

## **Impact of the Montreal Protocol: Does Stratospheric Ozone Data Confirm Model Predictions?**

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The manufacture and release of chlorofluorocarbons (CFCs) during the 1970s and 1980s led to an increasing stratospheric abundance of chlorine compounds that can catalytically destroy ozone. The Montreal Protocol is an international agreement that has limited the source of chlorine compounds to the stratosphere. The fluorocarbon-ozone theory predicts that stratospheric ozone is affected by CFCs. Ozone measurements from the series of SBUV instruments on NASA and NOAA satellites form a continuous data set from late 1978 to the present. I will show time series of these data that illustrate the long-term behavior of ozone in the stratosphere. We detect clear signals of ozone decrease during the 1970s and 1980s. There is no further decrease since the late 1990s. The question that we are asking is "How accurate were our model predictions of ozone change?" We use a standard time-series analysis of the total ozone data from SBUV to determine best-fit coefficients for equivalent effective stratospheric chlorine (EESC), solar cycle, QBO, and volcanoes. We then use the same time series analysis to fit to model results from a variety models developed at Goddard over the past two decades including the a CTM and the GEOSCCM circa 2005, the GMI CTM, and more recent versions of the GEOSCCM with stratospheric chemistry and with combined stratospheric and tropospheric chemistry. We also use the time-series analysis to fit to the output from the variety of models that participated in the CCMVal2 model evaluation.

We find that the models generally show more sensitive than does the data to chlorine as determined from the coefficient of the fit to EESC. We examine the reasons for this quantitative difference by comparing EESC sensitivity to lower stratospheric ozone, nitric acid and HCl columns from the various model results.