THE AIR WE BREATHE: A MULTIDISCIPLINARY PERSPECTIVE ON AIR QUALITY

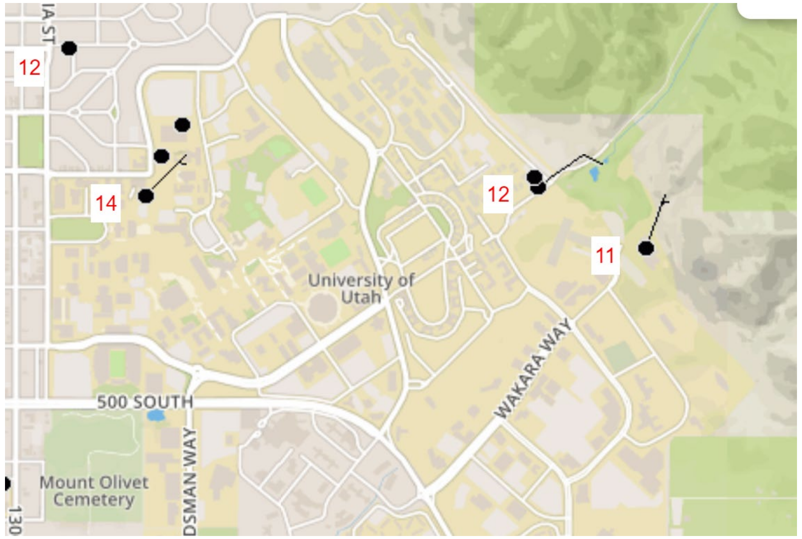
HOSTED BY

ONE U®

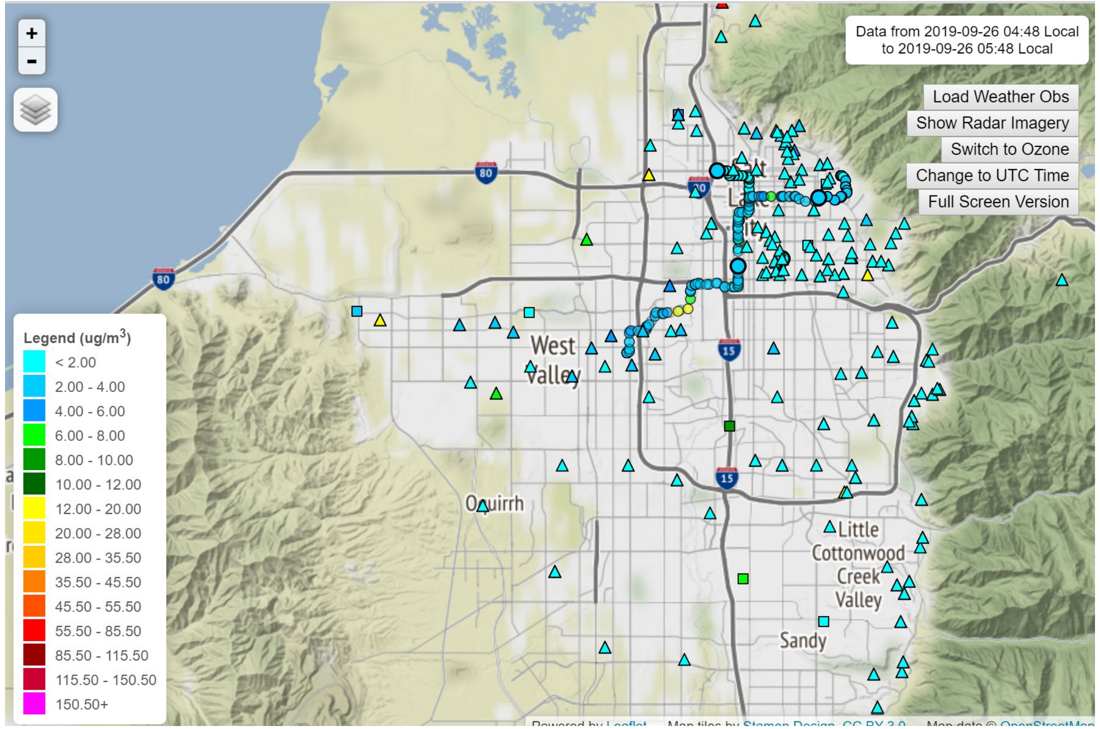
Thursday, October 3, 2019 | Salt Lake City, Utah

Air Quality this morning

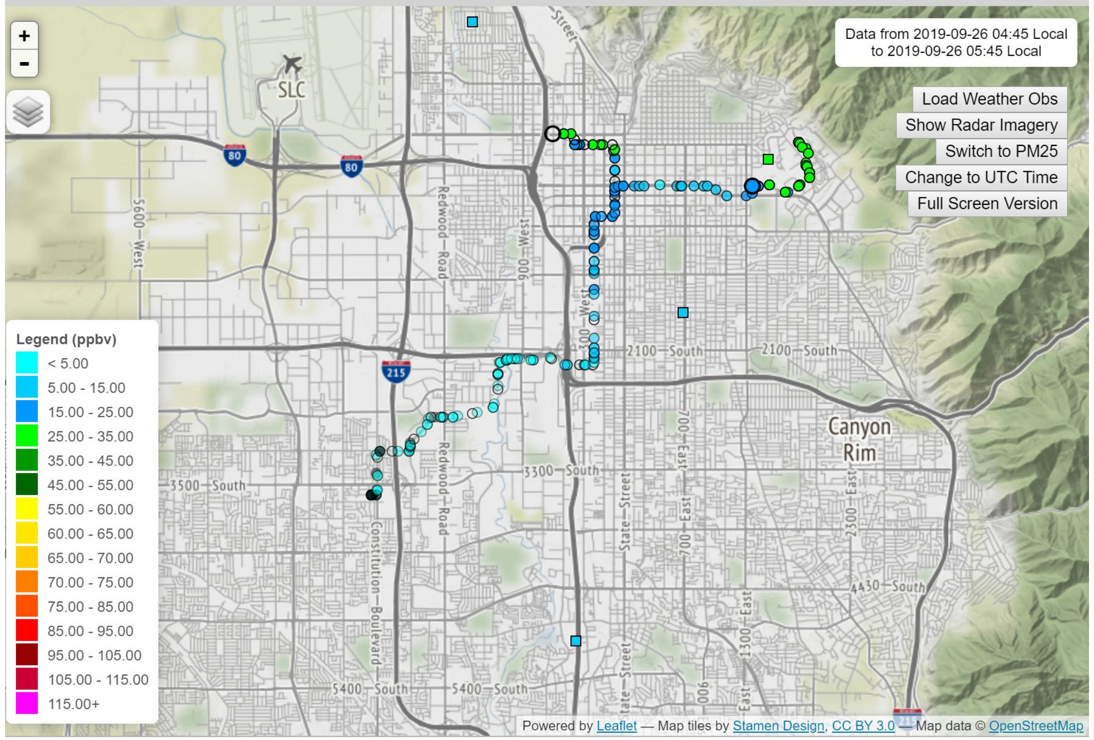
http://utahaq.chpc.utah.edu/



$PM_{2.5}$



Ozone



Meteorology-Chemistry Coupling in Western Basins

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

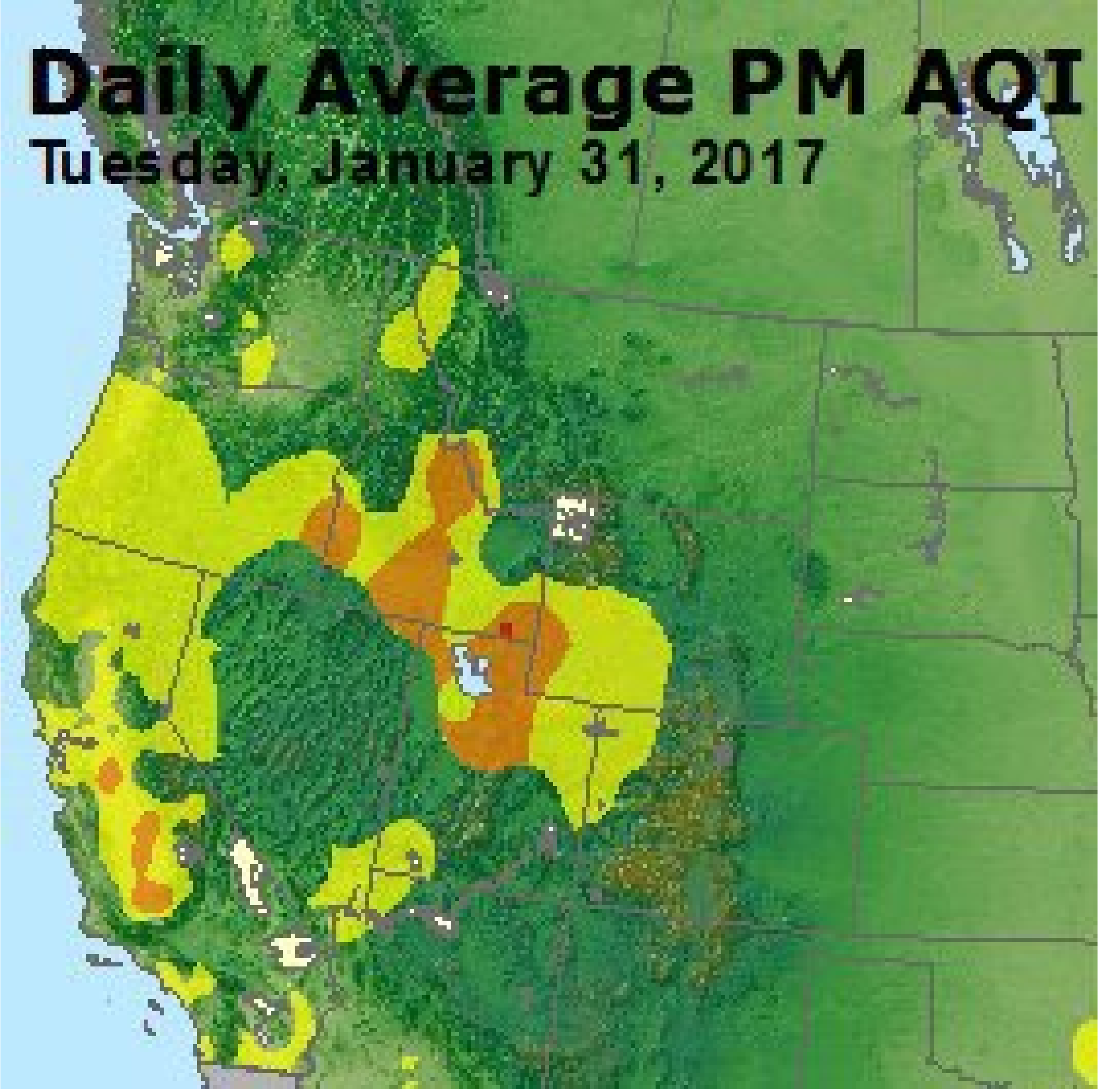
John Horel[1], Erik Crosman[2], Sebastian Hoch[1]

[1]University of Utah

[2]West Texas A&M

with contributions from:

Alex Jacques & Brian Blaylock, others in the Mountain Meteorology Group



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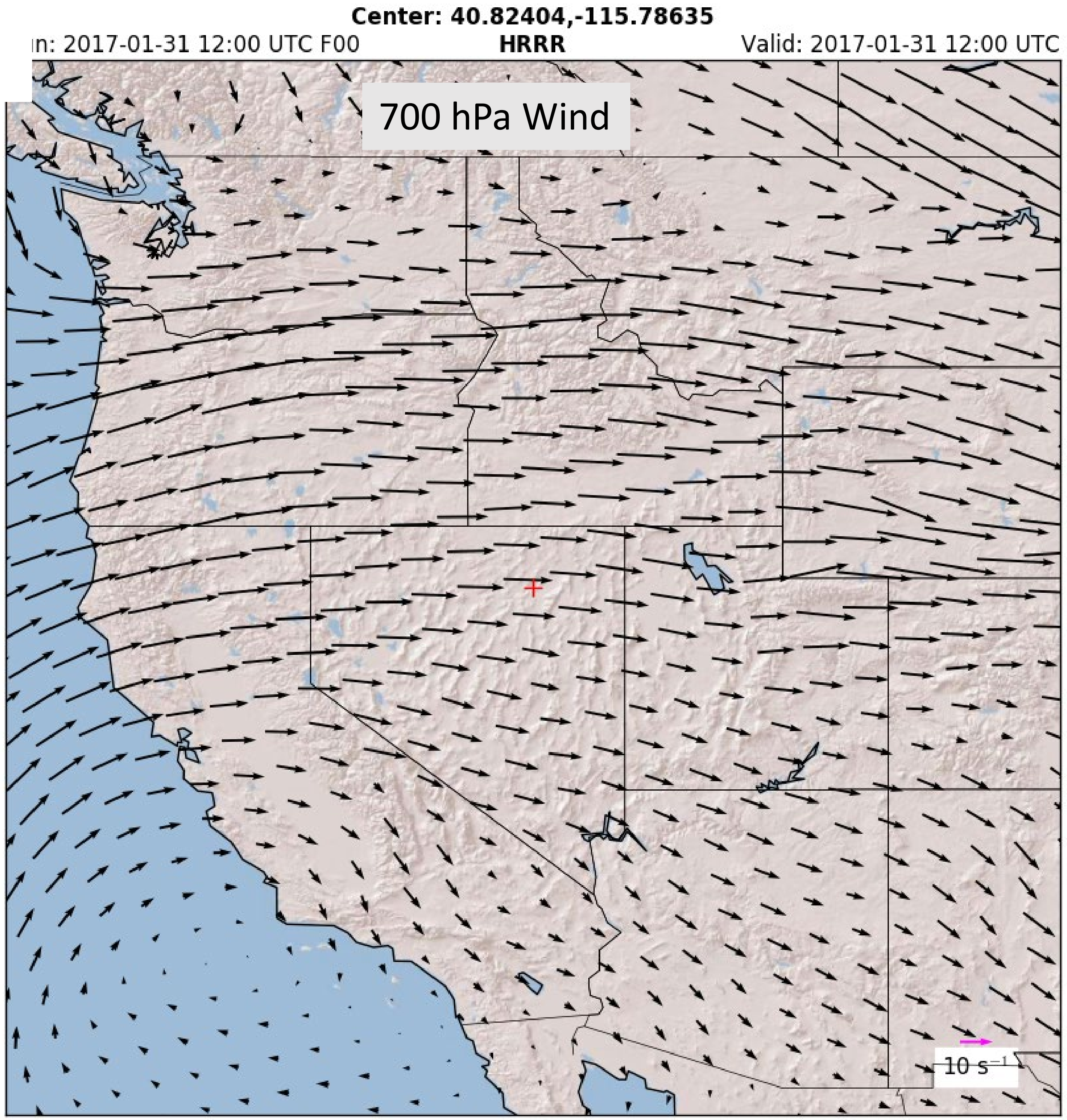

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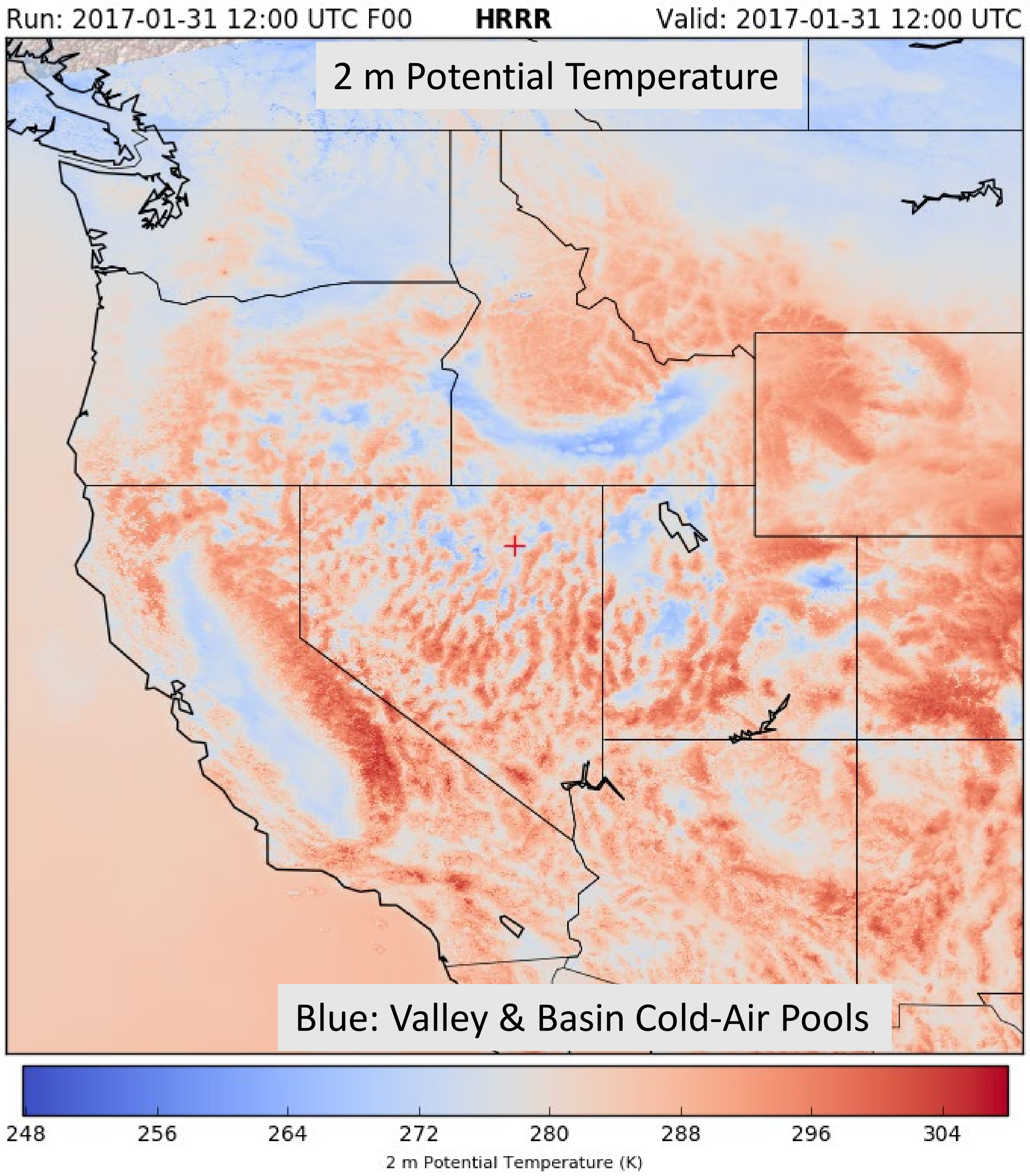
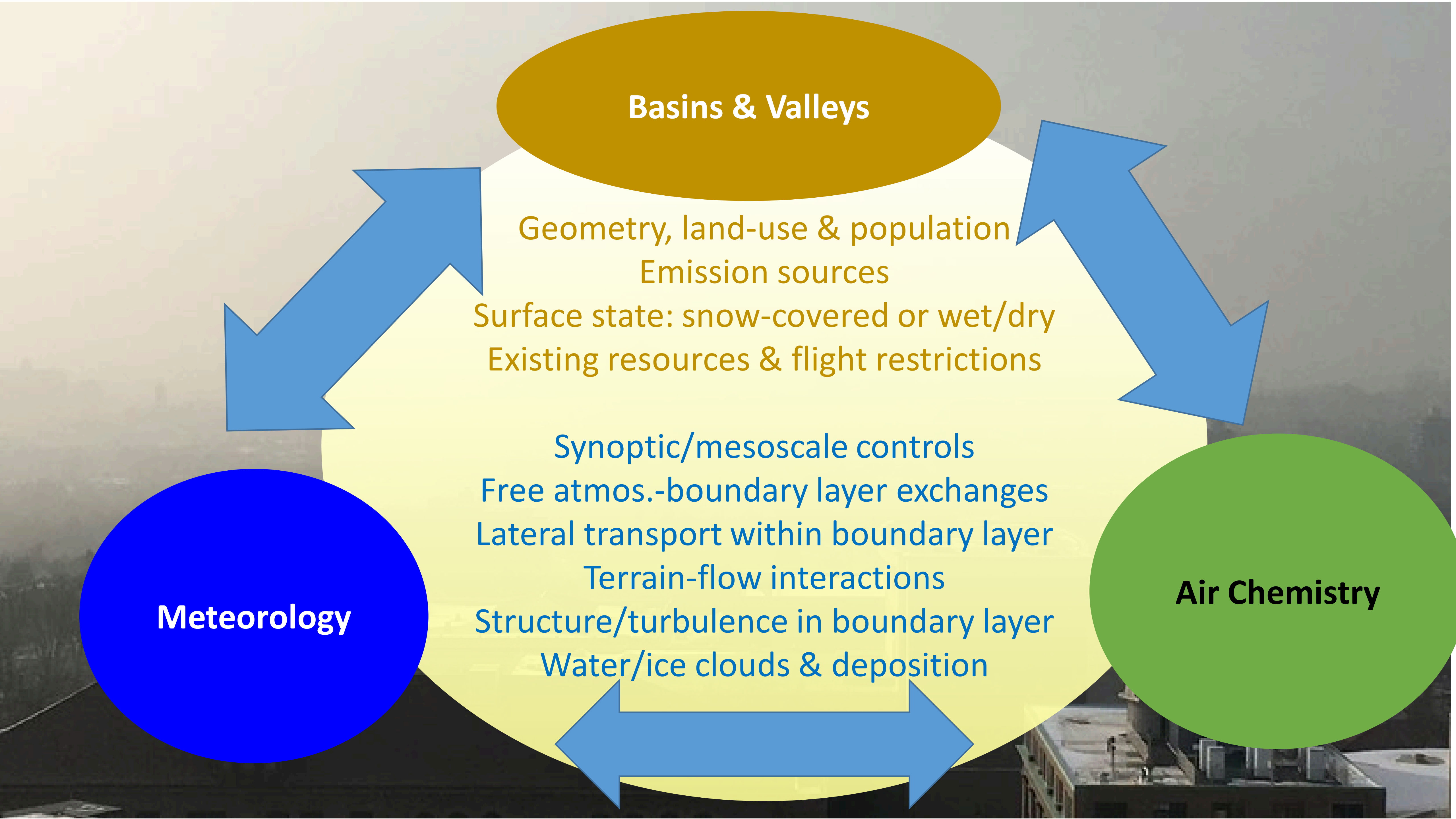
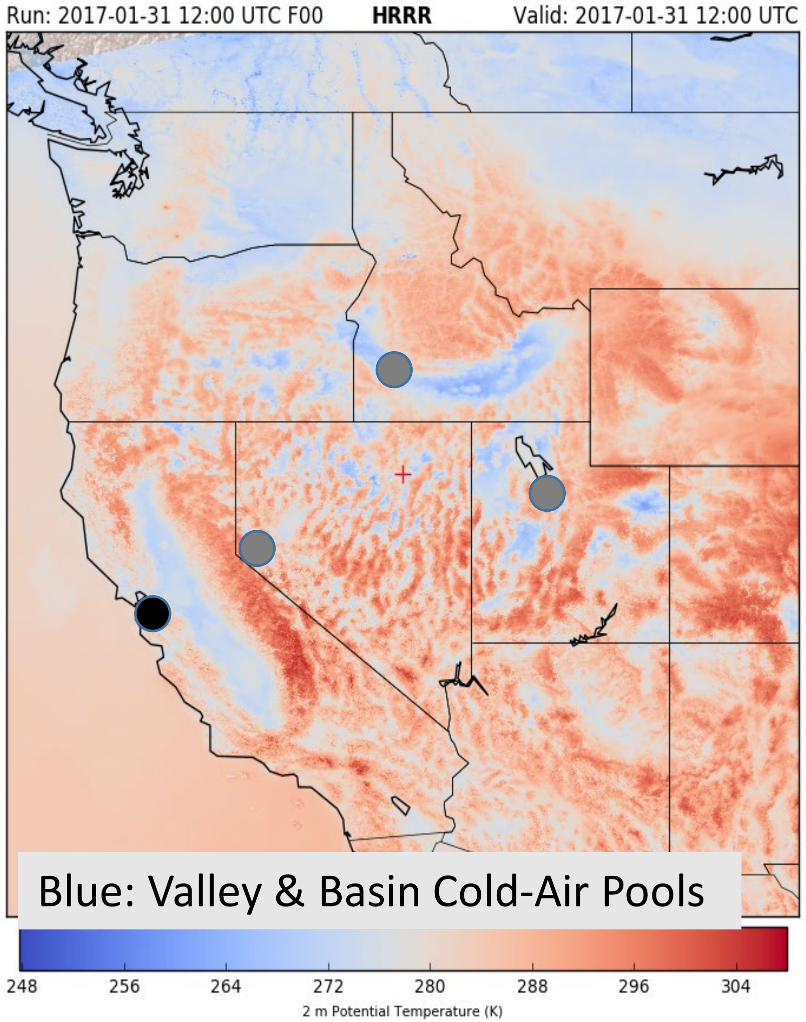
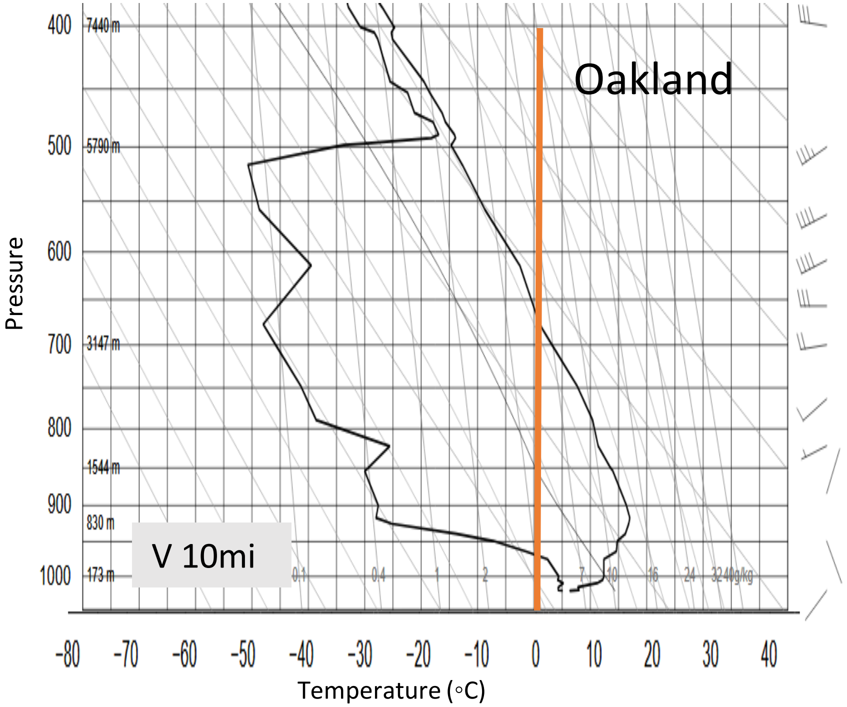



Basins & Valleys
Geometry, land-use & population
Emission sources
Surface state: snow-covered or wet/dry
Existing resources & flight restrictions
Synoptic/mesoscale controls
Free atmos.-boundary layer exchanges
Lateral transport within boundary layer
Terrain-flow interactions
Structure/turbulence in boundary layer
Water/ice clouds & deposition
Meteorology
Air Chemistry

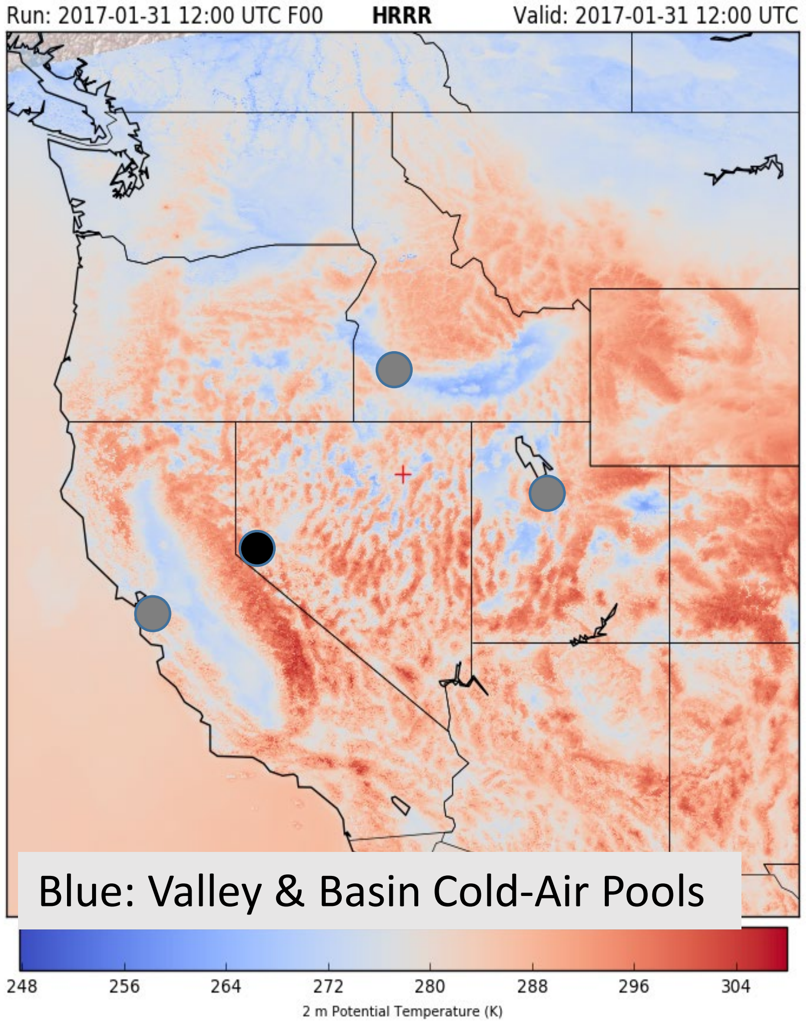
Vertical Structure January 31,2017 12 UTC

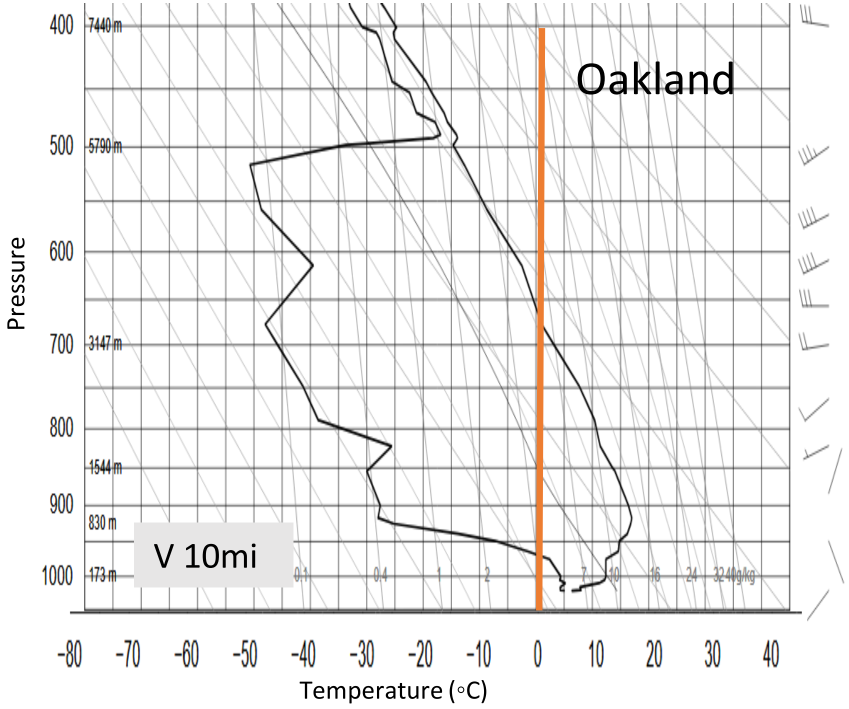


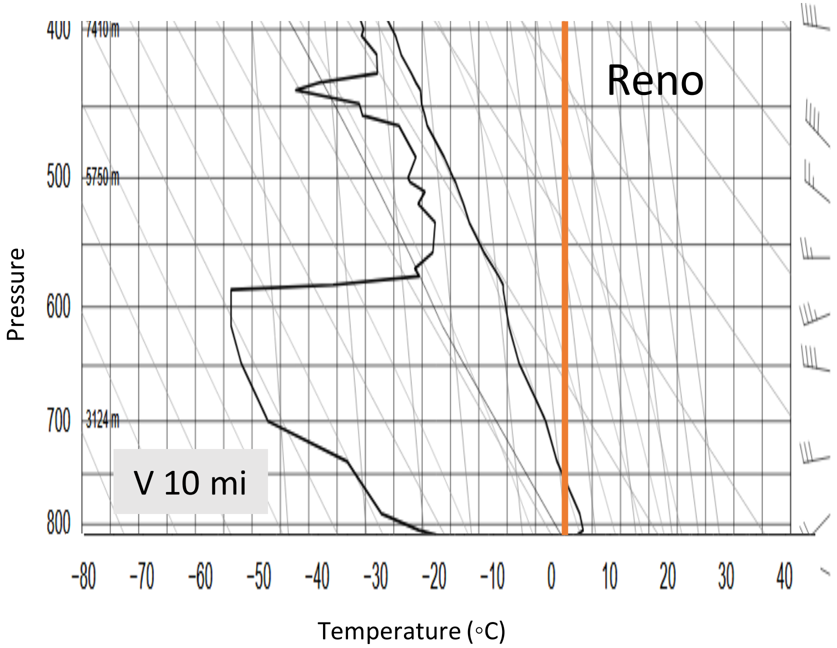


Temperature (◦C)

Vertical Structure January 31,2017 12 UTC







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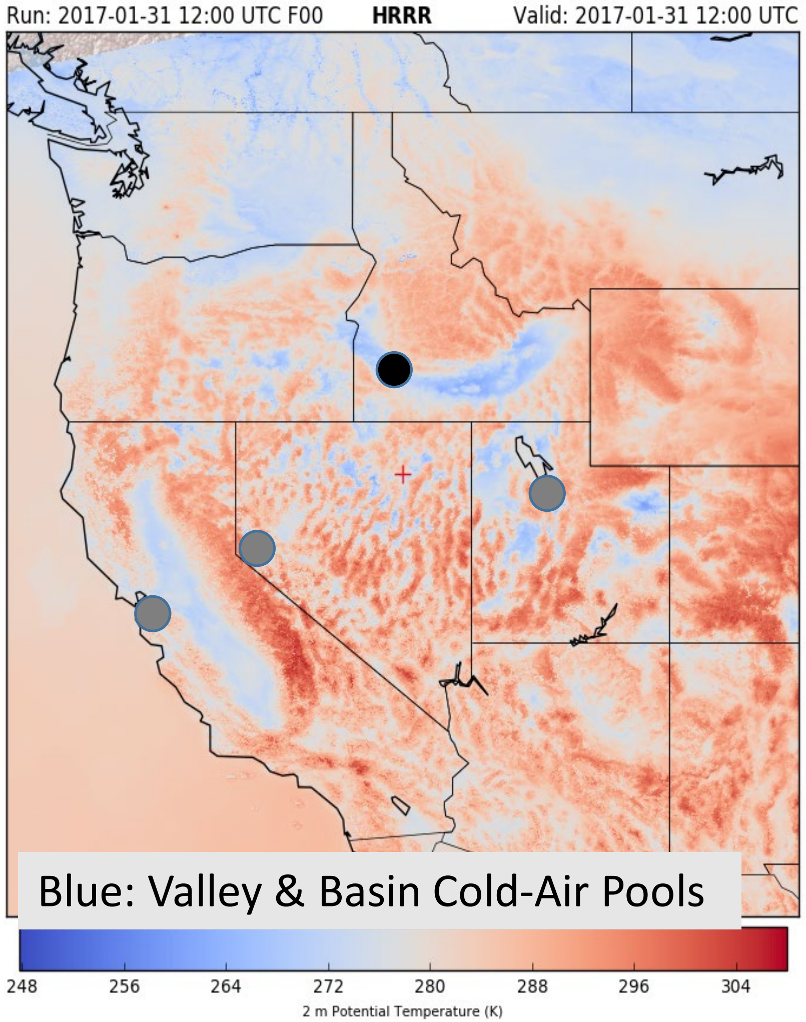
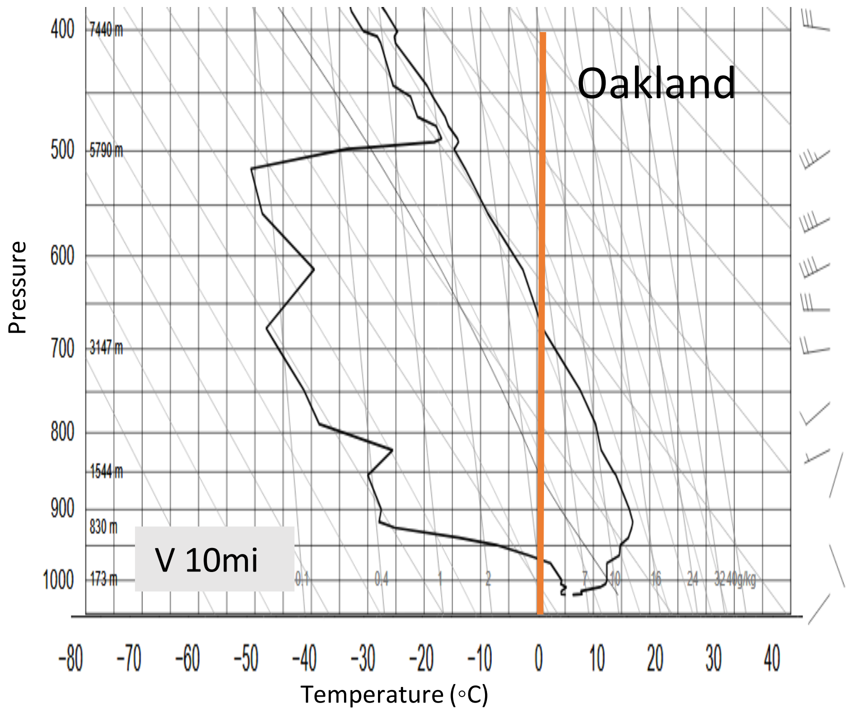
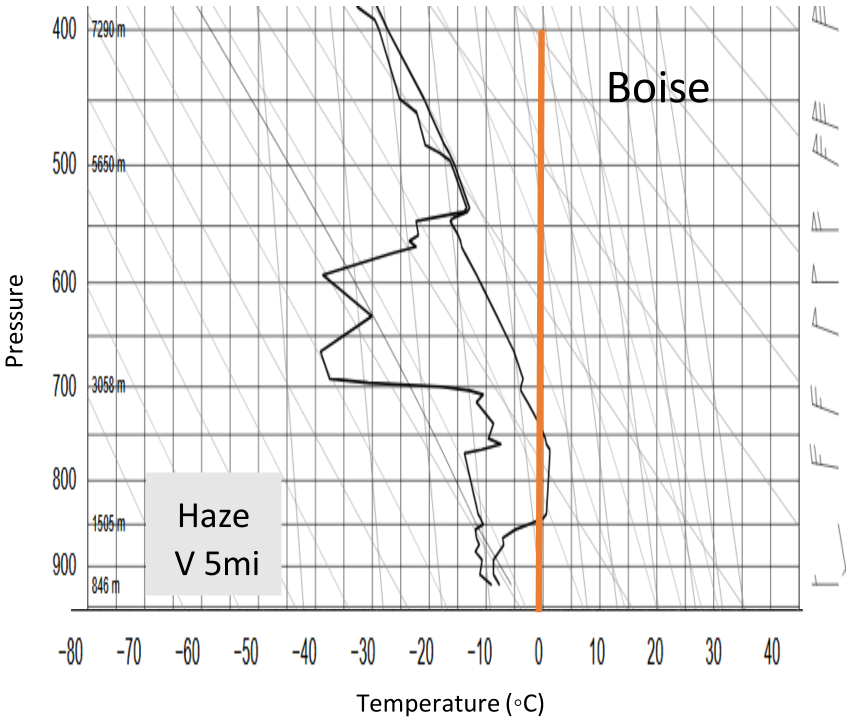
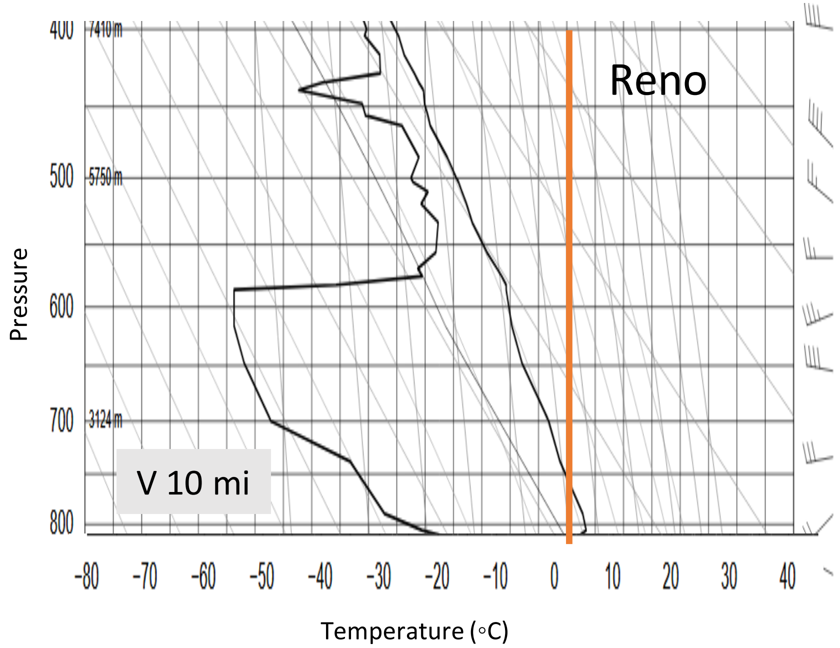
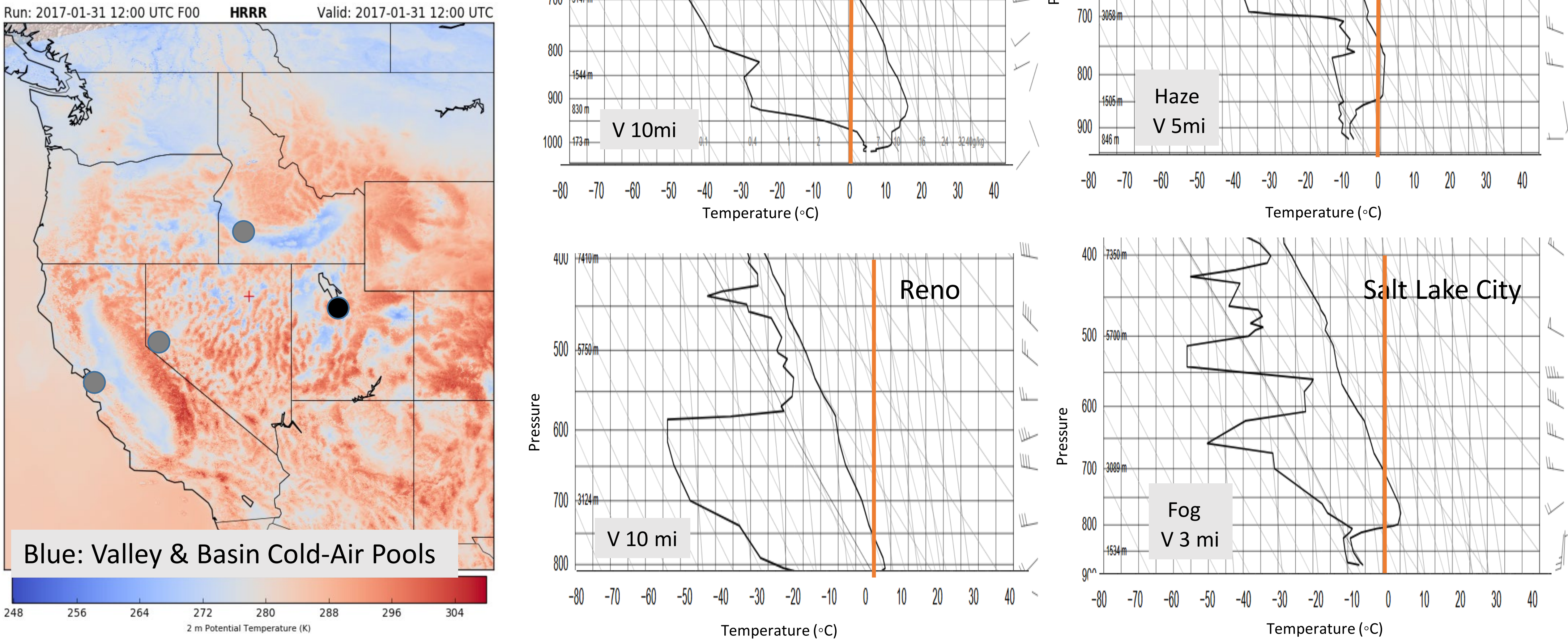






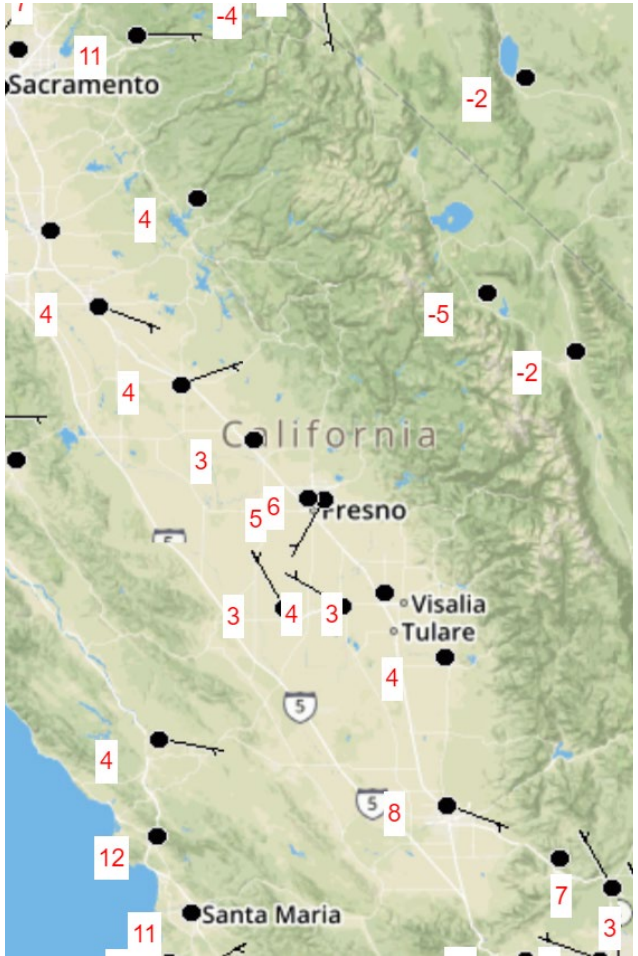


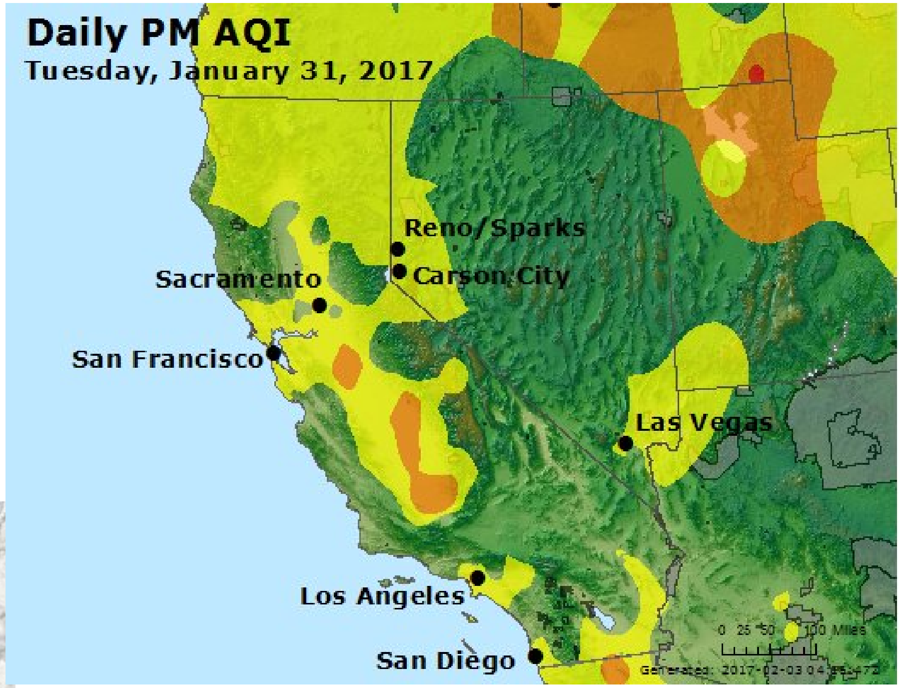
Vertical Structure January 31,2017 12 UTC



January 31, 2017
San Joaquin Valley

Temperature (°C)

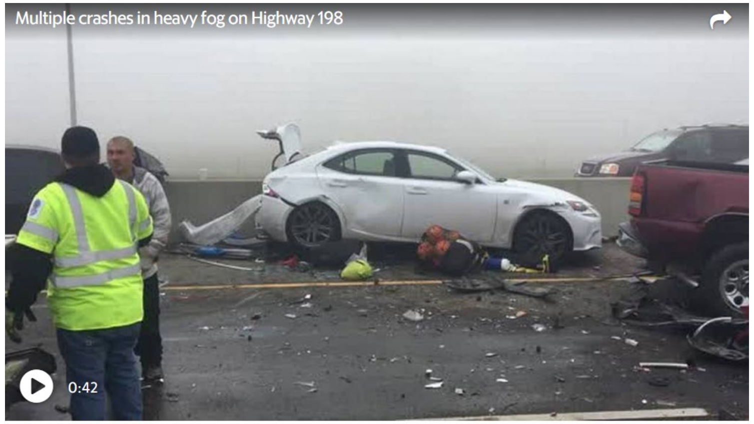




The Fresno Bee

LOCAL

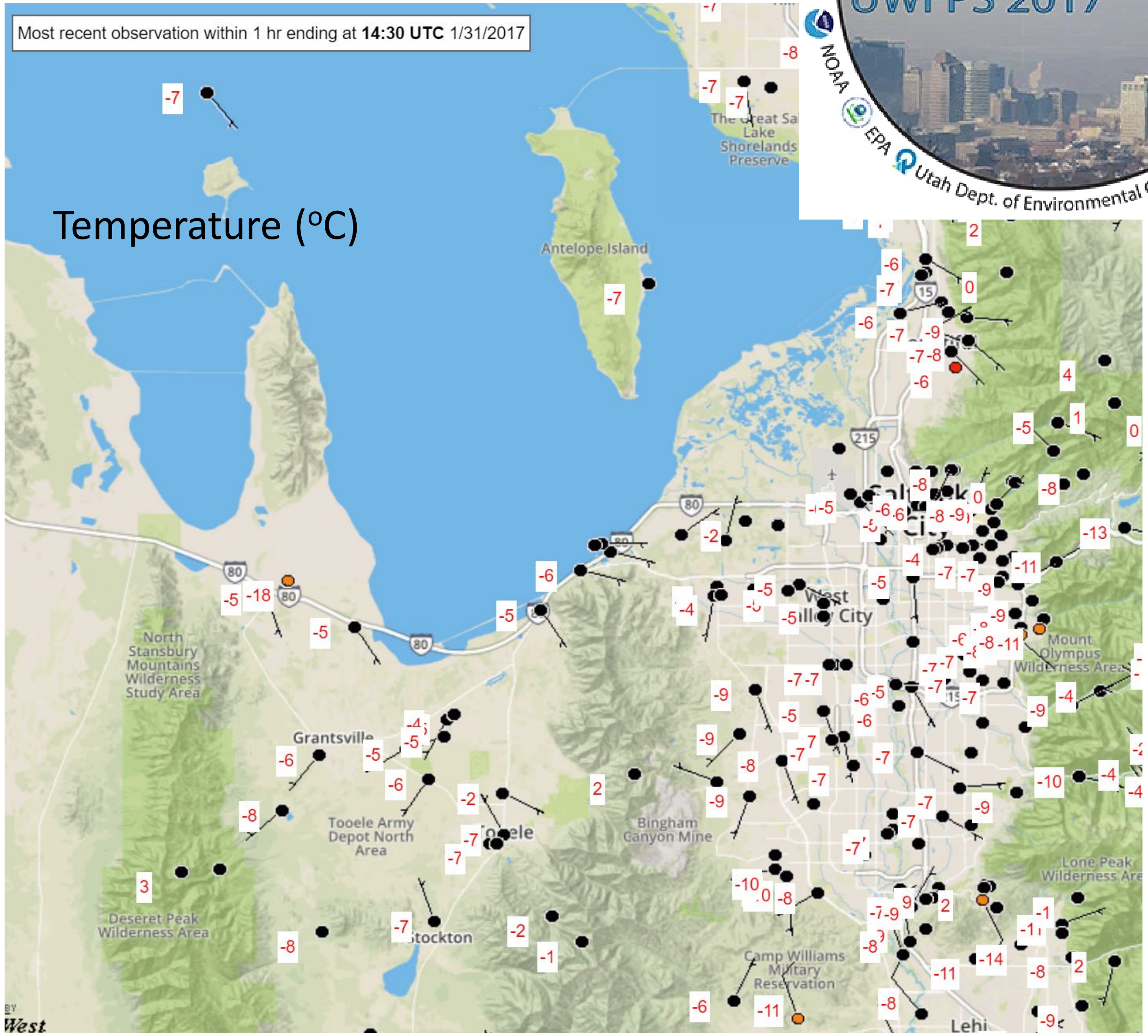
At least 40 vehicles crash in dense fog on Highway

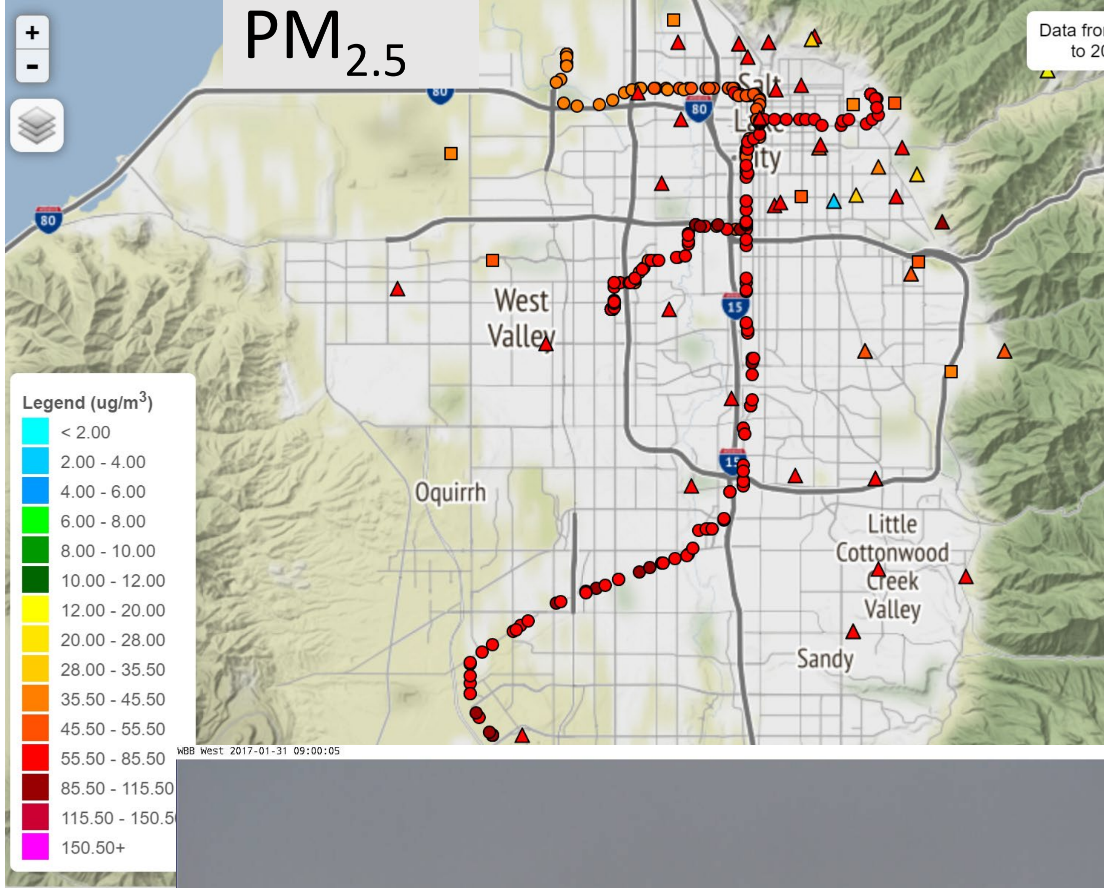


About 50 vehicles were involved in multiple crashes in dense fog on Highway 198 in Kings County on Tuesday morning Jan. 31, 2017, the California Highway Patrol reported.
By CRAIG KOHLRUSS

January 31, 2017
Salt Lake Valley

2017 UTAH WINTER FINE PARTICULATE STUDY
UWFPS 2017
NOAA EPA Utah Dept. of Environmental Quality University of Utah

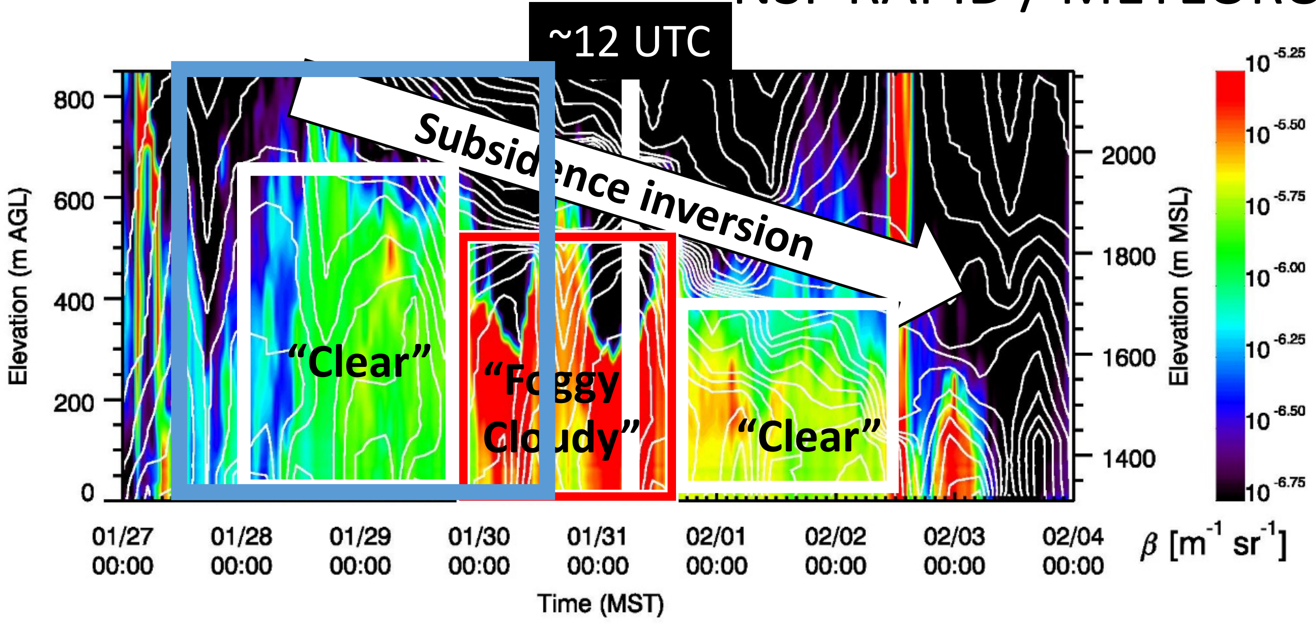


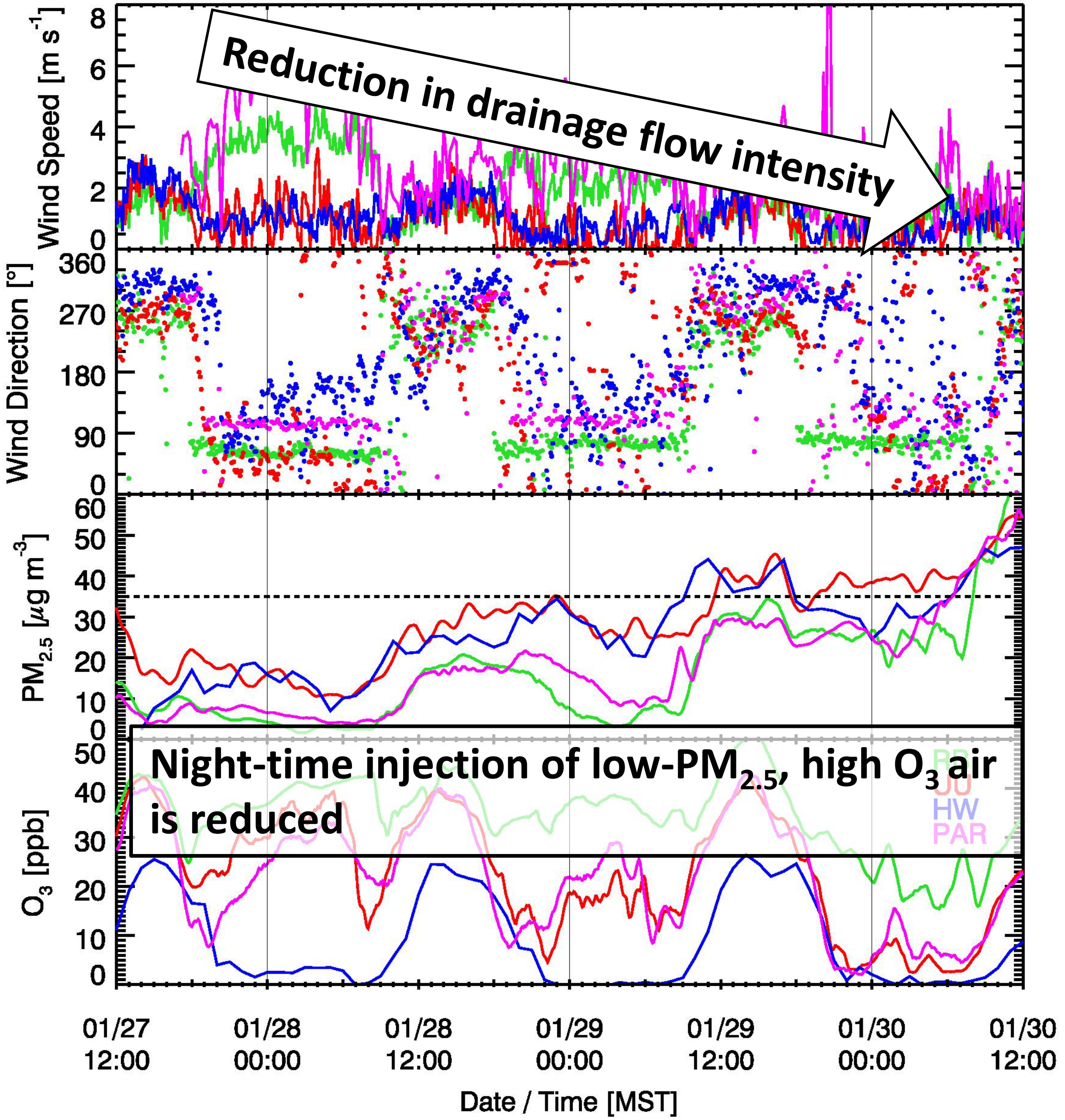


Boundary layer & slope flow evolution in the Salt Lake Valley: Jan. 31, 2017

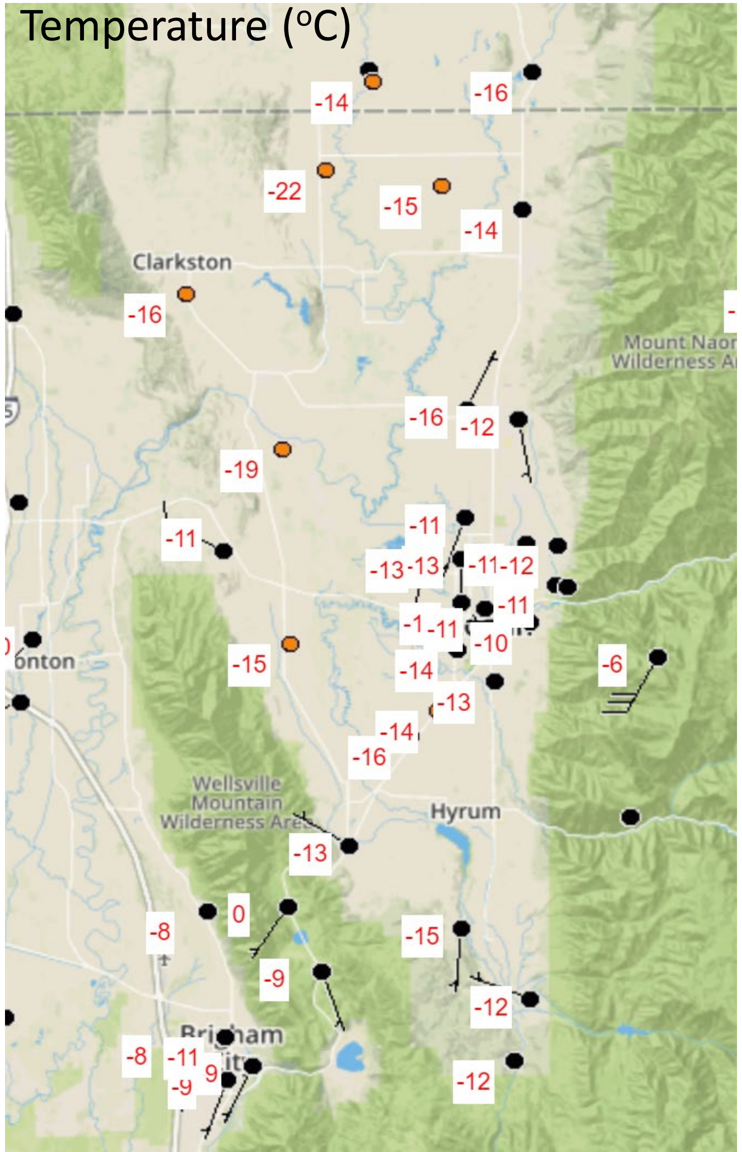
Hoch & Crosman

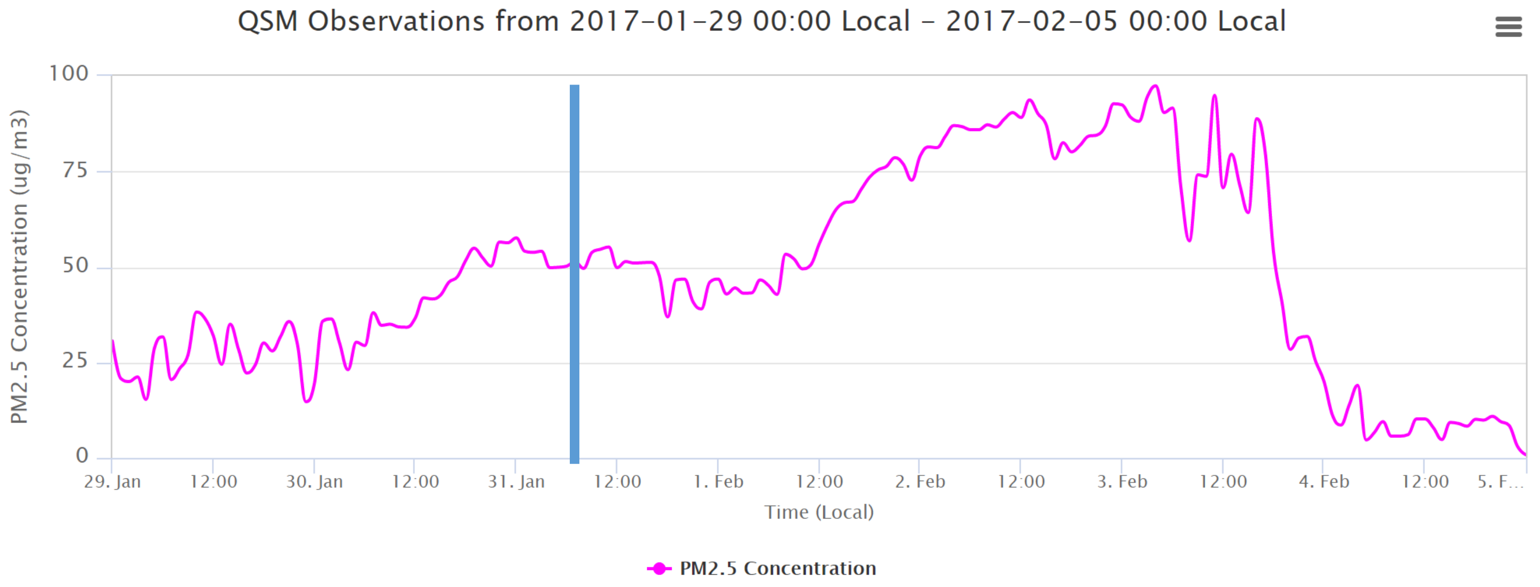
NSF RAPID / METEOROLOGY DURING UWFPS

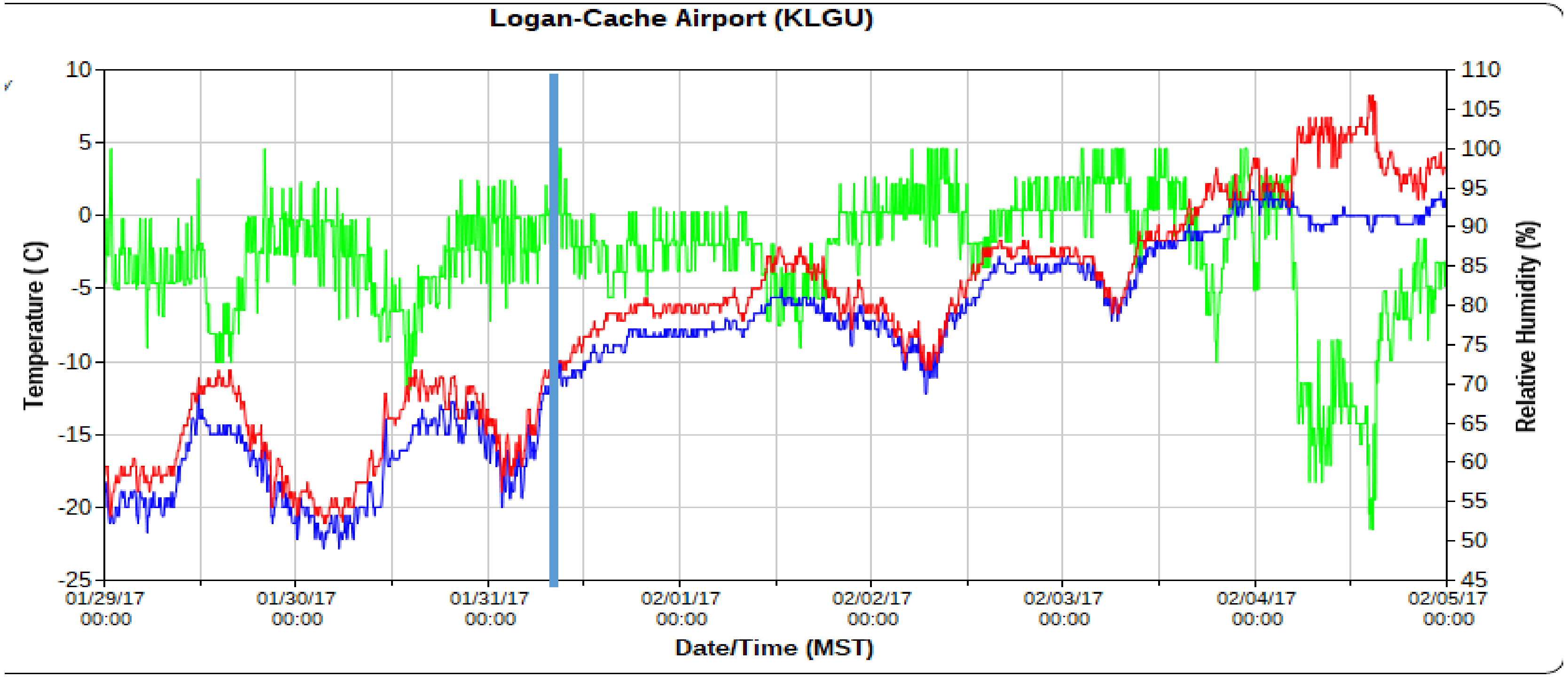




January 31, 2017
Cache Valley, UT







January 31, 2017

Similarities

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

Impacts

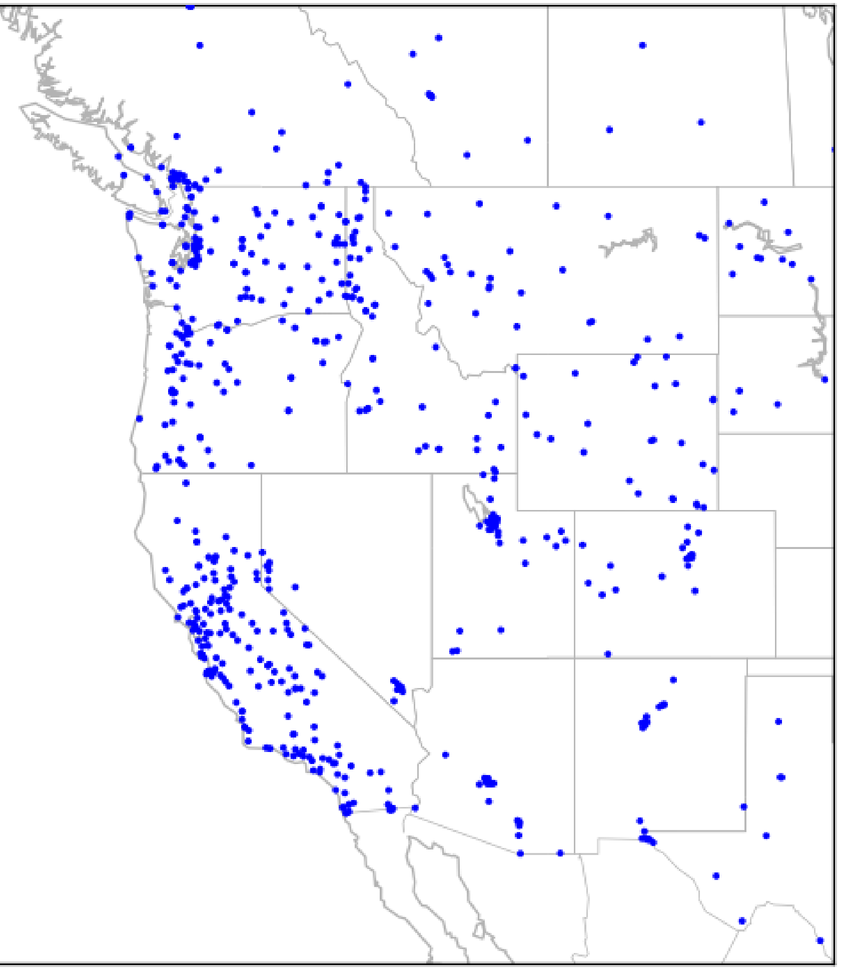
- Temperature dependent reactions
- Heterogeneous, aqueous (warm/ice) phase chemistry
- Changes in night-time injection of low-$PM_{2.5}$ & high O_3

Differences

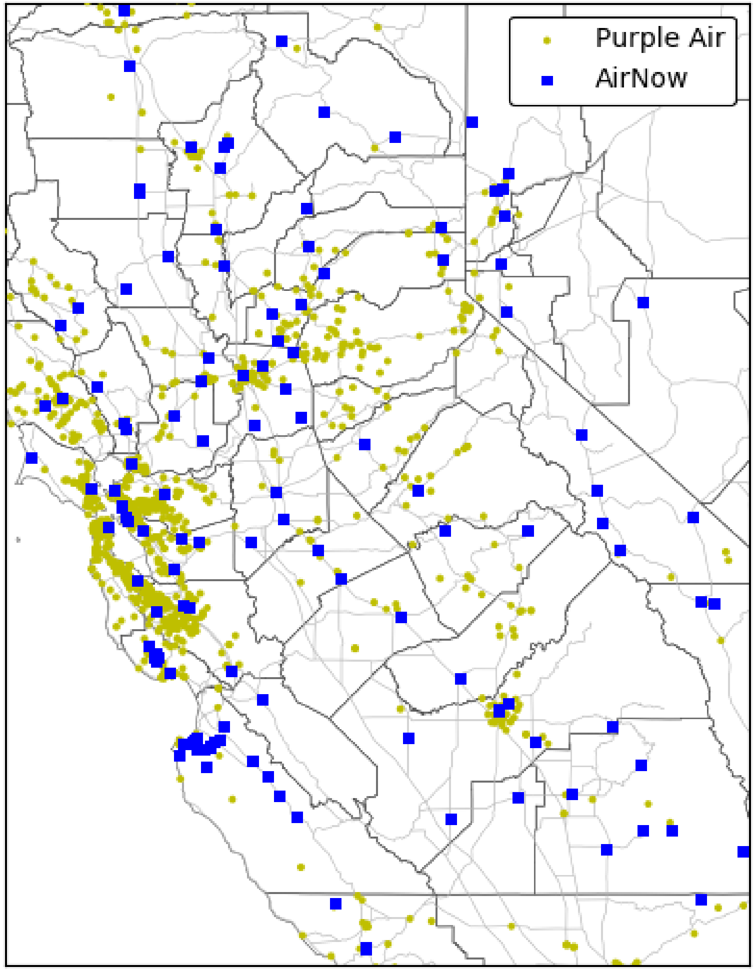
- Snow cover
- Temperature regime
- Boundary layer depth
- Fog/stratus
- Terrain, slope and intrabasin flows

Planning & Situational Awareness Resources: PM2.5

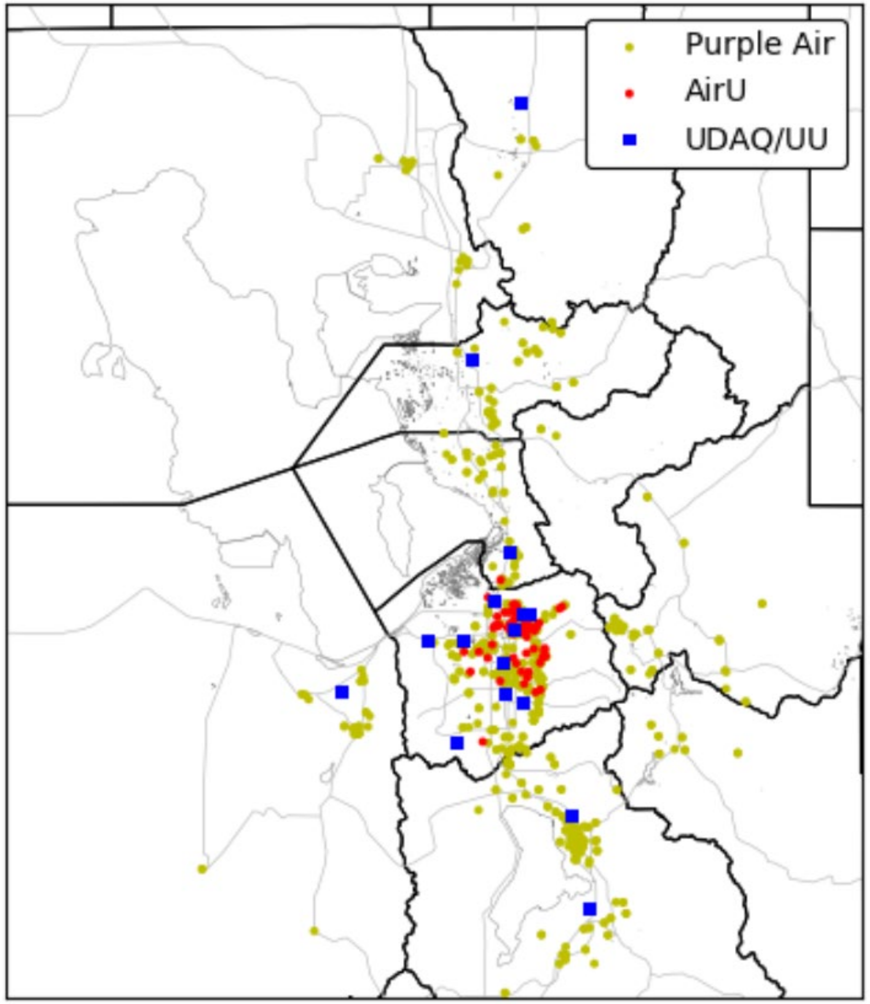
PurpleAir



> 700 state/county locations

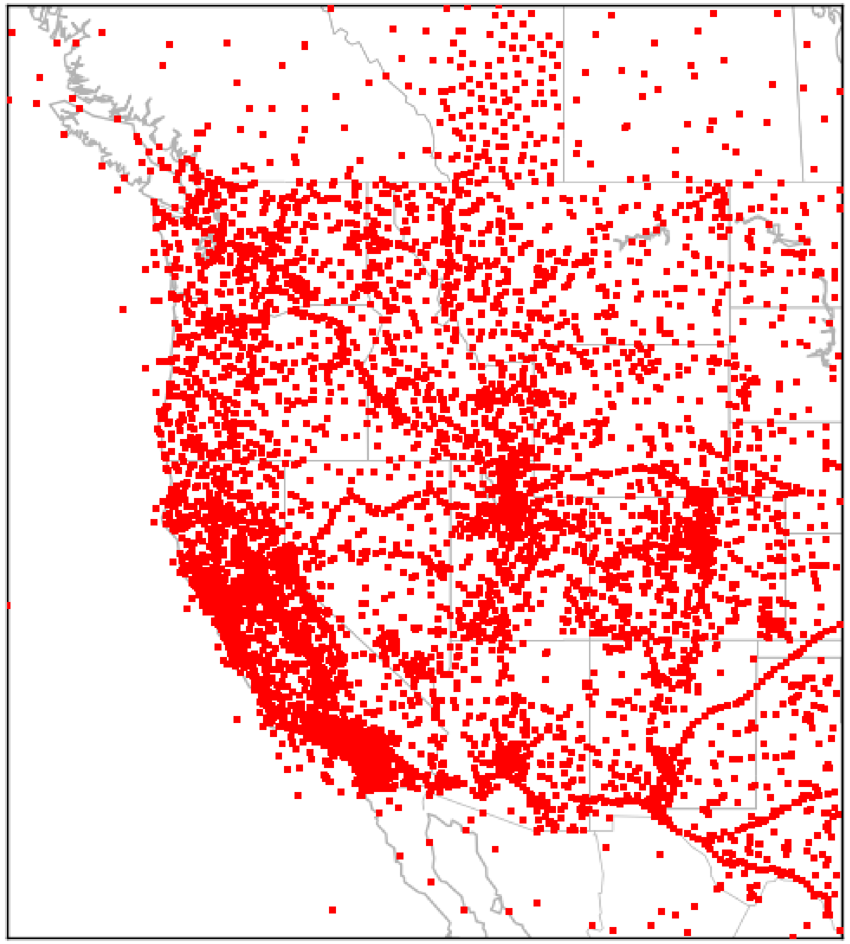


> 130 CARB/county
> ~1400 Purple Air

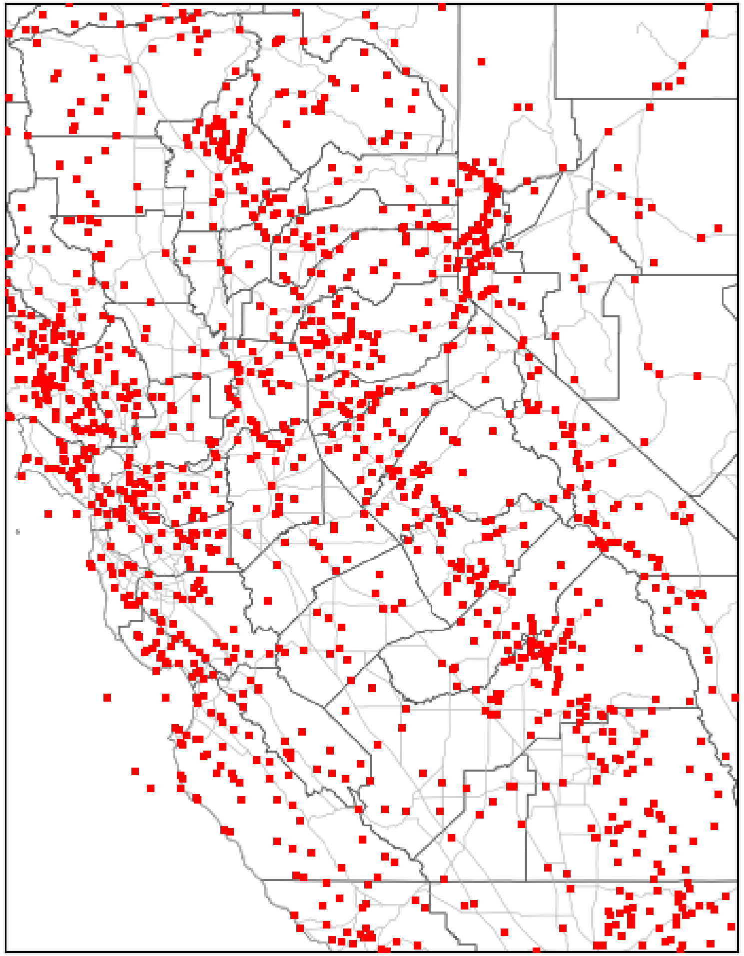


16 DAQ/UUtah
> 90 AirU sites; ~400 Purple Air

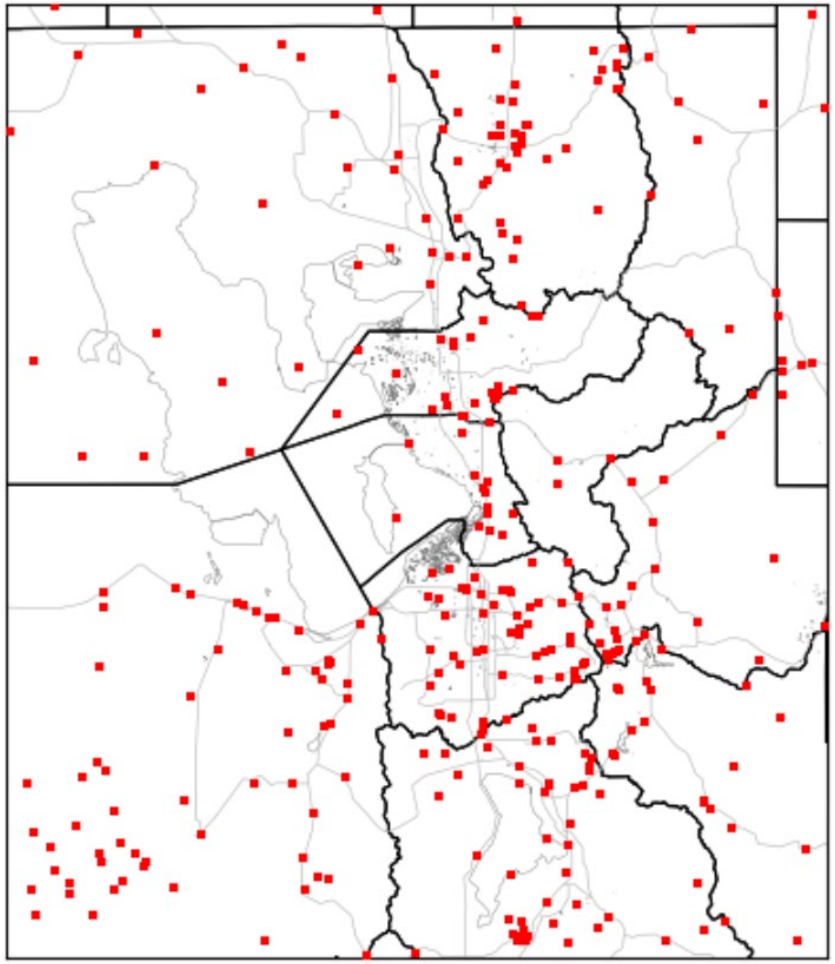
Planning & Situational Awareness Resources: Surface Wind Observations



> 7500 locations



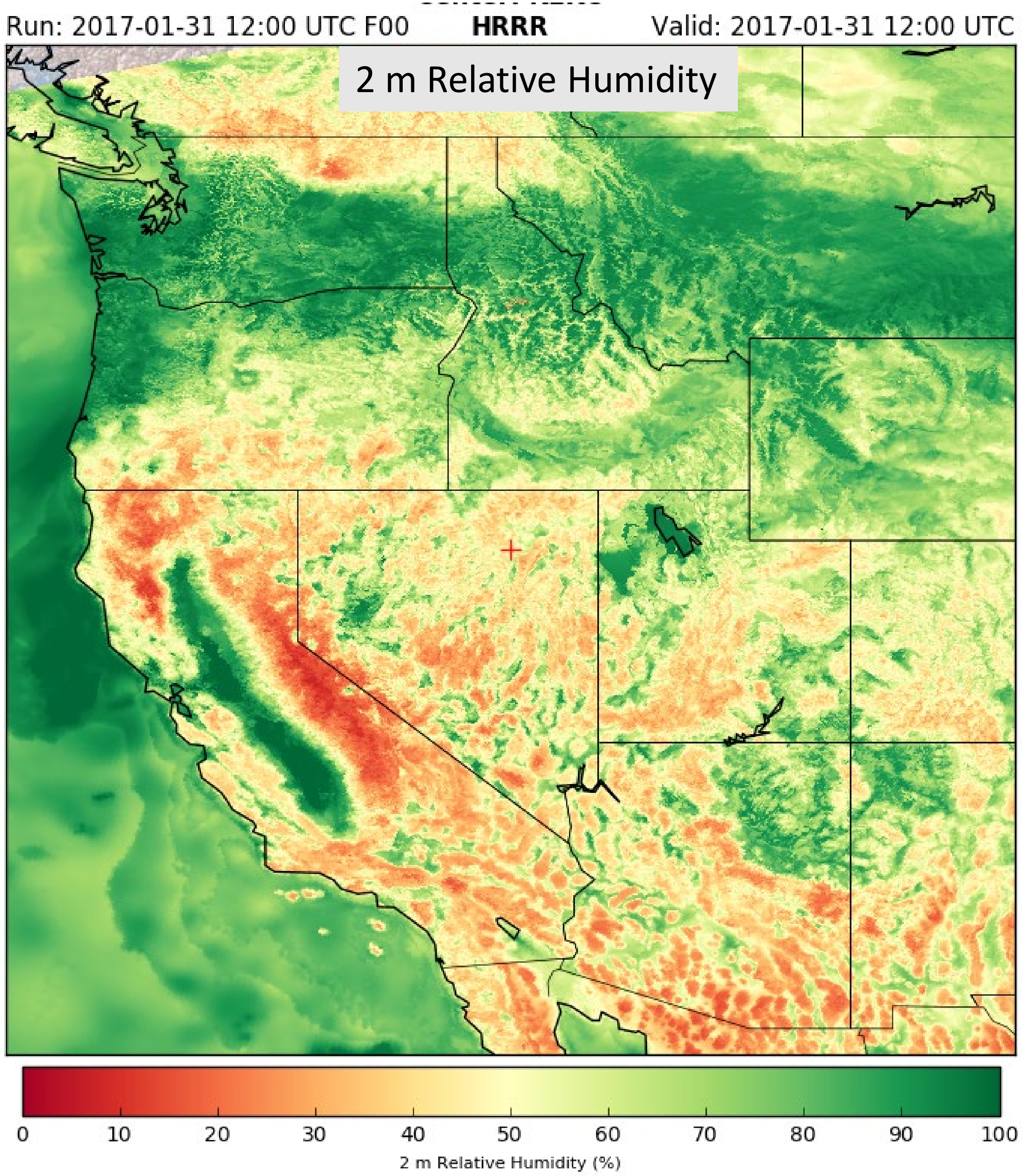
> 1300 locations



> 300 locations

Planning & Situational Awareness

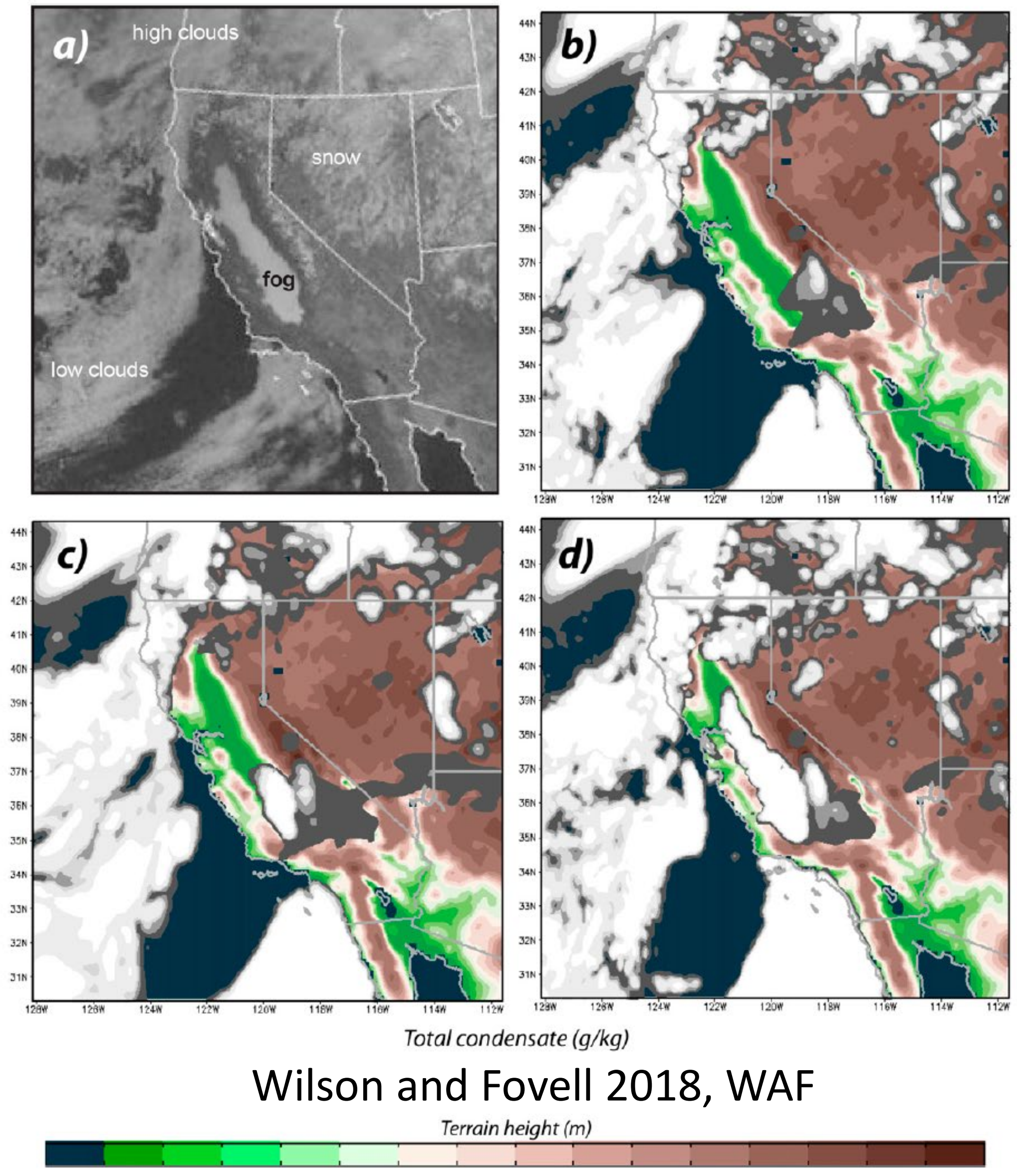
- Synoptic/mesoscale conditions usually simulated adequately by operational models
- But…
  - Breakup phase harder to forecast than onset
  - Transition from clear-air to cloudy boundary layers (and vice versa) difficult
  - Boundary layer processes tend to be overly dispersive/damped



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)

FEBRUARY 2018 WILSON AND FOVELL



Wilson and Fovell 2018, WAF

FIG. 3. (a) Visible satellite image for 1800 UTC 31 Dec 2008 along with simulated total-column condensate fields using (b) the default configuration of horizontal diffusion on model surfaces (diff_opt = 1) and no sixth-order filter, (c) no horizontal diffusion (diff_opt = 0) but with a monotonic and positive-definite sixth-order filter (diff_6th_opt = 2) with the typical setting of diff_6th_factor = 0.12, and (d) no horizontal diffusion and no sixth-order filter. These simulations were made without the 4-km innermost nest.

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

- Mitchell, L. E., and Coauthors, 2018: Monitoring of Greenhouse Gases and Pollutants across an Urban Area using a Light-rail Public Transit Platform. *Atmos. Env.*, **187**, 9-23, doi:10.1016/j.atmosenv.2018.05.044
- Lin, J. C., and Coauthors, 2018: CO2 and Carbon Emissions from Cities: Linkages to Air Quality, Socioeconomic Activity and Stakeholders in the Salt Lake City Urban Area. *Bull. Amer. Meteor. Soc.*, **99**, 2325-2339, doi:10.1175/BAMS-D-17-0037.1
- 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/
- Foster, C., and Coauthors, 2018: Constraining methane emissions in Utah's Uintah Basin with ground-based observations and a time-reversed Lagrangian transport model. *J. Geophys. Res. Atmos*. 122, https://doi.org/10.1002/2017JD027480.
- Crosman, E., A. Jacques, J. Horel, 2017: A Novel Approach for Monitoring Vertical Profiles of Boundary-Layer Pollutants: Utilizing Routine News Helicopter Flights. *Atmospheric Pollution Research.* 8, 828-835. http://dx.doi.org/10.1016/j.apr.2017.01.013
- 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
- Crosman, E., J. Horel, 2017: Large-eddy simulations of a Salt Lake Valley cold-air pool. *Atmospheric Research.* 193, 10–25. http://10.1016/j.atmosres.2017.04.010