Project Number 282910

ÉCLAIRE

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

Seventh Framework Programme

Theme: Environment

D1.4 – NH_3 fluxes over Mediterranean agricultural and semi-natural surfaces

Due date of deliverable: **31/12/2012**

Actual submission date: **30/07/2014**

Start Date of Project: **01/10/2011**

Duration: **48 months**

Organisation name of lead contractor for this deliverable : **NERC**

Project co-funded by the European Commission within the Seventh Framework Programme		
Dissemination Level		
PU	Public	☐
PP	Restricted to other programme participants (including the Commission Services)	☑
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

- A three month campaign measuring exchange fluxes of NH_3, CO_2 and O_3 between the atmosphere and a Mediterranean semi-natural grassland was carried out
- Ammonia deposition fluxes (measured using the aerodynamic gradient technique) were obtained providing a dataset that can be used for parameterising NH_3 exchange for Mediterranean vegetation
- During the growing phase CO_2 fluxes were bidirectional as a result of plant respiration cycles whereas during the senescent phase emission fluxes were mostly observed
- Diurnal cycles of ozone fluxes were not dependent on the vegetation phase, with similar deposition cycles for the growing and senescent phases. This suggests that the non-stomatal deposition pathway is large for this ecosystem

2. **Objectives**:

There is a complete lack of understanding of NH_3 exchange for Southern European vegetation and climate and, therefore, for those climatic conditions that will become more prevalent across Europe, with periods of high temperatures and associated drought. The objective of this deliverable was to make targeted measurements of the exchange of NH_3 above semi-natural vegetation in Spain, during a campaign covering the two contrasting vegetation phases of spring (growing phase) and summer (senescence). NH_3 fluxes were accompanied by measurements of CO_2/H_2O fluxes and meteorological parameters to study the fluxes in relation to plant functioning, stomatal controls and meteorological variables.

3. Activities:

The measurements were carried out on a non-fertilised, non-grazed semi-natural grassland belonging to the Spanish Ministry of Defence near Colmenar Viejo, Madrid, Spain (3.785584° W, 40.676704°N). The irregular measurement field has an area of approximately 1500 m2 and with a length and width of about 800 m and 250 m, respectively. A 6 m high scaffolding tower was placed in the centre of the field for the installation of the NH_3 gradient system (Figure 1). Table 1 lists the measurements made at the site. The campaign duration was three months (24 April – 27 July 2013).

Figure 1: Photograph showing the experimental field and the 6 m flux tower.

A training visit to CEH Ednburgh (funded through the ACTRIS TNA programme) to learn how to operate the AMANDA gradient system was also carried out as part of this deliverable.

Table 1: List of parameters measured during the campaign

PARAMETER	UNITS	METHOD	INSTRUMENT	FREQUENCY
Latent heat flux	W m^{-2}	Eddy cov	LI-COR LI-7500	30 min.
Carbon dioxide flux	µmol m^{-2} s^{-1}	Eddy cov	LI-COR LI-7500	30 min.
Sensible heat flux	W m^{-2}	Eddy cov	Gill Windmaster Sonic	30 min.
Ozone concentration at height of O3 fast sensor	µmol m^{-3}	Chemiluminescent analysis	2B ozone monitor	30 min.
Ozone flux	µg m^{-2} s^{-1}	Eddy cov	ROFI fast chemiluminescence	30 min.
Ammonia flux	ng m^{-2} s^{-1}	Gradient	AMANDA denuders at heights of 1.2, 3.2 and 5.2 m above the canopy	30 min.
Ground-level PAR	mmol m^{-2} s^{-1}	Sensor	Skye	30 min.
Leaf wetness	%	Wetness grid	Campbell Scientific	30 min
Air temperature	°C	Sensor	Vaisala WXT	30 min
Pressure	kPa	Sensor	Vaisala WXT	30 min
Precipitation	mm	Rain gauge	Vaisala WXT	30 min
Relative humidity	%	Sensor	Vaisala WXT	30 min
Soil heat flux	W m^{-2}	Soil heat flux plates	Campbell Scientific	30 min
Net radiation	W m^{-2}	Sensor	Campbell Scientific	30 min
Bulk density	g soil m^{-3} dry soil	Soil cylinders	-	One off
Soil Texture (in each layer)	(Cl:Sa:Si) g/kg	Without decarbonatation	-	One off
pH in water (in each layer)	-	-	-	One off
Water retention curve	% vs kPa	-	-	One off
Soil mineral N concentrations (NO_3^-, NH_4^+)	kg m^{-2}	Soil KCl extractions, 2 depths (0-5 cm; 0-30 cm)	Flow injection analysis (FIA)	Two samplings (spring and summer)
Mean canopy height	m	Direct sampling	-	Fortnightly
Leaf area index (1/2 total)	m² m^{-2}	Direct sampling	-	Two samplings (spring and summer)
Plant tissue C	% C dry matter	Carbo-Erma	-	Two samplings (spring and summer)
Plant tissue N	% N dry matter	Carlo Erba	-	Two samplings (spring and

PARAMETER	UNITS	METHOD	INSTRUMENT	FREQUENCY
				summer)
Plant species composition	% above ground biomass of each functional group	Direct sampling	-	Two samplings (spring and summer)
Bulk foliar NH_4^+	µmol l^{-1}	Direct sampling	Flow injection analysis (FIA)	Two samplings (spring and summer)

4. Results:

Full results are currently being submitted to the ÉCLAIRE data base. A short summary is presented here.

Ammonia fluxes

The ammonia flux data were filtered to remove periods of instrument down-time and periods with low wind speeds (<0.8 m s^{-1}), very stable or unstable stratification or less than 67% of the flux footprint inside the measurement field. An example of the flux time series is shown in Figure 2.

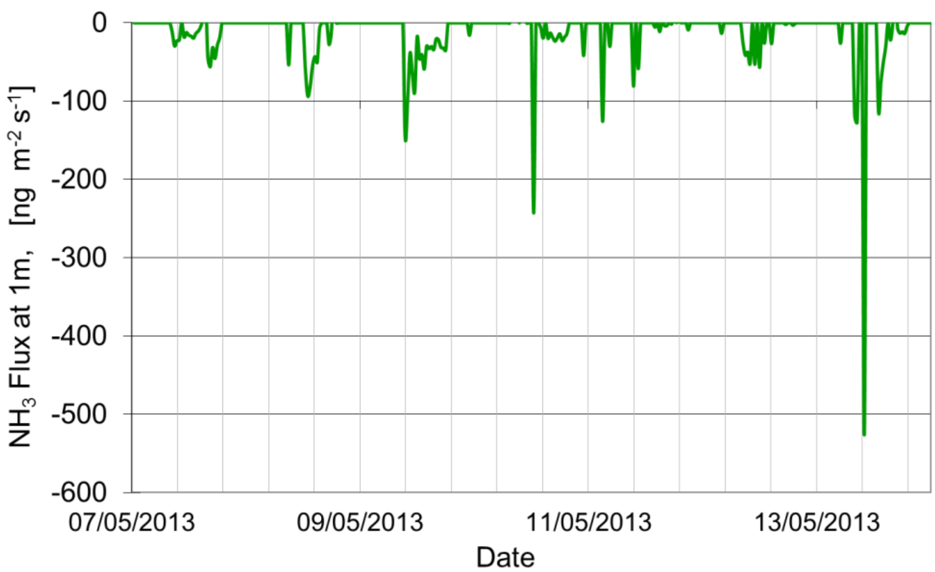

Figure 2: Example of the NH_3 flux time series

CO_2 fluxes

Measured CO_2 fluxes had different diurnal cycles during the two vegetation phases (Figure 3) as would be expected. During the growing phase fluxes were bidirectional as a result of plant respiration cycles whereas during the senescent phase emission fluxes were mostly observed.

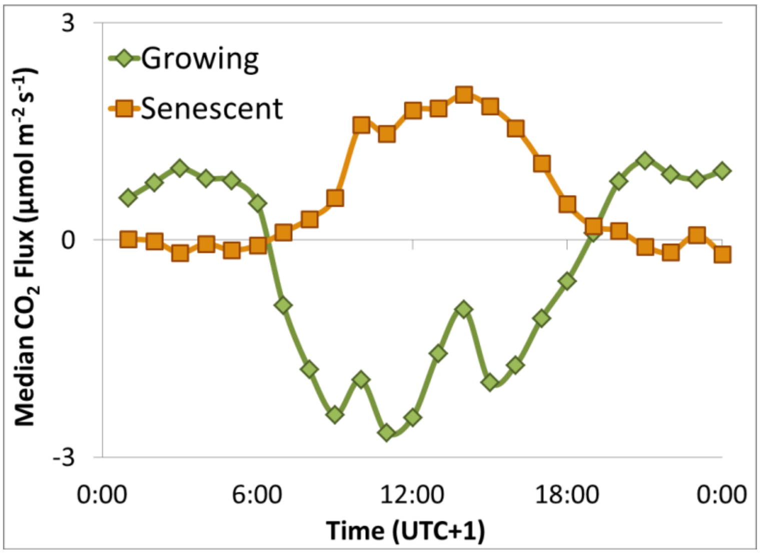

Figure 3: Diurnal cycle of median CO_2 fluxes for the growing and senescent phases of the vegetation.

O_3 fluxes

In contrast to the CO_2 fluxes, the diurnal cycles of the ozone fluxes were not dependent on the vegetation phase, with similar deposition cycles for the growing and senescent phases (Figure 4). This suggests that the non-stomatal deposition pathway is large for this ecosystem, possibly as a result of exposed soil areas. Stomatal deposition modelling should be carried out on this dataset in order to investigate this issue further.

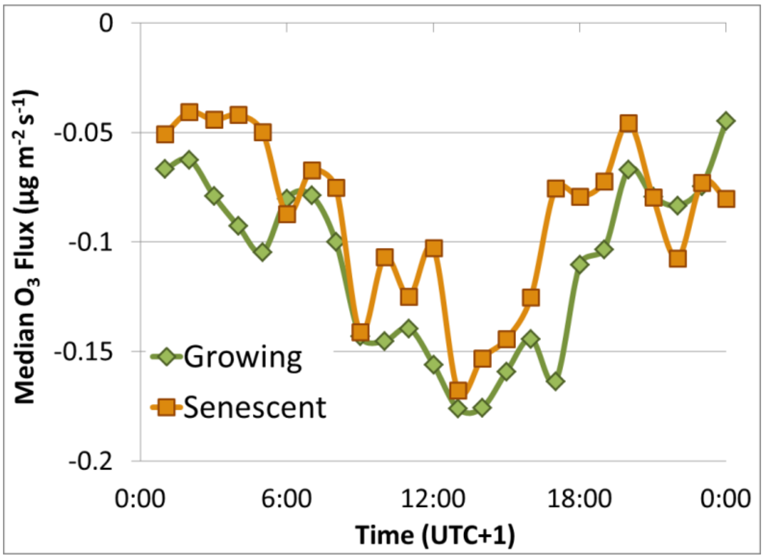

Figure 4: Diurnal cycle of median O_3 fluxes for the growing and senescent phases of the vegetation.

The complementary soil and vegetation sampling (Figure 5) that was carried out during the campaign will aid the interpretation and modelling of these results.

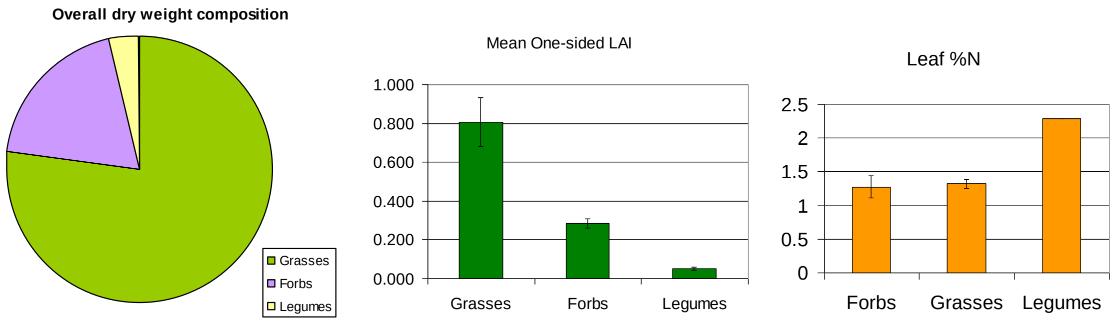

Figure 5: Selected complementary vegetation data

5. Milestones achieved:

None. No milestones are linked to this Deliverable

6. Deviations and reasons:

This deliverable was completed 19 months late due to the problems finding a suitable field site. This resulted in a delay of 12 months since it was not possible to start the experiment in Spring 2012 and we had to wait until Spring 2013. The additional 7 month delay has been due to the time required to analyse the flux data. These delays have not had any repercussions on the progress of other project tasks since this Deliverable was conceived as a stand-alone experiment.

7. Publications:

A summary of these results was presented in an oral presentation at the first CAPERmed meeting, held in Lisbon, Portugal in July 2014:

Theobald, M.R, Sanz-Cobena, A., Coyle, M., Nemitz, E., Twigg, M, Famulari, D, Vieno, M., Vallejo, A. and Sutton, M.A. (2014). Measurement and modelling of pollutant dry deposition to semi-natural Mediterranean ecosystems. Oral presentation given at the first CAPERmed meeting, Lisbon, 3-4- July 2014.

8. Meetings:

Meeting to discuss the experimental set-up were held at CEH Edinburgh in October 2012 and February 2013, as well as ad-hoc meetings during the annual project meetings

9. List of Documents/Annexes:

None