Development of a detection system for atmospheric NO3 and N2O5 using cavity ring-down spectroscopy

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The nitrate radical (NO3) is primarily formed via the oxidation of NOx(= NO + NO2) by ozone. Subsequently, NO3 can react with NO2 to form dinitrogen pentoxide (N2O5) reversibly.

NO3 + NO2 + M N2O5 + M (1, -1)

Both NO3 and N2O5 are removed relatively quickly during the day, while they are important primarily at nighttime. Because the reverse reaction (-1) is very strongly temperature-dependent, the concentrations of N2O5 increase as the temperature becomes colder. In arctic regions, during the winter long nights under low temperature conditions, the chemistry involving NO3 and N2O5 is activated. The NO3 radical plays an important role in the nocturnal troposphere as an oxidant, particularly for unsaturated hydrocarbons, sulfur compounds, and possibly for large branched alkenes. Additionally, tropospheric NO3 may be involved in aerosol formation. Because of the relevance of NO3 and N2O5 to a variety of chemical processes in the arctic atmosphere, accurate measurements of their ambient concentrations are of interest.

For in-situ detections of NO3, a variety of techniques such as electron spin resonance (ESR) spectroscopy [Geyer et al. 1999], laser-induced fluorescence (LIF) spectroscopy [Wood et al. 2003, Matsumoto et al. 2005], and cavity ring-down spectroscopy (CRDS) [King et al. 2000, Brown et al. 2001, 2002, Ball et al. 2001, Simpson 2003] have been utilized. We are developing an instrument for in-situ detection of NO3 and N2O5 in the ambient air, using a technique of pulsed CRDS at 662 nm. Using the standard deviation of the obtained mixing ratios, the achieved noise equivalent detection limit for sum of NO3 and N2O5 is estimated to be 1.7 pptv in a 100-s averaging period.