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Dry deposition velocity of sulfur dioxide over rice paddy in the tropical region

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Abstract

The SO_2 deposition velocity over a canopy of irrigated rice paddy in a tropical area was evaluated using the Bowen ratio and Fick's equations. The experimental facilities were set up in Chachoengsao province in the central region of Thailand and data was collected for a period of one year. The results showed that the deposition velocity of SO_2 varies with the time of day, and it was highest around noon time and lowest at night. Furthermore, the value for the seasonal average of V_d was the highest in winter and the lowest in the rainy season. The obtained seasonal average values of V_d were 0.67, 1.25, and 1.51 cm/s in the winter, summer, and rainy seasons, respectively.

Keywords: Sulfur; Acid deposition; Velocity deposition; Air pollution; Bowen ratio equation

1. Introduction

Acid deposition has been a subject of concern for over a decade in regions that consume fossil fuels with high sulfur content i.e. coal and heavy fuel oil. To assess the impact of the acid deposition on ecosystems, both wet and dry depositions are to be quantified. The amount of wet deposition can be determined by analyzing the amount of acid content in the collected rains. For dry deposition, the direct method (directly collecting dry chemicals deposited on absorbents) or the indirect method using Fick's equation (multiplying the deposition velocity with the ambient concentration) is practically applied. In this study, the work is intended to evaluate the dry deposition velocity, V_d. This value is useful for a long-term assessment of the dry deposition since the concentrations of the acid gases are practically monitored throughout the year.

Most of the V_d values of sulfur dioxide (SO_2) have been conducted in the temperate regions (Europe and upper East Asia) (Erisman, 1994; Colbeck and Simmons, 1994; Hicks et al., 1989; Kim et al., 1997; Mennen et al., 1996 and Wesely and Hicks, 2000). However, few studies on dry deposition have been conducted in the Southeast Asian region, especially in regards to V_d. One of these studies has been conducted by the Pollution Control Department and Acid Deposition Monitoring Network in East Asia (EANET), which have reported O_3 deposition velocity values on a teak forest in northern Thailand (Matsuda et al., 2005). From the previous studies, V_d was found

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to vary with the time of day, seasons and type of terrain (Matsuda et al., 2001, 2005; Feliciano et al., 2001). These studies have shown that the V_d above the rice paddy is different from those above other terrains (Matsuda et al., 2002). The purpose of this study is to evaluate the V_d for SO_2, an important value to be used in assessing the amount of acid deposition in the interested areas. This study also demonstrates the influence of daily and seasonal variations on the V_d over a rice paddy in the tropical regions.

2. Experimental description and methodology

2.1. Experimental site description

The SO_2 dry deposition was evaluated over a rice paddy located at 13° 58' N and 100° 56′ E, in Chachoengsao, Thailand. The experimental station was set up on a flat and homogeneous rice field with no high buildings or trees within a 300 m radius. To assess the dry deposition velocity under the variation of the tropical seasons, the field parameters were measured for a period of one year starting in May 2003 and ending in April 2004. Traditionally, rice is grown in 3 cycles per year, with a growing and harvesting period of 3 months, followed by a 1 month follow period. The height of the full grown rice was 1.5 m. The summer, rainy and winter seasons were represented in March–June, July–October, and November–February, respectively.

2.2. Methodology

The deposition flux of SO_2 over the canopy was measured continuously by a system based on the Bowen ratio technique. The SO_2 dry deposition flux (F, mg/m^2/h) was defined by Fick's law as the product of the transfer coefficient (D, cm/s) and the

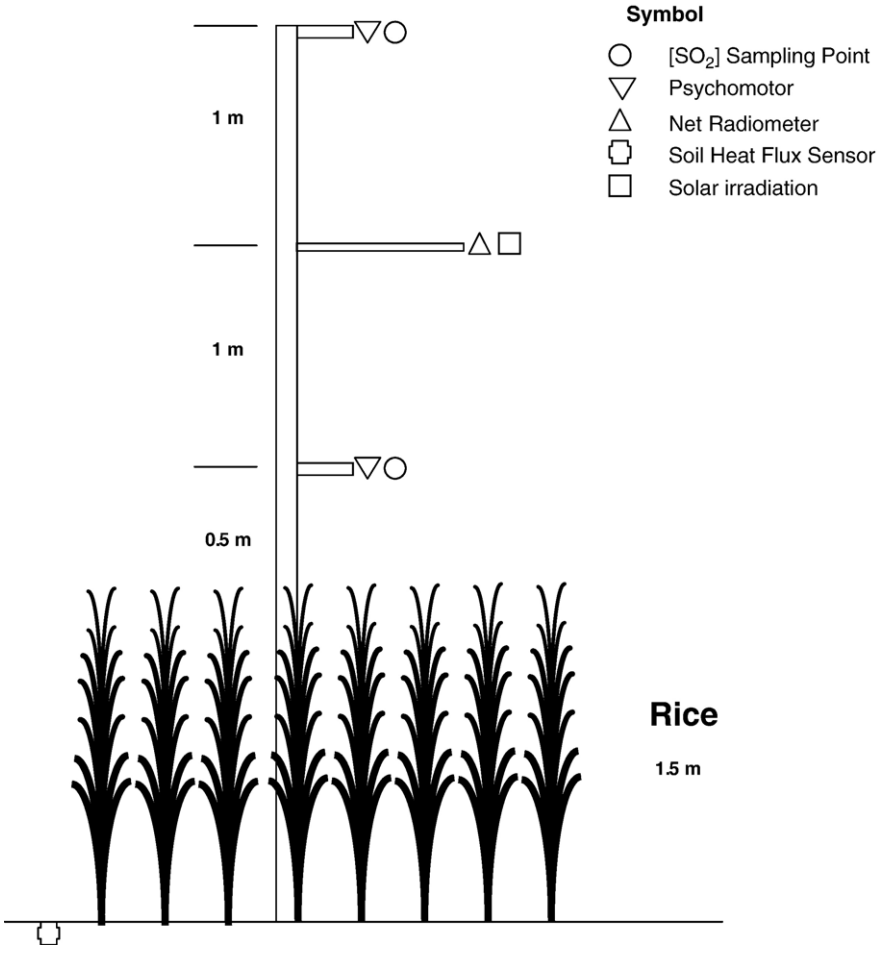

Fig. 1. Measuring equipment installation for SO_2 flux determination using the Bowen ratio technique.