Performance Evaluation of a Low-Cost, Real-Time Community Air Monitoring Station

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Abstract

The US EPA's Village Green Project (VGP) is an example of ~~using~~ innovative technology that can ~~to~~ enable community-level low-cost real-time air pollution measurements. The VGP is an air monitoring system configured as a park bench located outside of a public library in Durham, NC. It contains air monitoring and meteorological instruments that measure $PM_{2.5}$ (Thermo pDR-1500), ozone (2B Technologies), temperature, relative humidity, wind speed, and direction. These instruments are integrated together using an Arduino microcontroller with real-time data streamed wirelessly using an Ethernet gateway to a cloud database once every minute. The data are then made available online to the public after automated quality checks. The entire station utilizes solar energy with battery backup to be self-powered and totally off the grid. In the first six months of field sampling since June 2013, the station has successfully collected over 3600 hours of $PM_{2.5}$ concentration data, with fewer than 10 days of down time due to power loss. To evaluate the VGP sensor system performance, data collected were summarized and compared with measurements made at nearby air monitoring stations operating federal equivalent methods (FEM) for $PM_{2.5}$ and ozone, with comparisons at hourly and 5-minute average time resolutions. In addition, the use of solar energy to support VGP operation was also assessed. The hourly average VGP $PM_{2.5}$ concentrations generally co-varied with the nearest benchmark FEM site during the sampling period, with a slope of the regression line of 0.96 and r^2 of 0.74. Comparison results indicated that design features incorporated in the VGP are a promising approach to enhance air quality and exposure monitoring capacities in community settings, which provide additional air quality data to supplement regulatory monitoring.