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The ozone layer and ozone depletion

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HFCs and the ozone layer

Over 20 years ago it was established that HFCs have no chemical effect on stratospheric ozone [1].However, it has been postulated that a potential effect of HFCs on stratospheric temperatures may augment the reactions that deplete stratospheric ozone [2]. The calculations were performed by computer modelling using scenarios of future HFC production and release up to the year 2050.

The scenarios initially used were those of Velders et al. (2009) [3] which have very large HFC releases up to 2050. These scenarios did not have any constraints on HFC releases, so that not even the original F-gas Regulation and Directive of the EU were considered [4, 5]. The scenarios have been effectively discredited and superseded by more realistic scenarios. These incorporate the revised EU F-gas regulation [6], together with the proposed North American phase-down of HFC use and will result in reduced future emissions of HFCs to the point where they are similar to those envisaged in the scenarios used by climate scientists for the IPCC's 5th Assessment Report [7].

Under the IPCC scenarios accumulation of HFCs in the atmosphere should be reduced by at least 90% from the large emissions assumed by Hurwitz et al (2015) [2]. **The change in stratospheric temperature (about 0.02 °K) would then be insignificant compared to natural variation and hence there should be no real effect of HFCs on stratospheric ozone**. The theory that HFCs could modify stratospheric temperature sufficiently to accelerate ozone loss to a material extent there is based wholly on out-of-date scenarios.

More recently, for a revised high-growth HFC scenario [4], the total projected impact on globally averaged total ozone from HFCs remains less than 0.1 DU (Dobson unit) by 2050 [5]. To put this in context, the ozone layer's average thickness is about 300 Dobson Units [6], and the natural variability is larger [7].

The Scientific Assessment Panel 2018 Report [8] states that "**Outside the Antarctic, CO_2, CH_4, and N_2O will be the main drivers of stratospheric ozone changes in the second half of the 21st century, assuming full compliance with the Montreal Protocol.** These gases impact both chemical cycles and the stratospheric overturning circulation, with a larger response in stratospheric ozone associated with stronger climate forcing."

Sources:

1. Ravishankara A. R., A.A. Turnipseed, N.R. Jensen,.S. Barone, M. Mills, C.J. Howard and S. Solomon (1994), Do Hydrofluorocarbons Destroy Stratospheric Ozone?, Science, 263, 71–75, doi:10.1126/science.263.5143.71

2. Hurwitz M. M., E.L. Fleming, P.A. Newman, F. Li, E. Mlawer, K. Cady-Pereira and R. Bailey (2015), Ozone depletion by hydrofluorocarbons, Geophys. Res. Lett., 42, doi:10.1002/2015GL065856.

3. Velders, G. J. M., D. W. Fahey, J. S. Daniel, M. McFarland, and S. O. Andersen (2009), The large contribution of projected HFC emissions to future climate forcing, Proc. Natl. Acad. Sci. U.S.A., 106(27), 10,949–10,954.

4. Velders, G.J.M., D.W. Fahey, J.S. Daniel, S.O. Anderson, and M. McFarland, Future atmospheric abundances and climate forcings from scenarios of global and regional hydrofluorocarbon (HFC) emissions, Atmos. Environ., 123 (A), 200−209, doi:10.1016/j.atmosenv.2015.10.071, 2015.

5. Hurwitz, M.M., E.L. Fleming, P.A. Newman, F. Li, and Q. Liang, Early action on HFCs mitigates future atmospheric change, Environ. Res. Lett., 11, doi:10.1008/1748-9326/11/11/114019, 2016.

*6. From https://ozonewatch.gsfc.nasa.gov/facts/dobson.html What is a Dobson Unit? **T**he Dobson Unit is the most common unit for measuring ozone concentration. One Dobson Unit is the number of molecules of ozone that would be required to create a layer of pure ozone 0.01 millimeters thick at a temperature of 0 degrees Celsius and a pressure of 1 atmosphere (the air pressure at the surface of the Earth). Expressed another way, a column of air with an ozone concentration of 1 Dobson Unit would contain about 2.69×10^{16} ozone molecules for every square centimeter of area at the base of the column. Over the Earth's surface, the ozone layer's average thickness is about 300 Dobson Units or a layer that is 3 millimeters thick.*

7. Natural Variability of Stratospheric Ozone see http://www.atmosp.physics.utoronto.ca/people/sparc/ccmval_final/PDFs_CCMVal%20June%2015/ch8.pdf

8. World Meteorological Organization Global Ozone Research and Monitoring Project—Report No. 58, Scientific Assessment of Ozone Depletion: 2018 Executive Summary page ES.27