Atmospheric ammonia measurements using an external cavity-quantum cascade laser-based sensor

Lancee Griggs, Rafael Ermeski, Robert Griffin, and Frank Turner
Rice University, CEER Department, 6100 Main St, Houston, TX 77005, USA
Rice University, CEER Department, 6100 Main St, Houston, TX 77005, USA

August 2, 2013
Rice University
Houston, TX

Motivation

- Ammonia (NH₃) plays a significant role in atmospheric chemistry,
  - Particulate matter pollution (e.g., (NH₄)₂SO₄, NH₄NO₃)
- In urban areas, industrial and motor vehicle activities can contribute to increases in atmospheric ammonia levels.
  - Typical range: 0.1-10 ppb


Laser source and NH₃ absorption line selection

NH₃ sensor architecture

NH₃ data output

Sensor deployment at north Moody Tower
Field scenes

Preliminary results

Diurnal trend of atmospheric NH₃ concentration

Hour of day
February 12, 2010 - March 1, 2010

Preliminary results (cont.)

Diurnal trend of atmospheric NH₃ concentration

Hour of day
May 28, 2010 - July 6, 2010

Preliminary results (cont.)

NH₃ vs Total PAR

Hour of day
May 28, 2010 - July 9, 2010

Preliminary results (cont.)

Dependence of NH₃ concentrations on wind direction

Conclusion

- A 10.4 μm EC-QCL based NH₃ sensor, employing conventional photo-acoustic spectroscopy, was demonstrated.
- Minimum detection limit, obtained for the NH₃ absorption line at 965.35 cm⁻¹, reached sub-ppb concentration levels.
- The NH₃ sensor is capable of unattended operation with continuous data acquisition for extended periods of time.
- Remote access via internet, enabling real-time monitoring of the sensor performance was established.
- Environmental data acquired by NH₃ sensor, installed on the 200-foot-high Moody Tower roof, were used together with meteorological parameters to characterize the dynamic of atmospheric NH₃.
- Particle composition data from an Aerodyne high-resolution time-of-flight aerosol mass spectrometer (AMS) will be used to better understand the importance of NH₃ with respect to air quality.
- NH₃ measurements at ground level will be performed when the laser sensor is installed at surface facilities.