B-4.1 Feedback to the Greenhouse Gases Emission in Siberian Wetlands
B-4.1.1 Total Methane Emission Rate from Natural Wetland in Siberia

Contact Person Gen Inoue
Principal Research Scientist
Atmospheric Division and Global Environment Division,
National Institute for Environmental Studies, Environment Agency Japan,
16-2 Onogawa, Tsukuba, Ibaraki 305, JAPAN
Phone +81-298-50-2402, Fax +81-298-50-2468
e-mail inouegen@nies.go.jp

Total Budget for FY1994-FY1996 40,786,000 Yen (FY 1996 13,366,000 Yen)

Abstract

The methane emission inventory is widely spread among natural and anthropogenic sources. The strength of natural source is not well evaluated because the emission rate per unit area is small but the area of wetland is so huge to measure it everywhere. It is very variable by environmental conditions such as precipitation and temperature both in time and places. There is a biggest wetland in West Siberia and it is expected to be a large methane source, but little is known and it is important to do the measurement to reduce the uncertainty of global emission.

One of the method is to evaluate the methane emission by the aircraft measurement. In this measurement, an anthropogenic emission which should be ascribed to the leakage from oil mining was observed.

The methane emission was measured on the ground by a so called chamber method in a period of two month and positive dependence on the ground temperature was obtained. The gradient of emission strength decreasing in the direction from the wetland to the dry forest area was observed as well as the vegetation dependence.

The eddy correlation method was applied by conditional sampling method to evaluate the methane emission in patch scale, but it was less successful.

Key Wards Methane, Methane Flux, Natural Wetland, Siberia

1.Introduction

The methane emission inventory is widely spread among natural and anthropogenic sources, and the natural sources is difficult to evaluate as it is a weak source but big in area. The wetlands in northern hemisphere keeps about 14% of organic carbon in global scale, and most of them is emitted as CO_2 and CH_4, and little is stocked as bog. Recent studies in Canada suggests the emission rates from Northern wetlands are less than those reported before.

Judging from thus diversity of emission rates, it is important to measure the methane emission rate in West Siberia, where the largest wetland exists.

On the other hand, the increase of atmospheric temperature in high latitudes is suggested, and it really is observed in past 100 years. The increase of temperature in winter and spring leads to lengthen the season of methane emission and the photosynthesis period to produce methane precursors, which will be a positive feedback of greenhouse effect. However, the limitation of trace element such as dissolved nitrogen compounds, the dry circumstance produced by active evaporation, and the change of vegetation may lead to limit or reduce the methane emission rate. It is important to establish a model of methane emission to the atmosphere to predict the change of it in future climate conditions.

2.Research objectives

Methane emission measurement by use of chamber method and parametrize the environmental variables. The measurement must be performed in wide environmental change, and the key will be the development of some automatic method.

The evaluation of anthropogenic sources in West Siberia to distinguish between natural and manmade methane.

3.Research Field

We established a research site at Plotonikovo village, where the bogs above the ground water level spread between small rivers along which forest is formed as it is relatively dry. The bio-geochemical studies on the research site near the village is has been done by Institute of Soil Science and Agrochemistry, Novosibirsk, in past decades of years. The botanical study has been done by this group, too.

The wetland of research site is 15 x 30km in size and the prevailing vegetations are *Eriophorum* and *Carex Sphgnum*. The soil is acidic, pH is between 3.45 to 4.6. The concentration of dissolved nitrogen compounds, NO_3^- and NH_4^+, are so small and was less than 1 mg per 1 litter in surface layer, 0 - 10 cm. The maximum of N-compounds was fund in 50-60 cm layer, 0.24 and 2.8 mgN/L for NO_3^- and NH_4^+, respectively. The amount of biomass was 580-950 g m2 in surface layer, 0-10cm. The green phytomass was 30% in hammock, and 60% in hollow. Negative correlation between biomass and NO_3^- was found but no correlation with NH_4^+, which probably the plant consumed NO_3^- in hammock more than in hollow, and N-compounds are not the most important limiting factor.

Camping site was established in wetland for the over-night study, and the laboratories was established in the village for the chemical analysis and the fermentation experiment.

4.Vegetation dependence of methane flux

Methane emission rate has been obtained by so called chamber method. A stainless steel base was inserted in the soil and a plastic box was covered on it with water seal. The air in the chamber was sampled periodically, at every 5 min typically, and stored in a vacuum vial bottles for the following laboratory analysis. The methane concentration analysis has been done by FID-GC instruments. The distribution of carbondioxide emission rate shows a Gauss distribution with the center of 110 mg C m^{-2} hr^{-1} and the half width of 60 mg C m^{-2} hr^{-1}. In the contrary, the methane emission rate is widely scattered in logarithmic normal distribution with a mean value of 4 mgC cm^{-2} hr^{-1}, and standard deviation of 6 mgC cm^{-2} hr^{-1}. Most of organic matters are emitted to the atmosphere as CO_2, and its flux is decided by the organic matters and temperature in soil. In contrast, the methane emission is very dependent on the anaerobic condition in soil, and it is very variable from place to place.

The vegetation or the micro geological water level dependence of methane emission rate was obtained by a transect study with 13 monitoring point along a wooden bridge from the center of wetland to the forest. The vegetation dependence is shown in Fig.1, where *Pinus* habitats in relatively dry place. The temporal variation of methane emission is very large between -3.6 to 80 mgC m^{-2} hr^{-1}; sometimes it shows a sink, and sometimes bubble emission is observed. The transportation mechanism through a stem bypassing the oxidation area may responsible to the large vegetation dependence.

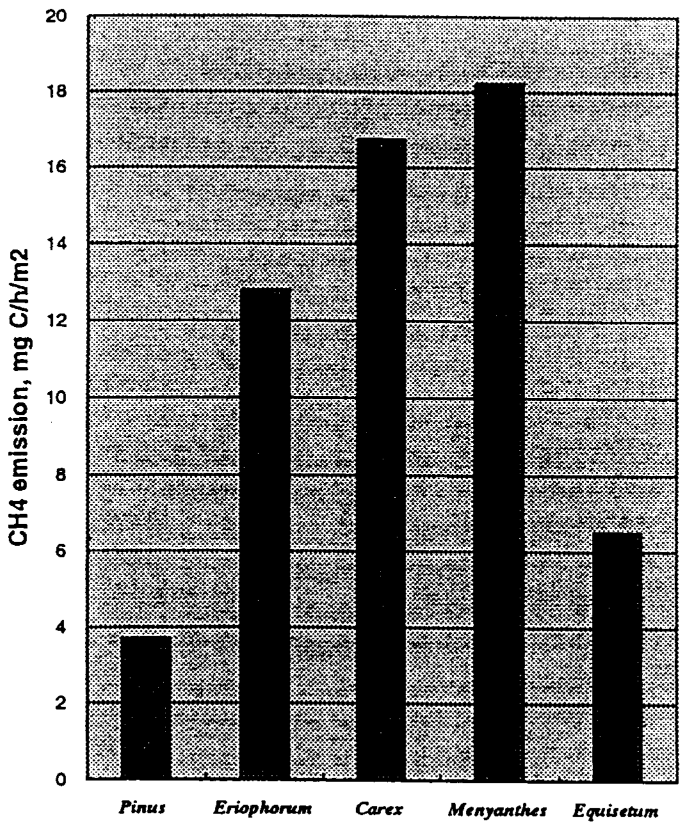

Fig.1. Vegetation dependence of methane emission rates in Plotnikovo research site.

5.Development of automatic sampling system

As the temporal variation of methane emission is large, it is important to make the measurements frequently, but the overnight manual sampling cannot be continued long. Then it is desirable to establish a automatic sampling system. Cost efficient and power saving automatic sampling system with lifting/closing mechanism of a chamber was tested. A motor was operated at every two hours and the air in the chamber was sampled through a microvalve array connected to vacuum vial bottles. One measurement requires four samples, and 24 samples were collected automatically in 12 hours.

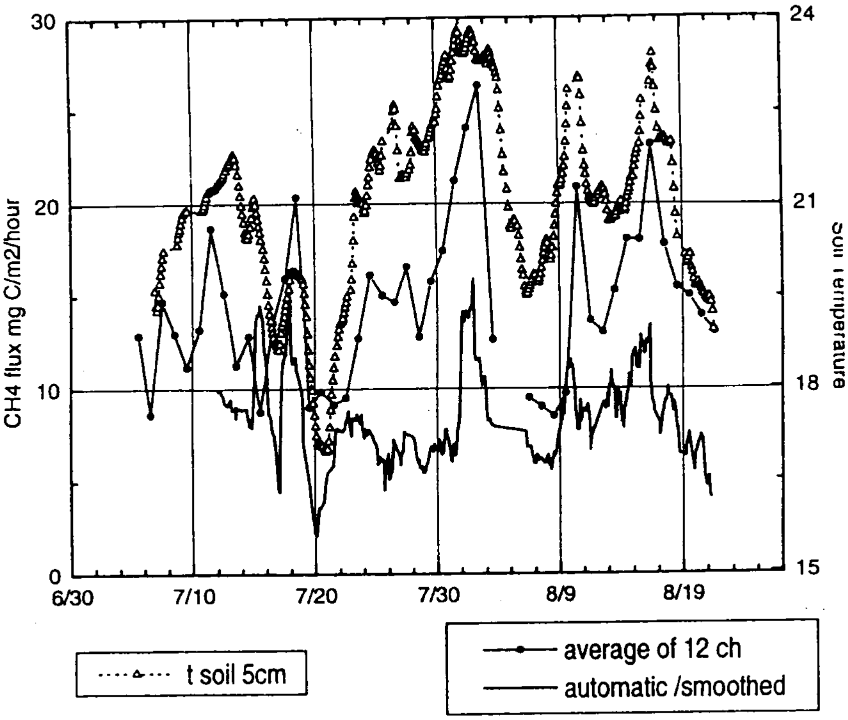

Fig.2. Temporal variation of methane emission averaged for twelve sampling points, filled circle, and automatic sampling chamber, solid line. The soil temperatures at the depth of 5 cm are shown by triangles.

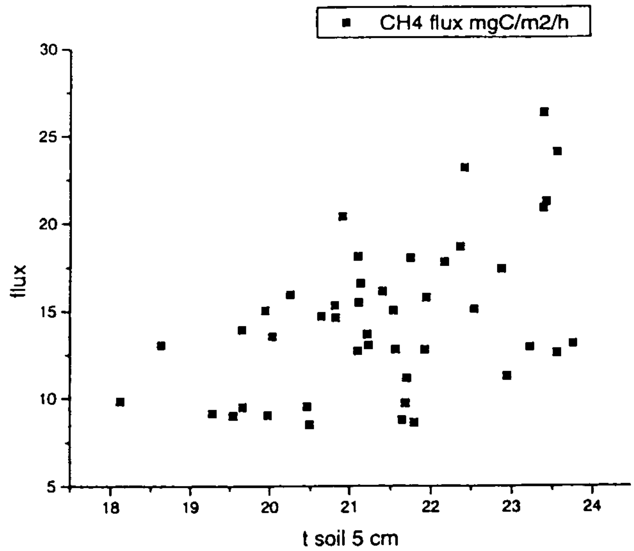

Fig.3. Correlation between methane emission rate and soil temperature.

6.Soil temperature and water level dependence of methane emission

In Fig.2, the methane emission rate measured in the period from July 5 to August 20 is shown together with the soil temperature at the depth of 5 cm. The closed circles are the methane emission of 12 sampling points average, and no marked solid line is from automatic sampling points. The peaks and bottoms of methane emission match to those of soil temperature, but the correlation between them, Fig.3, is not so clear. The water level dependence is not clear as the increase of water level by precipitation is accompanied by small radiation input and the soil temperature decreases this time. As the result, the water level dependence is rather negative, which was opposite to the prediction that the water level enhances an anaerobic condition and methane emission is enhanced.

7.Leakage of fossil fuel

The leakage of natual gas pipeline and oil and coal mining are one of the important methane source, and it is important to distinguish between natural and anthropogenic sources in West Siberia study as both activities are remarkable in scale.

During the flight research to evaluate the mathane emission from wetland at the middle latitude of West Siberia, very high concentration peak of methane was observed (Fig.4). In this experiment, a continuous methane measurement by catalizer combustion of non-methane VOC combined with FID developped by Tohjima was used. This is ascribed to the leakage from the leakage from oil production judging from the location of oil production site, and the stable isotope analysis of CH4 sampled in bottles.

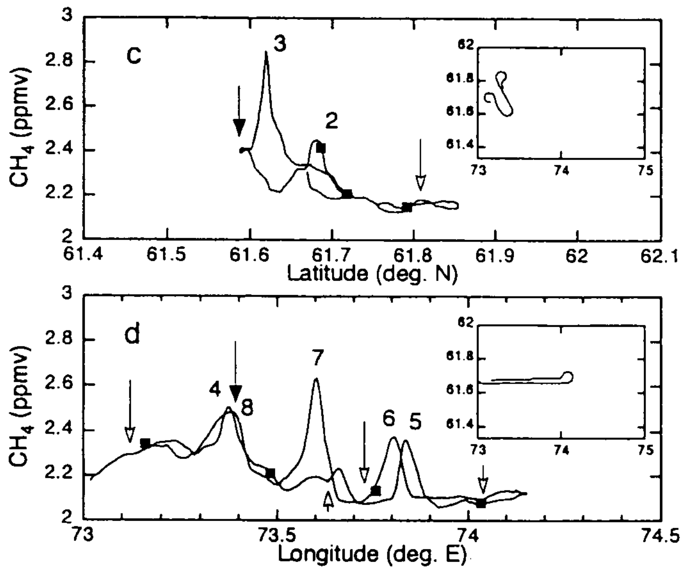

Fig.4. Variation of methane concentration over Surgut north in August 1, 1994. Solid lines are continuous measurement of CH_4, and ■ is the on board CH_4 analysis. Arrows indicate the bottle sampling point for the stable isotope analysis.

7.Conclusion

In order to evaluate the methane emission from Western Siberia wetlands, long term measurements at several different landscape are necessary to cover the full period of the active season, and to scale up to the full region. Chamber flux measurement method is suitable to do a fully automatic measurement, but the development of sensor is necessary.

The full season measurement will provide a set of data with wide environment variation, and the parametrization of emission rate with the variables obtained by remote sensing technique.

The wide variation of emission rate from time to time may be due to the chaotic transportation process such as bubble formation, and a continuous measurement of methane increase in a chamber is desirable.