# InGOS – Integrated non-CO2 Observing System

Detailed workplan, appendix to the online application. Request for access to an infrastructure (TNA1-TNA2-TNA3). The plan must not exceed 6 pages in 12 pt single line spacing, applications exceeding this limit will not be evaluated. The following information should be included in order to be evaluated:

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: Towards a partitioning of methane emission pathways of *Phragmites australis* (Partitioning CH4-*Phragmites*)

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Duration of the project: 10 days. Visit to the site from 24 November to 5 December 2014 (10 working days)

Infrastructure requested: Eddy covariance system located in the Padul wetland site (Spain)

1. **Background**
   1. Significance of the research
   2. Previous research relevant to the topic and how the proposed project links to this
   3. Links with current research of the applicant

Wetlands store 25%-30% of the global soil carbon pool (Millennium-Ecosystem-Assessment 2005) and are important CO2 sinks. In addition, wetlands act as sources for greenhouse gases (GHG) by emitting methane (CH4) to the atmosphere and potentially nitrous oxide (N2O). In this context, the function of wetlands in relation to global warming will be the balance between net CO2 assimilation, CH4 emission and N2O fluxes. With global warming, wetlands have the potential to release stored carbon, because of the high temperature sensitivity of microbial respiration (Davidson and Janssens 2006), and contribute to the increase of atmospheric CO2 concentrations. However, it is still unknown whether wetlands will convert from long-term carbon sinks to sources as a result of global warming and other anthropogenic effects by increasing the emission of CH4 and decreasing the assimilation of CO2 via photosynthetic processes. Their N2O contribution, could also be of great relevance as the radiative forcing of N2O is 298 times that of CO2 on 100 years’ time horizon (IPCC, 2007).

*Phragmites australis* is one of the most common species found in wetlands and is considered the most widespread and productive wetland plant species in the world(Brix et al. 2001; Zhou et al. 2009).Mesocosms studies, investigating the proportion of CH4emissions by Phragmites australis, have shown that 64% of CH4fluxes are emitted through the plants (Grünfeld et al. 1999). However, up to our knowledge, no similar CH4 flux partitioning evaluation has been done in the field. Moreover previous studies have shown that N2O emissions in wetlands and lakes where Phragmites australis is present can be of great relevance (Songa et al. 2008, Yang et al. 2012). Therefore, it would be interesting to measure simultaneously CO2, CH4 and N2O fluxes to quantify the full greenhouse gas budget of the ecosystem.

The eddy covariance technique (EC) is used worldwide to measure CO2 exchange and water vapor by "flux towers"(Baldocchi et al. 2001) at the ecosystem level. In addition, the recent development of CH4 gas analyzers to measure CH4at fast response has opened the possibility to investigate properly CH4 fluxes at the ecosystem-scale. Eddy covariance provides integrated measurements over a big surface and with a high temporal resolution. However, it does not give detailed information about the different mechanisms and pathways responsible of the emissions. Some other measurement techniques, such as the use of closed chambers, as they are very sensitive because of the large increase in gas concentration in the headspace (Denmead, 2008), might be more adequate to study the smaller scale processes involved in CH4 emissions.

In this context, this project proposes to analyze the GHG exchange (mainly CH4) of a wetland with *Phragmites australis* as the dominant species using these two different techniques, eddy covariance and closed chambers. Eddy covariance measurements will give information about the CH4 budget of the ecosystem, while the chambers, which will be placed on the soil (or water table, depending on the season) excluding the plants, are expected to provide information about the emissions from the soil. We would like to understand if some of the CH4 is transported and released by Phragmites australis. The difference between the estimates from both measurement techniques, would give us information about the magnitude of the different emission processes. Additional N2O analysis with chamber measurement would allow to understand if N2O could have a relevant contribution to the GHG balance in this type of wetlands.

Several studies have already been carried out comparing EC and chamber techniques, including for CH4 fluxes in wetlands, resulting in differences due to several factors (Meijide et al., 2012). More recently, Podgrajsek et al. (2014) have observed good agreements between CH4 fluxes measured with floating chambers in lakes and with EC. We will try to do the flux partitioning of CH4 fluxes emitted through each of the pathways in this ecosystems, through the plants (Phragmites australis) and the soil or water table.

The study will be carried out in *Padul* wetland, site located in southern Spain in a sub-humid warm climate, where Phragmites australis is the dominant vegetation. It is characterized by a mean annual temperature of 16ºC and total annual precipitation of ca. 470 mm. CH4 fluxes are measured by an LI-7700 since January 2013.

The current research of the applicant links perfectly with the project, since the applicant is currently evaluating CH4and N2O fluxes using both EC covariance and chamber techniques in an oil palm plantation in Indonesia, and has run similar experiments in a rice paddy field in Italy (Meijide et al., 2011). Moreover, she has extensively used the closed chamber technique to measure GHG in different Mediterranean ecosystems.

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

Previous studies in wetlands have shown that CH4 is diffused through the water table, but also released through the plants. We hypothesize that the plants could be the main emission pathway in this ecosystem. In relation to N2O fluxes, as wetlands are an anaerobic system, where denitrification is expected to be the most relevant nitrogen related process, and where there are no great nitrogen inputs, not great N2O fluxes should be expected. However, previous studies have shown that N2O emissions can be relevant in wetlands dominated by Phragmites australis. Therefore, it would be interesting to measure N2O emissions during a full year, and see if the ecosystem behaves as an N2O sink during certain periods, which could counteract some of the global warming effect caused by CH4 emissions.

The objectives of this project are (1) to design an effective chambers system to measure soil/water CH4 and N2O emissions, (2) to test the validity of the chambers system design, doing some measurement tests. Consequently, after this TNA2, the UGR team will be able to measure along one year; (3) to understand the different emission pathways for CH4 in a wetland dominated by Phragmites australis, and gain insight on the relative contribution to each of them into the global CH4 emission from the ecosystem; and (4) to evaluate the relevance of N2O emissions in a wetland dominated by Phragmites australis under sub-humid warm climate and establish a full greenhouse gas balance of the ecosystem.

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

The proposed project about the combination of eddy covariance measurement with chambers to test viability of these methodology to partition CH4 emitted through the plants (Phragmites australis) and the soil or water table, is very well connected with one of the most important objectives of InGOS: Improve measurement methods by testing new innovative techniques and strategies. Padul, dominated by Phragmites australis, with hug capability to emit CH4 through itself, is the perfect site for this project.

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

The proposed objectives will be reached by comparing the results fromCH4 measurements withEC and chambers, and evaluating the N2O chamber measurements. Eddy covariance CH4 measurements are already running in the site, and chamber measurements will start in December 2014 and will be takenon a bi-weekly basis for 1 year. University of Granada will be in charge of running the EC system and take the samples from chambers. Eight rings will be permanently installed in the site. Chambers will be designed in a way that they can be fitted to the rings. Sampling will be done by closing the chambers, and removing 4 samples from the chamber headspace at a constant time interval after closure. The exact closing time of the chambers will be decided after doing tests for linearity of the concentration of the gases of interest in the chamber headspace. Air samples will be taken with a syringe and stored in glass vials, and analyzed forCH4 and N2O concentrations at the University of Granada.

* 1. Research materials, instrumentation

The EC covariance systems is already running at the site measuring CO2, H2O and CH4 fluxes. For the chamber measurements the following material will be required: metal to build the rings, plastic for the chambers (exact design of the chambers still needs to be decided), septums, syringes, 3-way valves and glass vials.

The gas-chromatograph required for the analysis of the samples is already available at the University of Granada.

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

Not applicable.

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

|  |  |  |
| --- | --- | --- |
| *Task* | *Date* | *Personnel* |
| Seminar by the applicant about GHG flux measurements using chambers | 24/11/2014 | Ana Meijide (applicant) |
| Visit to Padul site | 25/11/2014 | Ana Meijide  Penélope Serrano Ortiz |
| Preparation of material for chamber measurements, placement of chamber rings, first chamber measurement at Padul site | 26/11-02/12/2014 | Ana Meijide  Enrique Pérez Sánchez Cañete  Ana López Ballesteros |
| Analysis of samples, discussion of results, sampling strategy for the upcoming year and paper outline | 03-05/12/2014 | Ana Meijide  Andrew S. Kowalski  Penélope Serrano Ortiz |

The collaboration between the applicant and the group responsible of Padul site (University of Granada) is planned to continue during 2015. University of Granada will continue running the CH4 EC system at Padul site, and take care of chamber sampling. During the proposed visit to the site by the applicant, she will install the rings in the field and show people at University of Granada how to do the sampling. The applicant will then be responsible of processing of the chamber data and calculation of the fluxes. Ana Meijide and Penélope Serrano-Ortiz will work in close collaboration during 2015 in order to obtain the expected results and write a paper.

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

The total budget requested would be the necessary to cover the flights from Göttingen (Germany), accommodation and expenses in Granada during the 2 weeks she will stay there. The estimated amount would be 1100 €.

* 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
   2. Applicability and feasibility of the research results
   3. Publication plan
   4. Data access plan

The results obtained about flux partitioning of CH4 fluxes in this type of ecosystem could be of relevance for the development of mitigation strategies or to understand if the ecosystem will become a carbon source under changing climatic conditions, as a better knowledge of the mechanisms responsible of the fluxes is therefore required.

The main risk of the proposed project could be that the results obtained with EC and chambers, would not allow to do the flux partitioning because of differences in the resolution of both techniques. If this was the case, we might consider building chambers were plants are also included, to better compare the CH4 fluxes from the wetland before doing the flux partitioning. We also expect to estimate the full GHG budget of the wetland combining the measured CO2, CH4 and H2O fluxes. The obtained results will be published in an international research journal.

1. **Key literature**

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Davidson EA, Janssens IA (2006) Temperature sensitivity of soil carbon decomposition and feedbacks to climate change. Nature 440:165-173

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IPCC (2007) Climate Change 2007: The Physical Science Basis. Contribution of Working Group I to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change. Cambridge University Press, Cambridge, United Kingdom and New York, NY, USA.

Meijide A, Manca G, Goded I, Magliulo V, di Tommasi P, Seufert G, Cescatti A (2011) Seasonal trends and environmental controls of methane emissions in a rice paddy field in Northern Italy. Biogeosciences, 8:3809–3821

Millennium-Ecosystem-Assessment (2005) Ecosystems and Human Well-being: Wetlands and Water Synthesis, Washington, D. C.

Podgrajsek E, SahléeE, Bastviken D, Holst J, Lindroth A, Tranvik L, Rutgersson A (2014) Comparison of floating chamber and eddy covariance measurements of lake greenhouse gas fluxes. Biogeosciences 11: 4225–4233

Songa C, Zhanga J, WangaY,Wangc Y, Zhaoa Z (2008) Emission of CO2, CH4 and N2O from freshwater marsh in northeast of China. Journal of Environmental Management 88: 428–436

Yang Z, Zhao Y, Xia X (2012) Nitrous oxide emissions from Phragmitesaustralis-dominated zones in a shallow lake. Environmental Pollution 166:116–124

Zhou L, Zhou G, Jia Q (2009) Annual cycle of CO2 exchange over a reed (Phragmitesaustralis) wetland in Northeast China. Aquatic Botany 91:91-98