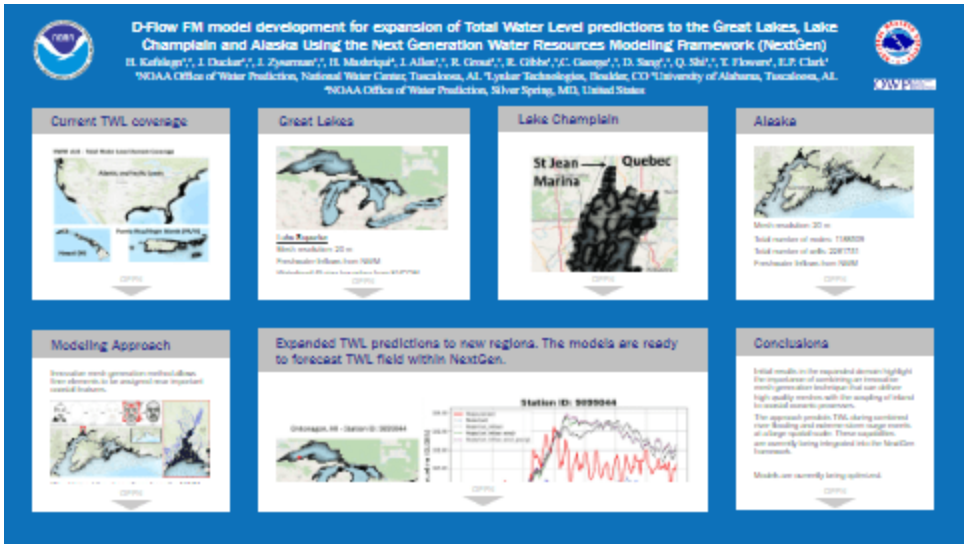
D-Flow FM model development for expansion of Total Water Level predictions to the Great Lakes, Lake Champlain and Alaska Using the Next Generation Water Resources Modeling Framework (NextGen)



H. Kefelegn[1,2], J. Ducker[1,2], J. Zyserman[1,2], H. Mashriqui[4], J. Allen[1,2], R. Grout[1,2], R. Gibbs[1,3],C. George[1,3], D. Sang[1,3], Q. Shi[1,2], T. Flowers[1], E.P. Clark[1] [1]NOAA Office of Water Prediction, National Water Center, Tuscaloosa, AL [2]Lynker Technologies, Boulder, CO [3]University of Alabama, Tuscaloosa, AL [4]NOAA Office of Water Prediction, Silver Spring, MD, United States

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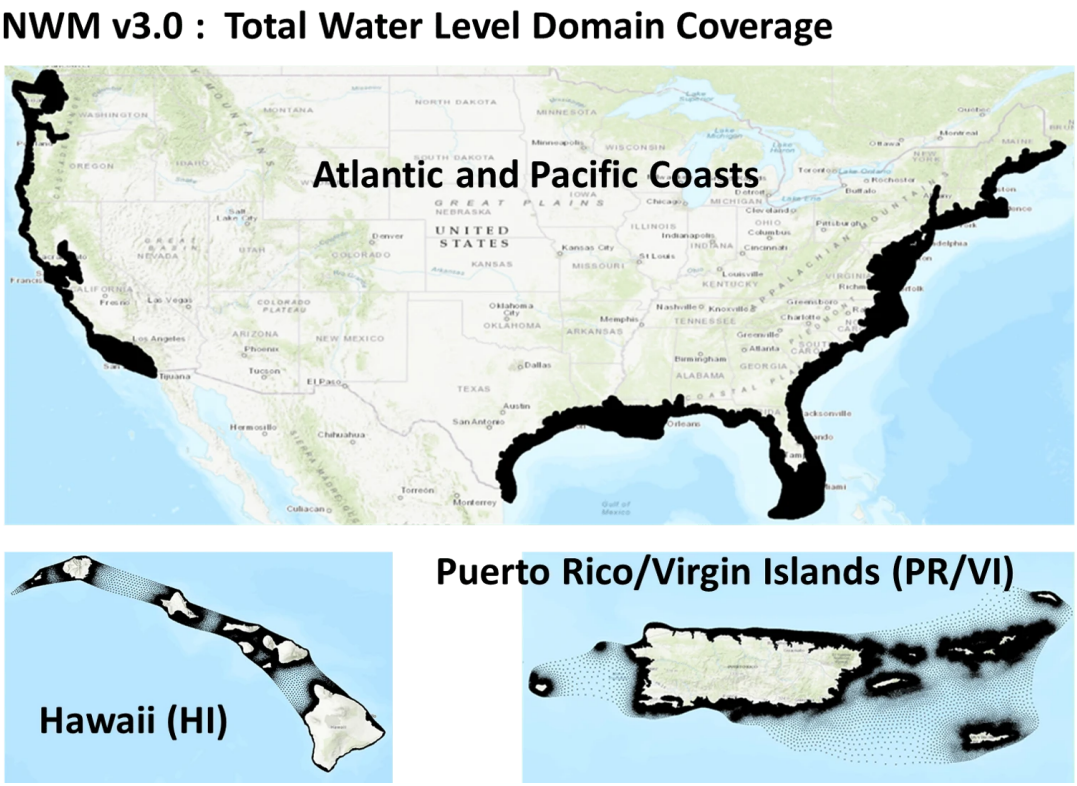
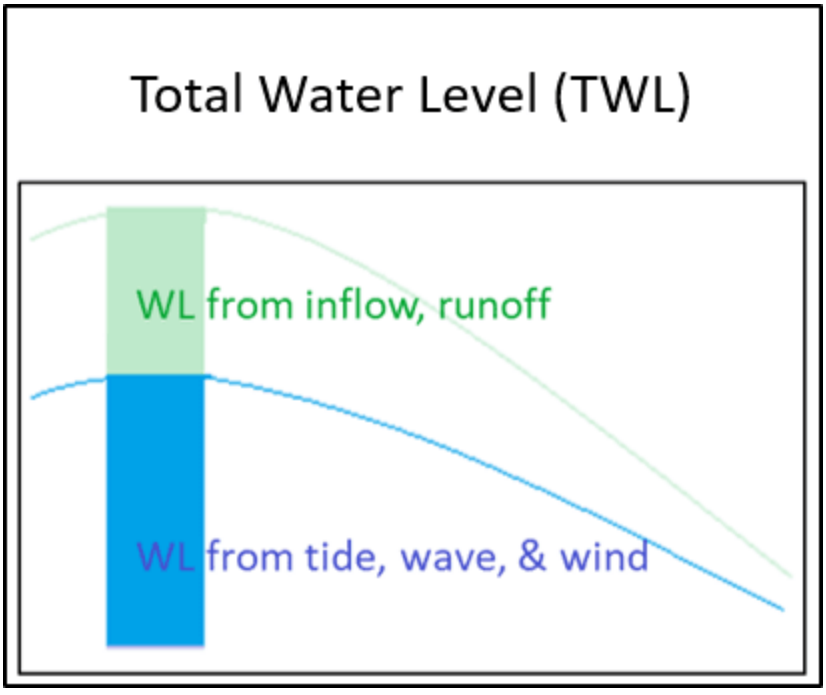
PRESENTED AT:

CURRENT TWL COVERAGE





- NOAA's branch of D-Flow FM source code version 1.2.184 is now Basic Model Interface (BMI) compliant which means it can be Integrated into NextGen for TWL prediction.

- Further information on D-Flow FM BMI development is highlighted on an AGU poster titled "Developing BMI capability for coastal models on the Next Generation Water Resources Modeling Framework (NextGen)" at session H31W-1814.

- NextGen essentially provides a framework for the ingestion of hydrodynamic model forcing data from other models, such as ADCIRC/ESTOFS, FVCOM, and P-SURGE, into the formulations of coastal models.

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GREAT LAKES

Lake Superior

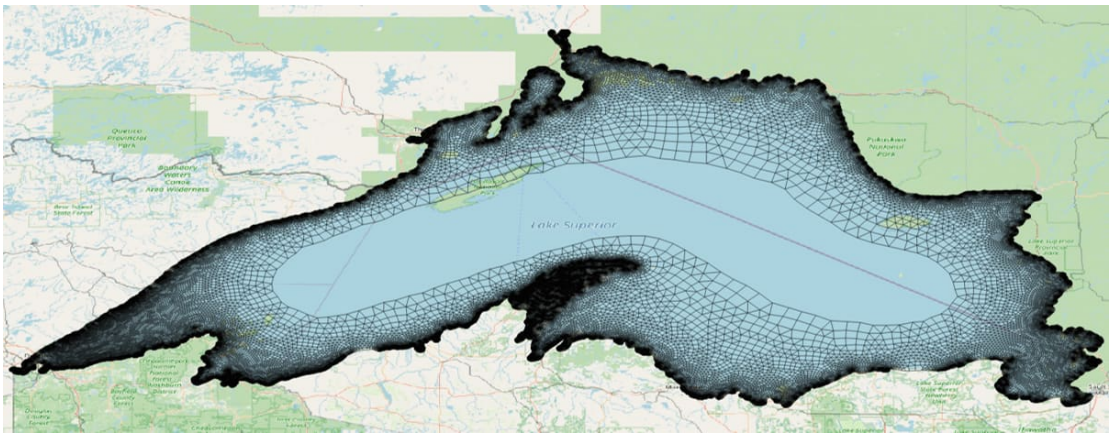
Mesh resolution: 20 m

Freshwater Inflows from NWM

Waterlevel @ ring boundary from FVCOM

Topo-Bathy Sources: NCEI Great Lakes Bathymetry, USGS and CDEM (Canadian Gov't)

Bottom Roughness (Manning's n) source: NLCD



Lake Michigan Huron

Mesh resolution: 20 m

Total number of nodes: 5064214

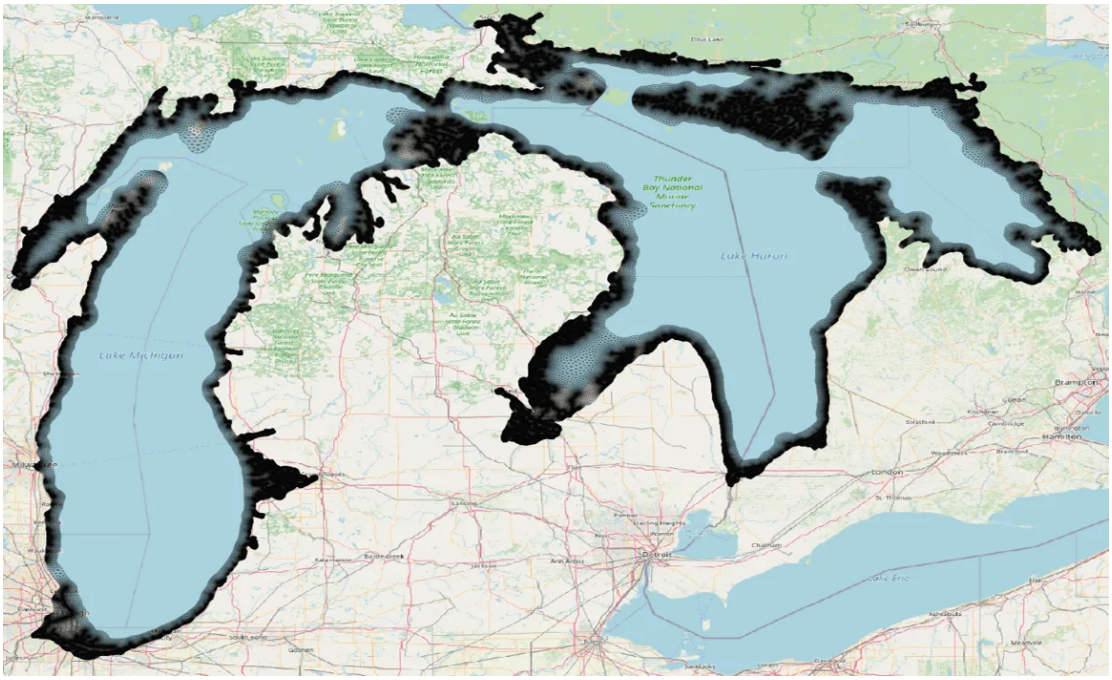
Total number of cells: 10013684

Freshwater Inflows from NWM

Waterlevel @ ring boundary from FVCOM

Topo-Bathy Sources: NCEI Great Lakes Bathymetry, USGS and CDEM (Canadian Gov't)

Bottom Roughness (Manning's n) source: NLCD



Lake Erie

Mesh resolution: 20 m

Total number of nodes: 974868

Total number of cells: 1916517

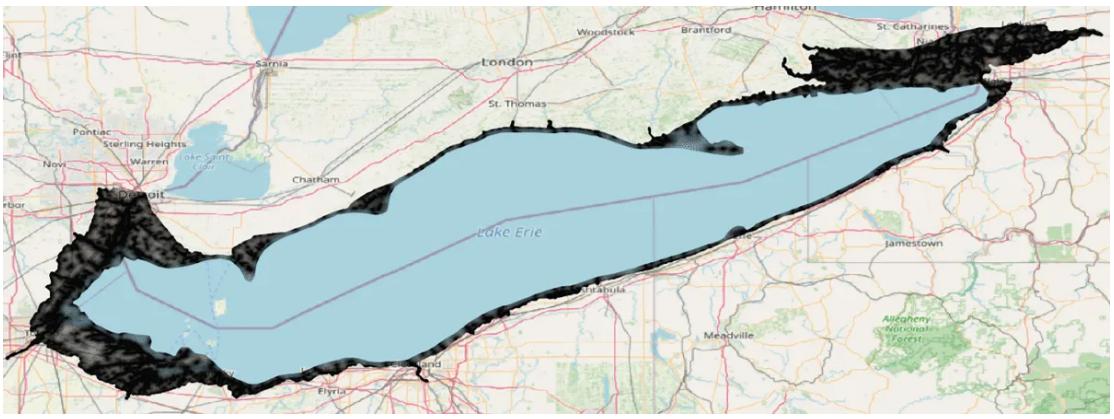
Freshwater Inflows from NWM

Waterlevel @ ring boundary from FVCOM

Topo-Bathy Sources:

NCEI Great Lakes Bathymetry and USGS

Bottom Roughness (Manning's n) source: NLCD



Lake Ontario

Mesh resolution: 20 m

Total number of nodes: 853212

Total number of cells: 1676030

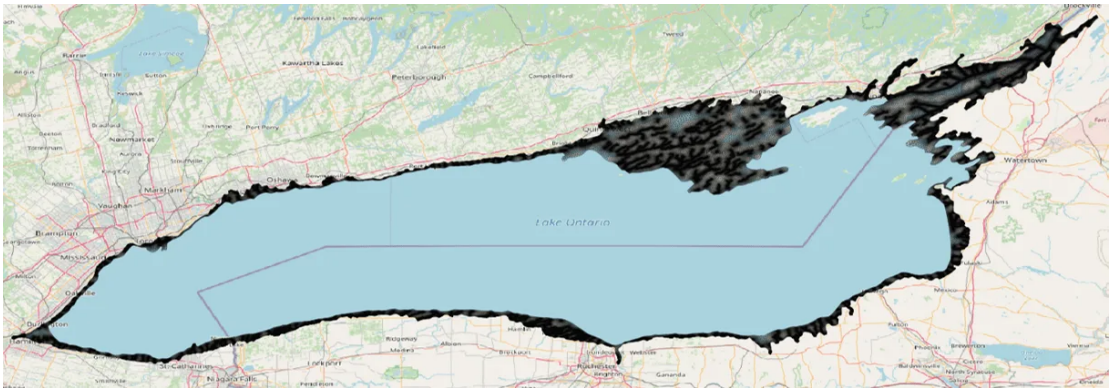
Freshwater Inflows from NWM

Waterlevel @ ring boundary from FVCOM:

Topo-Bathy Sources:

NCEI Great Lakes Bathymetry and USGS

Bottom Roughness (Manning's n) source: NLCD



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LAKE CHAMPLAIN


St Jean
Quebec
Marina
Napierville
Albans
Georgia
Milton
Essex
Hinesburg
Monkton
Vergennes
Waltham
Bristol
Addison
Middlebury
Bridport
Ripton
Salisbury
Leicester
Orwell
Brandon
New York
Vermont

Mesh resolution: 20 m

Total number of nodes: 278674

Total number of cells: 547339

Freshwater Inflows from NWM

Measured waterlevel @ St Jean Marina downstream boundary

Topo-Bathy Source: NOAA, H2D2 Model

Bottom Roughness (Manning's n) source: NLCD

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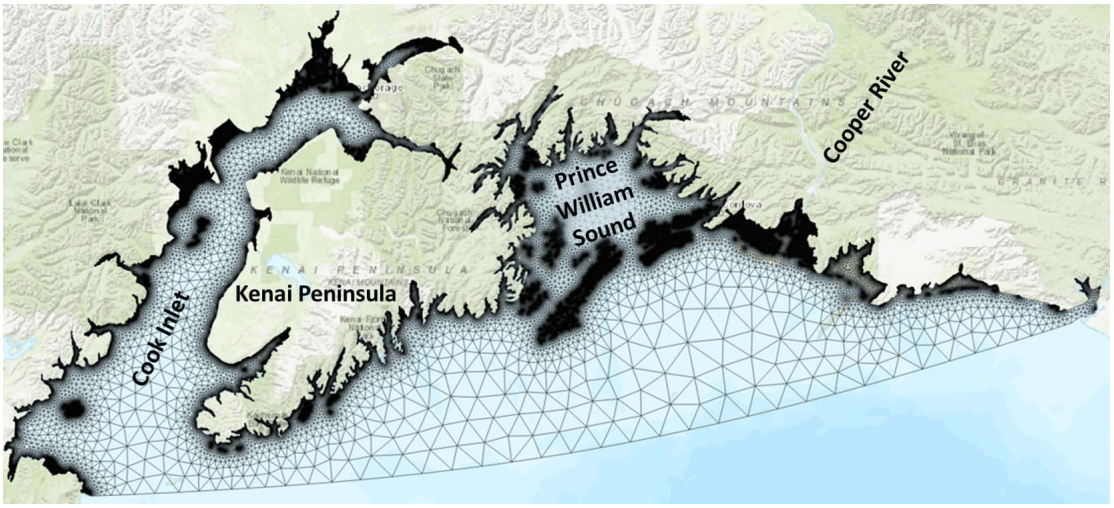
ALASKA



Mesh resolution: 20 m

Total number of nodes: 1188509

Total number of cells: 2281751

Freshwater Inflows from NWM

Waterlevel @ offshore boundary from STOFS-2D-Global.

Topo-Bathy Source: NCEI, NOAA Tidal Bathy, GEBCO (up to 0m MSL) and USGS

Bottom Roughness (Manning's n) source: NLCD

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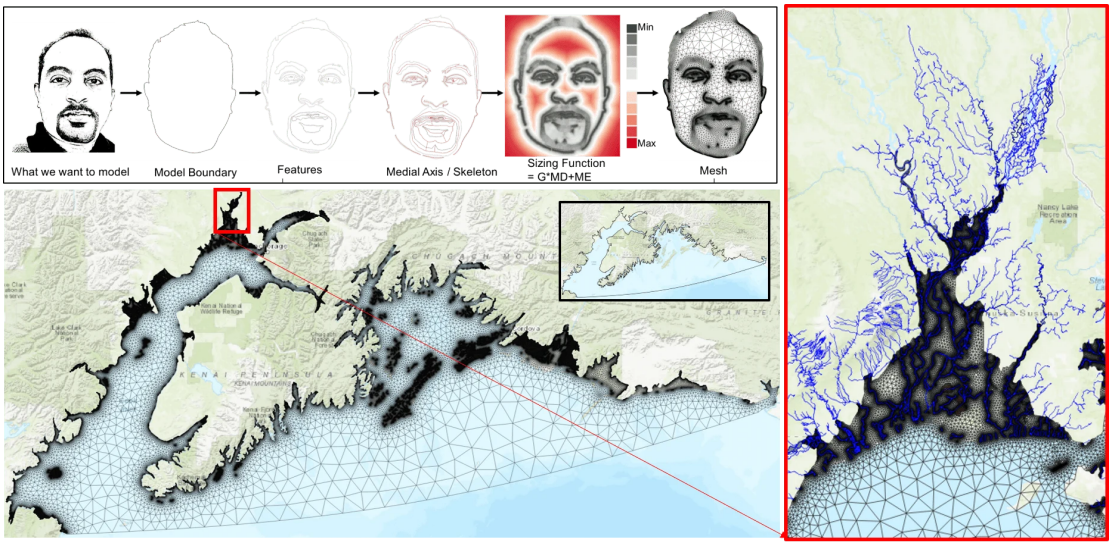
MODELING APPROACH

Innovative mesh generation method allows finer elements to be assigned near important coastal features.



We obtained the streamlines from the NWM, water bodies from the NHD, levee lines from USACE and dredging channels in the CONUS from USACE.

DFlow Flexible Mesh (FM)

•The Dflow-FM is the successor of the Delft3D 4 Suite.

•Dflow-FM Suite can simulate storm surges, hurricanes, tsunamis, detailed flows and water levels, waves, sediment transport and morphology, water quality and ecology, and is capable of handling the interactions between these processes.

•Dflow-FM implements a finite volume solver on a staggered unstructured grid.

•The handling of wetting-and-drying makes it suitable for flooding computations.

•The continuity equation is solved implicitly for all points in a single combined system.

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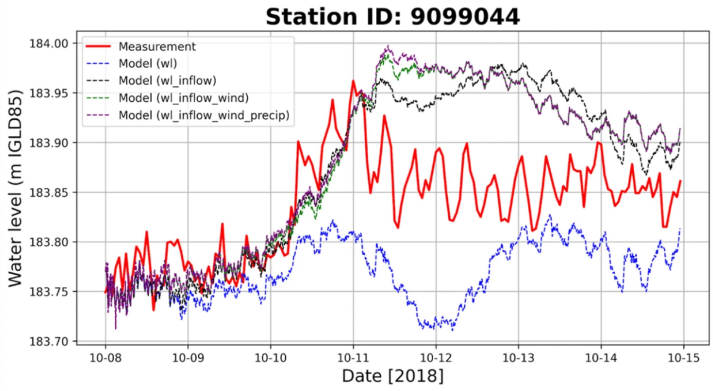
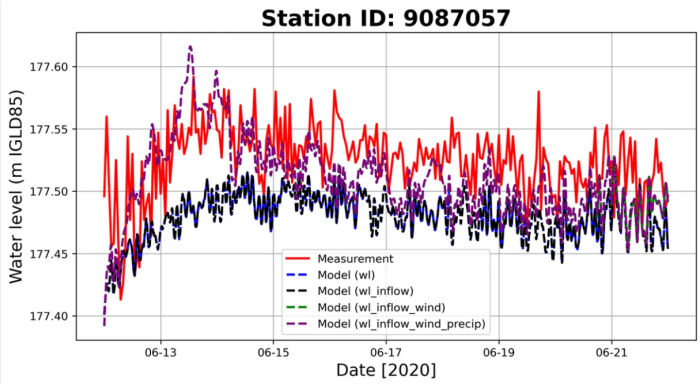
EXPANDED TWL PREDICTIONS TO NEW REGIONS. THE MODELS ARE READY TO FORECAST TWL FIELD WITHIN NEXTGEN.

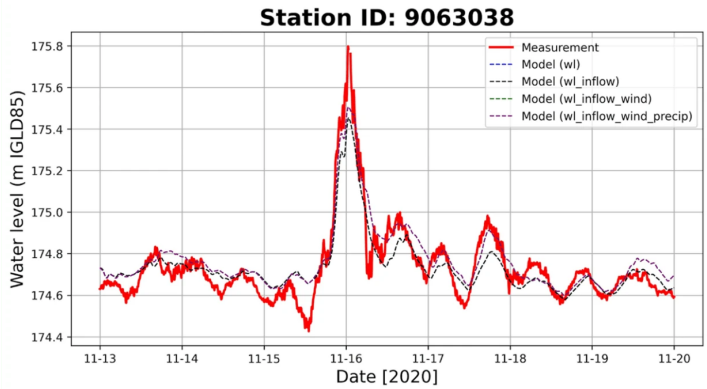
Ontonagon, MI - Station ID: 9099044



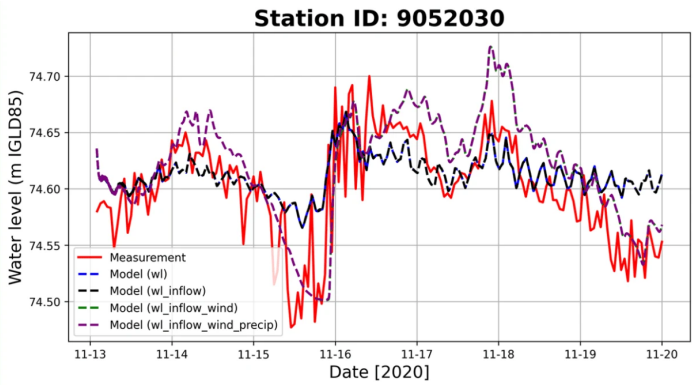
Milwaukee, WI - Station ID: 9087057



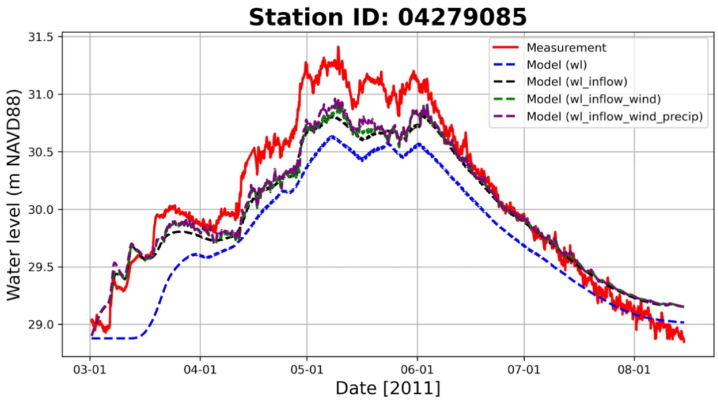
Erie, Lake Erie, PA - Station ID: 9063038



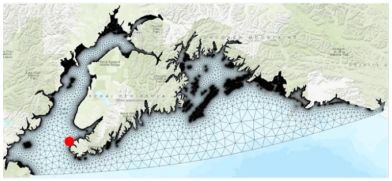
Oswego, NY - Station ID: 9052030

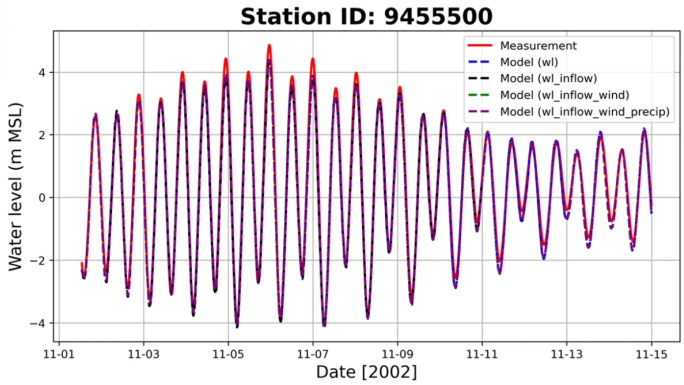


USGS 04279085 Lake Champlain North of Whitehall NY



Seldovia, AK - Station ID: 9455500





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CONCLUSIONS

Initial results in the expanded domain highlight the importance of combining an innovative mesh generation technique that can deliver high-quality meshes with the coupling of inland to coastal-oceanic processes.

The approach predicts TWL during combined river flooding and extreme storm surge events at a large spatial scale. These capabilites are currently being integrated into the NextGen framework.

Models are currently being optimized.

Challenges

-Scarcity of topo-bathy datasets

-Unavailability of Datum corrections in some areas of the model domains.

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Contractor with Lynker in support of
Office of Water Prediction - NWC, NOAA-NWS
904-651-8249

TRANSCRIPT

ABSTRACT

The Office of Water Prediction (OWP) is currently developing a Next Generation Water Resources Modeling Framework (NextGen) that will support the operational National Water Model (NWM) beginning with version 4.0. The NextGen Framework uses the Basic Model Interface (BMI) to couple models , which provides maximum flexibility in model selection, and eases implementation and evaluation of different models with standardized data and model setup workflows.

This presentation focuses on the application of BMI for two-way coupling of coastal models with hydrologic and inland hydraulic models. Currently, the NWM v3.0 Total Water Level (TWL) forecast covers the Continental United States, Puerto Rico, U.S. Virgin Islands, and Hawaii coastal areas. Under NextGen, the TWL prediction area is slated to expand to include the Great Lakes, Lake Champlain, and Alaska. The Alaska model includes coastal regions of Cook Inlet, Kenai Peninsula, Prince William Strait and Copper River estuary. One of the coastal models selected for the expansion of TWL predictions is D-Flow Flexible Mesh (D-Flow FM). D-Flow FM can simulate coastal compound flooding and is capable of handling the complex interactions between riverine inflows, precipitation, tides, and oceanic surges in coastal zones and lakes, which lead to significant flooding.

Initial results in the expanded domain highlight the importance of combining an innovative mesh generation technique that can deliver high-quality meshes with the coupling of inland to coastal-oceanic processes. The approach accurately predicts TWL during combined river flooding and extreme storm surge events at a large spatial scale under the NextGen framework.