Tropospheric Ozone Pollution and Personal Exposure

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ATOC 3500

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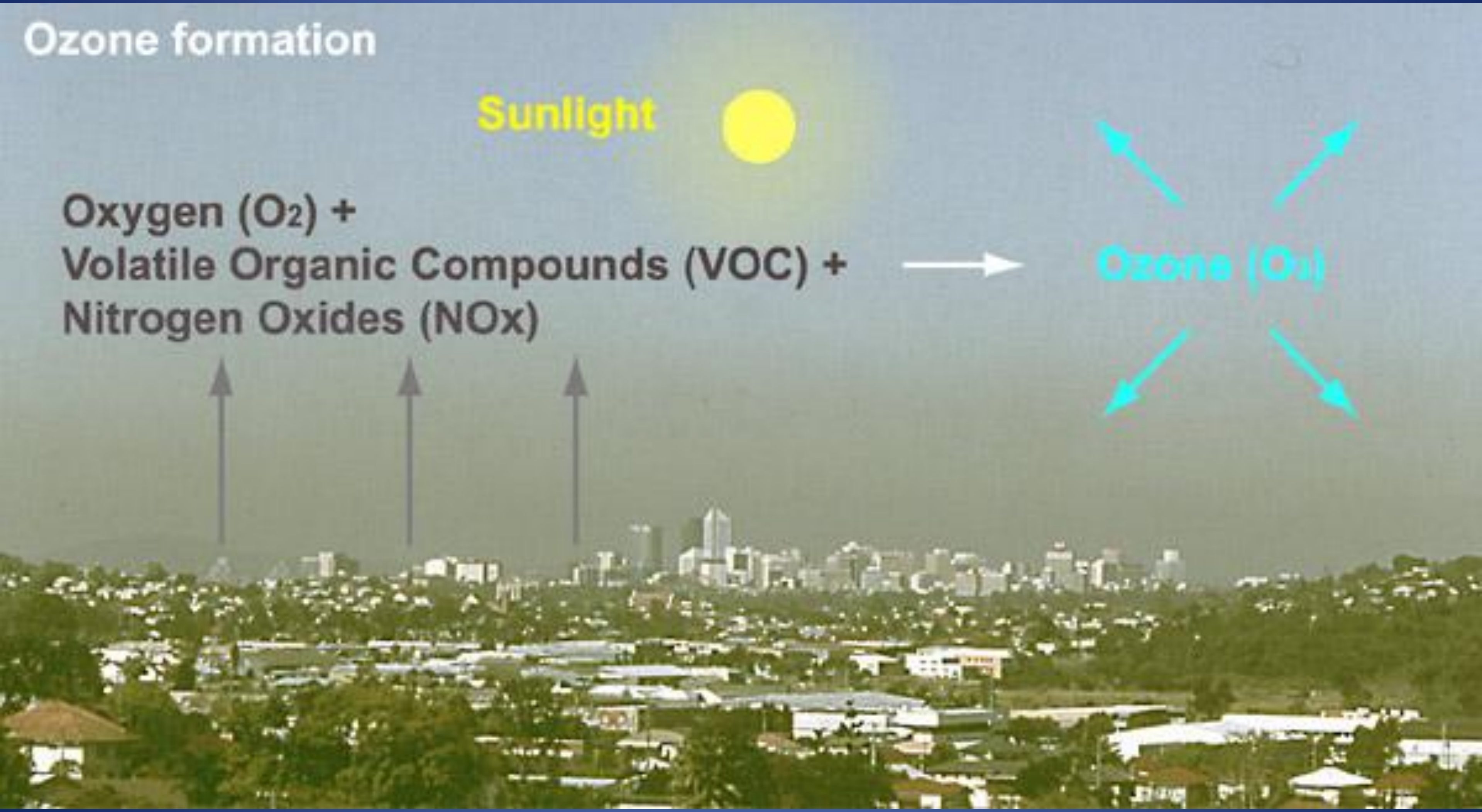
Photo: NREL

Tropospheric Ozone Formation



http://www.derm.qld.gov.au/images/environmental_management/air/ozone-formation.jpg

Nitrogen Dioxide

$$NO_2 + hv \rightarrow O + NO$$

$$O + O_2 + M \rightarrow O_3 + M$$

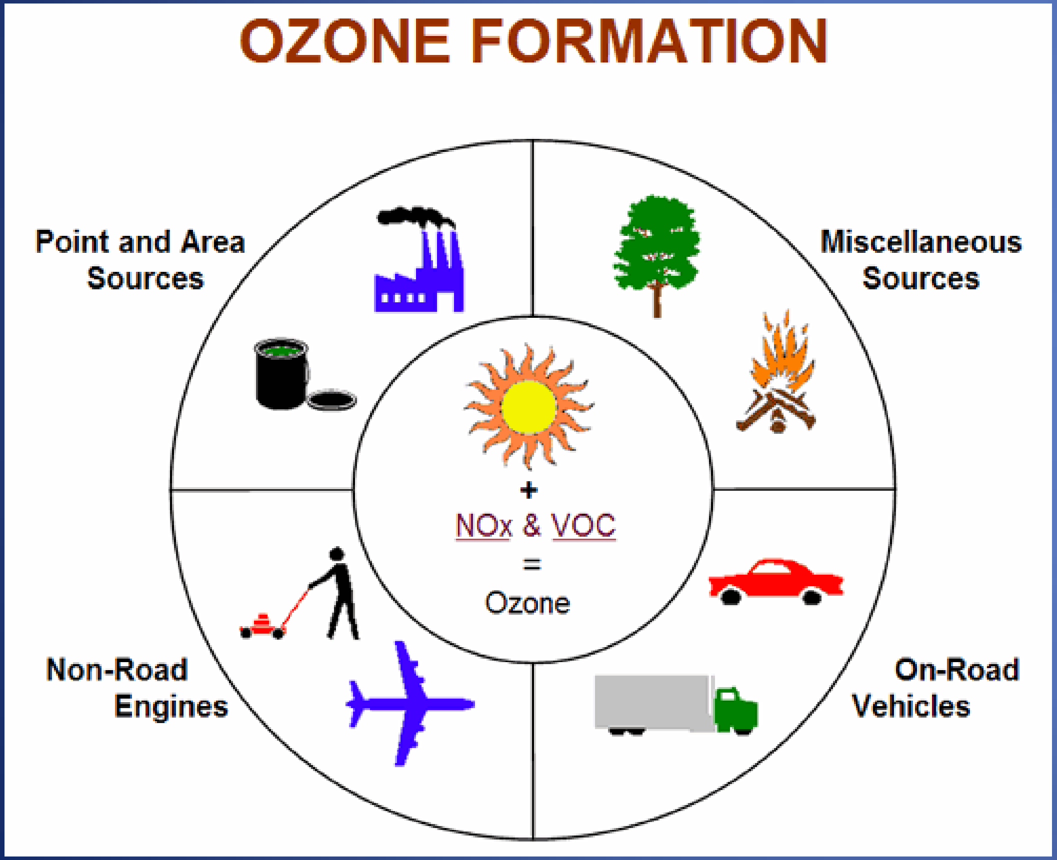
Methane

$$CH_4 + 4O_2 + 2hv \rightarrow CH_2O + H_2O + 2O_3$$

Other Hydrocarbons that Contribute to Ozone Production

- Iso-butene
- Propene
- Ethene
- Isoprene

Sources: NO_x and VOCs



http://www.nctcog.org/trans/air/ozone/formation.gif

- Motor vehicle exhaust
- Industrial emissions
- Gasoline vapors
- Chemical solvents

Health Effects

- Chest pain, coughing, throat irritation, and congestion
- Wheezing and difficulty breathing during outdoor activities or exercise
- Can worsen bronchitis, emphysema, and asthma
- Reduces lung function and inflames the linings of the lungs
- Repeated exposure can permanently scar lung tissue

Standards and Regulations

- Clear Air Act requires the EPA to set health-based standards for ozone
- Primary standards are the limits established to protect public health, including asthmatics, children, and the elderly
- EPA is proposing to strengthen the 8-hour primary standard to a level within the range of 0.060-0.070 parts per million (ppm)

National Ambient Air Quality Standards for Ground-level Ozone

	Primary Standards		Secondary Standards	
	Level	Averaging Time	Level	Averaging Time
Ozone	0.075 ppm (2008 std)	8-hour [1]	Same as Primary	
	0.08 ppm (1997 std)	8-hour [2]	Same as Primary	
	0.12 ppm	1-hour [3]	Same as Primary	

Ozone Exposure

- Several epidemiology studies have identified relationships between short-term ozone exposure and adverse health effects
- People with lung disease and existing respiratory problems, children, and older adults are particularly vulnerable to serious health effects
- Most epidemiology studies use measurements collected at stationary ambient ozone monitoring sites

Personal Ozone Exposure Research

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Research Objectives

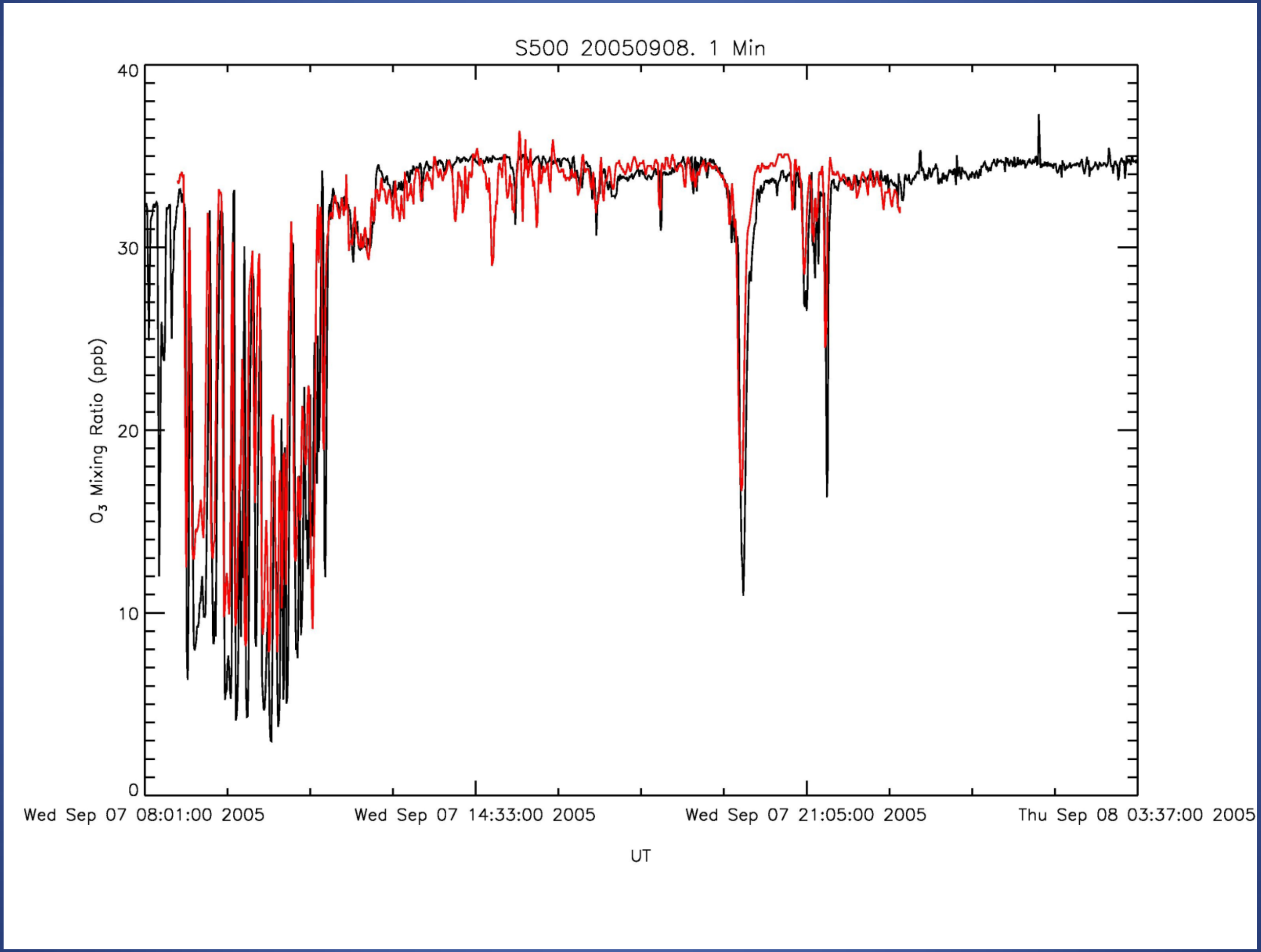
- Develop a personal ozone monitor in order to study people's true personal exposure to ozone
- Integrate a GPS device and temperature and relative humidity sensors into a personal ozone monitor
- Prepare for a pilot study and a full-scale study of older adults' personal exposures to ozone

Personal Ozone Monitor

Aeroqual Ozone Sensor Module

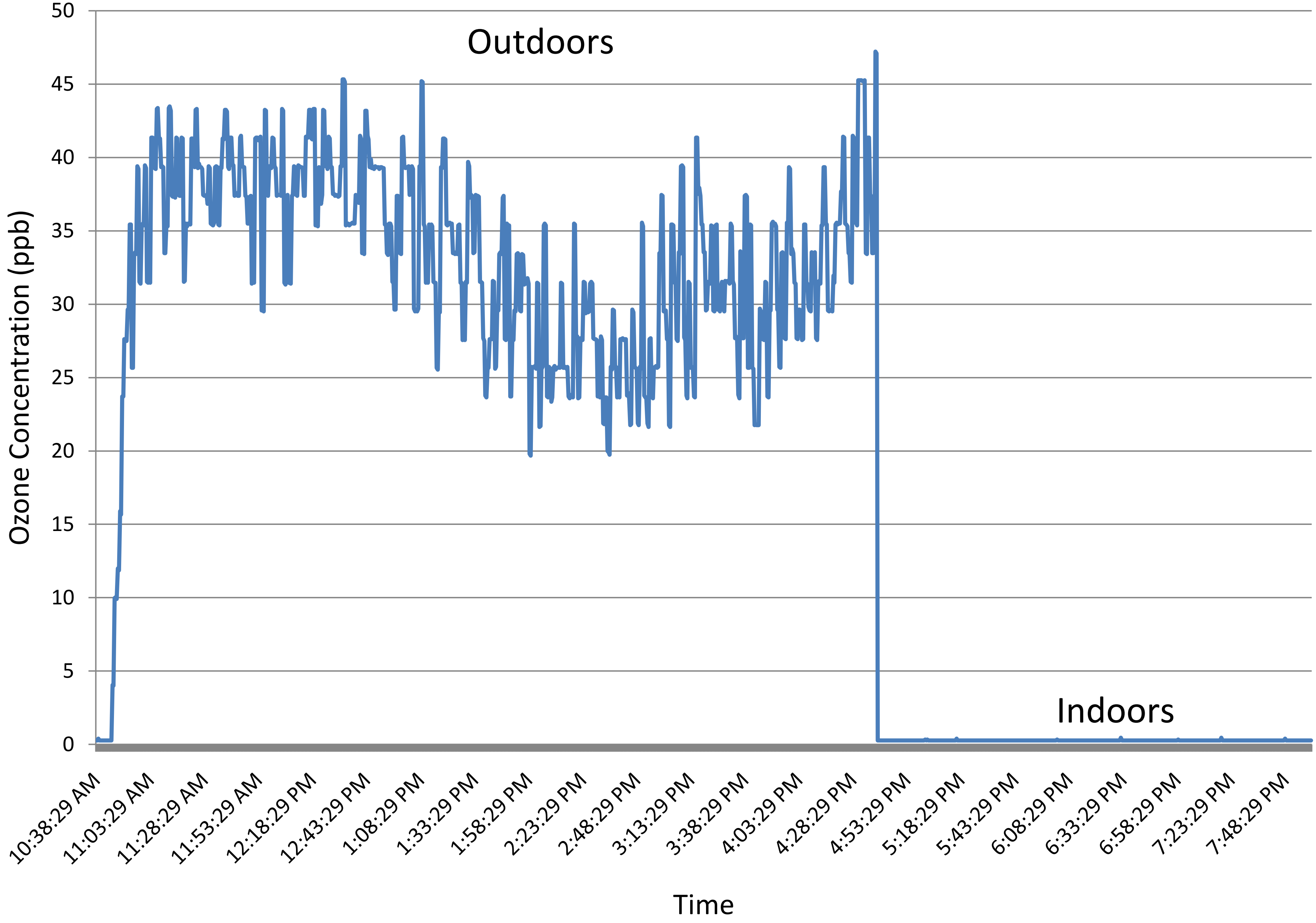
- Tungsten trioxide (WO_3) semiconductor
- Sensitive to ozone due to surface oxygen vacancies
- Decomposing ozone fills the vacancies and traps free charge carriers, causing a measurable increase in resistance

Comparison with TE 49C Ozone Instrument

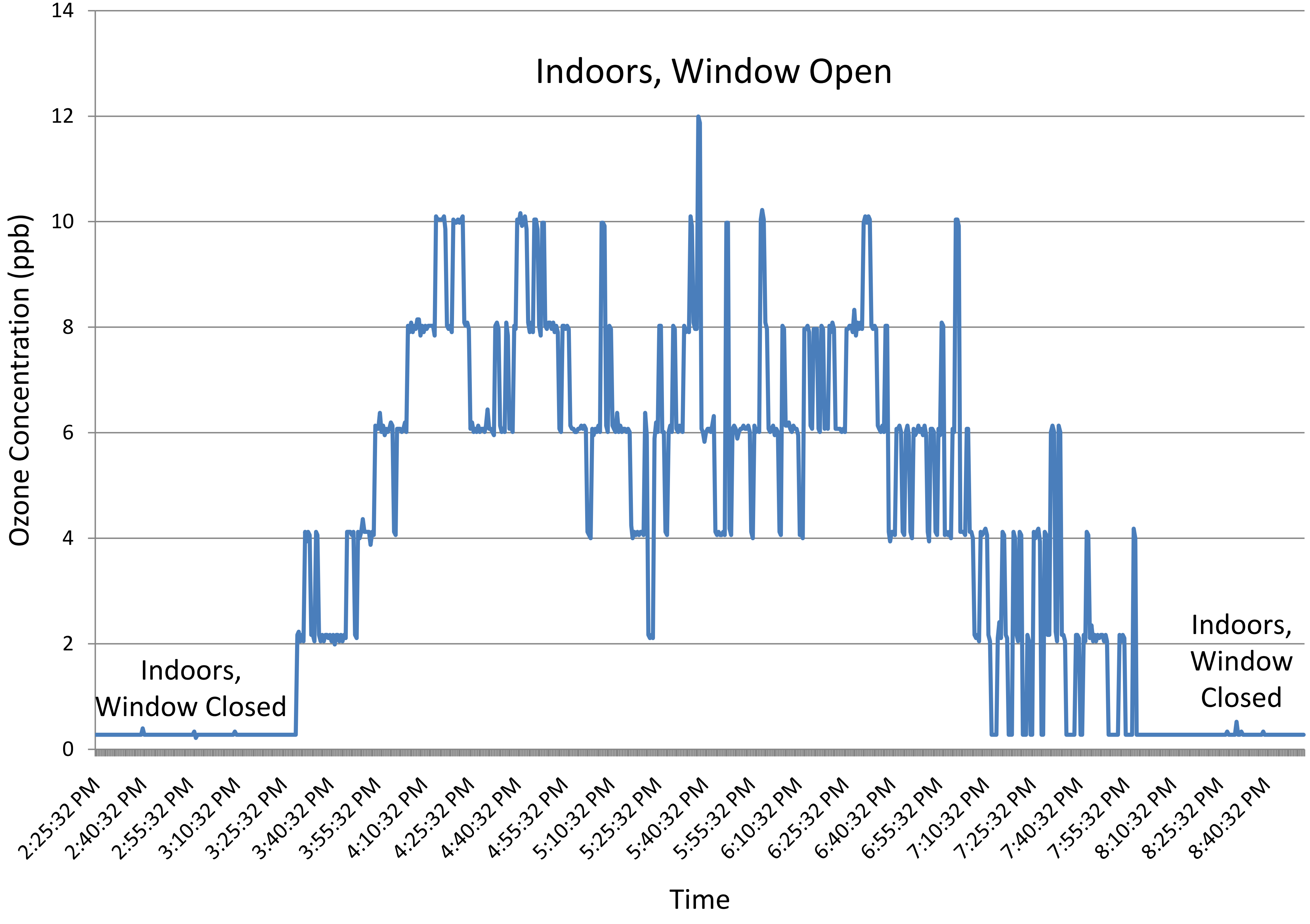


Comparison of measurements from the ozone sensor (red curve) with the Thermo Environmental 49C ozone instrument at McMurdo Station, Antarctica (black curve)

Ambient Ozone Concentration: April 4, 2010



Ambient Ozone Concentration: April 6, 2010



Future Research

- Build six devices for use in a pilot field study
- Conduct a pilot study of summertime personal exposure concentrations (ozone concentrations peak in the summer when solar radiation is strongest) for six older adults living in the Denver metropolitan area
- Compare the subjects' exposure concentrations with concentrations from Denver's ambient ozone monitors
- Assess how housing characteristics and activity patterns impact exposure
- Prepare for a full-scale study of older adults' personal exposure to ozone

Importance

- There have been few studies on personal ozone exposure
- The development of this monitor will allow for the study of people's true personal exposure to ozone
- Results from future pilot and full-scale studies can be used to understand the relationship between personal ozone exposure, activity patterns, housing characteristics, and health effects
- The data could be used to determine what interventions might help reduce personal ozone exposure

References

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Questions?

Photo: NREL