# Howard University Beltsville Research Site HUBC: A Re-Introduction

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***Remote Presentation: ICM-16: GRUAN16, Tenerife 17-21 November 2025***

***Time: Monday 17 November 2025 @ 15:05 -15:20 WET (UTC+0; 10:05 EST)***

# Outline

Beltsville Site GRUAN data statistics and trend monitoring:

- *Location and some facts*
- *Sonde Archive & Statistics*
- *Monitoring Examples*
    - *Tropopause height*
    - *Ozone Homogenization*

Early years and contribution

- *WAVES to GRUAN*
- *Highlights of experiments*
- *NWS/Sterling Coordination*

Beltsville is Uniqueness in GRUAN

- *Education & Training*

*Future Outlook*

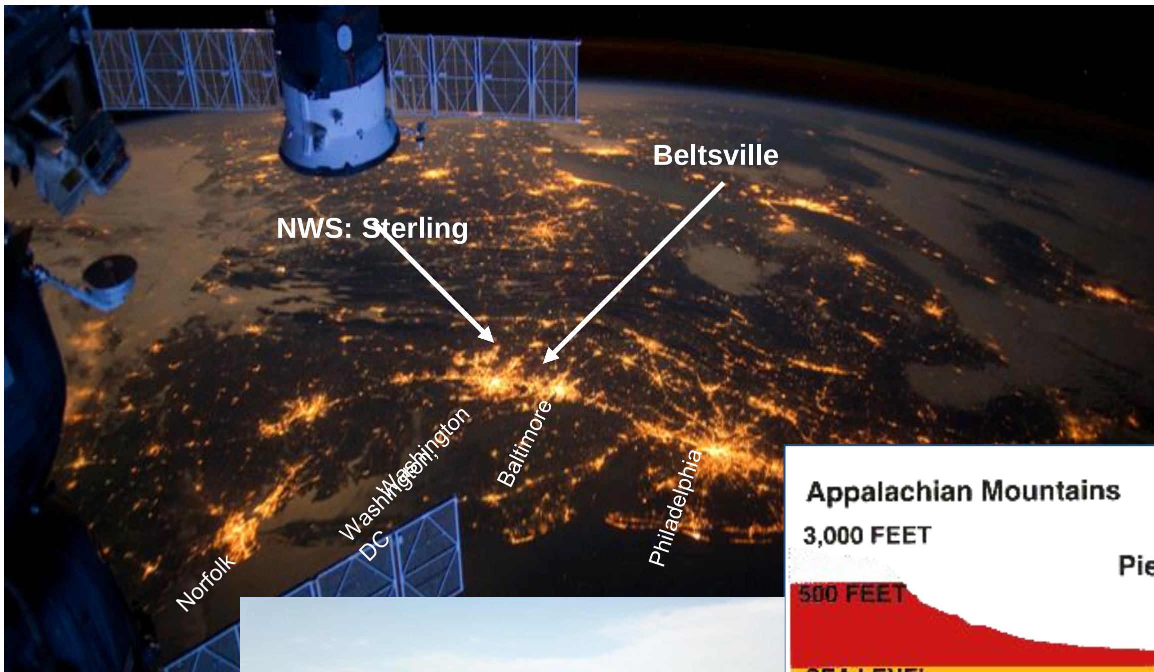
**My Motive**

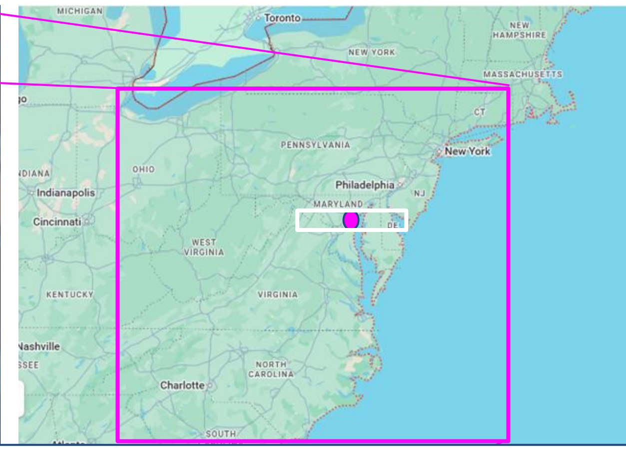
- Introduce Beltsville to new GRUAN members
- Helps me with a future publication
- The "GRUAN Value" - beyond climate priority measurements?

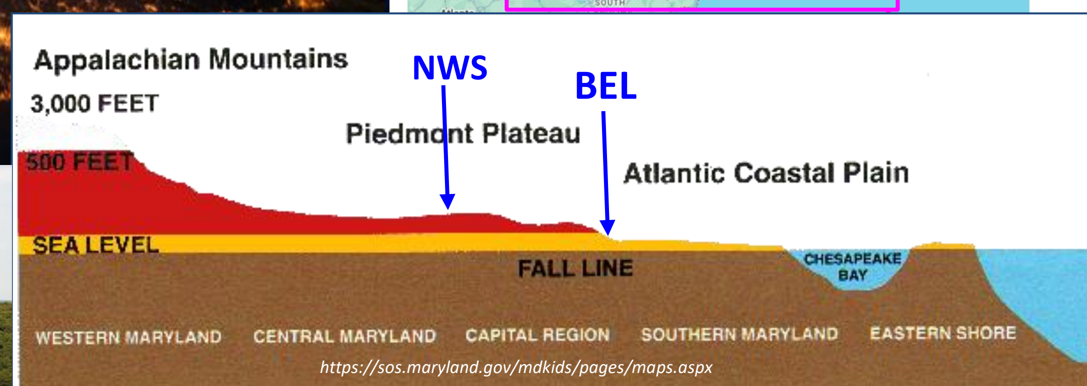
# Beltsville Site: *Location*

## Location: ***Beltsville, Maryland** 39.05°N, 76.88°W, 53m*

- High population density; pollution corridor & last place for before EU
- Federal and University concentration:
- Howard University: one of 5-HBCUs - Inclusive Excellence in Practice

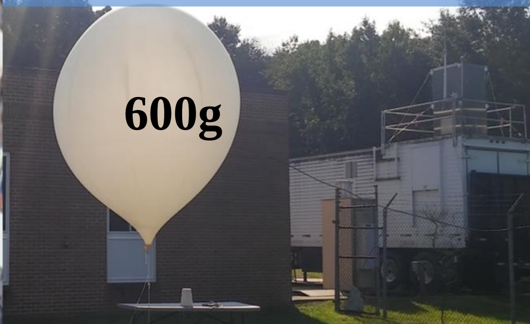



*https://sos.maryland.gov/mdkids/pages/maps.aspx*

# Beltsville Site: *radio-sounding update*




- *~ 2000 soundings to date*
- *See: https://hu-bc.org/raobs/*

**RS92**

| *Year* | *RS92* |
|---|---|
| 2025 | 90 |
| 2024 | 31 |
| 2023 | 3 |
| 2022 | 3 |
| 2021 | 4 |
| 2020 | 24 |
| <2019 | 513 |
| **total** | **668** |

**RS41**

| *Year* | *RS41* |
|---|---|
| 2025 | 66 |
| 2024 | 68 |
| 2023 | 71 |
| 2022 | 60 |
| 2021 | 64 |
| 2020 | 58 |
| <2019 | 160 |
| **total** | **547** |

**Dual**

| *Year* | *RS92-41* |
|---|---|
| 2020 | 22 |
| 2019 | 59 |
| 2018 | 45 |
| 2017 | 45 |
| **total** | **171** |

**CFH**

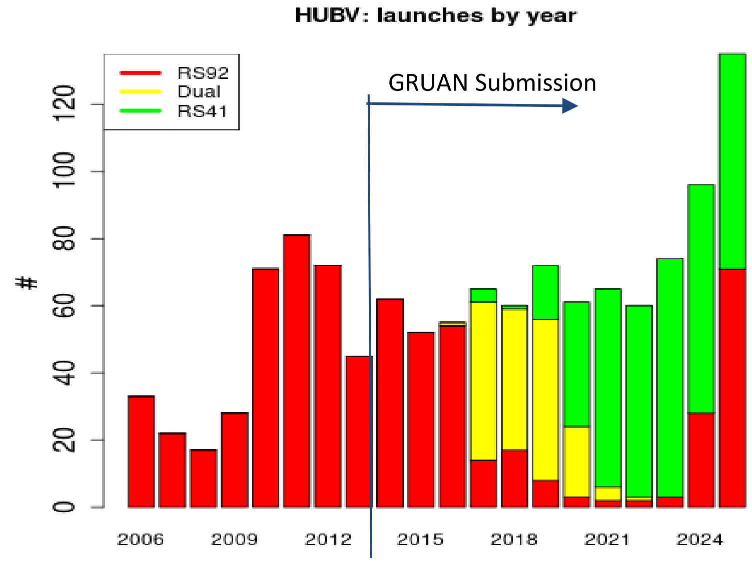
| *Year* | *CFH* |
|---|---|
| 2025 | 9 |
| 2024 | 10 |
| 2023 | 12 |
| 2022 | 11 |
| 2021 | 11 |
| 2020 | 8 |
| <2019 | 41 |
| **total** | **102** |

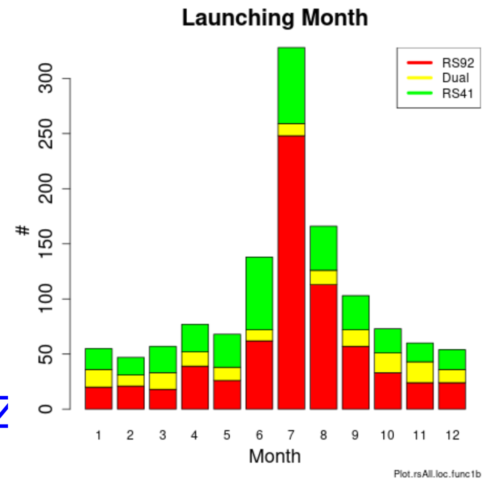
**$O_3$**

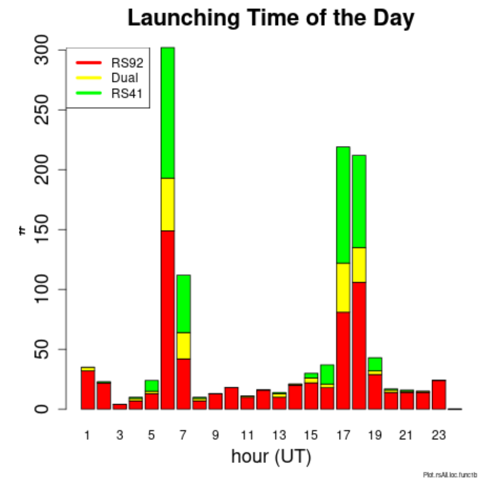
| *Year* | $O_3$ |
|---|---|
| 2025 | 38 |
| 2024 | 39 |
| 2023 | 43 |
| 2022 | 31 |
| 2021 | 29 |
| 2020 | 22 |
| 2019 | 24 |
| 2018 | 24 |
| <2017 | 160 |
| **total** | **410** |

# Beltsville Site: *Characteristics of launches*

- **<u>RS92⇒ RS41 transition:</u>** Dual launches mostly in 2017-2019 with RS41 dominant after.
- **<u>Satellite overpass focus:</u>** Most launches at 6Z & 18Z; overpass time.
  - *RS92 after 2019 used in specific campaigns (Thanks to Tony Reale!)*
- **<u>Summer Campaigns</u>**:
  - *We run workshops, campaigns, etc every summer.*
  - *We tend to do RS92s for these*
  - *In 2025: JCRDP/COURAGE, NASA launches were at 0Z, 6Z, 12Z, and 18Z*
  - *We will submitted to GRUAN*



# Beltsville Site: *Upper Air Characteristics*

***Tracking tropopause height***

- Fewer launches before 2013/2014 and in winter time.

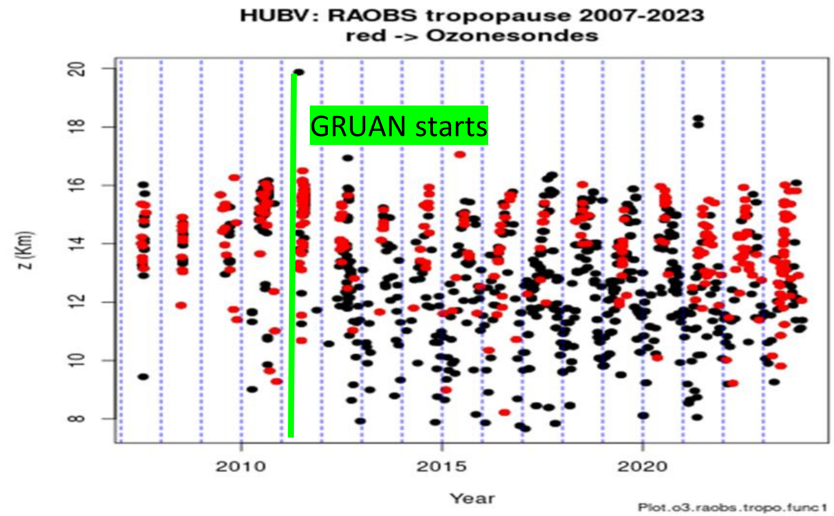
- ***Seasonality:***

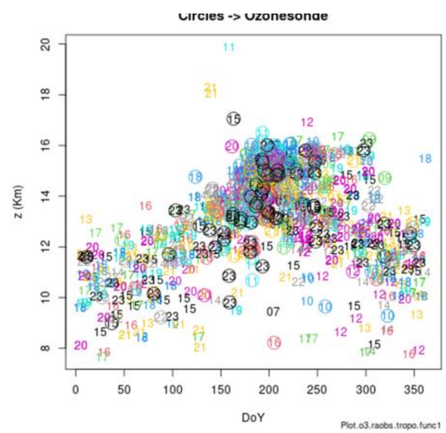
  *Summer: Trop height, $O_3$, Θ, and Specific humidity are high and wind speed is low*

  *Winter: Trop height, $O_3$, Θ, and Specific humidity are low and wind speed is high*

- ***Significance:***

  *No significant changes are observed for Tropopause height and specific humidity, but p-value for potential temperature is close to level 0.05 and total ozone (Troposphere) has a non-zero trend*




e: Line Fit for O3sonde parameters during
mer period (DoY 120 – 240), 2007 – 2023

| Variable | Trend (Slope) | Error(Trend) | P-value (Fitted line) | $R^2$ | RSE |
|---|---|---|---|---|---|
| Tropopause Height | -0.041 km/year | 0.026 km/year | 0.12 | 0.15 | 0.52 km |
| Potential Temperature | -0.22 K/year | 0.11 K/year | 0.058 | 0.22 | 2.2 K |
| Specific Humidity | -0.013 (g/Kg)/year | 0.015 (g/Kg)/year | 0.41 | 0.046 | 0.30 g/Kg |
| Total Ozone (Troposphere) | -0.49 (d.u./year) | 0.16 (d.u./year) | 0.0078 | 0.39 | 3.2 d.u. |

Red- no significant
Yellow – no significant, but p-value close to significant level 0.05
Green – significant (trend not zero)

# Beltsville Site: Ozonesonde Homogenization

***Homogenization*** *⇒ series of corrections (detective work) to ozonesonde measurement ⇒ consistent & "true" partial ozone measurements*

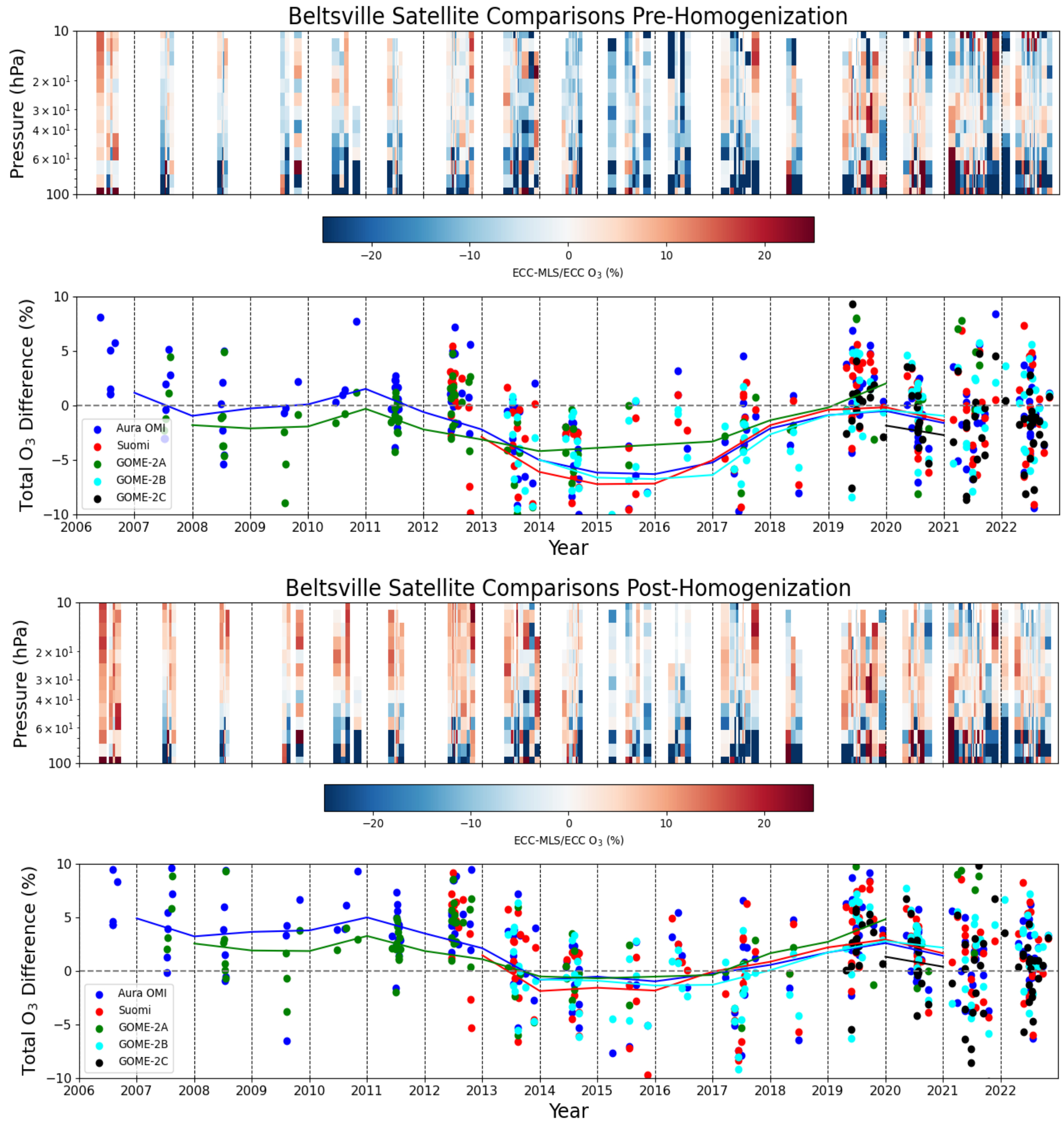
***Goal:*** *Improve the quality and consistent treatment of the 20+ year long ozonesonde dataset for trend detection*

## Results:

- ***Improved sonde dataset better capture pollution events than satellites***
- ***Improved data set for trend an physics attribution***

***Figure:*** *Example of satellite and sondes (Pre & Post reprocessing)*

***Joshua Richards et al (NDACC 2025 Presentation)***

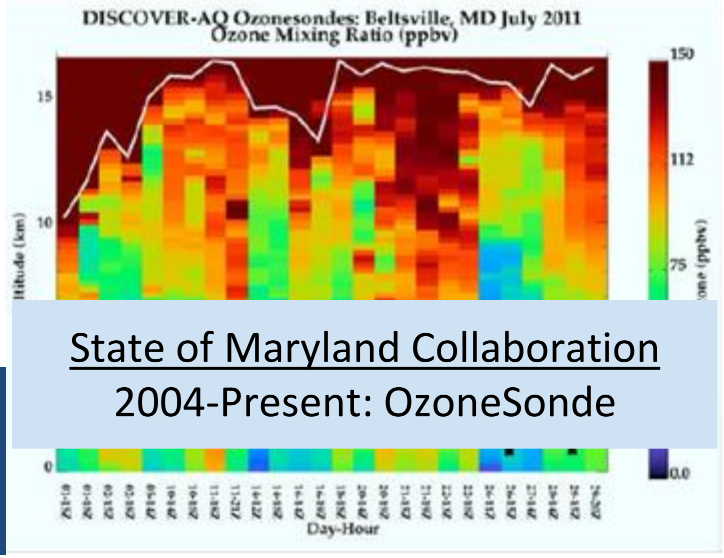


# Beltsville Site: *WAVES to GRUAN*

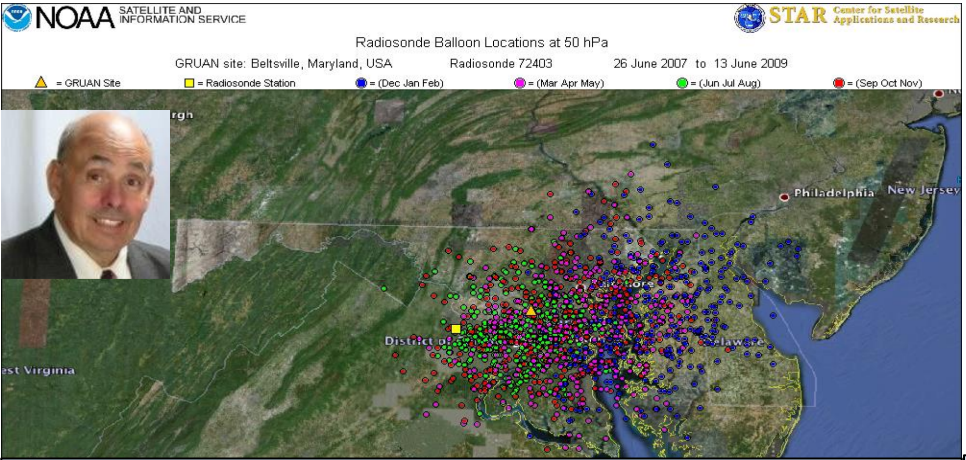
**In the beginning…**

- A co-laboratory for hands-on student training
- Collaboration with NASA, NOAA/NWS, MDE (*State*)
- 1st HBCU-based field campaign (2006-2012):
  - ***WAVES (Water Vapor Atmospheric Experiment - Satellite)***
  - ***Wind & Ozon***

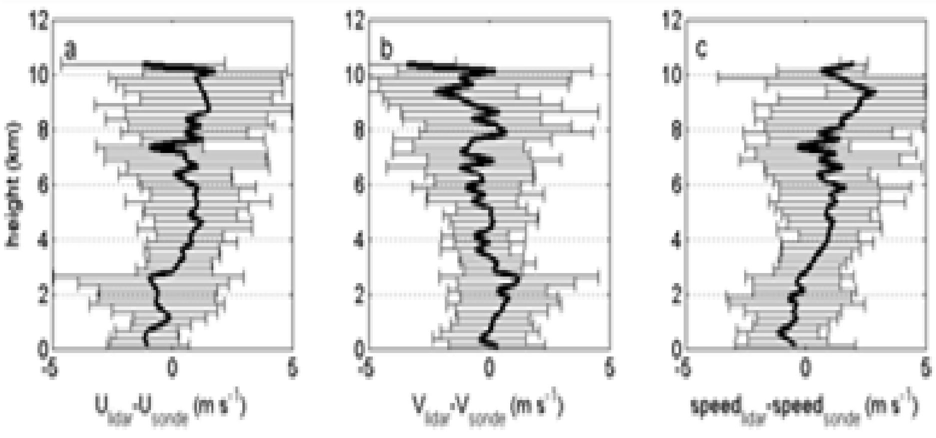
***2009: NRC Recommendation as an ideal collaboration site.***




State of Maryland Collaboration
2004-Present: OzoneSonde




NOAA Collaboration
2002-Present: Extensive Research & Education in Satellite Val and Observation

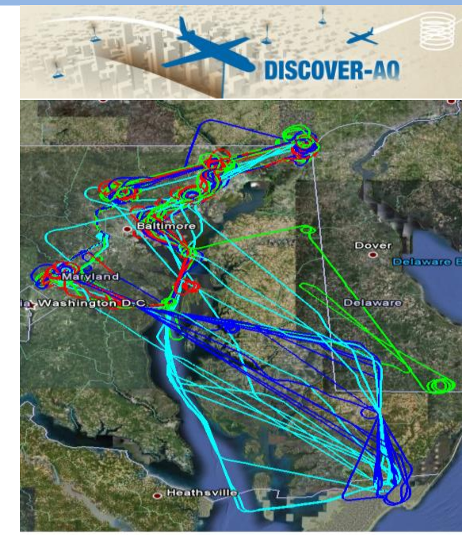



NASA/GSFC Research Collaboration
2000-Present: Lidar (Wind, Ozone, PBL, Lidar) and other

# Beltsville Site: *Highlights of experiments*

## Build it and they will come

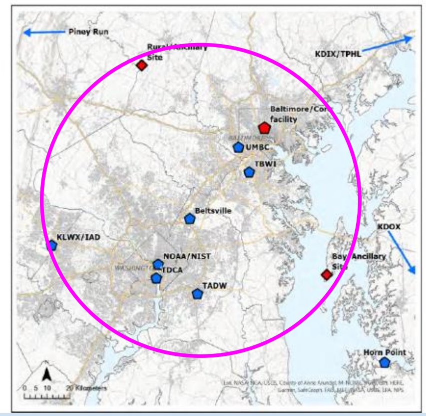
- Co-laboratory ⇒ super-site of instrumentation
  - ***WAVES (2005-2011), AEROSE (2004-present), DISCOVER-AQ (2011-2014) , PECAN (2014-2015), OWLETS(2017-2018), JCRDP (2024-2025), CoURAGE (2024-2025) …***

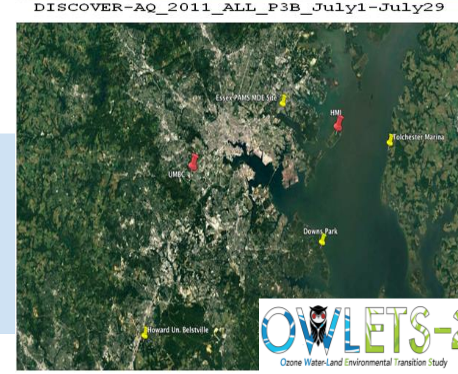


DISCOVER-AQ_2011_ALL_P3B_July1-July29

## CoURAGE:*(DoE)*

- *1 December 2024 - 30 November 2025*
- ARM Mobile Facility 1 (AMF-1) Deployment
- Understanding the mechanisms governing the urban atmospheric environment



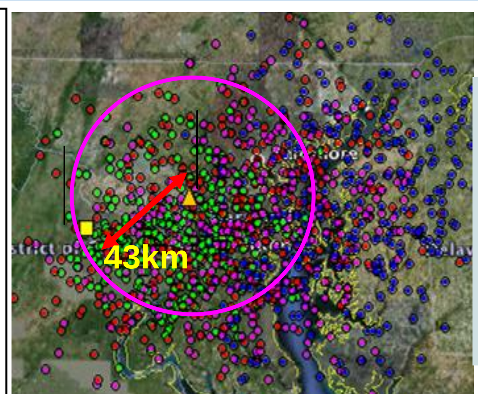

**GRUAN Interest …**

RS41 launches ~ 1300 RS41 [City] & ~130 RS41 [rural/IOP]

***CoURAGE ⇒ opportunity to repeat Fasso et al 2014: AMT***

| Source of uncertainty | | $\sigma^2$ | $\sigma^2\%$ | $\sigma$ |
|---|---|---|---|---|
| Total uncertainty | $\Delta_y$ | 343.8 | 100% | 18.54 |
| Collocation drift | $\Delta_\mu$ | 343.0 | - | 18.52 |
| Bias (adjustable) | $\beta_0^2$ | 11.6 | 3.4% | 3.40 |
| Environ. Error (reducible) | $x - \beta_0^2$ | 293.2 | 85.5% | 17.12 |
| Environ. Error (irreducible) | $\omega^2$ | 37.1 | 10.8% | 6.09 |
| Sampling error | $\hat{\beta}$ | 0.21 | 0.1% | 0.46 |
| Measurement error | $\Delta_\varepsilon$ | 0.81 | 0.2% | 0.90 |

**Table 1.** Budget of total collocation uncertainty for relative humidity ($\Delta rh$) in Beltsville-Sterling, using HFR model of Eq.s (14) and (15).




## *Fasso et al indicated*

**- ΔT within 1%; Total vapor (IPW) ~ 1%**

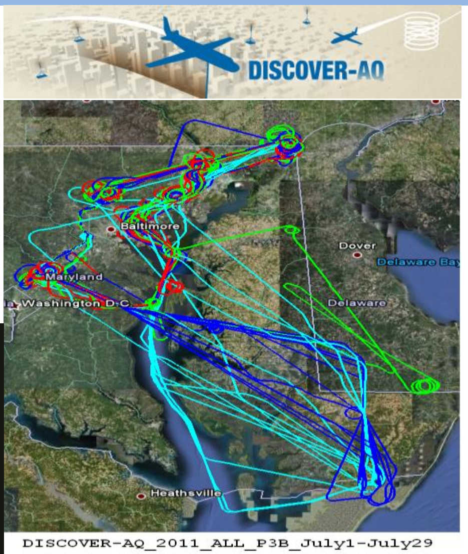
**- Δq as large as 60%!! “*reducible envir.” error* largest contributor**

- ***We intend to repeat the study using same sonde-type***

# Beltsville Site: *Experiment Participation*

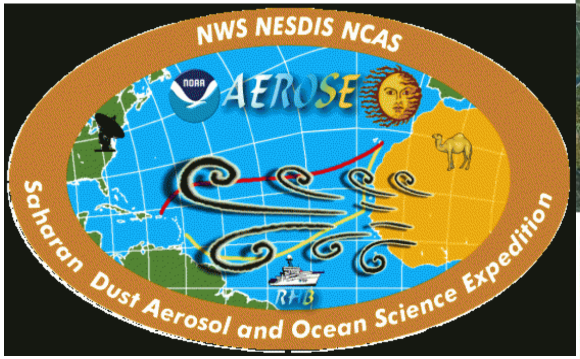
## Build it and they will come…

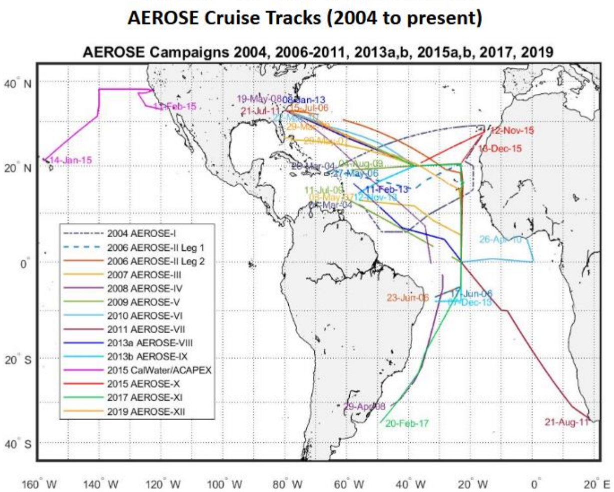
- Co-laboratory ⇒ super-site of instrumentation
  - ***WAVES (2005-2011), AEROSE (2004-present), DISCOVER-AQ (2011-2014) , PECAN (2014-2015), OWLETS(2017-2018), JCRDP (2024-2025), CoURAGE (2024-2025) …***



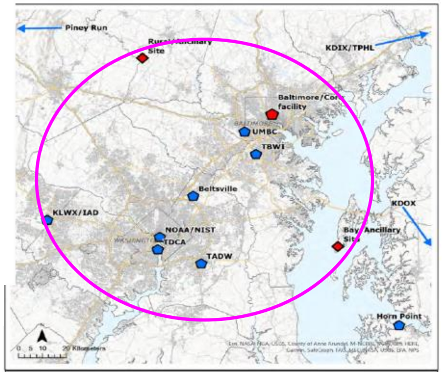

**AEROSE:***(https://www.ncas-m.org/aerose/)*

- *2004 - Present*
- Yearly deployment over the Atlantic
- One of the most comprehensive atmospheric and oceanographic datasets
- Major dust and smoke events were measured during some campaigns







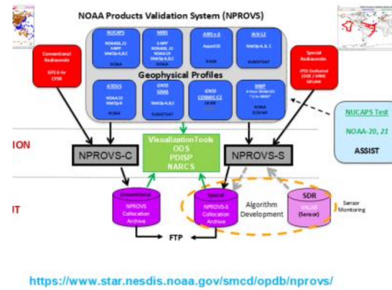

### GRUAN interest

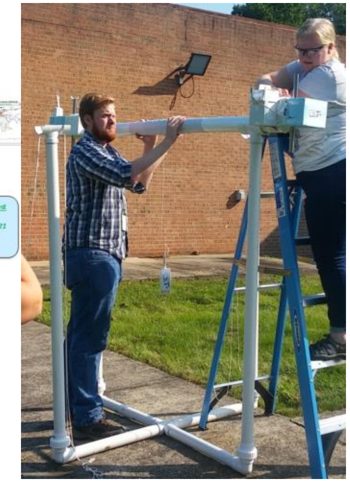
- Over 1100 sondes to date, including ozonesondes
- Unique - over water & SAL presence
- See Flores et al 2023 for more info
  - ⇒ ***extensive use in Sat. validation***

# Beltsville Site: *GRUAN Mid-Atlantic Consortium*

***GMAC:*** ***ad-hoc group coordination and discussion of GRUAN-like tasks and activities.***

- ***Extensive CFH operation and Training***
  - *CFH training between SFSC and Beltsville*
- ***NESDIS NPROVS support for radiosonde evaluation and transition monitoring***
  - *independent comparison of a radiosonde profile;*
  - *monitor transition and major differences in newly deployed NWS radiosondes (e.g Alaska region)*
- ***NWS Radiosonde Evaluation (NASA Wallops)***
  - *Sensitive acquisition for the U.S. NWS radiosonde transition*
- ***Advise on new NWS instrument systems***
  - *Solar Simulator- Quantifying measurement uncertainty*
  - *Infrared Sky Camera; Microwave Radiometer; Standard Humidity (100% RH)*
  - *Autosonde discussion (Vaisala & Meteomodem)*



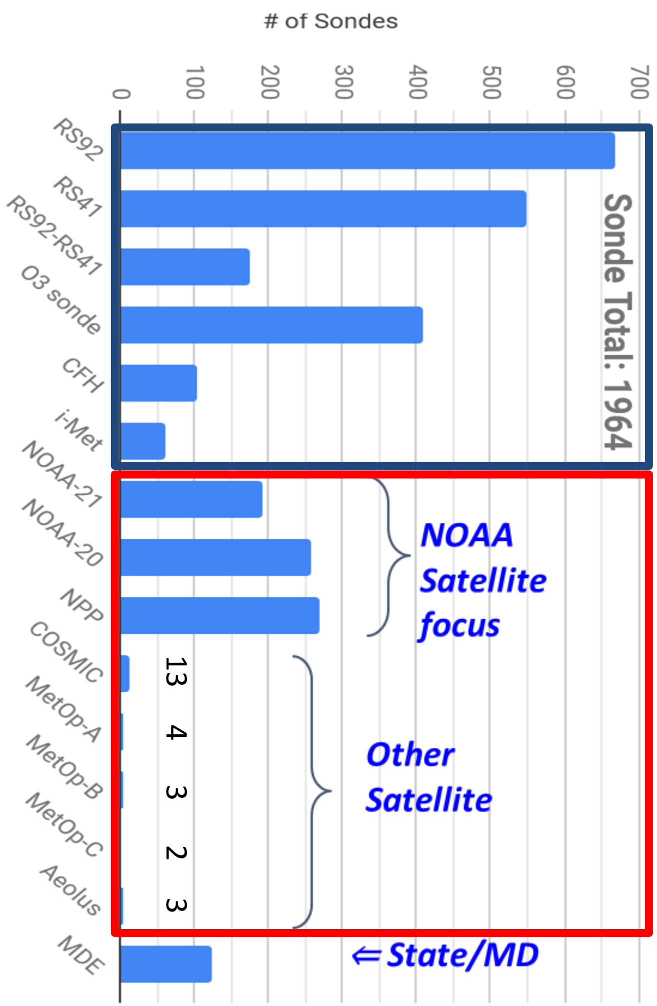



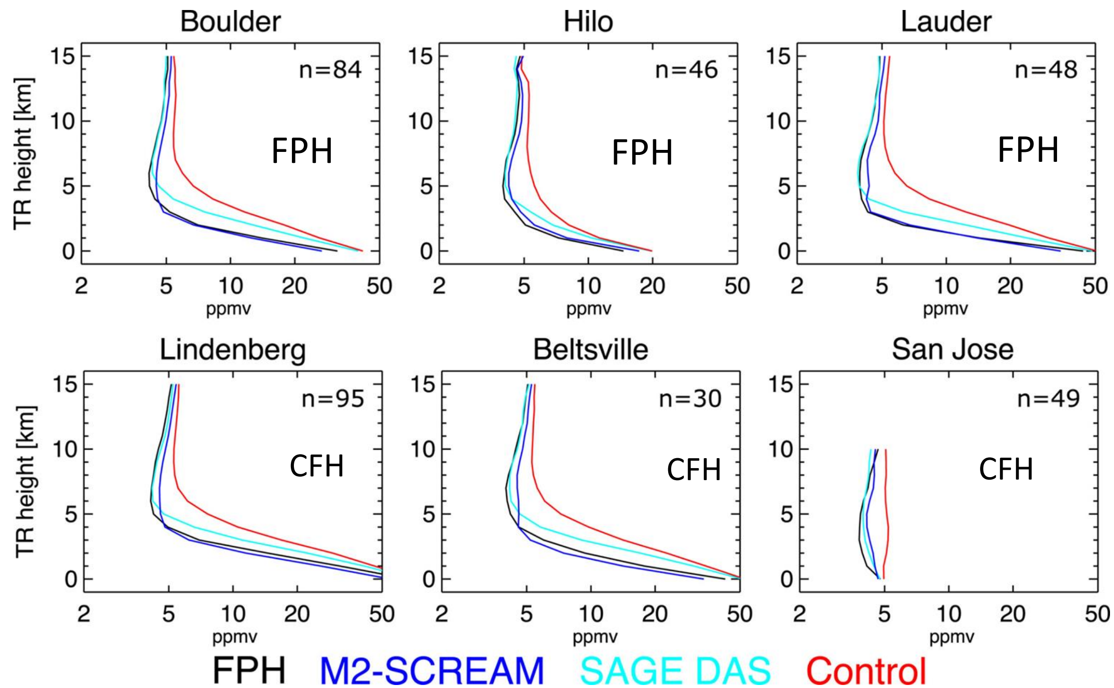
*J. Fitzgibbon; P. Hoch, D. Brewer, B. Sun, R. Smith, M. Petty, **M. Hicks**, K. Vermeesch, A. Flores, R. Sakai, **T. Reale**, **C. Calderela**, **D. Whiteman**, **M. Letaille**, N. Nalli*

# Beltsville Site: *GRUAN & More*

## Lasting and unique - *misc.*

- Satellite validation - *exclusive target*
- Model Validation - ***GOES Model and continuity of observation***
- Dissertations -



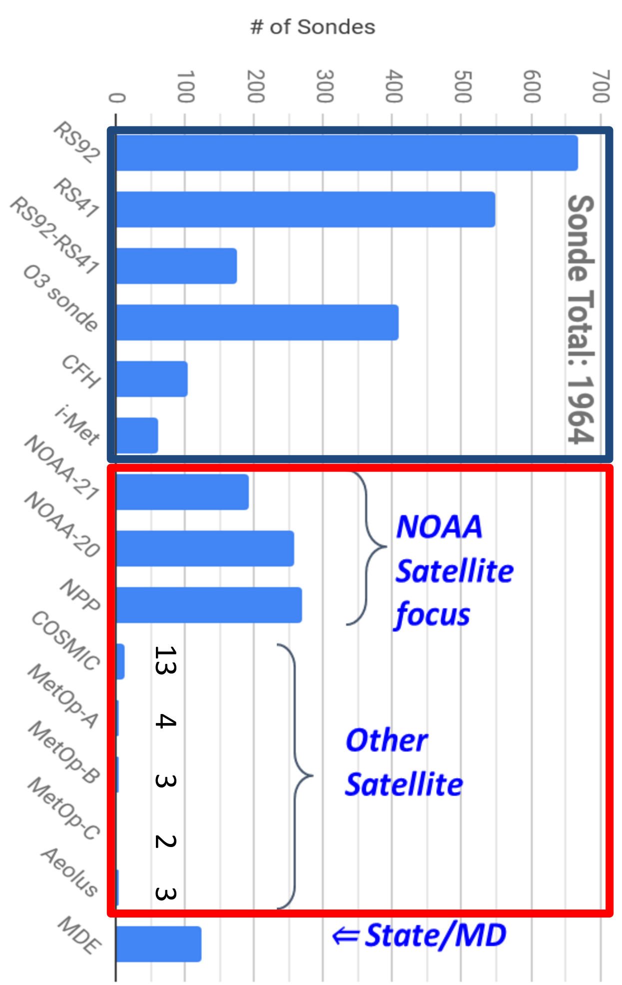

*Knowland et al (2025)* - https://doi.org/10.1029/2024GL112610

- Strat. vapor is important in climate ⇒ continued monitoring
- DA of SAGE III/ISS in to the NASA/GSFC GOES model (cyan) will allow continued monitoring of Strat. Vapor

# Beltsville Site: *GRUAN enabled*

## Lasting and unique - *misc.*

- Satellite validation -
- Model Validation -
- Dissertations - ***broadening "GRUAN" data use***




### ***MSc & PhD Dissertation Study (recent …)***

- *Ken Pryor (PhD; NOAA): Cassandra Calderella (MSc; NOAA)*
- *Megan Payne, Mike Hicks Ph.D. NOAA/NWS/ ⇒ NIST/Northrop)*
- *Fred Mashao (PhD. Univ. Limpopo, SA)*
- *J. Richards (Ph.D. UMBC Grad; Homogenizing ozone data)*
- *I. Sloan (MSc; Howard University; PBL detection)*

### ***Publications examples:***

*Flores, et al. 2023:* **https://doi.org/10.3390/atmos14040707**

*Pryor et al. 2022: Utility of Satellite Retrievals of Atmospheric Profiles in Detecting and Monitoring Severe Weather Events at NOAA"* ***BAMS****, 103, February 2022.*

*Pryor 2022: "Downburst Monitoring and Prediction Studies"* ***Edited.*** *Nalli*

*Pryor et al. 2022: "A Retrospective Satellite Analysis of the June 2012 North American Derecho" has been accepted in the Multidisciplinary Digital Publishing Institute (MDPI) journal* ***"Remote Sensing".***

*Our "local GRUAN" goal from the start is the training of students - inclusive excellence. GRUAN is a means to transforming the lives of underrepresented students without compromising the "climate" science. The next generation is the goal.*

# Beltsville Site: *Recent/ongoing Experimentation*

https://www.youtube.com/watch?v=FGezON6v7hc

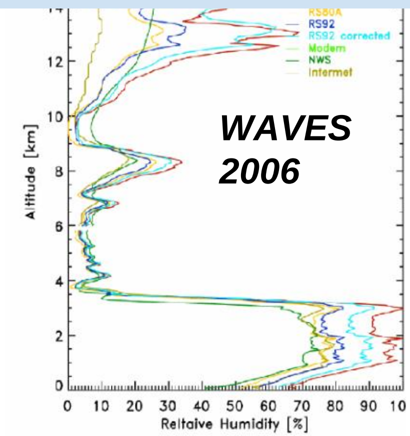
- CFH versions: R23 resolution … hope soon!
- **ThinAir**: Test flight collaborations with Thinair for the transport and return of sondes with gliders (*https://www.flythinair.com/*)
- **HyMPI:** Hyperspectral Microwave Photonic Instrument (HyMPI) and related activities with NASA-GSFC (*https://har.gsfc.nasa.gov/index.php?section=73*)
- **NOAA-JCRDP:** HU & CUNY Joint Collaborative Research and Development Project (JCRDP; *https://hu-bc.org/jcrdp-iop/*)
- **Atmospheric Rivers Recon (AR-Recon)**: University Partnership for Sonde coordination *(https://cw3e.ucsd.edu/arrecon_overview/)*

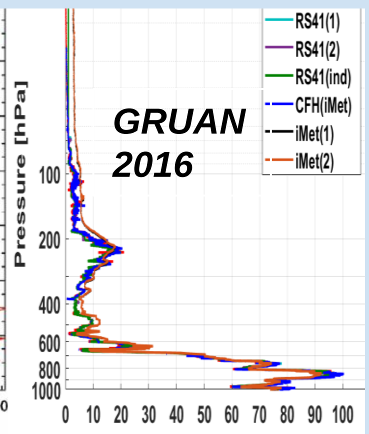
# Beltsville Site: *GRUAN enabled & More*

## Lasting and unique - *beyond papers*

- GRUAN contribution - *only university operated (?)*
- Student training - *many achievements*
- Co-laboratory with agencies - *"open" to all*

**1. *Contribution to "vendor" improvement***

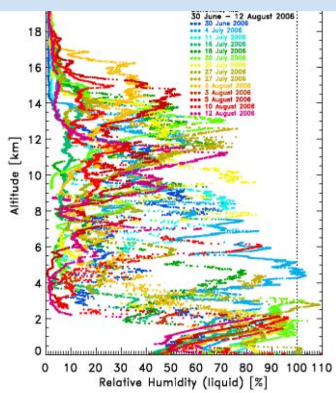


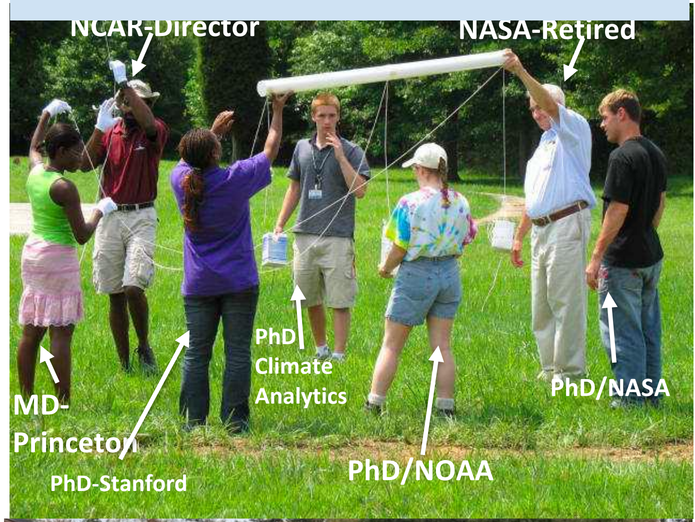

It is time for a GRUAN "Stories" publication.

GRUAN has achieved things that were not in the original goal?

**2. *CFH: few US sites - bridging the data gap***




**3. *Impact: Education***





# Beltsville Site: *Summary (and Outlook)*

**Beltsville Site GRUAN data statistics:**

- *Certified site operated by a university*

**Early years -**

- *Long history of serving as a super-site and inter-agency co-laboratory. Substantial collaboration and coordination with NOAA/NWS/Sterling*

**Beltsville: Uniqueness in GRUAN**

- *Focus in NOAA and other satellite validation*
- *Education & Training is a major focus*
- *Open for collaboration and testing of new-ideas*

***Future Outlook***

- *Hard to predict - but the above work will continue*
- *We plan to find our story and publish.*

**Every GRUAN site has a story.**

Find it!

It is time for a GRUAN “Stories” publication blitz? What was the plan and what we have we achieved?

# Acknowledgements

- NOAA:
  - NOAA - EPP FOr funding NCAS-M
  - NOAA/STAR (JPSS funds sondes) and
  - Howard Diamond (NCEI) fund the Sonde/CFH flights
- MDE:
  - Standing agreement to run a research grade ground observation site.
- NGA:
  - MWR and Ozone sonde activity; CRADA with Howard University
- NASA:
  - Through a Space-Act agreement with GSFC
  - NDAC collaboration starting through Dave Whiteman's work.
  - Ozone Collaboration with SHADOZ group (R. Stauffer, A. Thompson, D. Kollonige, and J. Richards)
- HU and UMBC
  - Graduate and undergraduate Students at Howard University at Beltsville.
  - Adjunct and affiliated status for Demoz

Thank You