Diurnal Variability of MLH and Ozone in NYC Urban and Coastal Area from an Integrated Observation during LISTOS 2018

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Motivation and Observation

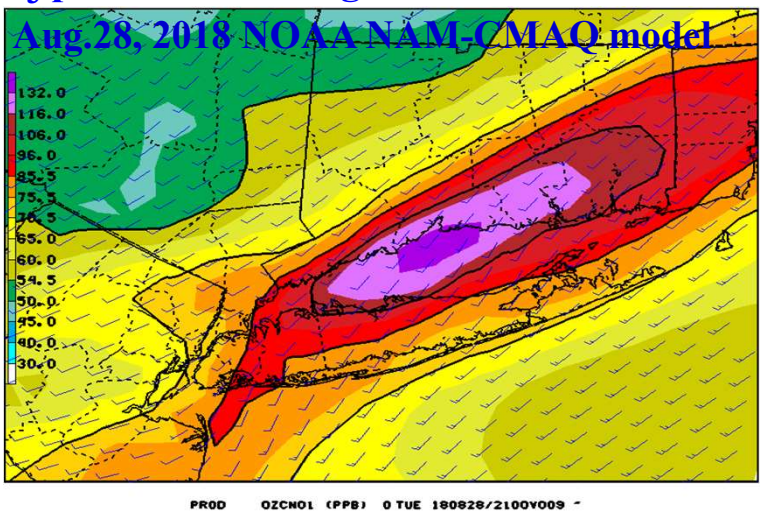
Background:

- High ozone (MDA8 O_3 >70 ppb NAAQS) episodes often occur in summer in New York City (NYC) and downwind coastal area due to urban emissions/pollutants transport, urban-coastal meteorology (land-sea breeze) and chemistry.
- **Long Island Sound Tropospheric Ozone Study (LISTOS):** Integrate ground-based, aircraft observation and model to investigate high O_3 formation and transport in summer 2018 and 2019 in Long Island Sound.

The goals of this study are to:

- Demonstrate the MLH and O_3 dynamics and comparisons in NYC urban and coastal area with the ground/airborne aerosol lidar, O_3-DIAL and Coherent Doppler Wind lidar observations;
- Investigate high O_3 formation processes associated with the urban plume transport, MLH dynamics, and sea-breezes;
- Evaluate NOAA NAM-CMAQ model forecast of O_3 and MLH.

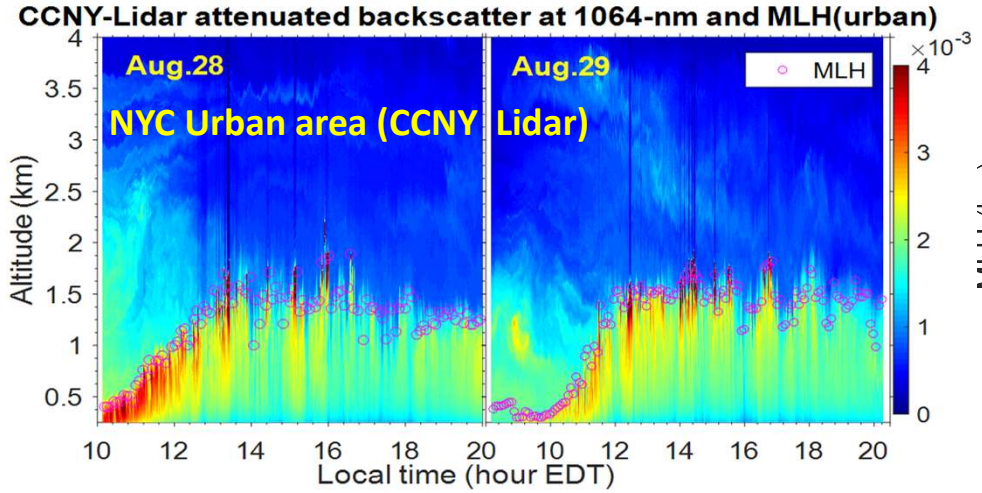
O_3 pollution in Long Island Sound: forecast



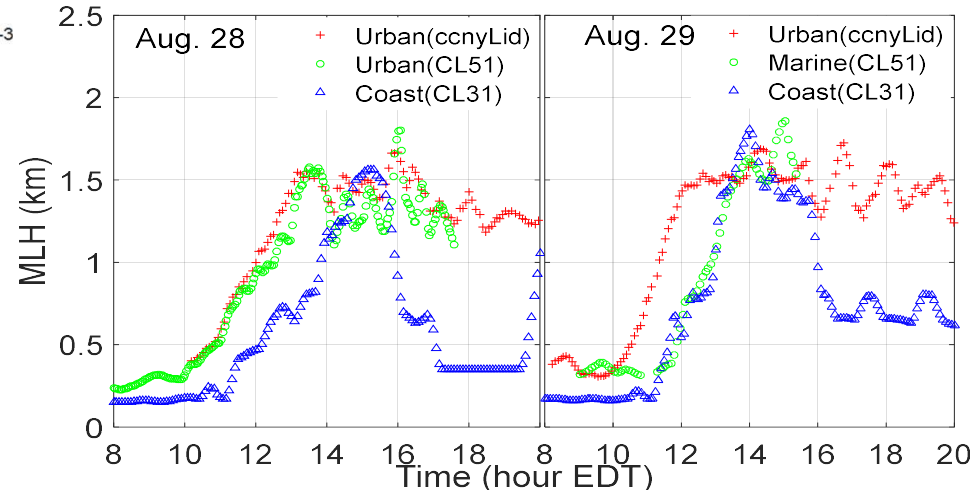
Ground sites used in this study

Results: (1) MLH Diurnal Variation in the NYC urban and coastal area

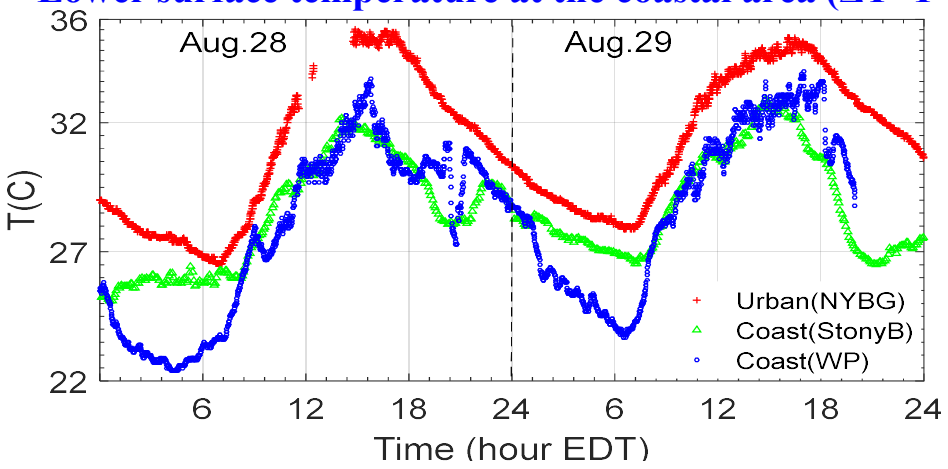
MLH estimate with a Wavelet transform method



MLH growth: a time-lag at the coast vs. urban area

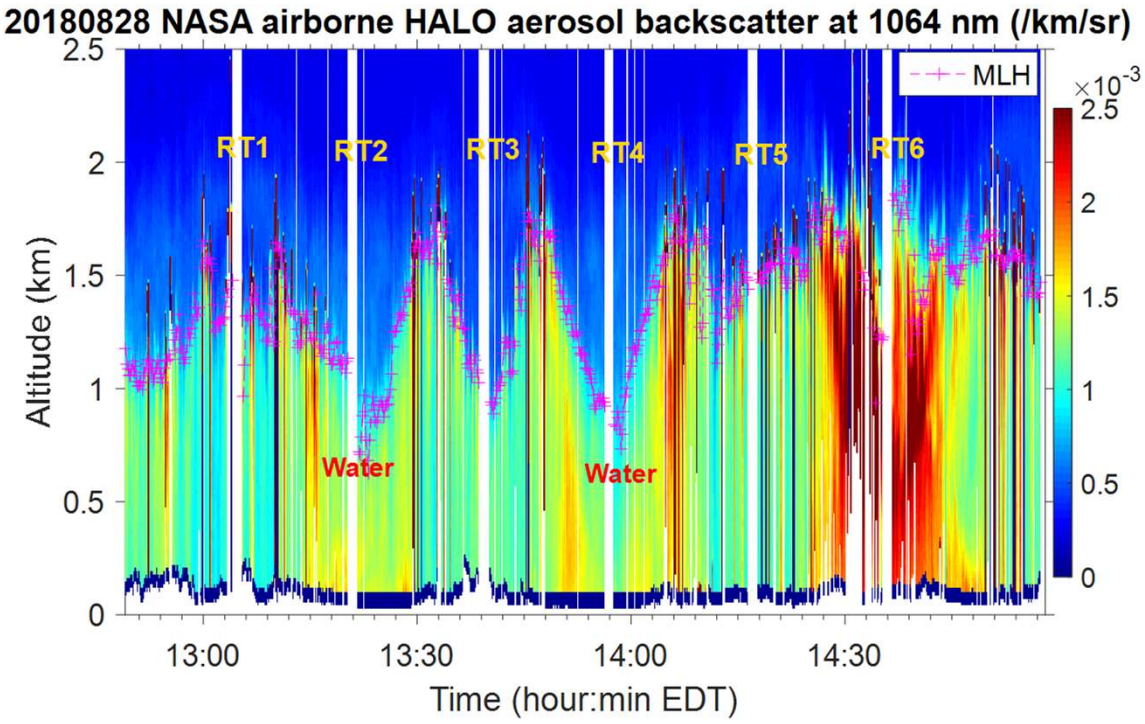


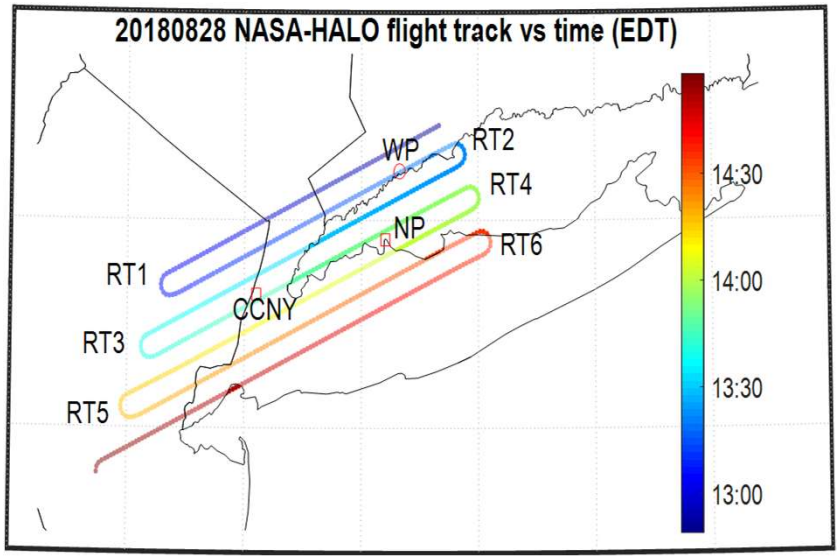
Lower surface temperature at the coastal area (ΔT=1~5°C)



Results: (2) MLH Spatial Variability from the NASA airborne Lidar

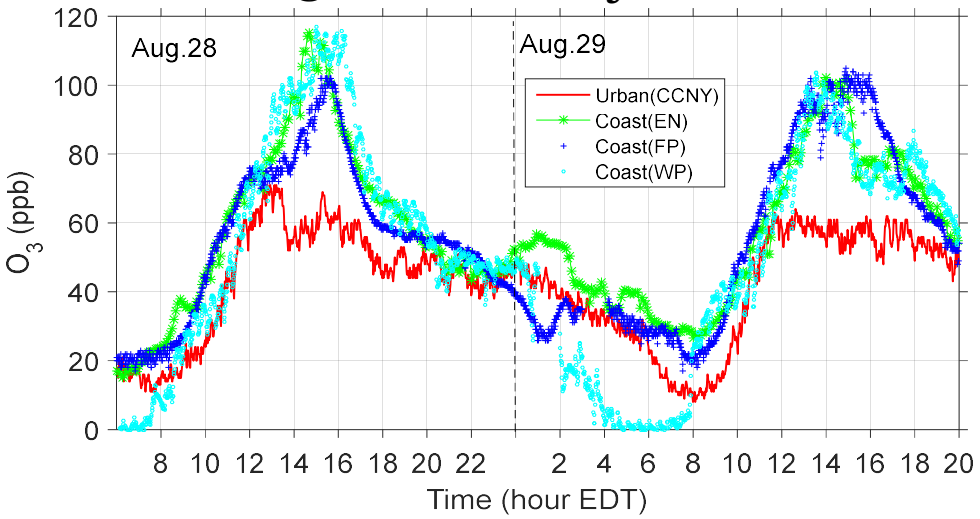
Lower MLH at the coastal area (0.7~0.8 km) than those in the urban area (~ 1.5 km altitude) in the afternoon
Good agreement with the ground lidar observations in the urban and coastal area.

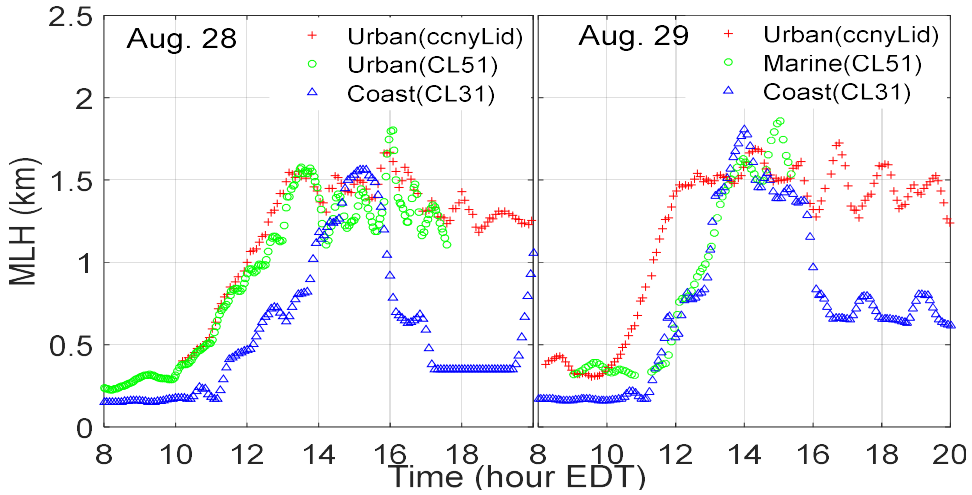




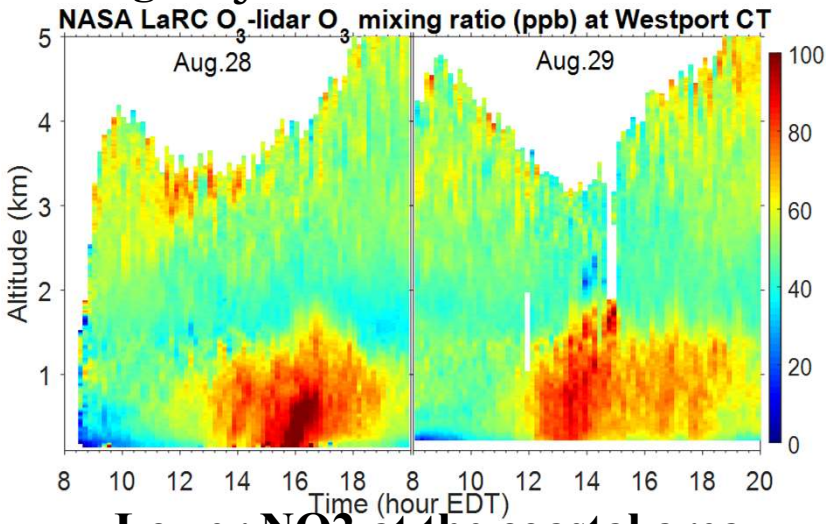
Results: (3) Much higher O_3 but lower MLH at the coast vs. urban area

Much higher surface-O_3 in the coastal area

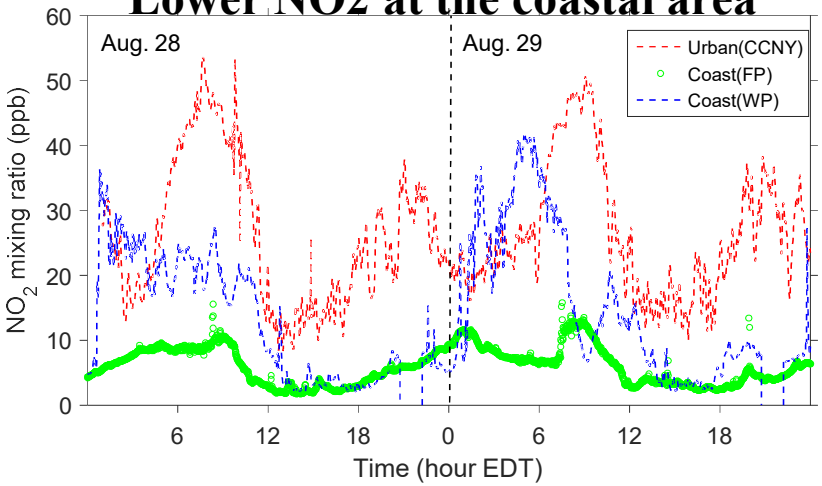




High O_3 in the PBL at the coast of CT



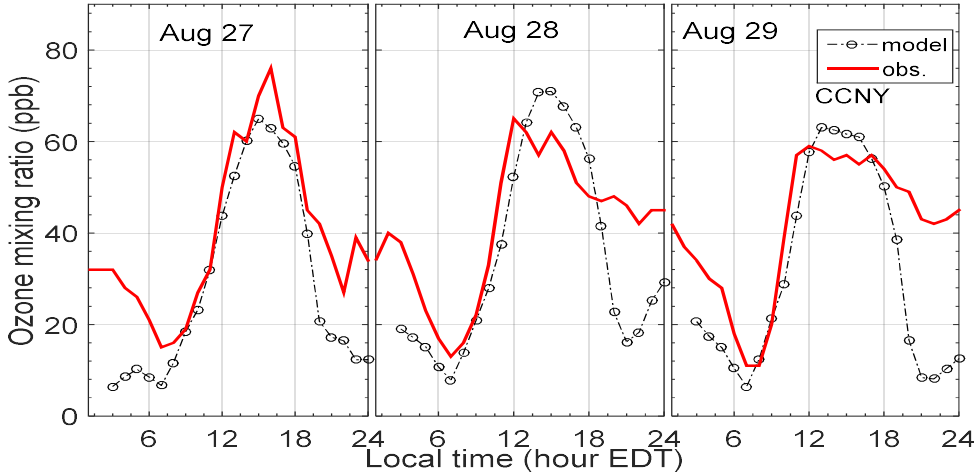
Lower NO2 at the coastal area

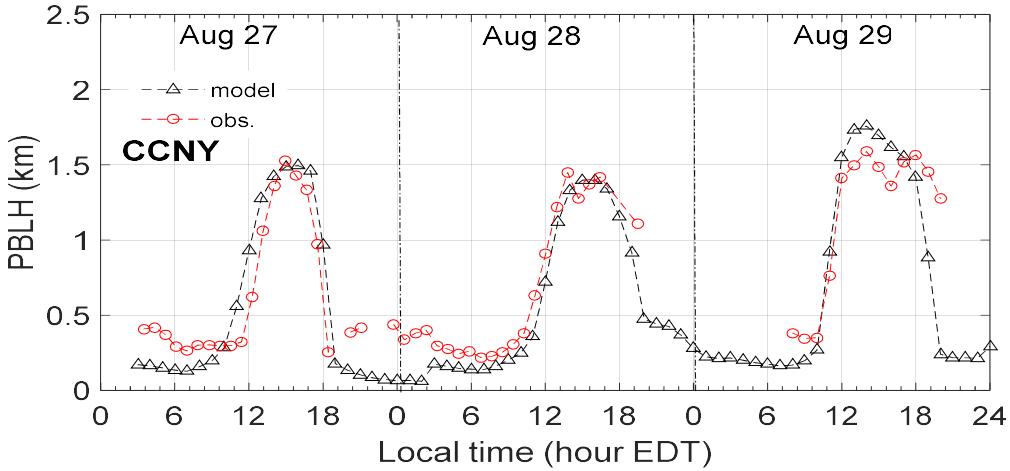


Results: (4) Evaluation of Model Forecast of O_3 and PBLH

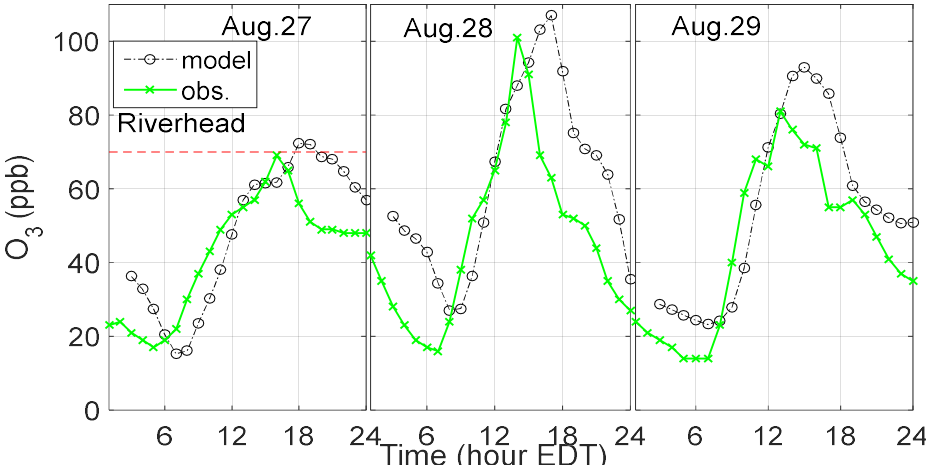
Model: good consistency at the urban site, but a timing shift for the maximum O_3 & PBLH growth at the coast site

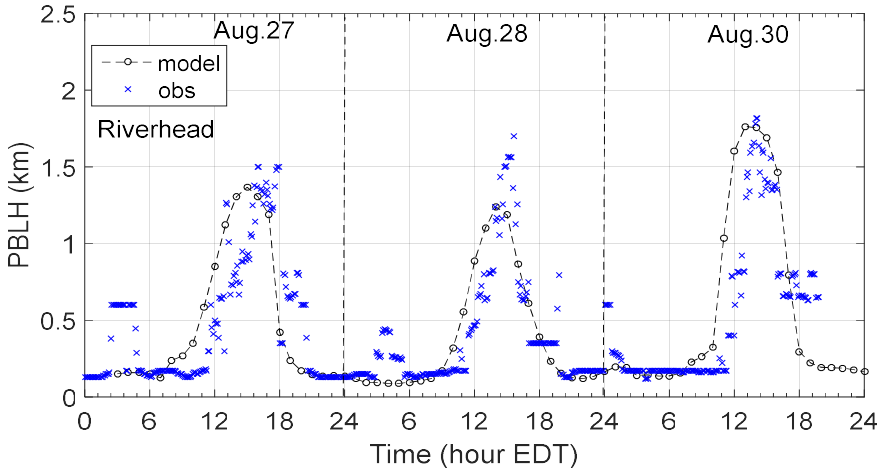
Urban-CCNY





Coast-Riverhead





Summary

- Lower MLH and time-lag of MLH growth in the morning at the coastal area versus the NYC urban area. The MLHs attain 1.5 km altitude in the urban area but 0.7~0.8 km in the coastal and marine area at noon on Aug.28, 2018.
- Higher O_3 attaining 100-120 ppb and exceeding the NAAQS are observed at the coastal area which is probably attributed to the urban plume transport, MLH dynamics and sea breezes effects.
- The NOAA operational model (NAM-CMAQ) forecast product show similar variation of O_3 and PBLH with the observations except the timing shift for the maximum O_3 and PBLH growth at the coastal site; but good consistency in the NYC urban area.
- Next: Statistical comparison and analysis of MLH dynamics and model product evaluation in the coastal and urban area during the O_3 episodes.

Comments/Questions? Contact at yhwu@ccny.cuny.edu

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