Measurement of Aerosol Size Distribution, Supermicron Aerosol Water Content, and New Particle Formation Events at T0-IMP

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INTRODUCTION

We undertook to measure the aerosol number size distribution at T0-IMP under both dry and ambient relative humidities, from 15 nm to 2.5 microns. This measurement provides insight regarding aerosol sources, properties, and processes. We were particularly interested in (1) new particle formation from nucleation and (2) aerosol water content – both for its effects on visibility and optical properties, and as a factor in partitioning and chemistry in the urban plume.

MEASUREMENTS

We measured the submicron aerosol number distribution with a SMPS system (TSI long column DMA and 3785 water-based CPC). The supermicron aerosol was measured by a TSI Aerosol Particle Sizer (APS 3321). Each of these two instruments had an inlet for RH modification. The SMPS had two flow paths – a dried path (Nafion stainless steel single tube dryer) and a RH controlled path, where it was possible to add or remove water vapour to maintain ambient RH in the DMA column. The SMPS sheath air was also alternated between dry and ambient RH air. The SMPS inlet was operated in the dry only mode for the majority of the study. The APS was equipped with a drying inlet (Nafion followed by silica gel diffusion dryer) and an inlet with no RH modification. APS sheath air was also either dry or ambient RH.

The aerosol physical measurements are combined with the CO_2 time series of the Eichinger group, taken at the soccer field at IMP, and the vertical staring elastic LIDAR measurements (from the soccer field as well). SO_2, O_3, NO_x, $PM_{2.5}$, and PM_{10} measurements from the RAMA network have also been downloaded and included in our analysis.

RESULTS AND DISCUSSION

New particle formation was observed in Mexico City on 4 of 13 days where daytime SMPS samples were taken. The days were we observed new particle formation were the 16th (10 AM), 17th (1 PM), 21st (11 AM), and 25th (2 PM) of the campaign. These events appear to be geographically widespread because the nucleation persists over several hours. The strength of the events in terms of creation of particles is modest, with $N_{15\text{-}500}$ increasing by 10,000 to 20,000 cm^{-3} during events. However, this occurs during periods where of ventilation of the boundary layer, so the increase may be during a period where the height of the mixed layer is growing. Growth rates are quite rapid, in the 10-15 nm per hour range, higher than previously measured growth rates in Pittsburgh PA (6-12 nm/hr), rural Illinois (4-9 nm/hr). Median SO_2 levels are certainly high enough for high sulphuric acid production rates, with a median SO_2 concentration of about 13 ppb and a 90th percentile of 28 ppb. Interestingly, NPF events often occur during periods of sharp reduction in SO2, suggesting ventilation of (relatively) depleted SO_2 air from above. We hope to confirm this with LIDAR and other data from the campaign.

Regional new particle formation events are most common in Pittsburgh (~3 of 10 days averaged over 1 year). Sampling duration was not long enough in Bondville (2 months) or Mexico City (1 month) to establish an overall frequency, but particle formation events appear to be somewhat less frequent (than Pittsburgh) in both locations. Mexico City new particle formation has been investigated previously by Dunn et al. (2004). In Bondville IL, which has lower SO_2 concentrations than Pittsburgh or Mexico City, growth rates are lower. In all three locations, particle formation events often occur simultaneously with rapid increase in boundary layer height. However, this is not always the case. In all locations, events also occur before rapid increase in the boundary layer height.

In Mexico City, the role of the boundary layer and residual layer in new particle formation appears to be very important. The Mexico City basin has been shown to have strong thermally and topographically driven circulations (Doran et al., 1998). The connection of this unique meteorology to new particle formation is potentially important because it may give clues as to the mechanism(s) at work for formation and growth, determine the spatial coverage, and explain the observance of formation events from ground-based samplers.

On several of the study days in Mexico City, rapid decreases in PM concentrations in the early afternoon are simultaneous with rapid increases in boundary layer height, high friction velocities, and the appearance of a newly formed and growing sub-50 nm mode in the number size distribution. We analyze these days by looking at ground based size distributions, collocated elastic LIDAR measurements, and collocated wind profiler readings.

Data reduction for the supermicron aerosol water content, as measured by the difference of the not-dried and dried APS channels is ongoing, and we hope to present results at the MILAGRO science meeting.

Keywords: *Aerosol Size Distribution Measurement, Nucleation Measurements, New Particle Formation and Growth*

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