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Intercomparison of Planetary Boundary Layer Parameterization and its Impacts on Surface Ozone Concentration in the WRF/Chem Model for a Case Study in Houston/Texas

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With over 6 million inhabitants the Houston metropolitan area is the fourth-largest in the United States. Ozone concentration in this southeast Texas region frequently exceeds the National Ambient Air Quality Standard (NAAQS). For this reason our study employed the Weather Research and Forecasting model with Chemistry (WRF/Chem) to quantify meteorological prediction differences produced by four widely used PBL schemes and analyzed its impact on ozone predictions. The model results were compared to observational data in order to identify one superior PBL scheme better suited for the area. The four PBL schemes include two first-order closure schemes, the Yonsei University (YSU) and the Asymmetric Convective Model version 2 (ACM2); as well as two turbulent kinetic energy closure schemes, the Mellor–Yamada–Janjic (MYJ) and Quasi-Normal Scale Elimination (QNSE). Four 24 h forecasts were performed, one for each PBL scheme. Simulated vertical profiles for temperature, potential temperature, relative humidity, water vapor mixing ratio, and the u-v components of the wind were compared to measurements collected during the Second Texas Air Quality Study (TexAQS-II) Radical and Aerosol Measurements Project (TRAMP) experiment in summer 2006. Simulated ozone was compared against TRAMP data, and air quality stations from Continuous Monitoring Station (CAMS). Also, the evolutions of the PBL height and vertical mixing properties within the PBL for the four simulations were explored. Although the results yielded high correlation coefficients and small biases in almost all meteorological variables, the overall results did not indicate any preferred PBL scheme for the Houston case. However, for ozone prediction the YSU scheme showed greatest agreements with observed values.