MLS-related Scientific Publication

Scientific Theme: Atmospheric Chemistry

On the unexplained stratospheric ozone losses during cold Arctic Januaries, M. Rex, R. J. Salawitch, M. L. Santee, J. W. Waters, K. Hoppel, and R. Bevilacqua, *Geophys. Res. Lett.*, **30**(1), 1008, doi:10.1029/2002GL016008, 2003.

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Summary and MLS contribution

This paper presents data from Match, POAM II and III, and UARS MLS to demonstrate that the chemical loss rate of Arctic ozone during January of four cold winters (1992, 1995, 1996, and 2000) is consistently faster than can be accounted for even assuming complete activation of reactive chlorine. Modelling results show that, using standard photochemistry, unrealistically high active chlorine abundances are required to explain the January loss rates observed by Match. In contrast, ozone loss rates measured during late February and early March 1996 are in excellent agreement with modelled loss based on MLS observations of ClO. Significantly, the air masses sampled later in winter had spent a considerably smaller portion of their overall sunlit time at high solar zenith angles than had those sampled in January. Detailed analyses suggest that the January ozone loss occurs by a process involving a photolytic step at high solar zenith angles that is not well represented in current models. Based on Match, POAM, and MLS data, the cumulative ozone loss during cold Arctic Januaries is estimated to be ∼0.5 ppmv. Although the estimated January loss is modest compared to that occurring in February/March in cold winters, the inability to accurately model this loss calls into question the reliability of predictions of future trends in Arctic ozone. This work benefits society by providing evidence of a currently unknown loss mechanism affecting stratospheric ozone.

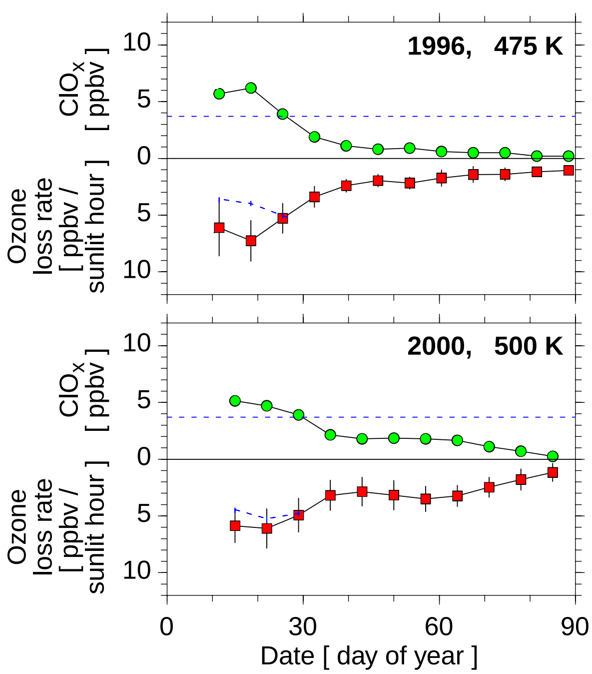

Figure 1 (adapted). Chemical loss rate of O_3 in the Arctic vortex, for the indicated years and isentropic surfaces, from Match (red boxes; error bars are 1σ uncertainty). Also shown are the abundance of ClO_x necessary to account for the observed ozone loss rate (green dots) and the modeled O_3 loss rate for January of each year assuming ClO_x=3.7 ppbv (blue dashed line).

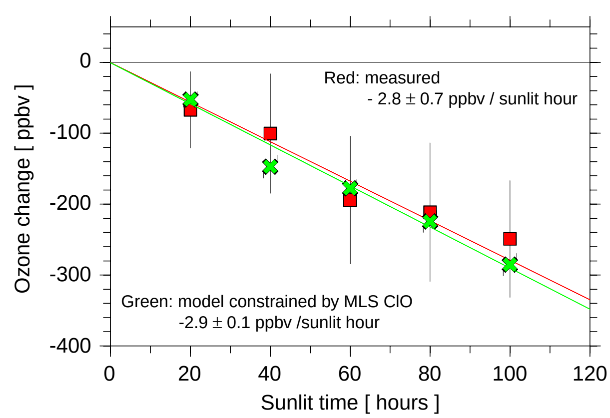

Figure 4. The chemical loss of O_3 measured by Match between 20 February and 3 March 1996 at 475 K versus the amount of sunlight exposure along each Match trajectory (red squares) and the computed reduction in O_3 along the same trajectory based on MLS Version 5 measurements of ClO (green crosses). Error bars are 1σ standard deviations.