THE AIR WE BREATHE:
A MULTIDISCIPLINARY PERSPECTIVE
ON AIR QUALITY

HOSTED BY

Thursday, October 3, 2019 | Salt Lake City, Utah
Air Quality this morning
http://utahaq.chpc.utah.edu/

PM$_{2.5}$

Ozone
Meteorology-Chemistry Coupling in Western Basins

What’s similar, what’s different, what’s missing?

John Horel¹, Erik Crosman², Sebastian Hoch¹
¹University of Utah
²West Texas A&M

with contributions from:
Alex Jacques & Brian Blaylock, others in the Mountain Meteorology Group
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Basins & Valleys

Geometry, land-use & population
Emission sources
Surface state: snow-covered or wet/dry
Existing resources & flight restrictions

Synoptic/mesoscale controls
Free atmos.-boundary layer exchanges
Lateral transport within boundary layer
Terrain-flow interactions
Structure/turbulence in boundary layer
Water/ice clouds & deposition

Meteorology

Air Chemistry
Vertical Structure
January 31, 2017
12 UTC

Blue: Valley & Basin Cold-Air Pools
Vertical Structure
January 31, 2017
12 UTC

Blue: Valley & Basin Cold-Air Pools

Oakland

Reno

V 10mi
Vertical Structure
January 31, 2017
12 UTC

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Vertical Structure
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Blue: Valley & Basin Cold-Air Pools

[Graphs showing temperature profiles for Oakland, Boise, Reno, and Salt Lake City with annotations for fog, haze, and visibility.]
January 31, 2017
San Joaquin Valley

Temperature (°C)
January 31, 2017
Salt Lake Valley

Temperature (°C)

Most recent observation within 1 hr ending at 14:30 UTC 1/31/2017

Legend (μg/m³)

- PM2.5
Boundary layer & slope flow evolution in the Salt Lake Valley: Jan. 31, 2017

Hoch & Crosman

NSF RAPID / METEOROLOGY DURING UWFPS

~12 UTC

Night-time injection of low-PM$_{2.5}$, high O$_3$ air is reduced

Reduction in drainage flow intensity

Subsidence inversion

“Clear”

“Foggy
Cloudy”

“Clear”

$\beta$ [m$^{-1}$ sr$^{-1}$]
January 31, 2017
Cache Valley, UT

Temperature (°C)

QSM Observations from 2017-01-29 00:00 Local - 2017-02-05 00:00 Local

Logan-Cache Airport (KLGU)

PM2.5 Concentration

Temperature (°C)
Relative Humidity (%)

Map of Cache Valley, UT with temperature readings at various locations.
Similarities

- Large-scale flow aloft
- Conditions evolving diurnally & over lifetime of pollution event

Differences

- Snow cover
- Temperature regime
- Boundary layer depth
- Fog/stratus
- Terrain, slope and intrabasin flows

Impacts

- Temperature dependent reactions
- Heterogeneous, aqueous (warm/ice) phase chemistry
- Changes in night-time injection of low-PM$_{2.5}$ & high O$_3$

January 31, 2017
Planning & Situational Awareness

Resources: PM2.5

> 700 state/county locations

> 130 CARB/county
> ~1400 Purple Air

16 DAQ/UUtah
> 90 AirU sites; ~400 Purple Air
Planning & Situational Awareness Resources: Surface Wind Observations

> 7500 locations

> 1300 locations

> 300 locations
Planning & Situational Awareness

• Synoptic/mesoscale conditions usually simulated adequately by operational models

• But...
  • Breakup phase harder to forecast than onset
  • Transition from clear-air to cloudy boundary layers (and vice versa) difficult
  • Boundary layer processes tend to be overly dispersive/damped
Planning & Situational Awareness

• Considerable work underway using research model simulations

• Improved treatment of boundary layer processes needed for:
  • Convection-Allowing Models (1-3 km)
  • Large-Eddy Simulations (10’s-100’s m)
Summary

- Boundary layer meteorology/air chemistry processes are too intertwined to treat independently
  - Understanding pollutant events from beginning to end requires close collaboration to understand how chemical species evolve as the conditions evolve

- Complexity of events in all basins requires:
  - taking advantage of existing sensor networks
  - deploying diverse sensor types and using innovative deployment strategies to fill in the gaps (e.g., plane, in situ and surface-based remote, mobile, drones, IOTs)
  - having the science plan factor in the strengths & weaknesses of sensor types to evolving boundary layer conditions
Links to Resources

• Web resources
  • MesoWest: https://mesowest.utah.edu
  • Utah air quality: http://utahaq.chpc.utah.edu/
  • LAIR group: https://air.utah.edu/

• Data Archives
  • Surface observational data: https://synopticdata.com/
  • HRRR analyses: http://hrrr.chpc.utah.edu/
Recent Related Publications


- Franchin, A., and Coauthors, 2018: Airborne and ground based observations of aerosol chemical and physical properties during intense winter pollution episodes in the Great Salt Lake Basin, *Atmospheric Chemistry and Physics*, 18, 17259-17276. [https://www.atmos-chem-phys.net/18/17259/2018/](https://www.atmos-chem-phys.net/18/17259/2018/)


- Foster, C., E. Crosman, J. Horel, 2017: Simulations of a Cold-Air Pool in Utah’s Salt Lake Valley: Sensitivity to Land Use and Snow Cover. *Boundary Layer Meteorology*. 164, 63-87. [http://dx.doi.org/10.1007/s10546-017-0240-7](http://dx.doi.org/10.1007/s10546-017-0240-7)