Observations of Dust Emission on the Drying Lake Bed of the Great Salt Lake

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Introduction

The Great Salt Lake (GSL) has reached a record low level with a surface elevation of 4188.5 ft (1276.7 m; 17 Dec 2022), both due to drought conditions and the overuse of annual snowmelt. This now exposes vast areas of former lakebed to the atmosphere and to aeolian erosion processes, and millions of people along the Wasatch Front to potentially harmful dust emissions.

To better understand the characteristics of the exposed lakebed, a dust erosion monitoring site was established in former Farmington Bay in the summer of 2022. The data collected there is intended to help derive the boundary conditions and parameters needed to successfully model and predict potential future dust emissions. These efforts are part of a NSF-funded source-to-sink investigation of the dust system in the southwestern US as a component of the critical zone.

1-2 November 2022 Case Study

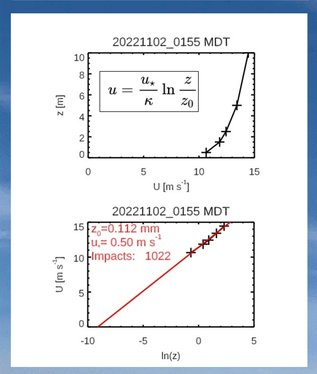
In this presentation, we show the approach how we evaluate parameters needed to drive dust emission models, such as the **threshold friction velocity u_*t**, the **roughness length, z_0**, of the exposed lake bed, and the **$PM_{2.5}/PM_{10}$ ratio**.

Threshold Friction Velocity u_*t

Plotting the wind speed as a function of ln(z), we can derive both the friction velocity u_* and the roughness length z_0. When the deployed Sensit particle impact counter registers sand movement, the threshold friction velocity has been reached, and dust can be released from the soil matrix.

$PM_{2.5}/PM_{10}$ ratio

Concentrations of dust are measured with an Optical Particle Counter (OPC, Alphasense N3) in 24 size bins between 0.3 and 40 **µm,** and are used to derive local $PM_{2.5}/PM_{10}$ ratios and their temporal changes.



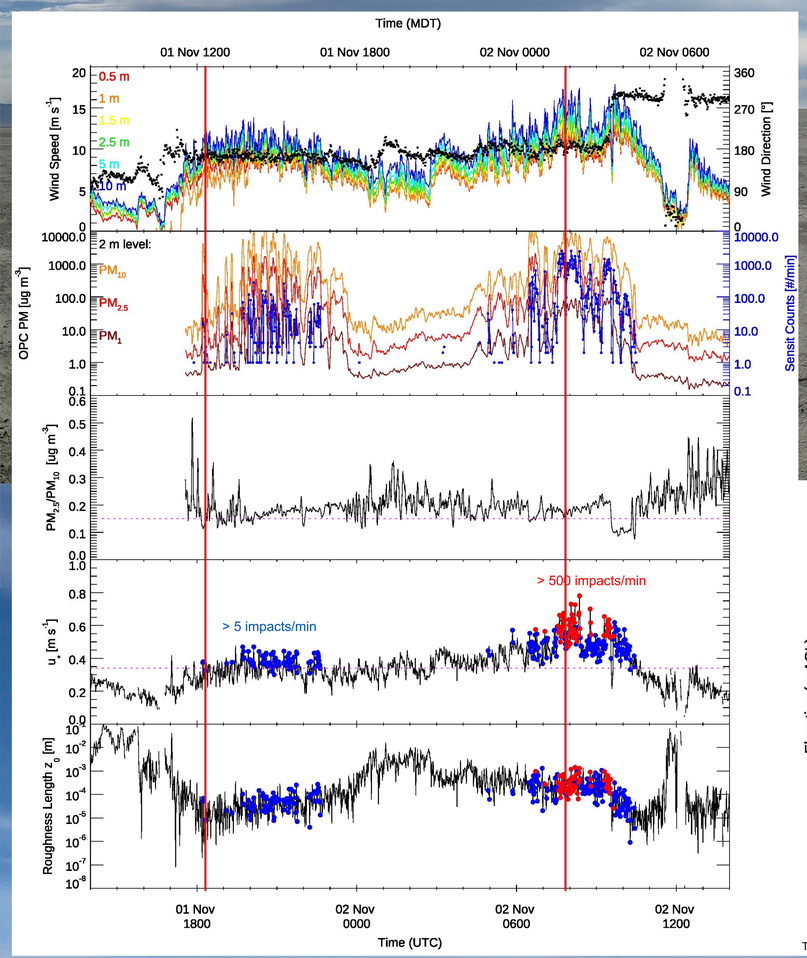
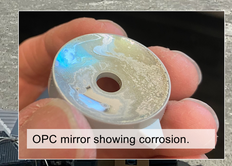


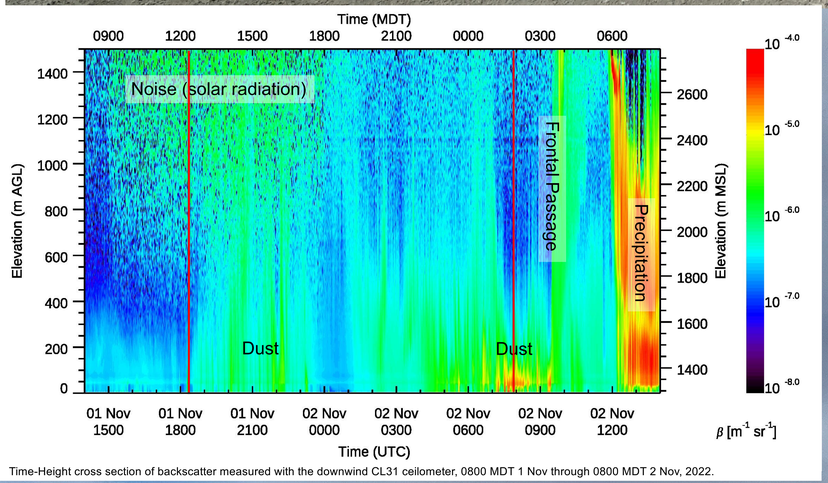
Photo: 1221 MDT, Nov. 1 2022


Sensit after a rain/dust event.

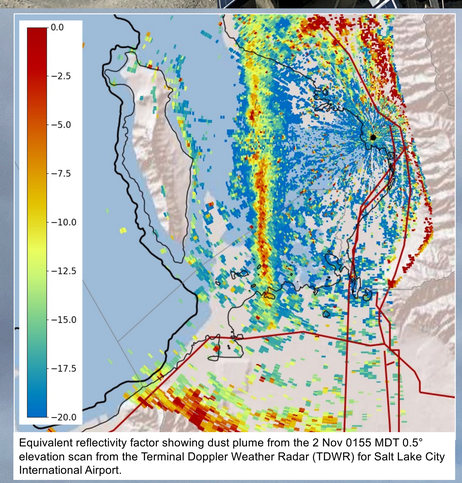

Cup anemometer collecting dust.


OPC after two months.


OPC mirror showing corrosion.



Time-Height cross section of backscatter measured with the downwind CL31 ceilometer, 0800 MDT 1 Nov through 0800 MDT 2 Nov, 2022.


Equivalent reflectivity factor showing dust plume from the 2 Nov 0155 MDT 0.5° elevation scan from the Terminal Doppler Weather Radar (TDWR) for Salt Lake City International Airport.

Scan this QR code to see some animations and webcam footage of this dust event!

Instrumentation

The research site, located at (41.030° N, 112.118° W) is instrumented following the recommendations of the National Wind Erosion Network (NWEN). A 10-m tower is instrumented with 6 levels of wind speeds, 3 levels of temperatures and relative humidity, a Sensit H14-LIN saltation sensor, a soil temperature profile, soil heat flux plates, a rain gauge, leaf wetness sensor, 4-component and UV radiation balance sensors, and optical particle counters (OPCs) at two heights. NNE, downwind under prefrontal flow, a CL31 ceilometer is positioned to monitor the height of a potential dust plume.

Summary and Future Plans

Based on the methods shown here, and using all observed dust events and auxiliary data collected at the site, we intend to better constrain model input parameters **z_0**, **$PM_{2.5}/PM_{10}$ ratio**, and **u_*t.**

TDWR data is shown to be a useful tool to locate dust emission and to track dust plumes in former Farmington Bay. The use of different scan elevations further resolves the vertical extent of the dust plumes.

Photo: 1222 MDT, Nov. 1 2022

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