University of Utah
UNDERGRADUATE RESEARCH JOURNAL

Blowing in the wind: The effect of the shrinking Great Salt Lake on snow duration in the Wasatch Mountains.

Chase Hodges-Heilmann (Gannet Hallar, Tanner Visnick, Christopher Rapp)
Department of Atmospheric Science

Introduction

Utah has two things that tourists know about, the Great Salt Lake, and the Greatest Snow on Earth. The Great Salt Lake is receding and impacting the seasonal duration of the Greatest Snow on Earth. As the Great Salt Lake shrinks, the more arid surface contributes to more windblown dust. When this dust deposits onto snow, the albedo of the surface is decreased, and thus snow melts quicker.

Relevant Literature

Health complications, issues with visibility, and climate change are all influenced by windblown dust. Dust from the Great Salt Lake accounts for a total of 7% of all wind-blown dust in the Wasatch mountains (Skiles *et al.*, 2018). Lake Sevier and the Great Salt Lake Desert make up the majority of wind-blown dust on the Wasatch mountains (Hahnenberger and Nicolli, 2012). Although dust from the Great Salt Lake right now isn't major, the lakebed of the Great Salt Lake is becoming more and more exposed. Since pioneers arrived to Salt Lake City in 1847 the Great Salt Lake has decreased in elevation by 11 feet, which translates to a volume reduction of 48% and exposing nearly half of the lake bed (Wurtsbaugh *et al.*, 2016). A decrease in volume of saline lakes is often attributed to global warming and climate change, but water development and diverting tributaries is also to blame (Wurtsbaugh *et al.*, 2017). Even now there are ongoing plans to decrease inflow to the Great Salt Lake through the Bear River Development plan, the

Lake's largest tributary. This diversion could expose up to 30 square miles of the lake bed. This will only lead to more dust events, causing more deposition of dust onto snow. As dust deposits into snow, the albedo of the snow decreases, causing snow to melt earlier (e.g., Skiles *et al.*, 2012). As much as 80% of the surface water supplies of Salt Lake City are from snowmelt in the Wasatch Mountains (Bardsley *et al.*, 2013), and the winter sports industry generates 1.15 billion dollars in revenue annually (Leaver 2018). Earlier melt times will decrease revenue for ski resorts, and decrease water supplies to Salt Lake City. The decrease in water supplies to Salt Lake City could cause more water development in the Great Salt Lake, exposing more lake bed and thus causing more dust events days, creating a positive feedback loop until possibly The Great Salt Lake dries out. Dust events days affecting Salt Lake City and the Wasatch Mountains are bimodal through the year, with the first and larger mode being March through June, and the second mode being in September and October (Steenburgh *et al.*, 2012). Setting up the instrumentation at the Atwater Study Plot before March is crucial to observe how the shrinking of the Great Salt Lake will affect the Wasatch Front snowpack, especially in the coming years if more water development occurs.

Methods

1. Using Data collected at the Atwater Study Plot at Alta (40.591206º N, 111.637685º W), created a program using R to plot a time-series of the 9.25-micron diameter channel.
2. Pinpointed the dates with highest values in this time series and created an aerosol size distribution for each of these dates.
3. Lastly, using NOAA's HYSPLIT model, created a back-trajectory of an air parcel for different times throughout the dust ending at the Atwater Study Plot,
    - Six hours before the dust event.

- Each hour of the dust event.
- Six hours after the dust event.

Results

The results of these methods show 17 days where there are very high concentrations of particles in the 9.25-micron channel. Four of these days have lined up with notable atmospheric events and dust visibility in the snow at Atwater Study Plot. These days are March 25th 2018, April 12th 2018, May 11th 2018, and May 1st 2019. Using NOAA's HYSPLIT model, May 11th 2018 and May 1st 2019 both show air parcels coming from the Great Salt Lake dry lake bed and the Great Salt Lake Desert.

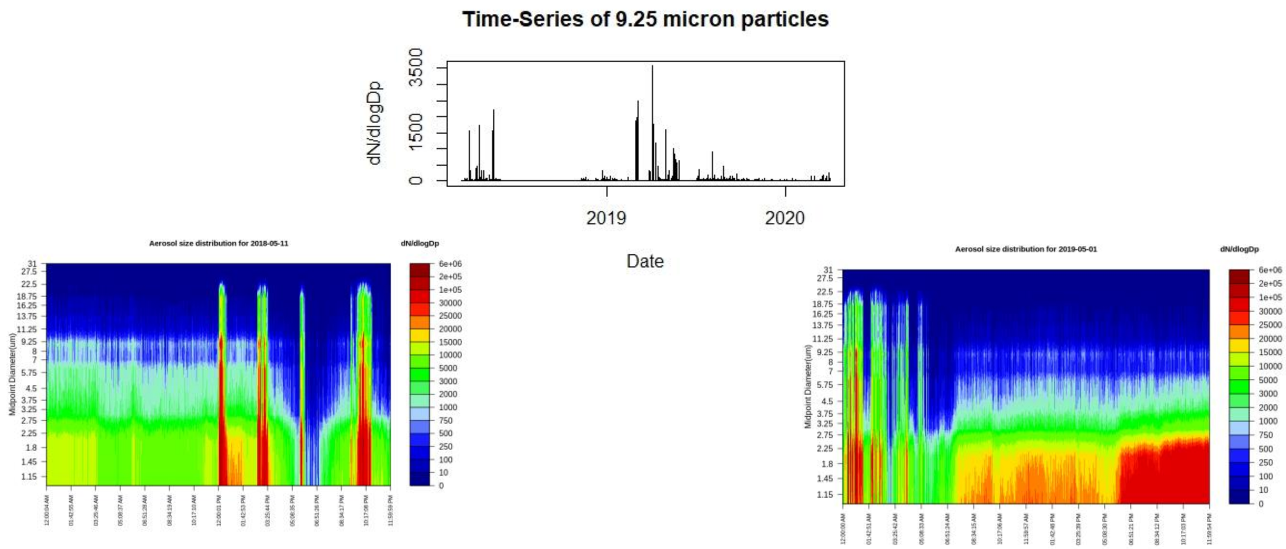

Figure 1: (Top) A time-series of 9.25 micron particle. (Bottom left) Aerosol size distribution during May 11, 2018. (Bottom right)

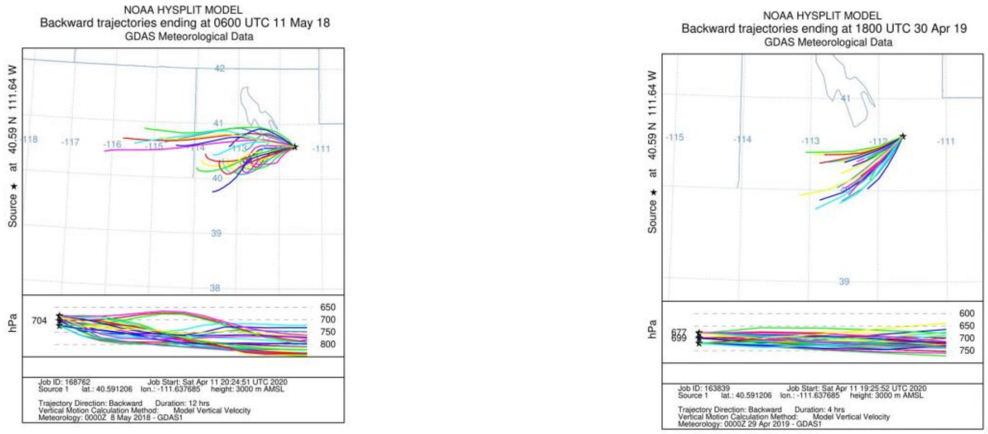

Figure 2: (Left) A back-trajectory of air parcels during May 11, 2018. (Right) A back-trajectory of air parcels during May 1, 2019.

Conclusion

Dust on snow is problematic for the snowpack of the Wasatch; therefore, new sources of dust should be treated with the upmost importance. Showing that these two dust events may contain dust from the Great Salt Lake dry lake bed has a serious consequence in that as the lake dries up more it is very feasible that there will be more wind-blown dust from the dry lake bed, increasing melt times further. More research will have to be done to determine whether the Great Salt Lake dry lake bed continuing to dry up will increase dust to the Wasatch mountains.

Works Cited

Bardsley, Tim, et al. “Planning for an Uncertain Future: Climate Change Sensitivity Assessment toward Adaptation Planning for Public Water Supply.” *Earth Interactions*, vol. 17, no. 23, 2013, pp. 1–26., doi:10.1175/2012ei000501.1.

Hahnenberger, Maura, and Kathleen Nicoll. “Meteorological Characteristics of Dust Storm Events in the Eastern Great Basin of Utah, U.S.A.” *Atmospheric Environment*, vol. 60, 2012, pp. 601–612., doi:10.1016/j.atmosenv.2012.06.029.

Painter, Thomas H., et al. “Radiative Forcing by Light Absorbing Impurities in Snow from MODIS Surface Reflectance Data.” *Geophysical Research Letters*, vol. 39, no. 17, 2012, doi:10.1029/2012gl052457.

Skiles, S. Mckenzie, et al. “Dust Radiative Forcing in Snow of the Upper Colorado River Basin: 2. Interannual Variability in Radiative Forcing and Snowmelt Rates.” *Water Resources Research*, vol. 48, no. 7, 2012, doi:10.1029/2012wr011986.

Skiles, S Mckenzie, et al. “Implications of a Shrinking Great Salt Lake for Dust on Snow Deposition in the Wasatch Mountains, UT, as Informed by a Source to Sink Case Study from the 13–14 April 2017 Dust Event.” *Environmental Research Letters*, vol. 13, no. 12, 2018, p. 124031., doi:10.1088/1748-9326/aaefd8.

Steenburgh, W. James, et al. “Episodic Dust Events of Utah’s Wasatch Front and Adjoining Region.” *Journal of Applied Meteorology and Climatology*, vol. 51, no. 9, 2012, pp. 1654–1669., doi:10.1175/jamc-d-12-07.1.

“Travel & Tourism.” *Kem C. Gardner Policy Institute*, 18 Sept. 2019, gardner.utah.edu/economics-and-public-policy/travel-tourism/.

Wurtsbaugh, Wayne A., et al. “Decline of the World's Saline Lakes.” *Nature Geoscience*, vol. 10, no. 11, 2017, pp. 816–821., doi:10.1038/ngeo3052.

Wurtsbaugh, Wayne; Miller, Craig; Null, Sarah; Wilcock, Peter; Hahnenberger, Maura; and Howe, Frank, "Impacts of Water Development on Great Salt Lake and the Wasatch Front" (2016). *Watershed Sciences Faculty Publications.* Paper 875.