Colorado Department of Public Health & Environment

Air Pollution Control Division

Ozone/NO_x Regional Trends Update

Nitrogen Oxides (NO_x)

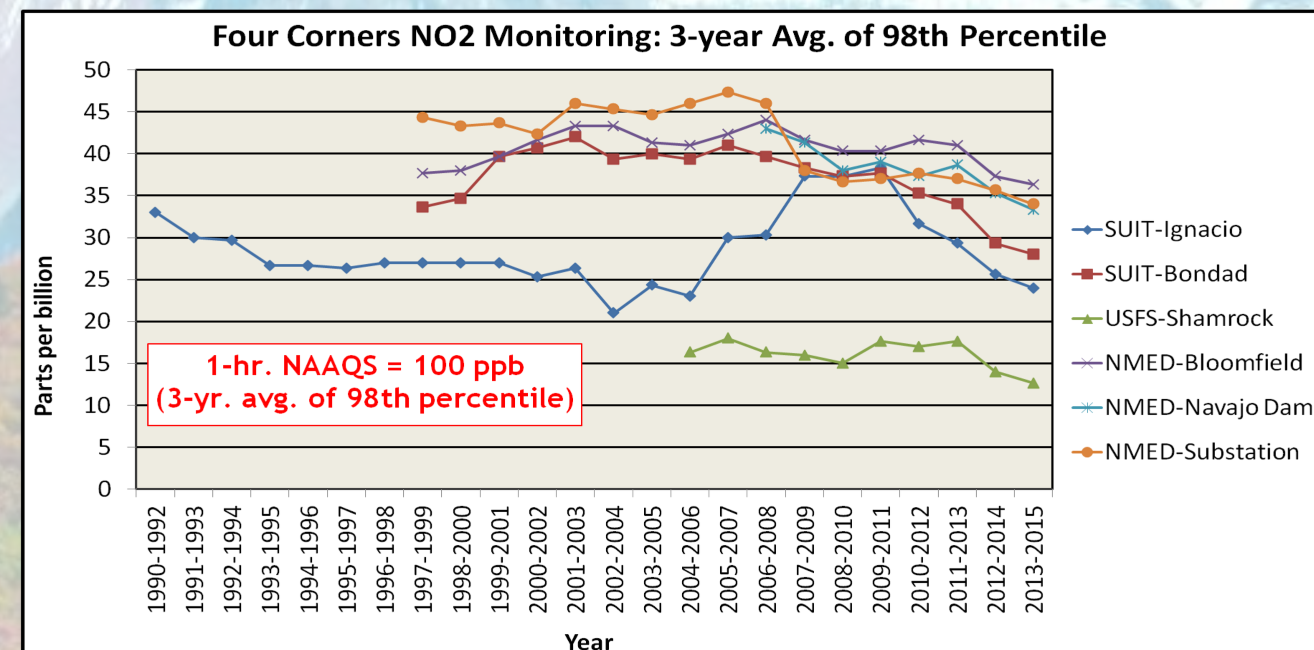
- Contribute to ozone formation, particulate matter, regional haze and acid rain.
- Primary sources include: burning fuel in automobiles, industrial engines and power plants.
- Primary forms are nitrogen dioxide (NO_2) and nitric oxide (NO).

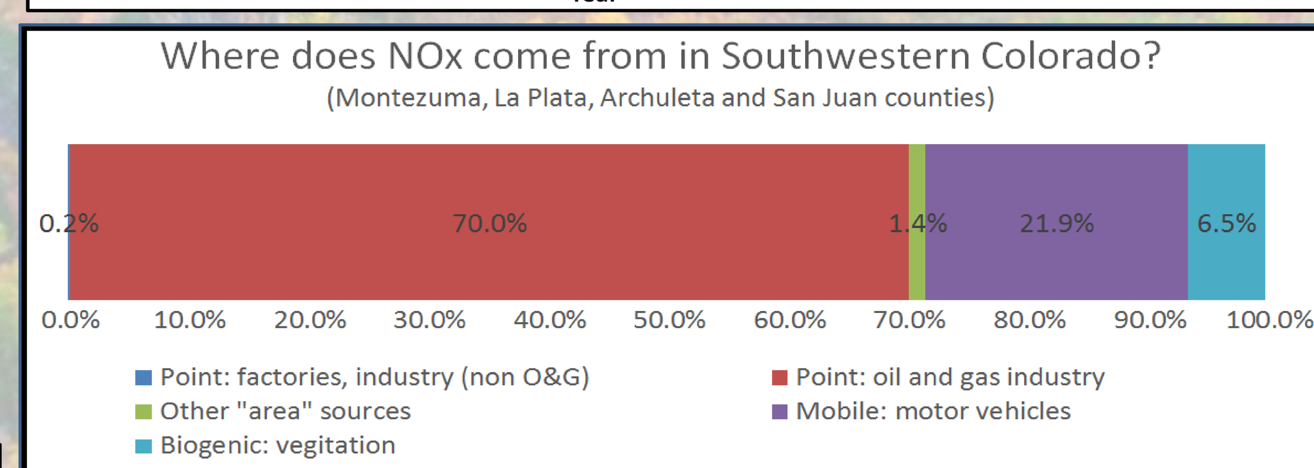
Health and Environmental Effects of NO_x

- Health effects: NOx impacts the respiratory system, causing symptoms in asthmatics & increases susceptibility to respiratory infections.
- Environmental effects: NOx contributes to acid rain, ozone, & visibility impairment. It can cause changes in plant species composition & diversity in terrestrial and wetland ecosystems, and drive eutrophication (excessive algae growth) in lakes & streams. It can also deplete dissolved oxygen and increase levels of toxins in water bodies which harms aquatic life.

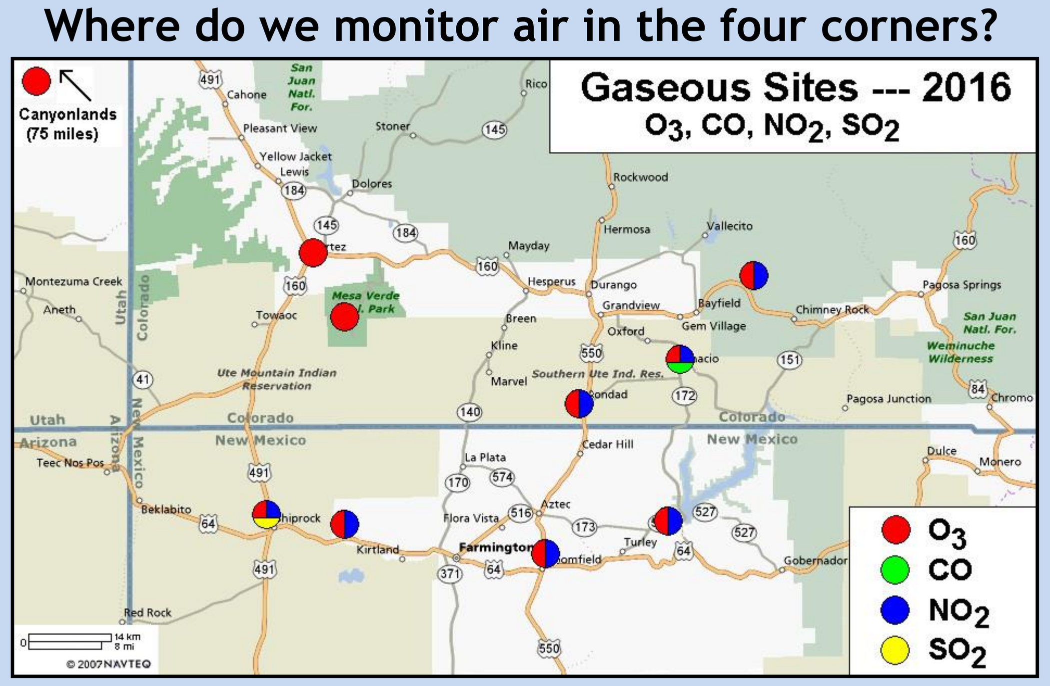
Impacts in Colorado

- Monitored NO_2 values in Colorado and the four corners show levels well below National Ambient Air Quality Standards (NAAQS). This is a national trend and NO_2 concentrations are expected to continue decreasing in the future due to new federal and state regulations aimed at reducing ozone precursors.

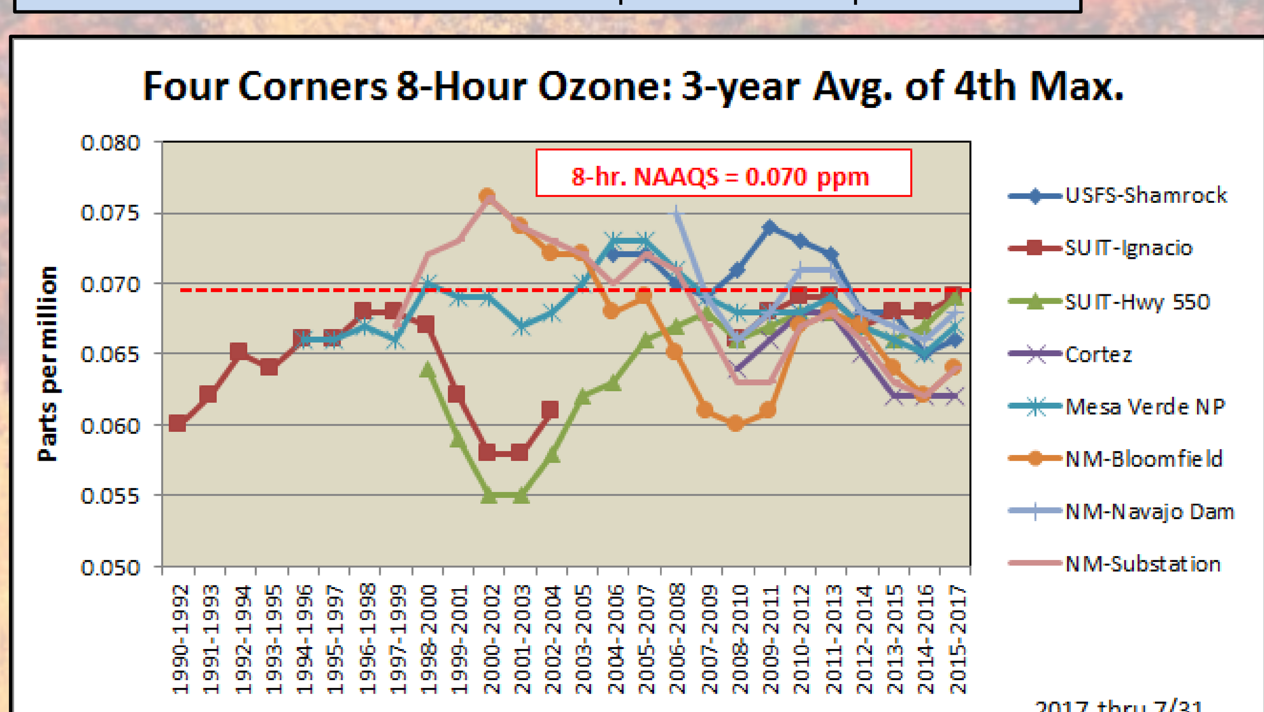




Where do we monitor air in the four corners?



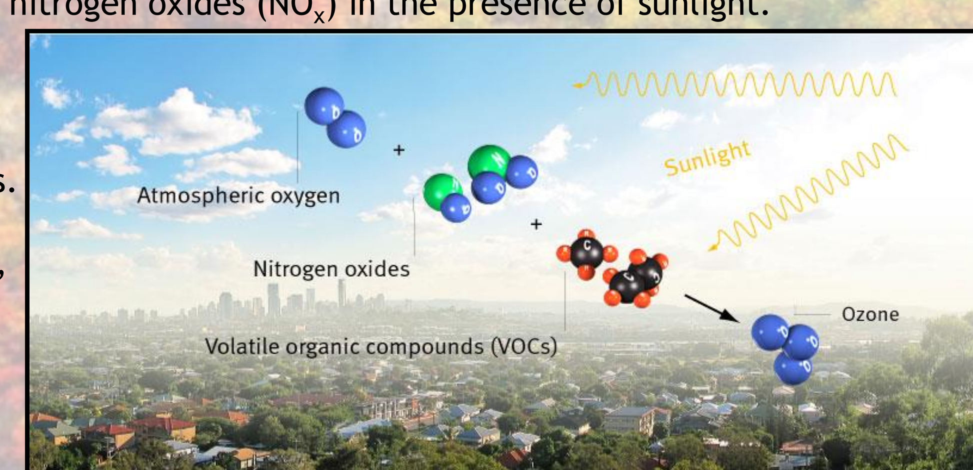
This map shows the air monitors we use to track NO_x and ozone trends. We work with state and federal partners to compile this data.



Ozone concentrations in the four corners are below the 70 ppb NAAQS. It is expected that these levels may decline depending on state and federal regulations aimed at reducing ozone precursors.

Ozone:

- Ozone is a colorless and odorless gas that forms when volatile organic compounds (VOCs) interact with nitrogen oxides (NO_x) in the presence of sunlight.
- Typically, ozone is not directly emitted by individual sources. However, emissions from motor vehicles, industry, oil and gas production, and vegetation all contribute to ozone formation.



Queensland Government 2013, *How Ozone is Formed*, digital image, Queensland Government, viewed 20 October 2015, <https://www.qld.gov.au/environment/pollution/monitoring/air-pollution/ozone/#>

- The highest ground-level ozone concentrations usually occur in the summer when hot, still days cause reactive pollutants to form ozone. However, high ozone levels have been observed in winter in areas with high oil and gas production activities as well.

Health and Environmental Effects

- Health effects: Ozone causes breathing difficulties & respiratory infections in the elderly, the young & those with preexisting ailments such as asthma. It can cause premature mortality and even healthy people who exercise or work outdoors can experience negative respiratory effects.
- Environmental effects: ozone is detrimental to plants and ecosystems.

Impacts in Colorado

The Denver-metro and the North Front Range is a moderate ozone nonattainment area for failing to meet the 2015 ozone standard of 70ppb. The rest of Colorado is in attainment with the ozone standard. The Colorado Air Quality Control Commission (AQCC) adopted a number of measures to reduce ozone including regulatory changes that significantly reduce VOC emissions from oil and gas production, and approving a regional haze plan that includes substantial NO_x emission reductions. New federal motor vehicle emissions standards and Colorado's motor vehicle inspection and maintenance programs also help reduce precursors of ozone.

Low Cost Air Quality Monitoring:

Background:

Traditionally air quality monitoring has been conducted using permanent fixed sites. These sites have been designed to measure air quality at the neighborhood or larger scale rather than at the individual or household level. Monitoring sites must meet a number of EPA requirements, undergo extensive QA/QC and complete mandatory reporting. This high quality data is used to:

- Inform National Ambient Air Quality Standards (NAAQS) designations;
- Forecast air quality and report status to the public;
- Complete health studies;
- Collect data that can be used for modeling inputs and/or validation.

Traditional air monitors

EPA's Air Sensor Toolbox

EPA's toolbox provides information for citizen scientists and others on how to select and use low-cost, portable air sensor technology and understand results from monitoring activities. The toolbox is free and available on EPA's website.

Drawbacks to traditional monitoring:

Because traditional monitors are designed to monitor air quality at a larger, more regional scale, they generally cannot be used to address specific community concerns such as dust, odors, smoke, or traffic. They cannot be used to determine what a single source is emitting and they are not easily moved. They are also costly and require extensive knowledge to operate.

The emergence of "Next Generation" sensors

Next generation sensors have emerged as an alternative to traditional monitors and have been geared towards community interests and needs. They recognize that for some questions, air monitoring doesn't need to meet regulatory requirements, or be in a fixed location. The key benefits of these sensors are their:

- Low cost
  - Most are under \$2,000, and many are under \$1,000
- Small size, easy to transport
- Easy to set up
  - Don't require power sources
  - Don't require phone lines
- Unobtrusive
- Easy to use and obtain data
- Can measure a variety of pollutants

"Next Generation" air sensor examples

Challenges with "Next Generation"

Because they are not held to the same standard as traditional monitors, and they are often not evaluated in the field, there are a number of concerns with their use, including:

- A higher risk for **false positives** due to instrument error or interferences. This may result in unwarranted concerns and significant resources being wasted to evaluate further.
- A higher risk for **false negatives** due to the instrument measuring the wrong pollutant or having poor sensitivity. This may result in a false sense of safety.

There are also a number of concerns with data collection and use. Next generation users need to be mindful of their objectives and utilize available resources such as EPA's toolbox, or local air quality experts prior to beginning a project to ensure proper design and data collection. Quality and accuracy of data should be evaluated prior to publicizing it.

Gaseous monitors

Gaseous monitors generally use metal oxide or electrical sensors to detect pollutants.

Issues:

- They generally don't last long (2-5 years);
- Certain gases can interfere with the readings;
- Temperature and humidity can interfere with the readings;
- Linearity - the sensor's readings are not always representative of the true air quality value. Due to this, calculations must be done to correct data before analysis.

Example units*:

- CairClip
- AirCasting
- AQMesh
- Air Quality Egg
- CitiSense
- Aeroqual
- U-Pod
- Cairpol

*Note, the Division does not endorse any sensor unit or brand and just provides these as examples for context.

Examples of gaseous air sensors

Particulate monitors

Particulate monitors generally use light scattering or particle counts to detect pollutants.

Issues:

- You can't identify the size of the particles being sampled;
- The sensor relies on airflow to collect samples which is less reliable than traditional sensors that use fans;
- They are not as sensitive as traditional monitors;
- To get concentration values, you may have to convert data.

Example units*:

- Dylos
- MicroAeth
- Shinyei
- Thermo PDR

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Examples of particulate air sensors

VOC monitors

Volatile Organic Compound (VOC) monitors generally use photoionization or IR sensors to detect pollutants.

Issues:

- Baseline drift - overtime your measurements become less accurate. For instance, the instrument may read "0" but it is actually "10";
- They are not as sensitive as traditional monitors;
- They generally don't last a long time;
- There are hundreds of VOCs but only one is used for total VOC calibration. Due to this, the sensor may be able to detect the calibrated compound accurately, but may not be able to detect other VOCs as well. The molecular difference between the calibrated VOC, and other VOCs determines how well the sensor will be able to detect and measure them. The greater the difference the less able the sensor will be to measure them.

Example units*:

- Spod
- MIPEX

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Examples of VOC air sensors

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