). This paper has induced many comments by journalists which did not carefully read the paper, and produced the usual scary text about "we will all die by increased UVB radiation". Actually the paper does not give this conclusion, but uses often well hidden statements to obscure it's main findings (after heavy data torturing by what I think very obscure statistics):

- the Total Ozone Column (TOC) remained more or less stable 1998 in the latitudinal band -60° to +60°
- the O3 concentration in the lower stratosphere seems to have declined by about 2 DU since 1998 (remember that the mean of this strongly varying TOC is about 300 DU?)
- the O3 concentration in the upper stratosphere is increasing, what the authors see as a fingerprint of the efficiency of the Montreal protocol
- the O3 in the lower troposphere is also increasing, which the authors see as a fingerprint of human activity

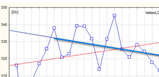
The conclusion of the paper: if the lower stratosphere O3 had not been decreasing, *we would notice the efficiency of the Montreal protocol in out-phase O3 destroying gases…* but alas, we do not observe any efficiency for the moment.

1. The most important figures from the paper



This is figure 1; it shows the global O3 trends according to the latitude (so every point at a certain latitude is the mean trend for that latitudinal band); red colors show an increase in TOC, blue a decrease.

Figure 4 of the Ball paper shows the tropospheric O3 column (i.e. the ground ozone) is increasing:

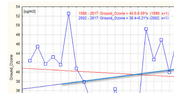


Don't be fooled by the slope of the linear regression line: in 12 years the total increase is just a meager 1.5 DU !

We will compare this to the measurements done at Diekirch and at Uccle (both locations approx. at 50° lat. North, i.e. at the extreme right border of the graphs.

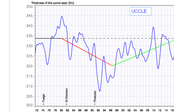
Here is what we measure in Diekirch:

The TOC at Diekirch seems to be slightly decreasing since 2002, even if the general trend since 1998 is positive.



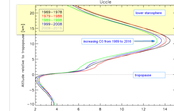
but the ground ozone levels are slightly increasing since 2002 (by 0.2 ug/m3 per year, please compare to the left side scale!)

Uccle finds this for the TOC (link):



So here we see two periods: a decline from about 1980 to 1996, and then an increase!

Uccle also has a good figure with the trends of their balloon soundings (I added the comments):

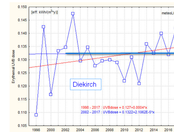


Here the lower stratosphere corresponds to the yellow marked region: just below that region, we see that over the years the O3 concentration is **increasing**, and that the changes in the yellow region are minimal.

Conclusion: the regional behaviour at our latitudes (50° North) do not quite correspond to the global latitudinal findings of the Ball paper.

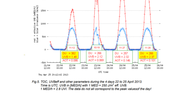
2. The UVB radiation measured at ground level.

Here is what we measured in Diekirch during the last 15 years:



UVB intensity remains practically constant over the whole period 2002 to 2017.

I wrote several comments and papers on the relation-ship between TOC and UVB levels at ground level: here the main figure in my paper from 2013:

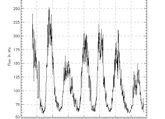


This figure clearly shows that when the TOC declines, UVB radiation increases (compare the two highlighted days). But alas, things not always go such smoothly during longer periods. The next figure shows the results of measurements done by Klara Czikova et al. in the Czech republic over 50 years ("Reconstruction and analysis of erythemal UV radiation time series from Hradec Králové (Czech Republic) over the past 50 years"),

Just look at the years between the two blue lines: TOC is more or less constant, cloud cover increases and, quite inexplicably the yearly UVB also increases(left scale shows daily mean dose) . This means that short time phenomena can show a different behaviour than yearly averages or totals. Note also the decreasing UVB dose from about 2008 on.

3. Conclusions

The findings of the Ball et al. paper may be interesting from a scientific stand-point, but they are not a cause for any panic. The important factor for health reason is the UVB dose, and that dose either remains constant or declines in our region. Does the Ball et al. paper vindicate the Montreal protocol? Yes and no: if really in the upper stratosphere both ozone depleting substances are decreasing and O3 concentrations increasing, than this should point to an efficiency. But the elephant in the room is the decreasing solar (and UVB) activity during the last years, as shown by this graph of the 10.7cm radio waves flux (a proxy for UVB activity):



Clearly solar activity is on a decline since 2000, so less ozone will be created at the lower layers of the stratosphere (even if the O3 destroying substances had remained constant…). The authors ignore this, and it might well be that the O3 depletion in the lower stratosphere is mostly a consequence of declining solar activity!

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