Introduction to Pollutant Aerosols

Air pollution can result from both natural and human-caused actions. Natural pollutants may result from events like: forest fires, volcanic eruptions, wind erosion, natural radioactivity, etc. Human pollutants can result from: toxic emissions from vehicles or manufacturing plants, burning fossil fuels, household or farming chemicals released into the air, second hand smoke from tobacco users, etc.

Pollution can obviously have an extremely negative effect on the air quality that we as humans, as well as all living creatures, breathe and depend on for life. Pollution can also negatively impact water and soil by introducing toxins into these resources needed for drinking water and growing crops.

Specifically to the Wasatch Front area of Utah, each winter we experience massive inversions that become so severe that people are advised to stay indoors or take public transport. Inversions are caused when warm air of higher atmospheric levels traps the cooler air below. With regards to the Wasatch Front area specifically, this is enhanced because the mountains on both sides of these valleys then traps the pollutant air in the valleys, which cause potential harm to both human and biological life.

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PROJECT OBJECTIVES:

What pollutant aerosols are in the air right here along the Wasatch Front, and in the atmosphere above these valleys? Are the pollutants found here dangerous? What percentage are from natural causes versus man-made? How can we obtain samples to study them to know both what is in the air, and how it is effecting us?

The purpose of our project is to answer some of these important questions.

PROJECT PROPOSAL:

Our proposal is to build a high altitude balloon that we can launch into the atmosphere that will collect samples of atmospheric air. We will use UVU Physics Department’s provided resources: high altitude balloon, collecting viles, parachute, helium tanks, go-pro camera, tracking devices, biology lab, electron microscope, etc. We will take this balloon out to the west desert and launch it, collect samples, retrieve the balloon, and then take the samples back to UVU’s microbiology lab to test what bacteria and pollutant sources were obtained from the atmosphere at varying altitudes.

High Altitude Balloon Experiment

Balloon Launch:
Our research team drove about an hour and a half west of UVU Campus, to the west desert. We filled a HWOYEE 1600 balloon (as seen in image 1 to the right) with Helium to carry a payload mass of 4,000g. Launch altitude of 1,500m, ascent rate was 3.79 m/s, and minimal wind.

Aerosol Collection:
Vile 1 collected aerosols for duration of flight, but vile 2 was opened around 60,000 feet to retrieve higher altitude aerosols. Image 2 below shows balloon near peak altitude of 101,000 ft, where it burst.

Balloon Retrieval:
Image 3 shows the mountain where the balloon landed (about 30 miles east of launch site).

BIO-AEROSOL SAMPLE #1:
Gram positive – Staphylococcus aureus

Bacterial growth in High and Low Altitudes after being cultured
E=Open early; L= Open late

BIO-AEROSOL SAMPLE #2:
Gram negative rods

BIO-AEROSOL SAMPLE #3:
Gram positive – Staphylococcus aureus

BIO-AEROSOL SAMPLE #4:
Gram positive – Staphylococcus aureus

Images below are the bacteria under a Scanning Electron Microscope

Once we had taken the samples to the lab and had them culture the bacteria they tested to see if they were gram positive or gram negative. At low altitudes there were both gram positive and negative, but only gram positive at the high altitude. The gram positive results were determined to be Gram positive – Staphylococcus aureus. This bacteria can range from mild to dangerous. It is one of the most common causes for infection post injury and surgery. This bacteria can be transferred through the air and can be spread by someone by sneezing or coughing.

The purpose of this project was to answer some of these questions:

• What pollutant aerosols are in the air along the Wasatch Front, and in the atmosphere above these valleys? Are the pollutants found here dangerous? What percentage are from natural causes versus man-made? How can we obtain samples to study them to know both what is in the air, and how it is effecting us?

By using UVU’s provided high altitude launching equipment, we were able to obtain the samples needed, as desired. Using this equipment, we were able to collect samples of several bacteria that exists in the atmosphere above the Wasatch Front (as referenced above). Some of the bacteria collected include:

• Micrococcus Luteus: found in soil, and on human skin, not found to be harmful
• Pantoea agglomerans: Has some positive traits in that it produces antibiotics found helpful in combating some plant and animal (and human) pathogens, but has also been linked to several human immune infections.
• Staphylococcus Aureus: This bacteria spreads very easily through coughing, touching, sneezing. Having this bacteria can cause skin irritations, and if it gets into bloodstream, can infect organs. While not deadly, can cause infection.

Lastly, it was impossible, based on the data collected, to get an accurate proportion or percentage of what percentage these bacteria’s are man made vs. not, as a much larger data collection project would be needed to get more bacteria collected, and to obtain accurate results and data to provide any evidence in that area.

Summary