



GLERL Coupled Ice-Ocean Modeling and Forecasting

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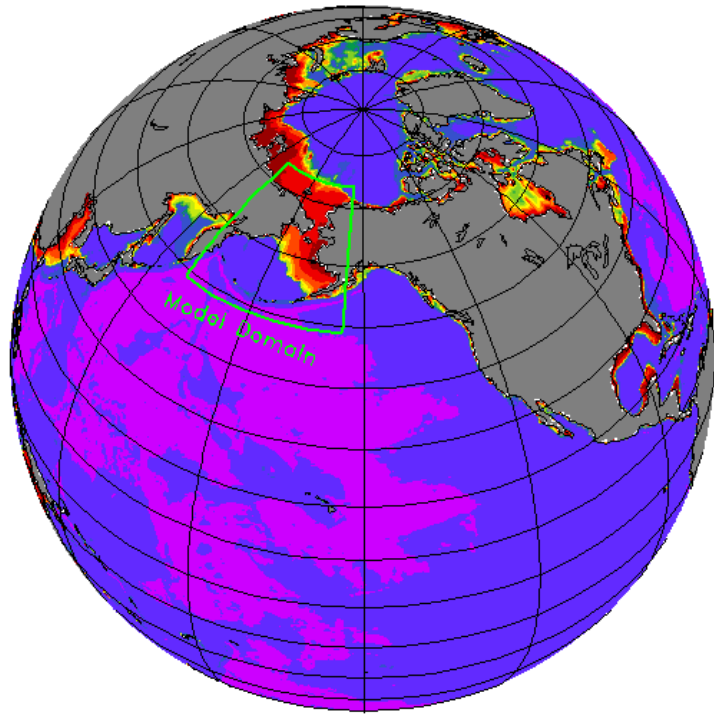
Jia.wang@noaa.gov

Haoguo Hu, Ayumi Manome, and Xuezhi Bai
CILER, University of Michigan

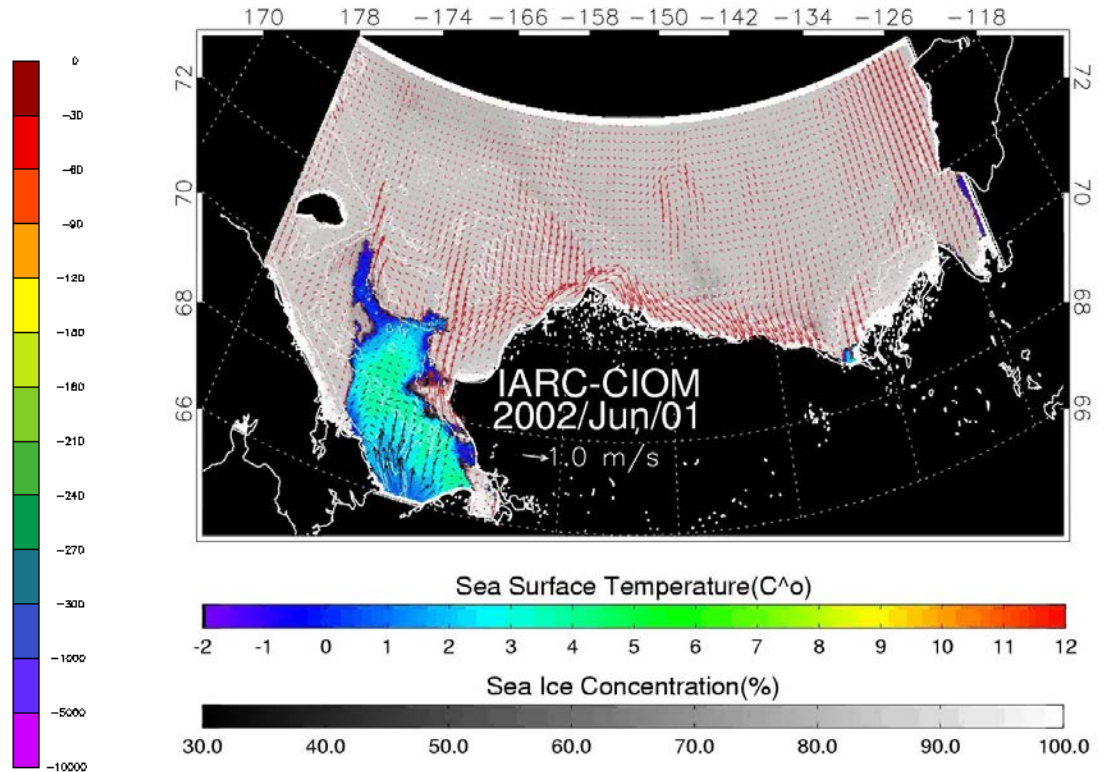
- 1) GLERL CIOM (Coupled Ice Ocean Model)
- 2) GLERL GLIM (Great Lakes Ice-circulation Model) and GLCFS
- 3) GLERL FVCOMice in the Great Lakes and in the Arctic Ocean
- 4) Future Efforts

Acknowledgements: NOAA CPO, NASA, MMS, GLRI

1) Regional Coupled Ice-Ocean Model (CIOM) and ecosystem models



View From Space



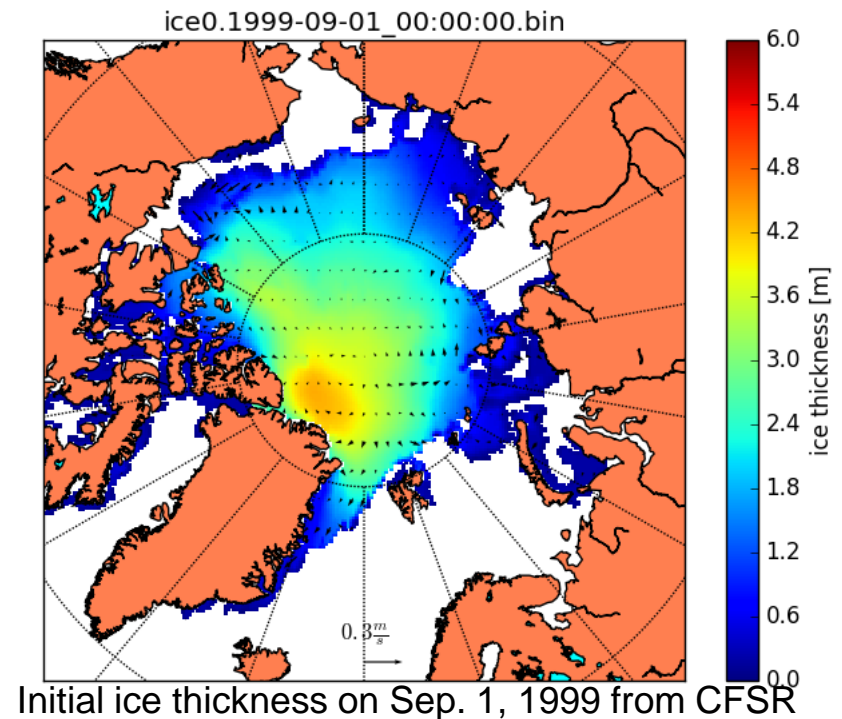
Coupled Ice-Ocean-Ecosystem Modeling System

Models developed by NOAA GLERL)

- 1) Regional Coupled Ice-Ocean Model (CIOM, Wang et al. 2002, 2005, 2009, 2013, 2014, 2015) in the Bering Sea (POM-based) (tides and wind-wave mixing param., lateral meting, multi-category, plastic-viscous, fully thermodynamic and dynamic)
- 2) 3-D NPZD (9-compartment) coupled Physical-Ecosystem (biogeochemical) Models (PhEcoM, Wang et al. 2003, 2013; Jin et al. 2006, 2007, 2009) (tides and wind-wave mixing)

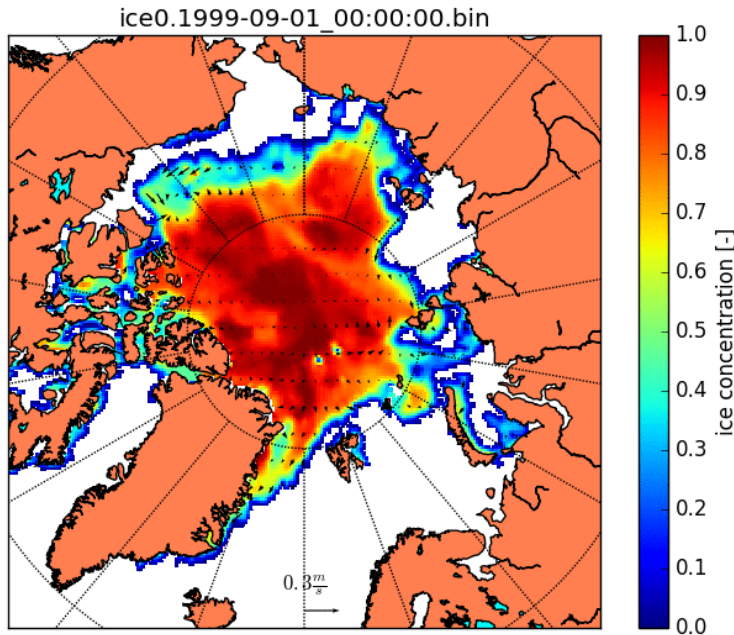
Arctic-ICEPOM

- Primitive equations (POM-based)
- Ice dynamics with EVP rheology
- 0-layer ice thermodynamics with snow cover
- 25km grids
- Climate Forecast Reanalysis (CFSR)
 - Initial conditions
 - Hourly atmospheric forcing
 - Climatology precipitation (NCEP)

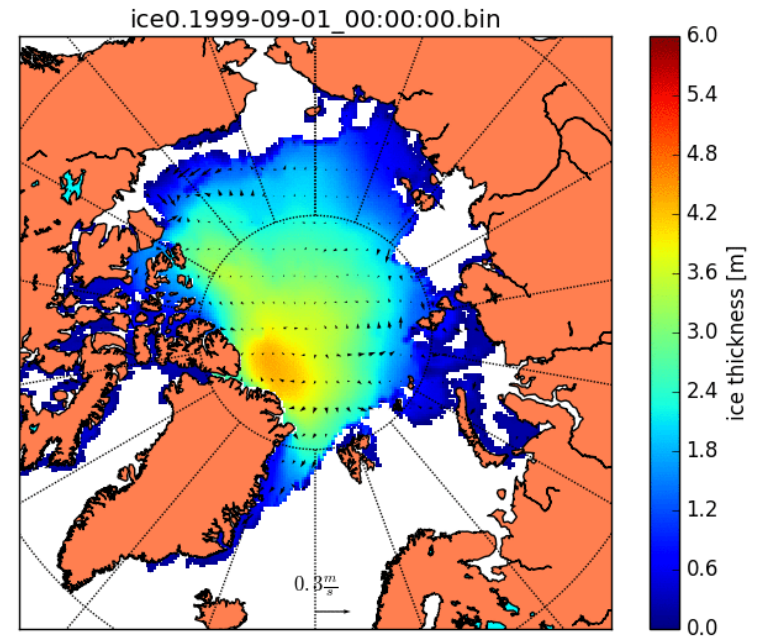


New configuration with nested fine grids in the East Siberian Sea for NOAA CPO RUSALCA Arctic project

Ice concentration



Ice thickness

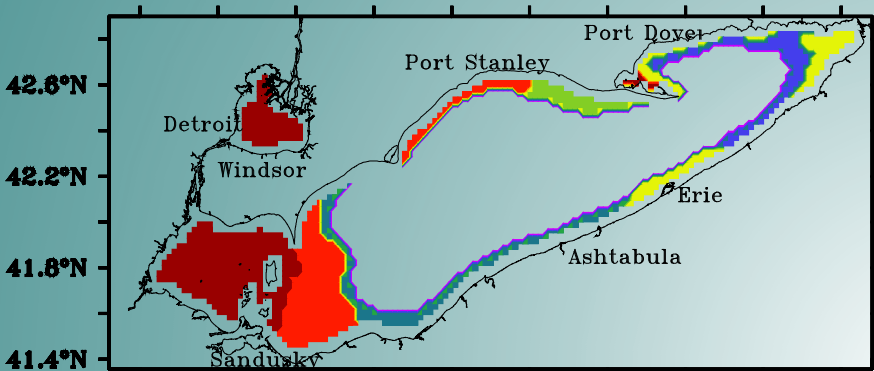




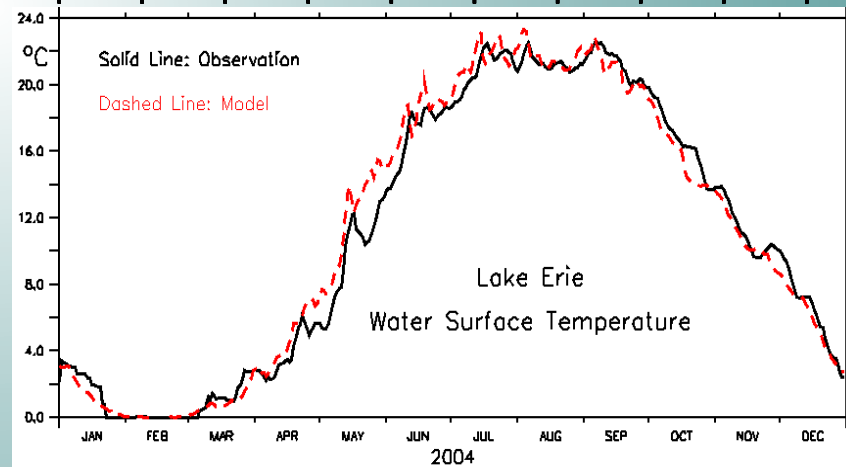
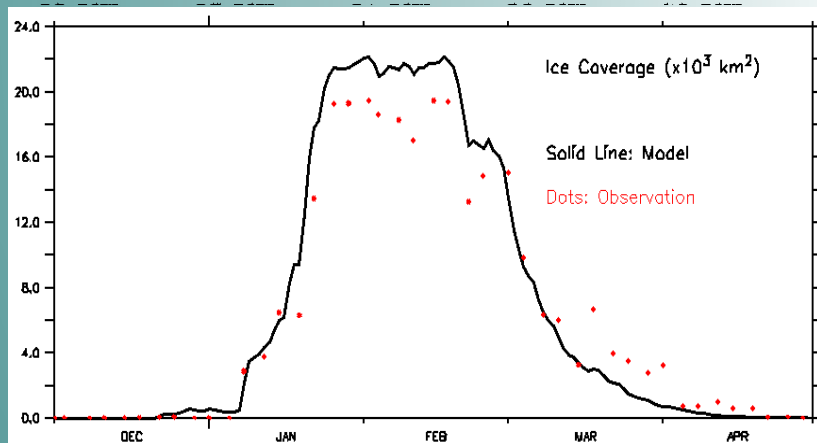
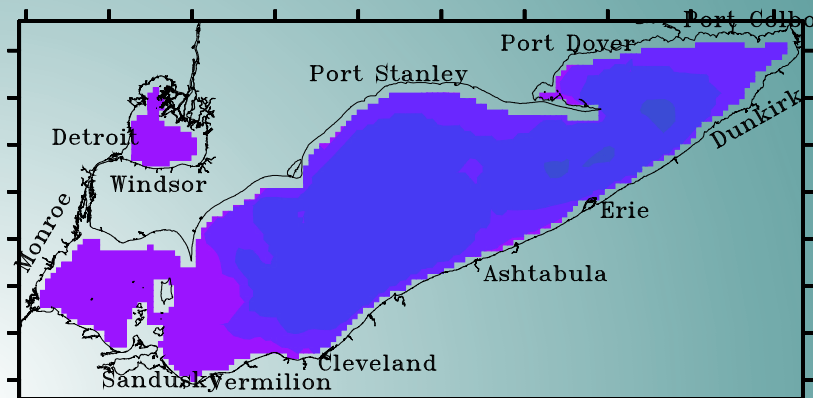
Development of GLIM (Great Lakes Ice-circulation Model) using CIOM: Validation

Wang et al. (2010, JGLR)

SSM/I, MODIS-Ice C.



AVHRR-SST



GLIM was implemented into the Great Lakes Coastal Forecasting System (GLCFS) beginning in winter 2009/10 (by Philip Chu, Dave Schwab and Greg Lang):

<http://www.glerl.noaa.gov/res/glcfs/erie-ice.php?lake=e&type=F&hr=01>

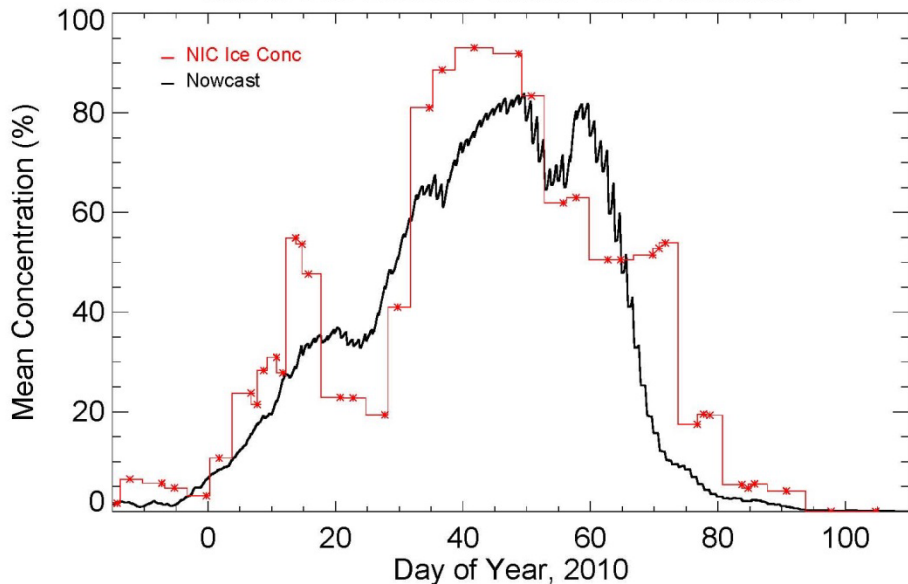


2) Lake Erie Ice Forecasting System

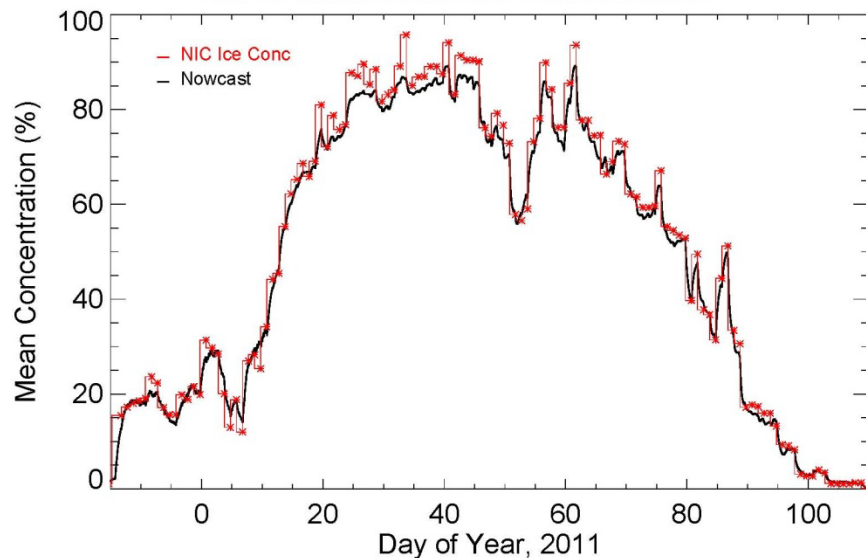
2009-2010 (no assim.)

2010-2011 (assim.)

NOAA/GLERL GLCFS, National Ice Center, NWS Cleveland
Year-to-Date Nowcast *without* Data Assimilation



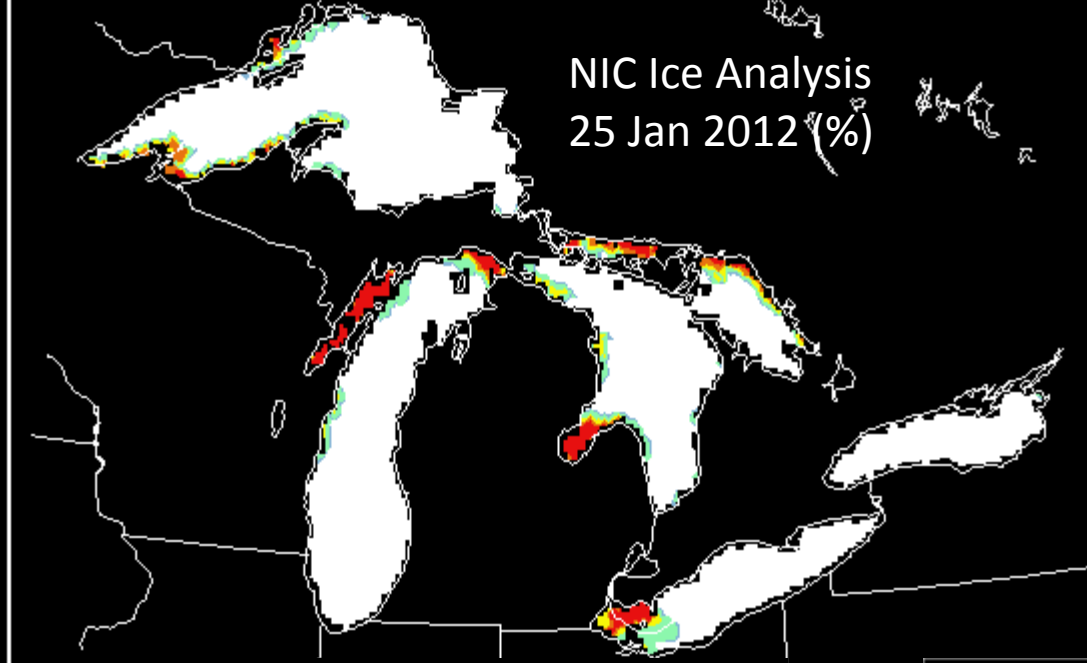
NOAA/GLERL GLCFS, National Ice Center, NWS Cleveland
Year-to-Date Nowcast with Data Assimilation



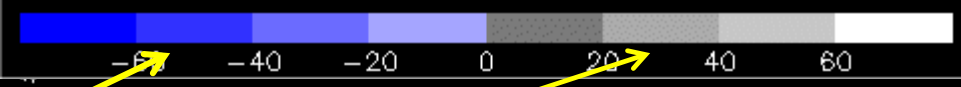
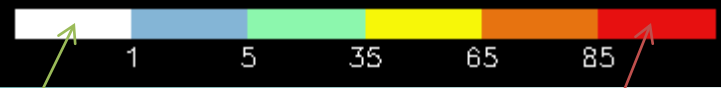
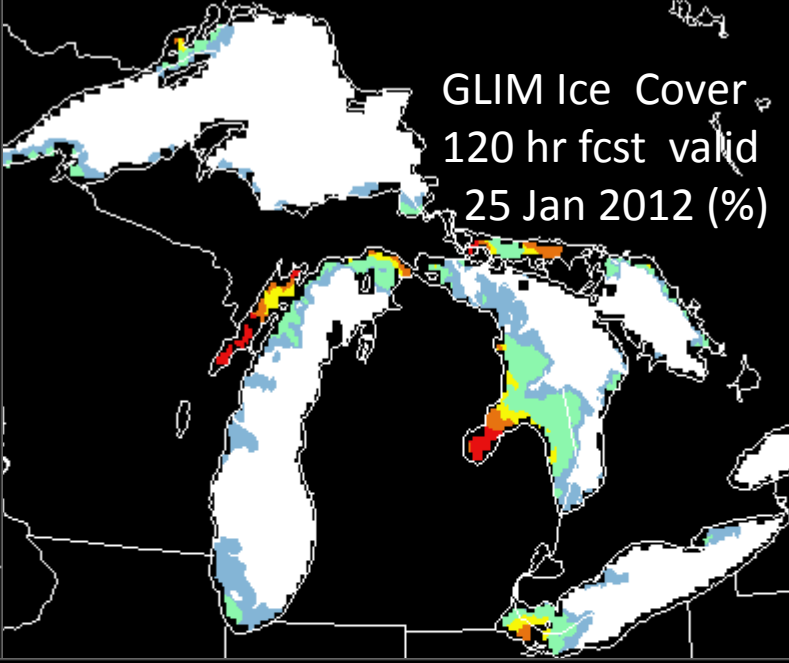
Ice forecast with “data assim.” has been implemented into the Great Lakes Coastal Forecasting System (collaborated with Dave Schwab and Greg Lang):

<http://www.glerl.noaa.gov/res/glcfs/erie-ice.php?lake=e&type=F&hr=01>

NIC Ice Analysis
25 Jan 2012 (%)



GLIM Ice Cover
120 hr fcst valid
25 Jan 2012 (%)



Ice Free

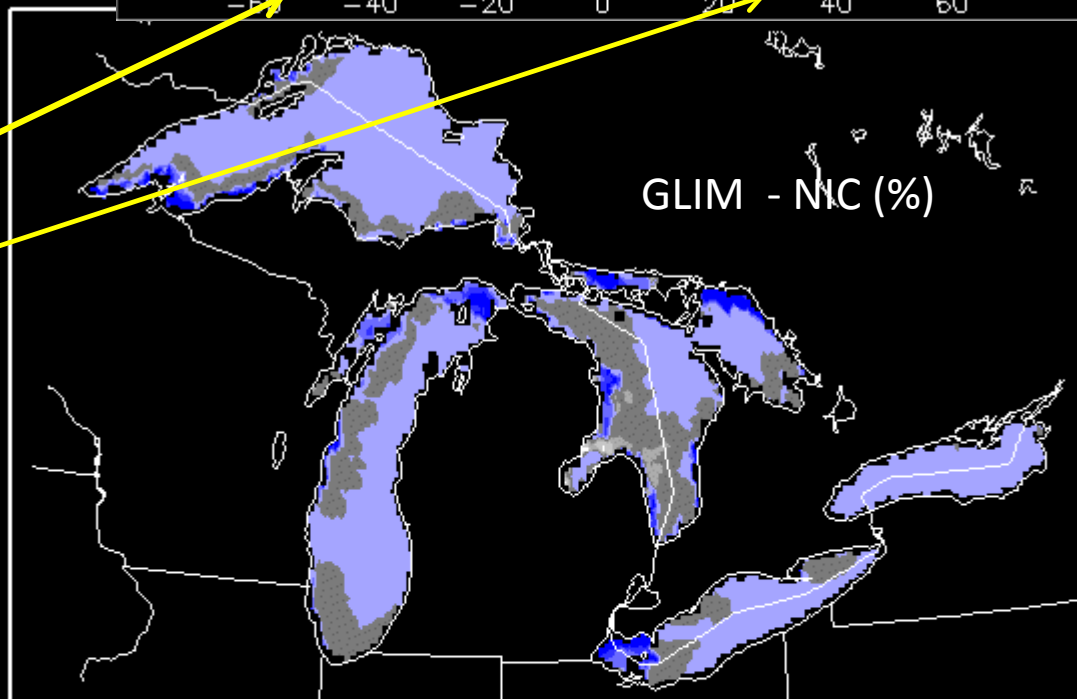
Ice covered

Too little ice forecast

Too much ice forecast

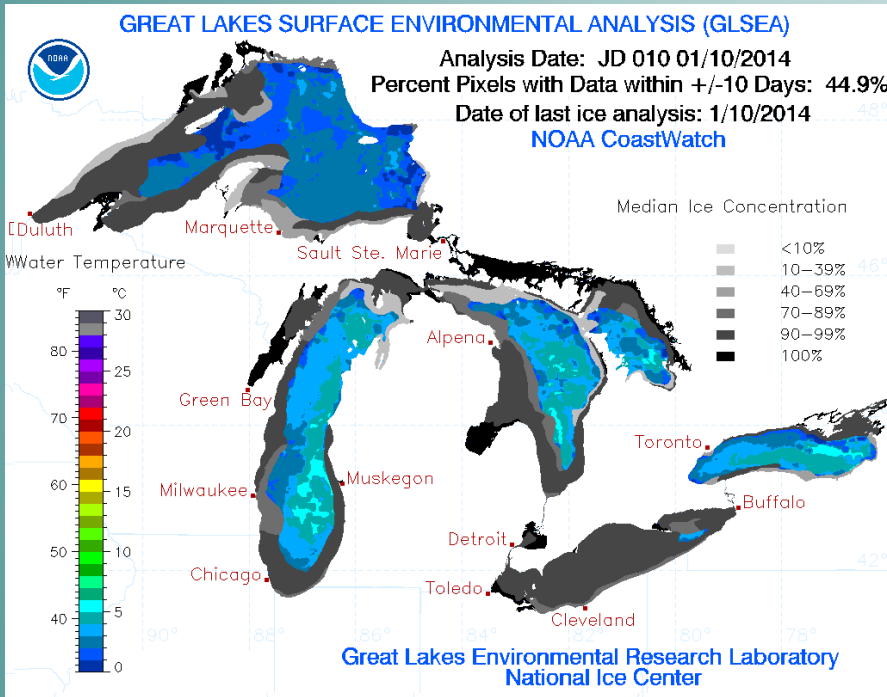
GLIM 120 hr fcst had too little
Ice concentration in northern
Georgian Bay, western Lake
Erie, northern Lake MI, & sw
Lake Superior

GLIM - NIC (%)





GLIM 5-day Prediction during 2013-14 ice season





R2O: GLERL Ice Forecast (GLIM) has been in the GLCFS (Great Lakes Coastal Forecasting System) since 2010

(Wang et al. 2010, JGLR; Fujisaki et al 2012 JGLR, 2013 JGR)

<http://www.glerl.noaa.gov/res/glcfs/> up to 5-day Forecast Ice Concentration

home search sitemap

National Oceanic and Atmospheric Administration
Great Lakes Environmental Research Laboratory

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Meteorological Data

Great Lakes Coastal Forecasting System, GLCFS

Select "Ice"

GLCFS NOWCAST: 03/12/2012 (DOY 072) 1200 GMT
Nowcasts are generally posted by about 0036, 0636, 1236, and 1836 GMT (subtract 4 for EDT, 5 for EST)

See also KML files:

NEW Data Download (Point Query). This query tool provides quick access to GLCFS input data and model output for a given location and time period, 2006-present (in partnership with GLOS).

NEW See also Winds, Waves, Currents, Temps, Ice, GLSEA via Google Maps (pan/zoom)

GLCFS FORECAST: 03/12/2012 (DOY 072) 0000 GMT - Experimental
Forecasts are generally posted by about 0236 and 1436 GMT (subtract 4 for EDT, 5 for EST)

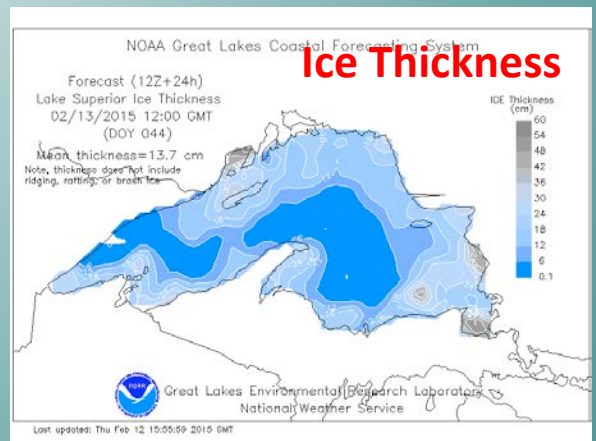
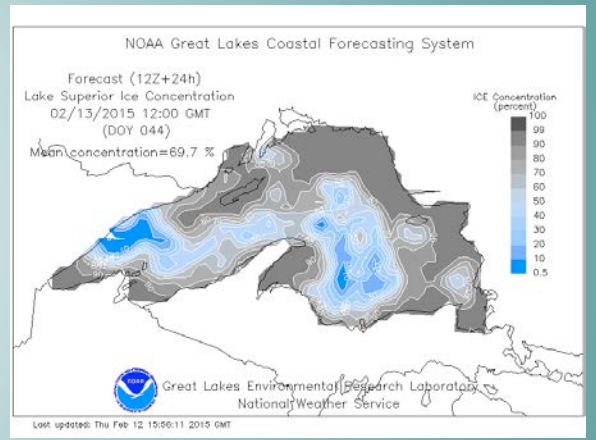
Sponsors:
NOAA/GLERL
National Weather Service

Links:

- CO-OPS Great Lakes Operational Forecast System
- GLOS THREDDS Server
- NWS Graphical Great Lakes NDFD Wave Forecasts
- NWS Graphical Great Lakes Forecast
- NWS White Lake
- NWS Cleveland
- NWS Grand Rapids
- CoastWatch GLSEA
- NOAAPORT Daily Weather Data and Marine Observations
- Additional Great Lakes Water Temperatures, Wind/Waves, Water Levels
- Related sites:
 - *Grand Haven Nested Grid
 - *Indiana Dunes Nested Grid
 - *Saginaw Bay Nested Grid
 - *HCCVFS
 - *USL

Realtime Data Disclaimer

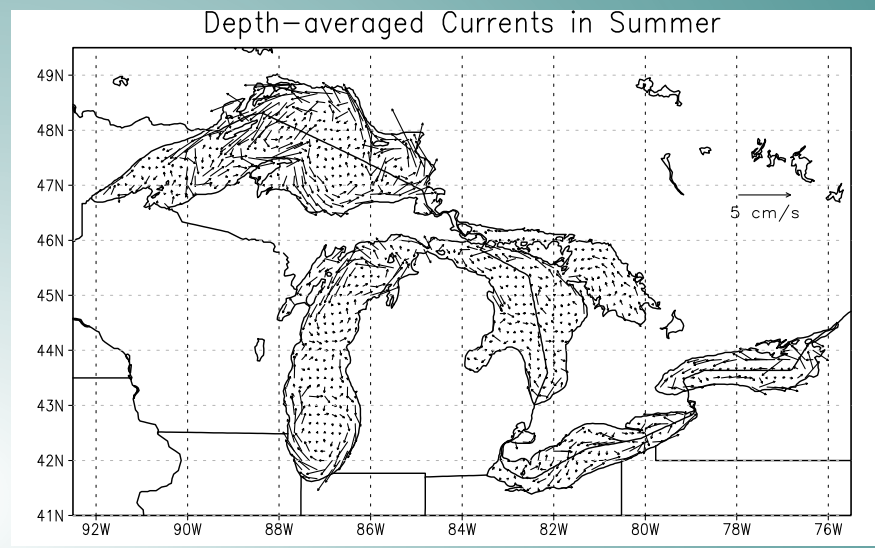
- Settings
- Status, Status2
- Schedule
- NDFD Status
- What's New
- Gridded Fields
- NetCDF Depot
- Grib Depot
- NWS log, plot1, plot2
- WWW stats
- POI/MGL stats: e, h, m, o, s



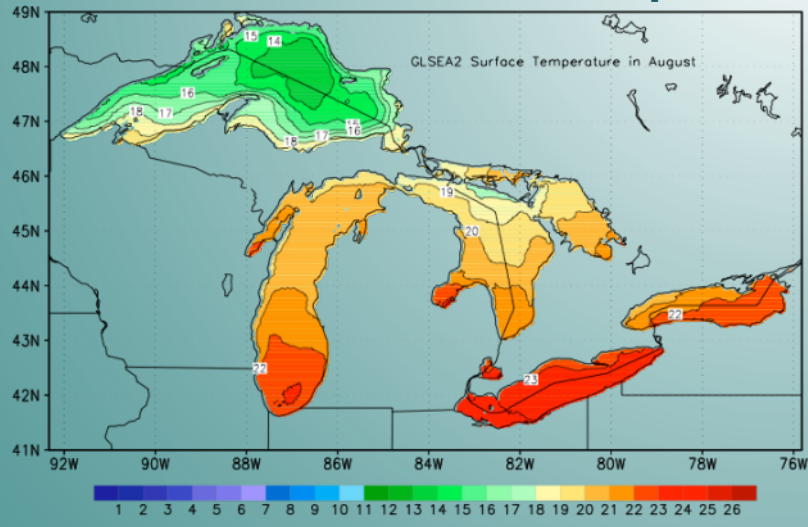


3) R&D: Development of 5-lake unstructured-grid FVCOM with ice (CICE4) (Chen et al. 2006)

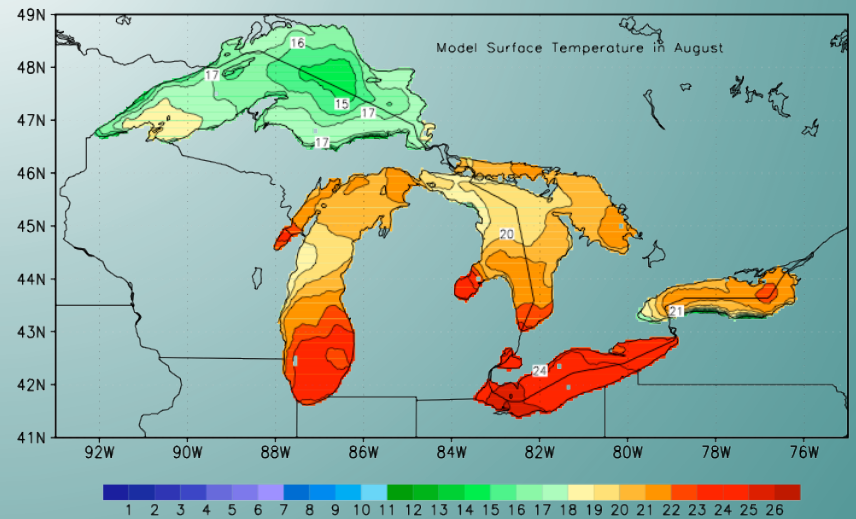
Grids Modeled summer circulation



Measured Lake Surface Temperature



Modeled Lake Surface Temperature



Aug

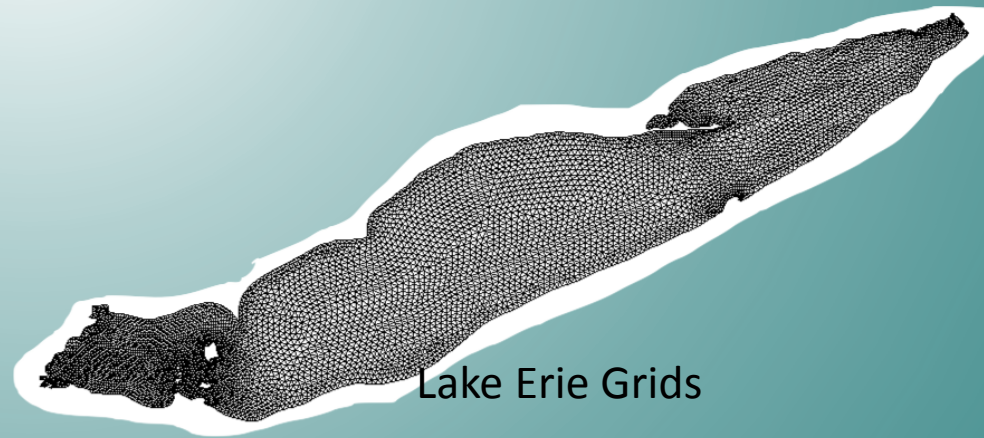
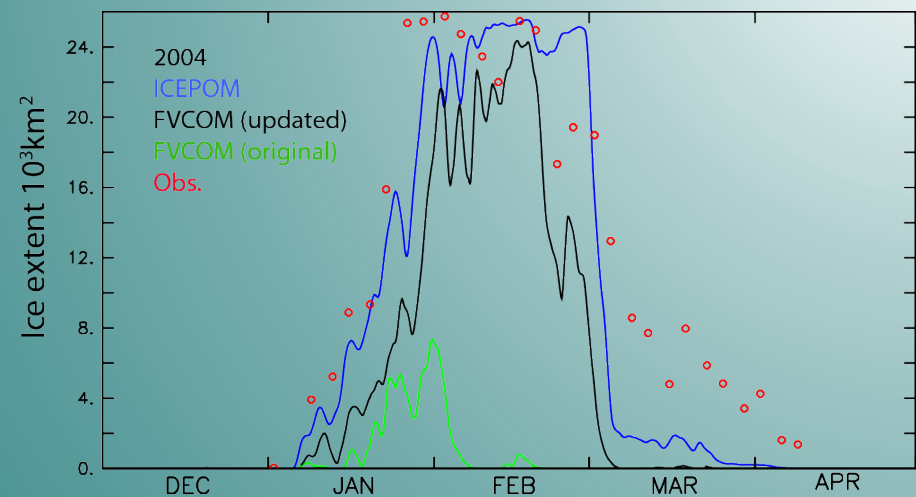
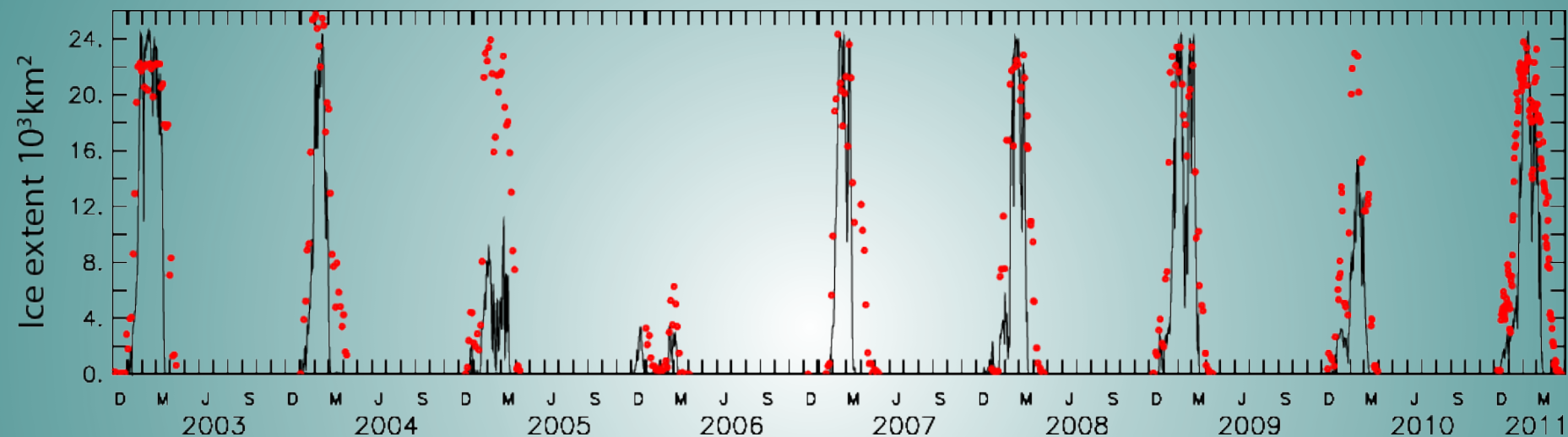
(Bai et al. 2013, Ocean Modelling)



R&D: Modification and Implementation of FVCOM-Ice in Lake Erie

Changed Euler forward scheme and 4th-order Runge-Kutta scheme that are inertially unstable (Wang and Ikeda 1997, MWR) to centered differencing scheme of neutral stability for inertial motion.

Observed (red) and Simulated (black) Ice Extent in Lake Erie from 2003-2011



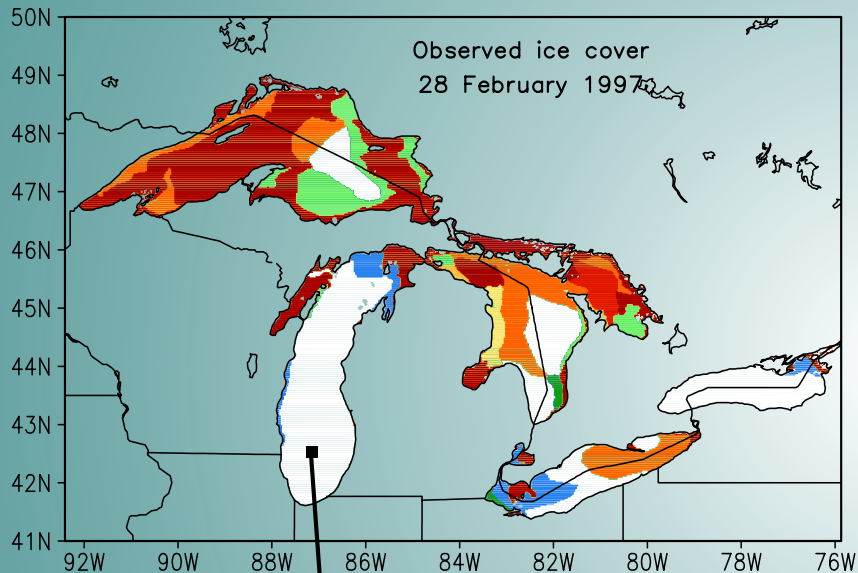
(Fujisaki-Manome and Wang 2015, in Prep.)



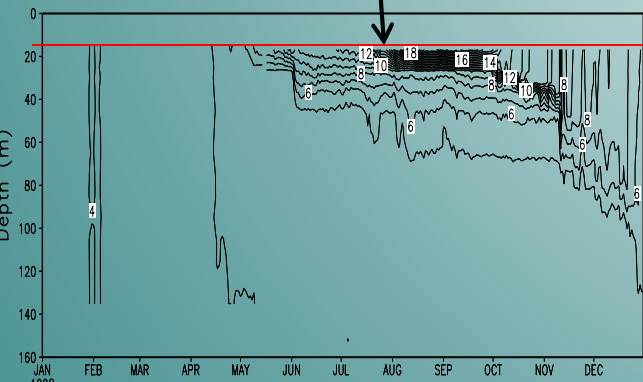
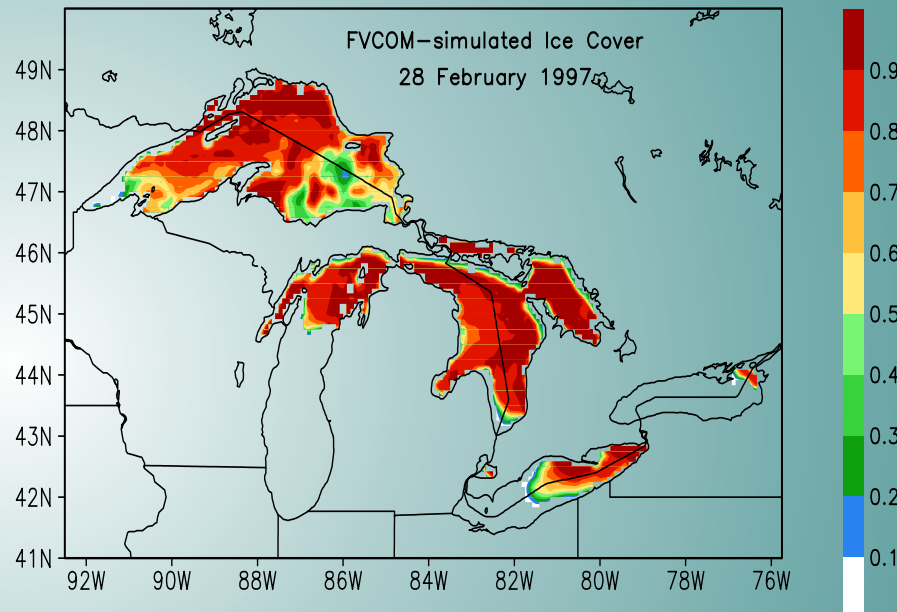
Implement the Modified FVCOM-Ice to all Five Great Lakes

(Transition efforts with ice to NOS/CO-OPS use of FVCOM in coastal ocean and GLCFS/GLOFS;
potential coupling to GLERL-WRF, ESRL's HRRR, and NCEP's models)

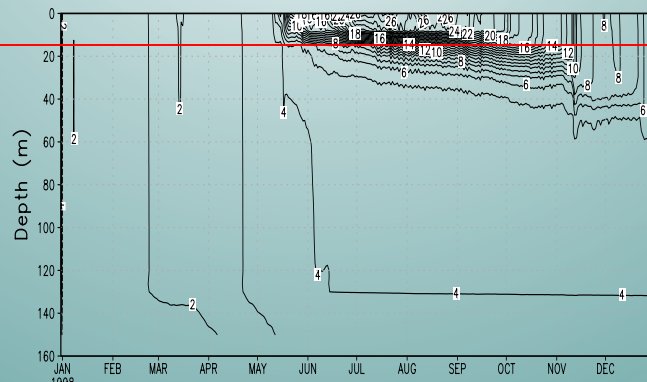
Observed



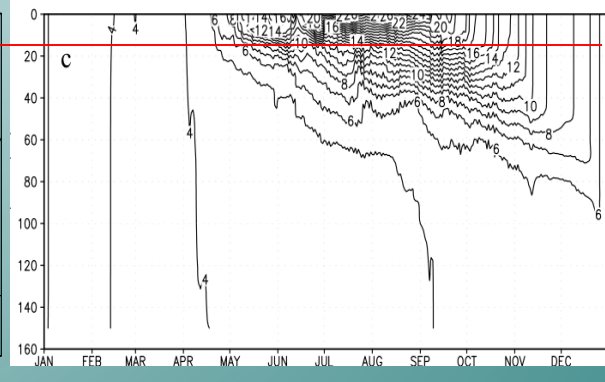
FVCOMice



Observed (Lake Michigan)



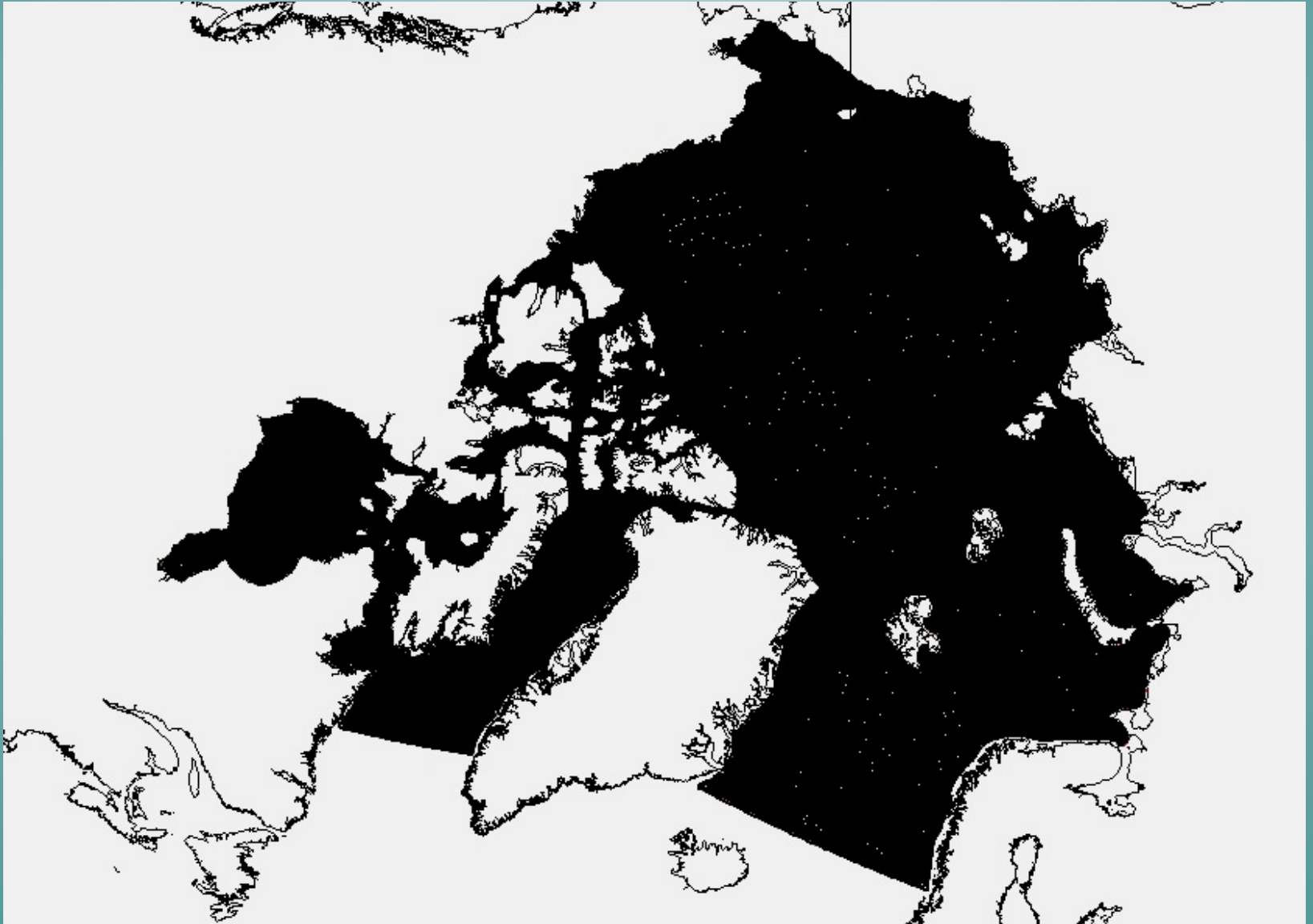
Centered differencing



Original: EF+RK43

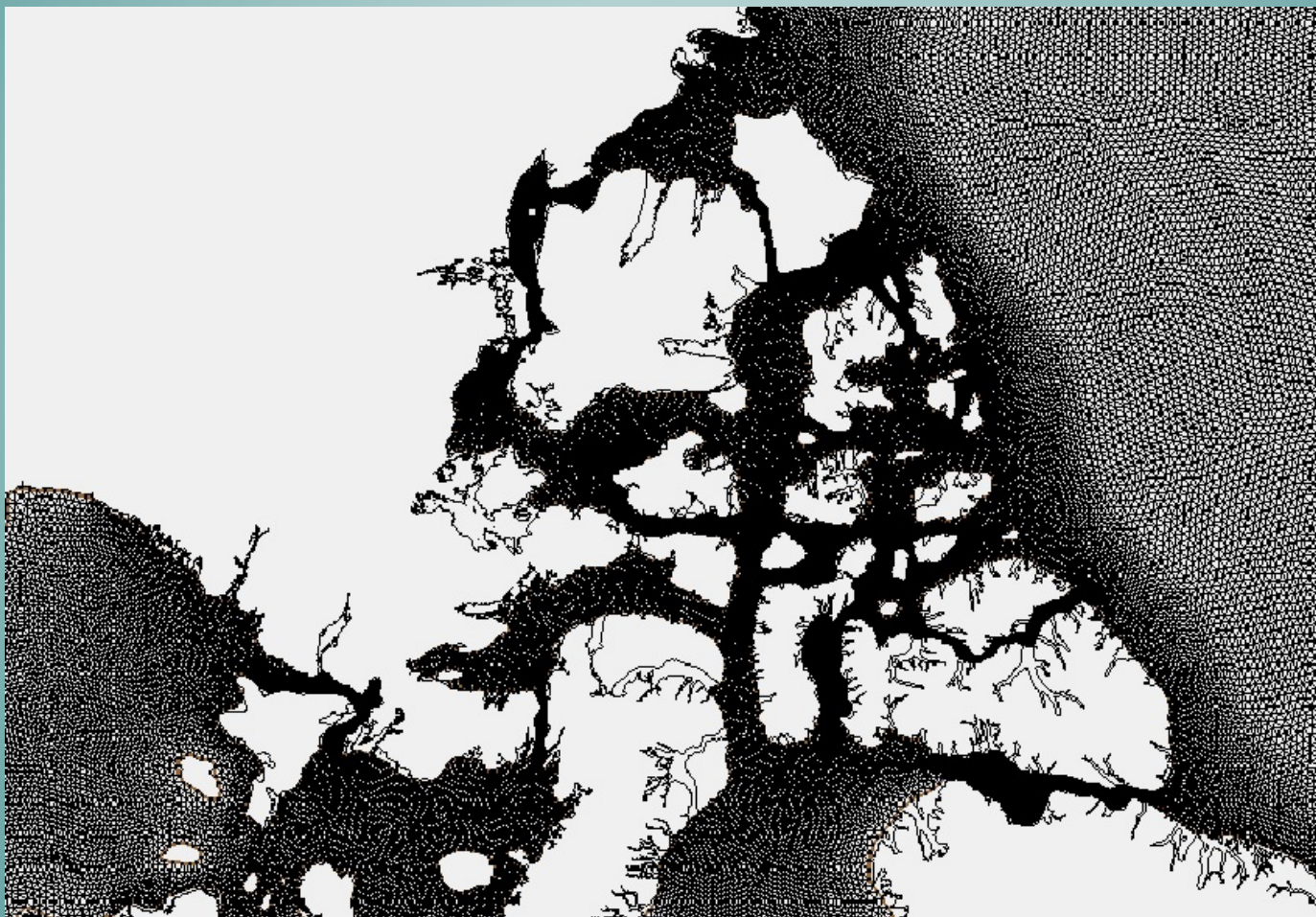


Arctic-FVCOMice unstructured variable grid



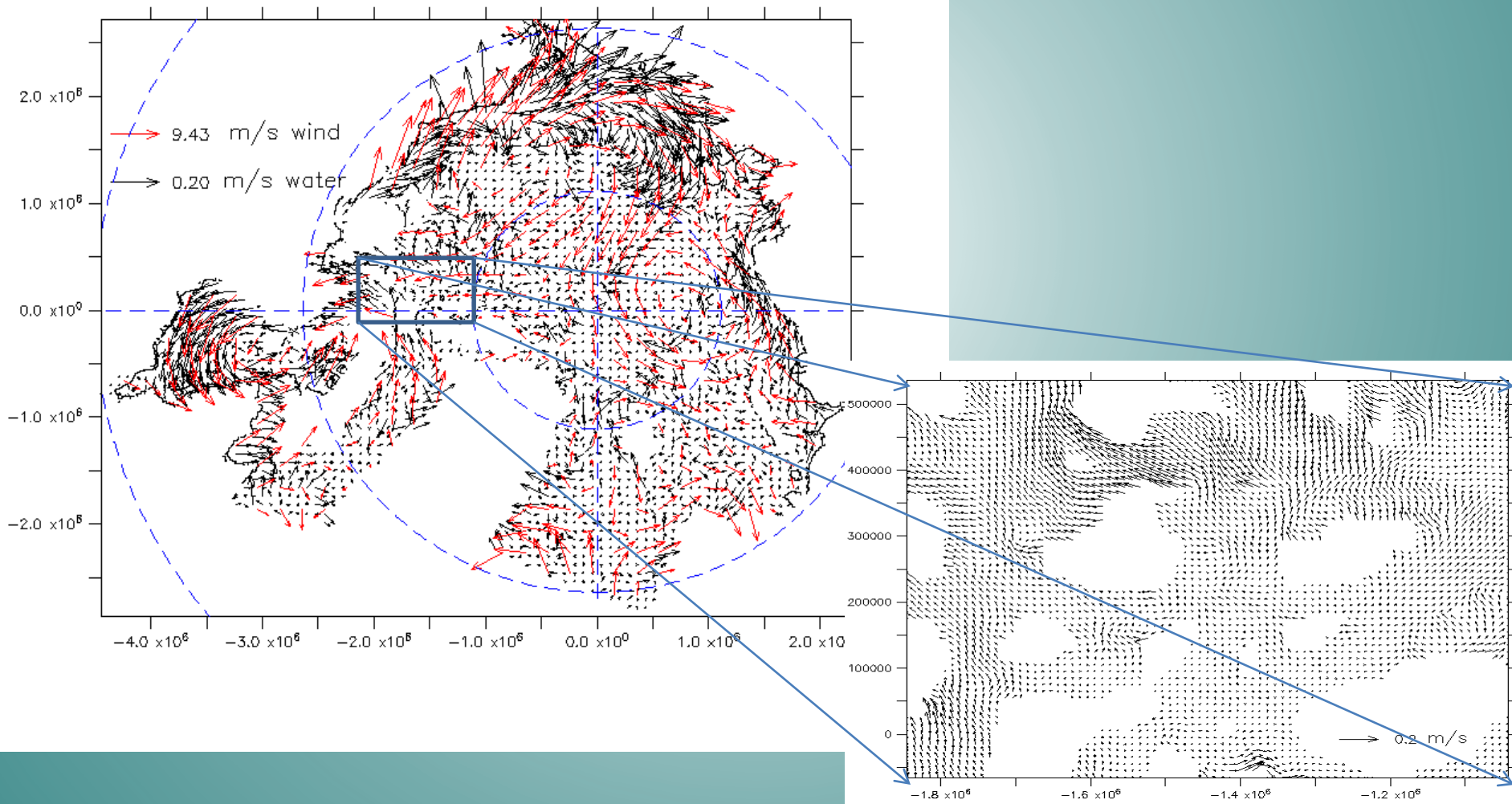


Enlarged grid covering CAA





GLERL Arctic-FVCOMice simulated surface ocean circulation (test run)





4. Future Efforts

- Validate Arctic-ICEPOM and Arctic-FVCOMice in the Arctic in addition to that GL-FVCOMice is being run from 1993-present
- Seasonal forecast/projection of lake ice using GL-FVCOMice
- Model comparison between Arctic-ICEPOM and Arctic-FVCOMice and other models in the community
- Seasonal forecast/projection of Arctic sea ice
- Transition of GL-FVCOMice to NOS for short-term operational prediction
- Model-module development to improve ICEPOM and FVCOMice (universal to other models)
 - Landfast ice module
 - Ice-wave parameterization (module)
 - Wave mixing parameterization to the water column (which feedbacks to sea ice) (module)