

UWFPS Ground-based Observations



- No news on the proposal
- Steve is visiting SLC Nov 10 - 11

Outline

- Overview of Measurements by EPA ORD by Russell
- Overview of ground sites by Munkh
 - Salt Lake Valley
 - Utah Valley
 - Cache
- Potential Sites in Cache: Randy (USU)
- Overview of met by Sebastian (UU)
- Update on Woodsmoke Contribution to PM2.5 in Utah Valley by Delbert (BYU)

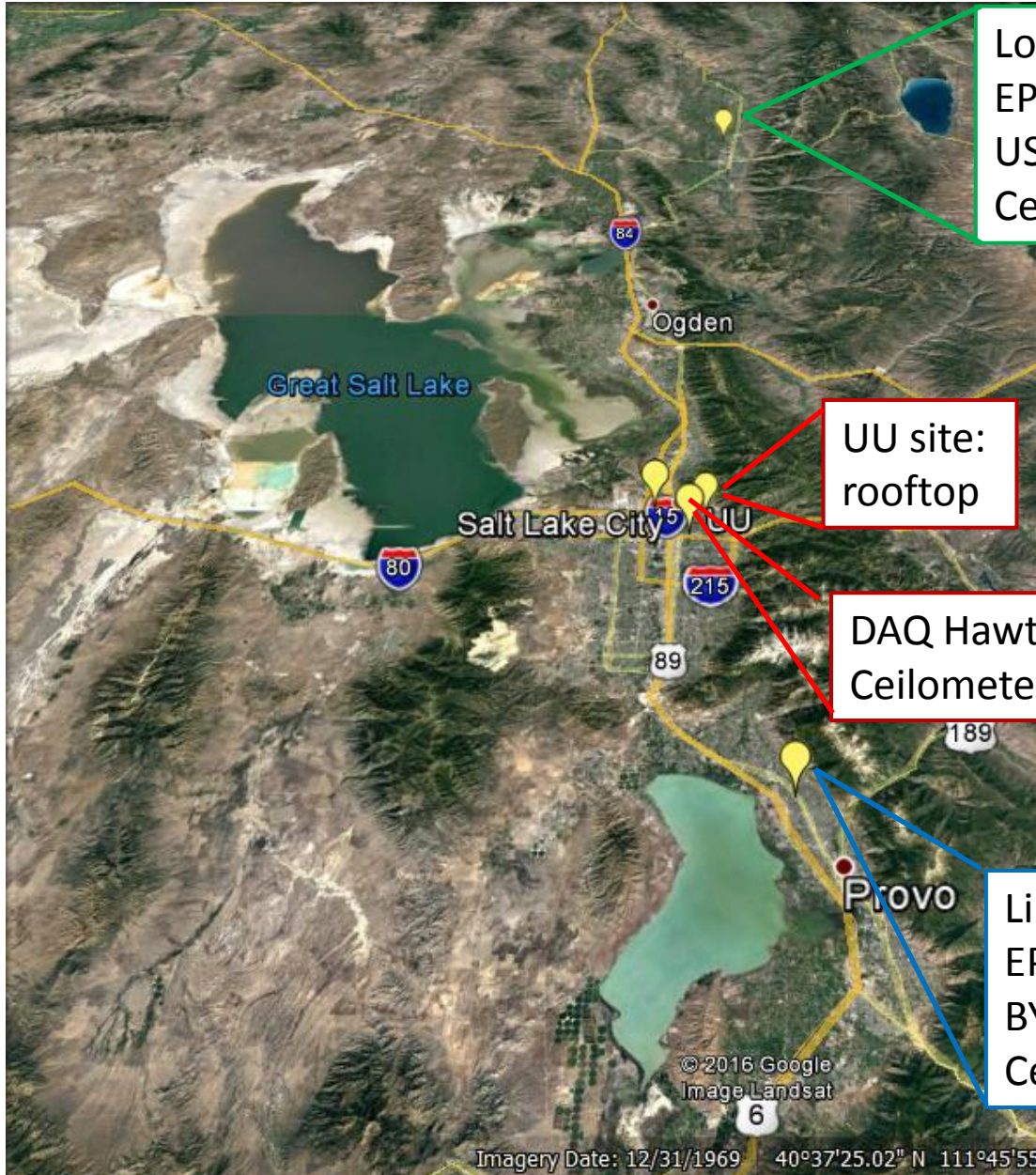
Meeting: Oct 17, 2016

EPA Office of Research and Development: Ground-Based Observations

Instrument	Species Measured
Trace gas analyzers x 2 (API-T, Thermo, Aerodyne) 2B 1 x Aerodyne QCL	NO ₂ only, NO _y , NO _x , NO, NO _y -NO, O ₃ , HCHO
TSI SMPS, APS, UPC OPC	Size distribution from ultrafines through coarse
4 x Tisch Hi-Vol samplers	PM composition: OA speciation, EC/OC, inorganic ions, C14, etc
~ 60 x canister sampling; 2 per day	VOC speciation
Aerodyne Iodide CIMS	HNO ₃ , N ₂ O ₅ , ClNO ₂ , HONO etc.
Aerodyne ToF-AMS	Real-time PM ₁ composition, size
3 x ceilometer	time evolution of aerosol layer
3 x PANDORA	-Total column measurements of HCHO, NO ₂ , and O ₃ , -Altitude profiles
Vaisala weather transmitter	Met parameters (T, RH, ws, wd etc.)



Sites for Ground-based Observations



Logan/Smithfield site:
EPA trailer
USU
Ceilometer, PANDORA

UU site:
rooftop

DAQ Hawthorne site:
Ceilometer, PANDORA

Lindon site:
EPA
BYU
Ceilometer, PANDORA

- Each site will have PM OC measurements (Joost's wish list)

Ground-based Chemistry Observations

Salt Lake Valley: Potential Ground Site Measurements at University of Utah

Atmospheric Sciences Building



Instrument	Species Measured	PI
Aerosol Mass Spectrometer	Speciated PM 1	Dr. Brent Williams (Washington University in St. Louis)
Chemical Ionization Mass Spectrometer	HONO, HNO ₃ , N ₂ O ₅ , ClNO ₂ , other species	Dr. Hans Osthoff (University of Calgary)
Proton Transfer Reaction Time of Flight Mass Spectrometer	Volatile Organic Compounds	Dr. Dylan Millet (University of Minnesota)
Nitrogen Oxide CRDS	NO, NO ₂ , NO ₃ , N ₂ O ₅ , NO _y , O ₃	Dr. Steve Brown (NOAA)
	met	Dr. Sebastian Hoch and E. Crossman
	CO ₂ , CH ₄	Dr. John Lin (University of Utah)
Others	PM _{2.5} , O ₃ , CO, CO ₂ , CH ₄	Dr. Munkh/Lin group (University of Utah)
AIM-IC	PM inorganics, HNO ₃ , NH ₃	Dr. Jen Murphy, U Toronto (90% committed)
Aerodyne QCL	HCHO	EPA ORD

Utah Valley: DAQ's Lindon Station

Trailer 1. UDAQ



Trailer 2. BYU



Trailer 1. UDAQ

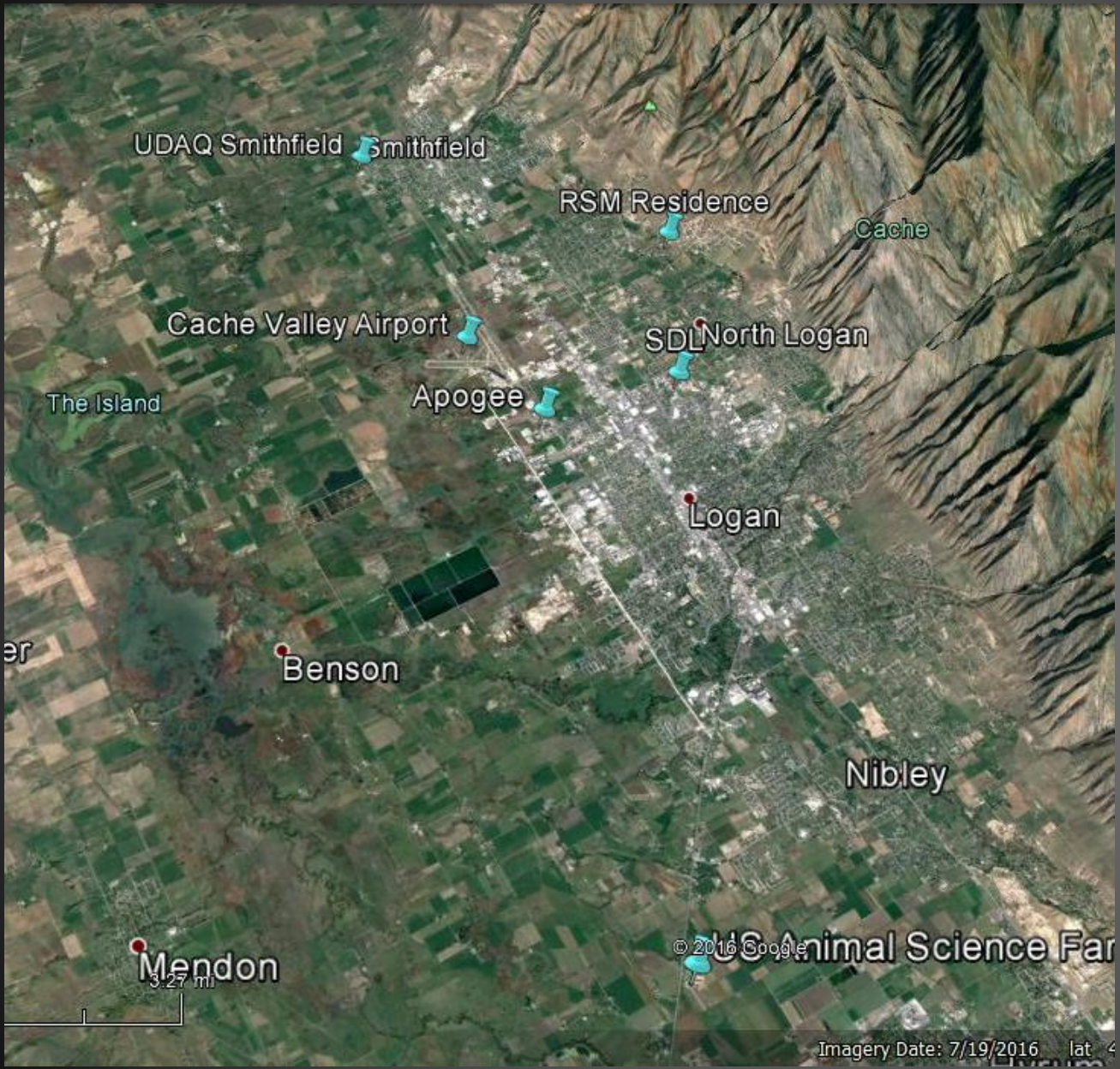
Instrument	Species Measured	PI
<u>Trace gas analyzers</u> Thermo 42iY Aerodyne CAPS 2B	NO _y , NO, NO _y -NO, NO ₂ only O ₃	Dr. Russell Long EPA ORD
TSI SMPS, APS, UPC OPC	Size distribution from ultrafines through coarse	
2 x Tisch Hi-Vol samplers	PM composition: OA speciation, EC/OC, inorganic ions, C14, etc	
Ceilometer	time evolution of aerosol layer	
PANDORA	-Total column measurements of HCHO, NO ₂ , and O ₃ , -Altitude profiles	
Organic Aerosol Monitor	Hourly speciated organic aerosol	Dr. Jaron Hansen/ Dr. Delbert Eatough BYU
Sunset	OC/EC	
	PM _{2.5} , PM ₁₀ , met parameters (T, RH, ws, wd etc.)	UDAQ

Cache Valley: site to be determined

EPA trailer
USU

Instrument	Species Measured	PI
<u>Trace gas analyzers</u> T-API T200U T-API T500U CAPS 2B	NO _y , NO, NO _y -NO, NO ₂ only O ₃	Dr. Russell Long EPA ORD
TSI SMPS, APS, UPC OPC	Size distribution from ultrafines through coarse	
2 x Tisch Hi-Vol samplers	PM composition: OA speciation, EC/OC, inorganic ions, C14, etc	
~ 60 x canister sampling; 2 per day	VOC speciation	
Aerodyne Iodide CIMS	HNO ₃ , N ₂ O ₅ , ClNO ₂ , HONO etc.??	
Aerodyne ToF AMS	Real-time PM ₁ composition, size	
Ceilmeter	time evolution of aerosol layer	
PANDORA	-Total column measurements of HCHO, NO ₂ , and O ₃ , -Altitude profiles	
Vaisala weather transmitter	Met parameters (T, RH, ws, wd etc.)	
Innova	NH ₃	
R & P	OC/EC	Dr. Randy Martin USU





Potential Ground Sites for Cache Valley

Smithfield UDAQ Site

- Birch Creek Elementary School
- 661 W 200 N (Smithfield, UT)
- 41.84284°N, 111.85245°W
- fence would have to be extended
- additional power line needed
- active dairy farm immediately adjacent to the north



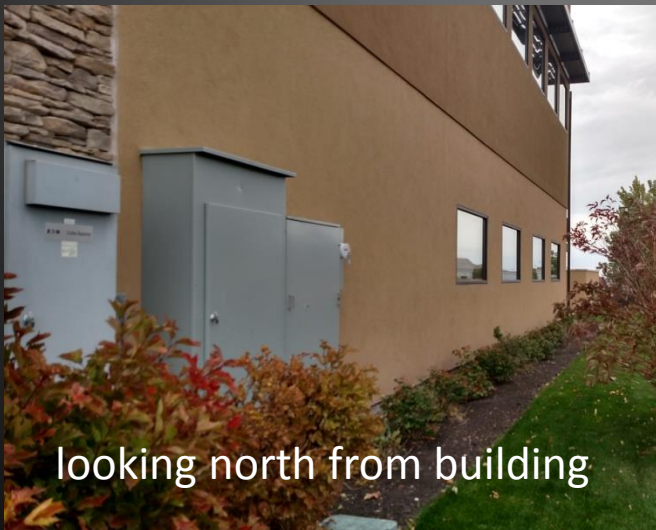
looking north



looking northeast

Apogee Site

- Commercial site, south of airport
- 700 W 1800 N (Logan, UT)
- $41.766150^{\circ}\text{N}$, $111.851787^{\circ}\text{W}$
- cooperative/interested USU colleague owner
- fairly open fetch
- power cord would need to be run from box (≈ 150 m)



Space Dynamics Lab (SDL) Site

- Industrial park, USU Innovation campus
- 1575 N 600 E (Logan, UT)
- 41.76039°N , $111.81931^{\circ}\text{W}$
- USU property/parking lot
- fairly open , some low buildings
- could hardwire into existing power box (240 V, I think)
 - SDL investigators tested lidar trailers there



RSMartin Residential Site

- residential site
- 3236 N 1500 E (N. Logan, UT)
- 41.76039°N, 111.81931°W
- on bench, above valley floor
- fairly open, 1 acre+ lots & agricultural fields adjacent
- could hardwire into existing power box
- 28'x12' concrete pad next to garage or non-landscaped backyard



Other Sites

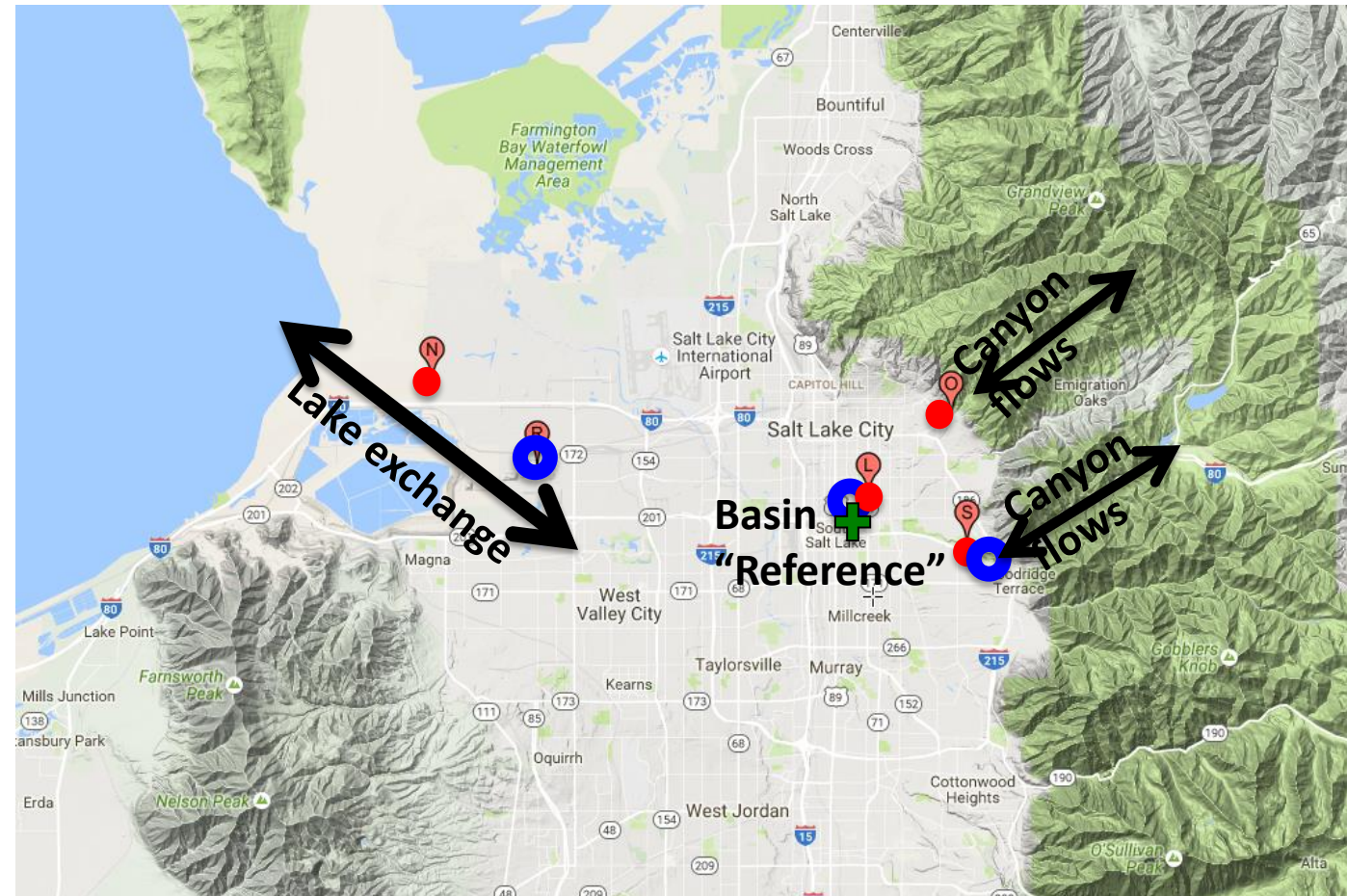
- **USU Animal Science Farm**
 - southern part of Cache Valley
 - 41.664653°N, 111.891842°W
 - location of UT01 (NADP NTN and AMoN collection sites)
 - active university research (livestock/vet farm)
- **USU Utah Water Research Laboratory**
 - 41.740110°N, 111.792737°W
 - power available
 - at the mouth of Logan Canyon (notable drainage flows, though)
- **other locations on USU campus/properties?**
 - in discussions with USU Facilities

Remote Sensing Measurements

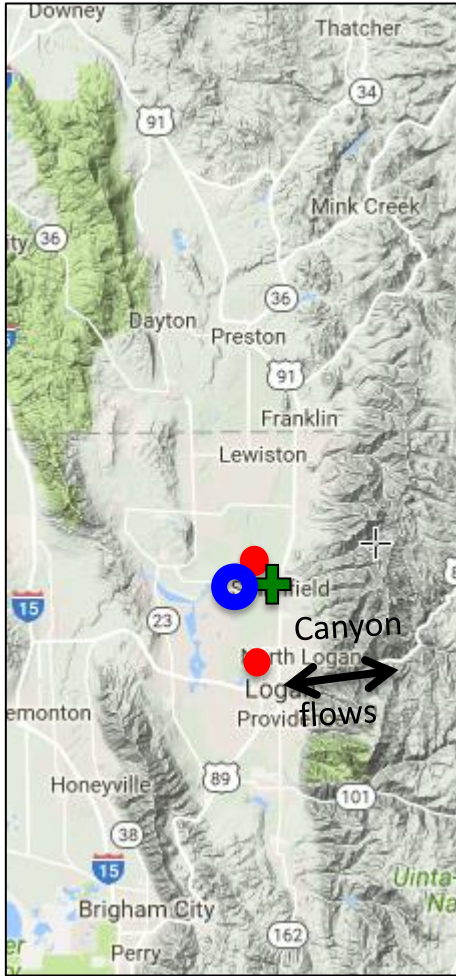
Salt Lake City Basin

- Ceilometer
- LiDAR / SoDAR
- + Pandora

Lake exchange processes and ventilation from tributary canyons will be in the focus.



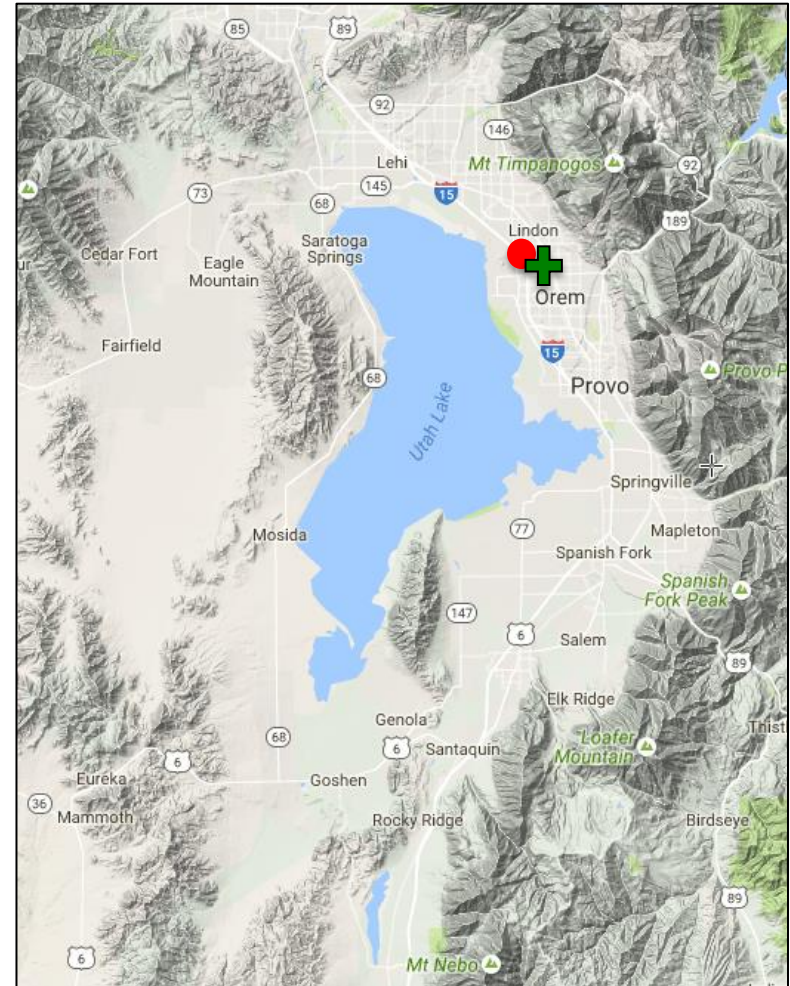
Cache Valley



- Ceilometer
- LiDAR / SoDAR
- ✚ Pandora

Co-location of instrumentation is planned to evaluate meteorological processes affecting the surface observations.

Utah Basin



Deployment University of Utah and EPA/ORD resources for the UWFPS Project to study transport patterns

Salt Lake Basin

Hawthorne: UU LiDAR, UU ceilometer-1, Pandora-1
Red Butte: UU ceilometer-fixed
Parleys Exit: UU SoDAR, ORD ceilometer-1
KSL/Landfill: UU SoDAR-fixed, UU ceilometer-2

Cache Valley

Smithfield: ORD ceilometer-2, Pandora-2, (UU SoDAR?)
Campbell: CS ceilometer-fixed

Utah Valley

Lindon: ORD ceilometer-3, Pandora-3

<p>Aerosol Backscatter</p> <p>Wind Profile</p> <p>Pandora / Chemistry Profile</p>
--



Use of the GC-MS Organic Aerosol Monitor for In-Field Detection of Fine Particulate Organic Compounds in Source Apportionment

January – February 2015 Study

Brigham Young University Campus

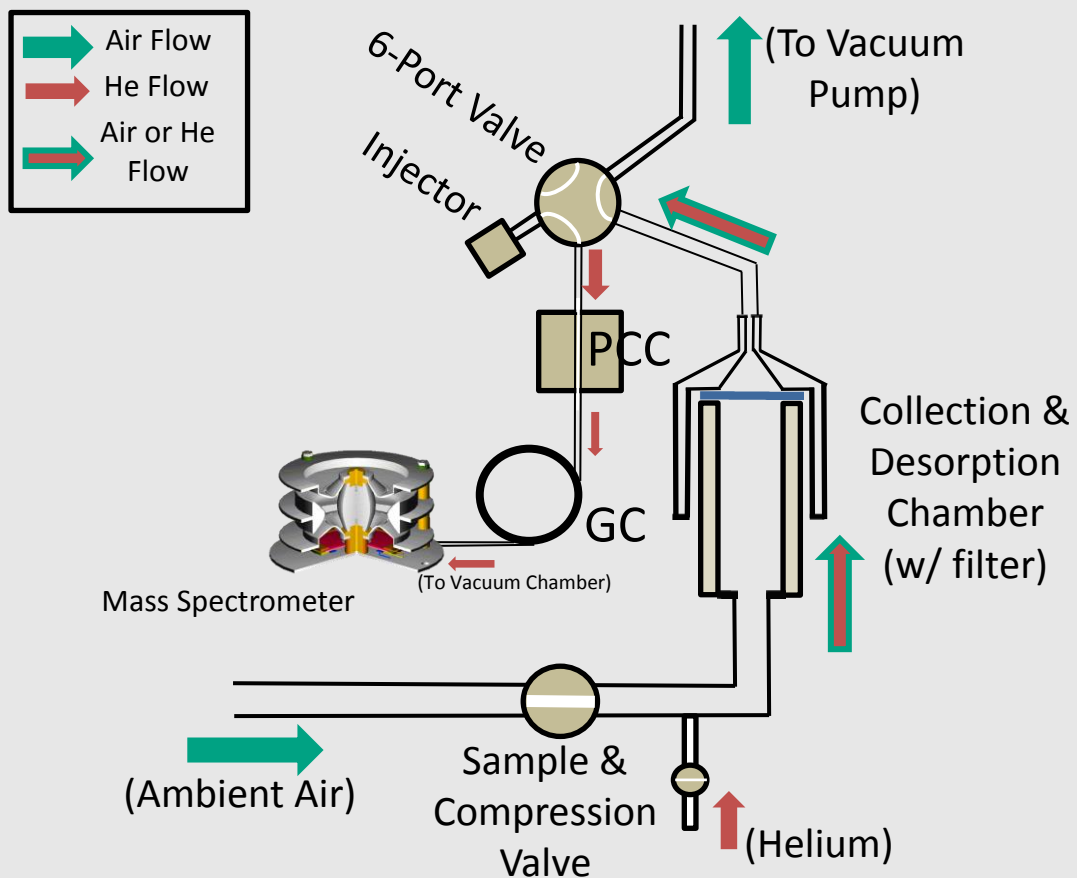
**Delbert J. Eatough, Paul Cropper, Devon K. Overson,
Fern Caka, Jaron C. Hansen, Brigham Young University
and**

Robert A. Cary, Sunset Laboratory Inc.

**Presented at the Atmospheric Optics: Aerosols, Visibility and the Radiative Balance
Conference, September 27-30, 2016, Jackson Hole, Wyoming**



GC-MS Organic Aerosol Monitor (OAM)



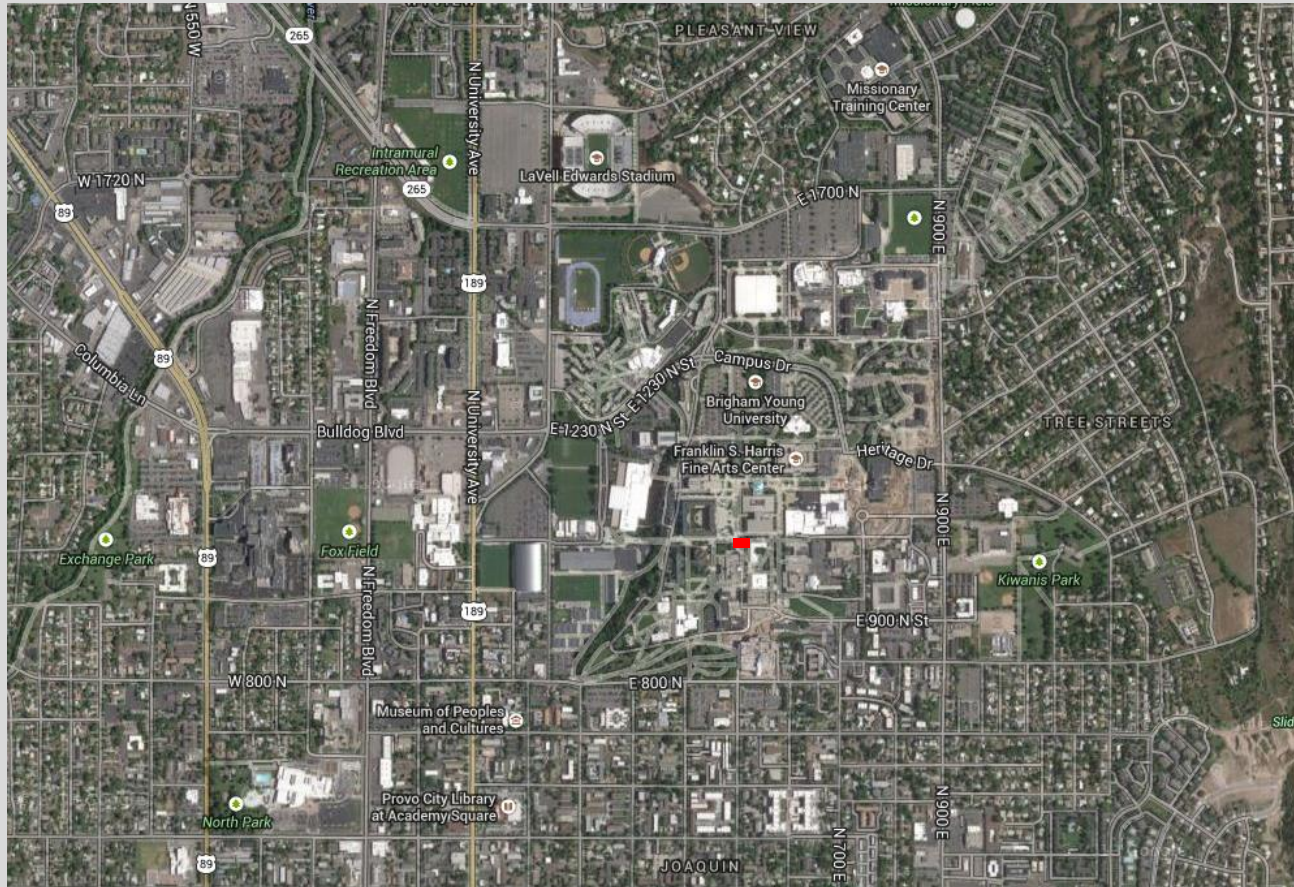
Thermal Desorption Chamber
↓
Pre-column Concentrator (PCC)
↓
Gas Chromatograph (GC)
↓
Mass Spectrometer



Utah Valley

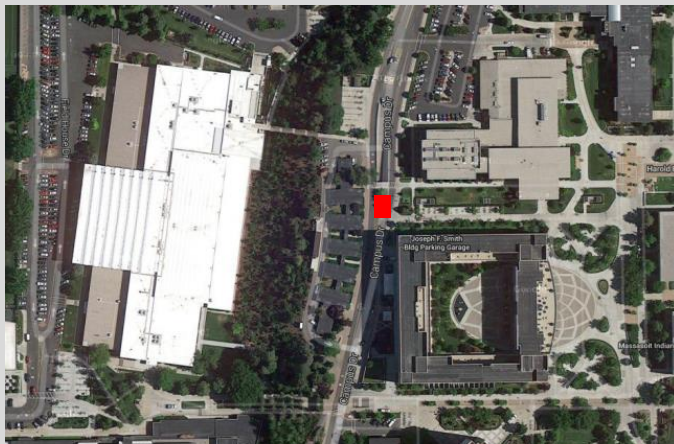
- **Winter inversions trap local pollution**
- **Natural test chamber**





2015 Sampling Location on BYU Campus

(Cooperative Study with Arden Pope)





Data Available for the PMF Source Apportionment Analysis (248 data sets (11 days), all on a 1-hr averaged basis)

Principal PM_{2.5} Components

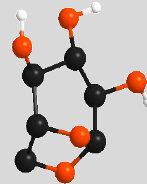
- Mass (FDMS)
- Ammonium Nitrate (IC)
- Ammonium Sulfate (IC)
- OM (mass balance)
- BC and UV (Aethalometer)
- Fine Particle Scattering (Neph)

Related Gas Phase Species

- NO_x
- NO₂
- CO
- O₃

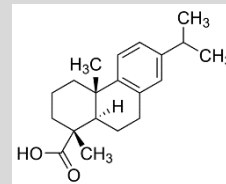
Marker Compounds Measured by GC-MS OAM

- Levoglucosan



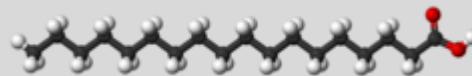
From combustion of cellulose

- Dehydroabietic Acid



From soft wood combustion

- Stearic Acid



Mixed combustion sources

- PAH  Pyrene Anthracene 



Two different PMF analyses were performed.

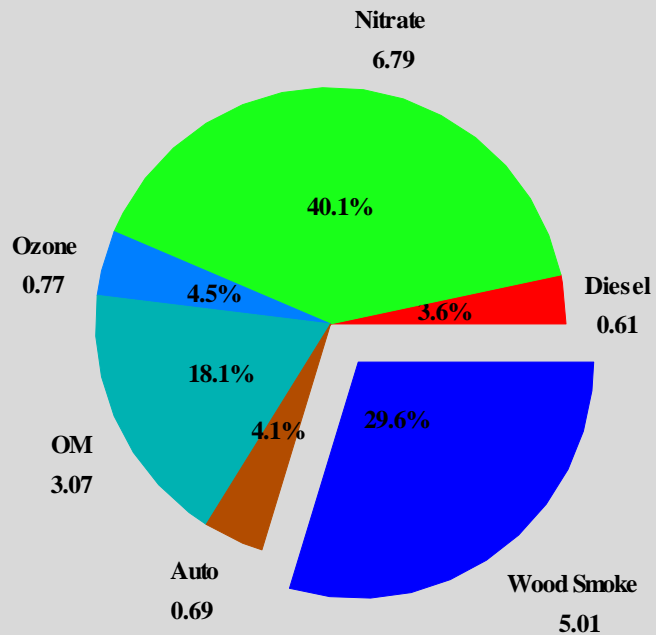
- **The first included all major PM and gas component data and only levoglucosan.**
- **The second included all major PM and gas component data and all 5 organic marker compounds**



Applying the assumptions given in the previous slide, the following comparison is made

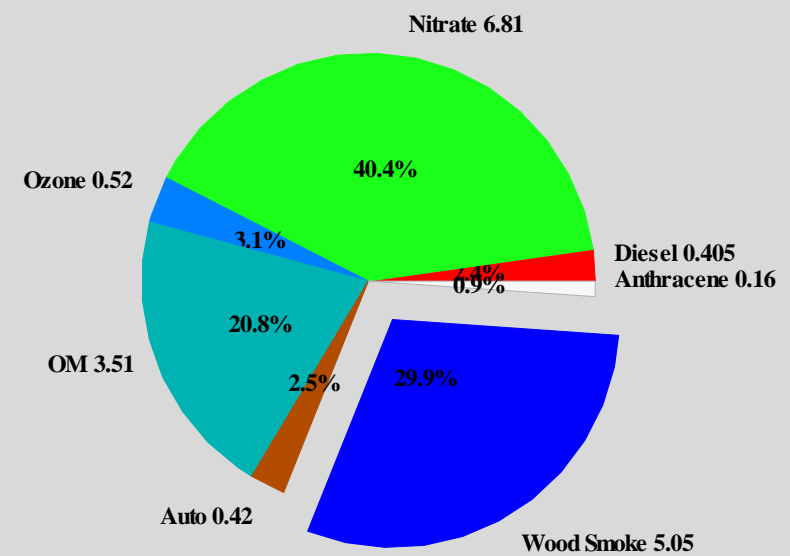
Initial Results

11 Species, 6 Factors. Chi=1209



Final Results

15 Species, 9 Factors. Chi=1749

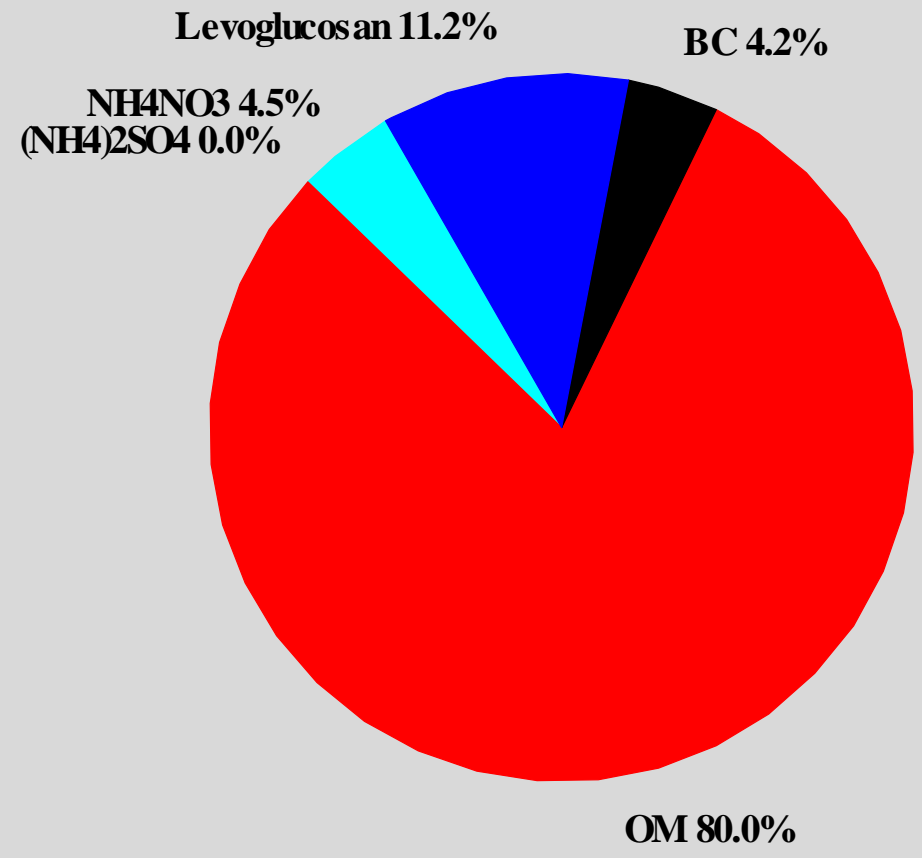




Wood Smoke Factor

Identified Components of Wood Smoke

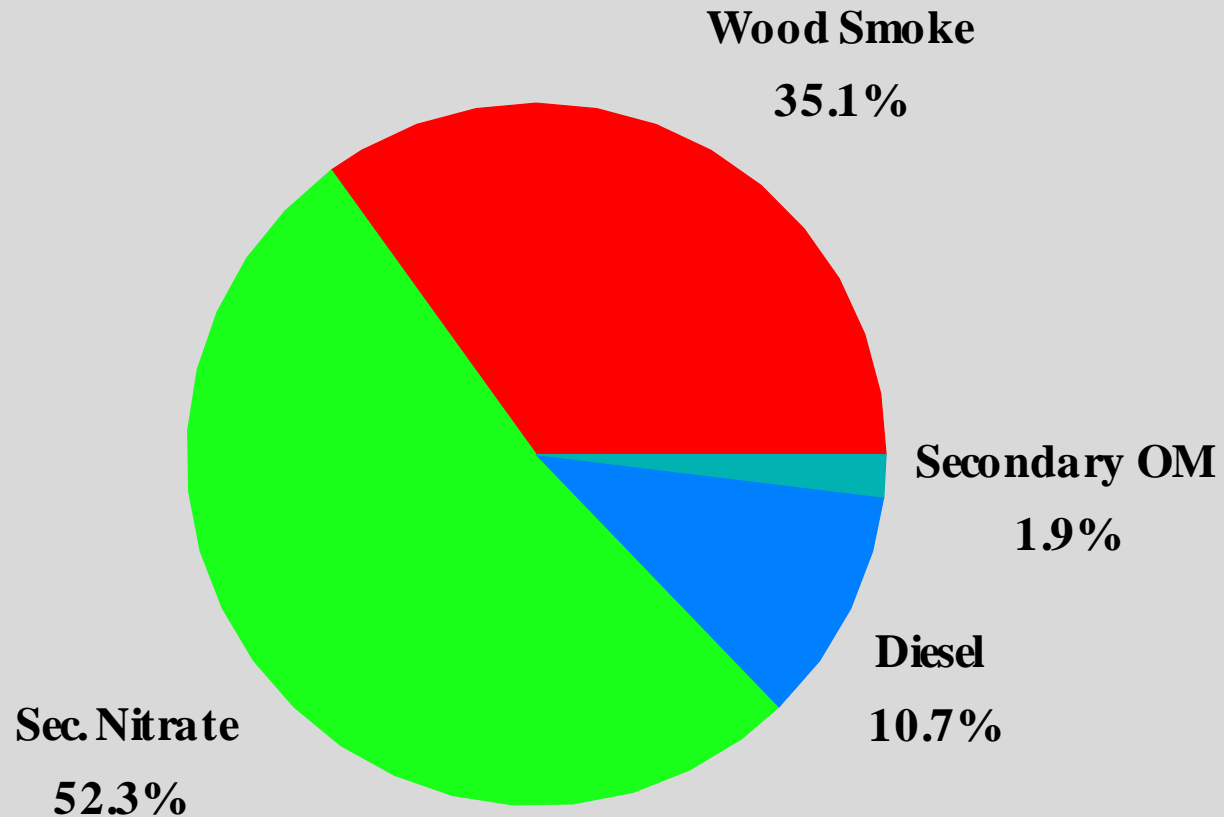
(Accounts for 90% of the WS CMB Mass)





Association of Fine Particle Light Scattering with PMF Factors

% Distribution of $B_{Scat, PM_{2.5}}$ in Factors



Relationship of $PM_{2.5}$ associated water and light scattering is being investigated (based on T, RH, sulfate and nitrate data to estimate aerosol water).



SUMMARY

- Hourly averaged measurements of organic marker compounds was incorporated into a PMF analysis. Complete identification of PM composition was vital to the PMF analysis.
- The origin of the PM_{2.5} at the sampling site on Brigham Young University campus was 36% primary and 64% secondary.
- The great majority of the primary PM_{2.5} was Wood Smoke (identified by the presence of levoglucosan) transported to the site from off-campus.
- 43% of the PM was secondary day-time produced PM (dominated by ammonium nitrate) and 21% was secondary night-time produced PM (dominated by OM).
- Fine Particle light scattering was dominated by the contributions from Secondary Ammonium Nitrate (52%) and Wood Smoke (35%).
- The PMF analysis was greatly aided by the use of hourly averaged data.



A similar analysis is now being performed on both the 2016 Winter and Summer studies at the Neil Armstrong Academy in West Valley.

The data set is much larger and more complete than the one used in the 2015 study.