



Shedding new light on the radiative impacts of ozone-depleting substances

Gabriel Chiodo^{1,2} and Lorenzo M. Polvani^{2,3}

¹ETH Zurich, Institute for Atmospheric and Climate Science, Environmental Systems Science, Zurich, Switzerland
(gabriel.chiodo@env.ethz.ch)

²Applied Physics and Applied Math, Columbia University, New York, NY, USA

³Lamont Doherty Earth Observatory, Palisades, NY, USA

It is well established that ozone-depleting substances (ODS) have been the primary cause of stratospheric ozone depletion. It is also widely accepted that stratospheric ozone depletion has been the primary driver of summertime circulation trends in the Austral Hemisphere in the second half of the twentieth century. However, the climate impacts of ODS that are independent of ozone depletion have received little attention. It has long been known that, while much less abundant than carbon dioxide, ODS have a much higher global warming potential (GWP) recent studies have indicated that ODS may have played a key-role in the observed weakening trends of the Walker circulation (Polvani and Bellomo, 2019), and in the warming of the Arctic and the associated sea ice loss (Polvani et al., 2020). that the climate efficacy of ODS may be much larger than previously thought, but .

Here, we seek to better understand the radiative effect of ODS in the global atmosphere. Instead of confining our attention on a single metric, e.g. globally averaged radiative forcing (RF) or GWP which are typically reported in the IPCC Assessment Reports, we seek to understand how ODS alter the temperature structure of the entire atmosphere. Focusing on the half-century 1950-2000, which saw the largest growth of ODS concentrations in the atmosphere, we start by performing careful computations of the RF of individual ODS, including the effects of rapid temperature adjustments. We then explore how the vertical and latitudinal distribution of ODS (which are not well mixed in the stratosphere) affects their RF, and what temperature responses are associated with those changes. These calculations are repeated individually for each of the other well-mixed GHG, as well as for other composition changes arising from ODS (ozone depletion). It is shown that ODS, in contrast to other GHG, warm the lower stratosphere, implying a different fingerprint from CO₂. Furthermore, the RF of ODS exhibits the largest meridional gradient of any other well-mixed GHG. Implications for the climate efficacy of ODS, and more generally for climate sensitivity, will be discussed.

References

Polvani, L.M and K. Bellomo: The key role of ozone depleting substances in weakening the Walker circulation in the second half of the 20th century, *J. Climate*, **32**, 1411-1418 (2019).

Polvani et al.,: Substantial twentieth-century Arctic warming caused by ozone depleting substances, *Nature Climate Change*, in press (2019)