# InGOS – Integrated non-CO2 Observing System

Detailed workplan for the request for access to an infrastructure Risoe Willow field.

1. **Project name: N2O intercomparison Denmark**
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   * **Duration: 3 day setup, 4 weeks on line assistance, 2 day repatriation**
   * **RWd’s : 10**
   * **Site: Risoe Willow field**
2. **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.

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

Kroon, PS, Hensen, A, Jonker, HJJ, Zahniser, MS, Veen, WH van 't & Vermeulen, A., 2007: Suitability of quantum cascade laser spectroscopy for CH4 and N2O eddy covariance flux measurements. Biogeosciences, 4, 715-728.

Kroon, P.S., Hensen, A., van den Bulk, W.C.M., Jongejan, P.A.C., Vermeulen, A.T., 2008: The importance of reducing the systematic error due to non-linearity in N2O flux measure-ments by static chambers. Nutr. Cycl. Agroecosyst. 82, 175–186, doi:10.1007/s10705-008-9179-x.

Kroon, P. S., Hensen, A., Jonker, H. J. J., Ouwersloot, H. G., Vermeulen, A. T., and Bosveld, F. C., 2010: Uncertainties in eddy covariance flux measurements assessed from CH4 and N2O observations, Agr. Ecosyst. Environ., 150, 806–816..

Kroon, P. S., Schrier-Uijl A. P., Hensen A., Veenendaal E. M., Jonker H. J. J., 2010: Annual balances of CH4 and N2O from a managed fen meadow using eddy covariance flux measurements. Eur. J. Soil Sc. 61,2010

Hensen,A. Methods for observation and quantification of trace gas emissions from diffuse sources, thesis VU Amsterdam, 2012

Links with current research of the applicant

ICOS preparatory phase: http://www.icos-infrastructure.nl/

Cost action: http://www.abba.ethz.ch/

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)**
   1. Research method, explaining how to reach the objective

ECN will apply the eddy covariance technique to evaluate the emissions upwind of a small 2 m tower. These data should provide 15 minute resolution data on the dynamics of the N2O (and CH4) emission pattern. The data will be available for comparison with the other techniques on site. Aim is both to get a better understanding of the emission process and to improve the measurement methodology to assess these emissions.

* 1. Research materials, instrumentation

ECN will provide the QCL instrument linked with a sonic anemometer. With this instrument CH4, N2O and H2O will be measured simultaneously the data will be made available for further processing.

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

No governance or permit issues are foreseen.

1. **Implementaton: timetable, budget, distribution of work**
   1. Timetable for the research including personnel efforts, favorably table wise
   2. Total budget for travel and logistical support as requested
   3. Plan for specific logistal needs like visa, import/export licenses etc.

Logistical needs have been coordinated with the host at the RISO Willow Site, and are fulfilled.

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, ECN data will be available for the project partners and uploaded to the InGOS flux data database either at the end of the InGOS project or earlier when evaluateion by ECN and/or partners has been done.

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.

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