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Numerical simulations of boundary layer structure during the high pollution episode in Tehran region

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In order improve meteorological fields and boundary layer structure in the Tehran region in finescale (Ĩ-km horizontal grid spacing) simulations, an urban canopy parameterization (UCP) that uses the drag force approach (DA) for dynamics and turbulent effects with a modified version of the soil model (SM2- U 3D), to represent the thermodynamic effects of the canopy elements is applied in comparison with 'standard version' of MM5. This version assesses the sensible and latent heat fluxes from rural and urban surfaces and anthropogenic heat flux in each of the computational layers inside the canopies by considering the shadowing effect, the radiative trapping by the street canyons, and the storage heat flux by the artificial surfaces. The observations and simulations show that Tehran PBL structure is extremely under effect of interactions between topographic and heat island flows and show a multi layer structure. The simulations by DA-SM2-U show better correlation with observations and standard version (The slab roughness approach: RA) are unsatisfactory at neighborhood scales in this area. The DA-SM2-U meteorological fields seem well simulated following the RSL and PBL: decrease of the wind speed inside the dense canopies and even in the majority of PBL, skirting of the flow around the canopy blocks, warmer air inside the vegetation canopy than above open areas during the night and conversely during the day, and constantly warmer air inside the urban canopy. A discontinuity in the eddy diffusivity profile is simulated by DA-SM2-U between the canopies and the upper atmosphere, with small values of the eddy diffusivity inside the canopies, inducing a limitation of the turbulent exchanges between the inside and the outside of the canopies. The vertical profiles of potential temperature in urban areas have shown that simulations using DA-SM2-U reduce the tendency toward stable stratification. The comparison with measurements shows that the surface air temperature above rural and urban areas is better simulated by DA-SM2-U than by the 'standard version' of MM5 and DA-SM2-U with considering anthropogenic heating shows warmer RSL at least 2 ° C and local circulation show more complexity and frontal condition between heat island circulation with mountain winds. This improvement of the treatment of the urban areas in the meteorological model could have implications for simulating air chemistry processes at this scale.

Keywords: Anthropogenic heat flux, Drag force approach, Eddy diffusivity, Heat island.