Evaluating Ammonia Deposition Rates for Deciduous Forest using Measurements and Modelling

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Evaluating Ammonia Deposition Rates for Deciduous Forest using Measurements and Modelling

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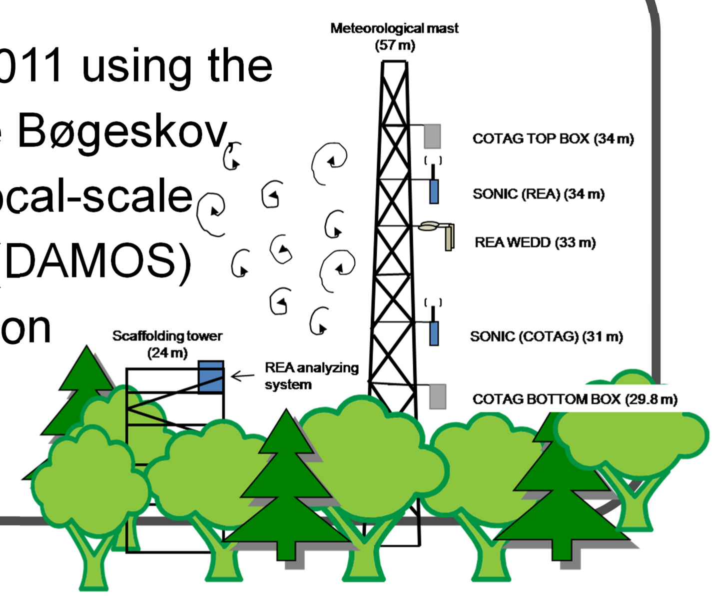
Introduction and aim

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, Sorø. 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].

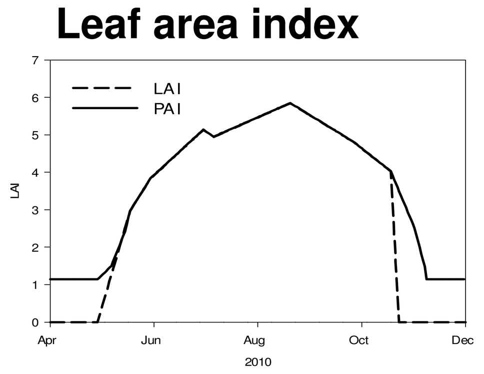


Results

Lille Bøgeskov

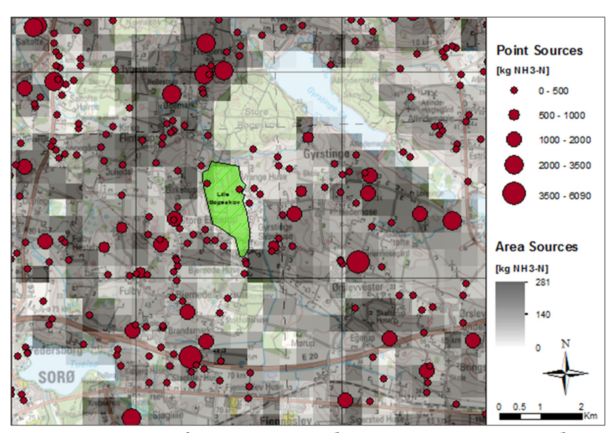
Lille Bøgeskov (55°29'13''N, 11°38'45''E) consists predominantly of 82-year-old beech trees (Fagus sylvatica) with an averagely height of 26 m. Scattered stands of conifers constitute about 20% of the forest area. The meteorological mast is located in the centre giving fetches from 500 m to 1 km.

Leaf area index



Plant area index (PAI) and leaf area index (LAI) measured in Ll. Bøgeskov by LAI-2000 PCA through growing season.

Ammonia sources

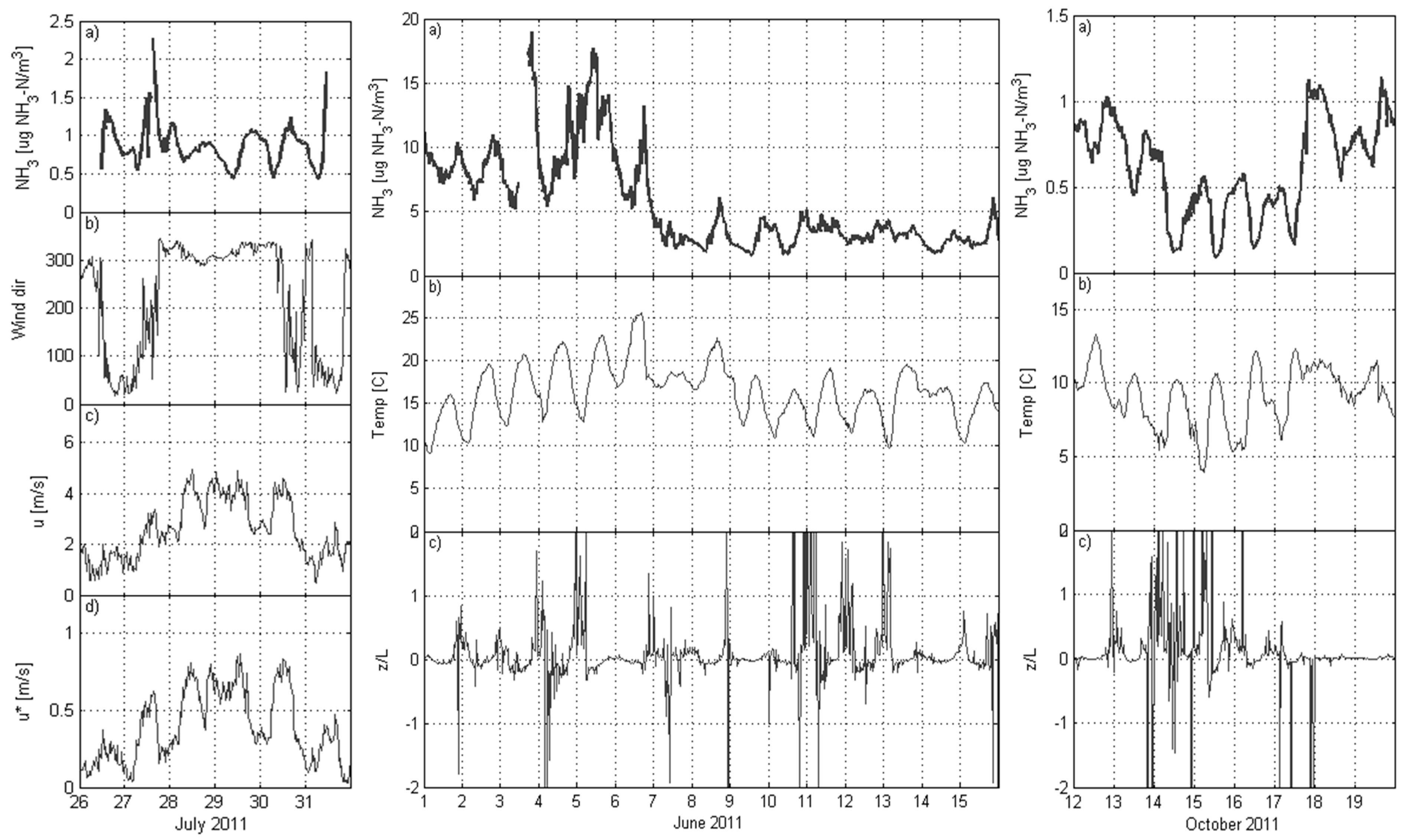


NH_3 emissions from point and area sources around Lille Bøgeskov. Point sources are shared among different stables and manure tanks, and area sources among fields in a spatial resolution of 100 x 100 m.

15 April 2010 | 17 May 2010 | 8 November 2010

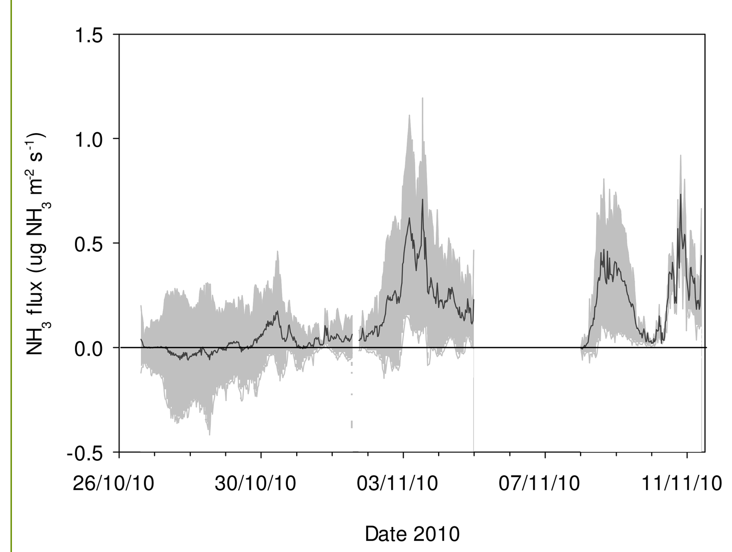
Photos are taken with webcam by Technical University of Denmark

Atmospheric ammonia concentrations

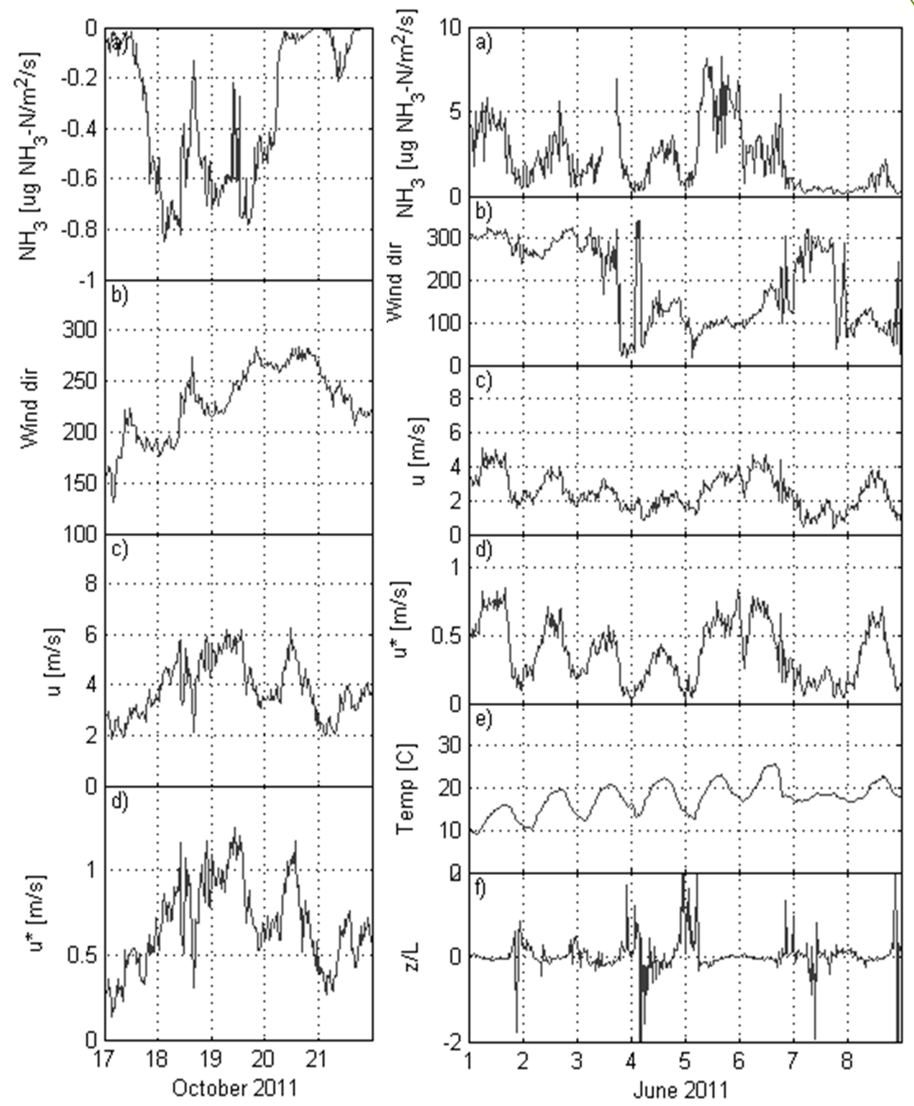


Highest atmospheric NH_3 concentrations are seen when wind is coming from the eastern sector and at lower wind and friction velocities (illustrated at the July example). A clear relation to the diurnal cycle of temperature and stability is seen in the NH_3 concentration measurements (see Jun and Oct figures).

Atmospheric ammonia fluxes



Evident NH_3 emissions in 2010 are observed after defoliation begins, indicating the potential of forest acting both as a sink and source for atmospheric NH_3.



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). I 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*.

Acknowledgement

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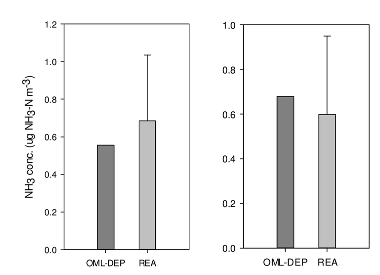
Conclusion and outlook

- 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 fwell 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.