Stratospheric Ozone: Ongoing depletion or recovery?

Martyn CHIPPERFIELD[1], Sandip DHOMSE[1], Ryan HOSSAINI[2], and Doug KINNISON[3]

[1] *University of Leeds, Leeds, UK*

[2] *Lancaster University, Lancaster, UK*

3 NCAR, Boulder, USA

We use a range of 3-D model simulations to investigate (i) if ozone depletion due to anthropogenic chlorine and bromine is still getting worse in non-polar regions and (ii) if/when ozone will return to pre-depletion (1980) values. For issue (i) we use height-resolved and total column satellite observations and 3-D chemical transport model (CTM) simulations to study stratospheric ozone variations during 1998-2017 as ozone-depleting substances decline. In 2017 ozone in the mid-low latitude lower stratosphere displayed a strong positive anomaly following much lower values in 2016. This points to large interannual variability rather than an ongoing downward trend, as reported recently by Ball et al. (2018). The observed ozone variations are well captured by the CTM throughout the stratosphere and are largely driven by meteorology. Model sensitivity experiments show that the contribution of past trends in very short-lived chlorine species (VSLS) to the ozone changes is small. Similarly, the potential impact of modest trends in natural brominated short-lived species is small. These results confirm the important role that atmospheric dynamics has on controlling ozone in the mid-low latitude lower stratosphere. For issue (ii) we use Chemistry-Climate Model Initiative (CCMI) simulations to estimate the return dates of the stratospheric ozone layer from depletion caused by anthropogenic halogens (Dhomse et al., 2018). We consider a total of 155 simulations from 20 models, including a range of sensitivity studies which examine the impact of climate change on ozone recovery. The interannual variability in the model results need to be smoothed in order to provide a reasonably narrow estimate of the range of ozone return dates. For a Representative Concentration Pathway (RCP) of 6.0, these new CCMI simulations project that global total column ozone will return to 1980 values in 2047 (with a 1-σ uncertainty of 2042-2052). At Southern Hemisphere mid-latitudes column ozone is projected to return to 1980 values in 2046 (2042-2050), and at Northern Hemisphere mid-latitudes in 2034 (2024-2044). In the polar regions, the return dates are 2062 (2055-2066) in the Antarctic in October and 2035 (2025-2040) in the Arctic in March. The earlier return dates in the NH reflect the larger sensitivity to dynamical changes. Our estimates of return dates are later than those presented in the 2014 Ozone Assessment by approximately 5-15 years, depending on the region. In the tropics only around half the models predict a return to 1980 values, at around 2040, while the other half do not reach this value. All models show a negative trend in tropical total column ozone towards the end of the 21st century. Overall the model results point to a change in the control of stratospheric ozone from anthropogenic halogens to climate gases over the course of this century.

Key words: Ozone, recovery, VSLS, tropics.

References

Ball, W. T., and Coauthors, 2018: *Atmos. Chem. Phys*., **18**, 1379-1394, doi:10.5194/acp-18-1379-2018.

Dhomse, S., and Coauthors, 2018. *Atmos. Chem. Phys. Discuss*., **18**, acp-2018-87.