Large Eddy Simulation of Particle Settling in the Atmospheric Boundary Layer

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With an aim to investigate how the dry deposition velocity is affected by the turbulent structure in the atmospheric boundary layer, large eddy simulation (LES) was performed in which the Lagrangian motion of a large number of particles was analyzed. Both convective and shear-driven turbulent boundary layers were considered, and particles were initially introduced near the top of the boundary layer with uniform horizontal concentration. The deposition rate was evaluated under different conditions of particle and turbulence, and compared with the existing empirical formula. It was found that the transition occurs in the deposition pattern from the diffusion-dominated regime to the gravitational-settling-dominated regime as ws/q increases, where ws is the terminal velocity of a particle and q is the turbulent velocity scale. The deposition velocity vd decreases with ws/q in the diffusion-dominated region, and it increases in the gravitational-settling-dominated regime. The transition occurs for much larger values of ws/q in the convective boundary layer than in the shear-driven boundary layer. The dynamical process is further elucidated on the relation how particle settling is affected by turbulence. Ultimately, LES is expected to provide essential information to clarify dry deposition process.