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Impact of eddy characteristics on the turbulent heat and momentum fluxes in the urban roughness sublayer

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Eddy covariance (EC) observations above the densely built-up center of Nanjing were carried out from December 2011 to August 2012. Separate EC systems installed at two levels on a 36-m tower standing on a rooftop were operated simultaneously. Observations are grouped into two sectors according to the prevalent wind directions. In sector A where nearby buildings are all below the lower measurement level, the sensible heat and momentum fluxes are larger at the upper level in general. In sector B where several high-rise buildings are located upwind, the sensible heat flux is almost the same but the momentum flux is still larger at the upper level. Analyses show that turbulent eddy characteristics differ between the two wind sectors, which lead to different behaviors of turbulent exchange of heat and momentum at the two levels. A conceptual model is proposed to address the vertical variation of turbulent heat flux in the urban roughness sublayer (RSL). In sector A, the presence of the buildings adversely affects turbulence organization and block source elements. Such effects become stronger near the canopy level and decrease with height in the RSL. Thus, the turbulent heat flux increases with height. In sector B, wake effects of the nearby high-rises strongly destroy turbulence organization at higher levels, leading to similar sensible heat flux at both measurement levels.