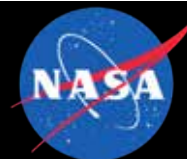


2018 Long Island Sound Tropospheric Ozone Study (LISTOS)

Presented by Dr. Laura Judd
NASA Postdoctoral Fellow at Langley Research Center



Motivations for LISTOS



Despite improving air quality nationwide, this region still suffers from poor air quality.

This work aims to better understand the formation of 'smog' in the region through assessing emissions, dynamics, and chemistry in this complex environment.

Emissions:
NO_x + VOCs



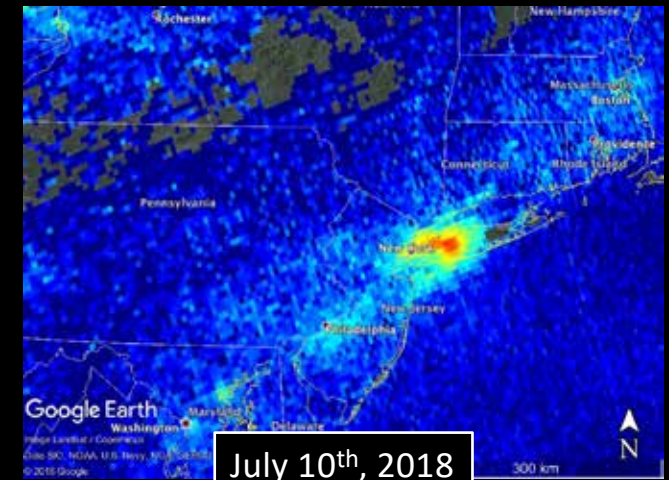
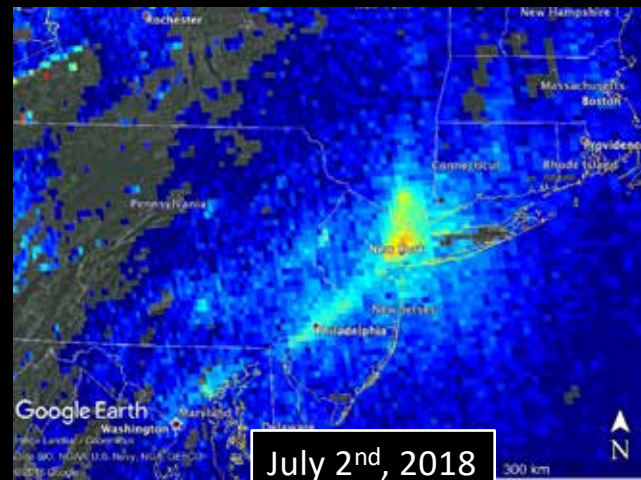
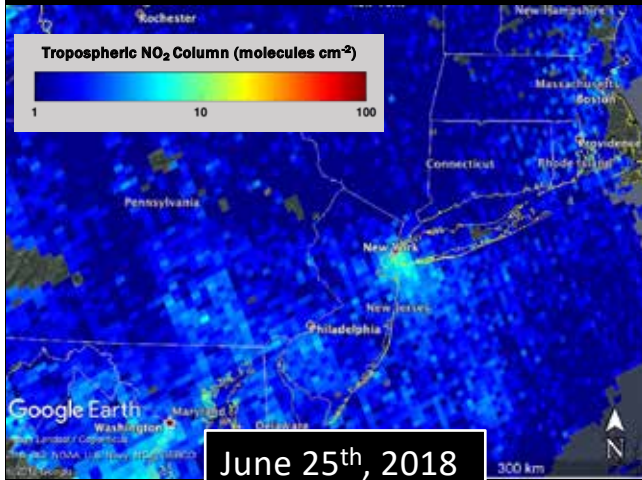
Ozone

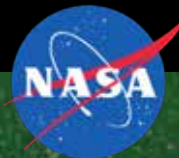
Long Island Sound



Landsat Imagery: <https://landsatlook.usgs.gov/viewer.html>

Air Quality from Space: Examples from TROPOMI NO₂





An Integrated Observing Strategy

In Situ Air quality and
meteorology measurements:

U. Maryland Cessna

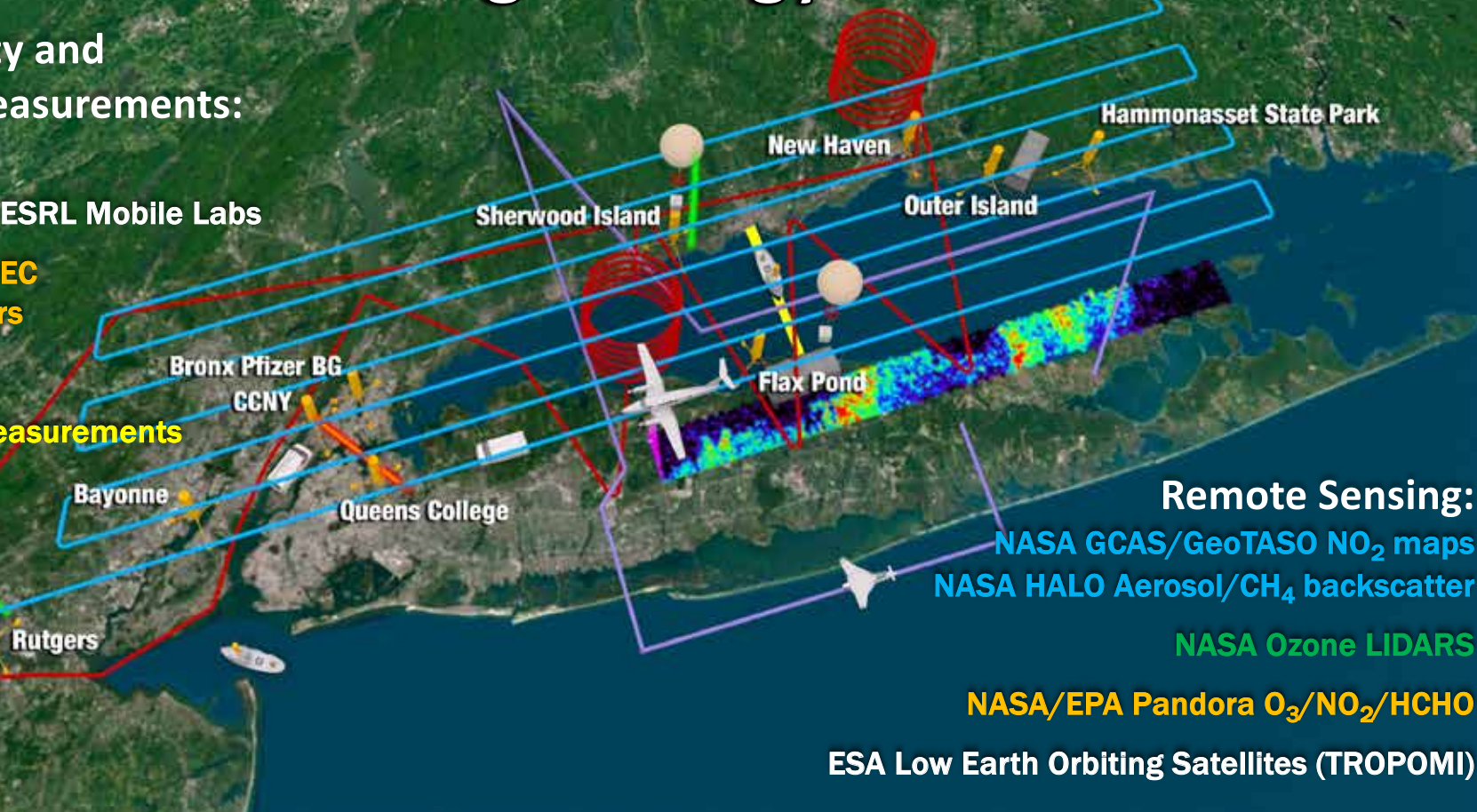
U. Albany and NOAA ESRL Mobile Labs

CTDEEP, NJDEP, NYDEC

Ground Sites monitors

Stonybrook Aircraft

CCNY Boat-based measurements
and LIS Ferry



Remote Sensing:

NASA GCAS/GeoTASO NO_2 maps

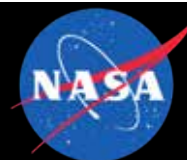
NASA HALO Aerosol/ CH_4 backscatter

NASA Ozone LIDARS

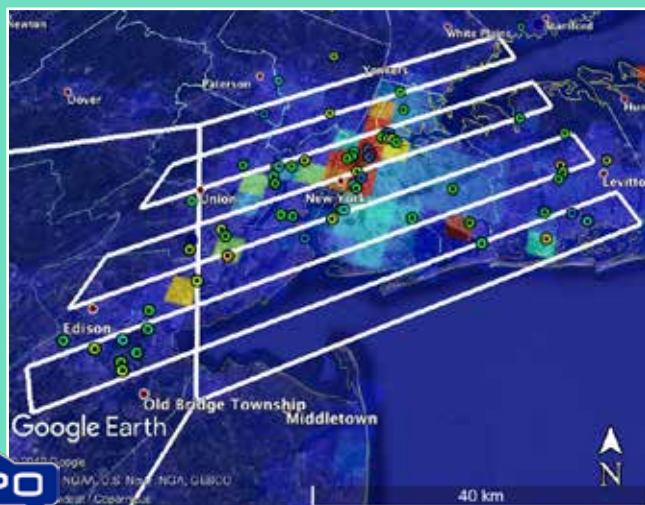
NASA/EPA Pandora O_3 / NO_2 / HCHO

ESA Low Earth Orbiting Satellites (TROPOMI)

Diurnal Sampling Strategy: Example from July 20th, 2018



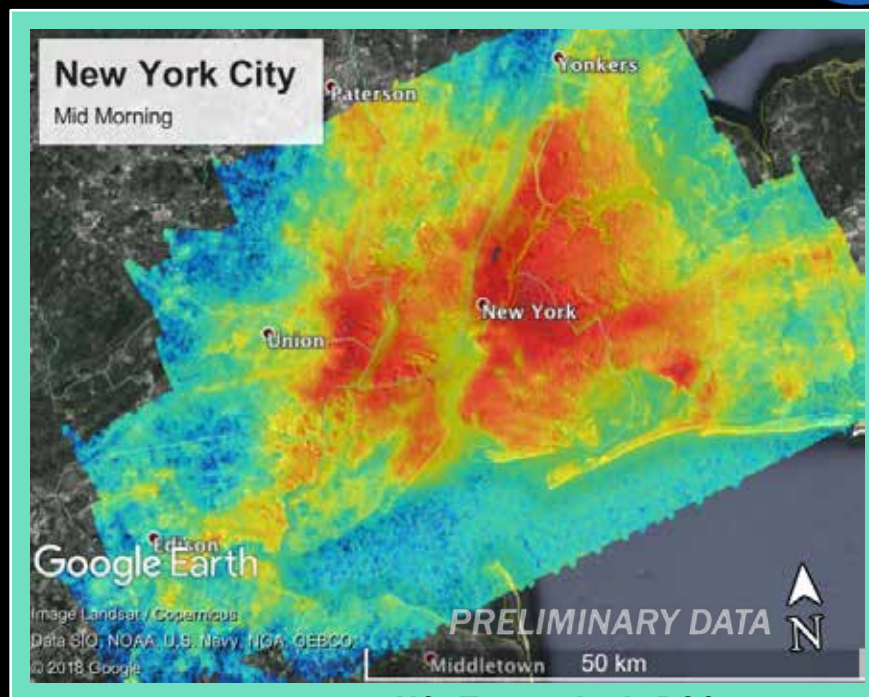
Airborne mapping of domain 4 times per day



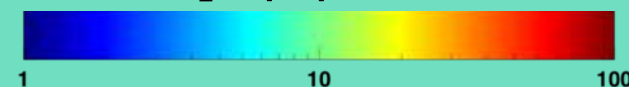
Base Map: STDEV of hourly daytime NEI NO_x emissions



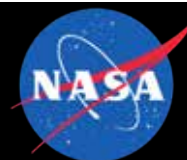
- Current air quality monitoring satellites overpass in the early afternoon hours (~13:30 LT).
- GCAS and GeoTASO are used as 'airborne simulators' for NASA's first geostationary air quality satellite, TEMPO, to test out retrievals prior to launch and to observe air quality at unprecedented spatial resolutions.



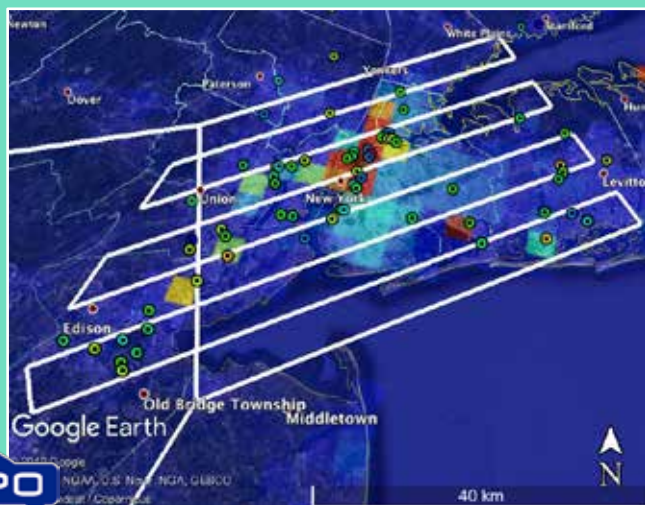
NO₂ Tropospheric DSC



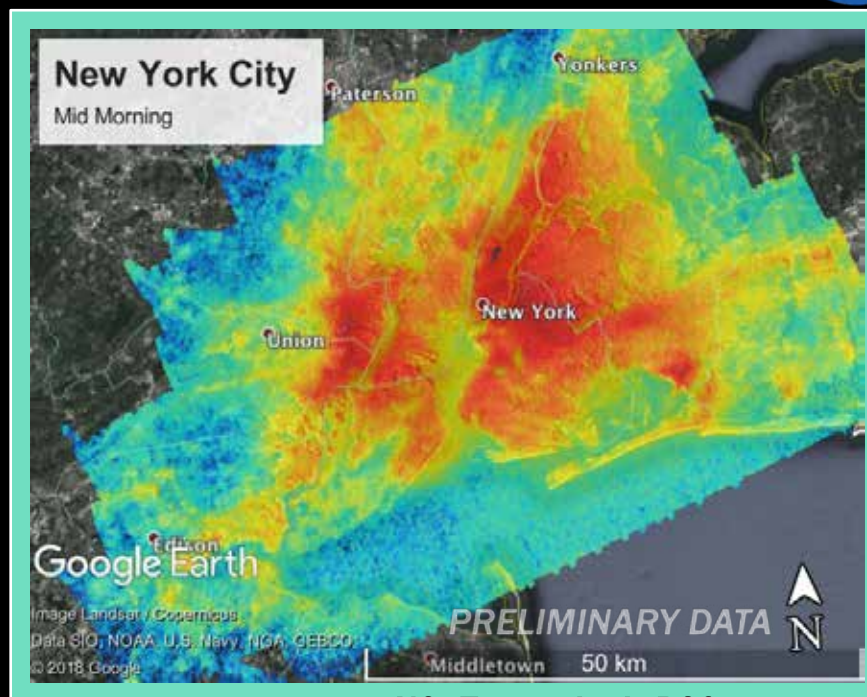
Diurnal Sampling Strategy: Example from July 20th, 2018



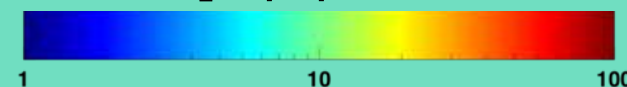
Airborne mapping of domain 4 times per day



Base Map: STDEV of hourly daytime NEI NO_x emissions



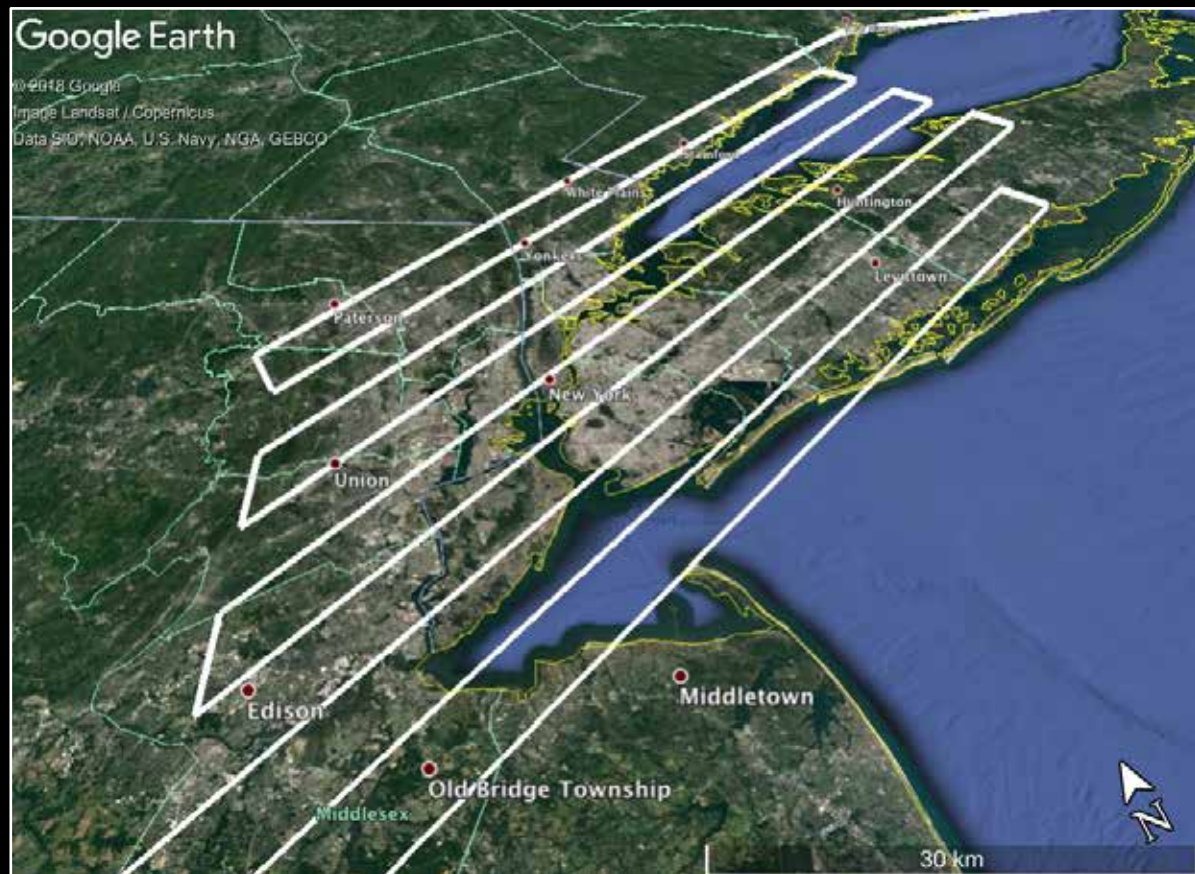
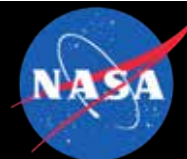
NO₂ Tropospheric DSC



- Current air quality monitoring satellites overpass in the early afternoon hours (~13:30 LT).
- GCAS and GeoTASO are used as 'airborne simulators' for NASA's first geostationary air quality satellite, TEMPO, to test out retrievals prior to launch and to observe air quality at unprecedented spatial resolutions.

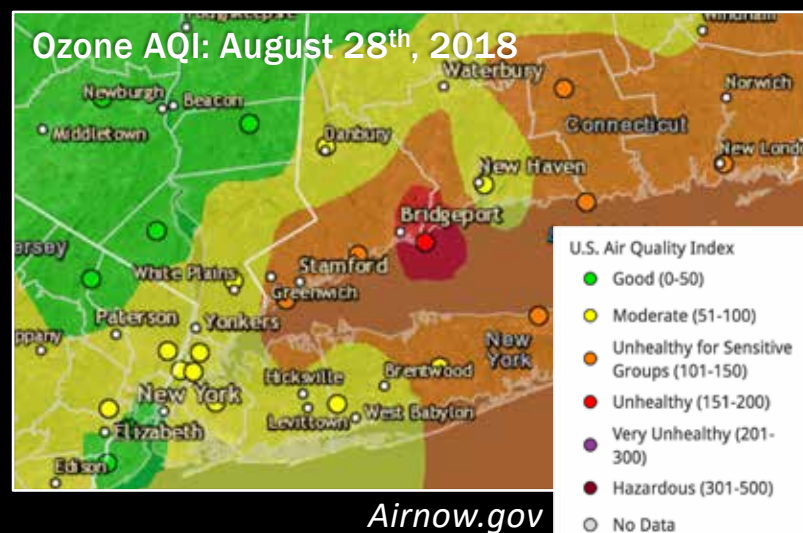


Long Island Sound O₃ Event: August 28th, 2018



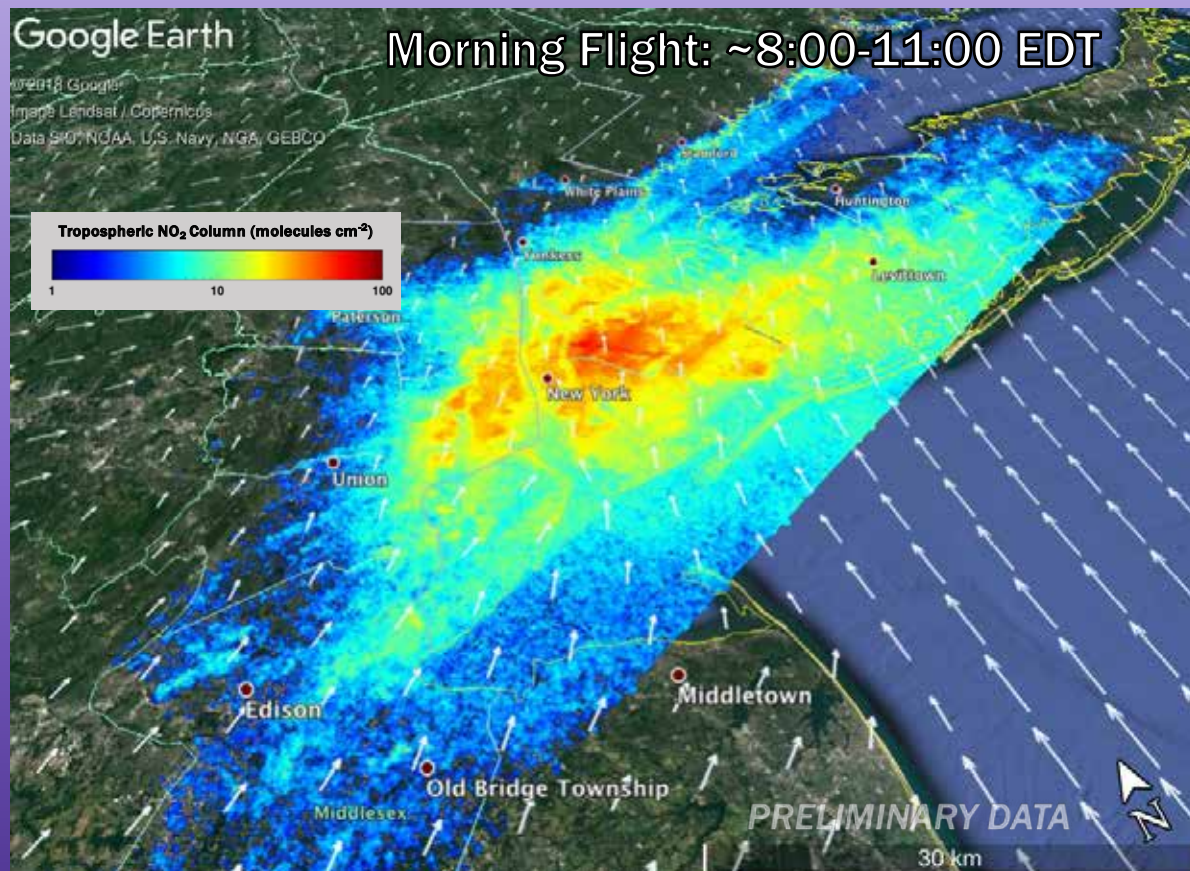
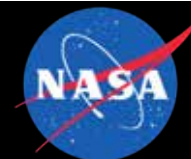
Based on air quality forecasts, we periodically executed a flight plan that covered a larger area, once in the morning and once in the afternoon, to capture the regional transport and evolution of emissions.

Ozone AQI: August 28th, 2018



Airnow.gov

Long Island Sound O₃ Event: August 28th, 2018



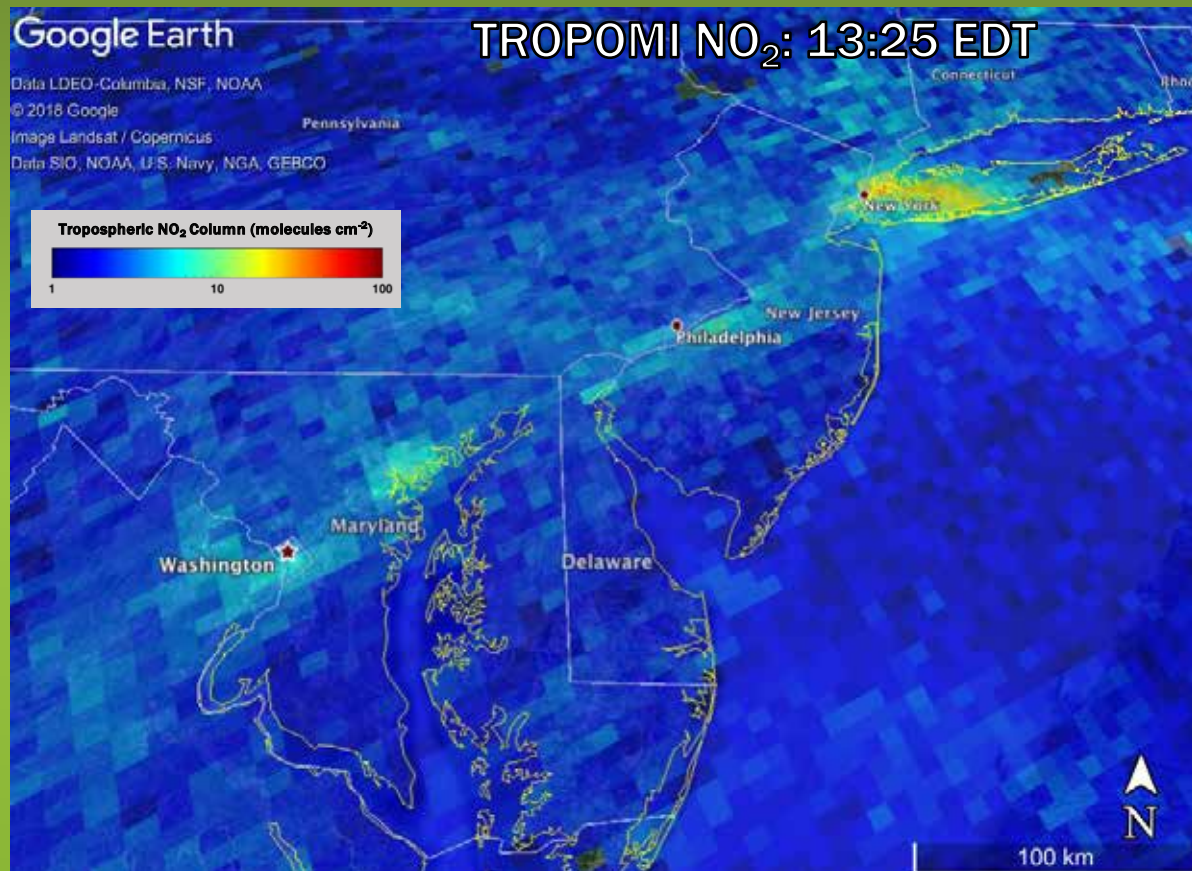
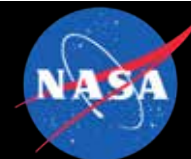
Starting in the morning...

Observations from NASA's airborne LIDAR, HALO, show lower mixed layer heights (MLH) over Long Island Sound than the surrounding land

NO₂ amounts, retrieved from NASA's airborne spectrometer, GCAS, are largest over Queens – an area with multiple point sources and likely traffic signatures

Wind vectors from the NAM (09:00 LT) show slow SSW flow over land slowly transporting emissions through the mouth of Long Island Sound

Long Island Sound O₃ Event: August 28th, 2018



In the afternoon...

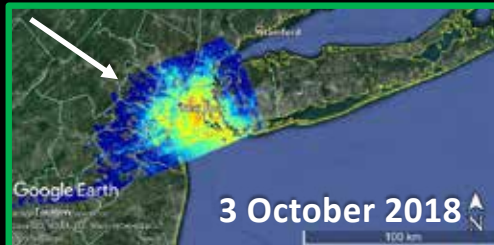
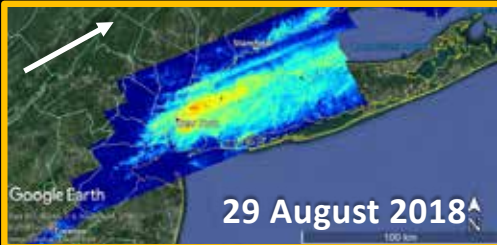
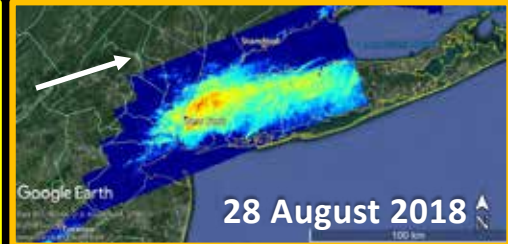
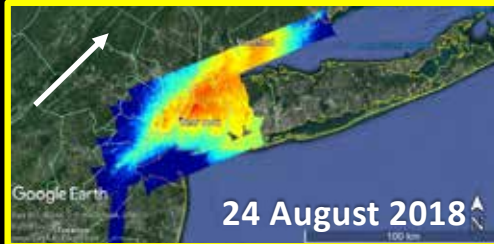
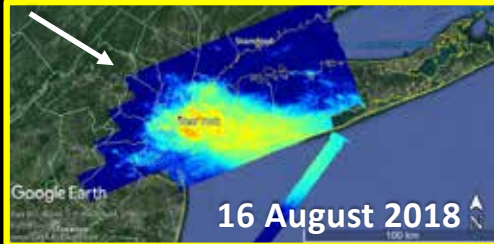
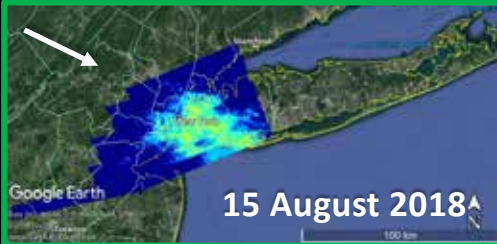
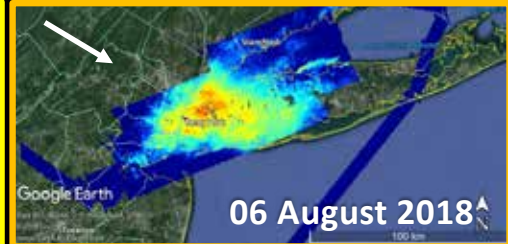
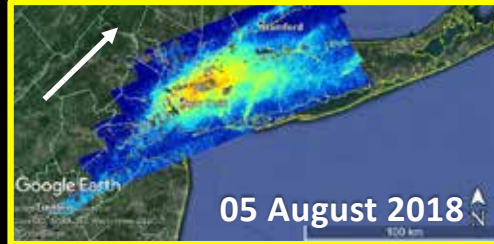
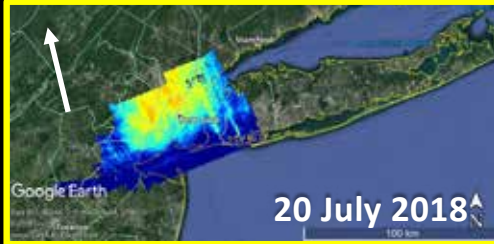
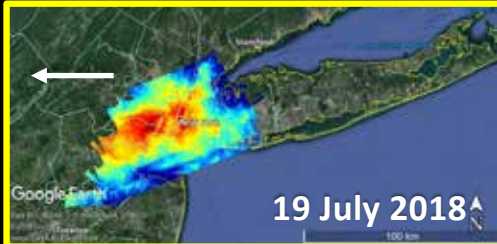
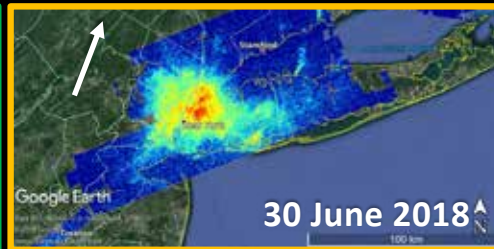
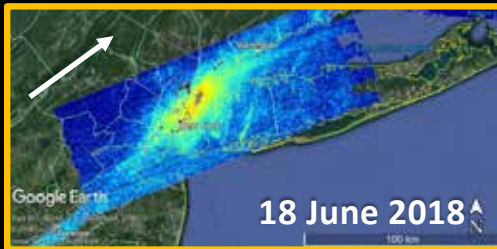
NASA's airborne spectrometer, GCAS, is able to pick up signatures from single point sources [e.g. powerplants, airports, traveling corridors]

3km NAM analysis from 13:00 EDT highlights emissions extending downwind with a convergence zone along the CT Coast

13:25 EDT overpass of TROPOMI correlates with the distribution of NO₂ observed by GCAS.

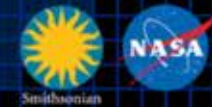
Regionally, TROPOMI shows enhanced NO₂ along the I95 corridor...
...with the highest values peaking near NYC

From June-October 2018, we mapped NYC 2-4 times per day on 16 days with air quality conditions ranging from **clean/cool** postfrontal air to **unhealthy** high ozone events.





Hourly atmospheric pollution from geostationary Earth orbit



PI: Kelly Chance, Smithsonian Astrophysical Observatory

Instrument Development: Ball Aerospace

Project Management: NASA LaRC

Other Institutions: NASA GSFC, NOAA, EPA, NCAR, Harvard, UC Berkeley, St. Louis U, U Alabama Huntsville, U Nebraska, RT Solutions, Carr Astronautics

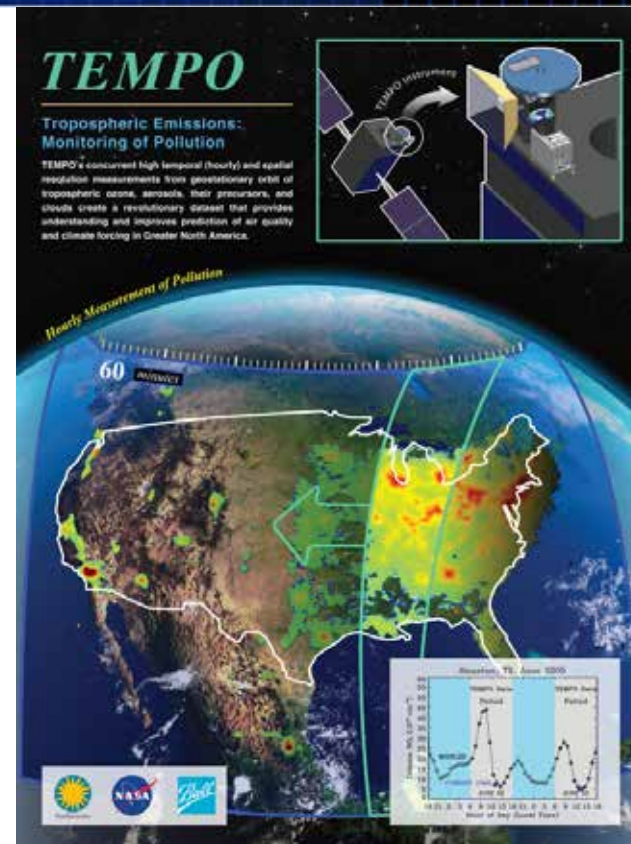
International collaboration: Mexico, Canada, Cuba, Korea, U.K., ESA, Spain

Selected Nov. 2012 as NASA's first Earth Venture Instrument

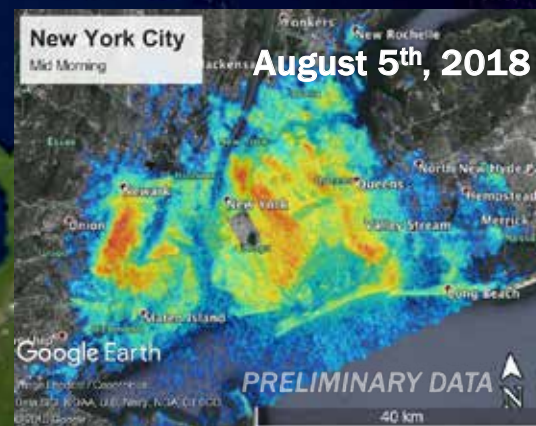
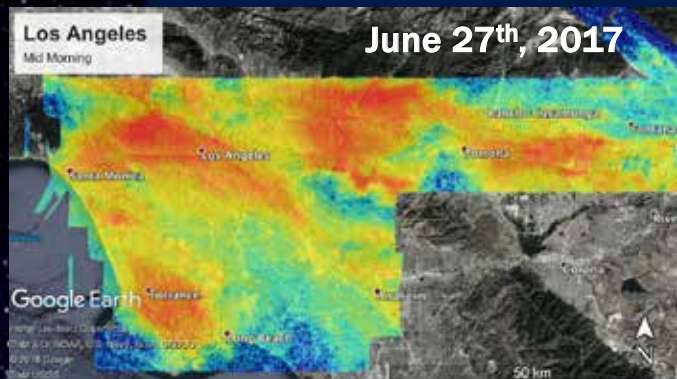
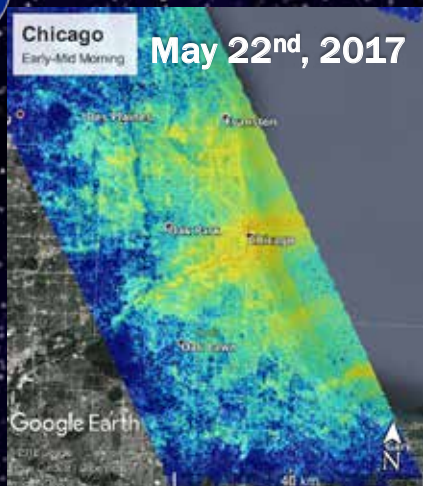
- Instrument delivered 2018
- NASA will arrange hosting on commercial geostationary communications satellite with launch anticipated 2020-2022 (TBC)

Provides hourly daylight observations to capture rapidly varying emissions & chemistry important for air quality

- UV/visible grating spectrometer to measure key elements in tropospheric ozone and aerosol pollution
- Distinguishes boundary layer from free tropospheric & stratospheric ozone

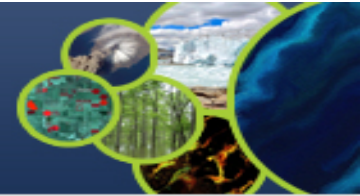


**North American component of an international constellation for air
quality observations**





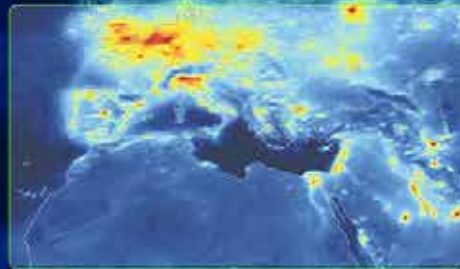
Atmospheric Composition Virtual Constellation Air Quality Missions 2017-2023



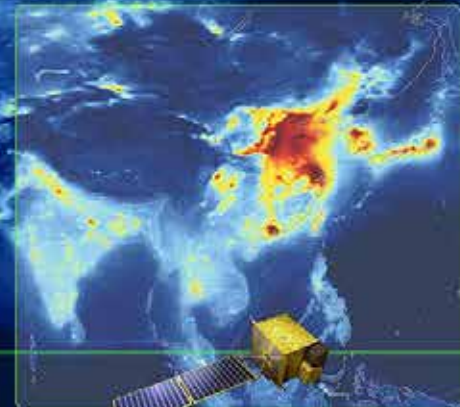
TEMPO (hourly)
Tropospheric Emissions:
Monitoring of Pollution



Sentinel-4 (hourly)



GEMS (hourly)
Geostationary Environmental
Monitoring Spectrometer



Equator

Sentinel-5P (once per day)

Graphic: NASA LaRC
NO₂ Image: KNMI/ESA

GaoFen-5 (once per day)

Concluding remarks



- Through collaborations with a number of state/federal agencies and research institutions, the LISTOS science team gathered a unique dataset that will be used to better understand air quality near NYC and its downwind neighbors
- This work also provided observations for validating the recently launched European Space Agency Sentinel-5 Precursor/TROPOMI and continues preparations for geostationary observations
- Keep an eye out for a number of presentations about LISTOS and similar campaigns throughout the week (particularly sessions A51A, A51N, A52A, A53C, A53G and A54D on Friday)

Special thanks to the entire LISTOS Science Team, NASA GeoCAPE, NASA LaRC RSD Pilots and Crew, and the EU Copernicus Program

LISTOS Participants

The City College of New York / NOAA-CREST Center
Connecticut Department of Energy and Environmental Protection
Maine Department of Environmental Protection
National Aeronautics and Space Administration
National Oceanic and Atmospheric Administration
New Jersey Department of Environmental Protection
New York State Department of Environmental Conservation
Northeast States for Coordinated Air Use Management (NESCAUM)

Stony Brook University School of Marine and Atmospheric Sciences
University at Albany Atmospheric Sciences Research Center
University of Colorado, Cooperative Institute for Research in Environmental Sciences
University of Maryland, College Park RAMMPP
U.S. Environmental Protection Agency
U.S. Environmental Protection Agency Region 1 (New England)
Yale University Department of Chemical & Environmental Engineering and Peabody Museum

LISTOS Support

Connecticut Department of Energy and Environmental Protection
National Aeronautics and Space Administration
National Fish and Wildlife Foundation
National Oceanic and Atmospheric Administration
New Jersey Department of Environmental Protection
New York State Department of Environmental Conservation
New York State Energy Research and Development Authority
U.S. Environmental Protection Agency Office of Research and Development
U.S. Environmental Protection Agency Region 1 (New England)