



PM_{2.5} in Fairbanks- Why Should We Care?

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Definitions



- Aerosol - Any solid particle or liquid droplet suspended in a gas
- Atmospheric Aerosol – Any solid particle or liquid droplet suspended in the atmosphere
- PM_{2.5} - Aerosols smaller than 2.5 μm in aerodynamic diameter (~1/50th the diameter of a human hair). These particles are also called fine particles or respirable particles.

Natural Sources of PM_{2.5}

- Wildfires
- Volcanoes
- Sea salt
- Soil dust
- Biological debris
- Etc.

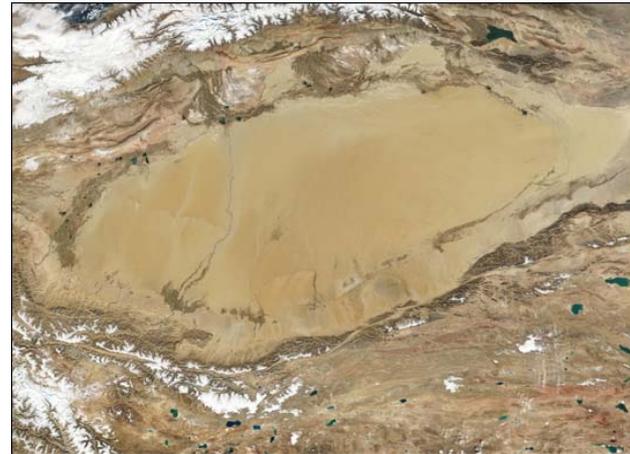


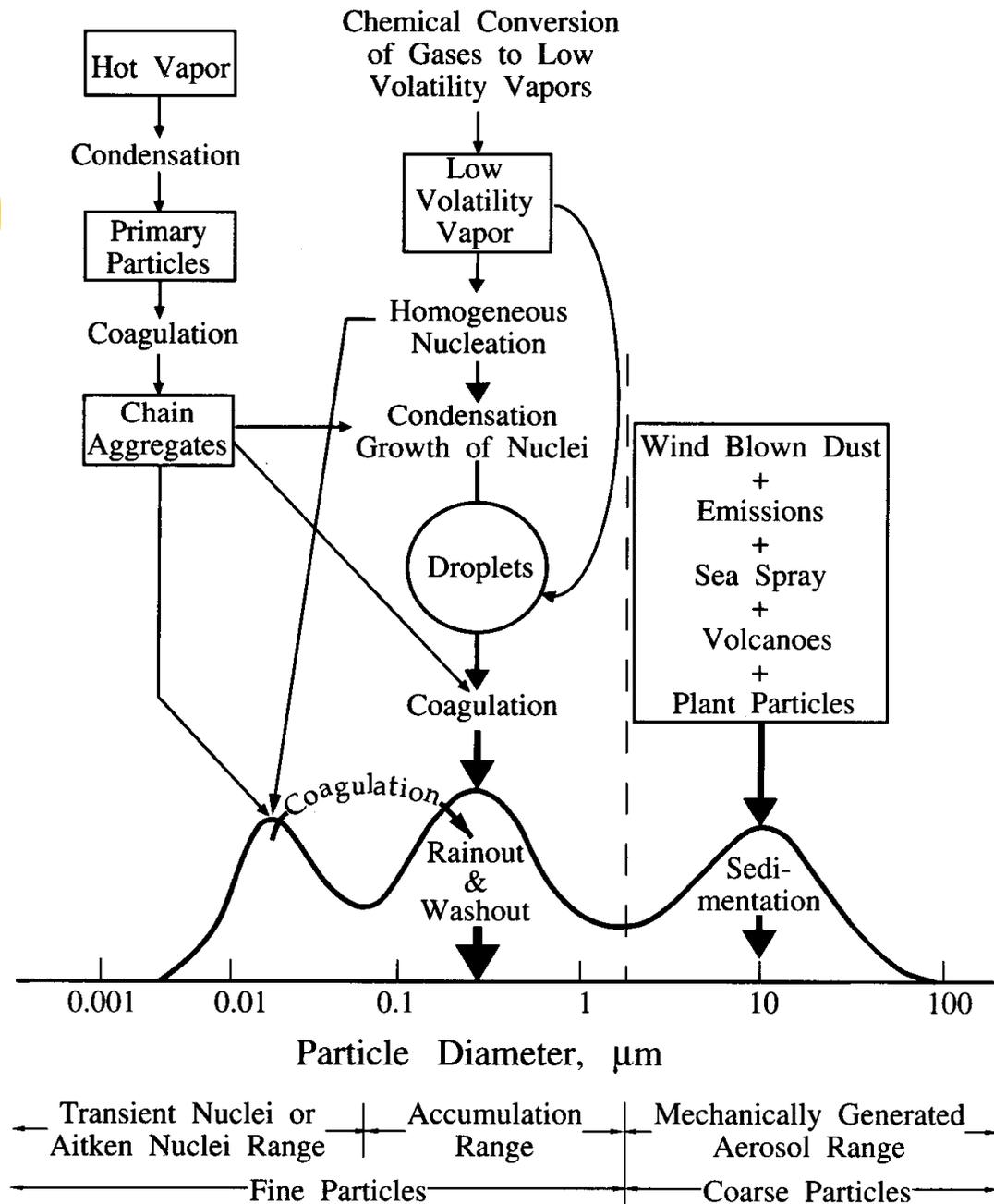
Image courtesy of Jacques Descloitres,
MODIS Land Rapid Response Team at
NASA GSFC

Anthropogenic Sources:

- Furnaces and other heat sources
- Automobiles, trains, ships, planes, etc.
- Power plants
- Smelters
- Road dust
- Smoking
- Etc.



How Do Aerosols Form?



PM_{2.5} Impacts - Health Effects (Extreme Examples)

- London - The 'Great Smog' or 'Big Smoke' on December 5-9, 1952, resulted in 4,000 immediate deaths and another 8,000 in the next several months due to smog produced by coal burning
- Denora, Pennsylvania – On October 26-31, 1948, almost half of the area's 14,000 residents reported becoming ill, 18 died immediately and another 50 deaths were later attributed to the smog covering the city

PM_{2.5} Impacts - Health Effects

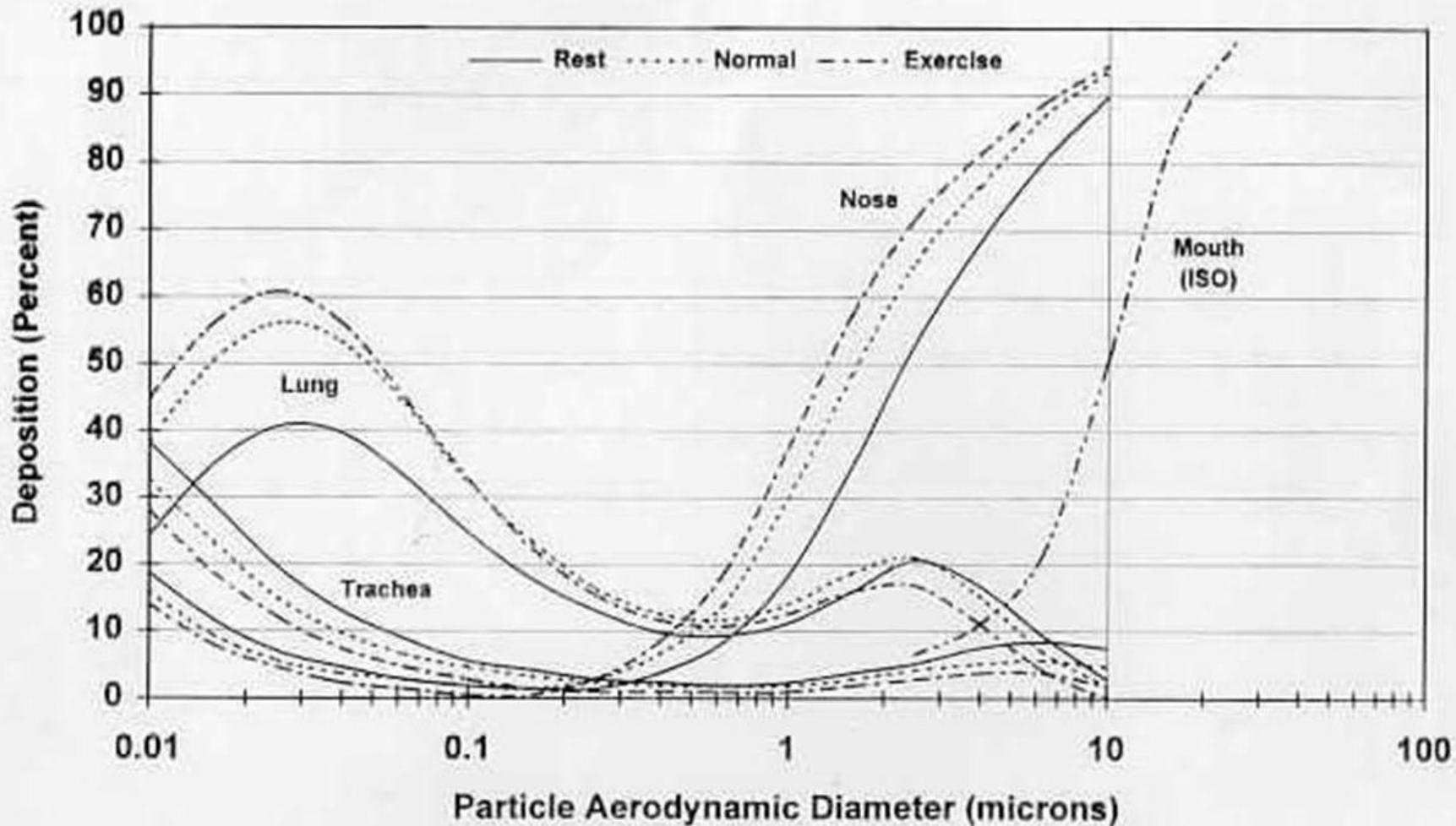
- In the early 1990s, the first epidemiological studies of ambient air quality and human health show that even small increases in PM_{2.5} result in observable health effects
- The populations most affected are:
 - The elderly
 - Children
 - Anyone with heart or lung disease

PM_{2.5} Impacts - Health Effects

Studies show that PM_{2.5} causes:

- Aggravated asthma
- Acute respiratory symptoms, including aggravated coughing and difficult or painful breathing
- Chronic bronchitis
- Decreased lung function (shortness of breath)
- Chronic Obstructive Pulmonary Disease (COPD)
- Premature death

PM_{2.5} Impacts - Health Effects



Protecting Human Health

- In July 1997, the Environmental Protection Agency instituted the National Ambient Air Quality Standards (NAAQS) for PM_{2.5}
- The new standards were:
 - An annual average of 15 $\mu\text{g}/\text{m}^3$
 - A 24-hour average of 65 $\mu\text{g}/\text{m}^3$
- These standards were designed to protect human health

Protecting Human Health



- In September 2006, the Environmental Protection Agency tightened the 24-hour average standard for PM_{2.5} to 35 µg/m³
- Why?
- Newer and better studies showed that the concentrations previously allowed under the NAAQS produced significant health effects and needed to be reduced

Health Benefits



The benefits of meeting the revised 24-hour PM2.5 standards include the value of an estimated reduction in:

- 2,500 premature deaths in people with heart or lung disease.
- 2,600 cases of chronic bronchitis.
- 5,000 nonfatal heart attacks,
- 1,630 hospital admissions for cardiovascular or respiratory symptoms,
- 1,200 emergency room visits for asthma,
- 7,300 cases of acute bronchitis,
- 97,000 cases of upper and lower respiratory symptoms,
- 51,000 cases of aggravated asthma,
- 350,000 days when people miss work or school, and
- 2 million days when people must restrict their activities because of particle pollution-related symptoms.

(http://www.epa.gov/air/particles/pdfs/20060921_factsheet.pdf)

Cost-Benefit Analysis

- Based on recently updated estimates, meeting the annual standard will result in benefits ranging from \$20 billion to \$160 billion a year in 2015. These updated estimates include the opinion of outside experts on the risk of premature death, along with other benefit information. EPA estimates the cost of meeting the 1997 standards at \$7 billion.

(http://www.epa.gov/air/particles/pdfs/20060921_factsheet.pdf)

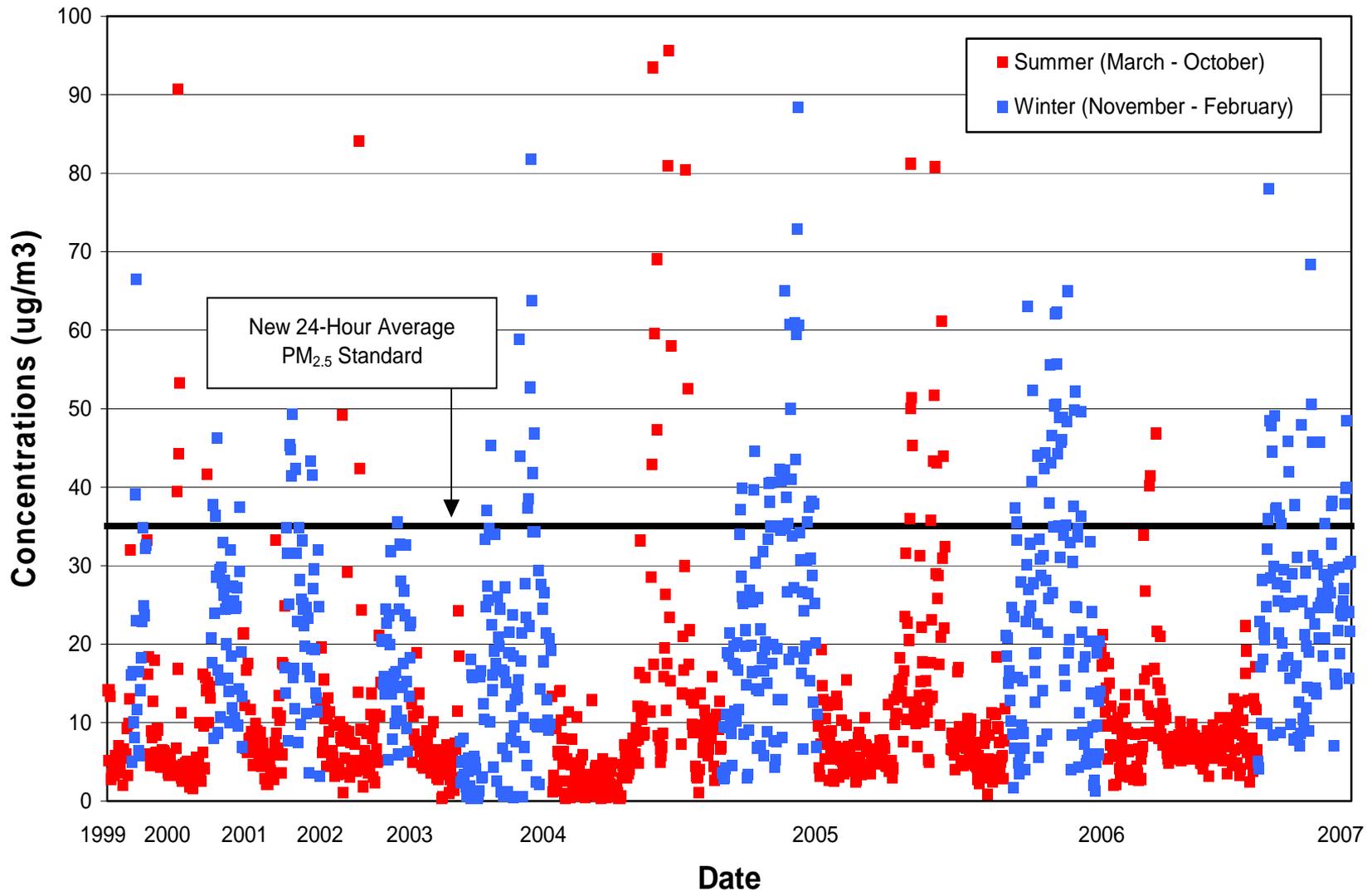
Fairbanks and PM_{2.5}



How Does the Revised Standard Impact Fairbanks?

- Fairbanks did not violate the old PM_{2.5} standard
- We do violate the new standard

PM_{2.5} in Fairbanks



Five Winter Comparison - Number of Daily Values Exceeding New EPA PM2.5 Standard downtown Fairbanks, AK



Winter (November, December, January, February)

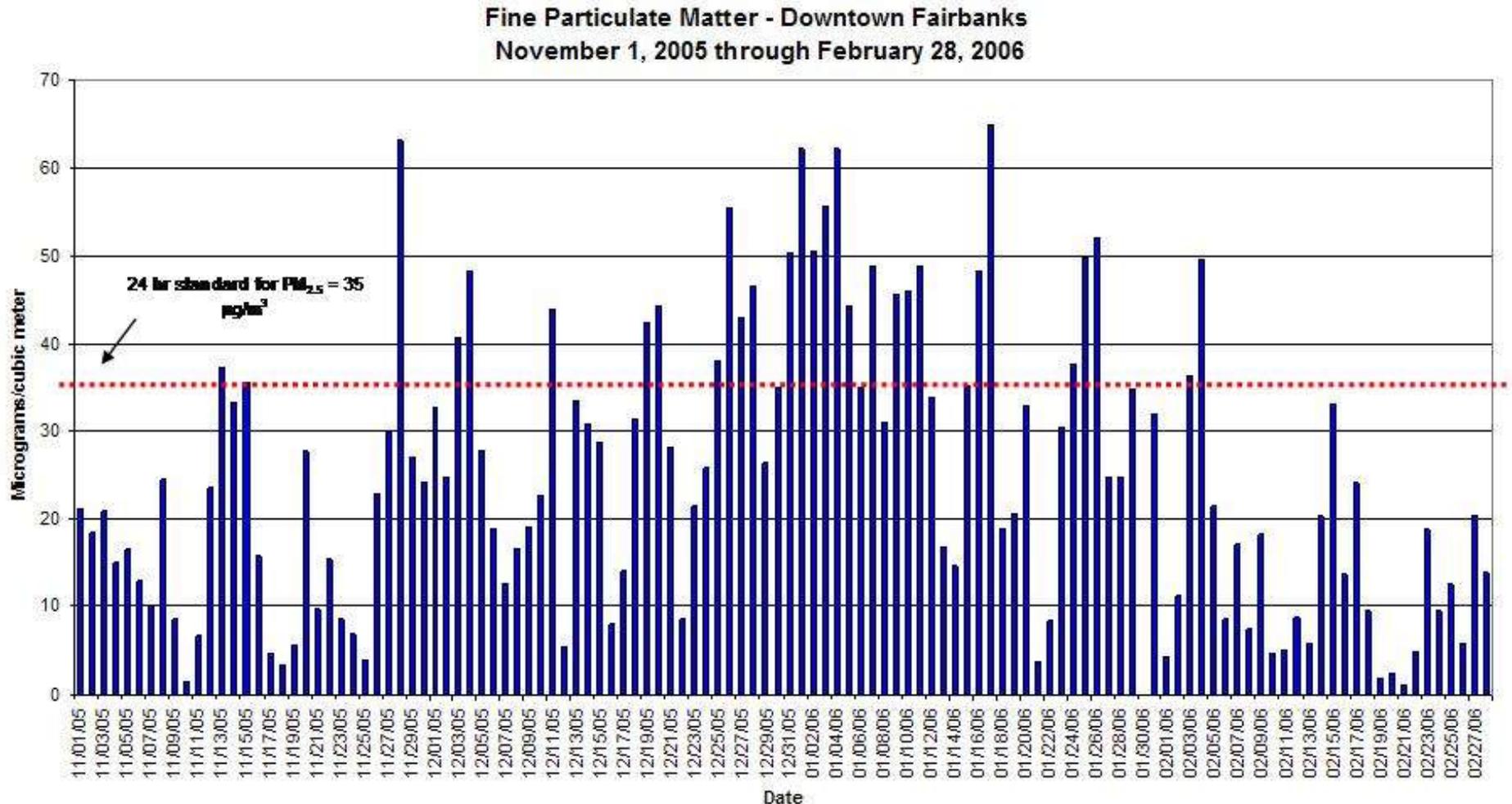
Figure from: http://www.dec.state.ak.us/air/anpms/as/pm/pm2-5_fbks.htm

PM_{2.5} Violations



- Why have there been an increasing number of PM_{2.5} violations?
- Probable culprits:
 - Population growth
 - Increase in use of woodstoves and other heating devices

When Do We Violate the Standard?



Fairbanks and PM_{2.5}

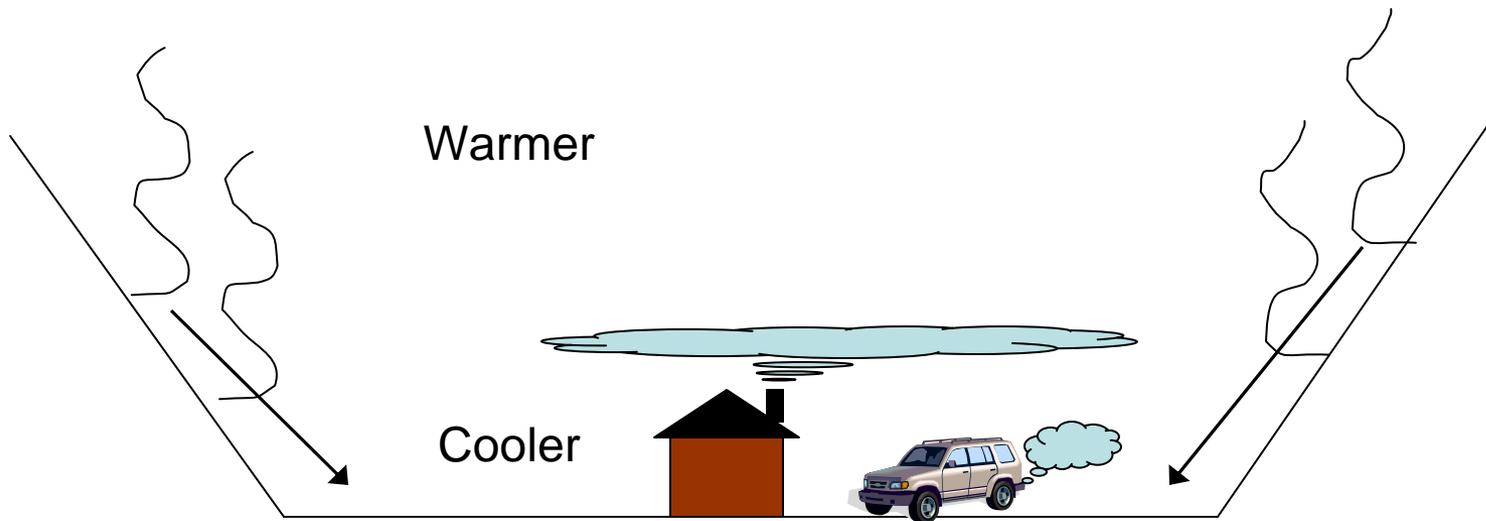


- Why do we violate the standard during winter?
 - Cold temperatures
 - More heating needed so more heating-related emissions are produced
 - The Fairbanks inversion
 - Atmosphere is very stable
 - Emissions from near-surface sources are trapped near the surface

The Fairbanks Inversion

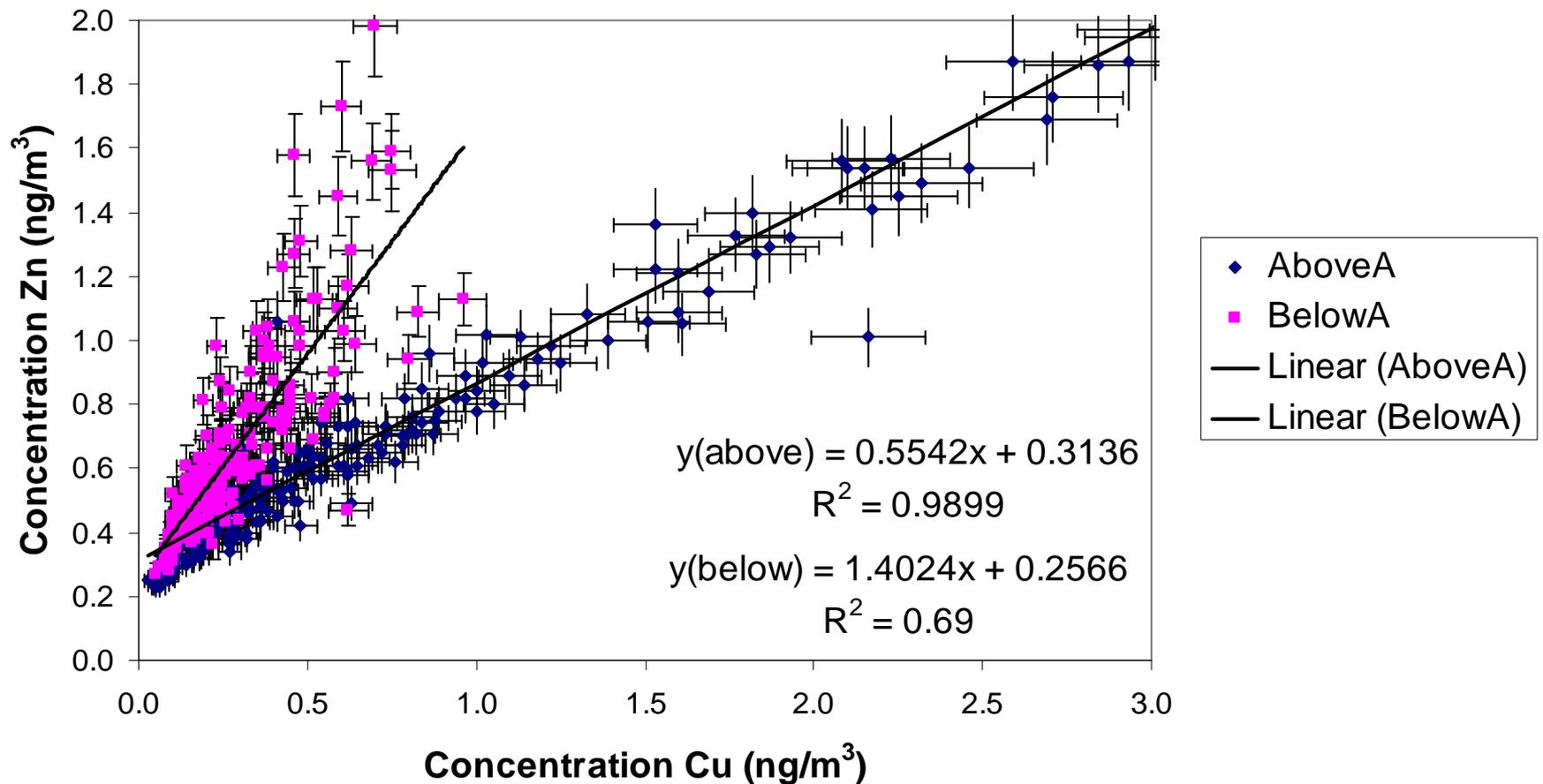


The Fairbanks Inversion



Aerosols Above and Below the Inversion

Copper vs Zinc, Size A

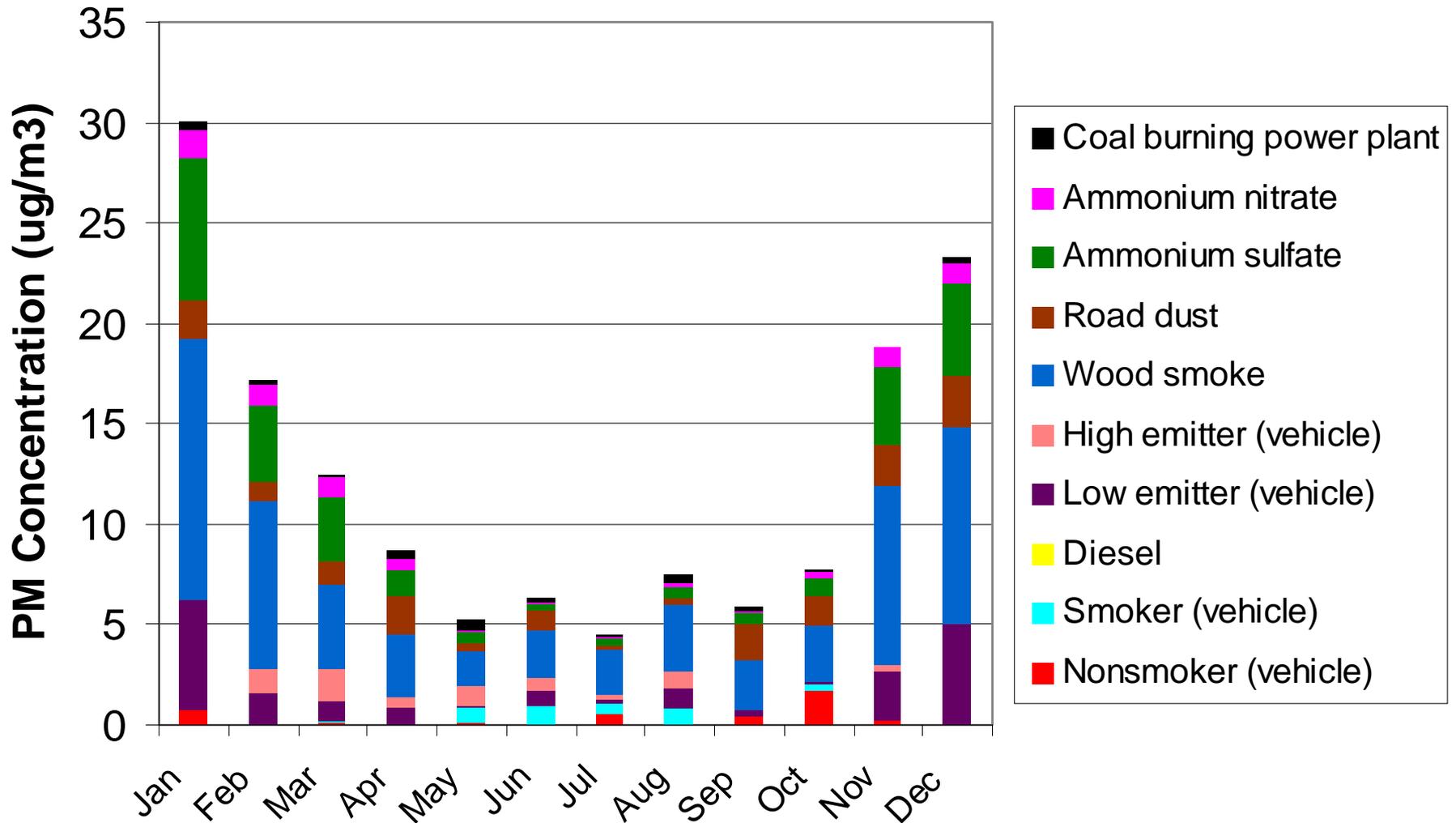


Aerosols Above and Below the Inversion



- Aerosols above and below the inversion show different concentrations and compositions
 - Lower concentrations above the inversion
 - Less anthropogenic influence above the inversion
- This implies different sources of the observed aerosols

PM_{2.5} Sources in Fairbanks



PM_{2.5} Sources in Fairbanks

- Analysis shows that heating and vehicles are the two primary sources of PM_{2.5} in Fairbanks
- These sources are tough to manage because they are 'area sources' so one piece of remediation equipment will not fix the problem
- From this analysis, power plants do not appear to be a significant PM_{2.5} source

Current Status



The Fairbanks North Star Borough was designated 'nonattainment' on December 18, 2008.

What Now?



EPA is working with the State to develop a nonattainment plan which shows how the Borough will come into attainment. The state must submit a plan within 3 years of the nonattainment designation date.

How to Comply?



- Determine the actual portions of the Borough that are out of compliance
- Identify the impact of each PM_{2.5} source and go after the ‘most bang for the buck’ sources first
- Common sense solutions
 - See what other states have done and add rules limiting the use of boilers and noncertified woodstoves (for example)
- New technology
 - Coal to liquid technology, etc.

PM_{2.5} Reduction Ideas Used by Other States



- Diesel engine retrofit programs
- Continuation of I/M program
- Increased mass transit
- No-burn days
- Woodstove replacement programs
- Changing fuel sources for heating
- Home winterization programs
- Etc.

Human Protection from PM_{2.5}

Personal protection -

- Masks (P95 or better because most masks are made for large particles)
- Respirators (more for gases than PM)

Home or Business –

- Special Ventilation Systems
 - HEPA
 - Activated carbon filters



NIOSH Protection Labels for Face Masks (under 42 CFR 84) – down to 0.3 μm

<p>N100 - Particulate Filter (99.97% efficiency level) effective against particulate aerosols free of oils; time use restrictions may apply.</p>	<p>R100 - Particulate Filter (99.97% efficiency level) effective against all particulate aerosols; time use restrictions may apply.</p>	<p>P100 - Particulate Filter (99.97% efficiency level) effective against all particulate aerosols.</p>
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Masks



- As you know, masks must fit properly and not be used for a longer period than recommended – it is a challenge to train people to use masks correctly
- As for when to wear them –
 - Ambient standards do not provide guidance on this
 - If you are in a cleaner indoor environment, you shouldn't need them in Fairbanks

Summary of PM_{2.5} in Fairbanks

- The PM_{2.5} standard is designed to protect human health
- We now violate the PM_{2.5} standards
- Therefore, we must be work hard to understand the issue and come up with reasonable methods for reducing PM_{2.5}
- We can take steps to protect human health when concentrations are high



Thank you for your attention.

Questions

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- **Dockery DW**, Pope CA III, Xu X, Spengler JD, Ware JH, Fay ME, Ferris BG Jr, Speizer FE. An association between air pollution and mortality in six US cities. *New Engl J Med* 1993;329:1753-1759.