

Great Lakes Surface Environmental Analysis (GLSEA) with ACSPO L3S SST

*Songzhi Liu*¹

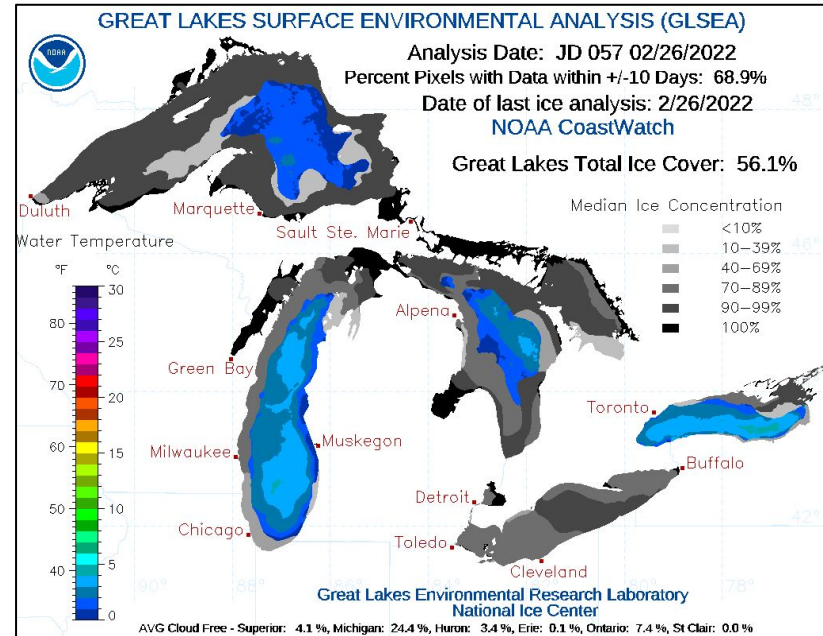
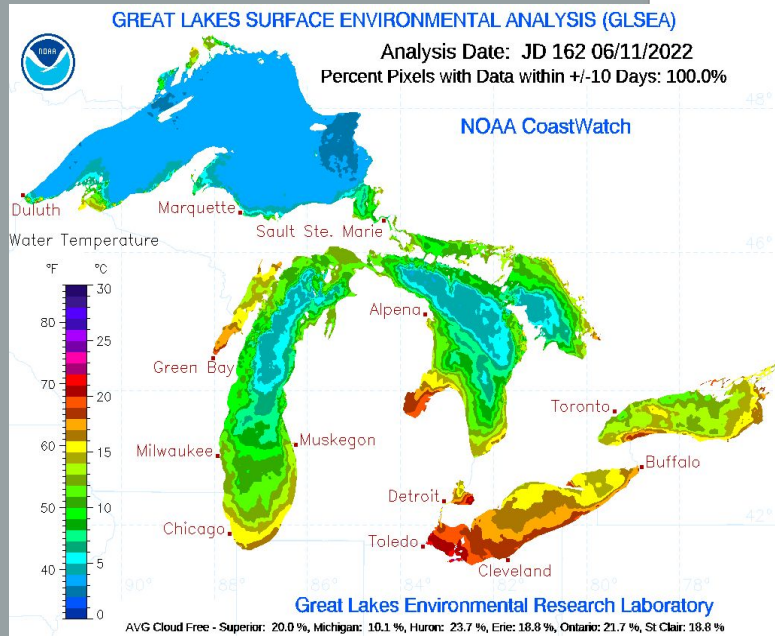
*Andrea Vander Woude*²



- **What is GLSEA?**
- **Who are the users?**
- **Development of GLSEA**
- **GLSEA validations**

GREAT LAKES COASTWATCH NODE

Great Lakes Surface Environmental Analysis (GLSEA)



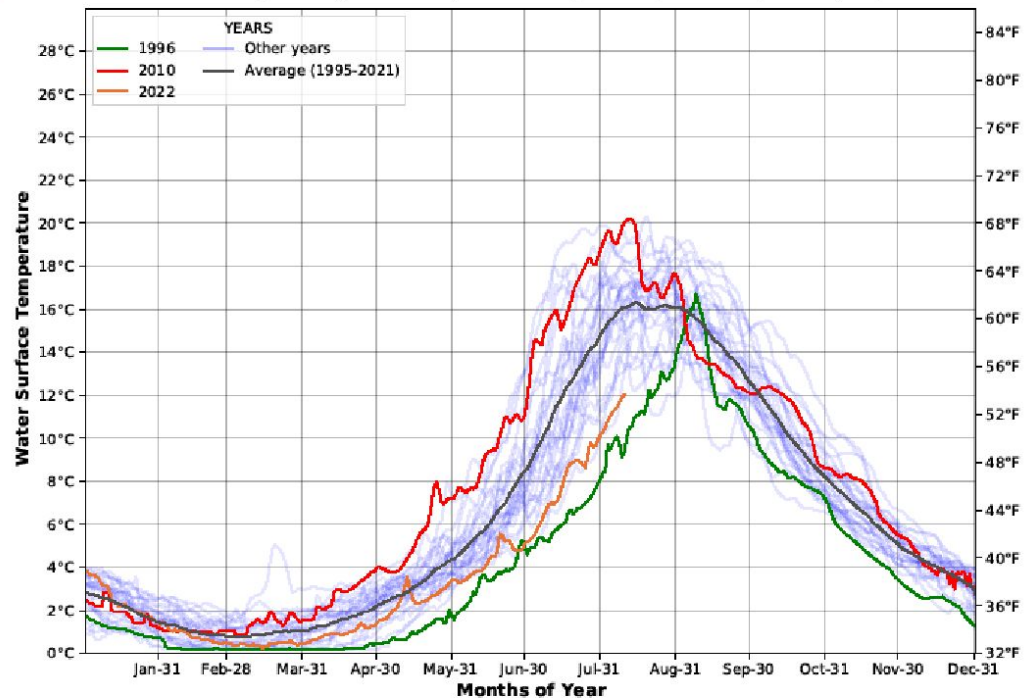
GREAT LAKES COASTWATCH NODE

GLSEA Surface Water Temperature Statistics - Satellite Trends Observed



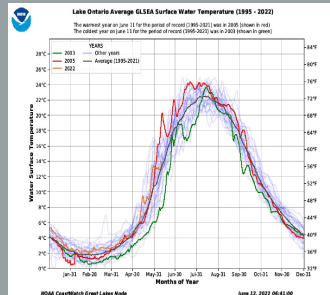
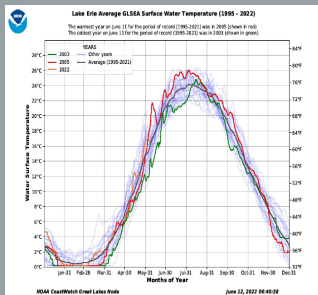
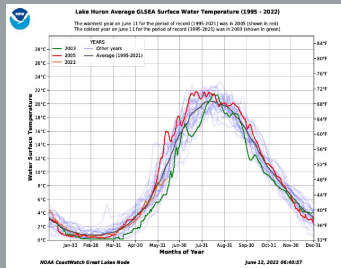
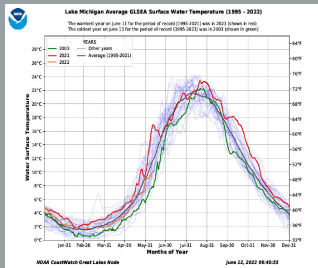
Lake Superior Average GLSEA Surface Water Temperature (1995 - 2022)

The warmest year on August 10 for the period of record (1995-2021) was in 2010 (shown in red)
 The coldest year on August 10 for the period of record (1995-2021) was in 1996 (shown in green)



NOAA CoastWatch Great Lakes Node

August 11, 2022 06:41:03

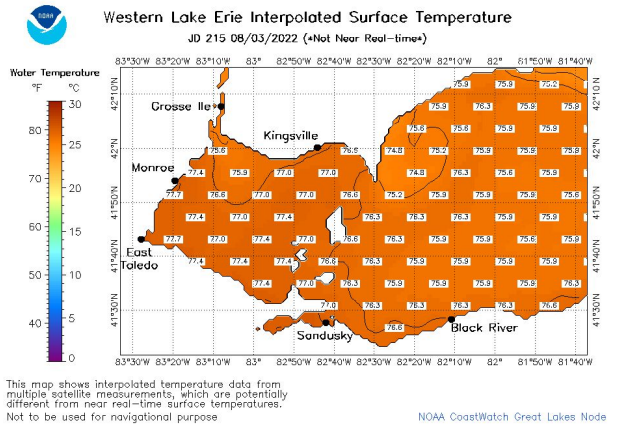
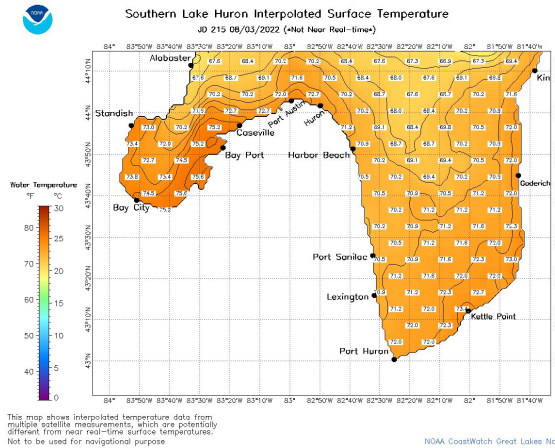
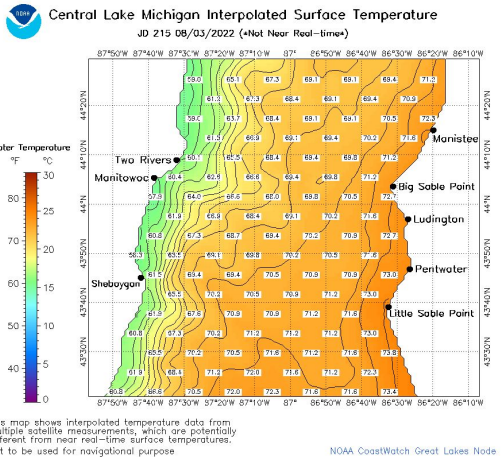
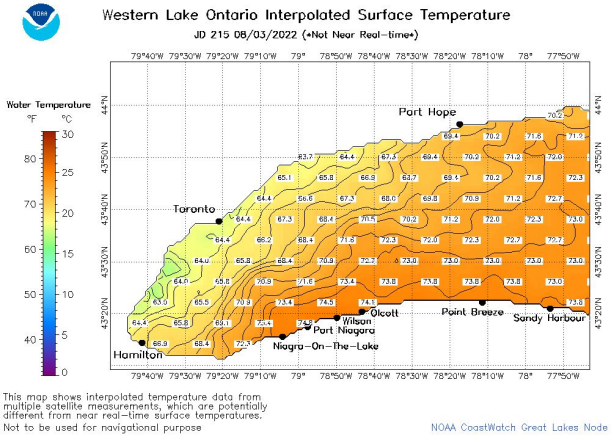
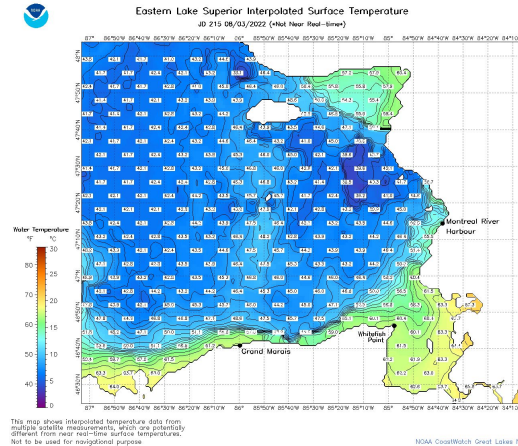
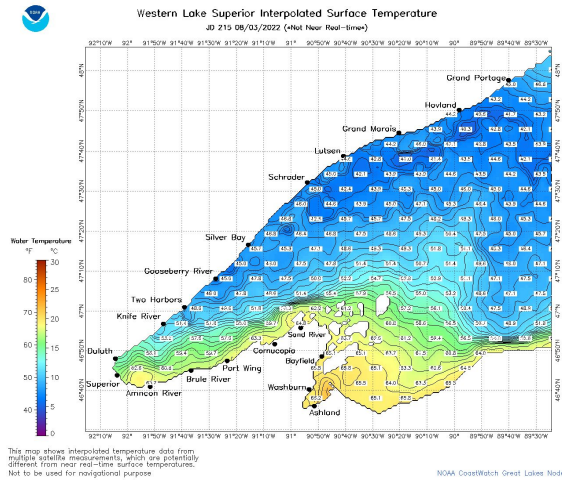


GREAT LAKES COASTWATCH NODE

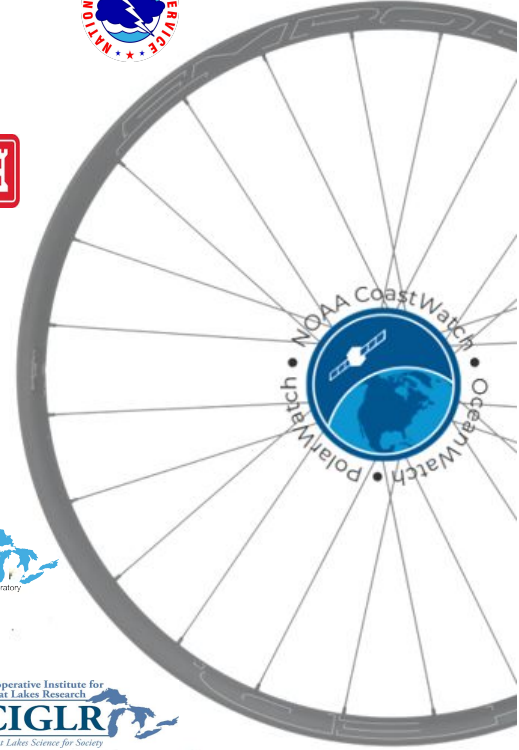
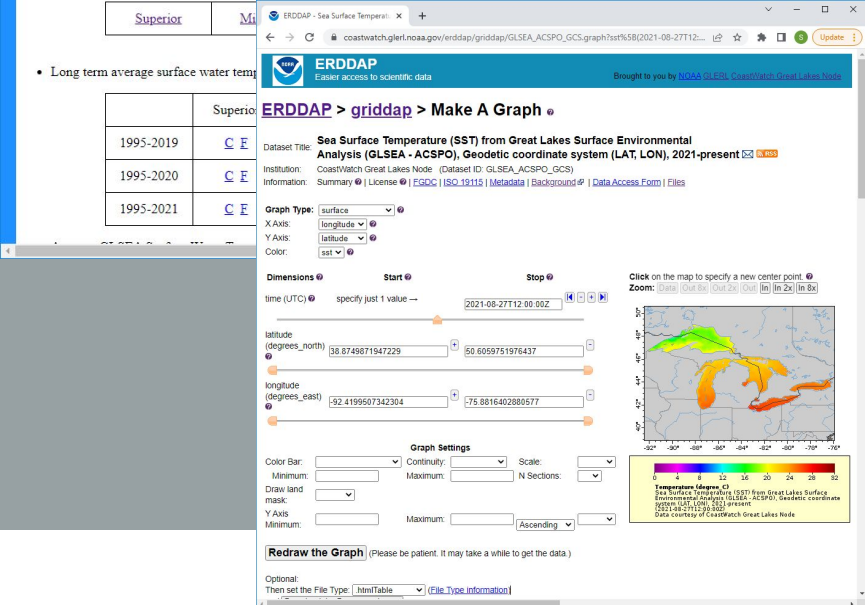
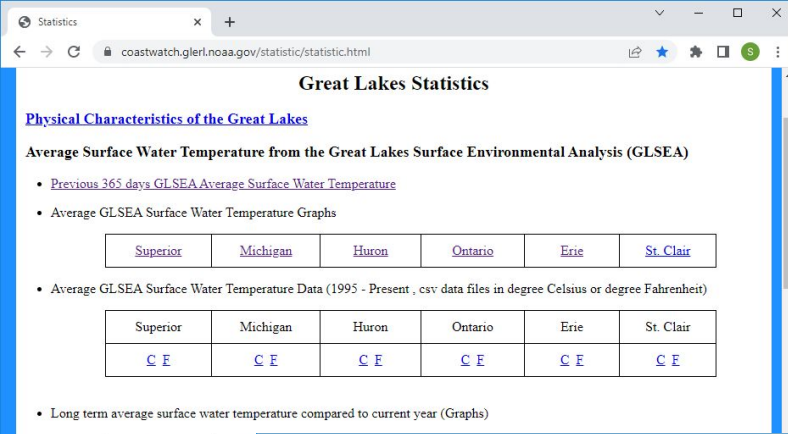
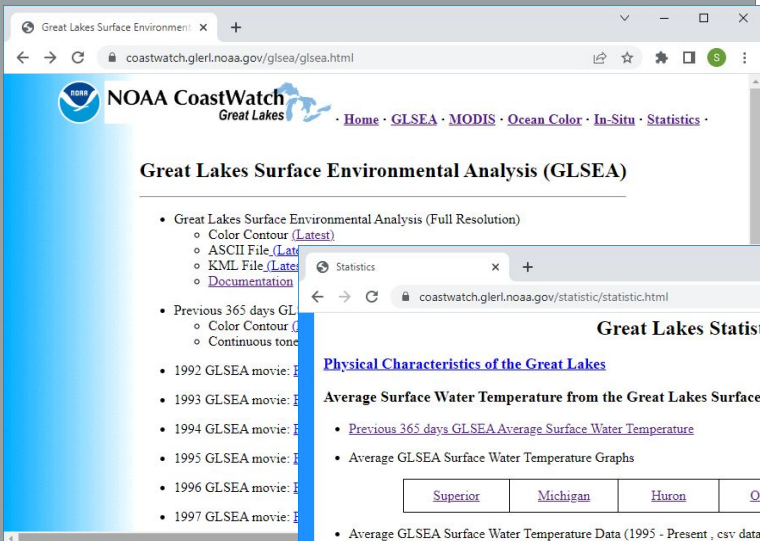


Great Lakes Surface Water Temperature Contour Maps

**** New transition from Michigan State for Stakeholders to the Great Lakes CoastWatch Node ****



SERVICES & STAKEHOLDERS

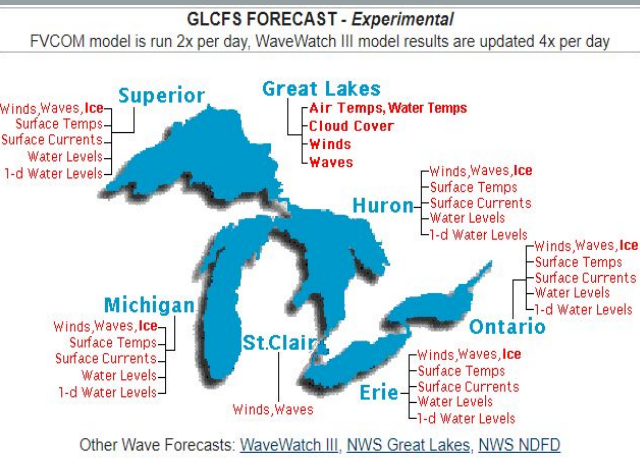
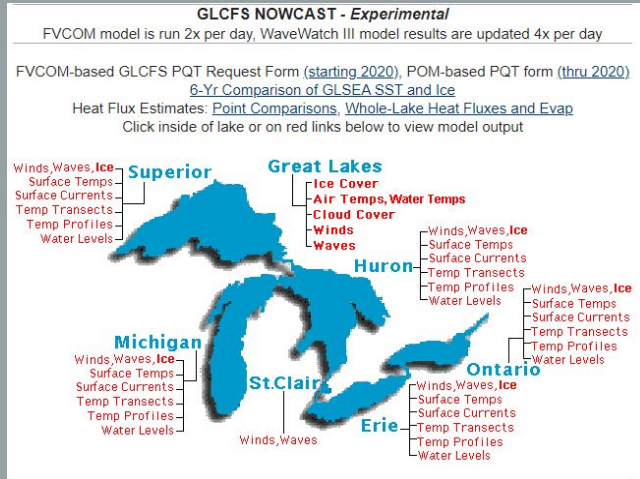


GREAT LAKES COASTWATCH NODE



NOAA NATIONAL OCEANIC AND ATMOSPHERIC ADMINISTRATION
UNITED STATES DEPARTMENT OF COMMERCE

Great Lakes Environmental Research Laboratory

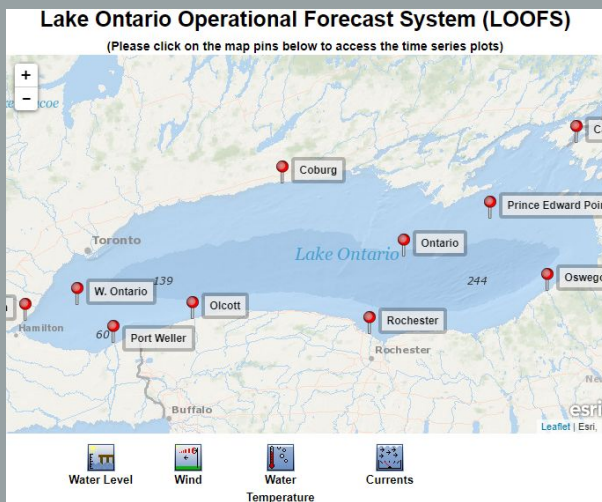


- Initialize the GLCFS nowcast and forecast models at GLERL
- Accuracy assessment of hydrodynamic models
- Biological-physical model initialization
- Predicting distributions of salmon and trout in Lake Michigan
- Field work planning
- To answer questions that went into the media inquiry

GREAT LAKES COASTWATCH NODE

National Center for Environmental Prediction National Ocean Service

- In LOOFS and LSOFS model for nowcast cycles
- Used to calculate atmospheric stability over the lake.



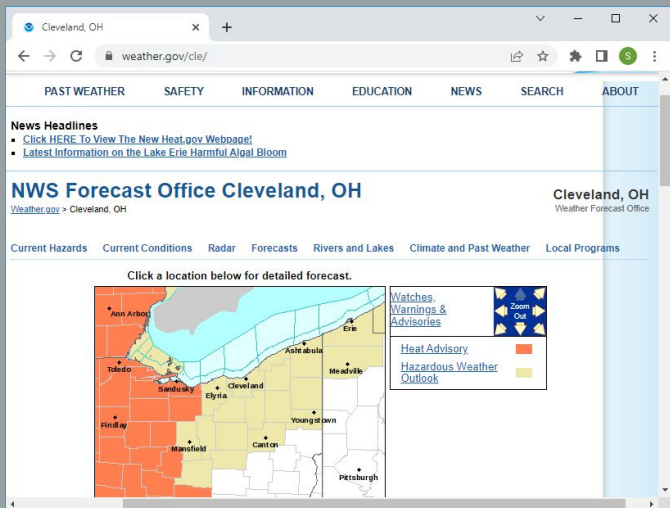
GREAT LAKES COASTWATCH NODE



NWS Grand Rapids Office

National Weather Service

- NWS Grand Rapids Office
Lake effect snow
Freezing spray



NWS Cleveland office website

- NWS Cleveland Office
(in development)
Lake effect snow
Ice forecasting program

GREAT LAKES COASTWATCH NODE

US Army Corps of Engineers Detroit District

- To inform the monitoring of Great Lakes basin conditions (**they also calculate their own statistics**)
- Provide guidance for 6-month water level forecast

Basin Conditions

ire.usace.army.mil/Missions/Great-Lakes-Information/Great-La...

US Army Corps of Engineers
Detroit District Website

Long Term Trends in Great Lakes Basin Conditions

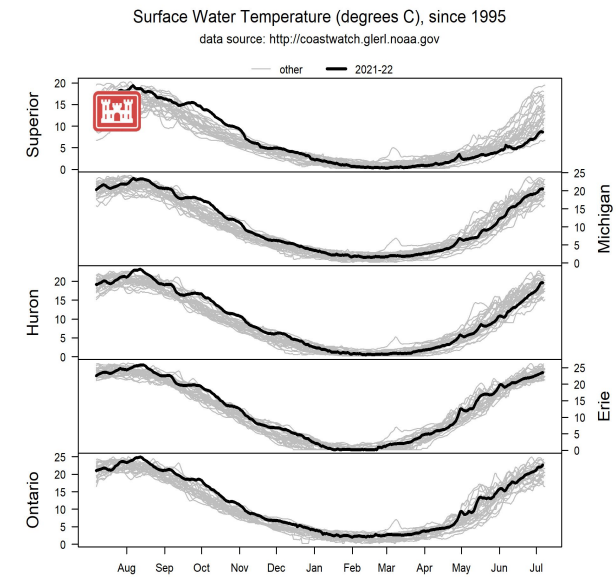
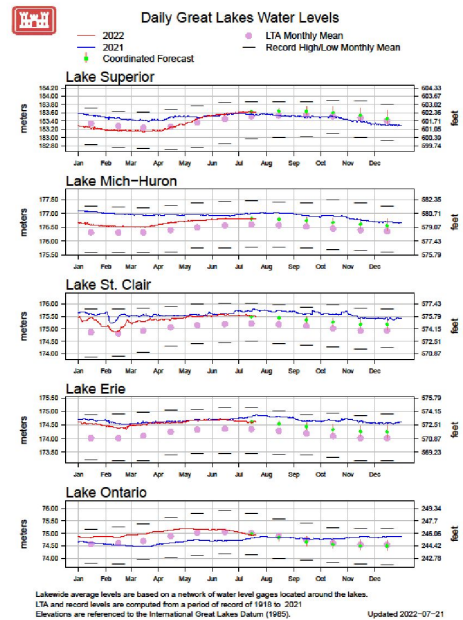
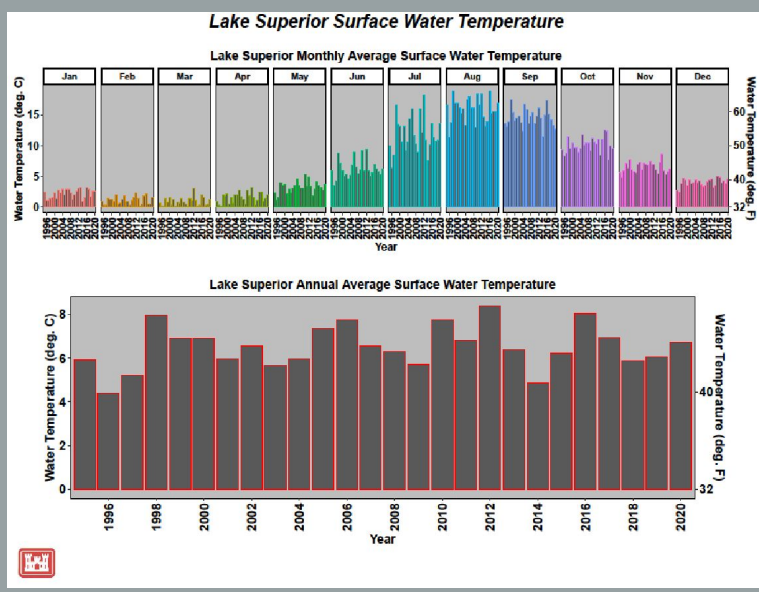
[Collapse All](#) [Expand All](#)

- NBS Components (Precipitation, Evaporation, Runoff)
- Surface Water Temperatures and Ice Cover

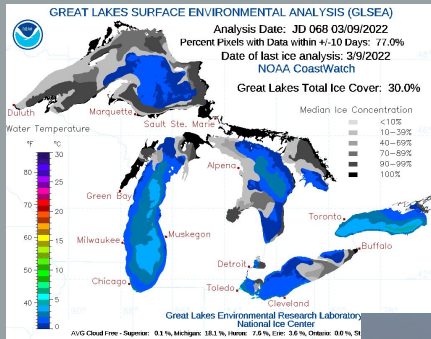
This page shows historical surface water temperatures and ice cover for Lakes Superior, Michigan, Huron, Erie, and Ontario. There are 5 sections, one for each lake, that provide a table describing past conditions, a graphic showing monthly and annual average surface water temperatures, and a graphic showing monthly and annual maximum ice cover. Average surface water temperatures are shown over the period 1995-2020 and ice cover is shown from November 1972 to June of 2021. Please note that the years on the annual plots refer to "Ice Years", which starts in November or December of the previous year. For example, the ice year of 2015, would be from November 2014 to June 2015.

Use the links below to go directly to the graphs for each lake.

[Lake Superior](#) [Lake Michigan](#) [Lake Huron](#) [Lake Erie](#) [Lake Ontario](#) [Data Information](#)



US Coast Guard



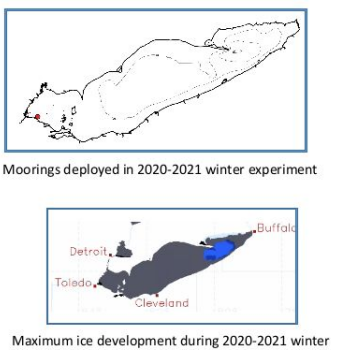
- Supporting the US Coast Guard's domestic ice breaking mission.
- The ice concentration data on GLSEA helps US CG inform the leadership of internal and external customers

Photos credit to: Mark S. Gill

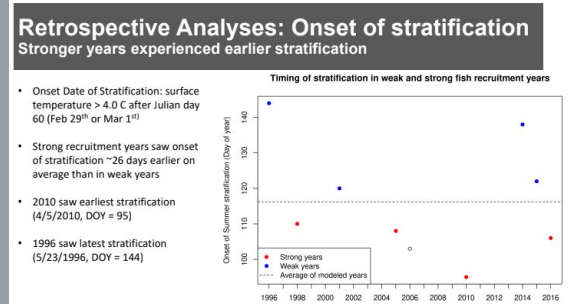
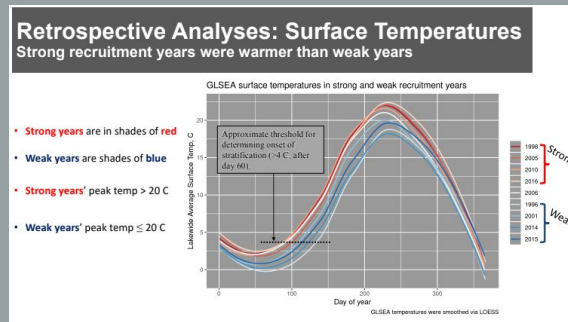
GREAT LAKES COASTWATCH NODE

Cooperative Institute for Great Lakes Research University of Michigan

- To validate modeled surface temperature
- To confirm the presence of ice in the vicinity of moorings with ice thickness observations.
- To analyze the effect of the surface temperature on fish recruitment



Lake Erie ice confirmation
Credit to: Beletsky, Fujisaki-Manome, etc)



Credit to: Peter Alsip

GREAT LAKES COASTWATCH NODE



Green water, photo credit R. Sterner

Large Lakes Observatory University of Minnesota Duluth

- R. Sterner, has been using GLSEA data to explore seasonal surface temperature patterns in relation to Lake Superior algal blooms
- Research shows a clear difference in surface temperatures in bloom vs. non-bloom years, before and during bloom season

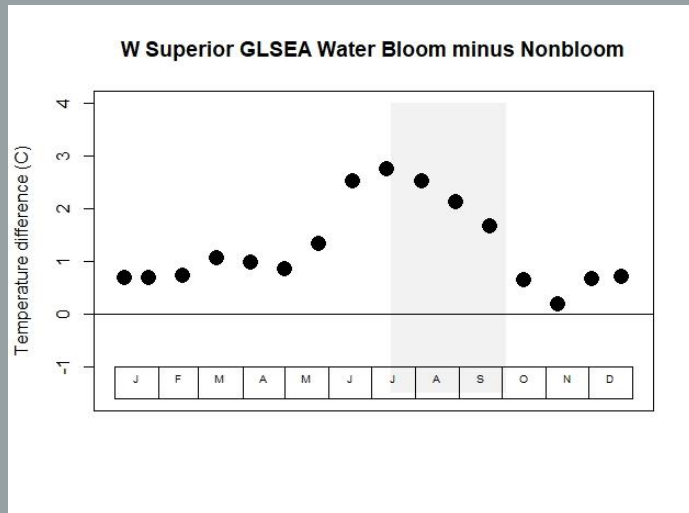
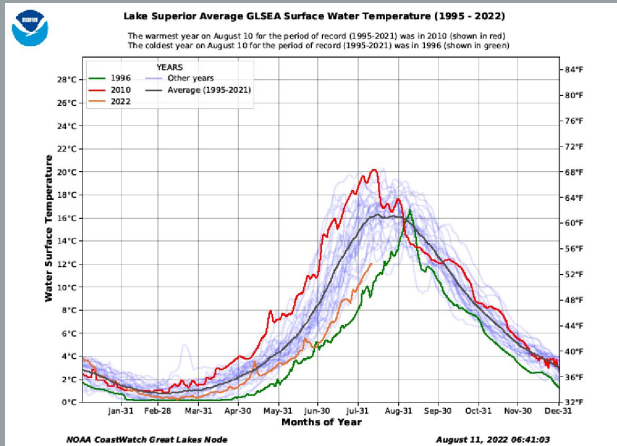
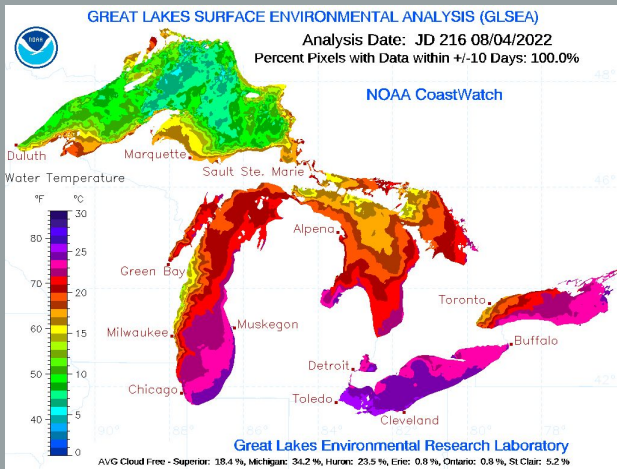


photo credit R. Sterner

GREAT LAKES COASTWATCH NODE





Media

Each year, the Great Lakes surface water temperature statistic data and plots are used by media



GREAT LAKES COASTWATCH NODE

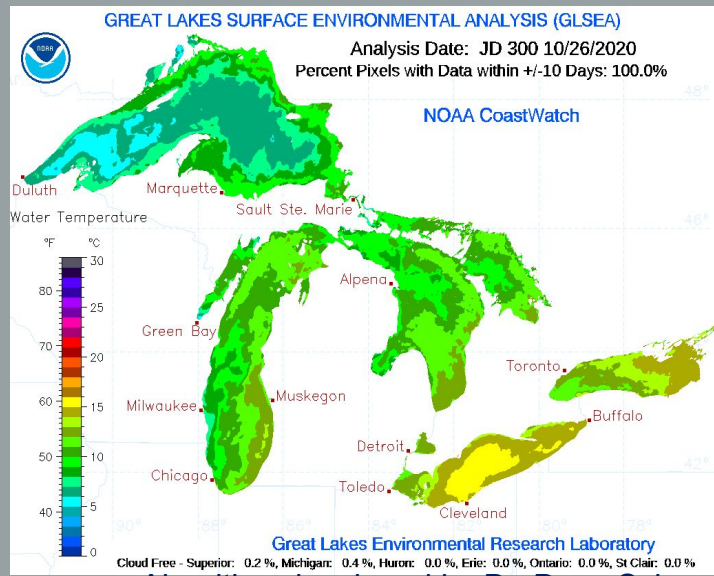
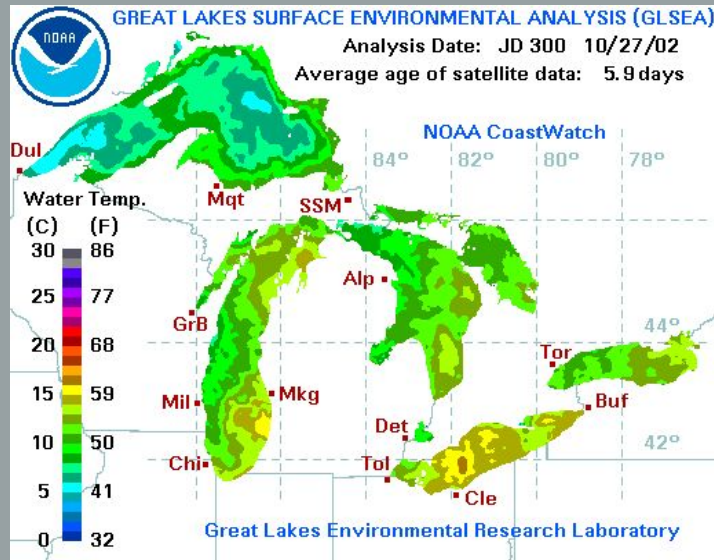
Development of GLSEA

First generation of GLSEA:

- AVHRR SST
- 5 days cloud free composite
- 512 x 512 pixels, 2.6 km.
- 1995 - 2013

Second generation of GLSEA2 is

- AVHRR and VIIRS SST
- 20 days cloud free composite
- 1024 x 1024 pixels, 1.3km
- 1995 - current



Algorithm developed by Dr. Dave Schwab

GREAT LAKES COASTWATCH NODE

Improvements to GLSEA

ACSP0 L3S SST data source as input to GLSEA

- Advanced Clear-sky Processor for Oceans (ACSP0) SST products
- Gridded super-collated products from low earth orbiting satellites (L3S-LEO)
- ACSP0 LEO collation algorithms (day, night)
- 2006-2011, two files each day derived from MetOp A
- 2012-current, four files each day derived from NPP, N20, MetOp A/B/C

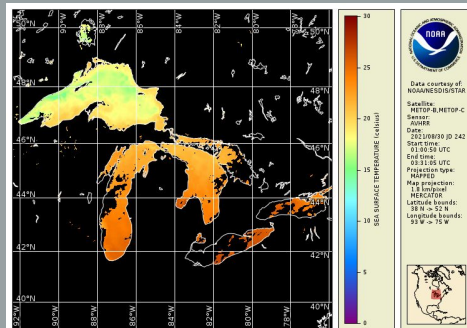
ACSP0 L3S SST
netCDF format
2 km/pixel



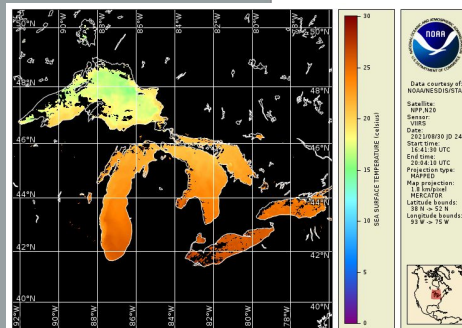
HDF format
1.3 km/pixel



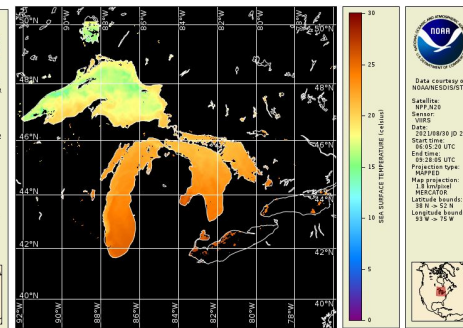
GLSEA
1.3 km/pixel



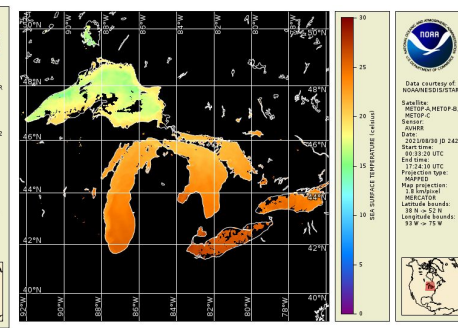
2021-08-30 AM-D



2021-08-30 AM-N



2021-08-30 PM-D

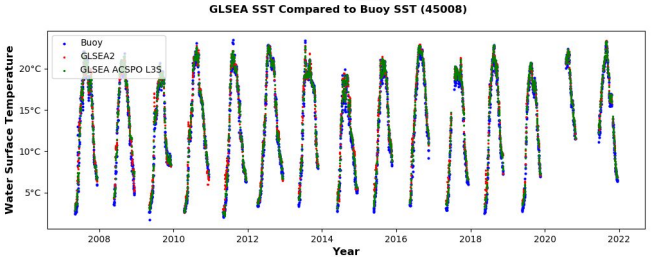
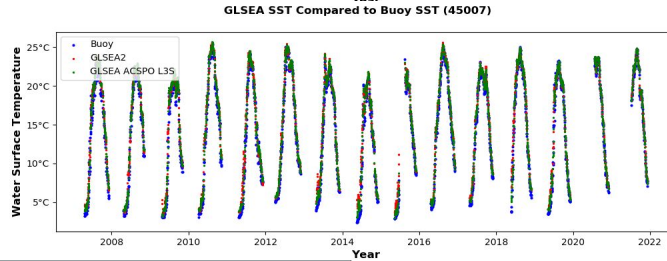
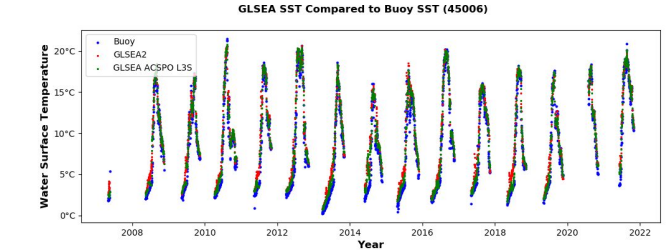
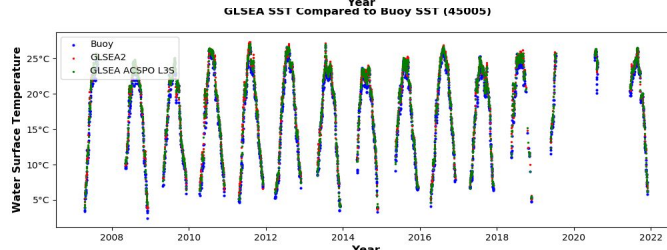
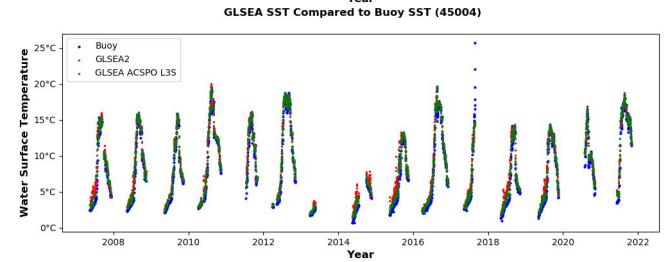
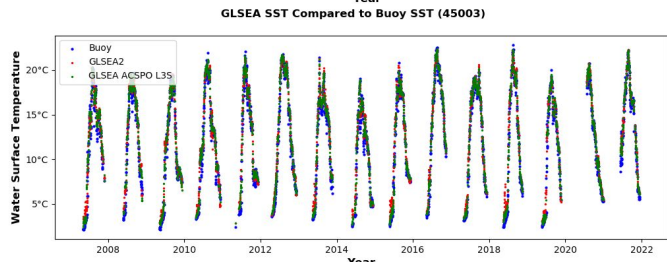
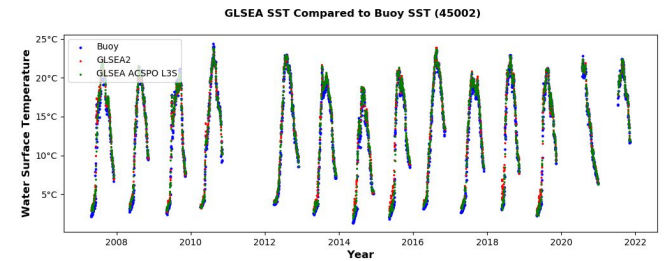
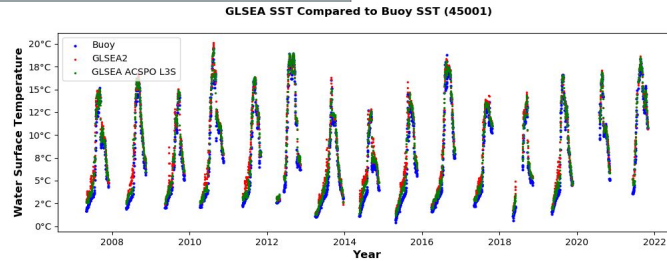


2021-08-30 PM-N



Assessment of GLSEA Compared to NDBC Buoy SST 2007-2021

- Buoy
- GLSEA2
- GLSEA ACSPO L3S

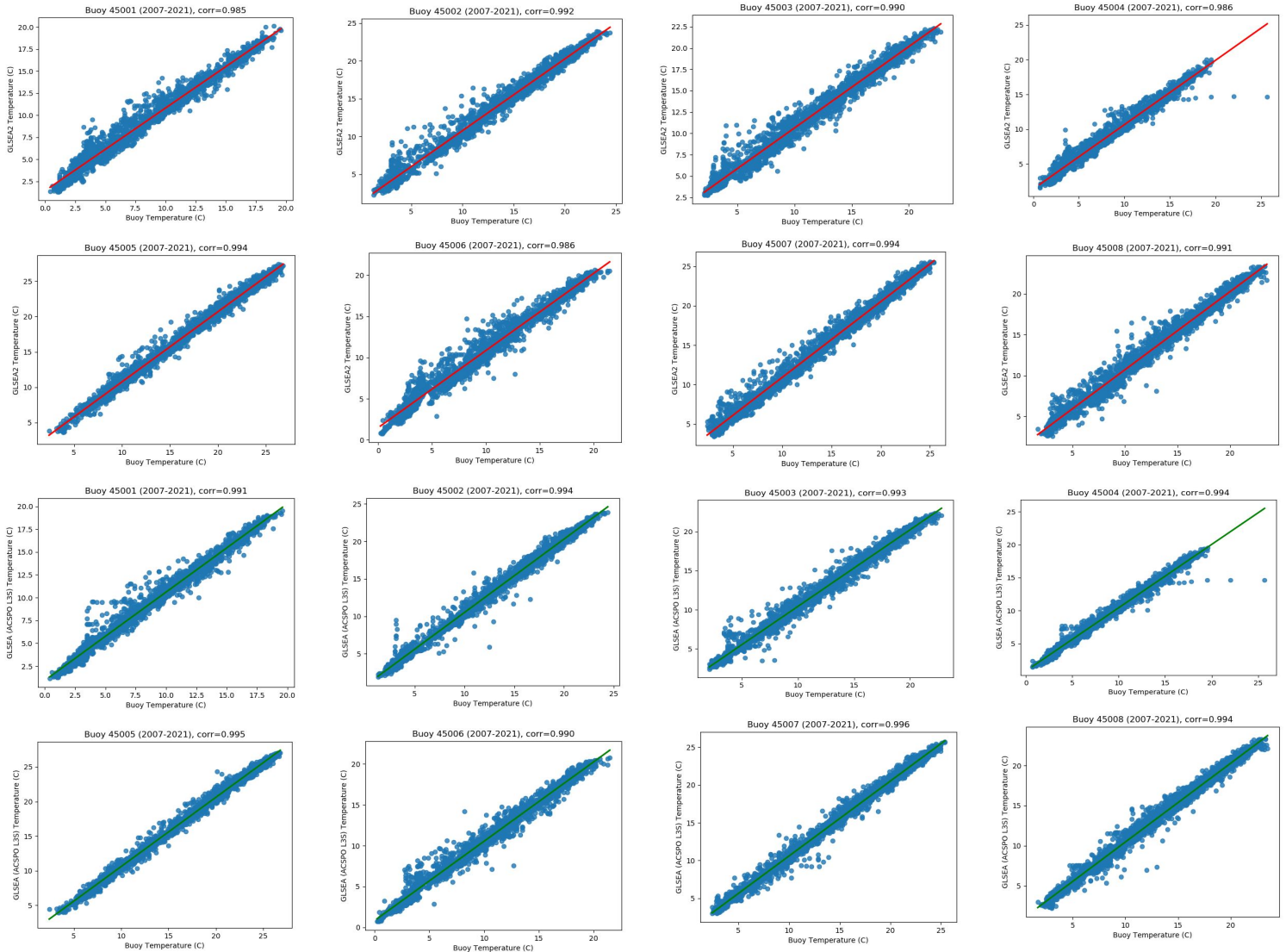


GREAT LAKES COASTWATCH NODE



Comparison with NDBC buoy SST 2007-2021

GLSEA2

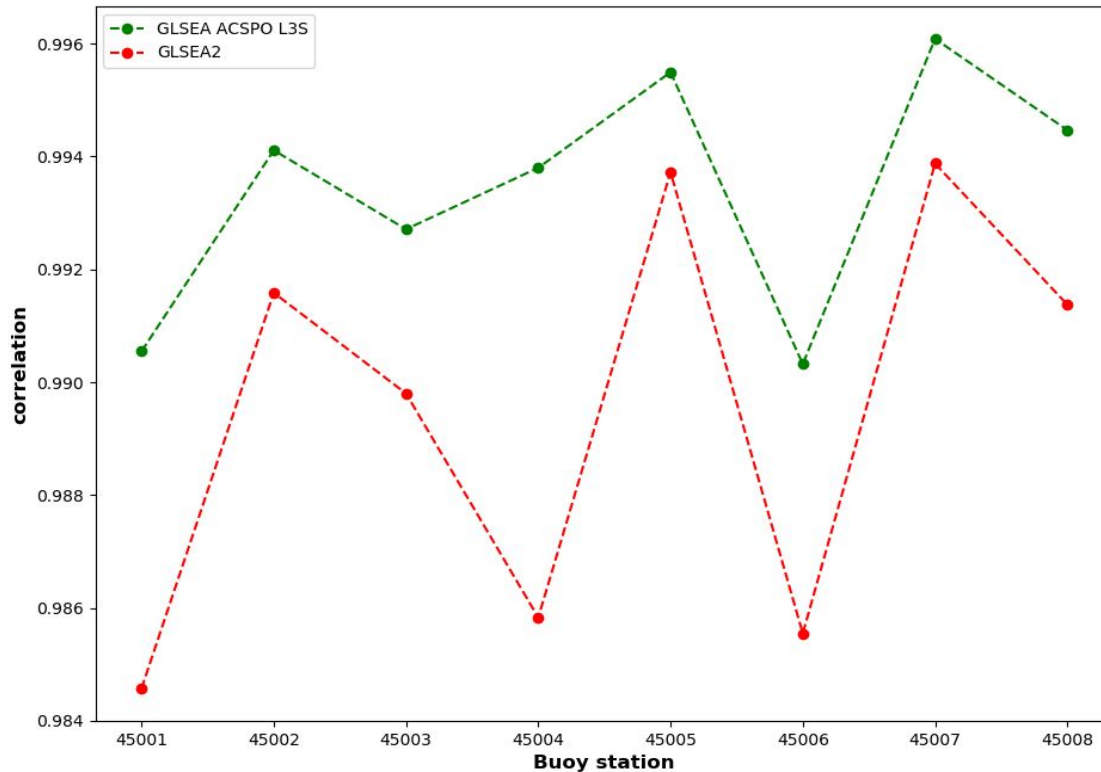


GLSEA with
ACSPO L3S



Assessment of GLSEA ACSPO L3S with Buoy data

GLSEA SST Compared to Buoy SST 2007 - 2021



**Strong Correlation
in GLSEA ACSPO L3S
with buoys**

GREAT LAKES COASTWATCH NODE



Assessment of GLSEA ACSPO L3S

Comparison with NDBC buoy SST and GLSEA SST 2007-2021

Compare GLSEA2 and GLSEA ACSPO L3S

GLSEA2

BUOY	MAE	RMSE	BIAS	MAE2	BIAS2	COUNT
45001	1.27	1.01	0.97	1.21	1.21	2727
45002	1.03	0.72	0.61	1.10	1.09	2722
45003	0.97	0.69	0.53	1.09	1.07	2895
45004	1.16	0.86	0.78	1.17	1.17	2361
45005	0.92	0.73	0.69	1.05	1.05	2707
45006	1.34	1.02	0.93	1.20	1.19	2646
45007	1.04	0.78	0.73	1.08	1.08	2961
45008	0.97	0.69	0.55	1.08	1.06	2901

GLSEA ACSPO

BUOY	MAE	RMSE	BIAS	MAE2	BIAS2	COUNT
45001	0.94	0.74	0.68	1.15	1.14	2727
45002	0.78	0.56	0.45	1.07	1.06	2722
45003	0.77	0.54	0.39	1.06	1.05	2895
45004	0.79	0.60	0.50	1.11	1.11	2361
45005	0.79	0.65	0.61	1.04	1.04	2707
45006	0.92	0.69	0.58	1.13	1.12	2646
45007	0.78	0.62	0.55	1.06	1.05	2961
45008	0.72	0.53	0.40	1.05	1.04	2901

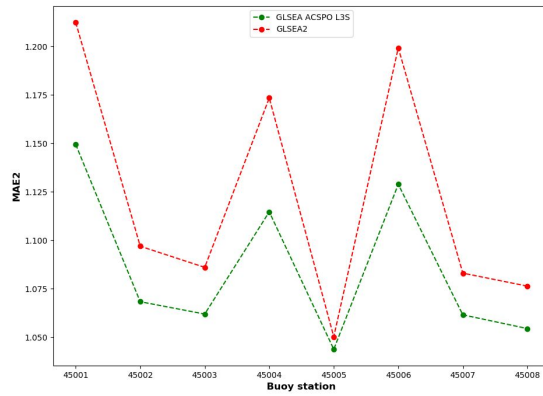
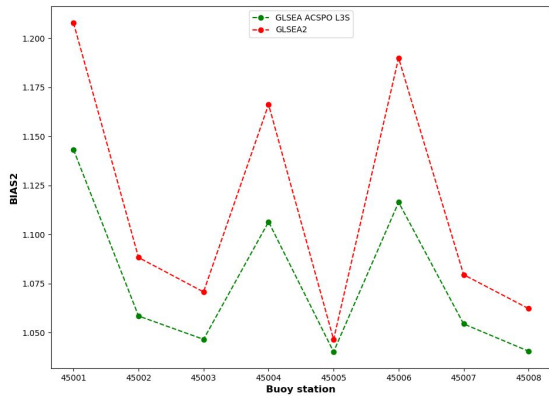
MAE2, BIAS2 based on: Bridget N. Seegers et al. "Performance metrics for the assessment of satellite data products: an ocean color case study"

GREAT LAKES COASTWATCH NODE

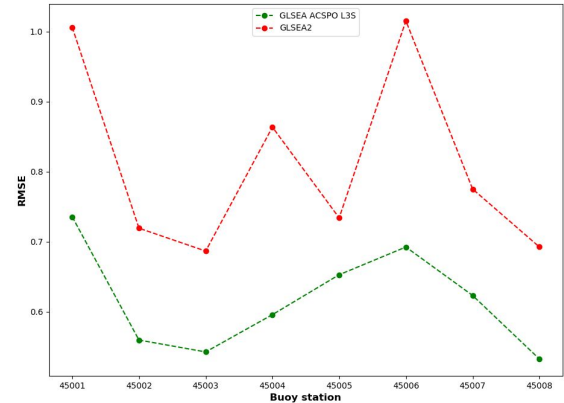
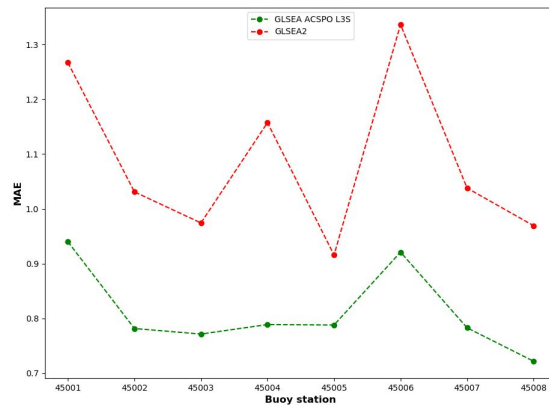
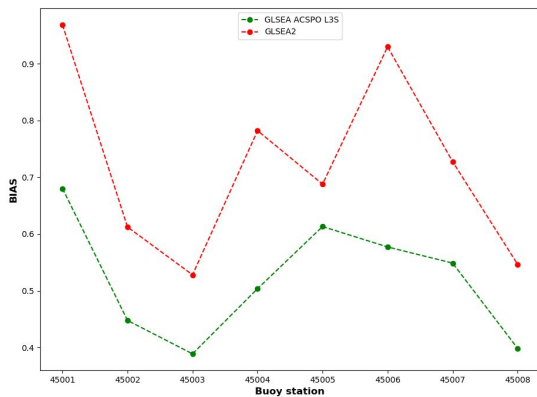


Assessment of GLSEA ACSP0 L3S

Comparison with NDBC buoy SST and GLSEA SST 2007-2021



GLSEA ACSP0 L3S is More Accurate



Great Lakes Surface Environmental Analysis

Next step:

- **GLSEA dataset from
1981 to present**

GREAT LAKES COASTWATCH NODE

Acknowledgement

People worked on the GLSEA project:

Dave Schwab, George Leshkevich, Glenn Muhr, Phillip Chu

People helped to process the ACSPO L3S SST data files:

Olafur Jonasson

Michael Soracco

Peter Hollemans

Many users provided information regarding how they used the GLSEA data:

Peter Alsip, Dimitry Beletsky, Fielder Deanna C, Ayumi Fujisake-Manome, Lauren Fry, John Kelley, Kirk Lombardy, Mark S. Gill, Lacey Mason, Ed Rutherford, Mark Rowe, Dan Titze

GREAT LAKES COASTWATCH NODE

Questions

Andrea Vander Woude, andrea.vanderwoude@noaa.gov
Songzhi Liu, sssliu@umich.edu