Ammonia air-surface exchange in an unfertilized hay field in the southeastern U.S

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Introduction

There is growing interest in the U.S. to derive total nitrogen deposition budgets for natural environments in support of critical loads approaches for managing ecosystem health. The contribution of NH_3 to nitrogen dry deposition currently represents a significant uncertainty in such budgets, owing to a general lack of data from which to derive site specific annual fluxes and for development and testing of flux algorithms suitable for regional air quality models.

We measured NH_3 bi-directional exchange over an unfertilized grass field managed for hay production. Objectives were to:

- *examine the influence of management practices (cutting and removal of cuttings) on fluxes*
- *assess the relative importance of soil versus foliage processes with respect to the net canopy-scale flux.*

Here we discuss results spanning the period May 31 to July 2, 2008.

Methods

Site

- Grass field at the Blackwood Division of Duke Forest near Chapel Hill, North Carolina.
- Vegetation is primarily tall fescue with a mix of C3 and C4 grasses and forbs and is unfertilized.
- Nitrogen input from the atmosphere is estimated to be of the order of 13.5 kg N ha^{-1} annually (Sparks et al., 2008).
- Field is mowed twice per year and cuttings are removed.

Methods

Site

- Grass reached a height of 55 cm before mowing on June 13, 2008. The cuttings were baled and removed on June 16.

Flux Measurements

- AMANDA rotating wet denuder system deployed in a 3-height flux gradient configuration (half hourly fluxes)

Surface Chemistry

- Soil, leaf tissue, and leaf surface water (dew/guttation) NH_3 compensation points determined from measured NH_4^+ and H^+ concentrations

Fig 1. Flux measurement system

Results

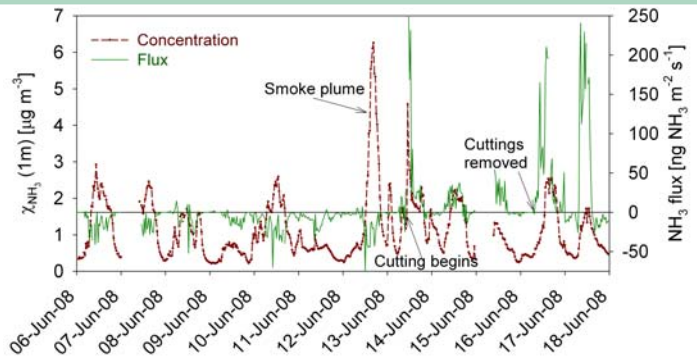

Fig 2. Ammonia concentration (χ) at 1 m and flux before and after cutting of the field. On June 12 a smoke plume originating from a peat fire in coastal North Carolina (250 km east) passed over the field site.

- Prior to cutting, fluxes were primarily directed toward the canopy, with larger fluxes observed during the day driven by greater turbulent mixing and smaller fluxes at night.
- After cutting, the general pattern of daytime fluxes switched from net deposition to net emission.

Results

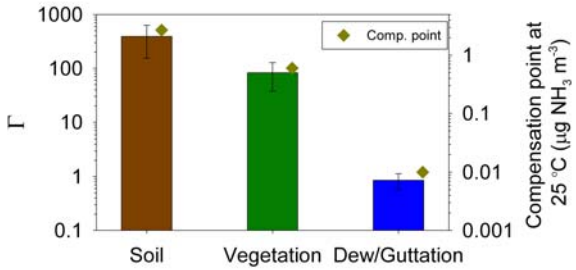

Fig 3. Emission potential (Γ) estimated from measured NH_4^+ and H^+ concentrations in soil pore water, bulk vegetation tissue, and dew/guttation. Vegetation Γ was estimated from NH_4^+ tissue concentrations using the parameterization of Massad et al. (2010). Bars and error bars represent median and interquarile range, respectively. Compensation point corresponding to median Γ at 25 °C is also shown.

- Dew/guttation demonstrated negligible Γ due to a combination of low NH_4^+ concentrations (0.1 – 1.4 µg L^{-1}) and pH (3.3 – 5.4).

Conclusions

- Low compensation points predicted from tissue and dew/guttation chemistry measurements are consistent with overall net deposition prior to cutting
- Following removal of the cuttings, daytime emissions likely reflect the influence of higher soil temperatures on emissions from soil and leaf litter coupled with the inability of the short canopy to fully re-capture these emissions (Sutton et al., 2009).
- Future work will include the parameterization and testing of a 2-layer compensation point model for predicting net canopy and soil/foliage NH_3 fluxes before and after cutting.

References

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Acknowledgements

This project was supported by National Research Initiative Competitive Grant no.35112 from the USDA Cooperative State Research, Education, and Extension Service Air Quality Program and by US EPA's Office of Research and Development. We appreciate the field support from Lauren Elich (US EPA), Judd Edeburn (Duke University), Mark Barnes (NCSU), David Kirchgessner (US EPA), and Robert Nettles (Brookhaven National Laboratory) and laboratory support from Guillermo Ramirez (NCSU).