A Study of Chlorine Activation after Polar stratospheric Cloud Events using UARS Data

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It is now well established that. chlorine chemistry is responsible for the late-winter/early-spring depletion in lower stratospheric ozone observed over Antarctica and, to a lesser extent , over the Arctic. Heterogeneous processes occurring on the surfaces of polar st rat ospheric clouds (PSCs), which form in the low temperatures of polar winter, rapidly convert chlorine reservoir species (e.g., C1ONO2") to more reactive species that are quickly photolyzed to yield C1O. In addition to activating chlorine, heterogeneous processes also sequester react ive ni trogen as HN03 in PSC particles.

Recent. measurements from the Upper Atmosphere Research Satellite (UARS) provide new opportunities to examine the correlation between PSC activity and C1O enhancement. In this study, we combi ne Microwave Limb Sounder (MLS) observations of C1O and HN03 with near-simultaneous and co-located Cryogenic Limb Array Etalon Spectrometer (CLAES) observations of aerosol extinction and ClONO2. In order to look for unambiguous evidence of direct. chlorine activation, we have searched the MLS and CLAES data sets for events satisfying the following criteria: (1) high aerosol extinction coefficients (> 1.0E-3 km** (- 1)) within regions of low temperature (< 195 K, the approximate threshold for the onset of Type I nitric acid trihydrate (NAT) PSCs), (2) unenhanced C1O conditions (i.e., low values of C1O immediately prior to formation of the PSC in question) , and (3) daytime conditions (measurement solar zenith angle < 94 deg) . Due to various orbital and observational considerations, few occurrences satisfy these conditions. We focus here on UARS observations of two chlorine activation events which occurred over northern Canada in late December 1992 and over northern Scandinavia and Russia inearly January 1993.

To track the motions of individual air masses, trajectory calculations are performed using horizontal winds and temperatures derived from the U.K. Meteorological Office data assimilation system. Approximately 19,500 air parcels are initialized on an equal-area grid covering the port ion of the northern hemisphere poleward of 50N. The trajectory code is run on the 465 K isentropic surface for the period 4-8 January 1993 (after which the UARS spacecraft per-formed a yaw maneuver and the MLS and CLAES high-latitude viewing shifted to the southei n hemisphere) . Because diabatic effects are negligible over a 5-day interval in the lower stratosphere, cross-isentropic flow is ignored. Parcels init ially located in the vicinity of observations of high aerosol extinctionare followed at. 4-hour timesteps and compared to the locations of observations of enhanced C1O on subsequent days in order to compile statistics on the incidence of C1O enhancement downstream from sunlit PSCs. These parcels are also correlated to the observed behavior of MLS HNO3 and CLAES C1ONO2.

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