G.J. Heij and J.W. Erisman (Editors). Acid Rain Research: Do we have enough answers?

The measurement of ammonia in the National Air Quality Monitoring Network (LML): (2) results and performance

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1. introduction

Since August 1992 ammonia (NH_3) concentrations have been measured at 8 locations in the National Air Quality Monitoring Network (LML) using instrumentation and network configurations as described in references 1 and 2.
This paper gives a general overview of:

a. the measurement results of the LML - stations (network configuration 1992-1993)
b. the representativeness measurements carried out with a mobile van in the surroundings of the LML stations
c. quality assurance and control
d. operational performance.

2. measurement results

network

Table 1 summarises the results (average, maximum and several percentile values) for each measurement location for the period August 1992 to July 1993 to give an impression of NH_3 concentration levels in the Netherlands. Since May 1994, the stations at Lunteren and Leiduin have been replaced by Wekerom and De Zilk respectively, and so for these last 2 locations, measurement results over a whole year are not yet available.
It can be noted that some stations show different concentration levels, as could be expected from the initial classification (emission, average or background).

For ammonia, local disturbances can cause these differences fairly easy. Witteveen, for example, is a station located in a forest, while Zegveld is probably influenced by cows grazing nearby. Evaluation of this, with the help of the representativeness measurements in the vicinity of the locations (discussed below), is necessary for correct interpretations.

Table 1
Measurement results based on 1-hour average concentrations for the period August 1992 to July 1993

station	average ($\mu g/m^3$)	max ($\mu g/m^3$)	percentile values ($\mu g/m^3$)					
			50	70	90	95	98	99.9
emission areas:								
Vredepeel	18.5	256	12	21	47	63	90	162
Lunteren	23.5	428	17	26	47	62	85	155
Eibergen	11.8	236	9	13	22	31	47	129
average areas:								
Zegveld	11.2	252	7	12	24	35	55	167
Witteveen	2.7	34	2	3	6	9	13	26
background:								
Huijbergen	3.3	37	2	4	8	10	14	25
Wieringerwerf	5.6	346	3	6	12	18	28	188
Leiduin	2.4	41	1	2	7	10	14	34

Figure 1 shows the variation in the monthly average concentrations during one year in a high emission-density area (Eibergen station). September and March show the highest monthly concentrations, reflecting the (beginning of the) manure application to the fields.

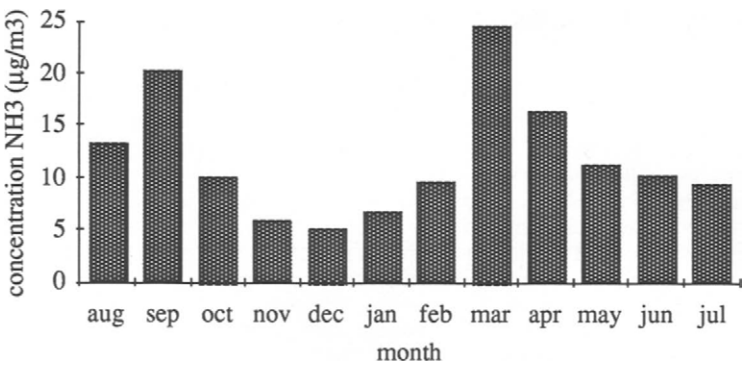

Figure 1. Monthly variation of NH_3 at Eibergen station (period 8-92 to 7-93).

The diurnal variations can be of special importance for modelling purposes. In Figure 2 this variation is plotted for Vredepeel and Witteveen stations.

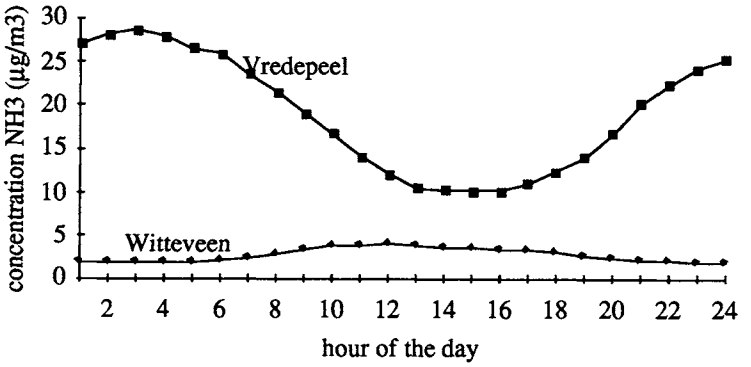

Figure 2. Average diurnal variation (period 9-92 to 7-93).

Figure 2 shows that this diurnal variation can be complete inversed due to several phenomena (for instance, meteorologics), which are not always easy to interpret.

representativeness measurements

As stated before, these measurements, which are carried out with a mobile van, are necessary to interpret the continuous measurements at the LML stations and especially the relation with concentration levels in the surroundings (5 x 5 km^2). Modelling is carried out on this scale. The representativeness measurements are scheduled to be carried out under different meteorological conditions. In total, 16 classes with different temperatures, wind speed and wind direction are defined (3). Figure 3 presents the results of just one representativeness measurement, for the Eibergen station (November 3 1993).

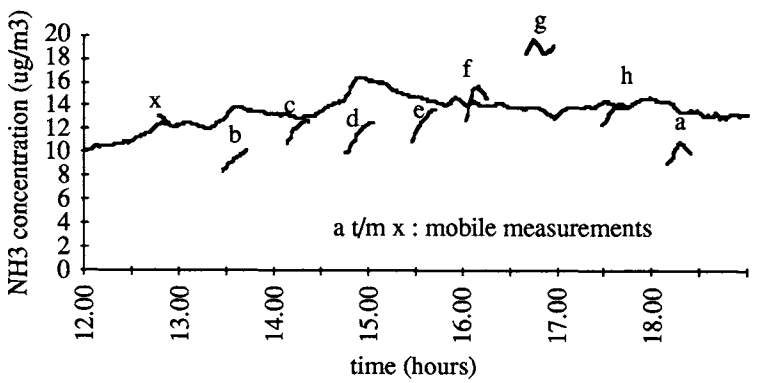

Figure 3. Representativeness measurement at Eibergen (Nov. 3 1993).

The concentrations measured at each van location are plotted against the concentration of the LML - station at the same time. Measurement *x* is the mobile measurement taken as close as possible to the LML station. Note: 1) the good agreement of this measurement with the LML station and 2) the sometimes neglected stability time for the mobile measurements. Typical measuring time at a mobile-van location is in effect only 15 min for several reasons (2).

Interpretation of these measurements turns out to be very difficult because, for instance:
- measurements can't be carried out frequently during the whole year because of the substantial personnel capacity needed
- measurements are carried out only during daytime (for the same reason).

For this, alternative measuring methods, preferably continuous in time, simple and low cost have to be investigated.

3. quality - assurance and control

quality assurance

Quality assurance is obtained by:

* using only standard operating procedures in the field as well as in the laboratory.
* validation procedures carried out for each single weekly data file. This validation includes the comparison of calibration data at the beginning and end of the measurement period, increase or decrease of air and liquid flows, condition of pumps, valves etc. A special software package was developed for this.
  Because of the previously mentioned experimental set-up of the equipment, this validation has to be carried out manually (however, computer-supported), thus requiring another person to check this validation.

quality control

Quality control is organised as follows:

* checking calibration liquids at an independent laboratory.
* checking response in the field with an NH_3 calibration device (2).
* comparison with another instrument.
  For this, a continuous-flow wet denuder is installed in a measuring van positioned as close as possible to the LML - station. This is done frequently for all stations of the network. Results are shown in Figure 4.

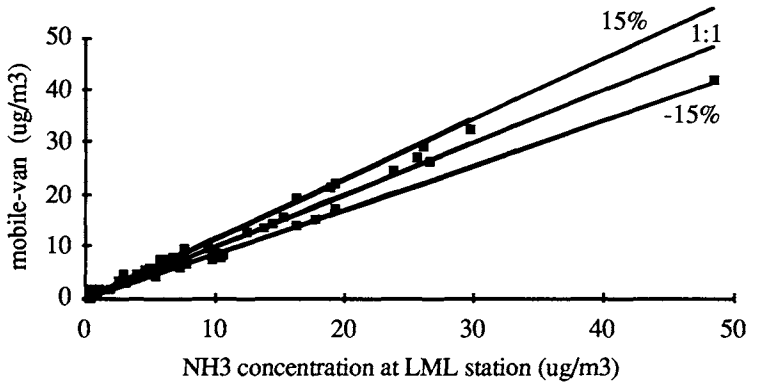

Figure 4. Quality control measurements (all stations).

Intercomparabilities are within 15% ($C > 10\ \mu g/m^3$) or $< 1.5\ \mu g/m^3$ ($C < 10\ \mu g/m^3$).

4. operational performance

Figure 5 shows the monthly availability of the (1-min) measurement data averaged over the 8 network locations.

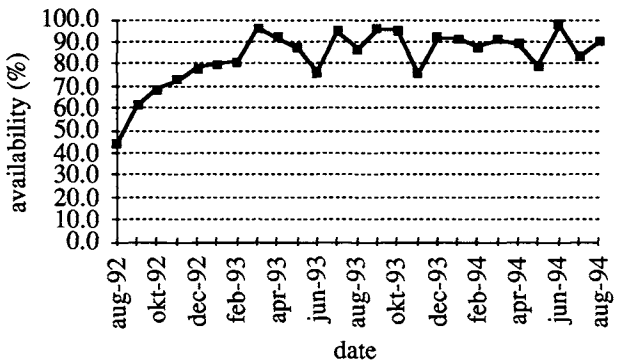

Figure 5. Monthly availability of NH_3 measurement data (all stations).

It can be seen that during the first 6 months of the interim network the availability increases from 50 to 80%, mainly due to improvements which could be made to the instruments.

Although the equipment used is experimental, the operational set-up with frequent visits to the LML - stations, use of the standard operating procedures and, last but not least, the employment of qualified personnel for maintenance etc. yields fairly satisfactory results. From February 1993 the average availability has been about 90% with a variation of about 10%, most often caused by just one station which performs less adequately during a certain period. One has to take into account that there is no continuous on-line control of these instruments in contradistinction to the automated equipment for other air pollutants in LML. Therefore the average availibility of 90% is high compared to the performance of the fully automated equipment (95-98%), taking into account the experimental set-up and complexity of the continuous-flow wet denuder. The availability will even increase with the anticipated implementation of less experimental equipment at the beginning of 1995 (1).

5. references

1 B.G. van Elzakker, E. Buijsman, G.P. Wyers and R. Otjes, The measurement of ammonia in the National Air Quality Monitoring Network (LML): (1) instrumentation and network set up (this volume)

2 B.G. van Elzakker, J. Aben, J.W. Erisman and M.G. Mennen, Het Interim Meetnet Ammoniak, RIVM rapport 723101008 (in prep.)

3 G.M.F. Boermans and J.W. Erisman, Meetstrategieontwikkeling voor het representativiteitsonderzoek als onderdeel van het additioneel meetprogramma ammoniak; fenomenologie van NH_3 en meetritsimulaties, RIVM report 222105001, September 1990