Impact of H_2O broadening effect on high-accuracy atmospheric trace gases detection

Jingsong Li[a,*], Hao Deng[a], Ningwu Liu[a], Zhou Shen[a], and Horst Fischer[b]

[a]*Laser Spectroscopy and Sensing Laboratory, Anhui University, 23061 Hefei, China*
[b]*Max Planck Institute for Chemistry, Hahn-Meitner-Weg 1, 55128 Mainz, Germany*

[*]*Presenting author (ljs0625@126.com)*

Unlike other atmospheric gases, the distribution of water vapor (H_2O) in the atmosphere varies with high dynamic range, which is strongly dependent on time, location, and altitude. Therefore, the broadening contribution due to water vapor mixing ratio variation would need to be known with a minimal uncertainty for high-accuracy data retrievals, especially in a humid atmosphere. In this study, a tunable quantum cascade laser spectrometer (QCLS) was developed to study H_2O broadening coefficients for CO and N_2O transitions at the 4.57 μm region which contains well-characterized and relatively isolated transitions of appropriate line strengths for sensitive gas detection [1]. The influence of H_2O broadening effect on CO R(11) and N_2O P(38e) transitions at 2186.639 cm^{-1} and 2187.099 cm^{-1}, respectively, was investigated in detail [2]. Our measurements indicate that H_2O broadening coefficients are 1.8 and 1.9 times higher than the corresponding air-broadening parameters, respectively. Based on the experimental data, our simulation confirmed that the WMS-2f shapes of CO and N_2O lines will be significantly affected by variations of the water vapor mixing ratio, while no significant dependence on target concentration, and prove that the difference between air- and H_2O-broadenings thus cannot be neglected if one wants to measure gas concentrations in a high humid environment with a sub-percent precision.

References

[1] Li, J. S., H. Deng, J. Sun, B. L. Yu, and H. Fischer, 2016: Simultaneous atmospheric CO, N_2O and H_2O detection using a single quantum cascade laser sensor based on dual-spectroscopy techniques. *Sens. Actuat. B* **231**, 723–732.

[2] Deng, H., J. Sun, N. W. Liu, H. Wang, B. L. Yu, and J. S. Li, 2017: Impact of H_2O broadening effect on atmospheric CO and N_2O detection near 4.57 μm. *J. Mol. Spectrosc.* **331**, 34–43.

Preferred mode of presentation: Poster