Estimation of methane emission from western Siberian wetlands by using satellite remote sensing techniques

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1. Introduction

Western Siberian wetlands are presumed to be large sources of atmospheric methane. Recent Japan-Russia airborne measurements conducted by the National Institute for Environmental Studies of Japan and the Central Aerological Observatory of Russia have yielded the results supporting this presumption. To evaluate the role of the western Siberian wetlands as sources of atmospheric methane, it is necessary to classify wetland ecosystems and to measure the mean methane flux for each ecosystem type. In this study we use a SPOT/HRV image to classify wetland ecosystems in a test area. As to the mean methane flux, there are not many data in western Siberian wetlands, but it is possible to obtain rough estimates from the results of the ground measurements performed in the Japan-Russia Siberian project. The methane emission from a test area is estimated by combining the result of ecosystem classification and the values of mean methane flux for different ecosystem types.

2. SPOT/HRV image at Plotnikovo in western Siberian wetlands

A SPOT/HRV image was obtained at Plotnikovo on 9 August 1994, three days after the intensive airborne measurements (which took place on 3, 5, and 6 August 1994) of greenhouse gases over the same area. Plotnikovo is located at the longitude 85°05'E and the latitude 56°51'N and in the wetland region along the Ob' river (see Fig. 1). Figure 2 shows the area covered by the SPOT/HRV image, whose size is approximately 60 × 60 km.

The SPOT/HRV is a high resolution imaging system with a ground resolution of 20 m and has three spectral bands of green, red and near infrared wavelengths (0.50-0.59,

0.61-0.68 and 0.79-0.89 μm). Figure 3 shows the image taken by SPOT/HRV sensor in a black and white picture, though it has originally three color components. By using an unsupervised classification technique (Interactive self-organizing data analysis technique) we classified the image pixels into fifteen clusters in three-dimensional spectral space. We then merged them into seven categories (wetland 1, wetland 2, forest, water, grass, cloud and cloud shadow) using spectral feature and spatial distribution of each cluster. Figure 4 shows the result of land cover classification. From aerial photographs, wetland 1 is identified as bog area with dwarf trees and shrubs and wetland 2 as bog area with peat moss and grasses.

3. Estimation of methane emission from a test site

In the Japan-Russia joint experiments Panikov measured methane fluxes in wetland areas near Plotnikovo and reported that mean methane fluxes in summer time were 233.9 mg CH_4 m^{-2} d^{-1} for open bogs and 21.1 mg CH_4 m^{-2} d^{-1} for forested bogs [Panikov, 1994]. We used his flux data to calculate methane emission from the SPOT image area and obtained the result that the total amount of methane emission was 470×10^6 g CH_4 d^{-1} and the average methane flux was 170 mg CH_4 m^{-2} d^{-1}. In this calculation, we eliminated cloud and cloud shadow areas and assumed that the mean methane fluxes of wetland 1 and 2 are equal and that methane fluxes from grass and water areas were negligible because these areas have small ratio (6.9 %) to the total area and no methane flux data were available in these land cover types.

4. Summary

A SPOT/HRV image was obtained at Plotnikovo shortly after the flight measurements of greenhouse gases in August 1994. The image area was classified into seven categories using spectral features and aerial photographs. Mean methane fluxes for different kind of ecosystems have been obtained from the ground measurements. Methane emission from the SPOT image area was estimated by combining the result of ecosystem classification and the values of mean methane fluxes.

References

N.S. Panikov, CH_4 and CO_2 emission from northern wetlands of Russia: Source strength and controlling mechanisms, Proceedings of the International Symposium on Global Cycles of Atmospheric Greenhouse Gases, 100-112, 1994.

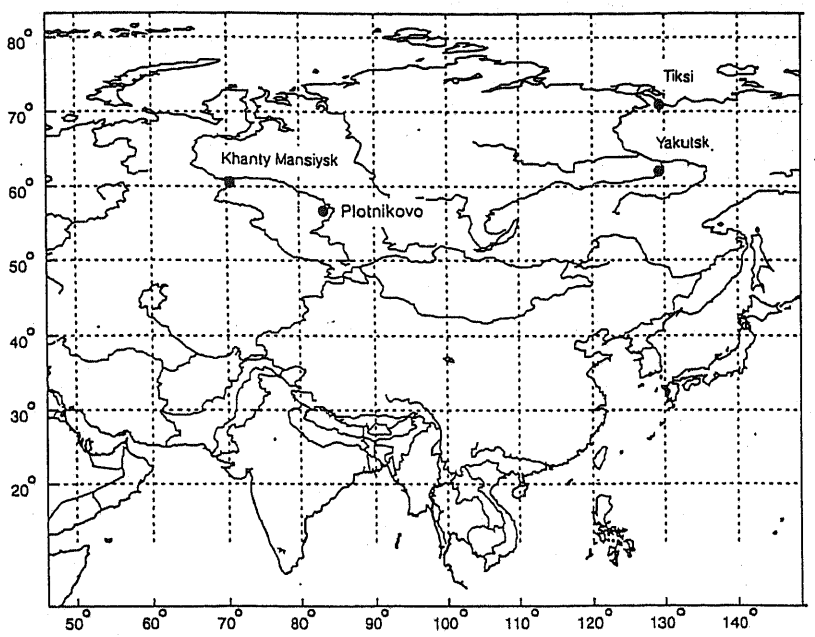

Fig. 1 Location of Plotnikovo.

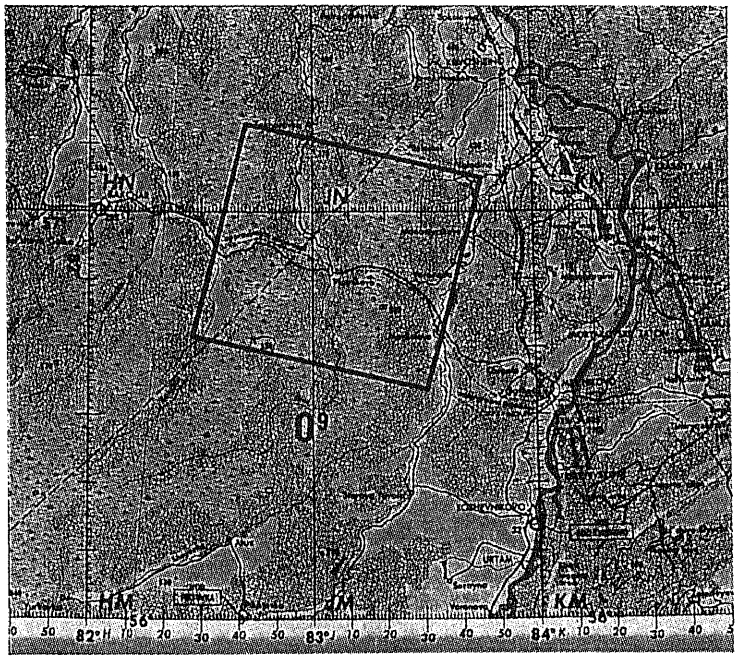

Fig. 2 Area covered by the SPOT/HRV image.

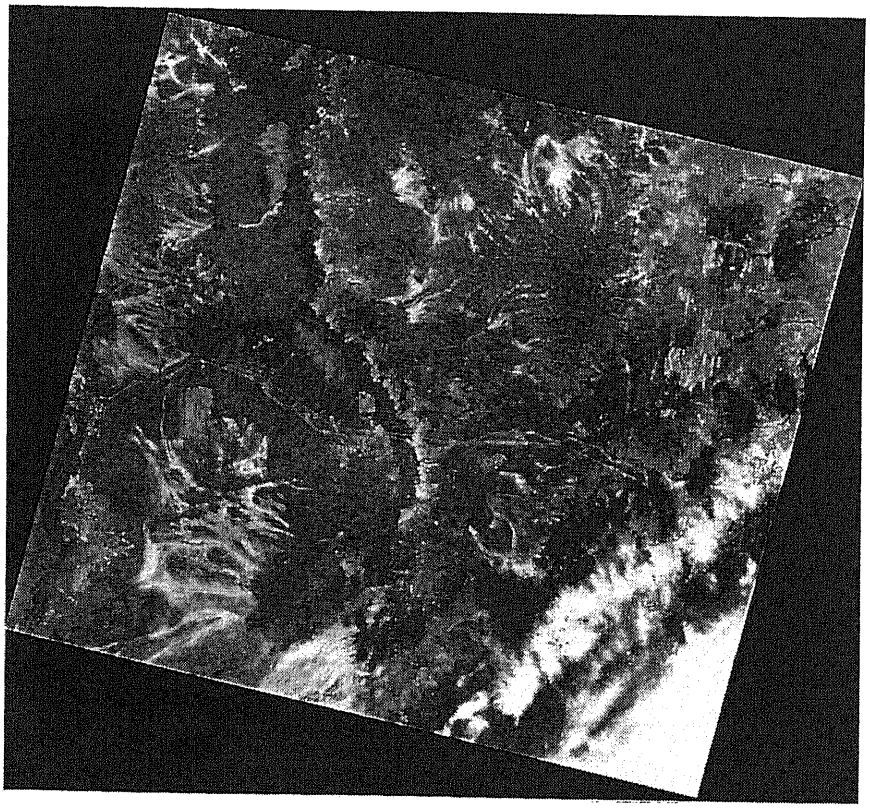

Fig. 3 SPOT/HRV image at Plotnikovo.

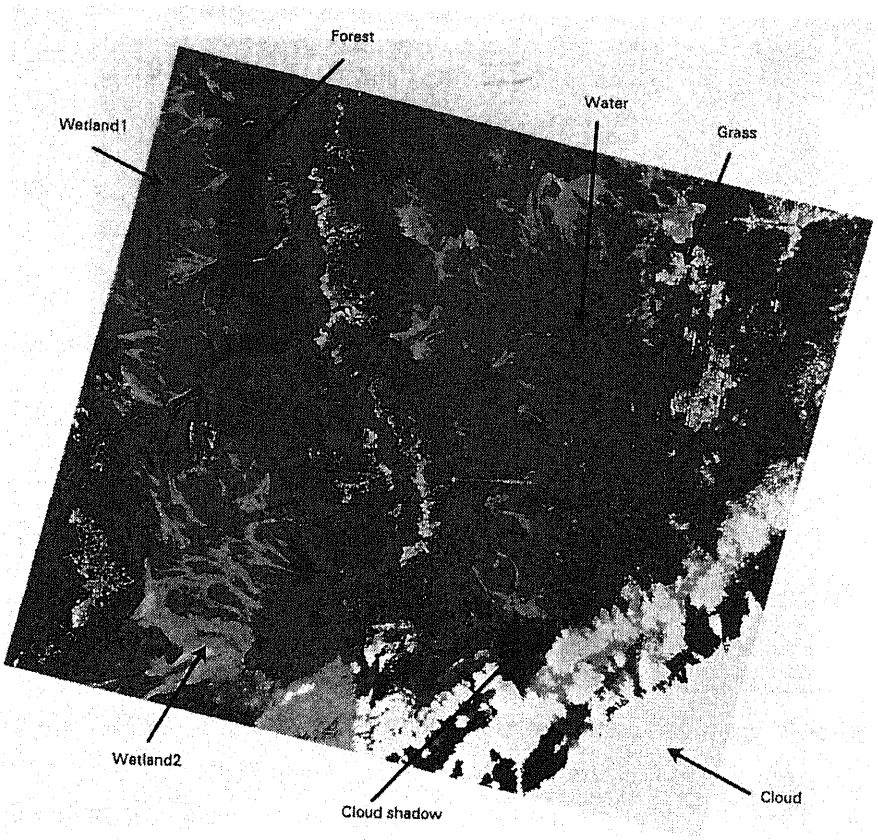

Fig. 4 Result of land cover classification.