Soil CO_2 emission and disturbances in the boreal forests of the Central Siberia

Makhnykina, A.V.*, Prokushkin, A.S., Polosukhina, D.A.

The University of Arizona, Tucson, USA

V.N. Sukachev Institute of forest SB RAS, Krasnoyarsk, Russia

Siberian Federal University, Krasnoyarsk, Russia

Corresponding author*: avmakhnykina@email.arizona.edu

The Boreal zone covers about one-third of the global forested area and is primarily located in Canada, Alaska, Russia and Scandinavia (Conard et al., 2002). This zone represents the most vulnerable ecosystems to any changes in the external conditions (Niinistö et al., 2011).

Boreal forests and soils of the northern hemisphere account for most of the net forest carbon (C) sink in the world (Pan et al., 2011), hence their importance in future climate change. However, a projected increase in forest disturbances (e.g. wildfires, strong winds, insect outbreaks) may reduce forest C stocks (Seidl et al., 2014). Wildfires are projected to increase worldwide within the coming decades as part of a global warming trend (Pechony and Shindell, 2010).

In this study we estimated how different post-fire successional states includes to the soil CO_2 emission and what are the main regulating climatic factors for these areas the most crucial.

The region of our research was located within the middle taiga subzone of Central Siberia (60 N, 90 E). The study areas consisted of a fire chronosequence of areas where there has been a forest fire 1, 14, 23, 46 and over 100 years ago. We observed the monthly changes in the soil CO_2 emission rates during the growing season. In addition we measured the soil moisture (5 cm depth) and soil temperature (5, 10, 15 depths) at each emission measurement.

The results indicated that soil respiration at the latest fire area was lower compared to older areas in 4 times. The highest fluxes observed at the site with a fire over 100 years ago averaged for whole season – 4.8 μmol CO_2 m^{-2} s^{-1} which are comparable with undisturbed lichen pine forest from this region. Also we compared the latest fire area and the area after human disturbance (logging) in term of the emission rates

and identified that CO_2 emission rates there are almost the same: the difference in between 5-10%.

Our results suggest that the natural forest disturbances gave a huge impact to the soil CO_2 emission dynamic and in addition to the human activities it can completely changes the main role of the boreal region in the global climate system.

References

Conard, S.G., Sukhinin, A.I., Stocks, B.J., Cahoon, D.R., Davidenko, E.P., Ivanova G.A. 2002. Determining effects of area burned and fire severity on carbon C. Ribeiro-Kumara, et al. Environmental Research 184 (2020) 1093288 cycling and emissions in Siberia. Climatic Change 55, 197–211.

Niinistö, S. M., Kellomäki, S., Silvola, J. 2011. Seasonality in a boreal forest ecosystem affects the use of soil temperature and moisture as predictors of soil CO2 efflux. Biogeosciences, 8: 3169–3186.

Pan, Y., Birdsey, R.A., Fang, J., Houghton, R., Kauppi, P.E., Kurz, W.A., et al., 2011. A large and persistent carbon sink in the world's forests. Science 333, 988–993. https://doi.org/10.1126/science.1201609.

Pechony, O., and Shindell, D.T., 2010. Driving forces of global wildfires over the past millennium and the forthcoming century. Proc. Natl. Acad. Sci. U. S. A. 107, 19167–19170. https://doi.org/10.1073/pnas.1003669107.

Seidl, R., Schelhaas, M.J., Rammer, W., Verkerk, P.J., 2014. Increasing forest disturbances in Europe and their impact on carbon storage. Nat. Clim. Chang. 4, 806–810. https://doi.org/10.1038/nclimate2318.