

Evaluation of biogenic emission sources contributing to ozone concentration in Osaka

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This study investigated biogenic volatile organic compounds (BVOC) emission sources contributing to ozone concentration in Osaka, Japan by using the Weather Research and Forecasting model (WRF) v3.5.1 and the Community Multiscale Air Quality model (CMAQ) v5.0.1.

Environmental standards of photochemical oxidants have not achieved in almost monitoring stations. BVOC have a large impact on ozone formation, but the behavior is still uncertain. In Osaka, high ozone concentration is often observed during summer. Osaka is characterized by highly urbanized area with small forest area, but is surrounded by prefectures with large forest areas. It may be considered that BVOC emitted around Osaka is one of the causes of high concentration in Osaka.

The WRF/CMAQ modelling system was run from 1 July to 9 August 2010 in the modelling domains from domain 1 covering Northeast Asia to domain 3 covering the Kinki region, which includes Osaka. BVOC emission in Kinki region was estimated with the experimentally-derived standard emission rates of the dominant tree species and the forest database in the region. Land areas in domain 3 were divided into 10 source regions. The BVOC emission sources contributing to ozone concentration in Osaka were identified by conducting backward trajectory analyses and 10 cases of zero-out BVOC emission runs.

As a result, the BVOC emissions substantially contributed to ozone concentration in Osaka with day-by-day variation of contributing source regions. Although ozone concentrations were especially high on 23 July and 2 August, the contribution of BVOC emissions on 23 July was much larger than that on 2 August. In order to further investigate the difference of the results on 23 July and 2 August, the backward trajectory analysis and additional zero-out cases for BVOC emissions from Osaka and for VOC emissions from the 10 source regions on the target days were performed. These analyses revealed that the urban ozone concentration in Osaka on 23 July was dominantly increased by the transport from the northwestern region outside Osaka with large contribution of ozone produced through BVOC reactions by the day before, which was retained over the nocturnal boundary layer and transported to the ground-level through vertical mixing in the daytime. On the other hand, the concentration on 2 August was dominantly increased by the local photochemical production inside Osaka under weak wind condition with particularly large contribution of BVOC emitted from Osaka on the day.

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