# +InGOS – Integrated non-CO2 Observing System

1. **Project name (acronym), name and contact information of the researcher(s), duration of the project (dates, number of working days), type and name of the infrastructure requested**

Project name: **Improving methane flux characterization over an abandoned peat meadow (APE-CH4)**

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| **Researchers** | **Position** | **Institute** |
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Number of working days at the site: July 21-30 2014 (10 days)

Infrastructure: Access to the site of Horstermeer (TNA2), Netherlands.

1. **Background**
   1. Significance of the research

Global mean surface temperature has risen of 0.74±0.18ºC over the past century (Le Treut et al., 2007) primarily due to the increase in greenhouse gas (GHG) atmospheric concentrations associated to fossil fuel emissions and in minor part also caused by other human activities which include land management (i.e.: agriculture, biomass burning,) (Forster et. al., 2007). Wetlands play an important role in the exchanges of GHGs globally as their anaerobic (water-logged) soil conditions favor the accumulation of carbon by slowing the rates of decomposition (wetlands are estimated to store 30% of the terrestrial soil C) yet in contrast they result in the production of methane (CH4) making wetlands responsible for 15% to 40% of current global CH4 emissions (Denman et al., 2007). The GHG budget of wetlands can thus be significantly altered by various management practices, in particular by artificially lowering or rising the water table, the latter being applied in areas subject to re-naturalization as in the case of the Horstermeer experimental site. Considering that about 50% of European peatlands are managed and contribute to substantial fractions ( e.g. 2.3-4.5% in Germany) of total emissions (Drösler et.al., 2008), research is needed to better evaluate the mid-long term effect of the re-naturalization of temperate wetland ecosystems on GHG land-atmosphere fluxes in a context of climate warming.

* 1. Previous research relevant to the topic and how the proposed project links to this

Intensive field campaigns targeting the GHG budget of the Horstermeer peat-meadow by using both micrometeorological and chamber based method, date back to the period 2005-2006 and demonstrated the high spatial variability of CH4 effluxes (Hendriks, 2009). The project builds fully on previous results to be used as a reference to test whether changes in vegetation cover distribution over time have significantly influenced GHG flux rates at ecosystem scale. At the same time it enhances the temporal resolution of flux measurements at plot scale, it tries to individuate methane emission hotspots previously overlooked and to better characterize the GHG fluxes from ditches. A comparative test of gas analyzers used in the old and new campaigns is planned in order to account for instrument related biases.

c. Links with current research of the applicant

The research of the applicant has been so far focused on wetlands ecosystems in western Poland (site of Rzecin): first on the quantification of CO2 uptake of sedge communities by chambers measurements (Chojnicki et al. 2012), then on monitoring the temporal variability of CH4 fluxes at ecosystem scale by eddy covariance technique (Kowalska et al. 2013). The Dutch site of Horstermeer presents analogies with Rzecin wetland for the presence of peat soils and partly of vegetation features.

1. **Objectives**
   1. **Hypothesis and research objectives**

The site was interested by a land use change in the recent past (20 years ago) which triggered a secondary ecological succession with a consequent dynamism of the fractions of different vegetation cover types. The GHG budget of Horstermeer was assessed at a particular point in time (about 10 years after LUC) conducting plot scale measurements of CO2 and CH4 fluxes over areas differing by water saturation and plant cover types (Hendriks, 2009). However a further evolution in the distribution of the various plant cover types and progressive accumulation of sediment and organic material in the ditches has taken place ever since, therefore a change in the magnitude of the land-atmosphere GHG flux is expected. This can be directly dependent on the relative changes of the distribution of plant types across the experimental area or determined also by changes in the specific flux rates of each plant cover type as a response to changes in soil nutrients levels and microbial communities.

The project aims in general at updating the figures of the GHG budget of the peat meadow ecosystem while introducing novel methodological approaches to improve the overall accuracy of the estimates. The following specific research objectives will be addressed:

1. Determination of changes in the plant cover distribution relative to the year 2006
2. Improvement of the flux sampling design through the evaluation of CH4 concentration spatial variability at the soil-atmosphere interface and individuation of CH4 emission hot spots.
3. Determination of plot scale flux rates of CH4/CO2 through continuous chamber- based monitoring
4. Characterization of the contribution of ebullition vs molecular diffusion to the CH4 emissions from ditches, which cover ~10% of the study area.

**b. Connection with the InGOS objectives and the ‘fitness’ of the use of the requested infrastructure to the objectives**

The site infrastructure fully allows to develop the described research activities which are in line with the overall InGOS objectives.

1. **Methods and materials (legal and ethical issues)**
   1. **Research method, explaining how to reach the objective**

1.Evaluation of plant cover types and their distribution

The most recent and cloud free high resolution (2m geometrical resolution) satellite image available (FORMOSAT-2) will be used as a GIS support to draw a vegetation map at site scale on the basis of observations of actual vegetation to be collected during a field survey. The botanical survey will first individuate the characterizing plant cover types consistently with the classification adopted by Hendricks et al. (2009) for the same site and target the same spatial range. The possible presence of new plant cover types, typical of later successional stages, as well the disappearance of others, will be taken into account and the classification scheme will be modified accordingly. Then spatially explicit data of the boundaries of the areas covered by different plant types will be collected by GPS and after the application of post processing differential corrections, plant cover types areas will be finally mapped.

2.Individuation of methane emission hotspots

The site area will be covered with measurements of CH4 concentration by means of a portable gas analyzer along parallel transects. Air sampling will be performed at a fixed height above the ground (i.e.~20cm) and concentration data will be logged at high frequency (1Hz) in parallel with geographical coordinates acquired by a GPS device. 2D concentration fields of methane will be retrieved by geo-statistical interpolation methods (e.g. Kriging) and they will be used to evaluate the adopted flux monitoring experimental design.

3. Use of a set of automated chambers for continuous measurements of CO2 and CH4 fluxes between the grassland and the atmosphere over targeted plant cover types.

During the field campaign a flux monitoring system made of 6 chambers with automated closure/opening connected to a laser spectroscopic gas analyzer will be deployed and tested for continuous monitoring of CH4 and CO2 fluxes at plot scale. A test comparing flux rates measured with laser spectroscopy against a photoacoustic analyzer (Innova 1312), used during previous campaigns at the site, is foreseen. This will allow to detect instrument dependent biases in the flux records while analyzing the whole dataset of chamber based measurements available so far for this site. Automated chambers installed during the planned summer field work will eventually provide a continuous monitoring of fluxes at the site and will allow the assessment of the ecosystem GHG budget by integrating data from different plant cover types.

4. Methane and carbon dioxide fluxes over ditches

Floating chambers (2) will be deployed over the water of the ditch enclosing the site area and CH4/CO2 and flux measurements will be taken using a high frequency (1Hz) gas analyzer which will enable to detect sudden increases of concentration inside the chamber as a result of ebullition episodes. Data processing, developed in MATLAB environment, will allow to distinguish the flux rate attributable to gas diffusion from that associated to gas bubbling inside the chambers. By this method it is possible to evaluate the contribution of ebullition to the total efflux.

1. **Research materials, instrumentation**

Research materials and instrumentation will include a suite of gas analyzers and systems for the measurements of gas concentrations/fluxes of CH4 and CO2 at different spatial and temporal scales:

* Portable gas analyzers: (a) Log Gatos Research, Ultra-portable CH4/CO2 analyzer, (b) Innova 1312 photoacoustic analyzer.
* Floating vented PVC chambers
* Automated chamber system including: PVC collars, 6 transparent vented chambers, tubing and valves + programmable controller, gas analyzer (a) or alternatively a LGR DLT100
* Eddy covariance CO2 flux system (Gill WindMaster, LiCor 7500)-already operating at the site on a continuous basis.
* Garmin GPS
* FORMOSAT-2 satellite imagery (panchromatic, 2m),(hyperspectral, 8m)

1. **Governance procedures, safety precautions, permit requirements and procedures**

No governance procedures or safety precautions are necessary for this project.

1. **Implementation: timetable, budget, distribution of work**
   1. **Timetable for the research including personnel efforts, favorably table wise**

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| *Task* | *Period* | *Researchers involved* |
| **Field campaign at Horstermeer**:  *(Vegetation classification and plants type cover assessment; Measurements of GHG concentration fields; set up of automated chambers system; gas analyzers inter-comparison; measurements of GHG fluxes over ditches)* | 21-30 July 2014 | Natalia Kowalska (applicant)  Luca Belelli Marchesini  Ko van Huissteden |
| Data processing (v*egetation cover map, chamber based fluxes, eddy covariance fluxes)*  Analysis of results | September-December 2014 | Natalia Kowalska  Luca Belelli Marchesini |
| Preparation of manuscript(s) | January-June 2015 | Natalia Kowalska  Luca Belelli Marchesini  Ko van Huissteden |

* 1. **Total budget for travel and logistical support as requested**

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| --- | --- | --- |
| **Cost category** | **Amount (euro)** | **remarks** |
| *Travel (Poznan-Amsterdam)* | *240* |  |
| *Subsistence* | *500* | *50 € \* 10 days* |
| *Transport (Amsterdam-Horstermeer)* | *-* | *In-kind contribution* |
| *Construction material (wood)* | *200* |  |
| **TOTAL** | *940* |  |

* 1. **Plan for specific logistical needs like visa, import/export licenses etc.**

Not applicable

1. **Expected results and possible risks**
   1. **Expected scientific impact of the research**

The analysis conducted in the project will prove insight into the methane emission temporal and spatial dynamics and will be important for development of methane emission models (e.g. Watts et al., 2013) to be used in Earth System Models. Understanding the temporal dynamics of GHG flux rates of a peatland ecosystem at different temporal stages after the abandonment of agriculture represents a valuable study case the results of which can be exploited widely to make projections of GHG fluxes over peatland areas interested by renaturalization.

* 1. **Applicability and feasibility of the research results**

Results can be used for improving the parameterization of existing ecosystem biogeochemical models of CO2/CH4 fluxes and to assess the relative changes in GHG fluxes of recovering temperate wetlands after land use change.

* 1. **Publication plan –tentative titles**

*1. “The influence of spatial variability and temporal dynamics of vegetation cover on the GHG balance of a peat meadow.”*

*2. “Contribution of ebullition to CH4 emissions from the ditches of a Dutch peatland”*

* 1. **Data access plan**

Eddy covariance (NEE flux) and plot scale flux measurements (NEE, CH4) will be delivered to the European Flux Database (http://gaia.agraria.unitus.it) in the first trimester of 2015.

1. **Key literature**

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