

Fire Emissions: Composition and Human Health Effects



Introduction

- Because of its acute episodic nature, wildfire, wildland fire use, and prescribed fire have great potential to impact human health.



- **What is Smoke?**

- Water vapor combined with gases and small particles.
- Composition changes with combustion stage.
- Flaming: Primarily CO₂ and water.
- Smoldering: Gases and vapors condense forming visible smoke. Particulate emissions highest in this stage.



Smoke Emissions

(Products of Combustion)

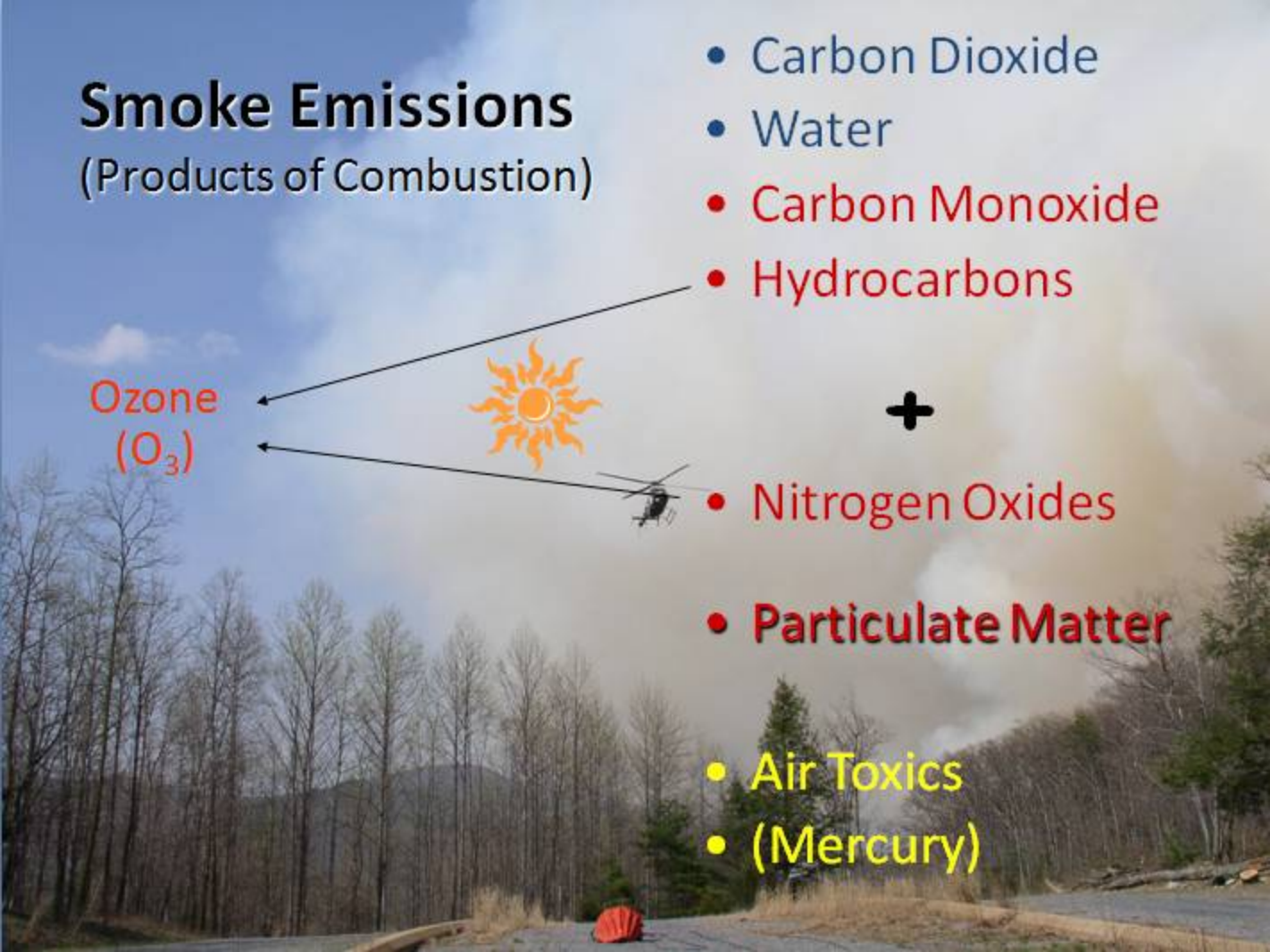
- Carbon Dioxide
- Water
- Carbon Monoxide
- Hydrocarbons

Ozone
(O₃)



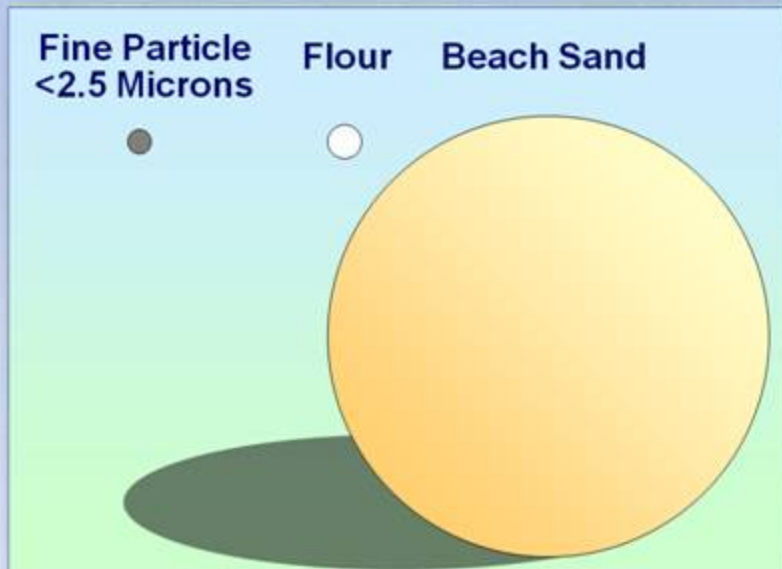
+

- Nitrogen Oxides
- Particulate Matter
- Air Toxics
- (Mercury)



Particulate Matter

- Ranges in size from visible pieces of ash to microscopic particles 2.5 microns and smaller.

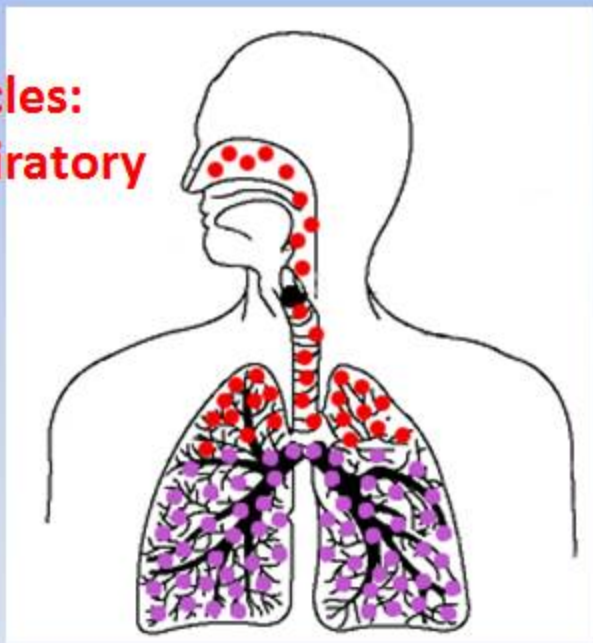


Particulate Matter

- Particulate matter 10 microns and small have great potential to affect human health.
- Of those, particulate matter 2.5 microns and smaller, are inhaled the deepest into the lungs, creating the most severe health affects. These are referred to as PM 2.5
- About 70% of particles from smoke are 2.5 microns and smaller.

Breathing Particulates

**Coarse particles:
upper respiratory
system**



**Fine particles:
lower
respiratory
system**

Where Are Particles Removed or Deposited?



5 μ : trachea, bronchi

<2 μ (smoke): bronchioles



>10 μ : nasal passages

Mouth (no filter system)



<1 μ : in alveoli

Particulate Matter

Short term health effects:

- Increased respiratory symptoms (i.e. shortness of breath and coughing)
- Changes in heart rate variability
- Irregular heart beat
- Non-fatal heart attacks

Particulate Matter

Long term health effects:

- Reduced lung function
- Development of chronic respiratory disease in children
- Premature death in people with heart and lung disease

Particulate Matter

According to the EPA, benefits of meeting the revised 24 hour PM 2.5 standards alone could include:

- 2500 less premature deaths
- 2600 less cases of chronic bronchitis
- 5000 less non-fatal heart attacks
- 97000 less cases of upper and lower respiratory symptoms

(<http://www.epa.gov/air/particles/actions.html>)

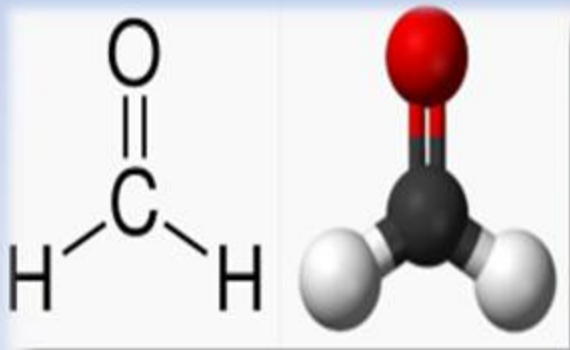
“Cleaner air equals 21 more weeks of life”

- Arden Pope, an epidemiologist at Brigham Young University in Utah led the study with his colleagues - they found when fine-particle air pollution dropped by 10 micrograms per cubic meter, life expectancy rose by 31 weeks.
- The bigger the decline, the longer people began living.
- In some areas where fine-particle counts dropped by 13 to 14 micrograms -- such as Buffalo, New York and Pittsburgh -- people typically started living about 43 weeks longer.

Other compounds

Smoke contains numerous other harmful compounds including...

- Carbon monoxide
- Ozone



Carbon Monoxide

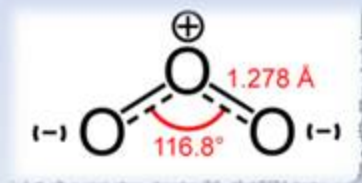
- Colorless, odorless, and not filterable through respirators
- Reduced oxygen carrying capacity of the blood (reversible)
- Low exposure causes loss of awareness, motor skills, mental acuity, nausea, headaches, and dizziness
- CO can lead to heart attack, especially in people with heart disease
- High exposures can cause death



Ozone

- Short term exposure to ozone can cause coughing, pain upon deep breathing, reduced lung function, and shortness of breath.
- Acute exposure can result in decreased lung function

(<http://www.epa.gov/03healthtraining/population.html>)



Air Quality Index (AQI)

- The EPA has developed a system to inform people about air quality in their area. Current values and tomorrow's forecast are displayed using the Air Quality Index.
- Link
 - <http://airnow.gov/>



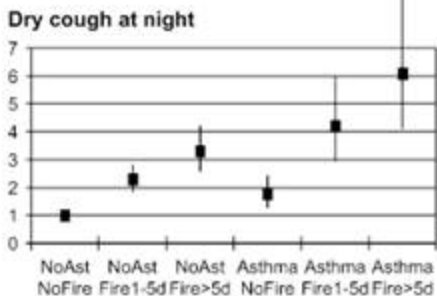
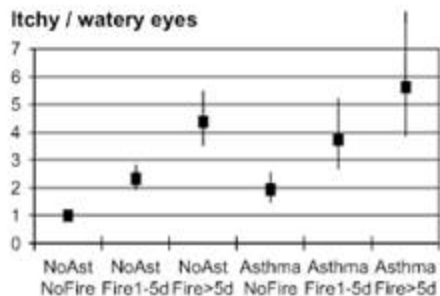
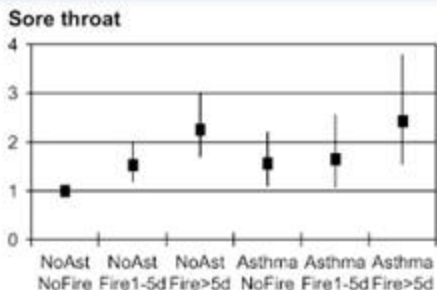
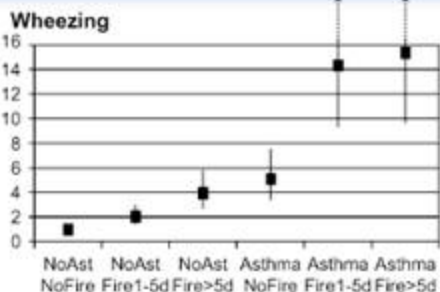
A Community Example

Health Effects of the 2003 Southern California Wildfires on Children

- Brushfires burned 750,000 acres
- Daily concentrations of PM₁₀ and below were almost 1000 $\mu\text{g}/\text{m}^3$
- The study followed the responses of several thousand California children elementary and high school age.
- This study confirmed substantial effects of wildfire smoke on respiratory systems in children with and without asthma.

(Kunzli et al. 2006)

A Community Example



Concluding thoughts

- Smoke from wildland fire use, wildfires, and prescribed fires has numerous and varied effects on human health.
- Because fires generate large quantities of smoke, relatively large amounts of pollutants are released in a short period of time.

Works Cited

Environmental Protection Agency. Particulate Matter: Regulatory Actions.
<http://www.epa.gov/air/particles/actions.html> Accessed on 11 Jan. 08.

Environmental Protection Agency. Health Effects of Ozone in the general Population.
<http://www.epa.gov/03healthtraining/population.html> Accessed 11 Jan 08.

Hathaway GJ, Proctor NH, Hughes JP, and Fischman ML [1991]. Proctor and Hughes' chemical hazards of the workplace. 3rd ed. New York, NY: Van Nostrand Reinhold.

Kunzli, Nino, Avol, Ed, Jun We, Gauderman, James W., Rappaport, Ed, Millstein, Joshua, Bennion, Jonathon, McConnel, Rob, Gilliland, Frank D., Berhane, Kiros, Lurmann, Fred, Winer, Arthur, and Peters, John M. 2006. Health Effects of the 2003 California Wildfires on Children. American Journal of Respiratory and Critical Care Medicine. 174:11 pg. 1221-1228.

US Department of Labor, Occupational Safety and Health Administration.
Agency <http://www.osha.gov/SLTC/healthguidelines/nitrousoxide/recognition.html>. Accessed on 11 Jan. 08.

Works Cited

Environmental Protection Agency. Particulate Matter: Regulatory Actions.
<http://www.epa.gov/air/particles/actions.html> Accessed on 11 Jan. 08.

Environmental Protection Agency. Health Effects of Ozone in the general Population.
<http://www.epa.gov/03healthtraining/population.html> Accessed 11 Jan 08.

Hathaway GJ, Proctor NH, Hughes JP, and Fischman ML [1991]. Proctor and Hughes' chemical hazards of the workplace. 3rd ed. New York, NY: Van Nostrand Reinhold.

Kunzli, Nino, Avol, Ed, Jun We, Gauderman, James W., Rappaport, Ed, Millstein, Joshua, Bennion, Jonathon, McConnel, Rob, Gilliland, Frank D., Berhane, Kiros, Lurmann, Fred, Winer, Arthur, and Peters, John M. 2006. Health Effects of the 2003 California Wildfires on Children. American Journal of Respiratory and Critical Care Medicine. 174:11 pg. 1221-1228.

US Department of Labor, Occupational Safety and Health Administration.
Agency <http://www.osha.gov/SLTC/healthguidelines/nitrousoxide/recognition.html>. Accessed on 11 Jan. 08.

Works Cited

Environmental Protection Agency. Particulate Matter: Regulatory Actions.
<http://www.epa.gov/air/particles/actions.html> Accessed on 11 Jan. 08.

Environmental Protection Agency. Health Effects of Ozone in the general Population.
<http://www.epa.gov/03healthtraining/population.html> Accessed 11 Jan 08.

Hathaway GJ, Proctor NH, Hughes JP, and Fischman ML [1991]. Proctor and Hughes' chemical hazards of the workplace. 3rd ed. New York, NY: Van Nostrand Reinhold.

Kunzli, Nino, Avol, Ed, Jun We, Gauderman, James W., Rappaport, Ed, Millstein, Joshua, Bennion, Jonathon, McConnel, Rob, Gilliland, Frank D., Berhane, Kiros, Lurmann, Fred, Winer, Arthur, and Peters, John M. 2006. Health Effects of the 2003 California Wildfires on Children. American Journal of Respiratory and Critical Care Medicine. 174:11 pg. 1221-1228.

US Department of Labor, Occupational Safety and Health Administration.
Agency <http://www.osha.gov/SLTC/healthguidelines/nitrousoxide/recognition.html>. Accessed on 11 Jan. 08.