Observing Spatial and Temporal Variations in Air Quality in the Salt Lake Valley Using Mobile Platforms

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Motivation for Study
Improved understanding of the spatial complexity and temporal variability of air pollutants during both summer and winter are needed along Utah’s Wasatch Front.

Methodology:
- Continuously measure greenhouse gases & criteria pollutants across the Salt Lake Valley along a fixed spatial route using a light rail car as a measurement platform.
- Targeted mobile observations in a news helicopter and several vehicles during summer 2015 during the Great Salt Lake Summer Ozone Study (GSLSO2S).

Goals:
- Test the feasibility of using a light rail platform to measure across rural and urban typologies.
- Supplement surface data from light rail platform with helicopter data aloft and additional mobile vehicles.
- Improve understanding of the spatial and temporal patterns of greenhouse gases & criteria air pollutants.

Utah Transit Authority (UTA) TRAX light rail system:
- Red Line: traverses the entire Salt Lake Valley (north-to-southwest)
- Green Line: runs from the SLC airport to West Valley

KSL Chopper 5
Often traverses Salt Lake Valley along major traffic corridors at elevation between 200-800 m AGL. Sometime travels outside of the SLV for breaking news.

Great Salt Lake research flight on June 17th 2015.

Mobile Units
Several vehicles were instrumented.

Instrumentation
TRAX
- Dec. 8, 2014 to present.
- Sensors and sampling on roof.
- Measures PM10, PM2.5, CO, CH4 and O3.

KSL Chopper 5
- 17-June-present.
- 2B Technology O3 sensor

Department of Atmospheric Sciences Truck and Nerdmobile
- 17-June-present only during intensive observational periods.
- 2B Technology O3 sensor.

Particulate Matter (PM)
Two optical particle counter instruments: measure PM
(1) Met One E-Sampler, heated inlet, PM2.5 cyclone, 1-minute averages.
(2) GRIMM 1109, no heated inlet, PM in 31-size channels (0.25-32 μm), 6-sac resolution.

- Higher PM2.5 observed frequently along the central urban corridor with lower PM2.5 on the valley benches.
- Red Line allows for quasi-vertical profiles of PM2.5 & GHGs during inversions.

Comparative PM2.5 analyses underway:
(1) E-Sampler vs. GRIMM as PM2.5 instruments.
(2) Mobile versus fixed-site observations maintained by Utah DAQ (Hawthorne).
(3) CO2 as a surrogate proxy for PM2.5.

Summer 2014 TRAX Averages
Computed over the course of month Aug-Sep 2014

Carbon dioxide
Ozone
Methane
Ozone 7 am
Ozone 3 pm

The Salt Lake Valley measurement programs:
(a) TRAX light rail network
http://meso1.chpc.utah.edu/meso/ri

(b) Great Salt Lake Summer Ozone Study
http://meso2.chpc.utah.edu/gslos2s

(c) S-station, urban CO2 network
http://co2.utah.edu

(d) Mesowest (http://mesowest.utah.edu/)
We gratefully acknowledge technical & logistic support from UTA TRAX & Siemens, Teresa Jessen, Elijah Jackson, Ted Brooks, and the rest of UTA TRAX staff, as well as the following students and faculty who are a part of this study: Ben Fassio, Bill Howard, and Nate Larson. We also acknowledge Seth Areas and the Utah Division of Air Quality for supporting the Summer Ozone Study.

Real Time TRAX Data:

Mobile Ozone Observations during the Great Salt Lake Summer Ozone Study (GSLSO2S) June-August 2015
Goals of study:
- What is the influence of GSL on ozone formation on Wasatch Front?
- What is the spatial and temporal distribution of ozone?
- Document the meteorology of high ozone events
- Increase accuracy of pollution forecasting

More details on the study can be found at the study website: https://glsos2s.wordpress.com/

Initial GSLSO2S Study Findings
- High spatial and temporal variations in O3 over and surrounding the Great Salt Lake.
- Complex terrain meteorology and lake breezes are important factors in precursor transport and afternoon ozone transport.
- KSL chopper has given insight into background ozone and elevated layering of ozone above the urban core.
- Great Salt Lake temperature may play a role in modulating shallow boundary-layer depth and ozone concentrations.
- Biogenics, playa albedo enhancements, wildfire smoke, and chlorine chemistry over Great Salt Lake Brine may all be important.

Upcoming TRAX Possibilities
- Expand TRAX setup to additional rail cars to increase spatial & temporal coverage.
- Low-cost sensors on additional trains.
- Additional trace gas species that could be added include: NOx (NO and NO2) would assist in closing the ozone budget, (b) ethane (C2H6) would provide a distinction between biogenic & fossil CH4 sources, and (c) radon (Rn) would constrain local atmospheric mixing.

18 June Lake Breeze Front
- Mobile truck, TRAX, and KSL Chopper sensors provided unprecedented view of spatial ozone distribution with Great Salt Lake breeze front.
- Much higher O3 at and behind lake breeze front.
- Spike in O3 at breeze front (up to 115 ppb).
- 20 ppb increase across front.