

Inversion and its effect on air quality

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Abstract

As a group, we decided to research the effect that the winter inversion has on the air quality in the Salt Lake Valley. We researched the natural phenomenon of inversion and upon learning about what this was, we shifted focus to its effects on the Salt Lake Valley. We researched the major contributors to pollution as well as the effects on air pollution as it relates to vehicle emissions. Finally, we researched the health effects that living in an environment with the air quality problems that Salt Lake faces and what can be done to mitigate this problem in the future.

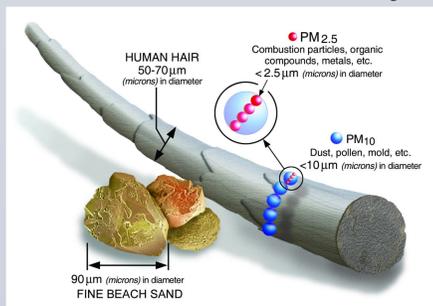
Background

Inversion is a natural phenomenon that occurs during winter months. Essentially, cold air gets trapped underneath a cover of warmer air resulting in a reversal of normal atmospheric conditions. This happens during winter months because sunlight is reflected off of the snow rather than allowing it to be absorbed, long nights also add to the decreased surface temperatures and calm winds preventing the cold air and warm air from mixing. The prevention of mixing creates an atmospheric blanket which traps pollution in the valley. In Salt Lake City, it is the surrounding mountains, the Wasatch and Oquirrh, that shield the valley from wind and prevents the mixing of air needed to clear out pollution.

Below is a quote based from the definition on the Salt Lake City Website: "Inversions occur during the winter months when normal atmospheric conditions (cool air above, warm air below) become inverted. Inversions trap a dense layer of cold air under a layer of warm air. The warm layer acts much like a lid, trapping pollutants in the cold air near the valley floor. The Wasatch Front valleys and their surrounding mountains act like a bowl, keeping this cold air in the valleys. The snow-covered valley floors reflect rather than absorb the heat from the sun, preventing the normal vertical mixing of warm and cold air. Fog exacerbates the problem, facilitating chemical reactions that create even more particles and higher pollutant concentrations. The longer the inversion lasts, the higher the levels of pollution trapped under it. The warm inversion air layer is usually displaced by a strong storm system which restores air quality to healthy levels."

In the Salt Lake valley inversions normally take place after a snowstorm. Due to Utah's unique geography and weather, gas emissions create unusual chemical and photochemical conditions that lead to the formation of PM_{2.5}, which are fine particulates.

There are two different types of PM, which stands for particulate matter. According to Particulate Matter Basics article, PM₁₀ is inhalable particles that have diameters that are generally 10 micrometers and smaller. The second type of PM is PM_{2.5} which is fine inhalable particles, with diameters that are generally 2.5 micrometers and smaller. The best way to describe PM and the two different kinds is with the diagram below:



In this diagram they are comparing PM to a single human hair. The average hair on a human is 70 micrometers in diameter, which makes it 30 times larger than the largest fine particle.

Methods

The Information presented was gained by researching data in government approved site, and talking with others that had experience with the subject. Knowledge was also gained from attending biology class from Salt Lake Community College.

Results

These PM_{2.5} particles have great effects on human health because it can pass through the nose and throat, lodge deeply in the lungs, and pass across the lungs into the cardiovascular system. Particles can aggravate lung diseases such as asthma and bronchitis, and increase respiratory symptoms such as coughing, wheezing, or shortness of breath, according to "Salt Lakes Commitment to Air Quality" article. PM_{2.5} can aggravate heart conditions, including congestive heart failure and coronary artery disease. PM_{2.5} pollution affects the health for people of all ages. Although, children and the elderly are at higher risks than others. People who strenuously exercise outside are also at a high risk of getting PM_{2.5} particles lodged in their lungs.

According to research, "Several scientific studies were able to associate PM[particulate matter] exposure to a variety of health problems such as nonfatal heart attacks, irregular heartbeat, aggravated asthma, decreased lung function, irritation to the airways, coughing, difficulty breathing, and premature death in heart or lung cancer patients.[8] Those who are at the highest risk to exposure of PM are people who already have heart or lung disease, children, and the elderly. Not only does PM affect health, but it affects the environment as well."(pg 27) You can also receive lead poisoning from high levels of exposure. As talked about in the quote, health effects are mostly common in young children and the elderly. This is because their immune systems are not as strong and as well built as adults and young adults.

The first health effect of the Salt Lake inversion is asthma, which is one of the most common diseases in children. Asthma is an inflammatory disease of the lungs which makes it hard to breathe. During an asthma attack, the airways in the body become sensitive and swollen. Because of this, the muscles surrounding the airways tighten making it hard for air to get through to the lungs. Cells in these airways may also produce a large amount of mucus, which makes the airways shrink more. As a result, this causes wheezing, breathlessness, chest tightness, and coughing.

Much like asthma, Chronic obstructive pulmonary disease (COPD) refers to a group of lung diseases that cause air flow blockage to the lungs and difficulty breathing. COPD has two main conditions: emphysema and chronic bronchitis, which most people have if they have COPD. COPD can cause coughing that produces large quantities of mucus, wheezing, shortness of breath, and tightness of the chest. When you breathe, oxygen enters the bloodstream through small air sacs, alveoli, at the end of the airways in the lungs. At the same time, waste gases like carbon dioxide leaves the blood and is exhaled. Normally, the air sacs are elastic, and inflate and deflate like balloons during breathing. In COPD, less air flows through the airways. COPD develops slowly and is a progressive disease, meaning that the symptoms typically worsen over time. It is most often diagnosed in middle aged adults. COPD has no cure, and can limit the ability to perform routine activities. COPD is a major cause of disability and the third leading cause of death in the United States.

Lastly, exposure to air pollution, particularly particulate matter (PM), is now known to also be a risk factor for coronary heart disease. Exposure to PM_{2.5} can cause heart disease-related deaths and nonfatal events. Research is progressing on how PM influences heart disease, but it is thought to involve several mechanisms, including increases in inflammation, clotting factors, blood pressure, and coronary artery stiffness. Utah has experienced a steady decrease in the rate of emergency room visits for heart disease over the past decade. The rate ranges from a high of 53 per 100,000 per month in 2001 to a low of 35 per 100,000 per month in 2011. The rate has some seasonal variation, being higher between the months of December to March when the inversion is high.

Sources of Pollution in Utah

Pollution distribution in terms of PM_{2.5}
Vehicles: cars, airplanes, lawnmowers etc. 57 percent



Area sources: homes, buildings, 32 percent



Point sources: industrial mining, larger corporations. 11 percent



What You Can Do

- Drive less/more efficiently
- Keep up on vehicle maintenance (oil changes, tune ups, tire rotations etc.)
- Use public transportation-During the winter months when air is at its worst UTA will sometimes give discounted rides.
- Turn down thermostat and put on a sweater.
- Avoid wood burning stoves
- Use electric tools for lawn care
- Get some exercise and shovel your driveway by hand instead of using a snowblower.
- Visit the www.epa.gov for more tips

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