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New aerosol particles formation in the Sao Paulo Metropolitan Area

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The Sao Paulo Metropolitan Area (SPMA), in the southeast region of Brazil, is considered a megalopolis comprised of Sao Paulo city and more 38 municipalities. The air pollutant emissions in the SPMA are related to the burning of the fuels: etanol, gasohol (gasoline with 25% ethanol) and diesel. According to CETESB (2013), the road vehicles contributed up to about 97, 87, and 80% of CO, VOCs and NO_x emissions in 2012, respectively, being most of NO_x associated to diesel combustion and most of CO and VOCs from gasohol and ethanol combustion. Studies conducted on ambient air pollution in the SPMA have shown that black carbon (BC) explains 21% of mass concentration of PM2.5 compared with 40% of organic carbon (OC), 20% of sulfates, and 12% of soil dust (Andrade et al., 2012). Most of the observed ambient PM2.5 mass concentration usually originates from precursors gases such as sulphur dioxide (SO_2), ammonia (NH3), nitrogen oxides (NO_x) and VOCs as well as through the physico-chemical processes such as the oxidation of low volatile hydrocarbons transferring to the condensed phase (McMurry et al., 2004).
The Weather Research and Forecasting with Chemistry model (WRF-Chem; Grell et al. 2005), configured with three nested grid cells: 75, 15, and 3 km, is used as photochemical modeling to describe the physico-chemical processes leading to evolution of particles number and mass size distribution from a vehicular emission model developed by the IAG-USP laboratory of Atmospheric Processes and based on statistical information of vehicular activity. The spatial and temporal distributions of emissions in the finest grid cell are based on road density products compiled by the OpenStreetMap project and measurements performed inside tunnels in the SPMA, respectively. WRF-Chem simulation with coupled primary aerosol (dust and sea-salt) and biogenic emission modules and aerosol radiative effects turned on is conducted as the baseline simulation (Case_0) to evaluate the model performance. For secondary aerosols, a simulation scenario (Case_1) with only emission of primary gases (biogenic and anthropogenic) is performed to evaluate its formation potential. The study period from 7th August to 6th September 2012 has been selected due to the avaliability of experimental data from the Narrowing the Uncertainties on Aerosol and Climate Changes in Sao Paulo State (NUANCE) project. Aerosol measurements consist basically on PM2.5 and PM10 concentration. OC, EC, ion, and aerosol mass size distribution measurements were also carried out in one of the measurement sites (IAG-USP).
Results show that overall the emissions of primary gases coming mainly from vehicles have a potential to form new particles between 20 and 30% in relation to the baseline PM2.5 mass concentration found in the downtown SPMA. In addition, both the observed and predicted OC and EC at the IAG-USP measurement site make up the largest fraction of PM2.5 mass with contributions around 55 and 40%, respectively.