Causes and implications of permafrost thawing on global warming in Central Yakutia, Eastern Siberia

M.L. Lopez C. (1), A.Fedorov (2), R.Hatano (3) and M. Fukuda (1)

(1) Institute of Low Temperature, Hokkaido University, Sapporo, Japan.

(larry@lowtem.hokudai.ac.jp / Fax:+81-11-706-5492 / Phone:+81-706-5492)

(mfukuda@lowtem.hokudai.ac.jp / Fax:+81-11-706-6884 / Phone:+81-706-6884)

(2) Permafrost Institute, Siberian Branch, Yakutsk, Saha Republic, Russia.

(fedorov@mpi.ysn.ru / Fax: +7-4112-334318 / Phone:+7-4112-334476)

(3) Graduate School of Agriculture, Hokkaido University, Sapporo, Japan.

(hatano@chem.agr.hokudai.ac.jp / Fax: +81-11-706-3857 / Phone:+81-706-3857)

Boreal forests extend in the large continuous permafrost area of Central Yakutia, eastern Siberia where large concentration of ice wedges (6 to 50 meters long) in the permafrost is widespread. Present disturbances, mainly forest fires and global warming are showing signs of permafrost degradation by deepening of the active layer (layer of soil that thaws in summer and freezes in winter). The objectives of this study are to evaluate the impact of these disturbances on the stability of the permafrost and the impact it can have on accelerating global warming since permafrost thawing can release large amounts of carbon trapped in the soil accelerating global warming by increasing the presence of greenhouse gases in the atmosphere. In the early Holocene, climatic changes caused the irreversible degradation of some portions of ice-rich permafrost that resulted in saline grassland thermokarst depressions where reforestation has been hindered. Salt concentration reaches (EC_e, electric conductivity) values of 5.4 mS cm^{-1} at 2 meters deep in the permafrost under forest soils which in case of thawing becomes part of the water stream upward to the root zone. According to some part of the results of the five-year Russian-Japanese project, which involved intensive monitoring of environmental variables combined with vegetation and soil characteristics, fire, despite of its recurrent nature and large scale impact, is assimilated by the forest. The early stages of fire impact appeared to degrade the permafrost below the forest soil but rapid vegetation regeneration cools soil temperatures aggrading the active layer to its original depth. This process takes between 10 to 15 years whereas the full cycle of larch forest regeneration may take approximately 100 years. Although, fire in its present condition do not produce large scale permanent permafrost degradation, increasing frequency of fires due to global warming could have a serious impact on forest regeneration and thus in permafrost recovery. Recent trends indicate that air temperature and snow accumulation have been increasing in winter during the last 50

years. The insulating effect of snow keeps soils warm which results in deepening of the active layer in summer. This study assesses whether assimilation rates of forest as well as its landscape characteristics (presence of thermokarst depression) in this region can cope with modern climate warming and thus to some degree ameliorate the degree of impact it can have on a global scale.