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Linking ammonia emission reduction and air concentrations and depositions of reduced nitrogen in Europe

A. Bleeker

M. Sutton (CEH)

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ECN

Energy research Centre of the Netherlands

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Albert Bleeker & Mark Sutton

ECN (Netherlands) & CEH (UK)

Outline

- Background of this (trends) study

- Results previous trends study
  - Data on emissions and concentrations/depositions
  - Conclusions drawn
- What happened since that study?
  - Did it bring new insights?

Background of this trends study

- Builds on previous study by Sutton et al. (2000)
  - Background document for the UN/ECE Ammonia Expert Group (AEG)
- Reason for update of the ‘old’ study
  - Additional 5 years of information
  - New studies on emission/concentration/deposition relations
- Input to new background document to be presented at the December meeting of UN/ECE AEG

Why is this study important?

- Emission/transport/deposition of reduced nitrogen (NH_x; NH_3 and NH_4^+) will eventually lead to eutrophication and acidification of ecosystems and contribute to local air quality
- Recognizing this, together with the transboundary nature of the problem, the UN/ECE developed protocols on:
  - Limiting NH_3 emissions
  - Reducing SO_2, NO_x and VOC concentrations
  - Setting national emission ceilings to be reached in 2010 (Gothenburg Protocol, 1999)
- In parallel: European Union agreed on the 'National Emissions Ceilings Directive (NECD)', setting targets for e.g. NH_3 emissions binding in European Law.

Why is this important ? (II)

- Evidence needed for effective NH_3 emission reduction:
  - Achievable
  - Measurable
- NH_3 emissions mainly from agricultural sources, thus:
  - Abating NH_3 will be in agricultural sector
    - Reduction in animal numbers
    - Reducing fertilizer consumption
    - Implementing technical measures
- Since reducing sector activity was not an option, there is a need to demonstrate the effectiveness of technical measures

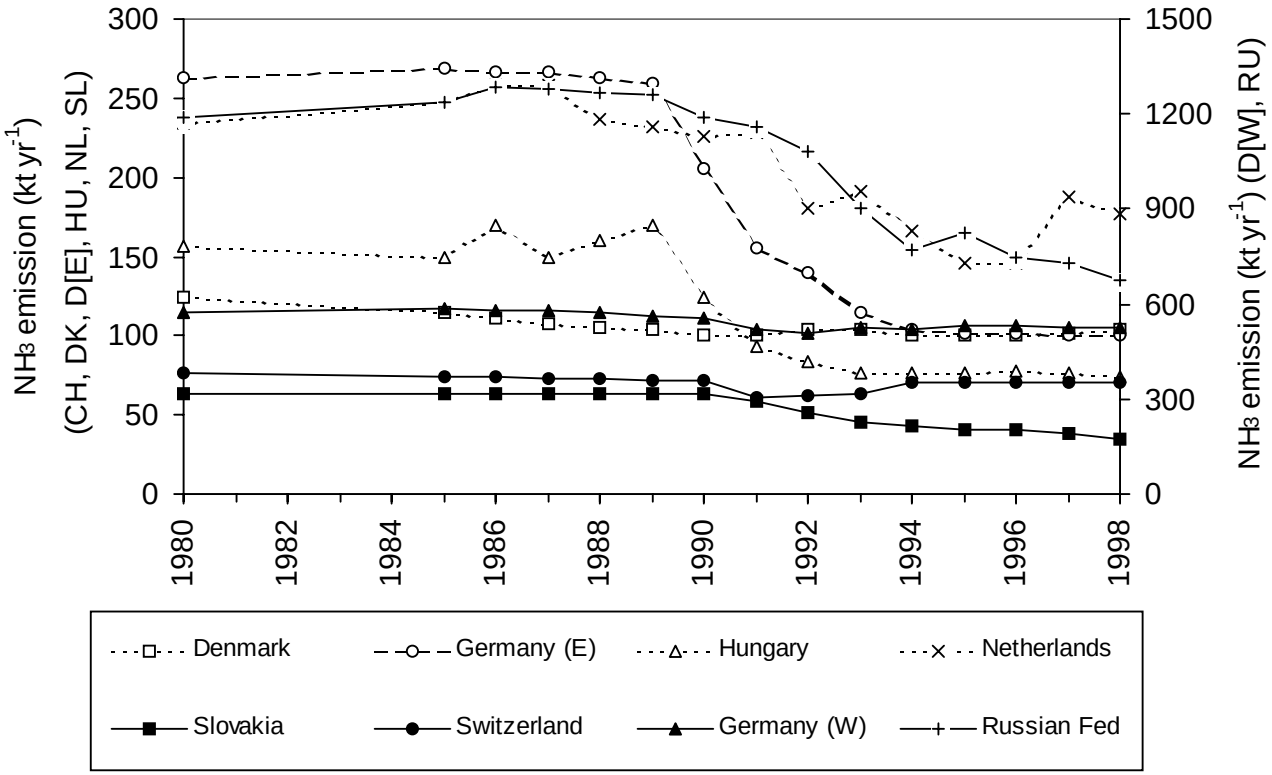
Challenges

- Quantify the link between NH_3 emission changes and monitored atmospheric NH_x in situations where emissions have definitely changed
  - Note: not only NH_x issue. Many questions regarding linearity between SO_2 and NO_x emissions and NH_x concentrations
- Assess the effectiveness of NH_3 emission abatement policies

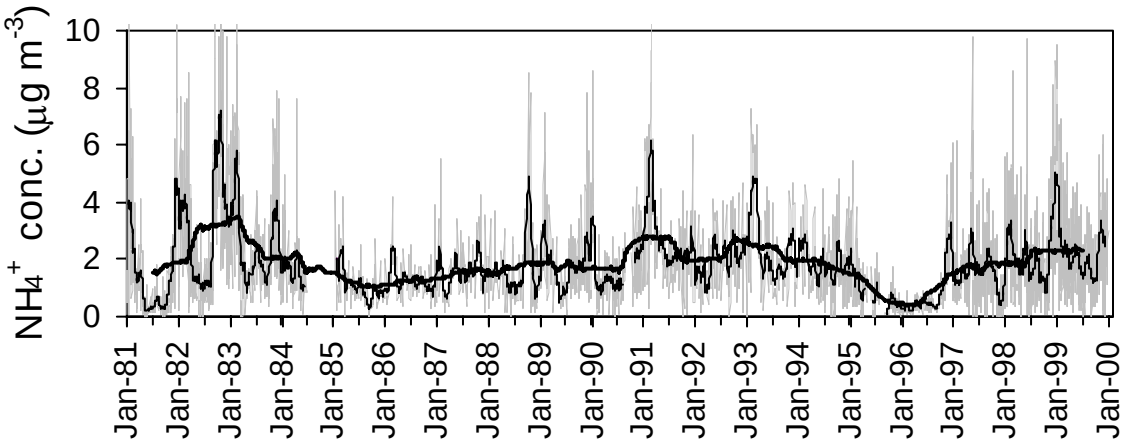
What has been done?

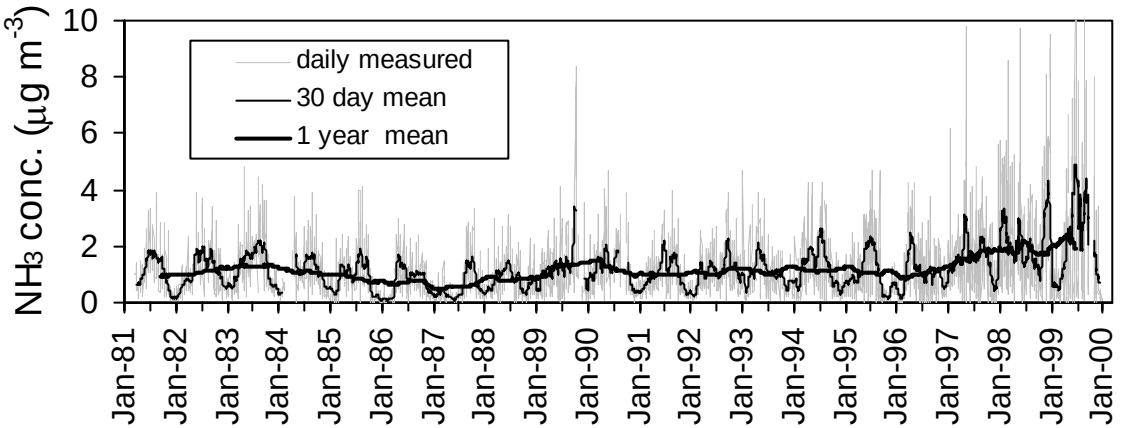
- 2000 trends study brought together information about the link between NH_3 emission and measurements (concentration and deposition) from different case studies:
  - link between agr. sector activity and atm. NH_x
    - Hungary, Slovakia, Former East & West Germany, Russia, Switzerland & North Carolina
  - link between NH_3 emission abatement and atm. NH_x
    - Netherlands
    - Denmark

Emissions: are they true?

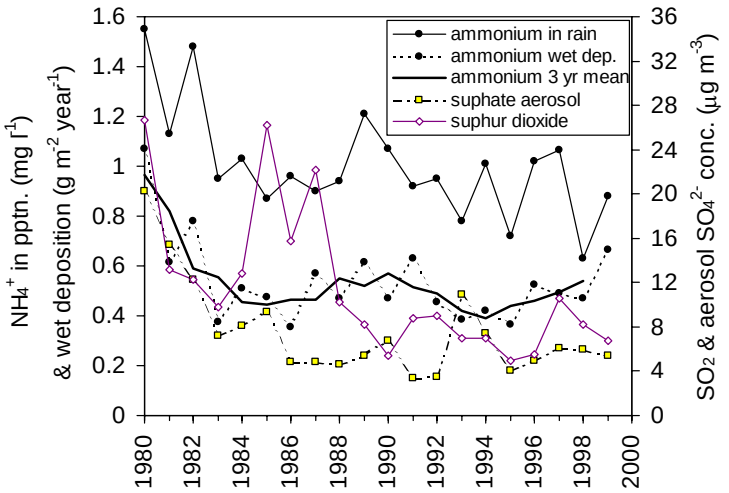


Hungary

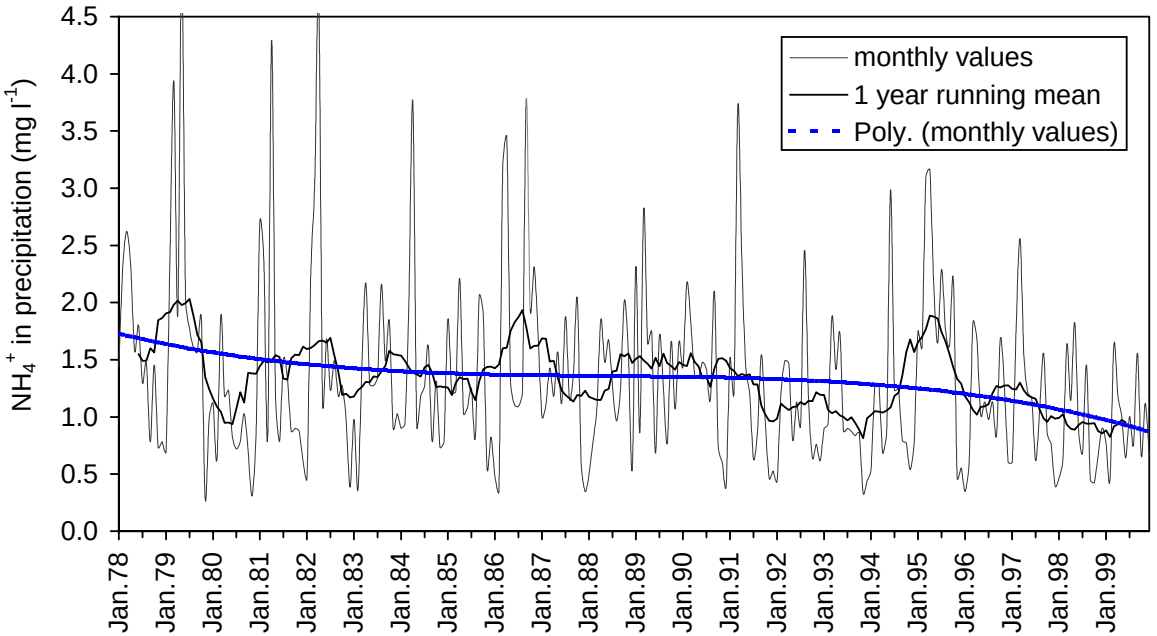




- 53% emission reduction
- no clear trend in either NH_4 or NH_3

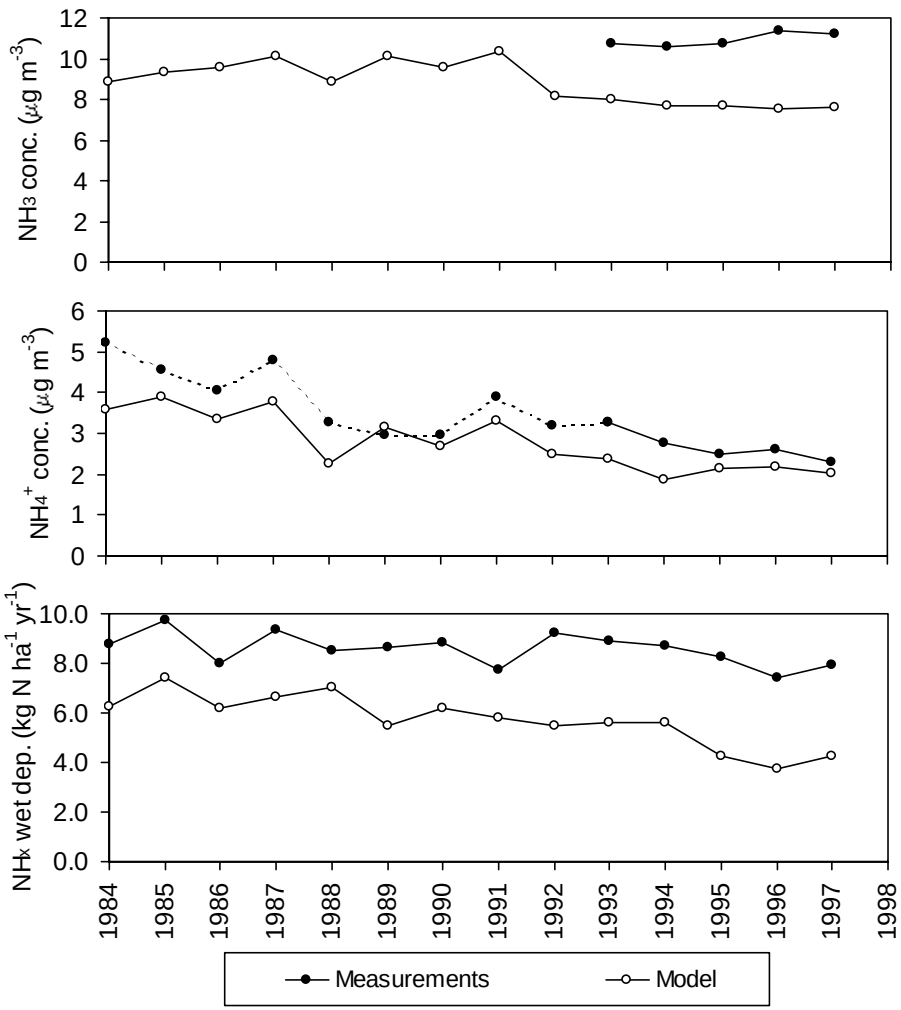


Slovakia



- 44% emission reduction
- ~20% reduction of NH_4 between 1990-1999

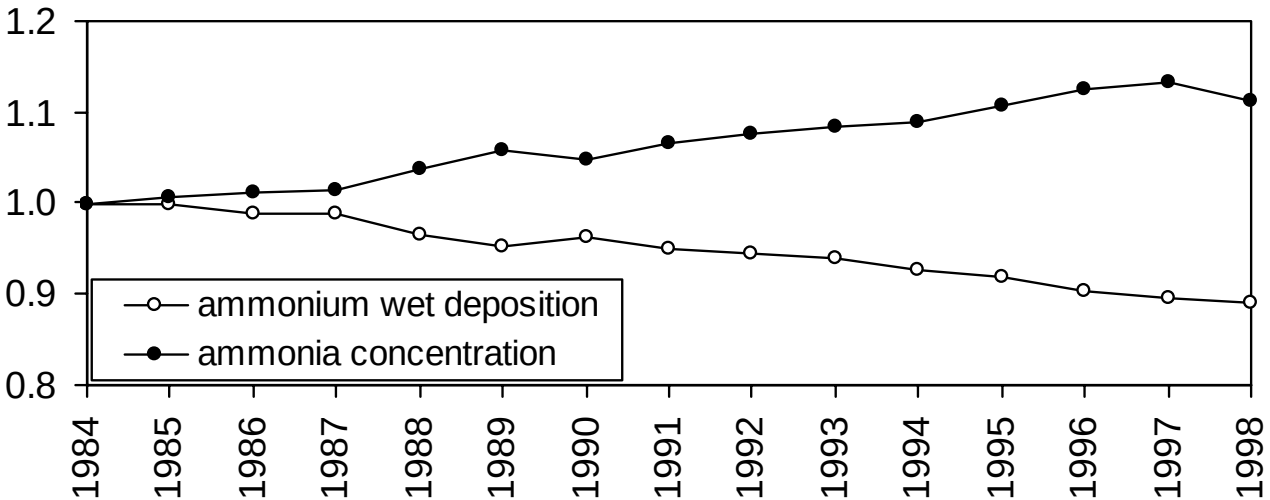
Netherlands



- 35% emission reduction
- 10% reduction NH_4 wd
- 29% reduction NH_4 aerosol

- Again: part of the explanation - parallel changes in SO_2 and NO_x emission
- But also: overestimation of effectiveness of measures

Netherlands – effect of changing SO_2 and NO_x



- 1984 SO_2 and NO_x emissions and actual emissions
- increase in NH_3 conc. and decrease in NH_4 wd

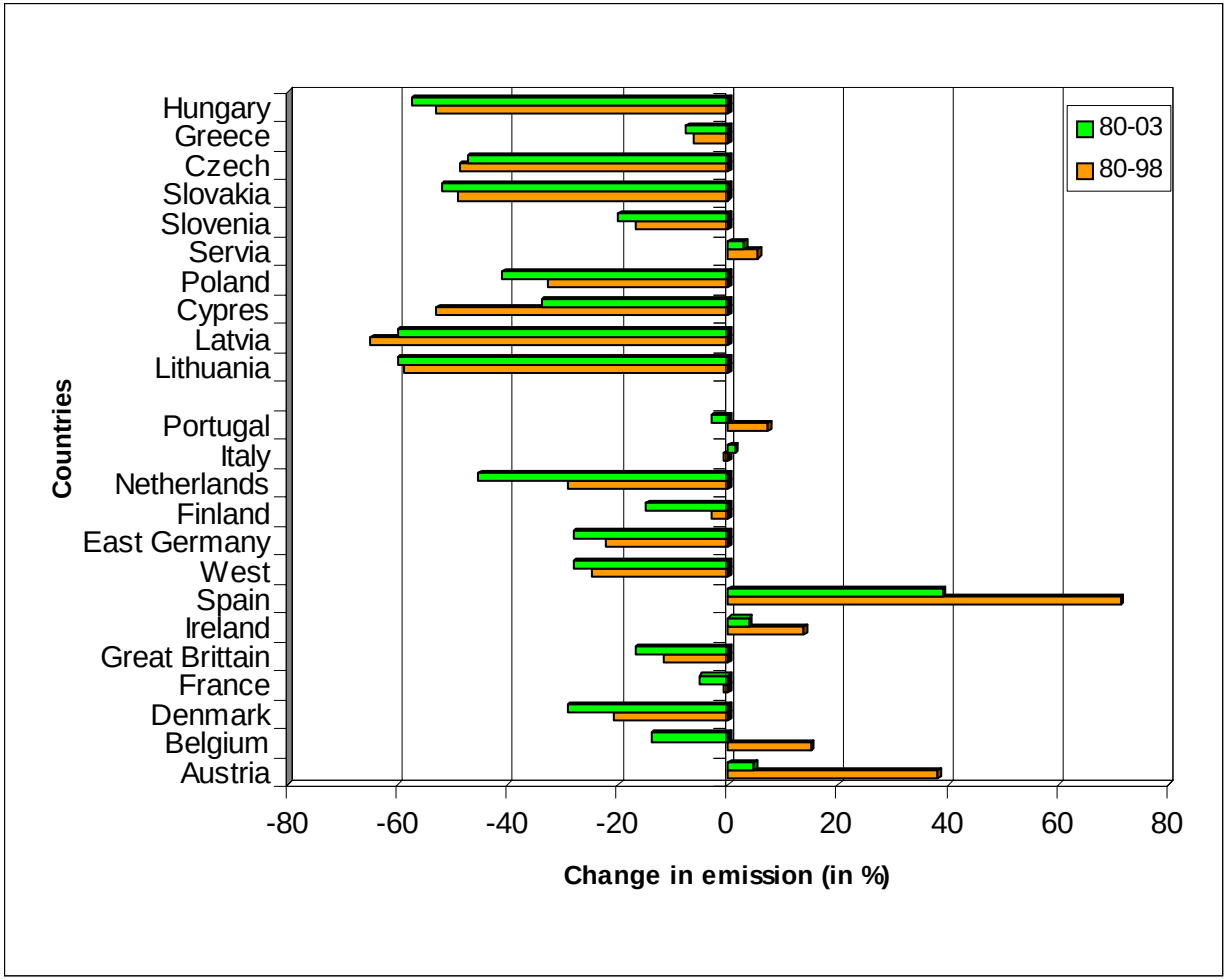
Overall conclusions

- many difficulties involved in evaluating changes in NH_3 emissions by using monitoring networks
  - need for long time series
  - interaction with other components (SO_2 & NO_x)
  - models used not always ‘complete’
- caution when measured values do not follow expectations:
  - limitations in the models
  - limitations in the monitoring
  - ineffectiveness of the abatement techniques

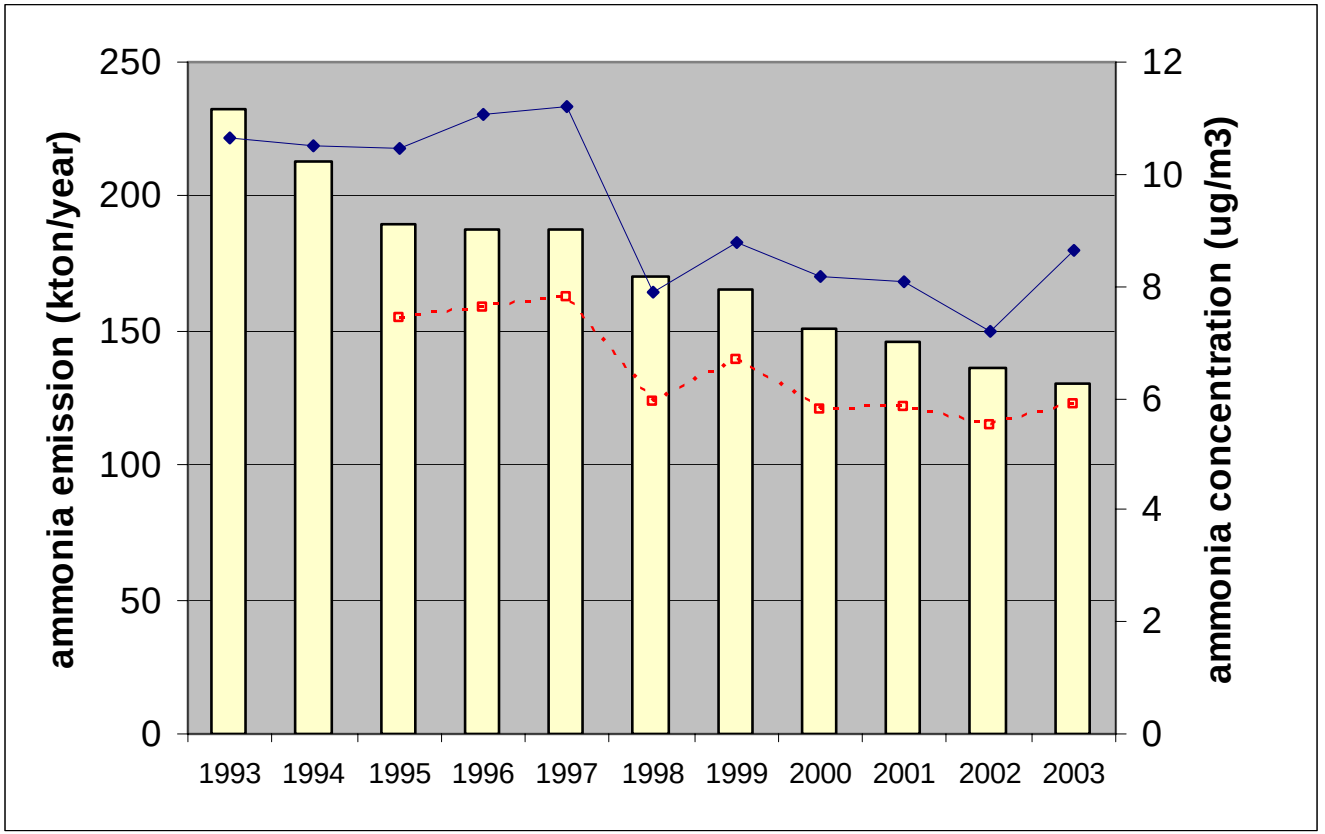
What happened since?

- Ongoing discussion on trends (in relation with meeting the NECD targets)
  - Additional measuring programmes
  - Evaluating/updating models
    - Emissions
    - Transport/deposition
- Updated information; 5 additional years
  - Emissions
  - Concentrations/depositions
- New studies
  - United Kingdom
  - Netherlands
  - EMEP

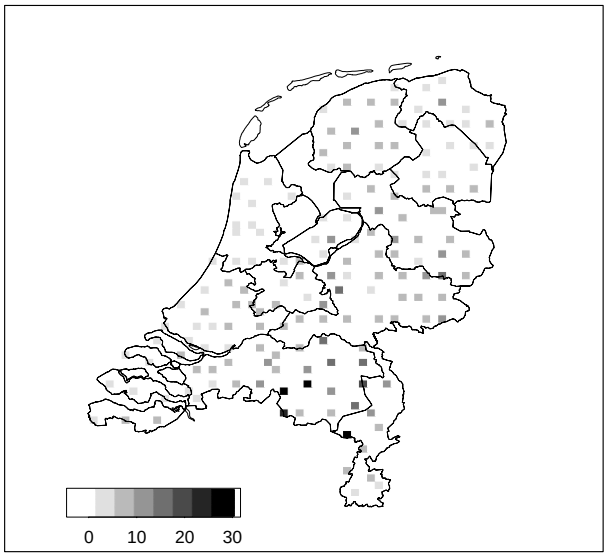
Updated EMEP emissions for Europe

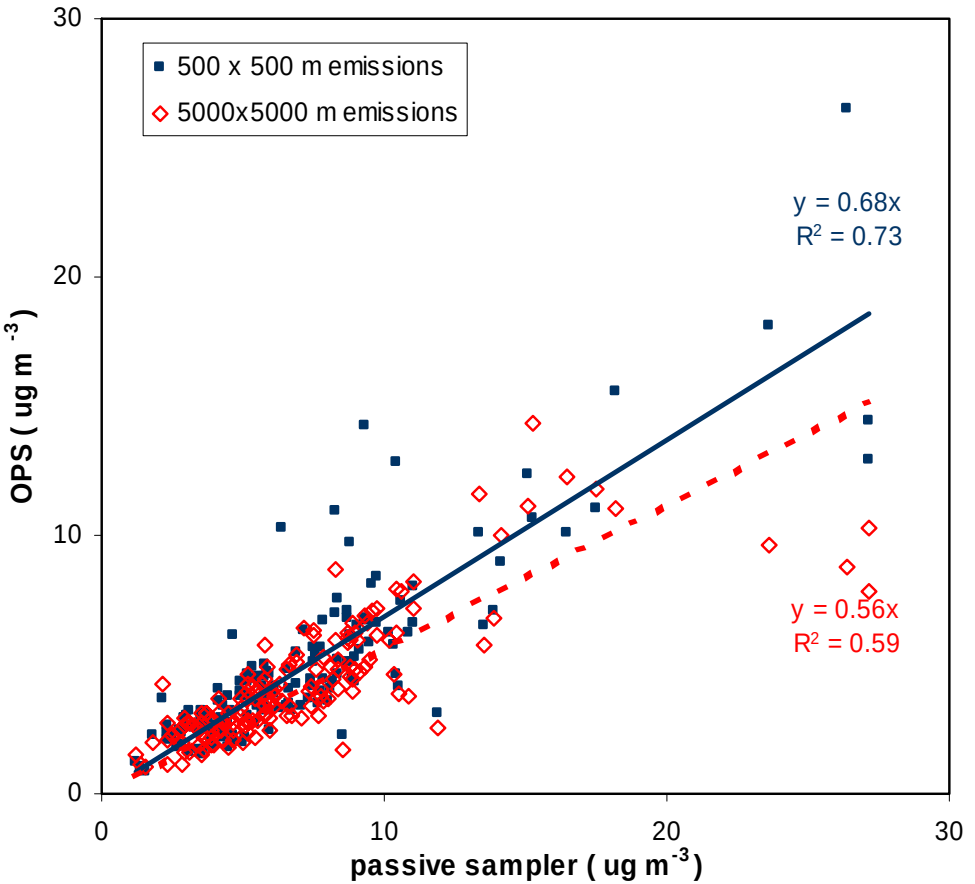


New studies (Netherlands)



Netherlands (II)



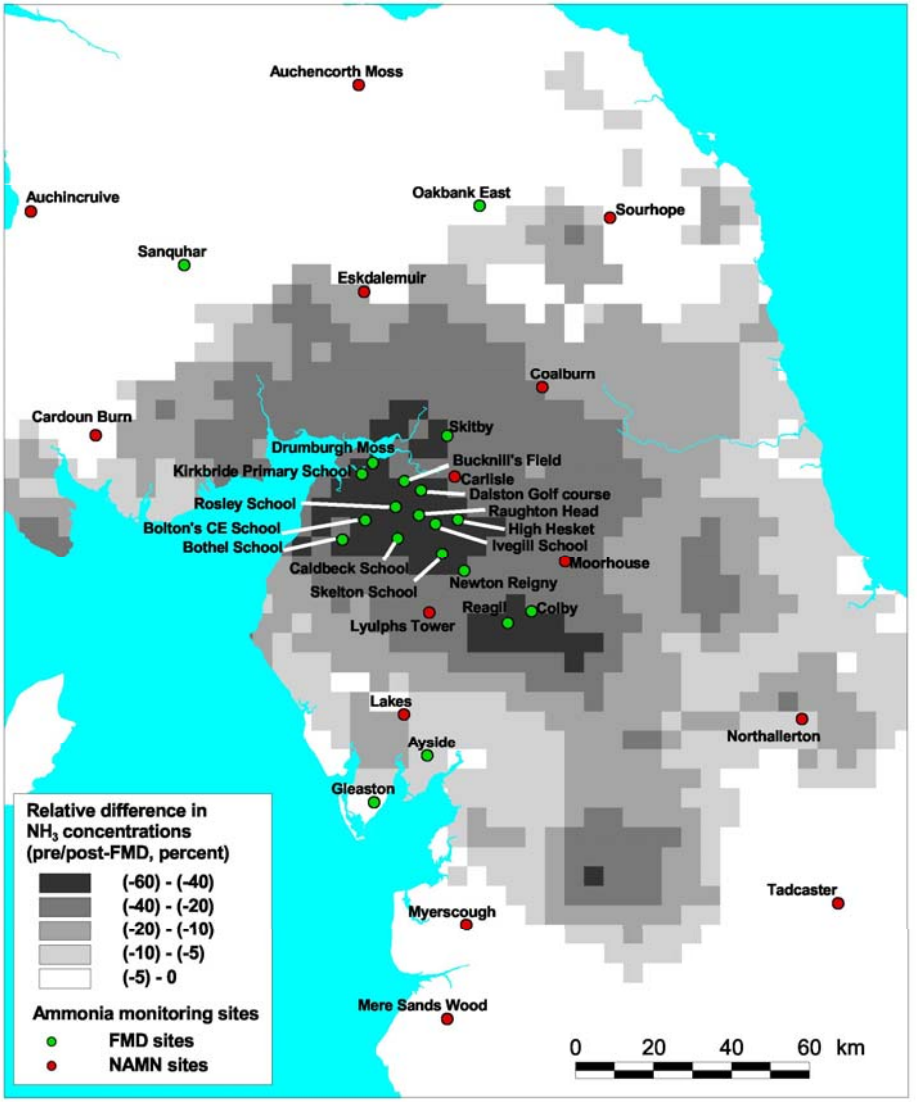


30 % difference

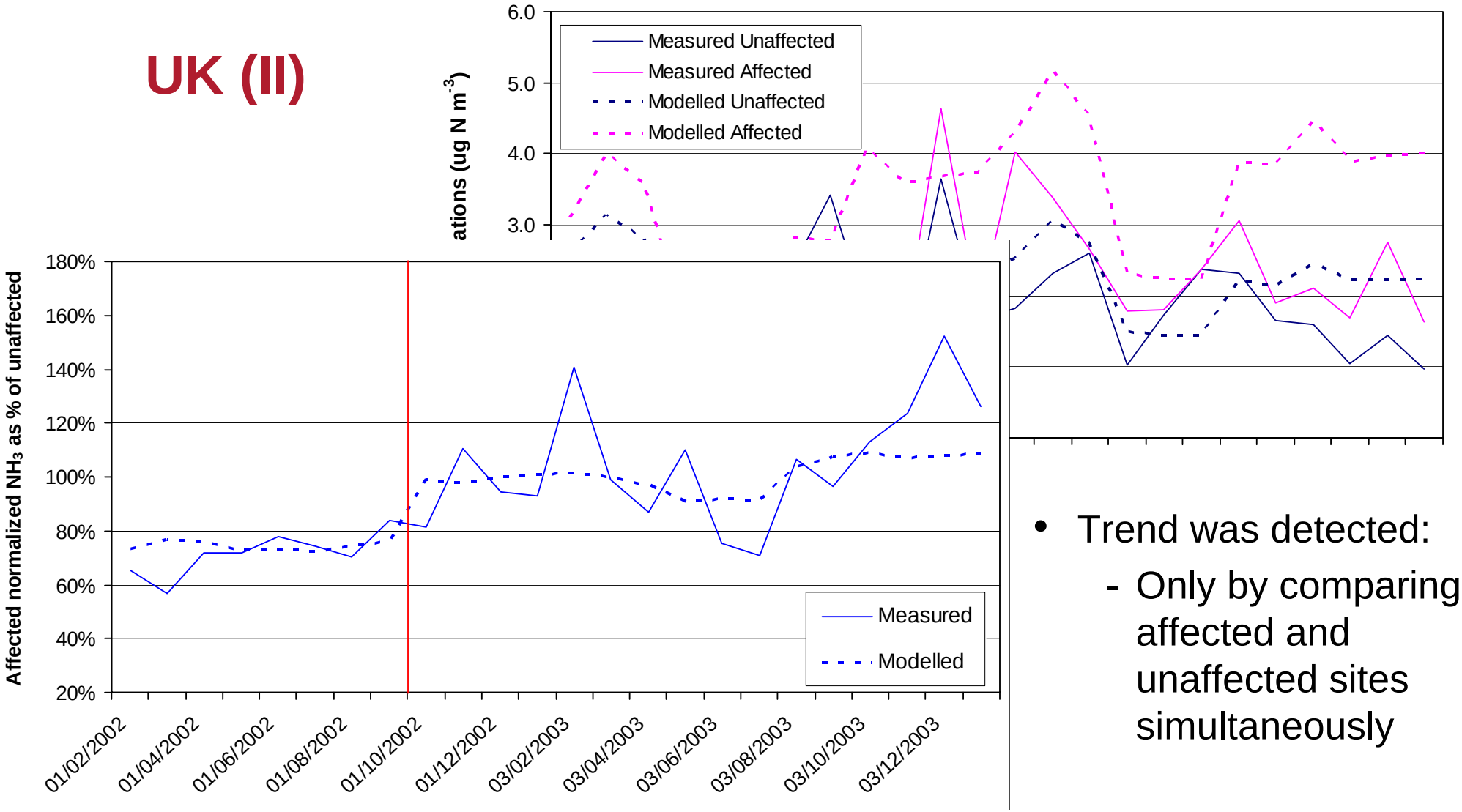
- Emission uncertainties
- Dry deposition parameterization

New studies (UK)

- Question to be answered:
  - Can we detect NH_3 emission changes after the outbreak of foot & mouth disease?
- Study motivated by Dutch & E. European experience of difficulty to see trends following emission reductions

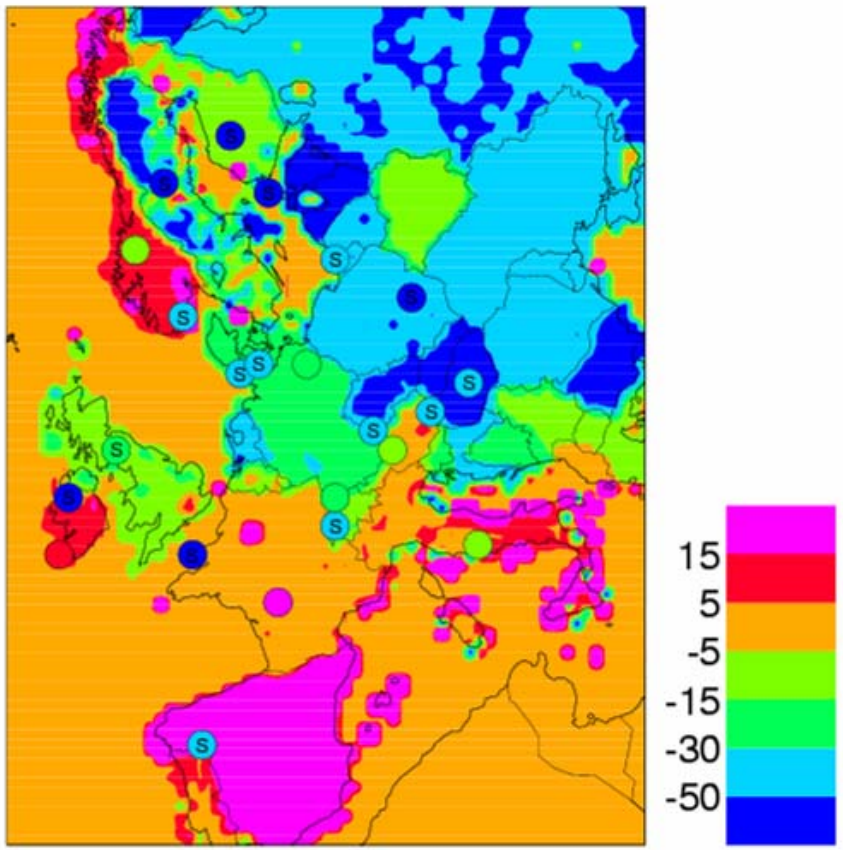


UK (II)



- Trend was detected:
  - Only by comparing affected and unaffected sites simultaneously

New studies (EMEP)

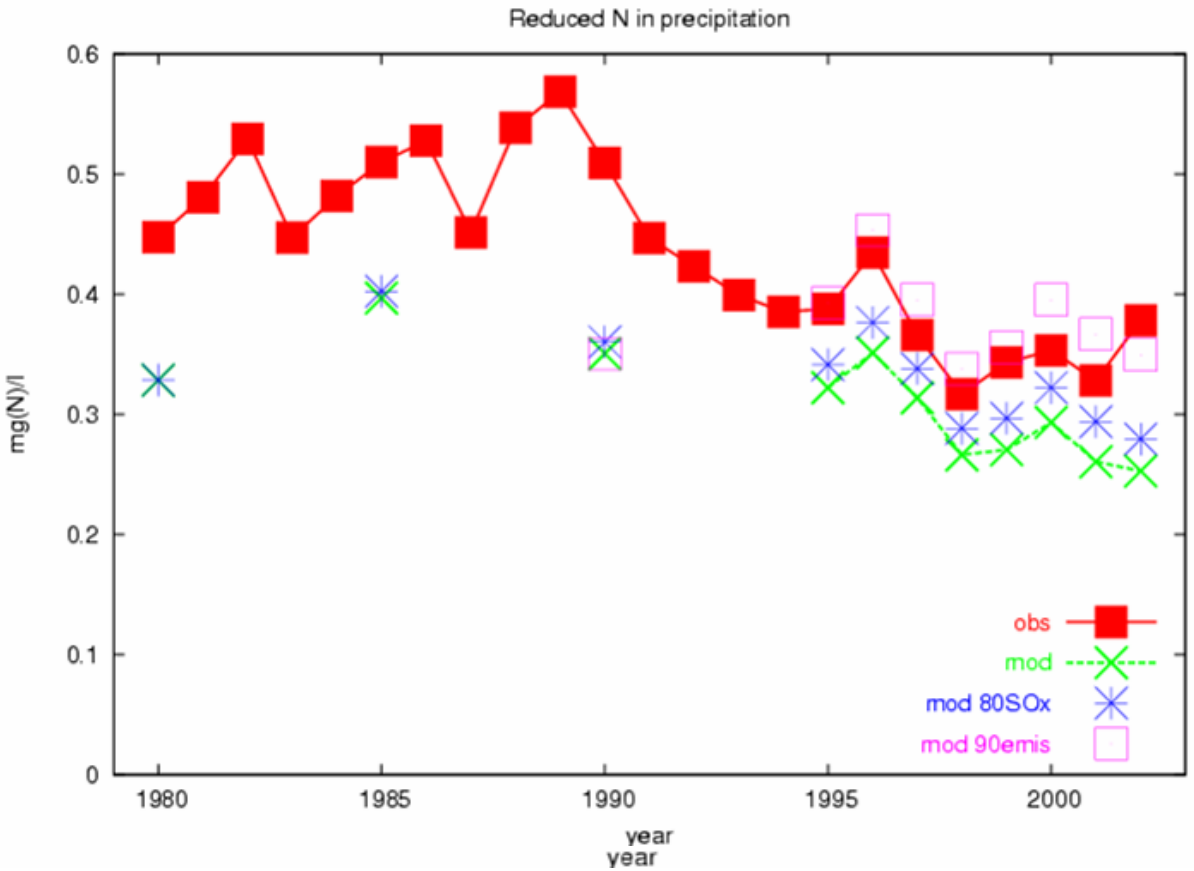


OBS

Changes ((1980-2002)/1980*-100%) in NH_3 emis. (field) versus trends in obs. concentrations of reduced N in precipitation (bullets in color) S marks significant trend.

Red. N in precipitation and air reduced similar to NH_3 emissions at a European scale, both in observations and model

EMEP (II)



NH_3+NH_4^+ decrease more as a consequence of SO_x reductions

Less effect on conc. in precip: less scavenging of NH_4^+ compensated by more of NH_3

Tendency for air concentrations to decrease more than wet depositions– model predicts this to be caused by the SO_2 emission reductions

Overall

- Much effort put in trying to get a grip on the linkages between emissions and concentration
- New studies (again) showed relevance of having insight in:
  - Adequate emission estimates
  - Adequate model parameterizations
  - Need for long-term good quality measurements
    - in contrasting areas (evaluating abatement measures)
- If all this can be brought together, valuable evaluations on the effectiveness of NH_3 abatement measures can indeed be made

UN/ECE Expert Group on Ammonia

4 – 6 December 2006, Edinburgh (UK)

- Datasets on trends of NH_x still welcome, to be included in the background document
  - Not only Europe; also other experiences are needed to get the full picture

- Contact: a.bleeker@ecn.nl