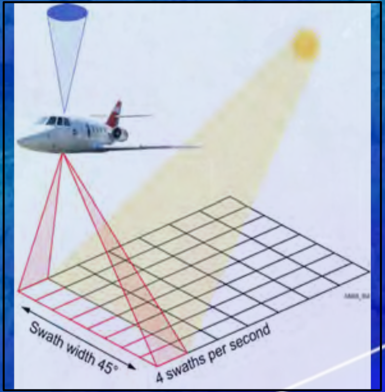
Non Satellite Remote Sensing

John Sullivan (Moderator)
NASA Goddard Space Flight Center

AGES Meeting
28 September 2022

Speaker	Measurement	Mission
Scott Janz	GCAS	STAQS - GV
John Hair	HSRL	STAQS - GV
Rory Barton-Grimley	HALO	STAQS - GIII
Robert Green	AVIRIS-NG	STAQS - GIII
Rainer Volkamer	MAX DOAS	CUPIDS
Joe Taylor	S-HIS	AEROMMA
Luke Valin	PGN	Ground Network
David Giles	AERONET	Ground Network
John Sullivan	TOLNet	Ground Network

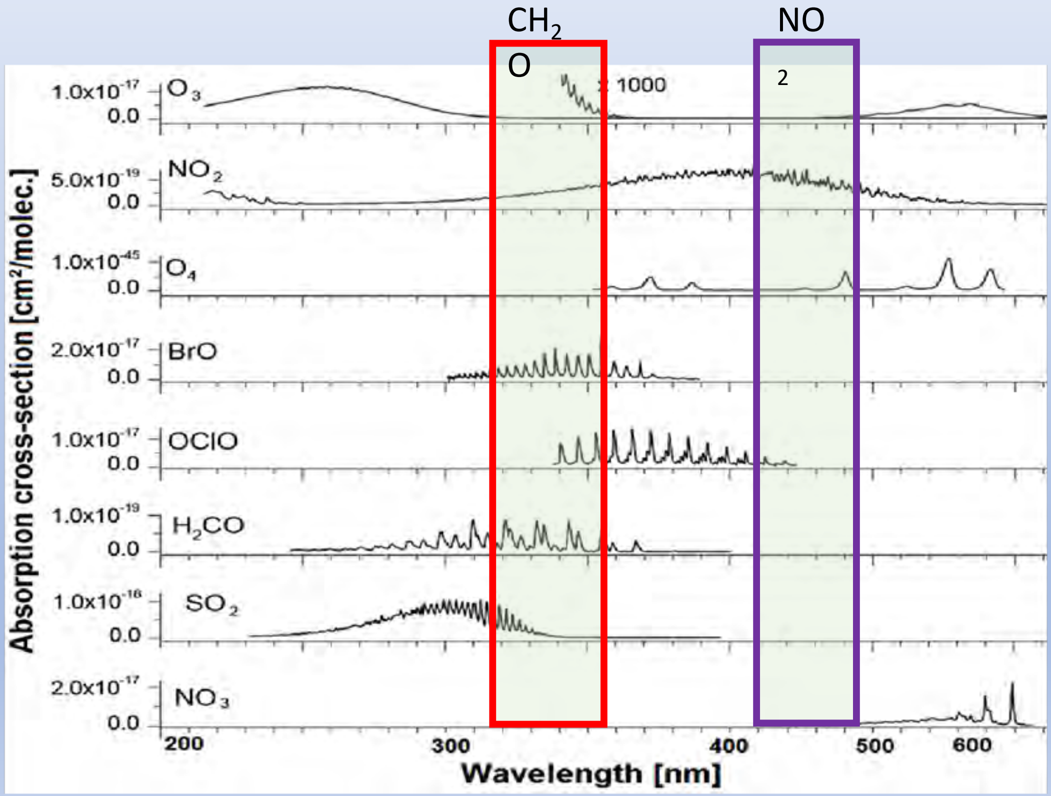
Geo-CAPE Airborne Simulator (GCAS)



Scott Janz (PI), Jayne Boehmler, Sam Xiong – Goddard Space Flight Center

Laura Judd – Langley Research Center *contact scott.janz@nasa.gov*

Measurement Technique



- UV-VIS Spectral fitting to absorption cross-sections is performed after normalization to a reference scene to remove solar absorption features and minimize instrument artifacts
- 2 different spectral windows are used to retrieve slant column absorption
- Reference scene calibration via external measurements

Science Objectives

- Characterize vertical column NO_2 and CH_2O abundance at sufficiently high horizontal resolution to enable satellite sub-pixel sampling.
- Inform and improve radiative transfer modeling of air mass corrections.
- Inform and improve chemical forecasting models using measured diurnal variations in NO_2 and CH_2O abundance.

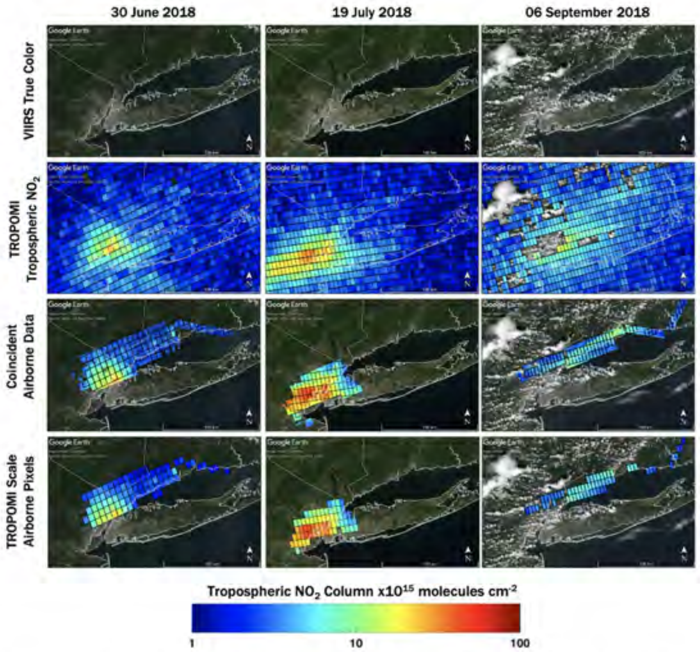
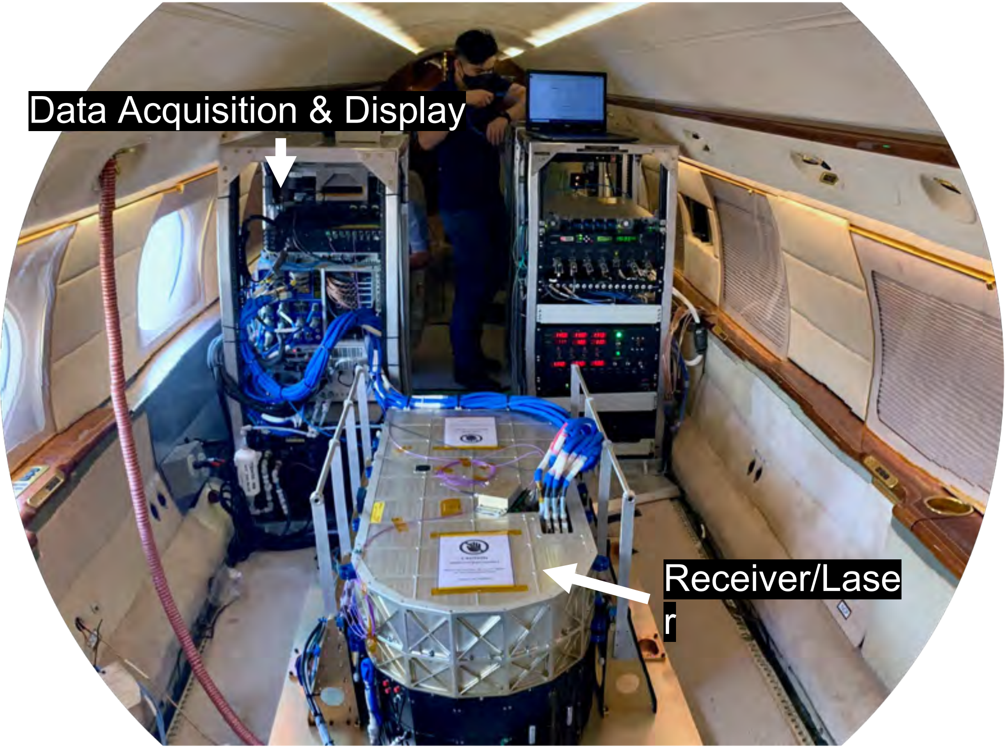


Figure 5. Maps demonstrating how airborne data are matched to TROPOMI for 3 out of 15 example overpasses: (top) VIIRS true color imagery (source: https://worldview.earthdata.nasa.gov/: last access: 18 April 2020), (second row) overlaid TROPOMI TrVCs where CRFs < 50 %, (third row) overlaid airborne data collected within ± 30 min of the TROPOMI overpass with outlined TROPOMI pixels with CRFs < 50 % and area mapped by aircraft > 75 %, and (bottom) airborne NO_2 column data scaled to the TROPOMI pixel. All maps were created in © Google Earth Pro.

HSRL - High Spectral Resolution Lidar (Aerosols/Clouds)
DIAL – Differential Absorption Lidar (Ozone)



- NASA LaRC
- Team members supporting field operations in STAQS
  - Johnathan Hair, Taylor Shingler (co-leads)
  - Rich Ferrare, Chris Hostetler
  - Marta Fenn, David Harper, Anthony Notari
- TRACER-AQ (Sept. 2021) was the most recent science mission with combined ozone and HSRL measurements on the JSC GV

https://www-air.larc.nasa.gov/missions/staqs/index.html, https://science.larc.nasa.gov/lidar/

Multiwavelength measurements from HSRL-2/DIAL

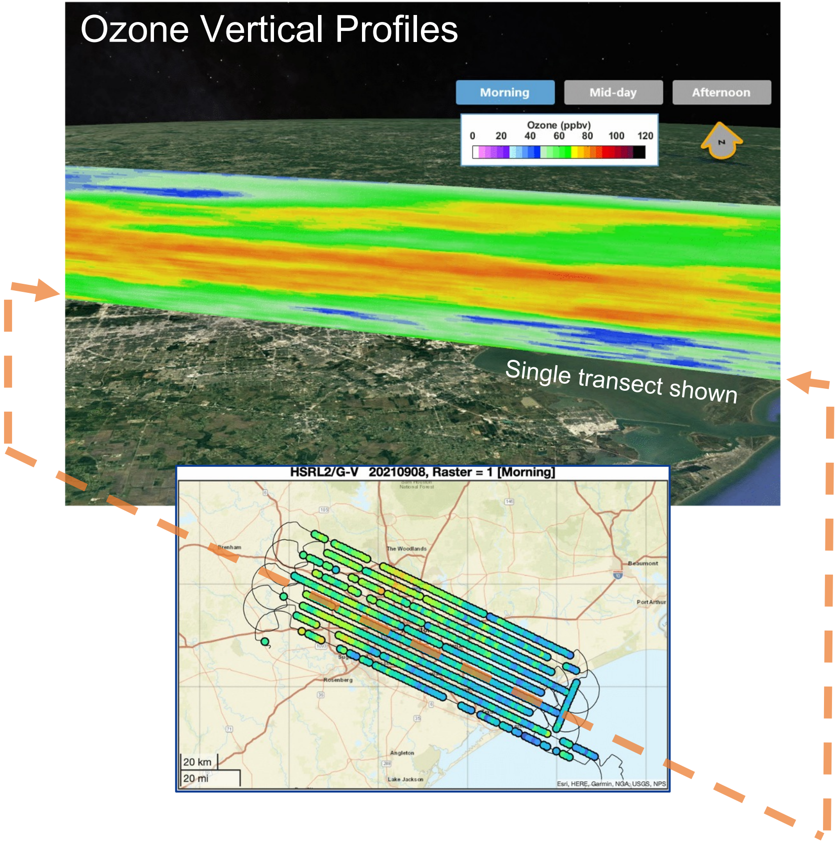
Objectives

- **Interpret the temporal and spatial evolution of ozone and aerosols**
  - *Spatial & temporal* profiles of ozone and aerosols tropospheric profiles
  - High horizontal resolution near surface ozone and aerosol extinction
  - Mixed layer heights, cloud heights
- **Provide datasets for model comparisons**
  - Interpretation of transport (advection), mixing, and photochemistry
- **Evaluate TEMPO**
  - Troposphere and near surface (0-2km)
  - Aerosol Optical Depth

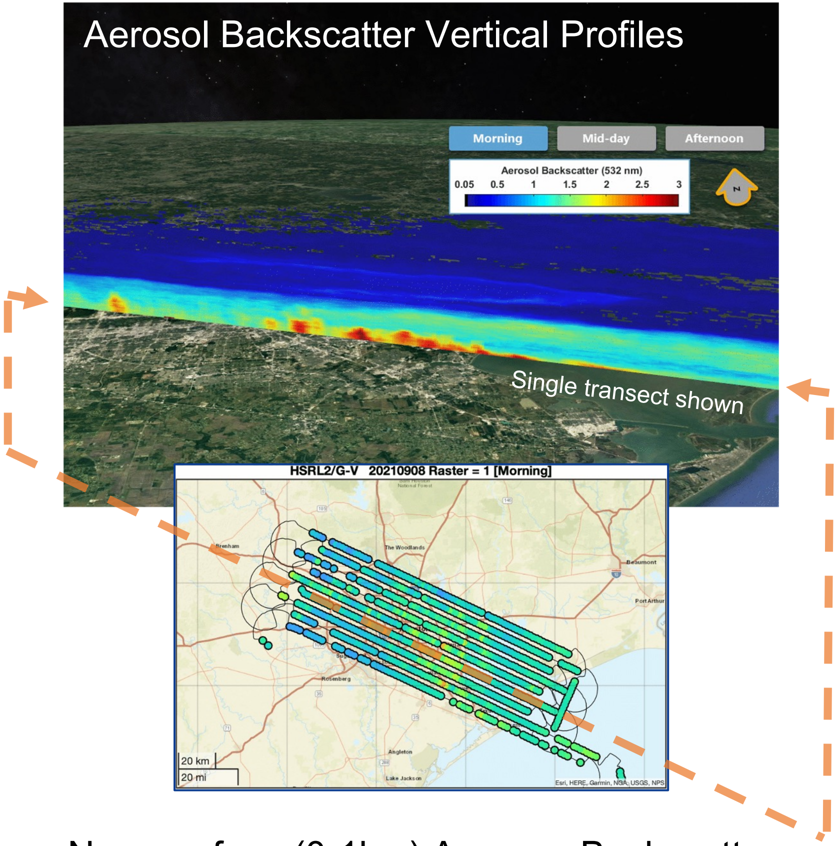
Measurements

- **Ozone**
  - Ozone Profiles (290,300nm)
  - Surface weighted ozone concentrations (2-km near surface products)
- **Aerosols and Clouds**
  - Particulate backscatter profiles (355, 532, 1064 nm)
  - Aerosol extinction profiles (355 and 532 nm)
  - Particle depolarization profiles (355, 532, 1064 nm)
  - Extinction-to-backscatter ratio profiles (355 and 532 nm)
  - Coarse aerosol type/Classification
  - Aerosol Optical Thickness (AOT) (355, 532 nm)
  - Mixed Layer Heights (MLH) (additional analysis/processing)

Vertical Profile Products: Connecting to the Surface Diurnal Variations (RF03 – 20210908)

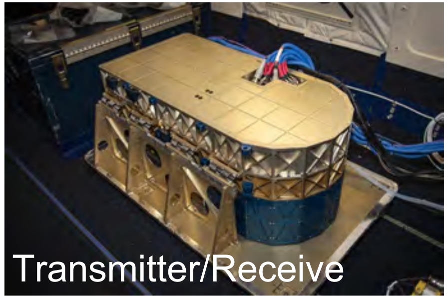


Near-surface (0-1km) Average Ozone



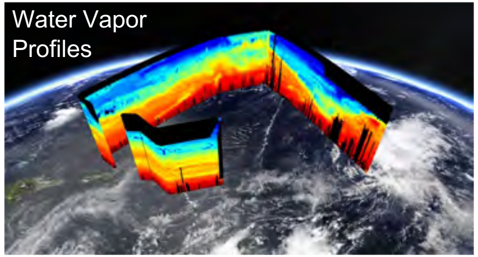
Near-surface (0-1km) Average Backscatter

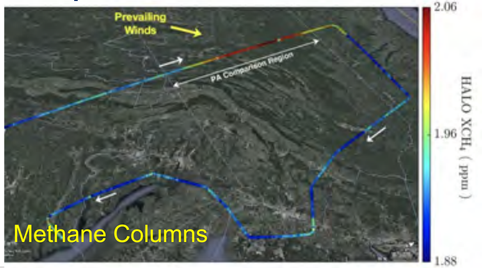
High Altitude Lidar Observatory (HALO) – Combined CH_4 DIAL and High Spectral Resolution Lidar

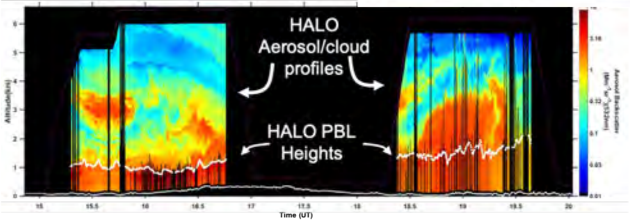


Amin Nehrir: Co-Lead
Rory Barton Grimley: Co-Lead
Team members
James E. Collins, Anthony Notari, David Harper, Rich Ferrare, John Hair, Taylor Shingler

HALO is a reconfigurable lidar: H_2O DIAL/HSRL or CH_4 DIAL/HSRL





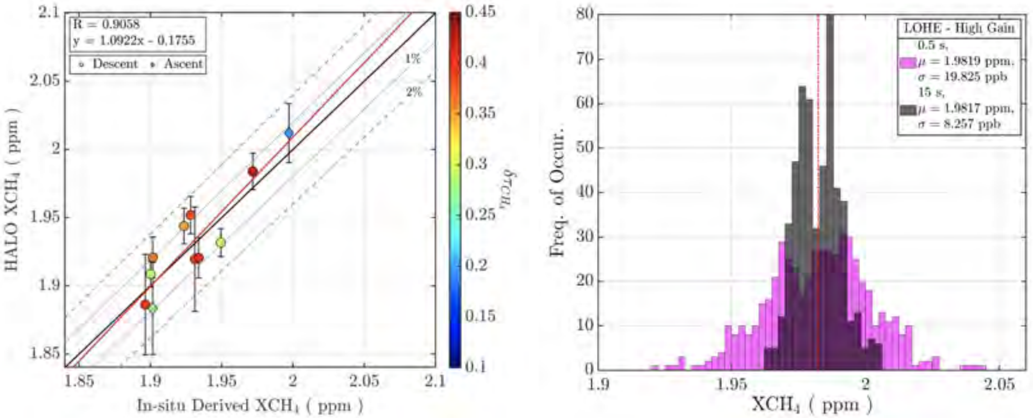


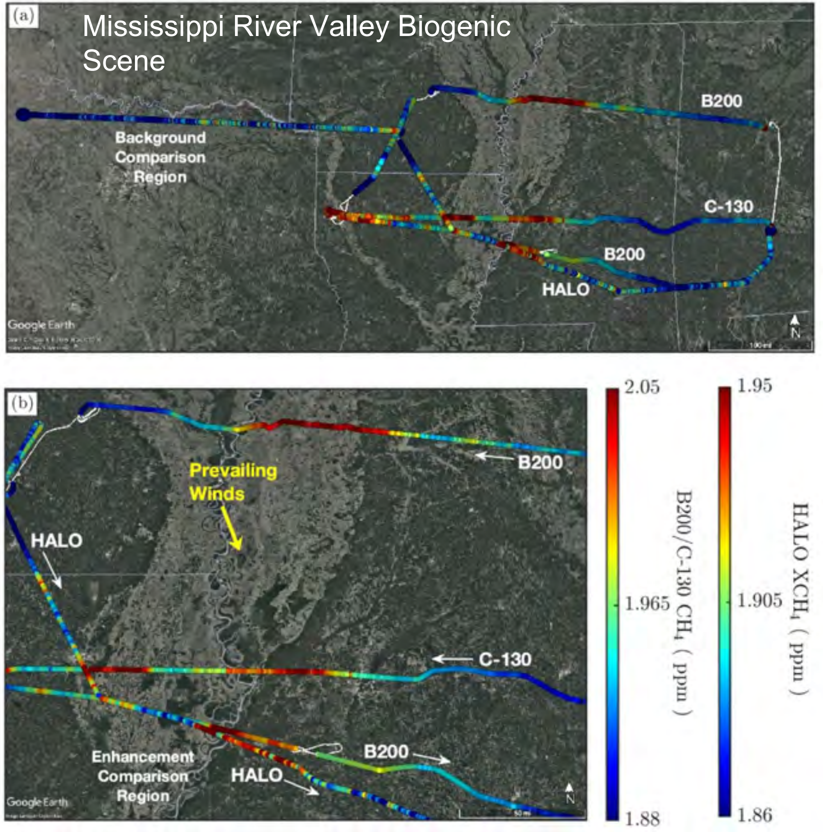
STAQS Geophysical Observables

- **Methane**
  - Surface weighted column mixing ratio (1645 nm)
  - PBL apportioned column mixing ratio (new exploratory measurement during STAQS)
- **Aerosol**
  - Particulate backscatter profiles (532, 1064 nm
  - Aerosol extinction profiles (532 nm)
  - Particle depolarization profiles (532, 1064 nm)
  - Extinction-to-backscatter ratio profiles (532 nm
  - Coarse aerosol type/Classification
  - Aerosol Optical Thickness (AOT) (532 nm)
  - Mixed Layer Heights (MLH)

HALO XCH_4 (Column Methane) Observables and Validation

HALO validation during the 2019 ACT-America Campaign

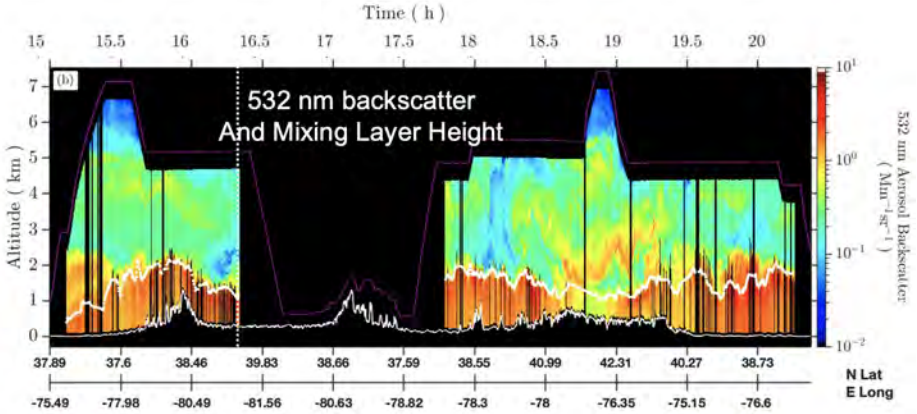


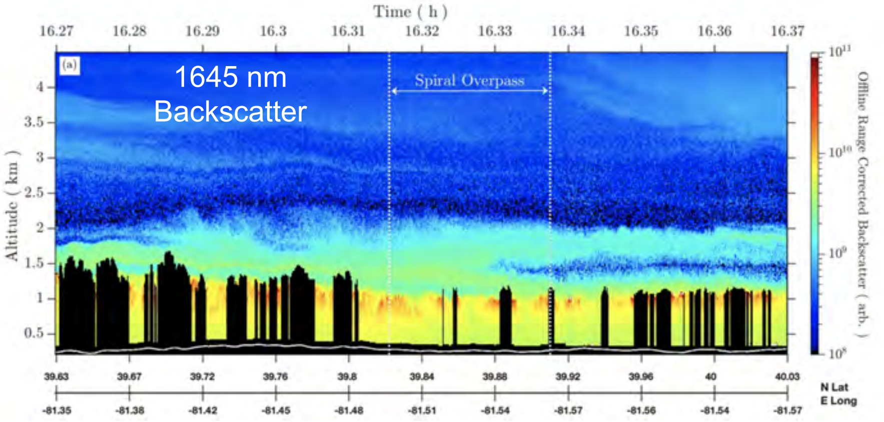


- Mean difference between HALO and in situ-validation is 2.5 ppb
- standard deviation of the differences between halo and validation observations across 11 comparisons is 16.66 ppb
- <1% precision with 1-2 km along track average

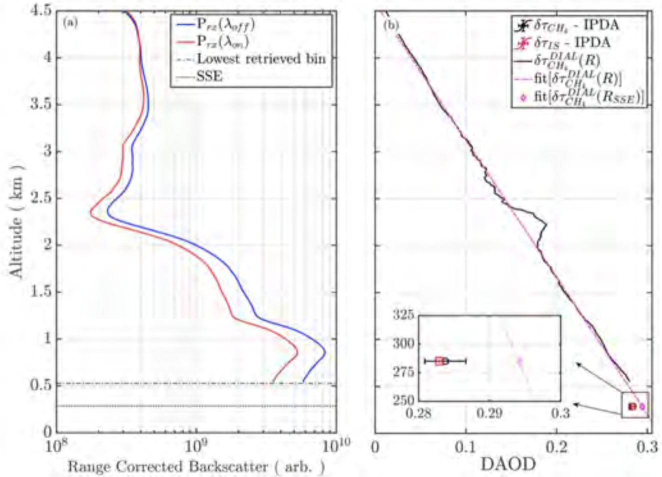
Barton-Grimley et al. 2022, AMT

HALO Profile and PBL Products

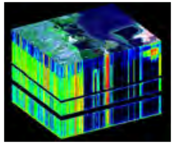




Barton-Grimley et al. 2022, AMT



- HSRL intensive and extensive observables ideal for evaluating impact of aerosols on passive retrievals from space
- Gradients in backscatter used for retrieval of the mixing layer height (proxy for PBL height)
- Atmospheric Backscatter at 1645 nm allows for profile measurement of methane absorption
- New detector for STAQS will improve backscatter at 1645 nm and allow for evaluation of PBL XCH_4 products



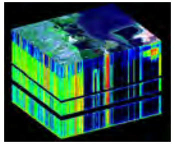
STAQS Overview:
Airborne Visible/Infrared Imaging Spectrometer Next Generation (AVIRIS-NG)
https://avirisng.jpl.nasa.gov

Robert O. Green, Andrew Thorpe, Ian McCubbin, Michael Eastwood and Team

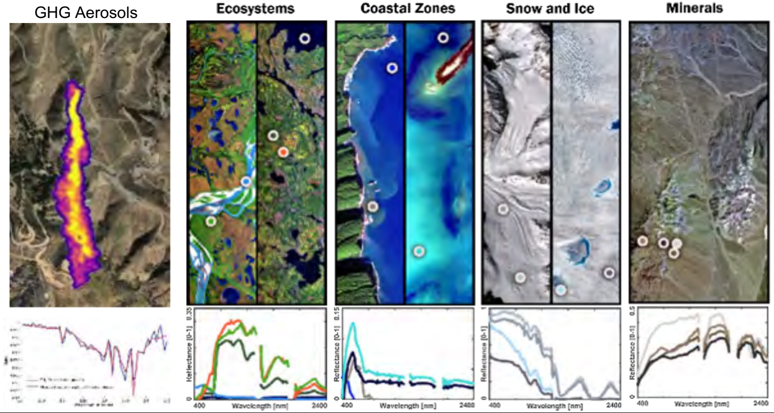
Contacts: Robert.O.Green@jpl.nasa.gov, Andrew.Thorpe@jpl.nasa.gov, Ian.McCubbin@jpl.nasa.gov, Michael.Eastwodd@jpl.nasa.gov

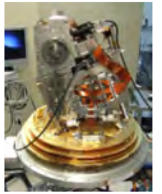
Jet Propulsion Laboratory, California Institute of Technology

Airborne Visible/Infrared Imaging Spectrometer Next Generation(AVIRIS-NG) https://avirisng.jpl.nasa.gov/



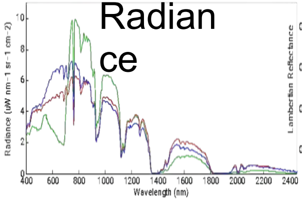
- *Imaging Spectroscopy: Earth System science*
  - *Very high SNR, Calibration, Full VSWIR (380 2500 nm @ 5 nm)*
  - *34 degree Swath 1 to 7 m sampling*
  - *Exceptional measurement quality for science (current state-of-the art)*

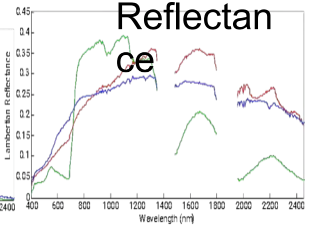




- *AVIRIS-NG is routinely flown on B200 aircraft.*
- *2023 will fly on G-3/5 as well*

- *AVIRIS-NG: US, India, Europe, Greenland, ABoVE, and more*



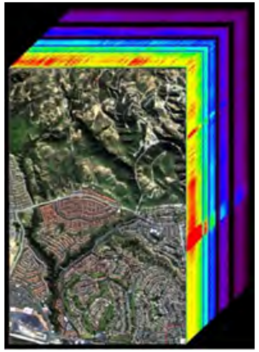


Products available: ecosystem, aquatic, geology, hydrology.

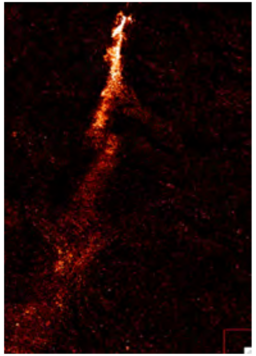
- *POC: Robert. O. Green@jpl.nasa.lgov*

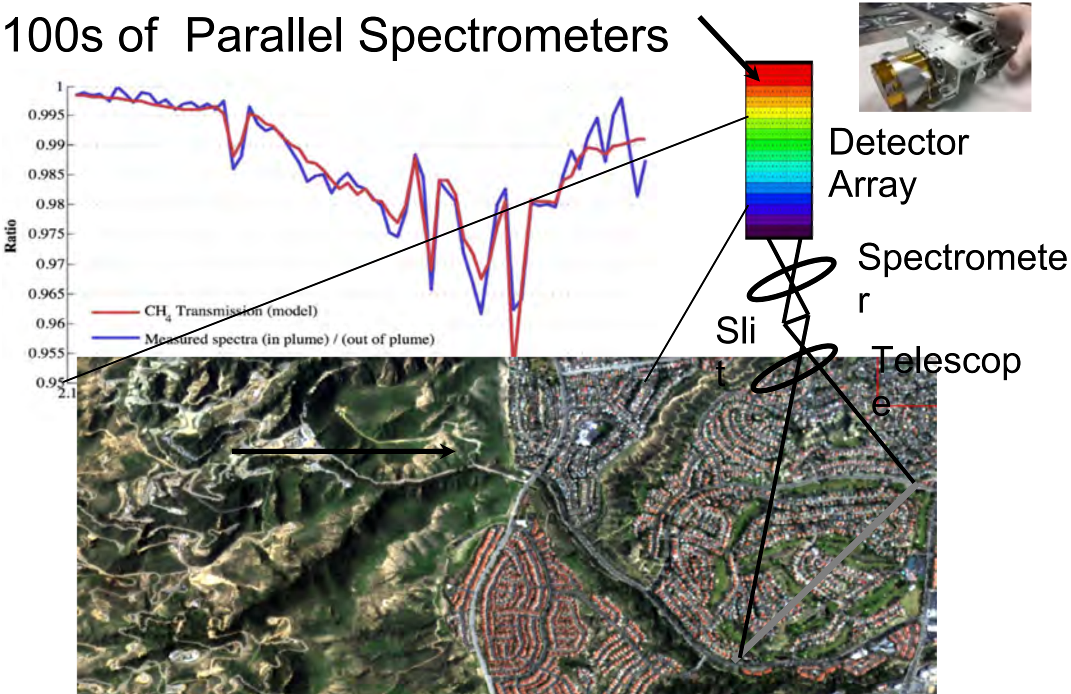
GHG Point Source VSWIR Imaging Spectroscopy History

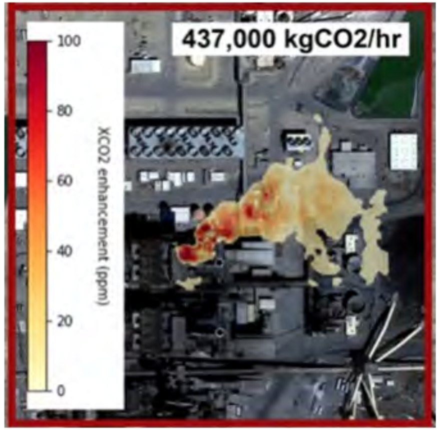
Calibrated Image

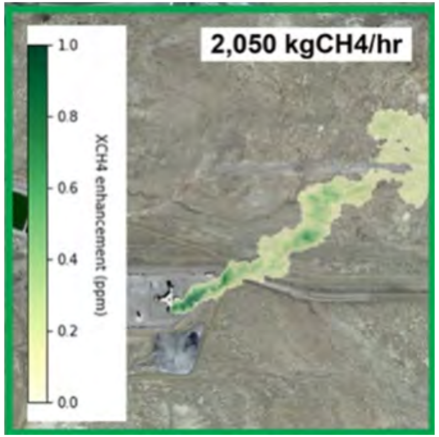


Methane









- Duren, Riley M., Andrew K. Thorpe, Kelsey T. Foster, Talha Rafiq, Francesca M. Hopkins, Vineet Yadav, Brian D. Bue et al. "California's methane super-emitters." ***Nature*** 575, no. 7781 (2019): 180-184.
- Frankenberg, Christian, Andrew K. Thorpe, David R. Thompson, Glynn Hulley, Eric Adam Kort, Nick Vance, Jakob Borchardt et al. "Airborne methane remote measurements reveal heavy-tail flux distribution in Four Corners region." ***Proceedings of the national academy of sciences*** 113, no. 35 (2016): 9734-9739.
- Thompson, D. R., A. K. Thorpe, C. Frankenberg, R. O. Green, R. Duren, Luis Guanter, Andre Hollstein, E. Middleton, L. Ong, and S. Ungar. "Space-based remote imaging spectroscopy of the Aliso Canyon CH4 superemitter." ***Geophysical Research Letters*** 43, no. 12 (2016): 6571-6578. **(many more)**

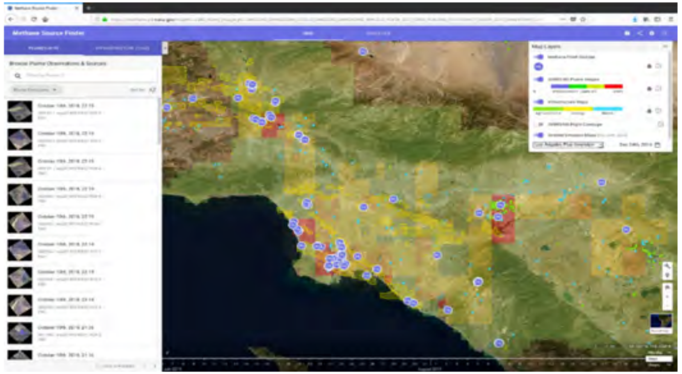
Methane and Carbon Dioxide

AVIRIS-NG CH_4/CO_2 flight campaigns

- Flight planning, management, flight crew, analysis, publication for multiple campaigns:
  - Summer 2019: ABoVE (natural arctic CH4)
  - Fall 2019: Permian Basin (anthropogenic CH_4)

Methane Source Finder

- Public launch of web portal, which aims to increase stakeholder engagement and mitigate emissions



Mitigation examples span multiple emission sectors

California's methane super-emitters — nature

Riley M. Duren, Andrew K. Thorpe, Kelsey T. Foster, Talha Rafiq, Francesca M. Hopkins, Vineet Yadav, Brian D. Bue, David R. Thompson, Stephen Conley, Nadia K. Colombi, Christian Frankenberg, Ian B. McCubbin, Michael L. Eastwood, Matthias Falk, Jorn D. Herner, Bart E. Croes, Robert O. Green & Charles E. Miller

Environmental Research Letters

Methane emissions from underground gas storage in California

Andrew K Thorpe[1,9], Riley M Duren[2,1], Stephen Conley[3], Kuldeep R Prasad[4], Brian D Bue[1], Vineet Yadav[1], Kelsey T Foster[5], Talha Rafiq[6], Francesca M Hopkins[6], Mackenzie L Smith[3], Marc L Fischer[7], David R Thompson[1], Christian Frankenberg[8], Ian B McCubbin[1], Michael L Eastwood[1], Robert O Green[1] and Charles E Miller[1]

Environmental Research Letters

Using remote sensing to detect, validate, and quantify methane emissions from California solid waste operations

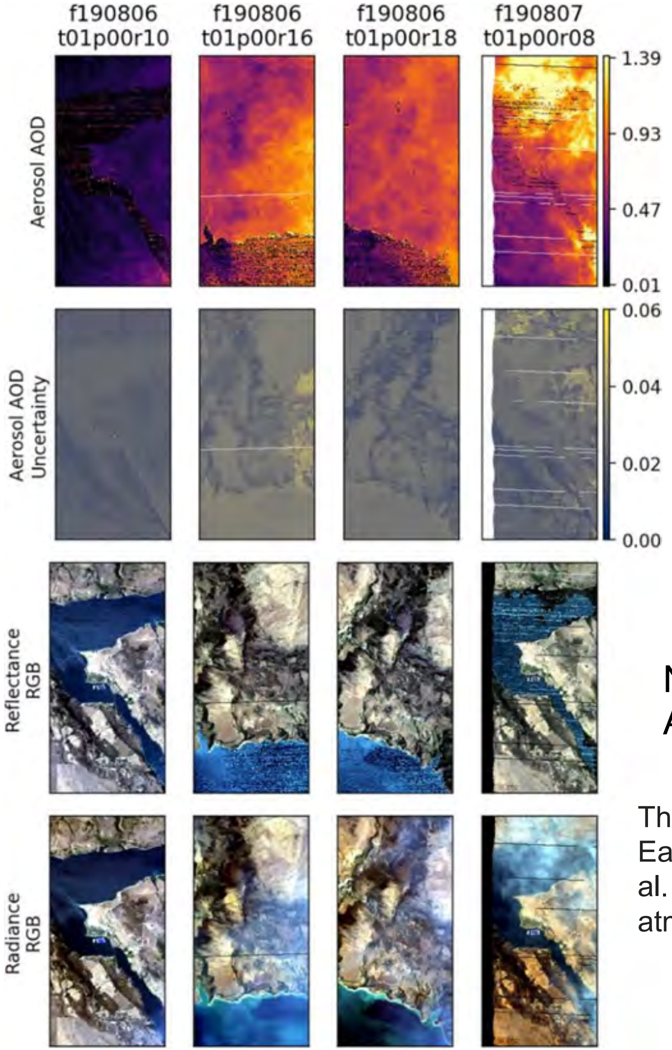
Daniel H Cusworth[1], Riley M Duren[1,2], Andrew K Thorpe[1], Eugene Tseng[3], David Thompson[3], Abhinav Guha[4], Sally Newman[4], Kelsey T Foster[1,5] and Charles E Miller[1]

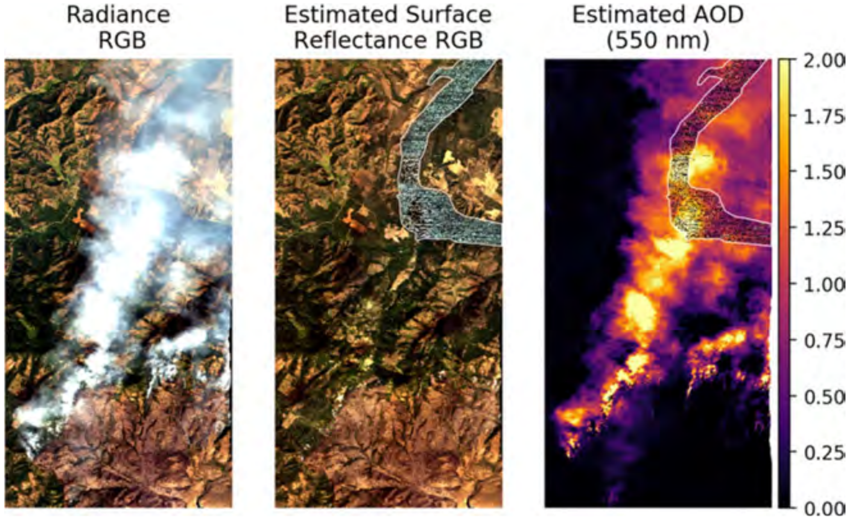
Methane Mapping with Future Satellite Imaging Spectrometers — remote sensing

Alana K. Ayasse [1,*], Philip E. Dennison [2], Markus Foote [4], Andrew K. Thorpe [3], Sarang Joshi [4], Robert O. Green [3], Riley M. Duren [3,5], David R. Thompson [3] and Dar A. Roberts [1]

Aerosols

Retrievals





Brodrick et al., 2022

New work is ongoing showing aerosol retrieval from AVIRIS-NG (Thompson, Broderick, and more.

Thompson, David R., K. N. Babu, Amy J. Braverman, Michael L. Eastwood, Robert O. Green, Jonathan M. Hobbs, Jeffrey B. Jewell et al. "Optimal estimation of spectral surface reflectance in challenging atmospheres." *Remote Sensing of Environment* 232 (2019): 111258.

University of Colorado Boulder

NOAA

CIRES

CUPiDS Coastal Urban Plume Dynamics Study 2023

Assessing NO_x emissions of NYC by mass balance

Rainer Volkamer

and the CUPIDS science team
(Coastal Urban Plume Dynamics Study)





Swlaeha Inamdar CU Boulder / CIRES

Kyle Zarzana CU Boulder / CIRES

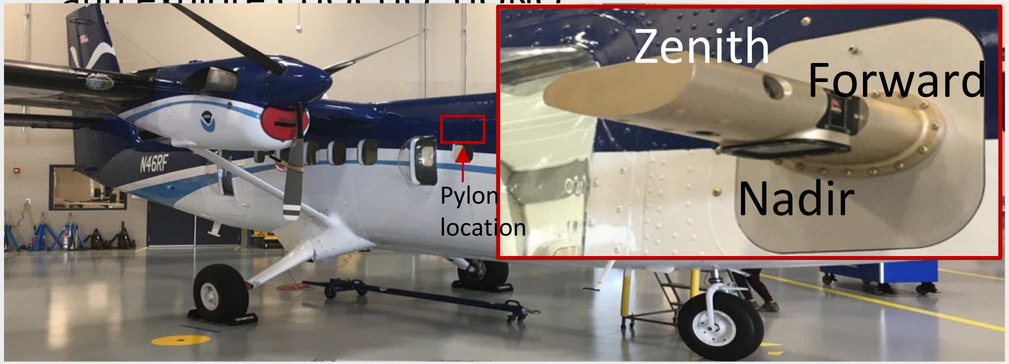
Rainer Volkamer (PI) CU Boulder / CIRES

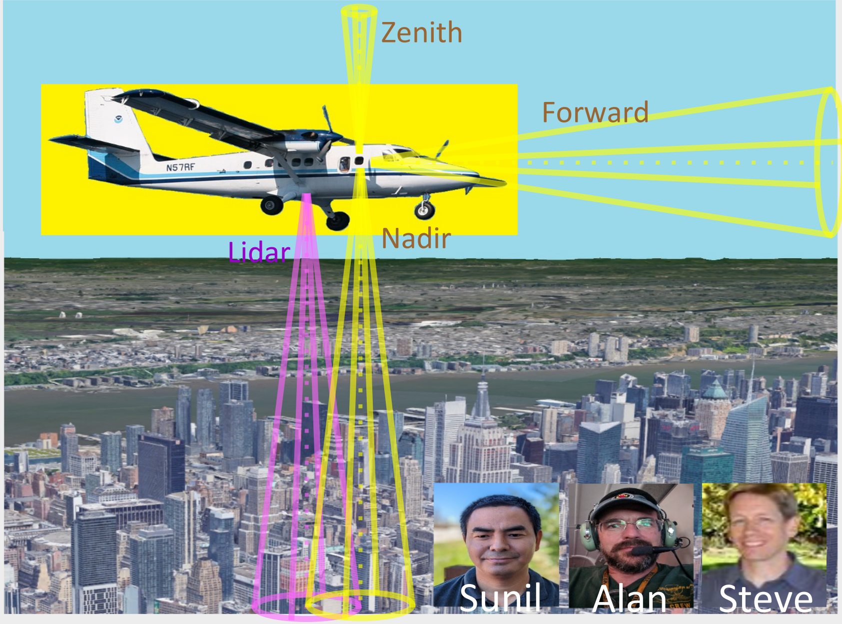
Brian McDonald CIRES / NOAA

Joost de Gouw CU Boulder / CIRES

CU Boulder Airborne Multi-Axis DOAS

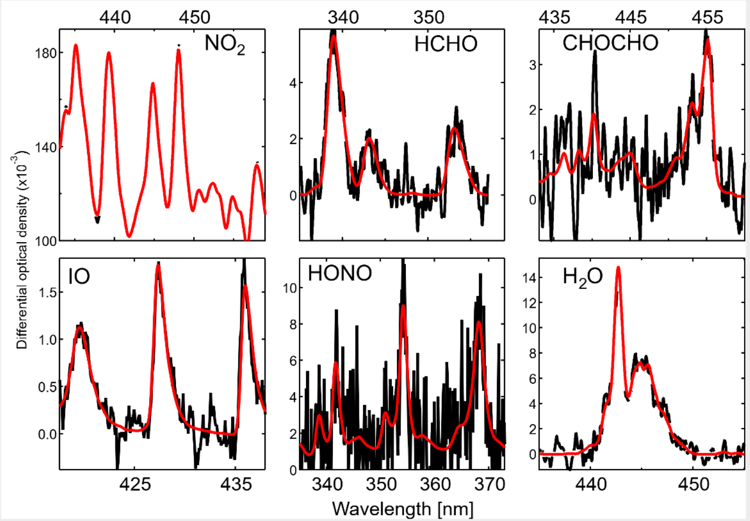
- UV/Vis DOAS instrument to quantify HCHO, NO_2, IO, and explore CHOCHO, HONO
- Forward, zenith, and nadir viewing modes





Deployment with NOAA CSL Doppler wind lidar on the Twin Otter

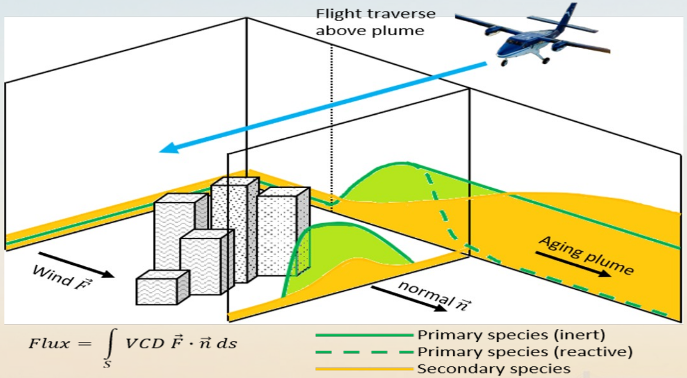
- FOV of 550 m along track x 20 m cross track at 4 km AGL with 2 second resolution
- Surface albedo sensor (UV-vis wavelengths)
- Combine DOAS passive remote sensing with active remote sensing from CSL wind lidar,



Baidar et al. 2013, 2015; Oetjen et al. 2013; Volkamer et al., 2015

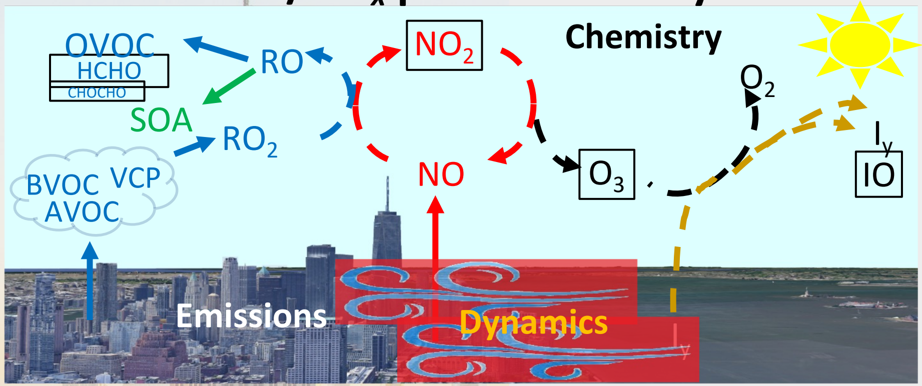
AMAX science goals and foci

NO_x emissions by mass balance



Quantify sources of NO_x and other relevant species by mass balance on the scale of megacities

VOC/NO_x photochemistry



Assess ozone sensitivity to NO_x and VOC; examine the mixing and impact of marine emissions (i.e., iodine) on urban ozone chemistry

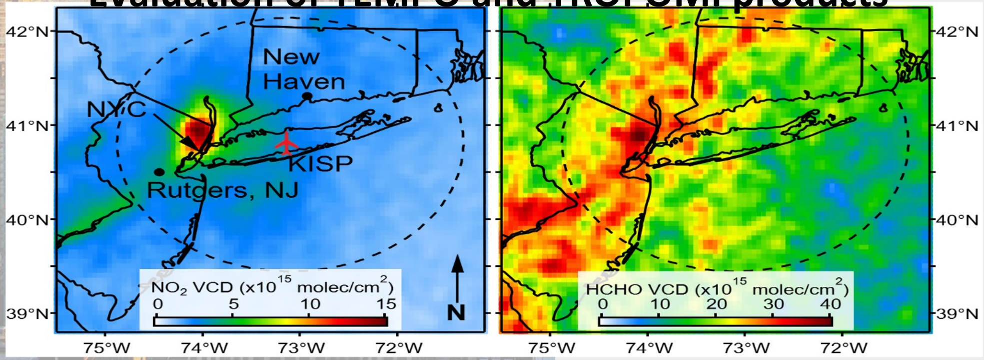
Project title: "Airborne DOAS Remote Sensing of Oxygenated VOCs and NO_2 During CUPiDS"

CUPiDS Coastal Urban Plume Dynamics Study

Dates: 6/24-8/8/2023

Base: McArthur (KISP)

Evaluation of TEMPO and TROPOMI products



Close collaboration with satellite groups to evaluate satellite products, and inform space-based metrics for ozone sensitivity

Scanning High-resolution Interferometer Sounder (S-HIS)

University of Wisconsin-Madison Space Science and Engineering Center (UW-SSEC)

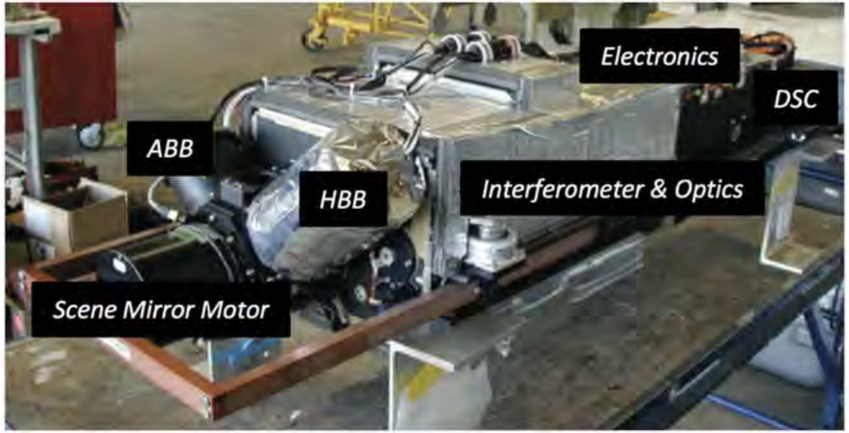
PI: Joe Taylor

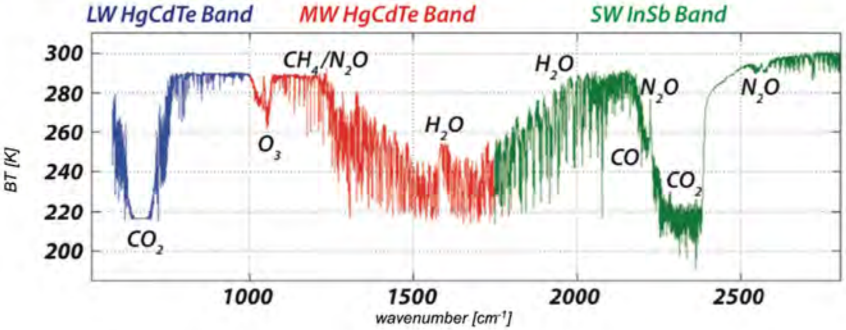
Team members and collaborators:
Hank Revercomb, Fred Best,
Dan DeSlover, Ray Garcia,
Robert Knuteson, Michelle Loveless,
Brad Pierce, William Smith Sr.,
Dave Tobin, Elisabeth Weisz

THE UNIVERSITY of WISCONSIN MADISON

SSEC

Scanning High-resolution Interferometer Sounder (S-HIS)





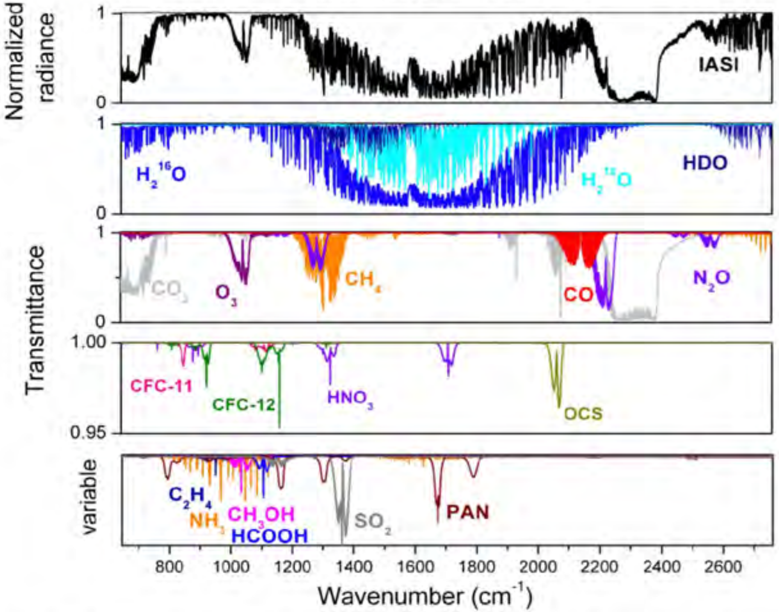
- 35 missions on the ER-2, Global Hawk, WB-57, Proteus, and DC-8 since 1998
- Extremely dependable (typically > 99.9% uptime)
- Operational Products: L1b calibrated radiance and L2 Dual Regression retrievals are available within a few hours after data download
- Near real-time products can be produced within 1 minute of observation time when a high bandwidth downlink is available

Instrument Characteristic	Value
Spectral range	580 – 2850 cm^{-1} 3.5 – 17.3 μm
Spectral resolution	0.5 cm^{-1}
Vertical resolution (T/q Sounding)	2 km
Footprint Size	1 km @ nadir (10 km altitude) (100m / 1km alt)
Swath	20 km (10 km altitude)

Operationally Generated Dual Regression Geophysical Retrievals
Temperature Profiles
Water Vapor Profiles (RH, Mix Ratio)
CO, N_2O, CH_4, SO_2, O_3 Profiles
Total Column CO_2 concentration
Surface temperature and emissivity

Science Goals and Foci

Several VOC spectral signatures are within the S-HIS measurement band

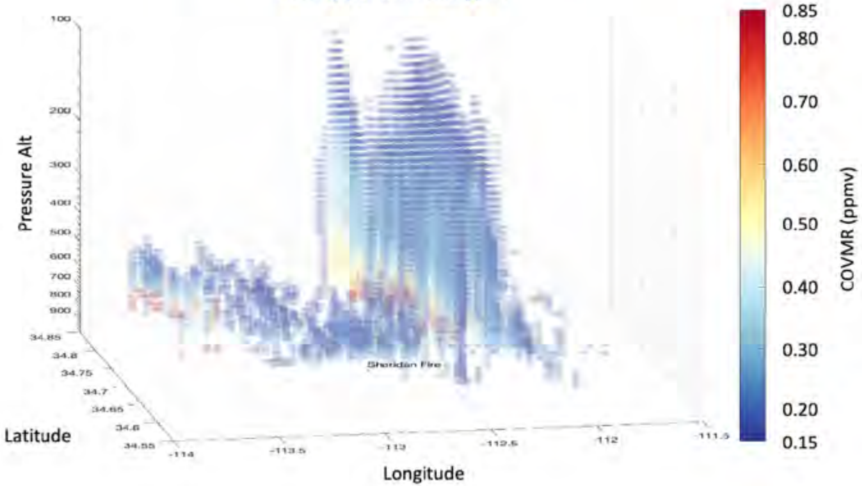


Clerbaux et al: Monitoring of atmospheric composition using the thermal infrared IASI/MetOp sounder, Atmos. Chem. Phys., 9, 6041–6054, https://doi.org/10.5194/acp-9-6041-2009, 2009.

Refine operational DRDA retrievals of CO, N_2O, CH_4, SO_2, O_3 profiles

Techniques and retrieval methodologies developed for the LEO hyperspectral IR sounders (CrIS, IASI ~14km footprints @ nadir) can be adapted for application to S-HIS measurements (1km footprint from 10km altitude @ nadir) to identify, map, and quantify VOC signatures

DRDA Retrieved COVMR (ppmv) plume (preliminary result)
First Flight Leg over Sheridan Fire on 2019-08-21
Plotting COVMR > 0.15 ppmv



Pandonia Global Network: Reference measurements of O_3, NO_2, and HCHO

1) Calibration and Quality Assurance:
   a) Laboratory and Field calibration of instruments
2) Network operation
   a) Remote monitoring and repair of instruments
3) Retrieval
   a) Production of O_3, NO_2 and HCHO Columns/Profiles

MANUFACTURING

- N. Abuhassan
- O. Abuhassan
- M. Costigan
- F. Nelson
- A. Kelly
- J. Edwards
- A. Soliman

INSTRUMENTATION &OPERATION

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- M. Gray
- J. Liao
- J. Robinson
- E. Baumann
- J. Szykman
- D. Williams

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- M. Tiefengraber
- M. Gebetsberger
- L. Haunold
- B. Place
- C. Posch
- A. Kreuter
- B. Wimmer
- C. Waldauf
- S. Morhenn
- I. Bougoudis
- M. Roca
- R. Rajagopalan

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- A. Dehn
- J. von Bismarck
- S. Casadio

SCIENTIFIC ADVISORS

- M. v. Roozendael
- A. Redondas
- E. Spinei Lind

The PGN operates 148+ Pandora instruments

https://www.pandonia-global-network.org/

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ESA/NASA Pandonia Global Network

Owner/Funding Source	Number
University/Other*	39
NASA	27
EPA	23
ESA	21
ECCC	9

*Universities are funded by NASA, ESA, EPA, and DOE. Other includes NIER and KOICA (S. Korea)

61 AldineTX
168 BlacksburgVA*
206 BuffaloNY
125 Cordoba
174 FairbanksAK
105 Helsinki
183 LondonderryNH
69 NewBrunswickNJ
115 Rome-ISAC
126 ShipSonne2
137 Hefei*
191 Yongin

65 Altzomoni*
155 BostonMA
20 Busan
36 Dakar
29 Fajardo*
25 HoustonTX
153 LynnMA
64 NewHavenCT
117 Rome-SAP
109 StGeorge
216 Ulaanbaatar

189 Anmyeon
57 BoulderCO
118 Cabauw
217 Dalanzadgad
102 Fang
66 HuntsvilleAL
186 MadisonCT
152 NyAlesund
147 SWDetroitMI
123 StonyPlain
150 Ulsan

119 Athens-NOA
204 BoulderCO-NCAR
76 CambridgeMA*
120 Davos
35 ForestParkMO
201 Incheon-ESC
178 ManhattanKS
51 OldFieldNY
154 SaltLakeCityUT
182 Tel-Aviv
159 Wakkerstroom

158 AtlantaGA*
21 Bremen
184 CapeElizabethME
39 DearbornMI
122 FortMcKay
110 Innsbruck
135 ManhattanNY-CCNY
166 PhiladelphiaPA
181 SanJoseCA
194 Tokyo-TMU
140 WashingtonDC

214 Bangkok*
134 BristolPA
70 ChapelHillNC
103 Downsview*
23 FourCornersNM
106 Innsbruck-FKS*
56 MaunaLoaHI
187 PittsburghPA
50 SaoTome*
145 Toronto-Scarborough
177 WestportCT

38 BayonneNJ
112 Broadmeadows
31 CharlesCityVA
185 EastProvidenceRI
199 Fukuoka
30 Juelich
142 MexicoCity-UNAM
53 Potchefstroom*
195 Sapporo*
108 Toronto-West
208 Windsor-West

172 Beijing*
180 BronxNY
67 Cologne
74 EdwardsCA
32 GreenbeltMD*
167 KenoshaWI
157 MexicoCity-Vallejo
55 QueensNY
164 Seosan
193 Tsukuba
68 WrightwoodCA

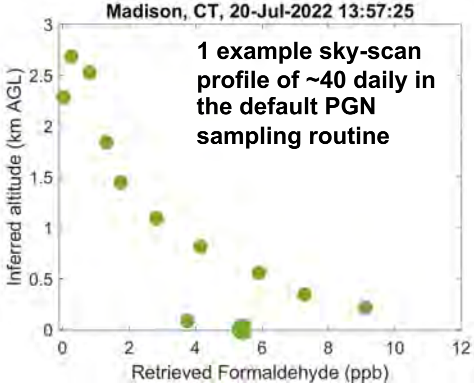
171 Beijing-RADI
162 Brussels-Uccle
223 ColumbiaMD*
169 Egbert
37 HamptonVA
198 Kobe
34 MountainViewCA
52 RichmondCA
54 Seoul
176 Tsukuba-NIES
161 Xianghe

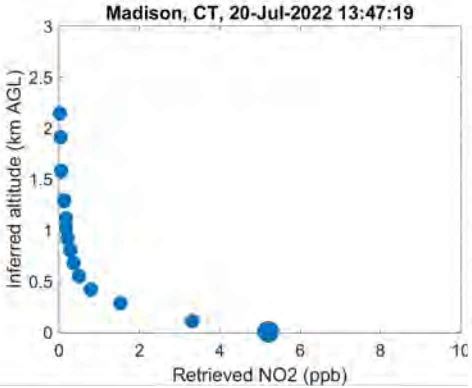
132 Berlin
111 Bucharest
124 ComodoroRivadavia
144 Eureka-PEARL
156 HamptonVA-HU
11 LaPorteTX*
197 Nagoya
138 Rome-IIA
149 Seoul-SNU
163 Tsukuba-NIES-West
146 Yokosuka

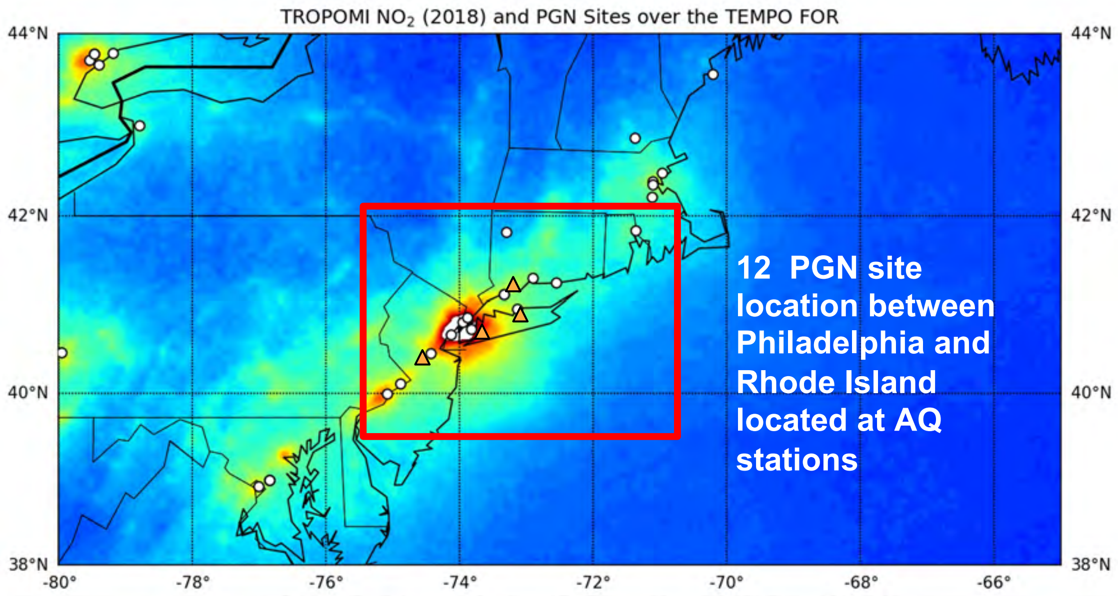
* more than one instrument

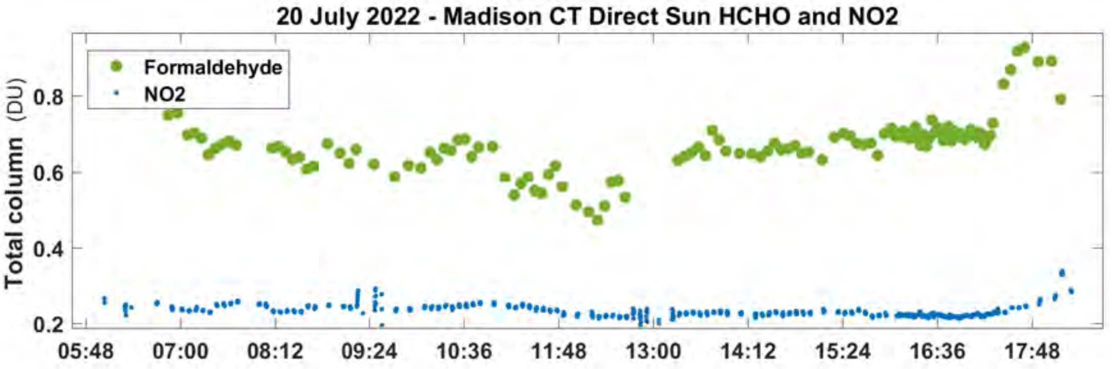
PGN in 2023 Studies

- Validation data for GCAS, TEMPO, TROPOMI SO2, HCHO, O3, NO2 data products
- Support model evaluation
- Use flight profiles and surface in situ monitoring to assess the PGN vertical profile products
- Tie study results to long-term records (several dating to 2018)





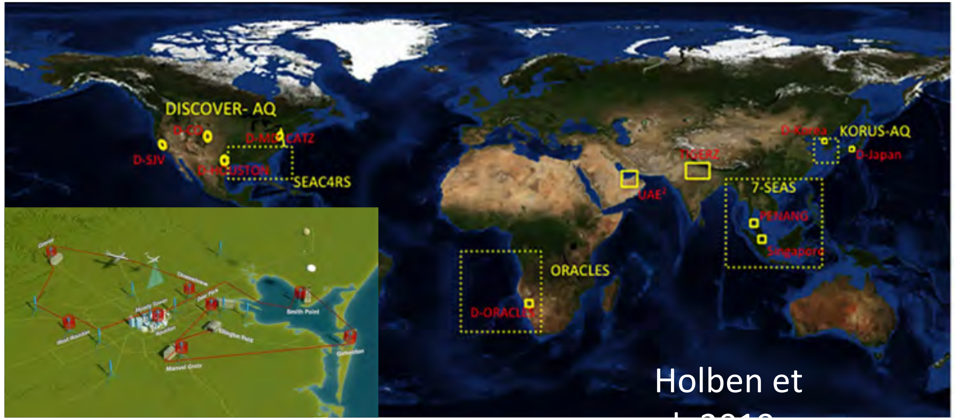




AERONET DRAGONs in the Context of AGES

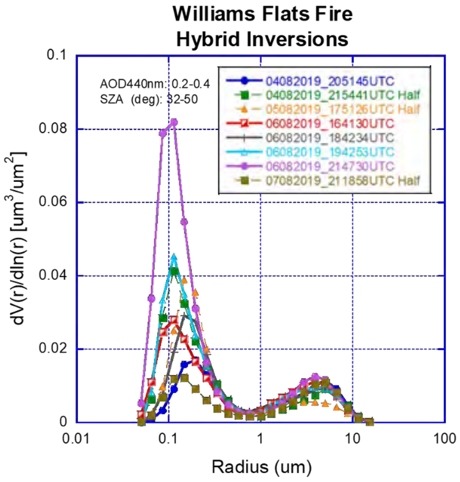
Cimel Sun/Sky/Moon Radiometer

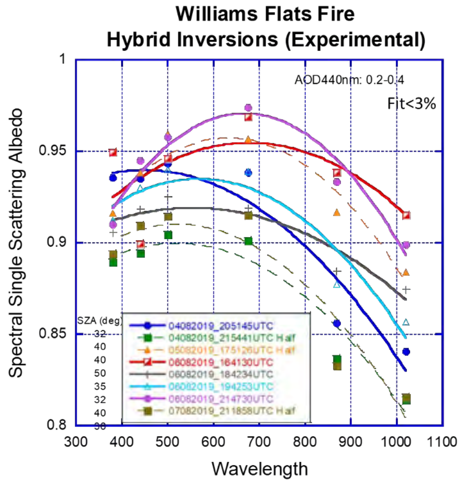
- 9 wavelengths UV, VIS, NIR
- Aerosol Optical Depth
- Water Vapor
- Size Distribution, SSA, Refractive Index
- Nighttime AOD
- Stationary or Mobile
- Minimal infrastructure requirements



AERONET DRAGONs

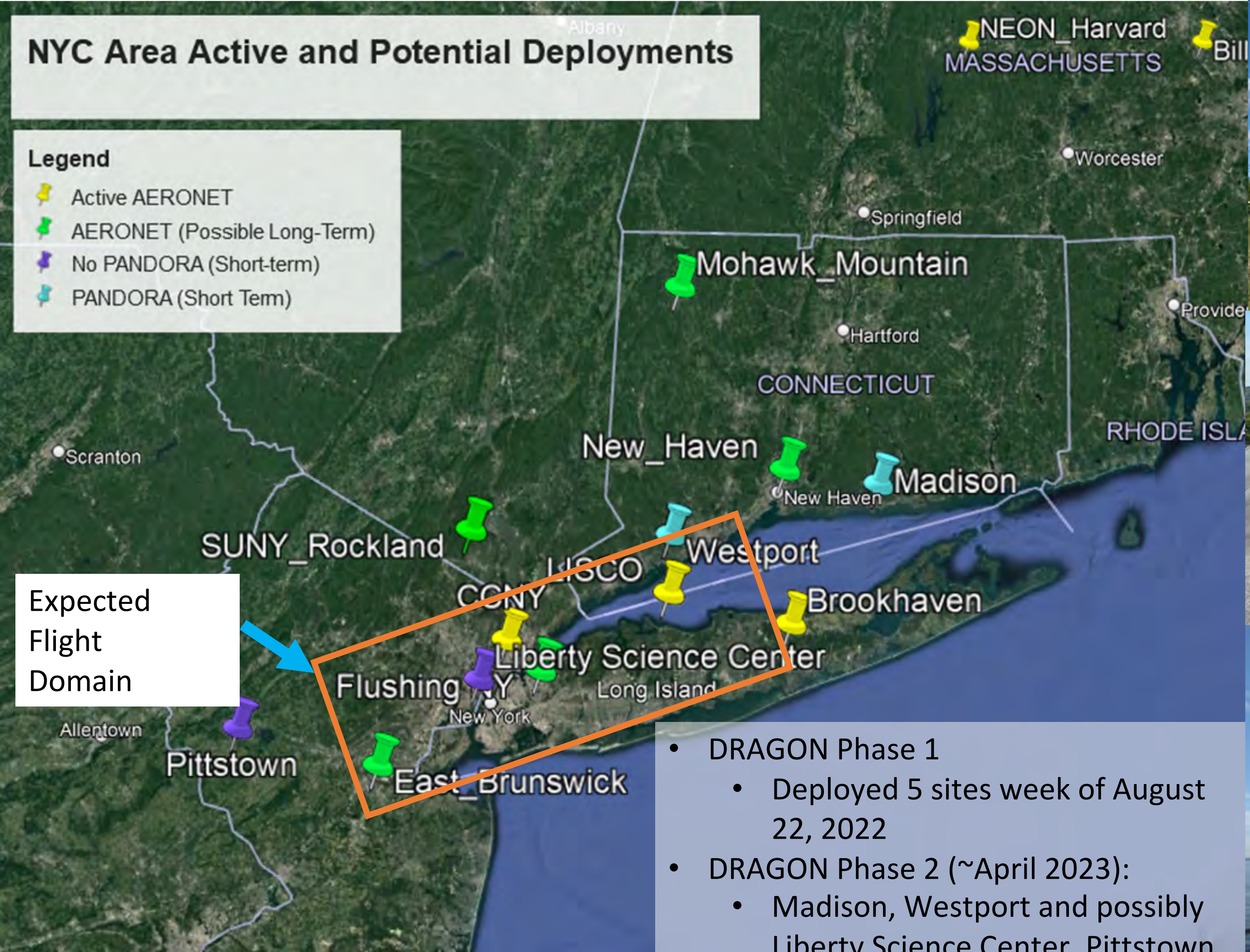
- Establish a mesoscale network of Sun/sky/Moon photometers encompassing various landscapes
- Optimize siting in conjunction with aircraft performing in situ measurements
- Optimize network for satellite retrieval validation
- Supplement regional sites to capture variability in aerosol
abundance and characteristics





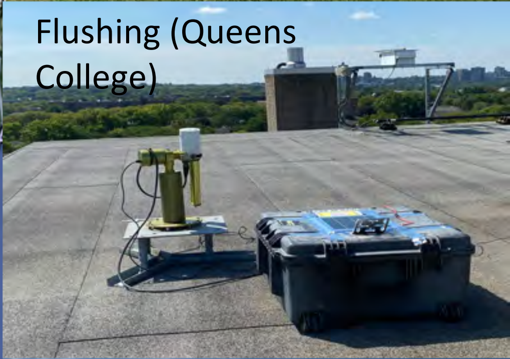
Giles et al. 2019; Warneke 2022, in

NYC Area Active and Potential Deployments



- DRAGON Phase 1
  - Deployed 5 sites week of August 22, 2022
- DRAGON Phase 2 (~April 2023):
  - Madison, Westport and possibly Liberty Science Center, Pittstown


East Brunswick


Flushing (Queens College)


LISCO (Long Island Sound)

LA Area Active and Potential Deployments

- 5 Active AERONET sites in LA vicinity
- Potentially ~5 DRAGON instruments could be deployed depending on resources

TOLNet Network Overview

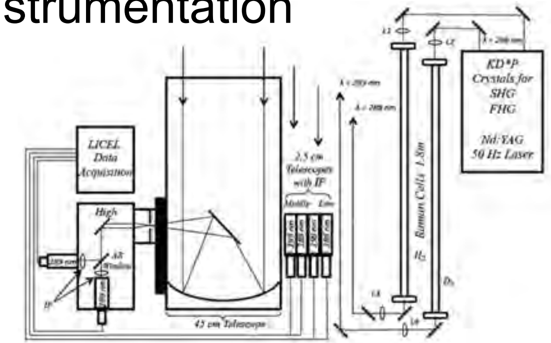
John Sullivan, TOLNet Project Scientist
Mike Newchurch, TOLNet Chief Scientist

Network Goals

1. Provide high spatio-temporal observations of planetary boundary layer (PBL) and free tropospheric ozone
2. Foster use of these high-resolution ozone observations to improve and evaluate air-quality forecast and chemical transport models used by the scientific and the regulatory community.
3. Study the atmospheric structure that current and future satellites observe and assess the fidelity with which a geostationary instrument, such as TEMPO, can measure that structure.

Network Instrumentation

Each TOLNet site consists of a unique UV lidar system. This includes a UV laser transmitter, receiver (telescope) and data collection system. Lidars are installed in portable containers for field efforts or stationary for long term observations.



Network History and Evolution

TOLNet was established in 2012 to provide high spatio-temporal observations of tropospheric ozone to **(1)** better understand physical processes driving the ozone budget in various meteorological and environmental conditions, and **(2)** validate the tropospheric ozone measurements of spaceborne missions. By FY23, TOLNet expects to have 8 operational lidar systems, a modeling center, and data center.

Project Scientist: John Sullivan, NASA GSFC

Network Map

Data: https://www-air.larc.nasa.gov/missions/TOLNet/

Site	Institution
TROPOZ	NASA/GSFC
LMOL	NASA/LaRC
RO3QET	UAH
TOPAZ	NOAA/CSL
TMTOL	JPL/TMF
AMOLITE	ECCC
HU-Lidar	Hampton U.
CCNY-Lidar	CCNY
Modeling	NASA/ARC
Data Center	NASA/LaR

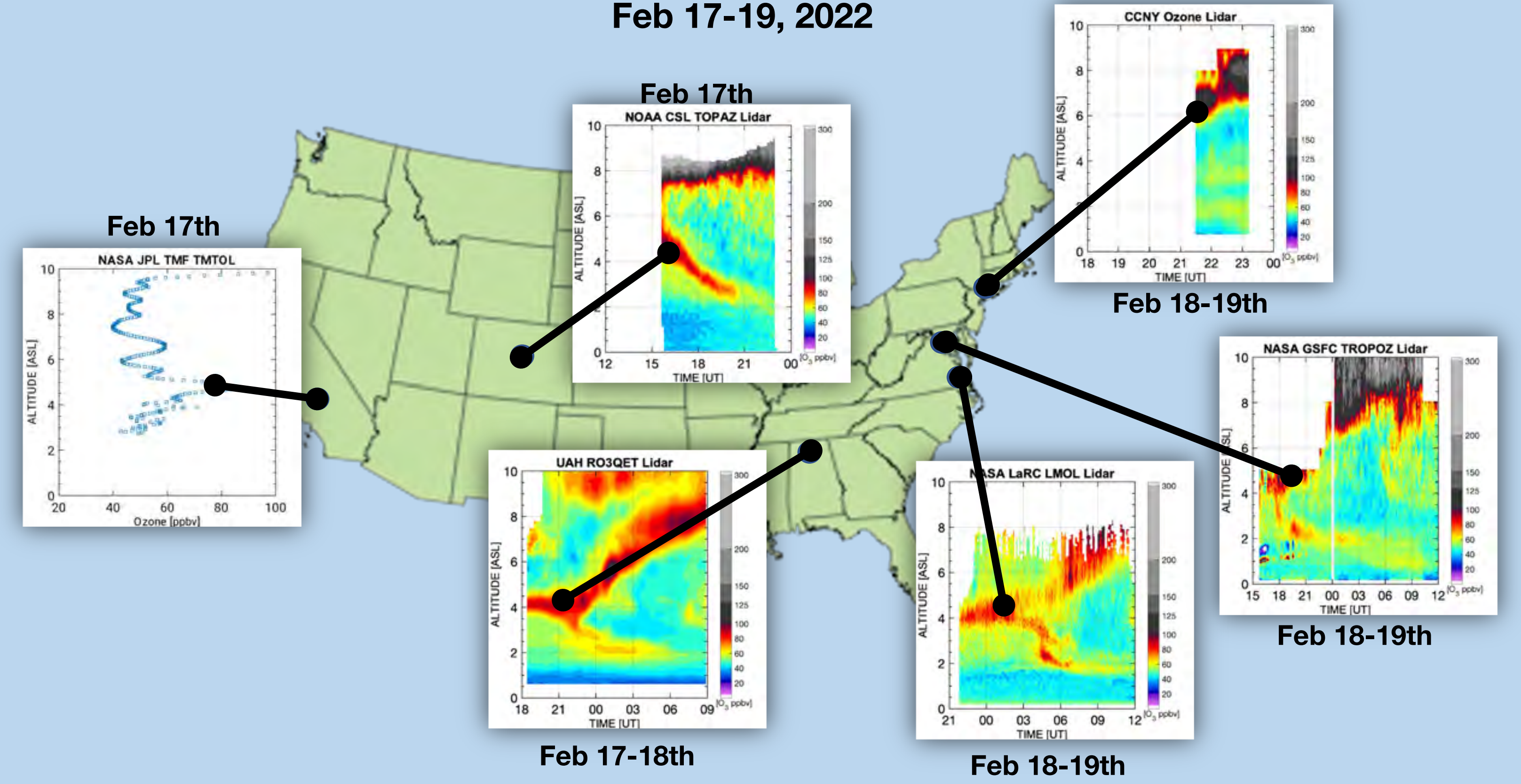
Annual TOLNet Science Team Meeting

2022- Virtual

NASA, NOAA, ECCC, EPA and external collaborators

Network Wide Observations of Stratospheric Intrusions Across the U.S.

Feb 17-19, 2022




UAH RO3QET
Sheboygan
Milwaukee
Muskegon
Grand Rapid
Holland
Kenosha
Kalamazo
Schaumburg
Chicago
Naperville
Joliet
Michigan City
South Bend
Elkhart

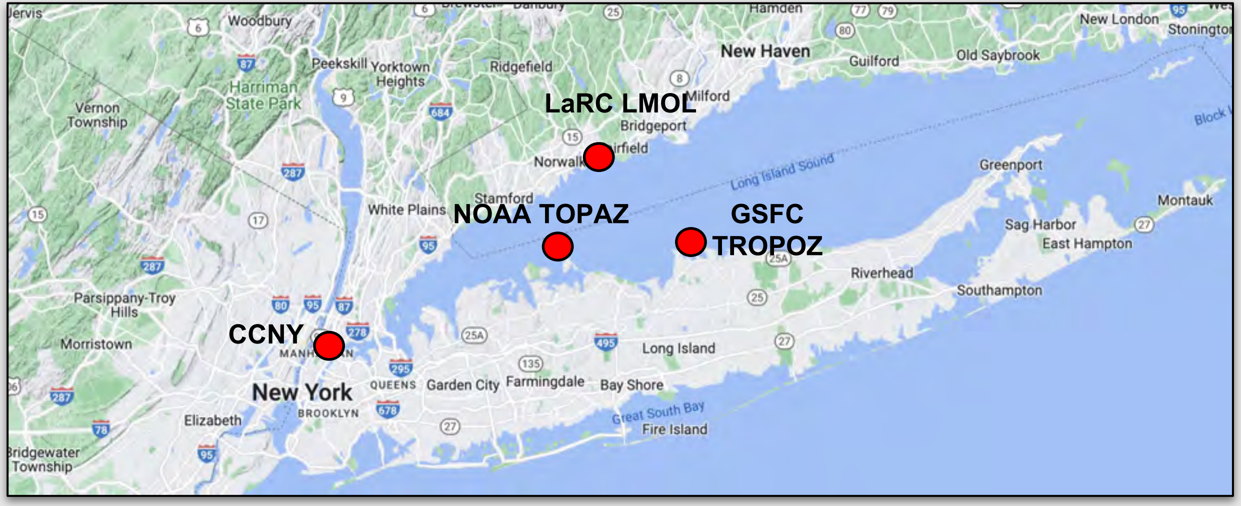
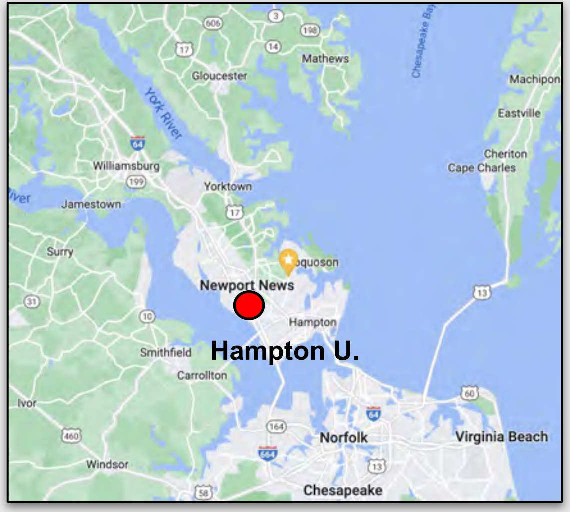

LaRC LMOL
NOAA TOPAZ
GSFC
TROPOZ
CCNY
Woodbury
Peekskill
Yorktown
Heights
Harriman
State Park
Ridgefield
New Haven
Guilford
Old Saybrook
New London
Stoningto
Milford
Bridgeport
Norwalk
Vernon
Township
Stamford
White Plains
Long Island Sound
Greenport
Montauk
Sag Harbor
East Hampton
Riverhead
Southampton
Parsippany-Troy
Hills
Morristown
New York
QUEENS
BROOKLYN
Garden City
Farmingdale
Bay Shore
Long Island
Elizabeth
Great South Bay
Fire Island
Bridgewater
Township


Table Mt.
Lancaster
Palmdale
Victorville
Hesperia
Angeles
National Forest
Ventura
Oxnard
Burbank
Pasadena
Los Angeles
San Bernardino
Santa Monica
Riverside
Anaheim
Long Beach
Irvine
Catalina Island


ECCC AMOLITE
Orillia
Kawartha
Lakes
Peterborough
Belleville
Brampton
Toronto
Mississauga
Kitchener
Hamilton
Lake Ontario
Rochester
Niagara Falls
Buffalo
Erie


Hampton U.
Gloucester
Mathews
Machipon
Eastville
York River
Williamsburg
Yorktown
Jamestown
Cheriton
Cape Charles
Surry
Newport News
Hampton
Smithfield
Carrollton
Norfolk
Virginia Beach
Windsor
Chesapeake

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2
3

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

Yonghua Wu [1, 2], Amin Nehrir [3], Guillaume Gronoff [3, 4], Jianping Huang [5], James Collins[3, 4], Timothy A. Berkoff [3], Liqiao Lei[3, 4], Dingdong Li [1], Margarita Kulko [1, 2], Mark Arend [1, 2], Barry Gross[1, 2], Fred Moshary [1, 2]

[1] CCNY, [2] NOAA–CSCESSRST, [3] NASA Langley Research Center, [4] SSAI, [5] NOAA/NCEP/ EMC

Background:

- High ozone (O_3) episodes occur in New York City downwind coastal area (Long Island Sound) due to urban emissions and pollutants transport, mixing-layer-height (MLH) dynamics, land-sea breeze and chemistry, etc.

Analysis:

- Characterize and compare temporal-spatial variation of MLH and O_3 in NYC urban and coastal area using CCNY-lidar, NASA airborne HALO, NASA LaRC ozone lidar, ground O_3, NO_2 and meteorological measurements.

Findings:

Consistently higher O_3 concentrations (max. 100-120 ppb) but lower MLH in the Coastal area of CT and Long Island than those in NYC urban area on Aug.28-29, 2018; Time-lag for the MLH morning transition in the coastal and marine area relevant to the urban-land and coast-water surface contrast (T, sensible heat).

Significance:

- NASA TOLNet is critical because the observations provide insights into understanding high ozone in the coastal area of LIS and CT.