DEMONSTRATION OF A RAPIDLY-SWEPT EXTERNAL CAVITY QUANTUM CASCADE LASER FOR ATMOSPHERIC SENSING APPLICATIONS[a]

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The application of quantum cascade lasers (QCLs) in atmospheric science for trace detection of gases has been demonstrated using sensors in point or remote sensing configurations. Many of these systems utilize single narrowly-tunable ($\sim$10 cm^{-1}) distributed feedback (DFB-) QCLs that limit simultaneous detection to a restricted number of small chemical species like H_2O or N_2O. The narrow wavelength range of DFB-QCLs precludes accurate quantification of large chemical species with broad rotationally-unresolved vibrational spectra, such as volatile organic compounds, that play an important role in the chemistry of the atmosphere. External-cavity (EC-) QCL systems are available that offer tuning ranges greater than 100 cm^{-1}, making them excellent IR sources for measuring multiple small and large chemical species in the atmosphere. While the broad wavelength coverage afforded by an EC system enables measurements of large chemical species, most commercial systems can only be swept over their entire wavelength range at less than 10 Hz. This prohibits broadband simultaneous measurements of multiple chemicals in plumes from natural or industrial sources where turbulence and/or chemical reactivity are resulting in rapid changes in chemical composition on sub-1s timescales.

At Pacific Northwest National Laboratory we have developed rapidly-swept EC-QCL technology that acquires broadband absorption spectra ($\sim$100 cm^{-1}) on ms timescales. The spectral resolution of this system has enabled simultaneous measurement of narrow rotationally-resolved atmospherically-broadened lines from small chemical species, while offering the broad tuning range needed to measure broadband spectral features from multiple large chemical species. In this talk the application of this technology for open-path atmospheric measurements will be discussed based on results from laboratory measurements with simulated plumes of chemicals. The performance offered by the system for simultaneous detection of multiple chemical species will be presented.

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