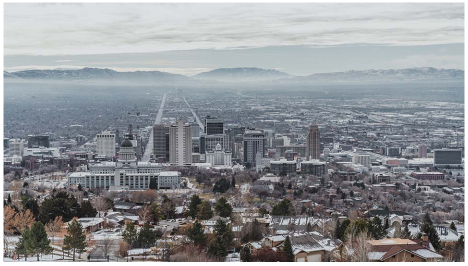
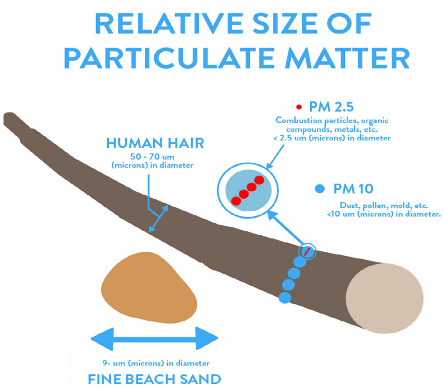
Utah Air Quality: PM2.5



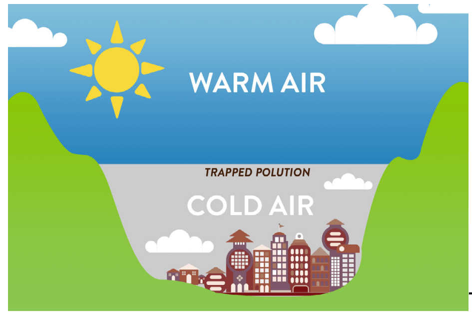
What is $PM_{2.5}$?



$PM_{2.5}$ size, adapted from the US Environmental Protection Agency

Particulate matter two-point-five ($PM_{2.5}$) is a tiny suspended particle of air pollution that can penetrate deeply into our lungs and potentially enter the bloodstream. The 2.5 unit means that the particles are smaller than 2.5 micrometers (a micrometer is one millionth of a meter). In Cache Valley and along the Wasatch Front, these tiny particles form and accumulate to unhealthy levels when air is trapped in the bottom of the valley during cold winter days.

Why does northern Utah have such high levels of $PM_{2.5}$ in the Winter?



The bowl-like structure along the Wasatch Front in Utah, resulting in enhanced inversions.

The majority of Utah's population lives along "the Wasatch Front." This consists of a chain of cities and towns along the Wasatch mountain range, from approximately Nephi in the south and Brigham City to the north. Along the Wasatch Front, the rapidly growing population is surrounded by mountains directly to the east, and to the west, which create a bowl-like setting.

This bowl structure, especially during the winter, results in enhanced inversions where warm air sits above the populated valleys, and cold air gets trapped below. Until a storm and associated wind disturbance comes through, many in Utah "swim in their own soup." Meaning that we breathe in the ever growing concentration of pollutants we emit as they are all trapped and transformed within our immediate surroundings. Cache Valley, Utah/Idaho, has similar $PM_{2.5}$ inversion episodes due to a growing population within an even more restrictive bowl-like geography. In fact, consistent violation of the 24-hour average U.S. EPA National Ambient Air Quality Standards for $PM_{2.5}$ resulted in Cache Valley's and the Wasatch Front's designation of non-attainment as identified by the Clean Air Act. Over the last 15 years, on average Cache Valley has exceed the EPA's standard 17 days per year (low 0 days; high 40 days) and exceeded health impact limit (yellow days) an average of 51 days per year.

What this means for Utah's Health & Economy

Air Quality Index (AQI)	PM 2.5	Ozone
Good	0 - 12.0 $\mu g/m^3$	0 - 0.059 ppm
Moderate	12.1 - 35.4 $\mu g/m^3$	0.06 - 0.075 ppm
Unhealthy for Sensitive Groups	35.5 - 55.4 $\mu g/m^3$	0.076 - 0.095 ppm

Air Quality Index (AQI)	PM 2.5	Ozone
Unhealthy	55.5 - 150.4 µg/m³	0.096 - 0.115 ppm
Very Unhealthy	150.5 - 250.4 µg/m³	0.116 - 0.374 ppm
Hazardous	Above 250.5 µg/m³	Above 0.375 ppm
	Based on a 24-hour average.	Based on an 8-hour average.

Air Quality Index. Taken from the Utah Dpt. of Environmental Quality

Breathing $PM_{2.5}$ is associated with multiple serious health effects. Studies associate $PM_{2.5}$ exposure with all-cause mortality[1] , stroke[2] , cancer[3] , cardiopulmonary and cardiovascular disease[1,4,5], asthma[6], pneumonia, hypertensive disease, cardiac arrest, ischemic heart disease[1,7], chronic obstructive pulmonary disease8 , Alzheimer's disease[9,10,11,12], and autism[13]. $PM_{2.5}$ is also associated with increased hospital admissions for cardiovascular and respiratory diseases[14]. Consistent and coherent health effects observed in these and other studies have led to the consensus of a causal link between particulate pollution and heightened morbidity and mortality[15].

There appears to be no discernible threshold effect to the adverse health effects associated with $PM_{2.5}$. Short-term (hours) exposure to $PM_{2.5}$ can trigger heart attacks; and long-term chronic exposure (years) has been shown to decrease life expectancy[15]. In one study, increases of 10 micrograms per cubic meter of air ($\mu g/m^3$) above "clean air" values (5 to 10 $\mu g/m^3$) are associated with up to a 1% rise in cardiovascular death[15].

Studies in Utah are consistent with those in other locations. Researchers at Brigham Young University associated PM exposure with early mortality16 from a variety of cardiovascular and other diseases[17]. Each incremental $PM_{2.5}$ rise of 10 $\mu g/m^3$ was associated with a 13.1% increase in hospital admissions due to heart failure[18]. Also, University of Utah and Brigham Young University researchers recently reported that the risk of "serious" heart attacks increase by 15% for every increase of 10µg above 25 µg per cubic liter of air[19].

In addition to the myriad health effects, Utah's business community is increasingly concerned as air pollution can reduce our ability to attract new companies, jobs, and quality employees and their families[20]. For example, in 2012, a state economic development officer testified before a Utah legislative task force about how representatives from a foreign company cut short a Utah site visit upon experiencing a "red air alert" pollution day. "These folks were shocked, literally shocked," he explained, "They basically said 'we're going to conclude our visit early because we're just not interested in being in a place that has this kind of issue.'"[21].

Sources of $PM_{2.5}$ in Our Atmosphere

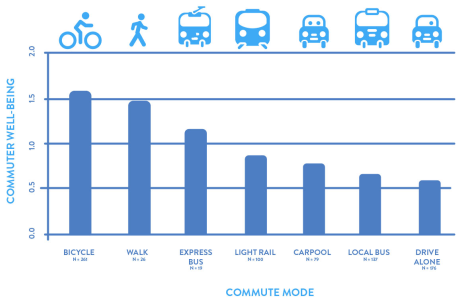
Northern Utah's $PM_{2.5}$ particles can come from a variety of sources and it is important to understand the magnitude of each of these contributions if remediation programs are to be effective. Some particles or particle components are directly emitted from a variety of sources; these are called "primary particles". These are emitted from sources such as diesel engines, wood smoke, road dust, soil erosion, incomplete combustion and similar physical processes.

$PM_{2.5}$ particles can also be formed in the atmosphere through chemical reactions of different gas-phase components. These are called "secondary particles". The most common forms of secondary $PM_{2.5}$ are ammonium sulfate ($[NH_4]2SO_4$) and ammonium nitrate (NH_4NO_3). Secondary particles are formed when oxides of sulfur (SOx) or oxides of nitrogen (NOx) combine with gas-phase ammonia (NH_3). On highly polluted days in Northern Utah, NH_4NO_3 makes up the bulk of the $PM_{2.5}$ material, approaching 90% of the total mass. An additional confounding factor is that the formation of ammonium nitrate particles is greatly increased in cold temperatures.

Therefore, control of the region's $PM_{2.5}$ requires an understanding of the sources and strengths of the precursor compounds NOx, NH_3 , and volatile organic compounds (VOCs). In the local area, NOx emissions are dominated (#75%) by the mobile (automobile) sectors, the NH_3 is emitted primarily from the agricultural sector, and the VOC emissions are split roughly equally between the mobile and industrial/residential sectors. While not obvious to the ultimate formation product (NH_3NO_3), VOC's are important because their atmospheric oxidation drives the reactions of the NOx to form nitric acid (HNO_3

) which is the actual species which combines with NH_3 to form the particulate $NH_4 NO_3$[22,23,24]. In the northern Utah wintertime atmosphere, studies have shown an excess amount of NH3 is present; therefore, the most effective control strategies should include emission limits of NOx and/or VOCs.

What You Can Do



Commute well-being from Portland State University's Urban Studies and Planning research by Oliver Smith and Nohad Toulan

We experience an average of 30 inversion days a year in our Utah mountain valleys. Given that vehicle emissions are a major contributor to $PM_{2.5}$, decisions we all make regarding transportation can have a large impact for everyone in Utah. Here are some tips to help improve our air:

Be Idle Free

The first easy step to take would be to turn your engine off when you park. Recent studies at USU and Weber State have shown that all VOC and most NOx emissions are minimized when shutting off your engine as opposed to idling, even for time periods as short as five minutes. Utah has a statewide initiative to reduce idling, called "Turn your Key, Be Idle Free," that many cities have adopted including Logan. More information about this initiative can be found on the Utah Clean Cities website (http://utahcleancities.org/idlefree-utah).

Bike or Walk

Biking or walking as your form of transportation has been associated with myriad of health benefits, including increased happiness and mental clarity. Find out more about switching to biking as your mode of transportation, here http://extension.usu.edu/files/publications/factsheet/Sustainability_2012n-12pr.pdf.

Trip Chain

Trip chaining involves mapping your route and tasks in a way that stacks as many functions into one outing as possible, while also minimizing the distance traveled on your route.

Carpool

Carpooling is a fun way to catch up with friends/colleagues, while also saving costs on gas money and stress single-driver commuting

Bus

Riding the bus is a great way to help reduce emissions. You can legally text and ride, and in Logan, Utah, the transit system is free!

More

Avoid driving a diesel vehicle on polluted air days. Also, observe Utah Law and do not burn wood stoves on polluted air days.

Your Local Air Quality

If you are interested learning more about your local air quality, the US Environmental Protection agency recently released an Environmental Justice Screening and Mapping Tool (https://www.epa.gov/ejscreen) that allows you to search for your current local $PM_{2.5}$ levels under the "Map Data" tab. Also, you can sign up to receive air quality alerts from the Utah Department of Air Quality, to know in advance when the air will be unhealthy so you can plan your travel and outdoor time accordingly (just send the blank email to Subscribe-deqChoose_Clean_Air@list.utah.gov and you will be added to the list). The EPA's AIRNOW website and the Division of Air Quality's webpage both also offer smart phone apps.

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