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Quantum cascade laser based absorption spectroscopy for direct monitoring of atmospheric N₂O isotopes

Sheng Zhou^{a,b,*}, Ningwu Liu^{a,b}, Lei Zhang^{a,b}, Tianbo He^{a,b}, Jingsong Li^{a,b,*}

^aLaser Spectroscopy and Sensing Laboratory, Anhui University, 230601 Hefei, China

^bKey Laboratory of Opto-Electronic Information Acquisition and Manipulation of Ministry of Education, Anhui University, 230601 Hefei, China

Corresponding authors:

Sheng Zhou, E-Mail: optzsh@ahu.edu.cn

Jingsong Li, E-Mail: jingsong_li@ahu.edu.cn

Abstract

A compact high-resolution spectroscopic sensor using a thermoelectrically (TE) cooled continuous-wave (CW) room temperature (RT) quantum cascade laser (QCL) operating at 4.6 μm , is employed for simultaneous detection of three main isotopic species ($^{14}\text{N}^{15}\text{N}^{16}\text{O}$, $^{15}\text{N}^{14}\text{N}^{16}\text{O}$ and $^{14}\text{N}^{14}\text{N}^{16}\text{O}$). To enable a high-precision analysis of N₂O isotopic species at ambient mixing ratios, a liquid nitrogen-free preconcentration unit is built to trap and load atmospheric N₂O. The absorption spectra of $^{14}\text{N}^{15}\text{N}^{16}\text{O}$, $^{15}\text{N}^{14}\text{N}^{16}\text{O}$, and $^{14}\text{N}^{14}\text{N}^{16}\text{O}$ between 2188.6 cm^{-1} and 2189 cm^{-1} are measured, and the respective ratios of the rare to the abundant isotopologues abundances are demonstrated. Moreover, spectroscopic parameters of pressure-broadening coefficient for selected absorption lines have been determined, and a good agreement is obtained by comparing with HITRAN database.

Key words: Laser spectroscopy, QCL, Isotope analysis, Nitrous oxide

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