Chapter 3

AIR

Key issues facing Utah's air

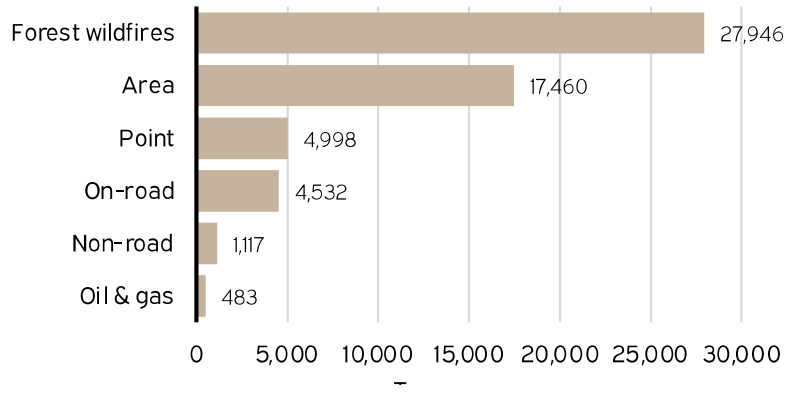
Chapter Summary *by BRIAN STEED*

Air quality remains top of mind for Utahns living along the Wasatch front and in the Uinta Basin. Although Utah has made some serious gains in air quality over the past decades, there is also cause for concern. In looking at the numbers for this year, we have seen fewer days of inversion and have seen lower levels of smoke pollution this summer from regional forest fires than we have seen in recent years. That has meant lower numbers of red or "unhealthy" air days than any year since 2019.

On the downside, Utah has seen an uptick in concern over summer ozone along the Wasatch Front and winter ozone in the Uinta Basin. Adding to the list of concerns is the emerging issue of dust blowing off the dry lakebed of the Great Salt Lake. Failure to address these new concerns will almost certainly draw regulatory action from air quality regulators from state and federal agencies.

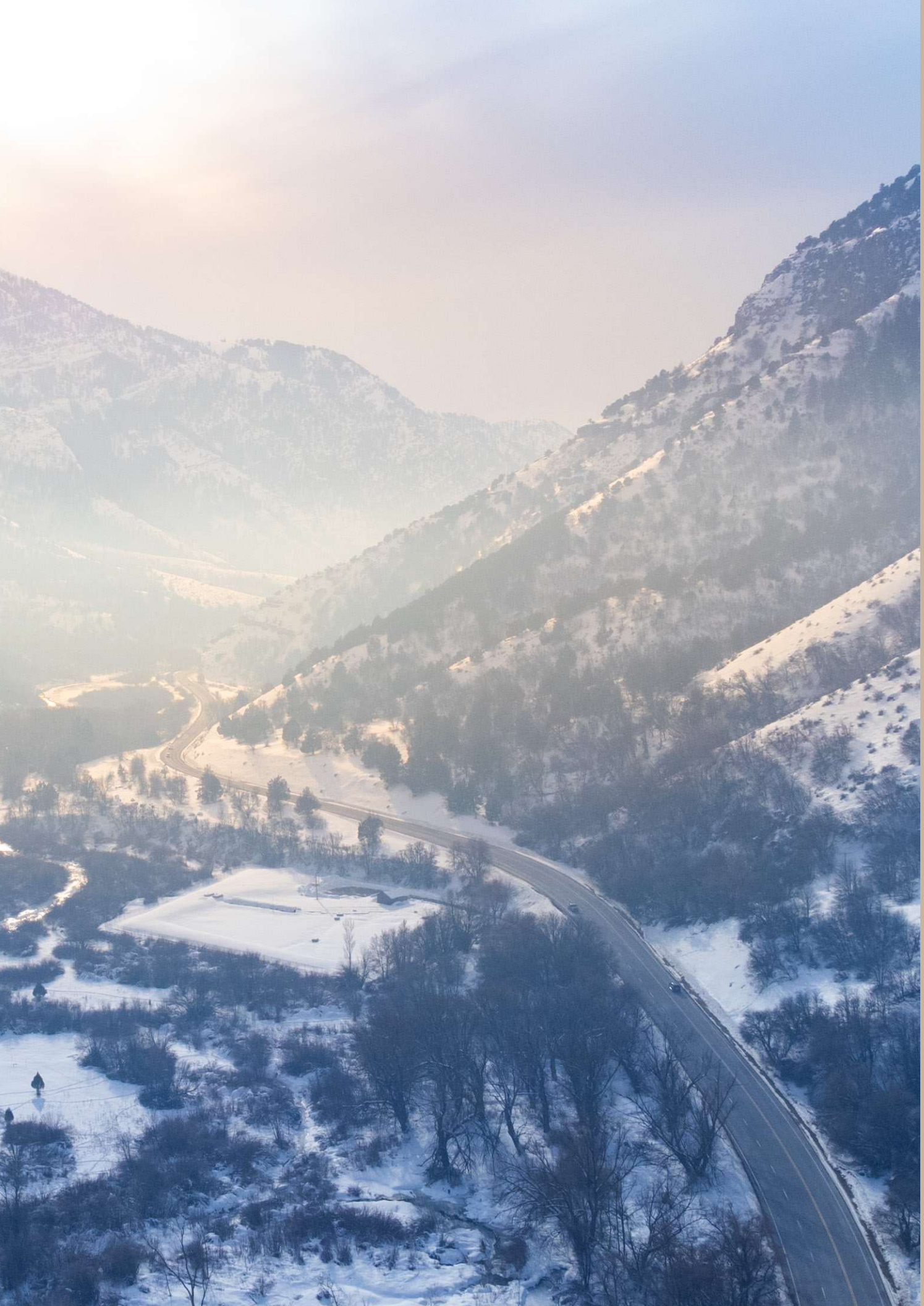
Addressing these concerns will require better understanding and monitoring of contributing factors. In the remaining sections of this chapter, we examine some of the trends and analysis of our air quality and the human behaviors that affect it.

Figure 3.1.1 Utah $PM_{2.5}$ triennial emissions inventory



Under current federal law, Utah is required to collect a statewide emission inventory every three years. The 2017 triennial inventory is the most recent statewide inventory available.

Source: *Utah Division of Air Quality, 2022*



NORTHERN UTAH AIR *by RANDY MARTIN*

3.A Progress and problems with northern Utah's $PM_{2.5}$

TAKEAWAY» **Even with inversion episodes in 2023, northern Utah appears to have reached EPA "attainment" status for its airsheds.**

Particulate matter in the air can have a noticeable impact on human health when breathed in. $PM_{2.5}$ particles are particles less than or equal to 2.5 microns (µm) that can travel deep into the respiratory system.

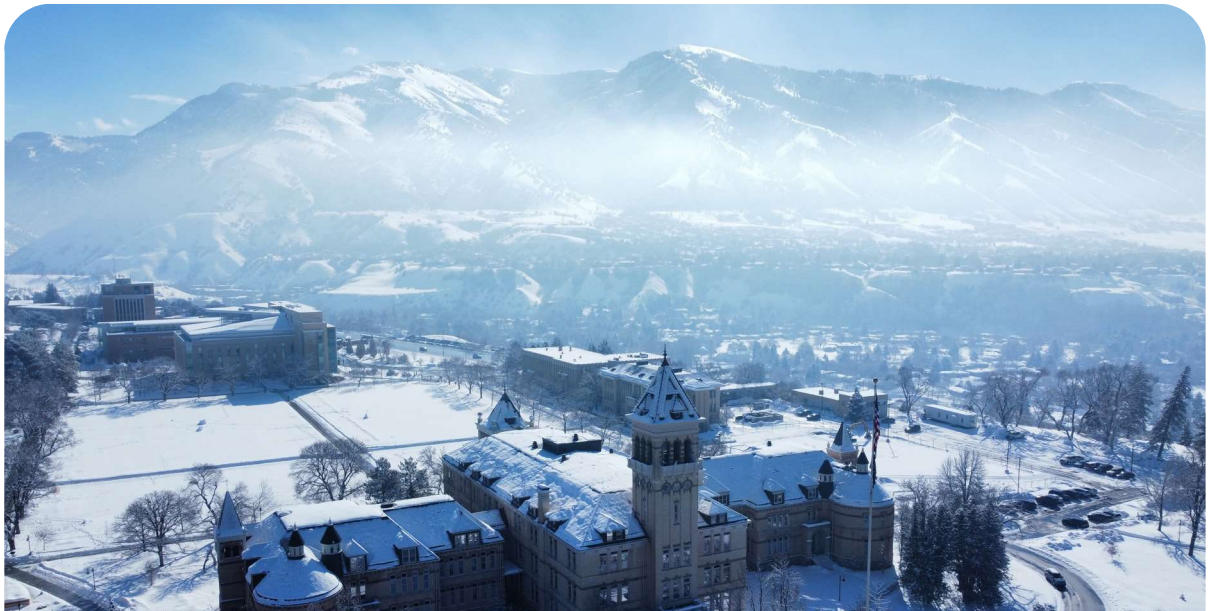
The regulatory status of northern Utah counties has not changed in the past year. The Wasatch Front counties are still officially listed as "serious non-attainment," although recent three-year averaging periods have shown the airsheds have achieved "clean data" status. Cache County reached "attainment" status and is listed as "maintenance" as of June 2021.

For the most part, Utah's $PM_{2.5}$ measurements indicate continued improvement of the state's implemented $PM_{2.5}$ reduction programs. However, some challenging inversions during January and February 2023 resulted in several exceedances across the region (Figure 3.A.1).

Northern Utah's winter was characterized by frequent storms and abundant snowfall, interspersed with brief high-pressure periods that allowed for multi-day inversions. The elevated concentrations observed were also some of the highest $PM_{2.5}$ values experienced across the region within the last decade.

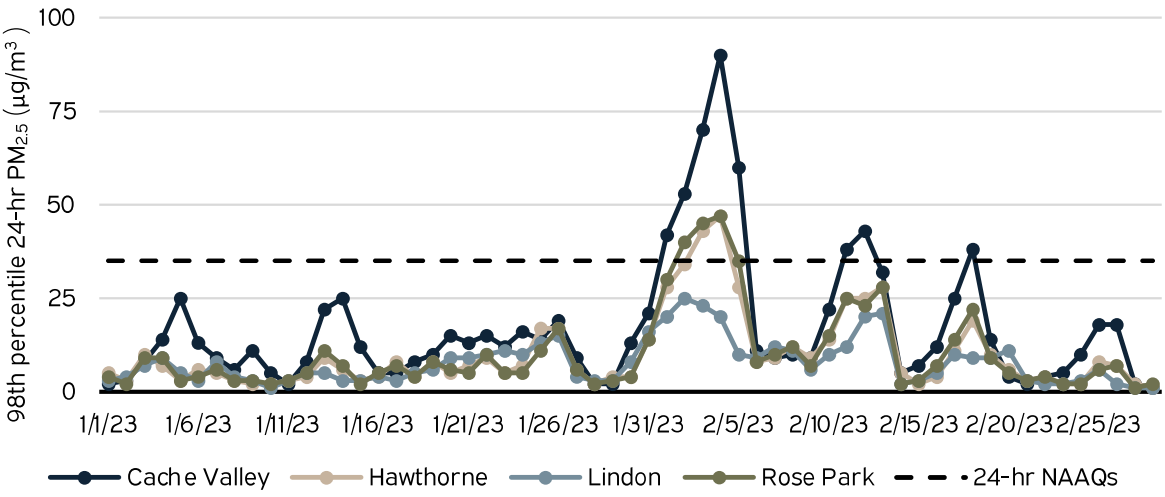
Figure 3.A.2 shows that airsheds have mostly been below the NAAQs for the past three years, suggesting that "attainment" status across the regulatory three-year averaging period can be reached.

Winter 2023 demonstrates that, although implementation protocols have resulted in recent $PM_{2.5}$ reductions, northern Utah is only a few consecutive strong winters away from once again exceeding the National Ambient Air Quality Standards.



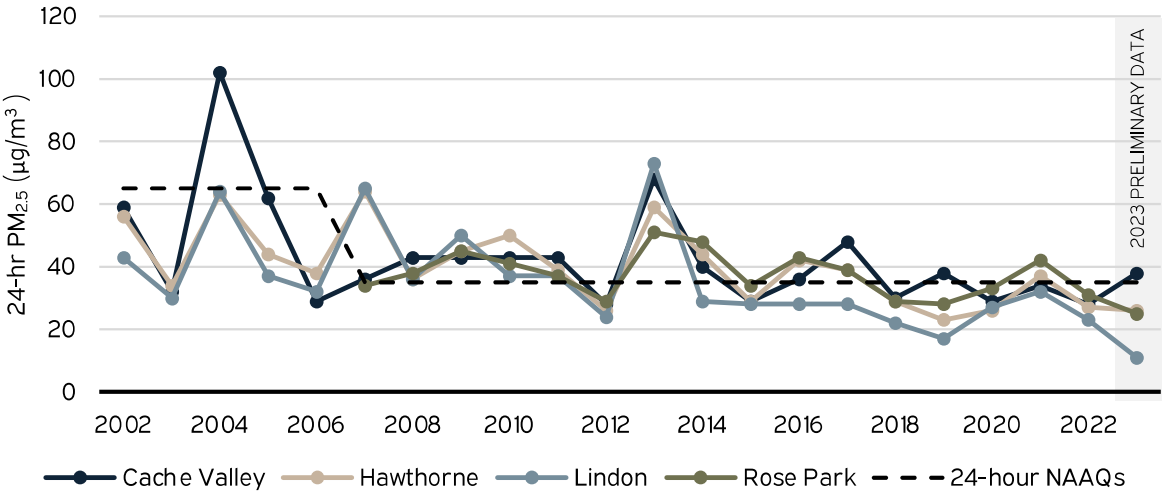
AERIAL VIEW OF USU CAMPUS / CACHE COUNTY

Figure 3.A.1 24-hour $PM_{2.5}$ along the Wasatch Front and Cache Valley (Winter 2023)



Inversion periods are evident above as the incidences of peaked $PM_{2.5}$ levels, lasting from about two-to-six days. These inversion/exceedance episodes are an important reminder that wintertime meteorological conditions are a significant component of many of Utah's seasonal air quality concerns.

Figure 3.A.2 Historical Wasatch Front and Cache Valley 98th percentile $PM_{2.5}$ values (2002–2023)



This graph shows the potential impact on the annual $PM_{2.5}$ trends on achieving attainment. Following federal protocols, a year's regulatory $PM_{2.5}$ concentration is reported as the 98th percentile of all the values measured. Three consecutive years of 98th percentile values are averaged and reported as an airshed's regulatory "design value".

WASATCH FRONT AIR *by RANDY MARTIN*

3.B How Great Salt Lake dust affects Utah's PM_{10} levels

TAKEAWAY» **Dust pollution could become a larger problem as the Great Salt Lake's playa gets drier.**

In the early to mid-1990's, areas along the Wasatch Front were declared non-attainment Air Quality Standards with PM_{10}, mostly during wintertime inversions. Since then, continued decreases in PM_{10} caused the airshed to be declared "maintenance" status in March 2020 with continued oversight through 2030.

More recently, however, PM_{10} has become a growing concern revolving around seasonal wind-blown dust potentially originating from the shores of the Great Salt Lake. These events frequently are observed in the spring and fall and are of limited duration.

As an example, a roughly nine-hour event occurred on June 23, 2023, wherein the measured wind speed at the Salt Lake Airport doubled from around 11 mph to 22 mph, accompanied by a wind direction shift. Figure 3.B.1 shows the hourly averaged PM_{10} values increased considerably.

Rather than exceedances of air quality standards, it is the short-term exposure to unhealthy concentrations of hazardous chemicals carried in the dust that have garnered recent attention.

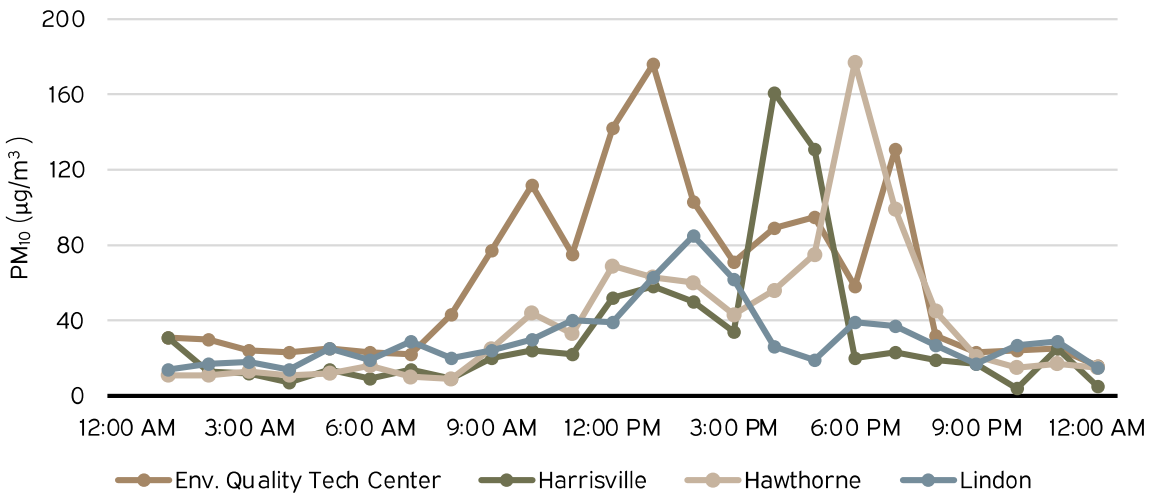
Research by several agencies and universities throughout Utah have shown Great Salt Lake dust composition to be variable but typically dominated by calcium, silica, magnesium, aluminum, sodium, iron, and potassium. Numerous other elements have also been identified within air-borne dust, including arsenic, copper, manganese, nickel, selenium, strontium, thallium, and vanadium.

A recent analysis of PM_{10} collected at two regulatory sampling sites found that, during observed dust events, the potential for inhalation of most of the observed elements increased ten-fold, but exposure to only four of the elements (magnesium, calcium, vanadium, and strontium) were enhanced above background dust expectations. This suggests the wind-blown dust from the Great Salt Lake playa provided additional levels of these elements.

In 2023, a working group was formed among Utah Division of Air Quality personnel and investigators across universities and colleges in northern Utah to coordinate, encourage commonality in sampling and analytical methods, and develop benchmark comparison criteria. The group is currently working to prioritize cooperative PM_{10} sampling campaigns for dust sources and composition.

EXPOSED LAKE BED | GREAT SALT LAKE | DAVIS COUNTY

Figure 3.B.1 PM_{10} levels in Salt Lake City during a dust event (June 23, 2023)



During the dust event PM_{10} levels from 10-25 µg/m³ to a maximum 177 µg/m³ were observed. The location nearest the playa (Env. Quality Tech Center) showed the longest, temporally-sustained PM_{10} increase. On the other hand, during this event, the Lindon location in Utah County showed a more moderate PM_{10} increase, from about 20 to 85 µg/m³.

RATHER THAN EXCEEDANCES OF AIR QUALITY STANDARDS, IT IS THE SHORT-TERM EXPOSURE TO HAZARDOUS CHEMICALS CARRIED IN THE DUST THAT HAVE GARNERED RECENT ATTENTION.

UINTA BASIN AIR *by SETH LYMAN*

3.C Uinta Basin ozone returns in a snowy winter

TAKEAWAY» **Winter ozone has declined over the past decade, but increased oil and gas activity, combined with unprecedented snow cover and inversions, led to a spike in high ozone this winter.**

The Uinta Basin occasionally experiences high ozone during winter months. Ozone is a respiratory irritant that impacts human health, and it is regulated by the U.S. Environmental Protection Agency. Winter ozone requires strong, multi-day temperature inversions, which only form when the basin is blanketed in snow. It also requires emissions of air pollution.

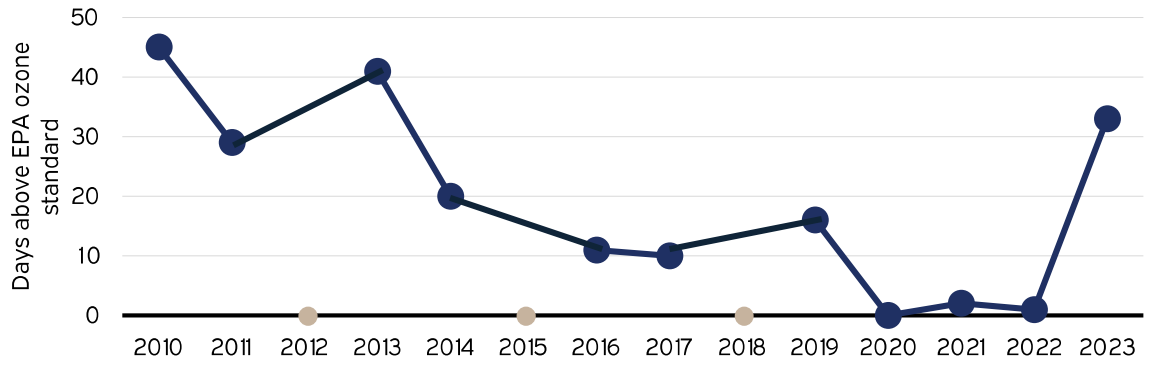
Most of the pollution that leads to winter ozone in the basin is emitted from the local oil and gas industry, and regulation that targets the industry may have a detrimental impact on the Uinta Basin economy.

The Uinta Basin is out of compliance with EPA air quality standards for ozone. Market forces and improvements to oil and gas operations have reduced emissions of ozone-forming pollution, and those changes led to a decline in winter ozone levels from 2010 through 2022. Because of that decline, the Uinta Basin was on the cusp of official compliance with the EPA ozone standard.

This year, a sharp uptick in oil and gas production, combined with unprecedented snow cover and many strong inversions, led to high ozone during the past winter, including 33 days above the EPA standard, and maximum ozone of 119 parts-per-billion (the standard is 70 parts-per-billion). This winter shows that more work is needed to reduce emissions and eliminate wintertime ozone in the Uinta Basin.

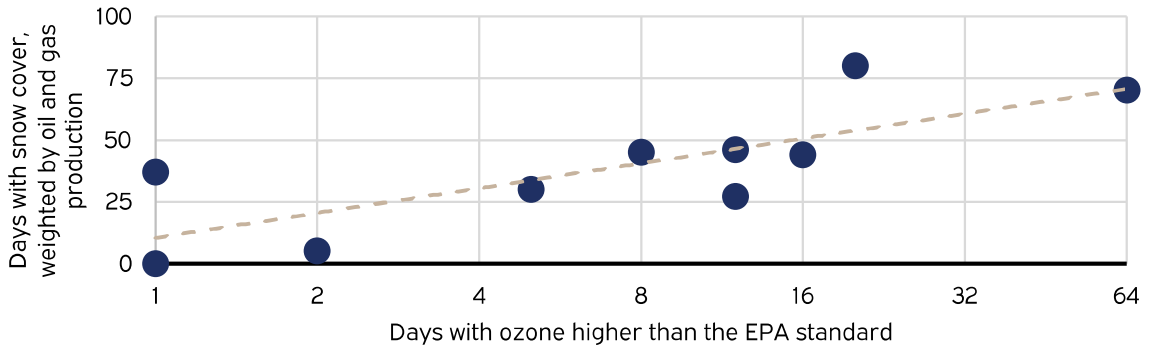
UINTA BASIN SNOWPACK | UINTAH COUNTY (JORDAN EVANS, USU)

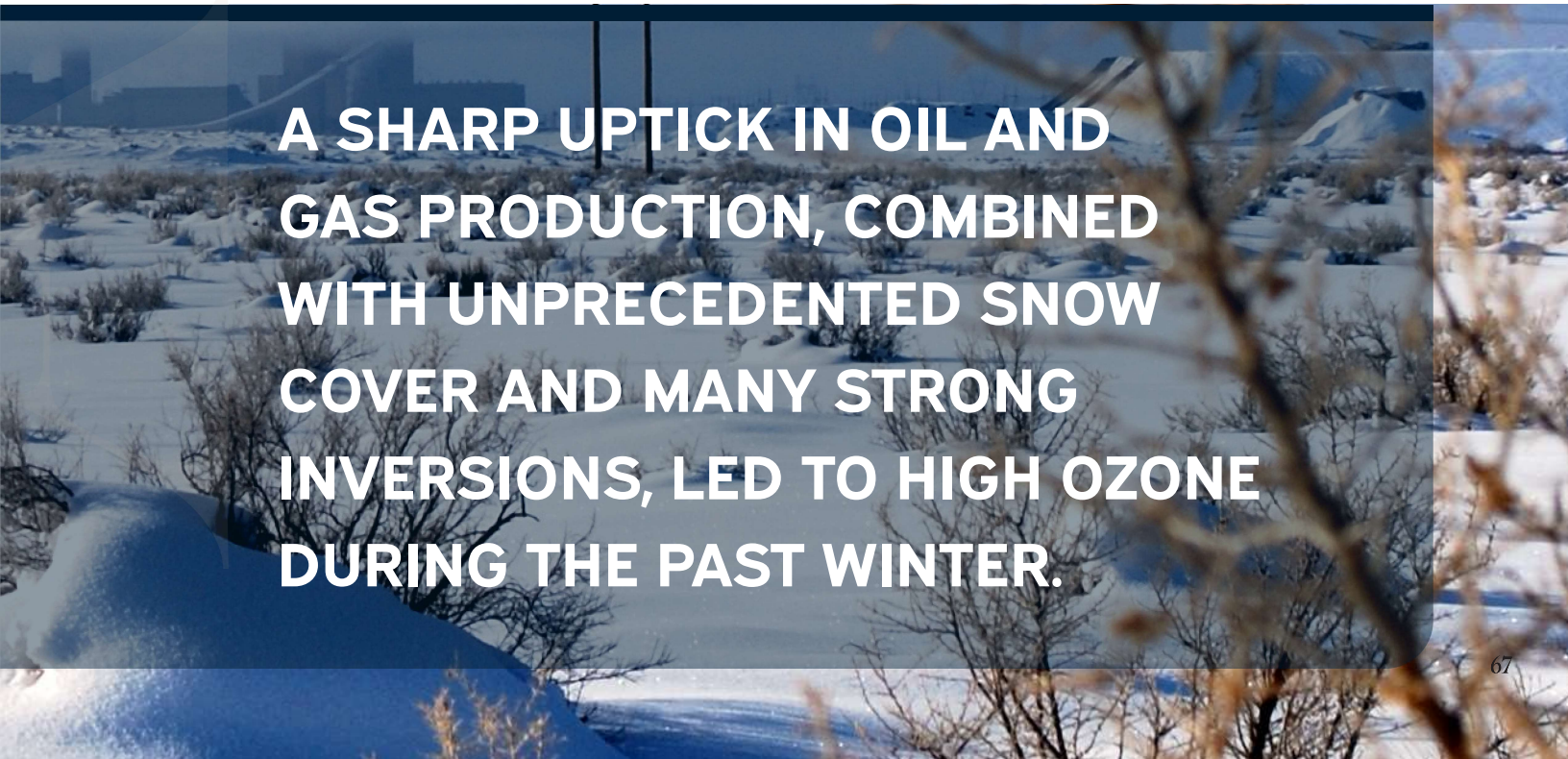
Figure 3.C.1 Number of days with ozone above the EPA standard in the Uinta Basin (2010–2023)



2021, 2015, and 2018 were low/no snow years in the Uinta Basin, during which winter ozone does not form, and are shown in beige.

Figure 3.C.2 Correlation of Uinta Basin days with snow cover and days with ozone higher than the EPA standard (2010–2023)





A SHARP UPTICK IN OIL AND GAS PRODUCTION, COMBINED WITH UNPRECEDENTED SNOW COVER AND MANY STRONG INVERSIONS, LED TO HIGH OZONE DURING THE PAST WINTER.

UTAH'S AIR POLLUTION *by ARTHUR J. CAPLAN*

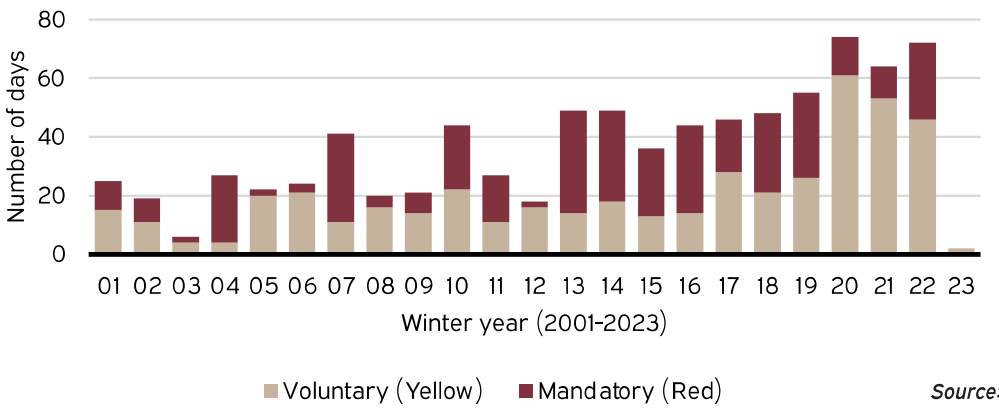
3.D Air quality advisories may not have the desired impact on reducing vehicle emissions

TAKEAWAY» **Issuing "yellow air day" advisories in northern Utah did not reduce vehicle trips or help reduce poor air quality during winter inversions.**

Using data on daily vehicle trips, $PM_{2.5}$ concentrations, and a host of climactic control variables, USU research tested the hypothesis that "yellow air day advisories" issued by the Utah Division of Air Quality resulted in drivers reducing the number of vehicle trips taken during northern Utah's winter-inversion seasons in the early 2000s. Winter inversions occur in northern Utah when $PM_{2.5}$ concentrations (derived mainly from vehicle emissions) become trapped in the lower atmosphere, leading to unhealthy air quality over a span of time known colloquially as "red air day episodes." When concentrations rose above 15 µg/m^3 toward the National Ambient Air Quality Standard (NAAQS) average daily threshold of 35 µg/m^3, residents were informed via different media sources and road signage that the region was experiencing a yellow air day. Residents were urged to reduce their vehicle usage during the day.

Results from this research suggest that the advisories provided at best weak, at worst perverse, incentives for reducing vehicle usage on yellow air days, and ultimately for mitigating the occurrence of red air day episodes during northern Utah's winter inversion seasons. A perverse incentive occurs when individuals react to an advisory by increasing their vehicle trips (and thus reducing their outdoor exposure to particulate pollution) in order to better protect themselves from the elevated $PM_{2.5}$ concentrations. Thus, "soft policies" such as issuing advisories are not, in and of themselves, sufficient to control vehicle emissions' impacts on air quality during inversions in northern Utah.

3.D.1 Yellow and red air days in Cache County (2000–2023)



** Starting in fall 2012, a new state air quality standard was adopted. "Yellow air" days (25.5 µg/m^3) became "voluntary action" days (15 µg/m^3), and "red air" days (35.5 µg/m^3) became "mandatory action" days (25 µg/m^3).*

Source: *airmonitoring.utah.gov*

"SOFT POLICIES" SUCH AS ISSUING ADVISORIES ARE NOT, IN AND OF THEMSELVES, SUFFICIENT TO CONTROL VEHICLE EMISSIONS' IMPACTS ON AIR QUALITY.

LIVING WITH POOR AIR DAYS | CACHE COUNTY

AIR TEMPERATURE

by WEI ZHANG, GRACE AFFRAM and CODY RATTERMAN

3.E Seasonal temperature trends

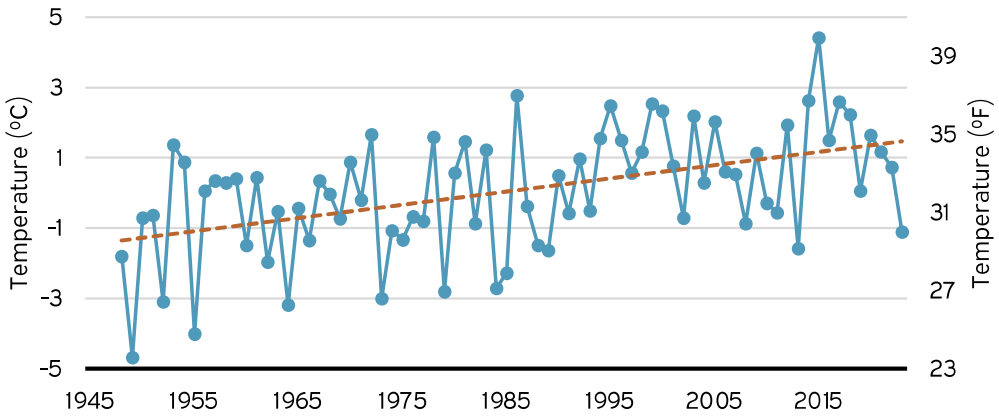
TAKEAWAY» **While the 2022–2023 winter was colder than average, it was not enough to break the trend of rising winter temperatures in Utah since 1948.**

Temperatures in Utah have trended upwards during cold seasons (January–March) and hot seasons (June–August) since 1948. While 2022–2023 winter temperatures were colder than average for the season, they did not overturn this long-term warming trend.

Snowpack accumulates during cold seasons and melts with spring warming. Increasing temperatures during cold seasons (Figure 3.E.1) indicate more rain, less snow, and more snowmelt. Higher temperatures during hot seasons will likely increase agricultural, municipal, and industrial water use, which puts stress on the availability of water resources (Figure 3.E.2). Precipitation deficit is a key driver in soil water shortage[3.E.1].

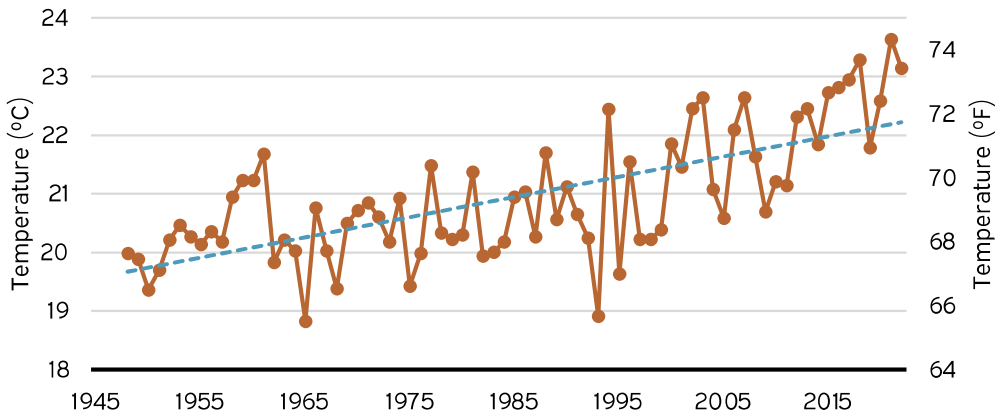
The combined effects of warming temperatures during both cold and hot seasons signify drying conditions and a shift in Utah's climate. If the warming trend continues, Utah will have a drier and hotter future along with the entire southwestern United States[3.E.2].

Figure 3.E.1 January–March Utah temperatures and trends (1948–2023)



THE COMBINED EFFECTS OF WARMING TEMPERATURES DURING BOTH COLD AND HOT SEASONS SIGNIFY DRYING CONDITIONS AND A SHIFT IN UTAH'S CLIMATE.

Figure 3.E.2 June–August Utah temperatures and trends (1948–2023)



LEFT: HEAVY SNOWPACK ON THE LA SAL MOUNTAINS | GRAND COUNTY

RURAL & AG AIR *by KIMBERLY HAGEMAN*

3.F Reducing air toxins through smarter pesticide management

TAKEAWAY» **A new tool provides guidance for optimal application of insecticides and other chemicals.**

Chemical insecticides can expose farm workers, rural homeowners, and others to toxins in the air, due to a process called volatilization. It happens when insecticide transfers from the leaf surface to a vapor in the atmosphere, due to light energy breaking down chemical bonds.

USU's PesticideToolkit website is helping farmers understand and plan for that process. The toolkit can improve pesticide usefulness, lower costs, help manage pesticide resistance, protect pollinators and beneficial insects, and aid understanding of insecticide exposure to humans through the air.

Insecticides harm insects for only a certain amount of time after being applied. Over time, the concentration in the leaves of crops decreases. The change in concentration in leaves over time depends on several factors. Those include the nature of the insecticide but also weather conditions (such as air temperature, wind speed, light intensity, and cloud cover) and crop characteristics (such as the length of the leaves). Insecticide behavior varies because these factors change with field location, season, and time of day.

To account for the complex interactions of these factors, the publicly-available model can predict insecticide behavior under given meteorological and crop conditions.

We designed the website for use by growers, sprayers, bee managers, extension services, pesticide regulators, and scientists. Users enter an insecticide, crop, and insect of interest. They then access weather information for the current day or manually enter weather details. They can use default values for leaf and soil properties or select their own.

The website creates a graph showing the change in insecticide concentration over the next seven days. If toxicology data is available, it will also show how long it takes for concentrations to no longer be harmful to the insect of interest (whether that's the targeted pest or a beneficial insect, like a pollinator).

This feedback helps farmers apply pesticides at the right time while avoiding potential negative health effects.

Table 3.F.1 Use cases for USU Pesticide Toolkit

FARMERS	REGULATORS	RESEARCHERS
Farmers can get a site- and condition-specific prediction of pesticide concentration after application. This can guide application timing based on the active ingredient of the pesticide.	Regulators can investigate recommendations for the pre-harvest interval (PHI), the re-entry interval (REI), and other timelines that are dependent on the rate of pesticide dissipation.	Researchers can assist with planning field work. The simulation of field work can guide decisions about sampling times as well as indicate conditions to record over the study.

THE TOOLKIT CAN IMPROVE PESTICIDE USEFULNESS, LOWER COSTS, HELP MANAGE PESTICIDE RESISTANCE, PROTECT POLLINATORS AND BENEFICIAL INSECTS, AND AID UNDERSTANDING OF INSECTICIDE EXPOSURE TO HUMANS THROUGH THE AIR.

CONSPICUOUS GRASSHOPPERS | GREEN CANYON | CACHE COUNTY


STOP
PRIVATE PROPERTY
4-WAY

by RACHEL EDIE and NANCY DAHER, Utah Division of Air Quality

3.G Determining the threat of halogens on the Wasatch Front

TAKEAWAY» **Measurements of ambient halogens will help assess the new halogen emission inventory.**

Air quality in Utah is a complex and an ever-changing challenge impacting many areas of the state, but recent research has highlighted a previously underestimated class of chemicals that could make a difference in particulate matter and ozone levels along the Wasatch Front.

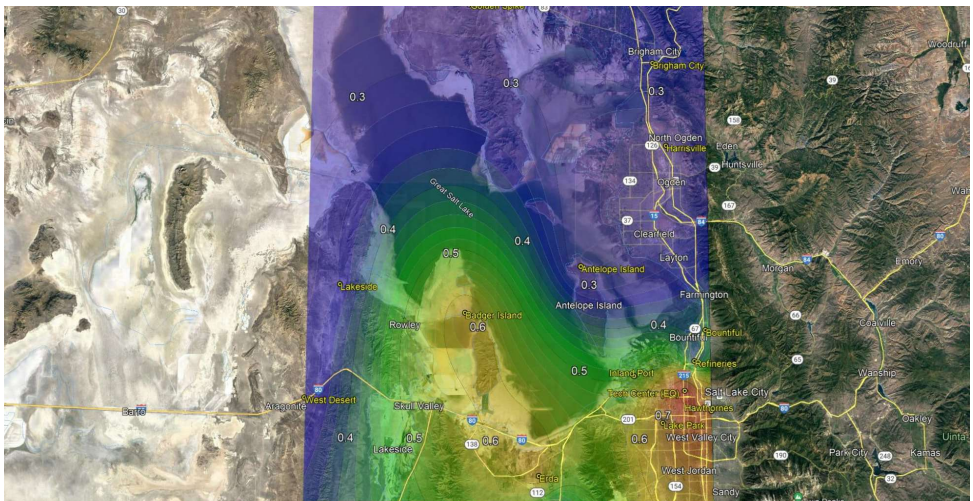
Halogens such as chlorine and bromine are highly reactive species, catalyzing numerous chemical reactions in the atmosphere. Although these species are probably best known for destroying the Earth's protective ozone layer in the stratosphere, they might also play an outsized role in Utah's ground-level air quality.

Halogens come from a variety of natural and anthropogenic sources including coal combustion, wastewater treatment, some mineral extraction, and sea spray. Despite being important for atmospheric chemistry, emissions from many of these sources are poorly constrained or sometimes, completely unknown. Utah's recent directive (HB220) to create a halogen emission inventory will help with the State's air quality modeling efforts and pollution control strategies, but a better understanding of ambient halogen concentrations is also a priority. The Utah Division of Air Quality and Utah State University are collaborating on a sampling campaign to better understand what halogen-containing compound concentrations look like along the Wasatch Front. Preliminary observations from the first phase of this three-part study (figure below) show enhanced hydrochloric acid concentrations along the southern part of the study area, including the Metro area and Badger island. The magnesium production operation of US Magnesium was offline during the sampling period. When complete, the study will constrain spatial variability of halogen levels and help identify hotspots and possible sources along the Wasatch Front.

Figure 3.G.1 Preliminary results from phase 1 of halogens study (Jan.-Feb. 2023)

Average hydrochloric acid concentrations (in parts per billion) are interpolated between the study measurement sites (yellow font). Warmer colors correspond to higher concentrations.

Source: *Dr. R. Martin, USU, 2023*



UTAH'S AIR *in the news*

As we've tracked Utah and national news through 2023, we have compiled some of the key air issues and topics that have appeared in media outlets this year.

01. HEALTH EFFECTS OF AIR POLLUTION

This year, a number of new studies further detailed the health impacts of air pollution on people. Health risks include high blood pressure, mental health issues like depression and anxiety, and even antibiotic resistance. Research indicates that breathing Utah's polluted air for a day is comparable to smoking up to five cigarettes. Poor air quality can lead to increased mistakes in tasks and has been linked to a heightened risk of breast cancer.

02. OZONE AND REGULATION

Utah faces significant ozone-related challenges, with a multimillion-dollar litigation process occurring between the state and the EPA regarding the "good neighbor" rule aimed at reducing downwind pollution. In June, the Tenth Circuit Court of Appeals granted a stay in the case brought by the State of Utah regarding the state-specific rule. In September, a federal appeals court rejected a general stay on the rule as it relates to all 26 participatory states. Litigation efforts continue as both parties appeal.

03. HALOGEN EMISSIONS' ROLE IN UTAH POLLUTION

Halogens, especially bromine, have diverse applications in industry and chemistry. However, concerns about environmental impacts have arisen. Emissions from the US Magnesium plant in Utah's Tooele County contributed to local air pollution. Lawmakers are amending an air quality bill to target this source. Additionally, studies and legislation focus on bromine emissions to address Utah's air quality issues.

04. NEW INVESTMENTS IN AIR QUALITY

New funding will support the installation of monitors for dust storms and ozone levels and a state-of-the-art facility for clean-air transit vehicles. A federal initiative is providing air purifiers for K-12 classrooms, with doctors urging schools to act. E-bike incentives were announced in Salt Lake County. Nationally, NASA launched a new satellite, TEMPO, to enhance air pollution data.

05. LOOKING TO THE FUTURE OF CLIMATE IN THE WEST

While a wet winter has brought drought relief to the West, challenges persist. The threat of returning drought looms, influenced by El Niño patterns. Extreme heat could exacerbate wildfires and reduce air quality in affected regions.

What's going on in Utah's land, water and air?

We publish a weekly email newsletter, containing a categorized roundup of about 30 stories in local and national media outlets related to Utah's land, water, and air. Subscribe at: **usu.edu/ilwa/newsletter**.

CHAPTER 3 REFERENCES

3.A.1 Environmental Protection Agency. (November 6, 1991). Designation of Areas for Air Quality Planning Purposes. *U.S. Federal Register,* 56(215), 56694-56858. https://www3.epa.gov/airquality/greenbook/frn/56fr56694nov61991.pdf

3.A.2. United States Environmental Protection Agency. (2023). *Utah Nonattainment/Maintenance Status for Each County by Year for All Criteria Pollutants.* Green Book. Retrieved July 2023. https://www3.epa.gov/airquality/greenbook/anayo_ut.html

3.B.1 Environmental Protection Agency. (July 28, 1995). Designation of Area for Air Quality Planning Purposes; Utah; Designation of Ogden City PM_{10} Nonattainment Area. *Federal Register,* 60(145), 38276-38729. https://www.govinfo.gov/content/pkg/FR-1995-07-28/pdf/95-18520.pdf#page=1

3.B.2 Utah Department of Environmental Quality (July 30, 2020). *PM_{10} State Implementation Plans and Maintenance Plans.* https://deq.utah.gov/air-quality/pm10-state-implementation-plans-and-maintenance-plans

3.B.3 Steenburgh, J.W., Massey, J.D., Painter, T.H. (2012). Episodic Dust Events of Utah's Wasatch Front and Adjoining Region. *Journal of Applied Meteorology and Climatology*, 51, 1654-1669. https://collections.lib.utah.edu/dl_files/a0/4d/

3.B.4 Hahnenberger, M., and Perry, K.D. (2015). Chemical comparison of dust and soil from the Sevier Dry Lake, UT, USA. Atmospheric Environment, 113, 1-9. https://www-sciencedirect-com.dist.lib.usu.edu/science/article/pii/S1352231015300571

3.B.5 Perry, K.D., Crosman, E.T., and Hoch, S. W. (2019). Results of the Great Salt Lake Dust Plume Study (2016-2018). University of Utah Department of Atmospheric Sciences. Report. https://collections.lib.utah.edu/ark:/87278/s6qw8qhv

3.C.1 Jensen, M. (2023, March 16). What is Ozone and What Can Be Done to Help Improve Levels This Winter? *Utah State TODAY.* https://www.usu.edu/today/story/what-is-ozone-and-what-can-be-done-to-help-improve-levels-this-winter

3.D.1 Caplan, A. (2022). Missing the Warning Signs? The Case of "Yellow Air Day" Advisories in Northern Utah." *Environmental & Resource Economics,* 85, 479-522. https://link.springer.com/article/10.1007/s10640-023-00773-7

3.E.1 Affram, G., Zhang, W., Hipps, L., & Ratterman, C. (2023). Characterizing the development and drivers of 2021 Western US drought. *Environmental Research Letters*, 18(4), 044040. https://doi.org/10.1088/1748-9326/acc95d

3.E.2 Zhang, W. (2023). The dry and hot American Southwest under the present and future climates. *Atmospheric and Oceanic Science Letters*, 100340. https://doi.org/10.1016/j.aosl.2023.100340

3.F.1 Hageman, K. (2021). *Pesticide Toolkit.* Utah State University Department of Chemistry and Biochemistry. https://pesticidetoolkit.usu.edu/

3.G.1 Williams, C. (2023, February 22). Bill to study halogen emissions, inspired by poor air quality report, clears first legislative hurdle. *KSL TV.* https://ksltv.com/527157/bill-to-study-halogen-emissions-inspired-by-poor-air-quality-report-clears-first-legislative-hurdle/a04d8f3575d0fc10682cb8df1fbd34f08860b909.pdf

LEFT: *WINTER INVERSION LAYER | CACHE COUNTY*