

# PAMS re-design: Enhanced Monitoring Plans (EMPs) and column measurements

*Background, Research & Applications, Deployment Possibilities*

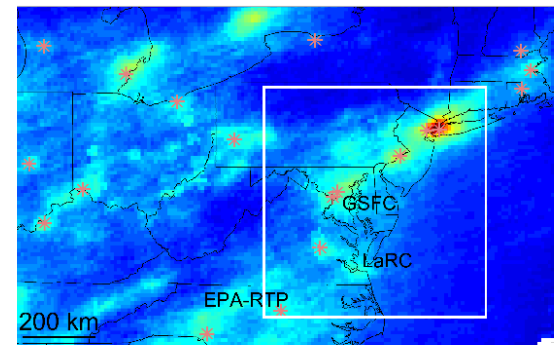
**EPA:** Luke Valin, Jim Szykman, Kevin Cavender

**NASA:** Bob Swap, Barry Lefer, Alexander Cede (NASA/ESA)

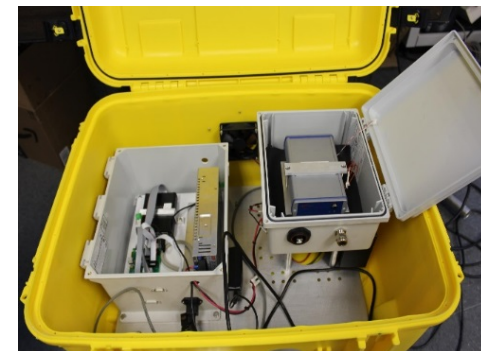
**Harvard Smithsonian:** Kelly Chance

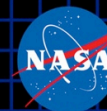
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**NASA HAQAST-3 Workshop**  
**November 29, 2017**  
**LDEO, Columbia University**  
**Palisades, NY**



- System developed at NASA Goddard
- Extensive Use/Testing During DISCOVER-AQ
- Solar source spectrometer (280 - 525 nm: 0.6 nm resolution) – column  $\text{NO}_2$ ,  $\text{O}_3$ ,  $\text{HCH}_2\text{O}$ , and  $\text{SO}_2$  every 80 second.
- EPA and NASA are exploring deployment of Pandoras at PAMS as research instrument to provide improved characterization of emissions and serve as a U.S. ground-based satellite validation network
- 2 main parts to instrument – (1) sensor head and (2) spectrometer, TE cooler, electronics, computer contained with environmental housing case 23"x16"x39" or 8" rack mounted enclosure.
- Can operate in DS-, ZS- and MAX-DOAS modes and potentially provide information on vertical profiles.
- Requires at least 1 month of operations at a given site to build calibrations before realtime data availability





## PAMS merged with NCORE + Pandora

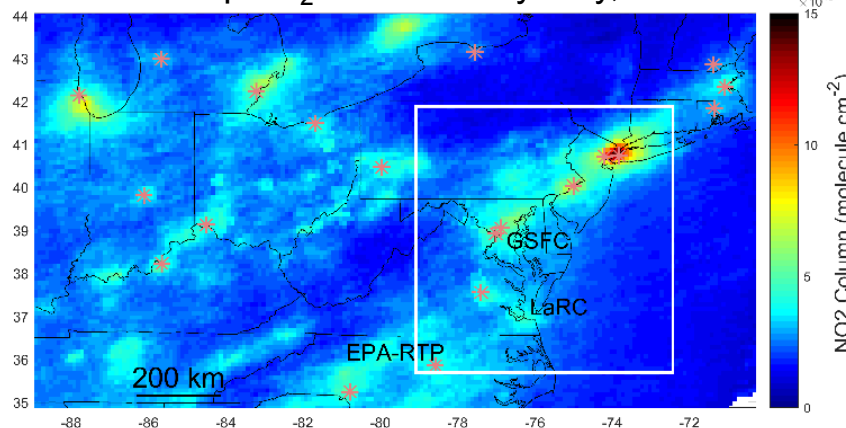
-NO, NO<sub>2</sub>, hourly VOC, aldehyde canister samples (or high-sensitivity HCHO), NO<sub>y</sub>, O<sub>3</sub> (year round). SO<sub>2</sub>, ppb-precision CO, PM<sub>2.5</sub> mass and speciation (At least 1-in-3 day), PM<sub>2.5</sub> continuous, PM<sub>10-2.5</sub> mass, basic met. parameters, **mixed layer height** (ceilometers or profilers)

-Pandora Instrument to be implemented under the Enhanced Monitoring Plans (EMPs).

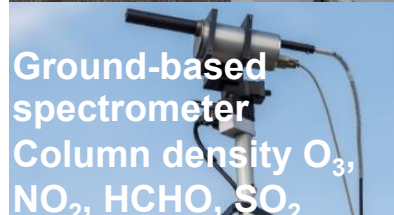
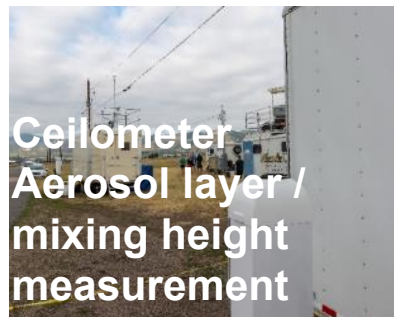
-Addition of NASA-developed Pandora spectrometers at select sites will add **correlative column density NO<sub>2</sub>, HCHO, SO<sub>2</sub>** measurements

The approach leverages existing/expanding monitoring infrastructure to develop high quality ground-based (correlative data) satellite validation (TROPOMI & TEMPO) sites across the United States in areas with the worst O<sub>3</sub> pollution. The approach provides a sustainable approach that increases the value of measurement suite at these sites to communities of interest. We hope this will further promote adoption of satellite data products to the air quality community - increasing societal benefit.

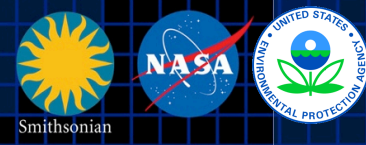
BEHR TropNO<sub>2</sub> Column May-July, 2015-2016



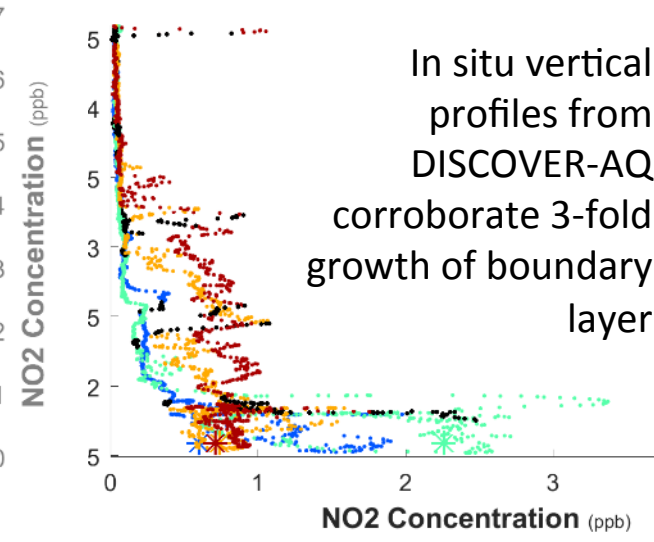
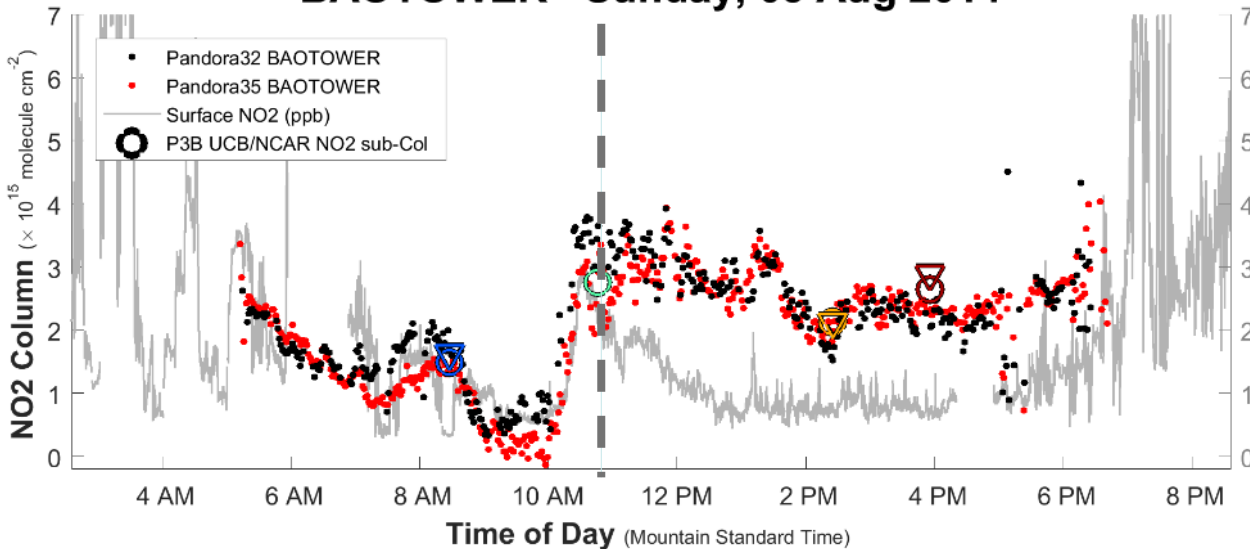
**\*PAMS locations: 10 EPA-NASA Pandoras to be placed within PAMS Network by 2018**



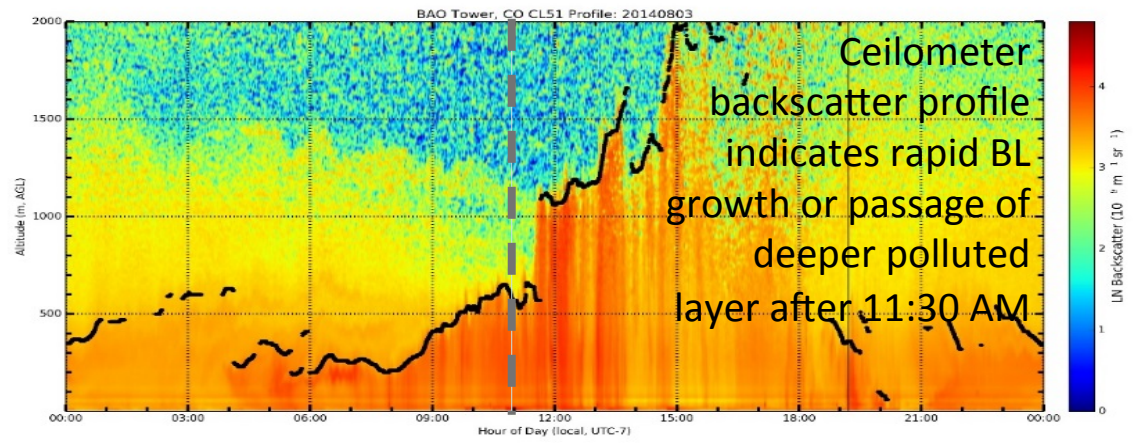
# Column NO<sub>2</sub> measurements: What's happening above our monitor?

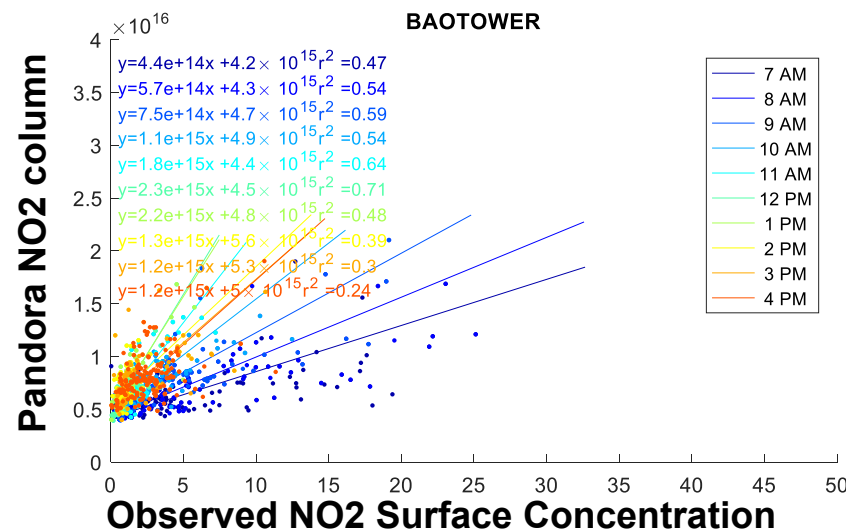
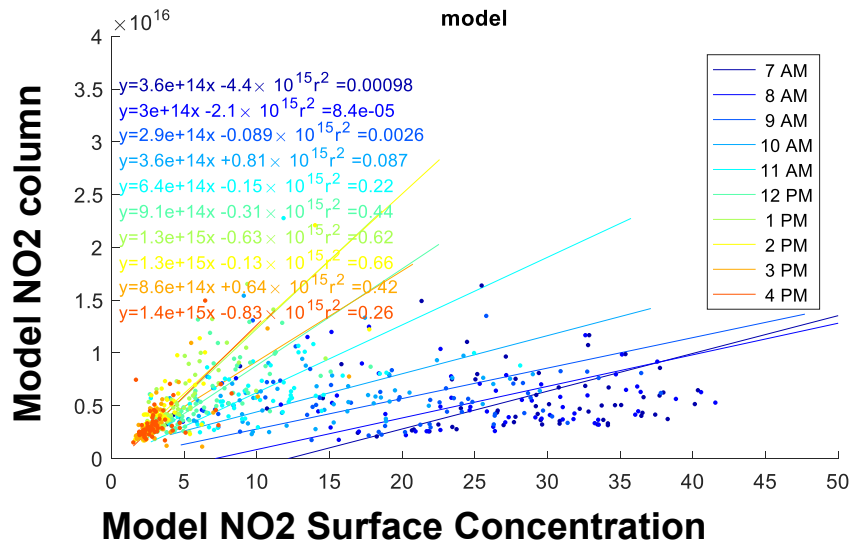


**BAOTOWER - Sunday, 03 Aug 2014**



The NO<sub>2</sub> column (●, ● molecule cm<sup>-2</sup>) divided by surface concentration (— molecule cm<sup>-3</sup>) → Information on mixed layer height ( cm )

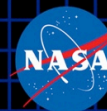




Regress daily NO<sub>2</sub> column vs surface concentration for each hour (**colors**)

- Observed slope at 1 PM:  $2.2 \times 10^{15} / 1 \text{ ppb} \rightarrow \sim 1 \text{ km PBL}$
- Simulated slope at 1 PM:  $1.3 \times 10^{15} / 1 \text{ ppb} \rightarrow \sim 0.6 \text{ km PBL}$
- Maximum observed R<sup>2</sup> is 0.71 and occurs at 12 PM. This is when BL mixing is most vigorous and repeatable each day

# Possible 2018 Deployment Sites as part of PAMS EMP (not all sites are PAMS sites)



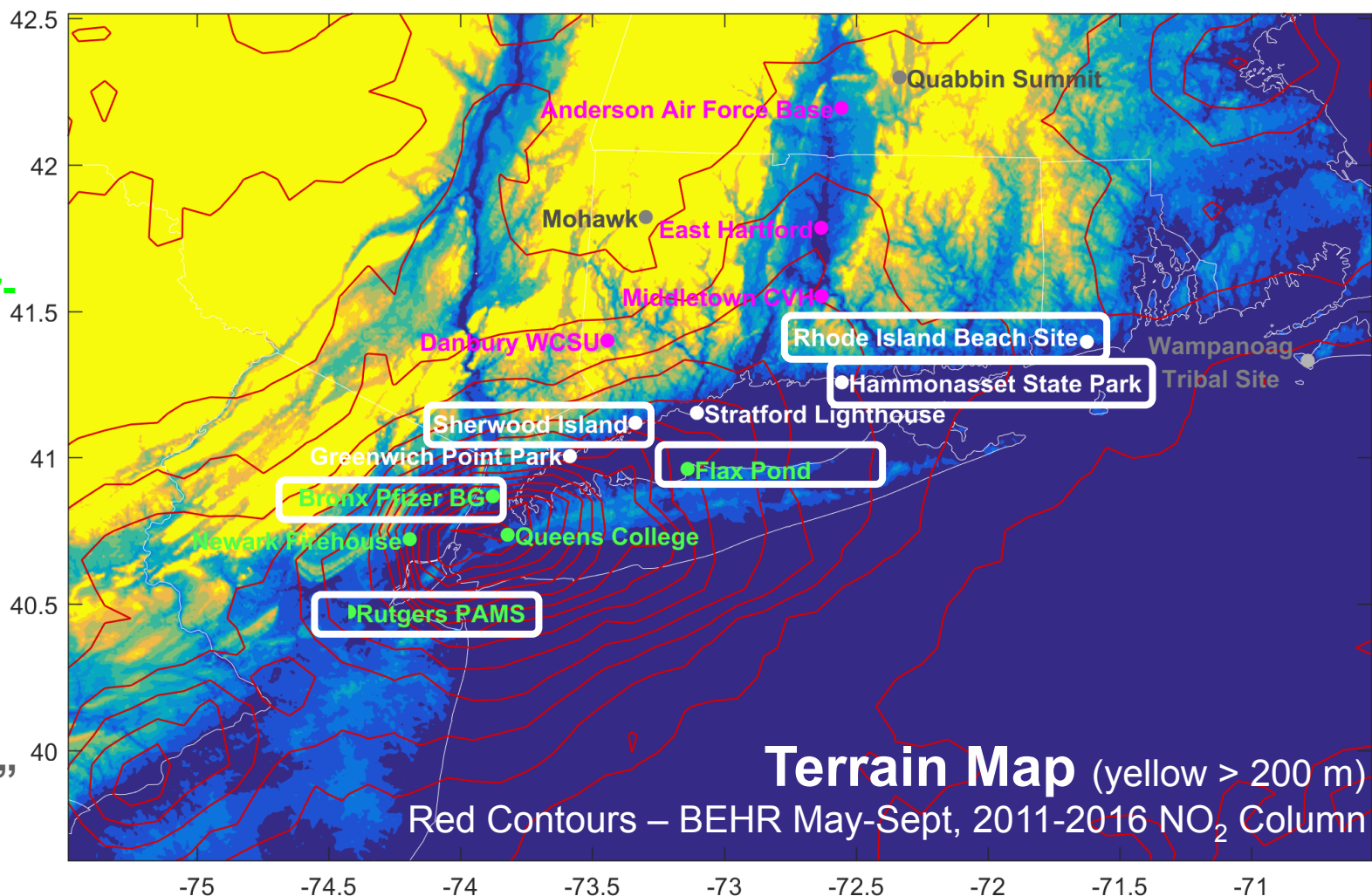
In discussion with 7 site operators + 1 likely in-land CT (pink)

• NY/NJ upwind / near-source sites

• CT/RI downwind coastal sites

• CT/MA downwind inland sites

• CT/MA "Background" downwind sites



**Terrain Map** (yellow > 200 m)

Red Contours – BEHR May-Sept, 2011-2016 NO<sub>2</sub> Column