

Motivation

- Pollution including high O3 events downwind and PM25 in Urban Areas during the summer is very complex with emission sources coupled to convective expansion as well as potential plume transport.
- Emission Sources can be highly localized as well as dynamically fast and the dynamics of NO2 may be affected by environmental and meteorological conditions
- Multiple sensors can be used to explore spatial and temporal dynamics
 - Spatial Dynamics- TROPOMI Satellite Sensor. A new instrument from the ESA which targets Emission Trace Gases such as SO2, NO2, CO and O3
 - Temporal Dynamics - Pandora: A NASA based Ground Spectrometer targeting Total Column O3 and NO2
- The new GOES-16 Advanced Baseline Imager (ABI) can provide 5' AOD maps useful to explore interesting temporal dynamics and possible diurnal behavior of PM25
- Issues with different errors occurring as function of diurnal cycle and the effects of Quality Flags need to be explored further
- Finally GOES-16 has a downwelling Shortwave Radiation (DSR) product allowing us to study Radiation effects on O3 events

NASA Pandora UV-VIS Spectrometer Sensor

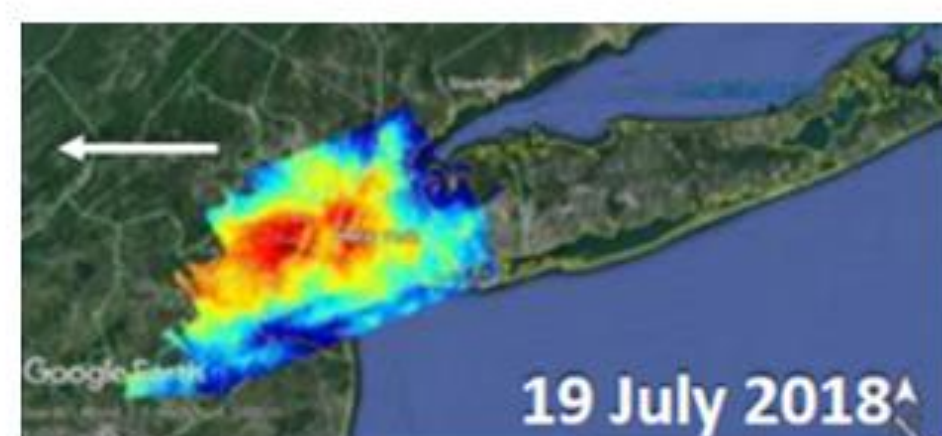
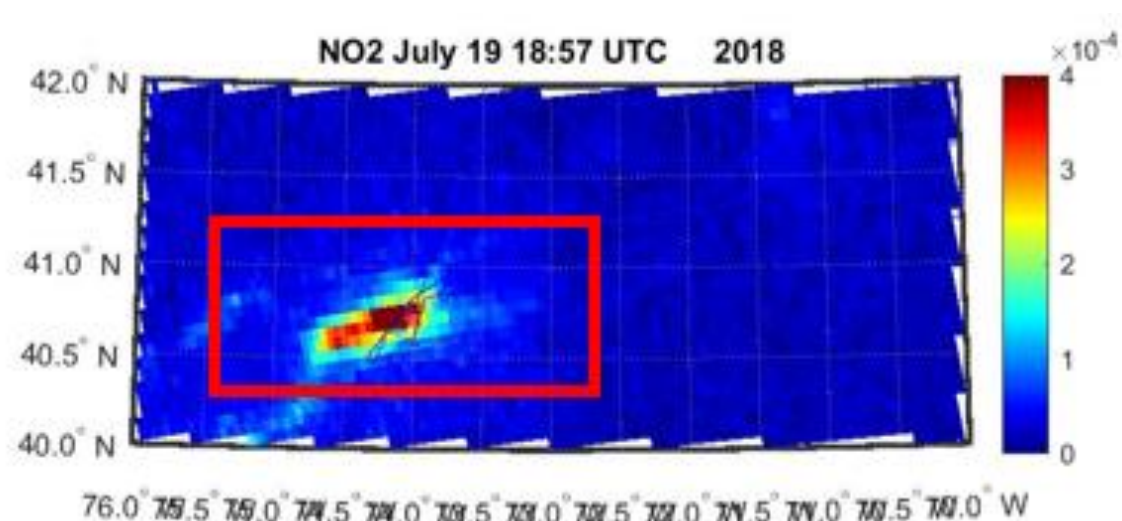
- The Pandora is a highly accurate spectrometer system that measures columnar amounts of trace gases O3, NO2, CH2O using differential optical absorption spectroscopy (DOAS).
- NO2 spatial concentration measurements have recently been dramatically improved with the new ESA TROPOMI instrument
- With better spatial resolution and SNR, the polar orbiter can provide high resolution plumes over urban centers
- The spatial extent of these plumes allows us to better assess the homogeneity of the NO2 concentration above background levels and plume dispersion can be affected by background winds



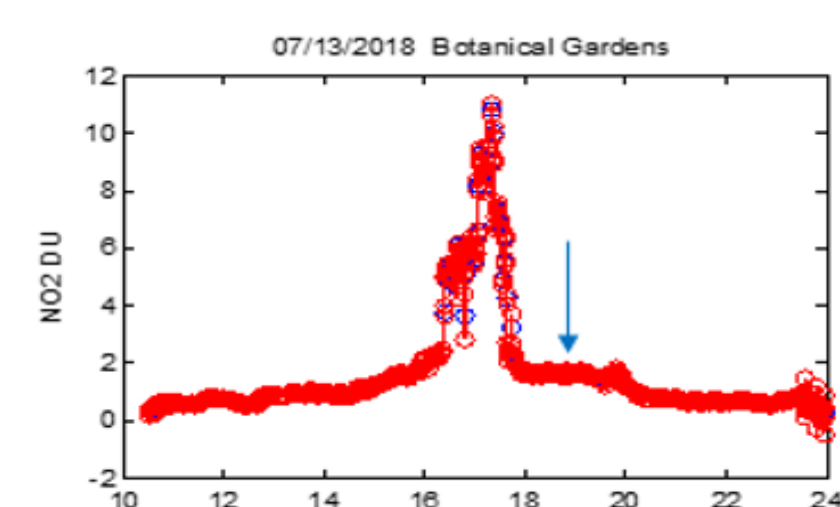
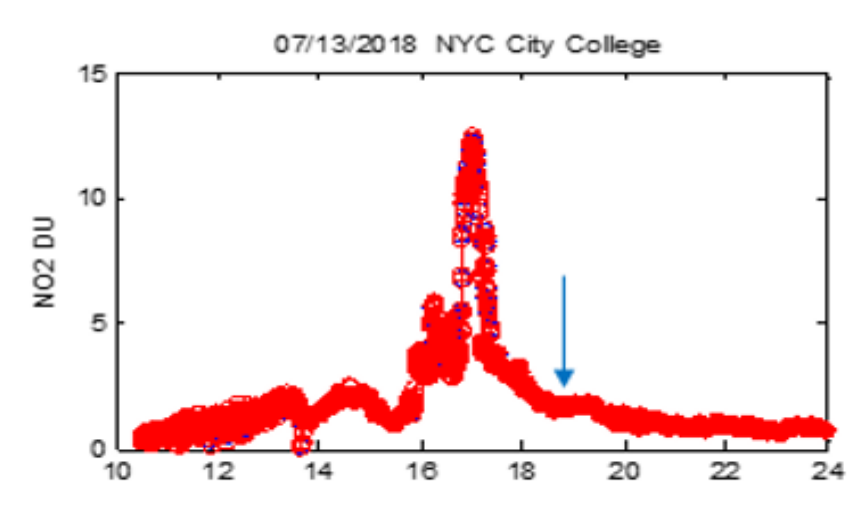
- Plans are being made to upgrade the CCNY Pandora for Tropospheric O3 in support for a recent NYSEDA / NESCAUM supported O3 lidar project

Satellite and Ground Based tools for Tropospheric NO2

Cross-validation between TROPOMI and GEO-TASO on LISTOS Campaign

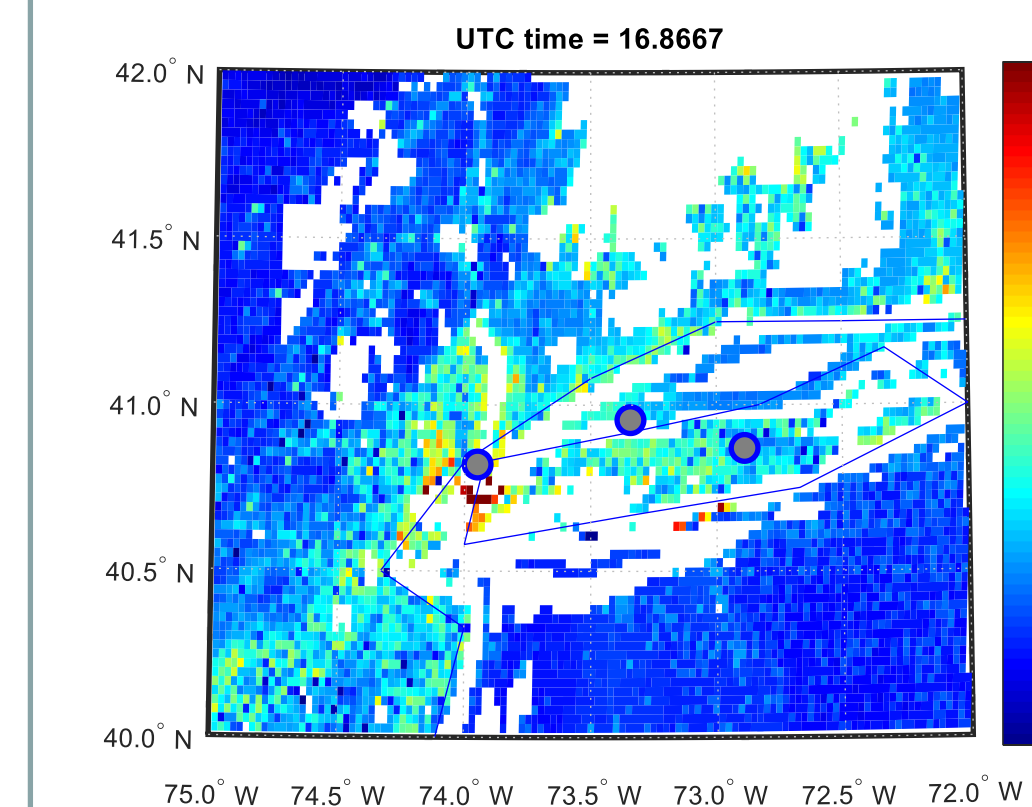


Unfortunately, Satellite Overpasses often miss the most dynamic NO2 concentration events. Important for assessing O3

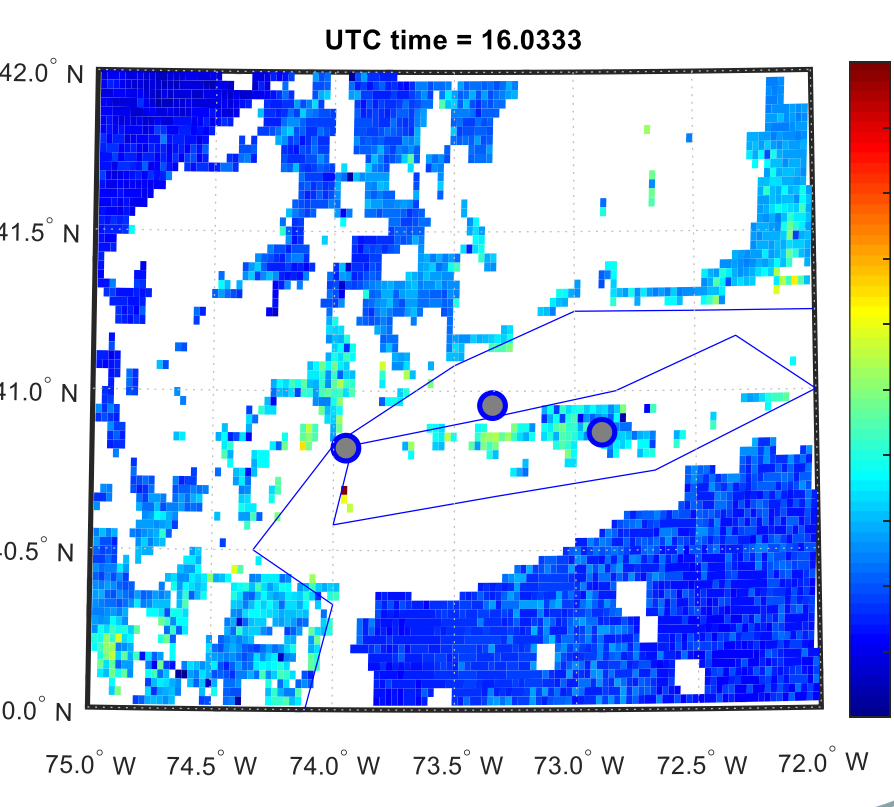


Effect of Quality Flags to get Statistical meaningful data

Med+High QC

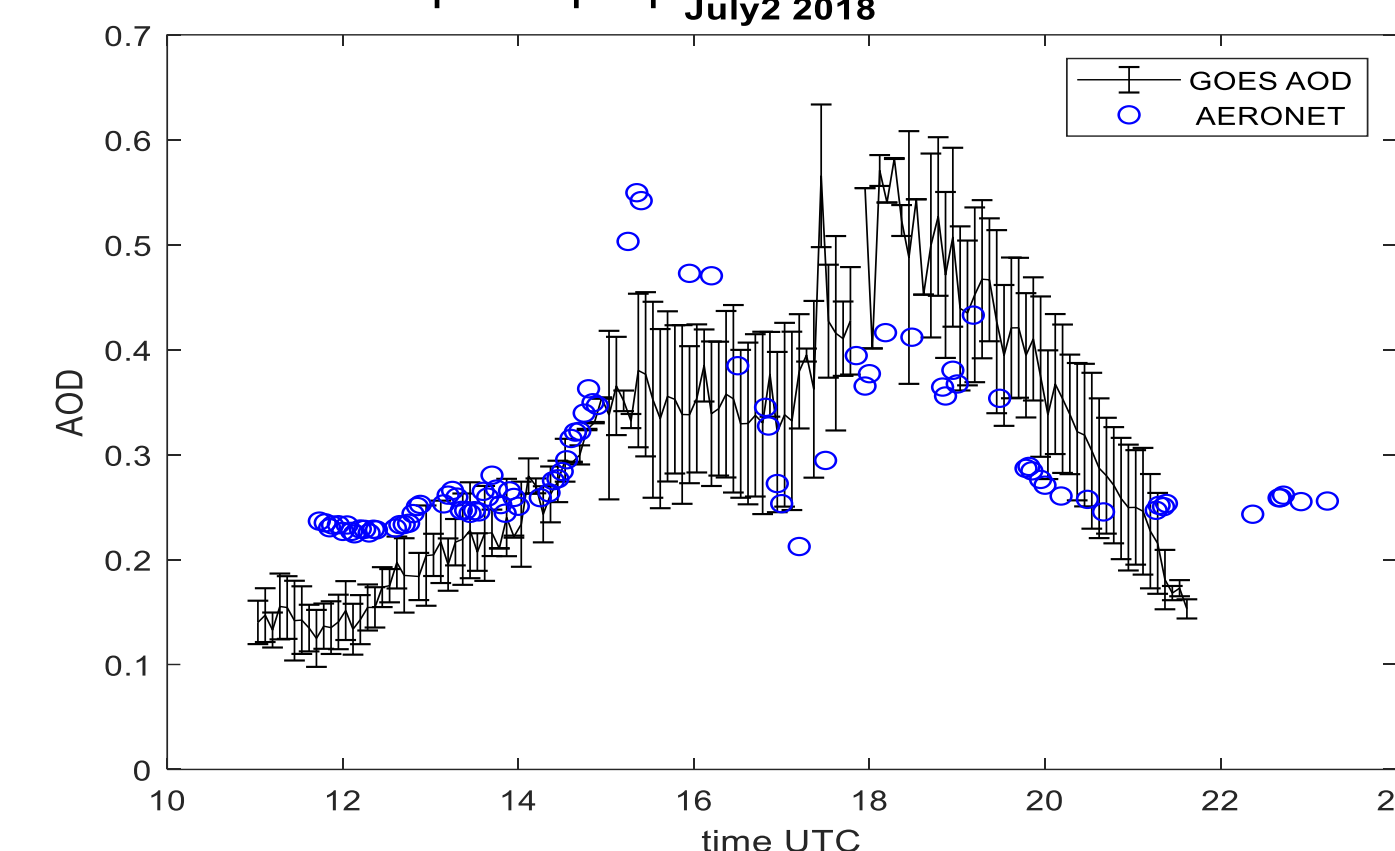


High QC Only

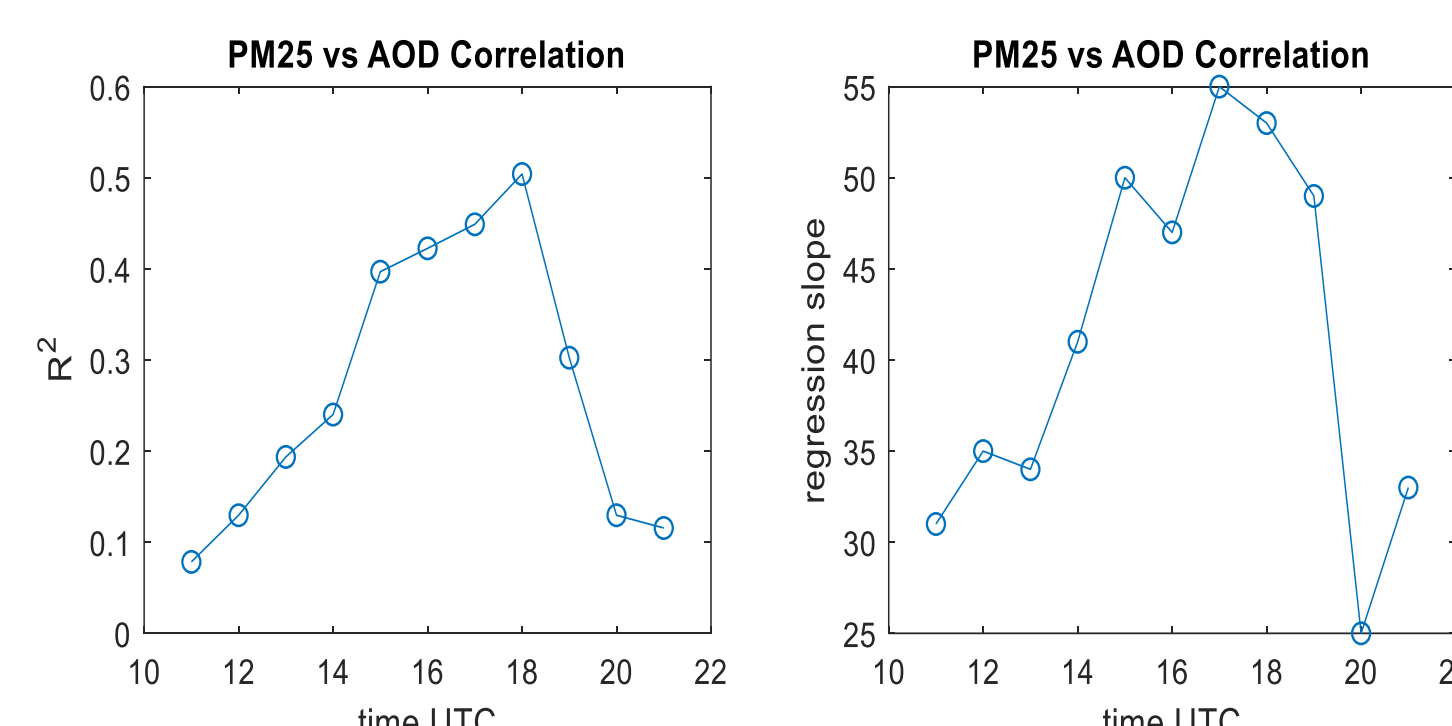


Potential for GOES ABI Diurnal Retrievals (Med+HC)

Around 1600 UTC, Surface air clean out observed at satellite level
Can affect the GOES-AOD retrieval since optical properties can be different



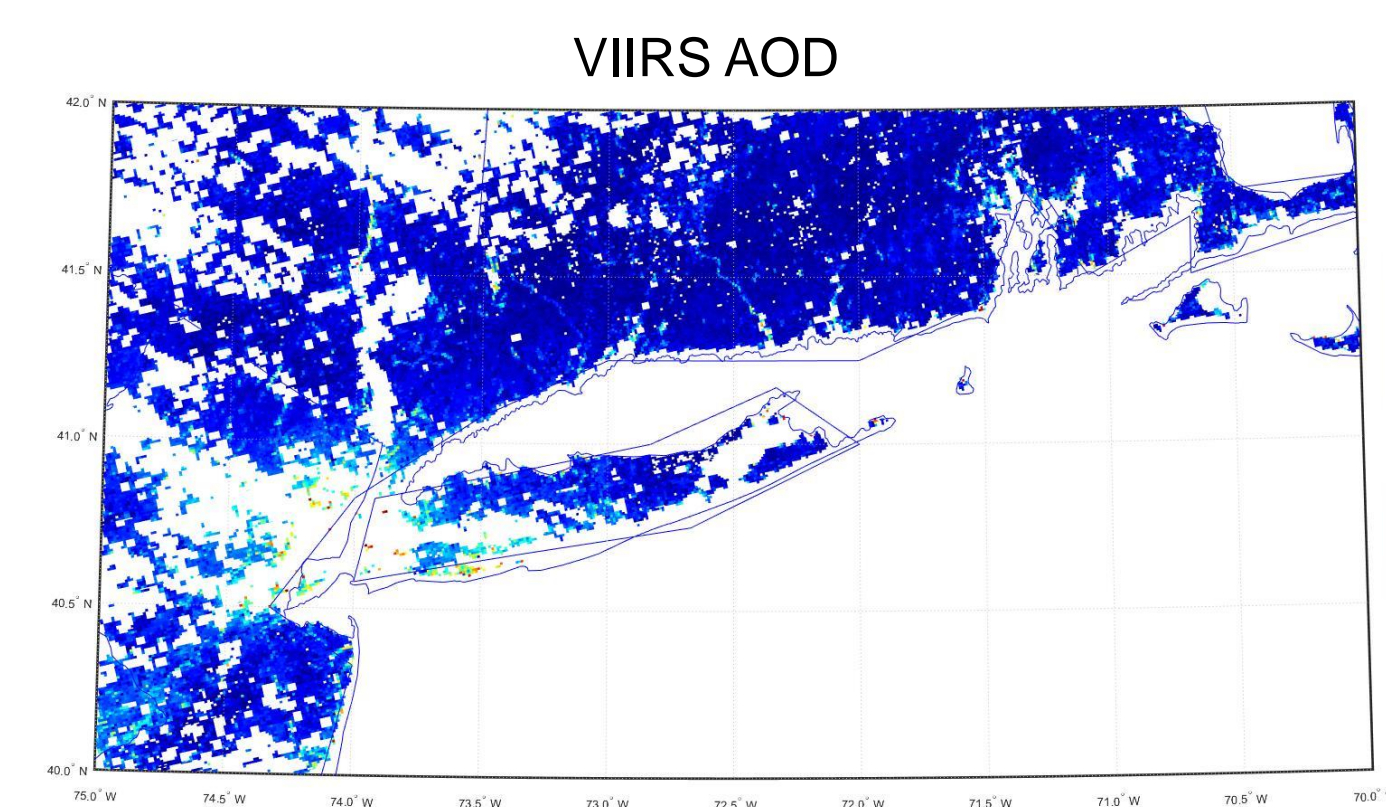
Preliminary Diurnal Relation between Summer 2018 PM25 And GOES-ABI AOD



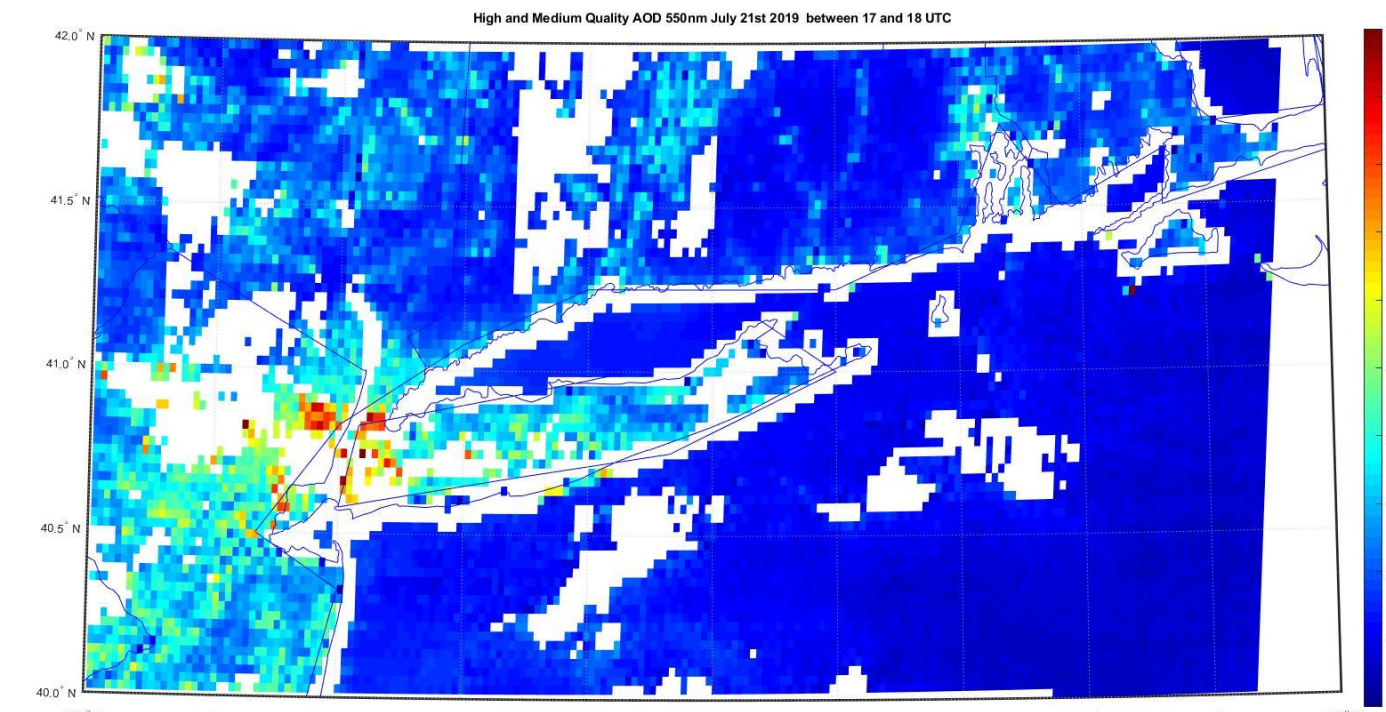
Summary

- Diurnal AOD from GOES-ABI can be extracted and compared to ground based AERIONET AOD measurements including the validation of dynamic cleanout events
- Preliminary Correlation studies between GOES-AOD ABI and surface PM25 show significant diurnal changes with best results occurring during mid day
- Partial explanations include less satellite AOD errors in mid-day with better solar illumination and better mixing of aerosols within the PBL layer
- We have made a preliminary assessment of the impact that O3 formation precursors have on high O3 cases
- GOES-16 ABI can also be used to quantify Downwelling Solar Radiation (DSR) and can be integrated over time
- We have found that the for the 'NO2' limited case, both NO2 and DSR have strong impacts although statistical significance needs to be improved
- More difficult, the VOC limited case had less statistics and even in this case, the impact of the input factors is not as clear
- Efforts to study the more relevant downwind condition requires we add wind speed and direction to the input factors and therefore the relevant data statistics must be dramatically increased

Comparisons between VIIRS AOD and GOES-ABI AOD (Med+HC)



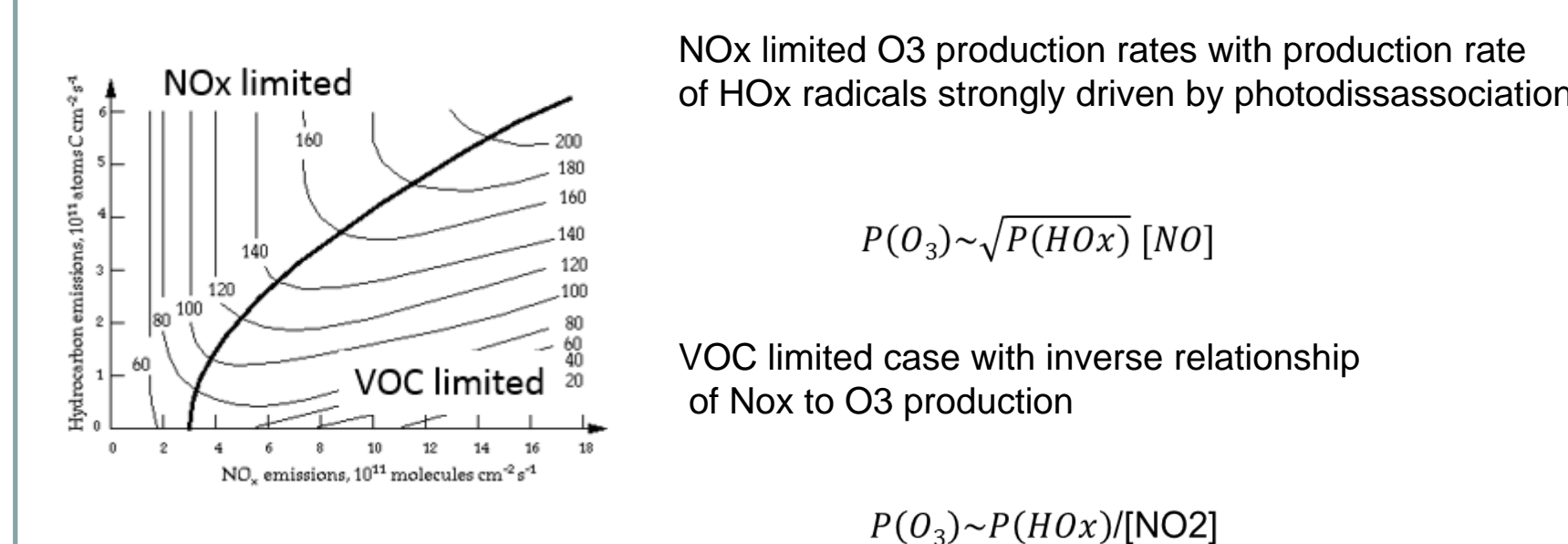
GOES 1 hour aggregate AOD



Clear Significant Over-bias in the GOES AOD over most land regions
VIIRS flags are more conservative

Different Regimes of O3 Production from NOx precursors

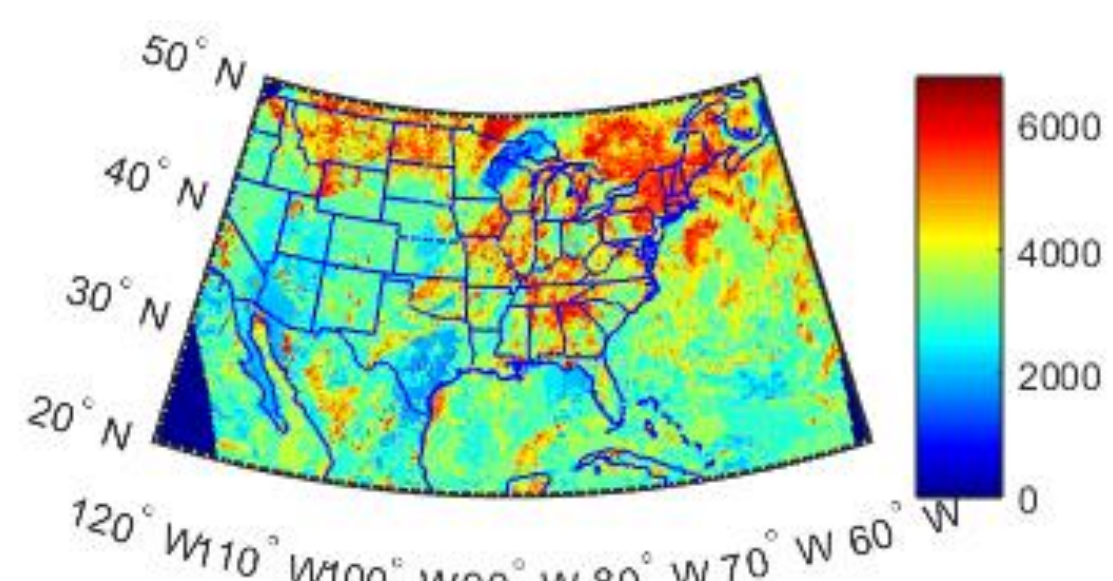
- O3 production rates are often separated into 2 regimes. NOx limited and VOC limited. In the NOx limited case which generally occurs with enhanced VOC concentrations, the dynamics of the O3 production is 'linearly' driven by the background NO2 (NOx) while in the VOC limited case, the relationship is less dynamic and at some level weakly anti-correlated with NOx



Time Integrated DSR from GOES-16 ABI

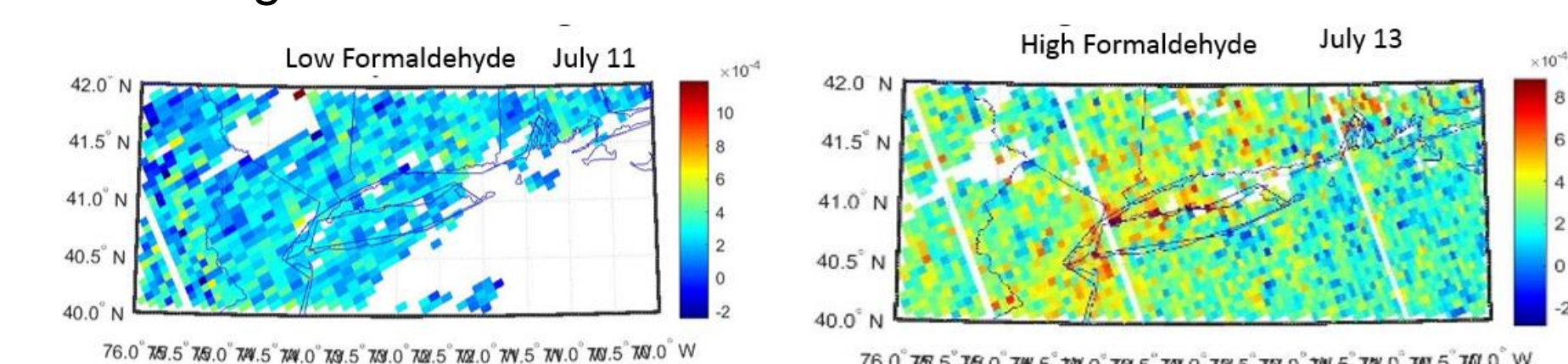
GOES 16 ABI measurements allow 5 " retrievals that can be time integrated over the day to provide downwelling solar radiation maps that can then be regionally integrated to estimate photoassisted reactions

- DSR includes cloud property estimates and aerosol factors in estimating downwelling radiation at 5km resolution



Effort to see regional VOC (e.g. Formaldehyde) using TROPOMI satellite observations

- Unfortunately, PANDORA is not operationally able to retrieve Formaldehyde
- Satellite Observations from TROPOMI can retrieve Formaldehyde but the retrieval is quite noisy
- However for an overall regional estimate, TROPOMI can give broad estimates



Relationship between High O3 > 40 ppb (2 hr peak average) and input factors in "NO2 limited regime (31/46 cases classified high HONO)

Input factors broken down by quartiles					
NO2 \ Radiation	Q1	Q2	Q3	Q4	
Q1	0	0	1	1	2
Q2	0	0	1	2	3
Q3	1	1	0	2	4
Q4	1	0	2	3	6
	2	1	4	8	

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