1. Introduction

There is a large area of peat lands in central Hokkaido where large mires previously existed. But almost all of them were drained and dressed with mineral soil for agricultural use in the 1960s. Peat lands store large amounts of organic carbon and nitrogen. The drainage of peat lands causes oxidation of accumulated organic matter and consequently leads to mineralization, which contributes to the emission of greenhouse gases, carbon dioxide and nitrous oxide. In general, nitrous oxide emissions from natural peat lands are small (Nagata et al., 2005) or show low uptake (Regina et al., 1996). However, some previous studies showed that drainage of peat lands increases nitrous oxide emissions (Martikainen et al., 1993; Nykänen et al., 1995; Maljanen et al., 2003). Nitrous oxide is much more potent greenhouse gas than carbon dioxide and methane because nitrous oxide has about 300 times more powerful greenhouse effect than carbon dioxide over 100-year time horizon (IPCC, 2001). Only few studies on nitrous oxide emissions from drained peat lands are conducted. Hence, the objective of this study was to quantitatively determine the rates of nitrous oxide emissions from drained and mineral soil-dressed peat land in central Hokkaido, Japan.

2. Materials and Methods

The study sites were set up in two fields (3.5 × 10⁴ m²) in Bibai experimental field (43° 19´ N, 141° 48´ E) of the National Agricultural Research Center for Hokkaido Region, Bibai City in central Hokkaido, Japan from April 2003 to October 2005. One is peat land field (D site) where only drainage was done; and another is peat land field (D-SD site) where drainage and mineral soil-dressing of about 20 cm depth were done. Crop production and cultivation were not done in these fields for over 10 years until this study, and only cutting of weed was regularly conducted two or three times a year. There were four gas flux measurement points at the center of each field, and the distance between two points was about 10 m. Nitrous oxide fluxes were measured by a closed chamber method. We used square (one side = 30cm; April 2003 to November 2004) or cylindrical (diameter = 30cm, height = 35cm; November 2004 to October 2005) chamber made up of polyvinyl chloride; and we set up four collars in each plot to place the chambers. We installed stainless steel pipes (inside diameter of 9 mm) around every collar to collect soil air during the periods August to November 2004 and June to September 2005. Nitrous oxide concentration was quantified with a gas chromatography equipped with an electron-capture detector (ECD) and porapak N column. Total emissions over the sampling period were calculated by successive linear interpolation of daily fluxes.

3. Results and Discussion

Nitrous oxide flux at D-SD site ranged from –7 to +1153 µg N m⁻² hr⁻¹, with sudden increase in June and October. Nitrous oxide flux at D site ranged from –8 to +4471µg N m⁻² hr⁻¹, showing much higher fluxes (403 to 4471µg N m⁻² hr⁻¹) during July to October 2004 than at other monitoring periods (maximum flux of 303µg N m⁻² hr⁻¹). These fluxes were much higher than those measured in undeveloped mire near this study site (Nagata et al., 2005). Annual nitrous oxide emissions at D-SD (12.5 kg N ha⁻¹ yr⁻¹) and D (19.7 kg N ha⁻¹ yr⁻¹) sites were far larger than the value (0.3 kg N ha⁻¹ yr⁻¹) reported by Nagata et al. (2005). This study showed that drainage and soil-dressing of the peat lands changed their atmospheric impact dramatically. Nitrous oxide concentrations of soil gas were higher at D than at D-SD, particularly in 2004, where the maximum nitrous oxide concentration at D site (1259 ppmv) was about 35 times compared to the D-SD site (36 ppmv). This result shows that soil-dressing of drained peat lands contributes to reduction of nitrous oxide generation.