InGOS – Integrated non-CO_2 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

InGOS Measurements for Footprint Evaluation

Dr Natascha Kljun (Associate Professor/Reader)
Dept of Geography, Swansea University, Swansea SA2 8PP, UK
phone: +44 1792 602801, email: n.kljun@swansea.ac.uk
21-23 April 2014, 3 days
Access to Norunda station (TNA2), Sweden

2. Background

a. Significance of the research

Aim: Field measurements to develop a dataset for upscaling surface sources/sinks to tall-tower scale.

Footprint models are used to determine the area of influence to measurements. Knowledge of this area is essential for correct interpretation of tower measurements and for upscaling exercises, especially in the case of tall towers within heterogeneous landscapes. This fact has been acknowledged by the InGOS participants at the very early project/planning state. We have very recently improved an existing footprint model (based on Kljun et al. 2002, 2004) allowing it to include heterogeneous surfaces using surface characteristics derived from airborne LiDAR data.

The suggested field work will set up and be the starting point of a series of transect chambers measurements of CH_4 and CO_2 (see Figure 1) for evaluation of the above footprint model; the data will also be available for comparison with other footprint models or upscaling exercises used within InGOS.

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

Natascha Kljun conducted an airborne survey of the Norunda site in 2011 (UK NERC/ARSF funding), collecting high-resolution LiDAR and hyperspectral data of an area of 4 km x 4 km centered at the flux tower. Maps of digital elevation, tree height, canopy height, and leaf area index were derived on the basis of the LiDAR data. The combination of LiDAR and hyperspectral data allows for further discrimination of deciduous and coniferous trees.

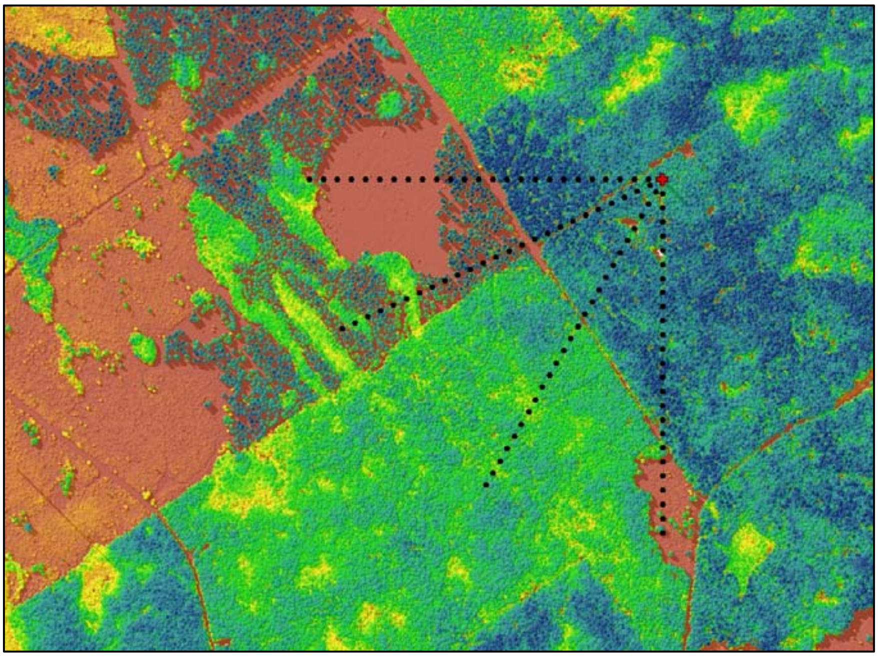

Fig. 1: Location of collars for chamber measurements of CH_4 and CO_2 (black dots, each transect covers a distance of 750 m). The tower location is depicted by the red cross. The background map is tree height from LiDAR measurements for illustration.

c. *Links with current research of the applicant*

The applicant has been at the forefront of footprint modelling for the last ten years. A similar methodology has been highly successful in partitioning net ecosystem uptake to C3/C4 plant pathways at a tall tower in Hungary.

3. Objectives

a. *Hypothesis and research objectives*

In line with InGOS objectives, we suggest using a footprint model as a tool for interpretation and allocation of sources and sinks for greenhouse gases measured at tall towers. So far, only sparse data are available for in-situ validation of footprint models. By classification and quantification of CH_4 and CO_2 surface fluxes within the footprint of tower-mounted instruments, we aim to develop a tool available to all InGOS tall tower sites. Further, the derived dataset will be available for comparison of several footprint models used by the InGOS team.

In addition to CH_4, we suggest using CO_2 as tracer, as CO_2 flux measurement techniques (using eddy covariance systems) at tower level are already well established. The same modelling approach will be applied to the CH_4 soil chamber data to test the footprint model for fluxes derived from the similarity-theory-method of CH_4 tower measurements. This is based on the assumption that even though fluxes, sources and sinks of CH_4 and CO_2 differ, the transport/dispersion of both greenhouse gases is comparable.

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

It is a set goal of InGOS to upscale and understand CH_4 sources/sinks from tall-tower measurements and it has been suggested to use footprint models for this exercise.

CH_4 similarity-theory approach and CO_2 flux measurements at several levels at the tall tower of Norunda, together with existing scattered soil chamber data for CH_4/CO_2, provide an ideal set up for this experiment. Furthermore, we have recently collected high-resolution LiDAR and hyperspectral data for Norunda and can hence use these data for running the updated version of the footprint model.

4. Methods and materials (legal and ethical issues)

a. *Research method, explaining how to reach the objective*

1) Setting up and starting chamber measurements along 4 transects of 750 m length, each with 25 collars, totaling 100 collars within 3000 m all situated within the main footprint of the tower (see Figure 1).

2) The field measurements will proceed throughout the growing season, with at least one measurement series per month (undertaken by site-affiliated ICOS technicians) to allow analysis of seasonal variability.

3) A footprint climatology will be derived based on turbulence input from the flux tower and on surface input from the LiDAR data. The footprint climatology describes the source/sink probability and the extent of the area measured by the tower instruments.

4) Upscaling exercise: allocation of CH_4 and CO_2 chamber measurements to surface/vegetation types and upscaling using footprint climatology.

b. *Research materials, instrumentation*

- Los Gatos Research ultraportable CH_4/ CO_2/H_2O chamber
- CH_4 concentration, CO_2 flux, turbulence data from tall tower
- Soil temperature, soil moisture probes
- LiDAR/hyperspectral data
- Footprint model

Availability of data and instrumentation has been discussed with site-PI Prof Anders Lindroth.

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

No special safety precautions or permits are required for the proposed work.

5. Implementation: timetable, budget, distribution of work

a. *Timetable for the research including personnel efforts, favorably table wise*

Field visit of the Norunda field site by Dr Natascha Kljun (Swansea University, UK) from 21 to 23 April 2014, to set up and run a first measurement series. Further measurements at the selected locations will be undertaken by the site-affiliated ICOS technicians (at least once per month during the growing season).

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

The timing of this field visit is set up such that it can be combined with a visit of Dr Kljun at Lund University. Hence only national transportation is requested and transport from/to UK is an in-kind contribution.

Train/Bus Lund – Uppsala/Bjorklinge return:	EUR 250
Accommodation at the Norunda site at no cost:	EUR 0
Subsistence for 3 days (3 x 50 EUR):	EUR 150
Total:	**EUR 400**

c. *Plan for specific logistal needs like visa, import/export licenses etc.*

n/a

6. Expected results and possible risks

a. *Expected scientific impact of the research*

1) Dataset for upscaling exercises and for testing of footprint models.

2) Evaluation of a footprint model that will be available to all InGOS tall-tower sites. It will be capable of processing long-time series of data, i.e. high temporal resolution for several years of data.

b. *Applicability and feasibility of the research results*

The dataset of CH_4 and CO_2 chamber measurements within the source area of the tower will provide valuable information for current and future projects (e.g. PhD studies).

The footprint tool/comparison of different footprint models will be a well-suited instrument to other tall tower sites and will complement already existing InGOS projects.

Transferability and suitability of methodology, data collection and expected results has been discussed with site PI Prof Anders Lindroth and his team.

c. *Publication plan*

To be determined by site PI

d. *Data access plan*

To be determined by site PI

7. Key literature

a. List of references used in the working plan

Barcza, Z., A. Kern, L. Haszpra, N. Kljun, 2009: Spatial Representativeness of Tall Tower Eddy Covariance Measurements Using Remote Sensing and Footprint Analysis. Agricultural and Forest Meteorology, 149, 795-807.

Gelybó, G., Z. Barcza, A. Kern, N. Kljun, 2013: Effect of Spatial Heterogeneity on the Validation of Remote Sensing Based GPP Estimations, Agricultural and Forest Meteorology, 174-175, 43-53.

Kljun, N., P. Calanca, M.W. Rotach, H.P. Schmid, 2004: A Simple Parameterisation for Flux Footprint Predictions. *Boundary-Layer Meteorology* 112, 503-523.

Kljun, N., M.W. Rotach, H.P. Schmid, 2002: A 3D Backward Lagrangian Footprint Model for a Wide Range of Boundary Layer Stratifications. *Boundary-Layer Meteorology* 103, 205-226.

Vesala, T., N. Kljun, Ü. Rannik, J. Rinne, A. Sogachev, T. Markkanen, K. Sabelfeld, Th. Foken, M.Y. Leclerc, 2008: Flux and Concentration Footprint Modelling: State of the Art. Environmental Pollution 152, 653-666.