Analysis of roadside air quality in Osaka using chemistry-coupled CFD model

○Qi Zhang[1)], Tomohito Matsuo[1)], Hikari Shimadera[1)], Akira Kondo[1)]
[1)] Graduate School of Engineering, Osaka University

【Background】In urban area, roadside air pollution such as NO_x and O_3 is a serious environmental issue. In order to evaluate the roadside air pollution caused by pollutants emitted mainly from automobiles, it is required to consider both chemical reaction and shape of buildings. Most of the air quality models, however, use coarser mesh resolution such as 1 km^2 or the larger, which is not sufficient to evaluate the roadside air pollution. On the other hand, the CFD models which have been incorporated with an atmospheric chemical reaction mechanism, can perform the 24-hour simulation of thermal environment and the distribution of contaminants of city-block scale with high spatial resolution. With this CFD model, we conducted an analysis of roadside air quality in Osaka city.

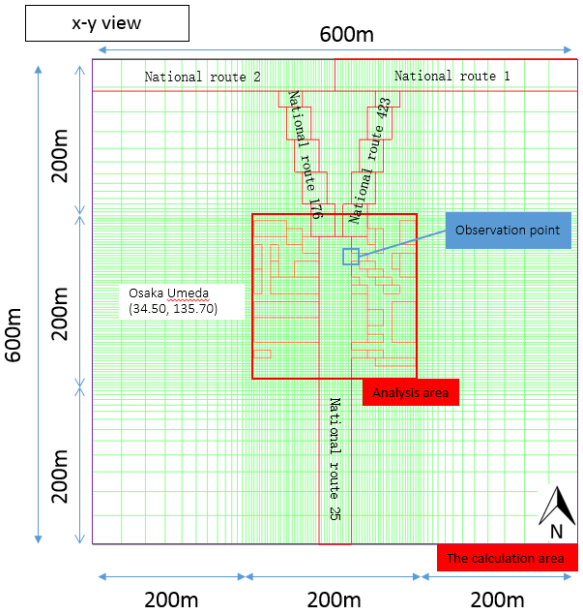

Fig.1. Plan view of the realistic Osaka city model

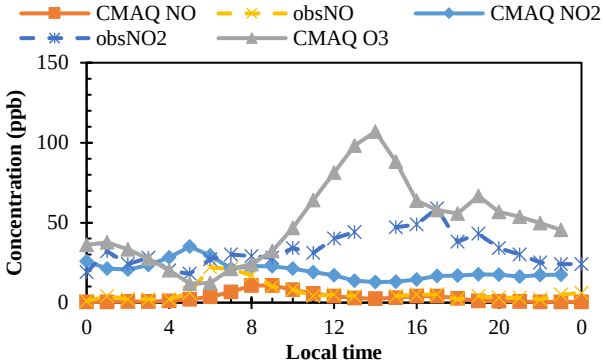

Fig.2. Diurnal variation of contaminants' concentration of boundary condition and observation data

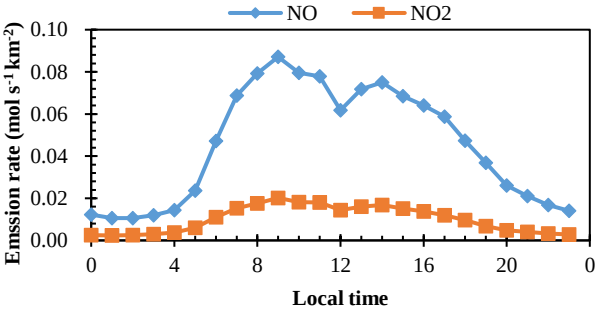

Fig.3. Diurnal variation of total emission rates in 1 km^2

【Methodology】In this study, an air quality simulation of realistic city model was performed with a chemistry-coupled CFD model. The CFD model consists of momentum, continuity and mass conservation equations, and is incorporated with urban surface radiation processes and an atmospheric chemical mechanism called CBM-IV. The calculation domain is shown in Fig.1. The domain includes 5 roads. The analysis domain is 200, 200 and 60 m in the x, y and z direction, respectively, which includes 22 buildings. The longitude and latitude of the real city (Osaka Umeda) is 135.50 and 34.70, respectively. The WRF-CMAQ model was used to consider the boundary condition of air temperature, wind profiles and air pollutant concentrations (Fig.2). Because we are focusing on the chemical reaction (especially photochemical reaction) in this study, sunny and high concentration day is suitable to assess the model performance so that the date on 2 August 2010 was selected because of the high air temperature and high concentrations of contaminants during the day. Fig.3 shows the total emission rates based on the JATOP emission inventory of vehicles in the year 2010 emission data, the emission data was distributed to each road according to the traffic volume.

【Results】In the daytime, the concentration of NO_x in the city is higher than that in outside of the city (boundary condition) because of the large emission rate. On the other hand, the concentration of O_3 is lower in the city because of titration. This result indicates that the model can express the roadside air pollution more appropriately than air quality model. The detail of the results will be shown in presentation.