SUPPORTING INFORMATION to "Field calibrations of a low-cost aerosol sensor at a regulatory monitoring site in California"

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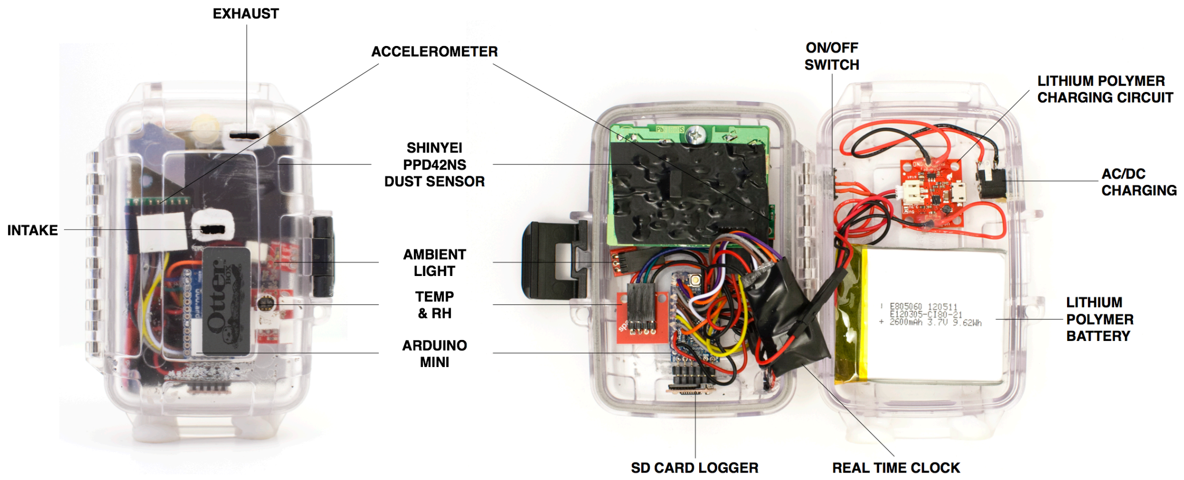

Figure S1. Elements and design of a PANDA instrument. All components were housed in a 12 × 9 × 4 cm, 250 g polycarbonate case, along with a charging circuit and a 16-hour, 2600 mAh lithium-polymer battery, which was charged continuously from a USB cable supplying 5V power. Manufacturer part identifiers and approximate costs for all components are listed in Table S1, Supporting Information.

	Component	Function	Approx Cost ($)
Base Components	Arduino Pro Mini	Microcontroller	10
	DS3234	Real-time clock	20
	Sparkfun OpenLog	MicroSD datalogger	25
	Shinyei PPD42NS	Dust sensor	16
	2000-2600 mAh battery	Power system	25
	Charging circuitry	Power system	20
	OtterBox	Enclosure	10
Additional Sensors	SHT15 / SHT75	Temperature and RH	40
	TEMT6000	Ambient light sensor	5
	ADXL335	3-axis accelerometer	25

Total Cost of Materials: about $200.00

Table S1. PANDA components. Prices indicative of June 2013 from popular online electronics retailers, including SparkFun, AdaFruit, and SEEEDStudio, excluding taxes and shipping.

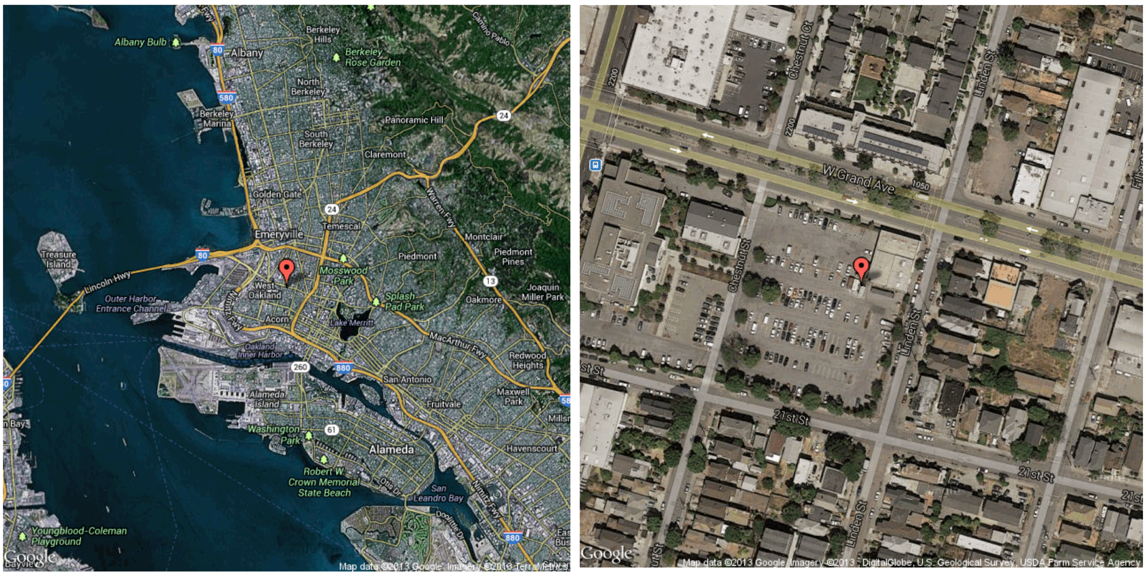

Figure S2. Location of the West Oakland monitoring site. Equipment was mounted on top of the trailer operated by the Air District in a parking lot, approximately 5 m above ground level.

Figure S3. To house our instruments, we constructed a portable chamber from an 8-gallon (30 L) plastic container, with 10 cm diameter holes cut into the front and rear. A 10 cm 12 V DC fan (Radio Shack #273-243, ~33 CFM) flush with the rear (exhaust) vent served to draw in ambient air. Using zip-ties, we secured PANDAs, a Dylos^{TM} DC1700, a GRIMM v1.108, and a laptop inside the chamber, along with AC power supplies. Due to space limitations, we constructed a second chamber to house our DustTrak^{TM} II Aerosol Monitor. We ran 1/4 inch tubing from the first chamber to the DustTrak, which has an active inlet and a 2.5 μm impactor. We ran 120V AC power from an outlet on the Air District trailer to a surge protector in each chamber and placed both chambers on the trailer roof from Apr 15–23 2013.

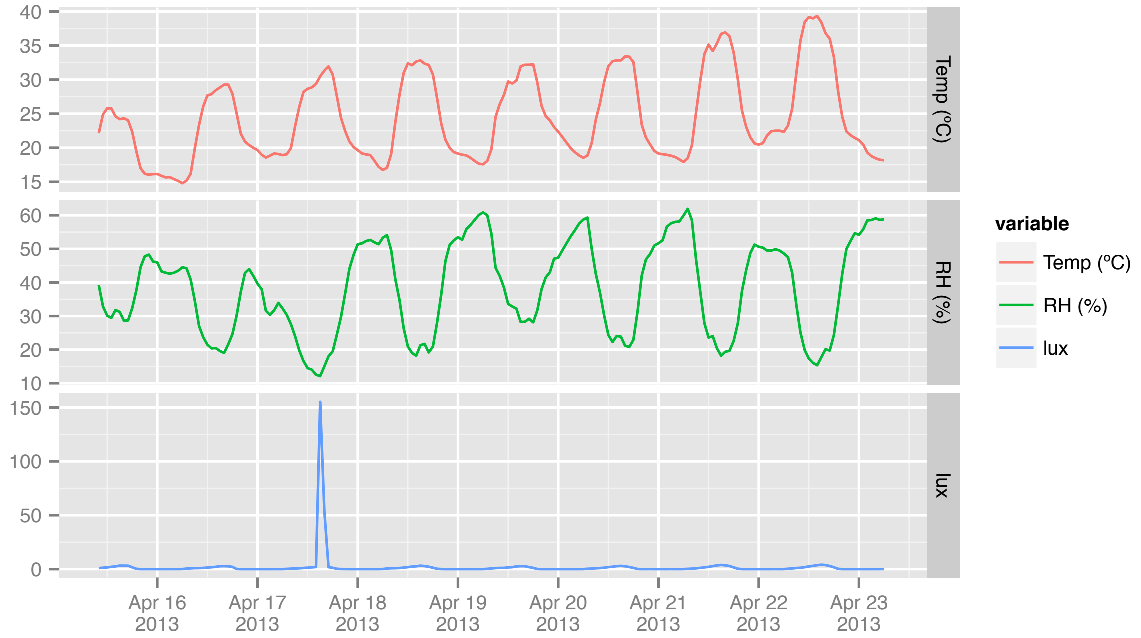

Figure S4. Relative humidity varied between 20 and 60%. Temperature was elevated relative to ambient temperature, presumably due to heat generated by the electronics. Ambient light was consistent across the study, save during the 1 h spot check when the lid of the chamber was removed to evaluate the operational status of equipment.

Pilot Study

As a pilot study, we colocated 5 Shinyei PPD42NS sensors in a 70 m^3 office environment, located on the 5^{th} floor of a building in downtown Berkeley, CA, for 6 weeks (Jul 16–Aug 30 2012). All windows were left open to promote extensive infiltration of outside air. Our aims for the pilot study were: (a) to assess whether previously reported high-frequency (1-minute) correlations between a PPD42NS and a consumer-grade optical counter (OPC) could be reproduced with a longer integration time (1 hour) at the much lower concentrations characteristic of ambient urban aerosol; and (b) to assess variations in response among a sample of PPD42NS sensors. We collected 1-minute data from a consumer-grade OPC (Dylos DC1700) positioned within 30 cm of the sensors. All data were subsequently binned and analyzed using 1 h arithmetic means.

During our pilot study, we observed very high pairwise correlations (R^2) of 0.98–0.99 between all sensors (Figure S6). The data were left-skewed, with 99% of observations between 0.013–1.623 and 95% between 0.023–1.362 (% FS; see Methods for an explanation of the metric). The mean and median were 0.366 and 0.215 % FS, respectively. The overall correlation between PANDAs and the OPC was slightly lower but still high, with R^2 = 0.85–0.87. We did not observe any obvious signs of an upper or lower detection limit in either PANDAs or OPC data.

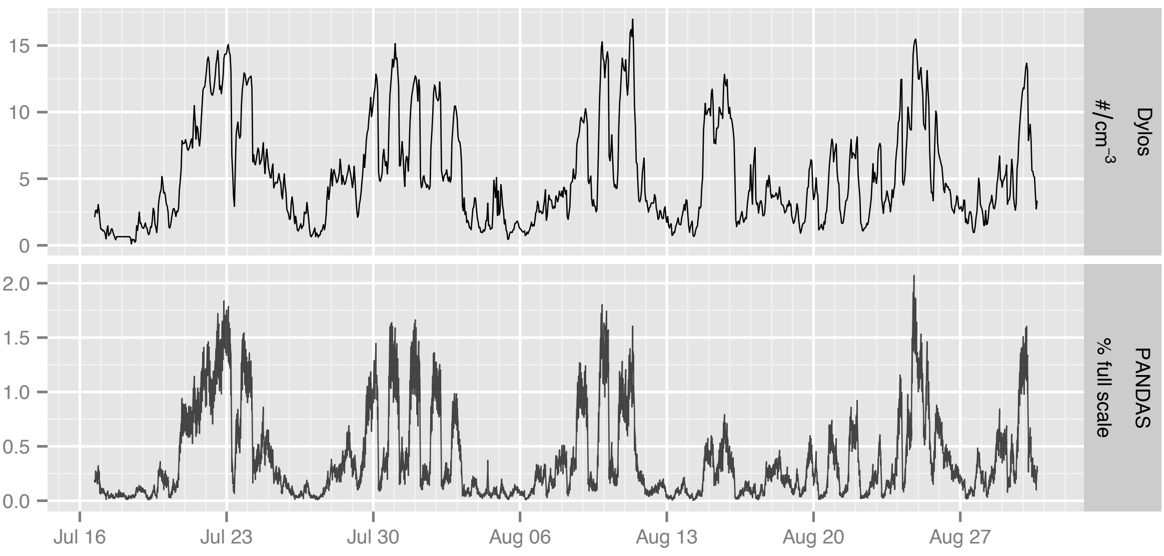

Figure S5. Temporal patterns (pilot study). Top: number concentration ($0.3 < d_p < 2.5\mu m$) from optical particle counter (Dylos DC1700). Bottom: 5 colocated PPD42NS sensors.

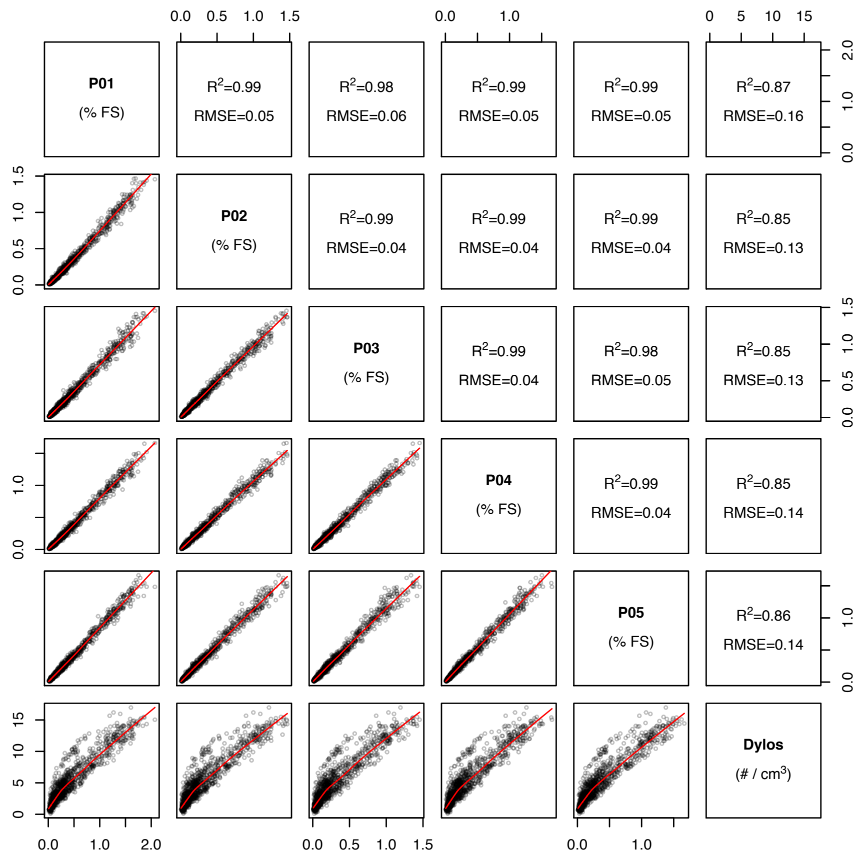

Figure S6. Pairwise associations (pilot study). Lower panels: 1 h data smoothed by loess (red lines). Top panels: coefficient of determination (R^2) and root mean squared error (RMSE) for linear models fit to the corresponding pairwise datasets.

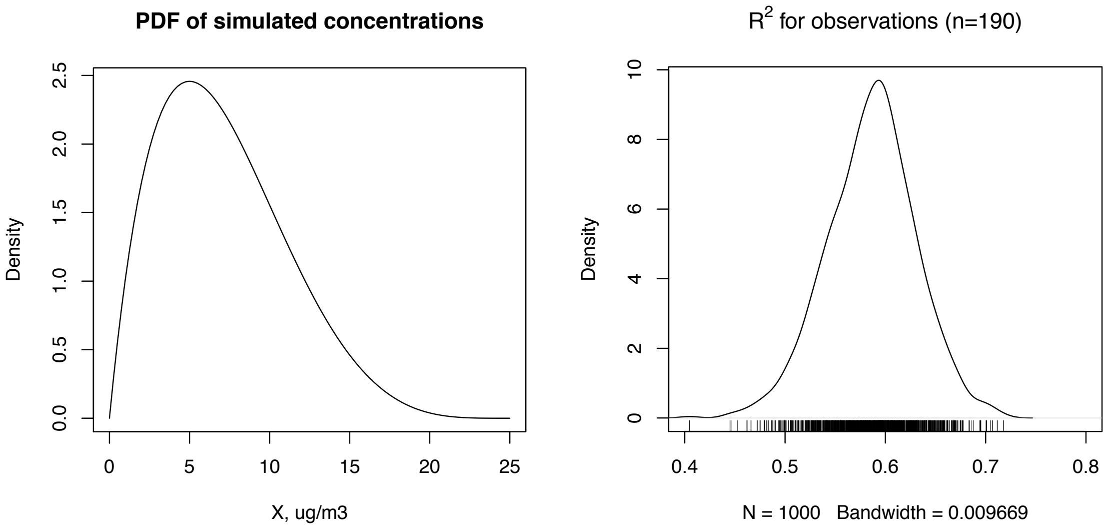

Figure S7. Simulation results and code. Left: scaled probability density function ß(2, 5) from which simulated 1 h concentrations were drawn. Right: Resulting distribution of R^2 from 1000 trials, each having 190 paired observations. Below: simulation code (R 3.0, http://www.r-project.org).

```
set.seed(1)     # for replicability
upper <- 25     # upper limit of "true" values
beta_pdf <- function(x) dbeta(x / upper, 2, 5)
curve(beta_pdf, 0, upper, main="PDF of simulated concentrations",
      ylab="Density", xlab="X, ug/m3", cex=0.5)
n <- 190        # simulated measurements per trial
p <- 1000       # trials
s <- 2.2        # s.d. of simulated measurement error
R2 <- replicate(p, {
  x <- rbeta(n, 2, 5) * upper
  z1 <- x + rnorm(n, mean=0, sd=s)
  z2 <- x + rnorm(n, mean=0, sd=s)
  summary(lm(z1 ~ z2))$r.squared
})
quantile(R2, c(0.025, 0.975))  # 95% empirical
plot(
  density(R2),
  main = expression(paste(R^2, " for observations (n=190)")),
  xlim = c(0.4, 0.8), cex = 0.5
)
rug(R2)
```