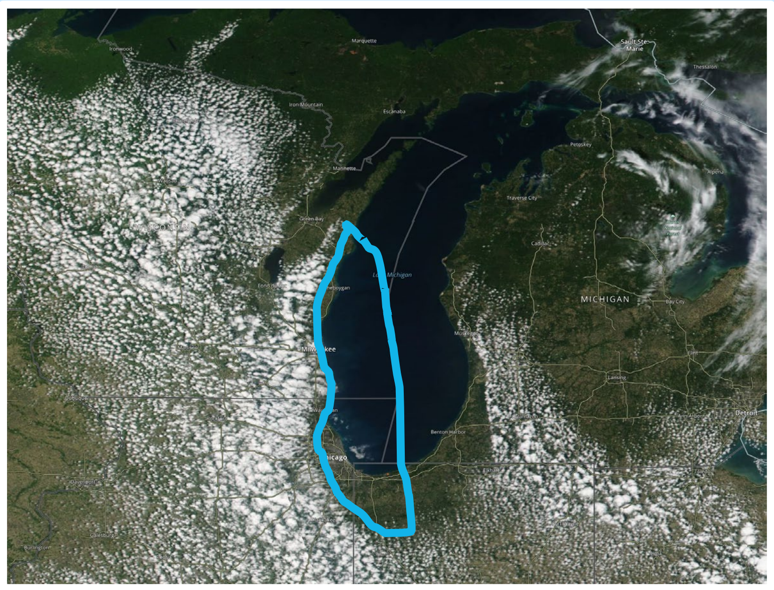
Re-design of Photochemical Assessment Monitoring System and ideas for analysis of measurements collected under Enhanced Monitoring Plans

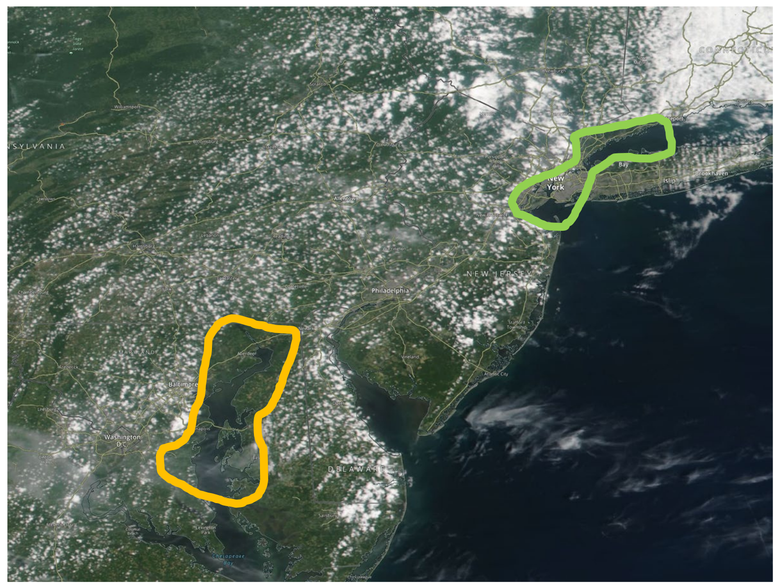
<u>NAAMC 2022</u>

Luke Valin, Jim Szykman, David Williams, Eric Baumann

EPA/ORD/CEMM

Coastal regions remain some of the more persistent and challenging ozone nonattainment areas to address in the East US





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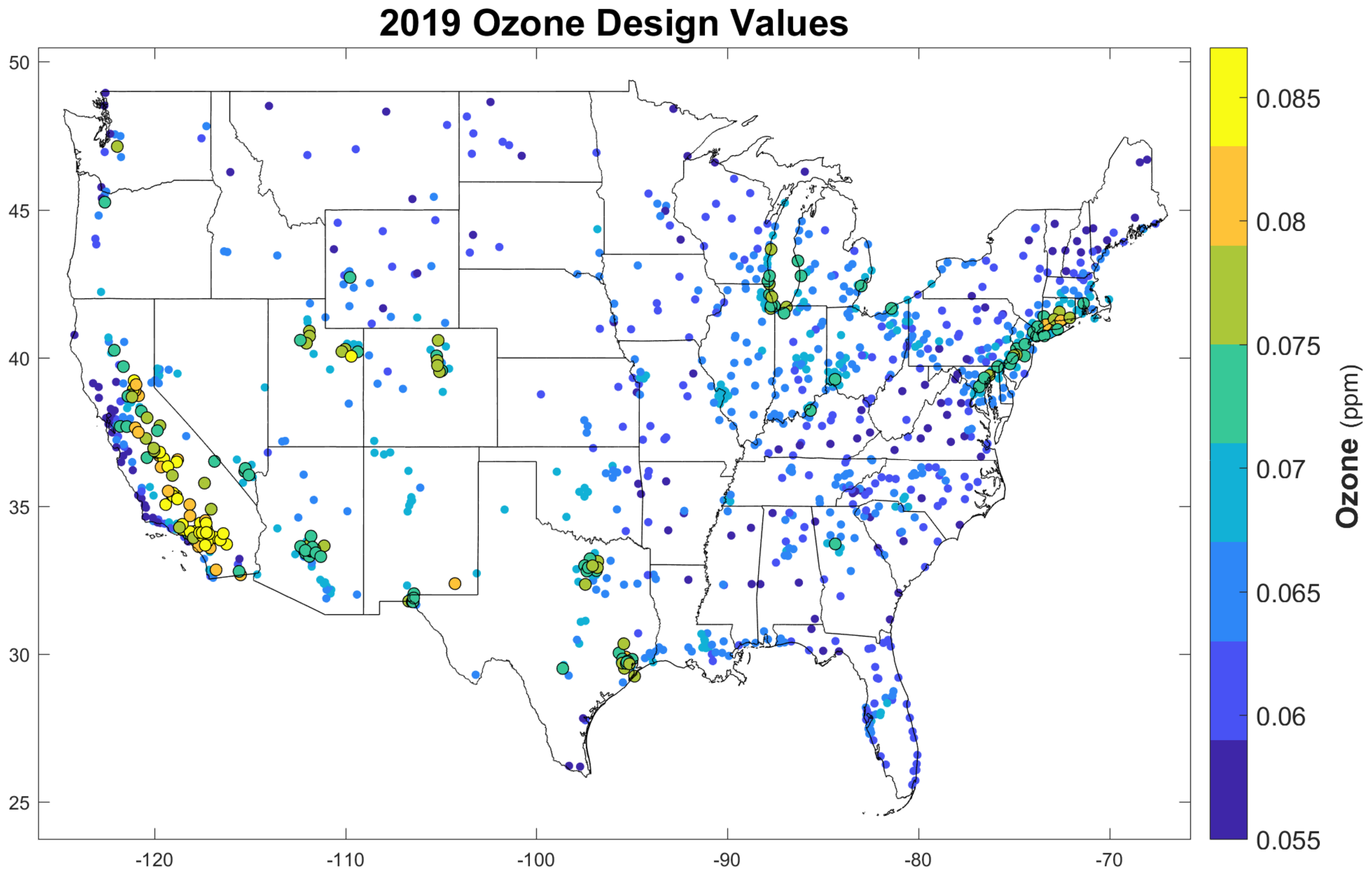
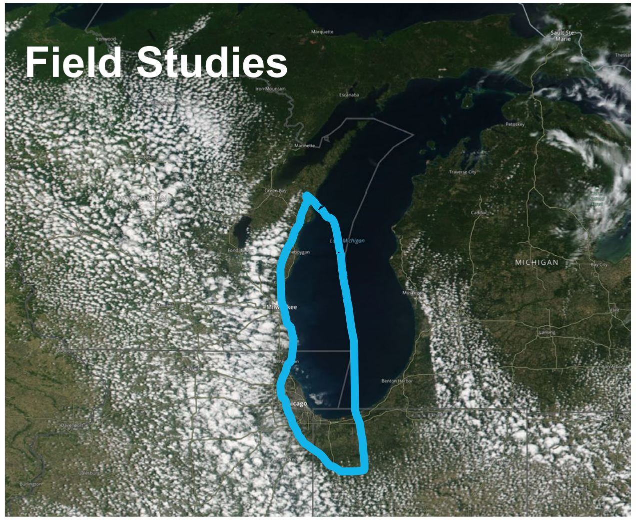
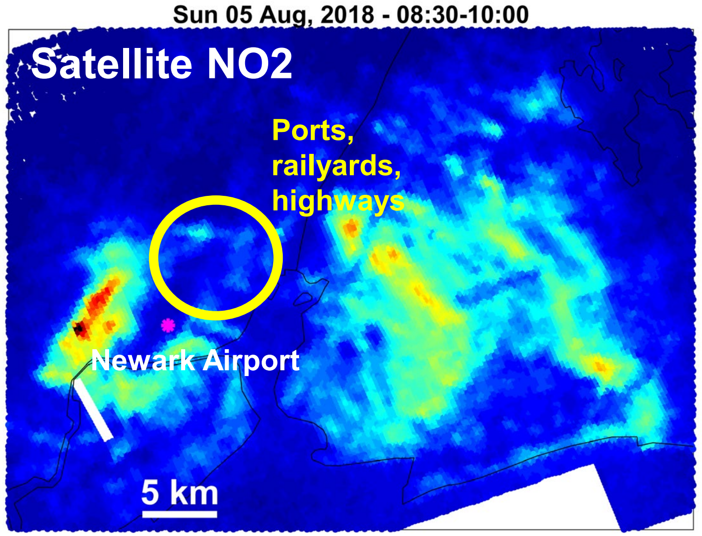
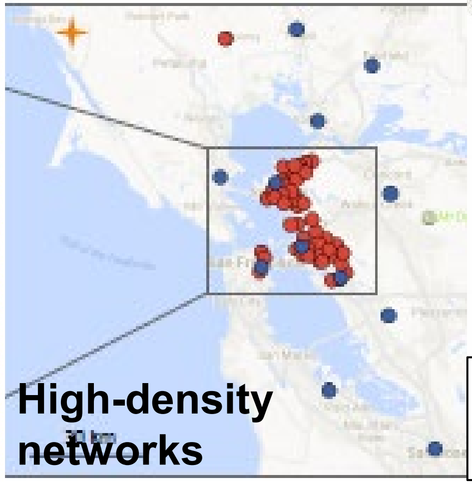
Ozone non-attainment an ongoing problem, primarily in valleys and along shorelines

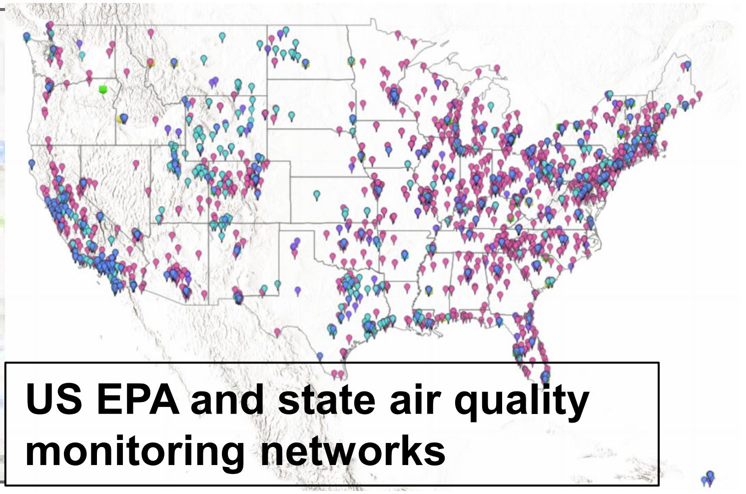


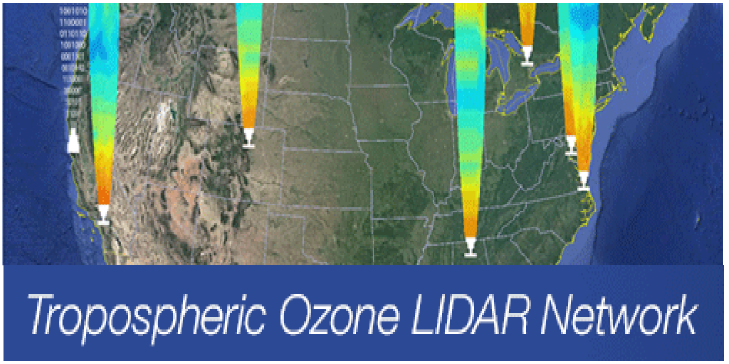
Leveraging air quality monitoring system for improved understanding of air pollution

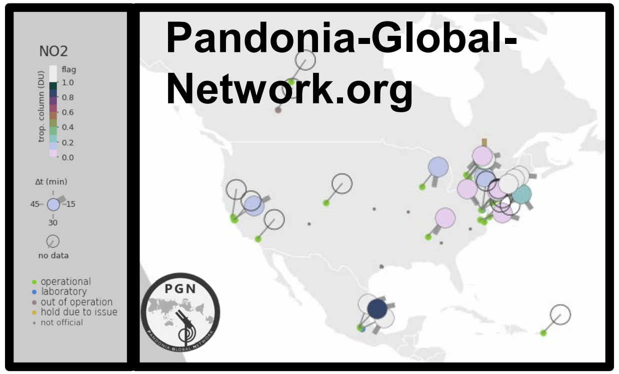




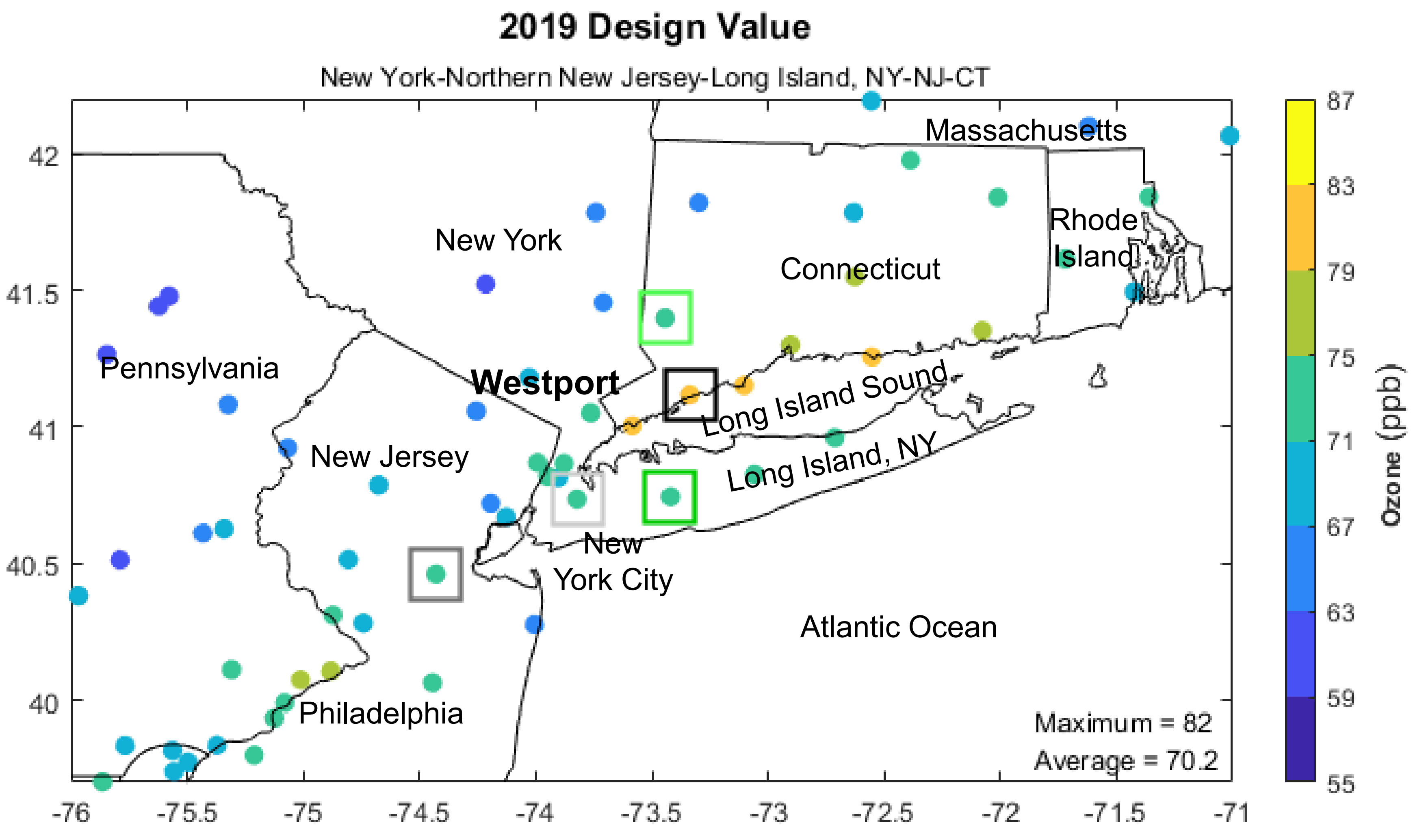




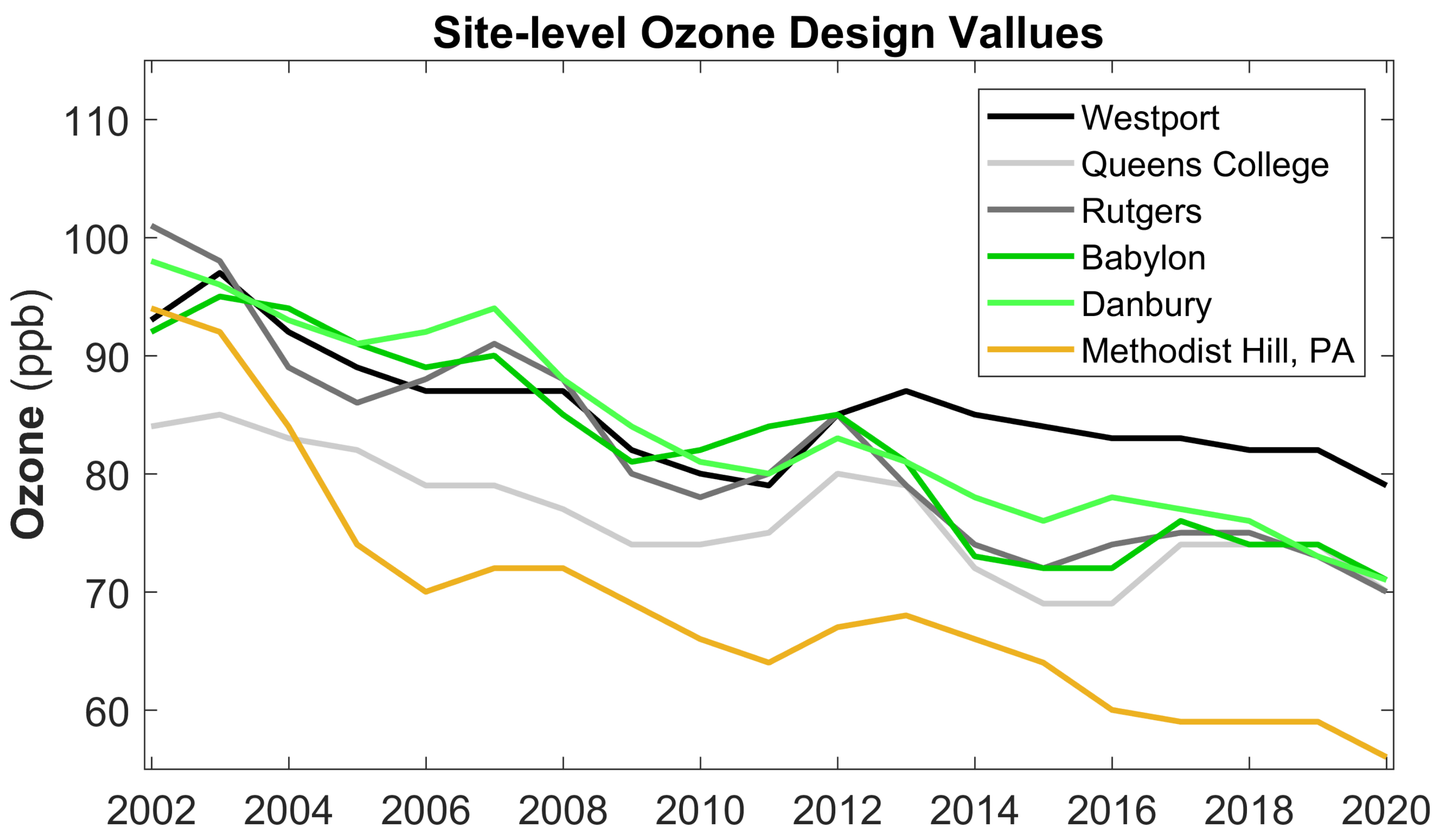




Site-level Ozone Design Values



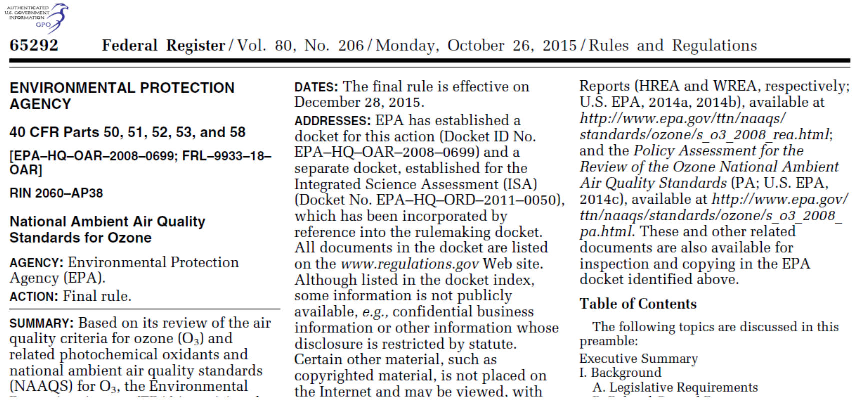
Design Value Trends



What is an Enhanced Monitoring Plan (EMP)?

PAMS Requirement #1:

- State-of-the-art regulatory grade, QA-QC hourly NO_x, NO_y, "true" NO_2, CO, ozone speciated VOC, formaldehyde (hourly or 8 hour), 1-in-3 day PM2.5 speciation
- Hourly boundary layer or mixed layer height measurement. Where available ceilometer return signal archived
- Meteorology measurements


65292 Federal Register / Vol. 80, No. 206 / Monday, October 26, 2015 / Rules and Regulations

ENVIRONMENTAL PROTECTION AGENCY

40 CFR Parts 50, 51, 52, 53, and 58

[EPA–HQ–OAR–2008–0699; FRL–9933–18–OAR]

RIN 2060–AP38

National Ambient Air Quality Standards for Ozone

AGENCY: Environmental Protection Agency (EPA).

ACTION: Final rule.

SUMMARY: Based on its review of the air quality criteria for ozone (O_3) and related photochemical oxidants and national ambient air quality standards (NAAQS) for O_3, the Environmental

DATES: The final rule is effective on December 28, 2015.

ADDRESSES: EPA has established a docket for this action (Docket ID No. EPA–HQ–OAR–2008–0699) and a separate docket, established for the Integrated Science Assessment (ISA) (Docket No. EPA–HQ–ORD–2011–0050), which has been incorporated by reference into the rulemaking docket. All documents in the docket are listed on the *www.regulations.gov* Web site. Although listed in the docket index, some information is not publicly available, *e.g.*, confidential business information or other information whose disclosure is restricted by statute. Certain other material, such as copyrighted material, is not placed on the Internet and may be viewed, with

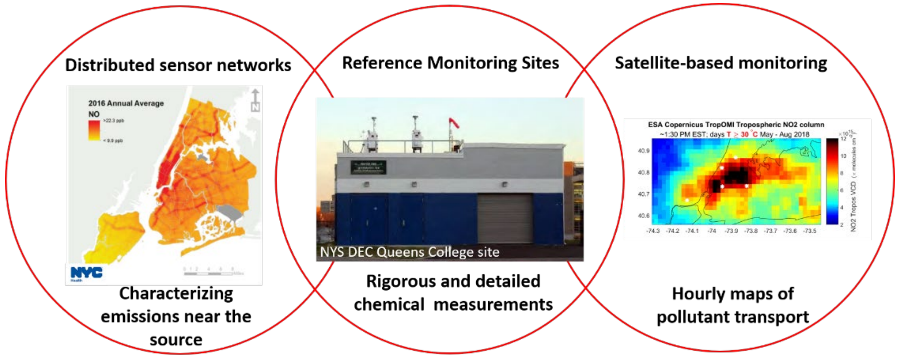
Reports (HREA and WREA, respectively; U.S. EPA, 2014a, 2014b), available at *http://www.epa.gov/ttn/naaqs/standards/ozone/s_o3_2008_rea.html*; and the *Policy Assessment for the Review of the Ozone National Ambient Air Quality Standards* (PA; U.S. EPA, 2014c), available at *http://www.epa.gov/ttn/naaqs/standards/ozone/s_o3_2008_pa.html*. These and other related documents are also available for inspection and copying in the EPA docket identified above.

Table of Contents

The following topics are discussed in this preamble:

PAMS Requirement 2:

- <u>"required states with moderate ozone non-attainment areas [and all states in the ozone transport region] to develop and implement Enhanced Monitoring Plans (EMPs)"</u>
- The inclusion of the EMP element is intended to provide monitoring agencies flexibility to implement monitoring that is needed to address data gaps in their particular area"
- NJ, NY, CT included **LISTOS** in their EMP to help bridge surface/column info for AQ managers.



EMPs: An opportunity to bridge scales, incorporate unconventional datasets and conduct integrated analyses

LISTOS Mission "3D" monitoring framework

We set out to measure as much information about ozone and its precursors in coordinated field research activities with support from ongoing state and local enhanced monitoring activities.

The overarching goal is to inform models and decision makers with sound measurements and scientific insights regarding ozone sources and transport.

ACE Researchers Jon Pleim and Ana Vazquez-Torres led multi-scale CMAQ evaluation with LISTOS data (2022)

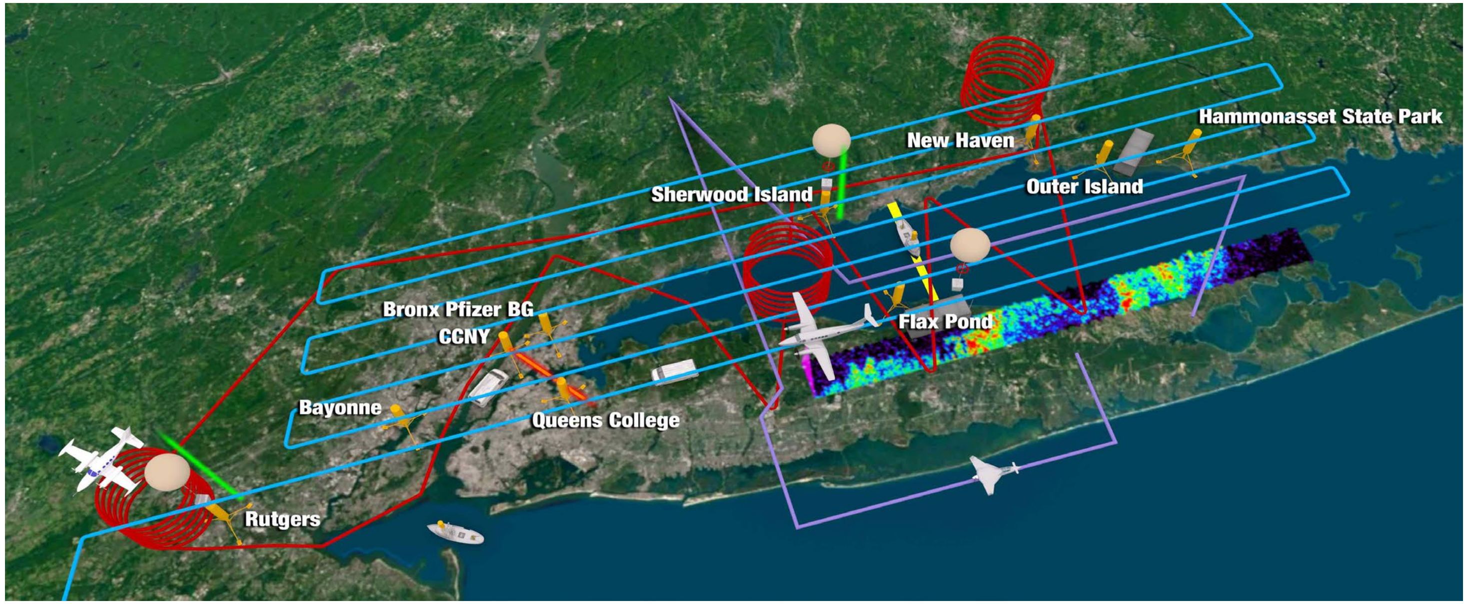
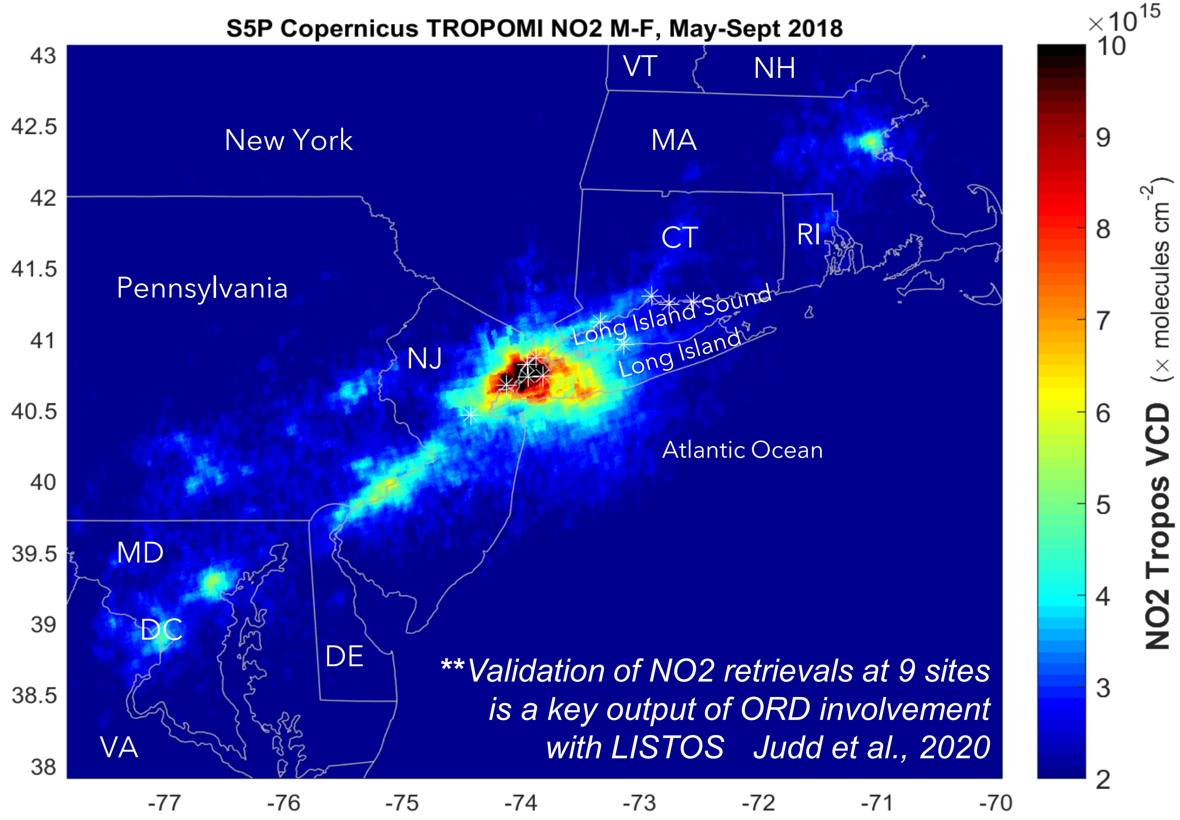
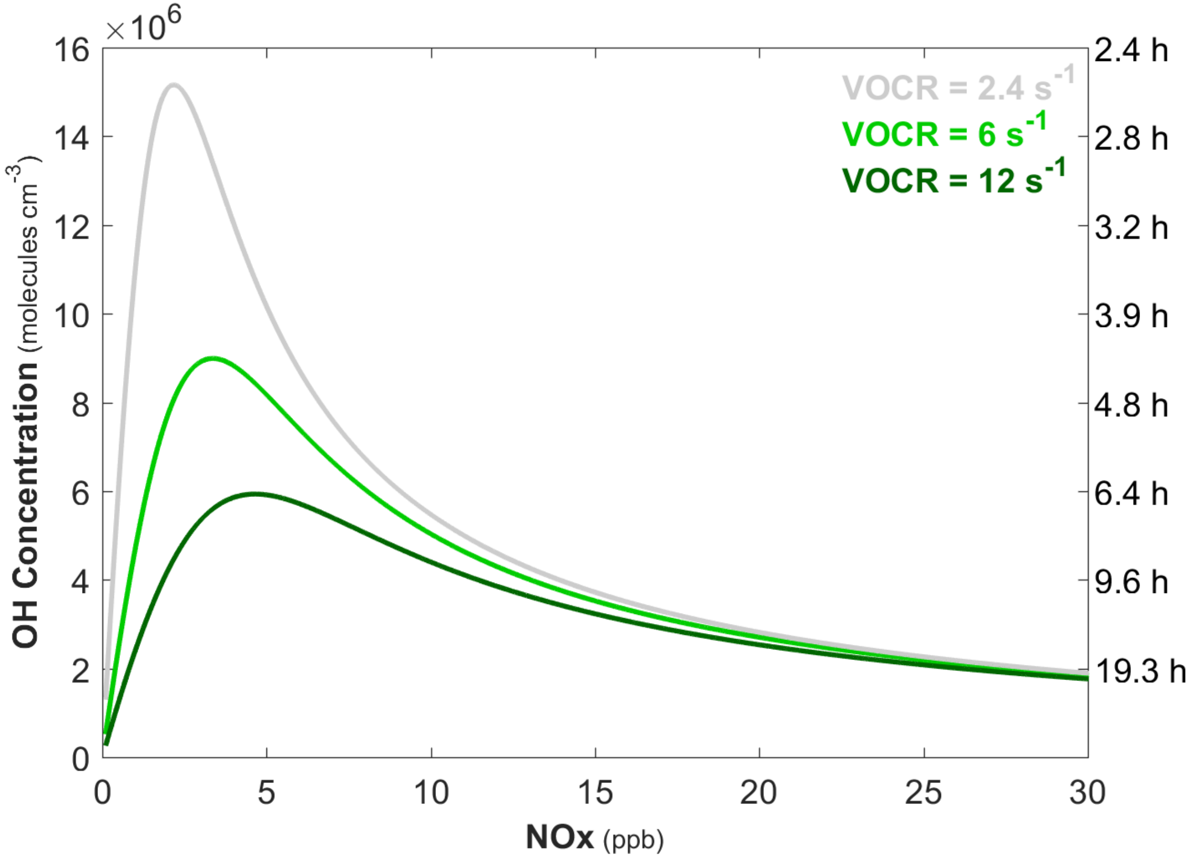


Table 1. Studies published using LISTOS data

Primary Focus	Reference
Ozone transport	Zhang et al., 2020; Couillard et al., 2021; Ma et al., 2021; Bernier et al., 2022; Han et al., 2022; Vazquez-Torres et al., 2022; This work
Ozone formation	Coggon et al., 2021; Ma et al., 2021; This work
Ozone precursors	Gkatzelis et al., 2020; Judd et al., 2020; Coggon et al., 2021;
Wildfire smoke transport	Rogers et al., 2020; Wu et al., 2021
PM and semi-volatiles composition	Zhang et al., 2020; Ditto et al., 2022; Lei et al., 2022
Satellite NO2 data evaluation	Judd et al., 2020

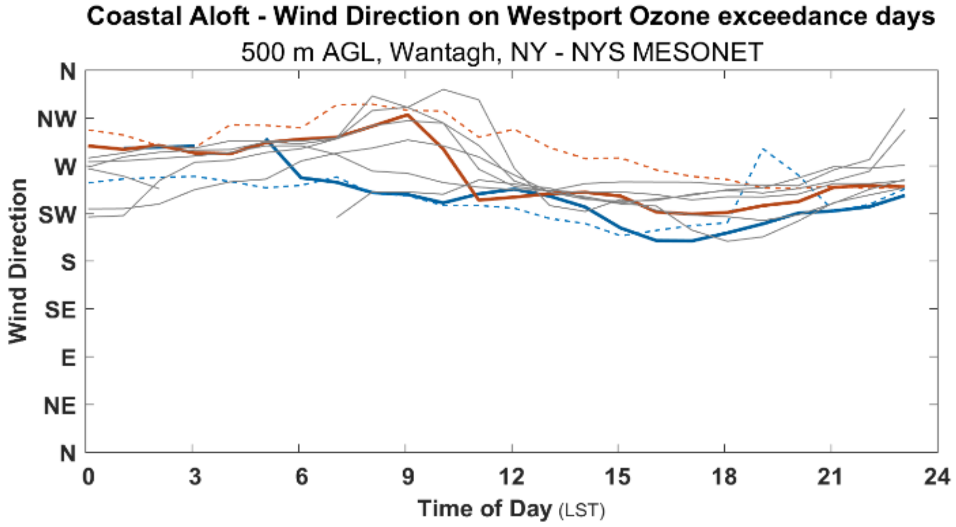
Regional pollution, the NOx “volcano” and non-linear chemistry

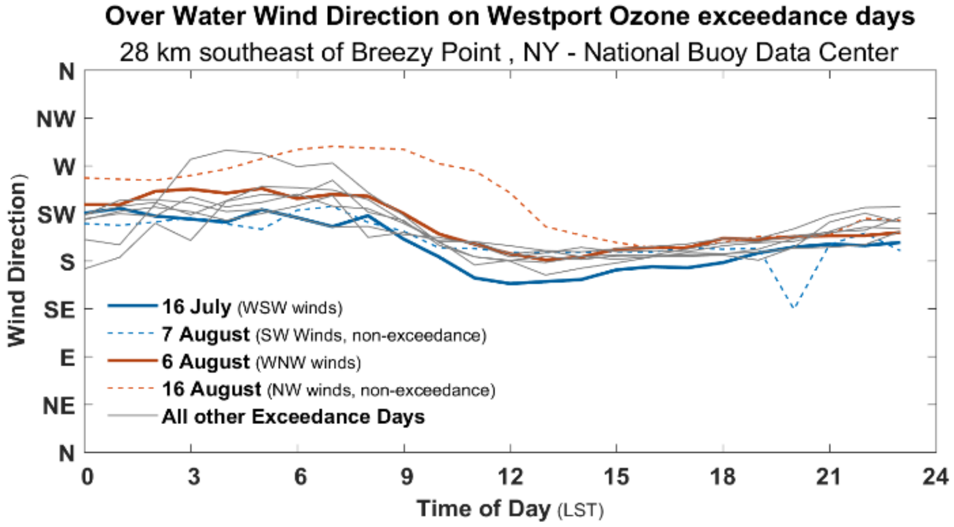


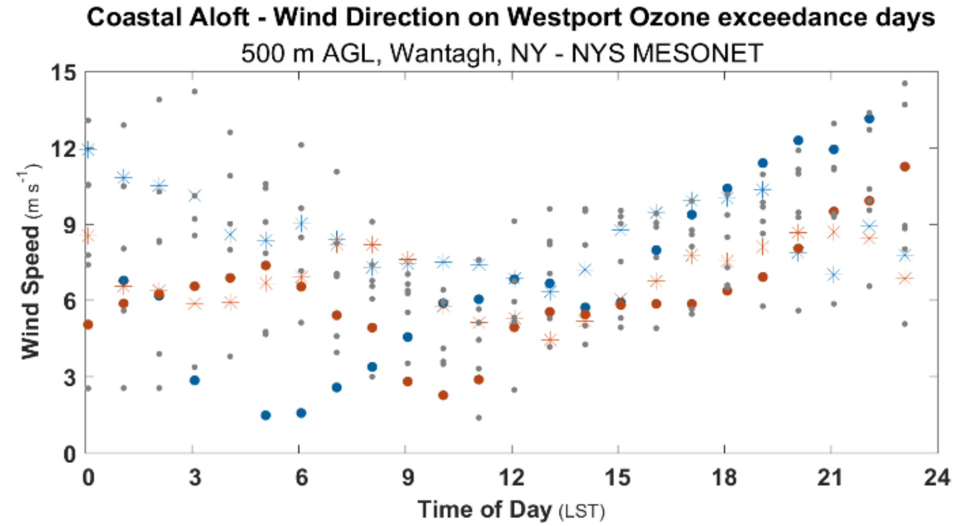


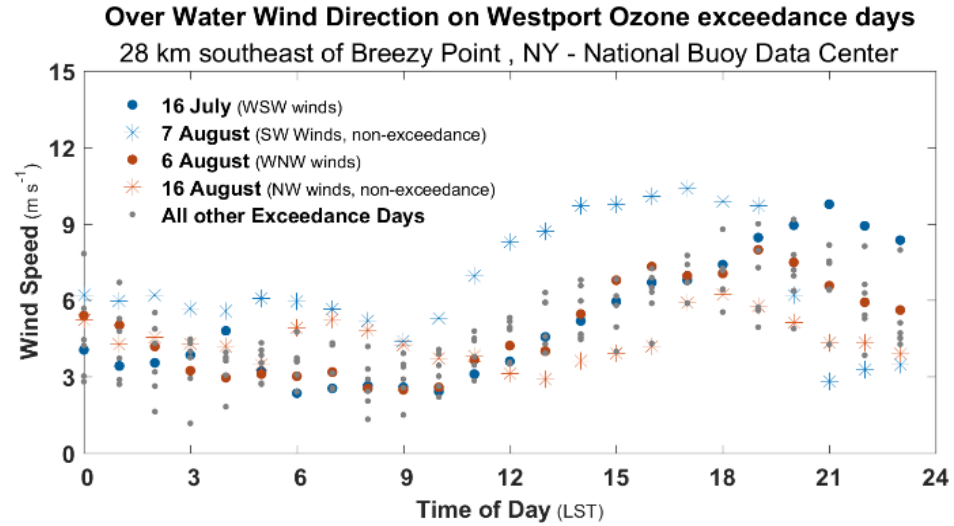
What are the principal features of ozone transport impacting shoreline Connecticut, from where do precursors originate and what chemical relationship exists between NOx abundance and ozone?

Synoptic wind patterns on ozone exceedances and non-exceedances



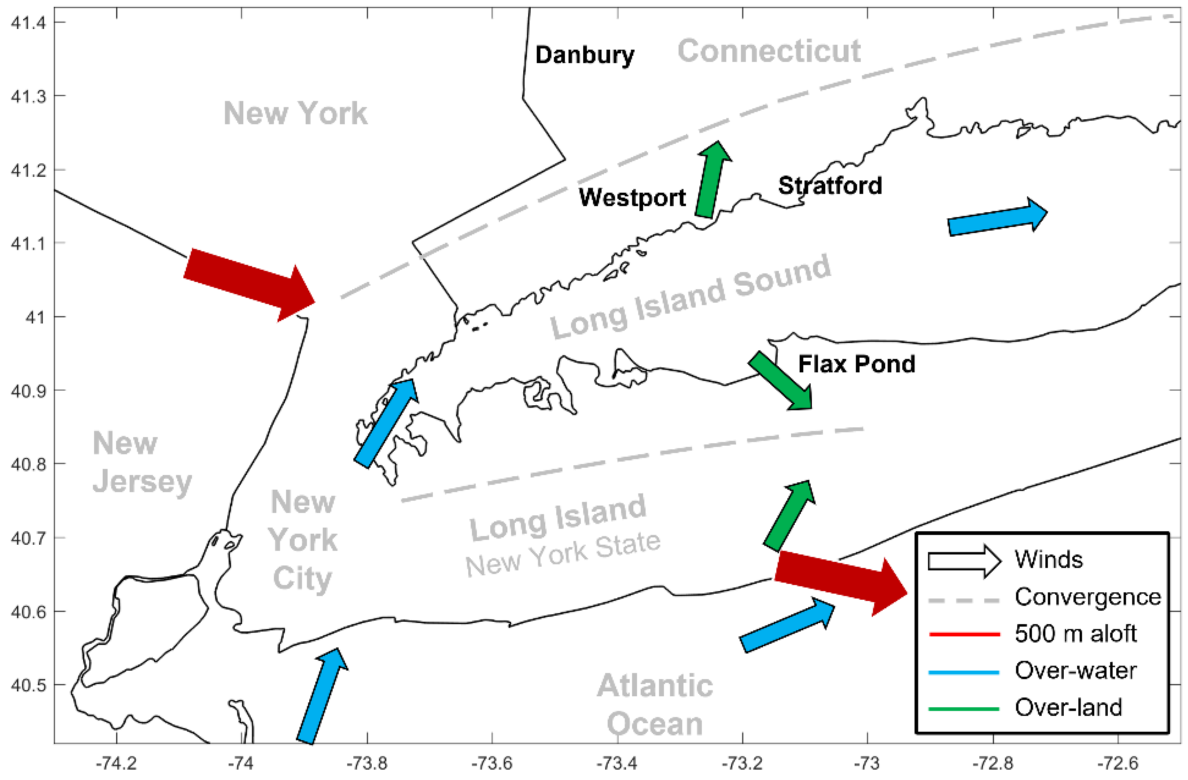




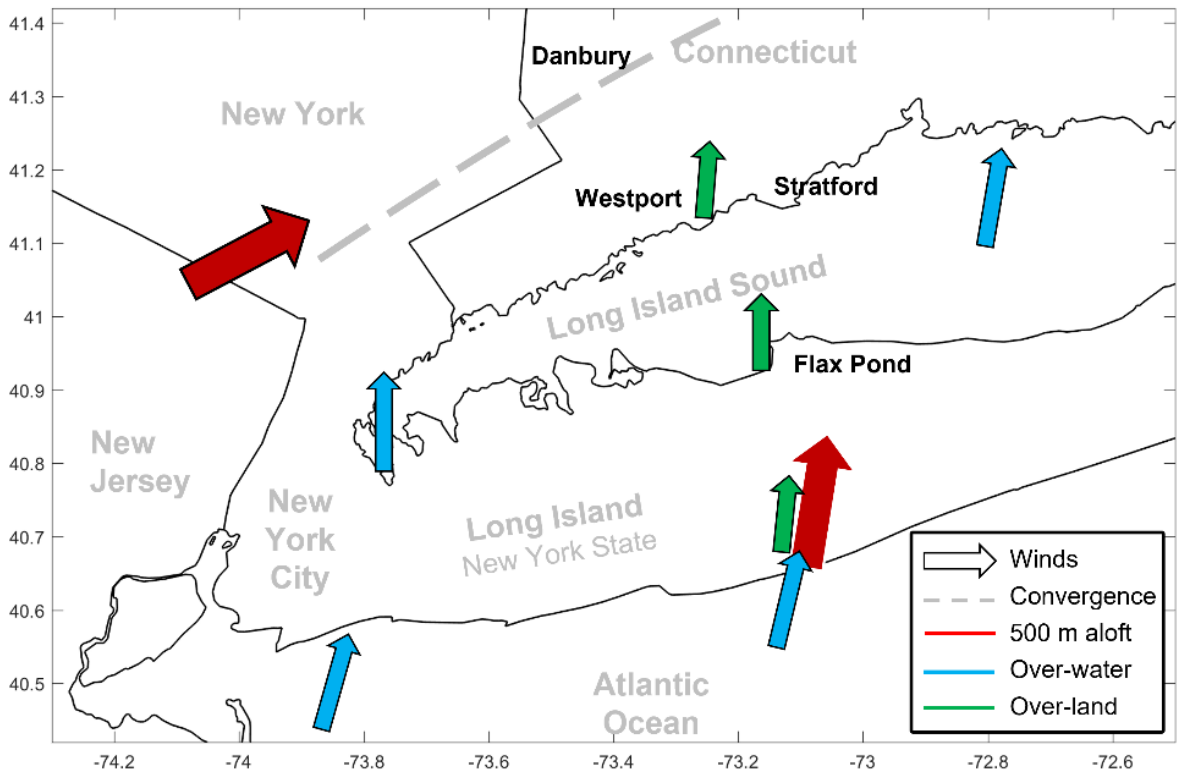


Wind patterns on ozone exceedance days

8AM – 12 PM Winds
Westport MDA8 > 70 ppb;



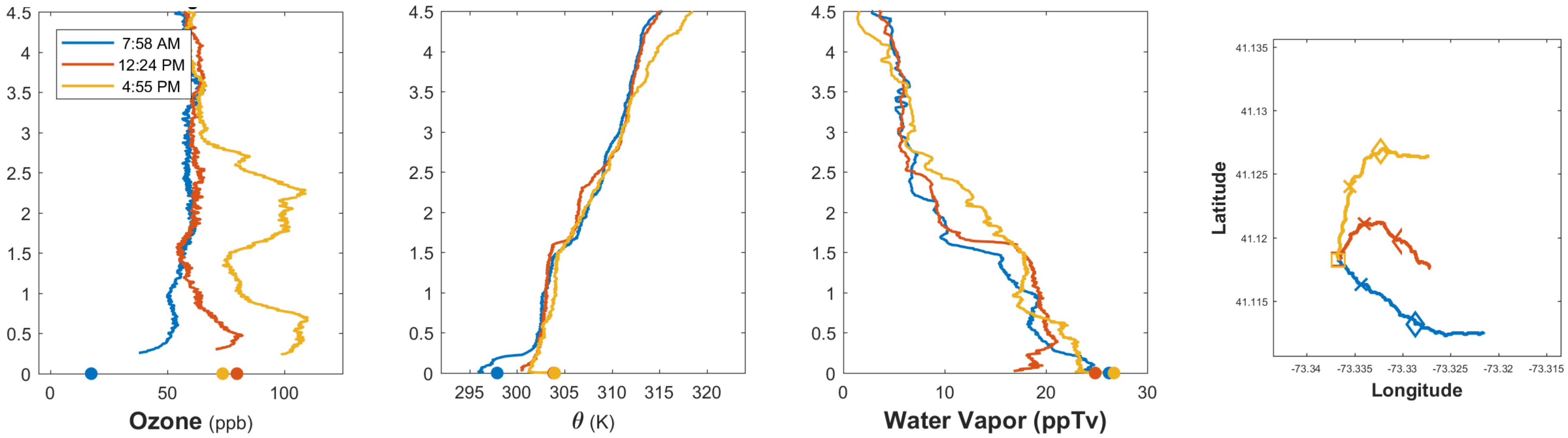
Late afternoon Winds
Westport MDA8 > 70 ppb;



The interface of synoptic westerly winds, sound breeze mesoscale circulation and the larger Atlantic Ocean breeze

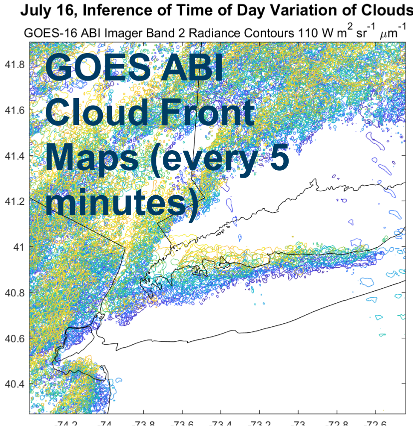
*Every arrow is based on collected measurements indicating a relatively repeated, narrow distribution of winds.

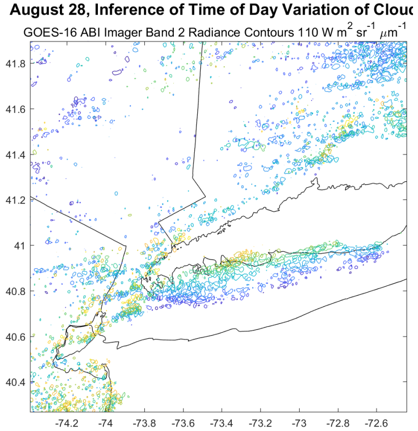
Vertical profiles of ozone, T, water vapor and position (i.e., winds) at three times of day

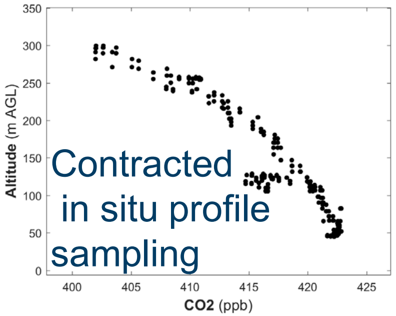


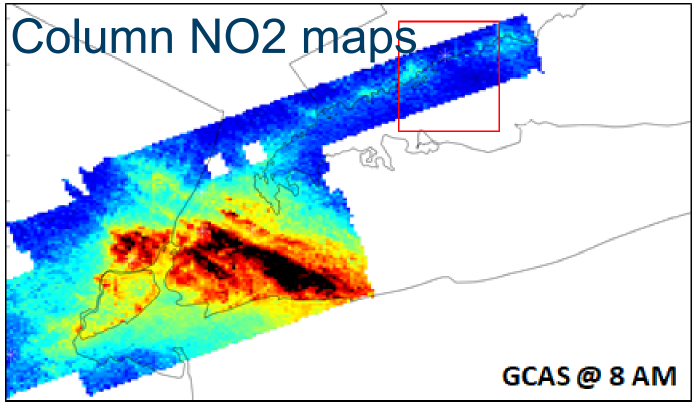
Key findings: prevalent wind shear, static stability and stratified ozone abundance. At 12 PM, O3 at surface is larger than aloft and vice versa at 5 PM. Wind pattern shows WNW shift to SW later in day, consistent with schematic presented above

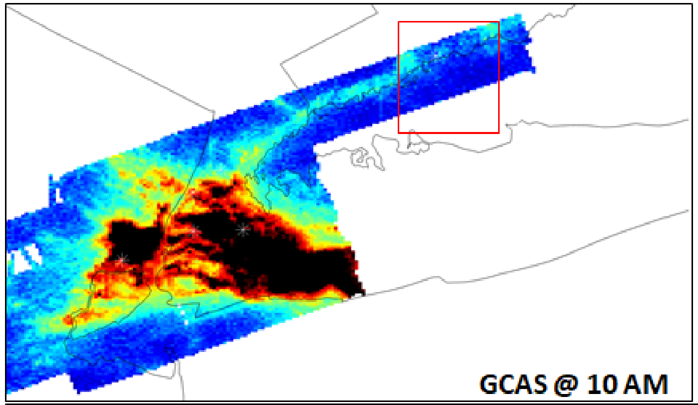
LISTOS: An example of the "3D" monitoring System



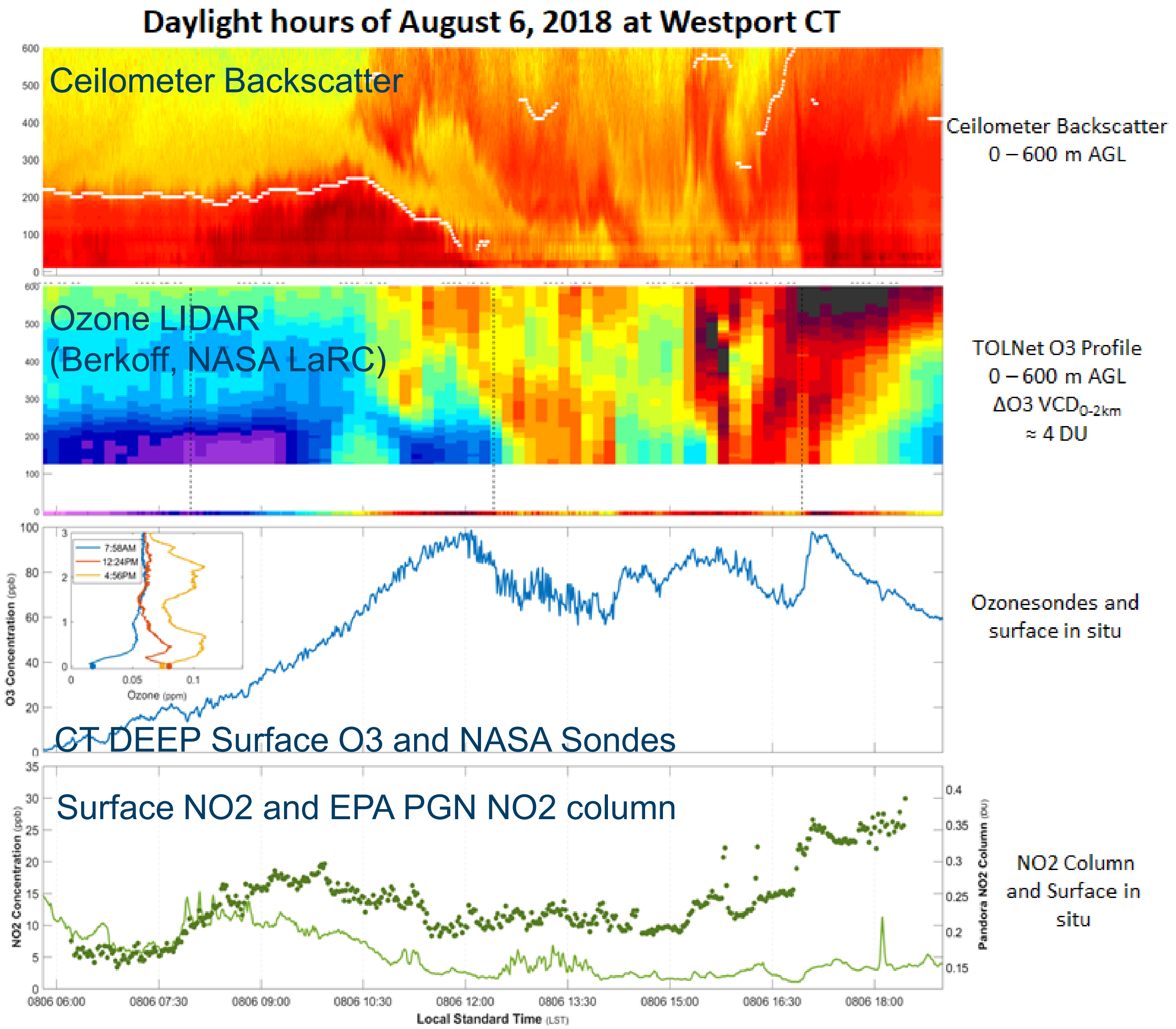




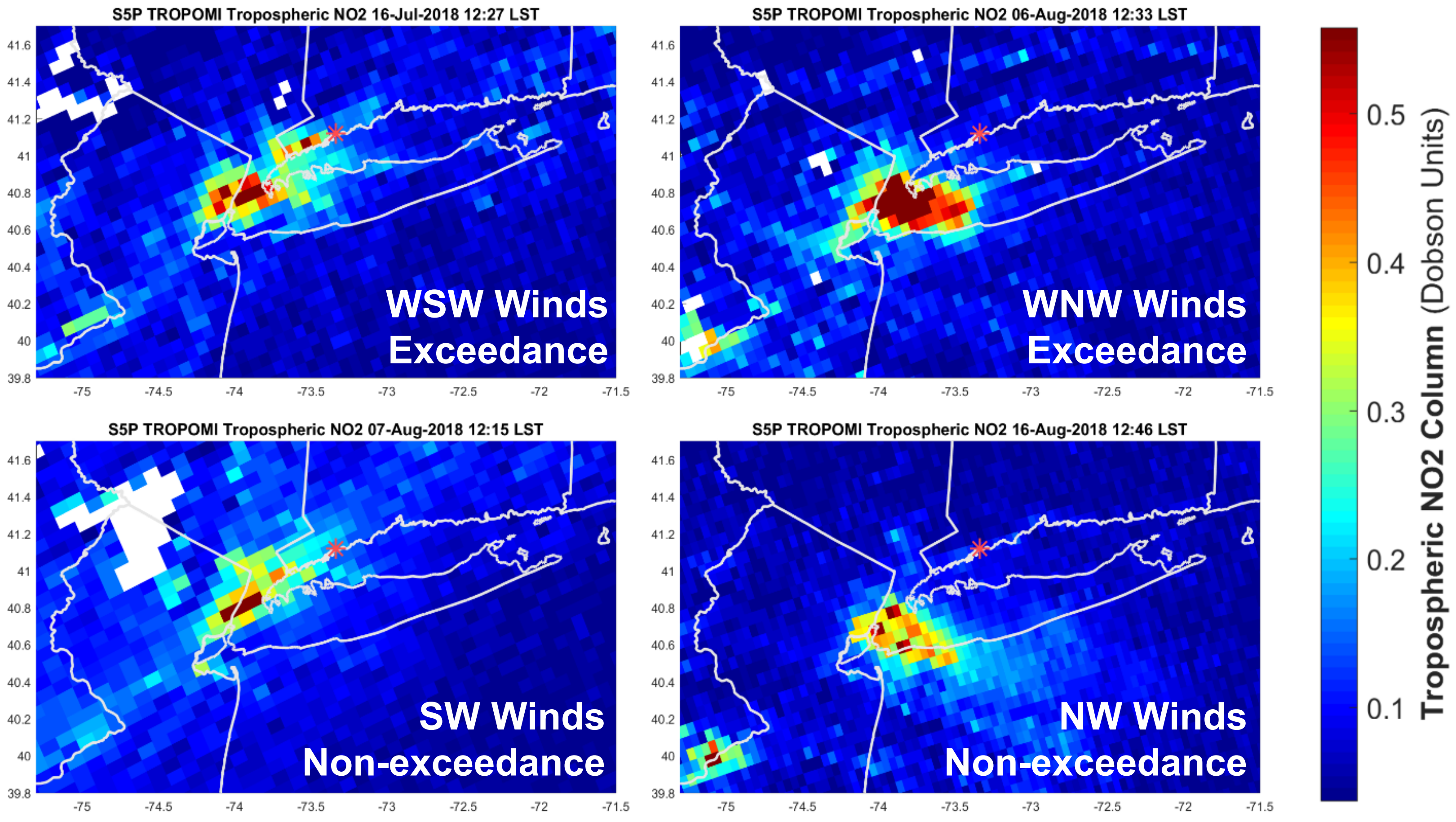




A single example of select variables demonstrates the value added by combining measurements to better understand both process and satellite validation. Preliminary analyses over longer-term data show an ability to gain statistics and perform "experiments"



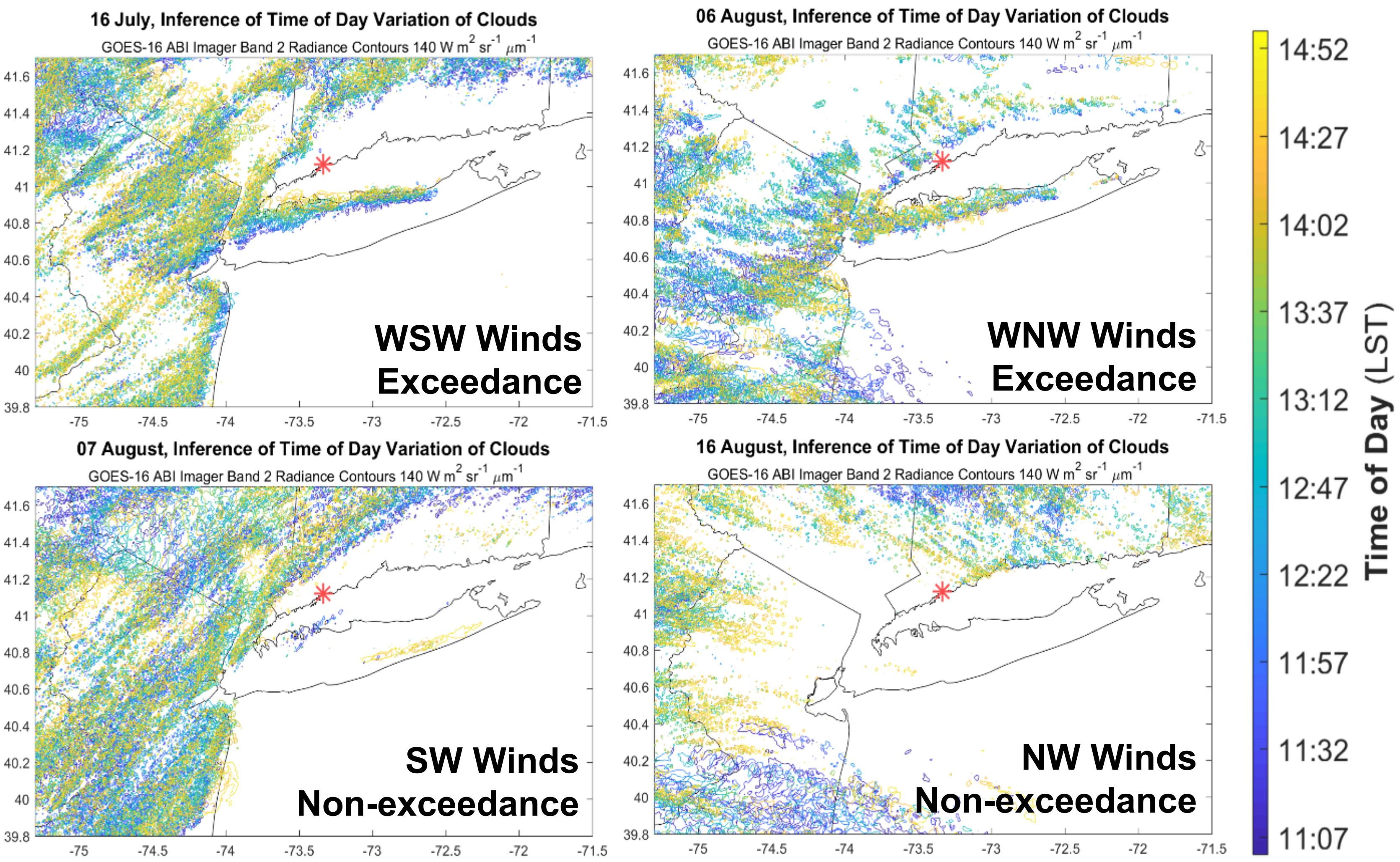
NO2 column captures diversity of synoptic conditions: exceedances and non-exceedances



GOES Satellite Sound and Atlantic Ocean Breeze

NYC plume transported directly towards CT shoreline through entire day.

Almost no convergence front over Long Island. Southerly Atlantic Winds transport O3 north early



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ter O3
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y NYC plume

eep O3 gradient
coastal sites
15 ppb between
estport and
ratford)

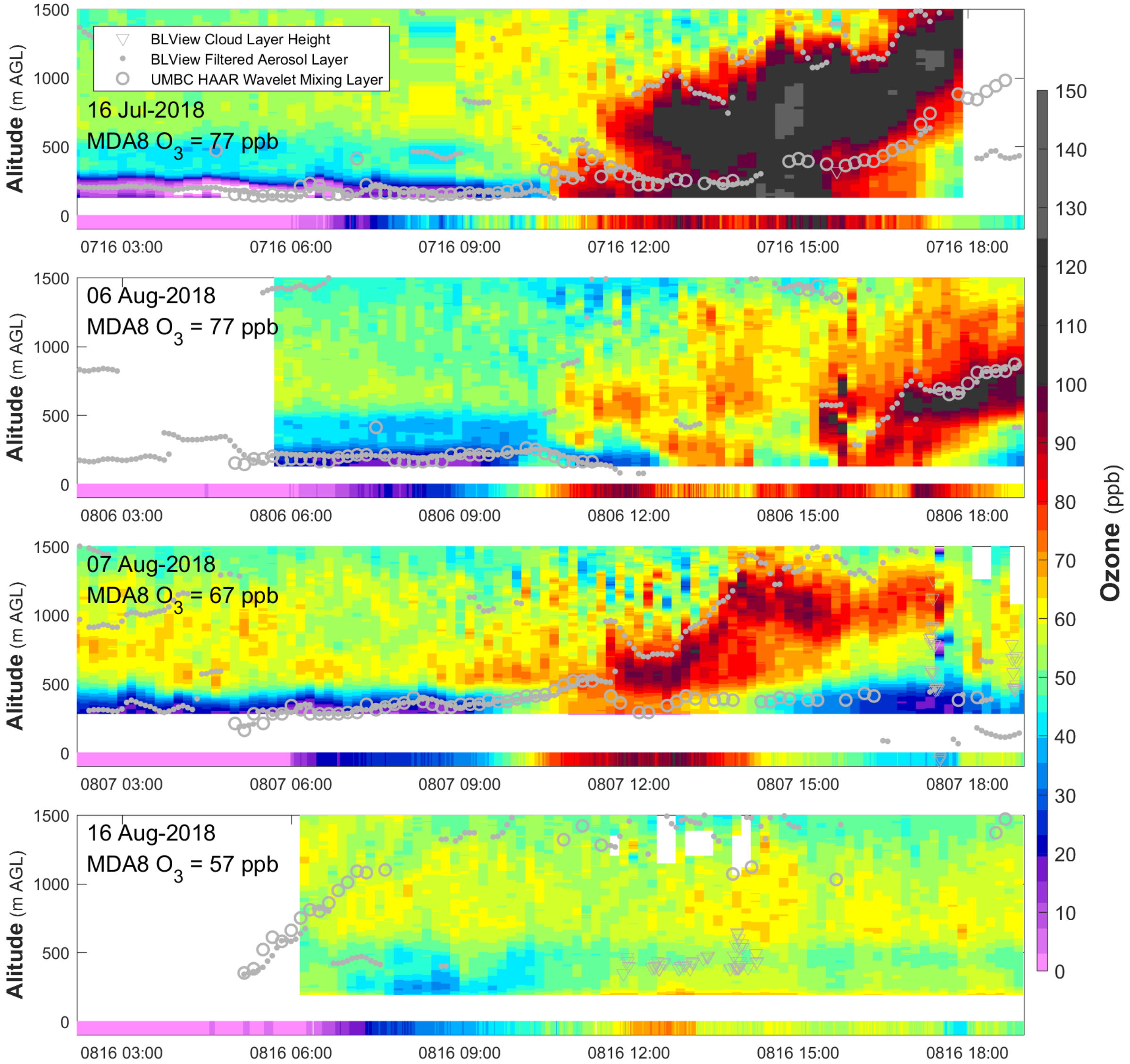
NASA LaRC LMOL Ozone LIDAR

WSW Winds Exceedance

WNW Winds Exceedance

SW Winds Non-exceedance

NW Winds Non-exceedance



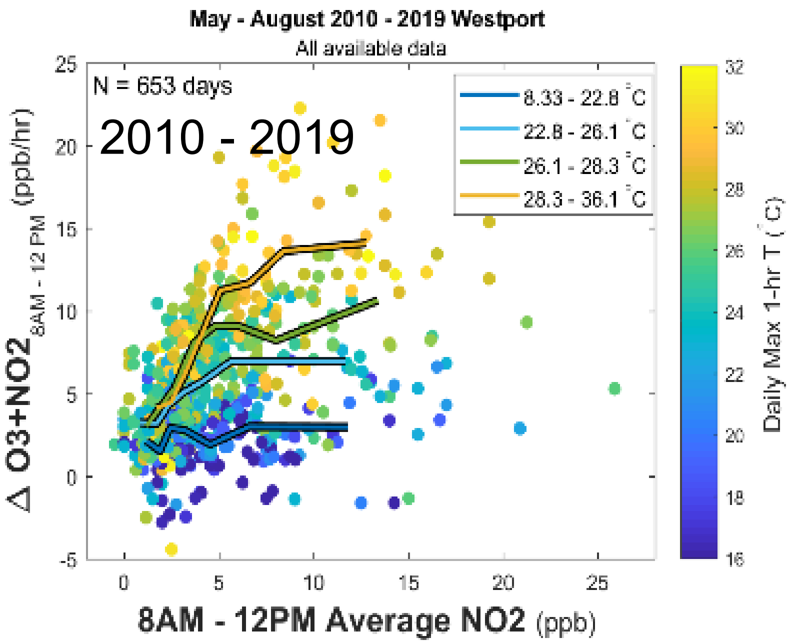
NYC plume transported directly towards CT shoreline through entire day.

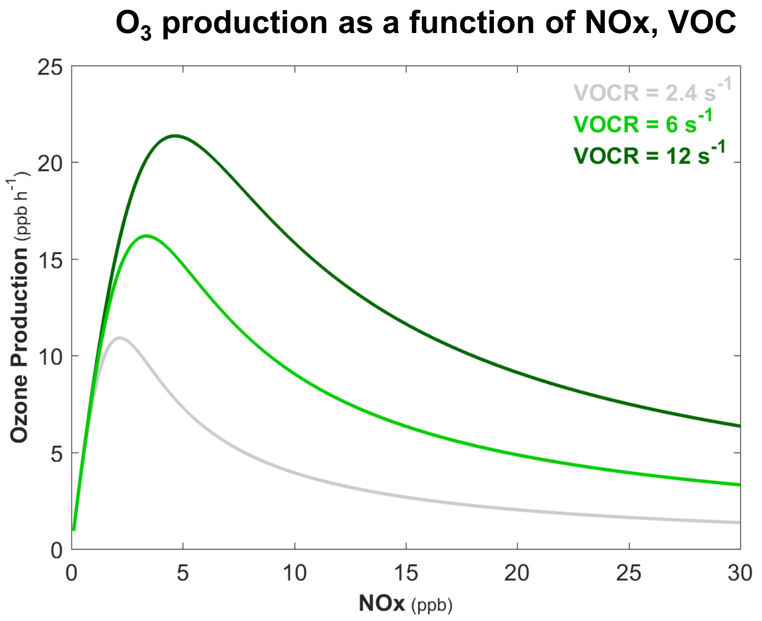
Mid-day over water O3 production, later day NYC plume

Almost no convergence front over Long Island. Southerly Atlantic Winds transport O3 north early

Steep O3 gradient at coastal sites (~15 ppb between Westport and Stratford)

Morning ozone growth: a function of NOx and temperature



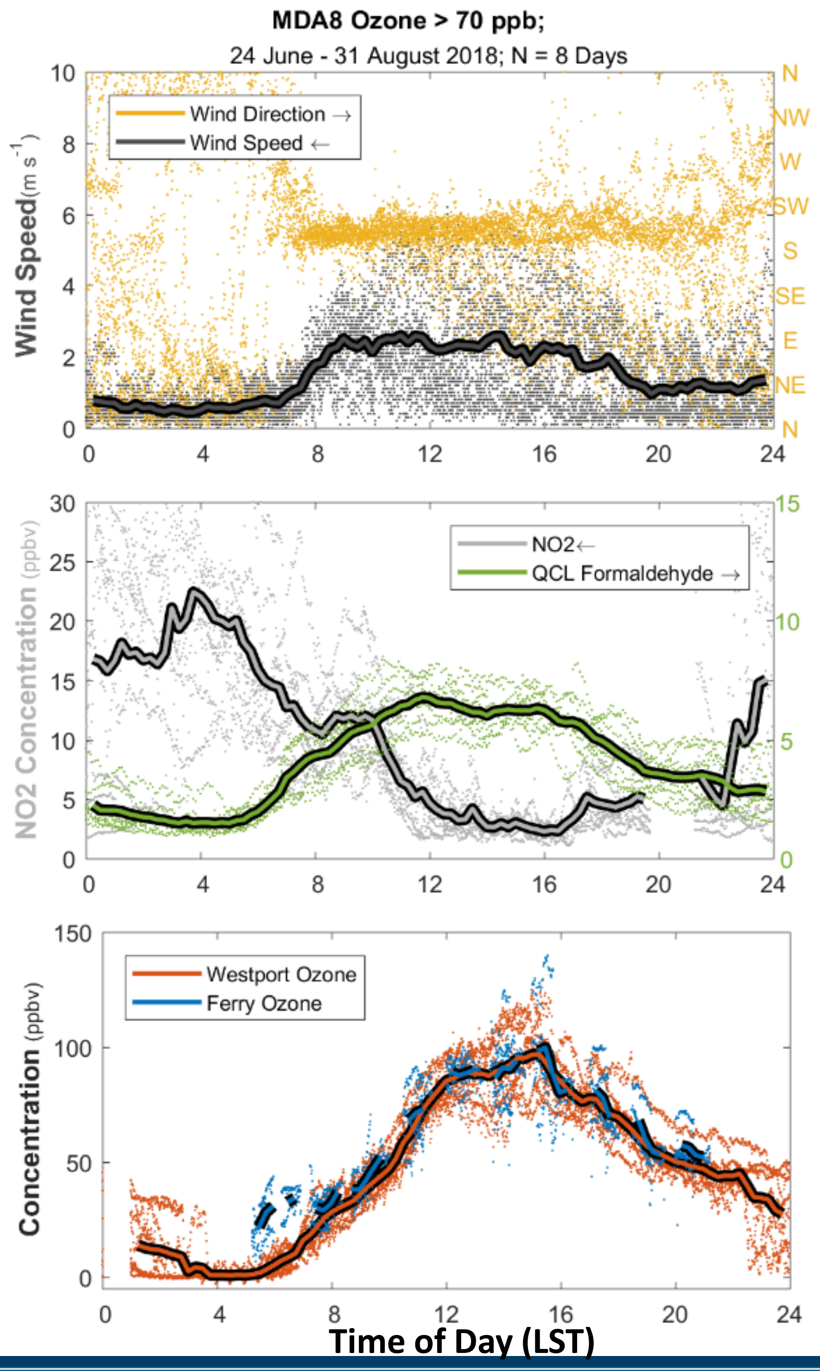


The growth rate of O3+NO2 (which accounts for O3 titration of emitted NO) is consistent with our understanding of photochemical O3 production (right) and a temperature dependent source of VOC (e.g., biogenic)

Westport surface air chemistry and winds

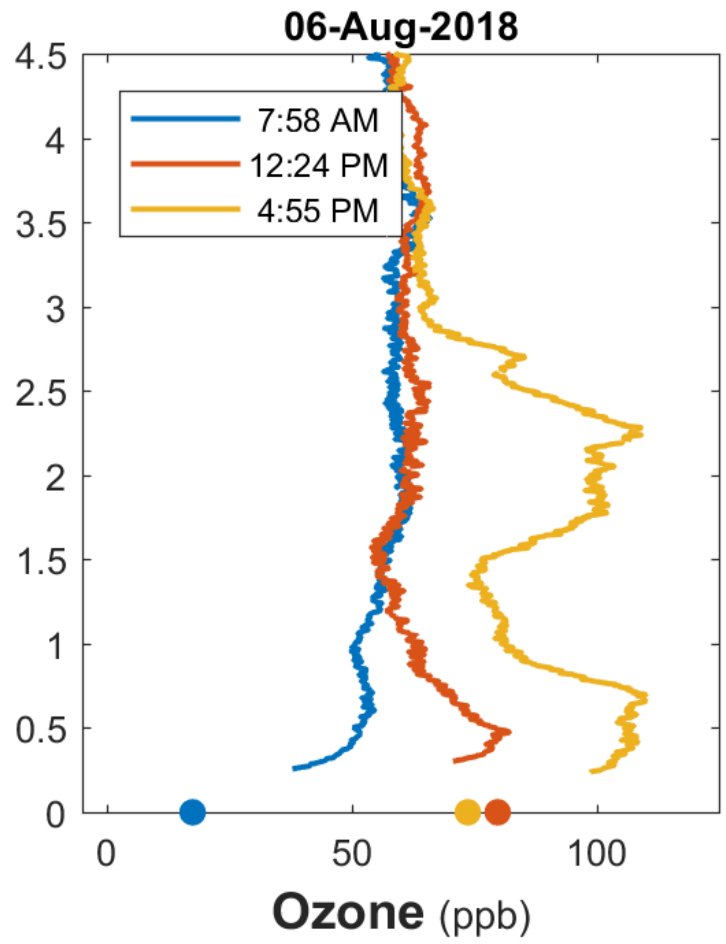
On Westport ozone exceedance days during LISTOS

- Robust sound breeze initiates at 8 AM, a shallow layer of air from over water is advected ashore
- Ozone (and formaldehyde) is rapidly formed in a shallow layer over LI Sound and transported ashore
- By 12 PM NO2 has oxidized and deepening of mesoscale circulation has potentially increased venting (inferred as via organized subsidence over LI Sound)
- In the afternoon, there is considerably more day to day and minute to minute ozone variability, reflecting primarily the 1) enhanced turbulent mixing induced by maximum temperature gradients and strong mesoscale circulations and 2) variable timing in the arrival and of the Atlantic Ocean Breeze.

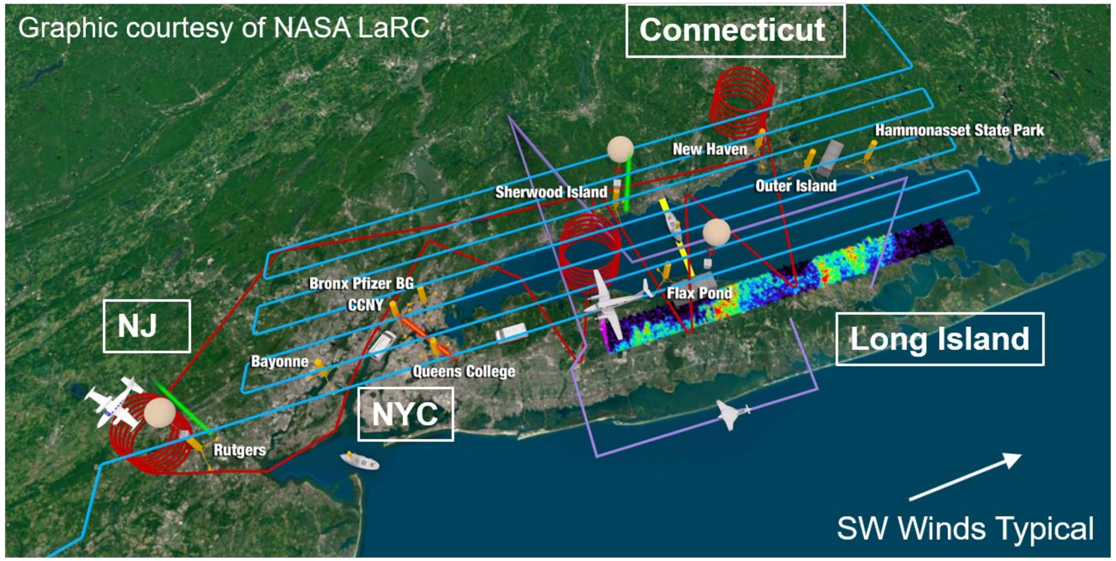


Findings

- There is demonstrated potential for rapid local ozone production over Long Island Sound
- The relationship of ozone, NO2 and temperature over the Long Island shoreline suggests that NOx emissions reductions in the airshed impacting LI Sound will improve ozone air quality at the CT shoreline
- NY/NJ/CT NOx emissions are abundant and routinely impact coastal Connecticut. LISTOS provided valuable spatial information on NOx abundance at ~1km scales
- The variety and uncertainty of VOC composition measurements makes even qualitative conclusions challenging. Observations of formaldehyde, a ubiquitous byproduct of VOC oxidation, indicate that VOC are abundant, and that their rate of oxidation is not necessarily decreasing over time



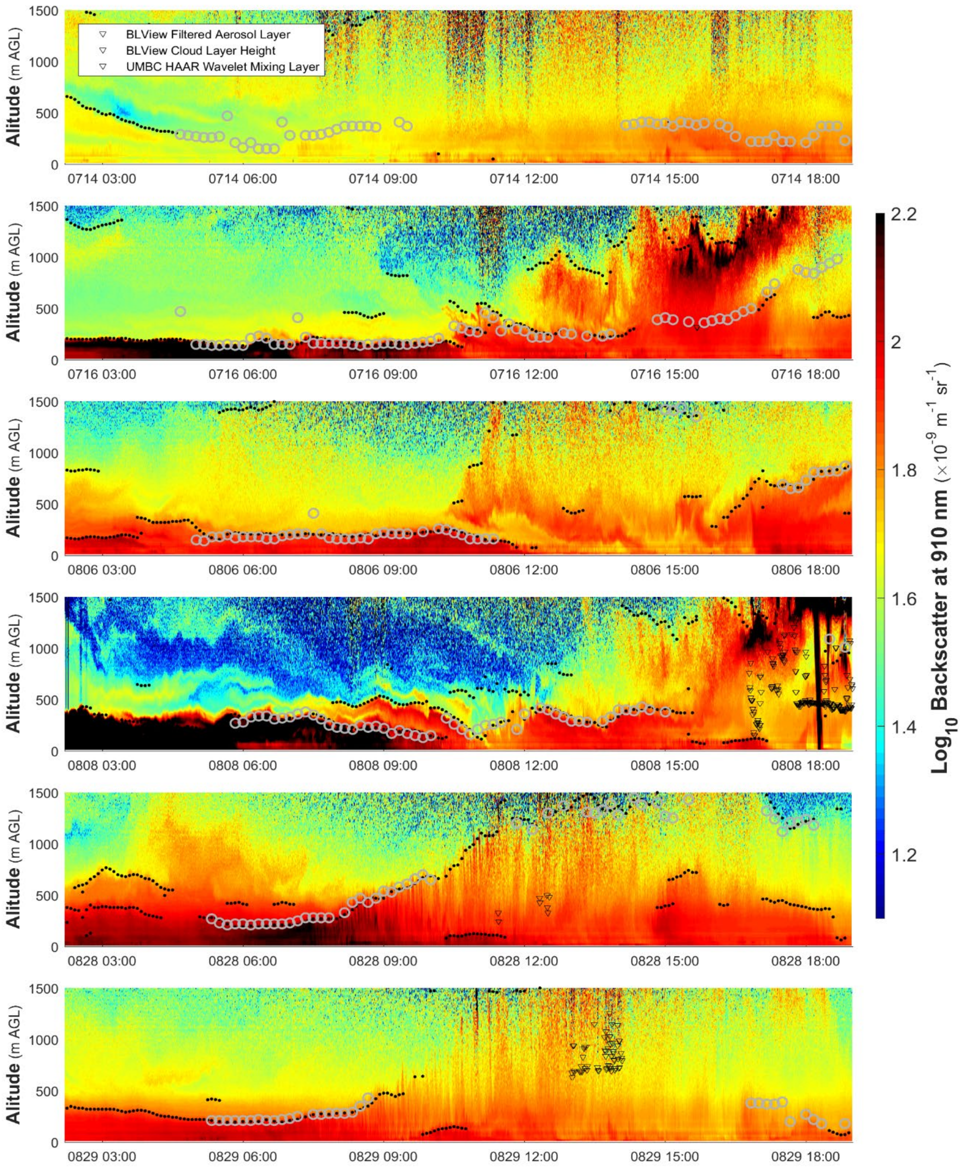
Lessons learned



- ORD efforts over 5 years to support several monitoring modernization efforts are becoming operational. We need help investigating all the data going forward
- Collaborative field studies have shown that a “3D” picture of air pollution can be inferred via various operational techniques.
- More sophisticated measurements along shoreline environment will improve emission source attribution and test mechanism development
- PAMS re-design and Enhanced Monitoring Plans have thus far been a huge success in adding to these types of smaller focused missions

Extra slides

Westport Ceilometer Backscatter for six exceedance days sampled during LISTOS 2018 (MDA8 O3 > 70 ppb)

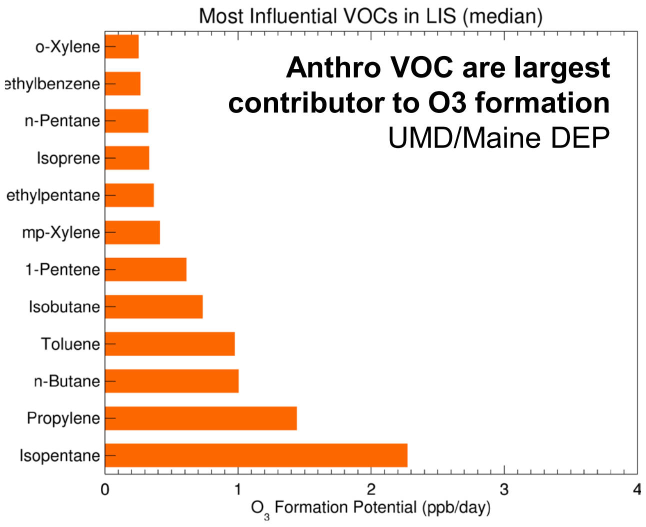


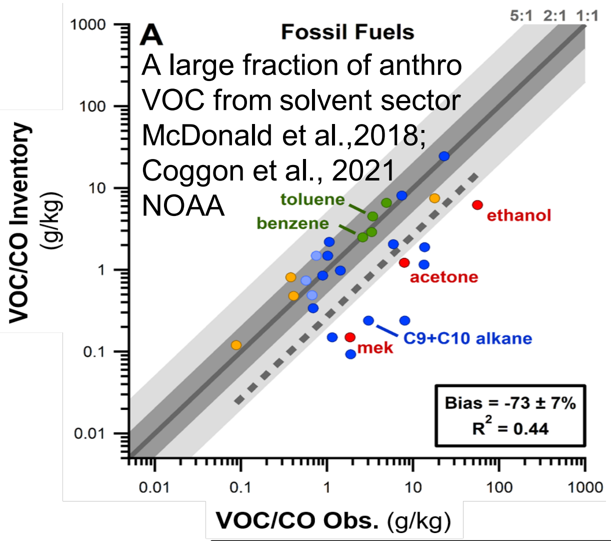
2018 LISTOS Participants & Enhanced Activities

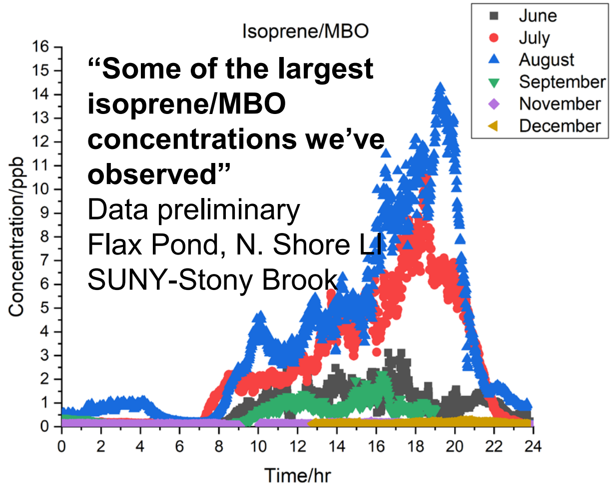
1. State AQI forecasters predicting ozone episodes to launch activities
2. NOAA-ESRL oxygenated/consumer product VOC mobile van measurements in NYC during March and July
3. Univ. Maryland Cessna 2018
4. Maine DEP and NYS DEC labs VOC canister analysis
5. NASA GeoTASO 20-30 high altitude flights; ozonesondes at Rutgers, NJ
6. EPA Pandoras Long Island Sound (LIS) coastline, Rutgers PAMS, NYC; ozonesondes& continuous HCHO at Westport, CT
7. CCNY boat-based air pollution measurements in LIS
8. CCNY aerosol LIDAR in northern Manhattan
9. Stony Brook Univ. oxygenated VOC measurements at Flax Pond PAMS site (Long Island north shore)
10. Stony Brook Univ. aircraft fine resolution wind field measurements over LIS
11. Univ. at Albany O_3, NOx, VOC mobile measurements across Long Island south to north shore transects
12. Univ. at Albany ozonesondes from Long Island
13. NASA ozone LIDARs upwind at Rutgers Univ., NJ, and downwind on CT's LIS shoreline
14. CT DEEP ozone monitor on LIS ferry between Bridgeport, CT and Port Jefferson, NY
15. PAMS VOC measurements at Rutgers, NJ & the Bronx, with new NYS DEC PAMS site at Flax Pond, Long Island
16. CT DEEP, NJ DEP, NYS DEC delivery of 1-minute continuous monitoring data from all sites requested
17. Yale Univ. Coastal Field Station –VOCs on CT coast

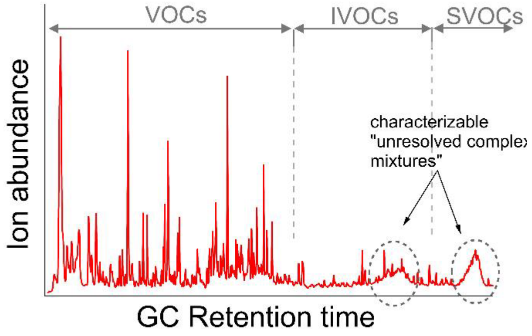
Sponsors and in-kind contributions: NYSERDA, NESCAUM, CT DEEP, NJ DEP, NYS DEC, US F&W, NOAA, NASA, EPA

A variety of researchers are exploring different sources of VOC and their impacts on O3 and PM2.5









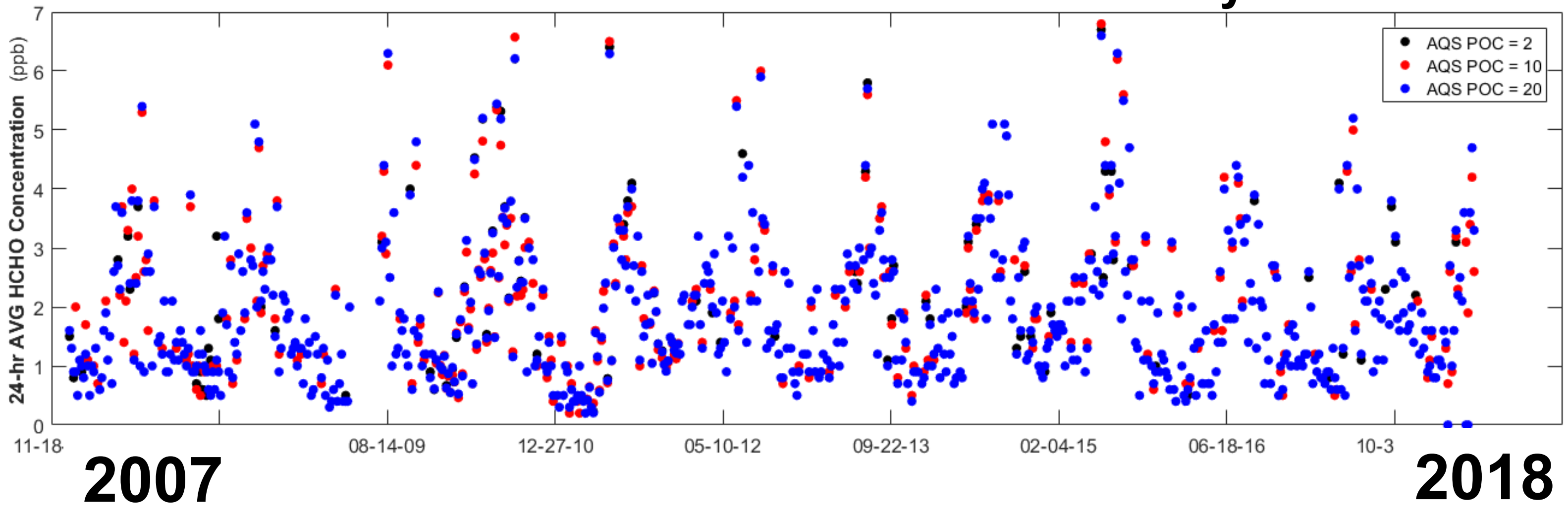
← NYC air: a soup of VOC,
Yale Group
Sheu et al., J. Chrom. A, 2018; Khare et al., 2019, Ditto et al. 2022

The variety of VOC compounds, their distinct sources, and the short lifetime of important compounds, like isoprene, make it extremely challenging to attribute VOC budget

Data Courtesy: UMD/Maine DEP, SUNY-Stony Brook, Yale ($ - NESCAUM); NOAA

Routine monitoring suggests relatively stable oxidized VOC abundance over the last decade

NYBG – Bronx 24-H DNPH Formaldehyde



- Formaldehyde amount is a function of VOC oxidation ($\sum_i k_{OH+VOCi} \times [VOC_i] \times [OH]$)
- Either past emission reductions have only marginally impacted total VOC reactivity (e.g., biogenic VOC are relatively more important that anthropogenic VOC) or the rate of oxidation (i.e., OH concentraion) has increased to compensate for emission decreases.