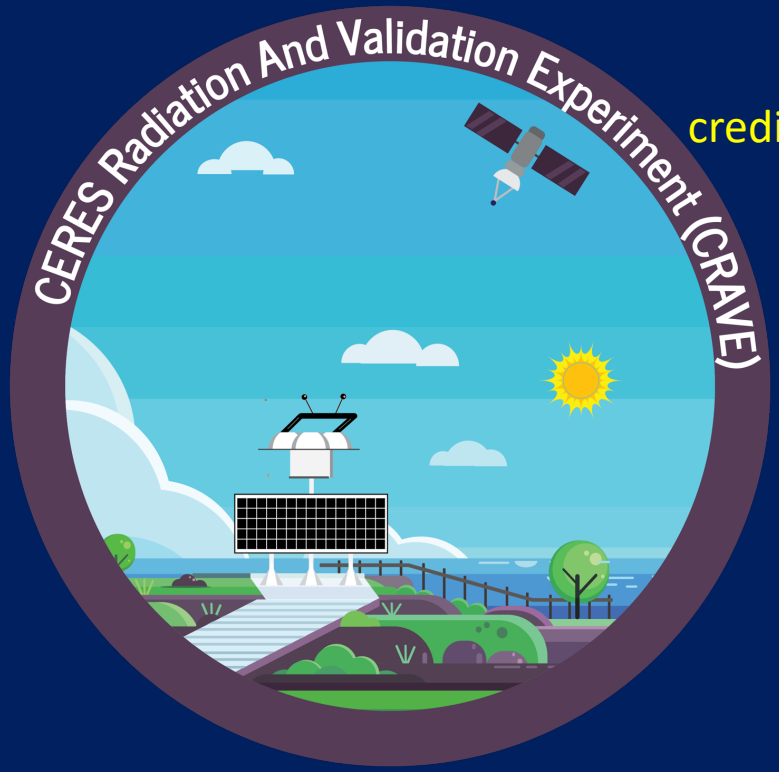
CRAVE Operations and Some Challenges at Granite Island



credit: Aimee Amin

credit: Jay Madigan

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

Bryan Fabbri[1], Greg Schuster[2], Fred Denn[1], Jay Madigan[1], Dave Rutan[3]

1 – Analytical Mechanics Associates (AMA), Hampton, Virginia

2 – NASA Langley Research Center, Hampton, Virginia

3 – Adnet Systems, Hampton, Virginia

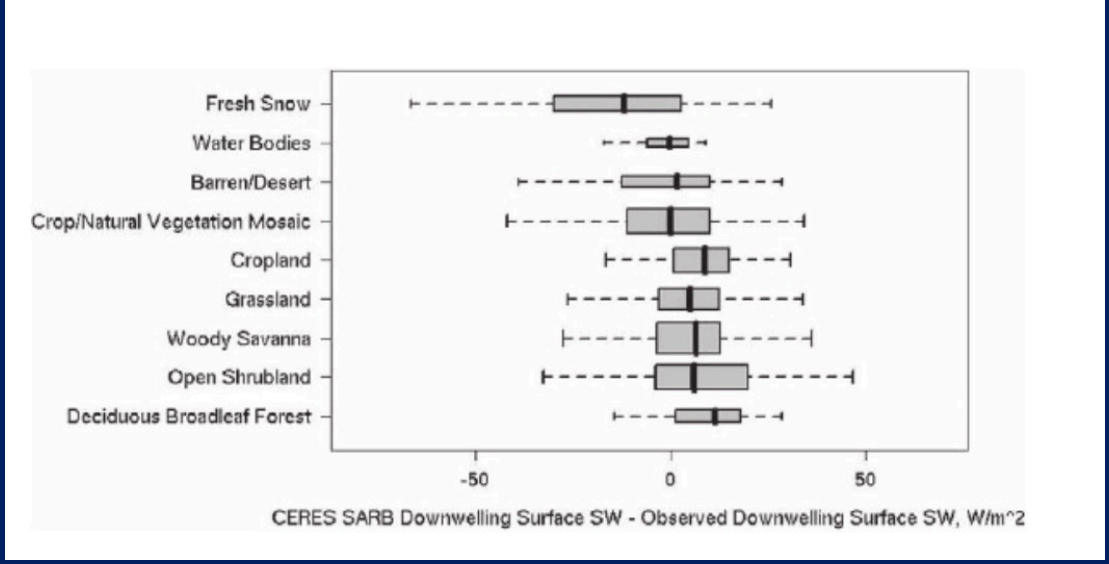
CERES Science Team Meeting, May 14-16, 2024, Hampton, Virginia

Outline:

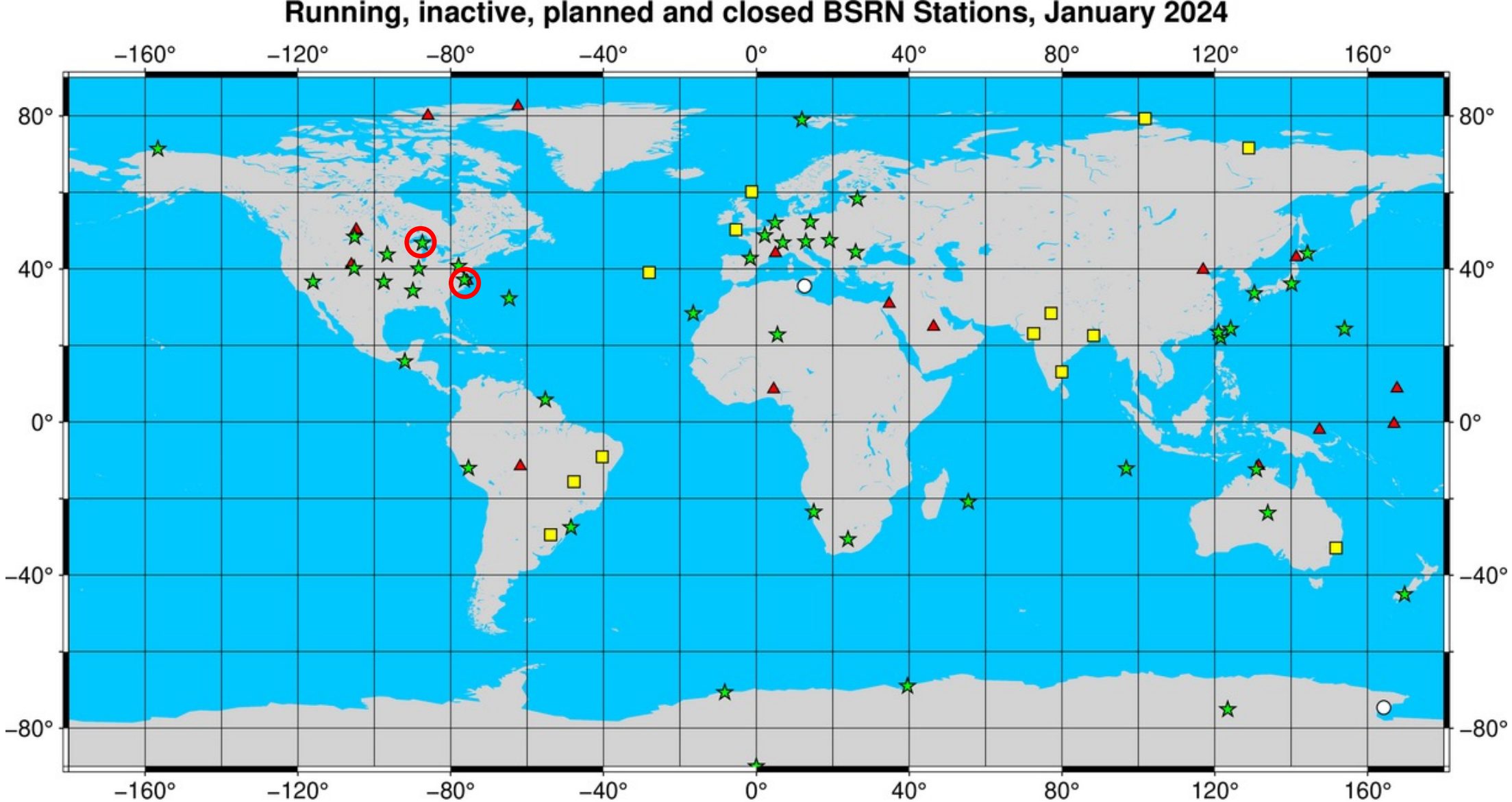
- What is CRAVE and its importance
- CRAVE locations, operations and instruments/measurements
- Focus on Granite Island; Logistics, Challenges and Solutions
- Data analysis (CERES SYN1deg vs CRAVE observations)

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 and Granite Island) and 1 legacy site (CERES Ocean Validation Experiment or COVE).
- CRAVE-LRC was established Dec. 2014 as a local site to conduct shortwave calibrations.
- CRAVE-GI was established in 2018 with interest to couple CERES, BSRN and evaporation data. CRAVE-GI is also a rare water site in the BSRN network.



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



- Use instruments with highest available accuracy
- High temporal resolution (1-3 minutes)
- Rigorous calibration protocols

BSRN is most highly respected archive of long-term surface radiation obs.

ALFRED-WEGENER-INSTITUT
HELMHOLTZ-ZENTRUM FÜR POLAR- UND MEERESFORSCHUNG

CRAVE-Langley Research Center

BSRN ID: LRC; Type: Grass, Flat, Urban

CRAVE-Granite Island (private)

BSRN ID: GIM; Type: Water, Lake, Flat, Rural

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

Calibration

- Shortwave Instruments calibrated in-house (yearly).
- Longwave instruments sent to NREL in Golden, CO (every 2-3 years).
- MET replaced as needed.
- AERONET ~18-month interval.

NOTE: Round robin calibration experiment was completed last year with Sandia labs (New Mexico) and University of Oregon's Solar Radiation Monitoring Laboratory. Results anticipated by end of year.

Granite Island

Batteries – Newly installed June 2022

Batteries specifications:

- Dimensions: 11.61” x 7.05” x “15.91”
- Weight: 123.5 lbs./ea. (total: 2223 lbs.)
- QTY : 18

Arranged in pairs to make a 12V system. Our estimate is 2800AH. This would be for 50% discharge with 5 days of heavy overcast.

Solar Panels, Charge Controllers and Comms.

Solar Panels (QTY: 4)

Panasonic

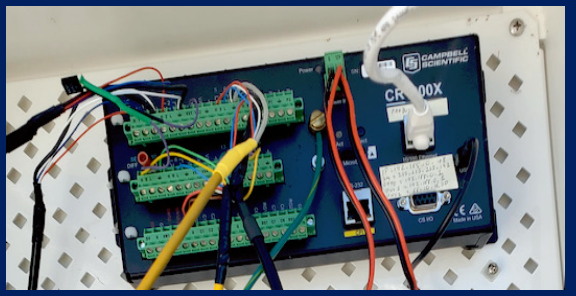
Panasonic:

- Industry-leading efficiency
- Eco-friendly manufacturing processes

Model	Part No.	Watts	Amps	Volts	Size & Weight	Price
Panasonic 330 watt Module 96 Cell HIT - Black Solar Panel	1941905	330W	5.70A	58.0VDC	62.6 x 41.46 x 1.38 in 40.81 lbs	CALL

Two Outback charge controllers

Dataloggers can store at least 9 months of data.



NOTE: NMU provides Internet and static IP’s

Remote Capabilities and Local Help

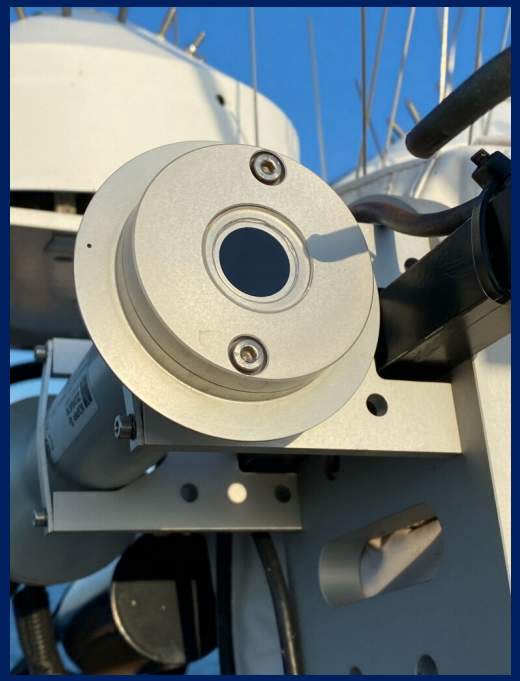
- LRC is easier to maintain (close, accessible and on the grid).
- GIM is more difficult (off the grid, inaccessible for several months, harsh winter).
- Steps have been taken to minimize issues at GIM.

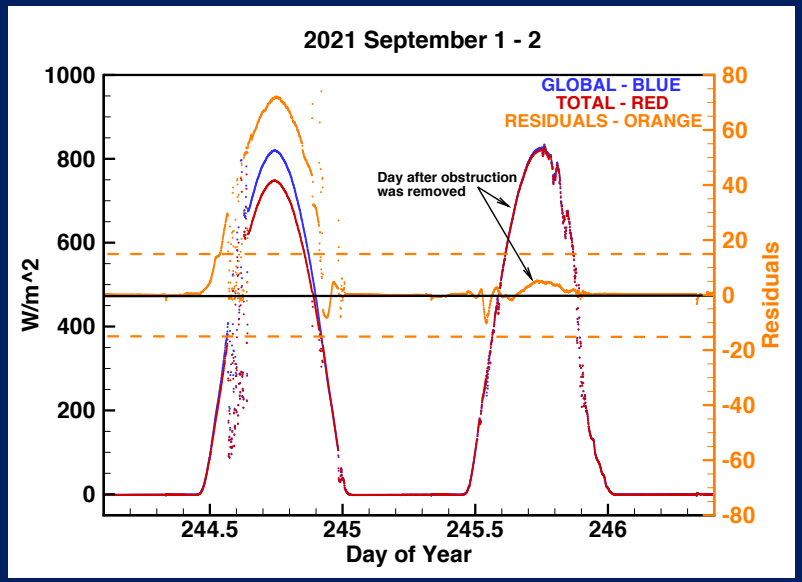
Auto clean of instruments

Remote switches turn hardware on/off

Local Help

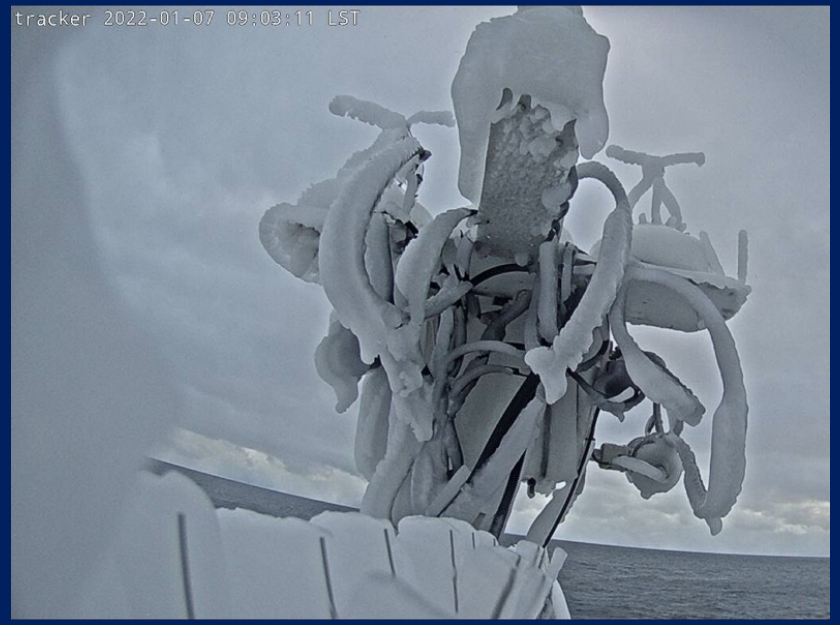
Initial Challenges and Solutions at Granite Island





The biggest issue is ice…

Ice Conditions



Ideal Conditions

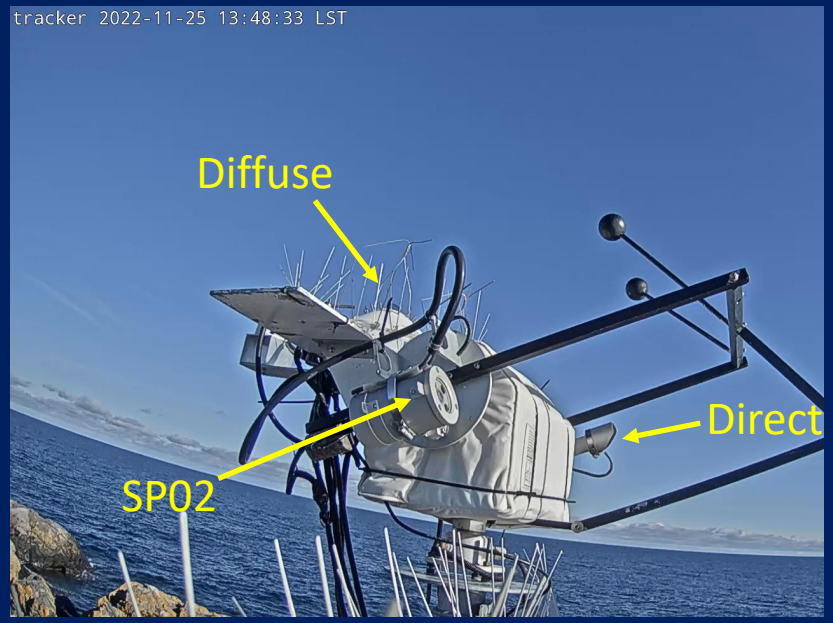
Solar tracker can be turned off; AERONET has sensor to not run in icy conditions.

Why so much ice?

Nearly full view of Granite Island. View is looking North

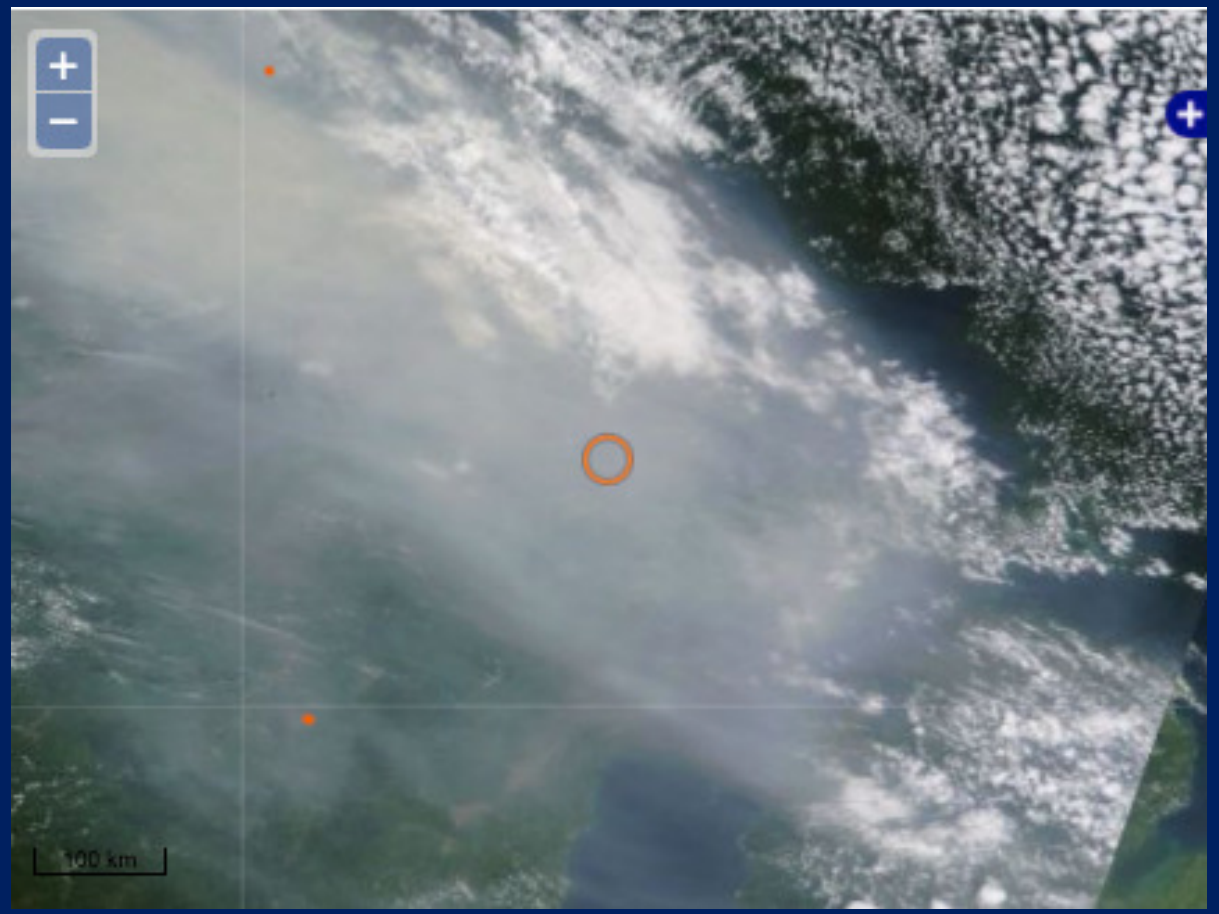
If Solar Tracker fails……

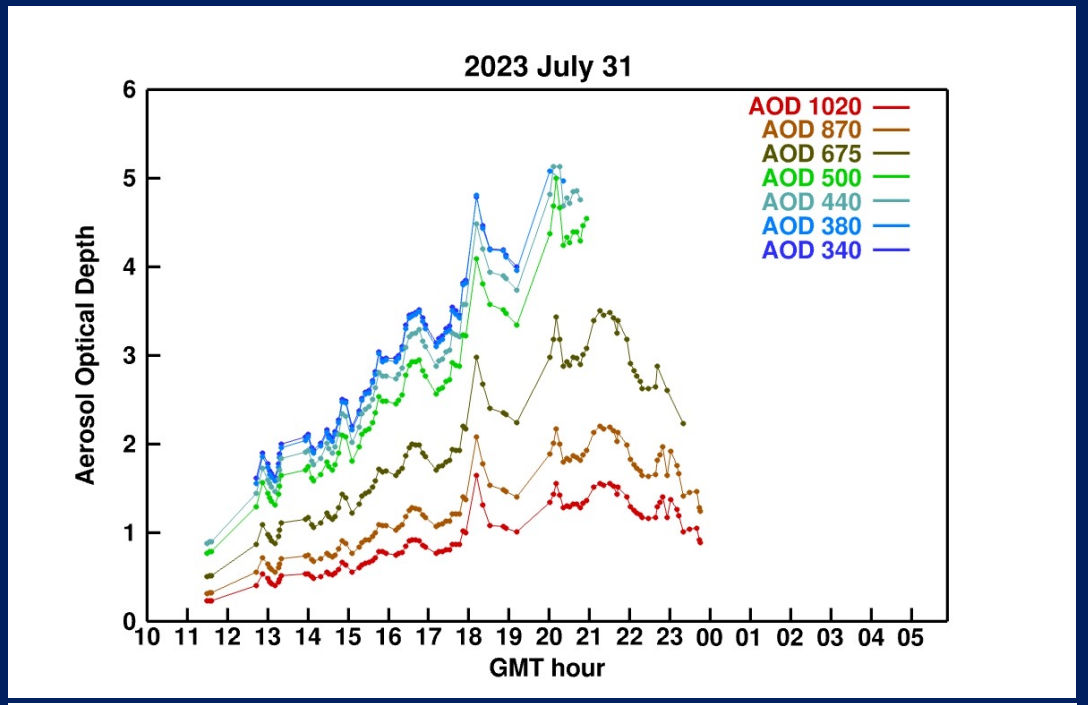
We lose downwelling direct, diffuse and SP02 (spectral sunphotometer)……

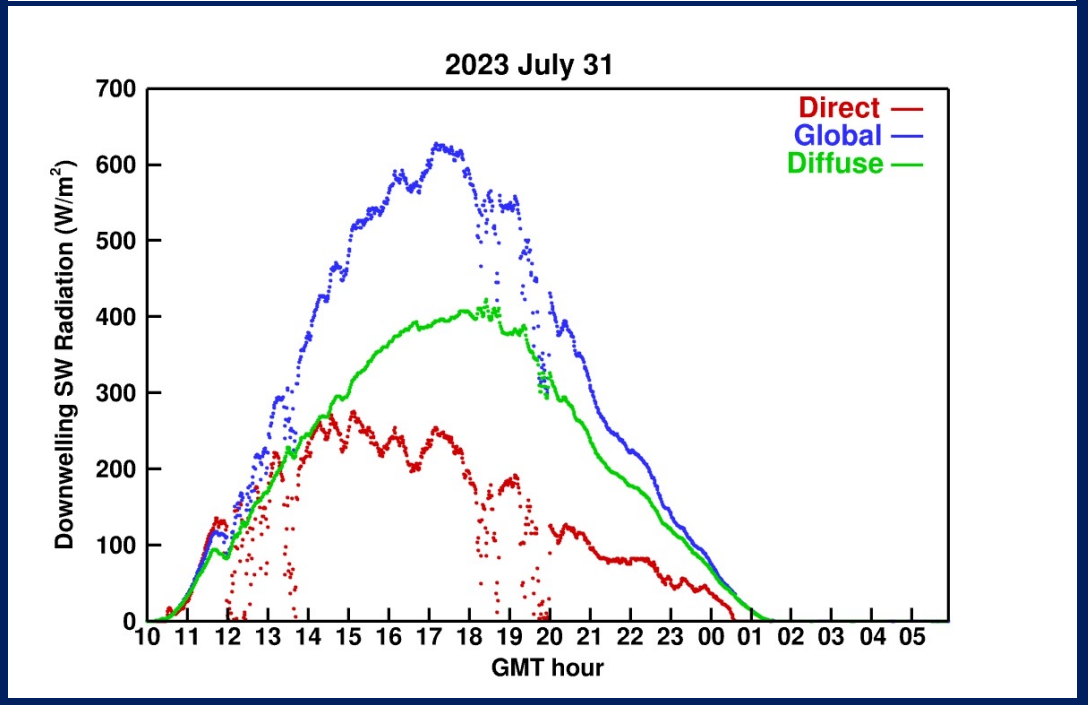


…..However, we continue to have MET, PAR, AERONET, Lake Temp, downwelling SW global (moved to stand-alone) and downwelling LW.

Wildfire Smoke over Granite Island (originated in Canada)

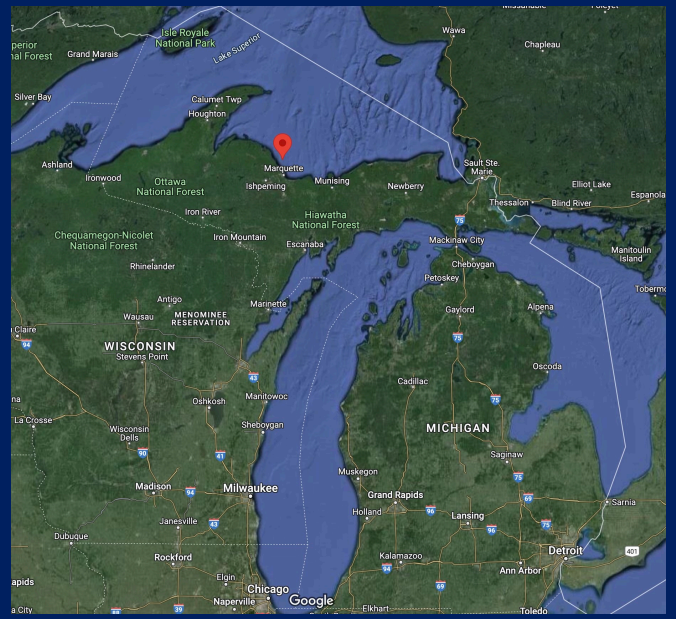




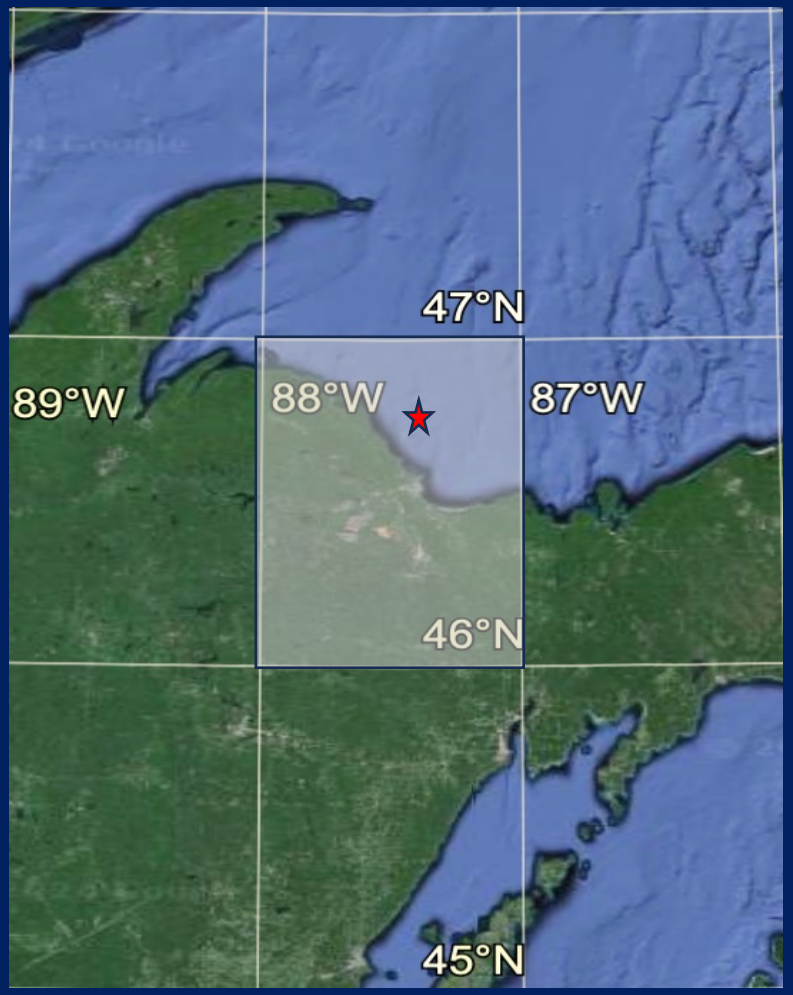


Surface Observations vs CERES SYN1deg

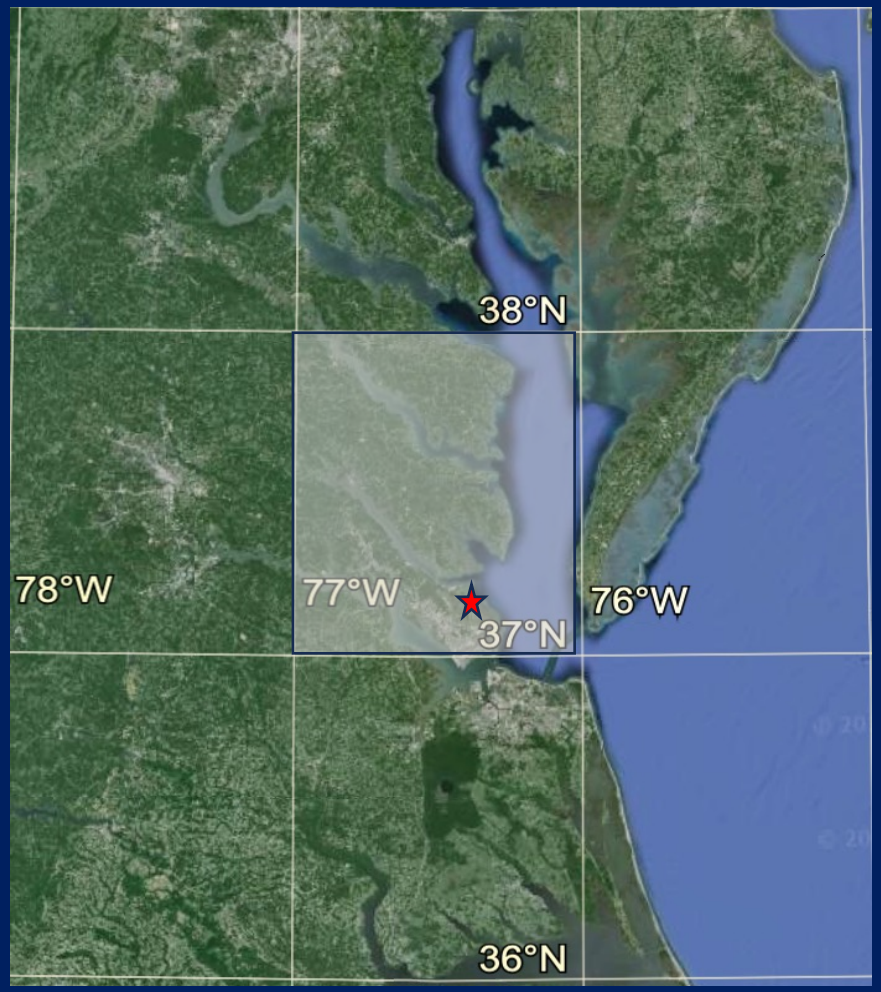
SYN1deg “grid box”



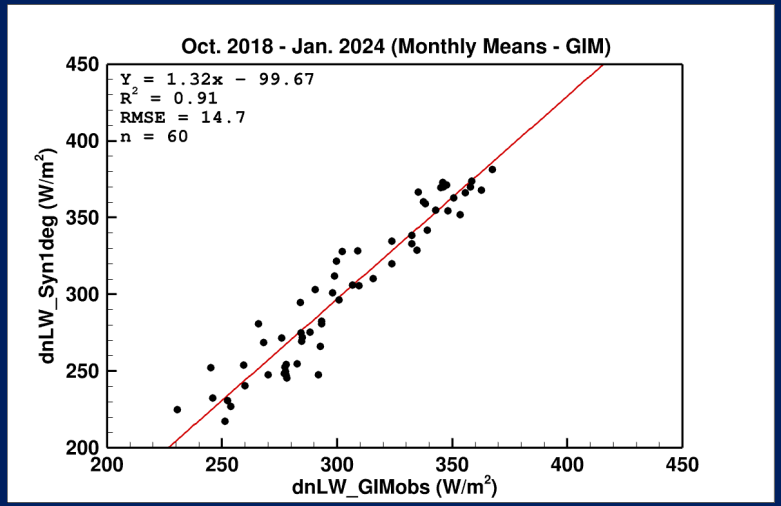
Granite Island (GIM)

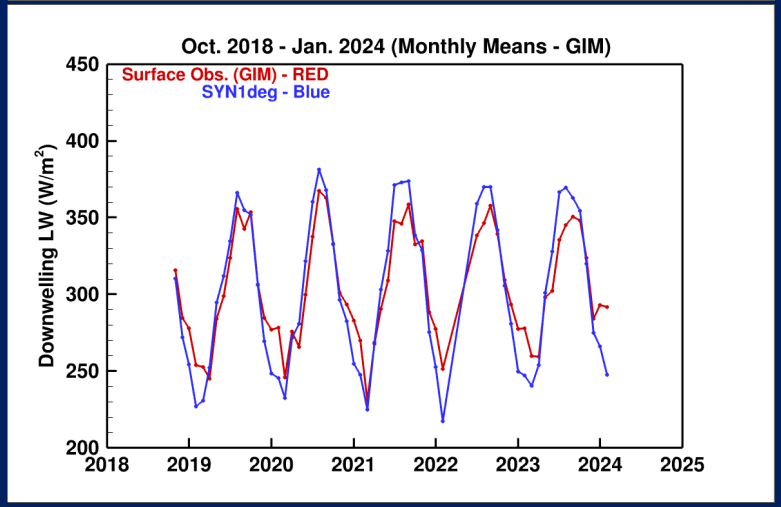


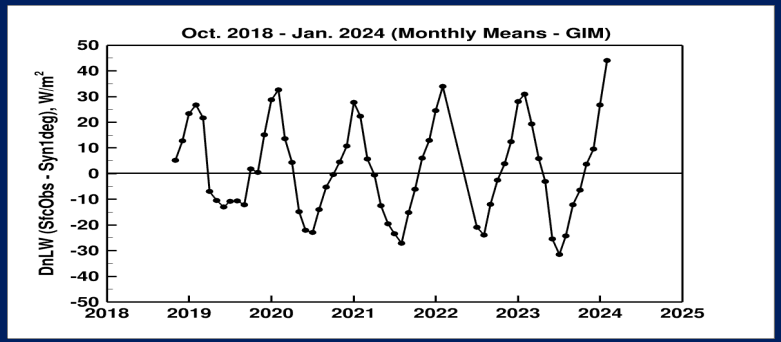
Langley Research Center (LRC)



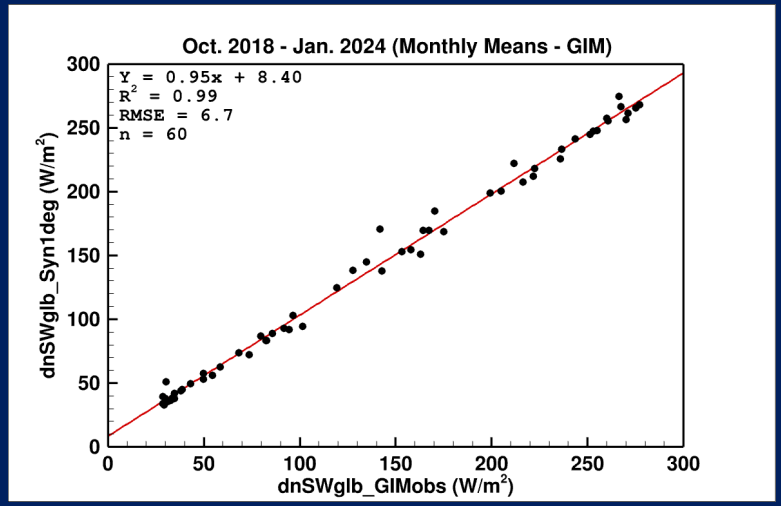
Downwelling LW

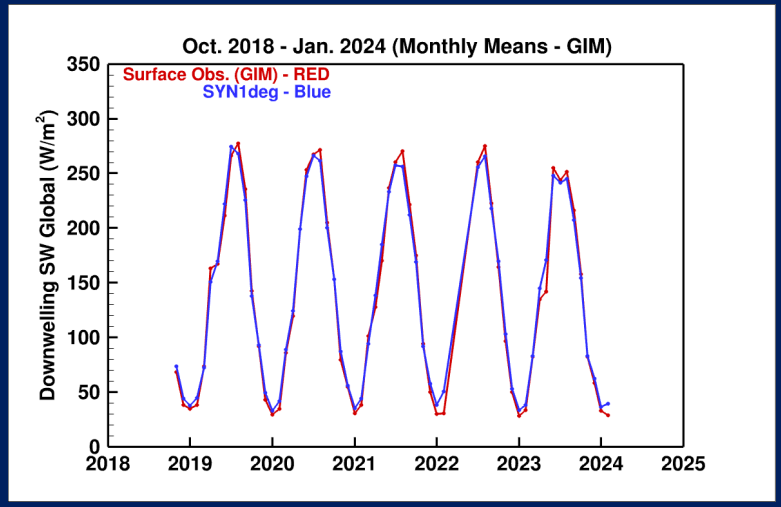


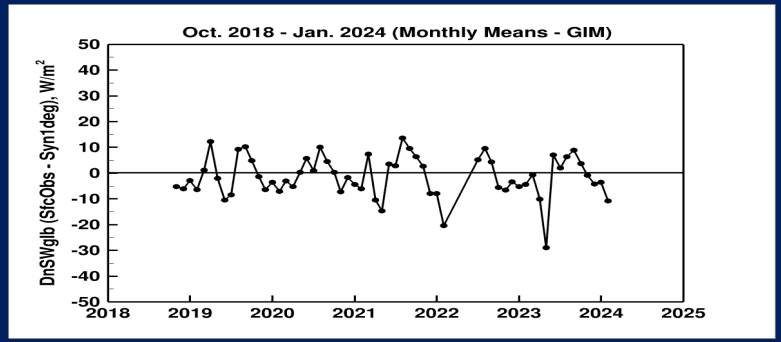




Downwelling SW Global

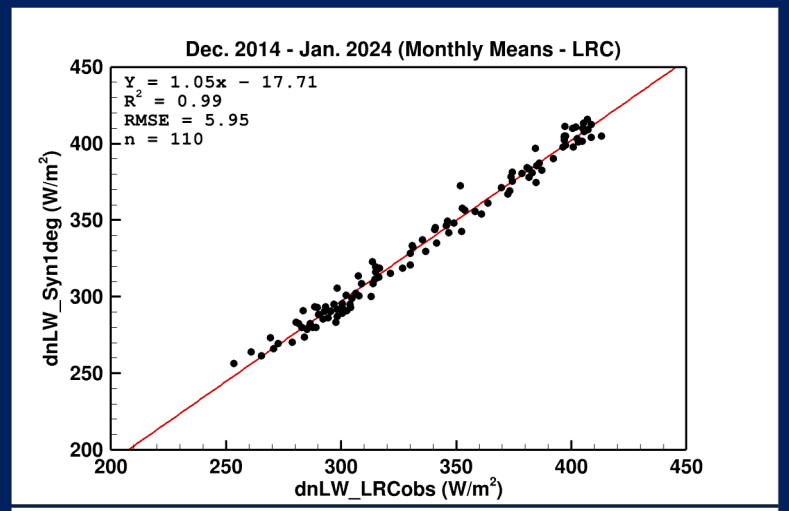


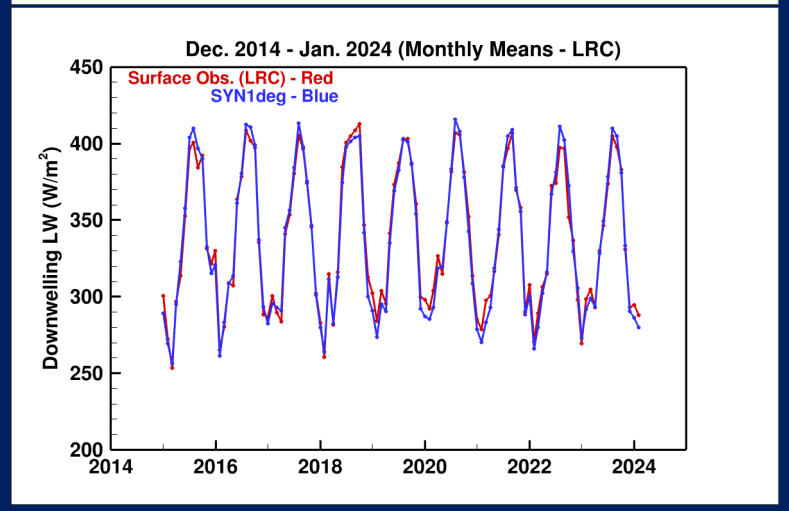


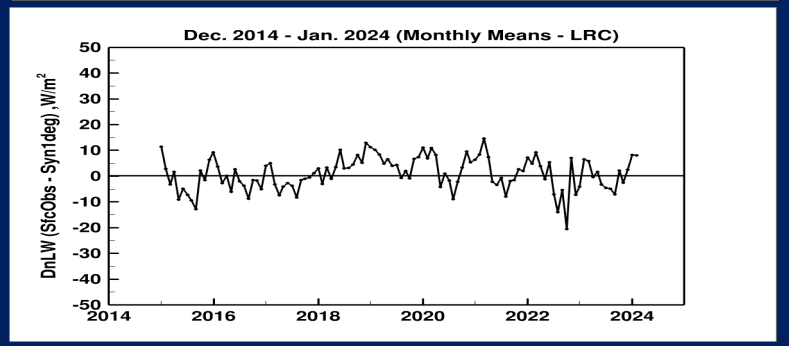


GIM

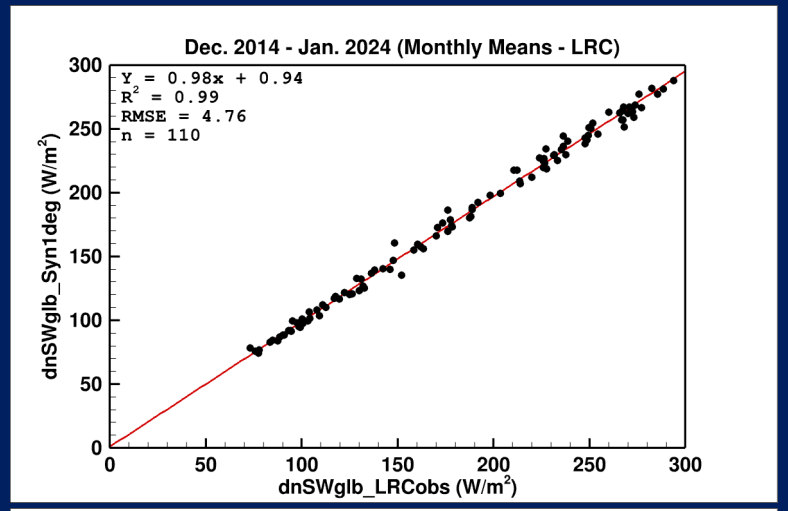
Downwelling LW

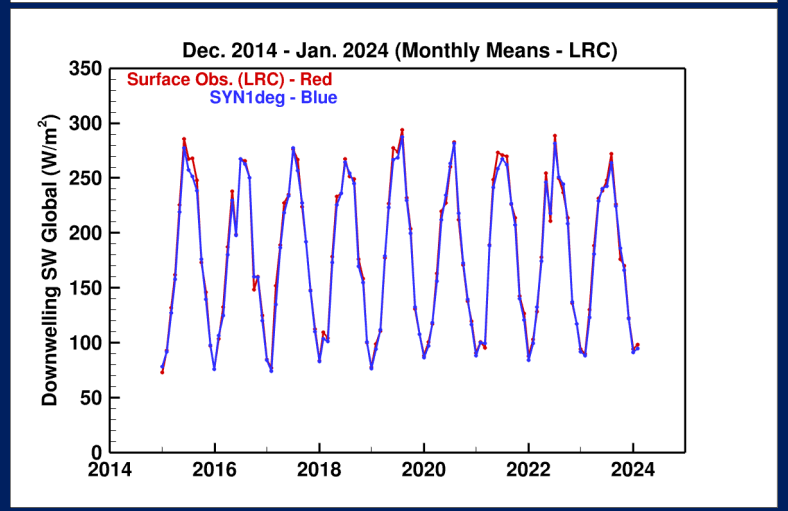


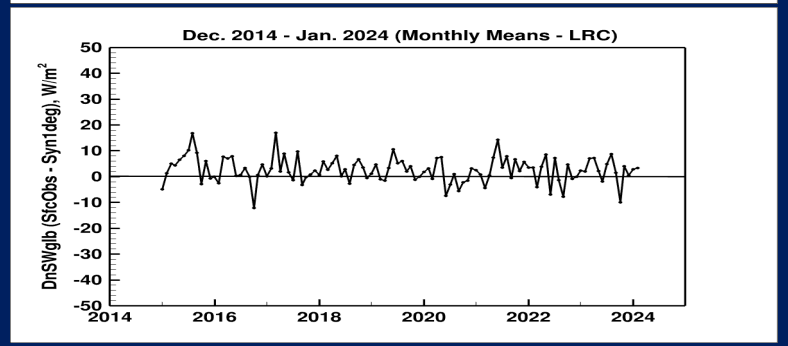




Downwelling SW Global







LRC

Journal Articles:

Granite Island:

- 10 papers (6 in the last year)
- Data availability: 2018 July - Present

Langley Research Center:

- 26 papers (8 in the last year)
- Data availability: 2014 December - Present

COVE:

- 155 papers (10 in the last year)
- “The Component Summation Technique for Measuring Upwelling Longwave Irradiance in the Presence of an Obstruction”
- Data availability: 2000 May – 2016 November

Seagulls at Granite Island

Summary

- Granite Island and Langley Research Center are 2 of only 51 active BSRN sites in the world.
- Downwelling SW (direct, global and diffuse) and LW, PAR, AERONET, MET (Pressure, Temp/RH) are measured at both CRAVE sites with some redundancy.
- Langley Research Center is approaching 10 years of measurements. Issues are limited but when they due occur, they are dealt with quickly due to accessibility.
- Granite Island has ~5 years of measurements and the site can be difficult, especially in winter (ice!), but issues have been minimized over the years with remote capabilities, trial and error and assistance by local help/interns.
- Downwelling SW global surface observations (monthly means) compare well with CERES SYN1deg at both sites; Downwelling LW comparisons are better at LRC than at GIM.
- In the last year, there has been an increase in the number of journal articles using data from both active CRAVE sites, with the legacy COVE site continuing to have much interest.

Acknowledgments:

- Thank you to Norman Loeb and the (CERES) project for funding the CRAVE project and the summer internships.

- Scott Holman (Owner of GI): For providing Granite Island to be utilized for this project.

- Dan Chiconsky: Primary captain of the boat for transport to Granite Island and helping with instrumentation issues.

- John Lenters: Maintains evaporation measurements at Granite Island and helps with instrumentation issues.

- Susy Ziegler and Jon Billman: For being liaisons between the CRAVE team and NMU students.

- NMU Interns since 2019 – Elizabeth Hoffmann, Casey Haugen, Matthew Alanskas, Jayde Schoolcraft, Kathryn Smith and Lillian Grear (2024 intern).