# 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**

Nitrous oxide flux inter-comparison campaign.

Period 15.4-29.4 2013

Name of applicant: Christian Brümmer (Thünen Institute, ICOS Germany)

TNA-site: RISO Willow Field

1. **Background**

Measurements of greenhouse gas fluxes from soils are still associated with great uncertainty due to insufficient methodologies. GHG budgets are consequently inexact, and there’s a need for improved approaches to improve current estimates. Recent developments have led to new instruments for real-time determination N2O concentrations in air that opens for new approaches to determine surface N2O fluxes. Fast response and sensitive instruments (e.g. QCL and Off-axis instruments) have the potential to be used in combination with conventional flux chambers and thereby achieve significant reductions on chamber closure times combined with the use of a number of increased chambers to cover spatial variability. Moreover, the new instruments are also applicable for use with micro-meteorological techniques (EC, gradients) as means to determine fluxes at the field scale. Meanwhile, knowledge on the suitability for the different approaches and their performances under realistic, environmental conditions is sparse, and there is a need for more thorough method inter-comparison for verification and improvement.

ICOS Germany is currently running through a Pilot and Demonstration Phase during which field methods will be tested. The Thünen Institute has developed an automated chamber system for the detection of small N2O fluxes, which will be compared to eddy covariance measurements during the Risø field campaign. The results will be used for the standard protocol for chamber measurements in ICOS.

1. **Objectives**

The proposed research activity has the objective to perform an inter-comparison of multiple chamber- and micro-meteorologically based techniques to study soil surface effluxes of nitrous oxide. The different combinations of analyzers and accessories included in the campaign are: chamber+GC – chamber+QCL – chamber+FTIR – EC+LGR – EC+QCL. Thus, the conventional chamber+GC method will be compared with more recent “state-of-the-art” methodologies, and the new generation of analyzers will be tested for performance both with chamber based approaches and micro-mets.

The activity conforms strictly with the several of the objectives of InGOS, i.e. to “Harmonize and standardize the measurements” and to “”Improve measurement methods by testing new innovative techniques and strategies”.

The RISO Willow super site has an excellent infrastructure to perform this campaign, and moreover the site will be managed accordingly to achieve expected high N2O effluxes during the campaign.

1. **Methods and materials (legal and ethical issues)**

The measuring equipment comprises two quantum cascade lasers (QCL), which are capable of providing high precision measurements of the nitrous oxide concentration at frequencies up to 10 Hz. One QCL will be connected to an eddy covariance system the other to automatic chambers. Chamber measurements will be conducted as a closed dynamic system (e.g. Pumpanen et al. 2009) comprising 3 chambers that are connected to the analytical unit by means of a multiplexer. The analytical unit contains a QCL laser to detect N2O, CO and H2O concentrations, a CO2 sensor and an automated flask sampling unit. The flasks will be analyzed consecutively by means of a gas chromatograph. Previous tests of the equipment have shown that using the QCL it is possible to estimate fluxes more reliably than what is possible with gas chromatography, especially under low flux conditions.

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|  | Fig. 1: Scheme of the chamber system, comprising 3 automated chambers, a multiplexer, a CO2 sensor (LI 820) and a QCL for N2O, CO and H2O. In order to compare flask and QCL measurements an automated flask sampling unit is also integrated. |

The transport of the equipment requires a van that can be provided by the Thünen Institute. However, ferry transfer costs (about 1000 €) should be supported.

1. **Implementaton: timetable, budget, distribution of work**

**Involved persons**

Bjarne Lyshede has recently started a PhD study of greenhouse gas fluxes and soil carbon storage in oilseed rape cultivation with special focus on the GHG balance of rapeseed biodiesel. As nitrous oxide is a significant greenhouse gas in agricultural systems, research into nitrous oxide dynamics and measurement techniques has a natural link to the topic.

Jeremy Smith, Jean-Pierre Delorme and Dirk Lempio are technicians who are currently involved in the development of automated chamber systems for ICOS Germany.

Christian Brümmer is a senior scientist from the Thünen Institute with an expertise on flux measurements of GHG and reactive nitrogen.

**Timetable for the research including personnel efforts and costs**

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| --- | --- | --- | --- |
| Day | Task | Persons | Costs |
| 8.4.2012 | Transport to Risø  Travel to Risø | Dürrkopp (Van),  Smith, Delorme, Lempio  Accomodation | ~500 €  ~200 €  300 € |
| 9.4.2012 | Installation | Lyshede, Smith,  Delorme, Lempio | 300 € |
| 10.4.2012 | Installation | Lyshede, Smith,  Delorme, Lempio | 300 € |
| 11.4.2012 | Installation | Lyshede, Smith,  Delorme, Lempio | 300 € |
| 12.4.2012 | Installation | Lyshede, Smith,  Delorme, Lempio | 300 € |
| 12.4.2012 | Return to Germany | Smith,Delorme, Lempio | ~200 € |
| 13.4.2012 | Measurements and maintenance | Lyshede | 24 € |
| 14.4.2012 | Measurements and maintenance | Lyshede | 24 € |
| 15.4.2012 | Measurements and maintenance | Lyshede | 24 € |
| 16.4.2012 | Measurements and maintenance | Lyshede | 24 € |
| 17.4.2012 | Measurements and maintenance | Lyshede | 24 € |
| 18.4.2012 | Measurements and maintenance | Lyshede | 24 € |
| 19.4.2012 | Measurements and maintenance | Lyshede | 24 € |
| 20.4.2012 | Measurements and maintenance | Lyshede | 24 € |
| 21.4.2012 | Measurements and maintenance | Lyshede | 24 € |
| 22.4.2012 | Measurements and maintenance | Lyshede | 24 € |
| 23.4.2012 | Measurements and maintenance | Lyshede | 24 € |
| 24.4.2012 | Travel to Risø | Smith, Delorme, Brümmer  Accomodation | ~200 €  300 € |
| 25.4.2012 | Dismanteling of instruments | Lyshede, Smith,  Delorme, Brümmer | 300 € |
| 26.4.2012 | Preparation of transport,  Transport back to Germany | Lyshede, Smith,  Delorme, Brümmer  Dürrkopp (van) | ~200 €  ~500 € |

Total costs are about 4164 €. Total Logistical needs have been coordinated with the host at the RISO Willow Site, and are fulfilled. An import license for ECD in GC has been issued by the Danish Government.

1. **Expected results and possible risks**

Results from this campaign will foremost be applicable for the method inter-comparison as outlined above. Conclusions from this work will inevitably be useful for future development and fine-tuning of greenhouse gas flux methods, and will consequently contribute to improve current estimates of GHG balances.

The field-campaign will be followed up by a workshop hosted by Risø-DTU beginning 2014 when a more thorough plan for publication will be outlined. It is expected that at least one joint peer-reviewed publication will be developed from the campaign.

**Data access plan**

Data will be freely available for the other participants under fair use conditions (e.g. ICOS data policy). We intend to actively participate in data evaluation and publishing integrated results.

1. **Key literature**

Christensen, S., Ambus, P., Arah, J.R.M., Clayton, H., Galle, B., Griffith, D.W.T., Hargreaves, K.J., Klemedtsson, L., Lind, A.-M., Maag, M., Scott, A., Skiba, U., Smith, K.A., Welling, M., and Wienhold, F.G. 1996. Nitrous oxide emission from an agricultural field: Comparison between measurements by flux chamber and micrometeorological techniques. Atmospheric Environment. 30:4183-4190.

Hensen, A., Groot, T.T., van den Bulk, W.C.M., Vermeulen, A.T., Olesen, J.E. and Schelde, K. 2006. Dairy farm CH4 and N2O emissions, from one square metre to the full farm scale. Agriculture, Ecosystems & Environment 112: 146-152.

Pumpanen J, Longdoz B, Kutsch WL (2009). Field measurements of soil respiration: principles and constraints, potentials and limitations of different methods. In: Kutsch WL, Bahn M, Heinemeyer A (eds.) Soil Carbon Dynamics – An Integrated Methodology. Cambridge University Press, 16-33

Venterea, R.T., Spokas, K.A. and Baker, J.M. 2009. Accuracy and precision analysis of chamber-based nitrous oxide gas flux estimates. Soil Science Society of America Journal 73: 1087-1093.