

# Dirtiest snow-year in the Wasatch accelerated snowmelt by 17 days in Utah, finds study

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A snow pit on May 10, 2022. All of the previous dust events are preserved in layers in a snow pit that is maintained throughout the 2022 winter season at the Alta study plot. Credit: Otto Lang

As the shrinking Great Salt Lake exposes an ever-growing area of its lakebed, wind-blown dust becomes more dangerous for those living in Utah's most populous region. It also makes the snowpack dirty, which threatens the state's most precious resource—water.

In a new study, University of Utah researchers analyzed the impact of [dust](#) on snow during the 2022 season. They found that 2022 had the most dust deposition events and the highest snowpack dust concentrations of any year since observations began in 2009.

The dust caused the snowpack to disappear 17 days earlier than if no dust had been deposited. The researchers say the impact would have been more dramatic if not for the wet spring—frequent snowstorms buried the dusty layers, which delayed the impact on snowmelt.

To understand if record high dust-on-snow concentrations were linked to record low Great Salt Lake water levels, the authors identified the areas where each dust event originated. They found that the Great Salt Lake contributed 23% of total dust deposition and had the highest dust emissions per surface area. The Great Salt Lake Desert and the dry lakebeds of Sevier Lake and Tule Lake contributed 45% and 17% respectively, but with lower per area emissions.

Seasonal snowmelt from the Wasatch Mountains is the primary water source for the metropolitan Wasatch Front, surrounding agricultural valleys and the Great Salt Lake.

"You might see 17 days and think it's no big deal, but our current snowmelt models don't account for dust," said McKenzie Skiles, assistant professor of geography at the U and senior author on the paper. "So, the snow is melting, water is coming out earlier and faster than we expect it to, and we're not prepared to use it in the most efficient way. The landscape is also not expecting the water earlier, so it impacts

watershed functionality as well as water availability downstream."

The study published in the journal *Environmental Research Letters*.

Skiles authored a 2018 [study](#) that found that a single dust event accelerated snowmelt in the Wasatch by one week. That paper identified the Great Salt Lake as a relatively new dust source due to historically low water levels. Subsequent years of prolonged drought, increased evaporation and sustained agriculture and domestic water consumption drove the Great Salt Lake to record lows in 2021 and 2022 and exposed even more dry lakebed.

"Anecdotally, we kept saying, 'This is crazy—this is the dirtiest snow in the Wasatch I've seen since I started making observations,'" said Skiles. "Ultimately, after we analyzed everything, it was the dirtiest year."

## **Digging a pit for science**

The dust that blows into the Wasatch Mountains deposits a dark grimy layer atop the snowpack and impacts the snow's albedo, a term that describes the amount of radiation reflected by a surface. The effect is like wearing a black shirt on a hot day—darker colors absorb more solar radiation and heat up faster than light colors. In the mountains, dirty snow heats up and melts faster than clean snow when exposed to the same temperatures.

The Snow Hydrology Research to Operations (Snow HydRO) Lab, which Skiles directs, studies this phenomenon using instrumentation at the Atwater Study Plot, a research site near the Alta Ski Resort in Alta, Utah. Their instruments record the physical elements that control snow accumulation and snowmelt, including albedo. The researchers use these observations and a model to remove the dust darkening impact and estimate how snow would melt if the dust were absent.

"Our model represents snowmelt under observed conditions. We then run the model again with the snow-darkening impact by dust removed. This allows us to say, 'If there was no dust and the snow surface was brighter, then how much longer would the snow have stuck around?' The difference between these scenarios allows us to quantify snowmelt acceleration due to dust," said Otto Lang, Ph.D. student and co-author of the study.

The researchers also regularly dig large snow pits that expose the dirty layers representing all dust events that had been buried by subsequent snowstorms. They sample each layer to measure the amount of dust deposited by each dust event, and to track the different layers through the winter.

### **Don't need a weatherman to know which way the dust blows...**

...You need Derek Mallia, a research assistant professor in the Department of Atmospheric Sciences at the U and co-author of the study. Strong winds can loft dust into the atmosphere and degrade air quality, which can trigger yellow or red air pollution warnings. Dust-on-snow deposition requires a specific set of factors; nearby dust sources, relatively dry conditions and winds that are strong enough to loft dust into the atmosphere.

Mallia developed a dust transport model that can pinpoint where the dust on snow originated by synthesizing meteorological and soil data. For every dust event, Mallia ran his model to identify dust sources that were responsible for accelerating [snow melt](#) in the Wasatch Mountains.

"We were expecting large areas like the Great Salt Lake Desert to be a major source of dust, but we were somewhat surprised that we observed such large contributions of dust coming from the Great Salt Lake, and especially Farmington Bay. While the [lake](#)'s dust sources are much

smaller than the West Desert in terms of area, the exposed dry lakebeds are much closer to the Wasatch Mountains," said Mallia.

"These results suggest that the Great Salt Lake is an important factor when it comes to accelerating snow melt across the Wasatch Front and will become a bigger player if it continues to shrink."

## **The future of dust in the Wasatch**

There's no need to imagine what dustier winters would mean to the Wasatch snowpack; just look at Colorado where Skiles also conducts dust-on-snow research. The southern Colorado Plateau deposits dark, red dust onto its slopes that accelerates snowmelt by one to two months. Over the same period of observation, dust-on-snow levels in Colorado have always been higher than in Utah. That may be changing.

"This year we saw dust event after dust event after dust event. I kept saying, 'It looks like Colorado. It doesn't look like previous winters in Utah to me,'" Skiles said. "We got really lucky that we had so many spring snowstorms. If we are approaching Colorado's dust-on-[snow](#) regime, it will have a dramatic impact that we haven't seen yet. But we could be getting there."

**More information:** Otto I Lang et al, The shrinking Great Salt Lake contributes to record high dust-on-snow deposition in the Wasatch Mountains during the 2022 snowmelt season, *Environmental Research Letters* (2023). [DOI: 10.1088/1748-9326/acd409](https://doi.org/10.1088/1748-9326/acd409)

Provided by University of Utah

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