$ClONO_2$ behavior in the Arctic polar stratosphere revealed by the Improved Limb Atmospheric Spectrometer (ILAS) – $ClONO_2$ dependence on NO_2 -

S. Hayashida, N. Ikeda, Y. Toda
Faculty of Science, Nara Women's University
H. Irie
Frontier Research Center for Global Change
T. Sugita and H. Nakajima
National Institute for Environmental Science

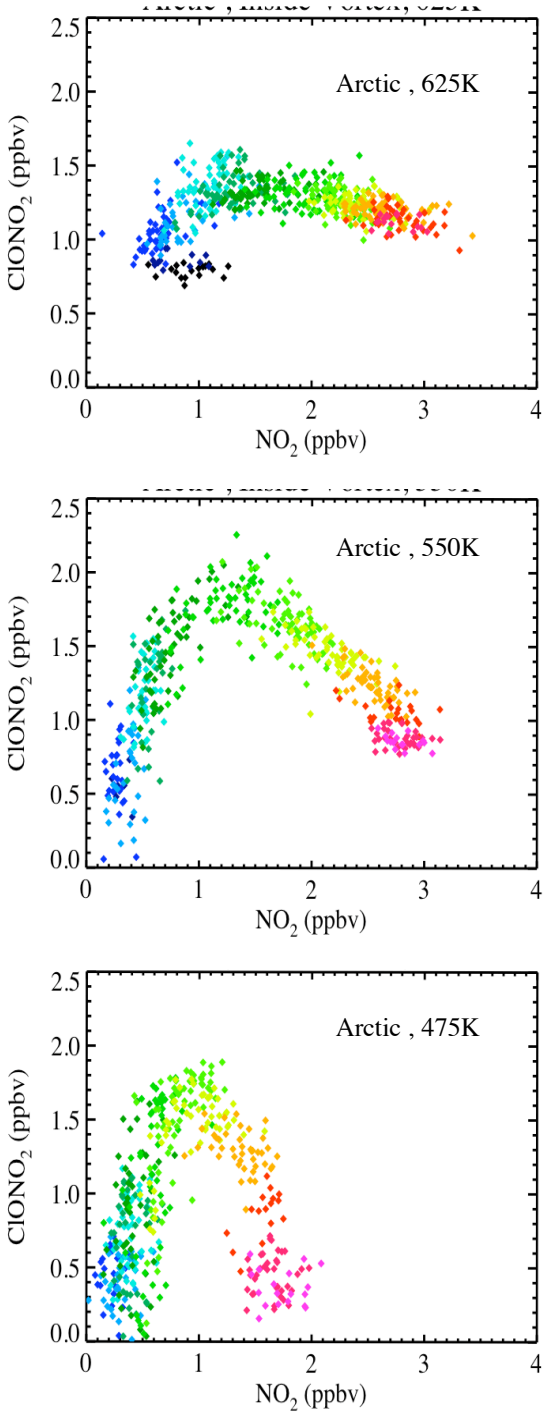
Abstract

In the past decade, there has been significant progress in understanding the ozone loss over polar regions that is caused by chemical processes. Nevertheless, uncertainties remain as to the quantitative amounts of the ozone loss. Many model studies suggest a deficiency in active chlorine species, suggesting our understanding of the partitioning of chlorine species must be improved. Further studies on activation and deactivation of chlorine species and their partitioning are called for.

The retrieval algorithm version 6.1 of the Improved Limb Atmospheric Spectrometer (ILAS) successfully derives chlorine nitrate ($ClONO_2$) profiles with other ozone-related minor species from November 1996 through June 1997 over high altitudes for both hemispheres. The $ClONO_2$ mixing ratios over Polar Northern Hemisphere indicated significant increase in February and March when solar exposure is sufficient to initiate deactivation of active chlorines. The maximum value of VMR of $ClONO_2$ reached as high as 2 ppbv at around daynumber 70 ~ 80 on 475K and ~ 65 on 550 K. However, the VMR of $ClONO_2$ does not increase monotonically but scatter largely. Some of the $ClONO_2$ values indicate even lower values than those outside the vortex: those low values suggest "reactivation" of $ClONO_2$ on newly formed PSCs as pointed out by Drdla and Shoeberl [2003].

As known by airborne measurements, $ClONO_2$ formation is NOx-limited as enough ClO is available inside the vortex. Therefore, it is expected that $ClONO_2$ VMR should have a good correlation to NO_2 VMR. Fortunately, ILAS observed NO_2 with $ClONO_2$ simultaneously. The correlation of NO_2 and $ClONO_2$ observed in the same occultation event was shown in Figure 1.

The reactivation of $ClONO_2$ via heterogeneous reaction with HCl coupled with deactivation of activated chlorines into $ClONO_2$ effectively shift chlorine partitioning toward $ClONO_2$. We confirmed the shift of the $ClONO_2$/HCl ratio according to season by applying HALOE data. This analysis is the first report from satellite observation on "reactivation" processes of $ClONO_2$ in the Arctic stratosphere.



Reference

Drdla and Shoeberl, JGR, doi:10.1029/2001JD001159,2003.