

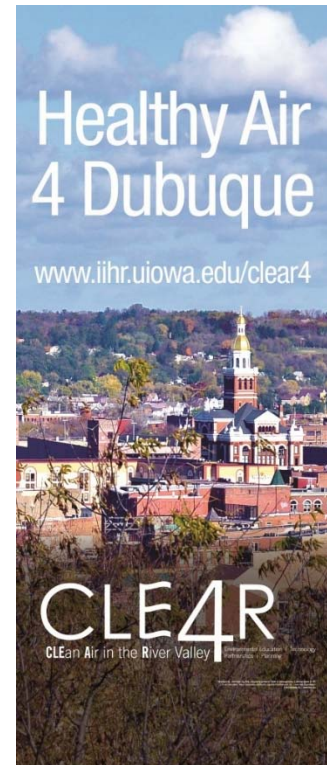
# CLE4R Partner Training

## Segment 3. Airbeam Monitors

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# Ambient Monitoring Station

- Sampling heads for
  - TSP – Total Suspended Particulates
  - PM10
  - PM2.5
- Good article at
  - <https://kydep.wordpress.com/2014/09/04/the-nitty-gritty-of-fine-particle-pollution/>



<http://www.pacwill.ca/RAAS25.htm>

New smaller electronic sensors exist but with significant accuracy, precision, calibration, and drift issues



Figure 2.1.6-1. Met One model 831 oriented in its shelter with the lid up.

Williams, R., Kaufman, A., Hanley, T. & Rice, J. *Evaluation of Field-deployed Low Cost PM Sensors.* (2014).



Air Quality Egg

Some Google Street View Cars Now Track Pollution Levels

JULY 29, 2015 9:28 PM ET

SAM SANDERS



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NPR

[http://www.npr.org/sections/alltechconsidered/2015/07/29/427462846/some-google-street-view-cars-now-track-pollution-levels?utm\\_medium=RSS&utm\\_campaign=news](http://www.npr.org/sections/alltechconsidered/2015/07/29/427462846/some-google-street-view-cars-now-track-pollution-levels?utm_medium=RSS&utm_campaign=news)

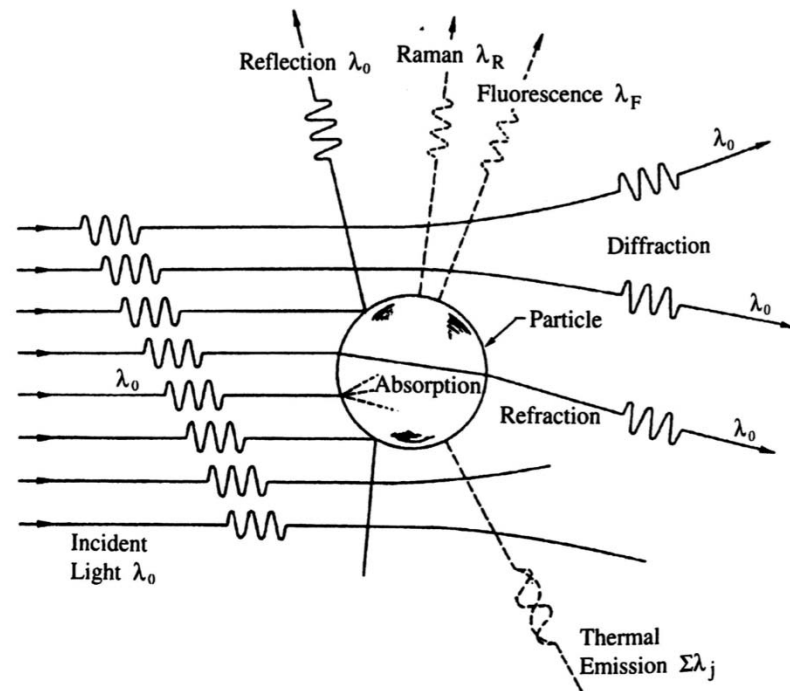
# Transition to Low Cost Sensors

- High cost sensors
  - Large design
  - Give data for general area
  - Too widespread
  - Much much more expensive
- Low cost sensors
  - Personal size
  - Gives more accurate representation of personal space air quality
  - More affordable for widespread distribution



# Light Scattering and Absorption

- Beam of light excites electric charges in particle
- Excited electric charges radiate energy in all directions (scattering)
- Some energy may be absorbed as thermal energy
- Electromagnetic radiation transports energy
- The amount crossing an area of a detector perpendicular to its direction of propagation is intensity (  $W/m^2$  )



# Light Light Scattering and Absorption

- Angular distribution of light intensity scattered at a given wavelength is a phase function

$$P(\theta, \alpha, m) = \frac{F(\theta, \alpha, m)}{\int_0^\pi F(\theta, \alpha, m) \sin \theta d\theta}$$

- Three types of scattering models
  - Rayleigh (particle smaller than wavelength)

$$P(\theta) = \frac{\lambda^2}{8\pi^2} \left( \frac{\pi D_p}{\lambda} \right)^6 \left| \frac{m^2 - 1}{m^2 + 2} \right|^2 (1 + \cos^2 \theta) F_0$$

- Mie (particle is about same size)
- Geometric (particle is larger than wavelength)

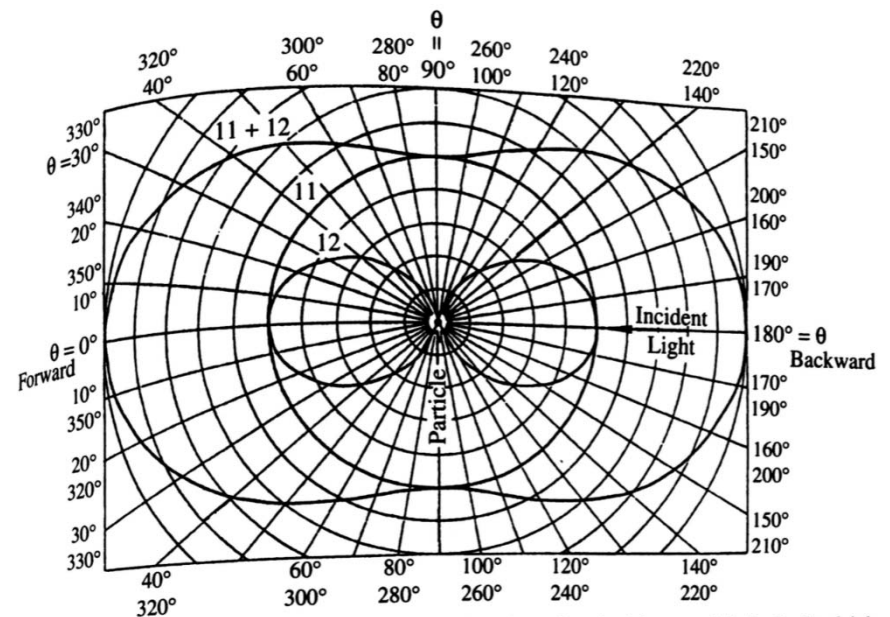
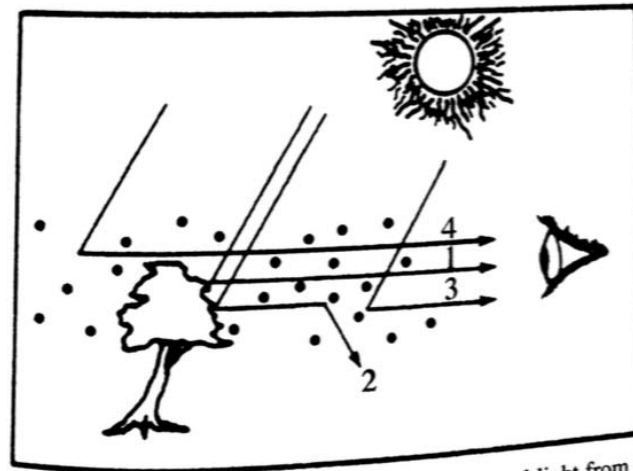


FIGURE 15.2 Pattern of light scattering (scattering phase function) by a particle in the Rayleigh regime. The scattered light intensity pattern is symmetric in the forward and backward directions, totally polarized at 90°, and independent of particle shape. Incident beam enters from the right. 11 indicates the circular component independent of  $\theta$ ; 12 is the  $\theta$ -dependent term.



# Light Scattering and Absorption

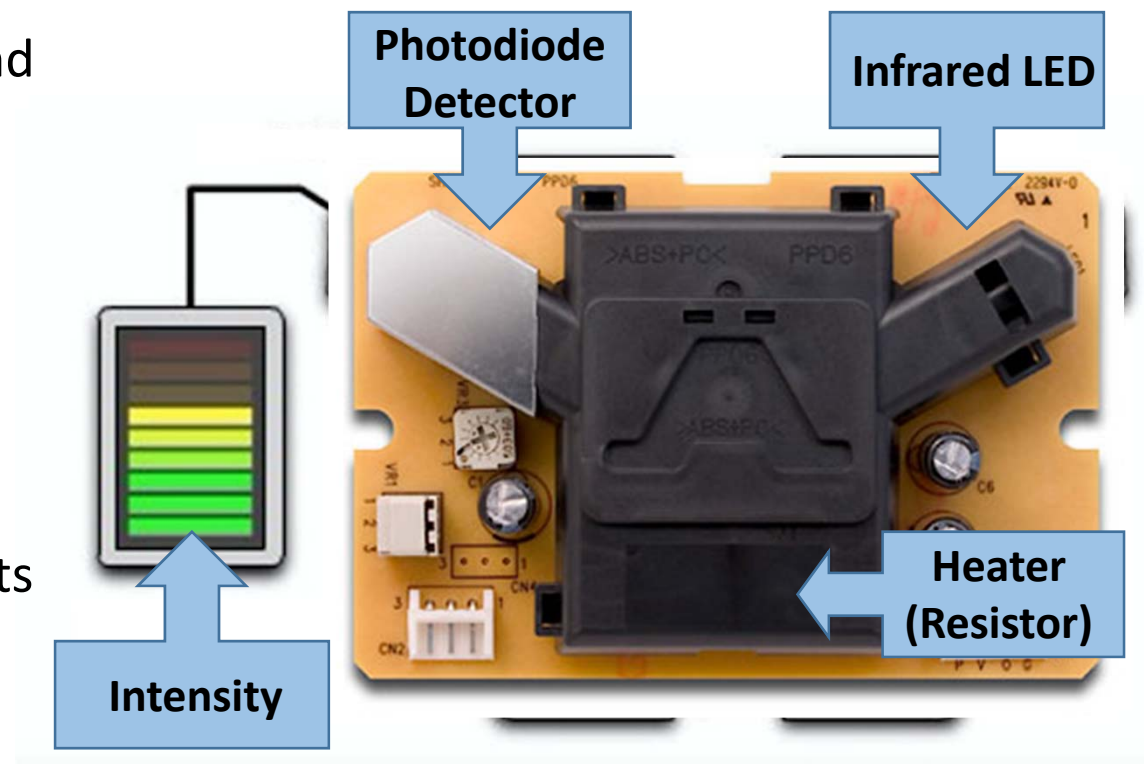
- Scattering is the most important phenomenon responsible for impairment of visibility
- Absorption of certain wavelengths are responsible for atmospheric colorations
- Scattering of light reduces contrast between object and person thus changing visibility
- Visibility degradation probably most readily perceived impact of air pollution



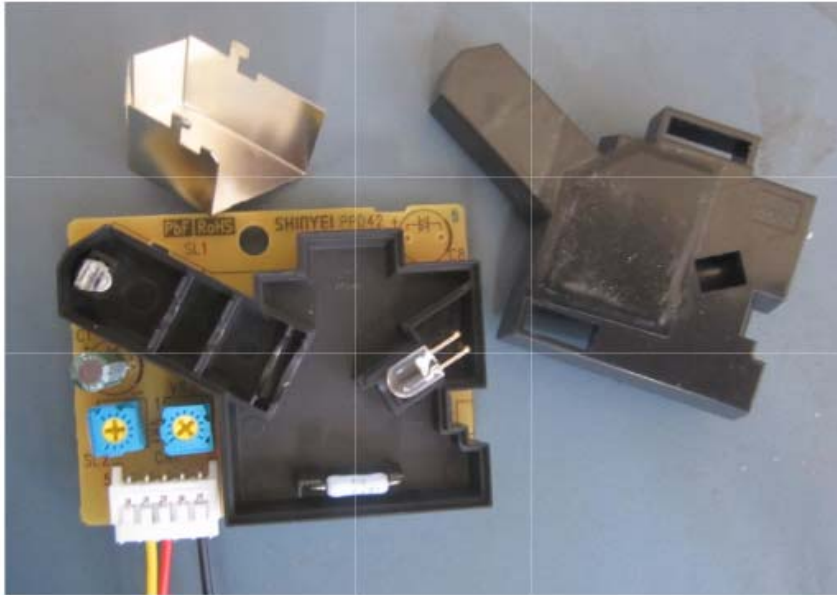
**FIGURE 15.5** Contributions to atmospheric visibility: (1) residual light from target reaching the observer; (2) light from the target scattered out of the observer's line of sight; (3) airlight from intervening atmosphere scattered into the observer's line of sight; and (4) airlight constituting the horizon sky.

# Detection

- Air enters the chamber and light from an LED scatters off of the particles
- Dual output of pulse and volts
- Photodiode detector register signal and converts measurement to  $\mu\text{g}/\text{m}^3$

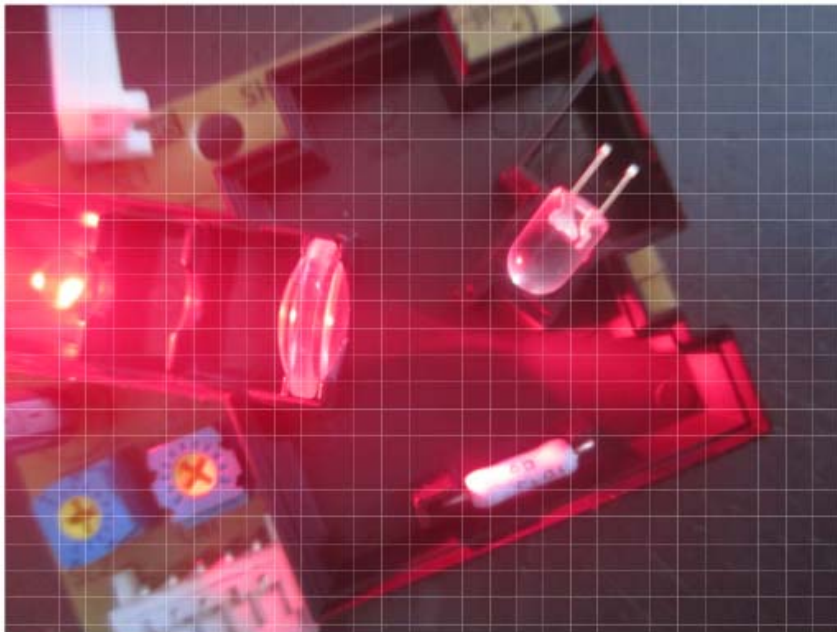






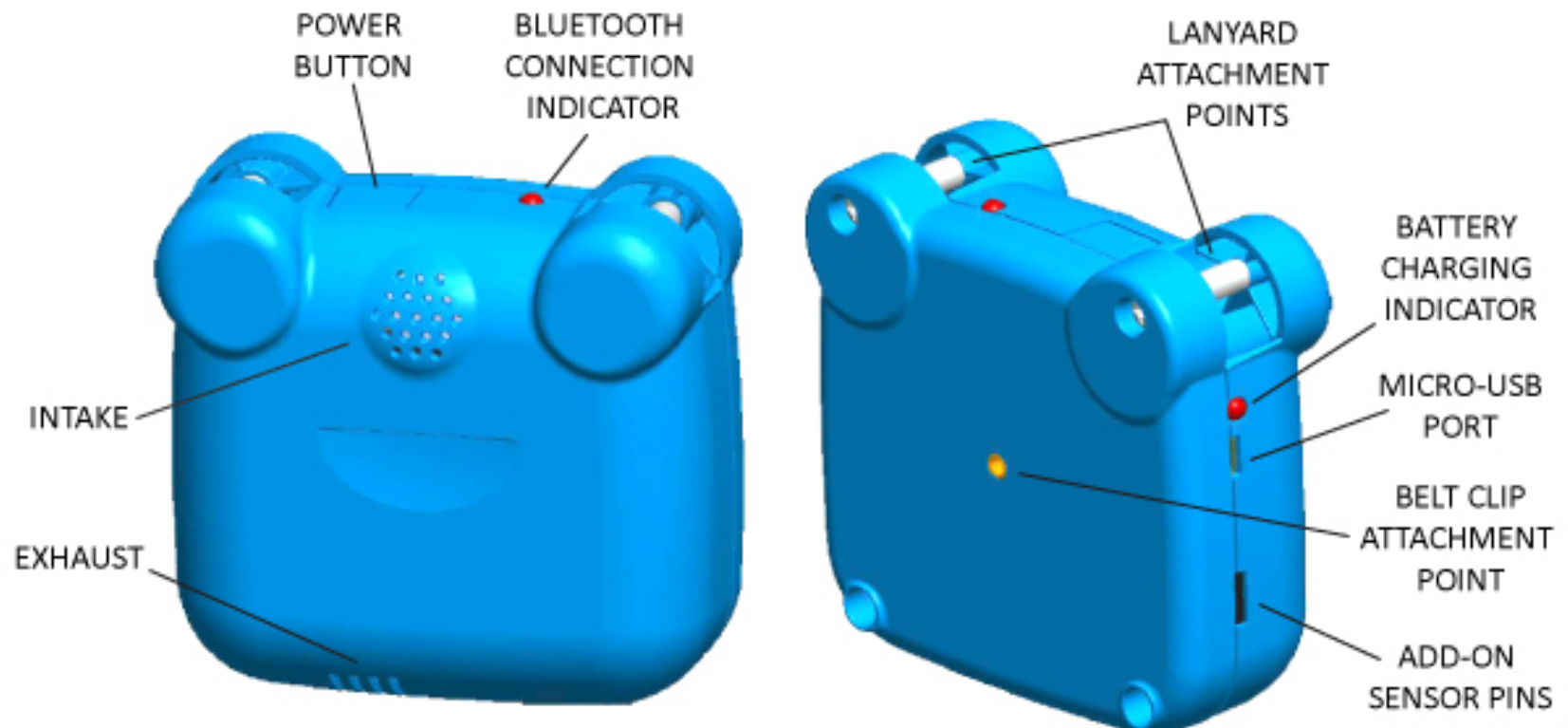
The shield can be unsoldered from the circuit board and removed, and then a tab on the end releases the plastic top cover to reveal the interior.

[http://takingspace.org/wp-content/uploads/ShinyeiPPD42NS\\_Deconstruction\\_TracyAllen.pdf](http://takingspace.org/wp-content/uploads/ShinyeiPPD42NS_Deconstruction_TracyAllen.pdf)

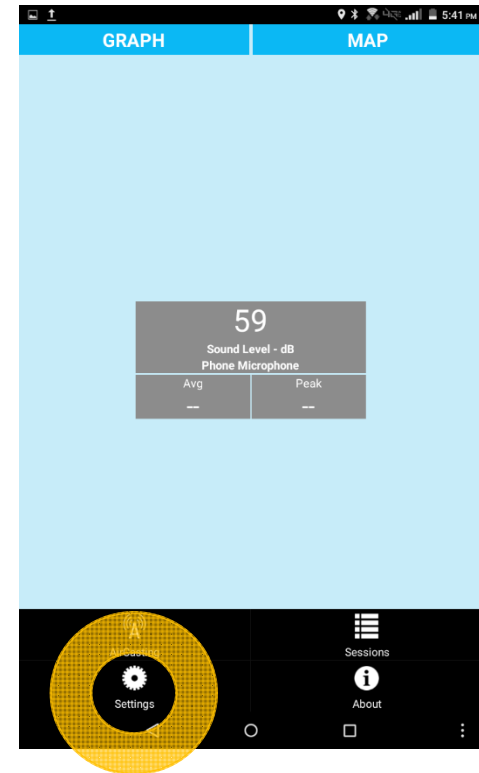
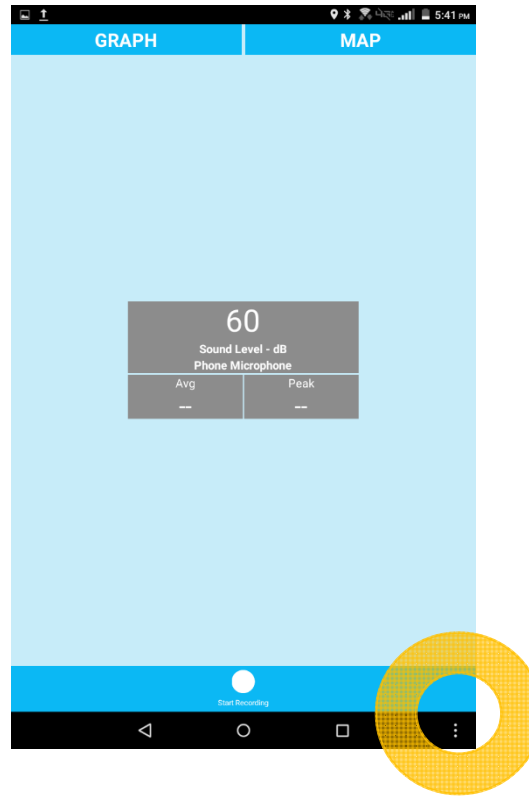
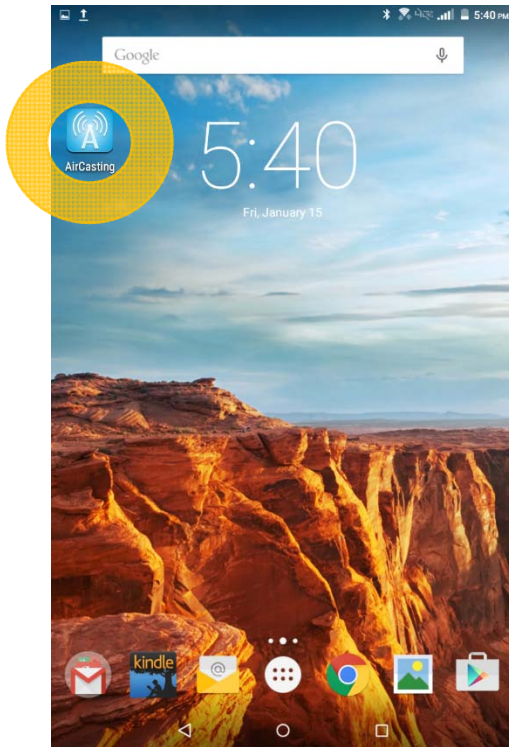


In this photo a bright red LED is placed at the position of the photodiode, and artificial smoke is sprayed into the detection area in order to help to visualize the focal point of the lens. The cone of light can be clearly seen as it comes down to a focal point directly in front of the opening behind which sits the infrared LED. Turning it around, light from the IR LED, scattered by particles in that same area, would be focused in reverse up onto the photodiode.

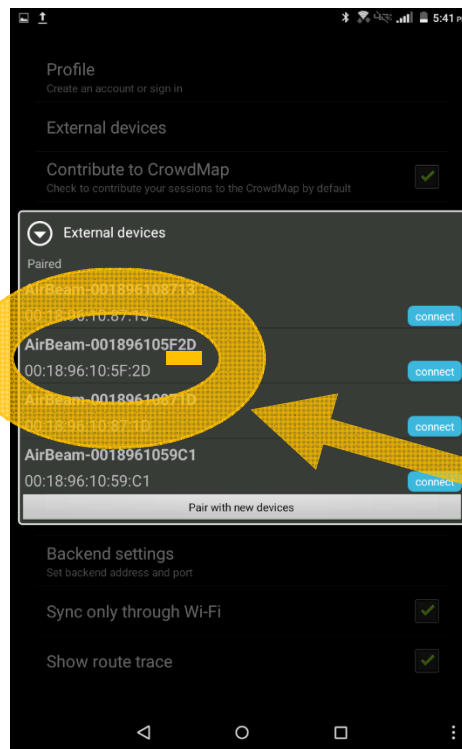
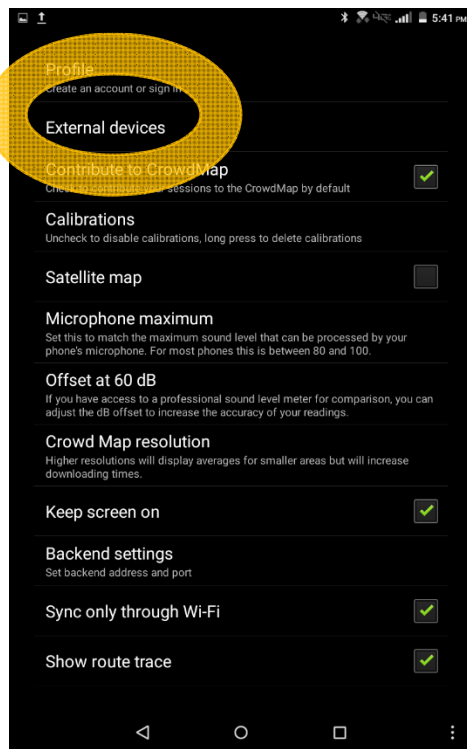
# AIRBEAM Specifications



# Aircasting Tour



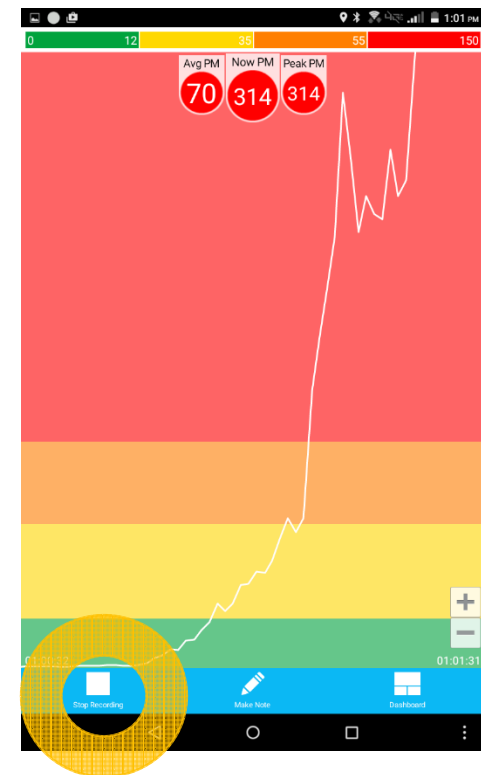
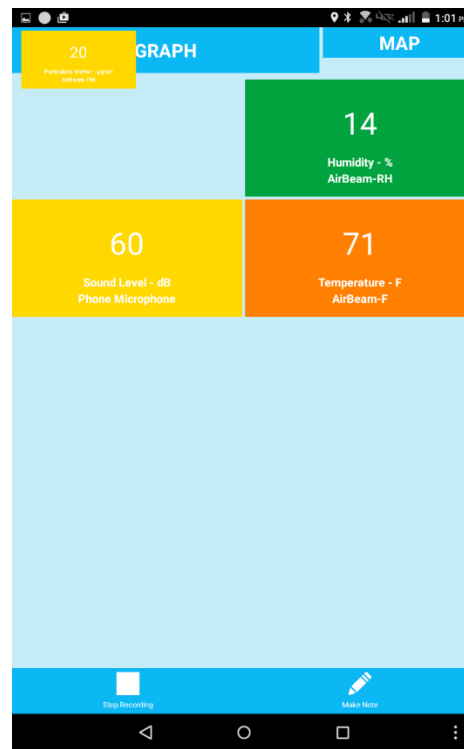
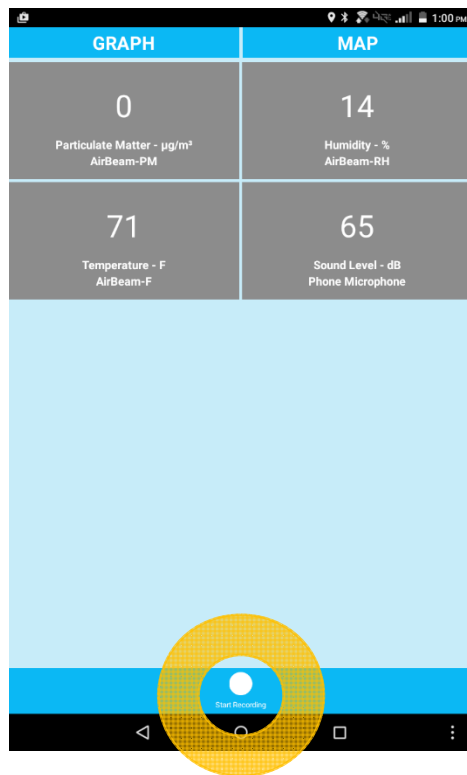
# Aircasting Tour



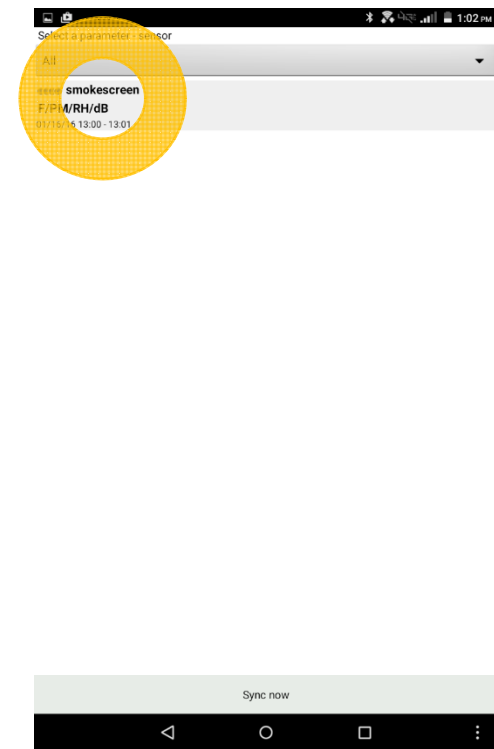
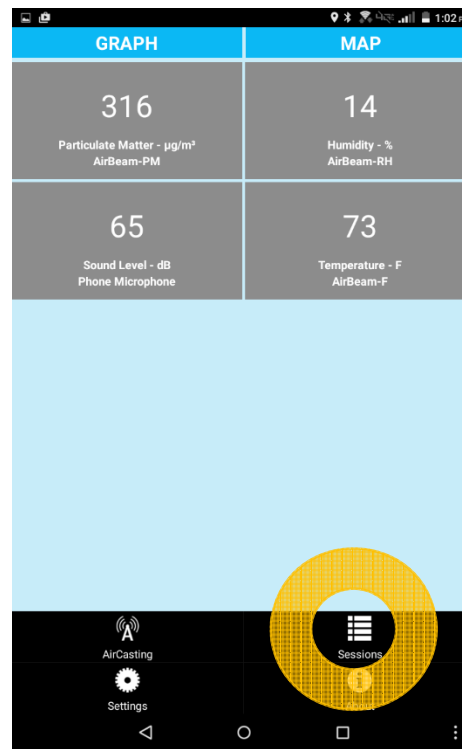
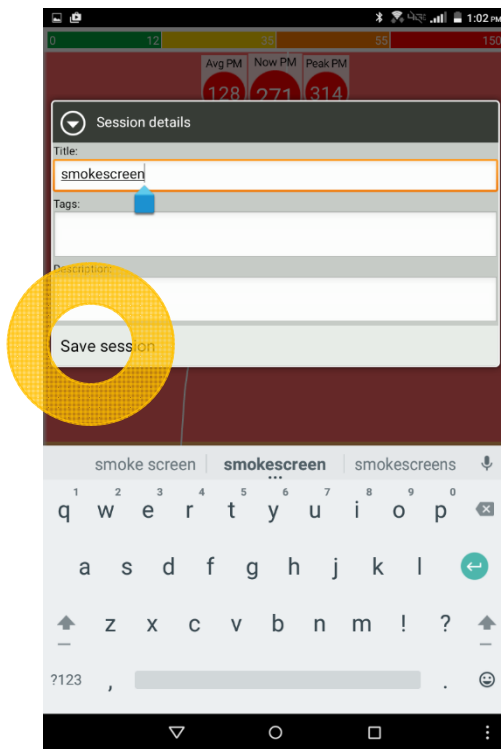
Must match up last 3 characters on application with Airbeam ID



# Aircasting Tour

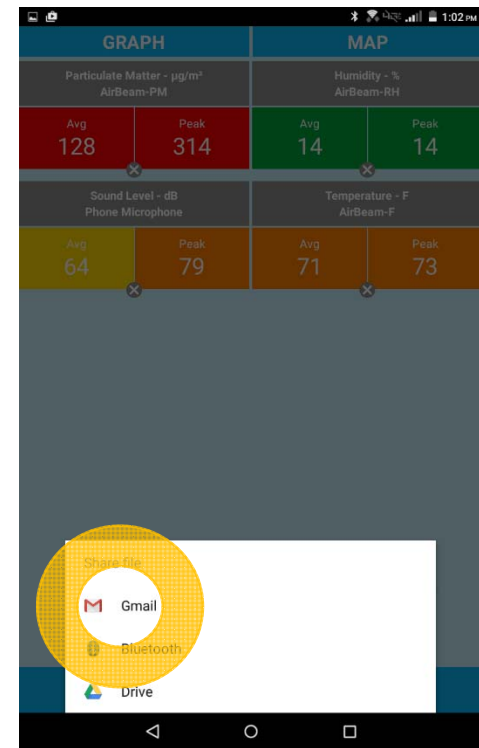
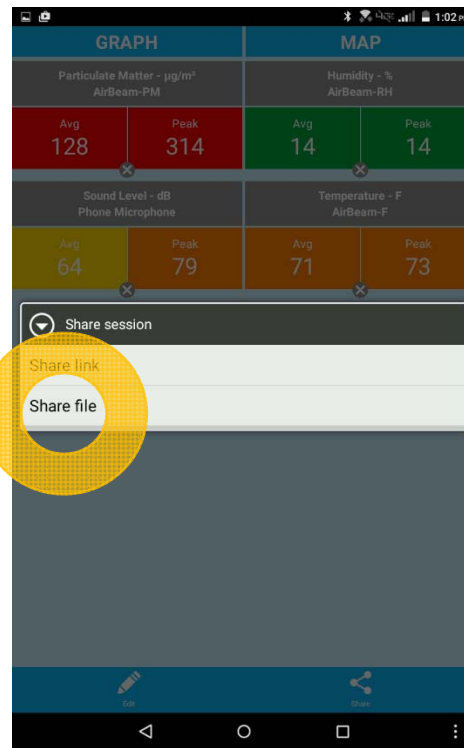
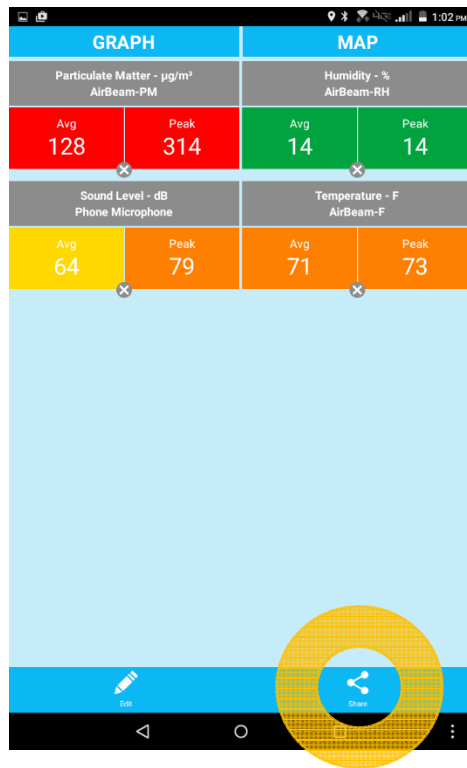


# Aircasting Tour

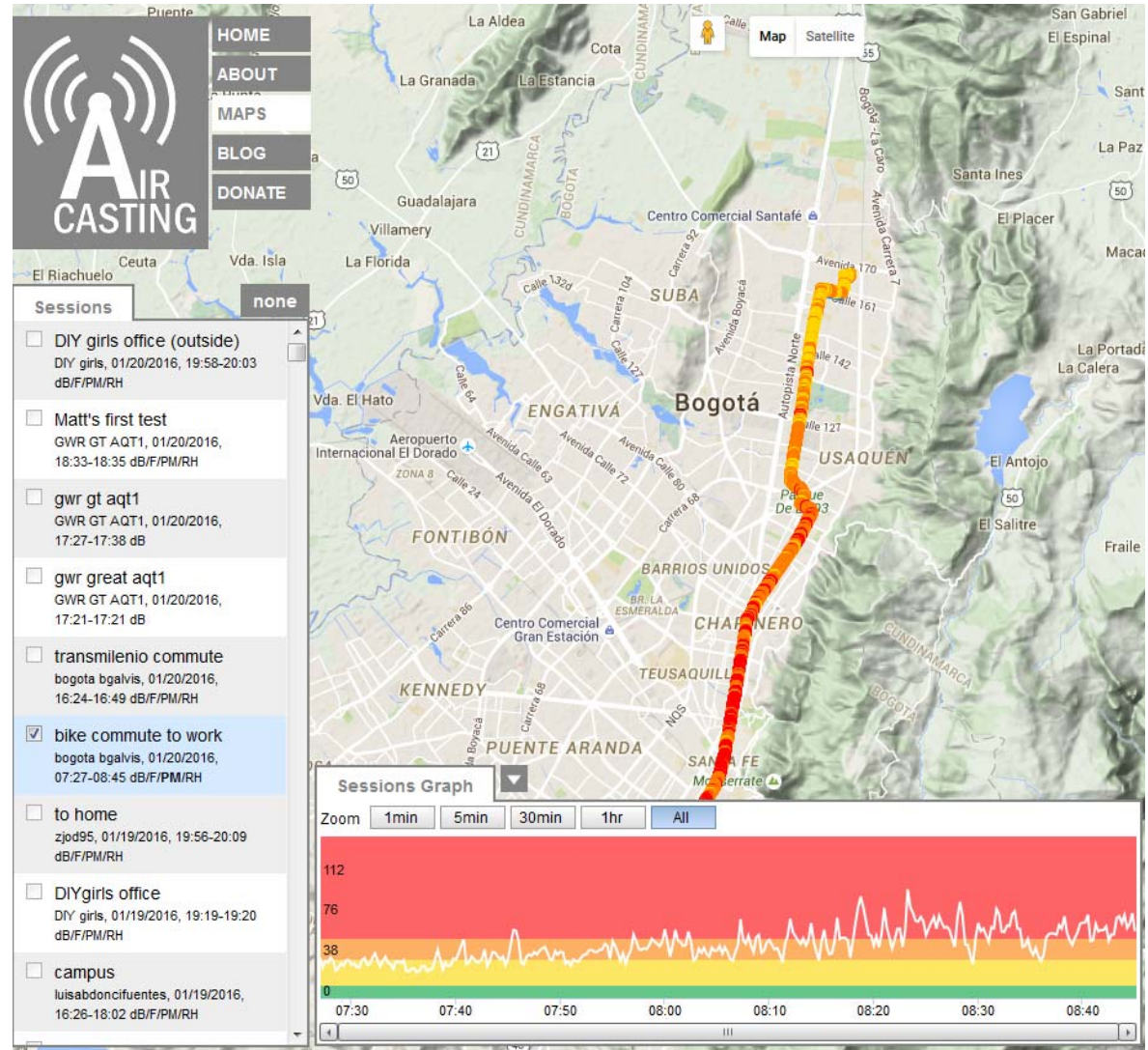




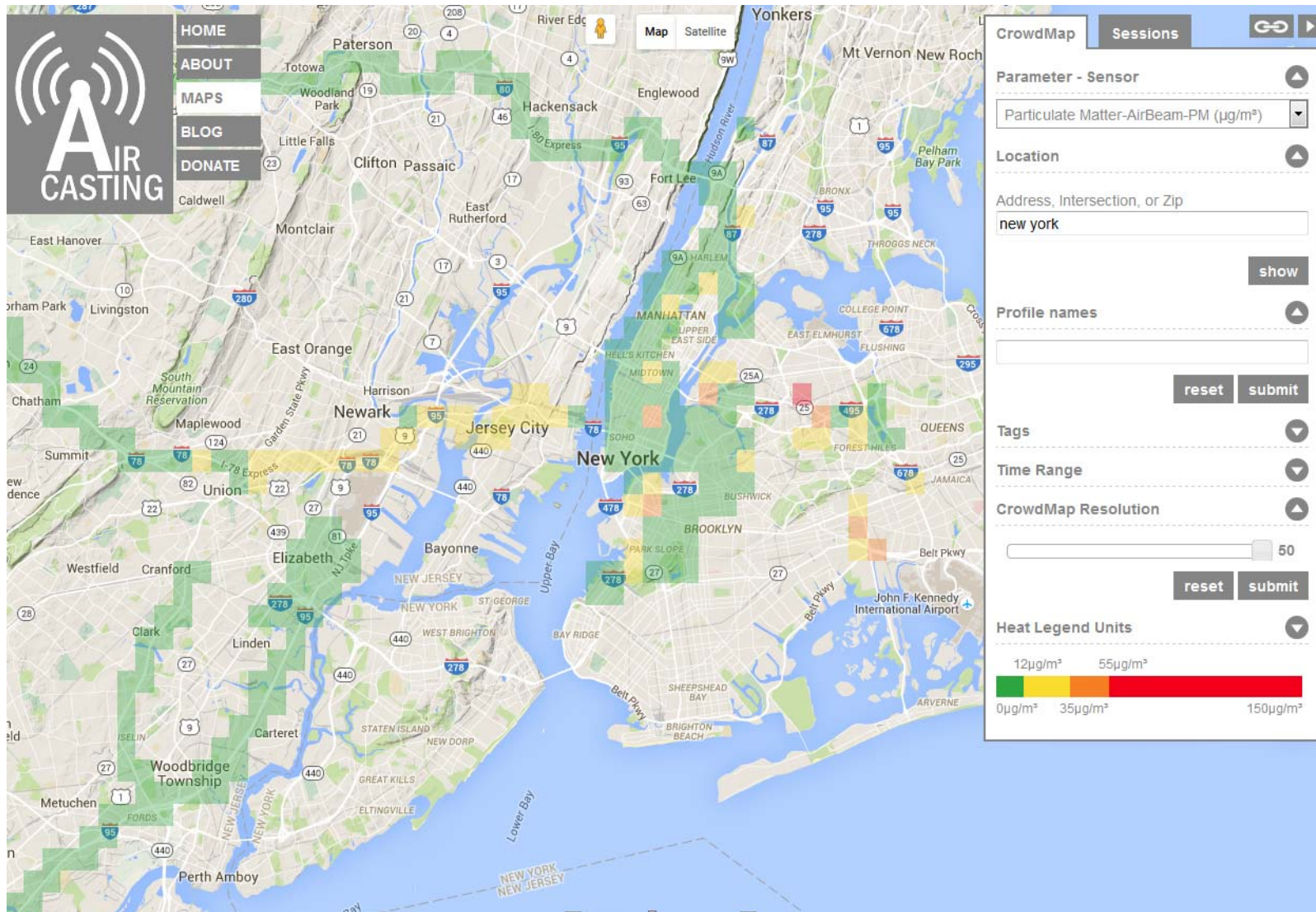
# Aircasting Tour



# Visualization



# Visualization





# Visualization – University of Iowa Google Earth

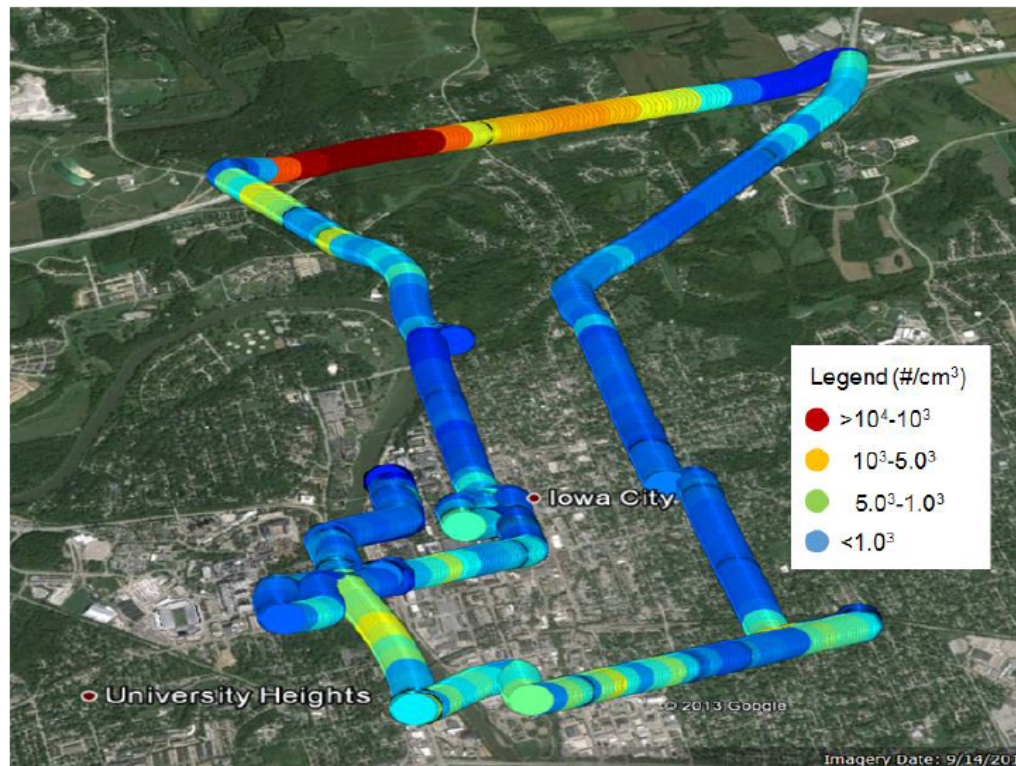


Figure 3.7 A trial mobile sampling conducted with the newly built Mobile CPC in various road networks (inner city, free-way, residential and commercial areas) in Iowa City on September 12 2012. Each circle indicate 1 s data collected for 1.2 hr during the trial

Source: Ashish Singh Ph.D. Thesis, University of Iowa, 2015