Analyzing Atmospheric Total Column NO_2 and O_3 Variability in New York City using Ground- and Satellite-Based Instruments

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INTRODUCTION

Ozone (O_3) and nitrogen dioxide (NO_2) are two of the six **criteria air pollutants** that the United States Environmental Protection Agency (EPA) set under the National Ambient Air Quality Standards (NAAQS) in 1970. Trace gases like these make up about 0.1% of our atmosphere, yet they are attributed to many health issues.

Total Column Amount: measurement of the total amount of an atmospheric gas in a given vertical column.

Nitrogen Dioxide (NO_2)	Ozone (O_3)
• a reddish-brown reactive gas that is formed through the oxidation of nitric oxide or reactions with existing compounds in the atmosphere.	• a colorless gas that can be formed naturally in the stratosphere through reaction with the O_2 compound and UV rays or in troposphere through reaction with NO_x.

Human Health Issues:

- Cause irritations in the lungs and respiratory tracts
- Increase likelihood or make existing respiratory illnesses (asthma) more severe
- Reduce immunity to lung infections like influenza

Environmental Issues:

- NO_2 → formation of acid rain and smog; nitrate concentration in soils, eutrophication
- O_3 → greenhouse gas effect; damage to crops and vegetation

RESEARCH QUESTIONS

- How variable are total column NO_2 and O_3 in New York City? And what are the weekly and seasonal cycles in NO_2 and O_3 over this urban coastal environment?
- What meteorological or human processes are influencing the O_3 and NO_2 variations observed during the time period of our observations (Dec 2017 to Dec 2018)?

METHODS

1. Extracted Total Column NO_2 and O_3 data from Pandora-135 and filtered for a normalized root-mean-square of the weighted spectral fittings of <0.05, solar zenith angles (SZAs) < 70, and for uncertainties less than 0.05 DU for $TCNO_2$ and less than 2 DU for TCO_3. (Tzortziou et al., 2012) ([4]).
2. Calculated and plotted the daily, and monthly average total column amounts for both air pollutants, using MATLAB.
3. Extracted Total Column NO_2 and O_3 data from the TROPOMI sensor, on the ESA polar-orbiting satellite, Sentinel 5P to develop monthly composites (spatial resolution 7 x 3.5 km) and from the OMI sensor (spatial resolution 13 x 25 km).
4. Created composites for certain months to visually see air pollutants.

RESULTS

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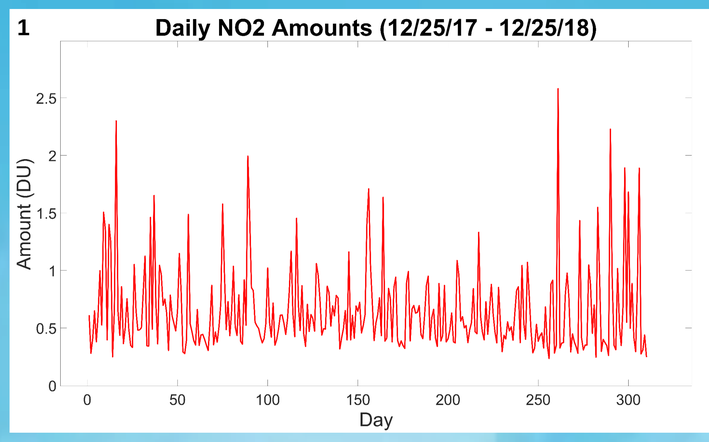

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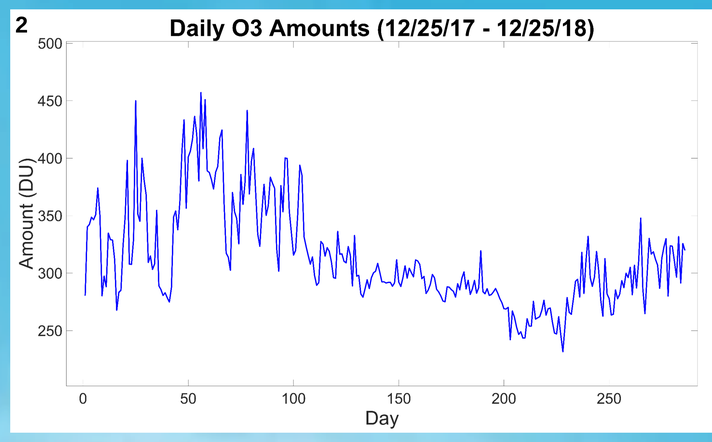

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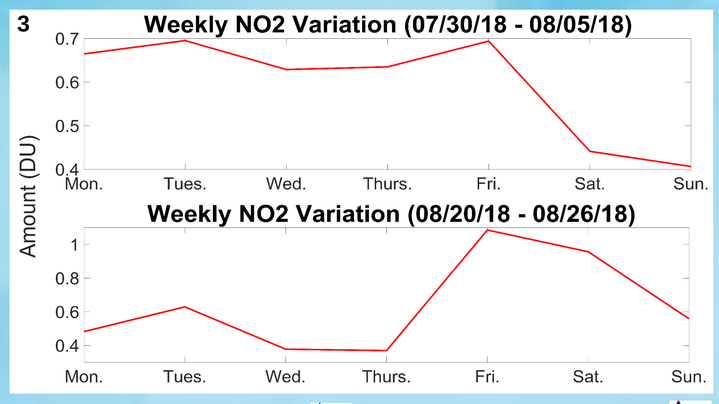

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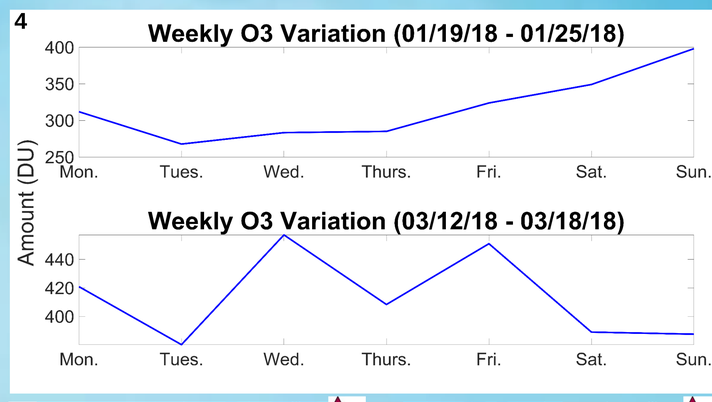

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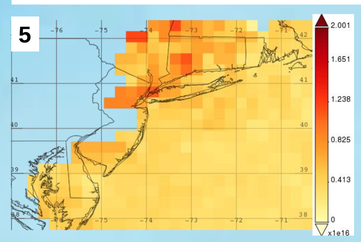

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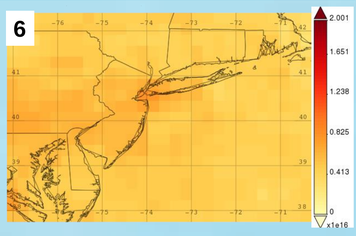

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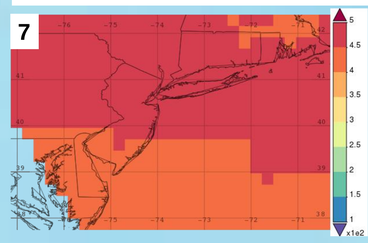

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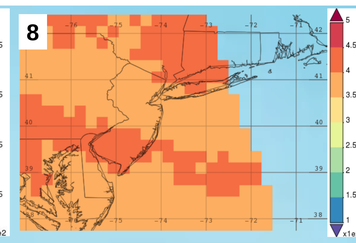

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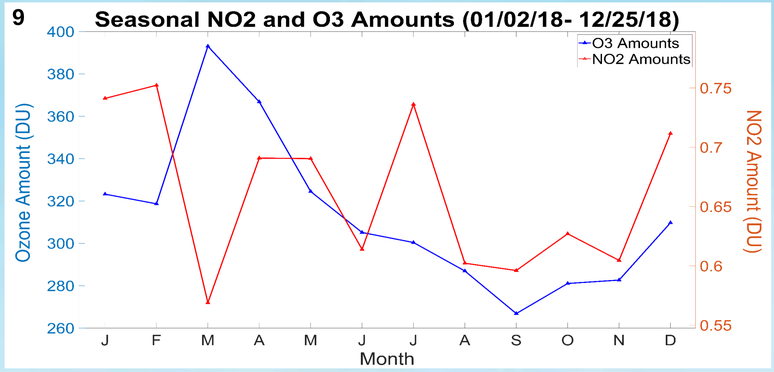

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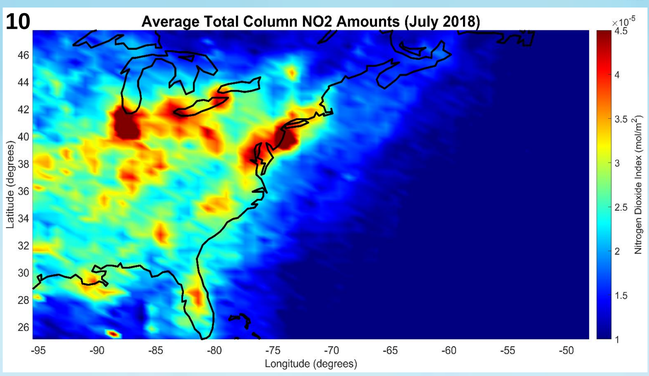

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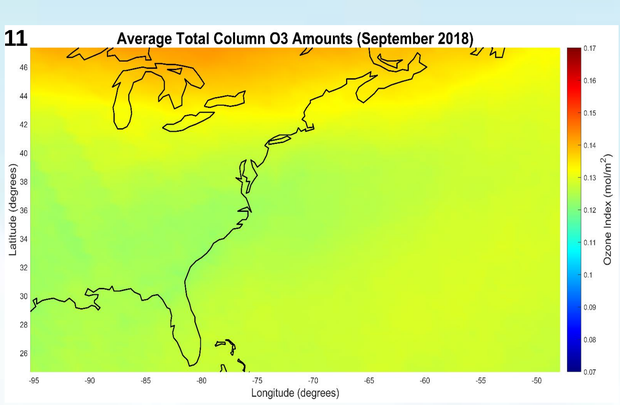

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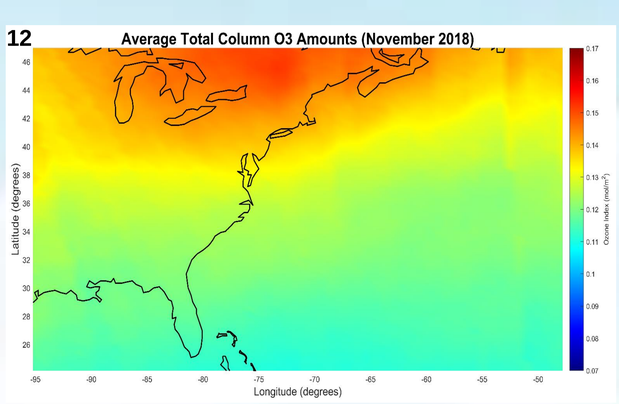

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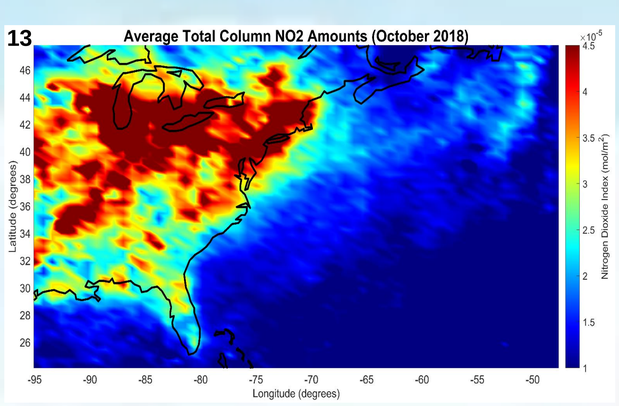

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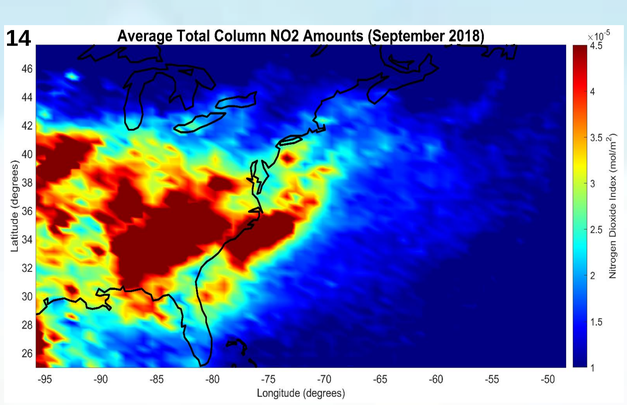

CONCLUSIONS

- Daily amounts (1, 2)
  - NO_2 varied by a factor of 10, ranging from 0.235 DU to 2.580 DU
  - O_3 varied by a factor of 2, ranging from 231.695 DU to 457.138 DU
- Weekly trends (3 - 8)
  - As the weekend approaches, there are lower amounts of NO_2.
  - Graphs from the same season have stronger correlations than comparing graphs from different seasons.
  - There is no correlation for the ozone weekly plots because most of the total column ozone amount is from the stratosphere and minimally influenced by local activity.
- Monthly amounts (9)
  - NO_2 ranged from 0.517 DU to 0.752 DU
  - O_3 ranged from 266.863 DU to 393.076 DU
- $TCNO_2$ is mostly influenced by local activity than larger scale meteorological processes (10, 13, 14).
- TCO_3 was mostly affected by larger scale meteorological processes (11, 12).
- O_3 builds up during the winter and decreases almost linearly during the summer-fall months. This is due to the combination of transport and photochemical destruction (maximum during the summer) processes.
- NO_2 values observed both during the winter months (due to increased heating) and summer months (due increased air conditioner use).

FUTURE WORK

- Determine the compatibility between Pandora-135, OMI, and TROPOMI to obtain and use data for the particular pixel at which the ground instrument is located on.
- Compare results from Pan-135 with measurements collected over the Long Island Sound from shipboard Pandoras' deployed onboard research vessels during the 2018 LISTOS field campaign to better understand transport and dynamics of NO_2 and O_3 over this urban coastal environment.

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