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Characterization of Dicarboxylic Acids in $PM_{2.5}$ during a PM Episode and a Non-Episodic Period

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1. Introduction

Dicarboxylic acids in atmospheric aerosol have received much recent attention because of their potential role in affecting the global climate. Dicarboxylic acids contribute 1-10% to total aerosol carbon (Kawamura and Sakaguchi, 1999). Oxalic acid is the dominant species, and malonic acid and succinic acid are major species. There is limited data on dicarboxylic acids in $PM_{2.5}$ and even less on dicarboxylic acids in $PM_{2.5}$ during PM episodes. In this paper, the presence, source and characteristics of dicarboxylic acids in $PM_{2.5}$ in suburban Tainan in southern Taiwan are investigated.

2. Experimental

$PM_{2.5}$ samples were collected at a suburban location in southern Taiwan during a moderate pollution loading (non-episodic, Sept.-Oct. 2004) period and a high pollution loading (PM episode, late Nov. 2004) period using a VAPS (Versatile Air Pollutant Sampler; URG-3000K, URG, USA). Two sets of atmospheric $PM_{2.5}$ samples were collected daily, one from 8 am to 7 pm (11 hours: 'daytime') and the other from 7 pm to 8 am (13 hours: 'nighttime'). Samples were analyzed by a modified version of the method of Hsieh et al (2007). The concentrations of the aqueous extracts were determined by ion chromatography (IC, Dionex).

3. Results and discussion

Total daily dicarboxylic acid concentration was 979.1±358.6 ng m^{-3} (1.32% by $PM_{2.5}$ mass) during the PM episode compared to 656.0±277.4 ng m^{-3} (1.17% by $PM_{2.5}$ mass) during non-episodic pollution. Oxalic acid was the dominant acid, at 460.4±203.7 ng m^{-3} and 70.2% of the total during non-episodic pollution and 795.1±303.6 ng m^{-3} and 81.2% during the PM episode. It was found in all samples with an average concentration 2.4-4.3 times higher than other dicarboxylic acids. Next was succinic acid, with an average concentration of 77.4±45.1 ng m^{-3} (11.8% by total dicarboxylic acids in $PM_{2.5}$) during non-episodic pollution and 61.2±25.8 ng m^{-3} (6.3%) during the PM episode, followed by malonic acid (64.7±30.7 ng m^{-3} and 9.9% by total dicarboxylic acids in $PM_{2.5}$ during non-episodic pollution and 50.7±15.7 ng m^{-3} and 5.2% during the PM period). Oxalic acid concentration increased 72.7% from non-episodic to PM episode aerosol while concentrations of succinic acid and malonic acid decreased 20.9% and 21.6%, indicating that large quantities of succinic acid and malonic acid were converted to oxalic acid in PM episode aerosol.

In addition to succinic acid, the most abundant C_4 diacid was malic acid with average concentrations of 36.3±20.6 ng m^{-3} in non-episodic aerosol and 41.7±23.5 ng m^{-3} during the PM episode.

Backward air parcel trajectories, shown in Fig. 1 (non-episodic period) and Fig. 2 (PM episode) show that non-episodic aerosol had passed through agricultural and urban regions with higher wind speed. However, the most significant event difference between the two periods was the open paddy field burning of agricultural wastes post rice harvest during the latter part of November, especially during nighttime. PM episode associated trajectories tracked over these areas to a greater extent than non-episodic associated trajectories. The higher oxalic acid concentrations in PM episode aerosol may therefore be attributed to this biomass burning.

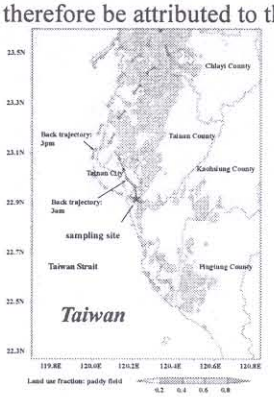

Figure 1. Backward trajectories for air parcels that affected southern Taiwan during the non-episodic pollution period. (a) 3 pm on 3 October 2004 (presented as daytime); (b) 3 am on 3 October 2004 (presented as nighttime).

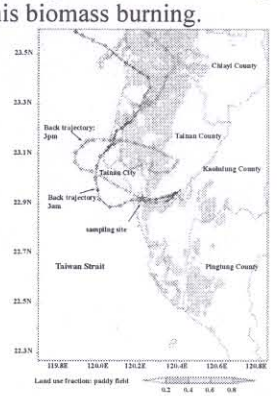

Figure 2. Backward trajectories for air parcels that affected southern Taiwan during the PM episode. (a) 3 pm on 25 November 2004 (presented as daytime); (b) 3 am on 25 November 2004 (presented as nighttime).

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