Mesoscale Meteorological Impacts on Criteria Air Pollutants Along Utah's Wasatch Front as Measured by Mobile Platforms



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- Two contrasting air quality concerns in Salt Lake basin:
 - Winter: multi-day secondary particulate (PM_{2.5}) formation
 - Summer: diurnal ozone formation
- Previous meteorological studies on cold-air pools, but limited analysis of the impact of meteorology on spatial air quality
- Mobile "observations lead the way" in Utah's Salt Lake Valley:
 - KSL-5 TV "Chopper 5" News Helicopter
 - Light Rail (UTA TRAX)
- Provide cost-effective observations for recent field studies:
 - Summer 2015: Great Salt Lake Ozone Study (GSLSO₃S)
 - Winter 2015-16: Utah DAQ Air Toxics Study
 - Winter 2016-2017: NOAA Utah Winter Fine Particulate Study

Utah's Salt Lake Valley: Complex Topography

 Complex basin topography: thermal and terrain-driven flows provide mechanisms for pollutant transport

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Courtesy: Sebastian Hoch

Multi-day PM_{2.5} and Diurnal Ozone Episodes



Winter (9 day time series)



Summer (3 day time series)





News Helicopter: Pollutant Monitoring Equipment



- 2B Technologies 205 Ozone Monitor
- MetOne ES-642 Remote Dust Monitor
- Campbell Scientific CR1000 Data Logger
- GPS and Cellular Communications
- Data Interval: 10 seconds







Light Rail Pollutant and Greenhouse Gas Monitoring



- Monitors installed on two cars (equipment varies on each car)
 - PM_{2.5}, O₃, CO₂, CH₄, NO₂
 - Ambient air temperature, humidity, and pressure
- Data storage locally via data loggers and Raspberry Pi
- Cellular Communications allow for real-time access to data
- Trains operate daily on 3 different rail lines across valley







Mobile Observations of Air Quality

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- Considerable spatial and temporal variability in pollutants
 - Atmospheric chemistry processes
 - Interactions of terrain and thermally-driven flows
 - Vertical stability of PBL



TRAX Pollutant Spatial Averages: Summer Ozone





TRAX Pollutant Spatial Averages: Summer Ozone







TRAX Pollutant Spatial Averages: Methane





Case Events – 18 Jun 2015 Lake Breeze

 Lake breeze convergence zone propagating southward from Great Salt Lake through Salt Lake Valley

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 Fixed and mobile observations depicted sharp increase in ozone concentrations as the convergence zone passed



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Case Events – 23 Jul 2016 Antelope Island Wildfire





Case Events – 7-16 Feb 2016 Valley Inversion

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- Strong stable layer in place allowing for buildup of PM2.5
- Elevated moisture lead to fog-dominated period 10-14 Feb 2016





Courtesy: Sean Heslin



Courtesy: Sebastian Hoch

Case Events – 7-16 Feb 2016 Valley Inversion

- Pre-fog event flight: 2315 UTC 9 Feb 0045 UTC 10 Feb
- Discrete changes as chopper "porpoised" in/out of pollution layer

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Case Events – 7-16 Feb 2016 Valley Inversion

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- Pre-fog event flight: 2315 UTC 9 Feb 0045 UTC 10 Feb
- Discrete changes as chopper "porpoised" in/out of pollution layer
- Pollution layer ~600-900 m deep depending on location



Summary



- Routine helicopter and train air quality data provides a costeffective platform for monitoring distribution of pollutants
- The spatial characteristics of dust storms, wildfire smoke, and summer and winter boundary-layer urban pollutants captured by these observation platforms in addition to fixed-site monitors
- Mobile observations show the impact PBL depth, complex terrain, and thermally-driven flows can have on spatial distribution of pollutants
- Live data remains available:
 - Criteria Pollutants: http://meso2.chpc.utah.edu/aq
 - Trace Gases: <u>https://air.utah.edu</u>

Manuscripts and Acknowledgements



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