

Submission Title:

The Impact of Atmospheric Dynamics and Anthropogenic Very Short-Lived Chlorine Species on the Recovery of Extra-Polar Ozone

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Abstract

The successful implementation of the Montreal Protocol has led to a decrease in the atmospheric abundance of ozone-depleting substances and a slowing in the destruction of the ozone layer. Previous studies have suggested that atmospheric dynamics, or a rise in compounds not regulated by the Montreal Protocol, such as very short-lived chlorine species (VSL Cl), may lead to a slower than expected recovery of the ozone layer. In this presentation, we examine the expected recovery of total column ozone (TCO) and stratospheric column ozone (SCO) to values observed in 1980 using a novel multiple linear regression (MLR) model that involves a month-by-month regression. The MLR model is trained to TCO anomalies from six data records (SBUV v8.7 MOD, SBUV v8.6 COH, WOUDC, GSG, GTO-ECV, MSR-2) over 1979 to 2021 for the Northern Hemisphere (35N – 60N), the Southern Hemisphere (60S – 35S) and the Tropics (20S – 20N), and SCO anomalies from ML-TOMCAT for these same zonal bands. The MLR includes the effect of halogens (equivalent effective stratospheric chlorine (EESC)), total solar irradiance, stratospheric aerosol optical depth, quasi-biennial oscillation, and the El Niño Southern Oscillation as regressors. We also include the effect of atmospheric dynamics such as the Brewer-Dobson Circulation, Arctic Oscillation, and the Antarctic Oscillation, and VSL Cl species in the formulation of EESC. We use a novel approach to the MLR framework, by separating the observed and regressor time series into the respective months (separating all of the Januarys, Februarys, etc.). Then we conduct a regression for each month from 1979 to 2021 for the three zonal bands denoted above. The model results for each month are combined together to achieve a full monthly time series from 1979 to 2021. We use this novel approach to ascertain the effect of atmospheric dynamics on TCO and SCO, since the dynamical proxies affect ozone in a distinctly different manner for various months. In this presentation, we will quantify the role of both the inclusion of VSL Cl species in the formulation of EESC as well as atmospheric dynamics in explaining the slower than expected recovery of extra-polar TCO and SCO over the past decade.