Ozone Exposure of Older Adults in Urban Neighborhoods

REU Final Presentation
By Deidre Ericson

Principal Investigators: Drs. Shelly Miller and Jana Milford
Graduate Student: Vanessa Pineda

Ozone (O_3)

•Secondary pollutant formed by reaction of NOx, VOCs, heat and sunlight

•Main sources of NOx and VOCs are car exhaust and power plants

•EPA standard is 75 ppb in a 8-hr averaging time

•Colorless, odorless gas that is highly reactive

Background

•Prolonged or high concentration ozone exposure can:

- ❖ Increase respiratory problems in people with preexisting asthma, heart disease, and emphysema
- ❖Increase the number of cases of bronchitis in kids and seniors
- ❖Create breathing difficulties, chest pain, coughing, and throat irritation

• As little as a 10 ppb increase in ozone concentration is associated with a 0.46% premature mortality rate in 80 US cities

Background

•**More than half** of the US population lives in an area that exceeds the federal ozone standard

•Indoor ozone concentrations are ≈30-70% of outdoor concentrations
•The average American spends on ≈ 87% of their time indoors
•Therefore, **25-60% of ozone inhaled each day is indoors**

Indoor ozone concentration depends on:

- • outdoor concentrations
- •air exchange rates
- •indoor emission rates
- •surface removal rates

Objective

•Construct a novel personal ozone monitor that combines a lightweight and portable ozone sensor, GPS, thermistor, and relative humidity sensor that is comfortably transportable

•Measure personal exposure of 6 older adults (>64 years) living in Arvada for two 5-day periods

•Compare personal exposure to Arvada's stationary monitors to better understand how home characteristics, ventilation, and location affect ozone concentrations by walk-though evaluations and activity diaries

•Assess the risk of ozone exposure of a vulnerable population

Motivation

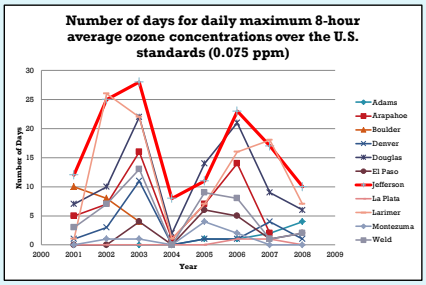
•The purpose of this Pilot Study is to get a grant for a larger scale study of 40 participants in Riverside, CA and Denver, CO

•Older adults are more vulnerable to ozone and at higher risk, yet very few studies have focused on this population

•First time a study has been done in the Denver area

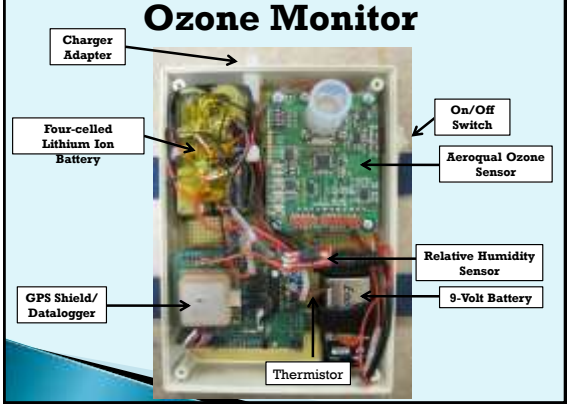
•Using a new ozone sensor that is lightweight and measures ozone as a function of time to compare the spatial variability of personal exposure to stationary ambient monitors

Why Arvada?

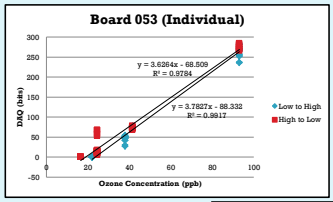


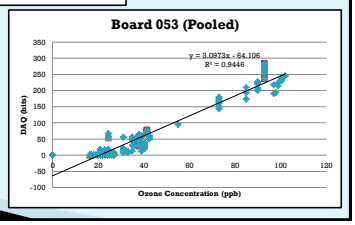
Why Arvada?

Ozone Monitor



Calibration Curves





Calibration Equations

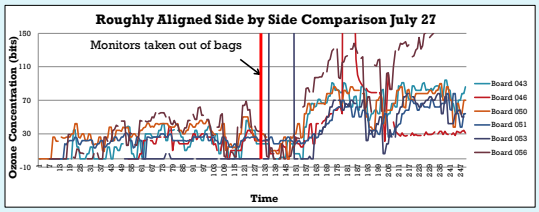
Board	Regression Equation	Correlation Coefficient	Slope	Y-intercept	Minimum Concentration (ppb)
043	y = 2.6852x - 47.761	0.9536	2.6852	47.761	17.79
046	y = 3.5824x - 79.615	0.962	3.5824	79.615	22.22
050	y = 2.4553x - 40.237	0.9648	2.4553	40.237	16.39
051	y = 3.4946x - 79.254	0.9614	3.4946	79.254	22.68
053	y = 3.0973x - 64.106	0.9446	3.0973	64.106	20.70
056	y = 3.0219x - 58.968	0.9782	3.0219	58.968	19.51

To convert 35 bits from Monitor 051 into ppb:

(35+79.254)/3.4946 = **33.122 ppb**

Carrying Design 1

Problems



- Bags were affecting ozone readings and causing them to malfunction
- Data from the first study may not be valid

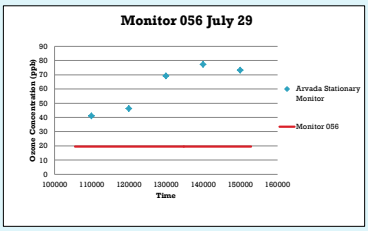
Carrying Design 2

Pilot Study

- 6 active older adults recruited from Arvada, CO
- Carry around monitors wherever they go from 11 am to 5 pm for two 5 day periods
- July and August were chosen because it is the hottest time of the year in Arvada so typically the highest ozone levels

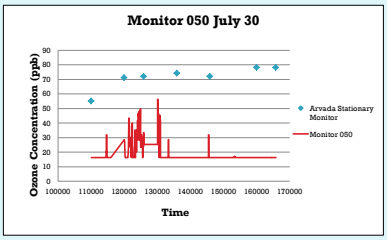
Sun	Mon	Tues	Wed	Thurs	Fri	Sat	
17-Jul	18	19	20	21	22	23	Pilot Study 1
24	25	26	27	28	29	30	Pilot Study 2
31	1-Aug	2	3	4	5	6	

Results



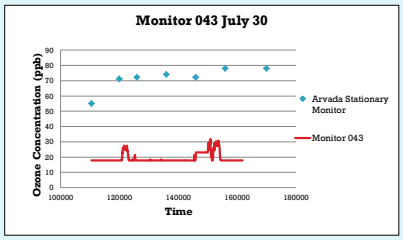
- Sensors were not sensitive enough detect ozone less than 15-30 ppb (depending on the sensor) and so little can be said about indoor concentrations
  - The hotter the day, the more time spent indoors,
  - which is a subconscious protective action

Results



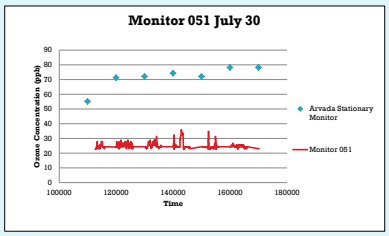
- Participants were usually not outdoors long enough to see correlation between their exposure and the stationary monitor

Results



- Personal exposure did not get nearly as high as the stationary outdoor monitor

Results



•Most sensitive to minute ozone concentration changes
•Clue that other monitors are getting to the end of their lifespan and may need to be fixed or replaced

Limitations

•Grant only provided enough money to buy, develop, and deploy 6 monitors making the sample population small

•Only females responded to recruitment efforts

•Were not as sensitive as we would have hoped

Future Research

Things we have learned from this pilot study:
•How to safely contain all components into smallest container possible
•Carrying design
•Handle sensors less
•Use them while they are new

Questions to consider:
•Why are outdoor concentrations lower than stationary monitors?

Acknowledgements

This pilot study is funded by the University of Colorado at Boulder through the **Innovative Seed Grant Program.**

A special thank you to Principal Investigators **Dr. Shelly Miller and Dr. Jana Milford**, and Graduate student **Vanessa Pineda** for guiding me through a great learning experience this summer.

Another thank you to **Tim May**, head of the Electronics Lab for his help and letting us use his lab and tools.

Questions?

References

Good vs. Bad Ozone
http://capita.wustl.edu/capita/capitareports/GLOBEO3/GoodBad.htm

Jefferson County Map and Graph
http://www.coepht.dphe.state.co.us/Environment/airQuality.aspx

Bell, M.L., McDermott, A., Zeger, S.L., Samet, J.M., Dominici, F. (2004) Ozone and short-term mortality in 95 US Urban Communities, 1987-2000, JAMA, 292(19), 2372-2378.

National Ambient Air Quality Standards (NAAQS) (2011) http://www.epa.gov/airquality/ozone_pollution/standards.html (7 June 2011).

Weschler, C.J. (2000) Ozone in indoor environments: concentration and chemistry, Indoor Air 10(4), 269-288.

Weschler, C.J. (2006) Ozone's Impact on Public Health: Contributions from Indoor Exposures to Ozone and Products of Ozone-Initiated Chemistry, Environmental Health Perspectives 114(10), 1489-1496.