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Improvement of multi-scale wind fields and its application to particle dispersion in urban building environments

Ju-Hee Jeong · Yoo-Keun Kim
Department of Atmospheric Sciences, Pusan National University

The WRF-CFD modeling has been conducted for the simulation of multi-scale wind fields and particle dispersion from road traffic in an urban building environment. The CFD model was combined with the WRF model in an offline way, which means that the boundary and initial conditions necessary for driving the CFD simulation in the city-block-scale are taken from the WRF simulation results in the urban-scale. The WRF model was designed to have a sub-kilometer resolution for applying detailed boundary conditions to CFD modeling. In addition, the urban canopy parameters (UCP) was considered to better predict urban-scale wind fields in the WRF model. The urbanization effects on the simulation of wind fields in the urban-scale and in the city-block-scale were evaluated using the WRF model and the WRF-CFD model, respectively. The study domains for the WRF and the CFD modeling are the Seoul metropolitan area and the Songpa district of Seoul, respectively. These domains include typical urban building environments with high-densities and multi-storied buildings. To create and compare urban land surface, the land cover was extracted from the Environmental Geographic Information System (EGIS-LC) and the spatial data of the Seoul Metropolitan area for the Biotope Mapping Project (BIOP-LC). The classification of three urban surfaces was made using BIOT-LC: (1) commercial and industrial, (2) high-intensity residential and (3) low-intensity residential. Overall, large differences in wind fields were shown distinctly by urbanization effect. However, the magnitude of the differences was distinguished between the time periods. The differences in the wind components by urbanization effect were somewhat stronger during the day than at night, and it was likely that the marked decrease in the wind speed during the day was mainly caused by increased mechanical drag, turbulence production, and thermal effects. The urbanization effect showed a decrease (up to 2.1 ms^{-1}) of wind speed in the urban canopy layer for two specific times. The particle accumulation was high in the recirculation zones, due to the presence of tall buildings near the road in this study.