CO_2, CH_4, and N_2O fluxes from a larch forest soil in Siberia

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1. BACKGROUND

Boreal forests comprise 13.7×10^6 km^2 in the world. They account for only 9% of the world's total terrestrial area, but contains about 25% (471 Pg C) of the global soil carbon pool (2011 Pg C) (IPCC, 2001). It has been predicted that the effects of global warming such as increasing temperature and precipitation are strong in the boreal region (IPCC, 2001). Therefore, it is worried that decomposition and soil carbon emission in this region may be increasing (IPCC, 2001). The Russian Federation includes 8.1×10^6 km^2 of forests (FAO 2005). The area of boreal forests in Russia accounts for 73% of the total boreal forest area (Kuusela, 1992). Larch is the dominant conifer species in 2.63×10^6 km^2 of the Russian forests, which corresponds to 39% of the boreal forests in Russia (Hytteborn, 2005). Ninety-eight percent of the larch forests in Russia is distributed in central and eastern Siberia, and in the Far East (Korovin et al., 1998), accounting for more than the total area of boreal forests outside of Russia (2.47×10^6 km^2) (Kuusela, 1992).

CO_2, CH_4 and N_2O are important greenhouse gases with a contribution of about 60, 20 and 5.7 % to the radiative forcing of the global climate, respectively (IPCC, 2001). The CO_2 flux from the soil is derived from both soil microbial respiration and plant root respiration. Therefore, substrate supply, soil temperature, and soil moisture control the CO_2 flux. The aboveground litterfall on the soil surface was found to have a liner relationship with the increase in CO_2 flux (e.g., Bowden et al., 1993). The CO_2 flux responds to aboveground herbivory (Ruess et al., 1998), fine root density (Shibistva et al., 2002), and availability of nutrients (e.g., Nadelhoffer 2000). Soil temperature strongly affects the CO_2 flux in many ecosystems (Chen and Tian, 2005). The CO_2 flux is also affected by soil moisture; very high soil moisture can block soil pores (Bouma and Bryla 2000), and very low soil moisture limits microbial and root respiration (Yuste et al. 2003). In some cases, however, the CO_2 flux is not related to soil moisture in relatively mesic environments (e.g., Palmroth et al. 2005).

In general, forest soils are acted as a sink for CH_4 and a source for N_2O (IPCC 2001). Because microbiological processes regulate the consumption of CH_4 in the soil (Mer and Roger 2001), soil temperature and moisture affect the CH_4 uptake, that is, increasing soil temperature increases the CH_4 uptake (e.g., Castro et al. 1994), however increasing soil moisture decreases CH_4 uptake (e.g., Whalen and Reeburg 1996). The N_2O flux from the soil is the sum of N_2O derived from nitrification and that derived from denitrification (Sahrawat and Keeny 1986). N_2O production by nitrification increases with an increase in soil moisture, but too much soil moisture decreases the amount produced by denitrification, because of oxygen limitation (Sahrawat and Keeny 1986).

2. IN THIS SESSION...

The Russian forest, because of its large area, might be expected to play an important role in controlling the dynamics of these greenhouse gases. Most studies of CO_2, CH_4, and N_2O fluxes from boreal forests have been conducted in northern Europe and Alaska. However, Siberia is characterized by extremely low air temperature and precipitation and the presence of continuous permafrost. These conditions are different from those in Europe and Alaska.

The groups including the author have studied on CO_2, CH_4 and N_2O fluxes from the soil in central and eastern Siberia, and had reported (Morishita et al. 2001a,b; Morishita et al., 2003; Morishita 2004; Morishita et al., 2005a, b; Morishita et al., 2006). Thus, in this presentation, I will mention the characteristics of these gas fluxes in central and eastern Siberia referred to the reports, and to compare them with those of previous studies in boreal forests.

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