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雑誌名	The science reports of the Tohoku University. Fifth series, Tohoku geophysical journal
巻	36
号	4
ページ	493-493
発行年	2003-05
URL	http://hdl.handle.net/10097/45433

Tôhoku Geophys. Journ. (Sci. Rep. Tôhoku Univ., Ser. 5), Vol. 36, No. 4, pp. 493, 2003

Studying Atmospheric Chemistry Using Cavity Ring-Down Spectroscopy (Abstract)

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(Received February 17, 2003)

Cavity ring-down spectroscopy (CRDS) can provide ultra-sensitive detection of trace chemicals. In CRDS, the decay time of light within an optical cavity is measured. This optical cavity is a set of very highly reflective mirrors that allow long decay times to be achieved (often 90 microseconds). Within the decay time of 90 microseconds, the light travels 30 kilometers, affording a very long optical pathlength for absorption. The decay time is shortened by the presence of an absorber within the cavity, allowing one to measure the absorber's spectrum and quantify its concentration. We have used CRDS to detect the nitrate radical, NO_3, in the parts-per-trillion by volume mixing ratio range. The nitrate radical is of interest to atmospheric chemists, as it can oxidize molecules at night as well as providing a sink of nitrogen oxides. A significant difficulty with detecting NO_3 in the ambient atmosphere is that NO_3 is destroyed on surfaces. Therefore, we have coated our inlet and shown that NO_3 is stable on the timescale of detection in the instrument. We are currently deploying this instrument to detect NO_3. Additionally, we can thermally dissociate N_2O_5, an important nitrogen oxide reservoir species to its components, NO_2 and NO_3, in a heated inlet. In this heated inlet mode, the instrument detects the sum of ambient NO_3 and N_2O_5, thus also quantifying the amount of N_2O_5 in the atmosphere. These measurements promise to increase our understanding of nitrogen oxide chemistry.