

Hazy Days of Winter

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I would like to thank my mom for teaching me how to use the psychrometer and the anemometer and helping with the computer.

I would like to thank my dad for helping me build the smokestack.

Abstract

The top two sources of air pollution are motor vehicles and large industrial factories. When fuel is not burned completely in a car motor, dirty exhaust or fumes are released. These fumes contain carbon monoxide and carbon dioxide, among other pollutants. Carbon monoxide is harmful to people in that it keeps the lungs from picking up oxygen. Excessive carbon dioxide is the cause of the “greenhouse effect”. Smokestacks of large industrial factories, particularly power plants that use coal, produce particulate matter, sulfur dioxide and other strong gases. In some areas the pollutants are often visible by haze or colored clouds hanging in the air.

Some particles in the air cause problems with the skin and eyes, but the particles do greater damage to the lungs. When the lungs have to work harder to get oxygen to the blood, the heart must also work harder. So, any problem that effects the lungs also effects the heart. The Environmental Protection Agency (EPA) estimates that at least 20,000 premature deaths occur each year due to particulate pollution alone.

Weather can effect how quickly pollutants leave an area. Normally pollutants rise and blow away without building up to an unsafe amount. Sometimes a pollutant can't escape, and after awhile they may build up to unhealthy levels. This trapping can happen when winds are slow or calm, and when warm air moves in over cold ground, keeping pollutants close to the surface. These conditions may last for days until changes in air pressure and moisture allow winds to clear away the pollution.

The purpose of my project was to see what type of winter weather condition in my area was the worst for air pollution. My hypothesis was that the worst conditions would exist when it was sunny, the wind was not blowing and the air pressure was high.

Through my experiment and the data I collected I found that wind had the biggest effect by far. Anytime the wind was blowing the pollution cleared out quickly. Given a lack of wind, high pressure and sunny conditions lengthened the amount of time it took for the pollution to clear the area.

Experiment

Problem

What is the worst winter weather condition for air pollution?

Materials and Equipment

Smoke stack
Small fan
Smoke bombs
Lighter
Thermometer
Psychrometer
Anemometer
Stop Watch

Procedure

Flag off an area 6-foot tall, 19 foot long and 19 foot wide, this is the “safety zone”. This represents the area near a pollution source. Once the smoke, which represents pollution, clears this zone the area is safe. The smokestack is set up in the middle of this safety zone with the small fan placed at the base on low speed.

The date and time of each test is recorded. Measure the independent variables using proper equipment. Temperature is measured with a thermometer. Wind speed using an anemometer. Humidity is measured with a psychrometer. The amount of sun is measured on a scale of 0 to 5, with 0 being sunny and 5 indicating rain.

Light a smoke bomb and drop into the smokestack. When the last smoke exits the stack, start timing using the stopwatch. Stop the stopwatch when all of the smoke has cleared the “safety zone”. Record the seconds it took for the smoke to clear the area.

Record air pressure data from a computer source; wunderground.com and accuweather.com were used in this case.

Repeat test under both similar and different weather conditions.

Data

Figure 1 contains the raw data from the study.

Figure 2 shows how wind speed effects the time it takes for smoke to clear the “safety zone”.

Figure 3 contains data collected when there was no wind. This chart shows that all of the clearing times of 15 seconds or greater occurred on sunny days, most, but not all of which had high pressure.

Figure 4 contains data collected when there was no wind. This chart shows how sunny conditions and higher pressure combine to extend the amount of time it takes for smoke to clear the “safety zone”.

Figure 5 contains data collected when there was no wind. This chart shows the effect of humidity of the time it takes for smoke to clear the “safety zone”.

Conclusion

The independent variables are temperature, humidity, wind speed, pressure, and sun. The dependent variable is how long it takes until the smoke clears from a 19 foot square by 6 foot high “safety zone”. The controlled variables were the amount of smoke as well as the smokestack. Based on the data, wind has the most effect on air pollution. A day in which there is no wind is worse for air pollution regardless of any other variable.

When no wind exists, the data suggests that sunny days with higher pressure contribute to a longer time to clear the “safety zone”. If the wind could somehow be blocked from the test area, additional data could need to be gathered to more accurately see the effects of the other variables.