Observation of atmospheric thermodynamics, winds, aerosols, and trace gases during Heat-wave events in New York City and Long Island Sound

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**Some data presented here is preliminary and not quality assured

Observation During LISTOS

CCNY Posters

Smoke Transport and Impacts

Satellite Observations

Point Source Emissions

Wind Analysis

Interaction of heatwaves with urban areas are complex and are driven by mesoscale meteorology, topology and thermal properties of urban surfaces (UHI-Urban Heat Island Effect), as well as anthropogenic thermal and pollution loadings

What Makes Heatwaves Different from Each Other? Heatwave Days Can Have Notably Varied Dynamics

CASE STUDY: A Detailed Examination of Heatwave Episode June 29th to July 3rd 2018

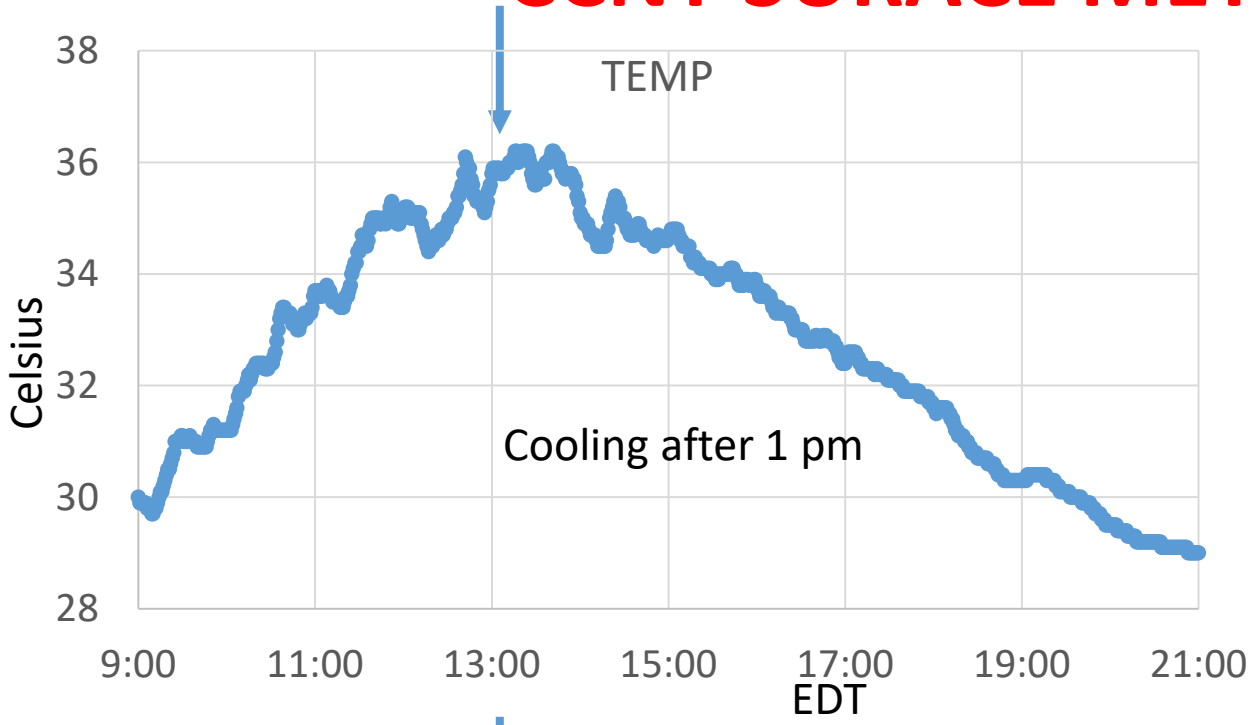
(peak near-surface air temperatures in excess of 90 F)

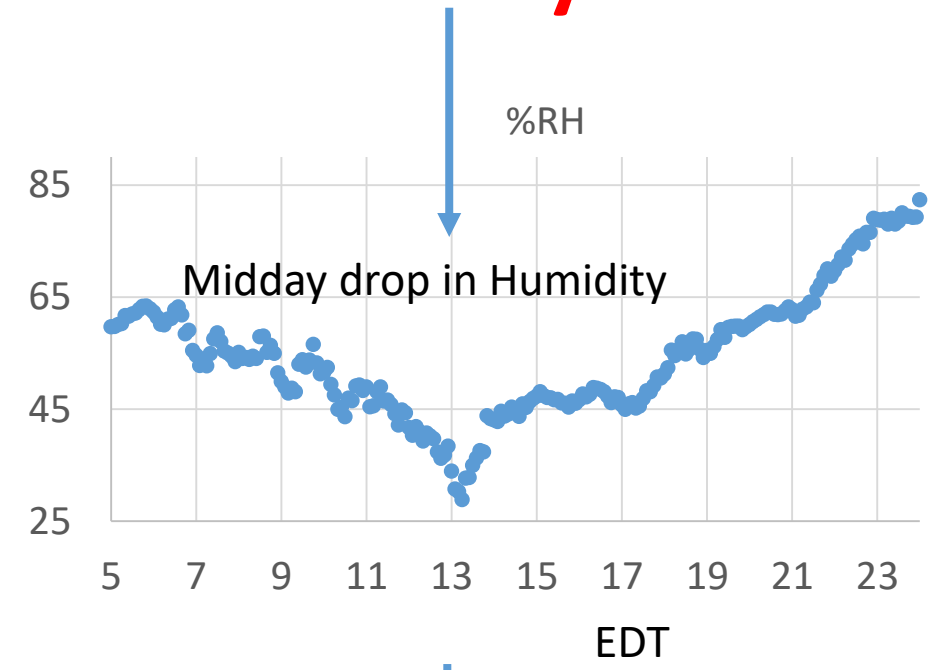
Focus:

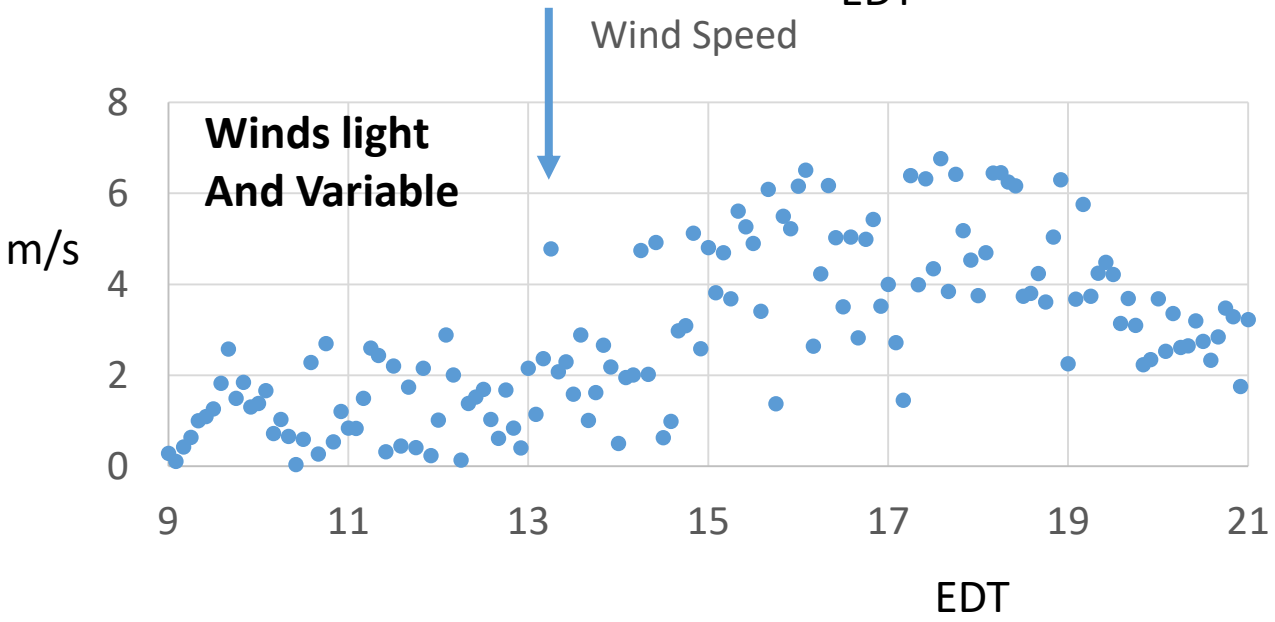
Dynamics of the boundary layer, heat index and pollutants

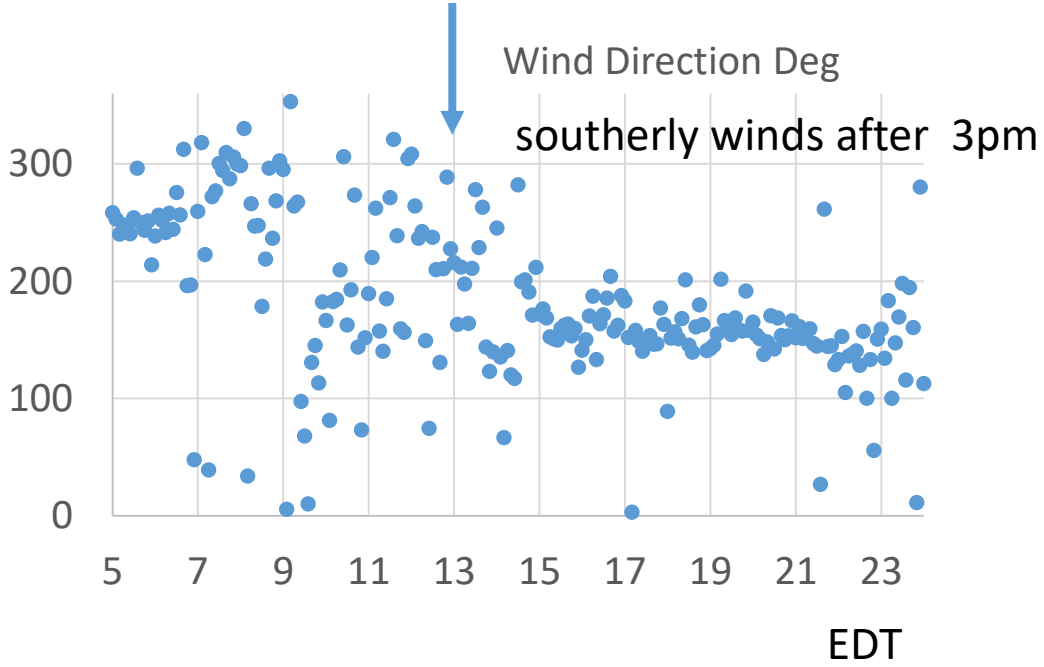
Day 4
July 2, 2018

CCNY SURACE MET CONDITIONS- July 2

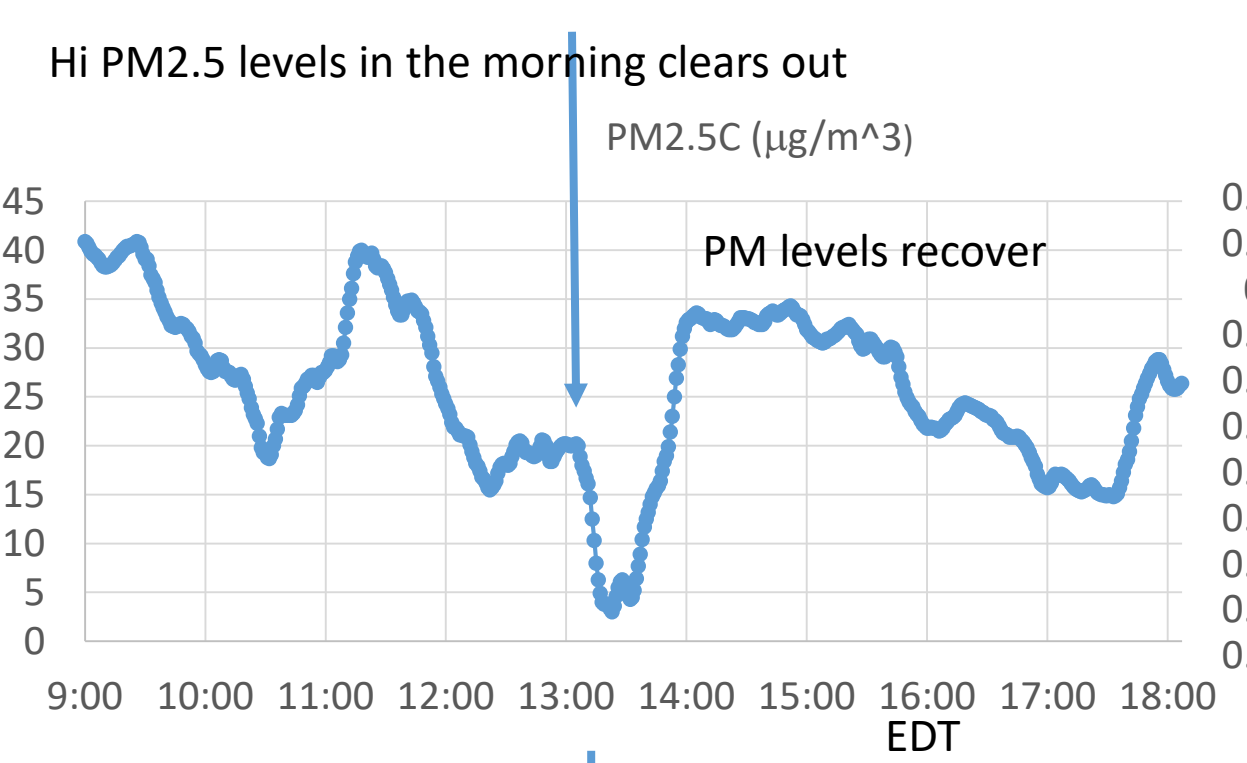


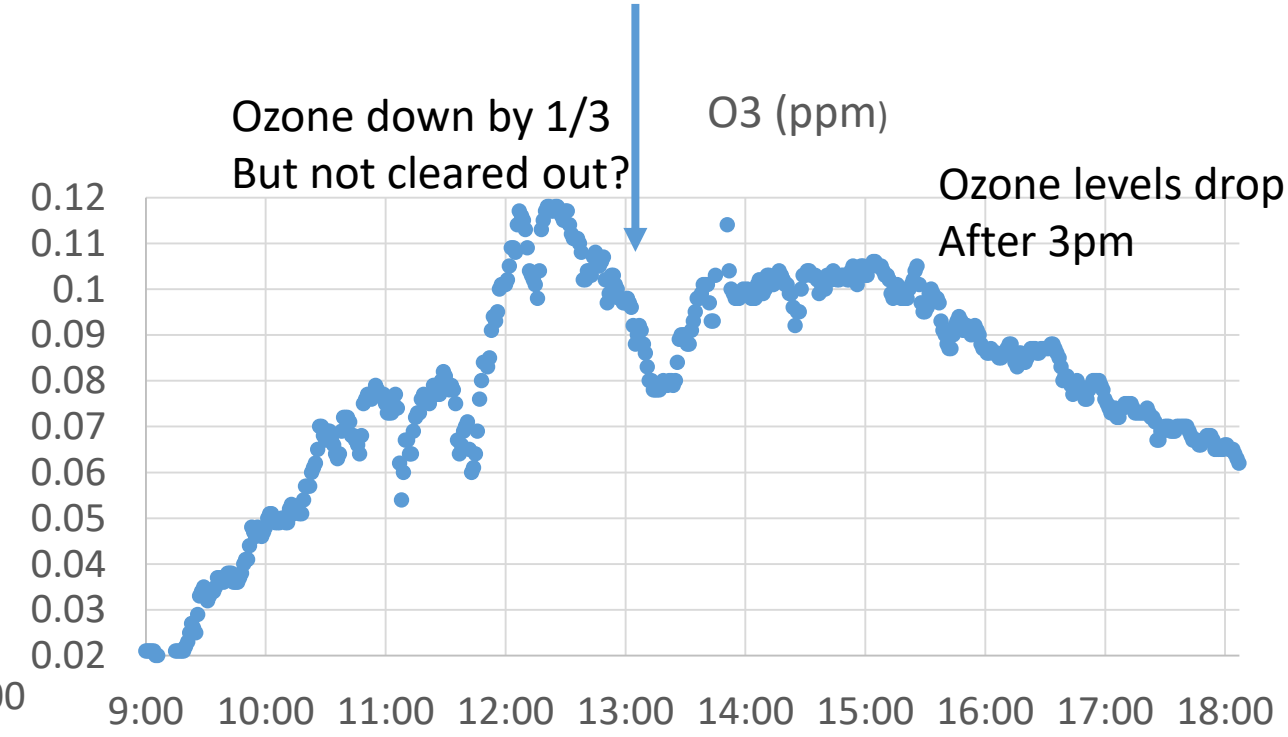


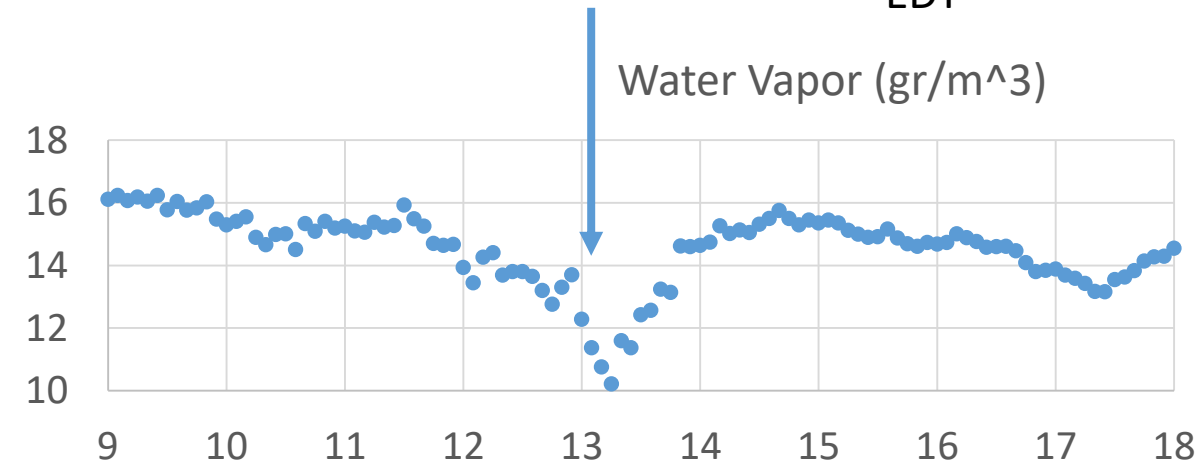


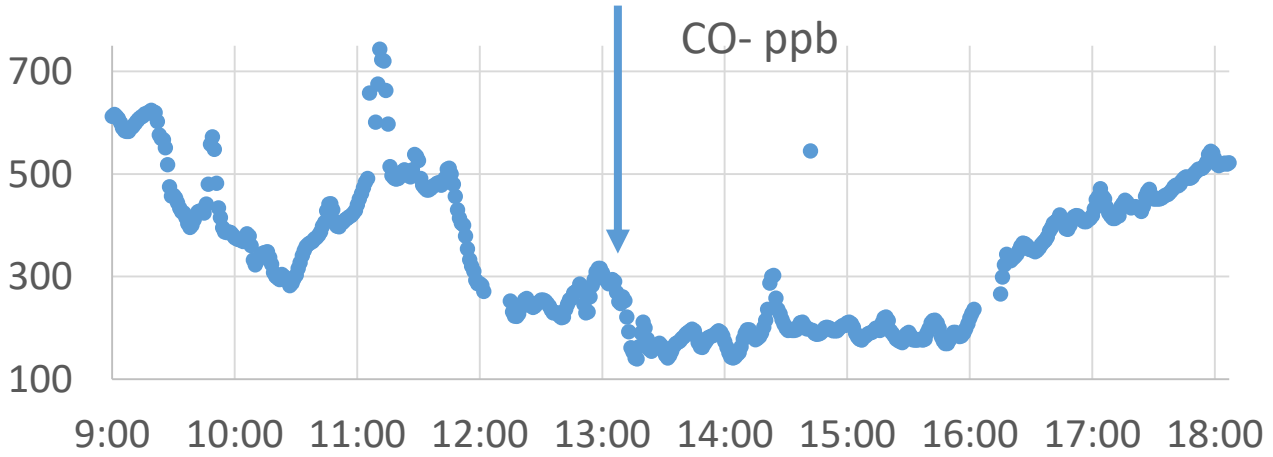


CCNY Surface Analyzer Observations July 2nd

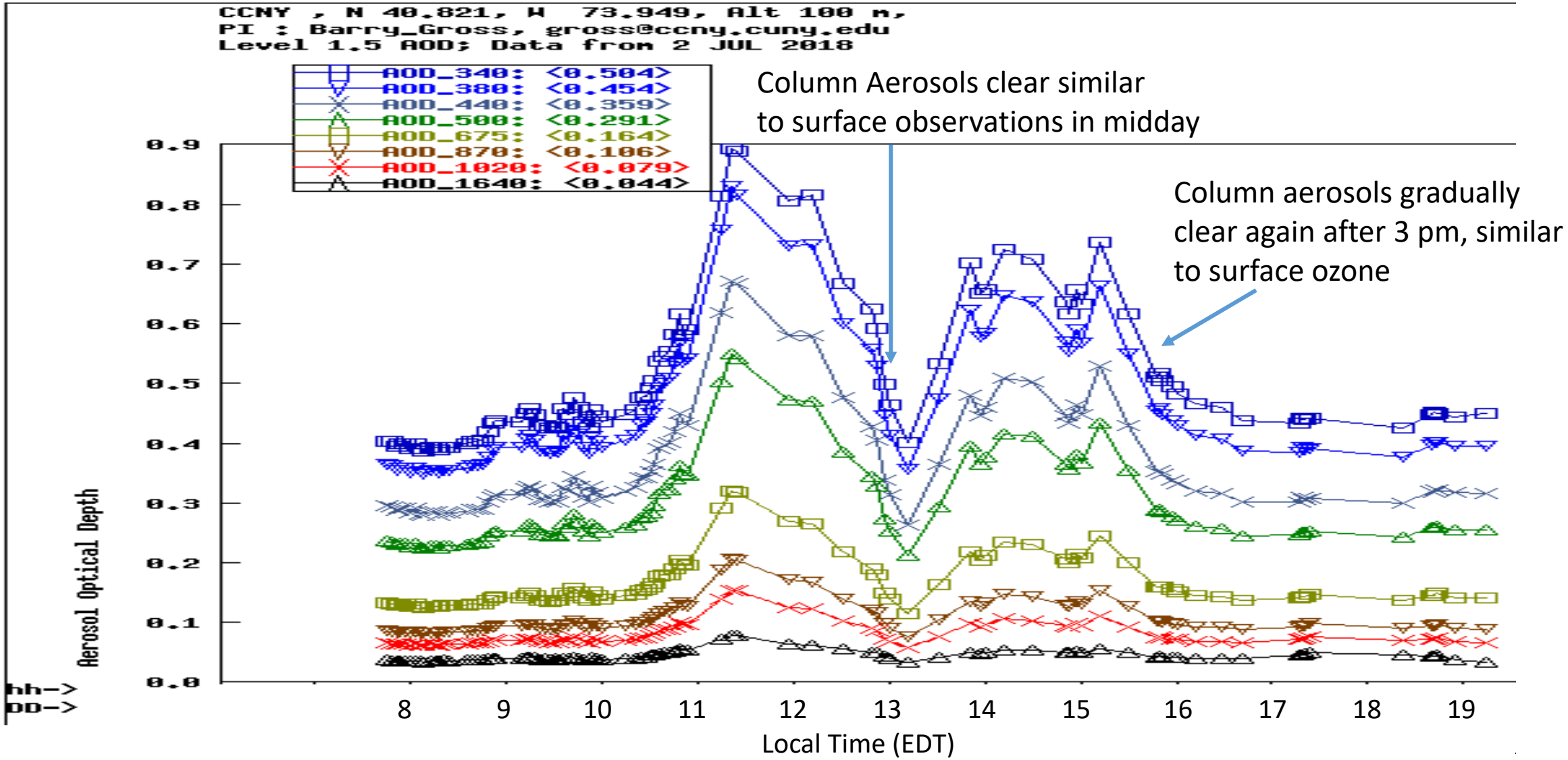








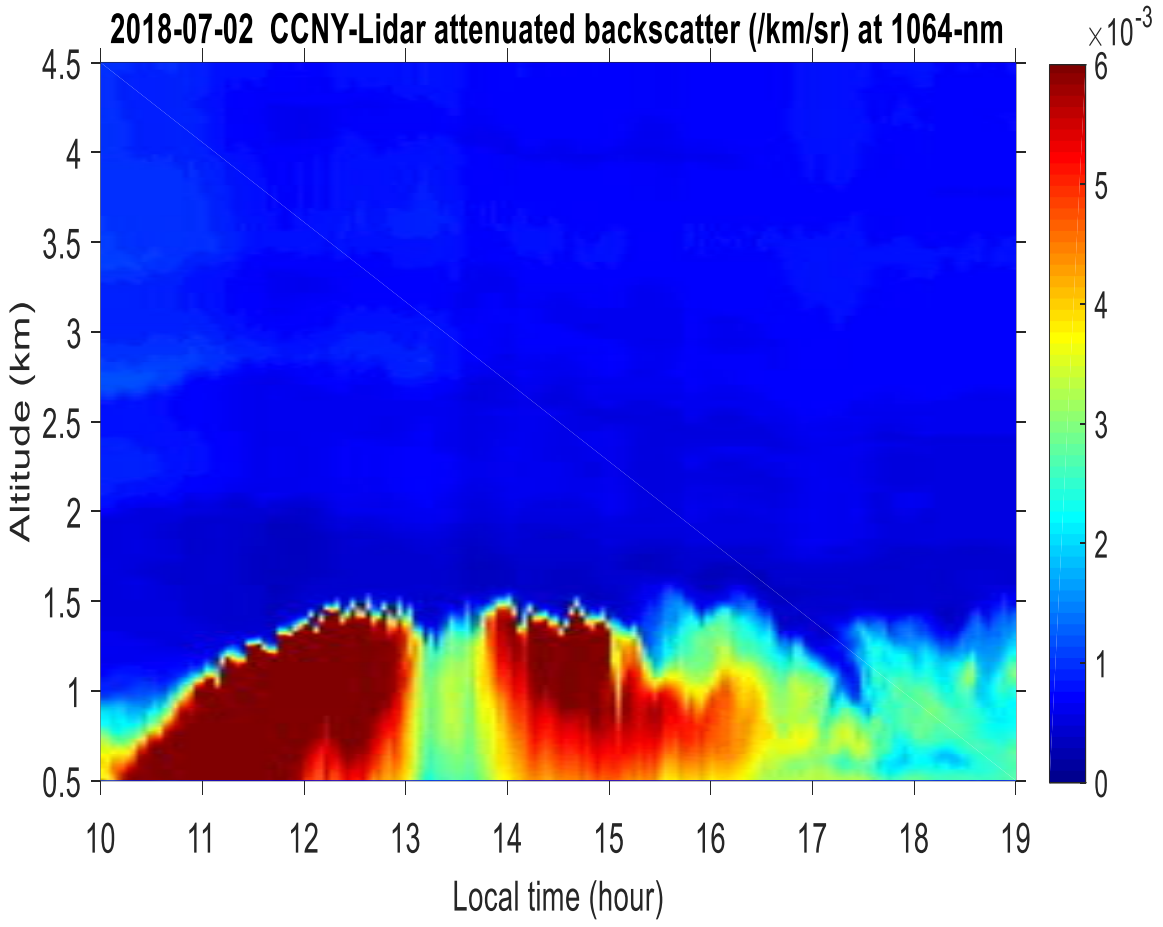
CCNY AERONET Column Aerosol Optical Depth July 2nd

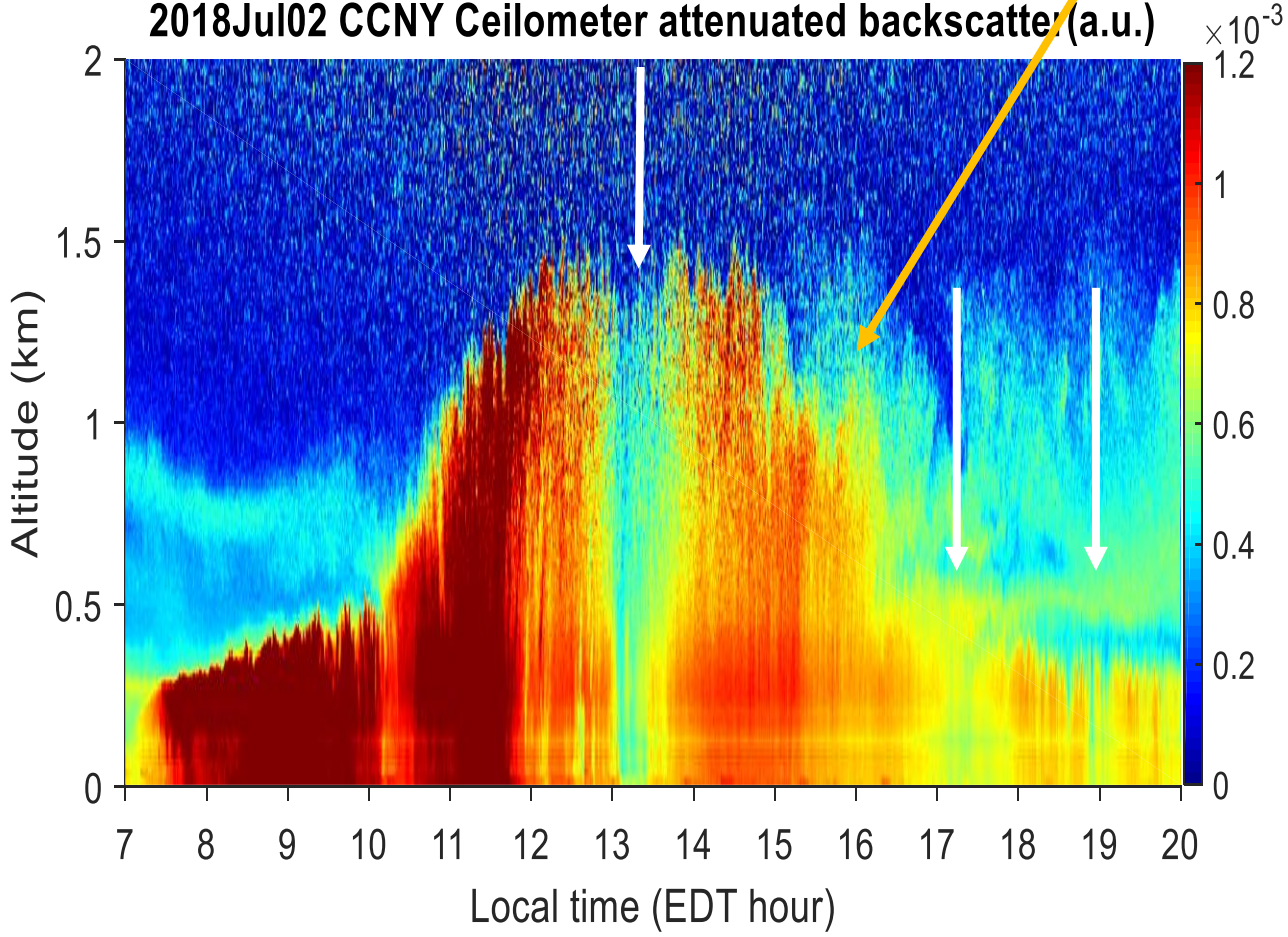


CCNY Profiles Observations July 2nd Lidar & Ceilometer

Column aerosols gradual clearing after 3pm similar to surface ozone

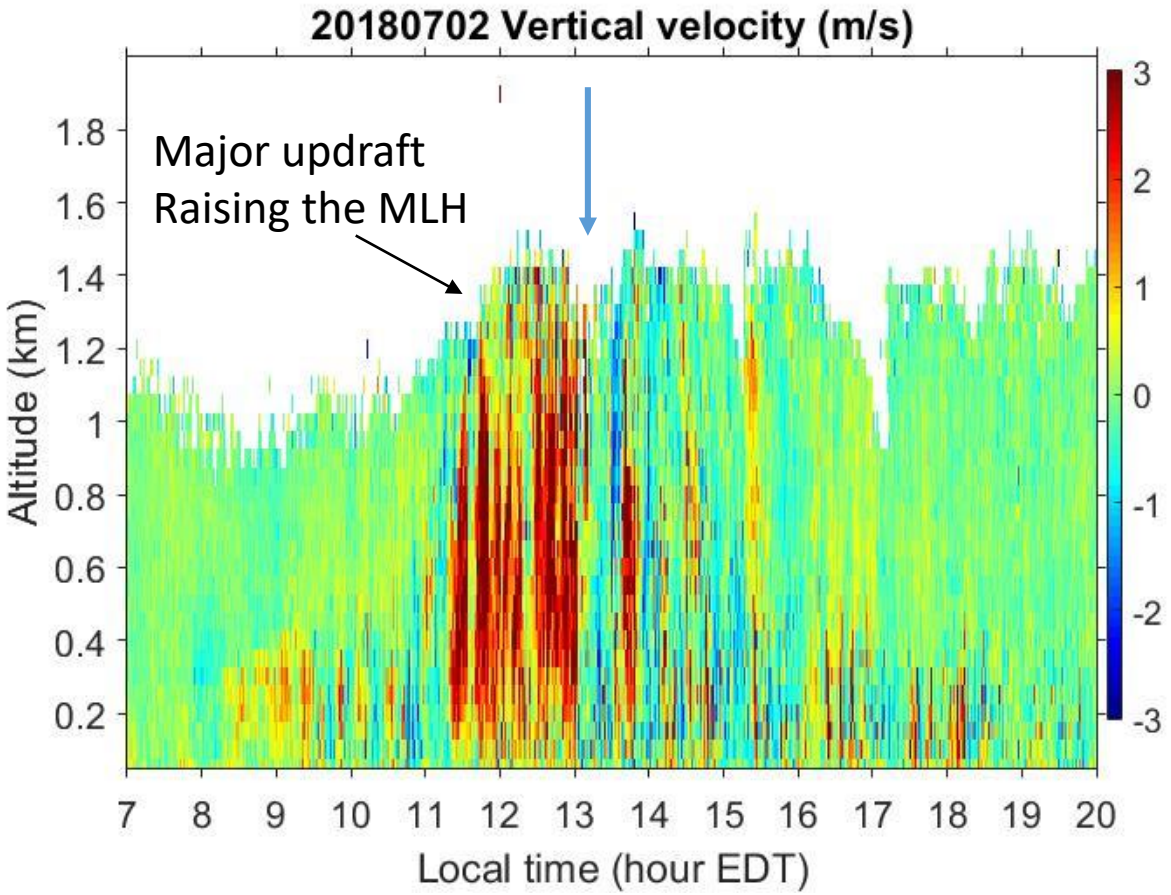
Aerosol Profiles consistent with Column and Surface, showing abrupt clearing at 13:00, and another more gradual clearing after 15:30

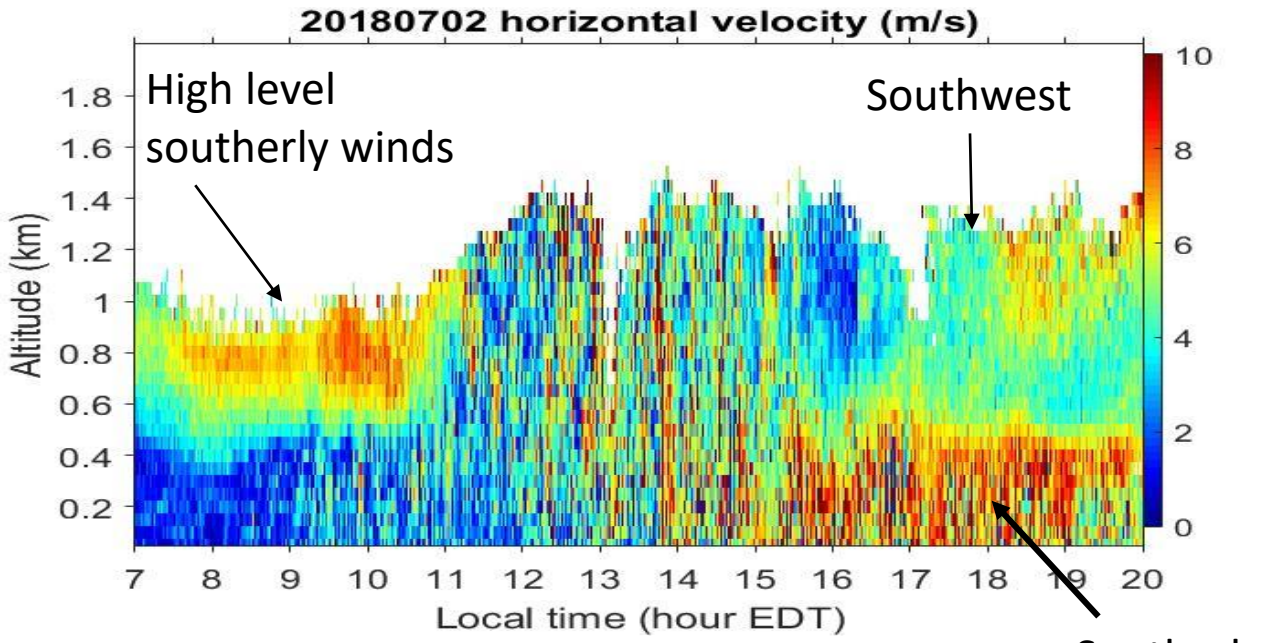


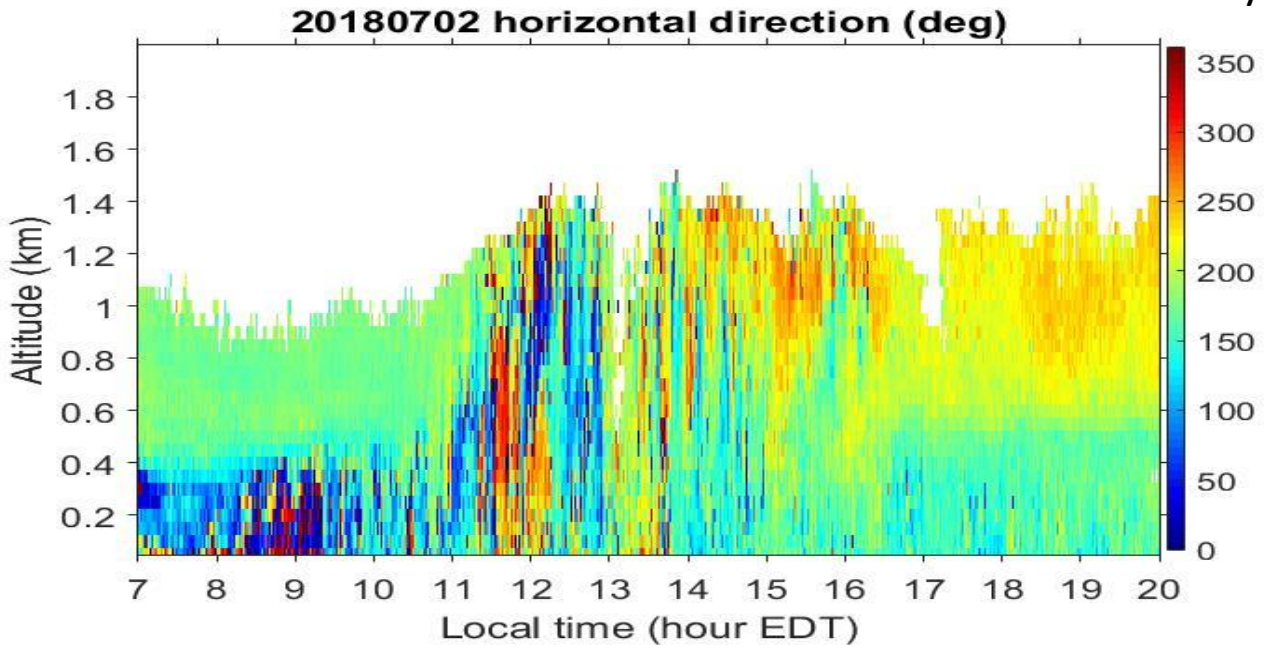


CCNY Profiles- July 2, 2018

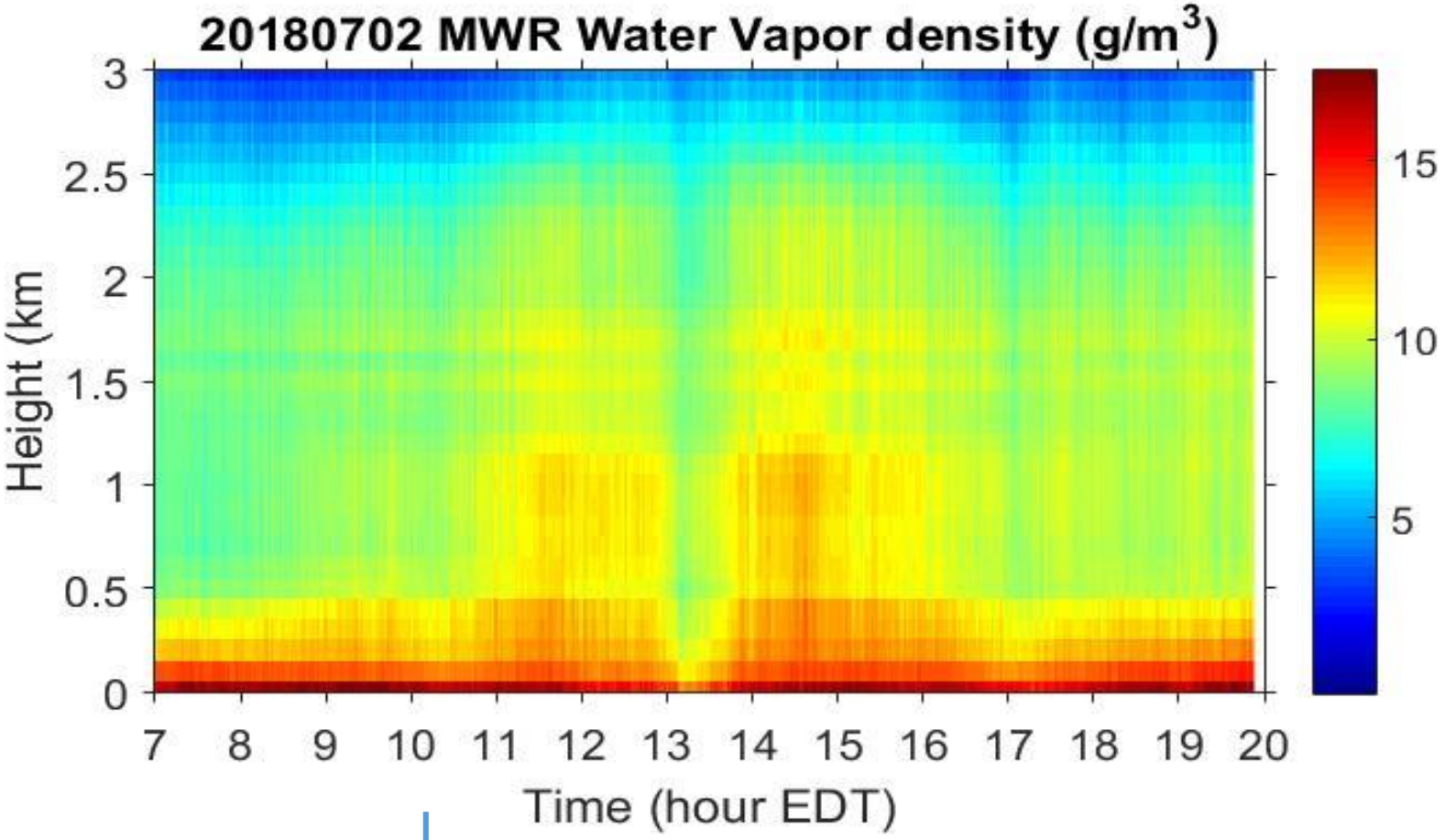
Vertical and Horizontal Winds

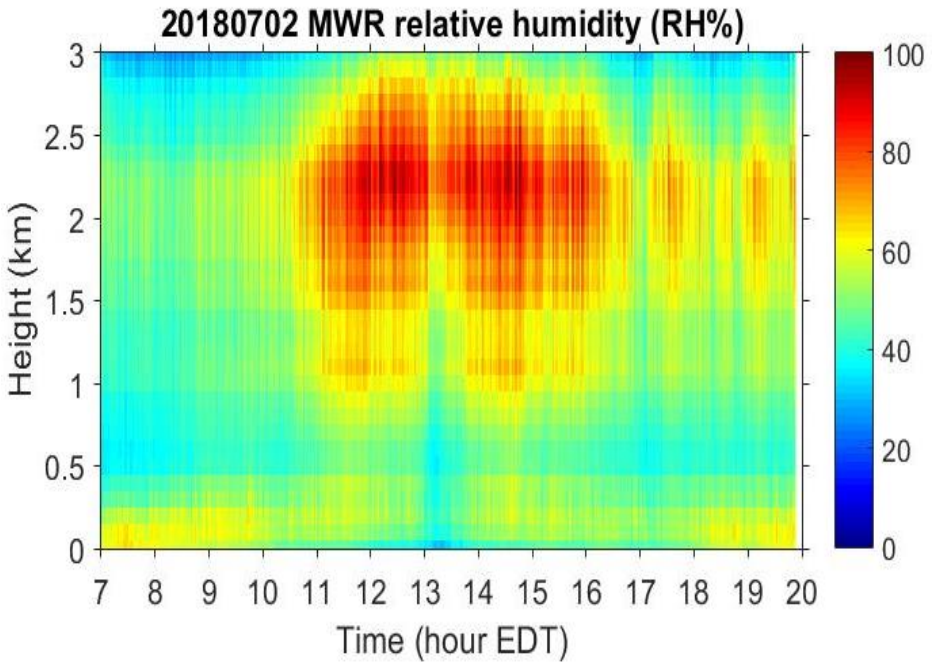


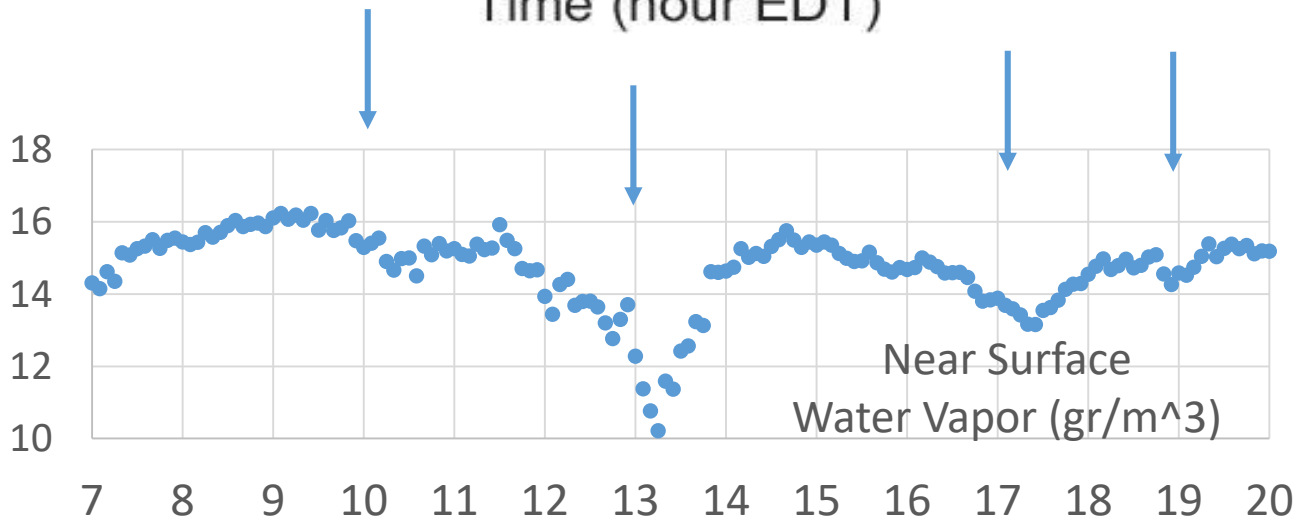




Water Vapor







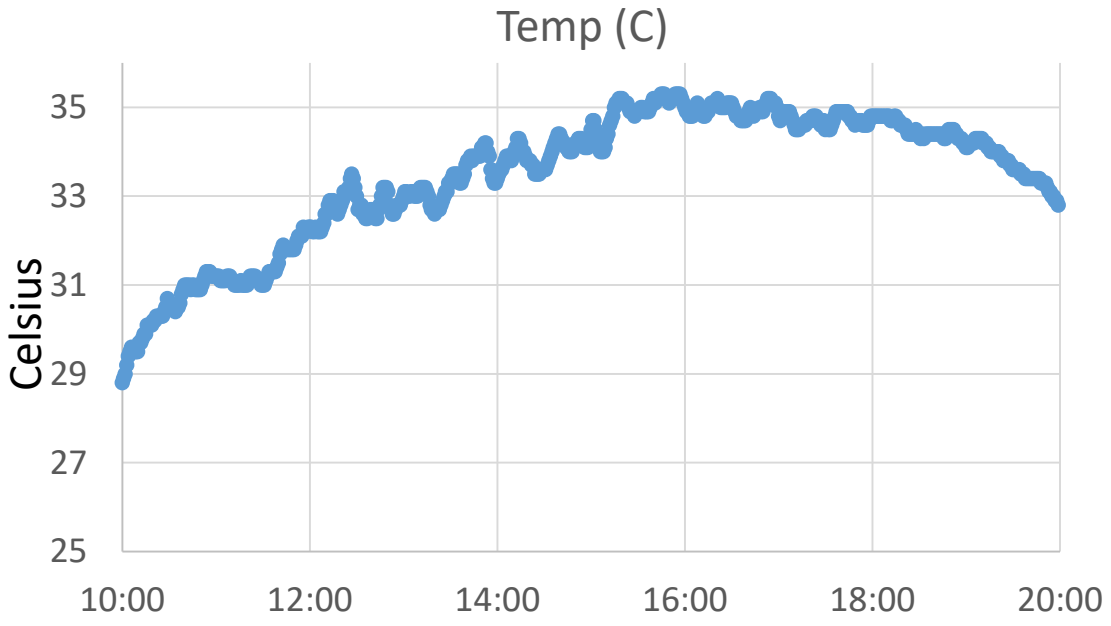
Possible Evidence of Subsidence?

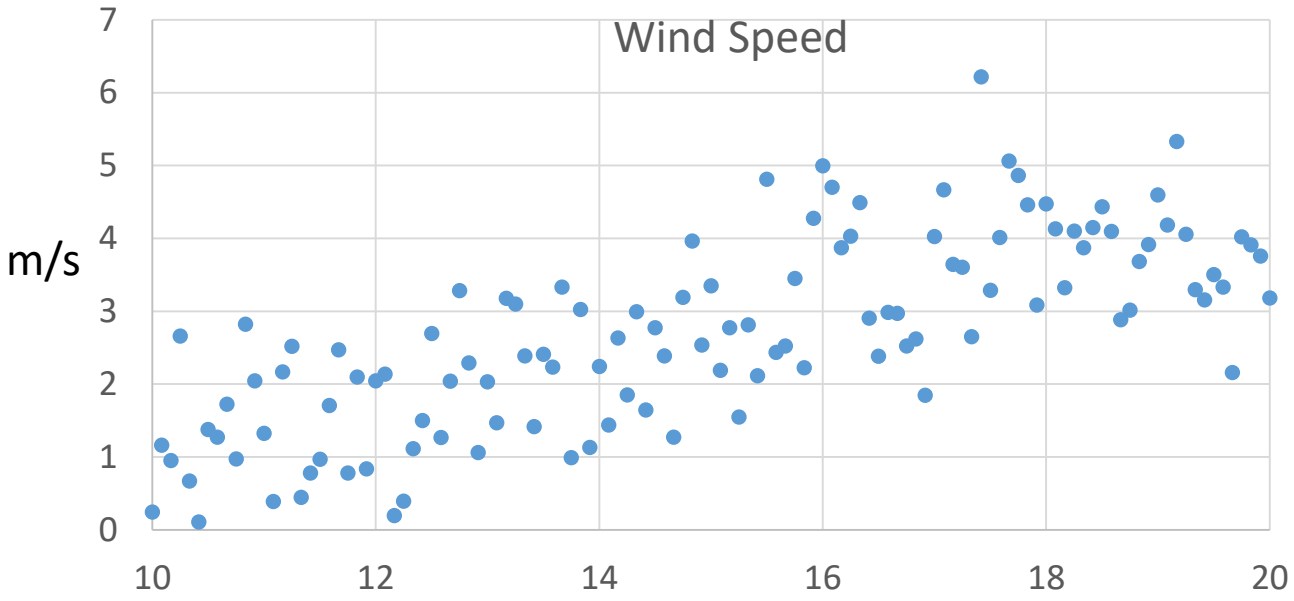
SPATIAL EXTENT of Clearing at 1 PM

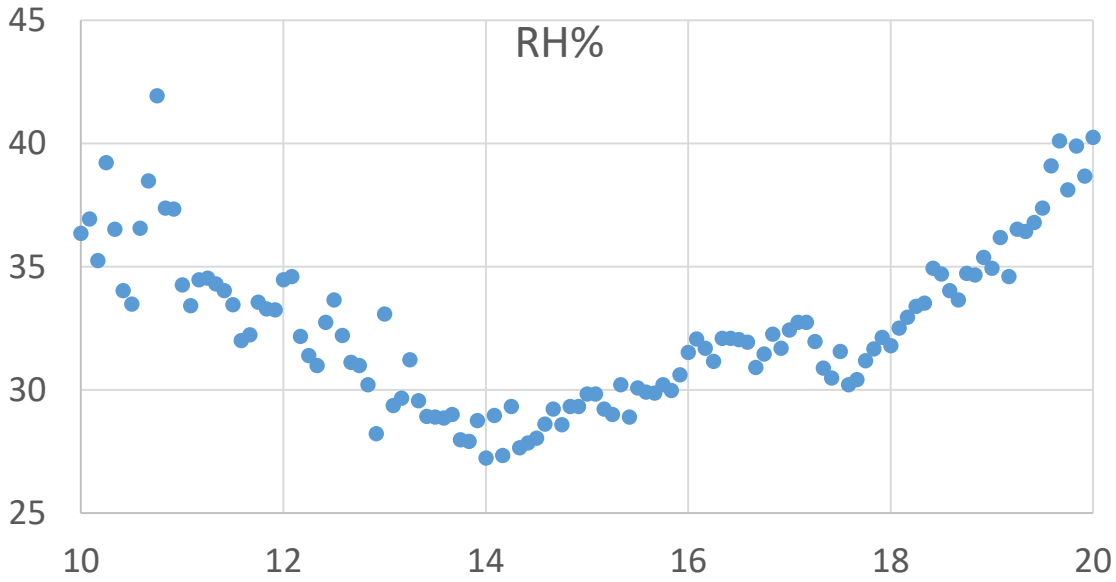
- Horizontal southeast pointing lidar observes the clearing to 4km (limited due to Signal to Noise)
- Lidar returns at Lehman College (7 km NE) observes the clearing but to a lesser extent
- Lidars in Queens (12 km SE) and Staten Island (29 km SW) do not Observe the same temporal pattern

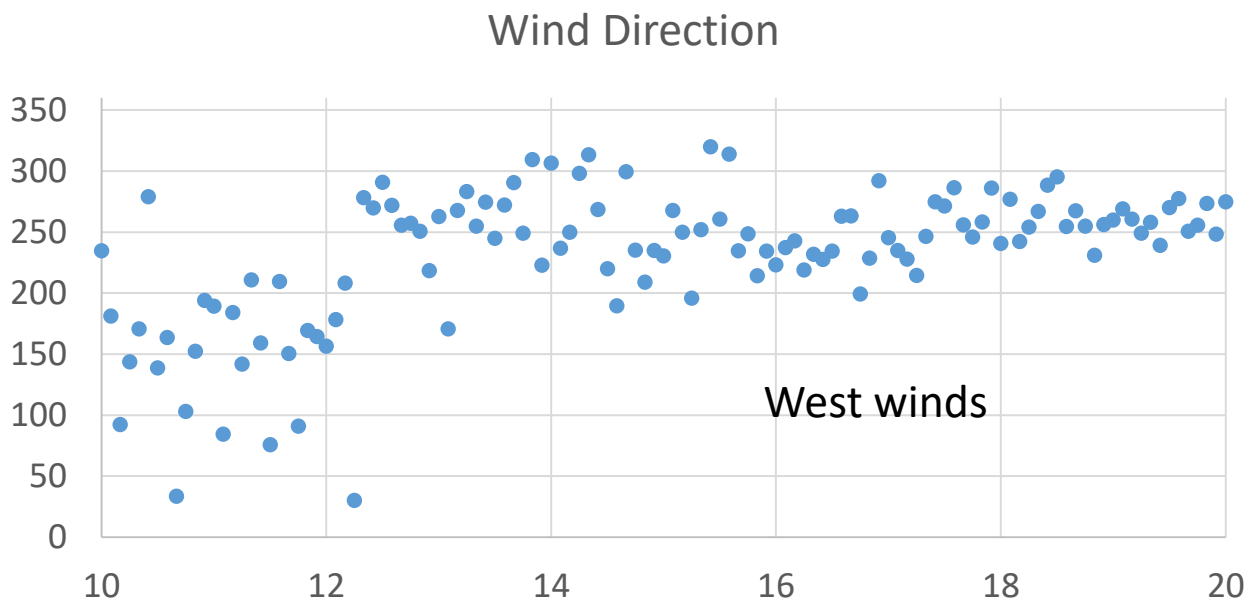
Day 2
June 30, 2018

CCNY Surface MET Conditions June 30



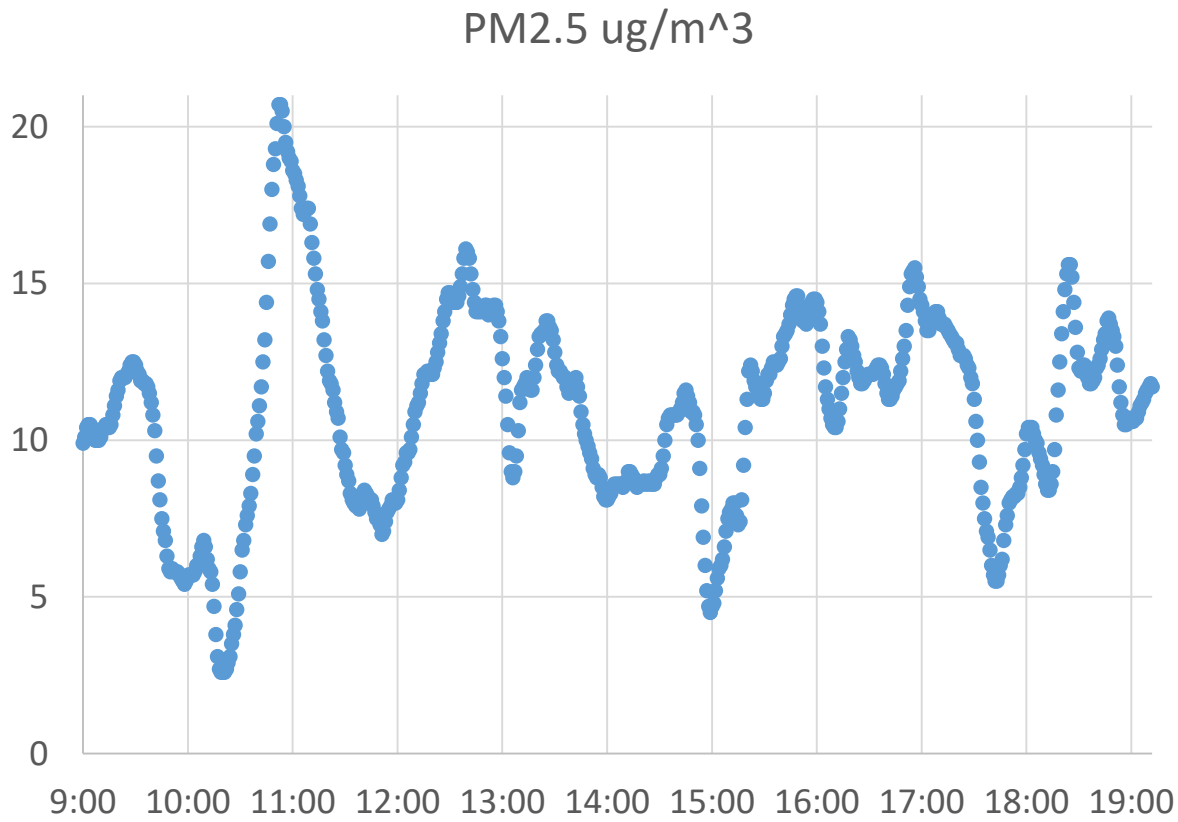






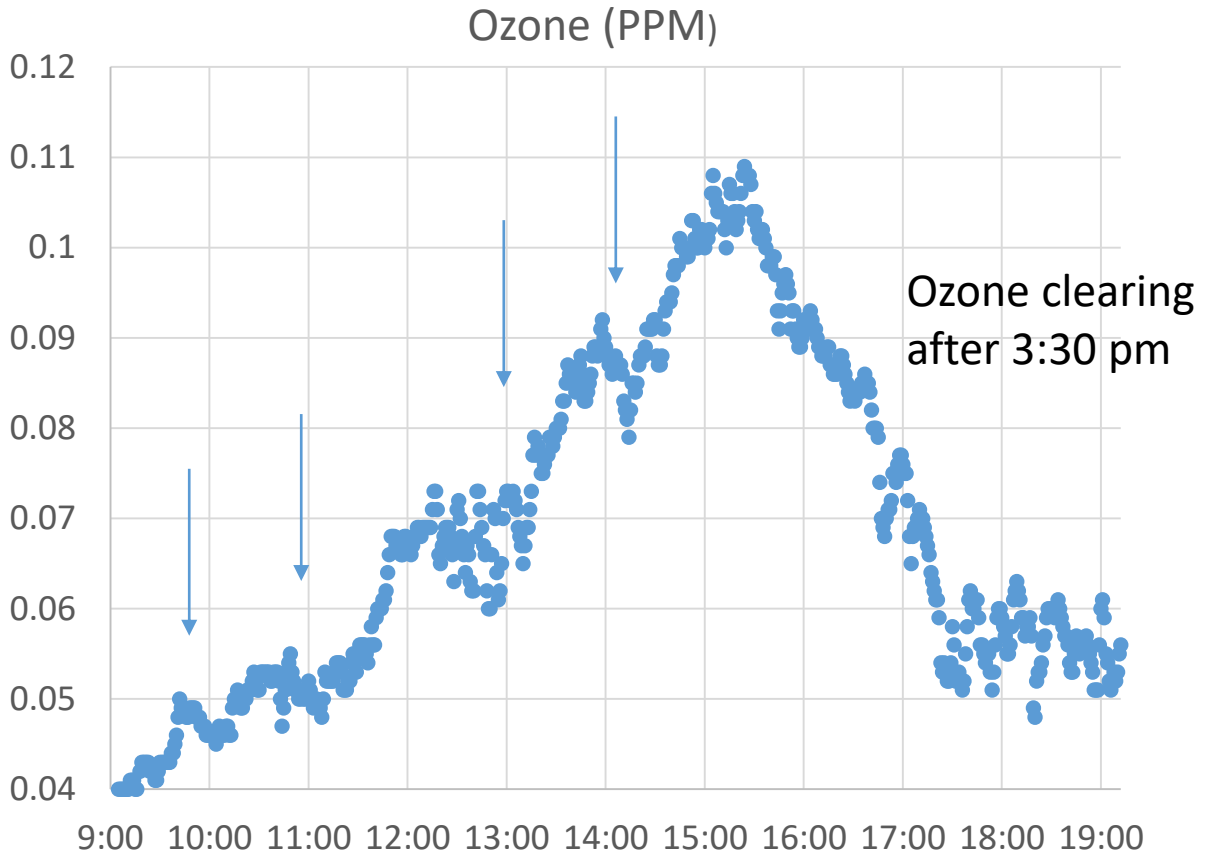
CCNY Surface Analyzer Observations June 30, 2018

Oscillation in PM2.5 concentration



Variable and oscillating PM levels

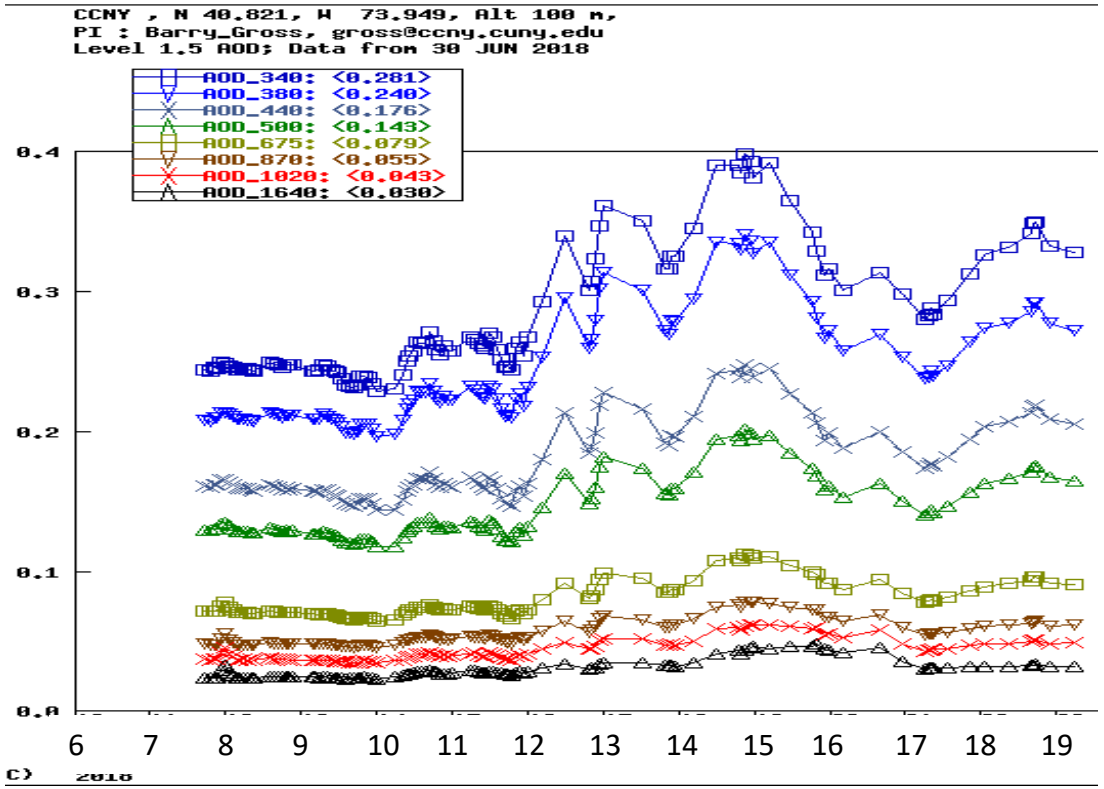
The modulation has much less contrast for Ozone Concentration



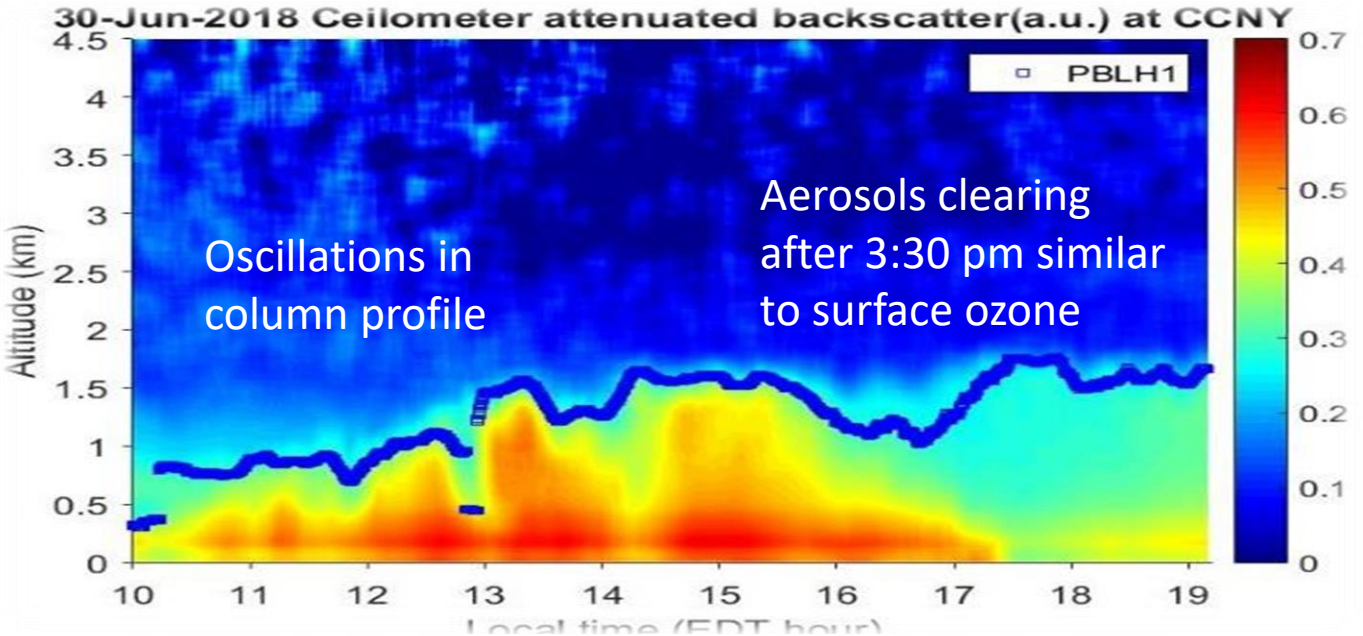
Some weak dynamics visible, but strong trend of increasing ozone levels to 3pm

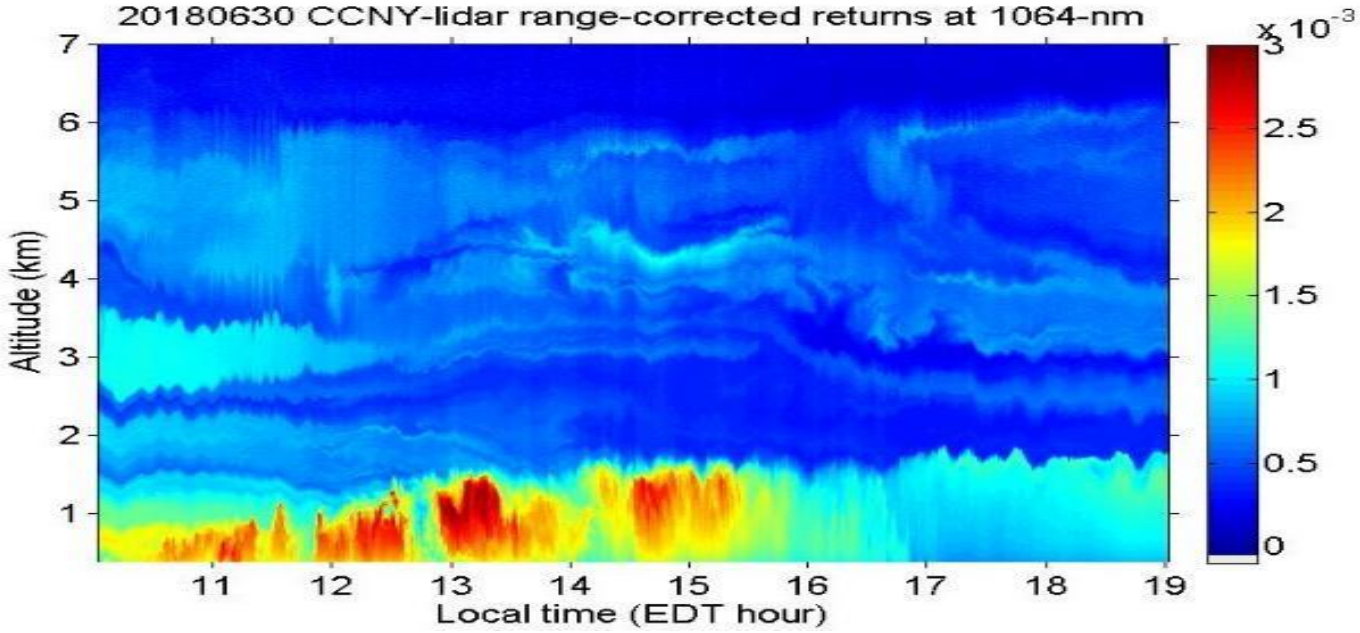
Column and Profile Aerosol Observations – June 30th

Oscillation observed in Column measurements and aerosol profiles



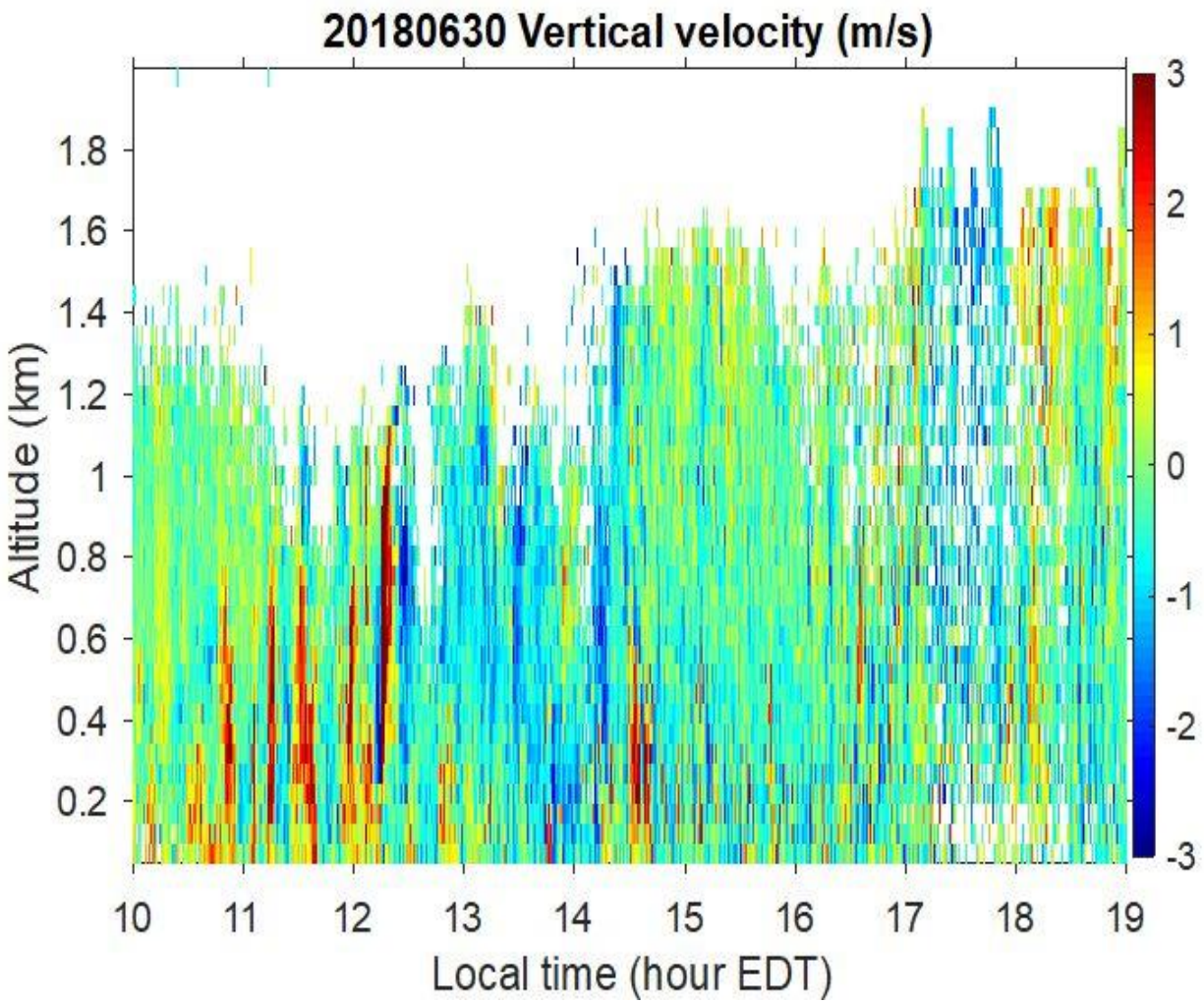
AERONET Aerosol Optical Depth



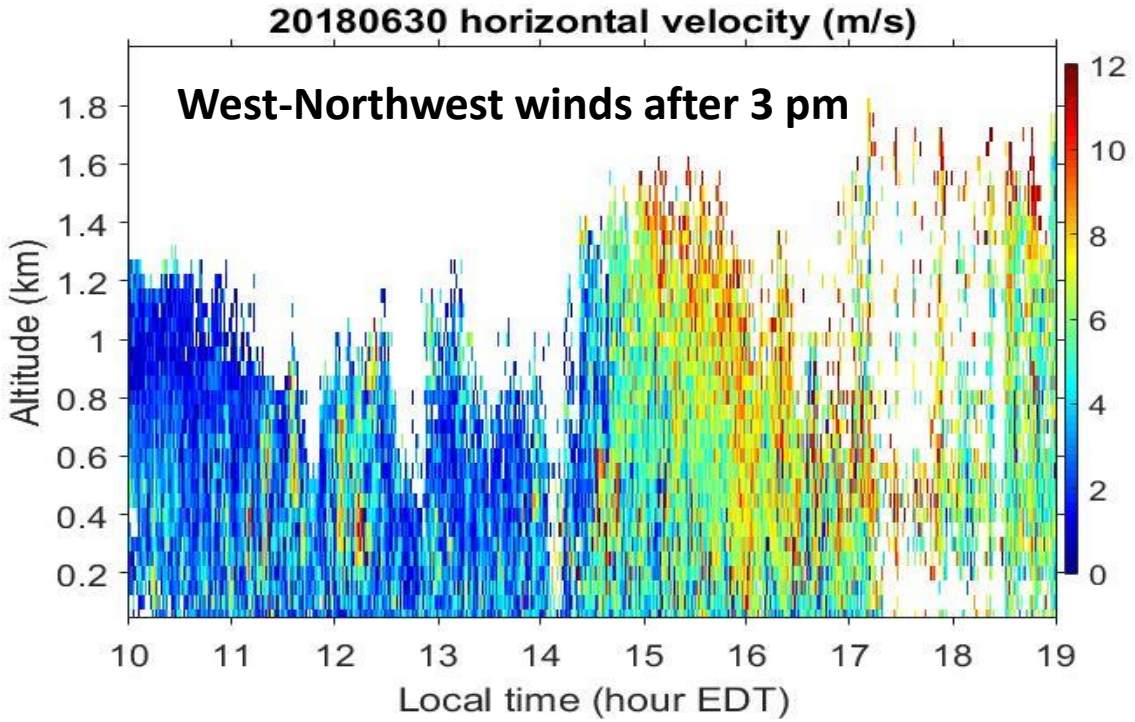


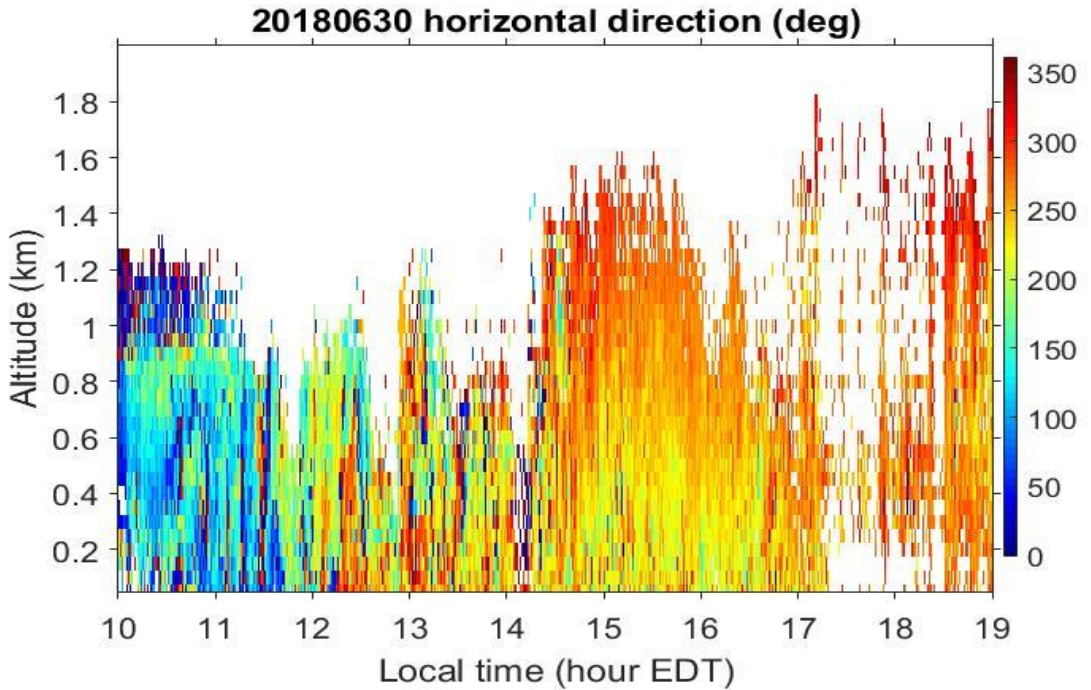
CCNY Profiles- June 30, 2018

Vertical and Horizontal Winds



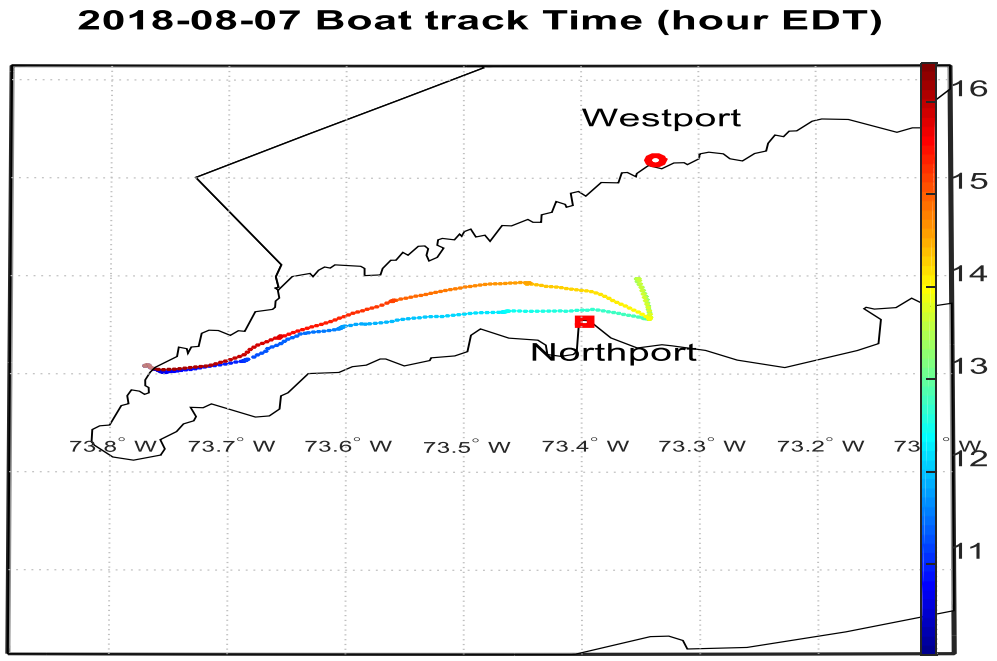
Turbulent convective boundary layer to 3 pm

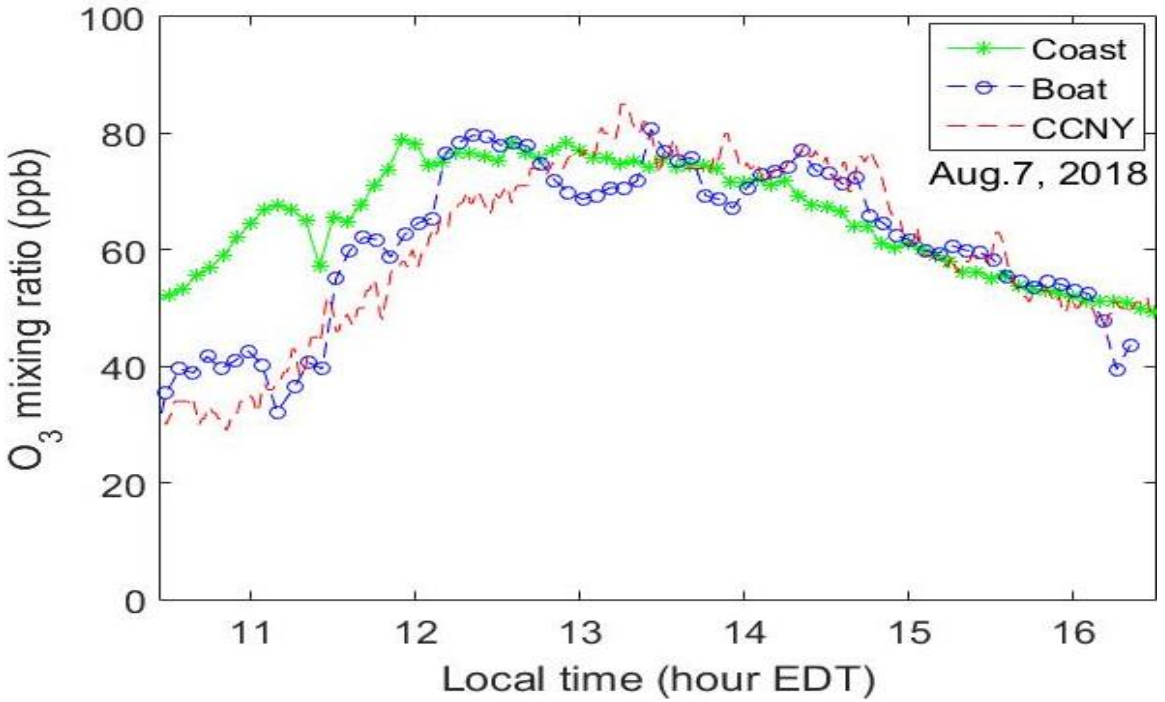


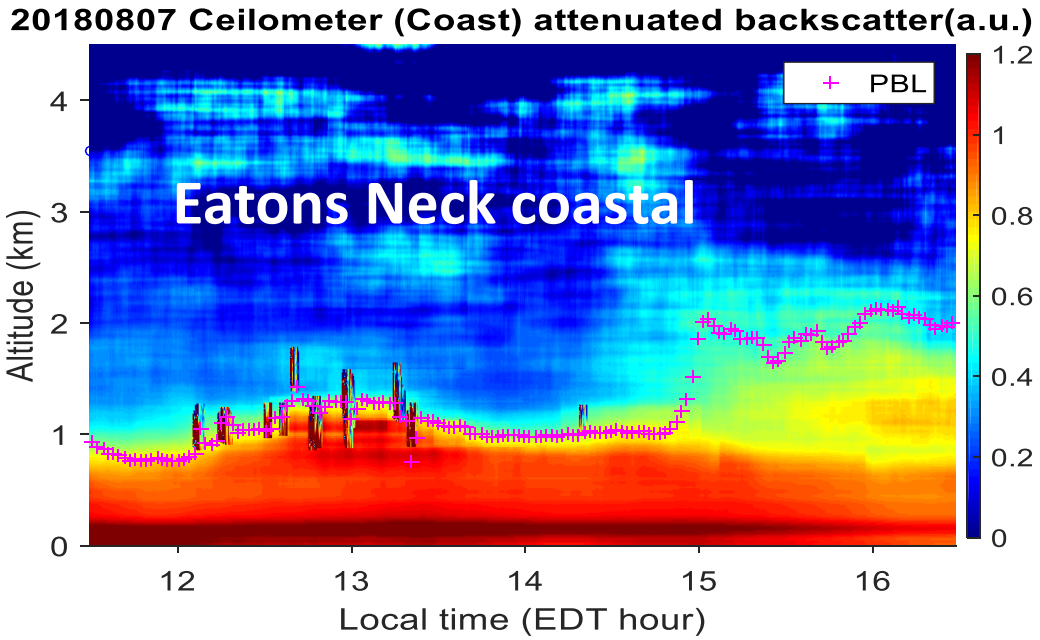


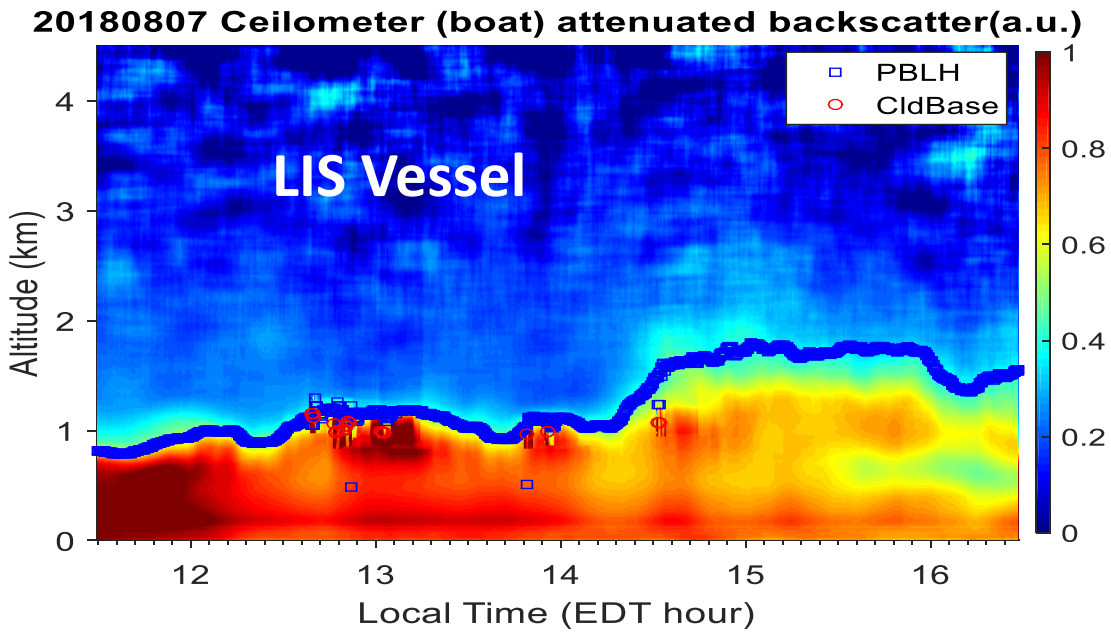
Long Island Sound CRUISES

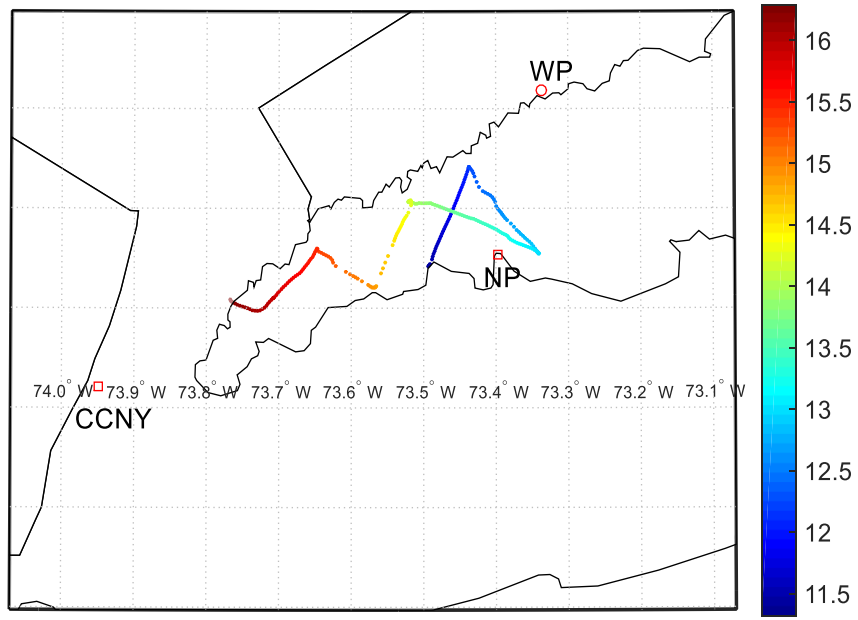
August 7
August 10
August 29

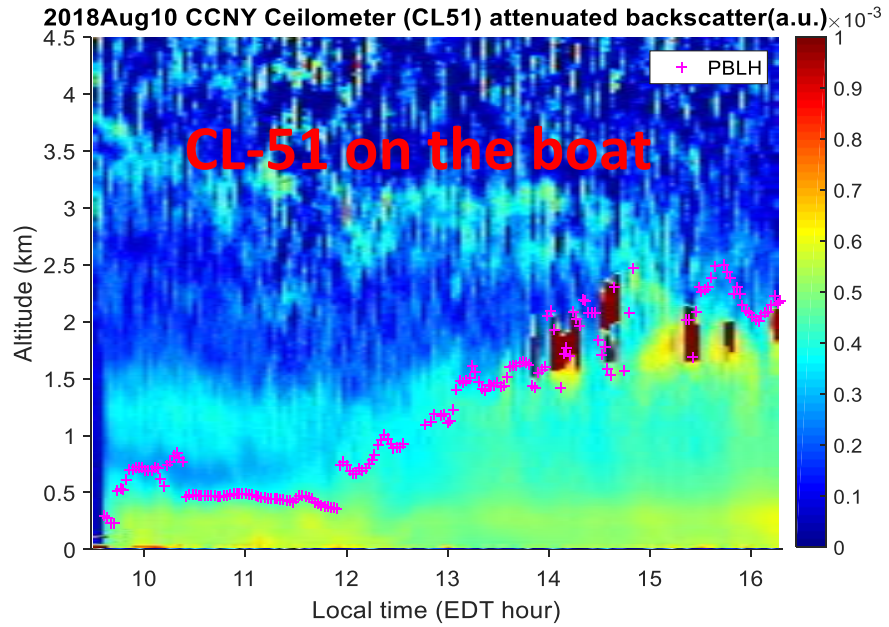

2018-08-07 Boat track Time (hour EDT)
Westport
Northport
73.8° W
73.7° W
73.6° W
73.5° W
73.4° W
73.3° W
73.2° W
16
15
14
13
12
11

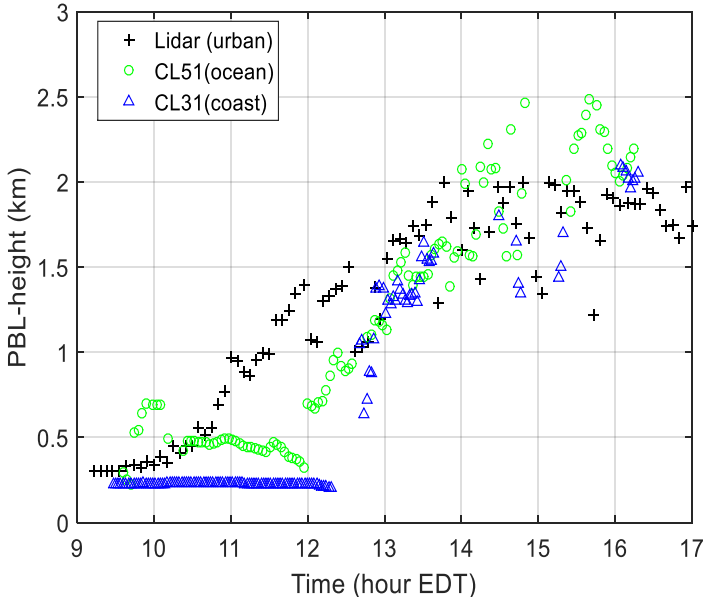

Coast
Boat
CCNY
Aug.7, 2018
O_3 mixing ratio (ppb)
Local time (hour EDT)
100
80
60
40
20
0
11
12
13
14
15
16

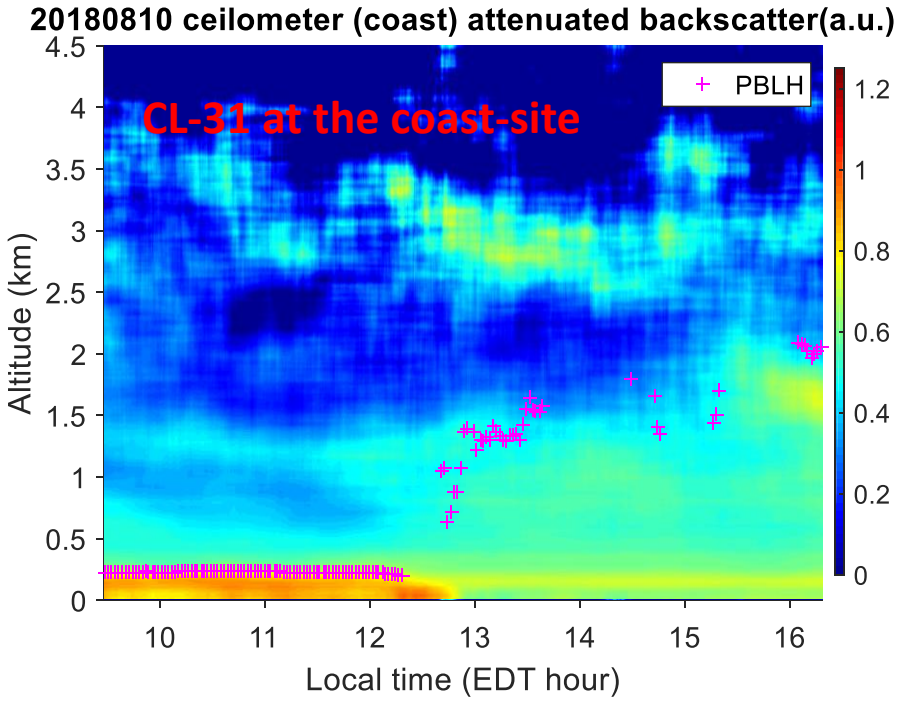

20180807 Ceilometer (Coast) attenuated backscatter(a.u.)
PBL
Eatons Neck coastal
Altitude (km)
Local time (EDT hour)
4
3
2
1
0
12
13
14
15
16
1.2
1
0.8
0.6
0.4
0.2
0

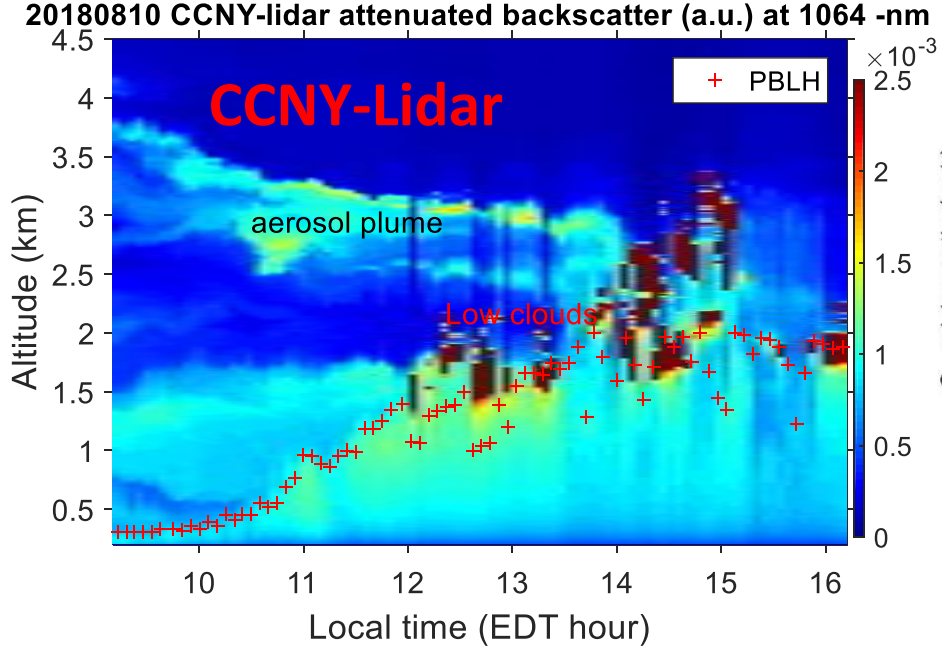

20180807 Ceilometer (boat) attenuated backscatter(a.u.)
PBLH
CldBase
LIS Vessel
Altitude (km)
Local Time (EDT hour)
4
3
2
1
0
12
13
14
15
16
1
0.8
0.6
0.4
0.2
0

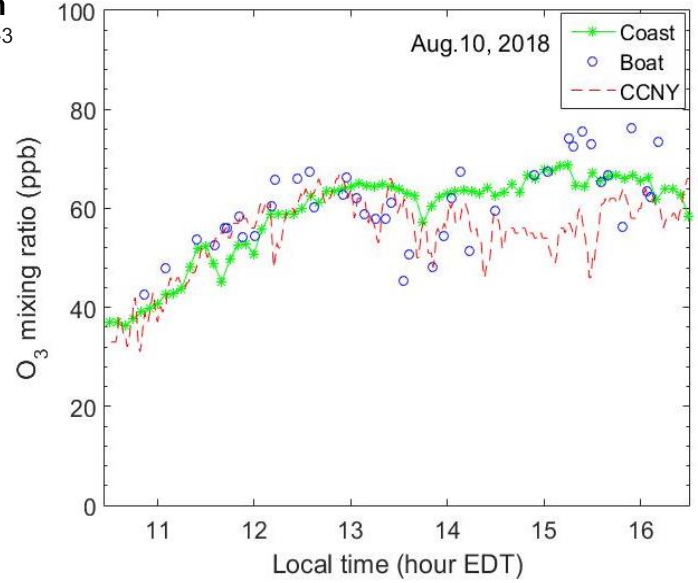

2018-08-10 Boat track Time (hour EDT)
WP
NP
CCNY
74.0° W
73.9° W
73.8° W
73.7° W
73.6° W
73.5° W
73.4° W
73.3° W
73.2° W
73.1° W
16
15.5
15
14.5
14
13.5
13
12.5
12
11.5

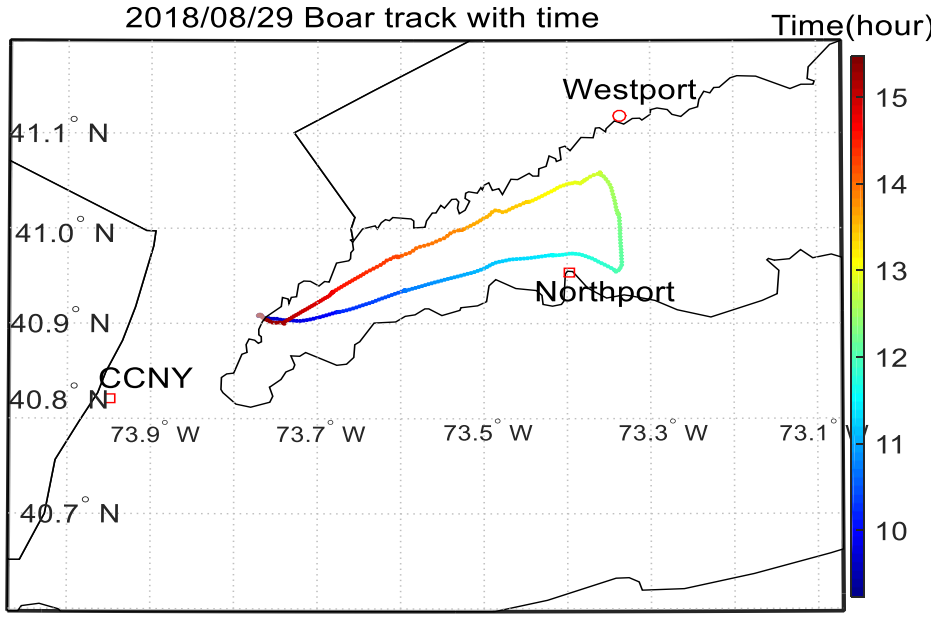

2018Aug10 CCNY Ceilometer (CL51) attenuated backscatter(a.u.)
CL-51 on the boat
PBLH
Altitude (km)
Local time (EDT hour)
×10^-3

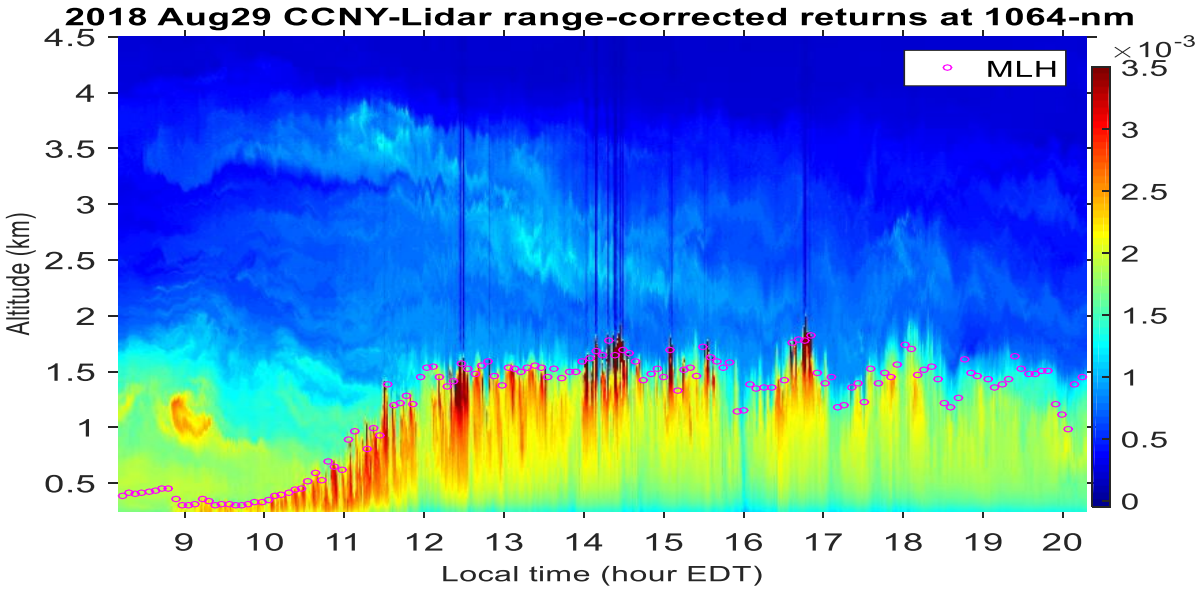

Lidar (urban)
CL51(ocean)
CL31(coast)
PBL-height (km)
Time (hour EDT)

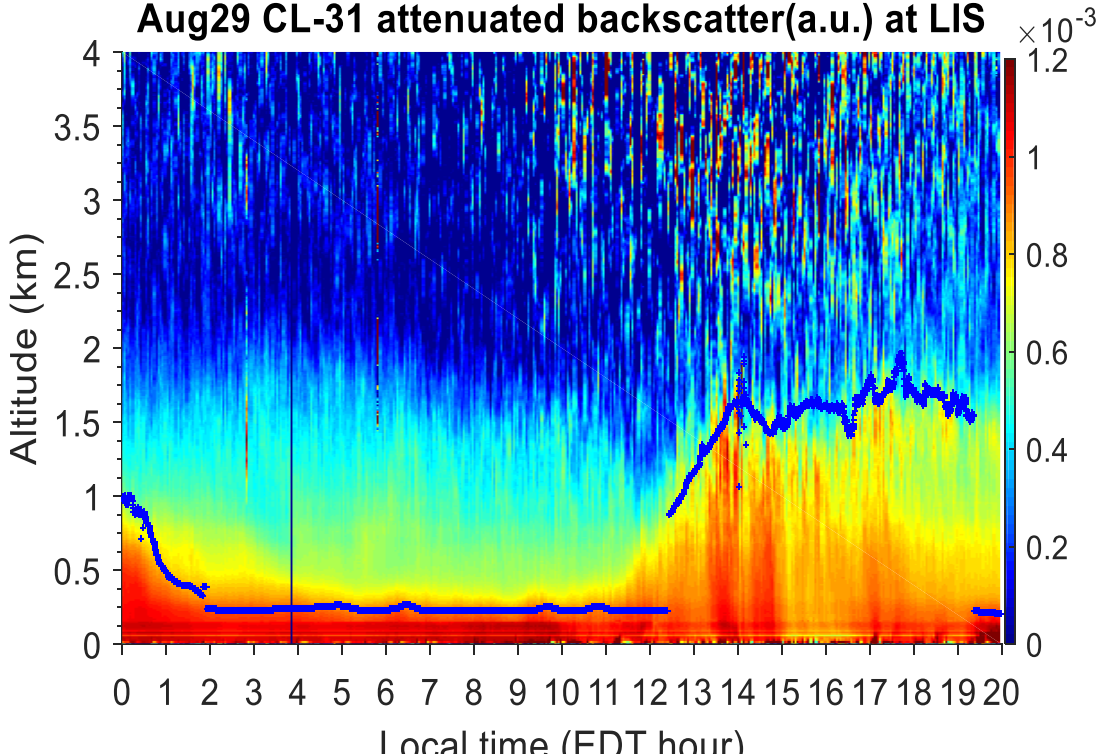

20180810 ceilometer (coast) attenuated backscatter(a.u.)
CL-31 at the coast-site
PBLH
Altitude (km)
Local time (EDT hour)

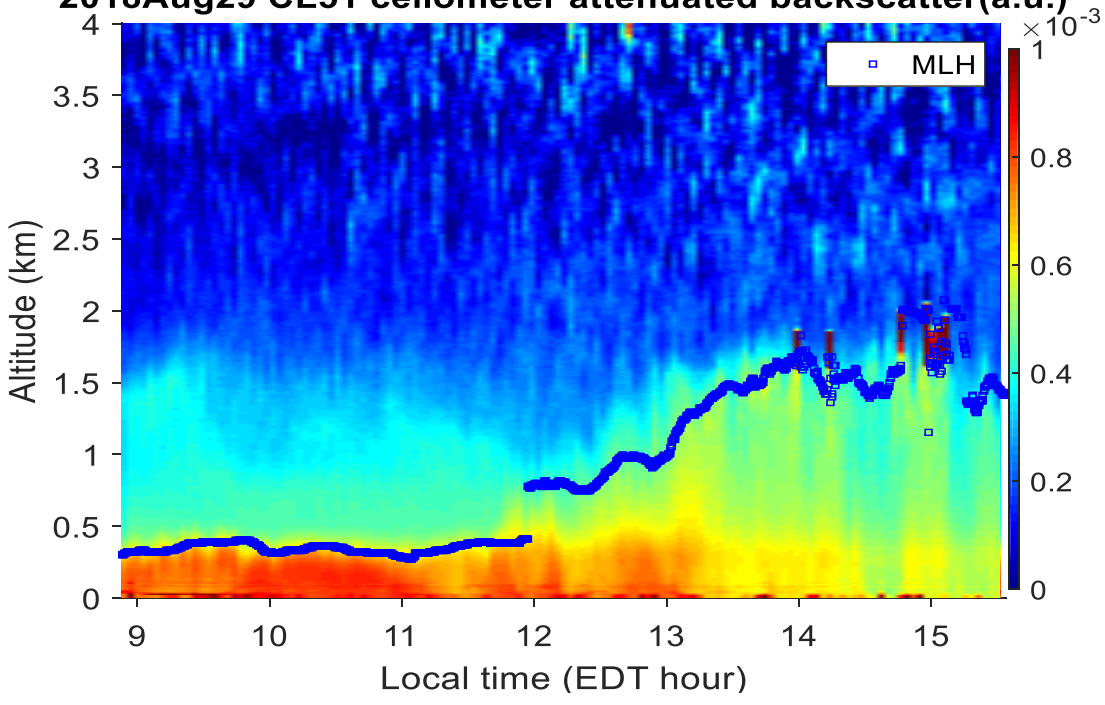

20180810 CCNY-lidar attenuated backscatter (a.u.) at 1064 -nm
CCNY-Lidar
aerosol plume
Low clouds
PBLH
Altitude (km)
Local time (EDT hour)
×10^-3


Aug.10, 2018
Coast
Boat
CCNY
O3 mixing ratio (ppb)
Local time (hour EDT)


2018/08/29 Boar track with time
Time(hour)
Westport
Northport
CCNY
41.1° N
41.0° N
40.9° N
40.8° N
40.7° N
73.9° W
73.7° W
73.5° W
73.3° W
73.1° W
15
14
13
12
11
10


2018 Aug29 CCNY-Lidar range-corrected returns at 1064-nm
MLH
Altitude (km)
Local time (hour EDT)
×10-3


Aug29 CL-31 attenuated backscatter(a.u.) at LIS
Altitude (km)
Local time (EDT hour)
×10-3


2018Aug29 CL51 ceilometer attenuated backscatter(a.u.)
MLH
Altitude (km)
Local time (EDT hour)
×10-3

KEY TAKE AWAYS:

Interaction of Heatwaves with urban areas are complex and dynamic

During a five day heatwave event in NYC (June 29-July 3), which led to exceedance of ozone NAAQS, we observe dynamic changes in humidity and pollution levels during heatwave days throughout the tropospheric column that **effect the surface air (Heat Index and Air Quality) and the impact of heatwaves on comfort and health.**

PM levels are more dynamic than ozone measurements. Afternoon surface ozone appear to be correlated to the boundary layer aerosol profile dynamics

During the Cruse Days:
Boundary layer heights inferred by ceilometer observations are consistent in NYC and LIS (both coastal and marine), while the boundary layer build-up is earlier in NYC

LIS Ozone levels on the water and coastal observations were generally similar

Acknowledgements

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We appreciate NYSDEC and NASA AERONET for their data presented here.