Atmospheric Dust Transport in the Great Basin

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Introduction

The suspension of dust and soil particles by wind is a natural process that results in wind erosion, dust transport, and dust deposition. The distance of dust transport can be local, regional, or long range. These processes perform critical geologic and biological services such as erosion and redistribution of nutrients. However, human activities such as grazing, human-caused wildfires, and development on arid lands has resulted in an increase in dust transport in some regions. This increased rate of dust transport has implications for air quality problems in populated regions, higher snowmelt rates in alpine areas that provide water resources, and removal of soil nutrients from source regions, among others.

Dust Impacts on Snow

Dust deposition on the spring snowpack of the San Juan Mountains of Colorado during 2009 (Center for Snow and Avalanche Studies).

Deposition of desert dust onto snow caused 18-35 fewer days of snowcover in the spring and early summer compared to snow not impacted by dust deposition (Painter et al. 2007). The impact is on the same order of magnitude as the snowpack change expected from global warming. This earlier melt also impacts the phenology of the landscape such as earlier greening and flowering (Steltzer et al. 2009). This can alter how species interact including pollination and nutrient cycling.

Scientific Questions

- What are the main dust sources for the population centers in the Great Basin region?
- What factors (geologic or meteorological) make these site prone to dust production?
- How much dust in deposited into valley and alpine ecosystems?
- How does dust production, transport, and deposition vary annually currently?
- How will dust production, transport, and deposition change in the future?

Instrumentation

These questions will be answered by deploying an 8-stage rotating drum impactor which collects size and time resolved aerosol elemental composition using Synchrotron X-Ray Fluorescence (SXRF). Combining this data with soil sampling and analysis from likely source regions we can determine the temporal variability of source, amount, size, and type of dust that is impacting the deposition sites.

Background

The Great Basin of the Western U.S. has been indicated as one of the major dust sources on the globe, and is the main regional source of dust in North America (Prospero et al. 2002; Washington et al. 2003). Each year dust produced in the Great Basin is transported locally, regionally, and globally. Main source regions for dust are terminal basins, alluvial deposits, and disturbed soils.

Global and regional climatic changes, as well as land use policies in the coming decades will likely significantly impact dust transport and depositions in the western U.S. Lake core sediments from Colorado already indicate increasing dust deposition due to human impacts (Neff et al. 2008). In addition aridity in the Western U.S. has increased during previous warm periods, which could mean that a warming regional climate could bringing increased drought occurrence (Cook et al. 2004).

References

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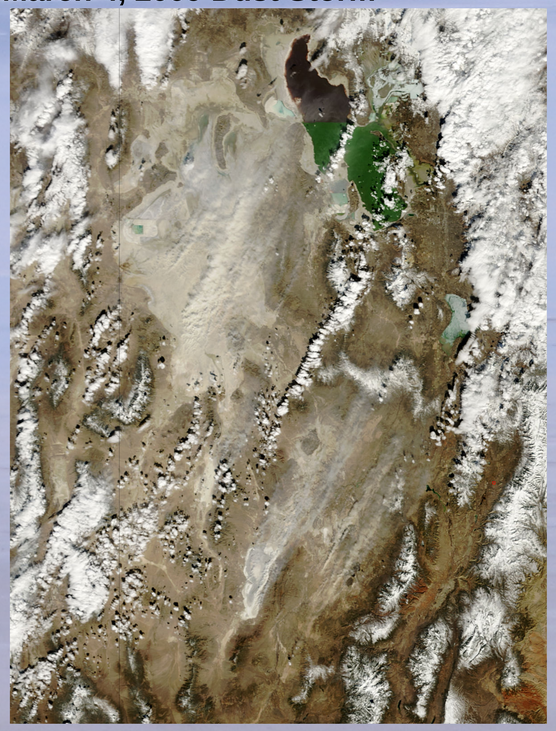
March 4, 2009 Dust Storm



MODIS image from of a dust storm in western Utah on March 4, 2009 (NASA Earth Observatory).

Particulate matter measurements from population areas in Utah ranged from 12.5-26.5 $\mu g/m^3$ for PM2.5 and 100-200 $\mu g/m^3$ for PM10. EPA 24 hour standards for these pollutants are 35 $\mu g/m^3$ and 150 $\mu g/m^3$ respectively (UtahDAQ).

Human Impacts on Dust

Anthropogenic activities have changed the amount, type, and frequency of dust production that has been transported and deposited in high elevation mountain ecosystems (Neff et al. 2008; Reynolds et al. 2009). This has been the result of grazing, mining, urban activities, and changes in land use since European settlement began. These activities will continue, but management could mitigate increased dust production.

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Background Photo by Ben Folsom