

Measurement of Ammonia in Ambient Air using Photoacoustic Spectroscopy

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Introduction

Ammonia is a relevant atmospheric pollutant. Deposition of gaseous ammonia and ammonium aerosol through dry and wet deposition contributes to both acidification and eutrophication of ecosystems. Ammonia has a relative short atmospheric lifetime and is deposited fairly close to its sources. Ammonia is able to neutralize acids and forming particulate ammonium, which can be transported over long distances.

In order to assess the effects of reduction measures, as well as to study the role of ammonia on secondary aerosol formation processes, accurate and reliable measurement systems for ambient ammonia are needed. The measurement systems are required to allow unattended long-term operation.

Method

A commercial photoacoustic (PA) system with sub-ppb detection limit is used for long-term measurement of ambient ammonia (TGA310, Omnisens SA, Switzerland). The set-up of the instrument is shown in Figure 1 and described in Schilt et al. (2004).

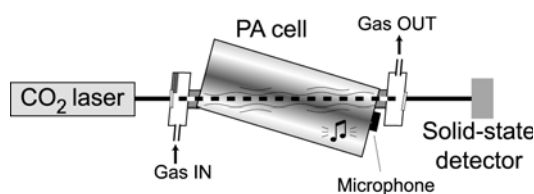


Figure 1: Schematic representation of the PA instrument (TGA310, Omnisens SA, Switzerland).

To account for the signal of interfering species (i.e. H_2O , C_2H_4 , CO_2 , and NH_3 resulting from thermal dissociation of ammonium nitrate), the measurement set-up shown in Figure 2 is used. The set-up consists of two sampling lines (sample and reference line). The two sampling lines are identical, except that the reference line includes a citric acid coated diffusion denuder for selective removal of NH_3 . A multi-channel sampling system (MS system) is used to switch between the two sampling lines. The ambient NH_3 concentration is derived from the difference of consecutive measurements of NH_3 in the reference and sample line.

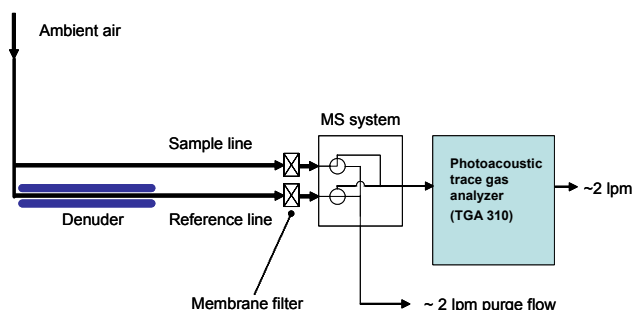


Figure 2: Set-up for measurement of ambient NH_3 .

Reference

Schilt, S., Thévenaz, L., Niklès, M., Emmenegger, L., Hueglin, Ch. (2004). Ammonia monitoring at trace level using photoacoustic spectroscopy in industrial and environmental applications. *Spectrochimica Acta Part A* 60: 3259-68.

Acknowledgement

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Results

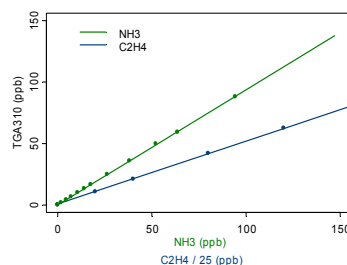


Figure 3: Linearity of the photoacoustic trace gas analyzer for NH_3 and C_2H_4 . The interference to C_2H_4 is used to calibrate the instrument.

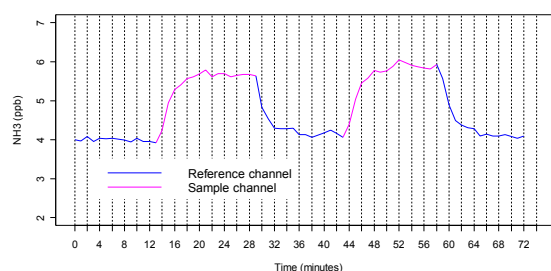


Figure 4: Two measurement cycles (15min reference channel and 15min sample channel per cycle) of ambient NH_3 in Duebendorf, Switzerland (March 2005).

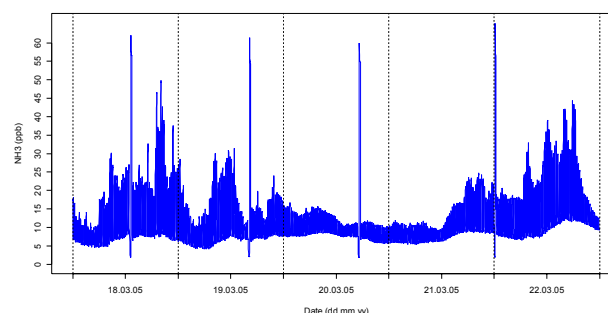


Figure 5: Instrument signal (in ppb NH_3 ; continuously switching between reference and sample line) during five days of ambient NH_3 measurements at Haerkingen, Switzerland (rural site type but 30 meters north of major highway). Sampling time for each channel is 10 minutes. The bottom of the blue area indicates the variation of the reference channel, the sharp vertical signals are automatic calibrations with C_2H_4 .

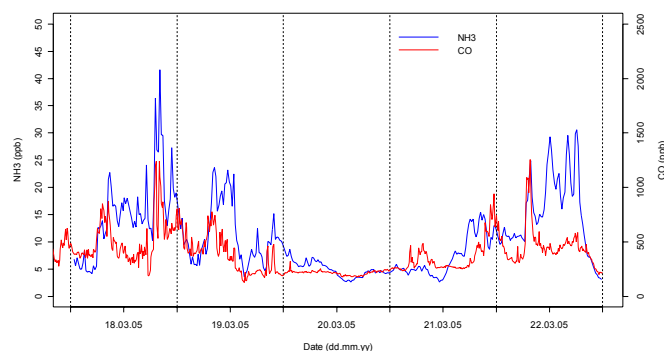


Figure 6: Ambient NH_3 concentrations derived from the data shown in the above figure. The similarities between the NH_3 and CO signals indicate that the ambient NH_3 level was influenced by emissions from the nearby road traffic. At 20.03.05 winds were arriving from the northern sector. During this period, the measurement site was representative for the rural parts of the Swiss plateau.