LIDAR BASED PARTICULATE FLUX MEASUREMENTS OF AGRICULTURAL FIELD OPERATIONS

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ABSTRACT

Particulate emissions from agricultural sources vary from dust created by operations and animal movement to the fine secondary particulates generated from ammonia and other gases. Environmental concerns and population-increase in rural areas are increasing pressure on agricultural operations to reduce particulate emissions. Collecting reliable emissions data on potential "Conservation Practices" using conventional point sensors is challenged by changing wind directions, disrupted flow fields due to nearby structures, and varied surface conditions. We describe three-wavelength lidar based flux measurement method, which when added to a standard point sampler array, provides unambiguous measurement and characterization of the particulate emissions. Point sampled data are used to provide the aerosol characterization needed for the particle refractive index and size fraction calibration, while the lidar allows 3D mapping of particulate concentrations leaving the operation. Differenced downwind and upwind measurements provide the area averaged aerosol mass concentration ($\mu g/m^3$), which multiplied by the wind speed (m/s) provides the unit area flux ($\mu g/m^2 s^{-1}$), and multiplying by the plume area provides the total emission ($\mu g/s^{-1}$) leaving the field. This approach assumes only conservation of mass, eliminating reliance on boundary layer theory and transport models, and provides a near real time method for practice comparison. We summarize the method, examine measurement errors, and demonstrate the approach using data collected during harvest and tillage operations.