Great Lakes Ice Forecast Model Development
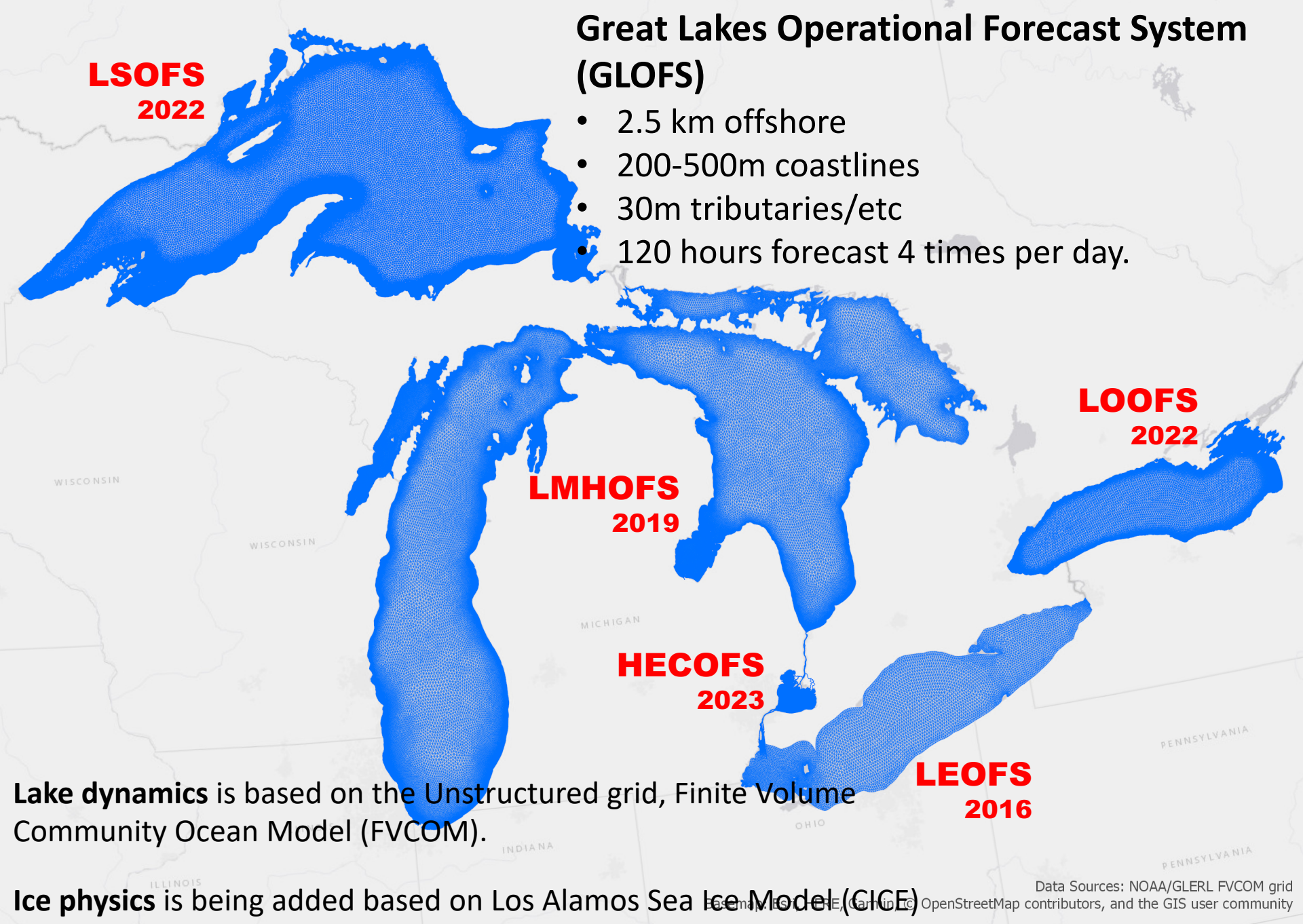
Ayumi Fujisaki-Manome[1], Eric Anderson[2], James Kessler[2,] Greg Lang[2], Philip Chu[2], Jia Wang[2], John Kelley[3], Yi Chen[3], and Aijun Zhang[4]

[1]Cooperative Institute for Great Lakes Research (CIGLR)
University of Michigan
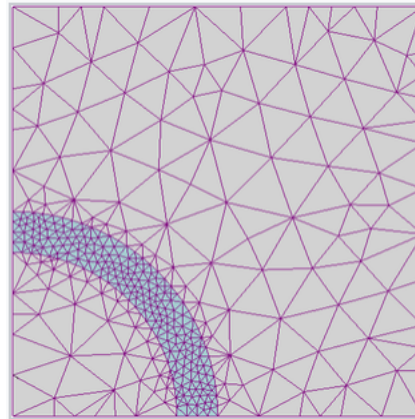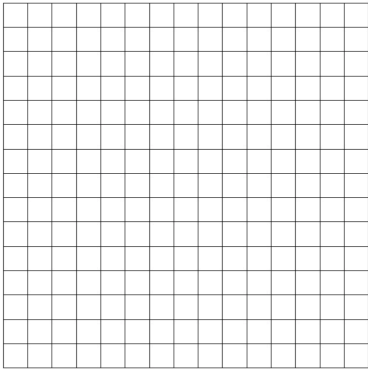[2]NOAA Great Lakes Environmental Research Laboratory
[3]Coast Survey Development Laboratory, Office of Coast Survey, National Ocean Service
[4]Center for Operational Oceanographic Products and Services, National Ocean Service

LSOFS
2022

Great Lakes Operational Forecast System (GLOFS)

- 2.5 km offshore
- 200-500m coastlines
- 30m tributaries/etc
- 120 hours forecast 4 times per day.

LOOFS
2022

LMHOFS
2019

HECOFS
2023

LEOFS
2016

Lake dynamics is based on the Unstructured grid, Finite Volume Community Ocean Model (FVCOM).

Ice physics is being added based on Los Alamos Sea Ice Model (CICE)

From NOAA Tide & Currents website

Migration from the old system based on the Princeton Ocean Model (POM) to FVCOM.

From NOAA GLERL website

The old system is still being run as real-time Great Lakes Coastal Forecasting System (GLCFS).

What's new?

Structured grid to Unstructured grid.

Addition of ice forecast

Unstructured grid snapshots

Superior Apostle Islands

Western Lake Erie

Straits of Mackinac
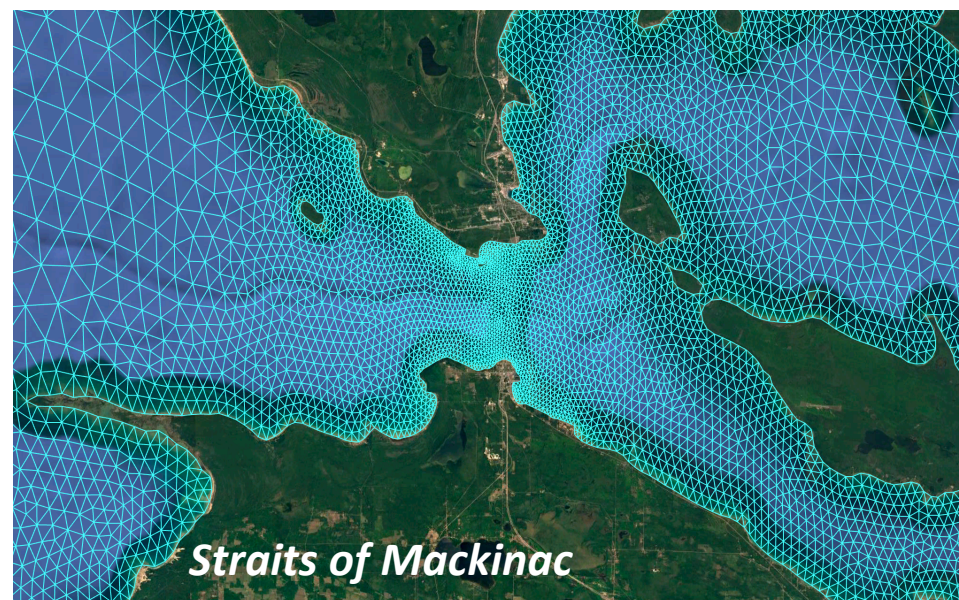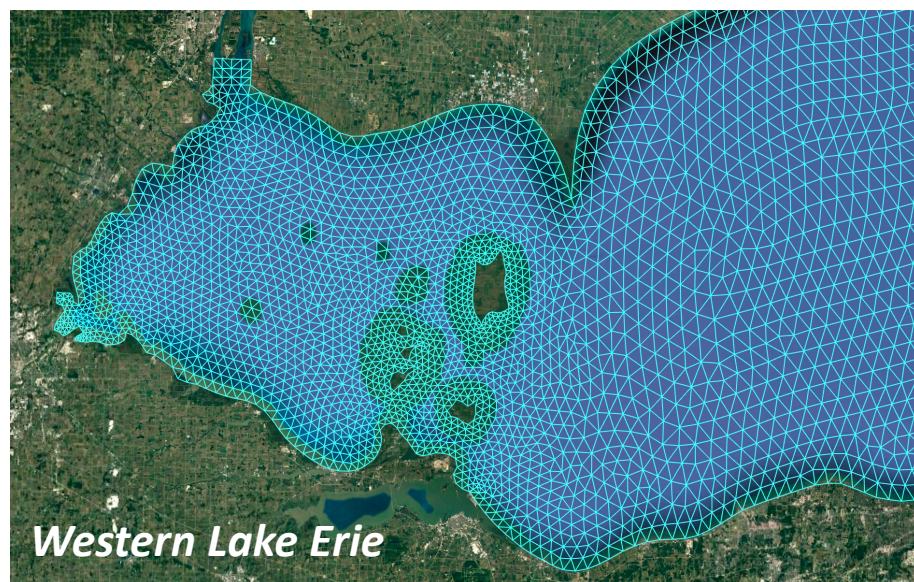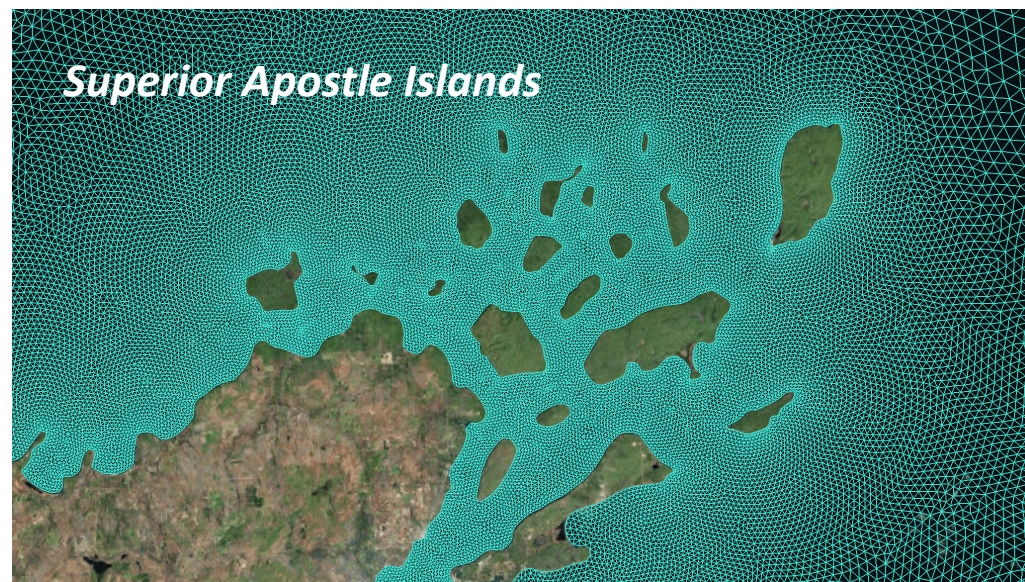
Ice Model Physics

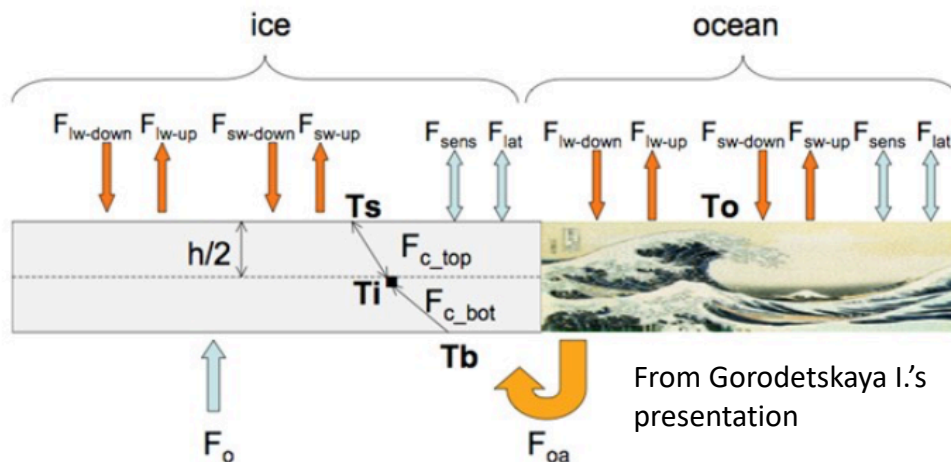Assume as a continuum body

1979 SSMI Composite Data. Credit: NASA

Dynamics
- motion
- deformation

Thermodynamics
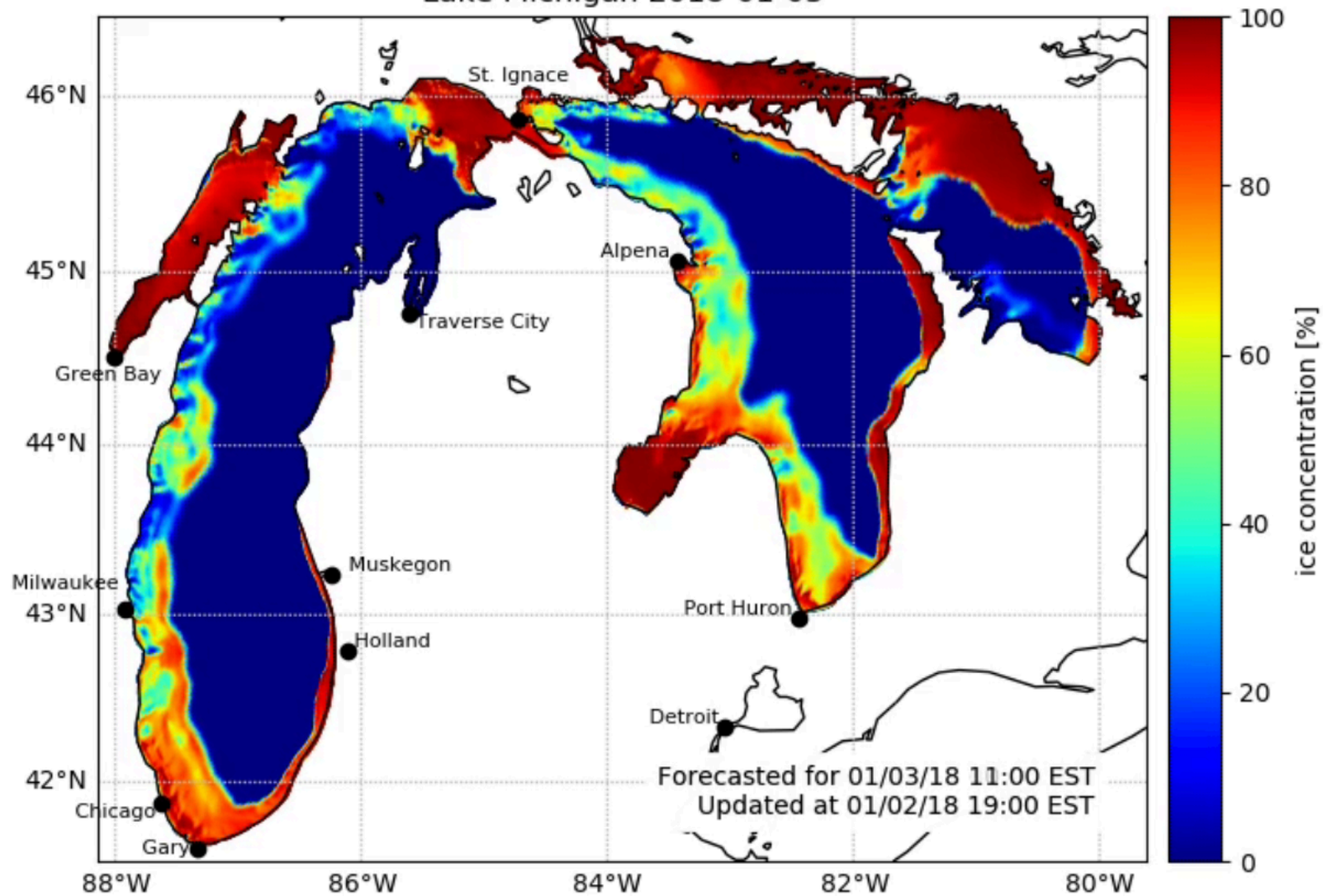- new ice formation
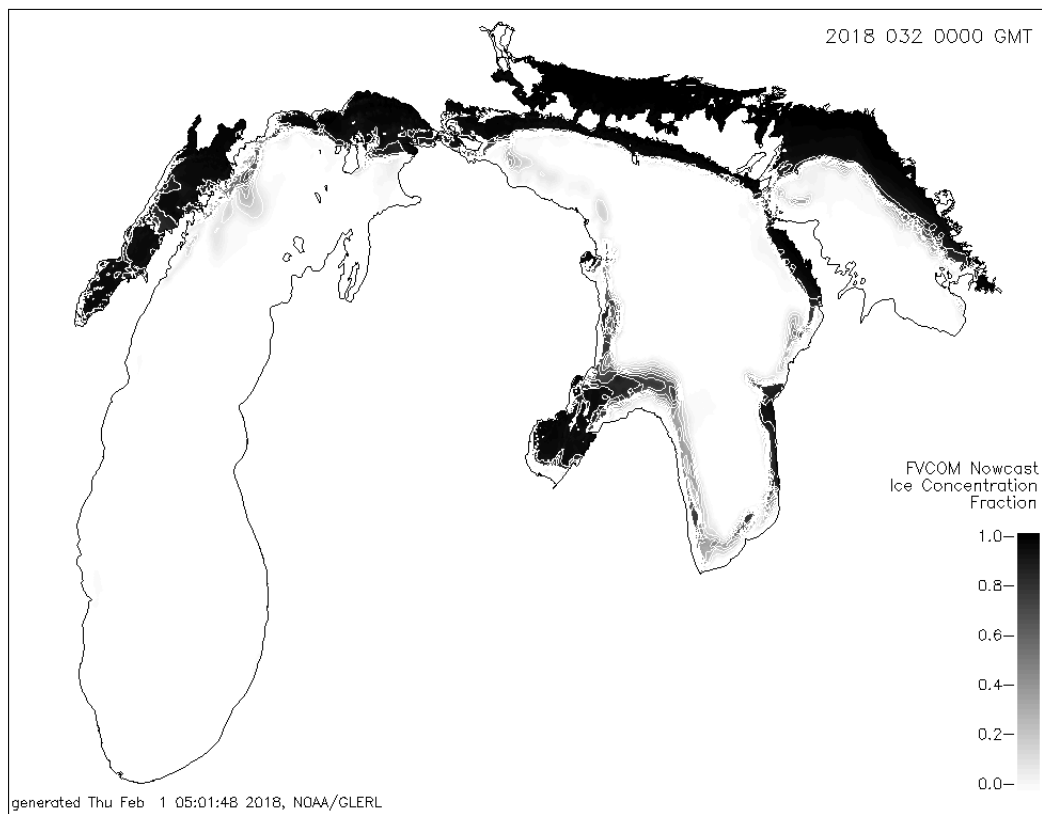- growth
- melting

From Gorodetskaya I.'s presentation

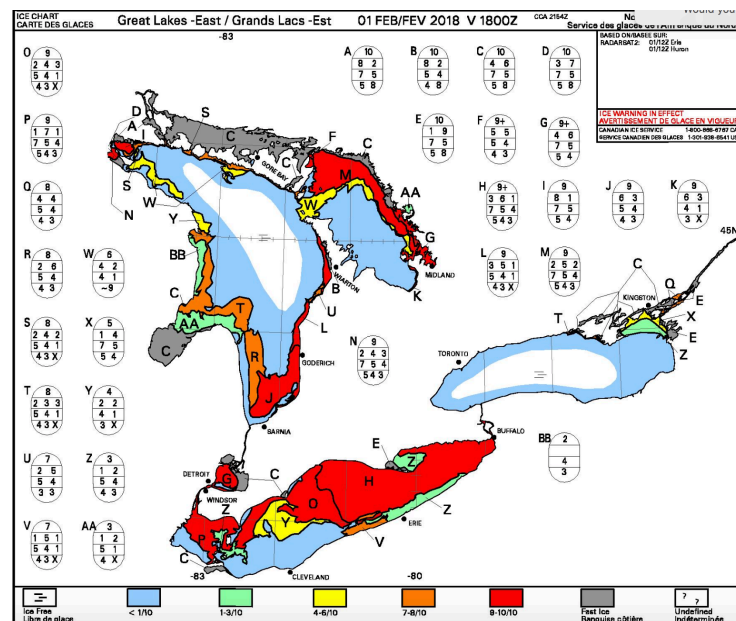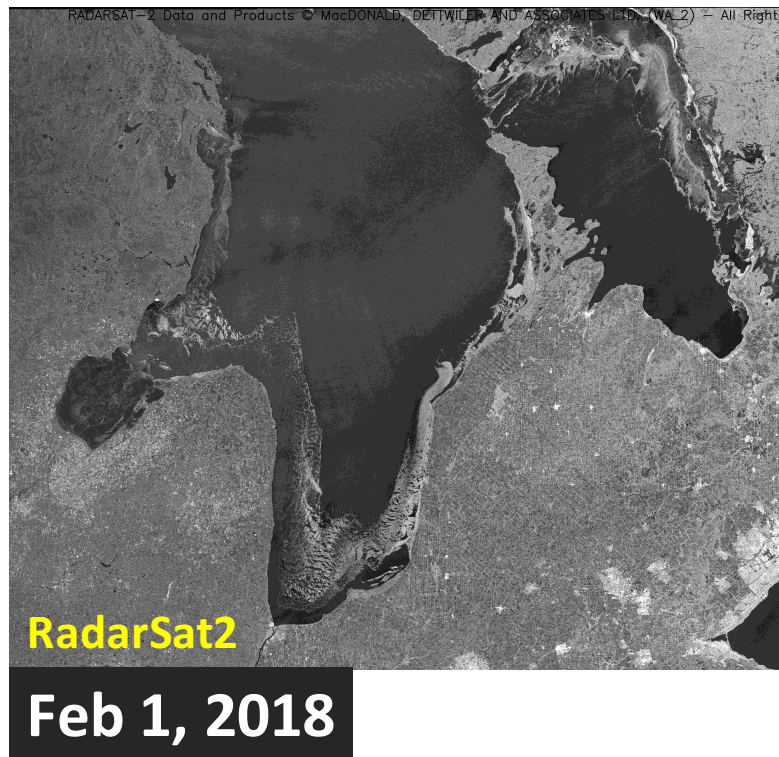Brash ice in northern Green Bay March 4, 2008.

Lake Michigan 2018-01-03

Forecasted for 01/03/18 11:00 EST
Updated at 01/02/18 19:00 EST

Ice Forecast Verification

2018 032 0000 GMT

FVCOM Nowcast
Ice Concentration
Fraction

generated Thu Feb 1 05:01:48 2018, NOAA/GLERL

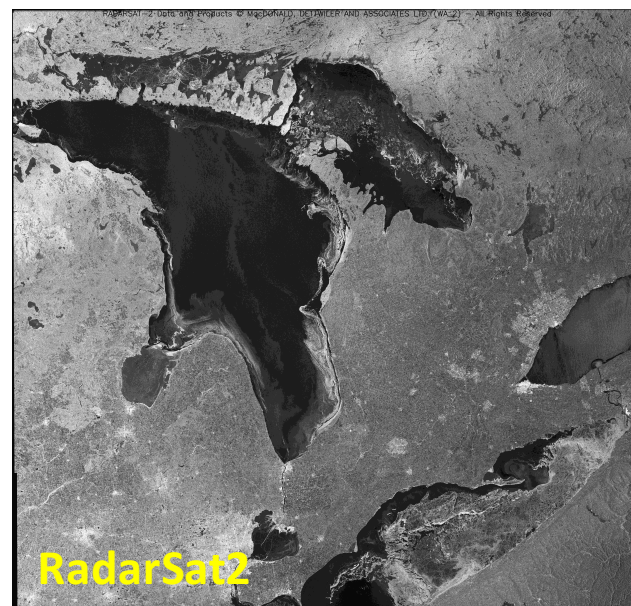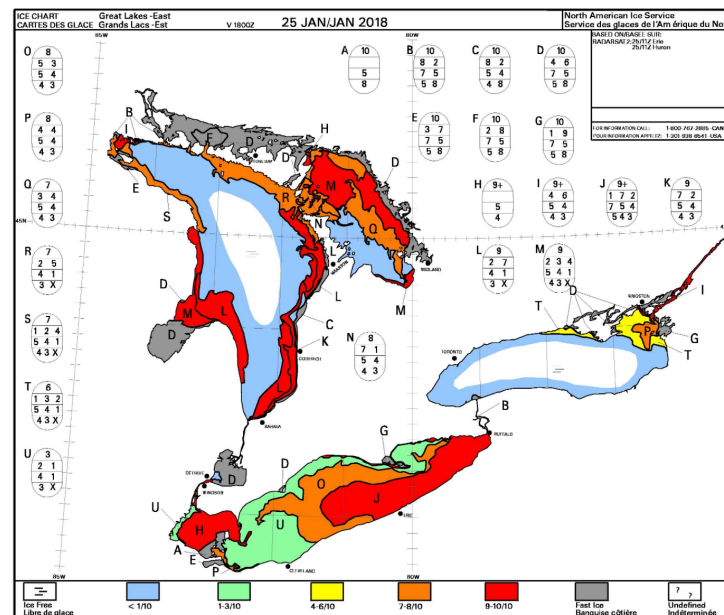Model Ice Concentration

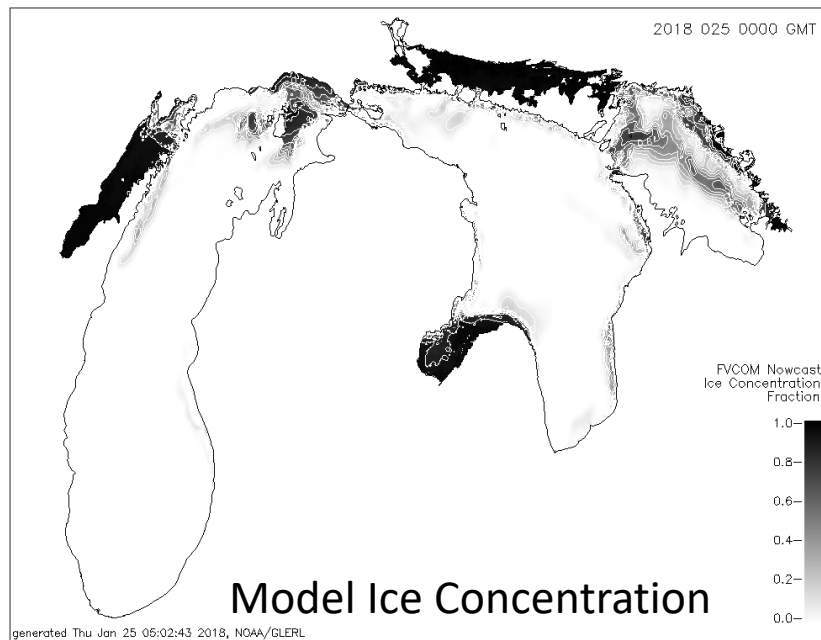**RadarSat2**

Feb 1, 2018

Ice Forecast Verification
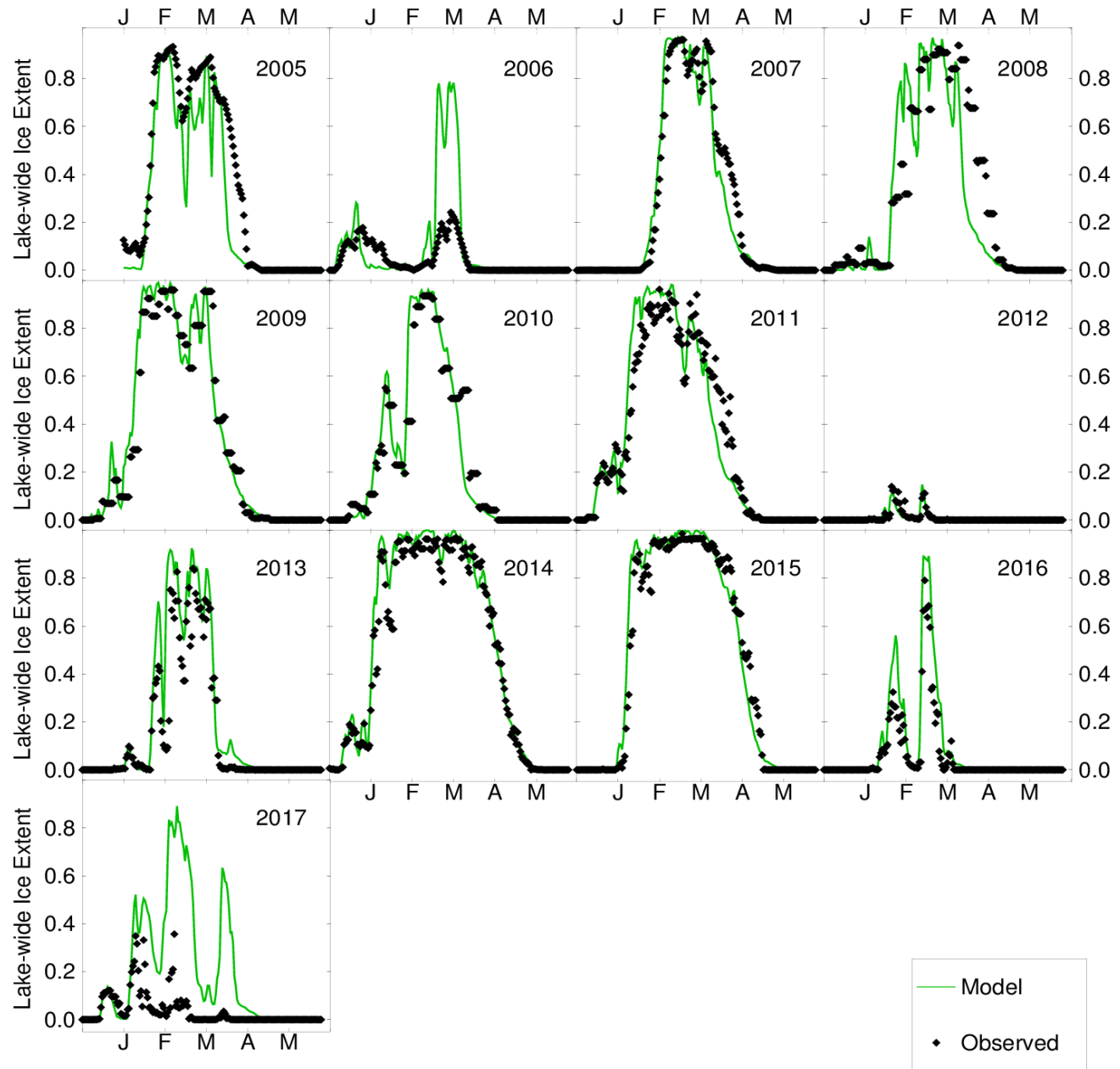

Model Ice Concentration

Model Ice Concentration
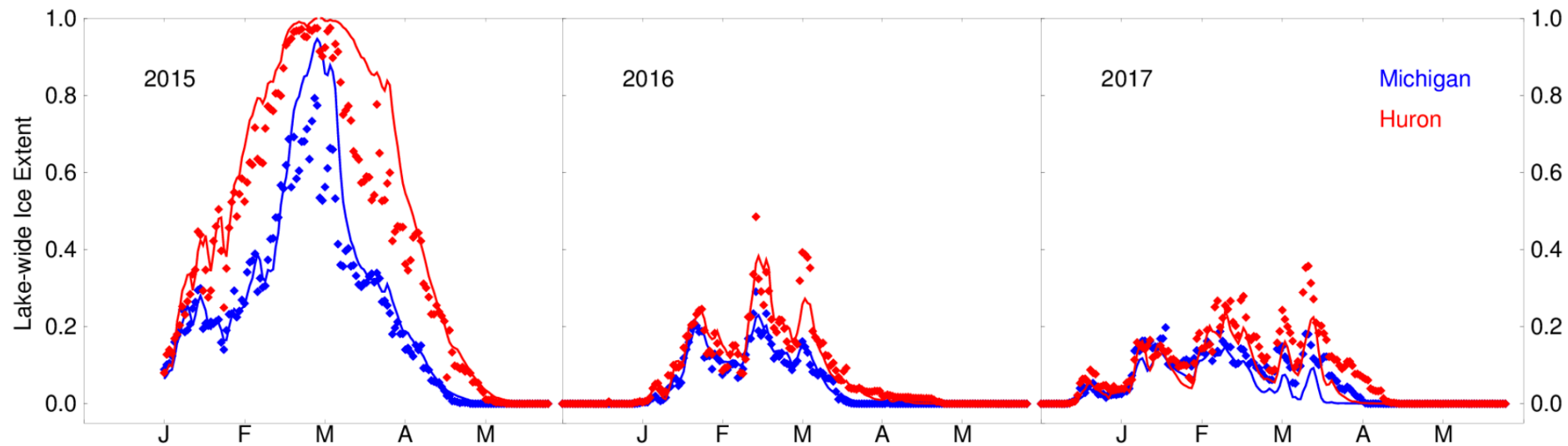

RadarSat2
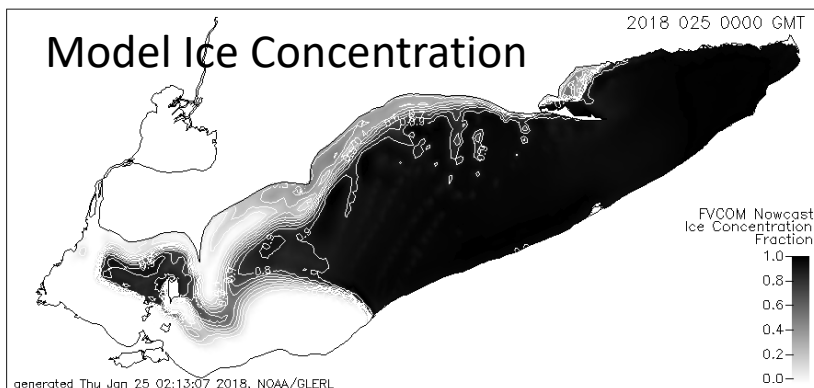
Jan 25, 2018

Ice Extent
- Lake Erie

Anderson et al. (2018) Ice Forecasting in the Next-Generation Great Lakes
Operational Forecast System (GLOFS), Journal of Marine Science and Engineering

Ice Extent
- Lake Michigan-Huron

Anderson et al. (2018) Ice Forecasting in the Next-Generation Great Lakes
Operational Forecast System (GLOFS), Journal of Marine Science and Engineering

The model can provide …

- Ice location
- Ice concentration (0-100%)
- Ice thickness
- Ice velocity

Needs more development to provide …

- Ice pressure
- Likelihood of ice presence
- Ice types[*]

[*]ICECON products can provide ice types

Ongoing research efforts

- Ice-wave interactions

- Linking with a weather forecast model

- Snow cover on the ice

- Coupling with hydrologic processes (e.g. run off, rivers), though mainly for hydrodynamics for now.

Great Lakes Operational Forecast System (GLOFS) Research-to-Operation flow

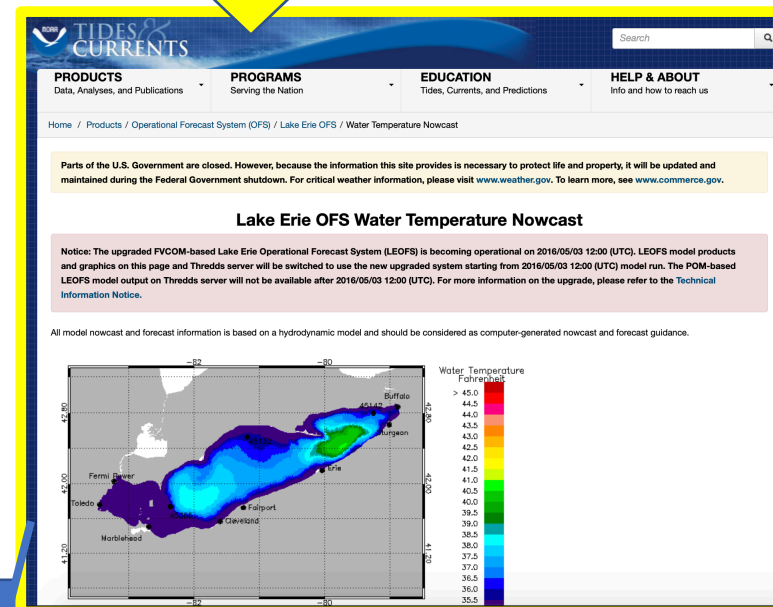**Research & Development** (*CIGLR, GLERL*)

Demonstration at quasi-operational environment (*GLERL*)

Operations to provide short term forecast (*National Ocean Service, National Ice Center*)

From NOAA GLERL website

Category 2: Longer term recommendations

Longer term development

Questions?