A SIMPLE PASSIVE SAMPLER FOR MEASURING AMMONIA EMISSION IN THE FIELD

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Abstract. A new type of passive sampler for the determination of NH$_3$ emission from land surfaces and manure storages was tested in a micrometeorological mass balance method. The sampler consists of 2 glass tubes, each with a length of 10 cm and an internal diameter of 0.7 cm. The two glass tubes are connected in series, with one end fitted with a thin stainless steel disc having a 1 mm hole in the center. The inner surface of each glass tube is coated with oxalic acid. The results show that the passive flux sampler can be used to give accurate determinations of NH$_3$ emission. The passive flux sampler makes gas washing bottles, pumps, flow meters, anemometers, and electricity unnecessary and ammonia loss can be determined easily and cheaply without the requirement of a large labor force.

1. Introduction

Ammonia is a major air pollutant. The principal sources of atmospheric NH$_3$ are generally concluded to be animal manure and N fertilizers. Ammonia that enters the troposphere is readily transferred from the air into acid cloud droplets, neutralizing acidity by accepting H$^+$ to form NH$_4^+$. Removal of NH$_4^+$ and NH$_3$ from the atmosphere takes place by wet and dry deposition. Close to sources, dry deposition of NH$_3$ is the most important removal process, while at greater distances wet removal of particulate NH$_4^+$ aerosols is most important. The deposited NH$_3$/NH$_4^+$ contributes to several undesirable environment changes like acidification and eutrophication of oligotrophic ecosystems (Schulze et al., 1989).

Estimates of NH$_3$ emission are still very uncertain. In order to improve the estimates there is a great need for data on NH$_3$ volatilization from manure storages and from manure and fertilizers applied to the surface of agricultural land. Furthermore, very few results are available on the emission of NH$_3$ from the foliage of agricultural crops.

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Ammonia volatilization is strongly influenced by air temperature and wind speed. The frequently used chamber technique alters the microclimatic conditions and may give incorrect estimates of NH₃ emission (Ferm, 1983; Ferguson et al., 1988). Instead, wind-tunnels (Vallis et al., 1982; Thompson et al., 1987; Sommer and Olesen, 1991) or micrometeorological techniques (Beauchamp et al., 1982; Brunke et al., 1988) have to be used. A disadvantage is that both wind-tunnels and micrometeorological methods require expensive instrumentation and a large labor force. In addition, micrometeorological measurements based on energy balance or aerodynamics require extensive and uniform land areas. Such requirements are not necessary in micrometeorological measurements based on mass balance (Denmead, 1983). Hence, mass balance methods are suitable for measuring NH₃ emissions from smaller plots.

The requirement for a large labor force in the micrometeorological mass balance methods has partly been overcome by development of the ZINST mass balance approach (Wilson et al., 1983) and the ‘theoretical profile shape solution’ (McInnes et al., 1985). By application of these simplified methods, NH₃ emission (vertical NH₃ flux density) can be determined from measurements of horizontal NH₃ flux in one height only. The nearby surroundings must be uniform and it is assumed that the flux of NH₃ from the surroundings into the area is negligible. The suitability of the ZINST method for determination of NH₃ loss from manure applied on a circular area has recently been demonstrated by Sherlock et al. (1989). In their study, the horizontal NH₃ flux was measured by a rotating sampler, automatically aligning its opening to the wind direction (Leuning et al., 1985).

The purpose of the present work was to test a new, simple, non-rotating sampler for measuring horizontal NH₃ fluxes in the atmosphere (product of NH₃ concentration, wind speed and cosine of the angle between wind direction and axis of the sampler). The sampler has the potential advantages of being easy to operate, no climatic variables have to be measured, no electricity is needed, and there are no specific restrictions to the surroundings of the experimental area. An additional advantage is that NH₃ emissions may be integrated over long periods.

2. Materials and Methods

2.1. Experimental area

The experimental area in experiment 1 was a square with a side length of 21 m. In the rest of the experiments, the experimental area was a circle with an area of 707 m² (radius 15 m). The NH₃ source consisted of 140 flat beakers (diameter 15 cm, height 3 cm), evenly distributed on the experimental area and containing an (NH₄)₂SO₄ solution. The experiments were started by adding a NaHCO₃/Na₂CO₃ solution to the beakers. The total volume of the solution was 0.5 L with a NH₄⁺ concentration about 1 M. The pH of the solution was initially 8.5 to 9.0 and dropped during the experiments to around 8.0 (Table I). The amount of NH₃ volatilized