AERONET Operations at Two CERES Radiation and Validation Experiment (CRAVE) Sites

https://science.larc.nasa.gov/CRAVE/

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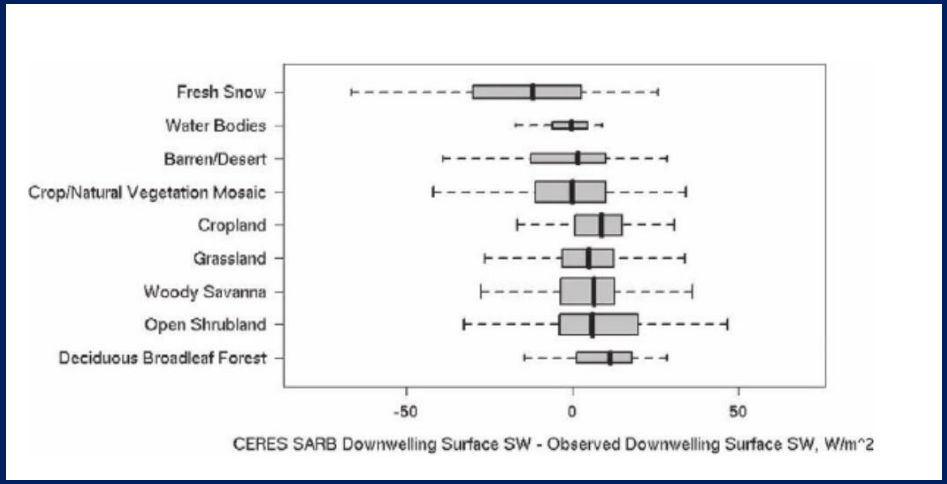
Outline:

- History of AERONET instruments at two active CRAVE sites and one legacy site
- CRAVE locations, instruments/measurements, and AERONET operations
- Focus on AERONET at Granite Island; Logistics, Challenges and Solutions
- Single Day plots showing wildfire smoke affecting measurements

What is CRAVE?

- CRAVE stands for CERES* Radiation and Validation Experiment and provides continuous world-class surface radiation measurements and validation of CERES and other satellite projects.
- CRAVE consists of 2 active sites, Langley Research Center (LRC) and Granite Island (GI), and 1 legacy site (CERES Ocean Validation Experiment or COVE). All with AERONET instruments.
- CRAVE-LRC was established 2014 Dec. (As a local site to conduct shortwave calibrations).
- CRAVE-GI was established 2018 Jun. (Initially to couple CERES, BSRN* and evaporation data).
- CRAVE-COVE measurements were from 1999 Oct. – 2016 Dec. (As a surface validation site for satellite measurements such as CERES).



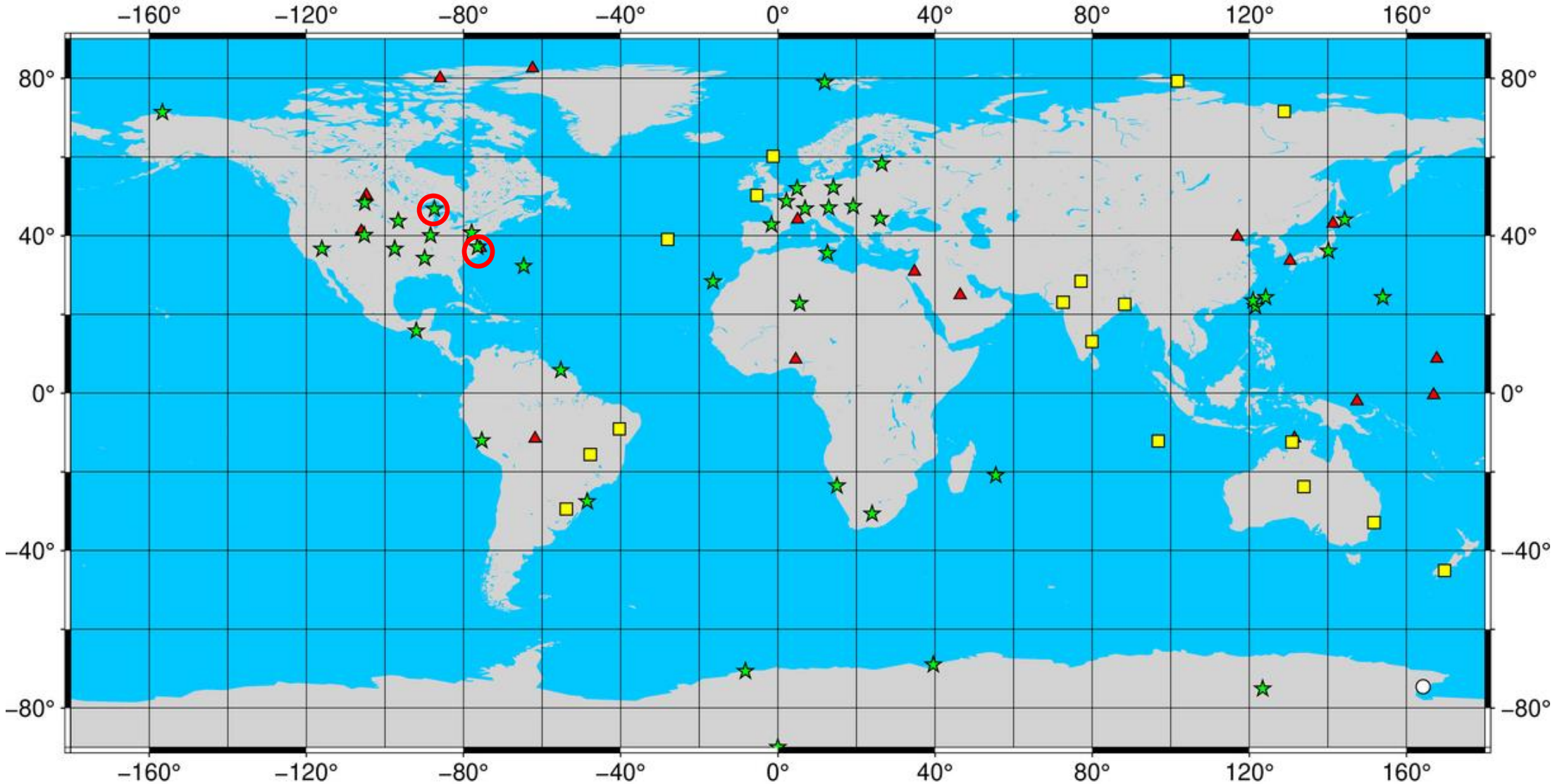
Validation of satellite measurements have been proven to be best over water than other scene types (Rutledge et al., 2006).

*CERES - Clouds and the Earth's Radiant Energy System
*BSRN - Baseline Surface Radiation Network

In addition to AERONET, a table of CRAVE instruments at both NASA LaRC and Granite Island

Measurement	Instrument (Model)	Units	Wavelength in μm (approximate)
Direct Shortwave Irradiance	Kipp and Zonen Pyrheliometer (CH1 or CHP1)	W/m^2	0.2 - 4.0
Diffuse Shortwave Irradiance	Kipp and Zonen Pyranometer (CM21, CM22 or CM31)	W/m^2	0.2 - 3.6
Global Shortwave Irradiance	Kipp and Zonen Pyranometer (CM21, CM22 or CM31)	W/m^2	0.2 - 3.6
Longwave Irradiance	Eppley Pyrgeometer (PIR), or Kipp and Zonen (CGR4)	W/m^2	4.0 - 50.0
Spectral Sun Irradiance and Sky Radiances	Cimel Electronique Sunphotometer (CE 318-T)		0.34, 0.38, 0.44, 0.5, 0.675, 0.87, 1.02 and 1.640
Aerosol Optical Depth (Granite Island only)	Middleton (SP02-L)		0.413, 0.5, 0.676 and 0.86
Photosynthetic Active Radiation (PAR)	Li-Cor (LI-190R)	$\mu mol\ s^{-1}\ m^{-2}$	0.4 – 0.7
Air Temperature	Vaisala (HMP60)	°C	
Relative Humidity	Vaisala (HMP60)	Percent	
Barometric Pressure	Vaisala (PTB110)	mb	
Wind Speed and Direction (LRC only)	R. M. Young (05108-45)	m/s and 0-360°	
Lake Temperature (Granite Island only)	Heitronics (KT15.85)	°C	9.6 - 11.5

Running, inactive, planned and closed BSRN Stations, July 2024



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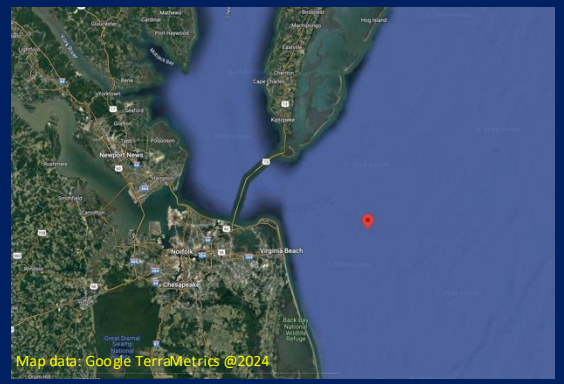
HELMHOLTZ-ZENTRUM FÜR POLAR- UND MEERESFORSCHUNG

Description of the AERONET Measurement Locations

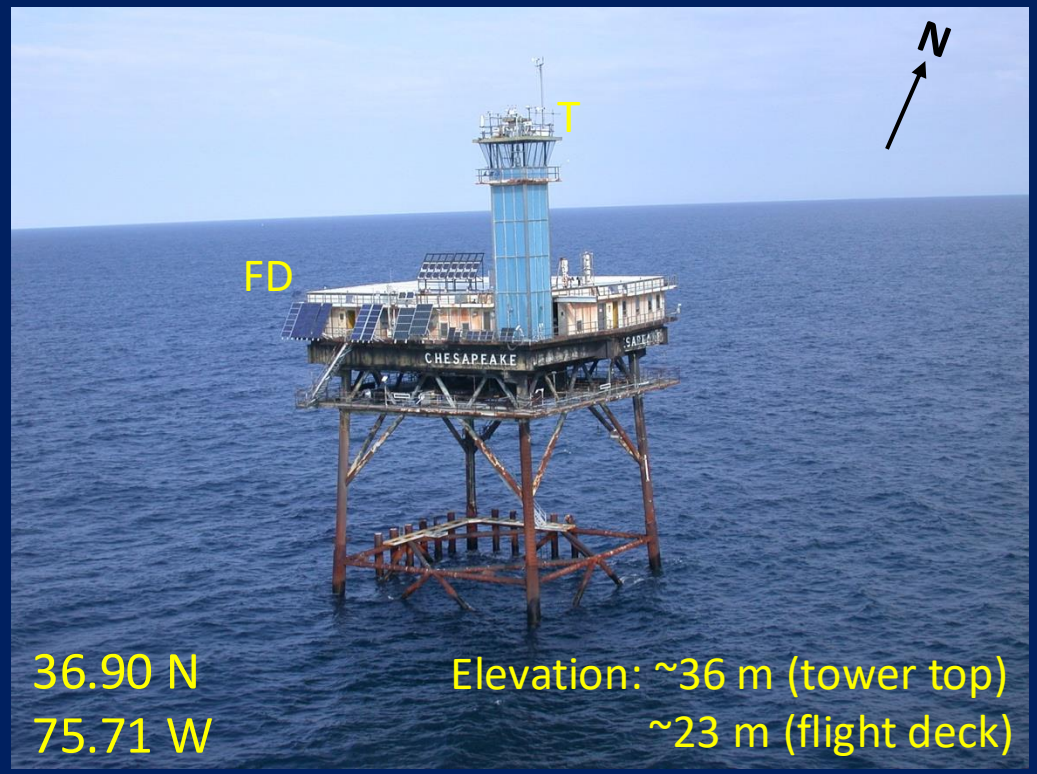
- COVE and COVE SEAPRISM
- NASA LaRC
- Granite Island

CERES Ocean Validation Experiment (COVE) at Chesapeake Lighthouse – Closed since 2016 Dec.



~ 25 km off the coast of Virginia Beach

COVE and COVE SEAPRISM



36.90 N
75.71 W

Elevation: ~36 m (tower top)
~23 m (flight deck)

Flight Deck (FD)

Tower top (T)

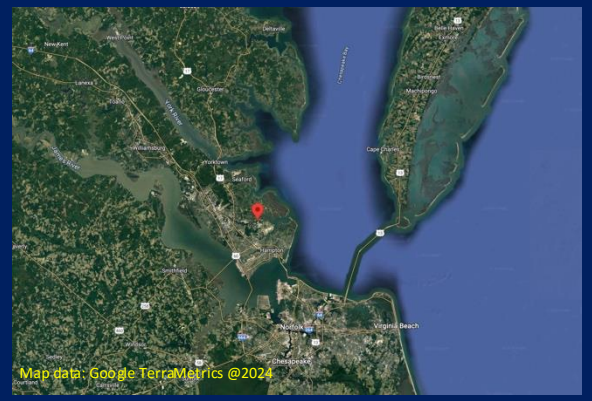
Operational Time: AERONET Standard (Oct. 1999 - Jan. 2016)

Version 3	Level 1.0	Level. 1.5	Level 2.0
Days	4050	3378	3378
Years	11.1	9.25	9.25

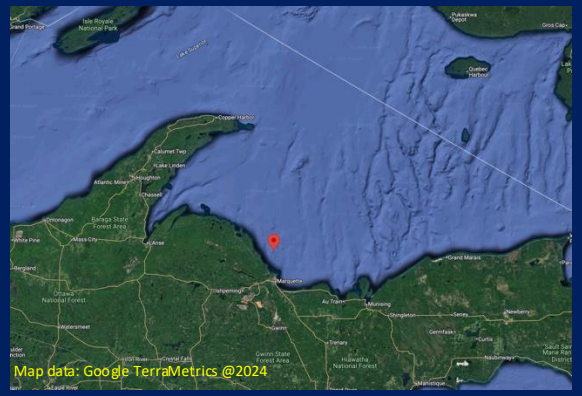
AERONET SeaPrism (2005 Nov. – 2016 Jan.)

Version 3	Level 1.0	Level. 1.5	Level 2.0
# Data pts.	14679	2106	848

NASA LaRC



Granite Island



~10 km from nearest land point

*Operational time: 2012 May – Present

Version 3	Level 1.0	Level. 1.5	Level 2.0
Days	3649	2971	2868
Years	10.0	8.14	7.86

Operational time: 2018 June – Present

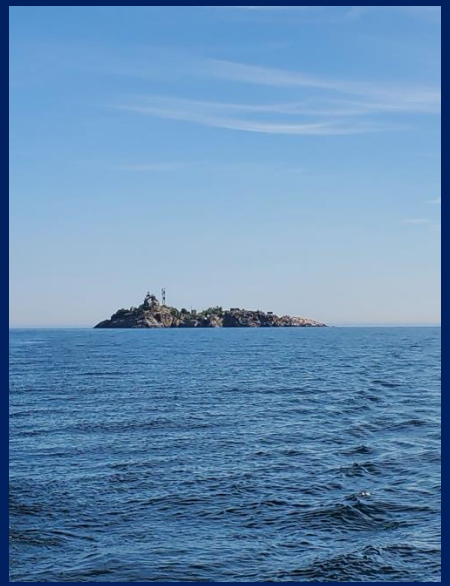
Version 3	Level 1.0	Level. 1.5	Level 2.0
Days	1358	1029	936
Years	3.72	2.82	2.56

*Some data 2004 Nov.-Dec., 2005 Apr., and 2011 Sep.-Nov.

Accessibility and Calibration:

- NASA LaRC is easier to maintain (close, accessible, on the grid)

- Granite Island is more difficult (off the grid, inaccessible for several months, harsh winter)



Calibration (Both sites):

- ~18-month interval
- Spare instruments are usually available to lessen data gaps

Solar Power System at Granite Island

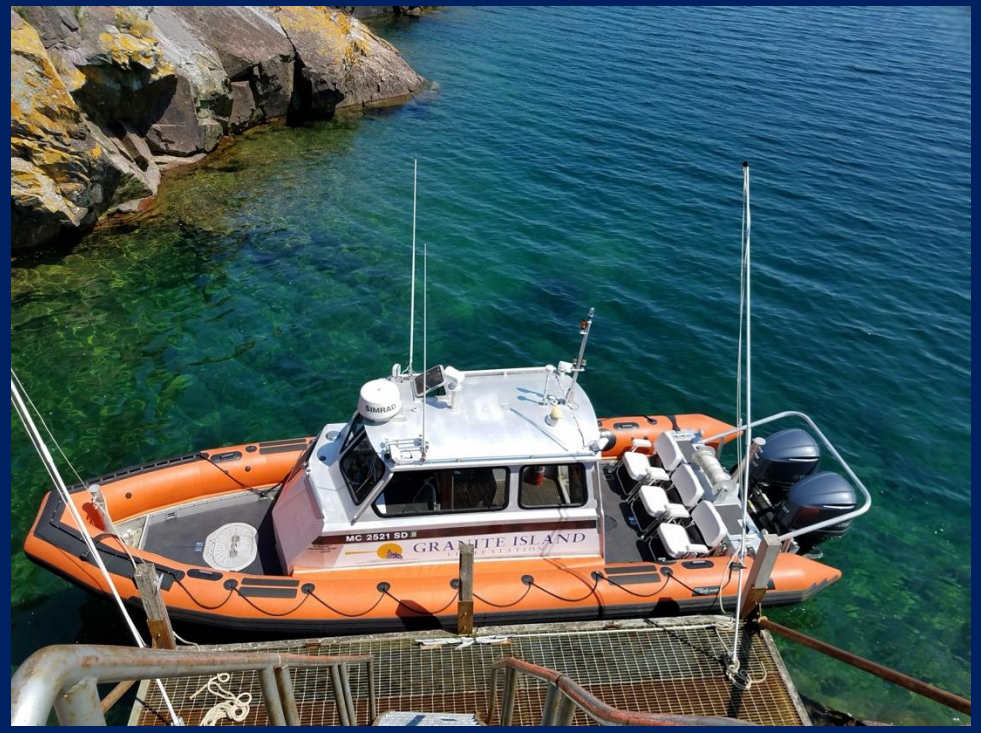
Solar Panels (Qty: 4)

Batteries (Qty: 18)
Arranged in pairs to make a 12V system

Two Outback charge controllers

Remote switches turn hardware on/off

Transportation and Communications at Granite Island



Boat transportation (9 m Zodiac 920)

Moxa serial over IP

AERONET instrument and inside enclosure

Northern Michigan University provides internet and static IP's

- Trips are twice a year (Usually Spring and Fall)
- Model: CE318-T (also at NASA LaRC)
- Uses "cimelTS_https_connect.exe" to upload data (NASA LaRC too) via Moxa serial over IP

Challenges and Solutions at Granite Island

Perching

Cable binding

Spiderwebs

The biggest concern is ice…

- AERONET has a “wet sensor” to not run in icy conditions, but it can also be turned off remotely (PhotoGetData)
- Since its inception, AERONET has operated well in this environment

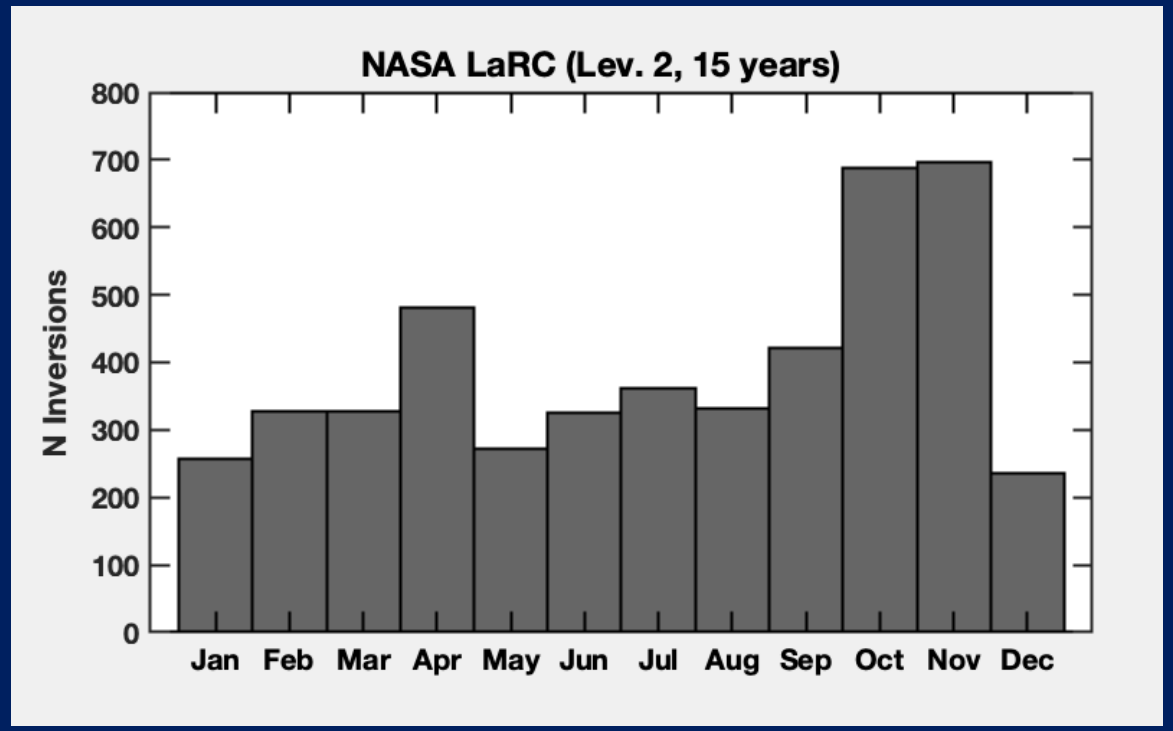
Ideal Conditions

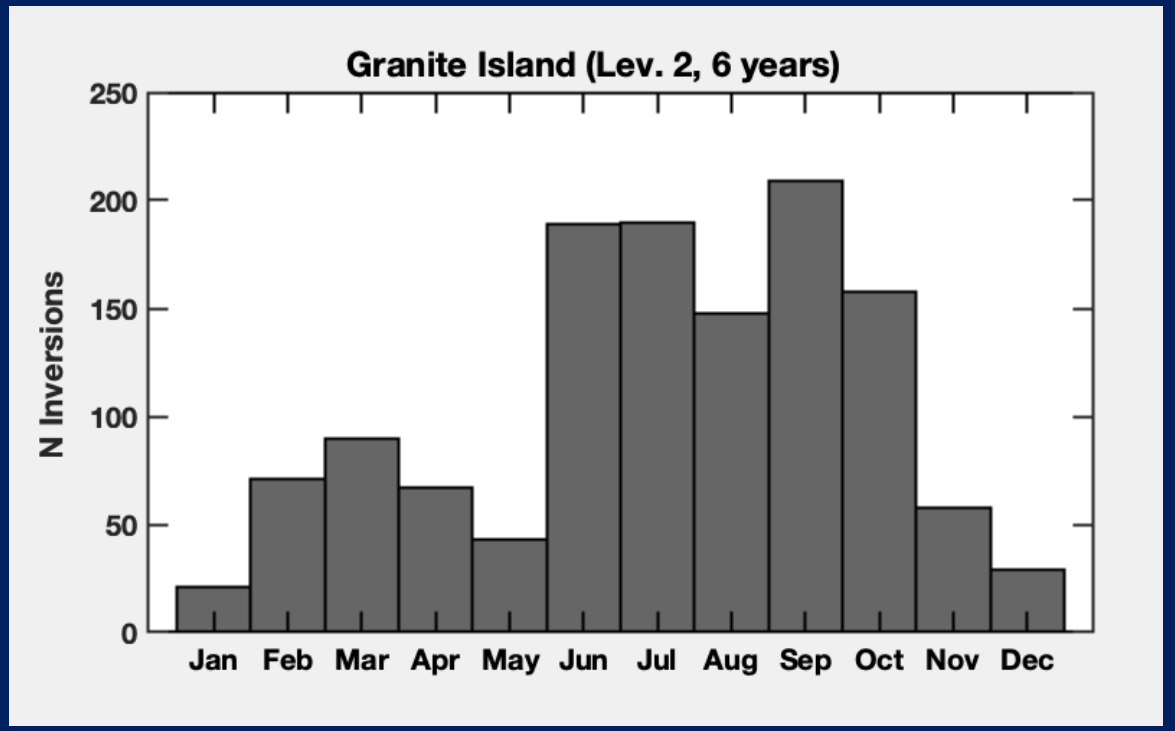
Icy Conditions

Why so much ice?

Nearly full view of Granite Island. View is looking North

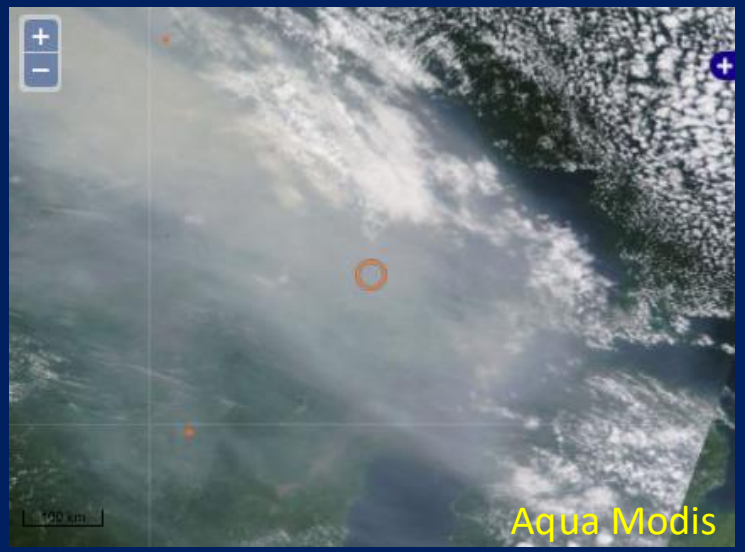
Number of Inversions (Level 2.0, Version 3)

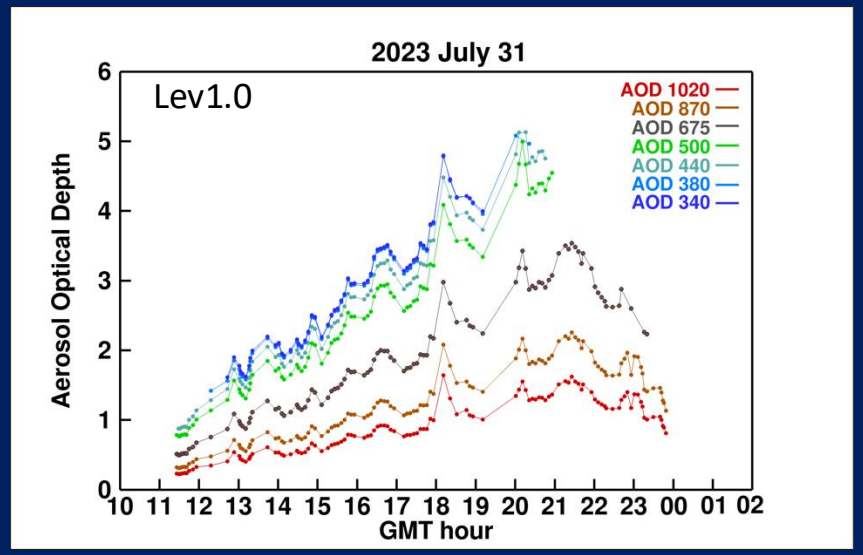


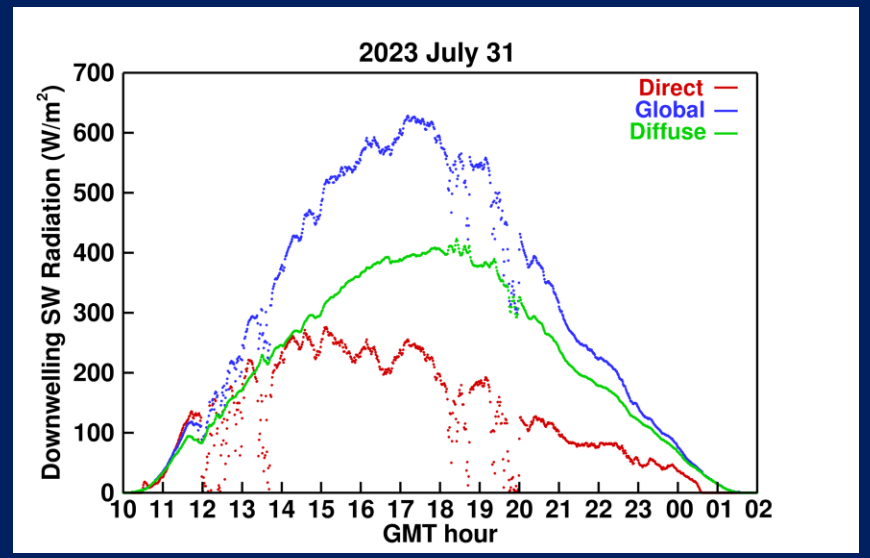


- Monthly N inversions at NASA LaRC is consistent over 15 yrs. except a few months being much higher
- Granite Island has less inversion data in the colder months compared to the warmer months
- Both sites appear to be ”cleaner” (less inversion data) in the colder months, particularly Jan. and Dec., but that could be due to clouds, especially at GI.

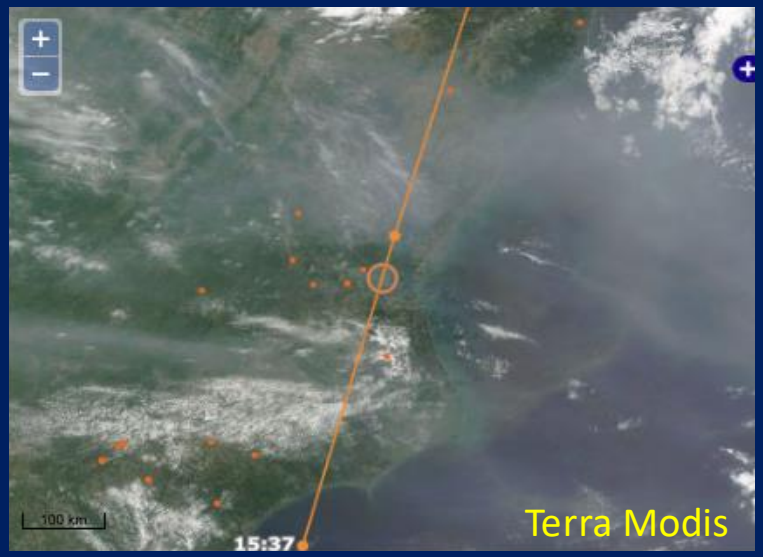
Wildfire Smoke over Granite Island (originated in Canada)….

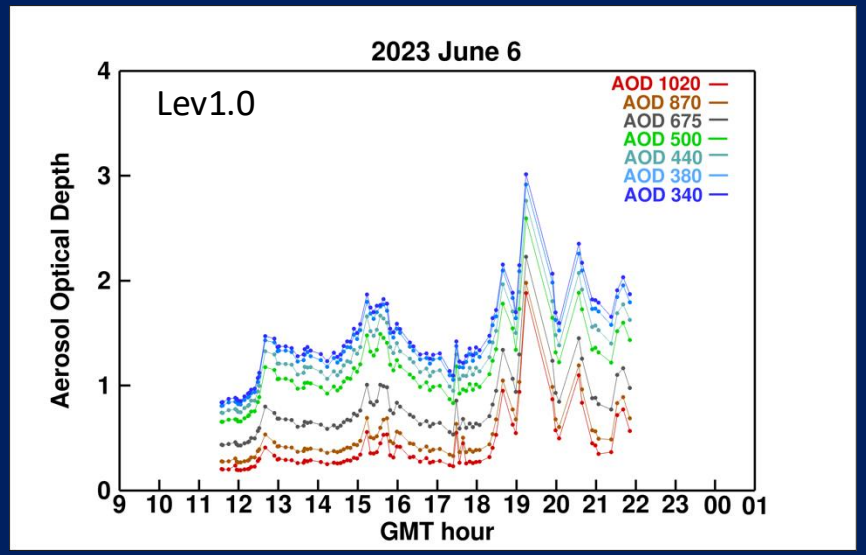


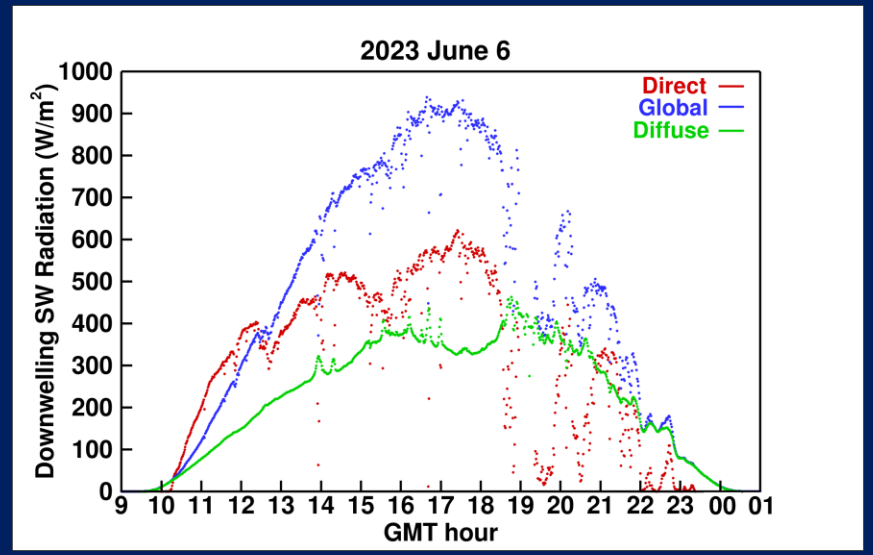




….over NASA LaRC







Seagulls at Granite Island

Summary

- Granite Island and Langley Research Center are 2 of only 43 active BSRN sites in the world and also host AERONET instruments.
- AERONET and Ocean Color measurements were ongoing at COVE for many years, but due to structural concerns at Chesapeake Lighthouse, was vacated in Dec. 2016.
- NASA LaRC has been operational for ~ 12 years. NASA LaRC is much easier to maintain due to its accessibility, being on the grid, and close to the office.
- Granite Island has been operational for ~ 6 years, and the site has functioned well in the difficult, “off the grid” environment, but troubleshooting techniques are in-place to minimize problems with remote capabilities (PhotoGetData) and by local help/interns.
- Granite Island and Nasa LaRC have less inversion data in the colder months and wildfire smoke from Canada creates high AOD’s at both sites.

Acknowledgments:

- Thank you to Norman Loeb and the (CERES) project for funding the CRAVE project
- Ali Omar for providing the AERONET instrument at CRAVE-LRC
- Elena Lind, Pawan Gupta and Brent Holben for providing an AERONET instrument at GI
- Scott Holman (Owner of GI): Provides Granite Island to be utilized for CRAVE and AERONET
- John Lenters: Maintains evaporation measurements at GI and helps with instrument issues
- Jon Billman: Assists with instrument issues at GI
- Dan Chiconsky: Primary captain of the boat for transport to Granite Island and helping with instrument issues at GI
- Aimee Amin, Jay Madigan: For the design and implementation of the CRAVE logo and QR code