# Project Number 282910

# ÉCLAIRE

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

**Seventh Framework Programme**

**Theme: Environment**

# D2.1 Controlled studies on exchange processes

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Duration: **48 months**

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



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| **Dissemination Level** | | |
| **PU** | Public | X |
| **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

Aim of task 2.1 is the determination of precise relationships between soil trace gas fluxes and climate conditions in order to improve our understanding of the couplings between climate change (warming and precipitation change), pollution and surface-atmosphere fluxes.
Controlled emission measurements of $CO_2$, $CH_4$, $N_2O$, NO and $NH_3$ using monoliths and litter from the ÉCLAIRE flux network.

## 2. Objectives:

Two key factors in the scope of current climate change research are temperature and moisture sensitivities of ecosystem processes. Understanding the environmental drivers of aerobic and anaerobic biogeochemical reactions will provide answers to the question how temperature and moisture effect redox-sensitive biogeochemical cycling and alter the net balance of the gases that contribute to climate change. Soils are a major terrestrial source of the greenhouse gases $CO_2$, $N_2O$ and $CH_4$ in the atmosphere and contribute to the budget of NO. Nitric oxide is stated as a secondary greenhouse gas because of its indirect impact on earth's radiative balance by catalysing tropospheric $O_3$ formation. Ammonia is the most abundant alkaline component of the atmosphere and an important intermediary of the Nitrogen Cycle. Moreover $NH_3$ has many complex effects on ecosystems and is of great industrial importance.

## 3. Activities:

Intact soil monoliths and litter samples from selected ÉCLAIRE flux network sites were incubated in the laboratory in a two-factorial design of different soil moistures (from 20-80% water filled pore space) and soil temperatures (from 5-25°C) and analysed for trace gas fluxes. With this technique, fluxes were estimated of $N_2O$, NO, $CH_4$ and $CO_2$ using a fully automatic laboratory incubation system (Schaufler et al., 2010). Carbon dioxide and NO were analysed by the open flow system using an infrared gas analyser ($CO_2$) and a chemiluminescence analyser (NO). Methane and $N_2O$ were measured with the closed chamber technique and analysis by GC. A customized device to hold soil samples (6 cuvettes) and divert soil emissions to a very sensitive ammonia (+ $H_2O$) measuring device (Picarro G2103 Analyzer for $NH_3$/$H_2O$) was built at BOKU to measure $NH_3$. Soil Samples will be measured for $NH_3$ emissions starting in summer 2014.

## 4. Results:

In general $CO_2$, NO and $N_2O$ emissions were strongly related to both variables temperature and moisture. $CH_4$ was mainly related to moisture. We found that the relationship between $CO_2$ and NO emissions coming from soils and litter with temperature could be well described by the equation $R(T) = R_0 \cdot e^{aT+bT^2}$ ($R^2$ ranges from 0.87 to 1) over all sites. No relationship between temperature and $N_2O$ and $CH_4$ emissions coming from soils could be found.
A linear relationship between $N_2O$ emissions coming from litter with temperature could be found at wet conditions between 60 and 90 %WW. No $CH_4$ emissions coming from litter could be detected.

Highest $CO_2$ emissions coming from soils occurred with intermediate moisture content (40% to 70% WFPS) over all sites, highest NO emissions coming from soils at dry conditions between 5% to 20% WFPS, highest $N_2O$ emissions coming from soils at high moisture content between 60% and 80% WFPS, highest $CH_4$ emissions from soils could be detected at 80% WFPS.

Highest $CO_2$ and NO emissions coming from litter were detected between 60 and 90 %WW. $N_2O$ uptake as well as $N_2O$ emissions could be detected when measuring litter samples with highest $N_2O$ emissions between 80 and 90 %WW.

## 5. List of Documents/Annexes:

See Deliverables_2.1_BOKU.xlsx