INTER-ACT call 2013-2014: Research plan

1. General information

Project name: Effect of vegetation cover on dissolved organic carbon in peatlands

Acronym: EVEDOC

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Research site: Shapsha-Mukhrino Field Station (Russia)

Duration of the project: 15 man-days from 30/06/2014 to 14/07/2014 (tentative dates depending on the phenology of the vegetation)

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2. Background

Peatlands are efficient sinks of atmospheric carbon (C) since the last glaciations (Smith et al. 2004), but this biogeochemical capacity is strictly dependent on suitable climate conditions, in particular the presence of a water surplus creating permanent anoxic conditions in the peat soil. As consequence, any change of climate favoring soil oxygenation can reduce peat accumulation by increasing the decomposition of old organic matter and, on the other hand, by reducing the yearly accumulation of recalcitrant plant litter by peat mosses (Limpens et al. 2008).

Northern hemisphere peatlands contain one-third of the world's soil organic C stock (c. 455 Gt) despite accounting for only 3–5% of total terrestrial surface. Climate warming has been proved to affect peatlands by, for example, increasing the decomposition of old organic C (Dorrepaal et al. 2009), but also promoting the spreading of vascular plants (= shrub encroachment), which tend to become more abundant (Bragazza et al. 2013). A change in the vegetation cover is expected to affect C accumulation because, if the underlying layer of *Sphagnum* (= peat) mosses will be outcompeted by vascular plants, the production of recalcitrant litter by peat mosses will diminish (Ward et al. 2009). In addition, it has been proposed that increasing vascular plant cover can alter microbial C cycling through change in litter chemistry and root exudates. To what extent vascular plant cover can affect peat accumulation remains however still unclear.

Western Siberia contains the most extensive peatlands at global scale (Sheng et al. 2004, Smith et al. 2004) and recent researches have shown as climate warming can increase the release of C as dissolved organic carbon (DOC) (Frey & Smith 2005). However, possible mechanisms responsible for enhancing surface water DOC are still unclear, and may include both a direct effect of higher air temperature on microbial decomposition (Freeman et al. 2001), but also an indirect effect of root exudates due to enhanced plant growth (Fenner et al. 2009).

The proposed project EVEDOC will be part of a broader latitudinal and altitudinal survey, headed by the group leader, which links shrub encroachment to surface water DOC in peatlands. Indeed, the sampling at Shapsha-Mukhrino Field Station (Russia) will permit to climatically enlarge the array of study peatlands, some of which have already been sampled in France, Italy, Switzerland and Sweden. In addition, the further advantage of including the Shapsha-Mukhrino Field Station in this survey is related to the possibility to start a sampling campaign of surface water chemistry in the open-top chambers installed in this Russian station.

3. Objectives

The present research proposal aims at assessing the effect of increasing vascular plant cover on the quantity and quality of DOC in peatlands. We hypothesize that increasing cover of vascular plants can contribute to increase the concentration of labile DOC during plant growing season through enhanced root exudates.

4. Research methods and material

In order to accomplish our objectives, we will apply two different field sampling methodologies to relate DOC quantity and quality to vegetation cover.

1. The first methodology will be applied to pristine lawn microhabitats, i.e. microhabitat characterized by the dominance of *Sphagnum balticum* along a natural gradient of vascular plant cover such as *Eriophorum sp.* and *Andromeda polifolia*. Microhabitat selection will be subjective in order to have a different degree of vascular plant cover. Surface water samples will be collected at the center of the microhabitat with a perforated needle about 10-12 cm long and connected to a syringe in order to collect pore-water in the rhizosphere. Water samples will be immediately filtered through a glass microfiber 0.45 µm and stored in 100 ml bottles until analyses. Aboveground plant biomass will be cut over a 25 X 25 cm square in correspondence of the microhabitat. Subsequently, the relative biomass of the main plant growth forms and standing litter will be sorted in order to calculate the total living biomass. Water samples will be analysed for total dissolved organic C and total dissolved N by means of a Shimadzu total C and N analyzer. In addition, we will also determine the signature of ^{13}C of DOC in the collected water by means of an elemental analyser (EA 1110, Carlo Erba) coupled online with an isotope ratio mass spectrometer (delta Plus XP, ThermoFinnigan). A set of spectrophotometric measurements, including absorbance and fluorescence indexes, will be performed by means of a BioTek spectrofluorometer.
2. The second methodology will be applied to the available experimental OTC plots. In this case water samples will be collected and analyzed according to the above methodology, but vascular plant cover will be determined in a no-destructive way such as the point intercept method (Stampfli 1991), that will be calibrated outside the plots in order to transform the number of hits to plant biomass. This methodology will provide an initial set of data in order to follow the temporal changes in DOC concentration and vascular plant cover in the experimentally warmed plots.

The information so obtained, in particular with methodology 1, will be then included in a wider dataset in order to assess the relationship between vascular plant cover and DOC along an altitudinal gradient (already established on Swiss Alps, see Bragazza et al. 2013), as well as along a latitudinal gradient from central Europe to Western Siberia.

5. Implementation: timetable, budget, distribution of work, specific logistic needs

As we aim to assess the relationships between vegetation and water chemistry, the field sampling is supposed to take place at the top of the plant growing season. A tentative sampling period is the first two weeks of July 2014 in relation to the phenological state of the vegetation (see below):

NAME	DATES	MANDAYS IN 2014 AT MUKHRINO	ROLES
Bragazza L.	30 June – 14 July 2014	11 (+ 4 days for travel)	Project coordinator, field sampling, laboratory activity coordination
Laggoun-Défarge F.	30 June – 14 July 2014	11 (+ 4 days for travel)	Field sampling, laboratory activity coordination
Jassey V.	30 June – 14 July 2014	11 (+ 4 days for travel)	Field sampling, laboratory activity

Travel costs: the expected cost for the train and plane tickets is about 1700-1800 euro/person.

Other logistical needs: a cost of about 250 euro/person is expected for the VISA (with invitation letter from the Yugra State University).

6. Expected results and possible risks

We expect to use the data collected at Mukhrino field station in a specific publication concerning the role of vascular plant cover in affecting the quality and quantity of DOC in peatlands. Next year will be the last scheduled year of field samplings connected to this topic so that all the information will be finally available to start processing the data and writing the manuscript.

If our main hypothesis will be confirmed, we expect that vegetation changes as observed in peatlands under warmer climate can further modify C cycling by affecting the release of labile DOC to the system as well as to other ecosystems through downward water transport.

All the data collected at Mukhrino field station will be available on requests and to the Russian colleagues managing the field station.

7. Key literature

Cited references:

Bragazza L. et al. (2013) Biogeochemical plant-soil microbe feedback in response to climate warming. Nature Clim. Ch. 3: 273-277.

Dorrepaal E. et al. (2009) Carbon respiration from subsurface peat accelerated by climate warming in the subarctic. Nature 460: 616-619.

Fenner N. et al. (2007) Interactions between elevated CO2 and warming could amplify DOC exports from peatland catchment. Environ. Sci. Technol. 41: 3146-3152.

Freeman C. et al. (2001) Export of organic carbon from peat soils. Nature 412: 785.

Frey KE & Smith LC (2005) Amplified carbon release from vast West Siberian peatlands by 2100. GEOPHYSICAL RESEARCH LETTERS, 32, L09401, doi:10.1029/2004GL022025.

Limpens J. et al. (2008) Peatlands and the carbon cycle: From local processes to global implications: a synthesis. Biogeosciences 5: 1475-1491.

Sheng Y. et al. (2004) A high resolution GIS-based inventory of the West Siberian peat carbon pool. Global Biogeochem. Cycles, 18, GB3004, doi:10.1029/2003GB002190.

Smith L.C. et al. (2004) Siberian peatlands a net carbon sink and global methane source since the early holocene. Science 303: 353-356.

Stampfli A. (1991) Accurate determination of vegetational change in meadows by successive point quadrat analysis. Plant Ecology 96: 185–194.

Ward S.E. et al. (2009) Plant functional group identity influences short-term peatland ecosystem carbon flux: evidence from a plant removal experiment. Funct. Ecol. 23: 454-462.

5 most relevant references of the user group:

1. **Bragazza L.** et al. (2013) Biogeochemical plant-soil microbe feedback in response to climate warming. *Nature Climate Change* 3: 273-277.
2. **Bragazza L.** et al. (2012) High nitrogen deposition alters the decomposition of bog plant litter and reduces carbon accumulation. *Global Change Biology* 18: 1163-1172.
3. **Bragazza L.** (2008) A climatic threshold triggers the die-off of peat mosses during an extreme heatwave. *Global Change Biology* 14: 2688-2695.
4. **Bragazza L.** et al. (2006) Atmospheric nitrogen deposition promotes carbon loss from peat bogs. *Proceedings of the National Academy of Sciences of the United States of America (PNAS)* 51: 19386-19389.
5. **Jassey V.E.J.** et al. (2011) Experimental climate effect on seasonal variability of polyphenol/phenoloxidase interplay along a narrow fen-bog gradient in Sphagnum fallax. *Global Change Biology* 17: 2945-2957.