Application for funding from the INTERACT Transnational Access programme

1. General Information

Project Title:	Greenhouse gas exchange in boreal wetland and freshwater ecosystems: a multi-scale approach.
Project Acronym:	GHG-FLUX
Principal Investigator:	Ivan Mammarella (ivan.mammarella@helsinki.fi)
Co-investigators:	Pavel Alekseychik (pavel.alekseychik@helsinki.fi) and Sigrid Dengel (Sigrid.dengel@helsinki.fi)
Contact Address:	University of Helsinki, Department of Physics, Division of Atmospheric Sciences P.O. Box 48, Dynamicum, room 1D14b FI 00014 Helsinki (Finland)
Research sites:	Mukhrino Field Station (RU)
Project duration:	50 mandays (three people for 10 days in April 2014 and two people for 10 days in September 2014)

2. Background

Despite covering less than 3% of the Earth's land surface, boreal and subarctic peatlands store between 270 and 370 TgC as peat (Turunen et al., 2002), which would amount to 34-46% of the 796 TgC currently held in the atmosphere as CO_2 (IPCC, 2007). This is the result of peatlands acting as sink of atmospheric CO_2 for millennia. Global warming and land use change may act to destabilize this huge carbon pool. However, the future net CO_2 and CH_4 exchange is widely uncertain and it will depend on the extent of near-surface permafrost thawing and the local thermal versus hydrological regime variations. In this respect, the role of freshwaters (lakes, rivers, reservoirs) may become more important, since part of this carbon pool is transported as dissolved carbon to aquatic ecosystems (Battin et al., 2009). Globally, after wetlands, lakes are the major natural source of methane (average estimates for wetlands = 180 $TgCH_4y^{-1}$, and for lakes= 103 $TgCH_4y^{-1}$). According to recent global scale estimates (Bastviken et al., 2011), the freshwater carbon emission is of the order of 79% of the land carbon sink (which currently does not include inland aquatic ecosystems). However, documentation of lake methane emission is limited, and the actual annual estimates are very uncertain, because they are mostly estimated by indirect methods and short term field measurements. In Western Siberia, the range of emission rates and its large uncertainty are similar, and discontinuous and short-term observations (static chamber technique) have been often used to derive regional and long term methane emission rates (e.g. Glagolev et al., 2011; Sabrekov et al., 2011). Current climate models do not explicitly include northern peatland and aquatic ecosystems, because relationships between small scale processes and fluxes at ecosystem scale are poorly known (Limpens et al., 2008). In this project we try to address such relationships in two topics relevant for climate change studies: a) methane emissions from boreal wetlands; b) gas exchange in aquatic ecosystems. A bottom-up approach is used, where small scale transport processes at water/soil - air interface are measured, parameterized and upscaled, and the resulting gas exchange rates are then compared to gas fluxes measured at larger scales. Such integrated multi-scale approach requires long-term field observations at different spatial and temporal scales, intensive measurement campaigns, laboratory experiments, and theoretical framework for the process based models. The user group will be responsible of ecosystem scale flux measurements performed by eddy covariance

technique, and the local scientists (Evgeny Zarov from Yugra State University and Leonid Golubyatnikov's group from A.M. Obukhov IAP RAS, Moscow) will be in charge of measurements by static chambers (small scale flux). The link between the user group and the local scientists has been established recently through a new FP7 Marie Curie IRSES project, coordinated by Ivan Mammarella, with Leonid Golubyatnikov being one of the project partners. The IRSES project will start at the end of 2013, and it will run for 3 years. Funding given by IRSES programme includes only of a flat rate allowance (about 60 euro per day) for each person visiting a third country (in this case Russia). This amount is apparently insufficient, and the INTERACT funds we apply for with this proposal are essential for the success of this research initiative.

3. Objectives

The objectives of this study are:

- To quantify CH_4 and CO_2 exchange rates (fluxes) over lake and wetland ecosystems (surrounding the Mukhrino Field Station) by means of eddy covariance (EC) method.
- To determine the diurnal and seasonal variations of CO_2 and CH_4 fluxes;
- To compare different flux measurement methods for CH_4 (chamber vs eddy covariance method); while there are several inter-comparison studies for CO_2, the studies for CH_4 are scarce.
- To exchange knowledge and information regarding existing wetland/lake GHG flux monitoring methods, already available data sets, access etc at the station, in order to assess the potential for establishing long term monitoring programme together with the local scientists, based on multi-methods approach.

These objectives fit in well with the overall INTERACT strategy. First of all, the project will bring new insights for studies of ecosystem feedback to climate change, by means of continuous and direct EC flux measurements. Second, the user group will offer training to local scientists during and after this project, in such way that they will be able to continue GHG flux measurements as permanent and long term monitoring at the station. Third, this research activity and potentials for new collaborations will strength the international dimension of PhD student Pavel Alekseychik (GHG-OBS Co-Investigator), who is working with the GHG exchange processes in Finnish boreal wetlands.

4. Research methods and material, ethical issues

Direct and continuous measurements of energy, CO_2 and CH_4 fluxes are performed by eddy covariance method, which provides exchange rates (fluxes) at ecosystem scale at high temporal resolution (30 min), extending 100 m – 1 km away from the tower (Aubinet et al., 2000). At Mukhrino field site (60°54' N, 68°42' E), one EC system (Gill R3 + Licor 7000 and Licor 7500) for energy and CO_2 flux measurements was already purchased few years ago. However, because of the lack of expertise of the local scientists, those measurements have never been started (Evgeny Zarov, Yugra State University, personal communication). In this project, we will bring our long-term experience to the local scientific community, start the EC measurements, and offer training to the local scientists on EC systems maintenance in the field and data storage. Moreover, we will bring our own CH_4 gas analyser to the station for measuring CH4 fluxes during April – September 2014. The location of the EC flux tower will be decided (together with local scientists) before the visit. In this respect, we will carefully consider practical logistic arrangements (access to the tower and connection to the power cable network of the site), meteorological conditions and the location of the chambers at the site. Data already collected at the Mukhrino automatic meteorological station will be used to assess the prevailing wind direction and together with footprint analysis, appropriate location and height of the flux tower will be assessed. The raw EC data are collected then in a local

computer, and transferred via remote connection to a computer server in Helsinki, where further data analysis is done. The final fluxes will be calculated by using the advanced post-processing software EddyUH (www.atm.helsinki.fi/Eddy_Covariance), developed by our group. Finally, the flux dataset is shared with the local scientists, and used for further reports and peer-reviewed publications on GHG exchange processes and budgets of lakes and different wetland types located around the station. As agreed with the station's manager, we will apply for a research permit for our activities after the INTERACT funding decision.

Implementation: timetable, budget, distribution of work

Three persons are going to the station for ten days each in April 2014 to set up an EC flux tower, start the measurements and give a short training on EC system maintenance to the local scientists. Nowadays the EC fluxes monitoring systems are very stable and they run automatically without any need for maintenance. After the visit we will follow on daily basis the measurements via remote connection from Helsinki. In case some basic maintenance is needed, we will give instructions to the local scientists, who have easy access to the EC system in the field. There is a potential risk (although it is very low) that a more serious instrument failure happens, and in this case one person from our group will visit the station (other funding will be used for this). In September 2014, two persons (Ivan Mammarella and Pavel Alekseychik) will visit again the station for 10 days, in order to stop the CH_4 flux measurements, to ensure that the other EC flux measurements are running properly, and to plan further scientific activities with local scientists (data sharing, further development and validation of process-based models, joint scientific publications). The exact travel dates are likely to be confirmed after further discussions with the site manager.

Site	Proposed Periods	Person	Number of mandays
Mukhrino Field Station	April 2014	Ivan Mammarella Pavel Alekseychik Sigrid Dengel	10 10 10
Mukhrino Field Station	September 2014	Ivan Mammarella Pavel Alekseychik	10 10

Activity	Costs
Return flight Helsinki / Moscow / Khanty-Mansiysk (April 2014)	400 euro x 3 people
Return flight Helsinki / Moscow / Khanty-Mansiysk (September 2014)	400 euro x 2 people
Accommodation and meals at the station	Given by the station manager
Visa for Ivan Mammarella and Sigrid Dengel (April 2014) Visa for Ivan Mammarella (September 2014)	65 euro x 2 people 65 euro
Equipments (CH_4 gas analysers + pump) shipping costs (Helsinki – Mukhrino Station) + Custom fees	2500 euro
Equipments (CH_4 gas analysers + pump) shipping costs (Mukhrino Station - Helsinki) + Custom fees	2500 euro
Total applied for	7195 euro + accommodation and meals at the station
*Pavel Alekseychik is from Russia and no visa is needed for him.	

Expected results and possible risks

A joint multi-methods database of gas exchange in aquatic and northern peatland ecosystems is provided. EC ecosystem scale data, together with small scale fluxes (measured by a chamber network) provide new insight on spatio-temporal dynamics of methane emission processes and their relative contribution. The dataset will be open access, shared between the user group and the INTERACT site, and if possible it will be also included in international database (e.g. FluxNet).
The scientific results will be actively presented in international and national conferences and workshops of relevance, and will be published in international peer-reviewed journals. In addition, a newsletter report will be written for publication via the INTERACT outreach website.
Finally, it is expected that this work can provide the basis for future collaborations and research activities with Russian scientists, through for example, international initiatives such like The Pan Eurasian Experiment (PEEX), coordinated by University of Helsinki.

5. References by the user group

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6. Other references

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