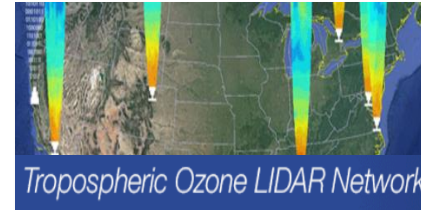


Ozone Lidar Observations During the Long Island Sound Tropospheric Ozone Study



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1. NASA Langley Research Center (LaRC)

2. NASA Goddard Spaceflight Center (GSFC)

3. Science Systems and Applications, Inc. (SSAI)

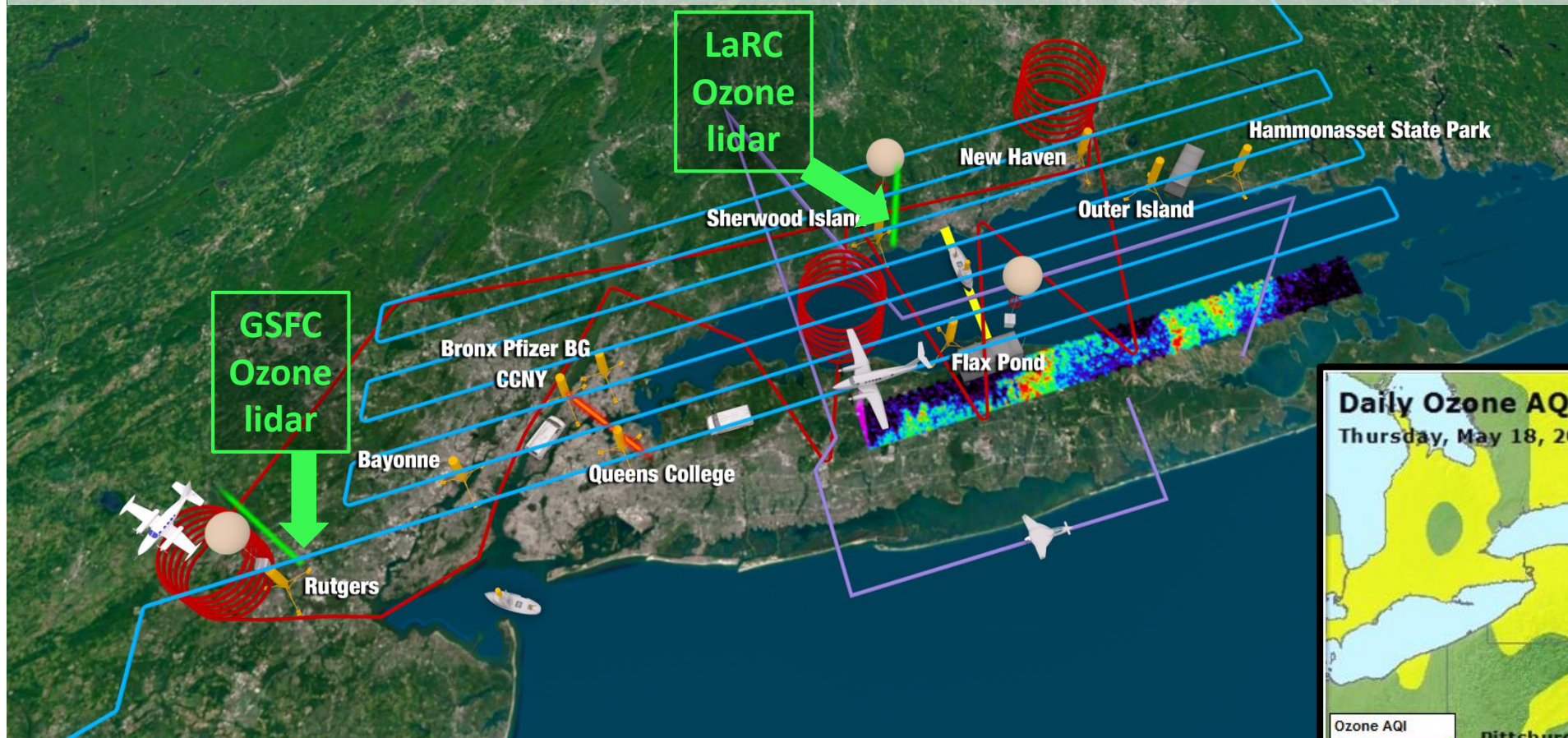
4. Connecticut Department of Energy & Environmental Protection (CDEEP)

5. United States Environmental Protection Agency (EPA)

Acknowledgements: In addition to NASA TOLNet funding, additional support was graciously provided by NASA HQ Tropospheric Composition Program to enable ozone lidars to participate in the LISTOS NESCAUM study. *And a special thank you to the Rutgers team (Luis Lim, Mark Miller, and Matthew Drews) and CT DEEP for being great site hosts at the O3 lidar locations!!*

Long Island Sound Tropospheric Ozone Study (LISTOS)

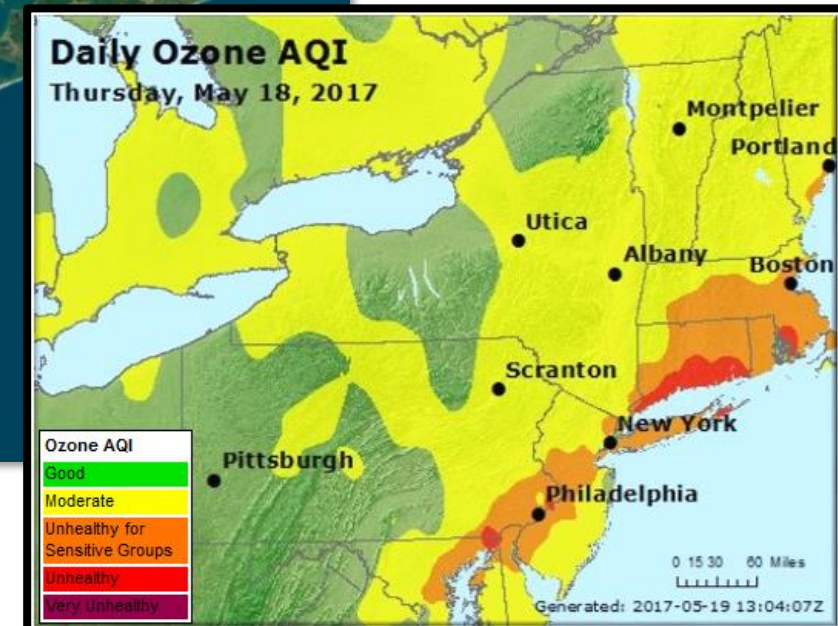
Miller et al., "Overview of the Long Island Sound Tropospheric Ozone Study (LISTOS)", AGU Fall Meeting, 2018



Summer 2018:

- Multiple aircraft
- Marine vessels
- Automobiles
- Ground lidars
- Sounding systems
- In-situ sensors
- Pandora sun-spectrometers
- Aeronet sun-photometers
- Radiosonde/Ozonesondes

Campaign description website:
<http://www.nescaum.org/documents/listos>



Using Two TOLNet O₃ lidars to measure regional spatial differences in atmospheric ozone profiles

OWLETS-1: Land/Water Chesapeake Bay South (summer 2017, see Sullivan et. al BAMS 2018)

OWLETS-2: Land/Water Chesapeake Bay North (summer 2018)

LISTOS: Urban inflow/outflow (summer 2018)

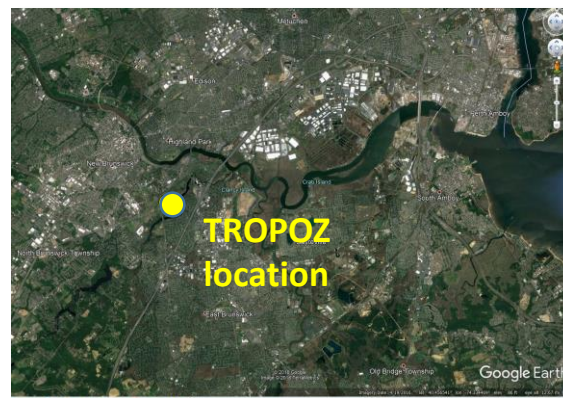
NYC “inflow”

NASA Goddard Tropospheric Ozone Lidar (TROPOZ)

Rutgers site, ~ 50 km SW of NYC

PI: John Sullivan, NASA GSFC

john.t.sullivan@nasa.gov 301-614-5549



NYC “outflow”

NASA Langley Mobile Ozone Lidar (LMOL)

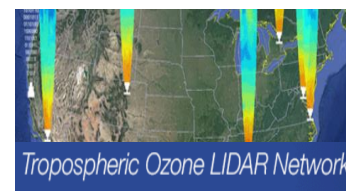
Westport site, ~ 60 km NE of NYC

PI: Tim Berkoff, NASA LaRC

timothy.a.berkoff@nasa.gov 757-864-3684

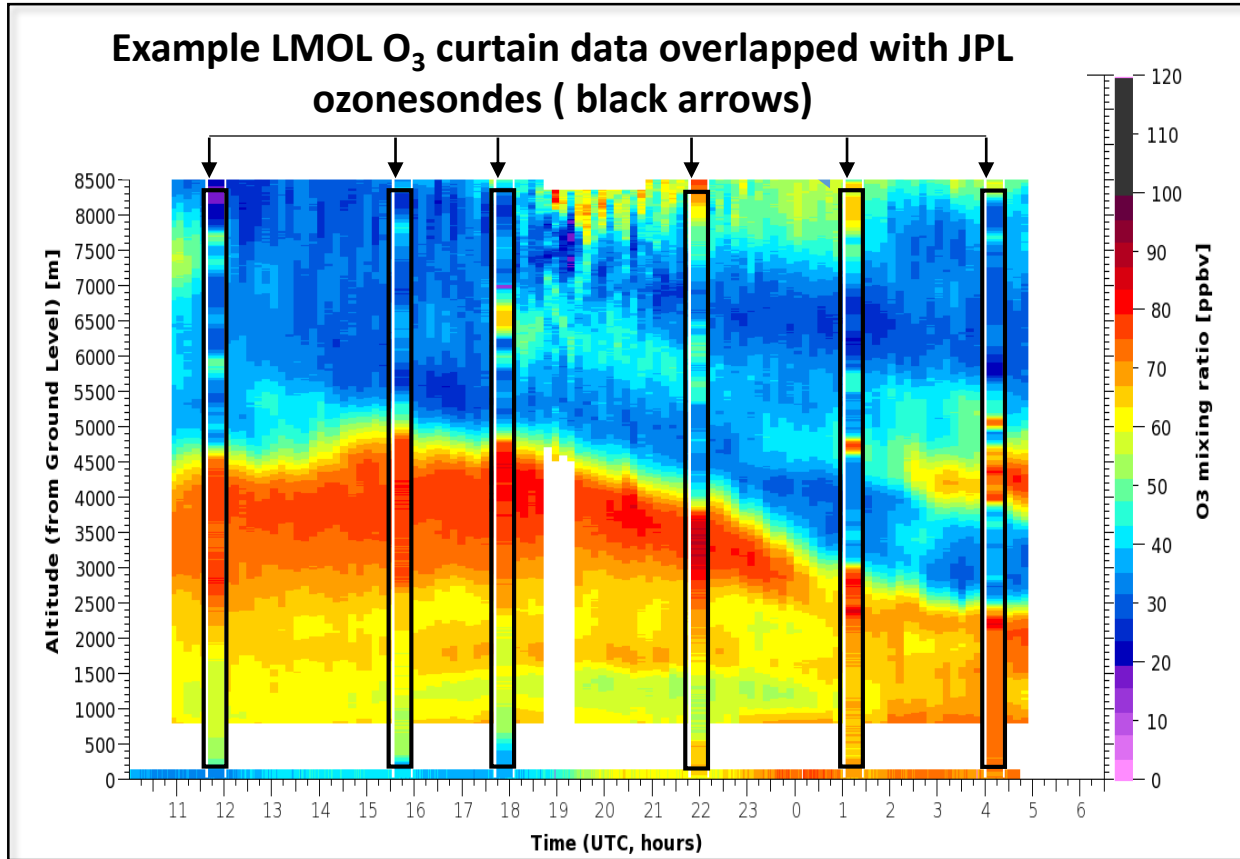


Tropospheric Ozone Lidar Network (TOLNet): Developing the maturity of O₃ lidar measurements

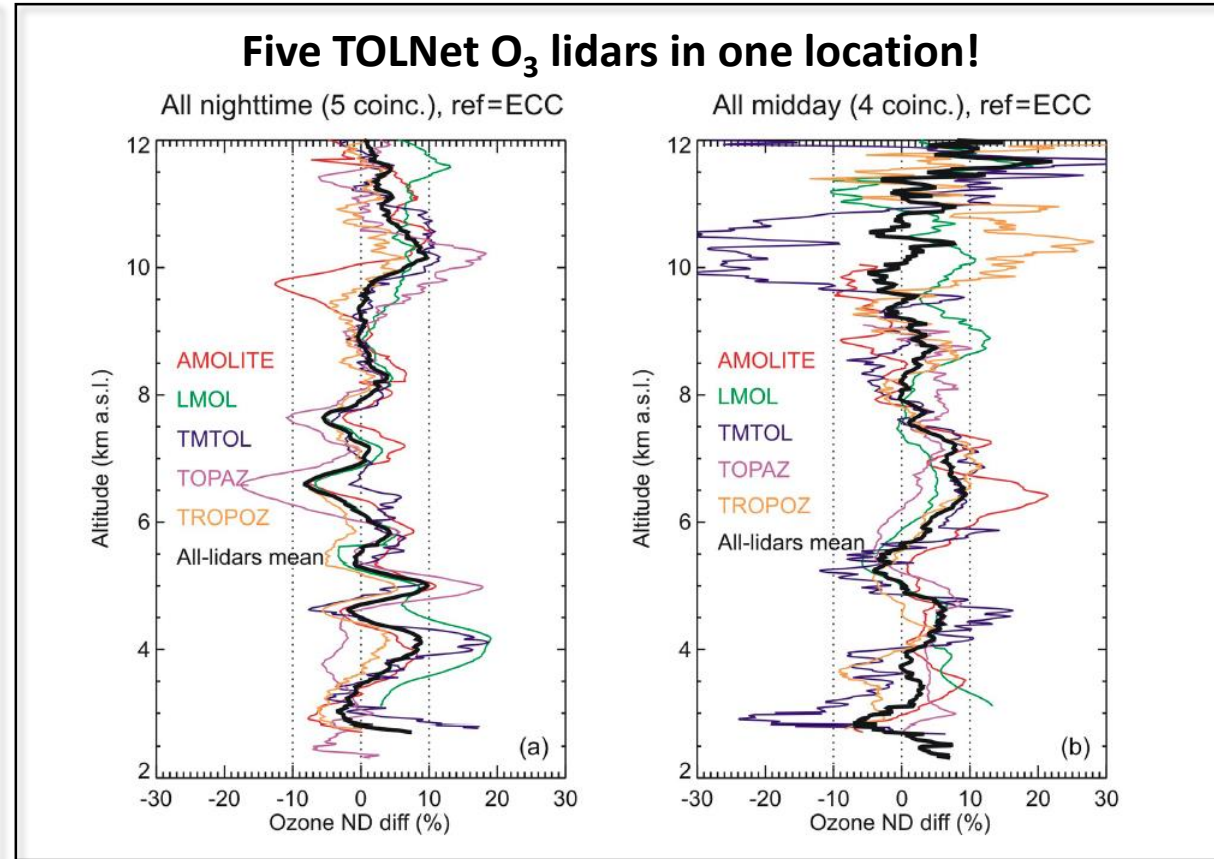


Southern California Ozone Observation Project (SCOOP campaign, 2016) See *Leblanc et al. AMT 2018*

Example LMOL O₃ curtain data overlapped with JPL ozonesondes (black arrows)



Five TOLNet O₃ lidars in one location!



TOLNet O₃ lidars utilize common approach for processing and error propagation, enabling lidar intercomparisons
SCOOP 2016 campaign: TOLNet O₃ lidars typically fall within +/-5% when compared to each other and ozonesondes

Ozone lidar measurements obtained during LISTOS

LaRC Lidar (Westport, CT):

Data taken on 30 different days between July 12 to Aug 29, 2018:

>300 hours of data

GSFC Lidar (Rutgers, NJ):

Data taken on 20 different days between July 19 to Aug 17 2018

Data collected on 11 Days > NAAQS 8-hour O₃ standard in CT

All data (LaRC & GSFC) are available on the NASA LISTOS archive, along with quicklook lidar curtain images

3 cases highlighted in these slides:

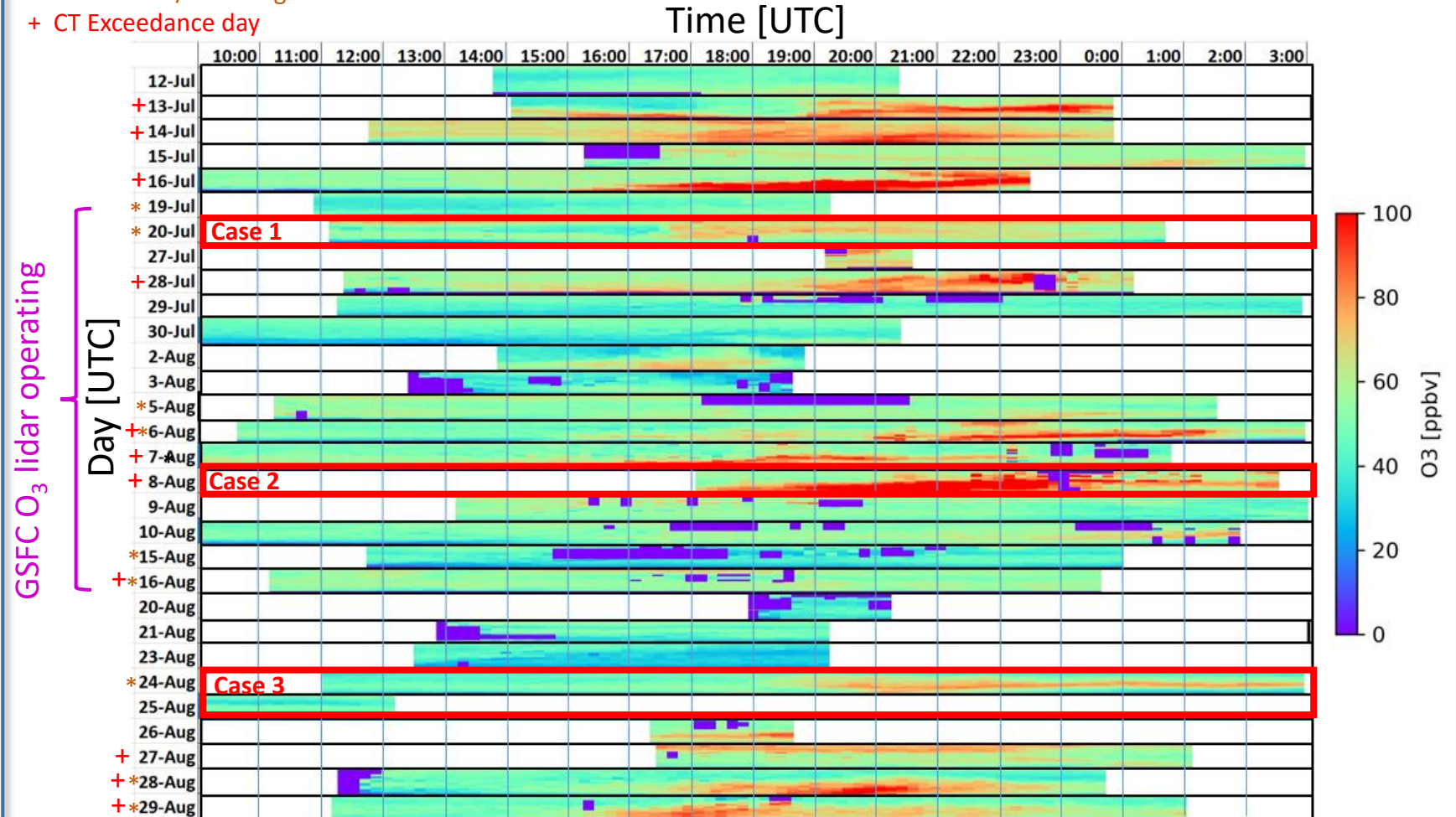
Jul 20: Simultaneous O₃ lidar

Aug 8: Urban Outflow

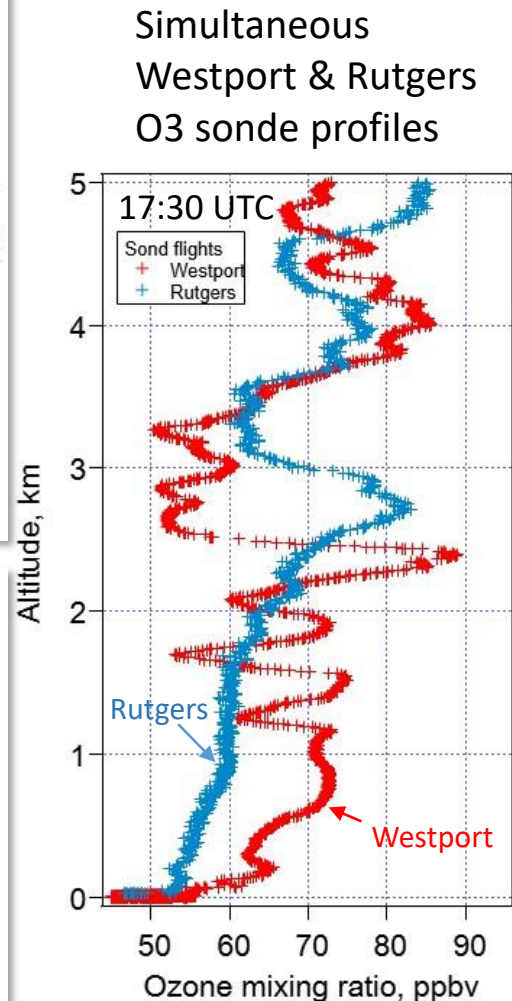
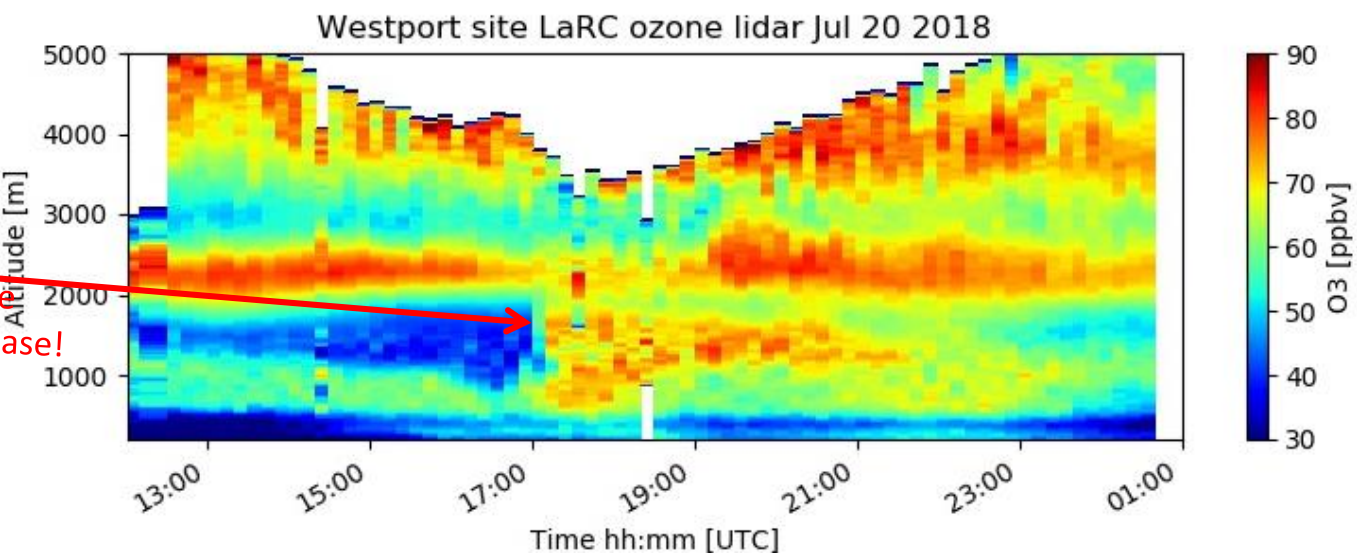
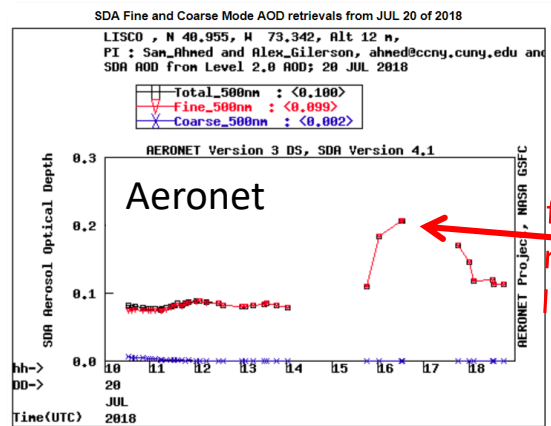
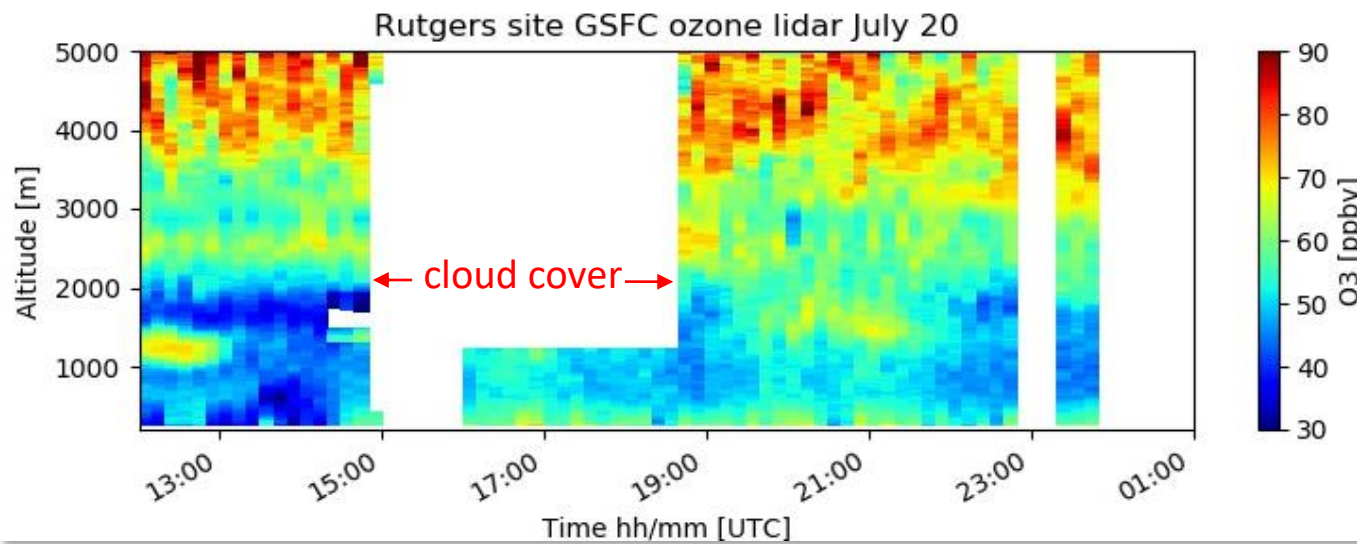
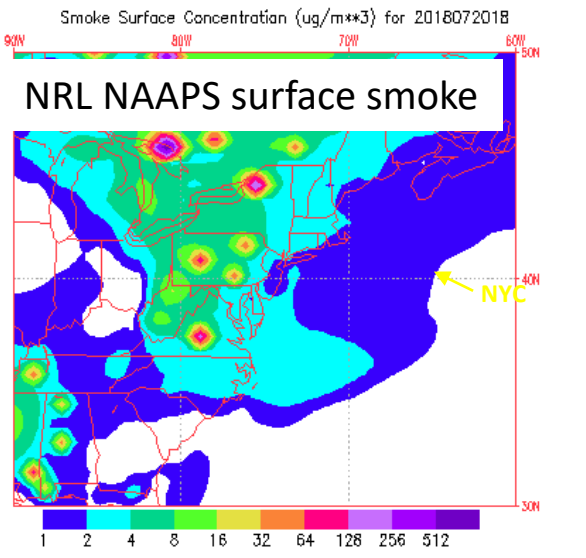
Aug 24/25: Wildfire transport

LaRC Mobile Ozone Lidar (Westport, CT) Data Record for LISTOS

- LaRC GCAS/HALO flight
- + CT Exceedance day

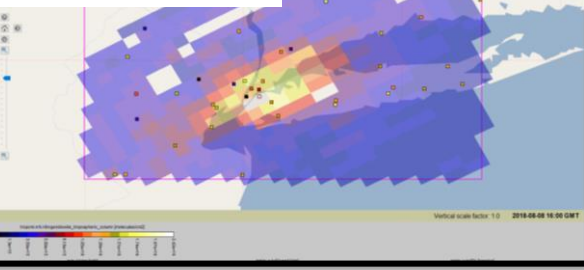


Case 1: July 20 Simultaneous O₃ Lidar Measurement Example

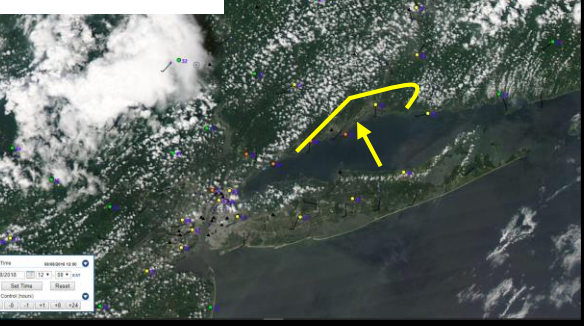


Case 2: Aug 8 Urban outflow exceedance event

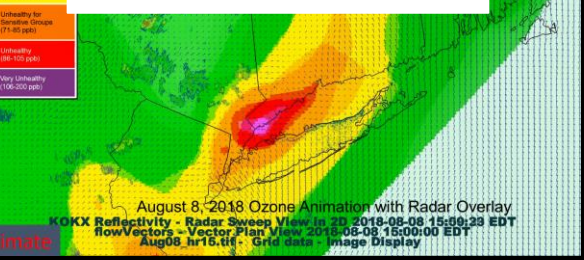
TROPOMI NO₂



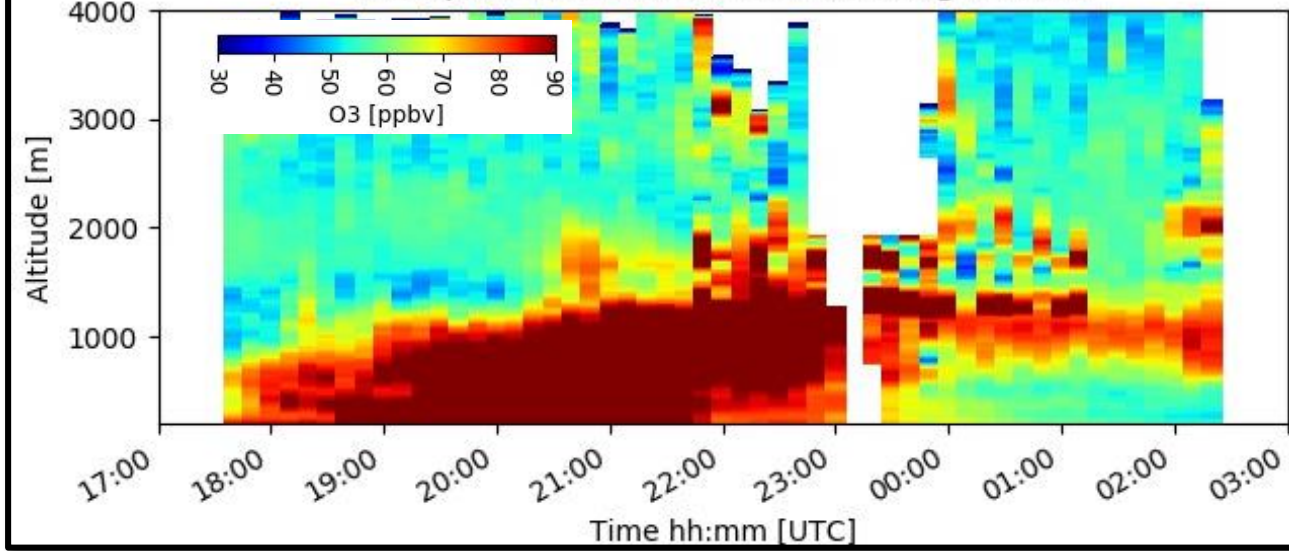
MODIS PM



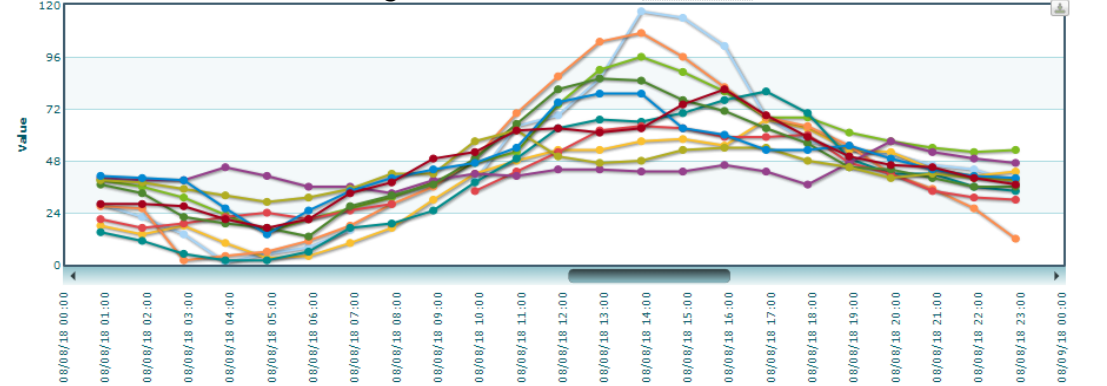
RTMA/Airnow surface O₃
Geigert, CT DEEP



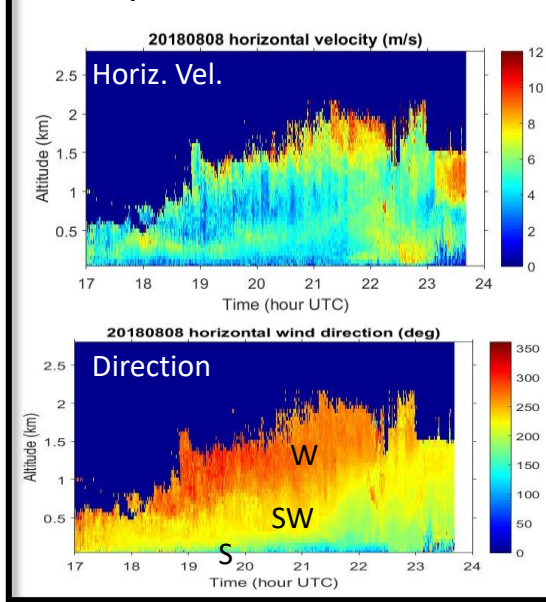
Westport site LaRC ozone lidar Aug 8 2018



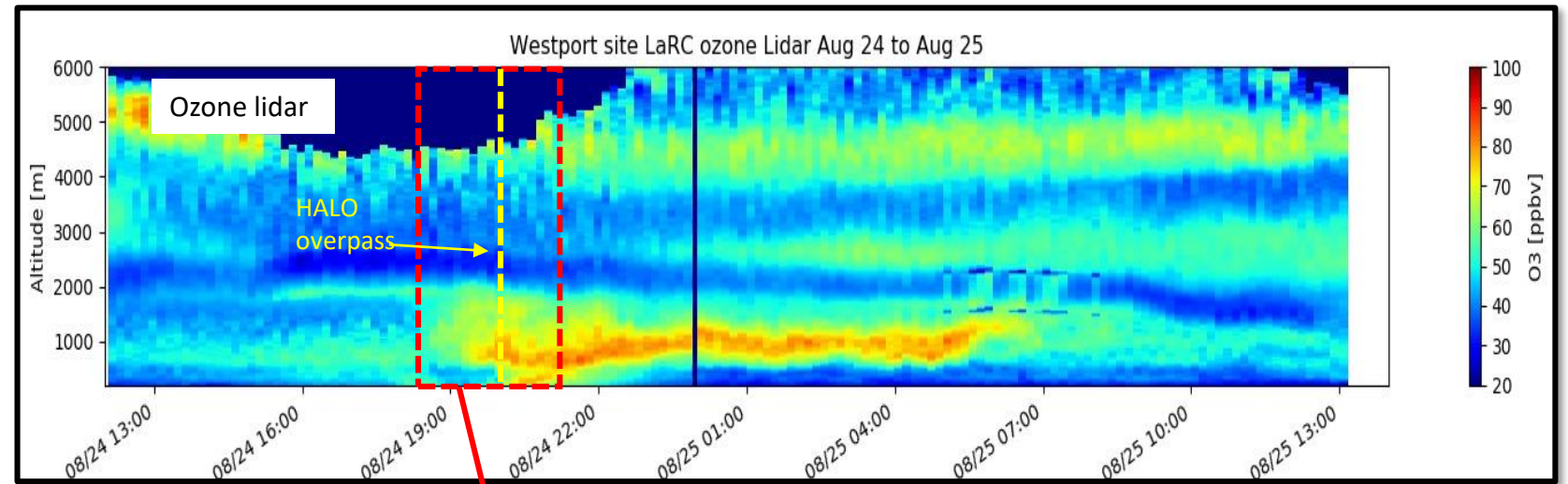
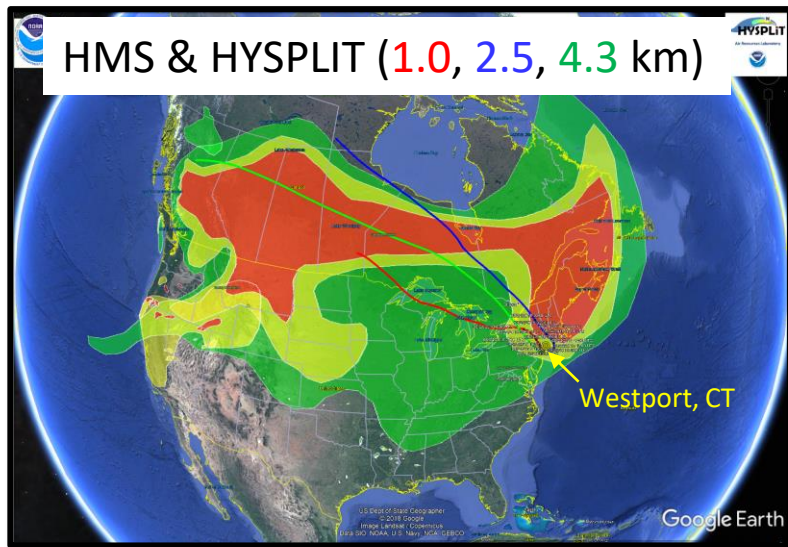
Aug 8 CT surface O₃ (AirNow-Tech)



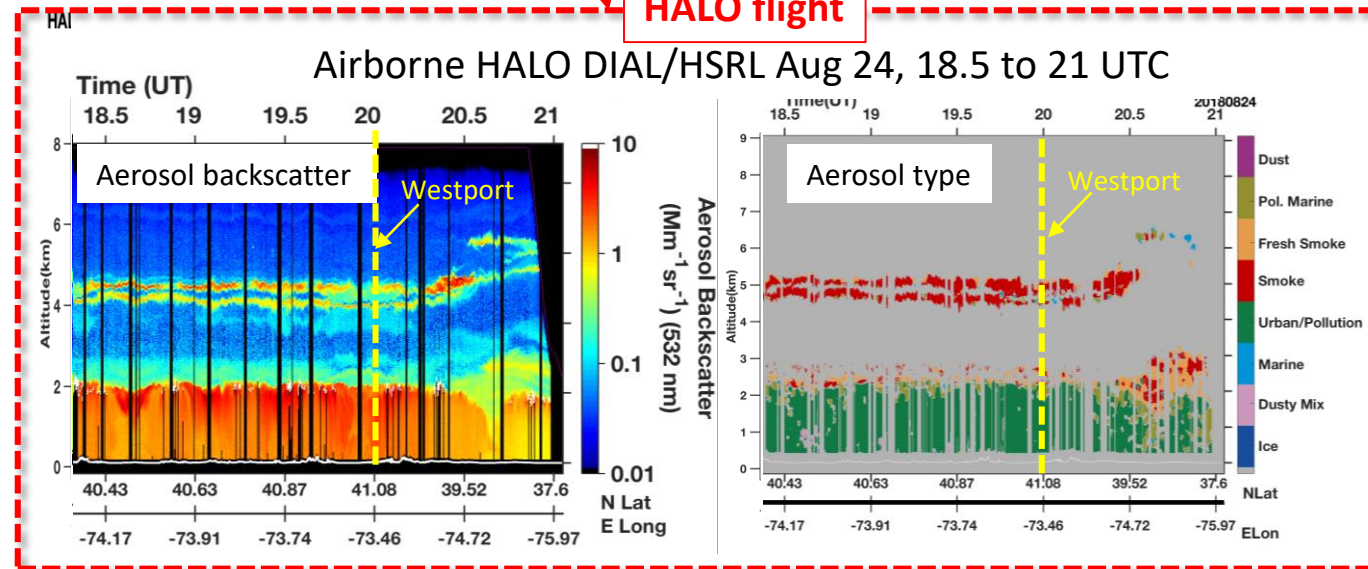
Westport CCNY wind data



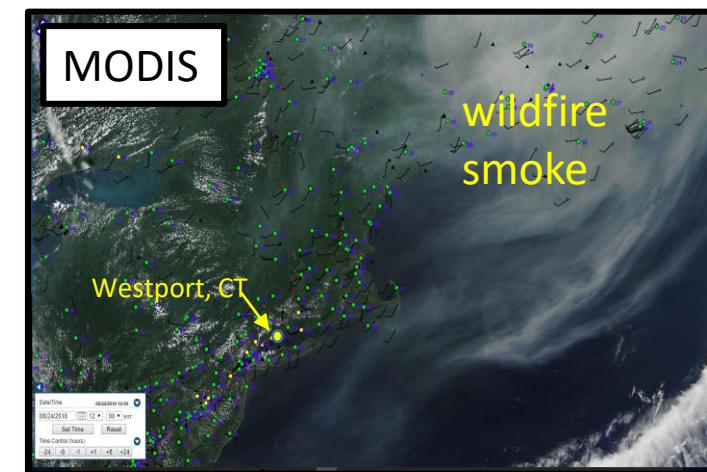
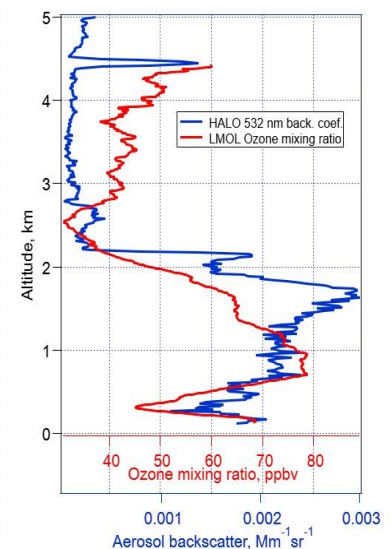
Case 3: Aug 24,25: Aloft ozone layers from wildfire emissions



HALO flight



Westport LMOL, HALO Profile Coincidence



Summary

- Vertical profiles of O_3 are needed to understand air quality events at the surface; TOLNet O_3 lidar systems provide a unique observation capability in this regard
- During LISTOS, LaRC and GSFC O_3 lidars captured data in a wide range of conditions, including “classic” urban outflow events & wildfire transport cases
- Anticipate further analyses and model comparisons (e.g. Brian McDonald’s and Michael Geigert’s presentations)
- Potential measurement synergies with ceilometers, surface-in-situ, wind profilers, aircraft and other mobile platforms (e.g. CCNY Westport wind profiler)
- Python free & open source example code can be provided upon request to read and display LaRC and GSFC lidar data

O_3 lidar data collected is ripe for further analysis, anyone interested is encouraged to contact:

Tim Berkoff (LaRC) 757-864-3684 timothy.a.berkoff@nasa.gov
or John Sullivan (GSFC) 301-614-5549 john.t.Sullivan@nasa.gov

View from the Westport, CT site



LISTOS real-time O_3 lidar curtain monitoring while touring in CT

Data acknowledgements: AirNow, AirNow-Tech, NRL NAAPS Model, NOAA HYSPLIT, CT Dept of Energy and Environmental Protection, TROPOMI, MODIS, NOAA RTMA, NOAA HMS, CCNY wind lidar data, LaRC HALO-HSRL lidar data.