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Downscaling a global climate model to simulate climate change over the US and the implication on regional and urban air quality

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Abstract. Climate change can exacerbate future regional air pollution events by making conditions more favorable to form high

levels of ozone. In this study, we use spectral nudging with the Weather Research and Forecasting (WRF) model to downscale NASA earth system GISS modelE2 results during the years 2006 to 2010 and 2048 to 2052 over the contiguous United States in order to compare the resulting meteorological fields from the air quality perspective during the four seasons of five-year historic and future climatological periods. GISS results are used as initial and boundary conditions by the WRF regional climate model (RCM) to produce hourly meteorological fields. The downscaling technique and choice of physics parameterizations used are evaluated by comparing them with in situ observations. This study investigates changes of similar regional climate conditions down to a 12 km by 12 km resolution, as well as the effect of evolving climate conditions on the air quality at major US cities. The high-resolution simulations produce somewhat different results than the coarse-resolution simulations in some regions. Also, through the analysis of the meteorological variables that most strongly influence air quality, we find consistent changes in regional climate that would enhance ozone levels in four regions of the US during fall (western US, Texas, northeastern, and southeastern US), one region during summer (Texas), and one region where changes potentially would lead to better air quality during spring (Northeast). Changes in regional climate that would enhance ozone levels are increased temperatures and stagnation along with decreased precipitation and ventilation. We also find that daily peak temperatures tend to increase in most major cities in the US, which would increase the risk of health problems associated with heat stress. Future work will address a more comprehensive assessment of emissions and chemistry involved in the formation and removal of air pollutants.

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