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Long-term effects of fire on carbon and nitrogen pools and fluxes in the arctic permafrost and subarctic forests (ARCTICFIRE)

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1. Introduction

●About 1 % of boreal forests burn each year[1]. Since most of this area is underlain by permafrost (Fig.1), forest fires have potential effects on the permafrost soils due to changes in albedo[2] and increased amounts of black C and the removal of the insulating organic layers[3]. These could cause increased warming of soil surface and deeper melting of permafrost, resulting in an increase in the depth of biologically active soil layer with large reserves of SOM containing C and N.

The aim of this project is to study what is the effect of forest fires on permafrost thawing and its consequences on the soil carbon pools and greenhouse gas (GHG) fluxes in the subarctic boreal forests. More specific objects are:

●to quantify how forest fires influence the quantity and quality of soil organic matter (SOM)

●to study how these influence soil greenhousegas effluxes

●to quantify the effects of fire and permafrost thawing on the soil microbial community

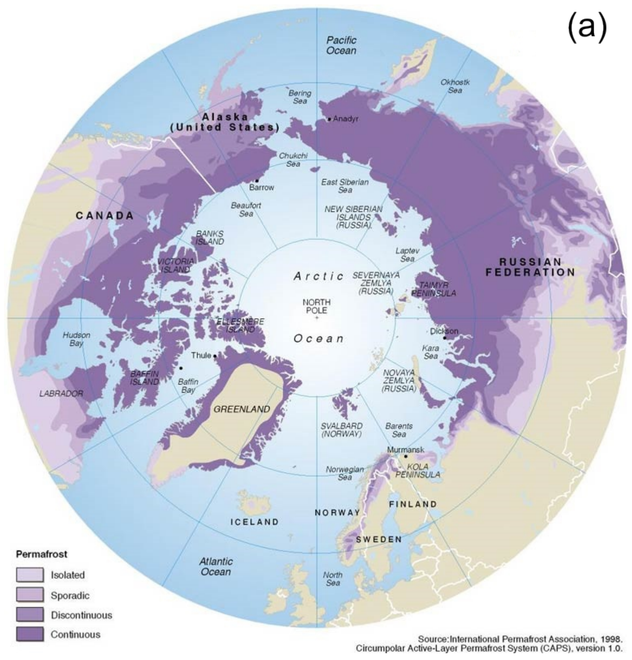

Figure 1: Distribution of (a) permafrost areas and (b) boreal forests in the arctic region. Pictures from the courtesy of International Permafrost Association and Natural Resources Defence Council.

Figure 4: Fire chronosequensis will be established in sub-arctic boreal forests.

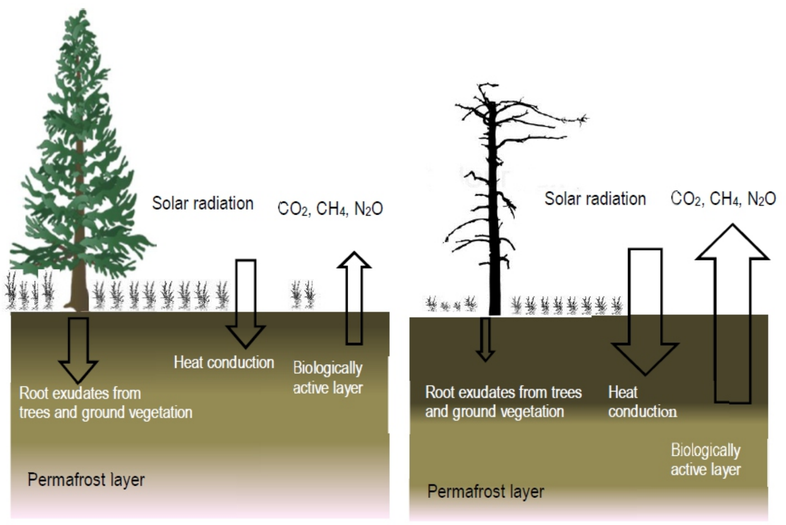

Figure 2:
Schematic presentation of the changes taking place in the permafrost layer and the research approach used in the study.

Figure 3: Soil carbon turnover as well as CO_2, CH_4 and N_2O fluxes from soil to the atmosphere will be measured from fire chronosequences in Canada, Siberia and Finland.

2. Methods

●Fire chronosequences (series of forest stands with different age since fire) will be established in sub-arctic forests with and without underlying permafrost.

●These will be established in following locations: Yukon Canada , Northern Finland (Värriö) and Siberia (Tura)

●The fire chronosequences will have 5 replicate forest stands in 6 different age classes having similar soil texture, altitude, precipitation and soil chemical properties (altogether 30 forest stands).

Collaborating institutes:

Russian Academy of Sciences Sukachev Institute of Forest
University of Saskachewan
Memorial University of Newfoundland
Austrian Academy of Sciences Commission for Interdisciplinary Ecological Studies
Kyoto University

3. Expected outcomes

●The effects of fire on the decomposition of SOM, belowground C allocation and thawing of permafrost have not yet been quantified or included in the coupled climate-C cycle models

●Incorporating this into process models describing C and N cycle in the terrestrial ecosystem, we will produce new information, which can change our view on the feedbacks of climate change on forest ecosystem.

●The study will also reveal the changes in forest productivity in the changing conditions and how the studied interaction increases the mobility of the C and N pools.

●By studying the processes in forests of different stages of succession we expect to predict what will happen to the large “dormant” terrestrial C and N pools.

References:
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[2]Korhonen J.F.J.,…, Pumpanen J.,…, Ilvesniemi. 2013. Biogesci. 10: 1083-1095
[3]Arneth A. et al. 2010. Nature Geosciences 3: 525-532

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