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Influences of planetary boundary layer mixing parameterization on surface ozone concentration and dry deposition over North China

Lin Zhang and Yuanhong Zhao

Peking University, School of Physics, Department of Atmospheric and Oceanic Sciences, Beijing, China (zhanglg@pku.edu.cn)

We present a regional-scale model study that analyzes how planetary boundary layer (PBL) and surface layer parameterizations influence surface ozone concentrations and dry deposition fluxes over the Beijing-Tianjin-Hebei region in summertime. We use the Weather Research and Forecasting Model coupled to Chemistry (WRF-Chem) to simulate surface ozone concentration and dry deposition, and examine three PBL schemes: the Yonsei University (YSU), Mellor–Yamada–Janjić (MYJ), and Asymmetric Convective Model version 2 (ACM2) schemes. The model sensitivity to surface layer schemes is also tested by coupling the ACM2 PBL scheme with either the revised MM5-similarity scheme or the Pleim-Xiu scheme. Key physical and chemical factors for ozone dry deposition parameterization are analyzed to explore the root causes of model discrepancies. We find that all simulations overestimate the daily mean ozone concentrations over North China in summer (42 ppbv in observations vs. 43-50 ppbv in model results). The YSU scheme has the largest overestimate in daily mean ozone concentration, but best reproduces the ozone diurnal cycle. The ACM2 scheme shows the largest underestimates of surface ozone over North China during nighttime, which can be explained by its weakest vertical mixing resulting in high NO_x concentrations and strong ozone nitration near surface. The choices of PBL and surface layer schemes lead to over 20% differences in ozone dry deposition fluxes due to differences in simulated surface ozone concentrations and dry deposition velocities. We find the differences in dry deposition velocity are mainly caused by differences in Monin-Obukhov length during nighttime and surface temperature during daytime.