2.107 Heterogeneous uptake of N2O5 in urban and sand dust plumes observed in spring in Beijing, China: implications for parameterizations and particulate nitrate formation.

Early Career Scientist

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Abstract:

Dinitrogen pentoxide (N_2O_5) and its heterogeneous product on aerosol, nitryl chloride ($ClNO_2$), contribute to nocturnal nitrate formation and impact daytime oxidative capacity. However, ambient observations of N_2O_5 and $ClNO_2$ are still limited, which precludes full understanding of reactive nitrogen chemistry in various conditions. Here we present observations of N_2O_5 and $ClNO_2$ at a ground site in Beijing in 2017, focusing on the intercepted urban and sand dust plumes with abundant N_2O_5 and/or $ClNO_2$. High levels of N_2O_5 (up to 2.2 ppbv) were observed on May 1^{st} night due to insignificant heterogeneous loss. In comparison, $ClNO_2$ mixing ratios of up to 3.3 ppbv were frequently observed in late May in humid and chemically processed urban plumes. Significant levels of $ClNO_2$ (up to 0.7ppbv) characterized with very fast heterogeneous loss of N_2O_5 ($k(N_2O_5)$ up to $0.02s^{-1}$) were observed in a sand storm event. N_2O_5 uptake coefficient (γ) is calculated for various air masses and found more variable than that suggested by parameterizations. The observed γ is mostly linked to the ratio of aerosol volume to surface area density (V_a/S_a) but less dependent on $[H_2O]$ or water-soluble ions. Utilizing the derived uptake coefficient ($\gamma=0.027\pm0.010$) along with related data, nocturnal nitrate production rates are calculated and found correlated to observed nitrate increasing rates. In the $ClNO_2$-rich urban plumes, heterogeneous uptake of N_2O_5 results in comparable or

higher nitrate formation potential than daytime OH+NO_2 reaction. Higher NO_3 production coupled with larger proportion of N_2O_5 lost in heterogeneous uptake is responsible for more significant nocturnal nitrate production. Overall, our results indicate notable nighttime chemistry of N_2O_5 in spring time of urban Beijing and its significant contribution to particulate nitrate formation.