Introduction
- Maize yields in northern China have increased from 1180 to 5000 kg/ha in last 50 years
- Increase due mainly to irrigation and use of nitrogen (N) fertilizer
- Over fertilising (> 200 kgN/ha) common; low N efficiency
- Much of N lost by ammonia (NH$_3$) volatilization and emission of N oxides (NO$_x$)
- Quoted magnitudes of NH$_3$ and NO$_x$ losses uncertain
- Best management practices for fertilizer application, involving deep placement, have been developed (described in Study site below)
- Previous experiments with deep placement in North China Plain indicate N losses by volatilization of NH$_3$ of around 12% (Cai et al., 2002)
- Experiments around the world indicate NO$_x$ losses from fertilizers of 0.5 – 0.7% (Veldkamp and Keller, 1997, Yan et al., 2005)
- Present paper reports determinations of these losses from a maize crop in China with micrometeorological techniques

Study site
- Farmer’s field at Yongji, Shanxi Province, China in 2008
- Cultivated horizon 0-20cm
  - 17% sand, 46% silt, 37% clay
  - pH 8.5
  - 9.6 kg/kg organic C, 1.1 kg/kg total N, 6.3 µg N/g as NH$_4$+, 5.1 µg N/g as NO$_3$–
  - Bulk density 1.23 g/cm$^3$
  - 60 kg N/ha applied as prilled urea 33 days after maize seeded
- Used recommended best planting practice of point deep placement of fertilizer (picture below)
  - Remove a small amount of soil to the required depth with a hoe
  - Add a calculated amount of urea to the hole by hand
  - Cover urea with soil

Micrometeorological
- Gas fluxes determined with a backward Lagrangian stochastic (bLs) dispersion technique
- Fertilizer applied to a rectangular area, approximately 100 x 50 m, (shaded green in the map shown at below left)
- Gas concentrations measured continuously at 2 m height at the centre of area with a chemiluminescence NH$_3$/NO$_x$ analyser (below right)
- Wind speed & direction & other turbulence data measured at 50,000 simulations of particle trajectories
- Calculates the surface flux from the numbers of particle touchdowns in the source area (red dots on the map), their vertical velocities & sensor concentrations

Gas concentrations and fluxes
Above left: Source area and background concentrations of NH$_3$ and NO$_x$
  - The high backgrounds result from extensive use of nitrogen fertilizers in the region
  - Difficult in these studies since accuracy of the calculated flux depends on the small difference between source and background
Above right: Fluxes of NH$_3$ and NO$_x$
  - Some power failures, but 158 hours of available data
  - Urea was hydrolysed immediately after application and emissions increased rapidly
  - Emissions remained high and then decreased around day 10
  - Most of urea hydrolysed by day 13
  - NO$_x$ emissions relatively small, but measurable
  - Estimated losses of NH$_3$-N and NO$_x$-N were 3.9 and 0.7 kg N/ha
  - Equivalent to 6.5 and 1.2% of N applied

Conclusions
- The bLs micrometeorological technique proved to be a very useful tool for measuring gas fluxes from small, well-defined areas
- NH$_3$ volatilization was much less than in other experiments in China
- In this soil, deep placement of the urea to limit NH$_3$ volatilisation proved to be a very effective method of fertilizer application
- NO$_x$ loss was not insignificant, amounting to ca. 20% of that of NH$_3$

References

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