Greenhouse gases and air quality monitoring system for urban anthropogenic emission estimation around Jakarta megacity

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National Institute for Environmental Studies (NIES) has implemented an international joint research project for greenhouse gases (GHGs) and air quality monitoring with three institutes in Indonesia, IPB, BPPT, and BMKG since 2015/2016. The purpose of this project is to quantify anthropogenic emissions from Jakarta megacity and characterize them in terms of socioeconomic activities in the city. In order to respond to the Paris Climate Agreement, it is important for a monitoring project like ours not only to be capable of monitoring the increasing anthropogenic emissions by rapid economic growth in a developing country, but also to assess future those reduction impacts resulted from mitigation strategies implemented. It is also important to observe GHGs and related air pollutants with high accuracy in Indonesia because such kinds of observations are very limited in Southeast Asia.

We have maintained continuous monitoring systems 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 at three sites: Serpong (Jakarta suburb), Bogor (center of Bogor city), and Cibeureum (mountainous area, background-like site) since 2016/2017. We have also performed automatic flask sampling of ambient air once a week. The air samples are used to analyze N_2O, SF_6, and carbon isotopes (^{13}C, ^{14}C) in CO_2 at NIES and to validate CO_2, CH_4, and CO data obtained from the continuous measurement.

We have also conducted high-resolution atmospheric CO_2 simulations using the Weather Research and Forecasting model coupled to Chemistry (WRF-Chem). We used two emission inventories to prescribe the surface emissions: ODIAC (Open-source Data Inventory for Anthropogenic CO_2) as fossil fuel CO_2 ($ffCO_2$) and MsTMIP (Multi-scale Synthesis and Terrestrial Model Intercomparison Project) as biogenic CO_2 ($bioCO_2$).

We analyzed the intersite differences of daytime CO_2 mole fractions (dCO_2) between the urban sites (Serpong, Bogor) and the background-like site (Cibeureum) in the dry season (July-August 2017) and the rainy season (January-February 2018). The observed dCO_2 at Serpong was 8.7 and 0.9 ppm in the dry and rainy seasons, respectively. The simulated dCO_2 at Serpong shows similar decreasing trend, which is 8.5 and 3.1 ppm in the dry and rainy seasons, respectively. While the simulated CO_2 values at Serpong are slightly overestimated in the rainy season possibly due to the poor reproducibility of meteorological fields (wind environment near the surface), the simulation indicates two main factors of the seasonal differences in dCO_2: one is the reduction of $ffCO_2$ at Serpong in the rainy season (3.3 ppm) and another one is the reduction of $bioCO_2$ uptake by photosynthesis at Cibeureum in the rainy season (2.9 ppm). The seasonal

differences in dCO_2 observed and simulated at Bogor are similar to those of Serpong, but smaller. In our presentation, we will also present the relationship between CO_2 and the other species.

Keywords: greenhouse gases, air quality, urban monitoring, CO2 simulation, Indonesia

