Comprehensive monitoring project of greenhouse gases and air pollutants around Jakarta megacity in Indonesia

*Masahide Nishihashi[1], Hitoshi Mukai[1], Yukio Terao[1], Shigeru Hashimoto[1], Rizaldi Boer[2], Muhammad Ardiansyah[2], Bregas Budianto[2], Gito Sugih Immanuel[2], Adi Rakhman[2], Rudi Nugroho[3], Nawa Suwedi[3], Agus Rifai[3], Iif Miftahul Ihsan[3], Anies Marufatin[3], Albert Sulaiman[3], Dodo Gunawan[4], Eka Suharguniyawan[4], Asep Firman Ilahi[4], Muharam Syam Nugraha[4], Ronald Christian Wattimena[4], Bayu Feriaji[4], Thomas Lauvaux[5], Tomohiro Oda[6]

1. National Institute for Environmental Studies, 2. Bogor Agricultural University (IPB), Indonesia, 3. Agency for the Assessment and Application of Technology (BPPT), Indonesia, 4. Meteorological, Climatological, and Geophysical Agency (BMKG), Indonesia, 5. Laboratory for Sciences of Climate and Environment (LSCE), France, 6. Universities Space Research Association/NASA Goddard Space Flight Center, USA

The emission increases of greenhouse gases (GHGs) and air pollutants in megacities have been recognized as one of the important issues as a concern for health and climate change. Jakarta, the capital city of Indonesia, including suburban cities (Bogor, Depok, Tangerang, and Bekasi; locally known as “Jabodetabek”), has a population of 32 million people and has been listed as the second largest megacity in the world and the largest megacity in Southeast Asia. Several air quality monitoring campaigns were conducted in Jakarta. However, previous studies lacked continuous high-accuracy monitoring stations due to the limitations of environmental monitoring budgets and experts. We present here a new interdisciplinary project to expand our current understanding of the interactions between emissions, air quality, and regional/global climates.

To estimate the amount of anthropogenic emissions from Jakarta megacity and compare with city activities, we developed a ground-based comprehensive monitoring system of GHGs and air pollutants controlled remotely in addition to automated start-and-stop operations during power failures. Monitoring systems were installed at Bogor (center of Bogor city), Serpong (Jakarta suburb), and Cibeureum (mountainous area) in 2016–2017. Each monitoring system consists of system control/data acquisition units controlling multiple instruments and collecting continuously and continuous monitoring instruments of CO_2, CH_4, CO, NO_x, SO_2, O_3, aerosol concentrations ($PM_{2.5}$, PM_{10}, BC) and the chemical components (NO_3^-, SO_4^{2-}) of $PM_{2.5}$ and PM_{10}, and meteorological parameters. Flask sampling of air is also performed automatically once a week to analyze N_2O, SF_6, and carbon isotopes (^{13}C, ^{14}C) in CO_2 in NIES and to validate the continuous measurement data of CO_2, CH_4, and CO.

The results show that the daytime values of CO_2, three hours averages from 12 to 15 local time, at Bogor and Serpong are 6.8 and 7.1 ppm higher than Cibeureum, respectively. These features are also presented in the other species, i.e., CO, NO_x, SO_2, $PM_{2.5}$, $PM_{10-2.5}$, and BC. Moreover, we found 5–10 ppm lower values of CO_2 during daytime at Bogor and Serpong in December and January, mid-rainy season in Jakarta, compared with the other months and frequent and extremely high CH_4 enhancements during nighttime (i.e., 3 to 5 ppm) at Serpong.

We present here the temporal variability observed at three monitoring sites and some preliminary results based on high-resolution CO_2 simulations using Weather Research and Forecasting model coupled to Chemistry (WRF-Chem).

Keywords: greenhouse gases, air pollutants, urban monitoring, Indonesia

