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Abstract

Agricultural facilities are the source of many types of particles and gases that can exhibit an influence on air quality. Emissions potentially impacting air quality from agricultural sources have become a concern for regulatory agencies such as the United States Department of Agriculture (USDA) and the Environmental Protection Agency (EPA). Particle mass concentration influences from agricultural sources can include both primary particles (direct emissions such as dust) and secondary particles (formed from gaseous precursors such as ammonia).

In support of other investigations at a swine production facility (Zavylov, 2006), continuous and near real-time measurements of particulate size distribution and composition were obtained. The facility consisted of three separate, parallel, deep-pit style barns. Each barn housed around 1,250 pigs with an average weight of approximately 90 pounds per animal. A single trailer was equipped with an aerosol mass spectrometer (AMS-Aerodyne, Inc.), a $PM_{2.5}$ elemental/organic carbon (EC/OC) analyzer (R&P, Inc., Series 5400) and an eight-stage cascade impactor (Tisch Environmental, Inc., Model TE-20-800). The trailer was located approximately 40 meters north (downwind based on available historic data) of the nearest barn. This suite of instrumentation allowed characterization of a wide range of particulate properties.

The aerosol mass spectrometer provides real-time information on particle size and chemistry. The AMS analyzed particles in the size range of ~30 nm to ~1 μm. Throughout the study, the AMS detected mass concentrations in this size range of 3-5 $\mu g\ m^{-3}$. The AMS consistently observed organic carbon as the dominant particulate constituent within this size range, with OC making up ~60% of the total mass during a typical time period. Smaller amounts of sulfate and nitrate were detected.

The real-time carbon analyzer found typical out-of-plume elemental and organic $PM_{2.5}$ carbon concentrations on the order of 0.4 and 1.2 $\mu g\ m^{-3}$, respectively. In-plume concentrations were observed with nominal values of 2.2 and 4.0 $\mu g\ m^{-3}$, respectively. These mass concentrations are consistent with the values reported by AMS.

Several optical particle counters (MetOne, Inc. Model 9012) and portable PM_{10}/$PM_{2.5}$ samplers (AirMetrics MiniVol) were arrayed (collocated) within and around the facility in order to determine particle plume transport throughout the facility. Background PM_{10} and $PM_{2.5}$ concentrations were found to average around 35 and 10 $\mu g\ m^{-3}$, respectively. In-plume values were 40-60 and 10-15 $\mu g\ m^{-3}$, respectively, depending on sampler location relative to the barns. The eight channel optical particle counters remotely recorded real-time number concentration data over particle size ranges from 0.3 μm to 10 μm and showed size distribution variations as a function of time and sampler location. Of special note were the differences observed for the horizontally-collocated but vertically-separated samplers, which indicated the facility's plume was emitted straight aloft directly above the building.

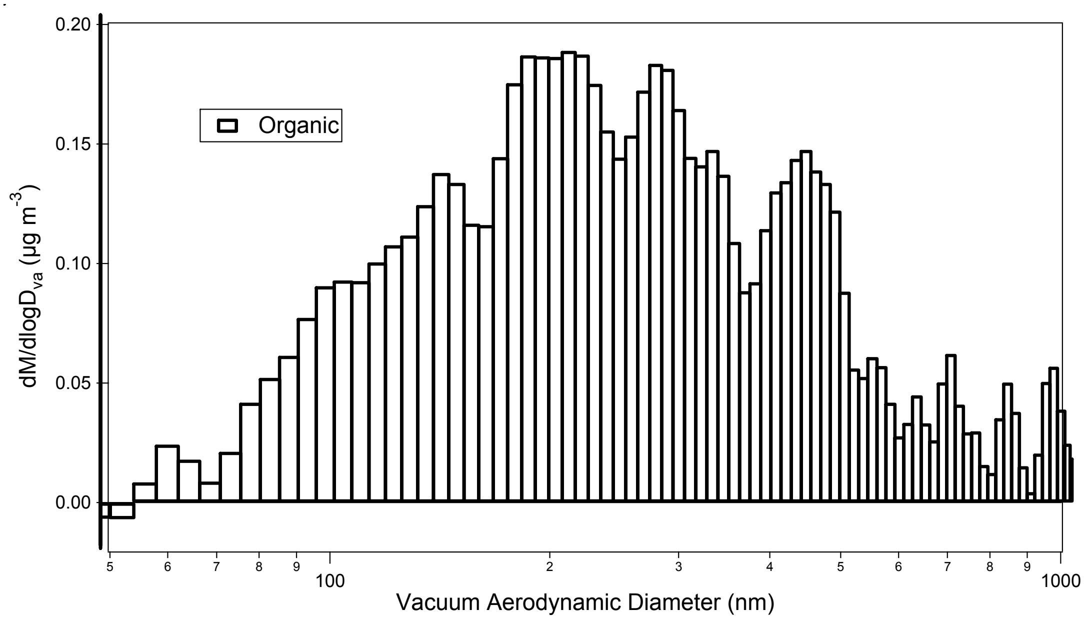

Figure 1: The organic carbon mass distribution detected by the aerosol mass spectrometer (eight hour average) at a pig barn facility in Ames, Iowa, 30 August 2005.

References

Zavyalov V.V., G.E. Bingham, T.D. Wilkerson, J. Swasey, C. Marchant, C. Rogers, R. Martin, P.J. Silva, and V. Doshi. 2006. Characterization of particulate emission from animal feeding operations with three-wavelength Lidar using simultaneous in-situ point measurements as calibration reference sources. Proceedings of the Workshop on Agricultural Air Quality: June 5-8.