Characterisation and first application of a cavity ring-down instrument for measurements of NO$_3$ and N$_2$O$_5$

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A new instrument was built for atmospheric measurements using the cavity ringdown technique for a simultaneous measurement of nitrate radicals (NO$_3$) and dinitrogen pentoxide (N$_2$O$_5$) using a red laser diode at 662 nm. The instrument consists of two channels: The inlet and the cavity of the first one is heated up to 120°C to force the thermal equilibrium of N$_2$O$_5$ and NO$_3$ to the side of NO$_3$, so that this channel measures the sum NO$_3$ and N$_2$O$_5$. The other channel stays at ambient temperature to measure NO$_3$ only. To prevent aerosol extinction, a filter is installed upstream of the cavities. The detection limit is within the range of a few ppt at 1 s time resolution. Measurements have an accuracy of 15%. Instrument losses were characterized by a titration method using the conversion of NO$_3$ to NO$_2$ by adding NO. Two addition points were chosen, right before and after the NO$_3$ instrument. The NO$_2$ concentration was measured downstream of the instrument with another CRDS instrument using a blue laser diode at 405 nm. Estimated losses are within the range of 40% due to a high point loss on the used filter housing. First application took place at the SAPHIR simulation chamber at Forschungszentrum Jülich GmbH. Experiments were made by injecting known concentrations of NO$_3$ and ozone into the dark chamber filled with pure synthetic air to analyse the behavior of NO$_3$ and N$_2$O$_5$ in the clean chamber. Possible losses were estimated from the steady-state lifetime of NO$_3$, which can be calculated from measured NO$_3$, NO$_2$ and ozone concentrations. Estimated lifetimes of NO$_3$ and N$_2$O$_5$ were within the range of 19 min and 44 min, respectively. During further experiments organic compounds (isoprene, β-pinene, limonene) were additionally injected, in order to test the applicability of chamber experiments for the investigation of oxidation processes by NO$_3$. 