QOS2016-193, 2016
Quadrennial Ozone Symposium of the International Ozone Commission

Northern Hemisphere Surface Response to Extreme Arctic Ozone Events in a Chemistry-Climate Model

C. D. Rae (1), A. C. Maycock (2), J. A. Pyle (1,3)

(1) Centre for Atmospheric Science, University of Cambridge (cdr39@cam.ac.uk), (2) School of Earth and Environment, University of Leeds, (3) NCAS, University of Cambridge

In the Antarctic, substantial springtime ozone losses have had significant impacts on regional surface climate in recent decades. In the Arctic, an unusually large ozone depletion episode was observed in March 2011. It is therefore pertinent to investigate whether substantial ozone losses in the Arctic may impact on Northern hemisphere surface climate. This question is addressed using three modelling approaches: (1) time-slice experiments using HadGEM3-A with prescribed ozone losses based on 2011 observations and a 2011 "world-avoided by the Montreal Protocol" case for comparison (Chipperfield et al., 2015); (2) a time-slice UM-UKCA experiment with interactive chemistry; (3) an ensemble of transient UM-UKCA experiments with interactive chemistry covering the period 1980-2080.

The prescribed ozone experiments with observed 2011 ozone anomalies show a cooling in the polar lower stratosphere in spring and a strengthening of the westerly winds in the lower stratosphere. These signals are enhanced in the world-avoided 2011 case, which includes substantially larger ozone losses. No significant surface impacts were observed from the prescribed ozone anomalies.

In the time-slice UM-UKCA experiments, composite differences between years with simulated high and low spring-time Arctic ozone confirm that the polar vortex is stronger in years with low ozone abundances. Statistically significant differences in tropospheric & surface climate are observed between the highest and lowest ozone regimes. However, in the transient ensemble, there is no discernible impact of the differences in stratospheric state (associated with highest/lowest ozone) on surface climate. This may be related to the model's representation of inter-annual variability in Arctic ozone.