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ナイジェリア内陸部地方都市での $PM_{0.1}$ 特性の予察的考察

Preliminary Investigation on Characteristics of $PM_{0.1}$ in a Local Inland City in Nigeria

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Abstract

The aim of this study was to the status of ambient TSP ~ $PM_{0.1}$ in Akure, a typical inland local city in Nigeria. Using a cascade air sampler with stages of $PM_{10/2.5/1/0.5/0.1}$, a set of size fractionated samples were collected for continuous 7-days in a local city, Akure, Nigeria. Particle mass concentration and particle-bound chemicals as carbons, ions, WISOC, WSOC in each size fraction were evaluated to discuss possible contributions of local emission source. The distribution of hot spots and air mass trajectory were also discussed. Traffic, biomass and plastic waste burning may be possible local emission sources. $PM_{0.1}$ may be influenced both by biomass and fossil fuel burnings.

1. Introduction

Air pollution is a problem in terms of climate and health risks. As similar to other areas, in Africa, rapid urbanization, population growth as well as biomass burning for agricultural and household purposes may cause various adverse influences. However, information on the status and detailed characteristics of urban air pollution has been very limited. In this study, as the first evaluation of PM0.1 in Nigeria, the air sampling was conducted in Akure, Nigeria as a collaboration between Federal College of Agriculture, Akure in Ondo State, Nigeria and Kanazawa University, Japan and the status and characteristics of ambient PM were discussed in relation to possible emission sources.

2. Methodologies

Sampling site

A sampling site was in Akure city, which is the capital city of Ondo state in south-western Nigeria with an estimated population of 662800 (2016). The weather in Akure is under the tropical climate and significant rainfall in most months (April-October), with a short dry season (November -March).

The sampling site was located on the roof floor of a building at a Federal College of Agriculture (FCA) (15 m (approx.) above the ground and about 294 m above sea level, latitude 7.520_N and longitude 4.520_E). FCA is located in a suburban area surrounded by agricultural fields, 350 m south from a high way and approximately 1.3 km west from another high running between Akure city area and the sampling site. The site is surrounded by trees, residential buildings, tarred and untarred roads for vehicular activities (low traffic), farms, and waste dump site. There are a lot of open biomass burnings in preparation for the new planting season. During the course of sampling, there was burning of papers, plastics, cellophane papers, tyre, bushes, and the dead carcass of fowl on the waste dump site. There was no herbicide usage since it was just the beginning/preparation for the planting season.

Air Sampling and Analysis

Duration of the sampling was 24-hours from 6 am to 6 am for a period of 7-days (14th – 21st October 2017). A cascade air sampler for $PM_{0.1}$ consisting of 4-impactor stages (>10, 2.5-10, 1-2.5, 0.5-1μm), an inertial filter stage (0.5-0.1μm) and a backup filter stage (<0.1μm) operated at the flow rate of 40 $Lmin^{-1}$ was used. Quartz fibrous filters (Pallflex 2500 QAT-UP, ϕ 55 mm, pre-baked at 350°C in an oven for 1-hr then conditioned at 21ºC, 35%RH for 48 hrs) were weighed before and after the sampling. Filter samples were cut into 4-pieces for the analysis of different chemical components.

Carbonaceous components were analyzed by the Sunset Carbon Analyzer (IMPROVE_TOR protocol). Following previous report[1)], ions were analyzed using ICs (DIONEX ICS-2100 for anion, DIONEX ICS-1600 for cation). WSOC was analyzed by TOC analyzer. WISOCs (organics) were analyzed by GC-MS for extracted samples.

3. Results and discussions

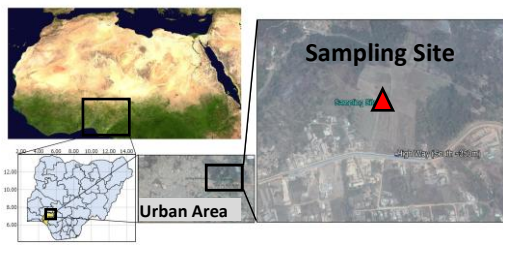

Fig. 1 Sampling Site, Federal College of Agriculture, Akure, Nigeria.

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Particle mass concentration

Fig.2 shows the mass concentration of size fractionated particles for successive 7-days. A fluctuation probably related to local emission sources existed although there might be an inter-regional influence of open biomass burning. The average mass concentration of PM_{10} and $PM_{2.5}$ was 140.2 and 88.1 μg/m^3, respectively, indicating a seriously contaminated situation by PM. The average value 34.2 μg/m^3 of $PM_{0.1}$ was higher than that in Phnom Penh[1]. Average $PM_{0.1}$ ratio to $PM_{2.5}$ is 38.83%, which is slightly larger than other locations (Kanazawa = 19.91%, Bangkok = 22.19%, Phnom Penh = 22.20%)[1].

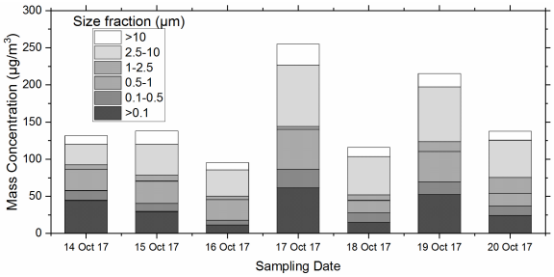

Fig. 2 Mass Concentration of Ambient PM in Akure.

Chemicals

Average concentrations of particle-bound carbon components are listed in **Table 1**, where values for PM > 0.5 μm are tentative ones for spot samples. OC dominating and especially in $PM_{0.1}$ may be largely attributed to open biomass burning. Char-EC/Soo-EC, an index of biomass burning (0.1 ~ 0.5 for diesel soot)[2], was ~ 1.5 and similar in PM below 2.5 μm. This might indicate the influence of local biomass burning related to agricultural activities is important also on $PM_{0.1}$.

K^+ had a peak in 0.5-10 μm (See **Fig.3(a)**) consistently with levoglucosan. There was a clear influence of the sea salt (See **Fig.3(b)**), which can be described also by the air mass trajectory in this season. However, Cl^- concentration was not consistent with that of Na^+ in 0.5-1 μm (Cl^-/Na^+>1), indicating influences also from other sources. This may be reinforced by **Fig.4** shows the concentration of terephthalic acid possibly emitted from plastic waste burning[3], which had a peak also in 0.5-1 μm. $PM_{0.1}$ was found to contain the largest amount of hopane, which is nearly 10 times more in a large city in Japan, indicating a contribution from the fossil fuel[4] burning is also important for $PM_{0.1}$.

Table 1 Particle-bound carbonaceous components

PM size (μm)	OC	EC	Char-EC	Soot-EC	OC/EC (-)	Char-EC /Soot-EC (-)
<0.1	20.8	1.24	0.73	0.51	14.8	1.43
0.5-1	2.88	0.91	0.54	0.37	3.29	1.46
1-2.5	1.25	0.48	0.29	0.19	2.89	1.53
2.5-10	1.46	0.76	0.41	0.35	1.95	1.17
>10	0.38	0.19	0.1	0.09	2.06	1.11

Mean values over 7-days (μg/m^3).

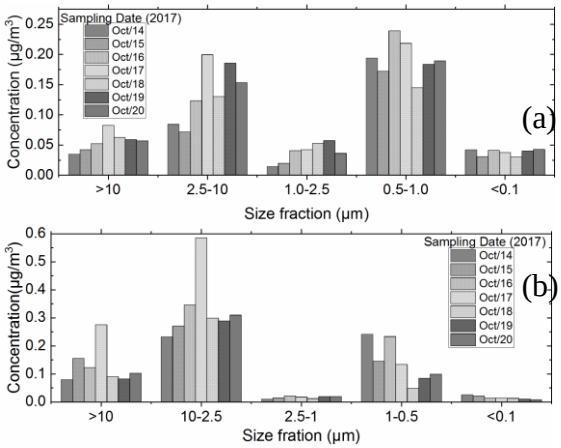

Fig.3 Concentration of (a)K^+, (b)Cl^- in Akure, during sampling period

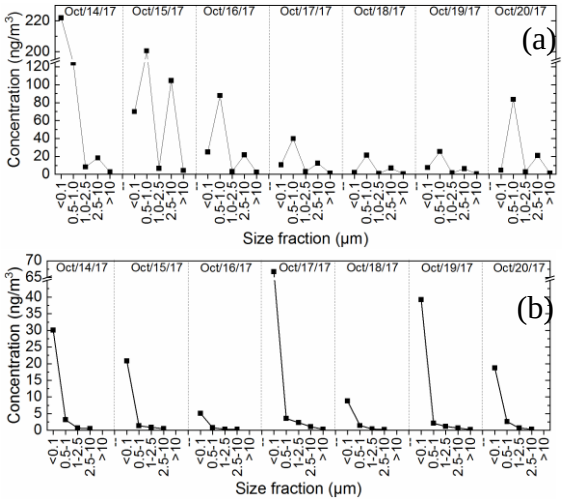

Fig.4 Concentration of (a) Terephthalic acid, (b) Hopane

4. **Summary**

Traffic, biomass and plastic waste burning may be possible local emission sources. PM concentration was seriously high and OC dominates carbons. $PM_{0.1}$ may be influenced both by biomass and fossil fuel burnings. From the air mass trajectory and hot spot distribution during the period (not shown here), there might be an inter-regional influence of biomass burning in the northern Nigeria. Further discussions based on chemical markers, hot spot distribution and air mass behaviors may be needed.

5. **References**

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