The Twenty-first Session of the Scientific Advisory Committee
on the Acid Deposition Monitoring Network in East Asia
26-28 October 2021, Virtual Meeting

Observational Studies of PM2.5 Components and EC/OC in EANET Countries

I. Introduction

1. Fine particulate matter ($PM_{2.5}$) is considered as an important environmental pollutant and has adverse effects on human health, including effects on the heart, nervous, and vascular system. Moreover, $PM_{2.5}$ is proved to be linked to degradation of visual range, with the features of light extinction. To evaluate these effects, components of $PM_{2.5}$ need to be investigated at different temporal and spatial scales because chemical properties in $PM_{2.5}$ are important factors to determine the effects. Niigata City is located in eastern Japan and faces the Northeast Asian continent. Since the northeast Asian continent is upwind with respect to Niigata during the winter monsoon period, $PM_{2.5}$ in Niigata is probably influenced by long-range transport from the continent. A field observation study including seasonal intensive measurement of $PM_{2.5}$ and long term monitoring of elementary carbon (EC) and organic carbon (OC) in $PM_{2.5}$ and precipitation is conducting.

2. Bangkok Metropolitan Region (BMR) is a region consisting of populated central area of Bangkok and surrounding provinces, sharing industry, infrastructure, and housing. BMR has been suffered serious air pollution issues due to rapid economic growth, urbanization, and motorization. In order to design appropriate air pollution countermeasures, information on major contributing sources of air pollutants such as particulate matter and O_3. The Thai government operates national monitoring network of gaseous and particulate pollutants as well as precipitation. There were several previous studies focusing on the PM pollution in BMR with the detail PM compositions for source apportionment studies. However, there are lack of long term monitoring data of PM and precipitation, which are necessary to analyze source apportionment of PM. The two joint projects between Japan and Thailand have implemented monitoring of chemical components of $PM_{2.5}$, coarse particles (>2.5 μm) and precipitation at the selected sites in BMR. By using these monitoring data and receptor models, vehicle exhaust, biomass burning and secondary formation could be identified as the main sources of $PM_{2.5}$ in BMR. These results can be compared with the simulation results by the air quality models and will provide information on the sources for which intensive measures should be taken.

II. Observation methodologies and major results

3. The Niigata-Maki EANET station is located at 1 km from the seashore, and 25 km southwest of the center of Niigata City, Japan. There are no industrial sources near Niigata-Maki site, but a small community (approximately 1300 population) is located 2 km northwest of the station, and thus it is classified as a rural station. Air masses reaching the station are dependent on seasonal wind patterns, which are affected by the monsoon circulation: in winter the northwest cold currents prevail, while in summer they are replaced by the hot and humid currents of the Pacific Ocean. 37 chemical components (including EC, OC, Cl^-, NO_3^-, SO_4^{2-}, Na^+, NH_4^+, K^+, Mg^{2+}, Ca^{2+} and 23 metallic elements) in $PM_{2.5}$ and water soluble OC and water insoluble EC and OC in precipitation was measured and the seasonal variations of chemical characteristics in PM2.5 were elucidated. The detailed description of observation methodology is shown in the literature (Li et al, 2018, Huo

et al., 2016).

4. Daily mean concentrations of $PM_{2.5}$ at the Niigata-Maki station were lower than Japanese Environmental Quality Standard for $PM_{2.5}$ (35 μg m^{-3} for daily average) for most days. $PM_{2.5}$ concentration variation was highly correlated with meteorological conditions. The higher concentrations of SO_4^{2-}, NH_4^+ and OC also observed in spring and summer may result from higher temperatures and more intense solar radiation, which provide favorable conditions for photochemical activity and secondary OC production. The $PM_{2.5}$ source apportionment results inferred four major emission sources: sea salt, biomass combustion, soil dust and secondary aerosol. During 2011 and 2012, the concentrations of EC and WIOC in precipitation were 24.6 μg/l and 274 at the Niigata-Maki site. The ratio of EC to OC in the precipitation and aerosol samples at Niigata maki-site were lower than that in the Tokyo site, which inferred lower contribution of automobile sources.

5. By the joint project of JICA Research Institute, Asian Institute of Technology (AIT), ACAP and the Pollution Control Department (PCD). long term monitoring of PM and acid deposition was conducted at the two sites which represent urban and suburb area of Bangkok (Narita et al., 2019). One is located at the rooftop of the PCD office building in urban area of Bangkok. The PCD building is mainly surrounded by houses, commercial places, and institutions within a radius of 5 km. It is approximately located of 0.75 km away from the main road, which has heavy traffic congestion during rush hours. The other site is at the rooftop of the ambient laboratory of AIT in Pathumtani, suburb area of Bangkok. This site is surrounded by many canals, rice paddies and other crops fields, as well as some small and medium industries. The monitoring were conducted simultaneously at these two sites during the period from September 2015 to March 2017. The detailed description of observation methodology is shown in the literature (Sato et al, 2020). The annual average of $PM^{2.5}$ concentrations in 2016 was 20.6 $\mu g/m^3$ at PCD and 22.5 $\mu g/m^3$ at AIT that were below the National Air Quality standard (25 $\mu g/m^3$). The seasonal averages of PM2.5 concentrations in the dry season; 29.0 $\mu g/m^3$ at PCD and 32.6 $\mu g/m^3$ at AIT, were significantly higher than those in the wet season; 14.7 $\mu g/m^3$ at PCD and 15.2 $\mu g/m^3$ at AIT. The $PM_{2.5}$ source apportionment results demonstrated that secondary particles, biomass combustion and diesel exhaust particles were the major sources of $PM_{2.5}$ in the BMR.

6. By the Japan Thailand Clean Air Partnership (JTCAP) project, 24 hour sampling of PM2.5 was conducted at 3 sites in BMR once a two or three days during December 2018 to April 2019,. The monitoring sites were selected to cover various site characteristics. One is located in the industrial area of Bang Na district, the second one is in the residential area of Phaya Thai district, and third one is at the roadside of Din Daeng district. The collected PM2.5 samples were analyzed by sent to Japan for ionic and metallic components by PCD, and for carbon components for analysis by ACAP. The detailed description of observation methodology is also shown in the literature (Sato et al, 2020). The $PM_{2.5}$ concentrations at 3 sites exceeded the national standard of 24 hour average (50 $\mu g/m^3$) from late December 2018 to late January 2019. hereafter, the PM2.5 concentration was lowered in February and the concentration increased again in April and May. By comparison among the sites, the roadside site was the highest, followed by the industrial site and the residential site. The $PM_{2.5}$ source apportionment results demonstrated that secondary particles, biomass combustion and diesel exhaust particles were the major sources of $PM_{2.5}$ in the BMR, which is consistent with the above described observation from 2015 to 2017.

(References)

Huo, M.Q., Sato, K., Ohizumi, T., Akimoto, H., and Takahashi, K. (2016) Characteristics of carbonaceous components in precipitation and atmospheric particle at Japanese sites. Atmos. Environ. 146: 164-173.

Li, P., Sato, K., Hasegawa, H., Huo, M., Minoura, H., Inomata, Y., Take, N., Yuba, A., Futami, M., Takahashi, T. and Kotake, Y. (2018). Chemical Characteristics and Source Apportionment of PM2.5 and Long-Range Transport from Northeast Asia Continent to Niigata in Eastern Japan. Aerosol Air Qual. Res. 18: 938-956.

Narita, D., Kim Oanh, N.T., Sato, K., Huo, M., Permadi, D.A., Ha Chi, N.N., Ratanajaratroj, T. & Pawarmart, I. (2019) Pollution Characteristics and Policy Actions on Fine Particulate Matter in a Growing Asian Economy: The Case of Bangkok Metropolitan Region, Atmosphere, 10(5): 227.

Sato, K. Huo, M.Q., Kurokawa, K., (2020) Joint Research Project with Asian Institute of Technology, Pollution Control Department and JICA Research Institute: Source analysis and reduction strategy of fine particulate matter in Bangkok Metropolitan Region, Thailand, EANET Sci. Bull., 5: 113-127