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Seven year particulate matter air quality assessment from surface and satellite measurements

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Abstract. Using seven years of the Moderate Resolution Imaging Spectroradiometer (MODIS) aerosol optical thickness (AOT) data and ground measurements of particulate matter mass over one site in the Southeastern United States (33.55° N, 86.82° W) we present a comprehensive analysis of various aspects of particulate matter air quality. Monthly, seasonal and inter-annual relationships are examined with emphasis on sampling biases, quality indicators in the AOT product and various cloud clearing criteria. Our results indicate that $PM_{2.5}$ mass concentration over Northern Birmingham has decreased by about 23% in year 2006 when compared to year 2002 and air quality during summer months was poor when compared to winter months. MODIS-Terra AOT data was available only about 50% of the time due to cloud cover and unfavorable surface conditions. However, the mean difference in monthly mean $PM_{2.5}$ was less than 2.2 μg m^{-3} derived using all the data and from only those days when satellite AOT was available indicating that satellite data does not have sampling issues. The correlation between $PM_{2.5}$ and MODIS AOT increased from 0.52 to 0.62 when hourly $PM_{2.5}$ data were used instead of daily mean $PM_{2.5}$ data. Changing box size for satellite data around the ground station during comparisons produced less than ±0.03 difference in mean AOT values for 90% of observations. Application of AOT quality flags reduced the sample size but does not affect AOT-$PM_{2.5}$ relationship significantly. We recommend using AOT quality flags for daily analysis, whereas long time scale analysis can be performed by using all AOT retrievals to obtain better sampling. Our analysis indicates that satellite data is a useful tool for monitoring particulate matter air quality especially in regions where ground measurements are not available. While these results are representative for the region of interest, it is difficult to extrapolate these results to a larger context without detailed analysis using ancillary data sets.

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