Granite Island in Lake Superior

A New CERES Measurement and Validation Site

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Location: Hampton University

Hampton University Center for Atmospheric Research and Education Seminar Series

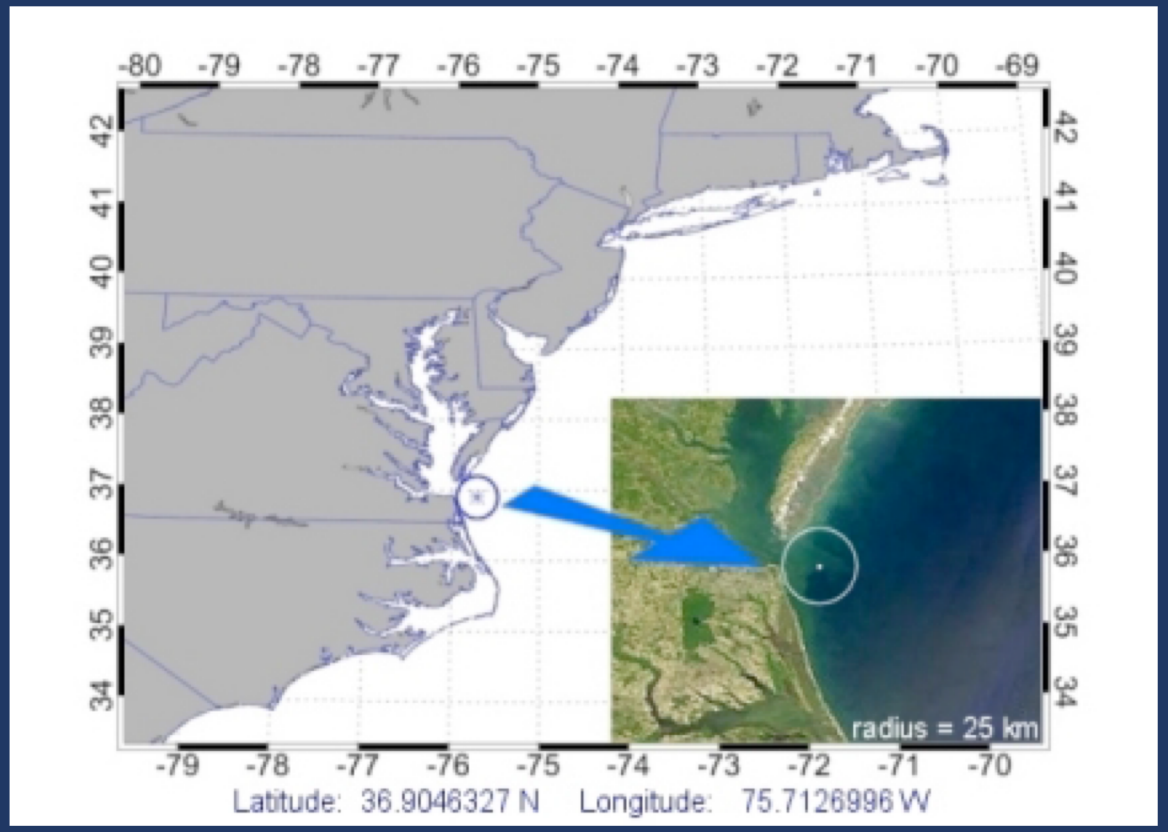
Introduction:

- Chesapeake Light Background
- The CERES Ocean Validation Experiment (COVE) at Chesapeake Light
- Why was COVE established
- Measurements at COVE
- New Opportunity at Granite Island (GI)
- Why was GI established
- Logistics, Measurements, Calibration and Challenges at GI
- Acknowledgements

A Review of COVE….

Where is Chesapeake Light?

- 25 kilometers (~15 miles) East of Virginia Beach, Virginia
- Coordinates: 36.90 N , 75.71 W
- Water Depth is shallow. Only 10 meters (~ 33 feet)



Timeline:

- 1965 – Chesapeake Light is built & stands 36 meters (120 ft) tall to mark the entrance to Chesapeake Bay
- 1980 – Chesapeake Light was automated
- Nov. 1997 – NASA agreement in place with Coast Guard (CG) for atmospheric and oceanic research. Chesapeake Light is coined Clouds and the Earth's Radiant Energy System (CERES) Ocean Validation Experiment (COVE)
- Oct. 1999 - First AERONET sunphotometer measurement
- May 2000 - First Baseline Surface Radiation Network (BSRN) measurement
- July 2001 - Global Positioning System Meteorology (GPS-MET) installed
- May 2004 - Micro-Pulse Lidar (MPL) installed
- Nov. 2005 - AERONET Ocean-Color measurements commenced
- Apr. 2012 - Bat Detection instrument installed
- Oct. 2012 - Department of Energy (D.O.E.) took over Chesapeake Light from the CG
- Sep. 2016 – Chesapeake Light sold to private consortium from New York City
- Dec. 2016 – Ordered to vacate Chesapeake Light by NASA safety

Other Noteworthy Events:

- Several IOP's through the years – CLAMS, WHOI, UMBC, ODU
- National Data Buoy Center (NDBC) – Met data since August 1984


1st year - 1965
CHESAPEAKE
CHESAPEAKE


Most Recent – 2014

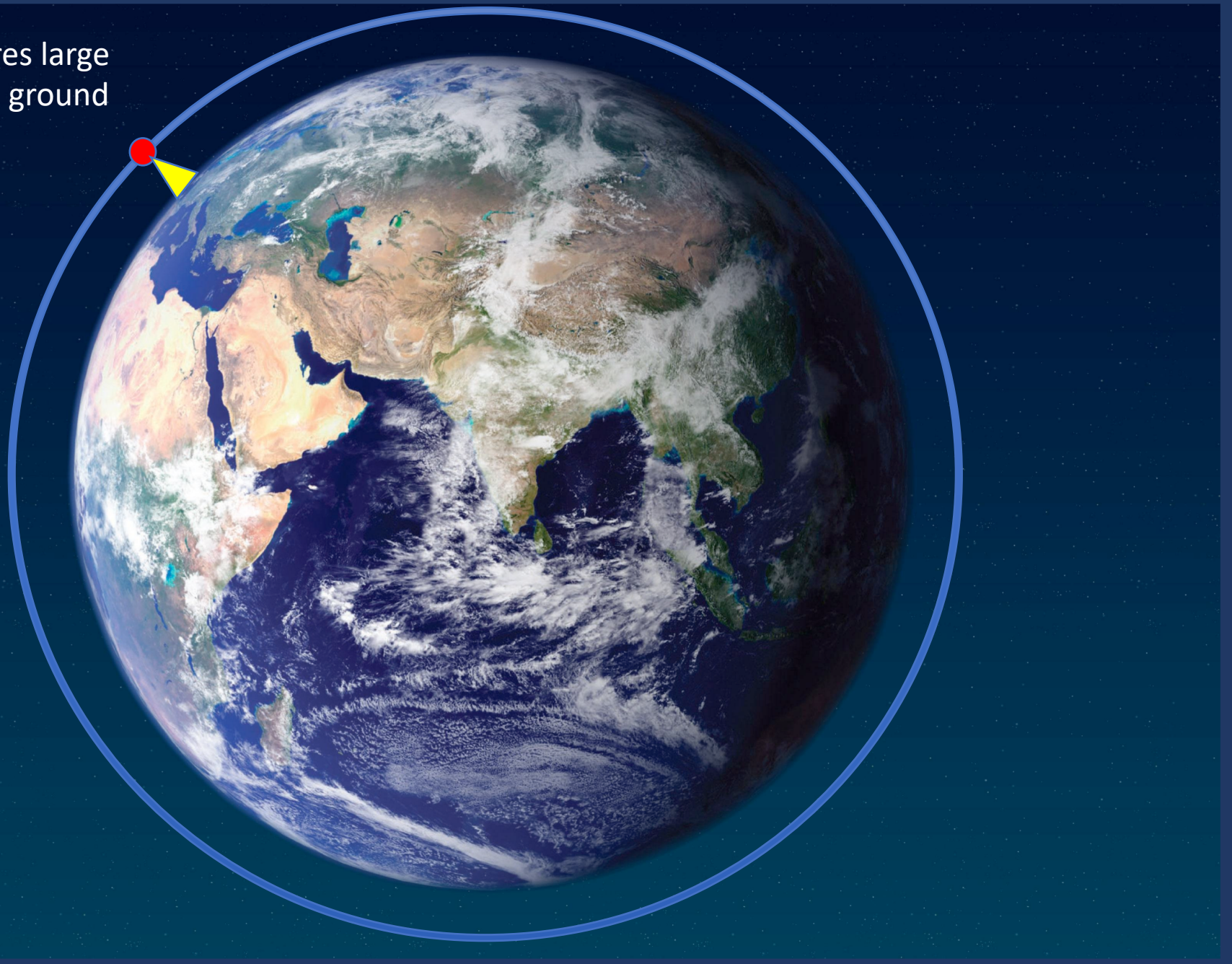
Why was COVE established?

- Validating measurements from CERES and other satellites was the primary motivation to establish COVE at Chesapeake Light
- COVE has 2 advantages when viewed from a satellite

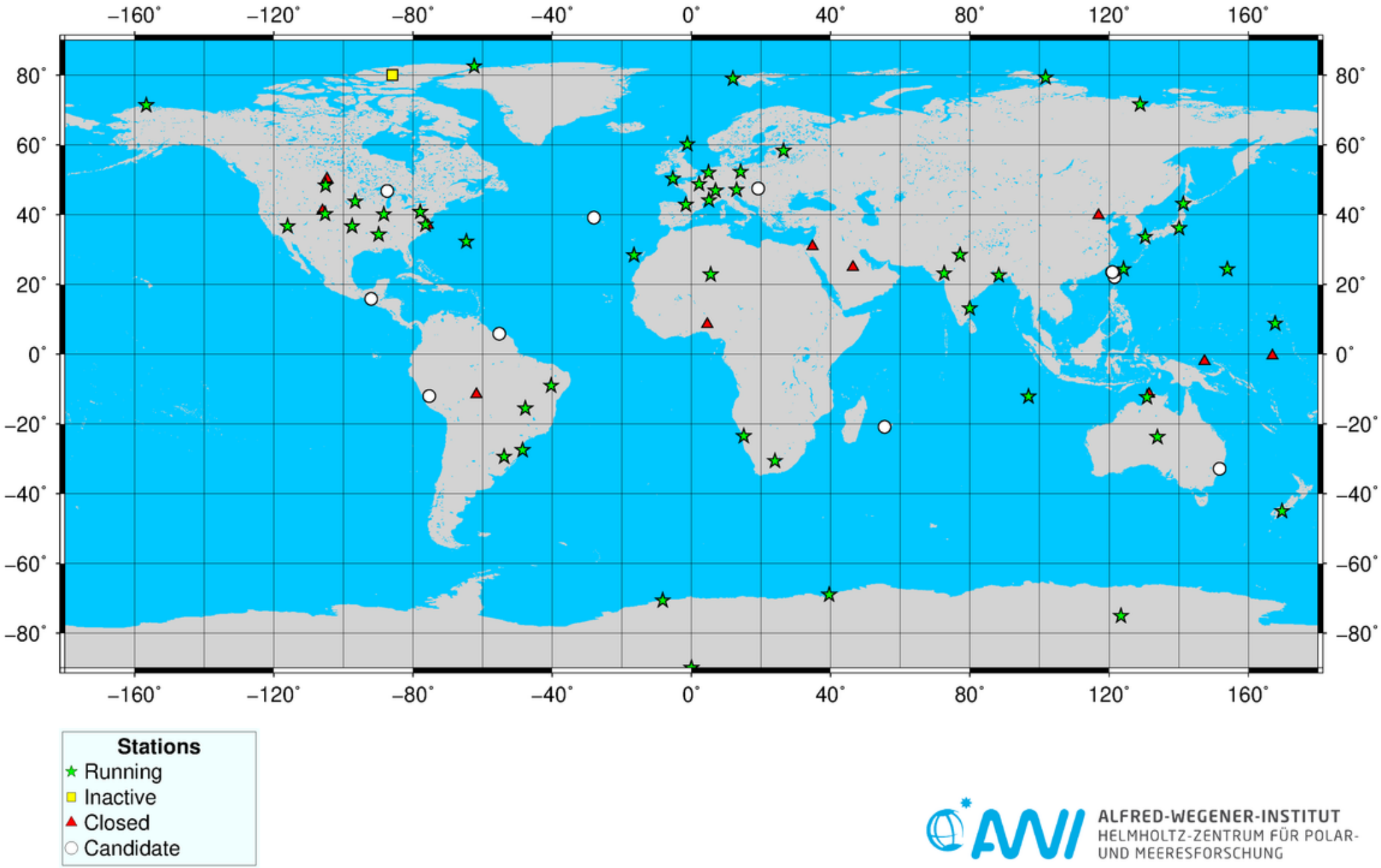
COVE is in a dark, more homogeneous background

COVE does not have an island effect

Satellite measures large areas we have a ground truth site.

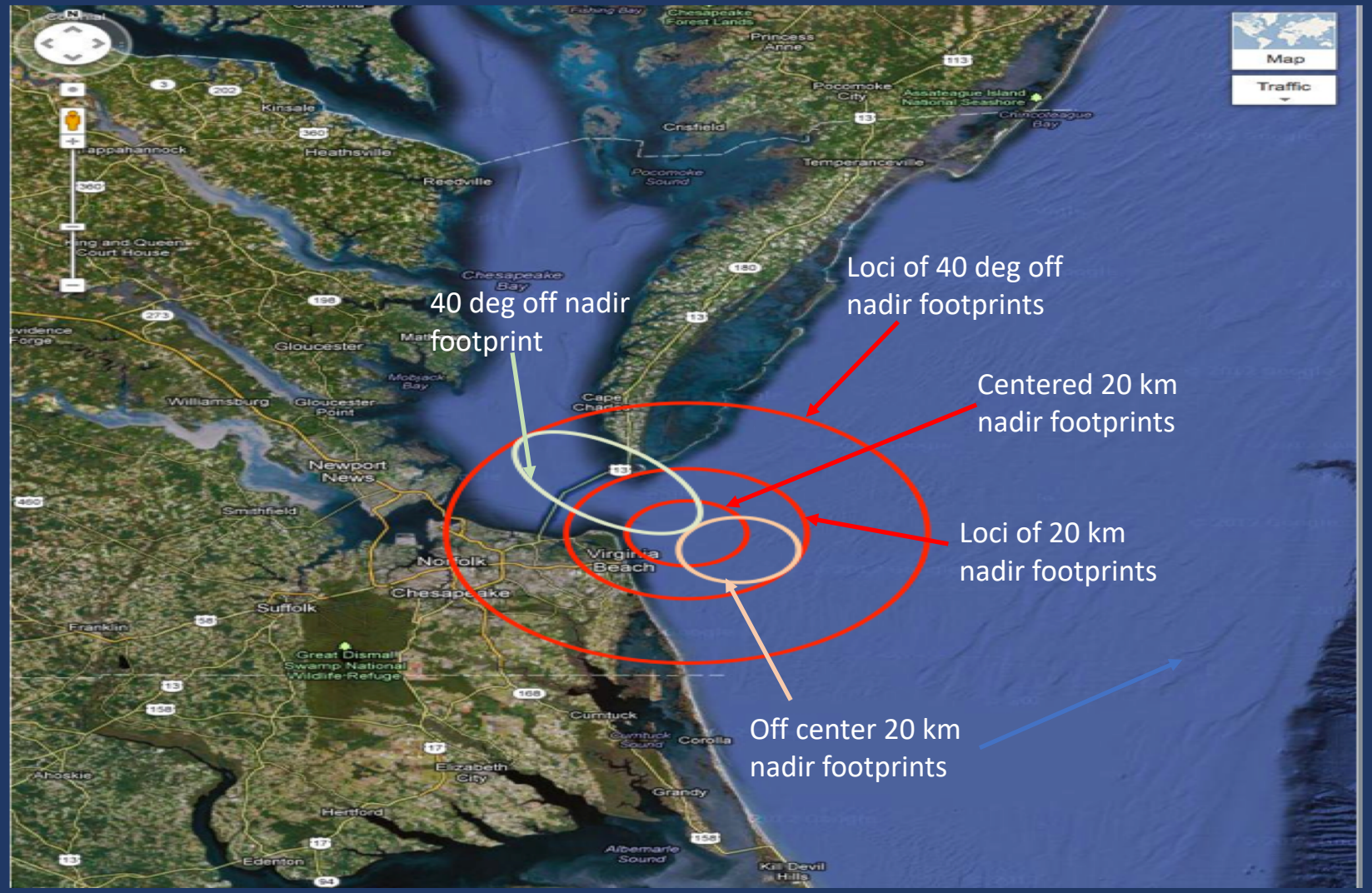


Running, inactive, planned and closed BSRN Stations, September 2018



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

COVE satellite footprint



COVE at Chesapeake Light collected various data parameters from Oct. 1999 – Dec. 2016. 17 years!!

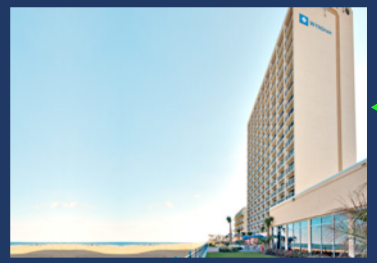
Power at COVE (self-sufficient)

Transportation To Chesapeake Light

Communications at COVE

Freewave Radio - 900 MHz, 867 Kbps over the air throughput

Internet connection and Freewave at Hotel site



Radio Link ~25 km

Freewave at COVE

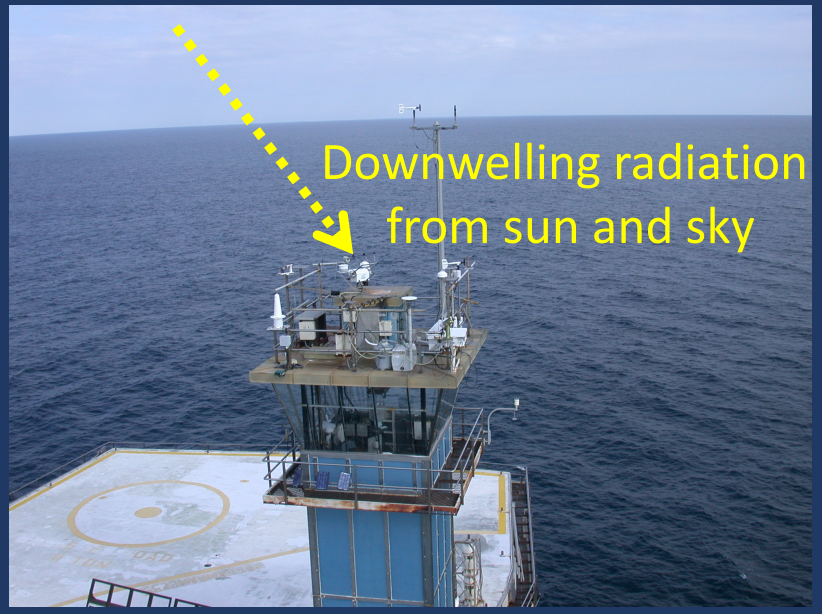
Remote Desktop from office

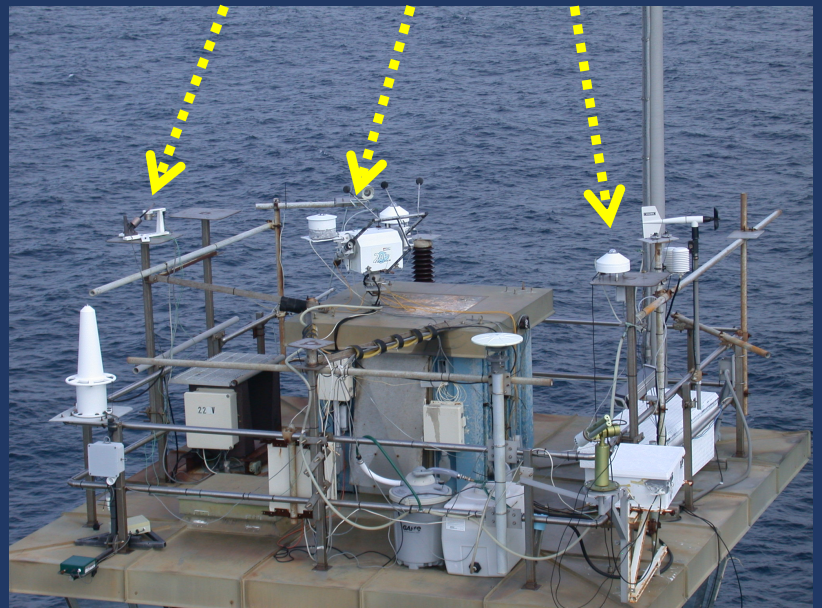
List of Measurements At COVE

Measurement	Instrument (Model)	Units	Wavelength (nm)	Remarks
Direct Shortwave Irradiance	Kipp and Zonen Pyrheliometer (CH1)	W/m^2	200-4000	Since May 2000
Diffuse Shortwave Irradiance	Kipp and Zonen Pyranometer (CM31)	W/m^2	200-4000	Since May 2000
Global Shortwave Irradiance	Kipp and Zonen Pyranometer (CM22)	W/m^2	200-4000	Since May 2000
Longwave Irradiance	Eppley Pyrgeometer (PIR)	W/m^2	5000-50000	Since May 2000
Global and Diffuse Narrowband Irradiance	Yankee Environmental Systems MFRSR (MFR-7)		415, 496, 614, 671, 671, 868 and 939	Since 2000. Aerosol Optical Depth derived from MFRSR
Direct and Diffuse Narrowband Radiance	Cimel Electronique SeaPRISM Sunphotometer (CE 318N SP9 Ver. 5)		412, 443, 490, 532, 551, 667, 870 and 1020	Part of AERONET Network since October 1999
Normalized Water Leaving Radiance	Cimel Electronique SeaPRISM Sunphotometer (CE 318N SP9 Ver.5)	mW/cm^2 sr µm	413, 441, 489, 530, 551, 668, 869 and 1020	Part of AERONET-OC since November 2005
Aerosol and Cloud Vertical Structure	Science and Engineering Services Micro-Pulse Lidar (Type 3)		523	Part of MPL-NET since May 2004
Integrated Precipitable Water Vapor	Trimble Global Navigation Satellite System (NetR9)	cm		Part of NOAA's GPS-MET network since July 2001
Black Carbon	Magee Scientific Aethalometer (AE-42-7-HS-AW)	$\mu g/m^3$	370, 430, 470, 520. 565. 700. and 950	Since March 2006
Light Scattering Extinction Coefficient	Radiance Research Nephelometer (M903)	1/m	530	Since March 2006
Sky Temperature	Heitronics Infrared Thermometer (KT 19.85)	Kelvin	9600-11500	Since December 2005
Sea Surface Temperature	Heitronics Infrared Thermometer (KT 19.85)	Kelvin	9600-11500	Since 2001
Air Temperature	Rotronic (Hygroclip-S3)	°C		Since May 2000
Relative Humidity	Rotronic (Hygroclip-S3)	Percent		Since May 2000
Barometric Pressure	Vaisala (PTB101B)	mb		Since May 2000
Wind Speed and Wind Direction	R. M. Young (05103)	m/s and 0-360°		Since May 2000
Photosynthetically Active Radiation (PAR)	LI-COR (LI-190SB)	mV	400-700	Since 2001. Calibrations are inconsistent
Surface Wetness Sensor (Rain Sensor)	Skye (SKLW 1900)	mV		Since October 2006
Ultrasonic Echolocation Calls	Anabat			Since April 2012

Downwelling Instrumentation

37 m (121 ft) above sea level



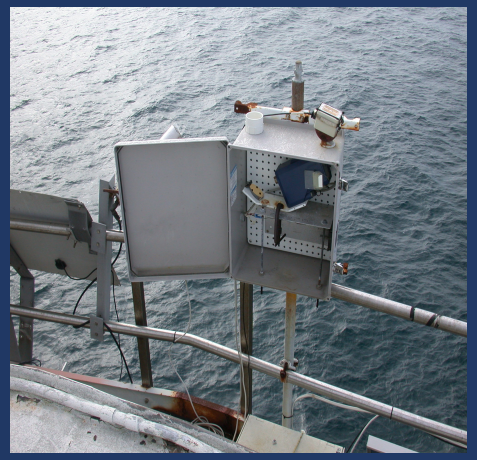


- Water tanks stored rain water.
- Filters cleaned rain water.
- Every morning a program turned on our “washer system” to automatically clean the downwelling shortwave instruments

Upwelling Instrumentation

21 m (69 ft) above sea level.
Catwalk extends 8 m (25 ft)

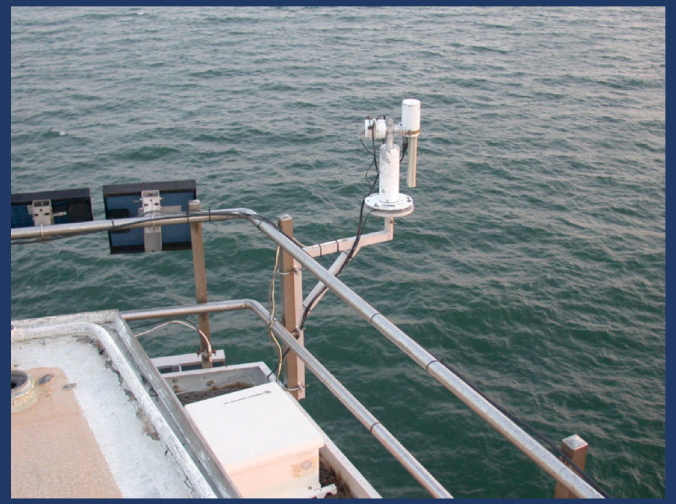
Flight Deck Instrumentation



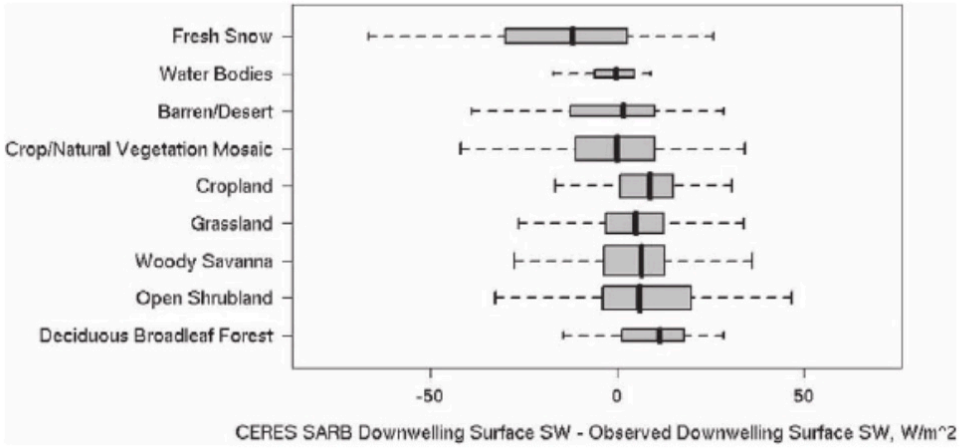
INSITU

AERONET SEAPRISM

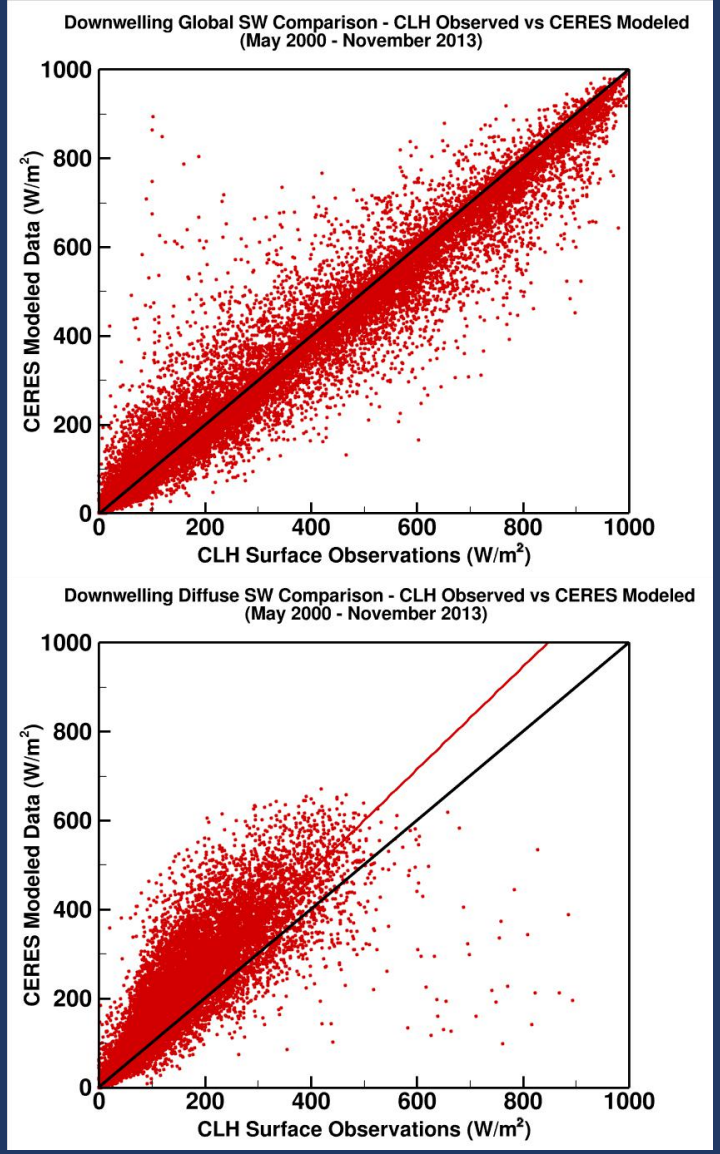
(scans atmosphere and ocean)

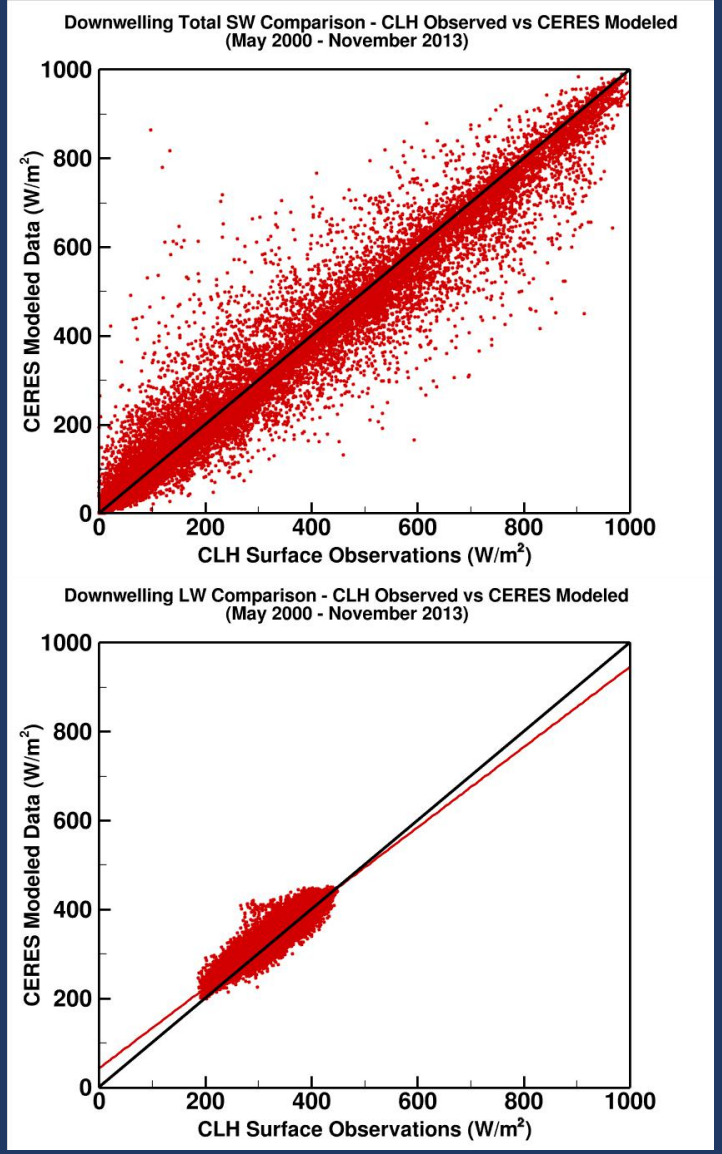


Surface Observations at COVE vs CERES Modeled over COVE



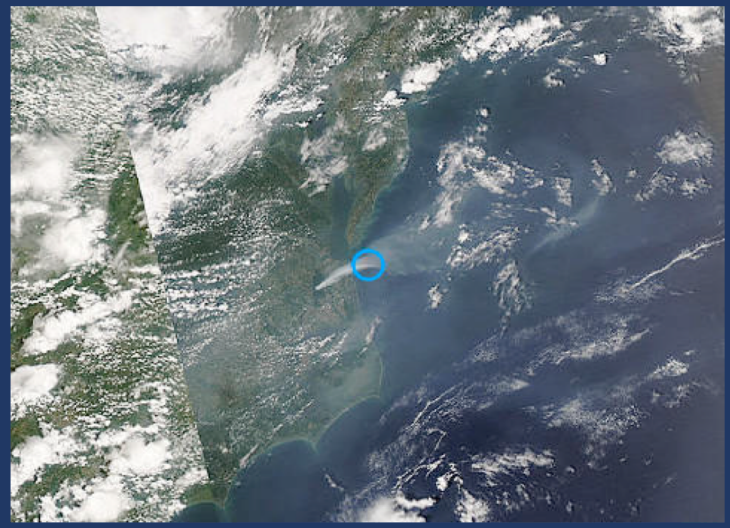
Water scene compared best (clear sky only) between observed and CERES SARB estimates of downwelling SW global radiation

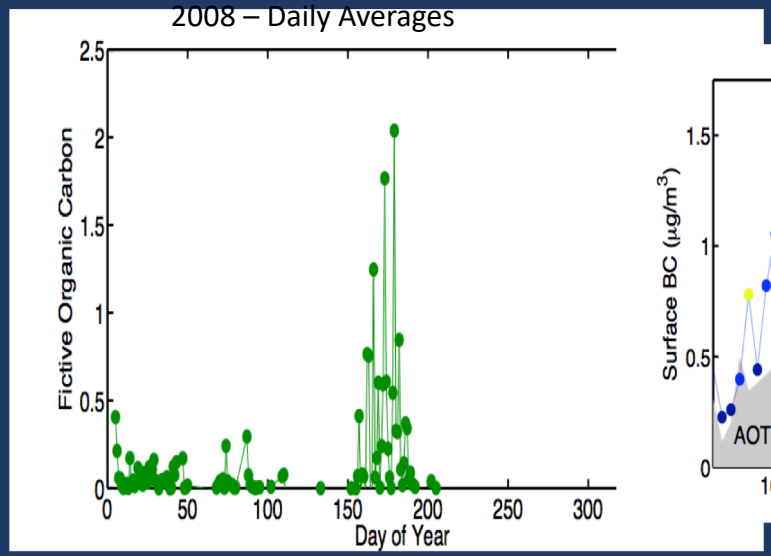


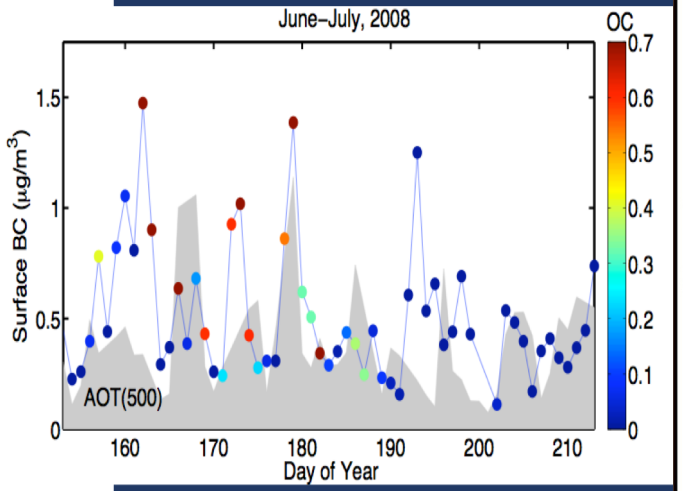


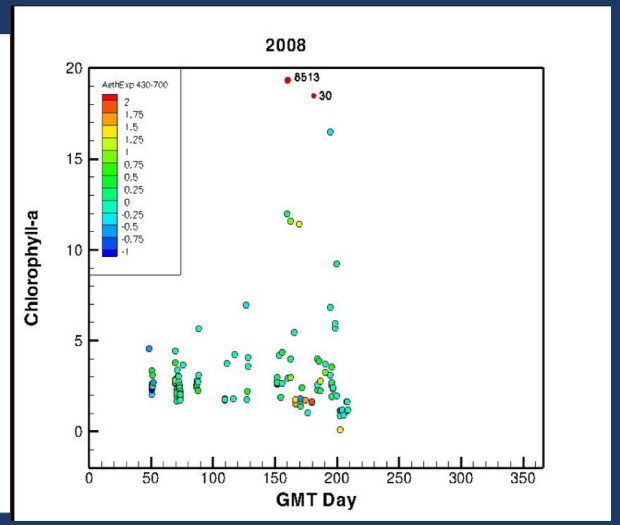
Downwelling Parameter Comparison	n	Y=mx+b	R^2	Mean Bias	Standard Deviation
SW-Global	22883	Y = 0.931x + 13.975	0.951	7.057	61.825
SW-Total	21730	Y = 0.938x + 14.094	0.952	4.415	60.928
SW-Diffuse	21802	Y = 1.154x + 23.137	0.791	-40.922	65.374
LW	37507	Y = 0.903x + 43.638	0.908	-10.810	16.938

Fire Events Over COVE in 2008







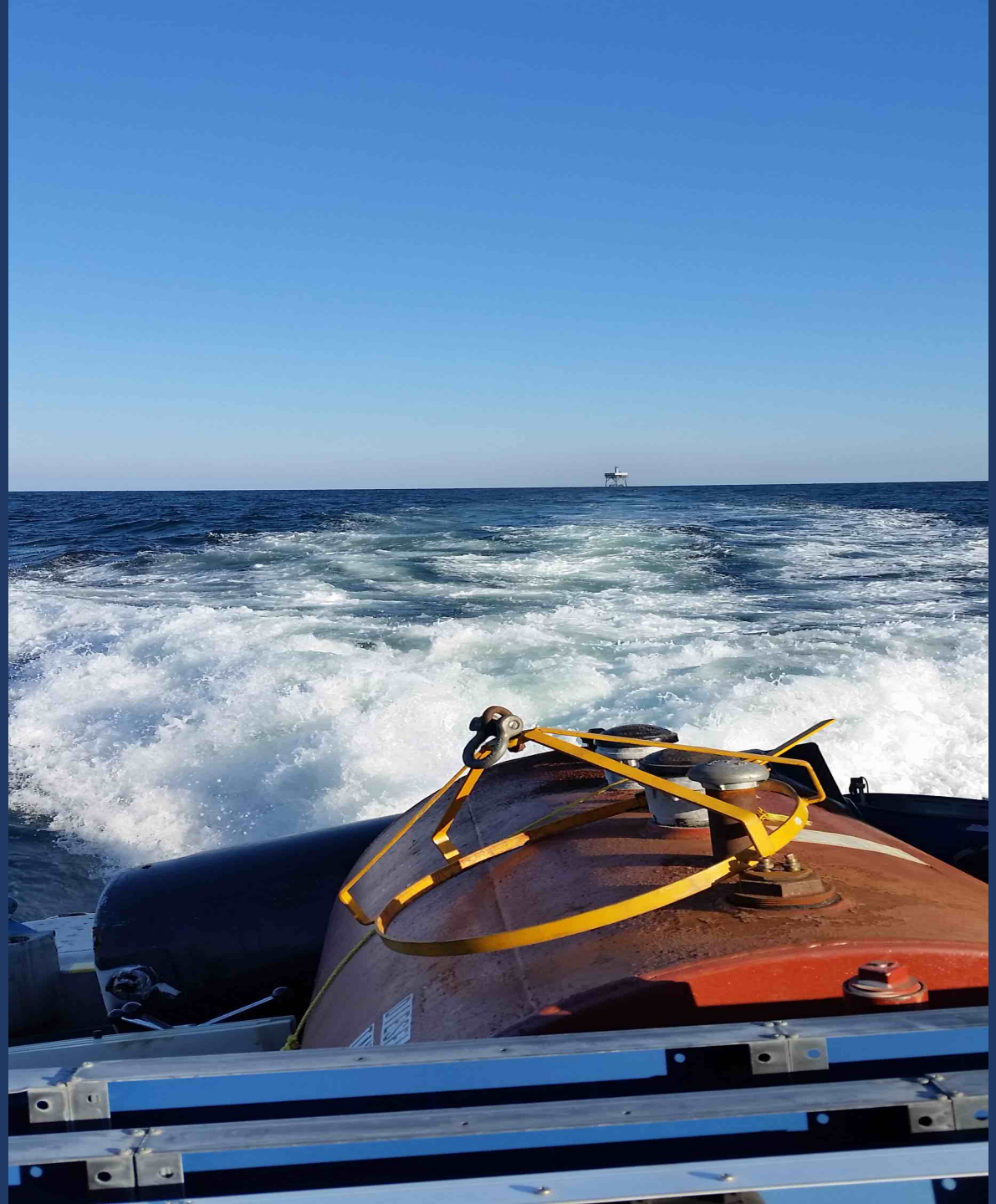


NASA/SSAI Research at Chesapeake Light:

- COVE was established to provide continuous downwelling and upwelling solar radiation measurements for surface validation of CERES and other satellites
- Compare coincident surface measurements with modeled satellite data for several different parameters
- COVE is part of the Baseline Surface Radiation Network
- Other parameters measured are aerosols, black carbon, water vapor, cloud and aerosol vertical structure, meteorological and more
- COVE's website is http://cove.larc.nasa.gov

Primary reason why COVE was shuttered

Goodbye
COVE



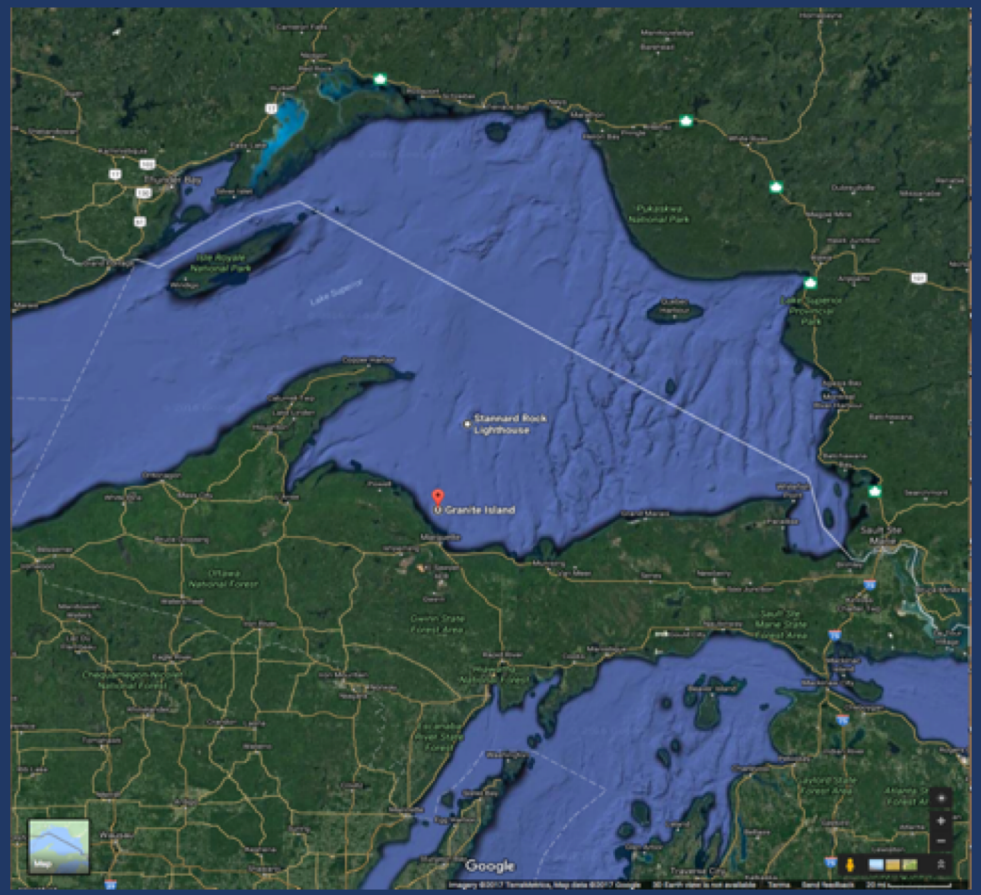
☹

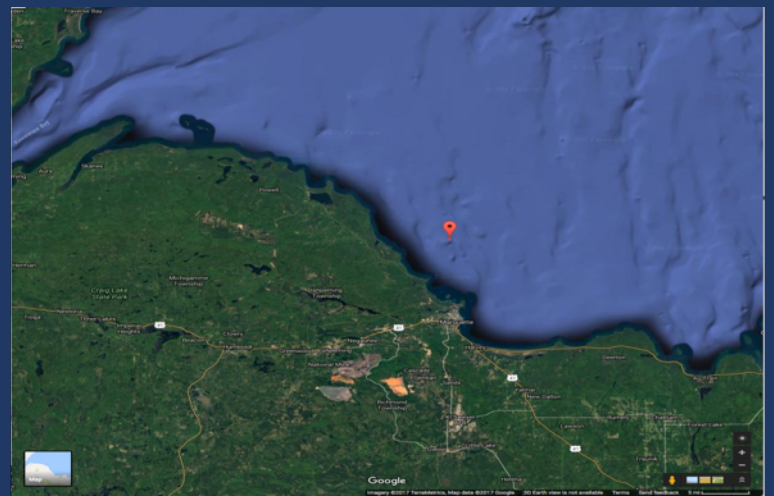
A New Opportunity

Outline

- How we were introduced to Granite Island (GI)
- Granite Island background
- Why CERES was interested
- Logistics
- Current and future measurements
- Challenges (i.e. seagulls, cold) and mitigation
- Conclusions and Acknowledgements

Granite Island Location





Closest land point is about 10 km (6 miles) away.

<u>Granite Island Coordinates:</u>

46.721 N (46° 43’ 15°N)

87.411 W (87° 24’ 41° W)

Granite Island information:

- 0.01 square km (2.5 acre) granite rock island
- Granite Island at its base is approximately 193 m (633 ft) above sea level
- Rises nearly perpendicular to 18 m (59 ft) above surface of Lake Superior
- Surrounded by deep water (~18-30 m, or ~60-100 ft)

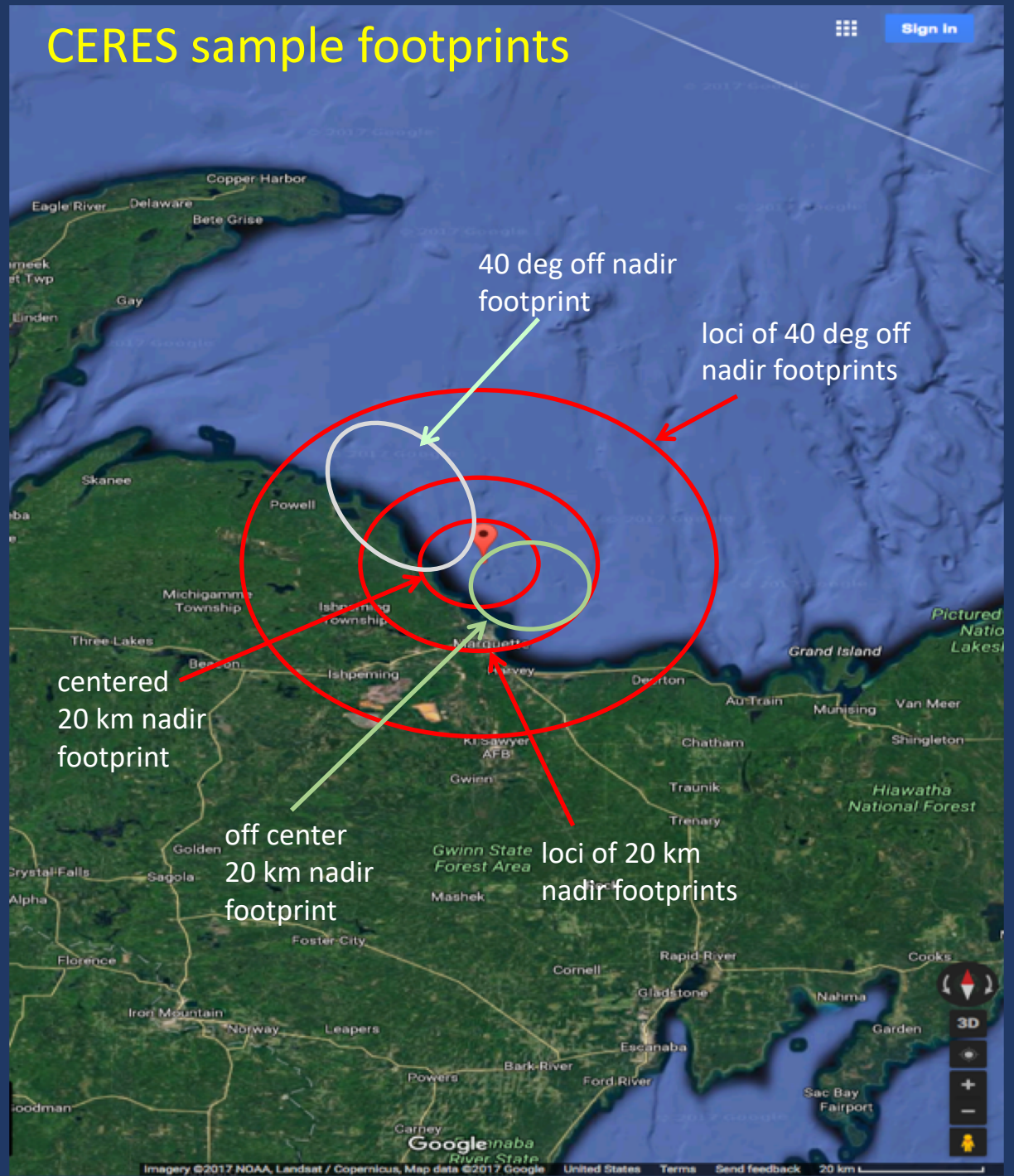
Motivation for establishing a Measurement Site at Granite Island

+

NASA Langley is interested in using BSRN and Clouds and the Earth's Radiant Energy System (CERES) measurements with the Great Lakes Evaporation Network (GLEN) data to improve understanding of the Earth's energy budget.

Other motivations:

- Water sites are uncommon
- Surface validation of satellites such as CERES

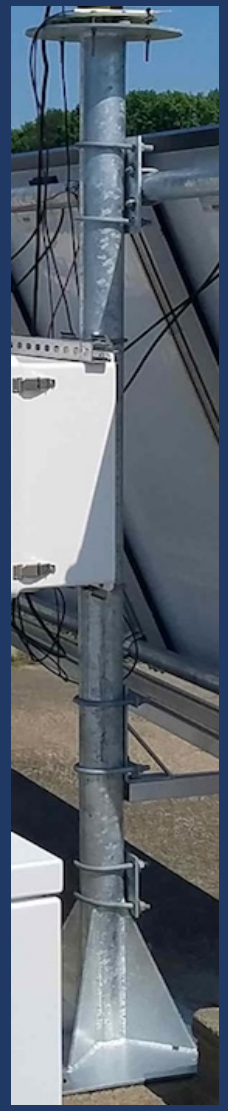


Mock Setup at the NASA Langley Measurement Site (a.k.a. CAPABLE)

Mounting Hardware for Solar Panels and Environmental Enclosure

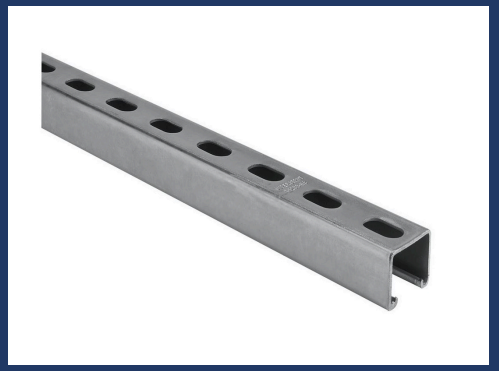
Rotary Hammer

Anchor bolts



Hot-dipped galvanized post

U-bolts



Strut

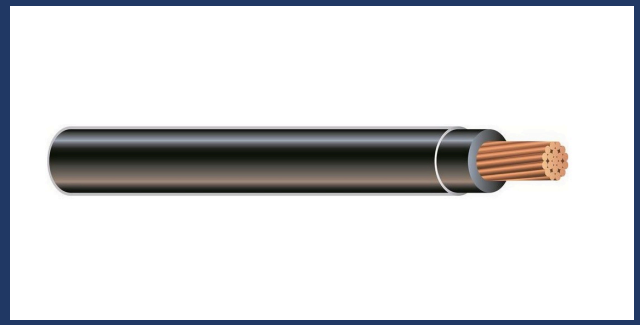
Spring Nut

Clamp for Strut

Power Details

6V cells (Qty: 18) wired in series and parallel for a 12VDC system

330W Solar panel (Qty: 4)



Various sizes of stranded wire

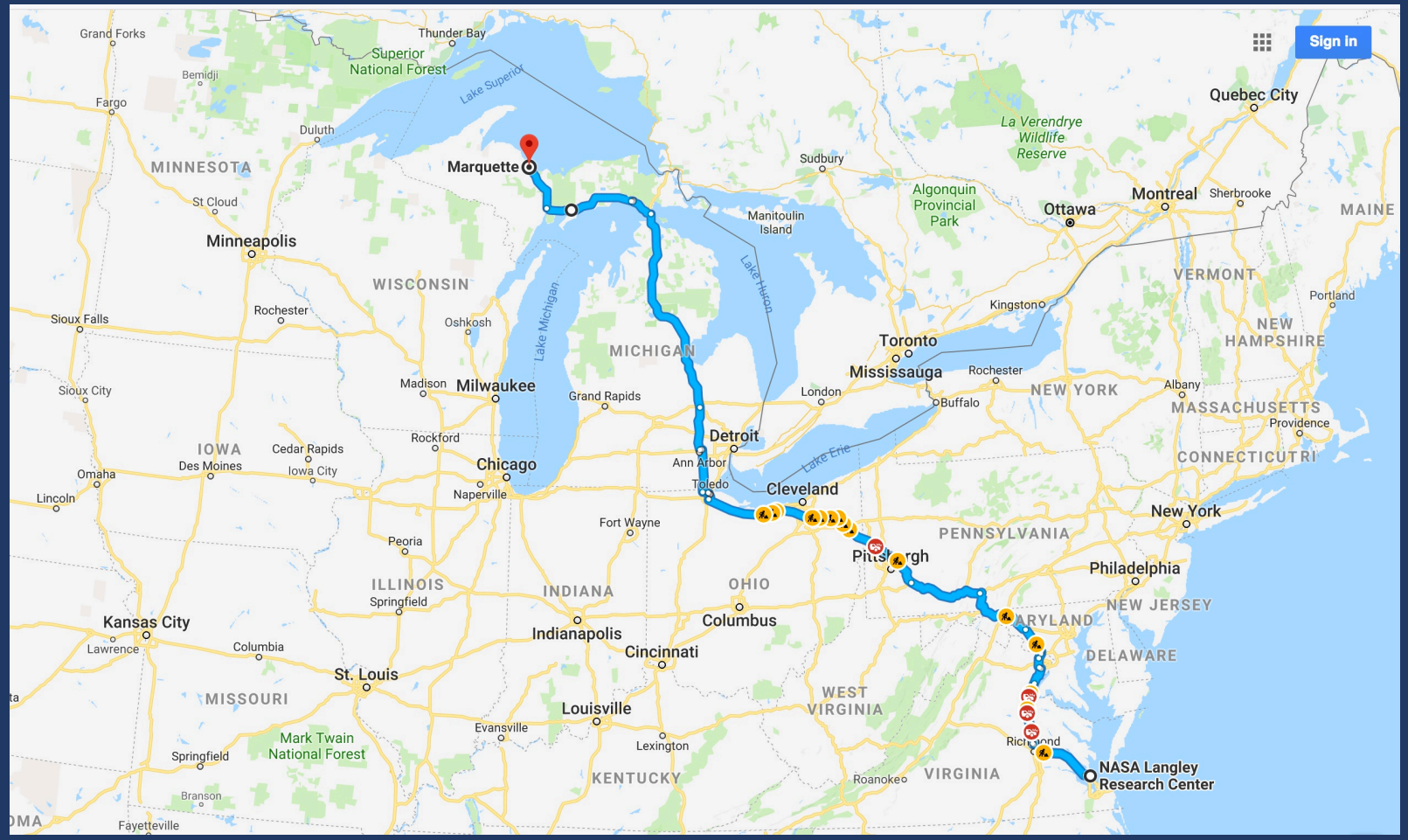
Fuse Block

Charge Controller

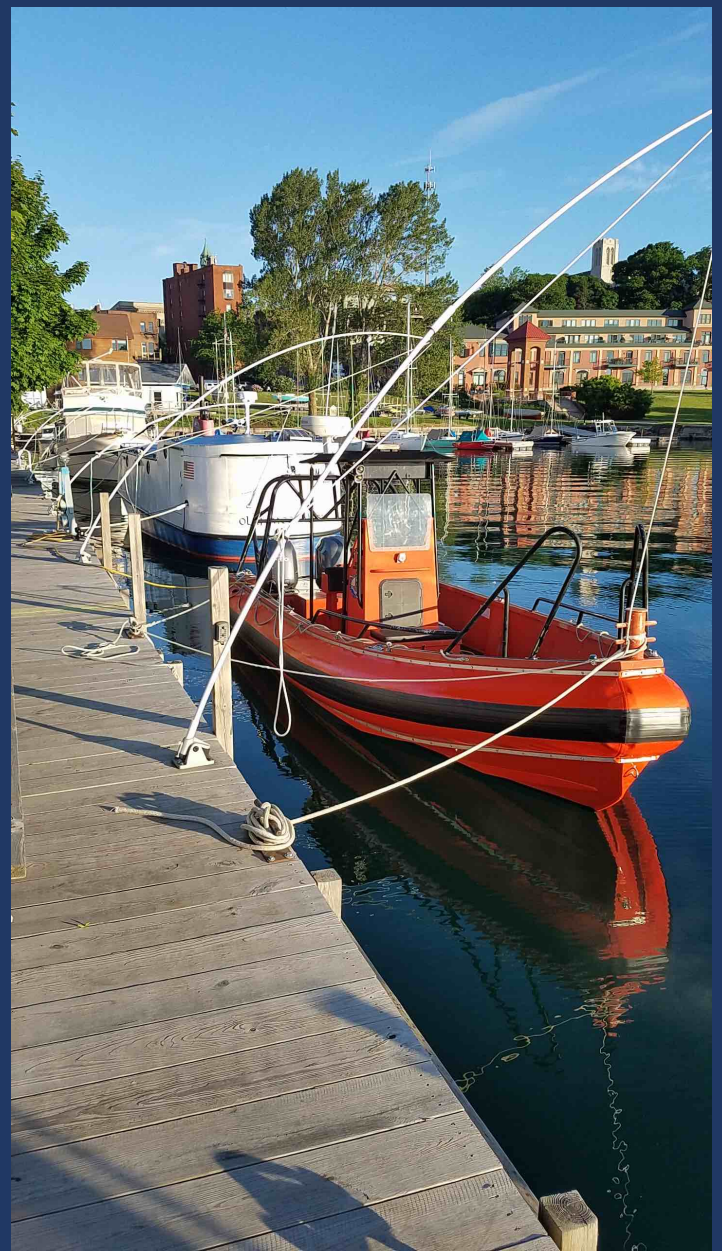
Fuse Box

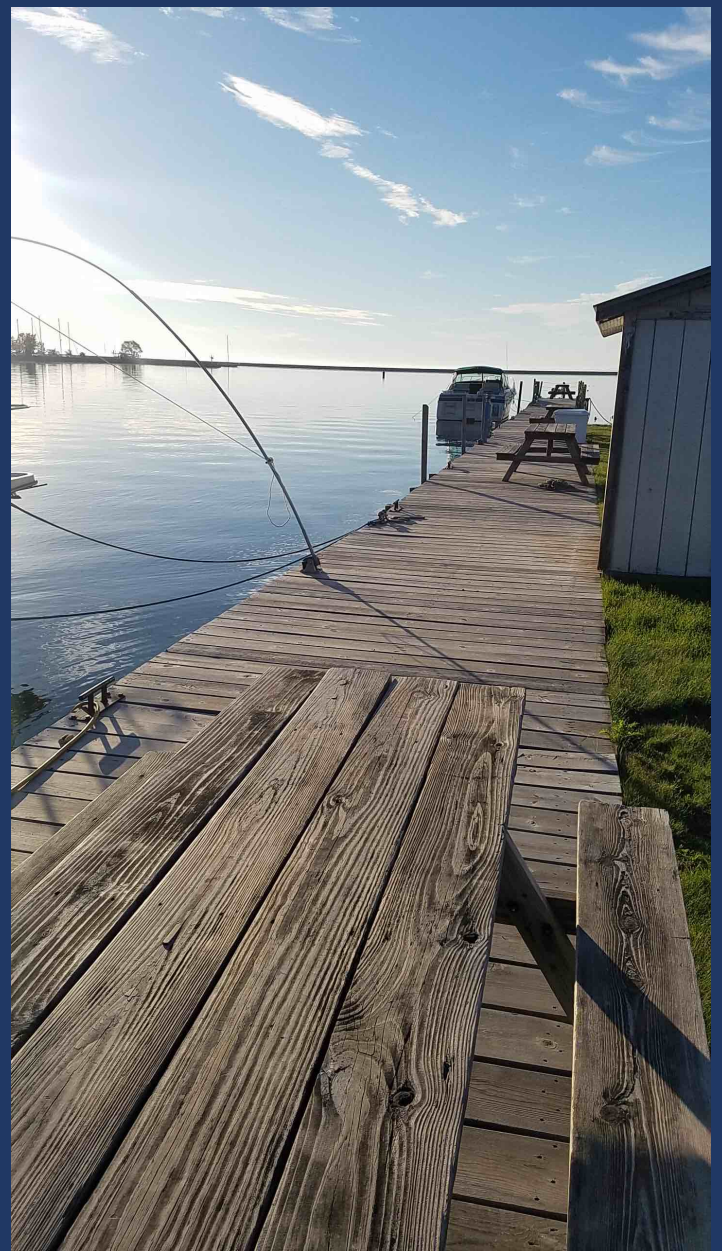
Fuses

Load ‘er up for the 1,134 mile journey (over 2 days)



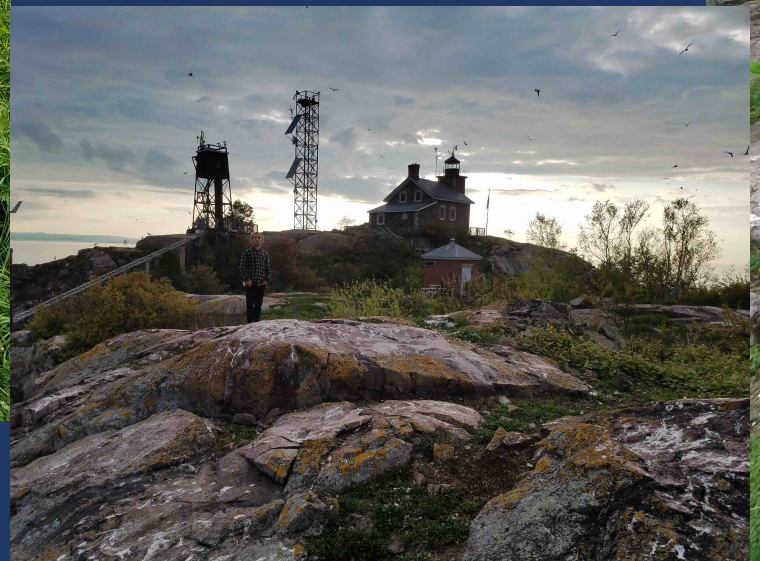
Dockside – Marquette, Michigan



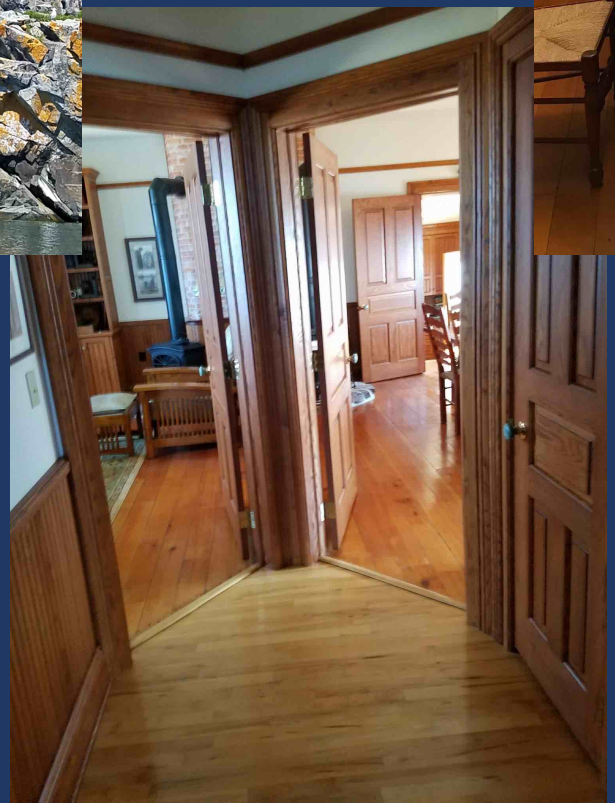


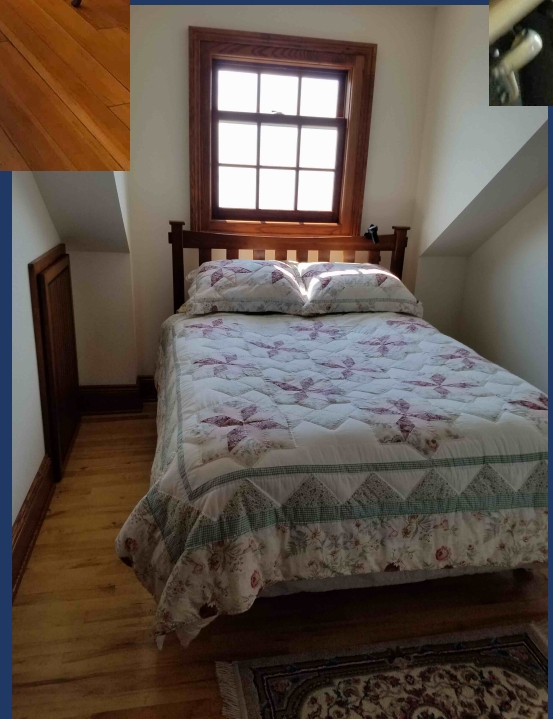
Moving Equipment to Granite Island

Moving Equipment to Granite Island…..The Grind Continues



Accommodations – Quite Nice



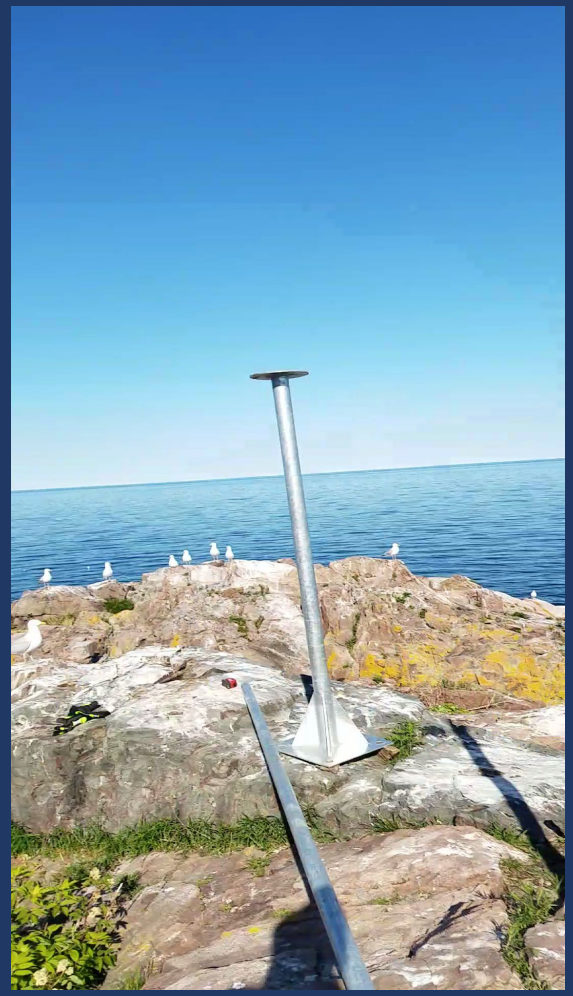


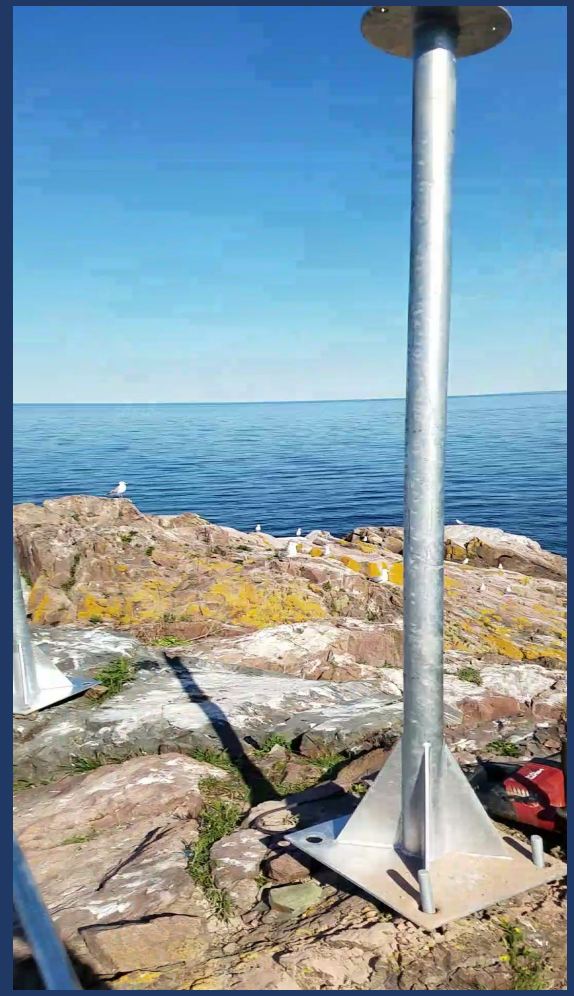
Mounting the Two Large Posts (Base) to the Granite Rock

Hilti Rotary Hammer

Anchor Bolts. 1” x 12” long

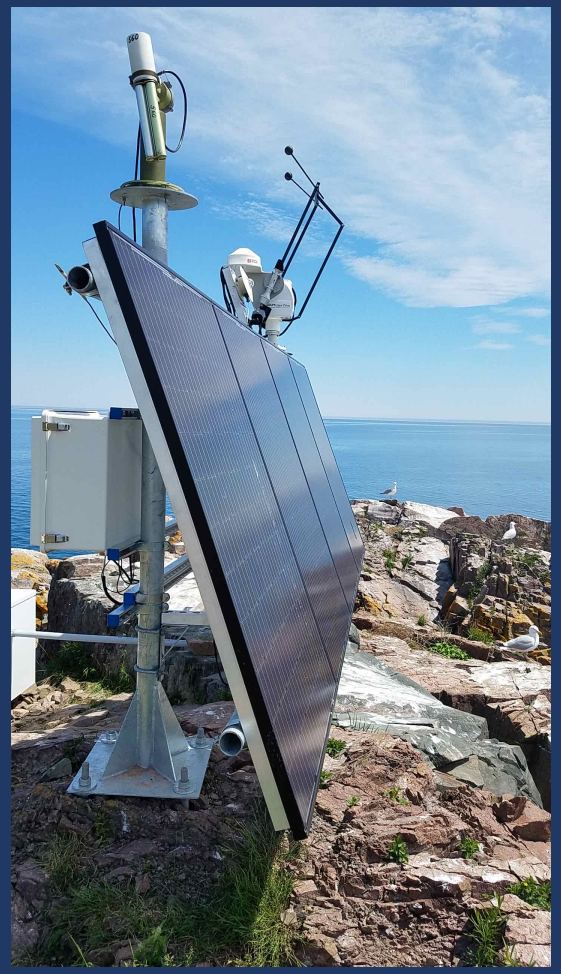
Epoxy





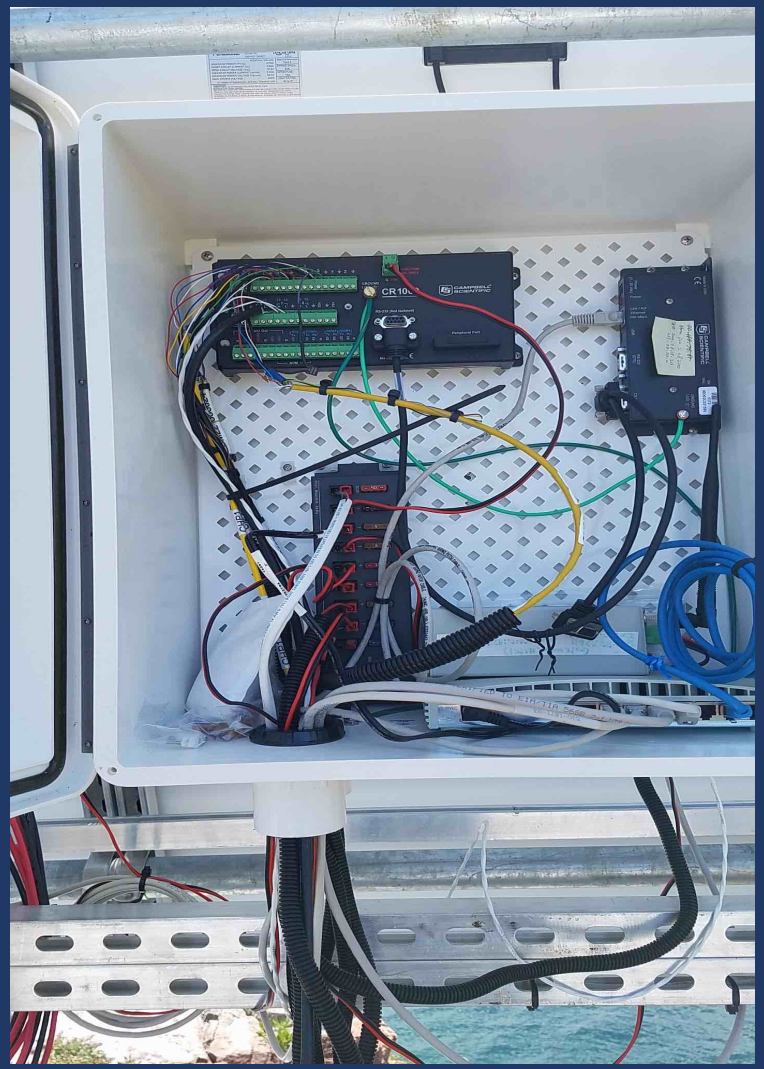
2 large posts installed in granite rock with anchor bolts. Solar tracker and AERONET cimel secured on top of circular mounts

Power Distribution



Data Acquisition

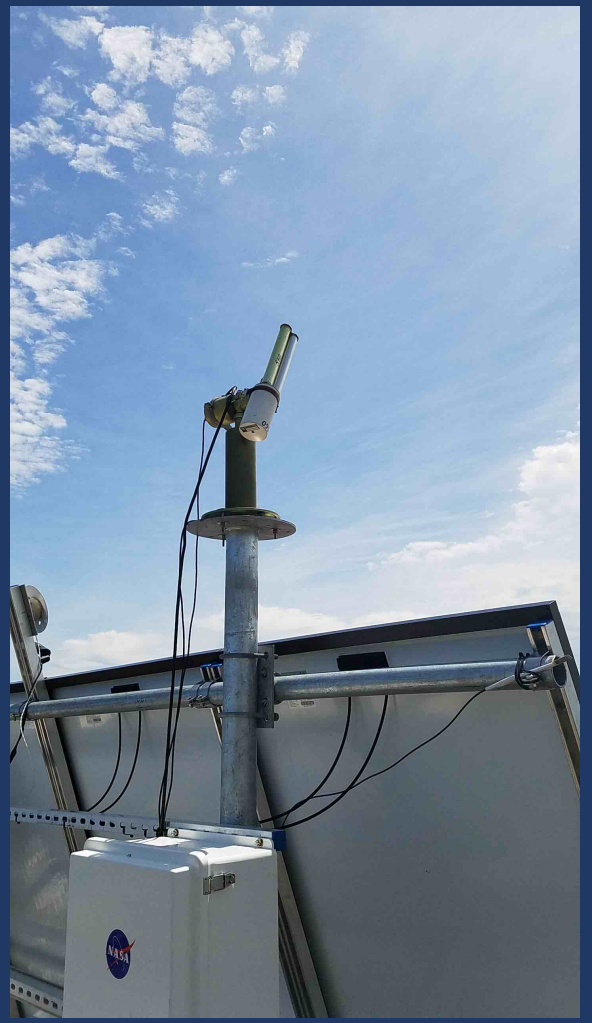
AERONET control box with MOXA serial over IP connection



Campbell Scientific datalogger with NL201 serial over IP connection

Instruments Currently Collecting Data at Granite Island:

- Downwelling Shortwave Direct (K&Z CHP 1)
- Downwelling Shortwave Diffuse (K&Z CM 22)
- Downwelling Shortwave Global (K&Z CM 22)
- Downwelling Longwave (K&Z CG4)
- Solar Tracker (K&Z Solys2)
- AERONET cimel sunphotometer



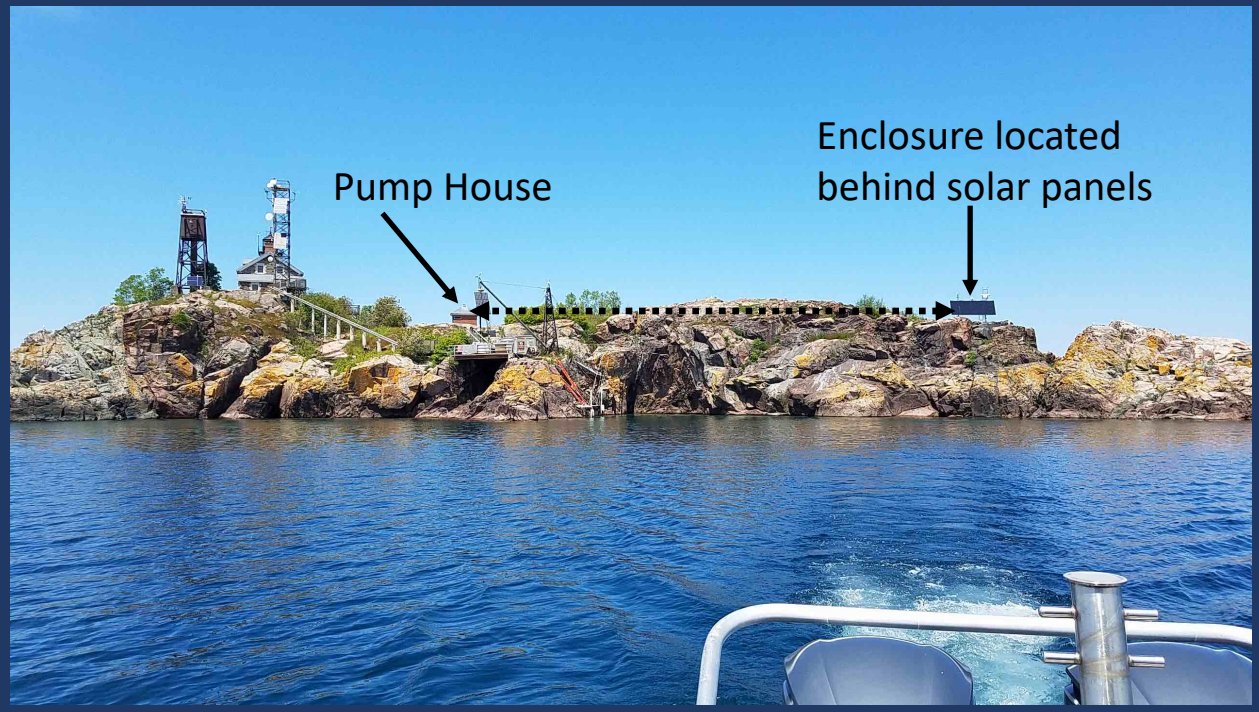
Upcoming Instruments Planned:

- Meteorological (Temperature, RH, Pressure, Wind Speed and Direction)

Communications

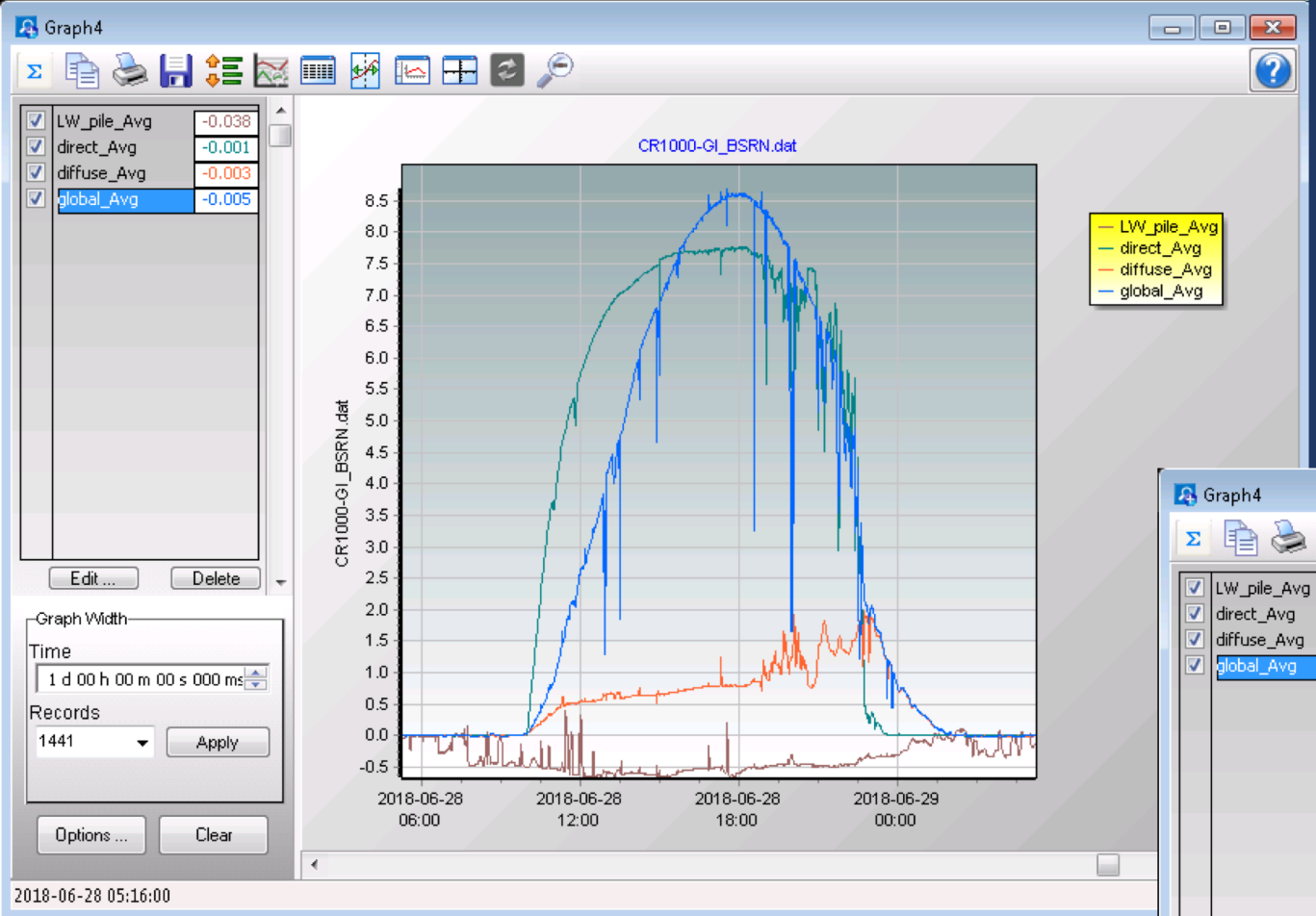
- Acquired 8 static IP numbers from NMU to assign to various instruments and hardware
- Freewave radios for communications. One is located in the pump house and one is in an enclosure mounted behind the solar panels

Freewave Radio - 900 MHz, 867 Kbps over the air throughput. Using whip antennas

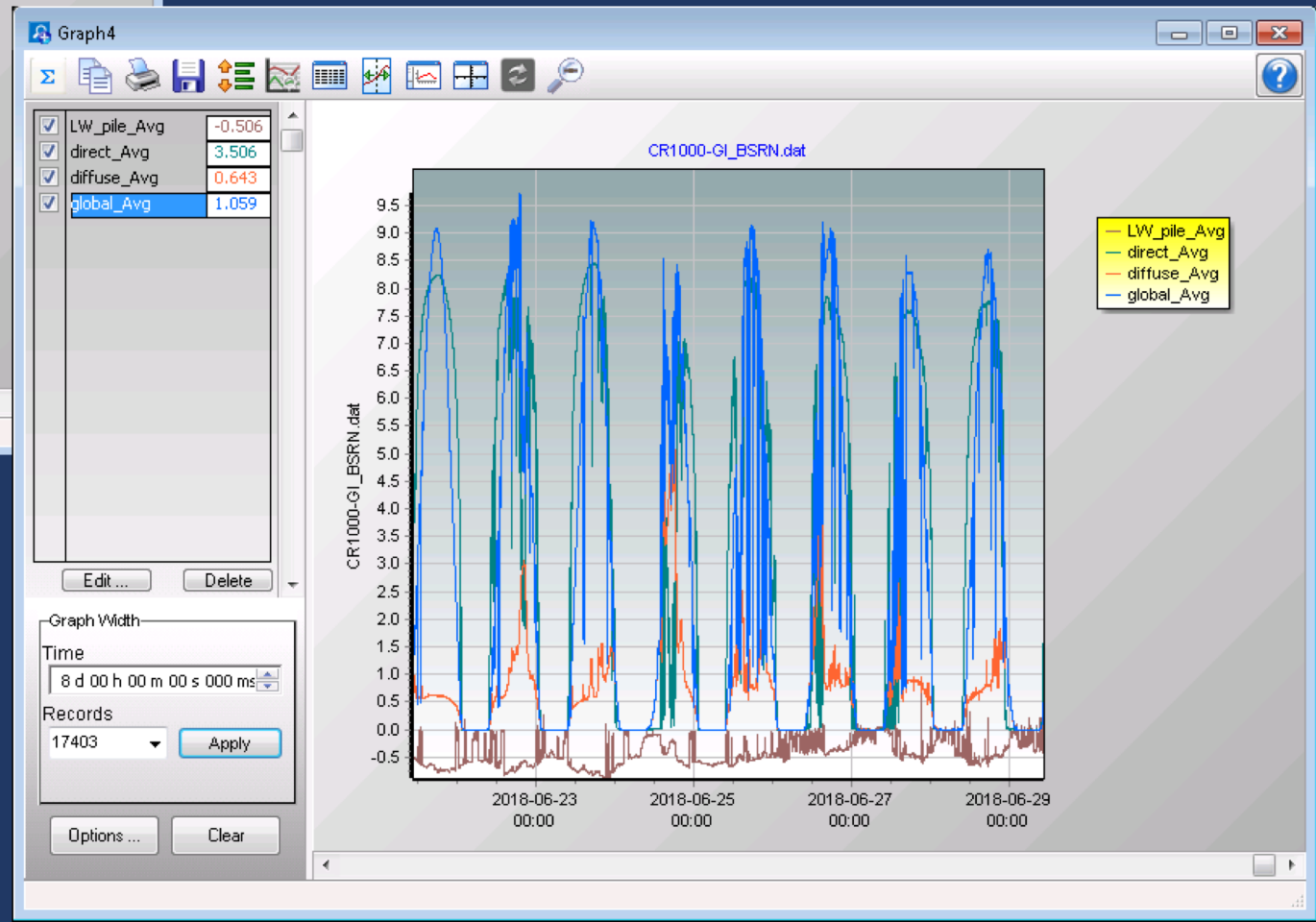


Installation as viewed from the boat.

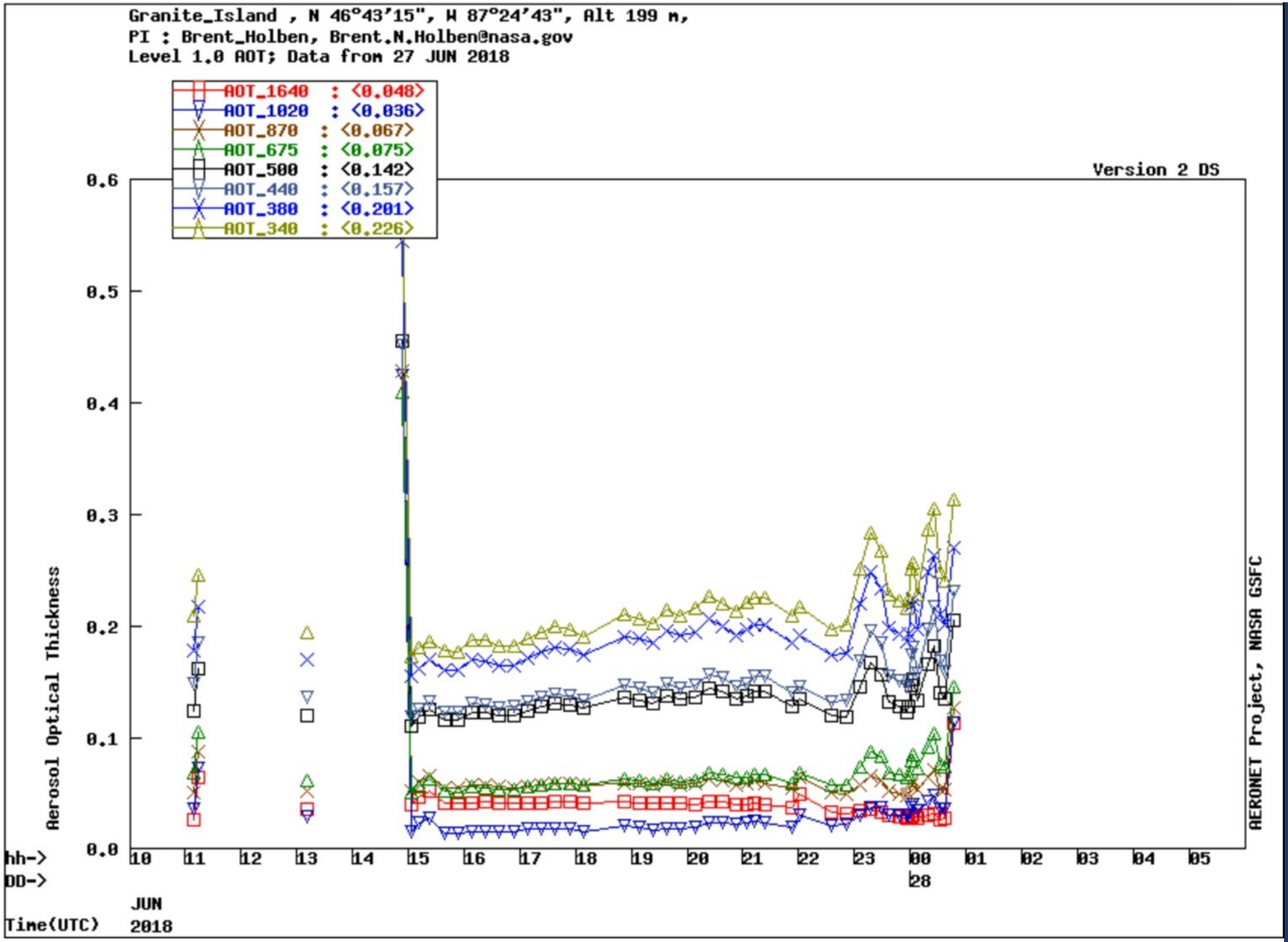
Installation is approximately 15 m (~ 50 ft) above the water line (as measured from the solar tracker height). The Granite Island installation is approximately 208 m (~ 680 ft) above sea level.



A single day of downwelling shortwave (direct, diffuse and global) and downwelling longwave.



A week of downwelling shortwave and longwave data.



A single day of AERONET data at Granite Island.

Calibration Procedures

- Two Automatic Hickey-Frieden (AHF) cavity radiometers are used to calibrate the shortwave instruments every year at the Langley Research Center location (BSRN site ID: LRC).

- Have attended the National Pyrheliometer Comparison at the National Renewable Energy Laboratory (NREL) in Golden, Colorado every year to calibrate the AHF's for the last 20 years.

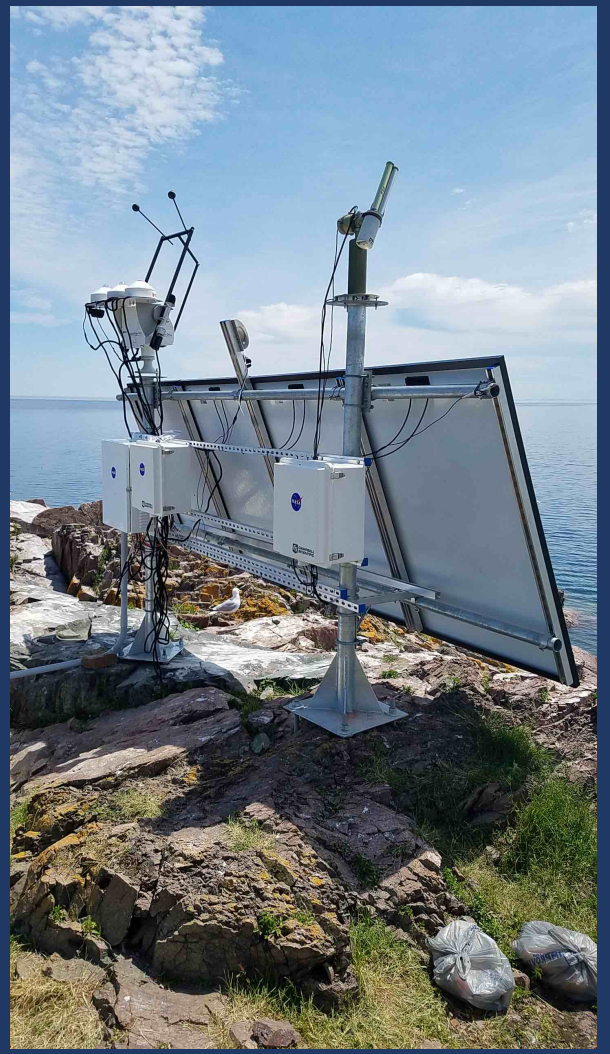
- Have attended the International Pyrheliometer Comparison in Davos, Switzerland every 5^{th} year (last was in 2015) since 2000.

- The longwave instruments are sent to NREL for calibration every other year.

Calibration Procedures Continued….

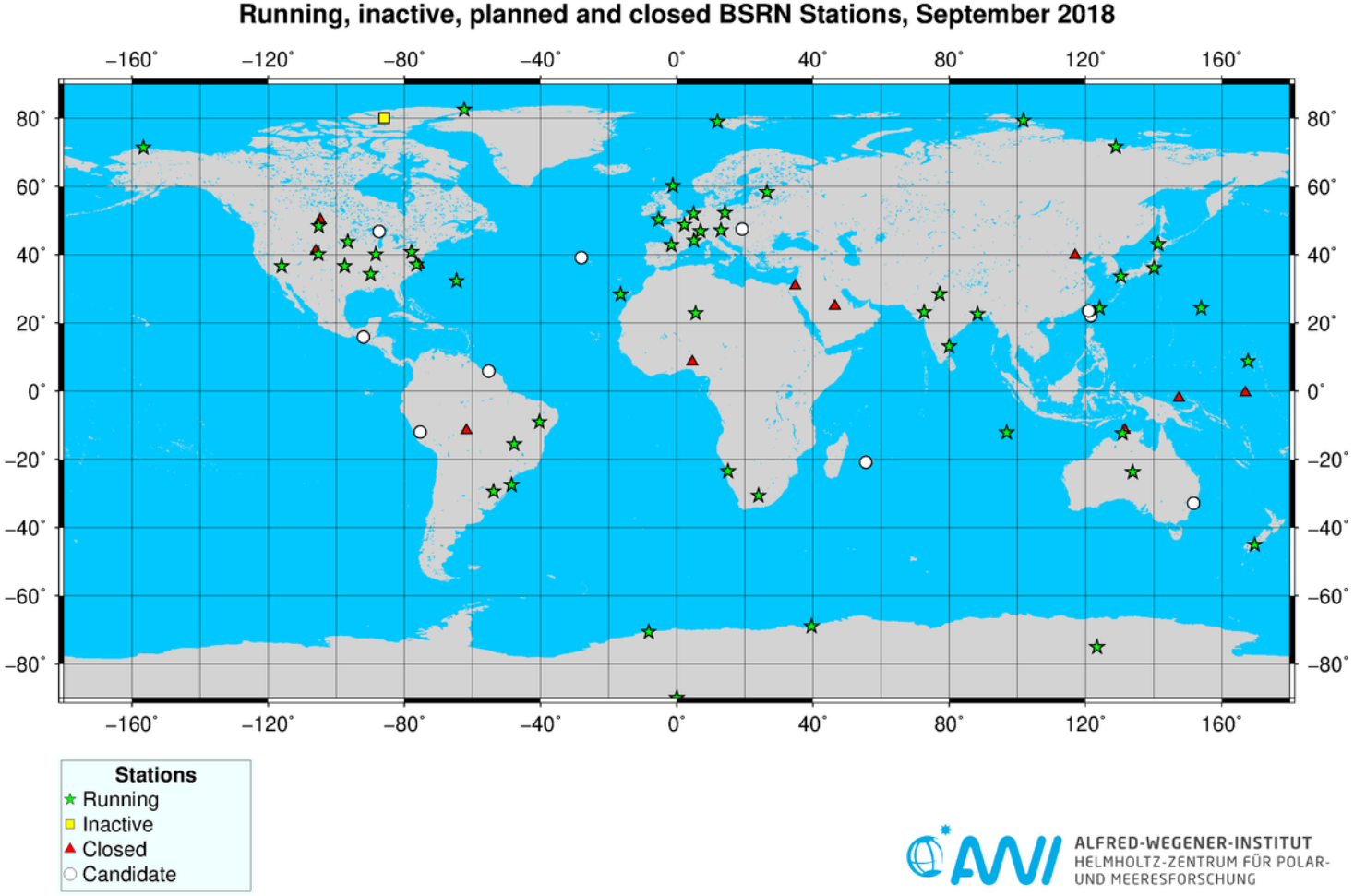
SW calibrations will be performed at the CAPABLE site and swapped with instruments at Granite Island on a yearly basis

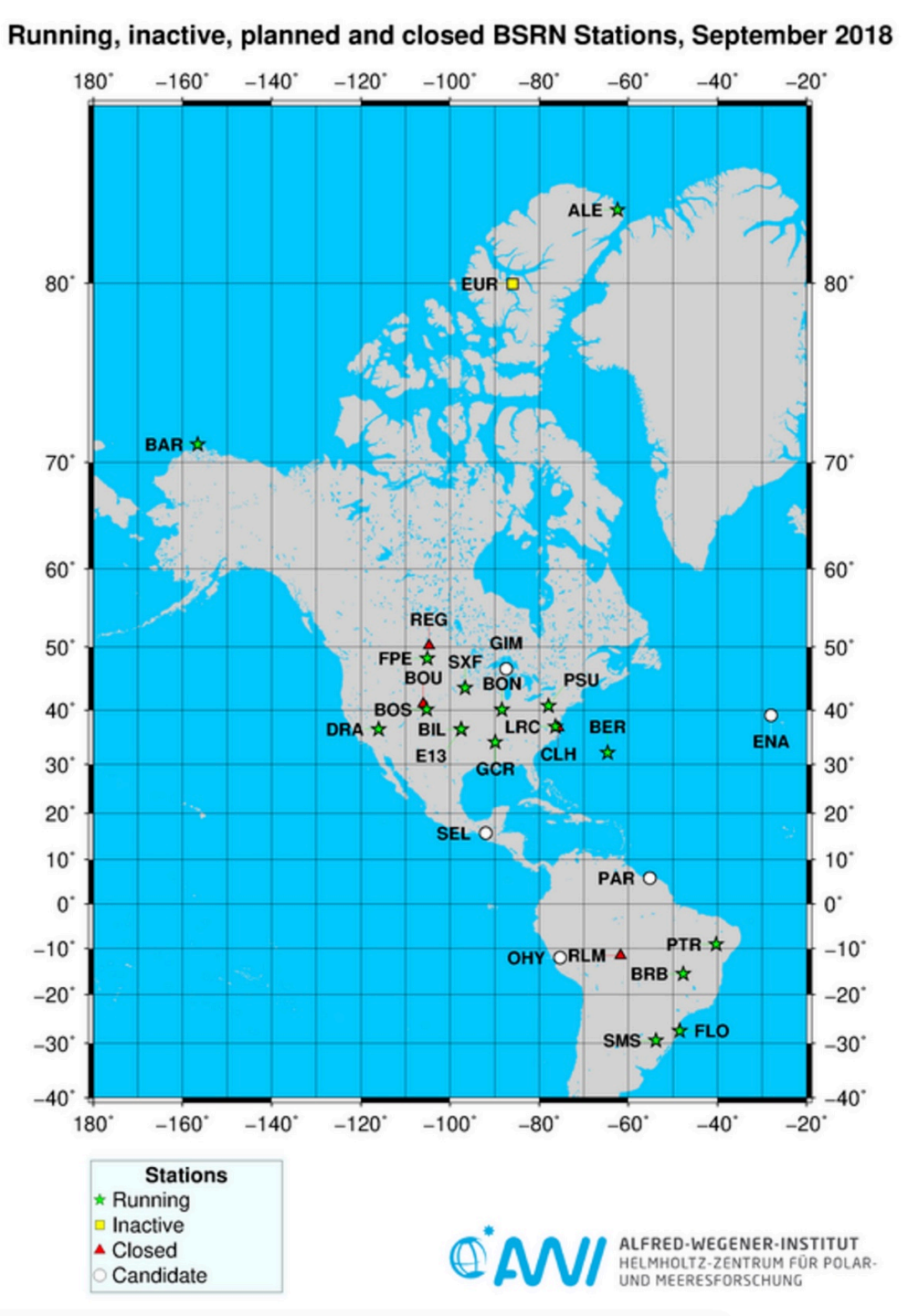
CAPABLE



Granite Island

Granite Island (BSRN ID: GIM) is now a candidate station for BSRN

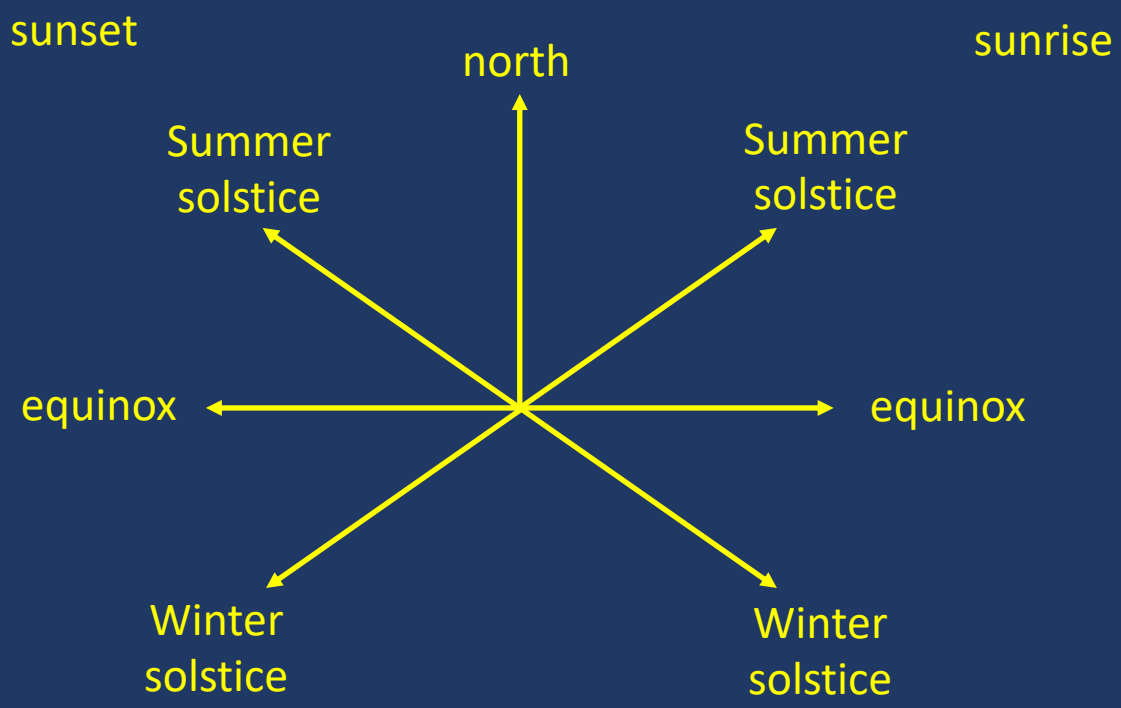


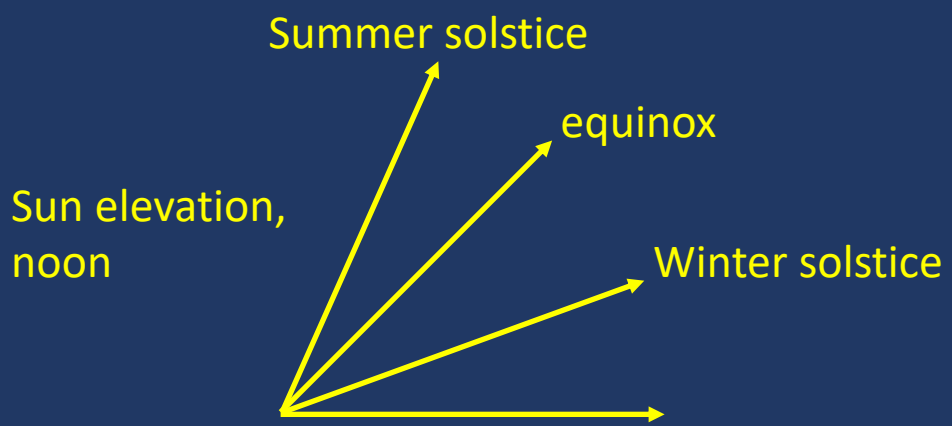


Issues, Challenges and Mitigation Efforts

Island View.

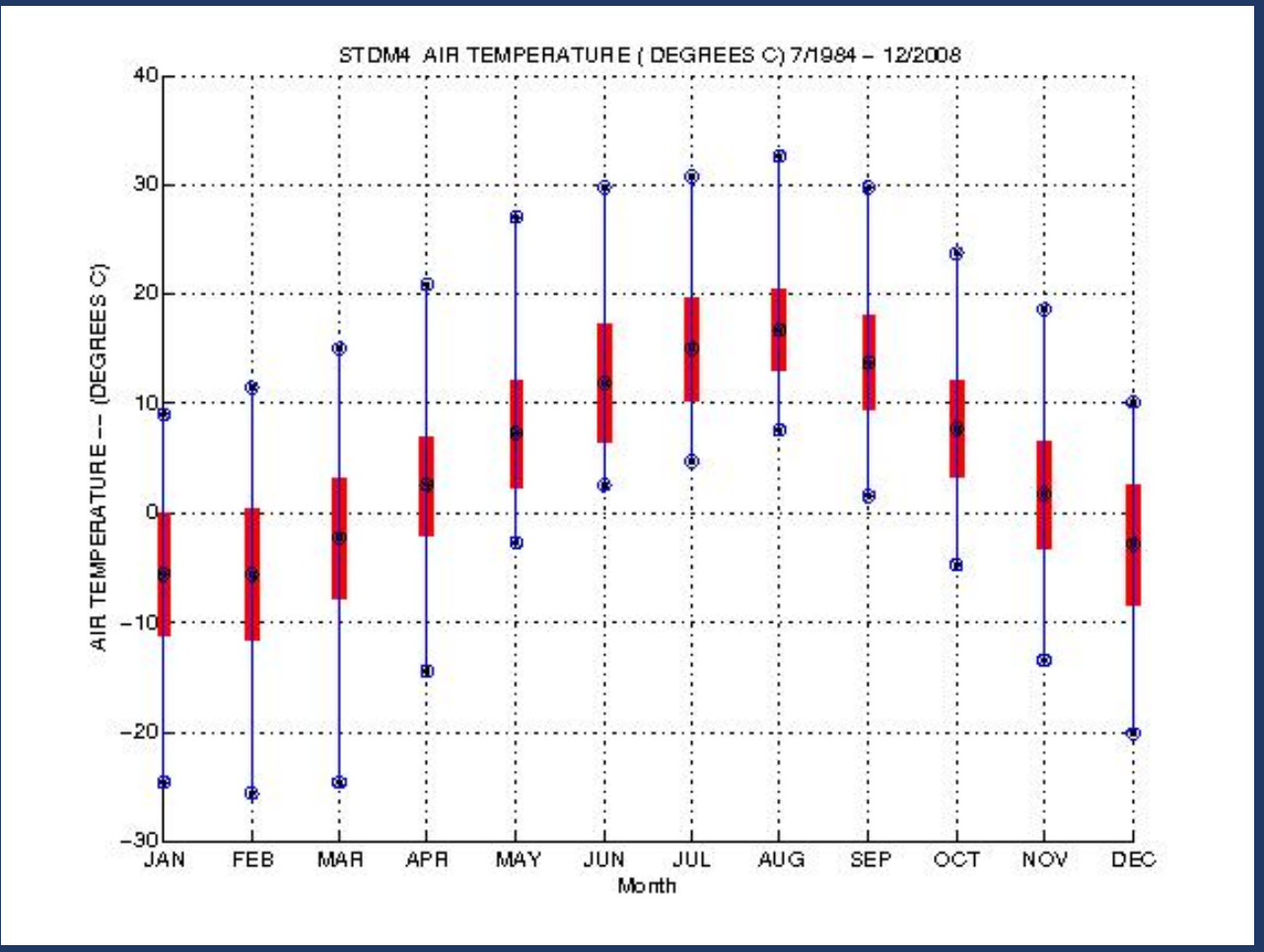
Sun rise/set azimuths

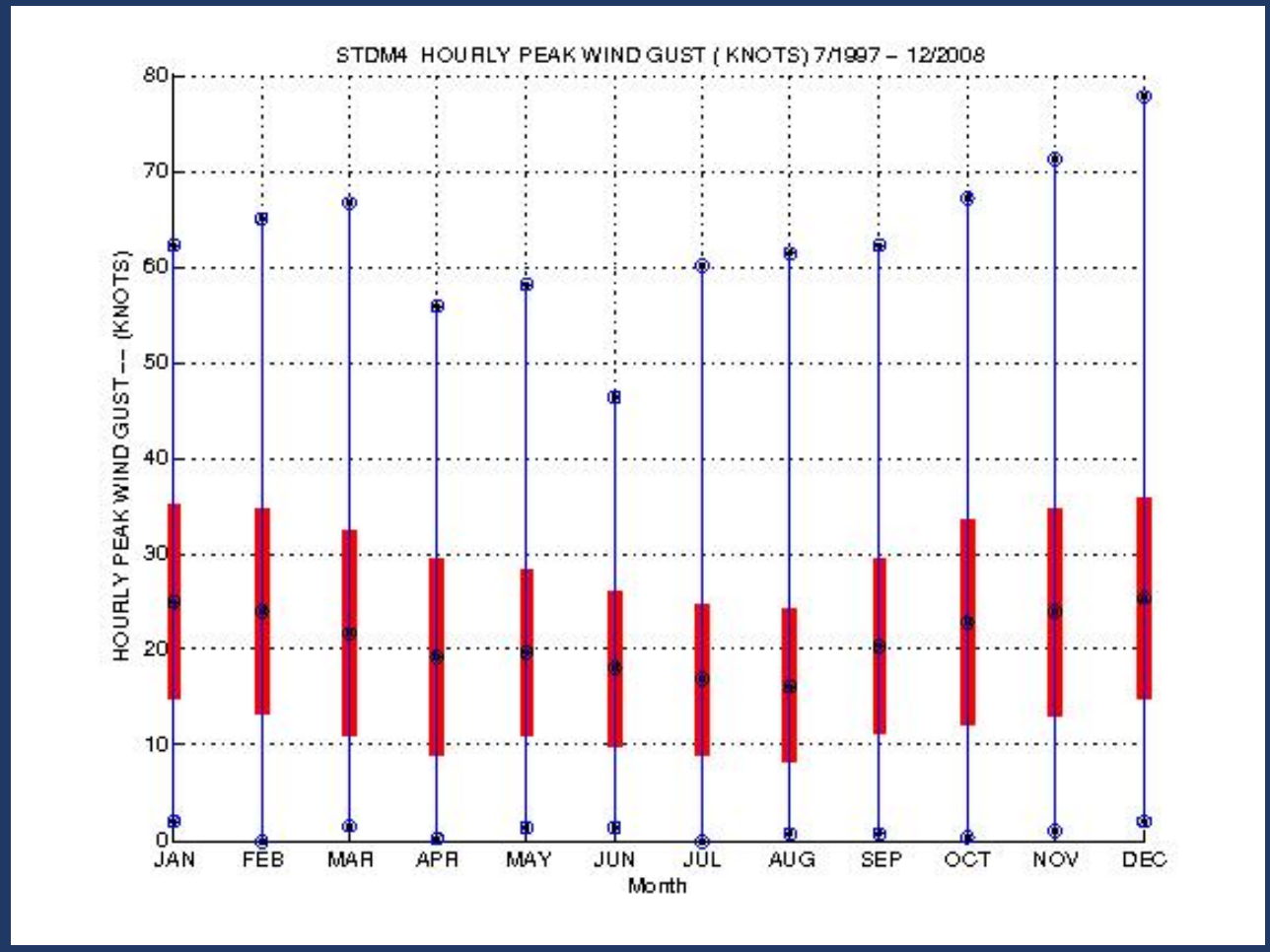




Approximate 9-10 degree blockage, late in day, by towers and house in the summer months.

It’s Cold and Windy on the Island

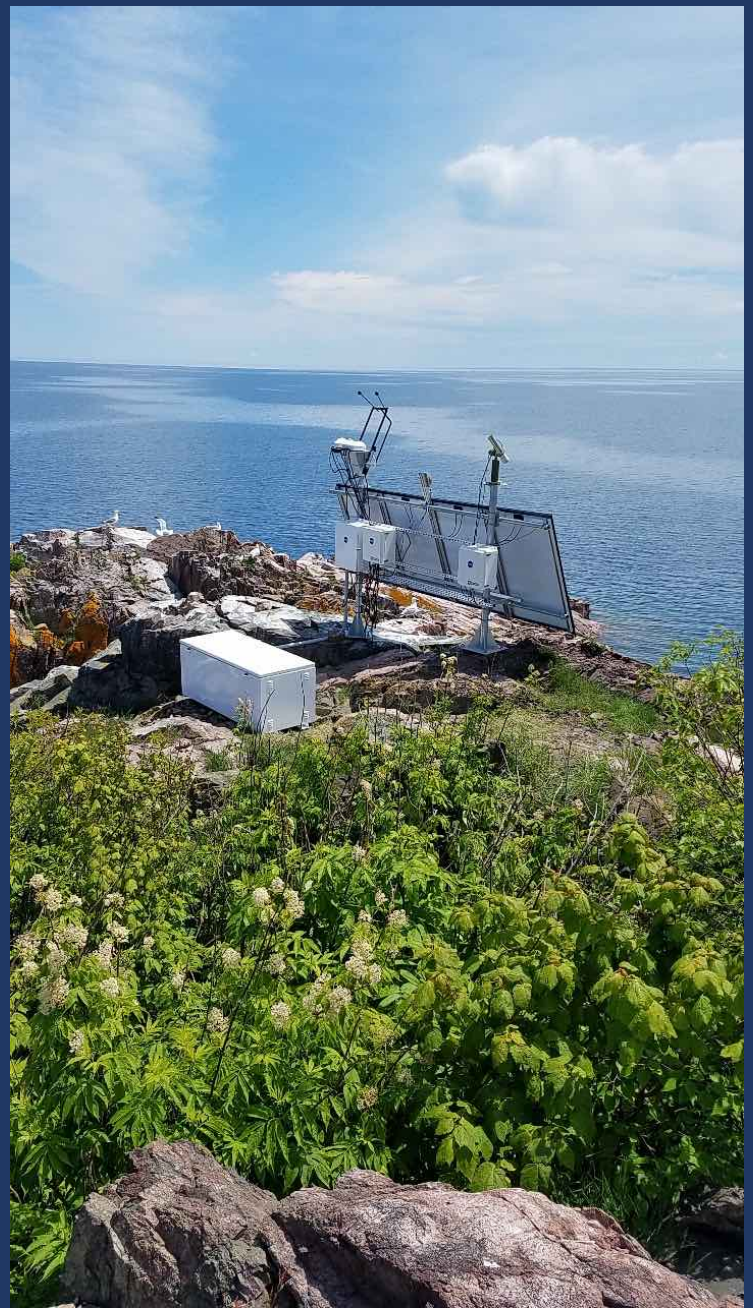


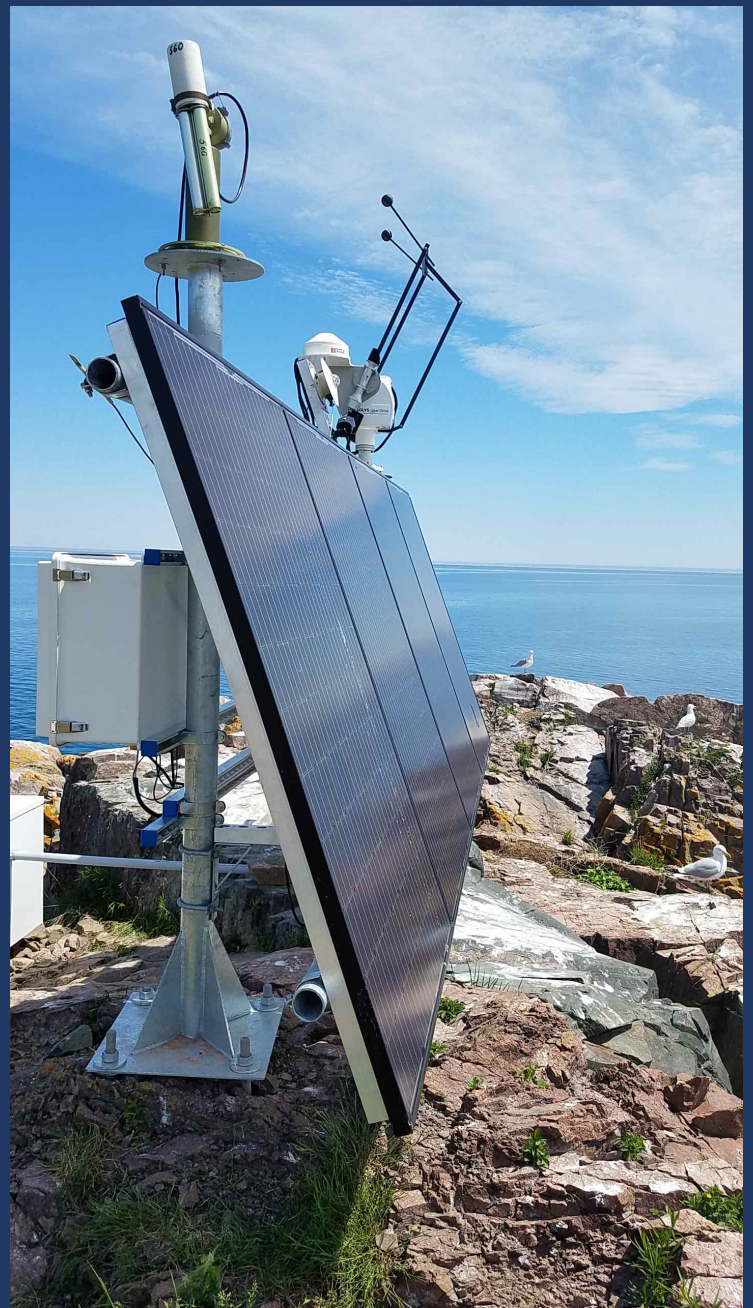


Problems with Seagulls

Solution to perching seagulls

Final Setup. Front and Back View





Conclusions

- Soon after COVE was shutdown due to structural concerns, a new opportunity opened at GI
- A mock installation was setup at the CAPABLE site as a testbed for all GI equipment
- CERES is interested in radiometric data coupled with evaporation data that could further improve understanding of the Earth's energy budget
- Surface validation of satellites over water are rare but GI will help fill this underrepresented scene type (when ice is not present)
- Seagulls were initially an issue due to perching, but modified shields appear to be a deterrent
- Help is available from NMU students and others who visit GI periodically in the summer
- 2 trips a year to GI (after winter and late fall to swap instruments with newly calibrated ones)
- Data collection commenced in June 2018

Acknowledgements:

- We would like to thank Scott Holman, owner of Granite Island for allowing a new measurement site to be introduced

- We thank NASA Langley and the CERES project for providing the funding for Granite Island

- We appreciate Brent Holben (AERONET PI) for providing an AERONET cimel at Granite Island

- We thank John Lenters, Warren Smith, students and faculty of Northern Michigan University and most importantly, Dan “Ducky” Chiconsky for assisting in the installation of instruments at Granite Island

- We thank many SSAI personnel who assisted in getting Granite Island off the ground. We especially thank Jackie who had to deal with our ever changing schedule and deadlines!

THANK YOU

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