13A.3

Real-time Ozone and Particulate Measurements on a News Helicopter

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THE UNIVERSITY OF UTAH

Introduction and Motivation

- Two contrasting air quality concerns impact greater Salt Lake basin:
  - Winter: secondary particulate formation over several days
  - Summer: diurnal buildup of boundary layer ozone

- Both episode types examined recently via several field studies:
  - Winter 2010-11: Persistent Cold Air Pool Study (PCAPS)
  - Summer 2012: Utah DAQ Ozone Analysis
  - Summer 2015: Great Salt Lake Ozone Study ($GSLSO_3S$)
  - Winter 2015-16: Utah DAQ Air Toxics Study

- Instrument packages created over last 2 years to provide spatiotemporal distribution of pollutants using mobile systems
  - Light Rail (UTA TRAX) - **Presentation J11.6 (Today 2:45pm)**
  - KSL-5 TV "Chopper 5" News Helicopter

Chopper 5 Instrumentation Packages

- Package Requirements
  - Research-grade ozone and/or particulate instrumentation
  - GPS and real-time/near real-time communications
  - Robust logging system in event communications fail
  - Self-contained unit (easy to install/uninstall on helicopter)
  - Only need from helicopter for the unit is 120V AC power source

2B Tech 205 Ozone Monitor

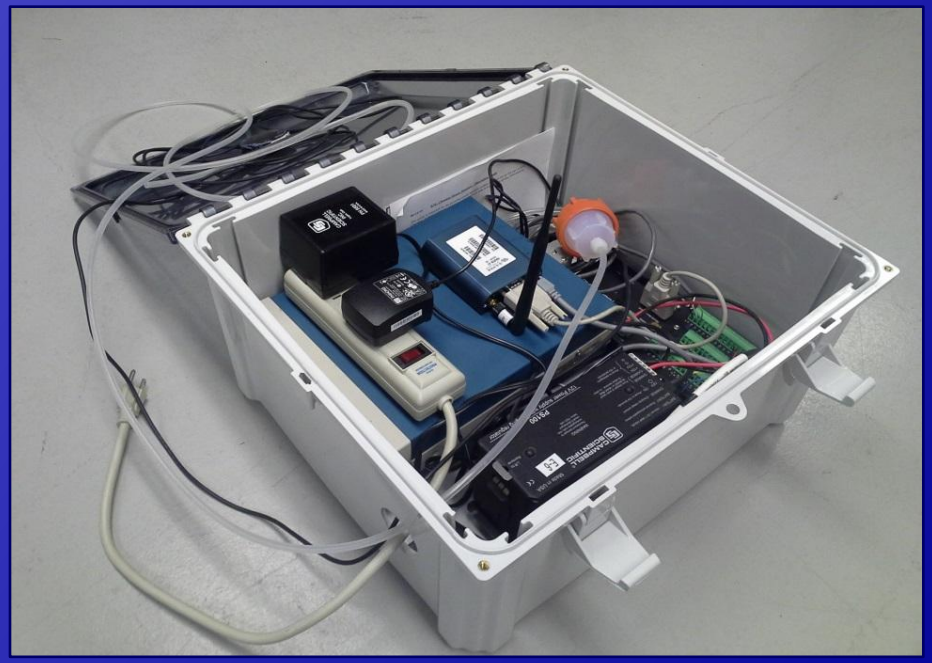
http://www.twobtech.com/model-205-ozone-monitor.html

MetOne ES-642 Dust Monitor

http://www.metone.com/docs/es642_datasheet.pdf

Chopper 5 Instrumentation Packages

- "Summer Package" (deployed summer 2015)
  - 2B Technologies 205 Ozone Monitor with GPS
  - Campbell Scientific CR1000 Data Logger
  - Cellular Communications
  - Data Interval: 10 seconds



Courtesy: Alex Jacques

Courtesy: Erik Crosman

Chopper 5 Instrumentation Packages

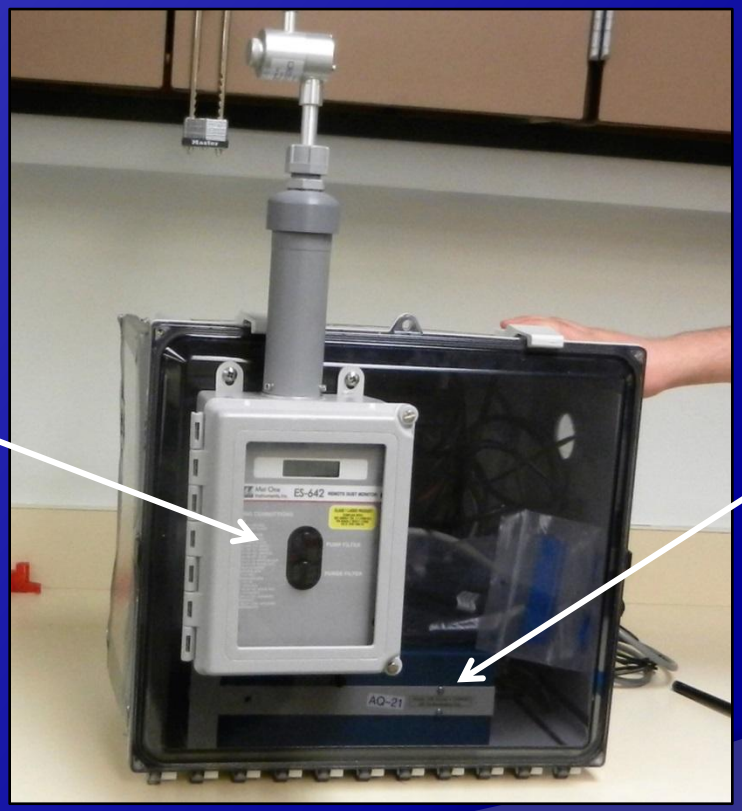
- "Winter Package" (deployed winter 2015-2016)
  - MetOne ES-642 Remote Dust Monitor
  - Garmin GPS
  - Same logging, communications, and data interval

Photos Courtesy: Erik Crosman

Chopper 5 Instrumentation Packages

- "Combo Package" (deployed spring 2016 - present)
  - 2B Technologies 205 Ozone Monitor
  - MetOne ES-642 Remote Dust Monitor
  - Same logging, GPS, communications, and data interval

ES-642 mounted outside main box



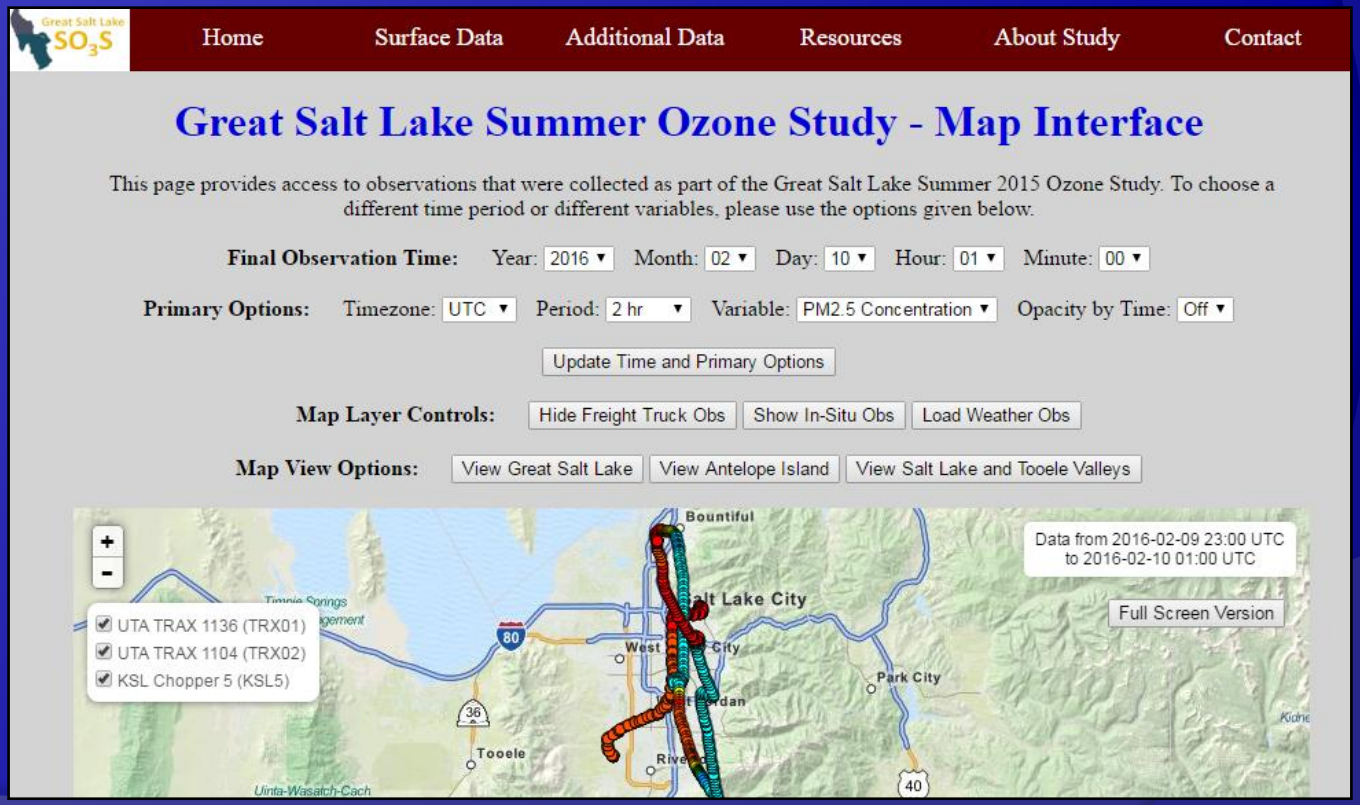
2B 205 mounted inside main box

Courtesy: Erik Crosman

Data Collection and Visualization

- http://meso2.chpc.utah.edu/gslso3s

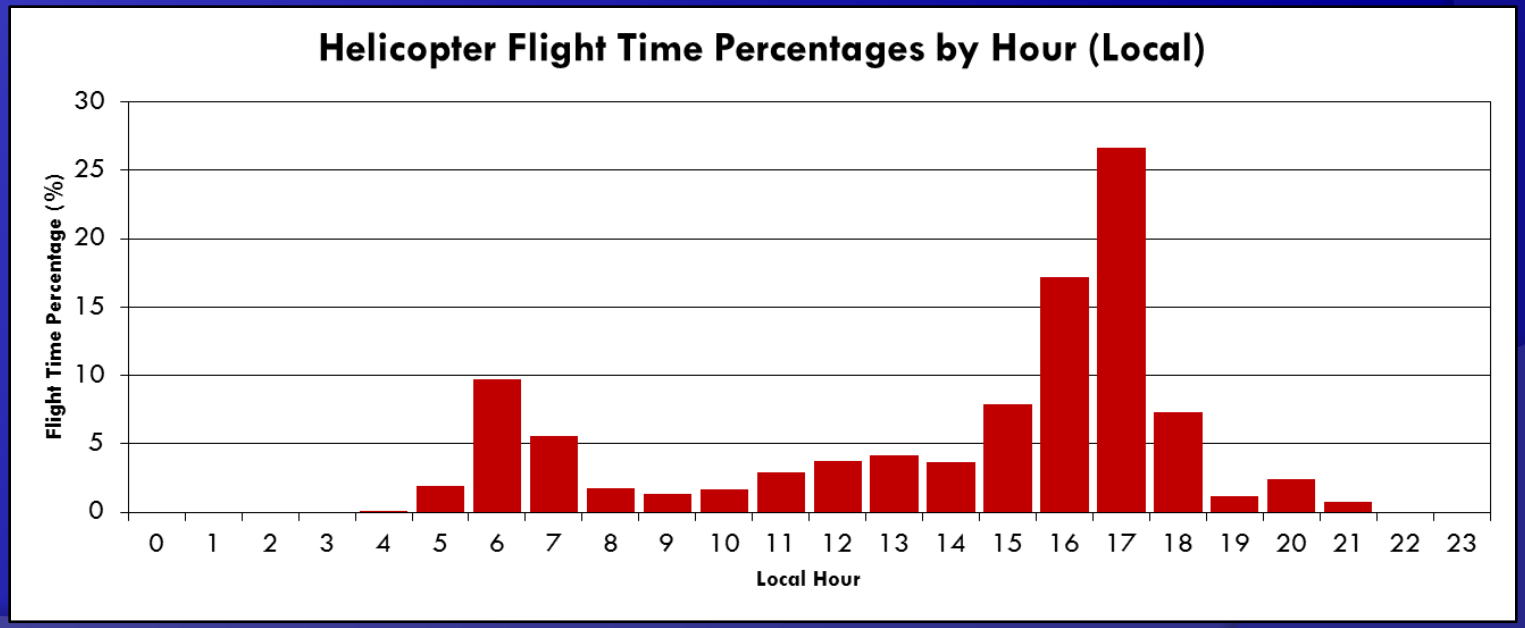
- Data collected in real-time every 5 minutes during flights and available for viewing on several different map/graph products



Flight Summaries

- Flights primarily dictated by the following:
  - Weekday afternoon commute traffic monitoring
  - Breaking news and large city events

- Typical flights per week: ~8
- Median flight time: 56 min (range ~20 min – 3 h)
- Horizontal Speed varies ~10 (hovering) – 70 m s^{-1}



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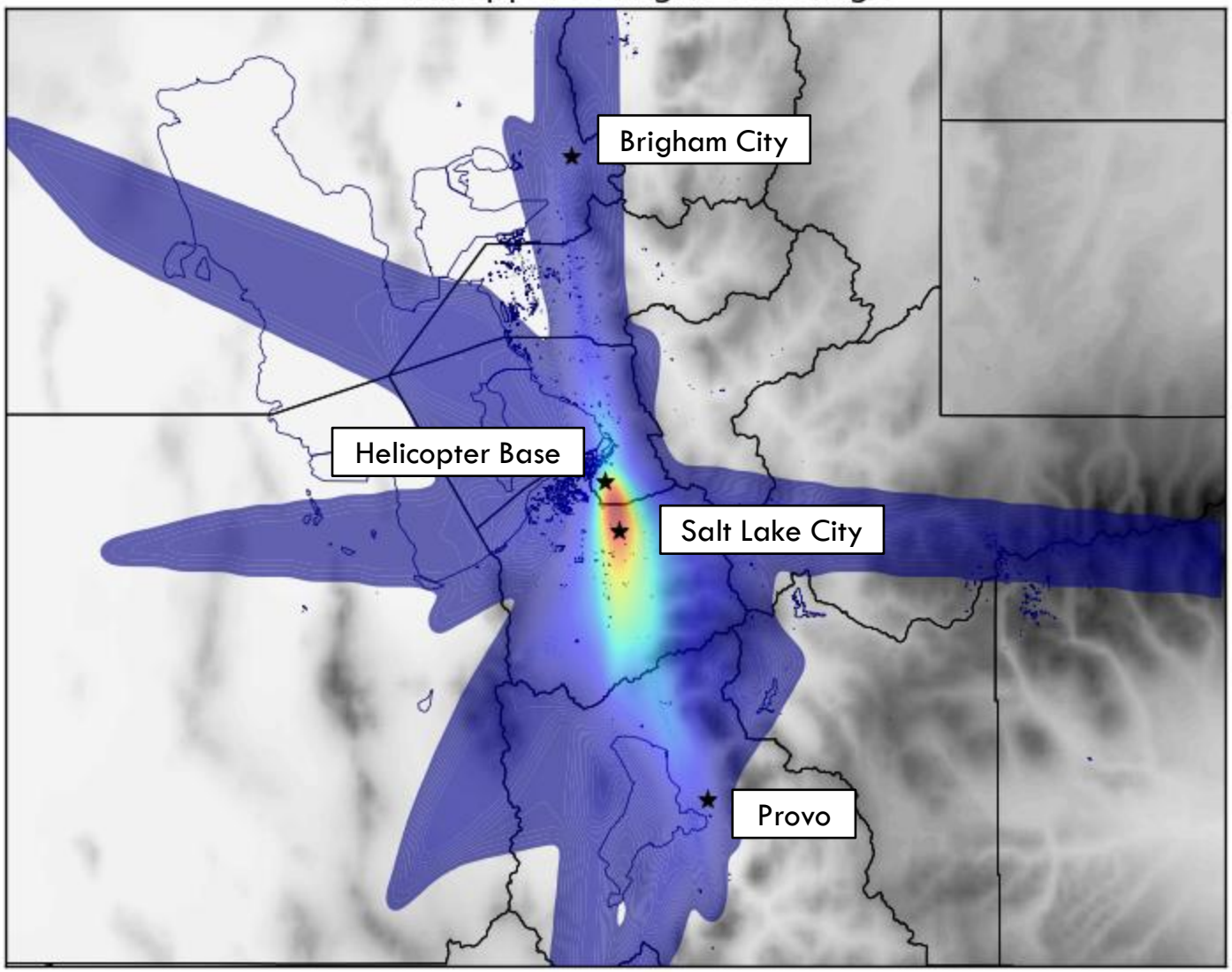
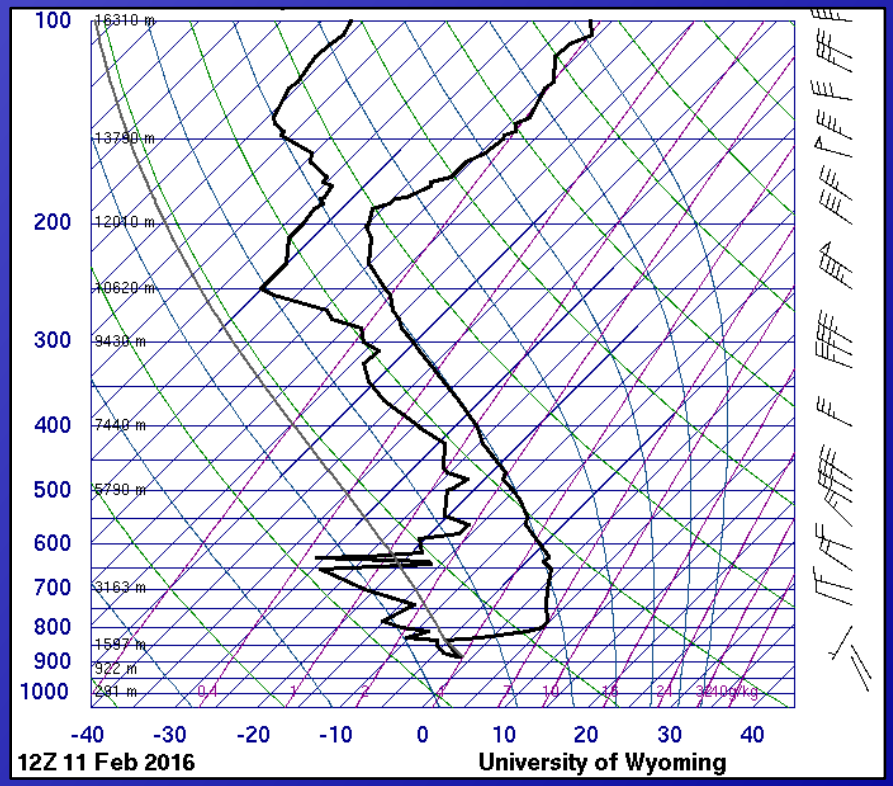


Case Events – 7-16 Feb 2016 Valley Inversion

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

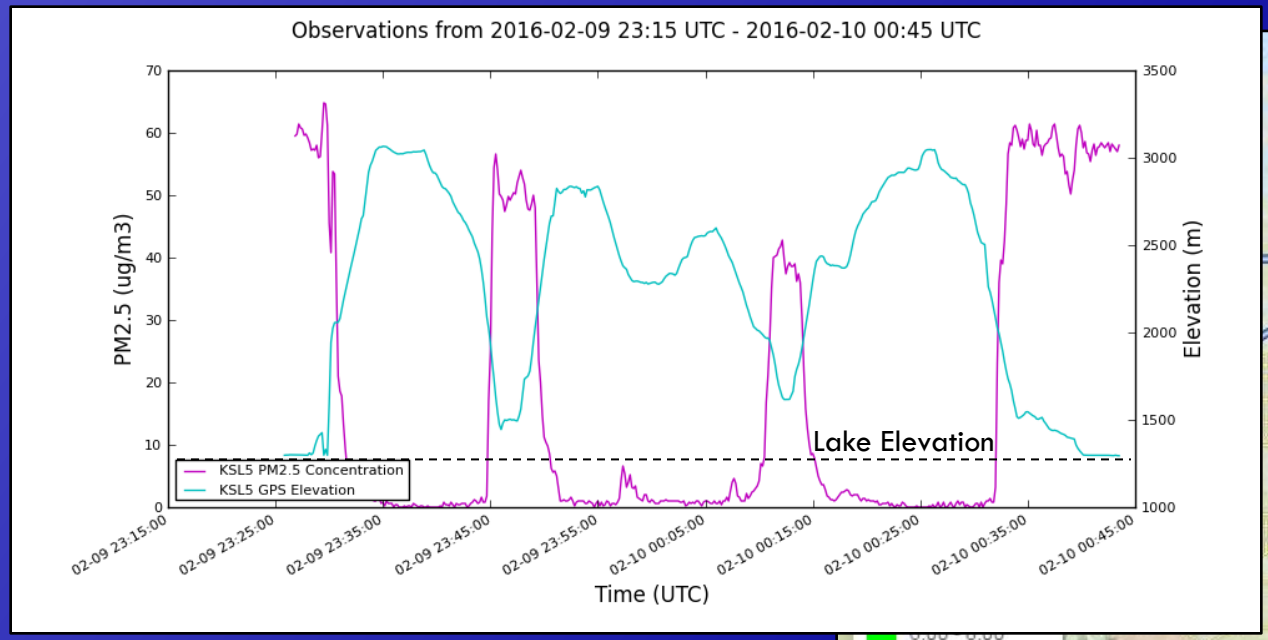


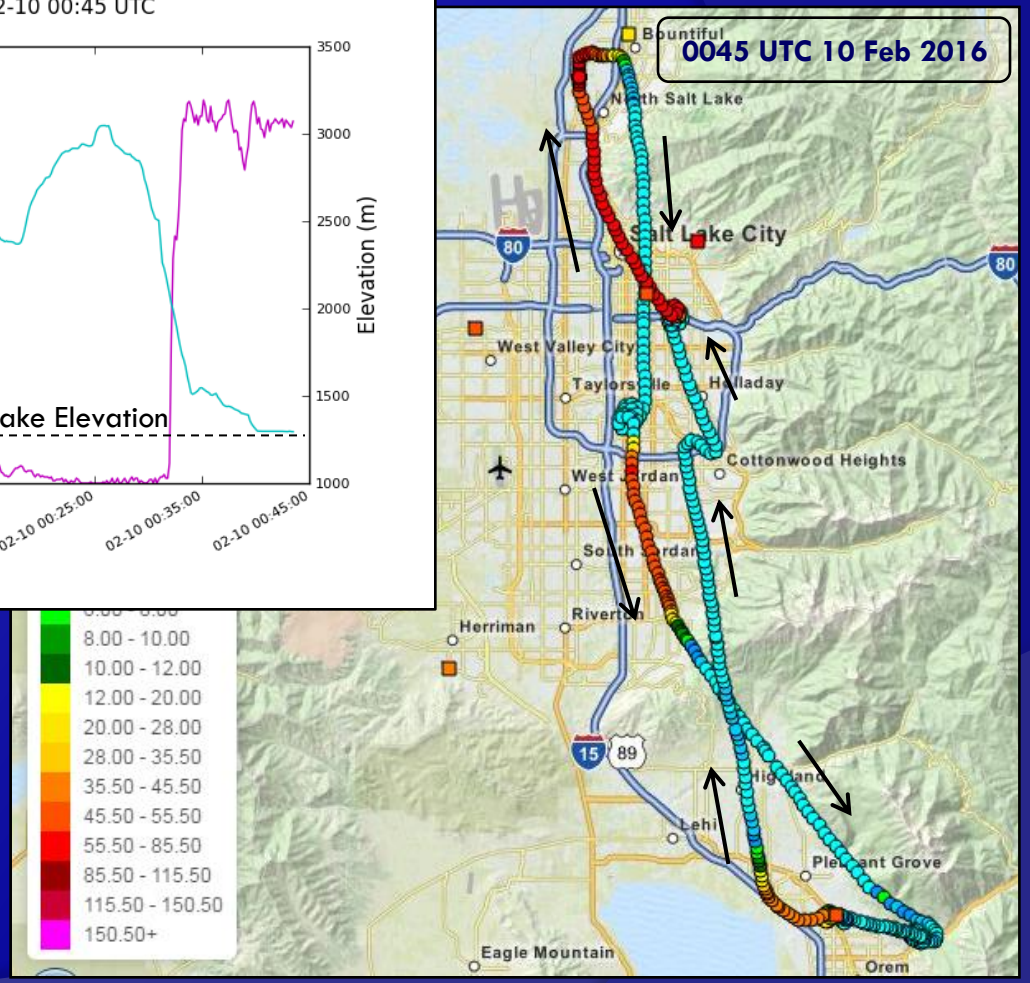
Courtesy: Sean Heslin

Courtesy: Sebastian Hoch

Case Events – 7-16 Feb 2016 Valley Inversion

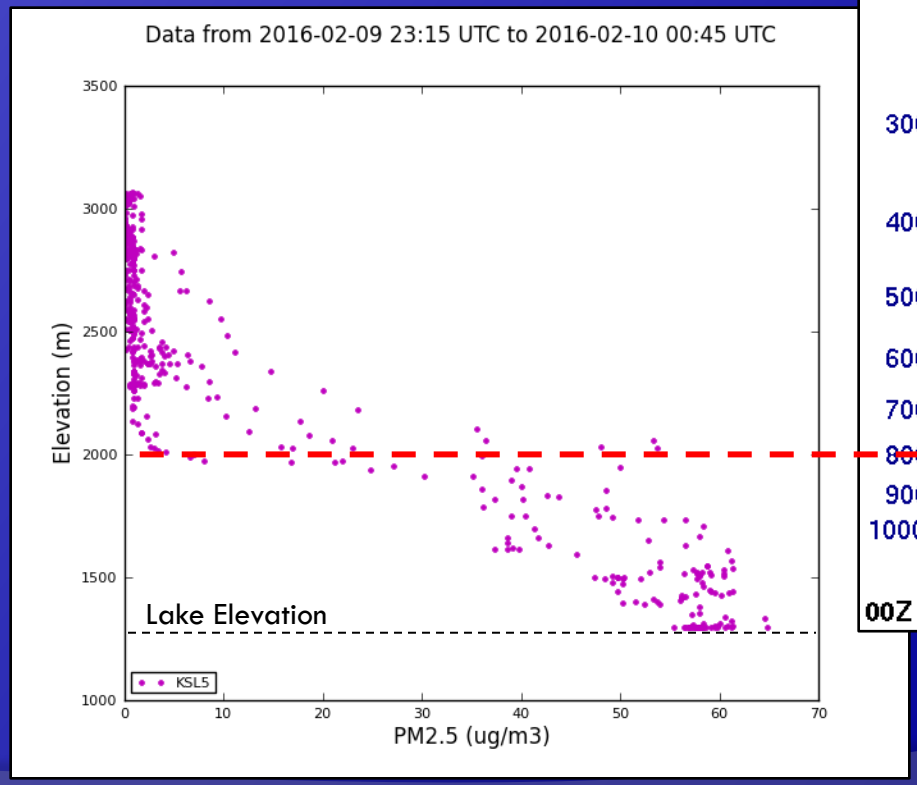
- Pre-fog event flight: 2315 UTC 9 Feb – 0045 UTC 10 Feb
- Discrete changes as chopper "porpoised" in/out of pollution layer

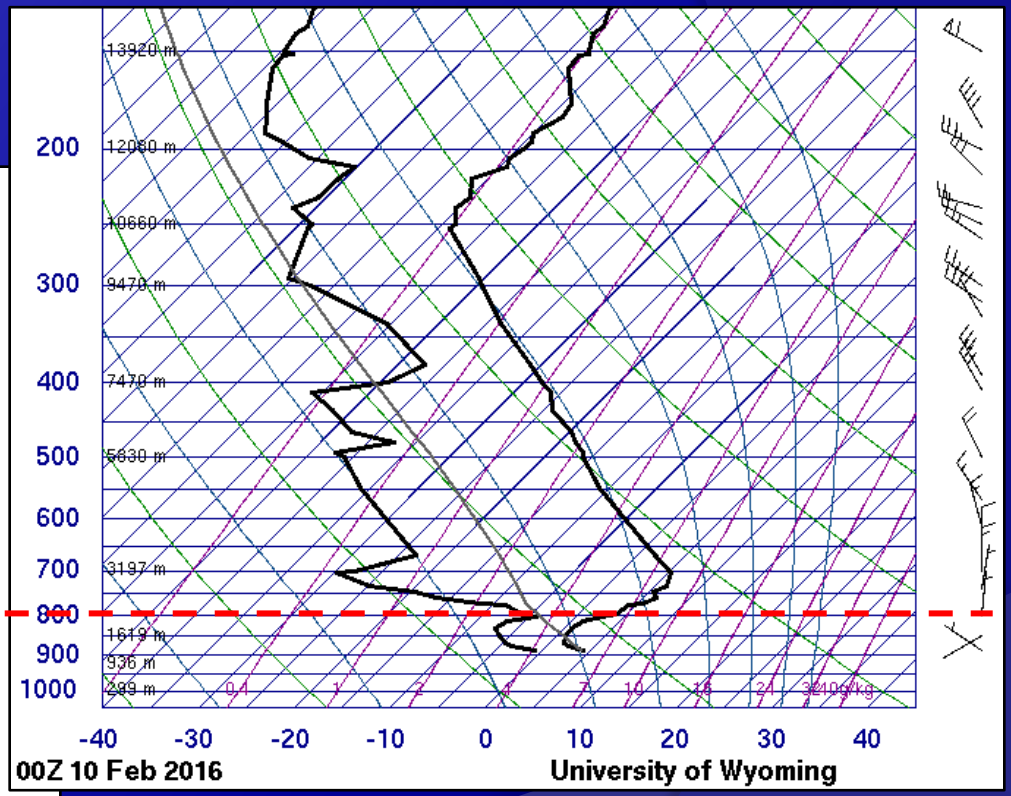




Case Events – 7-16 Feb 2016 Valley Inversion

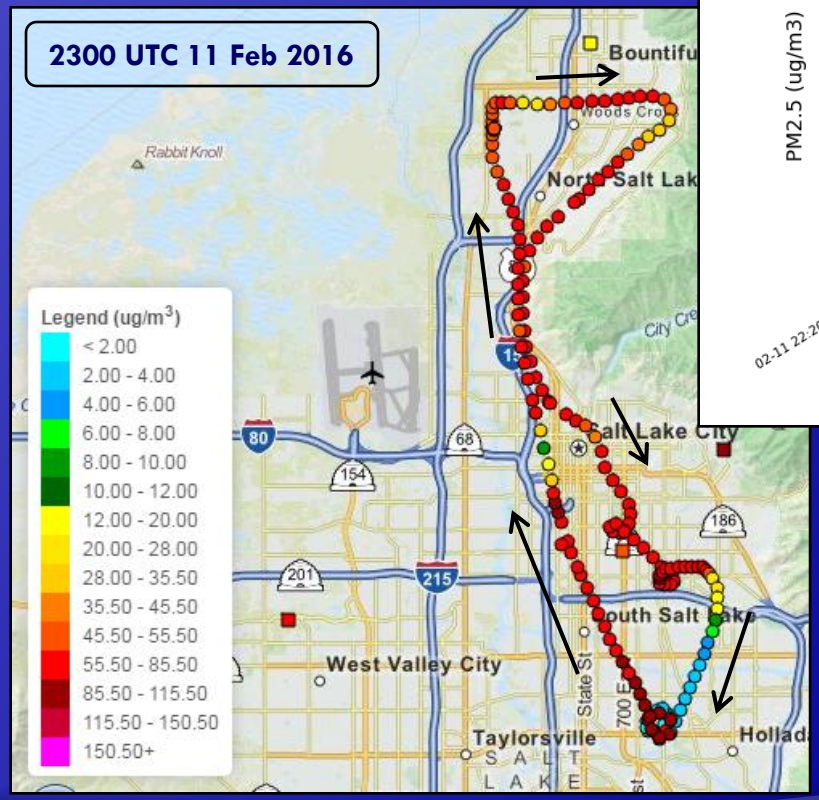
- Pre-fog event flight: 2315 UTC 9 Feb – 0045 UTC 10 Feb
- Discrete changes as chopper "porpoised" in/out of pollution layer
- Pollution layer ~600-900 m deep depending on location

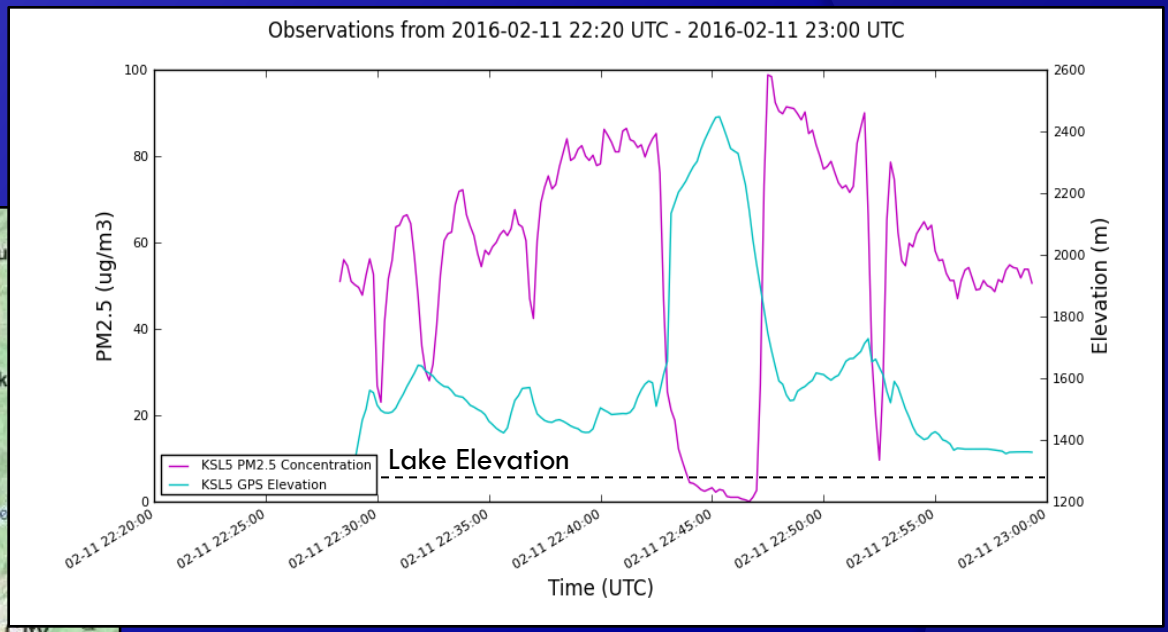




Case Events – 7-16 Feb 2016 Valley Inversion

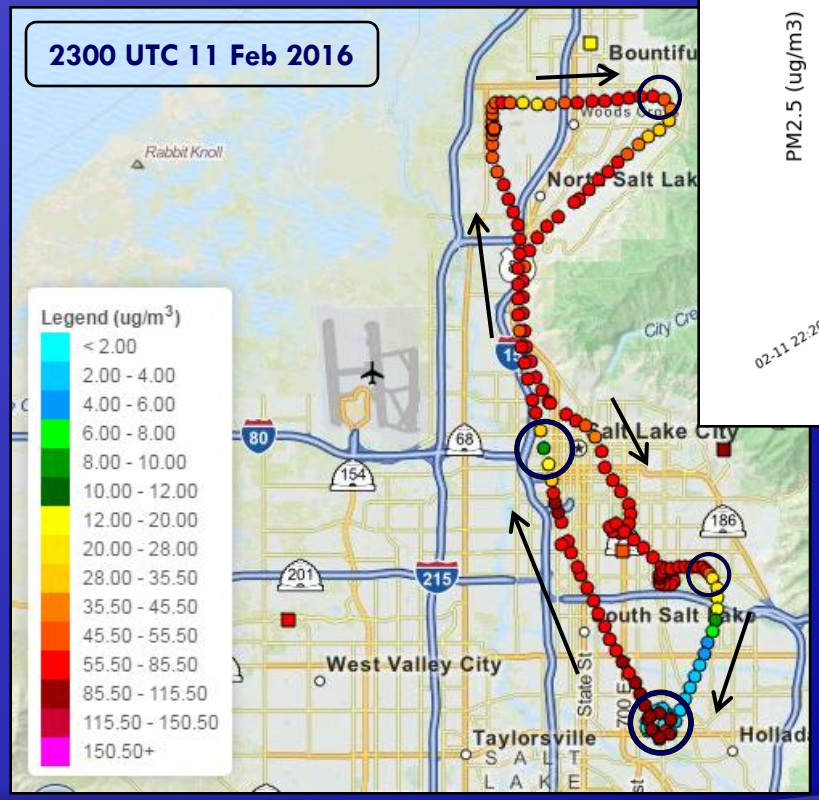
- Fog breaks allowed for quick flight: 11 Feb 2220-2300 UTC

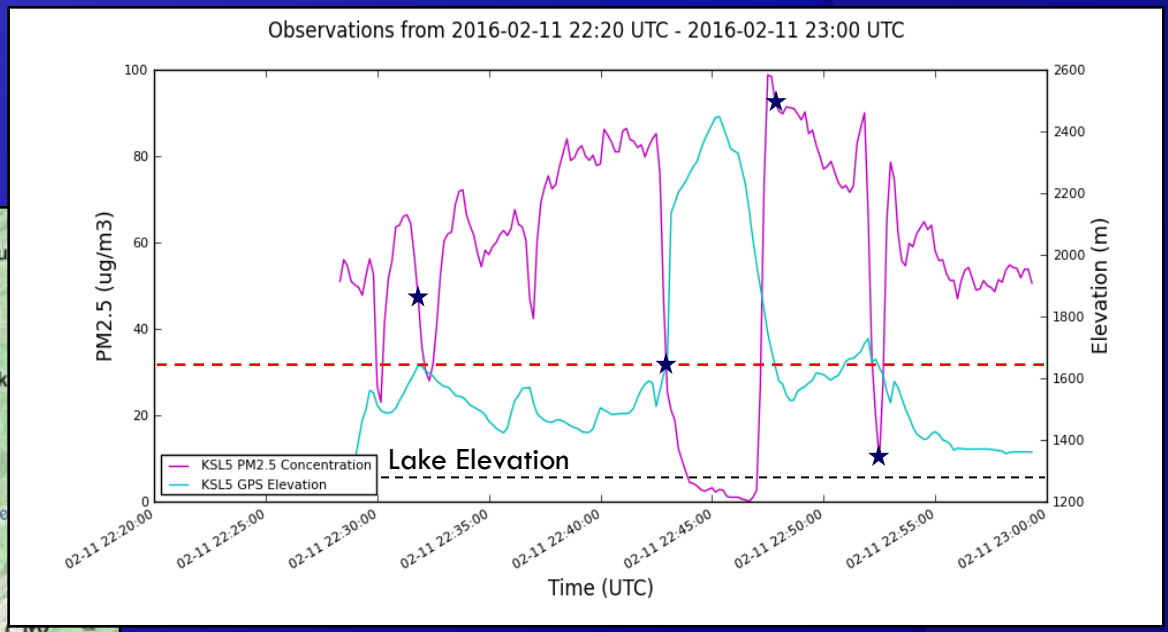




Case Events – 7-16 Feb 2016 Valley Inversion

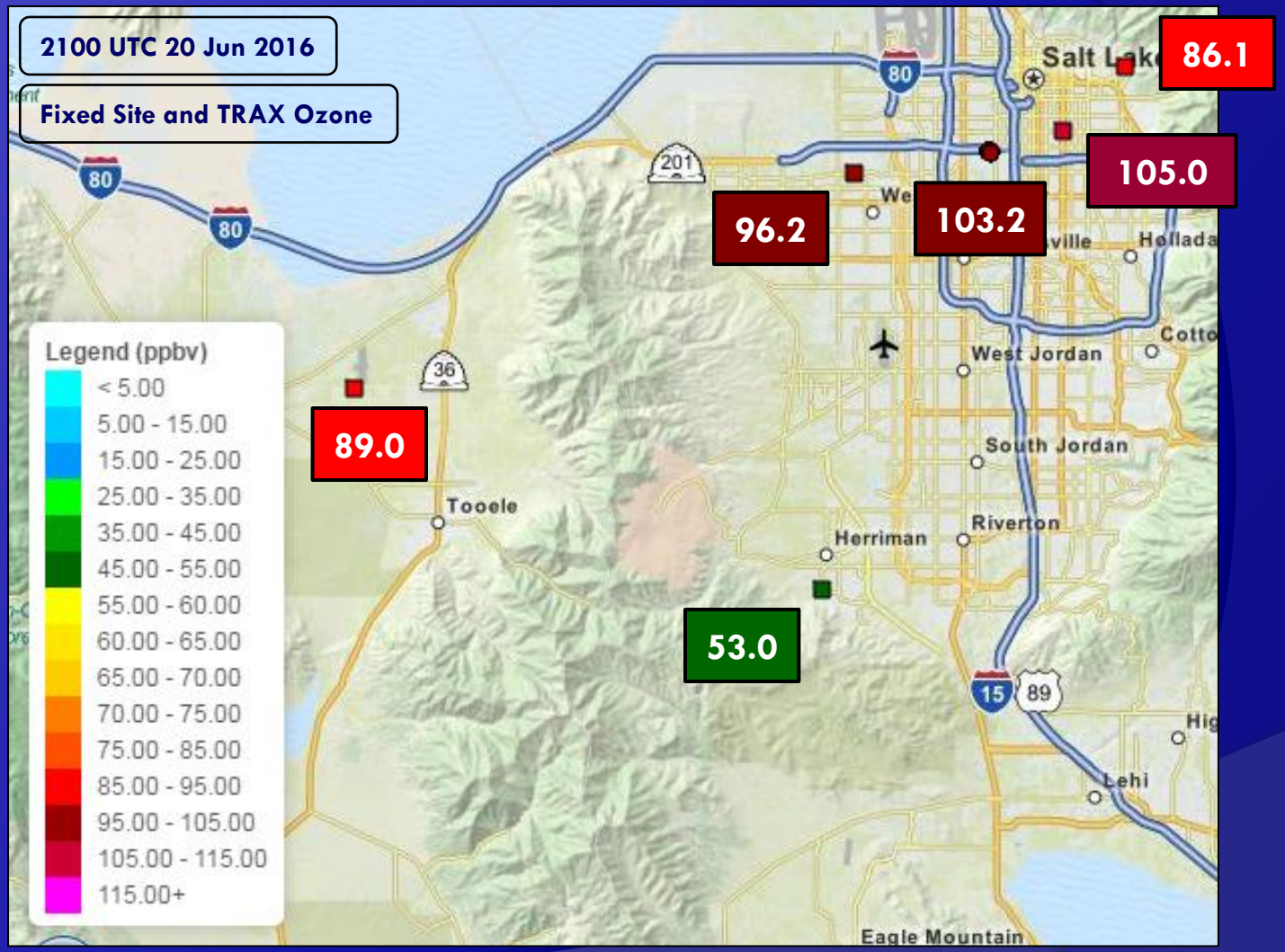
- Fog breaks allowed for quick flight: 11 Feb 2220-2300 UTC
- Vertical and horizontal variations seen throughout flight





Case Events – Monday's (20 Jun 2016) High Ozone

- Strong variations (~40 ppbv) seen near lake breeze boundary



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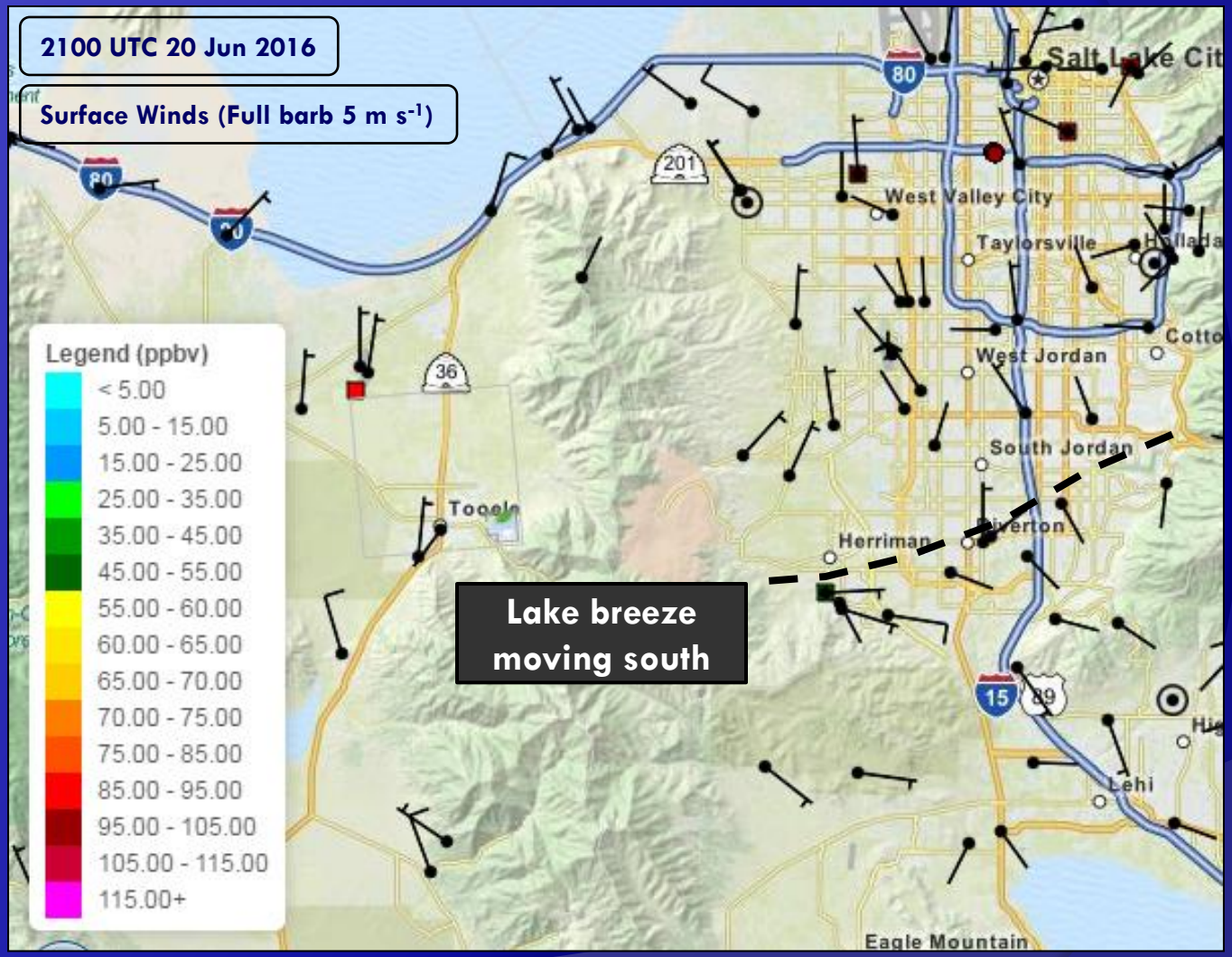

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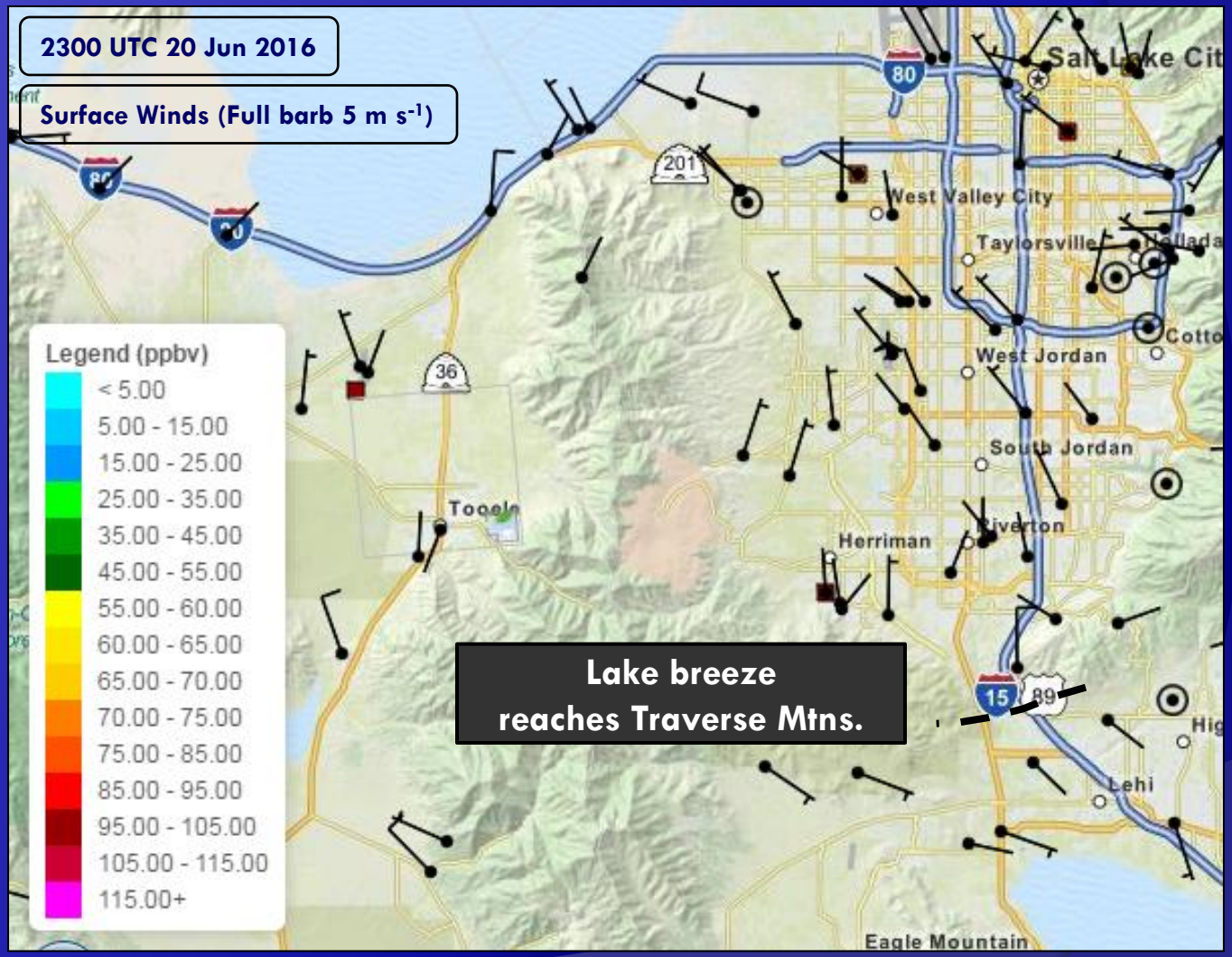

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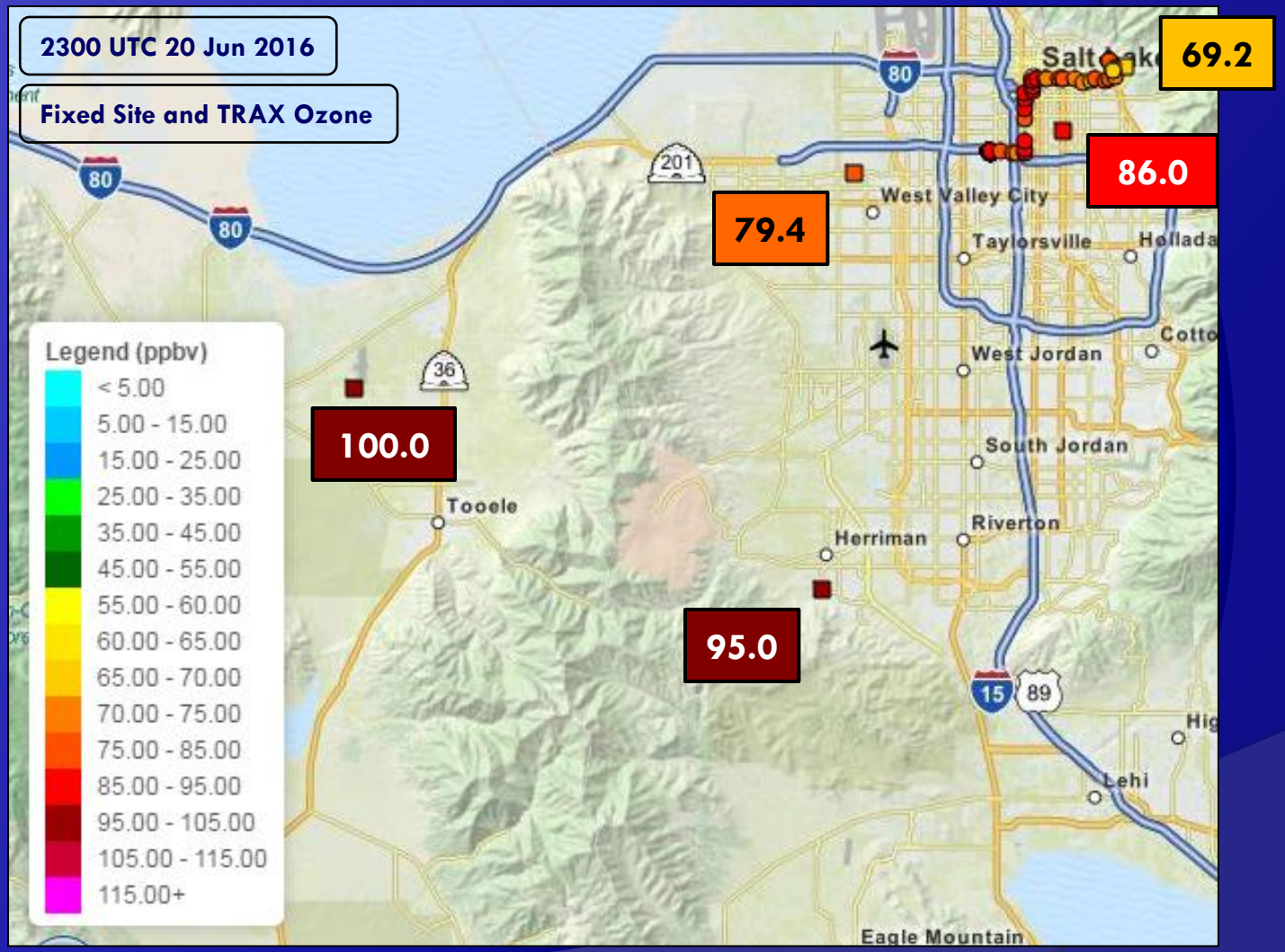

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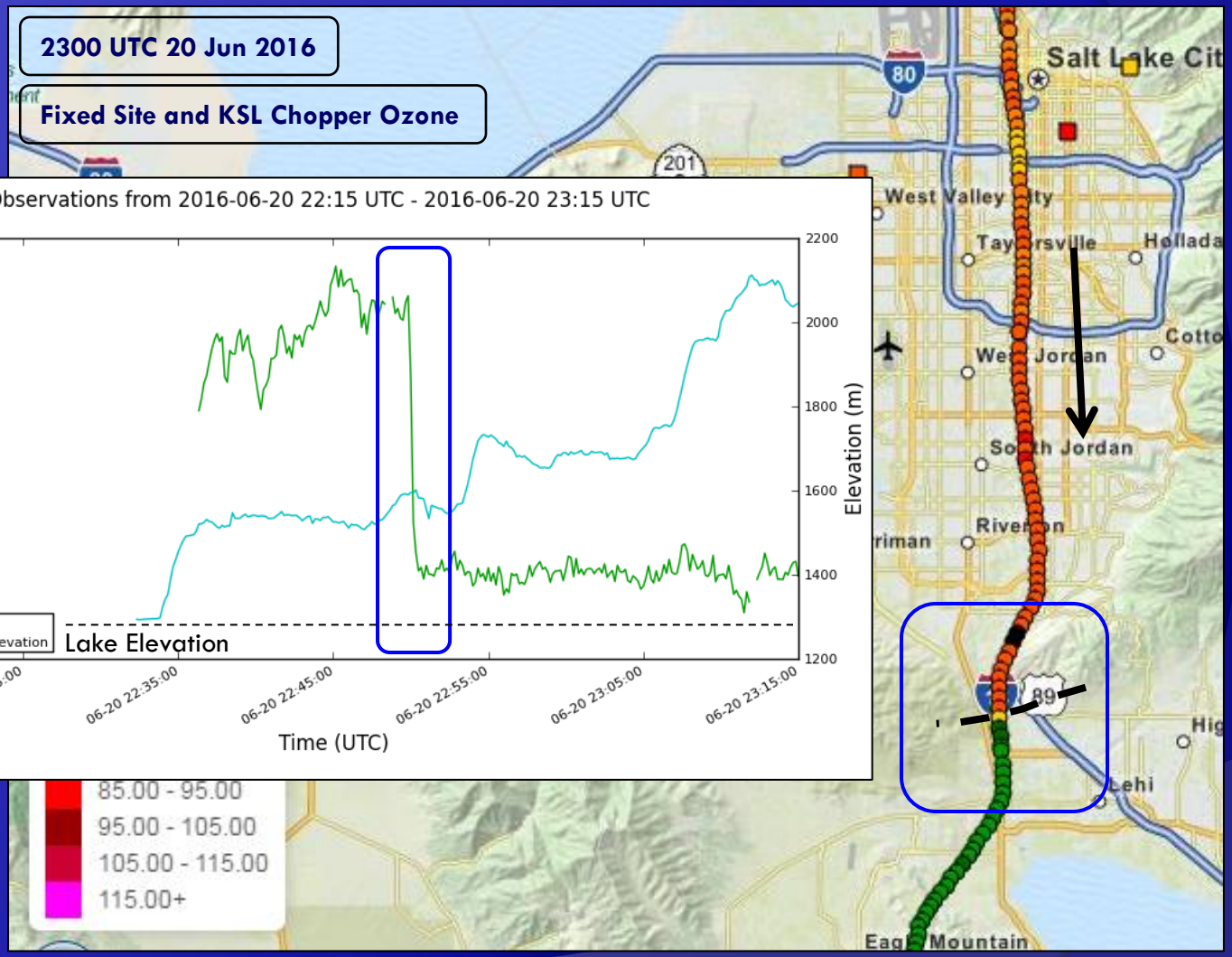

Summary

- Helicopter provides a unique platform for studying horizontal and vertical distribution of pollutants in greater Salt Lake region
- Pseudo-daily flights provided nice distribution of varying case events, meteorological flow regimes, etc.
- Instrument package designed such that helicopter pilot can power/remove/reinstall if necessary without additional support
- "Combo Package" presently installed this summer to continue to collect PM2.5 and ozone data for future events (e.g., wildfires)
- **When available, live data can be viewed via http://meso2.chpc.utah.edu/gslso3s/cgi-bin/current_map.cgi**

Manuscripts and Acknowledgements

Horel, J. and Coauthors, 2016: Summer Ozone Concentrations in the Vicinity of the Great Salt Lake. *Submitted to Atmospheric Science Letters.*

Blaylock, B., J. Horel, and E. Crosman, 2016: Impact of Lake Breezes on Summer Ozone Concentrations in the Salt Lake Valley. *Submitted to Journal of Applied Meteorology and Climatology.*

- Acknowledgements
  - KSL Broadcasting and pilot Ben Tidswell for allowing our group to install instrumentation on Chopper 5
  - Summer 2015 GSLSO$_3$S campaign funding courtesy Utah Division of Air Quality
  - MesoWest and University of Utah Center for Higher Performance Computing for collection and storage of data