Project Number 282910

ÉCLAIRE

Effects of Climate Change on Air Pollution Impacts and Response Strategies for European Ecosystems

Seventh Framework Programme

Theme: Environment

D11.1 Parameterization of the impact of reduced and oxidised wet and dry N deposition on GHG and NOx fluxes, N immobilisation, natural vegetation types, species physiology, soil chemistry, and losses and allocation of C and N

Due date of deliverable: **31/03/13** Actual submission date: **10/09/13**

Start Date of Project: **01/10/2011** Duration: **48 months**

Organisation name of lead contractor for this deliverable :
CNR

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Dissemination Level		
PU	Public	☐
PP	Restricted to other programme participants (including the Commission Services)	v
RE	Restricted to a group specified by the consortium (including the Commission Services)	☐
CO	Confidential, only for members of the consortium (including the Commission Services)	☐

1. Executive Summary

Parameterization of the impact of reduced and oxidised wet and dry N deposition on GHG and NOx fluxes, N immobilisation, natural vegetation types, species physiology, soil chemistry, and losses and allocation of C and N (D11.1) is ~ 80 % completed.

- Ammonia continues to reduce the cover of *Calluna* further away from the NH_3 source, indicating both acute and chronic effects. In the absence of competition from *Calluna*, the sedge *E. vaginatum*, which appears to tolerate ammonia, has expanded. In response to wet N, particularly in the reduced form, *Calluna* continues to dominate. *E. vaginatum* provides a conduit for methane. Thus a consequence of enhanced ammonia concentrations on bogs naturally dominated by *Calluna* could be increased methane emissions.
- The form of N in wet deposition, water table height and temperature are important drivers controlling CH_4 emissions. N_2O fluxes suggest that as vegetation begins to repopulate areas where NH_3 toxicity had significantly decreased vegetation cover. Given that soil water nitrate levels remain quite high, it seems that nitrate availability was not the key factor controlling N_2O emissions.
- CO_2 fluxes measured in situ have not identified effects of N form, but have shown fluxes to be highly temperature dependent. CO_2 fluxes from *Sphagnum capillifolium* measured in the lab indicate that N deposition can stimulate photosynthesis but no significant effects of N form were found for either photosynthesis or respiration.

Objectives:

Task 11.1: Peat bog experiment on N-climate-O3 interactions (NERC(EDI) (Sheppard), BFW, NERC(BAN)). To quantify how climate change, including increasing background ozone concentration will enhance greenhouse gas and NO release and exacerbate the threat to vegetation caused by dry or wet N deposition, including the distinction between oxidized (NOy) and reduced (NHx) nitrogen forms.

Determine the effects of ammonia, ammonium and nitrate on species composition and function, carbon cycling, on an ombrotrophic peat bog.

2. Activities:

In July, August 2013 species cover assessments were made in permanent quadrats in 54 treatment plots and also at a larger scale, 2*1 m^2 at various distances along the ammonia transect. Such datasets were collected pretreatment (2002) and every 2-3 years since, providing an 11 year record of species cover change. In March 2011 three dipwells were inserted into each plot. Individual plot water table levels have been measured monthly and samples removed for chemical analysis (pH, DOC, DIC, NO_3^-, DON, DIN, NH_4^+, Ca, K, Mg, Na, SO_4^{2-}, Cl). Soil pH was sampled at least once per season. Litterfall collectors were put out under *Calluna* at the beginning of spring 2013 and are being emptied seasonally. In 2012 the summer was very wet and attempts to measure NEE were unsuccessful, a different system was designed for 2013. In 2013 samples of *Eriophorum* and *Calluna* were taken monthly from ambient and at 4 distances along the ammonia transect and analysed for CN, additionally measurements of GHG emissions have been made using static chambers. A small lab experiment was conducted to look at NO emissions in relation to water content. In May soil cores were removed from the wet and dry plots and sent to Vienna (BFW). Carbon dioxide and methane have been measured (LiCor system) in real time, in control and high N plots (Nred56, Nox56, amm56) monthly since May. In autumn 2012 CO_2 fluxes were measured in the field from *Sphagnum capillifolium* (PPsystems EGM) and in 2013 *S. capillifolium* was removed and CO_2 measurements made in the laboratory (LiCor), to establish respiration losses in the absence of heterotrophic soil respiration. Light response curves and CO_2 fluxes have also been measured on *Calluna* in *Eriophorum* shoots. Since June 2013 soil respiration measurements have been made (PP systems EGM). Collection of monthly soil water and flux data will continue through to March 2014. The combination of field and lab measurements of GHG fluxes, together with species cover and meteorological data will provide important new insights into how the form of N deposition affects the GHG balance of a peatland ecosystem.

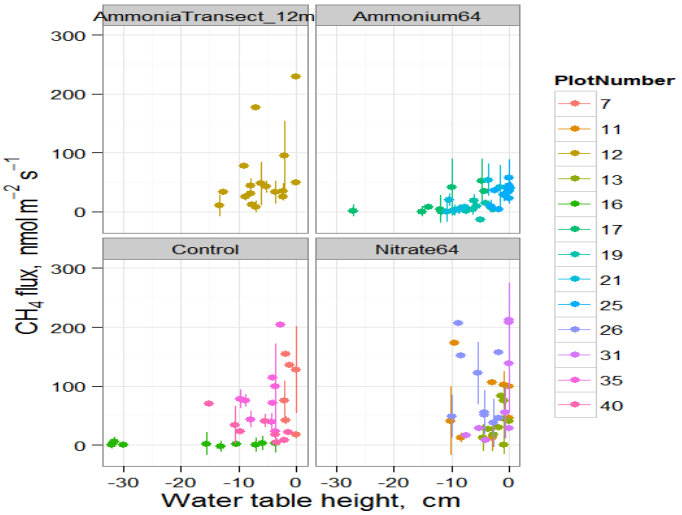
D11.1:
Parameterization of the impact of reduced and oxidised wet and dry N deposition on GHG and NOx fluxes is ~ 80 % completed.

3. Results:

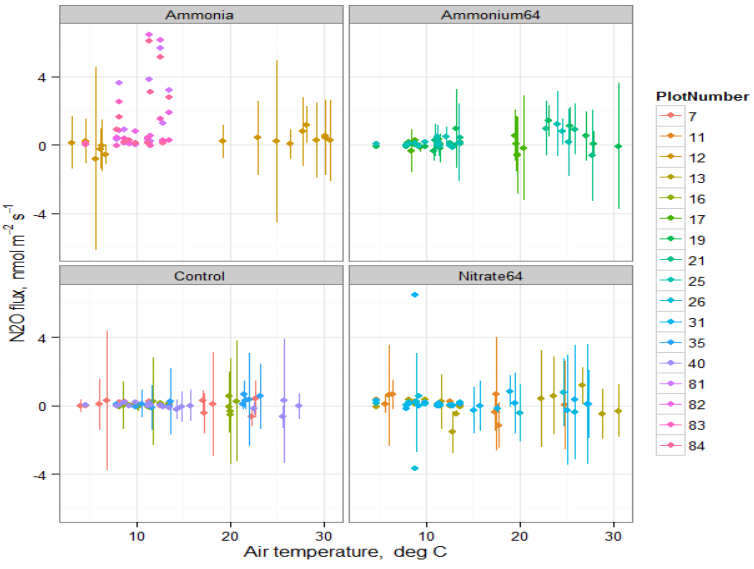
D11.1:
Large effects of N form on species cover continue to manifest themselves with implications for GHG fluxes:

- Ammonia continues to reduce the cover of *Calluna* further away from the NH_3 source, indicating that effects are not simply driven by direct toxicity from high gaseous concentrations but in addition, by cumulative effects of exposure to lower NH_3–N doses. In the absence of competition from *Calluna*, the sedge *E. vaginatum*, which appears to tolerate ammonia, has expanded its cover to fill most of the area vacated by the death of *Calluna*. In response to wet N, particularly in the reduced form *Calluna* continues to dominate plant cover, stopping *E. vaginatum* from expanding. This sedge provides a conduit for methane. Thus a consequence of enhanced ammonia concentrations on bogs naturally dominated by *Calluna* could be increased methane emissions.

- Methane flux measurements also indicate trends in effects due to the form of N in wet deposition: oxidised N as nitrate increases emissions whereas reduced N as ammonium suppresses emissions. Water table height and also temperature are important drivers controlling CH_4 emissions.



N_2O fluxes measured in 2010, 2011 and 2012 suggest that as vegetation begins to repopulate areas where NH_3 toxicity had significantly decreased vegetation cover and led to high N2O fluxes in 2010, pink dots on ammonia graph, this stimulation in N_2O fluxes is only temporary. Given that soil water nitrate levels remain quite high, it seems that nitrate availability was not the key factor controlling N_2O emissions, as we had previously thought.



- CO_2 fluxes measured in situ have not identified effects of N form, but have shown fluxes to be highly temperature dependent.
- CO_2 fluxes from *Sphagnum capillifolium* measured in the lab indicate that N deposition can stimulate photosynthesis but no significant effects of N form were found for either photosynthesis or respiration.

4. Milestones achieved:

MS47 Completion of experimental set up.

5. Deviations and reasons:

- MS48 is 80% on schedule but a decision was made to extend collection of data to 2 years rather one year because of the very wet season in 2012 which made flux data collection almost impossible.
- MS49 - Soil mesocosm removal for exposure to O_3 at Bangor has been delayed until summer 2014. It is planned that cores that are presently being used for field flux measurements (already surrounded by a static chamber (29 cm diam) will be removed and transported to Bangor in November 2013.
- MS50 is on schedule > 80 % of data promised for parameterization of the impact of reduced and oxidised, wet and dry N deposition on GHG & NOx fluxes has been collected. Data collected prior to ECLAIRE (up to Dec 2011) was uploaded to the NEU database in January 2013. Some recent data has been made available to the modellers and working up the data into fluxes and populating the database template is progressing but will not be completed until March 2014.
- Progress has been made in Vienna on Whim cores that were collected in May 2013.

6. Publications:

N/A

7. Meetings:

N/A

8. List of Documents/Annexes:

N/A