Stratospheric Ozone Loss over the Eurasian Continent Induced by the Polar Vortex Shift

Jiankai Zhang[1], Wenshou Tian[1*], Fei Xie[2], Martyn P. Chipperfield[3], Wuhu Feng[3,4], Seok-Woo Son[5], N. Luke Abraham[6,7], Alexander T. Archibald[6,7], Slimane Bekki[8], Neal Butchart[9], Makoto Deushi[10], Sandip Dhomse[3], Yuanyuan Han[1], Patrick Jöckel[11], Douglas Kinnison[12], Ole Kirner[13], Martine Michou[14], Olaf Morgenstern[15], Fiona M. O'Connor[9], Giovanni Pitari[16], David A. Plummer[17], Laura E. Revell[18,19], Eugene Rozanov[18,20], Daniele Visioni[16,21], Wuke Wang[22], Guang Zeng[15]

[1]College of Atmospheric Sciences, Lanzhou University, Lanzhou, China; [2]Beijing Normal University, Beijing, China; [3]School of Earth and Environment, University of Leeds, Leeds, UK; [4]NCAS, University of Leeds, Leeds, UK; [5]School of Earth and Environmental Sciences, Seoul National University, Seoul, South Korea; [6]NCAS, University of Cambridge, Cambridge, UK; [7]Department of Chemistry, University of Cambridge, Cambridge, UK; [8]LATMOS, Paris, France; [9]Met Office Hadley Centre, Exeter, UK; [10]Meteorological Research Institute, Ibaraki, Japan; [11]DLR, Wessling, Germany; [12]NCAR, Boulder, USA; [13]KIT, Karlsruhe, Germany; [14]CNRM, Toulouse, France; [15]NIWA, Wellington, New Zealand; [16]Università dell'Aquila, L'Aquila, Italy; [17]Climate Research Branch, Montreal, Canada; [18]ETHZ, Zürich, Switzerland; [19]Bodeker Scientific, Alexandra, New Zealand; [20]PMOD/WRC, Davos Dorf, Switzerland; [21]CETEMPS, Universitá dell'Aquila, L'Aquila, Italy; [22]Nanjing University, Nanjing, China

The Montreal Protocol has succeeded in limiting major ozone-depleting substance (ODS) emissions, and consequently stratospheric ozone concentrations are expected to recover this century. However, there is a large uncertainty in the rate of regional ozone recovery in the Northern Hemisphere. Here we identify a 'Eurasia-North America dipole' (ENAD) mode in the total column ozone (TCO) over the Northern Hemisphere, showing negative and positive TCO anomaly centres over Eurasia and North America, respectively. The positive trend of this mode explains an enhanced TCO decline over the Eurasian continent in the past three decades, which is closely related to the polar vortex shift towards Eurasia (Zhang et al., 2016). Multiple chemistry-climate-model simulations indicate that the positive ENAD trend in late winter is likely to continue in the near future. Our findings suggest that the anticipated ozone recovery in late winter will be sensitive not only to the ODS decline but also to the polar vortex changes, and could be substantially delayed in some regions of the Northern Hemisphere extratropics.

Key words: stratospheric ozone, polar vortex shift, climate change

References

Zhang, J., Tian, W., Chipperfield, M. P., Xie, F., and Huang, J., 2016: Persistent shift of the Arctic polar vortex towards the Eurasian continent in recent decades. *Nature Climate Change*, **6**(12), 1094-1099.