



Pandonia Global Network (PGN) Status & Plans

Presentation to AC-VC-14 & GEO-CAPE Joint Meeting

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NOAA NCWCP, College Park, MD, May 2-4, 2018

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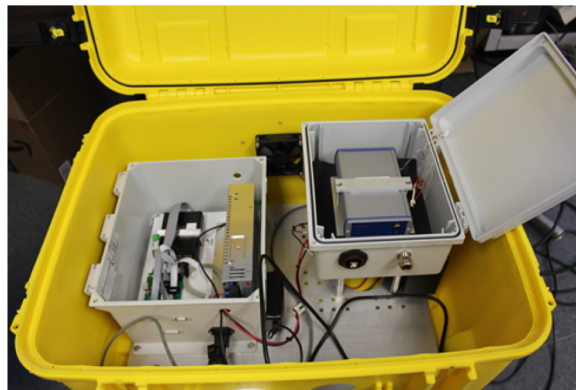
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What is the Pandora Spectrometer System?

- Small, ground-based Sun/Sky/Lunar observing spectrometer system initiated in 2006 at NASA Goddard Space Flight Center
 - (Pandora 1S - 270 – 530 nm, 0.6 nm; 2S – 400 – 900 nm, 1 nm)
- NRT Standard Products at high frequency (~ 2 mins)
 - Tot. Column O₃ (+/-15 DU, ~5%); Tot. Column NO₂ (+/-0.05 DU, ~10%)
- Additional non-validated products
 - HCHO - Total column, trop. & near sfc; NO₂, O₃ – trop. & near sfc
- Operates autonomously off of line power and wifi; software runs on a small PC found inside the weather resistant container.



Boulder, CO



Pandora Field Box



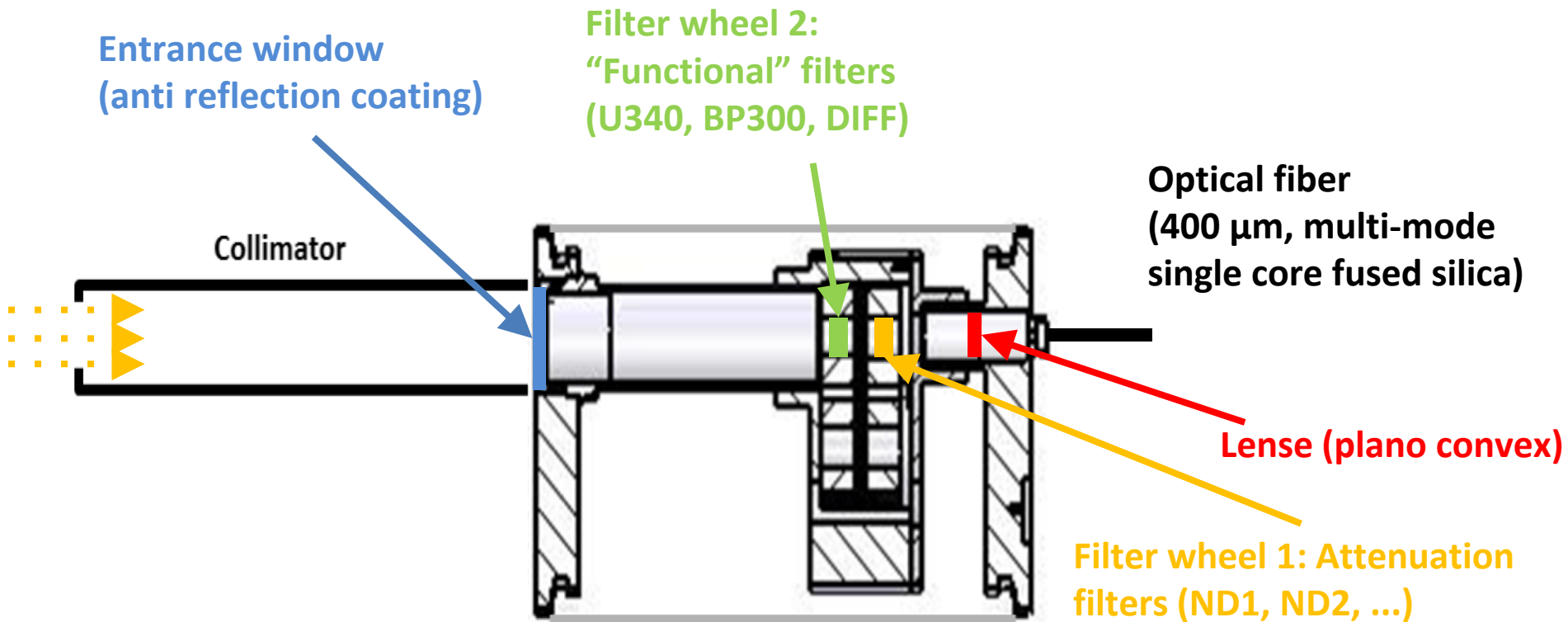
Spectrometer



Sensor Head

Instrument Specifications*

- Elevation (zenith) Range: 0° to 270°
- Azimuth Range: 360°
- Set Temperature Range: -20°-40°C; calibrated at 15° and 20°C
- Field of View: 1.5°
- Spectral Range: 270 - 530nm
- Spectral Resolution: 0.6nm
- Power: 120/220VAC
- Internet connectivity (Wifi/Wired)



*Configuration of a standard Pandora 1S



What is the Pandonia Global Network (PGN)?

- Ground-based network - a joint NASA/ESA collaborative effort modeled in the spirit of other networks (e.g. AERONET)
- From 2017 onwards, focus primarily on operationalization
- Objective: expand and coordinate a global network of standardized, calibrated instruments and systematically process and disseminate the data to the greater global community in support of in-situ and remotely sensed air quality monitoring

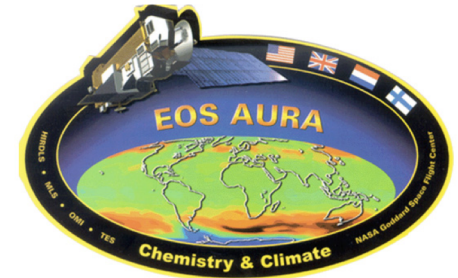


LUFTBLICK
EARTH OBSERVATION TECHNOLOGIES



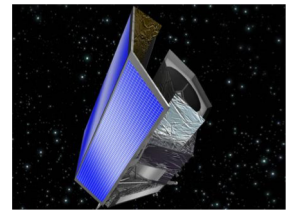
Why is it important?

Support of ESD Science and Satellite Validation/Verification



sentinel-5p

SENTINEL-4



Current and Future AQ/AC Satellite Missions

Mission	Agency	Launch	Instrument(s)	Synergistic Pandora Observations	Orbit
AURA	NASA	2004	OMI	O3, NO2, SO2, HCHO, BrO	LEO
MetOp-A	EUMETSAT	2006	GOME-2	O3, NO2, SO2, HCHO, BrO	LEO
S-NPP	NASA	2011	OMPS	O3, SO2	LEO
MetOp-B	EUMETSAT	2012	GOME-2	O3, NO2, SO2, HCHO, BrO	LEO
DSCOVR	NASA	2015	EPIC	O3, SO2	L1
Sentinel 3A	EUMETSAT	2016	MWR, OLCIS, LSTR	H2O	LEO
Sentinel 5P	ESA	2017	TROPOMI	O3, NO2, SO2, HCHO	LEO
Sentinel 3B	EUMETSAT	2018	MWR, OLCIS, LSTR	H2O	LEO
GaoFen-5	CSA	2018	EMI	O3, NO2, SO2, HCHO	LEO
GEO-KOMPSAT 2	KMA	2019	GEMS	O3, NO2, SO2, HCHO, CHOCHO	GEO
TEMPO	NASA	2019	TEMPO	O3, NO2, SO2, HCHO, CHOCHO	GEO
Sentinel 4	EUMETSAT	2021	UVN	O3, NO2, SO2, HCHO	GEO
Senintel 5	EUMETSAT	2021	UVNS	O3, NO2, SO2, HCHO	LEO
MAIA	NASA	TBD	MAIA	SO2, NO2 (aerosol precursors)	LEO

Pandonia Global Network (PGN)



NASA Pandora

Responsibilities:

- NASA Instrument Builds
- Calibration/deployment maintenance
- Network Operations
- Data Mirroring

Managed by: NASA GSFC



ESA Pandonia

Responsibilities:

- Software Development
- Calibration
- Network Operations
- Central Processing
- Data Serving

Managed by: Luftblick



Shared Responsibilities

- Network Operations
- Calibration, QA/QC
- Training of Local Operators
- Field Campaigns
- Science



NASA/ESA/PGN Accomplishments for past year

STANDARDIZATION and CONVERGENCE:

- Summer Intern Training by ESA-Pandonia for NASA GSFC (July '17)
- NASA/ESA instrument deployment / local operations training (Oct '17)
- Maturing remote monitoring/support of operations:
 - instruments, local operators and scientists (Oct-Dec '17)
- Week-long ESA/NASA PGN Workshop - focus on manual development / harmonization of calibration procedures/data processing / Global Network development (Dec '17)
- Quick Start Guide for Instrument Set up, local operations and troubleshooting (started in Oct 17' - ongoing)



NASA/ESA/PGN Accomplishments for past year cont.

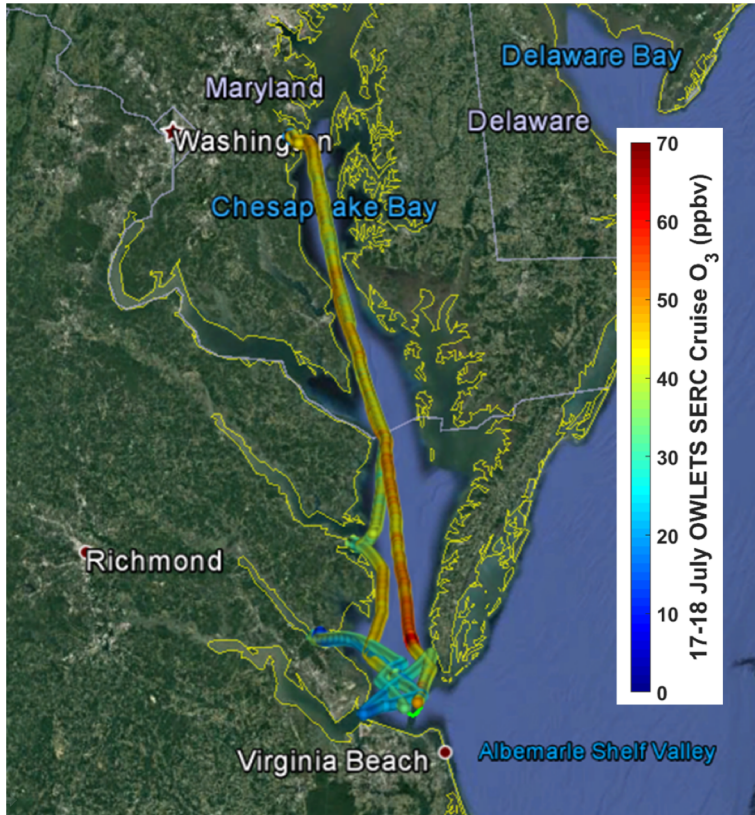
- Production of scientific manuscripts
 - a. Spinei, E. et al. The First Evaluation of Formaldehyde Column Observations by Pandora Spectrometers during the KORUS-AQ Field Study, *Atmos. Meas. Tech. Discuss.*, <https://doi.org/10.5194/amt-2018-57> , in review, 2018.
 - b. Herman, J. et al.: NO₂ and HCHO measurements in Korea from 2012 to 2016 from Pandora Spectrometer Instruments compared with OMI retrievals and with aircraft measurements during the KORUS-AQ campaign, *Atmos. Meas. Tech. Discuss.*, <https://doi.org/10.5194/amt-2018-56> , in review, 2018.
 - c. Jeong, U et al. (2018). Langley calibration analysis of solar spectroradiometric measurements: Spectral aerosol optical thickness retrievals. *Journal of Geophysical Research: Atmospheres*, 123. <https://doi.org/10.1002/2017JD028262> .
 - d. Sullivan, J. T. et al. The Ozone Water-Land Environmental Transition Study (OWLETS): A Unique Strategy for Understanding Pollution Events within the Chesapeake Bay. Submitted to *Bulletin of the American Meteorological Society*, March 2018.
 - e. Judd, L. et al. (2018). The Dawn of Geostationary Air Quality Monitoring: Case Studies from Seoul and Los Angeles. Submitted to *Frontiers in Environmental Science*
 - f. Gronoff, G. et al. A Method for Observing Near Range Point Source Induced O₃ Titration Events Using Co-located Lidar and Pandora measurements. *Atmospheric Measurement Techniques*. Submitted April 2018
- Engaging with international agencies (e.g. EUMESAT, KIER, ESA, ECCC)
- Exposure and training of cohorts of interns (2017 and 2018)

Recent NASA/ESA/PGN supported Field Campaigns



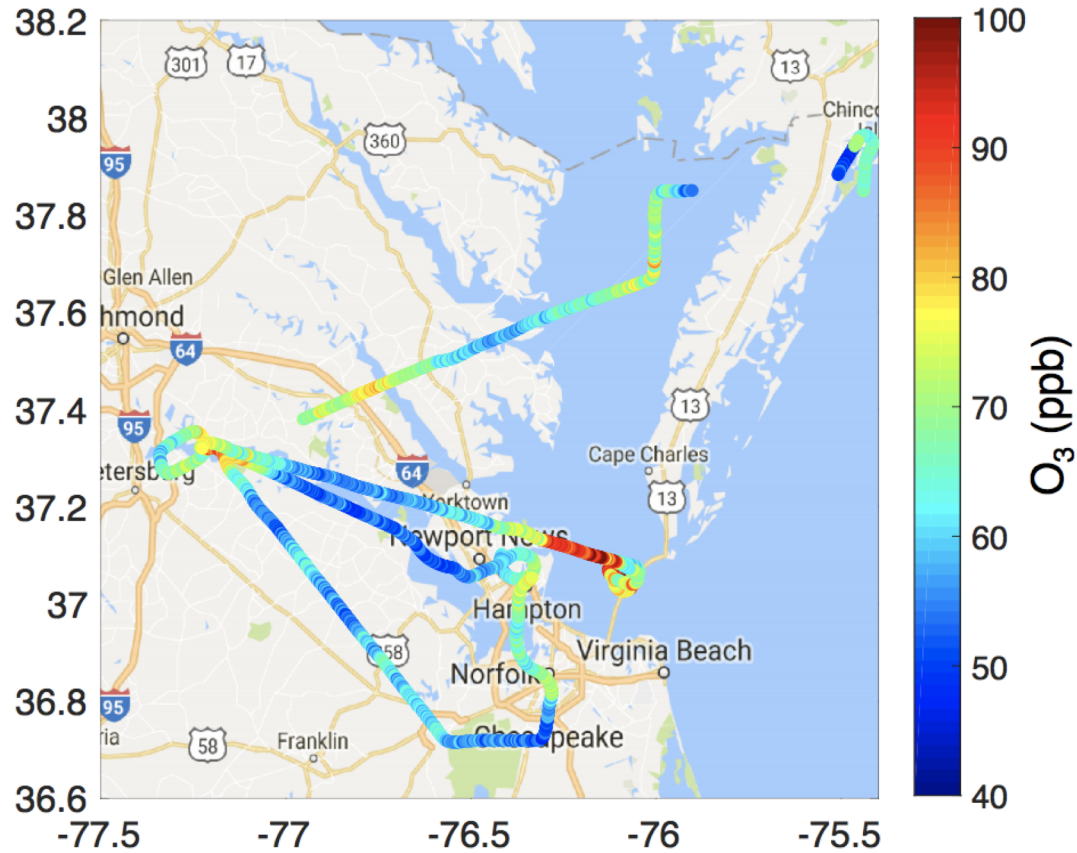
Ozone Water-Land Environmental Transition Study

SERC RV



07/17 & 07/18 in-situ Ozone

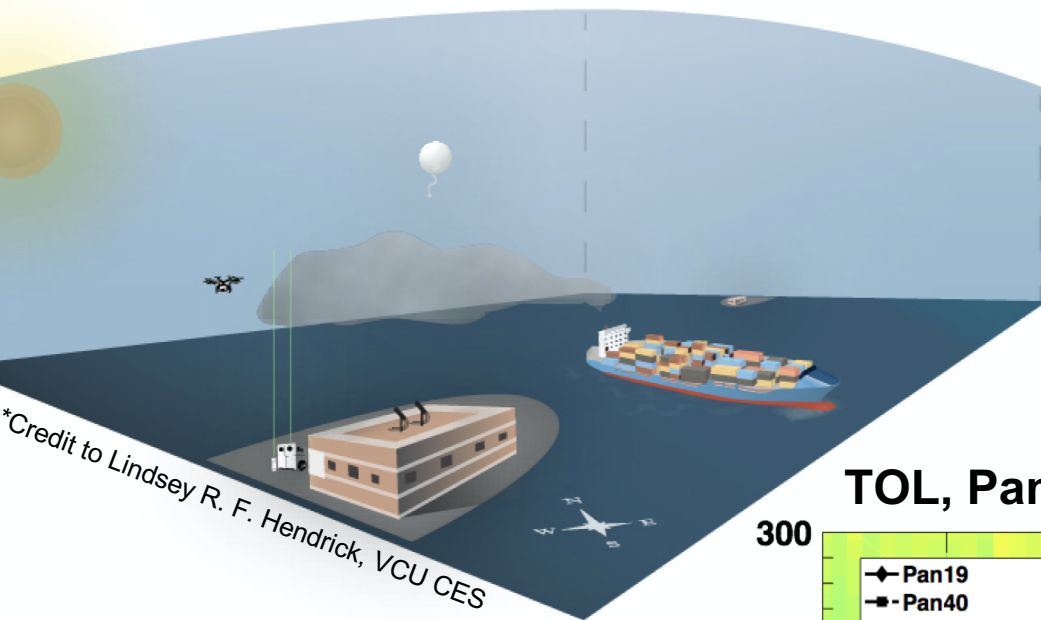
NASA C-23 Sherpa



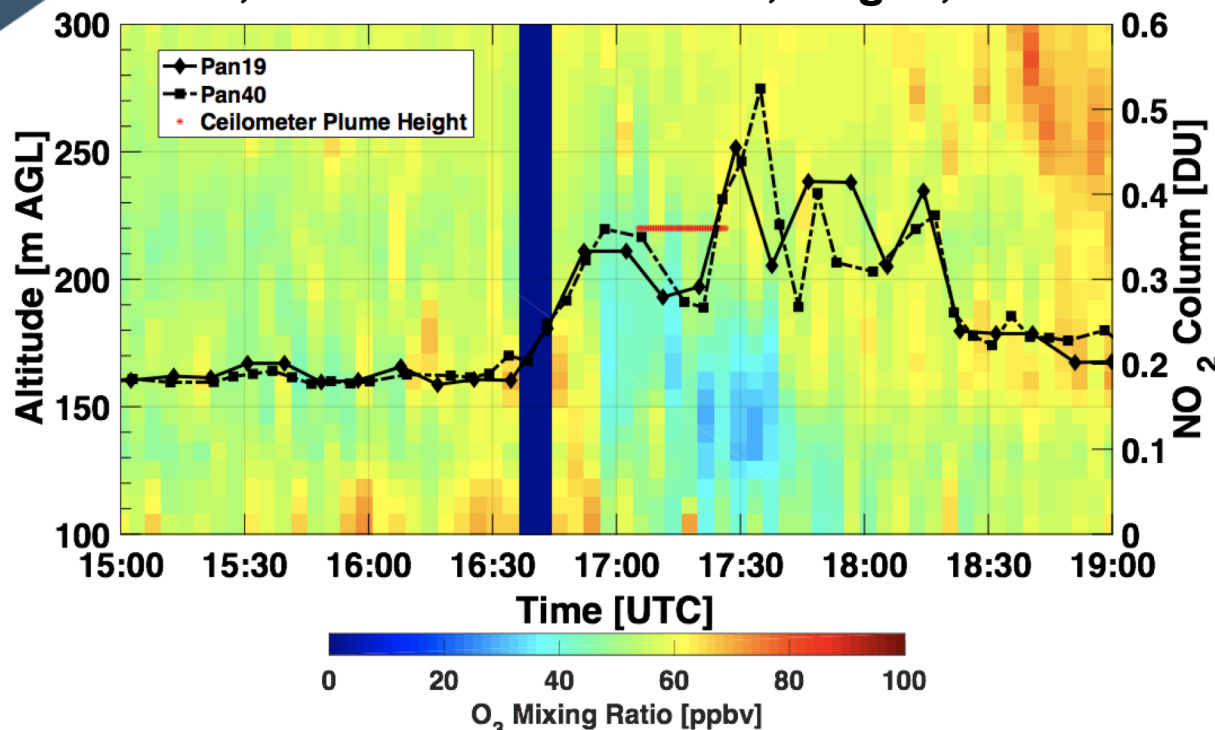
07/20 Ozone (≤ 500 m ASL)



Interconversion/Titration Event




TOL, Pandora & Ceilometer, Aug. 1, 2017




“Growing Our Own Timber”: Grooming the Next Gen of ES Scientists






Sherpa Student Participation

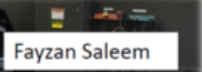


6 GSFC summer interns (Swap)

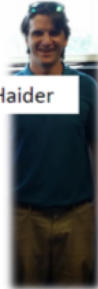
Brett Poche




Hakeem Bisyr



Fayzan Saleem



Faran Haider



Weston Millar Joe Robinson



NIFS

NASA INTERNS, FELLOWS & SCHOLARS
ONE STOP SHOPPING INITIATIVE



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Opportunity Info

Opportunity Title: Goddard Groundhogs: Pandora Project Undergraduate Student Support


Opportunity Type: Internship

Opportunity Description/Objective (specific student assignment): The NASA GSFC Pandora Project is seeking four highly qualified undergraduate candidates to be part of the Summer 2018 Goddard Groundhog Experience. The Project needs undergraduate students with the following science/engineering skillsets/experiences: 1) deployment/use of air quality/atmospheric composition sampling equipment in field settings; 2) hands on experience with mechanical and electrical systems; 3) chemistry/atmospheric chemistry and 4) statistics and applied math. These students are needed to collaborate with ongoing efforts to advance the Pandora Spectrometer System, the Pandora Global Network and to help support the Pandora Project and their deployment of Pandora Instruments for a number of field campaigns, most notably OWLETS-2 (Ozone Water-Land Environmental Transition Study-2). Successful applicants will be exposed to the Pandora Spectrometer System - how it works and the science behind it - and are expected to learn how to operate, deploy and monitor the instrument and its performance. Students will also be exposed to and mentored on the Pandora data acquisition and processing system and are expected to work with the resultant air quality data (e.g. total column and profile O3, NO2, HCHO) in support of ground based campaigns and the larger global network.


Expected opportunity outcome (i.e. research, final report, poster presentation, etc.): Successful candidate(s) are expected to participate in a "hands on" fashion with the OWLETS-2 field campaign experience during the summer of 2018. Furthermore, they are expected, with mentorship, to compile and present on their field and lab experience as well as prepare preliminary field data for presentations at branch and center wide functions. They are also expected to contribute to and submit peer reviewed articles where applicable.

Student's Computer and/or Special Skills: Familiarity with data analysis and/or experience with Python, Matlab, Minitab, Excel, IDL, C/C++, Fortran, HTML5 or similar programming language required. Previous experience with intensive field campaigns/field experiments/field observations - preferably of an interdisciplinary nature highly desirous. Proficiency with statistics/applied mathematics also highly desirous as is hands on experience with mechanical and electrical systems. Experience with ground-based and mobile instrumentation highly desirous as is a teamwork mindset and comfortability with varying degrees of uncertainty in the field. Familiarity with project management software such as Slack, Trello, DaPulse/Monday, Inflow, as well as with webpage software/development is also highly desirous. Additional language skills (e.g. Spanish, German, Portuguese, Korean, Chinese, etc.) also highly desirous.

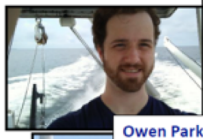
Comments:




SERC R/V Student Participation




- 2 CUNY/Columbia Univ. Summer Interns (Mentor: Maria Tzortzoglou)
- 2 NASA/GSFC Summer Interns (Mentor: Bob Swap)
- 1 NASA/GSFC Postdoctoral Researcher (Mentor: Anne Thompson)




Owen Parker




Lena Shalaby




Ryan Stauffer

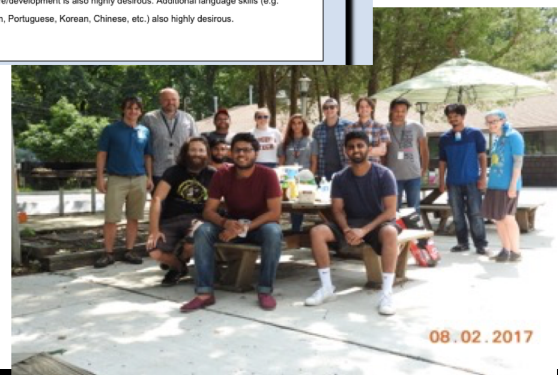


Rachel Li



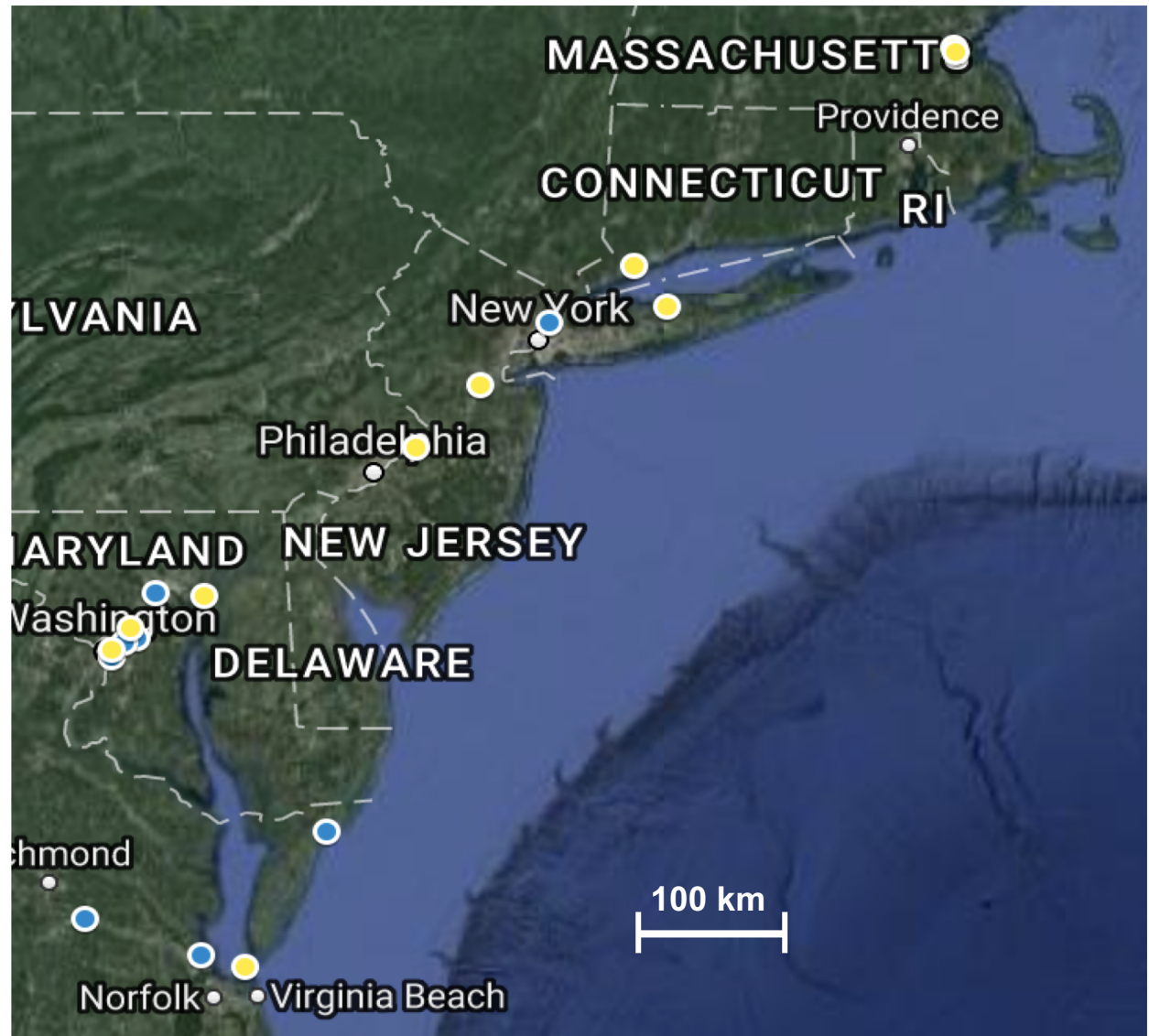
Julio Roman

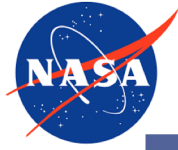




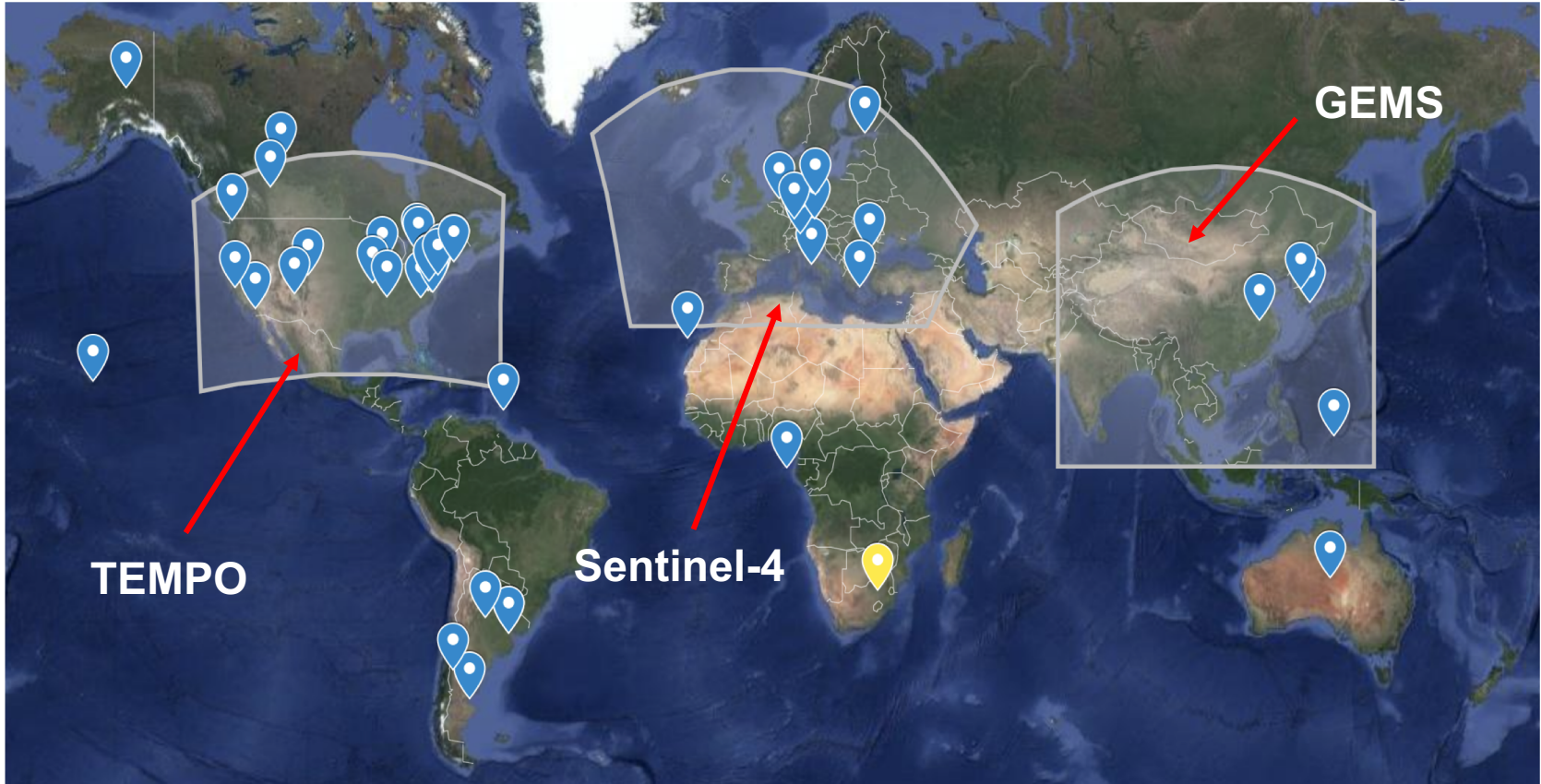
2018 Pandora Deployments in Northeastern U.S.

- **Yellow** - to be deployed (11) + 2 mobile (boat)
- **Blue** - currently sited (8)
- Majority coincident w/ EPA PAM sites - for additional sites, see L. Valin poster





Current Configuration of PGN



58 Instruments active globally with another 26 to be delivered in 2018

- 37 monitored by NASA GSFC Pandora, 21 by ESA-Pandonia
- Possibility to provide hourly observations of O_3 , NO_2 , SO_2 , HCHO from GEO is a major advancement for air quality (vs LEO 1x/day)
- By year end min. 50 NASA owned instruments deployed and operational



Goals for this year



- Establishment of international site / real property agreement templates where PGN Expectations are articulated in draft PGN Site Information Form to be released mid-May
- Collaborative development of new operational algorithms and evaluation of existing ones
- Maturing the remote monitoring and support of operations: instruments, local operators and scientists
- Launch of collaborative PGN website (est. mid-July)
- AGU Special Session (Observations and Modeling of Air Quality at Land-Water Boundaries, session ID#51995) with possible side meeting
- Continued collaboration w **AERONET, TOLNET, MPLNET**
- Science Workshop on Pandora - details TBD - possibly in conjunction w AGU
- Continued expansion of the NASA Pandora, leveraging ancillary observations at local, state and fed DEQ/EPA AQ monitoring sites

Thank you.

For more information please contact:

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