Geophysical Research Abstracts
Vol. 20, EGU2018-3079, 2018
EGU General Assembly 2018

Past, present and future states of the ozone layer

Wolfgang Steinbrecht
Deutscher Wetterdienst, Met. Obs. Hohenpeissenberg, Hohenpeissenberg, Germany (wolfgang.steinbrecht@dwd.de)

The Montreal protocol and its later amendments were successful. Concentrations of ozone-depleting substances (ODS) have been declining in the troposphere since 1994, in the stratosphere since the late 1990s. The previous decline of ozone has been stopped by about 2000. Since then, ODS have been declining and ozone increases are observed in the upper stratosphere. Recent studies indicate that the Antarctic ozone hole is also getting smaller. However, clear signs of increases in total column ozone are not observed so far. This is not unexpected, because the decline of ODS is three to four times slower than their previous increase, and because natural ozone variations, especially those due to meteorological fluctuations from year to year, mask the relatively small chemical ozone recovery signal. Significant recovery of total ozone columns is not expected before 2020 to 2040.

While ODS and their importance for the ozone layer should decline over the next 50 to 70 years, model simulations indicate that emissions of greenhouse gases, especially CO_2, N_2O and CH_4, will become more and more important. Their effects on ozone could be as large as past ozone depletion due to ODS (outside of the ozone hole). CO_2 warms the troposphere and cools the stratosphere. This affects climate and global transports of ozone and other trace gases by the stratospheric Brewer Dobson Circulation. N_2O and CH_4 are greenhouse gases as well, but they also affect ozone chemistry directly by releasing NO_x, CO, and H_2O in the stratosphere. Generally, more N_2O will result in less ozone, more CO_2 or CH_4 in more ozone. However, the balance varies with latitude, altitude, and depends on the unknown future concentrations. Large future increases in very-short lived chlorine and bromine containing gases (e.g. CCl_2H_2) might also influence ozone.

The predicted acceleration of the global Brewer Dobson Circulation should increase ozone columns over most of the globe, but reduce ozone columns over the tropics. Since ozone is a key player in the radiative balance, these changes feed back into the circulation. Particularly in the lower stratosphere, we can expect a complex intertwining of ozone changes and the Brewer Dobson Circulation. Climate change and the evolution of the ozone layer are, thus, intimately connected. Many of these processes are currently not well understood. Observational evidence is also scarce, and is not conclusive. It is especially difficult to compare decadal variations available from the observations with the centennial changes predicted by the models. This is, however, very relevant for the future of the ozone layer.