Project Bulletin

CICEET

Rapid Field Measurement of Airborne Ammonia/Ammonium

Challenge

Atmospherically derived nitrogen can represent a significant fraction of the total nitrogen budget in East Coast estuaries. This pollution is primarily caused by fossil fuel emissions of nitrogen oxide and nitrogen dioxide (NOx), and volatilized ammonium and ammonia from animal waste (from agriculture and fertilizers). While a variety of commercial sensors exist for NOx species, ammonia and ammonium sensing still requires relatively slow sampling procedures that make it difficult to manage nitrogen inputs and apportion the source of airborne nitrogen pollution.

Science

Approach

The goal of this project is to develop a field instrument that reduces sampling time for particle-phase ammonium and gas-phase ammonia. (Discrete sampling—taking samples in the field and doing the analysis in the lab—can take 12-24 hours.) Researchers accomplished this by looking at newly available technologies that speed up sampling times, designing methods for integrating these techniques into a field-deployable unit and testing the accuracy of the prototype against other methods.

Design

The final design uses a two-channel flow-through mist chamber to collect both gas-phase and particle-phase nitrogen. One of the channels has a scrubber that removes the gas-phase ammonia, so that the gas-phase portion can be obtained by subtracting the particle-phase portion from the total. The sample is then converted into an aqueous stream, which is then analyzed using standard colorimetric methods. The unit is relatively compact and can be set up in a van (see photo at right) to increase mobility.

Results

- The resulting instrument has demonstrated the ability to provide accurate results at a rate of 8-10 minutes per sample.
- Tests of the instrument near a dairy barn showed that the nitrogen concentration could vary by an order of magnitude with slight changes in wind, underscoring the need for a sub-hourly sampling system.

Application

EPA Funds Further Application

The instrument developed for this project caught the eye of the EPA, which has funded the researchers to use the device to measure ammonia emissions from agricultural systems as well as urban areas.

How Does the Instrument Compare?

The 8-10 minute sampling time is much faster than the 12-24 hours needed for discrete sampling. Some technologies are equal to or faster than this newly developed device. However, this instrument measures particulate-phase ammonium in addition to gas-phase ammonium, which alternative technologies do not.

Adapting the Instrument for Other Nitrogen Species

Researchers believe that the device could be used to measure nitrate/nitrite by changing the analytical system to one based on long pathlength absorbance spectroscopy .

Project Essentials

Title: Development and Application of a Rapid and Robust Sensor to Determine Nitrogen Species in the Coastal Atmosphere

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