QOS2016-235, 2016
Quadrennial Ozone Symposium of the International Ozone Commission

The observed sensitivities of Antarctic Ozone loss to chlorine and temperature: why attribution remains a challenge

S.E. Strahan (1,2), A.R. Douglass (2), and L.D. Oman (2)

(1) Universities Space Research Association, Goddard Earth Science and Technology and Research Center, Greenbelt, MD, United States (susan.strahan@nasa.gov), (2) NASA Goddard Space Flight Center

Unlike ozone measurements made with UV spectrometers, Aura Microwave Limb Sounder (MLS) ozone measurements can be made during Antarctic winter. We use the MLS O_3 data to determine how ozone loss during the winter months (July to September) has changed from 2005 to 2015. Inorganic chlorine (Cl_y) in the Antarctic lower stratosphere has been inferred from MLS N_2O observations, making it possible to directly attribute changes in ozone loss to changes in chlorine. Ozone loss appears to be responding to Cl_y changes but the statistical significance is low.

Ozone loss depends on temperature and Cl_y levels. Antarctic lower stratospheric Cl_y is declining at a mean rate of $\sim$22 ppt/yr ($<$ 1%/yr) with interannual variability of up to $\pm$150 ppt ($\sim$5%/yr) caused largely by the Quasi Biennial Oscillation. Over the small range that Cl_y has varied during the Aura period, the variations in ozone loss it causes are much smaller than the variations caused by temperature. When only the coldest winters are considered in order to minimize the contribution of temperature variability, we show that the very large ozone hole of 2015 adds to the weight of evidence that the ozone hole area is decreasing due to declining Cl_y levels.

The greater contribution of temperature variability in Antarctic ozone loss variability compared to Cl_y variability and trend is inescapably responsible for the difficulty in attribution of Antarctic ozone increases to the Montreal Protocol and its amendments at the present time. We use the Goddard Earth Observing System Chemistry Climate Model (GEOS CCM) simulation to examine Antarctic ozone sensitivity to Cl_y and temperature from 1980 to 2040. Rapidly changing Cl_y levels in the 1980s cause a rapid increase in Antarctic ozone loss, but the influence of slowly declining Cl_y levels after 2000 cannot be isolated because of the large contribution of variability in temperature to variability in ozone loss. The magnitude of the interannual O_3 loss variability seen in both the simulation and the observations suggests that a reduction in Antarctic winter O_3 loss attributable to Cl_y requires an observational ozone record of at least 20 years since the beginning of Cl_y decline.