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Ambient Particulate Matter during MILAGRO in Mexico City: Main Findings, Impacts (on AQ and Climate), and Future Research Needs

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The MILAGRO campaign was a large international field experiments conduced in Mexico City and Central Mexico during March 2006. We present an overview of the main findings related to particulate matter and aerosol radiative properties. PM levels inside Mexico City were similar or higher than those in the most polluted North American cities, but ∼5 times lower than levels in the most polluted Asian megacities During the study, PM10 and PM2.5 concentrations in the urban area of were about double the concentrations in the rural areas surrounding Mexico City. PM2.5 made up about half of the PM10 concentrations, with small amounts of mass in the PM2.5-PM1.0 range. Mineral matter made up approximately 25% of the PM10 and on average 15% and 28% of the PM2.5 in the urban and rural areas, respectively. Approximately 25% of the PM2.5 was secondary inorganic ions with the remaining PM2.5 mass being comprised of largely carbonaceous aerosol. Except for surface measurements at the central sampling sites in Mexico city, the elemental carbon mass absorption efficiency was relatively constant for aircraft and surface measurements throughout the study, contrary to expectations. Although different organic aerosol (OA) source apportionment methods had some differences, there was agreement that the dominant sources of carbonaceous aerosol were secondary OA (SOA), biomass burning, and mobile sources. The impact of biomass burning to the aerosol outflow from the region was much larger than to the surface concentrations inside the city. SOA formation from primary semivolatile and intermediate volatility precursors has the potential to close the gap in predicted vs. measured SOA, while formation from glyoxal also makes an important contribution, especially to organic oxygen. Biogenic SOA advected from the coastal mountain ranges contributes about 1 μg m-3 to concentrations in the MCMA. Primary OA from anthropogenic and biomass burning sources was found to be semivolatile, while secondary OA was less volatile than POA and aged SOA was essentially non-volatile, in contradiction with current models. Growth rates of new particle formation in Mexico City was very large and found to be impacted by nitrogen containing organic compounds, organic acids, and hydroxyl organic acids, with only a smaller fraction of sulfate aerosol.

Some open research questions include the following: additional work is needed to fully quantify the sources of substantial (30-45%) modern carbon in organic aerosols during low biomass burning periods. Discrepancies between the two modern carbon datasets deserve further study. The impact of regional dust vs. road resuspension, as well as heterogeneous reactions of HNO3 with dust need to be quantified. The impact of some POA sources such as food cooking, biofuel use, and open trash burning may be important, but remains poorly characterized. Some differences in the apportionment of biomass burning PM between different approaches were observed and need further research, as these techniques together represent the state of the art for source apportionment. Anthropogenic SOA predictions are improving in terms of magnitude but are poorly constrained by the data. More specific precursor, intermediate, and tracer measurements are needed in future campaigns. SOA from biomass burning sources, although not dominant in the city, remains poorly characterized and appears to be underpredicted by traditional models.