PMCAMx evaluation over Europe against AERONET and MODIS aerosol optical depth measurements

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Atmospheric aerosols are suspensions of solid and/or liquid particles in air that scatter and absorb light. The aerosol optical depth (AOD) is defined as the integrated extinction coefficient over the entire atmospheric column and is a measure of the total aerosol loading (Kokhanovsky et al., 2008). Calculations of AOD require knowledge of the aerosol vertical profile, including size distribution, chemical composition, and the aerosol microphysical state (Seinfeld and Pandis, 2006). Aerosol properties can be retrieved from ground-based measurements as well as from satellite earth observations (Duncan et al., 2014). Ground-based measurements of AOD are direct measurements while satellite AOD measurements are indirect, resulting from inversion procedures and exhibiting larger uncertainties (Anderson et al., 2013).

Chemical transport models **(**CTMs) are valuable tools for the study of the impact of pollutant emissions, studies of the aerosol radiative forcing, visibility, and global climate change. Uncertainties of the CTM's input data as well as weaknesses in representation of atmospheric processes may lead to weak model performance (Kinne et al., 2006). CTMs have been used in the past to provide AOD predictions either globally or over specific regions like Asia, United States and Europe (Carnevale et al., 2011; Im et al., 2014).

In the present study we provide a first-time evaluation of the CTM PMCAMx AOD predictions over Europe. In previous work, the PMCAMx predicted PM_1 composition has been evaluated in a limited number of European ground sites in May 2008 and aloft over Central Europe, the UK and Ireland (Fountoukis et al., 2011). PMCAMx performance against AMS airborn measurements was as good as its performance against the hourly ground measurements. More than 94% for organic aerosol (OA) and more than 82% for sulfate of the hourly PM_1 data were

reproduced within a factor of 2. However, the evaluation was limited in space. In this work detailed comparisons of the PMCAMx predicted AODs against the AERONET and MODIS measured AODs are analyzed for the same period and domain. The mean discrepancies of PMCAMx AODs with the MODIS AODs range from 0.04 to 0.06, and fall within the expected MODIS error envelope except for the South Atlantic. PMCAMx has the best performance in Spain, Portugal, Russia, England, Ireland, and the Mediterranean with mean bias ranging from -0.1% to -3% and fractional bias ranging from -0.2% to -12%. Over the Balkans PMCAMx appears to underpredict the AODs above 0.2 possibly due to sulfate underestimation. The details of the intercomparisons and the reasons for the discrepancies are analyzed.

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