Evaluating Ammonia Deposition Rates for Deciduous Forest using Measurements and Modelling

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Introduction and aim

Atmospheric ammonia (NH$_3$) deposition is important in ecosystem modelling as nitrogen (N) deposition enhances photosynthesis at leaf level and might stimulate the growth of N limited forests [de Vries et al. (2009) For. Ecol. and Man.]. However, measurements of atmospheric NH$_3$ fluxes for forests are limited and very uncertain. The aim of this presentation is 1) to investigate observed atmospheric NH$_3$ concentration and fluxes above deciduous forest and 2) to examine the performance of the Danish local-scale deposition model OML-DEP for calculating the dry deposition of NH$_3$ to deciduous forest, by comparing calculations with advanced flux measurements.

Method

Vertical atmospheric NH$_3$ fluxes were measured in campaigns during 2010 and 2011 using the relaxed eddy accumulation (REA) technique at the Danish Fluxnet forest site Lille Bøgeskov, Sora. Calculations of concentration and dry deposition are performed using the local-scale deposition model (OML-DEP) applied in the Danish Ammonia Modelling System (DAMOS) [Geels et al. BGD]. The DAMOS calculations are based on state-of-the-art emission inventories with hourly time resolution and a spatial resolution down to single farm level [Skjøth et al. (2011) ACPD].

Results

Lille Bøgeskov (55°29'13"N, 11°38'45"E) consists predominantly of 82-year-old beech trees (Fagus sylvatica) with an averagely height of 26 m. Scattered stands of conifers constitute about 20% of the forest area. The meteorological mast is located in the centre giving fetches from 500 m to 1 km.

Highest atmospheric NH$_3$ concentrations are seen when wind is coming from the eastern sector and at lower wind and friction velocities (illustrated at the July example). A clear relation to the diurnal cycle of temperature and stability is seen in the NH$_3$ concentration measurements (see Jun and Oct figures).

NH$_3$ deposition is seen when wind is coming from south while the flux is small from the N-E and N-W directions (i.e. Oct 2011). June 2011, emissions of NH$_3$ in the daytime occurred while the flux was small during nights. The NH$_3$ flux indicates a fine correlation with $u^*$. However, the model does not consider vegetative and soil NH$_3$ emissions from non-agricultural areas, and is therefore not able to simulate NH$_3$ emissions for Lille Bøgeskov.

Conclusion and outlook

- The atmospheric concentration and flux for Lille Bøgeskov are highly dependent on local meteorology and forests phenology, as well as the spatial distributions of local anthropogenic NH$_3$ sources.
- OML-DEP simulates the atmospheric concentration of NH$_3$ well for periods of app. two weeks, however the model does not consider vegetative and soil NH$_3$ emissions from non-agricultural areas, and is therefore not able to simulate NH$_3$ emissions for Lille Bøgeskov.
- A contribution to NH$_3$ emissions from the forest could exist from advection of NH$_3$ emitted from local anthropogenic NH$_3$ sources and from re-emissions after leaf fall.

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