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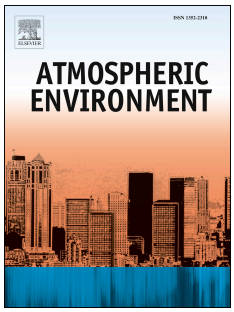

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A Study of Model Nighttime Ozone Bias in Air Quality Modeling

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HIGHLIGHTS

- Large nighttime ozone biases were found in past CMAQ simulations in southeast Texas
- The high model background ozone is likely the prime contributor of regional ozone bias for August 2015 period
- Land cover change has a significant impact on nighttime ozone bias, dry deposition and vertical diffusion. Updating land cover resulted an increase in ozone bias
- The default minimum eddy diffusivity coefficient (Kzmin) setting helps reduce bias by 31%
- Coastal, urban, and suburban sites respond quite differently to the change of land cover / vertical diffusion setting

Abstract

This study investigated the causes behind the nighttime ozone biases in southeast Texas, including background ozone, the land use/land cover (LULC) change and the minimum nighttime eddy diffusivity coefficient (Kzmin) setting. It also tried to shed light on a historical issue of large ozone biases by tracing the history of Community Multiscale Air Quality (CMAQ) model's treatment of Kzmin. The ozone biases associated with the low and active ozone days are distinctively different through examination of their diurnal cycles. Hence the model background ozone bias is likely responsible for ozone bias at the regional level. Significant differences in PBL height, vertical mixing, dry deposition and spatial patterns of ozone biases were found in two LULC cases. Spatial patterns of nighttime eddy diffusivity and dry deposition are consistent with the underlying LULC data. By using the default Kzmin setting which lowering the nighttime vertical mixing, the average ozone bias is reduced as compared to the alternative Kzmin setting. The reduction is 3.7 ppb or 31% when the latest National Land Cover Database (NLCD) 2011 is used. Still biases as high as 20 ppb exist at a number of sites. There are minimal changes in ozone biases in inner city and coastal sites while the changes in some rural/suburban sites are substantial. Also higher sensitivity was observed when preceding day ozone was high. The results showed that both downward mixing of ozone above and dilution of surface NO are important processes for nighttime ozone. By comparing the spatial bias pattern of 2006 and 2015, we are fairly certain the high nighttime eddy diffusivity in the old simulation played a significant role in the large nighttime biases. The impacts from the uncertainties in dry deposition can be medium while uncertainties caused by model horizontal