Simultaneous measurements of atmospheric ammonia and particle number concentrations in Houston, TX

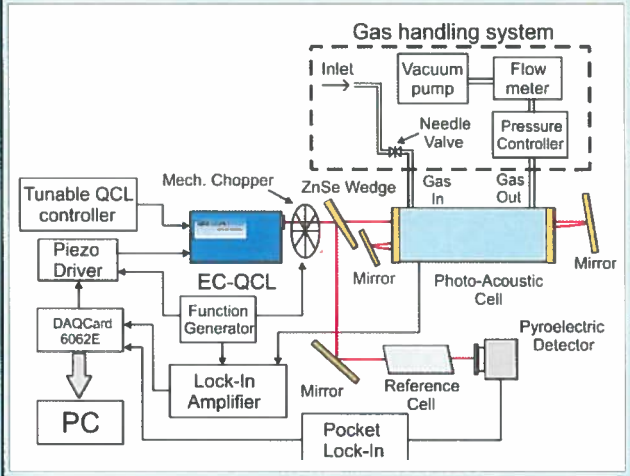
Briana Foxworth[1,2], Rafał Lewicki[1], Longwen Gong[2], Frank Tittel[1], Robert Griffin[2]
1-Rice University, ECE Department, 6100 Main St., Houston, TX 77005, USA
2-Rice University, CEVE Department, 6100 Main St., Houston, TX 77005, USA

Introduction

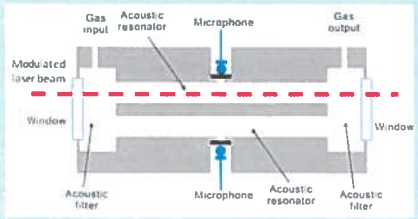
An abundance of natural and anthropogenic ammonia (NH_3) sources form the basis for the creation of ammonium salts (e.g., $(NH_4)_2SO_4$). These salts largely contribute to the formation of particulate matter (PM). Increased rates of respiratory and cardiovascular illness as well as increased morbidity and mortality rates can arise from exposure to PM [1]. NH_3 is currently not regulated under the National Ambient Air Quality Standards by the United States Environmental Protection Agency and little is known about atmospheric NH_3 levels in urban areas.

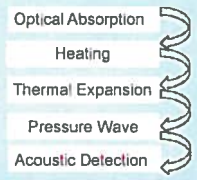
NH_3 is also often not considered when modeling aerosol nucleation and growth. Monitoring particle number concentrations alongside NH_3 allows the effect of NH_3 on new particle formation to be investigated.

NH_3 Sensor Configuration



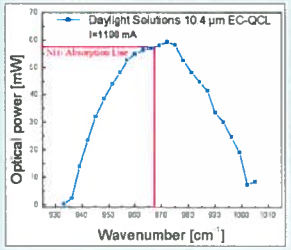
Amplitude Modulation Photo-Acoustic Spectroscopy

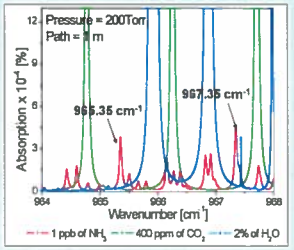




[2]

Laser Power and Absorption Line





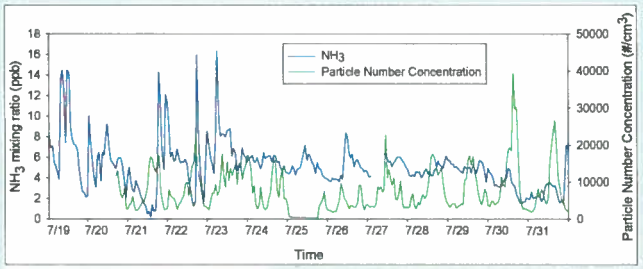
Daylight Solutions 10.4 μm EC-QCL

Optimal line at 967.35 cm^{-1}

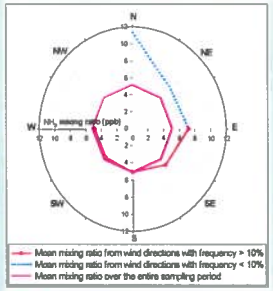
Tunable range from 933 to 1006 cm^{-1}

Maximize laser power
Maximize absorption line signal
Minimize effect of CO_2 and H_2O

Results

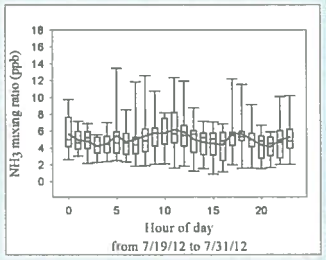


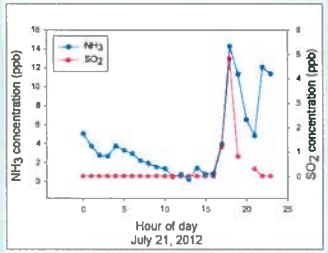
Comparison between NH_3 and particle number concentration time series 7/19/12-7/31/12



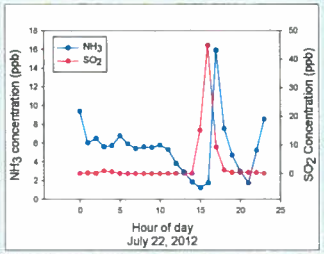
Left: Dependence of NH_3 on wind direction

Right: Diurnal profile of atmospheric NH_3 levels





Correlation between NH_3 and SO_2 as well as wind direction suggests the co-emission from a point source (coal-fired power plant)



Conclusions

The NH_3 sensor was successfully deployed atop the North Moody Tower at the University of Houston and the continuous data collection is currently underway.

In the future an extended NH_3 dataset, meteorological parameters, and other air pollutants measured by a TCEQ CAMS will be incorporated into data analysis in order to further examine the effect of NH_3 on local and regional air quality with respect to PM formation.

[1] Schwartz, J., Dockery, D.W., and Neas, L.M. "Is Daily Mortality Associated Specifically with Fine Particles?" Journal of Air & Waste Management Association 46, 927-939 (1996)
[2] Gong, L., Lewicki, R., Griffin, R. J., Flynn, J. H., Lefer, B. L., and Tittel F. K. "Atmospheric ammonia measurements in Houston, TX using an external-cavity quantum cascade laser-based sensor" Atmospheric Chemistry and Physics 11, 9721-9733 (2011)

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