5B.5

A Review of the Summer 2022 Ozone Field Study in Northern Utah



Alexander A. Jacques, *John D. Horel, Colin Johnson, Sebastian W. Hoch, and Aaron McCutchan*
Department of Atmospheric Sciences, University of Utah

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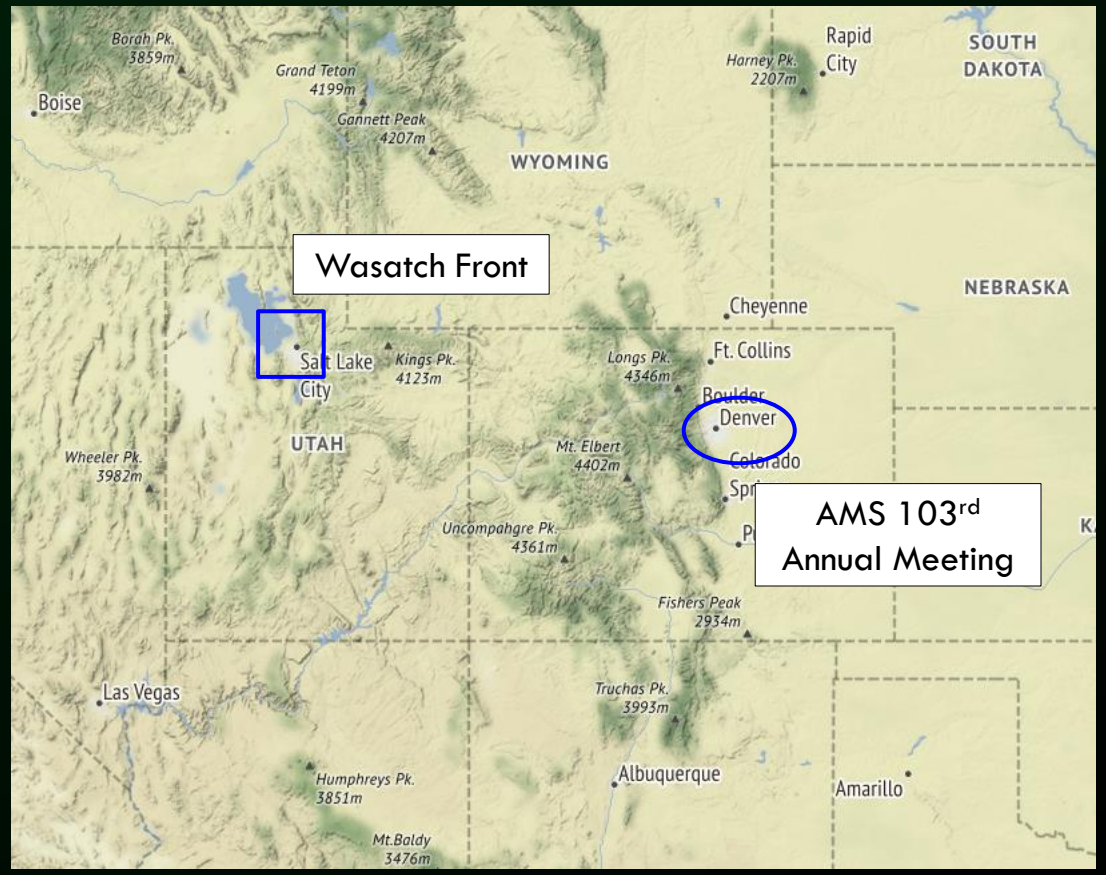
THE UNIVERSITY OF UTAH

Introduction and Motivations

- Greater Wasatch Front currently out of attainment for NAAQS ozone standard
  - State Implementation Plan (SIP) action items under development to address known anthropogenic sources of ozone precursors
  - Further action expected to be necessary in years to come

Salt Lake City

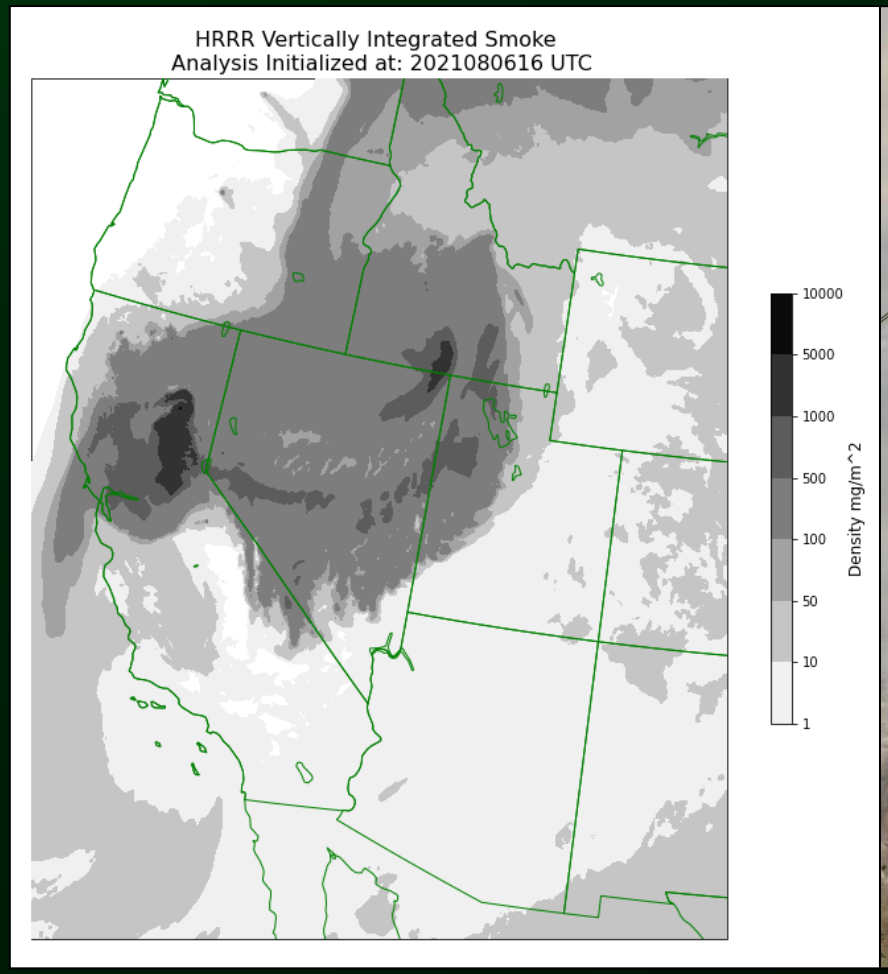


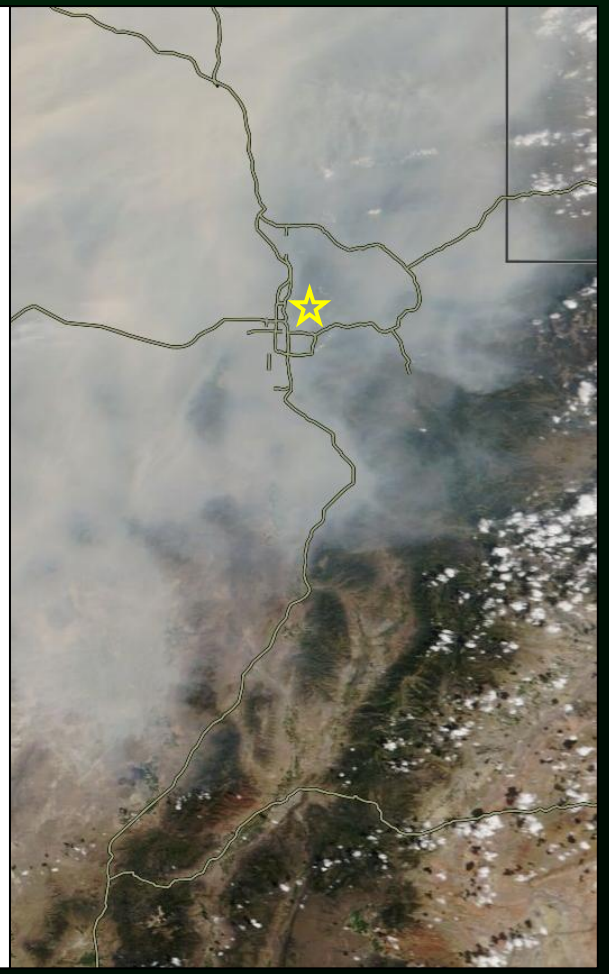
Wasatch Front

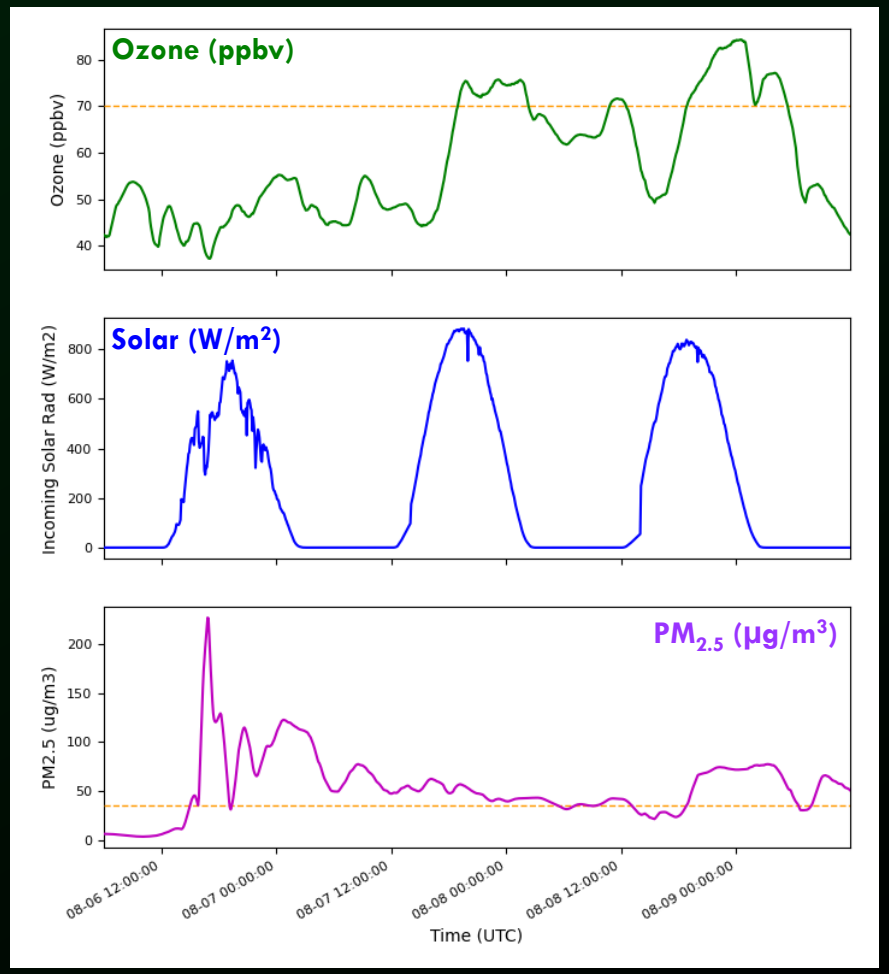
AMS 103rd Annual Meeting

Introduction and Motivations

- Increases in local and regional wildfire activity introduce additional factors
  - Impacts of smoke on ozone formation not straightforward
  - Simultaneous impacts on health due to high ozone and particulate matter exposure

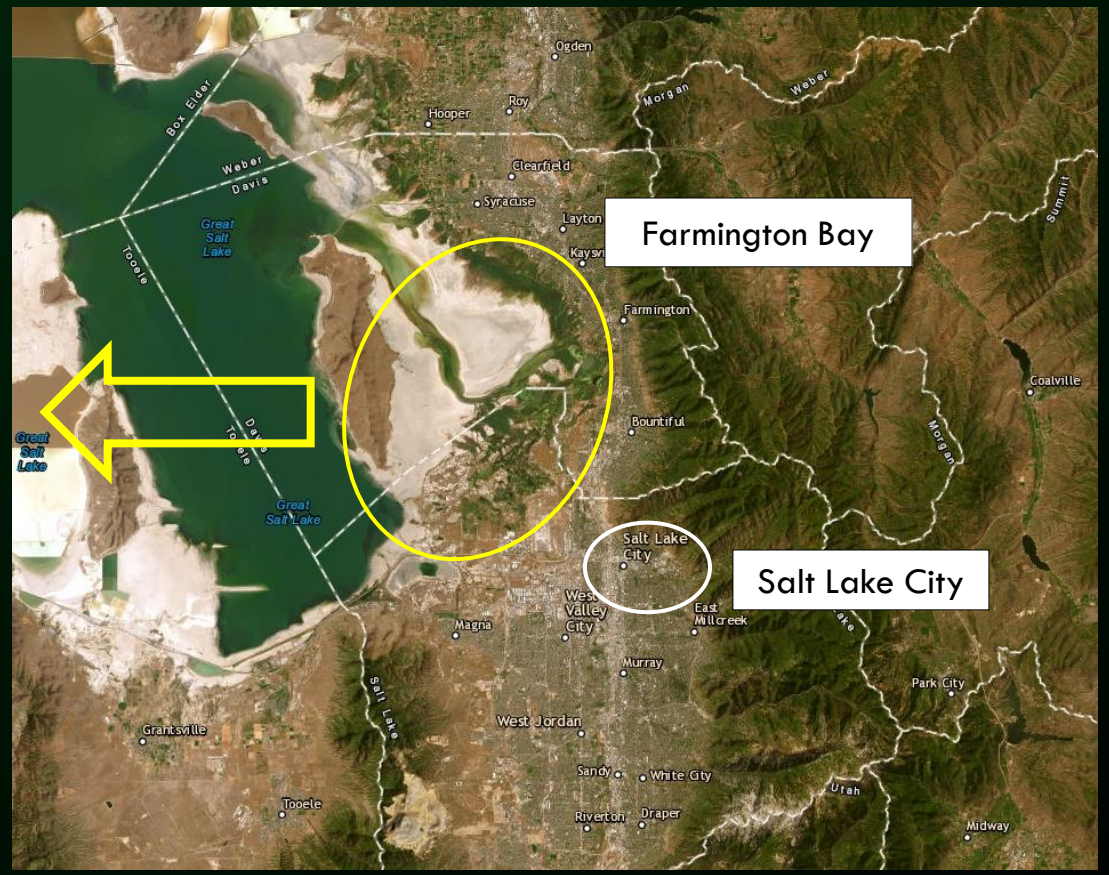






Summer 2022 Study - Project Initiatives

- Previous research (e.g., Horel et al. 2016, Blaylock et al. 2017) identified the Farmington Bay region as a potential source location for local ozone formation



- Project funded by Utah Division of Air Quality to further investigate high ozone within the Farmington Bay region w.r.t. local meteorology and land surface characteristics

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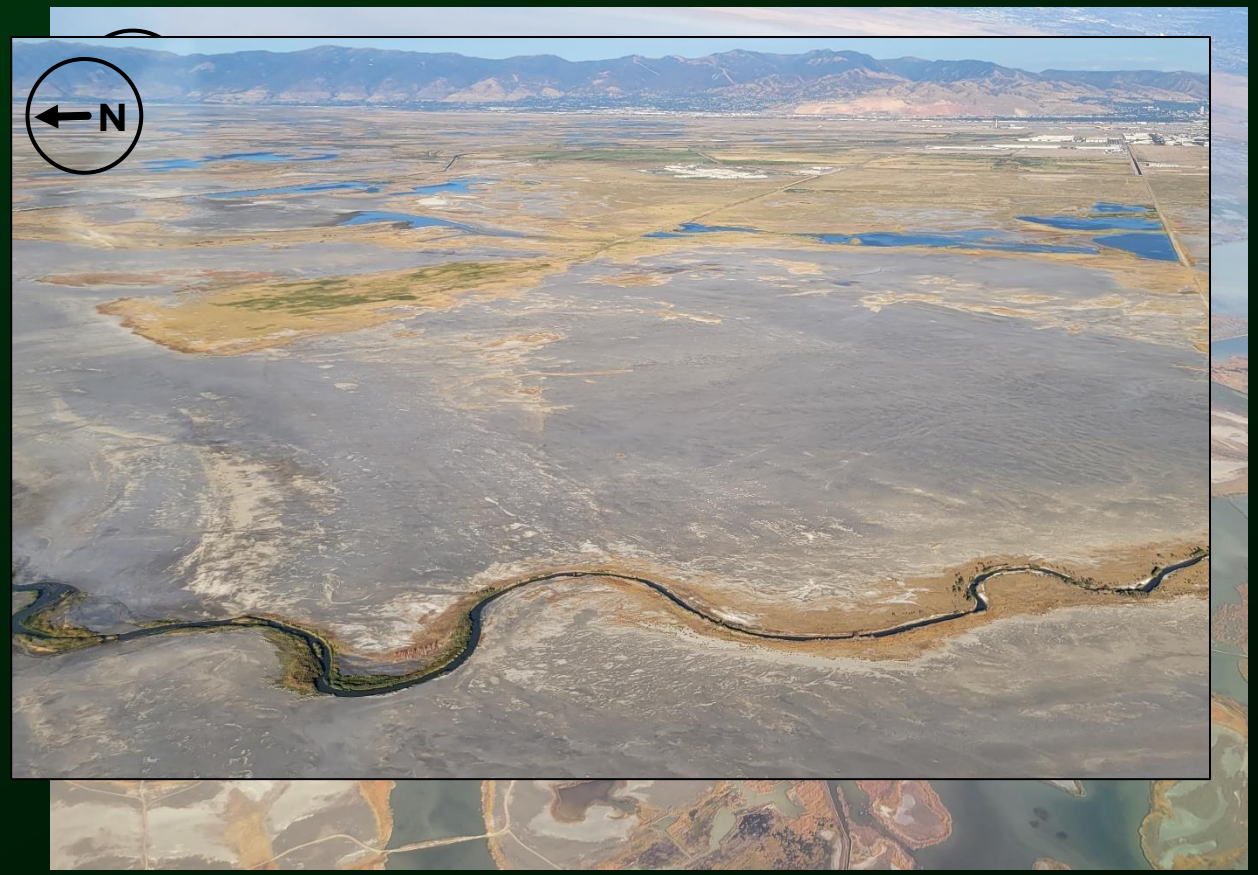

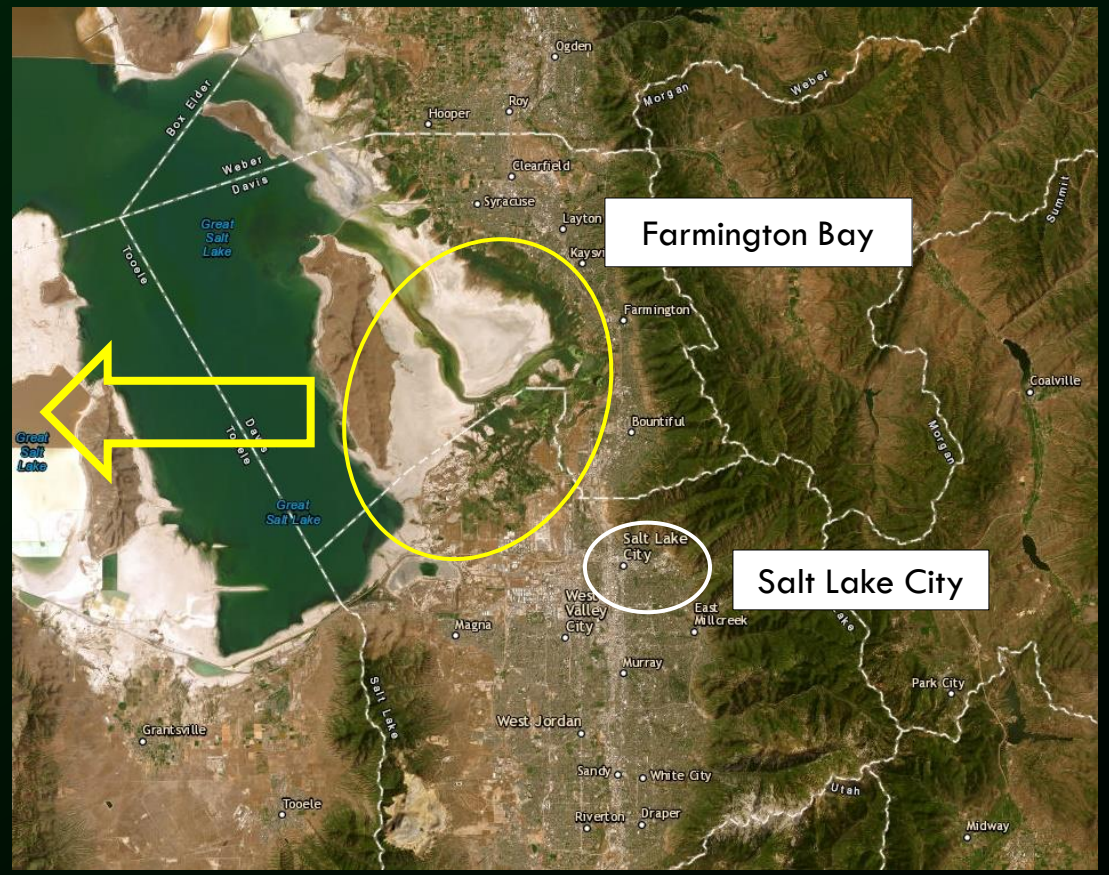

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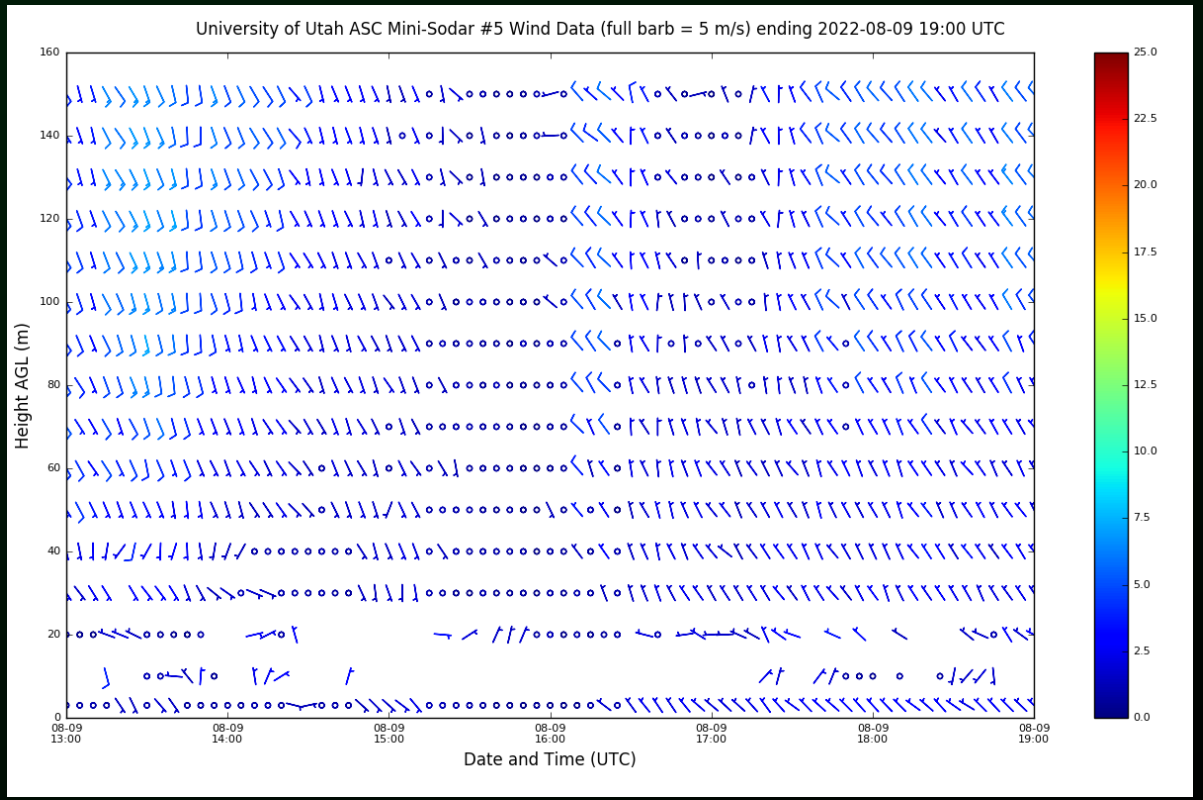
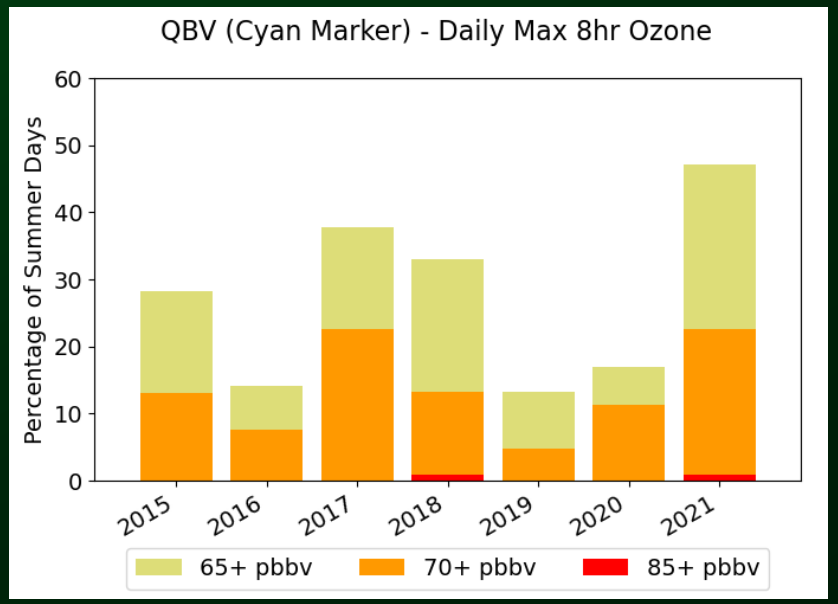
Summer 2022 Study - Project Initiatives

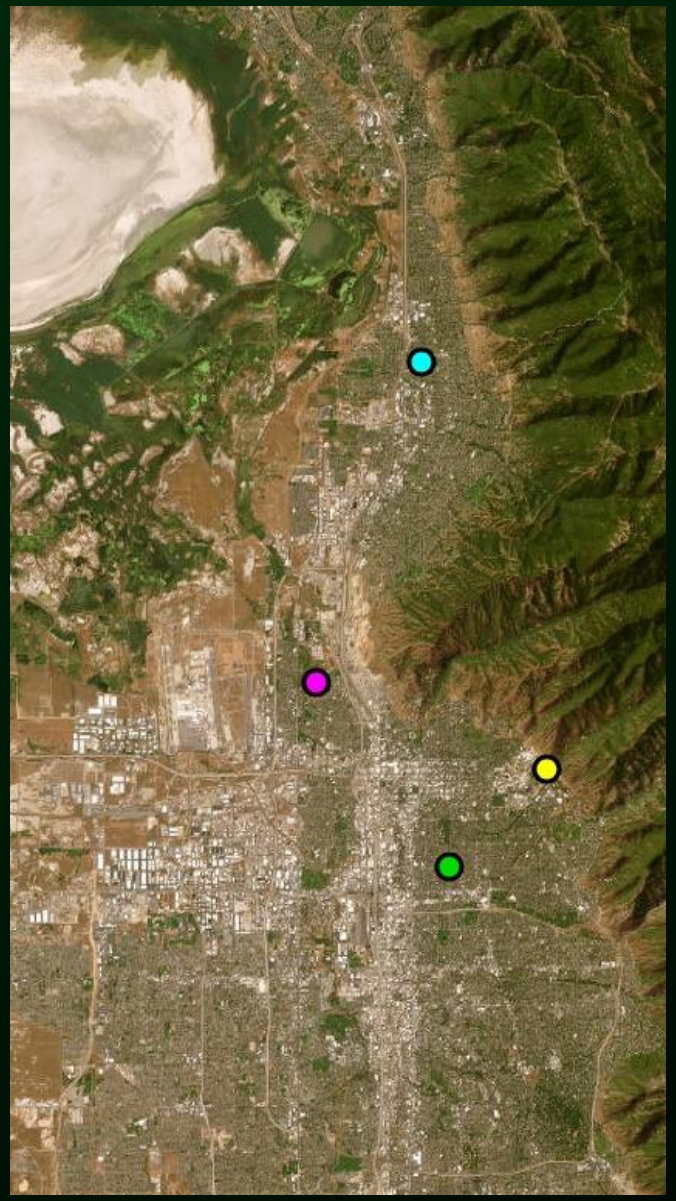
- ***Task 1:*** Review previous 7 summer seasons (2015-2021) for high ozone events adjacent to Farmington Bay region

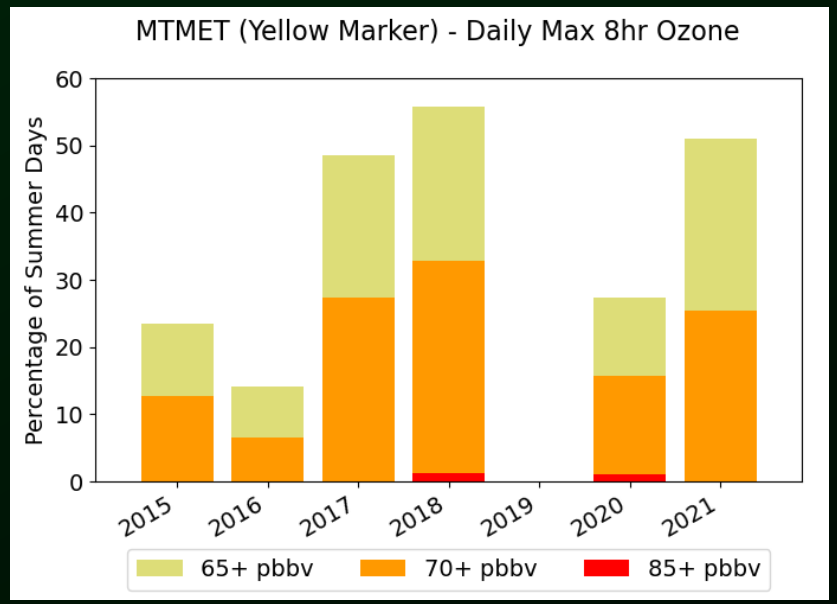
- ***Task 2:*** Deploy additional ozone, meteorological, and boundary layer monitoring equipment near Farmington Bay for summer 2022 to document and evaluate ozone episodes w.r.t. local meteorological conditions

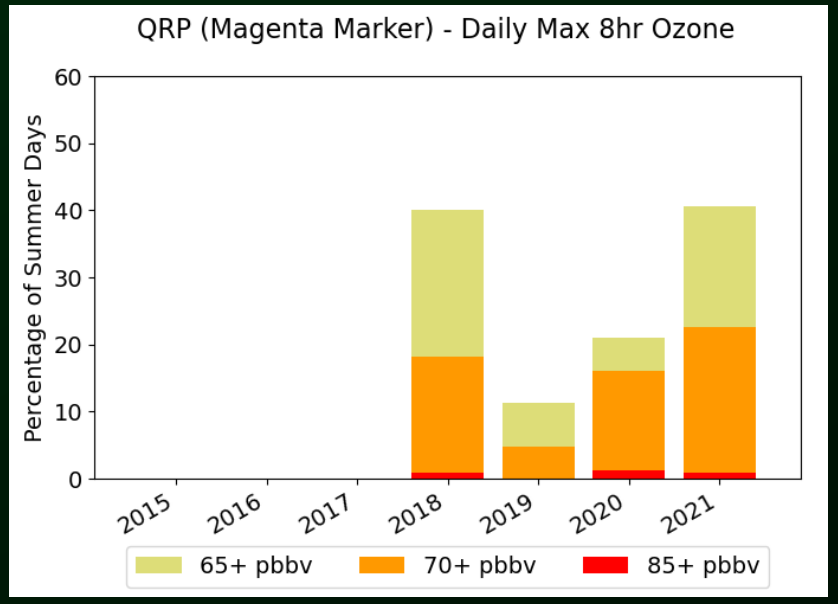


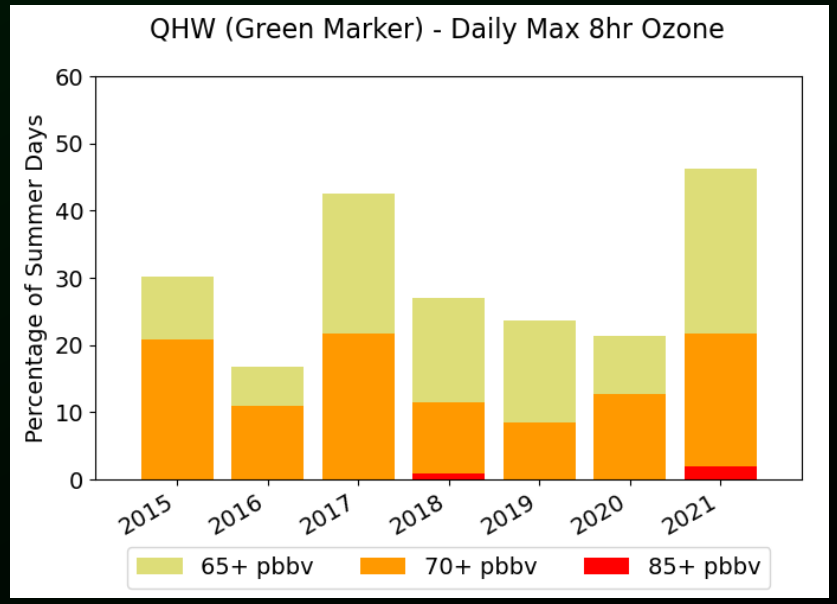
2015-2021 Summer Ozone Exceedances





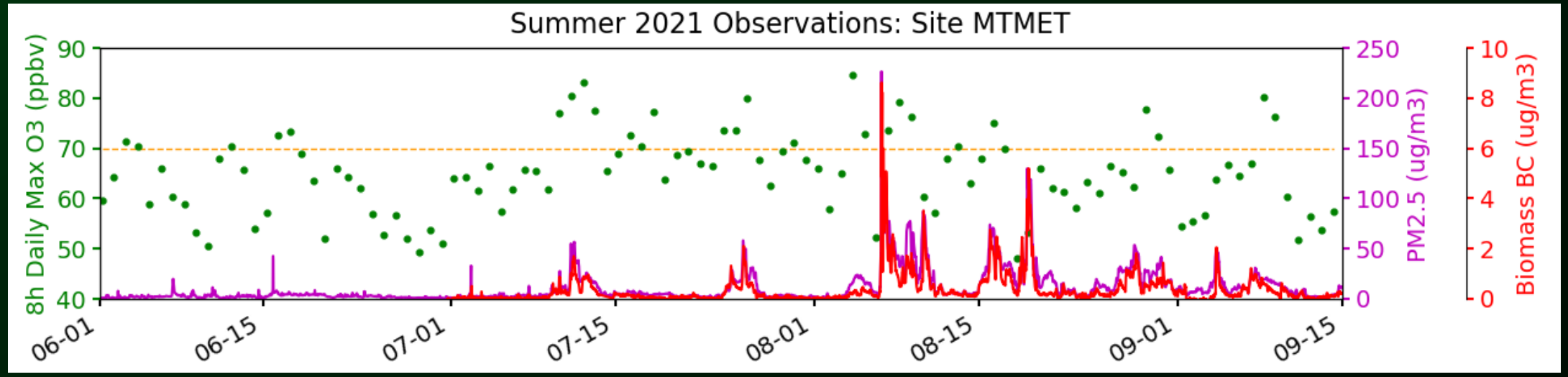




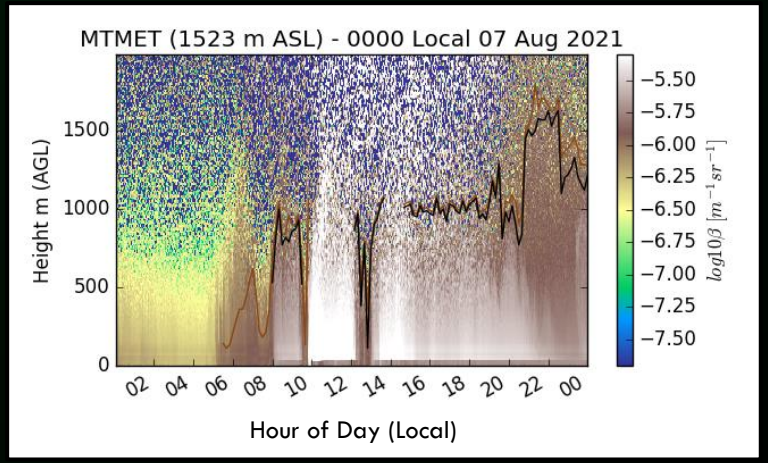


Summer 2021 Wildfire Impacts

- July-September 2021 heavily influenced by wildfire smoke

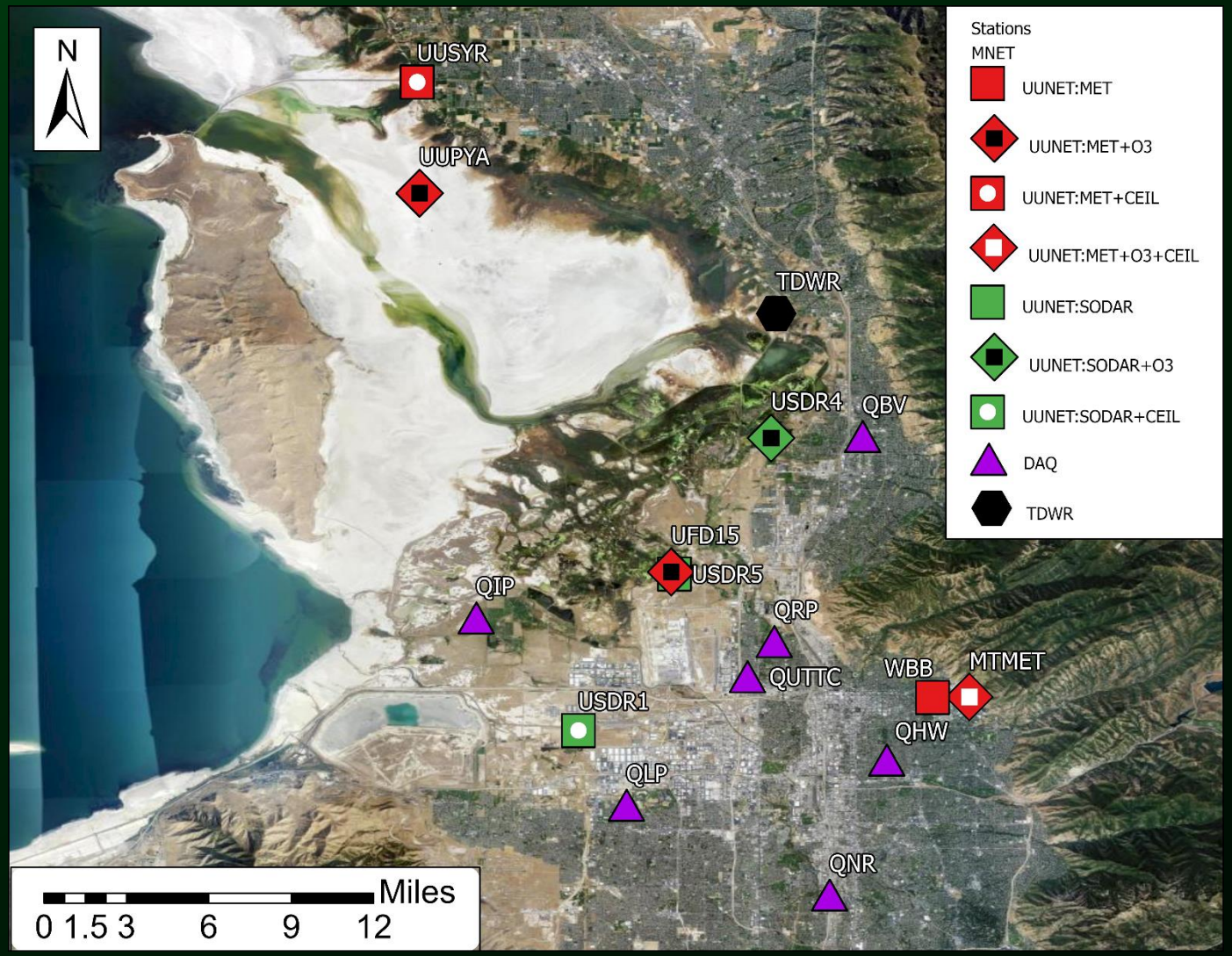


- Case Example: 6-9 August 2021
  - 6 August: Frontal passage - strong post-frontal mixing and very dense smoke held ozone concentrations closer to background levels (site MTMET: max 8hr O_3 52 ppbv)
  - 7-9 August: Remaining smoke, light winds, increased solar resulted in daily 8hr avg O_3 exceeding NAAQS standard (74, 79, and 76 ppbv respectively)



Summer 2022 Study - Instrumentation

- 2022 Study Period: 15 June – 15 September



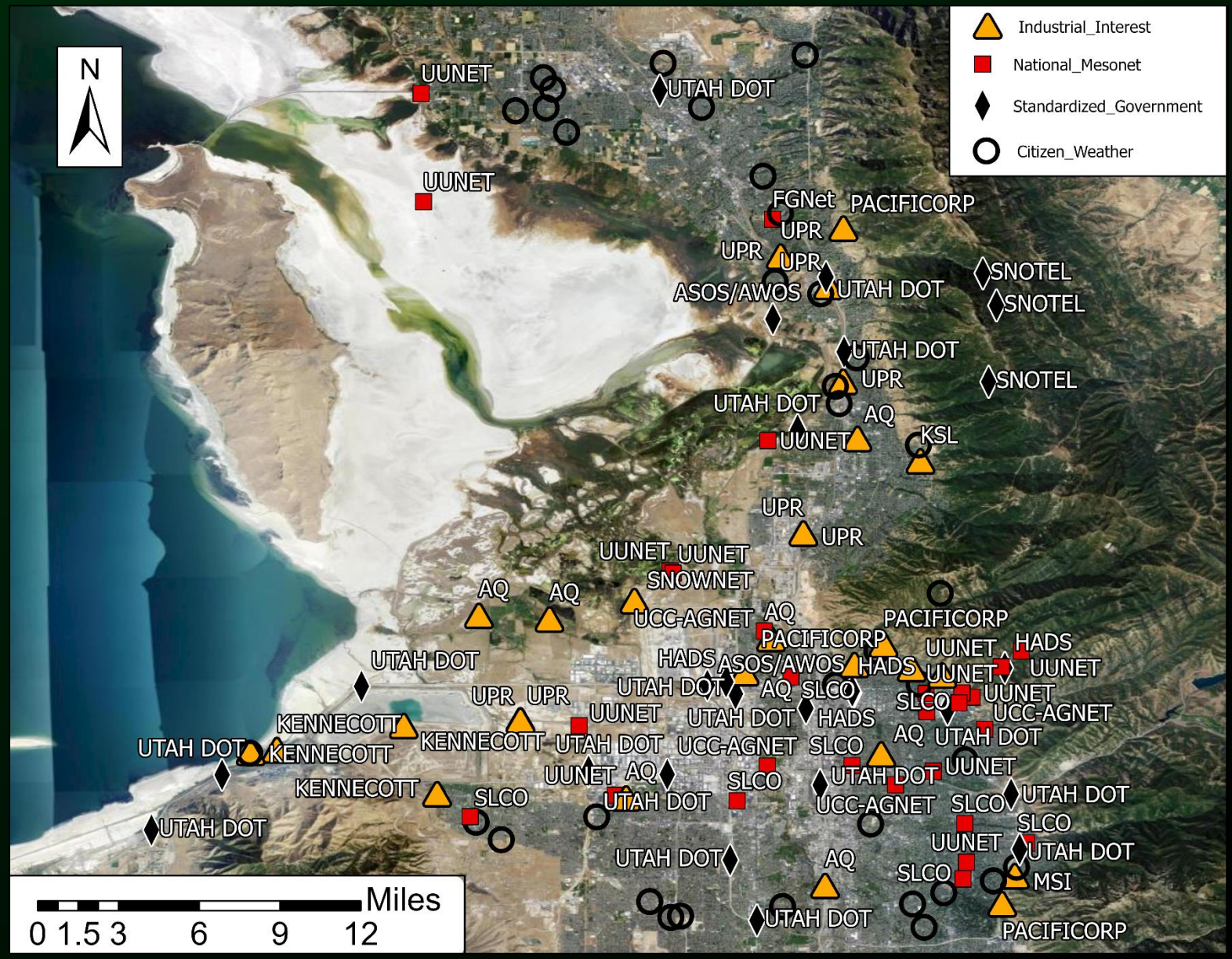
Site / Provider	Measurements
***UFD15** - UU 2022 Ozone Trailer	Met, Albedo, O_3
***UUPYA** - UU Playa Research	Met, Albedo, O_3
USDR1 - UU MiniSodar1	PBL Winds, Ceilometer
***USDR4** - UU MiniSodar4	PBL Winds, O_3
***USDR5** - UU MiniSodar5	PBL Winds
UUSYR - UU Syracuse	Met, Ceilometer
MTMET - UU Mountain Meteorology Lab	Met, Solar, O_3, $PM_{2.5}$, Ceilometer
WBB - UU William Browning Building	Met, Solar
DAQ - Utah Division of Air Quality Stations	Met, Solar, O_3, $PM_{2.5}$
TDWR - Terminal Doppler Weather Radar	C-Band Radar

** Deployed for Summer 2022*

Summer 2022 Study - Additional Data Resources

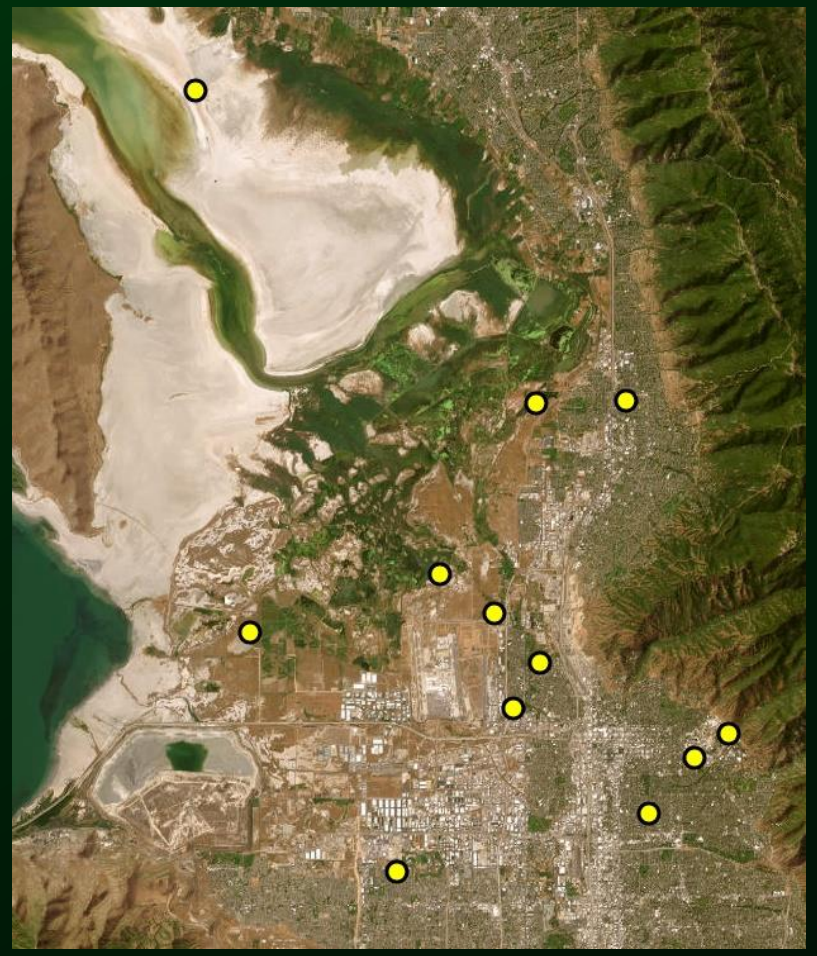
- Many publicly-accessible surface weather stations available from variety of providers (government, industry, citizen science, etc. - https://mesowest.utah.edu/, https://synopticdata.com/)

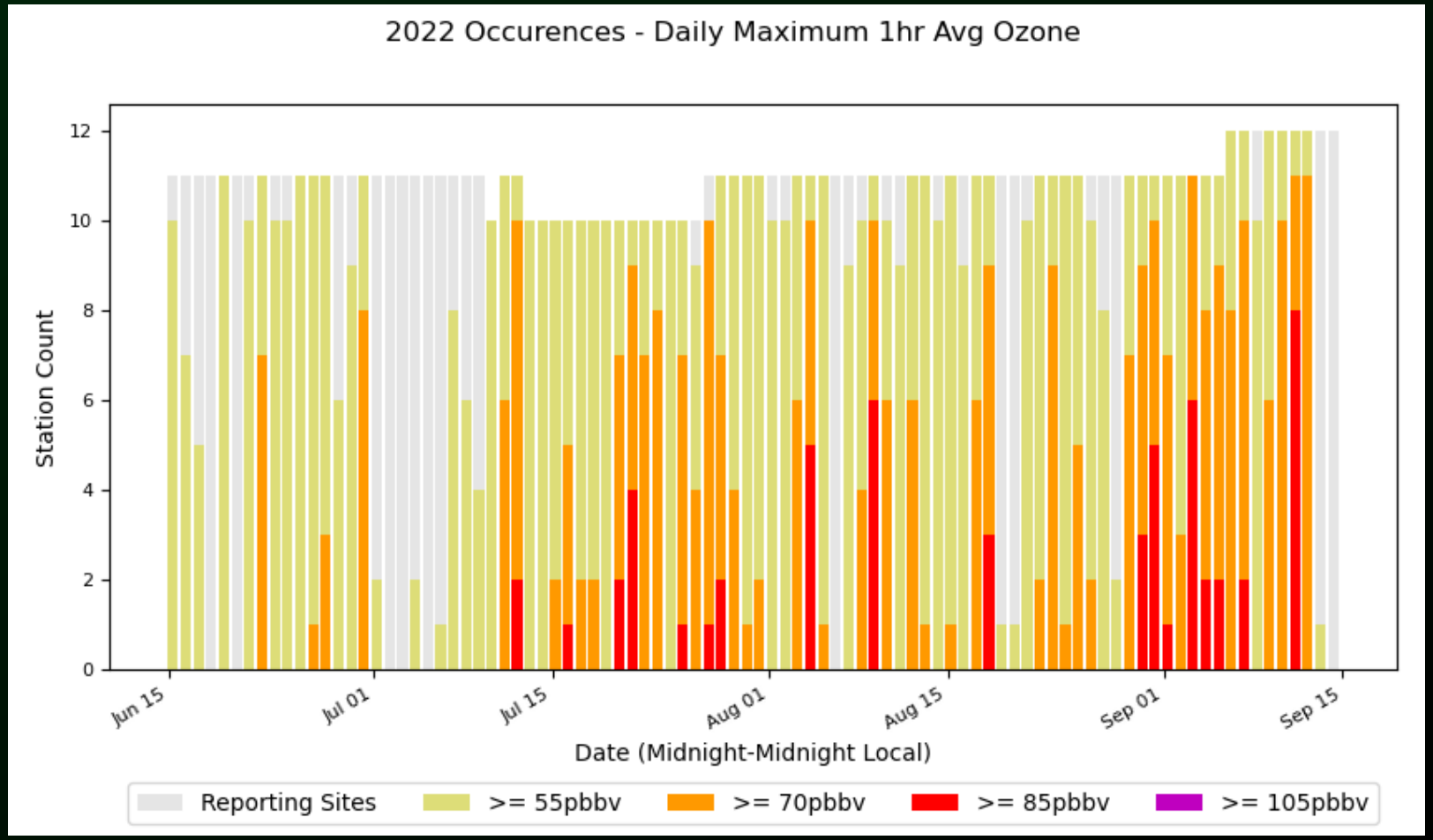
- Additional research-grade mobile platform air quality systems (light rail, electric bus, news helicopter - https://utahaq.chpc.utah.edu/)



Summer 2022 Study - Ozone Episode Occurrences

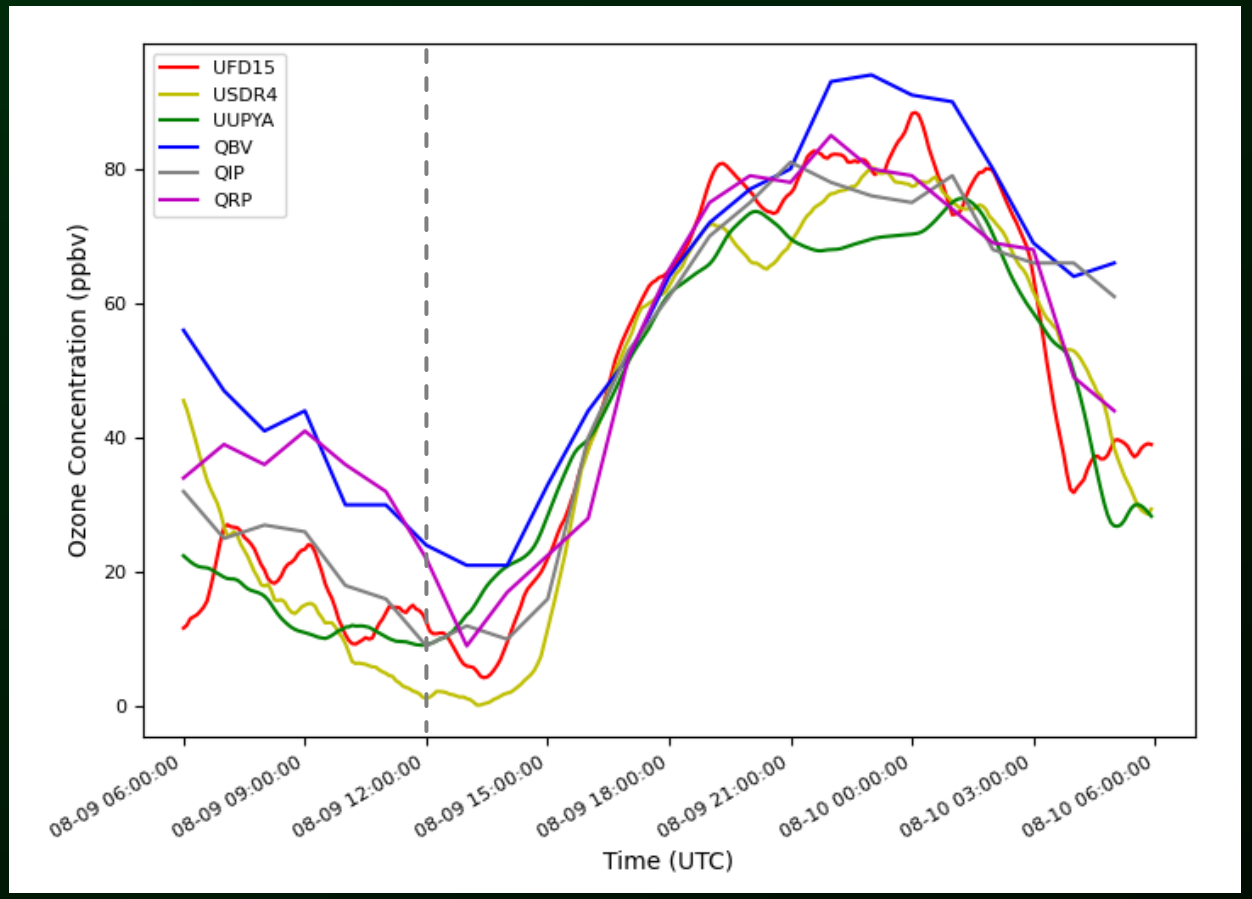
- 2022 High Ozone Events (70+ ppbv) primarily occurred in second half of summer
  - Percentage of summer days with high ozone close to 2015-2021 median
  - June and early portion of July dominated by synoptically active weather pattern

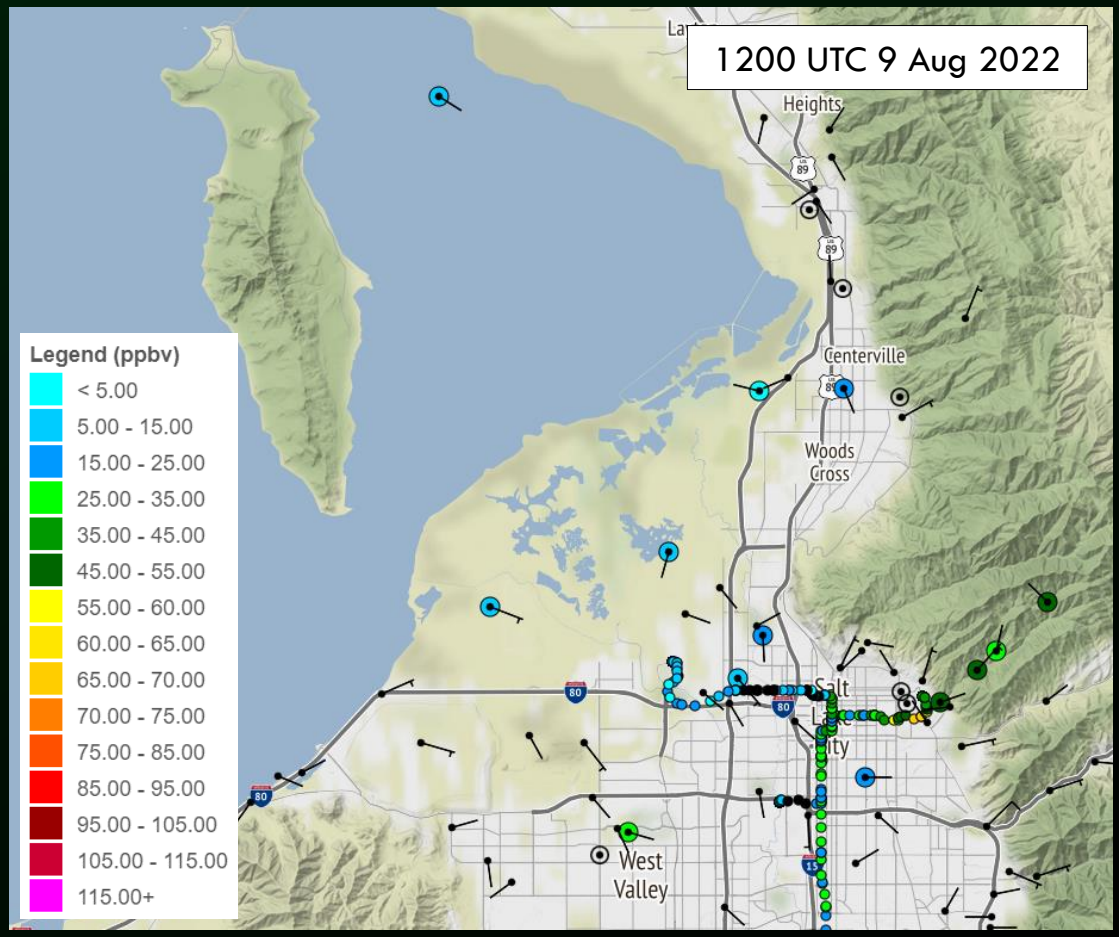




Summer 2022 Study - Case Event I: 9 August 2022

- Northern Utah on western edge of upper level ridge that was moving east
  - Very hot temperatures (KSLC high 37.2 C) and wind patterns dictated by local thermally-driven flows due to terrain
  - Monsoon moisture remained suppressed





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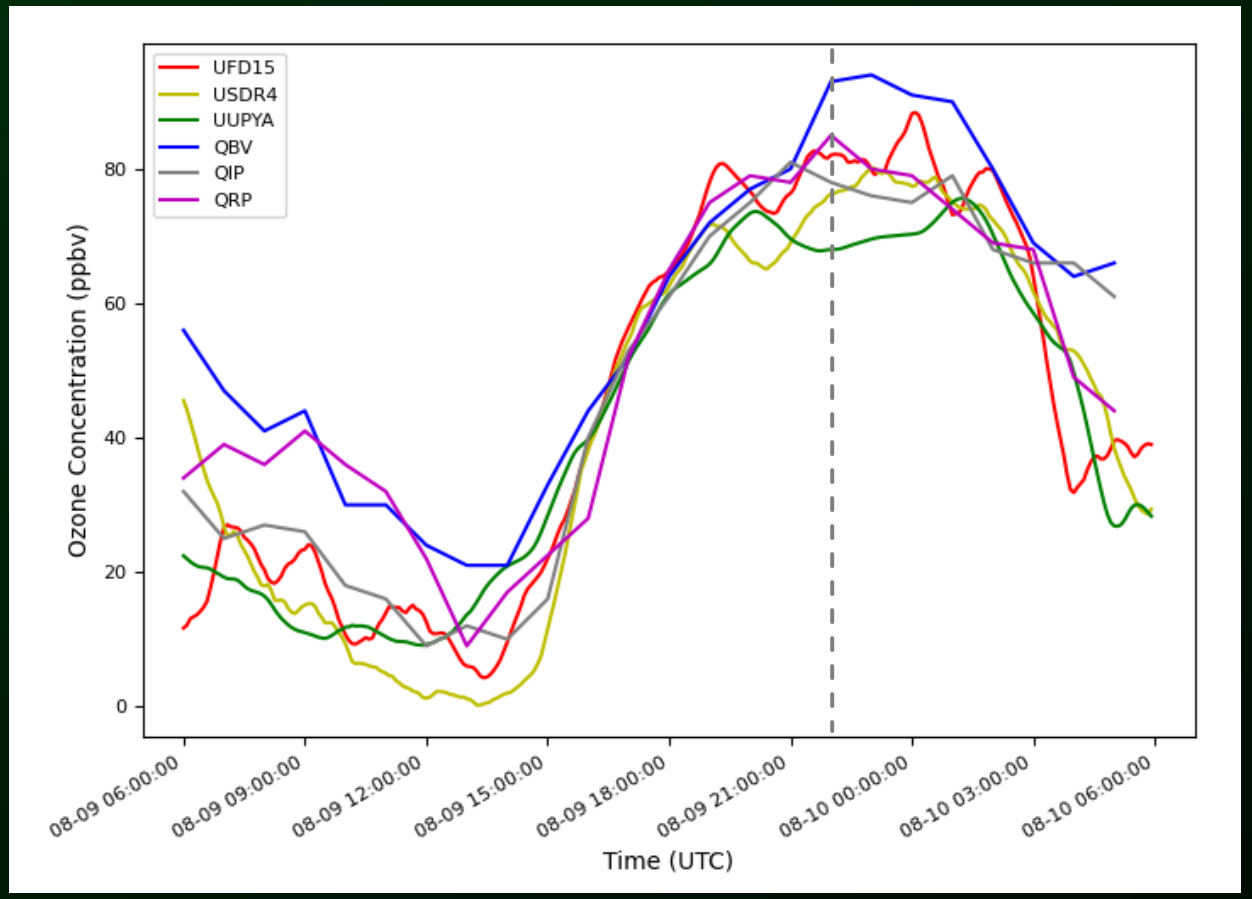
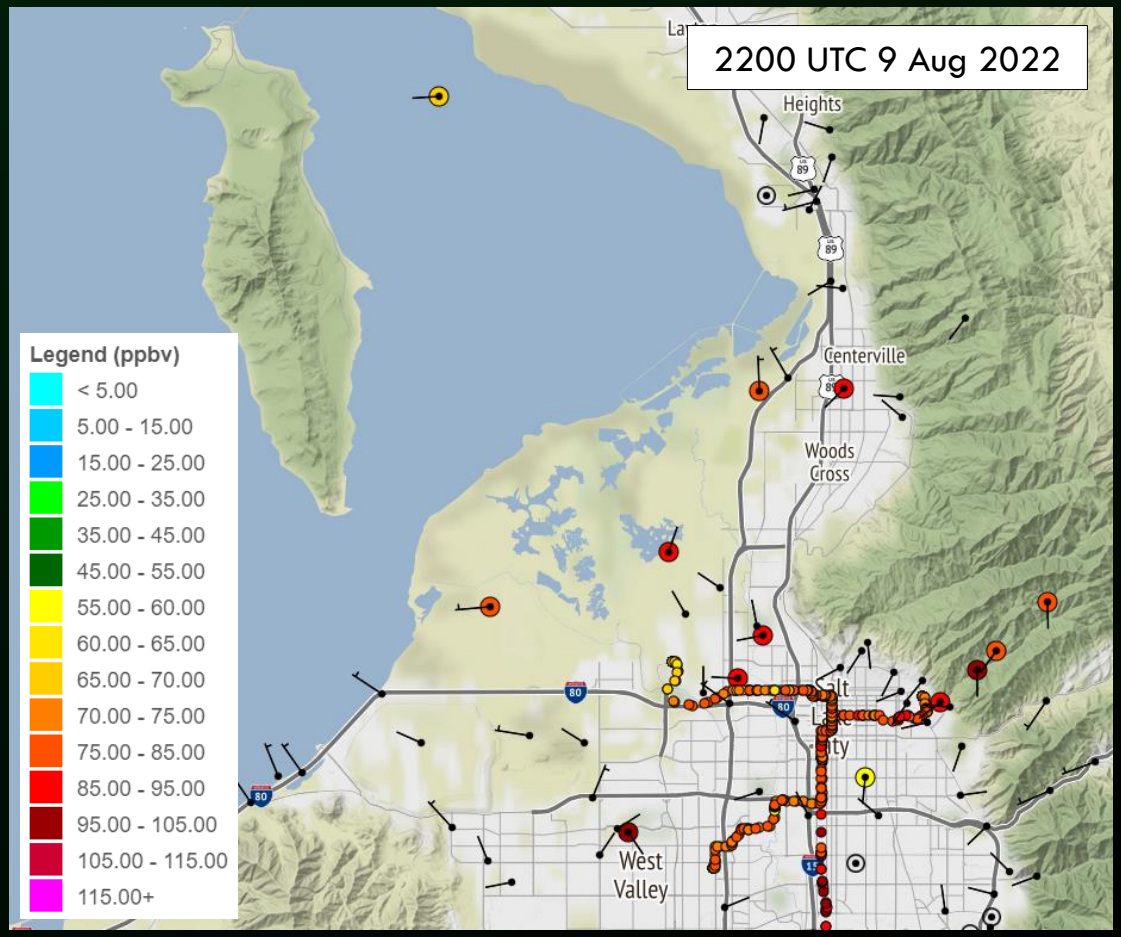
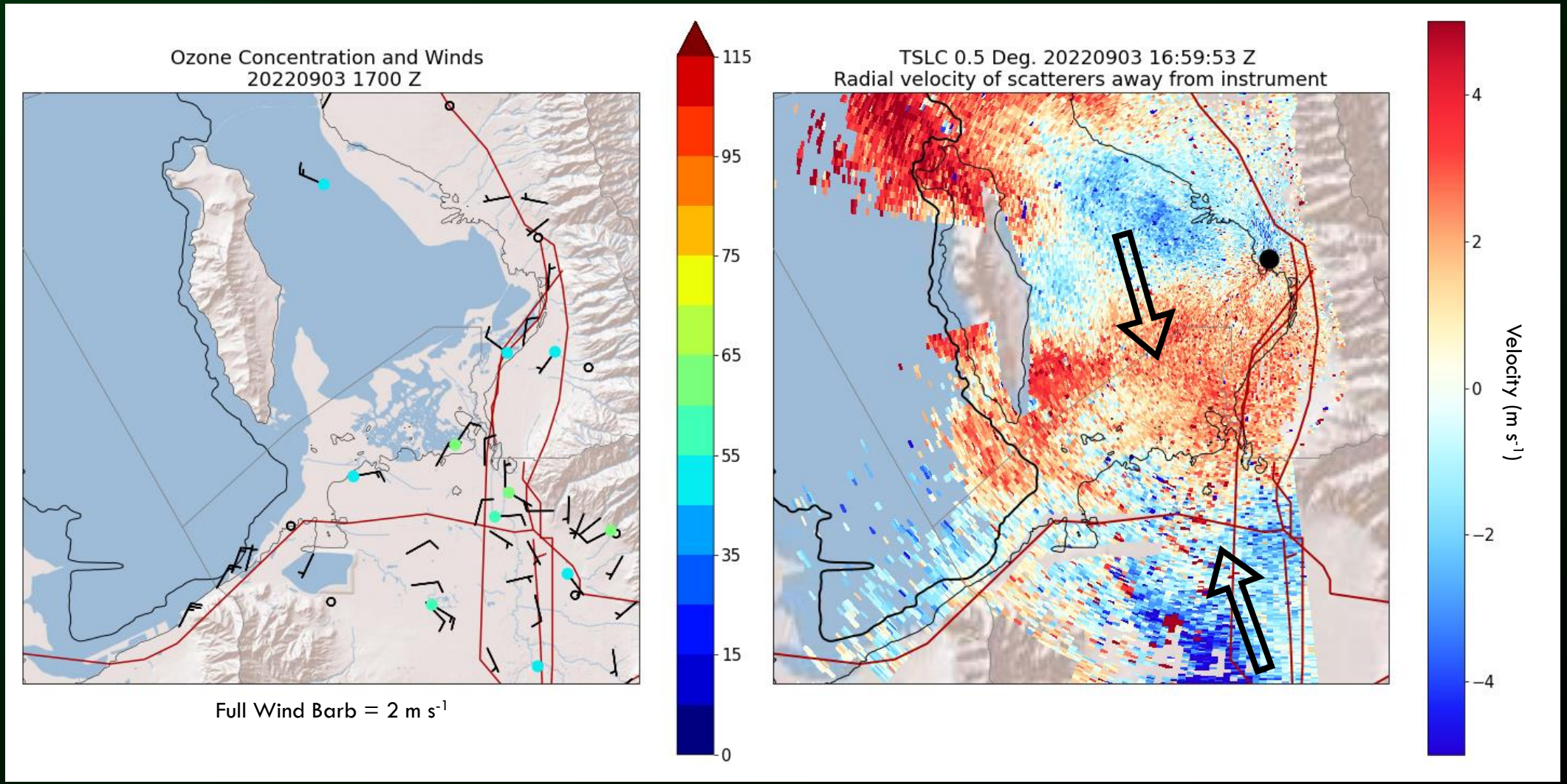




Summer 2022 Study - Case Event II: 3 September 2022

- Salt Lake City Terminal Doppler Weather Radar (TDWR) detected presence of lake breeze and flow reversal from 1700-2000 UTC as ozone increased near Farmington Bay



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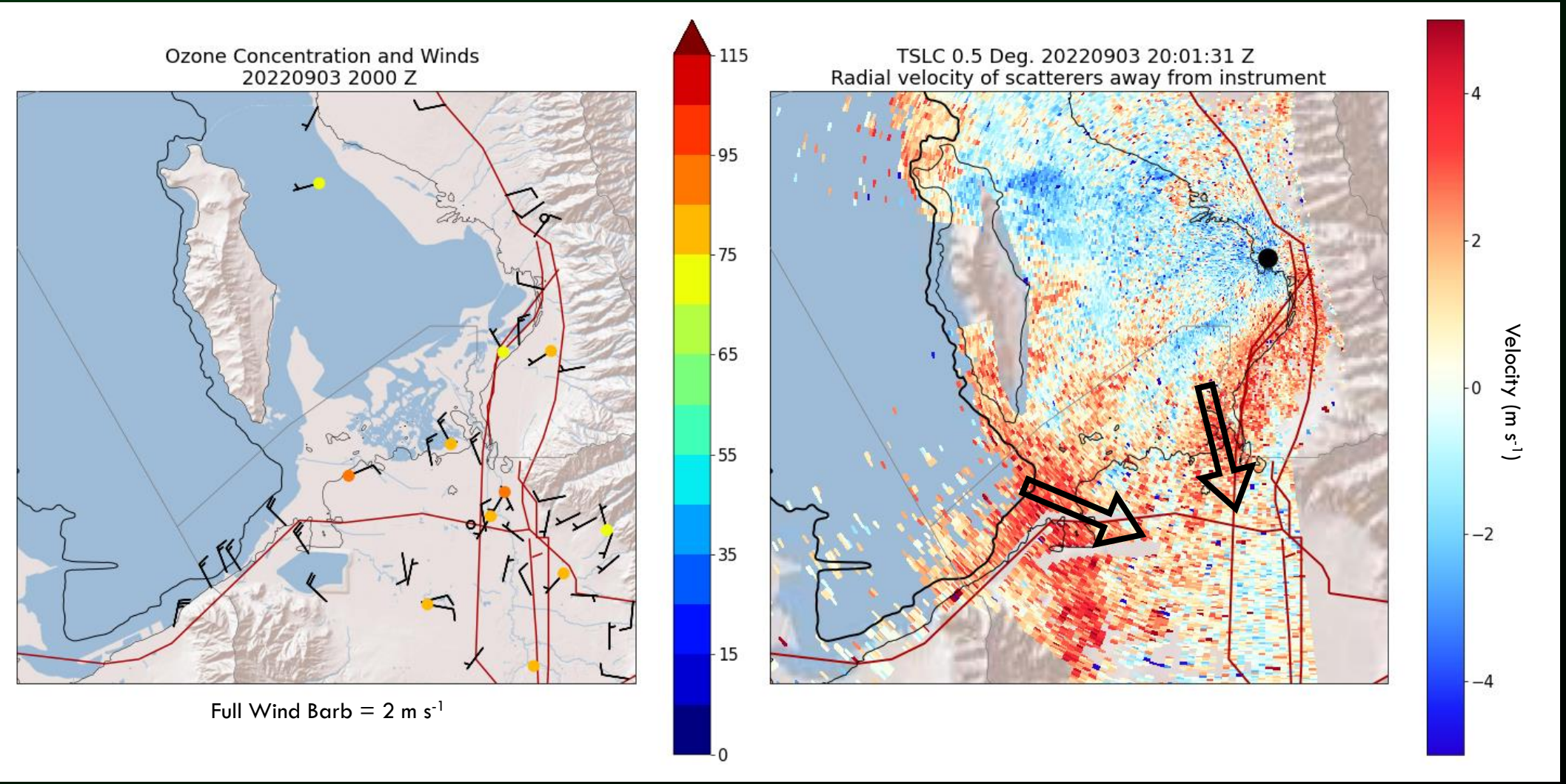
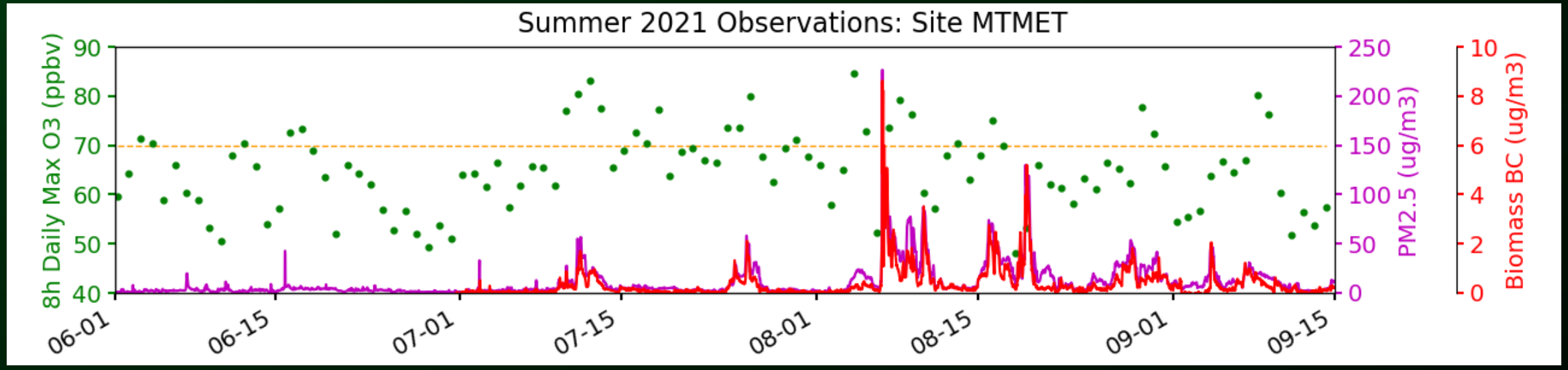
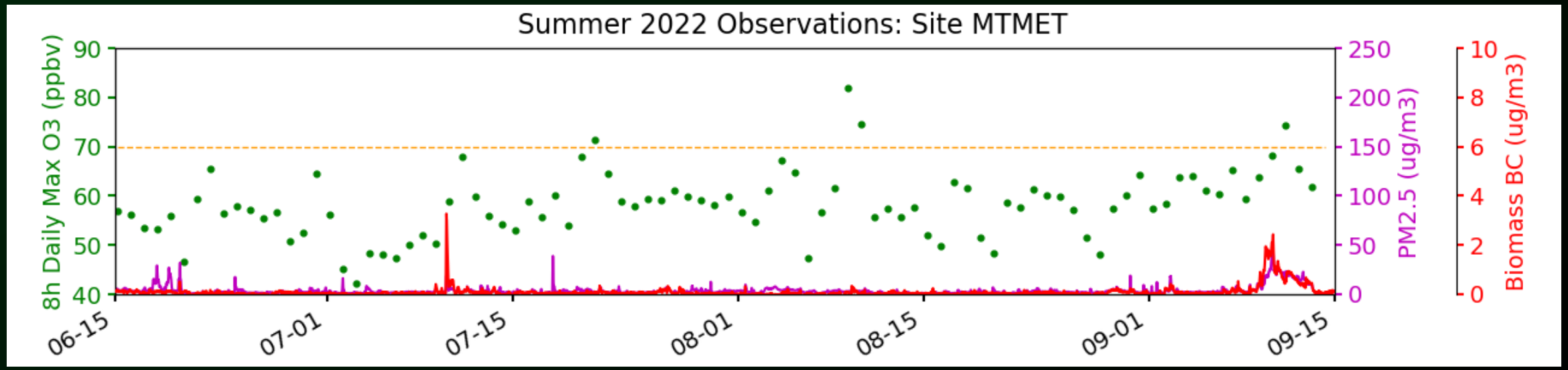


Summer 2022 Wildfire Impacts

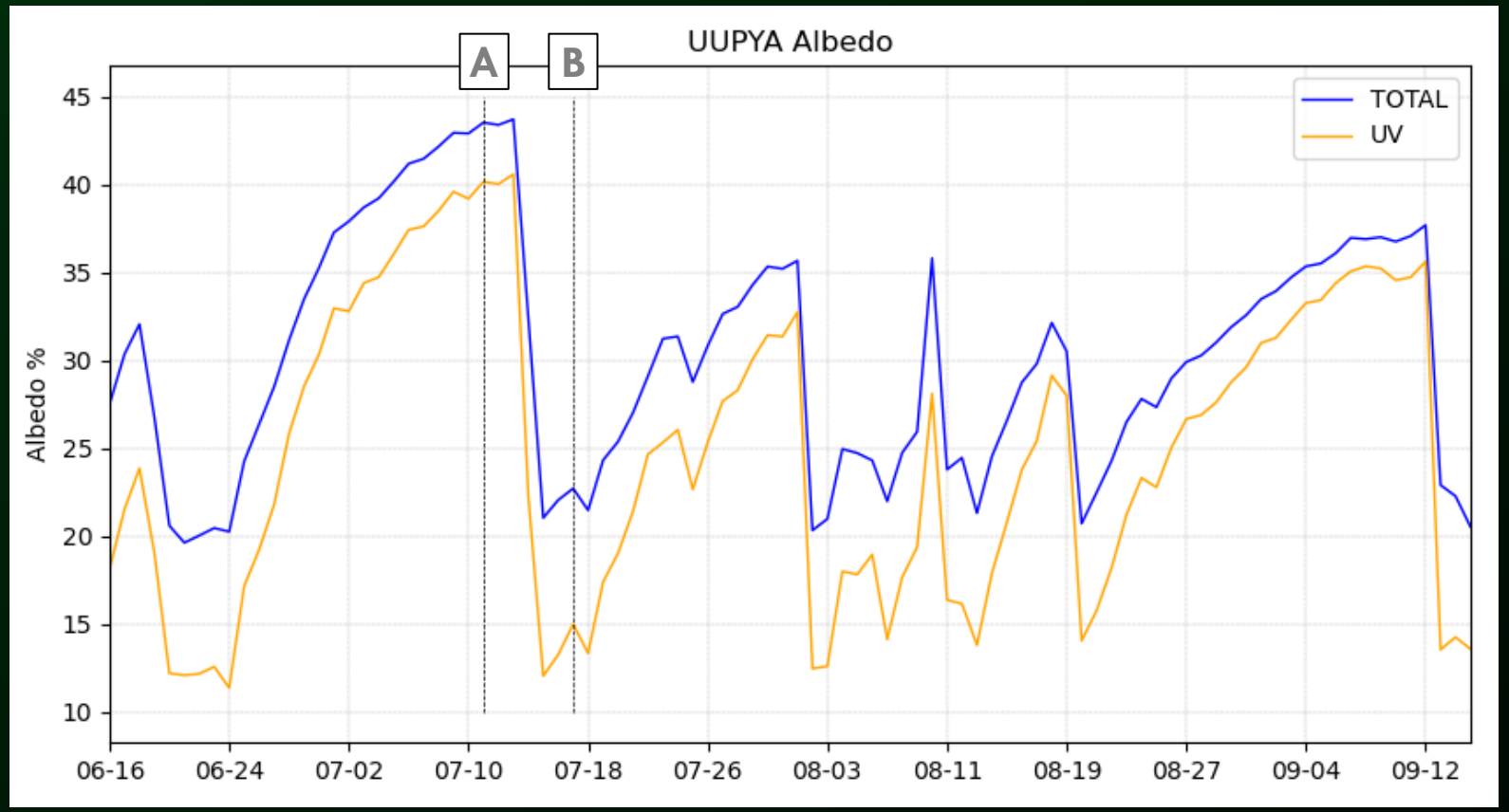
- Much less influence by local and regional wildfires in summer 2022 compared to 2021





Summer 2022 Study - Playa Surface Albedo Calculations

- Derived shortwave and ultraviolet albedo measurements from playa site (UUPYA)
  - Gradual increases during periods of extended drying (sharp decrease after precip)
  - UV albedo over playa 5-10% less than total (larger differences when playa surface is wet)



Initial Conclusions from Summer 2022 Study and Future Work

- Summer 2022 high ozone events primarily during second half of summer
  - Percentage of summer with high ozone similar to 2015-2021 median
  - Wildfire influence minimal (very different from 2021)

- Farmington Bay Ozone Event Evolution
  - High ozone titration overnight, rapid increases late morning
  - Generally quiescent synoptic conditions: local flow patterns dominate
    - Down-valley flows overnight put Farmington Bay downstream of Salt Lake County
    - Up-valley flow reversal occurs late morning coinciding with maximum ozone increases

- GSL playa surfaces: no strong relationship between reflected shortwave/UV radiation over the playa and maximum ozone concentrations

- Future Studies: need combination of meteorological instruments to capture 3D boundary layer structure + atmospheric chemistry measurements for O_3 precursors

Acknowledgements and References

- Funding for 2022 Field Campaign provided by Utah Division of Air Quality

- Fixed-site surface-based observations acquired using Data API Services made available from Synoptic Data PBC (https://developers.synopticdata.com/)

- TDWR Radar Imagery processed using Py-ART (https://arm-doe.github.io/pyart/)

Publications

Blaylock, B. K., J. D. Horel, and E. T. Crosman, 2017: Impact of Lake Breezes on Summer Ozone Concentrations in the Salt Lake Valley. *Journal of Applied Meteorology and Climatology*, **56**, 353-370, doi:10.1175/JAMC-D-16-0216.1

Horel, J., E. Crosman, A. Jacques, B. Blaylock, S. Arens, A. Long, J. Sohl, and R. Martin, 2016: Summer Ozone Concentrations in the Vicinity of the Great Salt Lake. *Atmospheric Science Letters*, **17**, 480-486, doi:10.1002/asl.680