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From: Patrick Burke
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Subject: Implementation of new Oceanographic Forecast Modeling Systems for the Cook Inlet and Lake Michigan and Lake Huron Effective: July 23, 2019

Effective July 23, 2019, beginning at 18z Coordinated Universal Time (UTC), the new National Ocean Service(NOS) operational forecast systems (OFS) for the Cook Inlet (CIOFS) and for the two Great Lakes of Michigan and Huron (LMHOFS) will be implemented. LMHOFS combines Lake Michigan and Lake Huron into one model grid and will replace the present two separate operational forecast systems of LMOFS and LHOFS. Both LMOFS and LHOFS will be retired and their products (NetCDF output files and web products) will no longer be available after LMHOFS is implemented to operations.

1. Changes to the existing OFS

Because LMHOFS will replace LMOFS and LHOFS, the following files from both LMOFS and LHOFS will no longer be available on the CO-OPS THREDDS server,

https://opendap.co-ops.nos.noaa.gov/thredds/catalog.html
ftp://tidepool.nos.noaa.gov/pub/outgoing/ofs

and on National Centers for Environmental Prediction (NCEP) NOMADS and FTP Web services:

https://nomads.ncep.noaa.gov
ftp://ftpprd.ncep.noaa.gov

Under directory structure:
pub/data/nccf/com/nos/prod/glofs.YYYYMMDD

nos.OFS.fields.nowcast.YYYYMMDD.tCCz.nc
nos.OFS.fields.forecast.YYYYMMDD.tCCz.nc
nos.OFS.stations.nowcast.YYYYMMDD.tCCz.nc
nos.OFS.stations.forecast.YYYYMMDD.tCCz.nc
nos.OFS.corms.YYYYMMDD.tCCz.log

Where YYYY, MM, DD is year, month, day,
CC is cycle (00,06,12,18) and OFS is lmofs or lhofs

- With this implementation, the NetCDF 4 replaces NetCDF 3 for ROMS-based models of CBOFS, DBOFS, TBOFS, GOMOFS and CIOFS. But the contents (variables) in the NetCDF output files keep same for the existing OFS except LEOFS. There are very small differences in the NetCDF outputs generated.
- The additional variables below of turbulent parameters and vertical velocities are included in LEOFS 3D field output files for both nowcast and forecast runs. Those variables are required by the operational Lake Erie three-dimensional Harmful Algal Blooms (HAB) Tracker:

nos.leofs.fields.nHHH.YYYYMMDD.tCCz.nc
Where HHH is 001,002,006
nos.leofs.fields.fHHH.YYYYMMDD.tCCz.nc
Where HHH is 001, 002, 003,...,120

Variables:

omega - Vertical Sigma Coordinate Velocity
ww - Upward Water Velocity
viscofm - Horizontal Turbulent Eddy Viscosity For Momentum
viscofh - Horizontal Turbulent Eddy Viscosity For Scalars
km - Turbulent Eddy Viscosity For Momentum
kh - Turbulent Eddy Viscosity For Scalars
kq - Turbulent Eddy Viscosity For Q2/Q2L
q2 - Turbulent Kinetic Energy
q2l - Turbulent Kinetic Energy X Turbulent Macroscale
l - Turbulent Macroscale

- The following models will experience changes of product delivery time:

creofs - up to 20min earlier availability
gomofs - up to 34min earlier availability
leofs - up to 17min earlier availability
negofs - up to 12min earlier availability
ngofs - up to 13min earlier availability
nwgofs - up to 8min earlier availability
sbofs - up to 8min earlier availability

2. New Cook Inlet Operational Forecast System (CIOFS)

Cook Inlet is a 180-mile long water body. It incorporates almost every coastal use in Alaska: recreation, commercial fishing, sport fishing, subsistence, tourism, oil and gas, mining, shipping, conservation, search and rescue, and scientific research. The wide variety of users in the inlet results in a wide variety of needs to understand and operate safely in its waters and along its coastline. Cook Inlet oceanography is complex. Thirty feet tide ranges, mudflats, sea ice and large glacial rivers all contribute to complicated circulation patterns that change hourly, daily and seasonally. Major external factors such as the Aleutian Low pressure system, the Alaska Coastal Current, and the freshwater inflow affect both the physical characteristics of the Inlet and the biota that live there. The challenge of understanding such an intricate and dynamic system has attracted scientists from around the country.

As its core ocean prediction model, CIOFS uses the Regional Ocean Modeling System (ROMS) developed by the coastal ocean modeling community and supported by Rutgers University. ROMS is a free-surface, terrain-following, primitive equations ocean model widely used by the scientific and operational community for a diverse range of applications. CIOFS operates within the NOS Coastal Ocean Modeling Framework (COMF) and has four daily nowcast and forecast cycles at 00, 06, 12 and 18 UTC. CIOFS will provide users with nowcasts (analyses of near present) and forecast guidance of the three-dimensional physical conditions of the Cook Inlet, including surface water levels and 3-D water currents, water temperature, and salinity out to 48 hours.

The CIOFS uses orthogonal grid with horizontal dimension of 1132 x 777. Its horizontal resolution ranges from 10m within the

upper bay/estuaries and navigational channels to 3.5km near offshore waters. The vertical grid follows the terrain and consists of 30 sigma levels. The bathymetry of the Cook Inlet model grids is populated from the best available data, which include NOS sounding data, National Geophysical Data Center and National Geodetic Survey shoreline data, USGS topography gridded product. Digital Elevation Map (DEM) was used for wetting/drying process.

The surface meteorological forcing used to run CIOFS is based on forecast guidance from the NWS North American Mesoscale (NAM) weather prediction model (for both nowcast and forecast). Forecast guidance from the NCEP Global Forecast System (GFS) are used as a backup forcing if forecast guidance from the NAM is not available.

CIOFS relies on NCEP's Global Real-Time Ocean Forecast System (G-RTOFS) to provide open boundary temperature, salinity. The NWS Extra-Tropical Storm Surge (ETSS) provides sub-tidal water level boundary conditions. The ADCIRC 2003 Tidal Database is used to generate CIOFS tidal forcing. Additionally, near real-time observations from USGS river gauges are used to specify river discharge, river temperature and salinity at seven major rivers (Knik River, Susitna River, Matanuska, Kenai River, Sixmile Creek, Matanuska, Terror River) in the Cook Inlet.

3. New Lake Michigan and Huron Operational Forecast System (LMHOFS)

LMHOFS will provide users with nowcasts (analyses of near present) and forecast guidance of the three-dimensional physical conditions of the Lake Michigan and Huron including surface water levels and 3-D water currents, and water temperature out to 120 hours.

As its core ocean prediction model, LMHOFS uses the Finite Volume Community Ocean Model (FVCOM) developed jointly by the University of Massachusetts, Dartmouth and the Woods Hole Oceanographic Institution. FVCOM is a prognostic, unstructured-grid, finite-volume, free-surface, 3-D primitive equation coastal ocean circulation model with a horizontal grid comprised of unstructured triangular cells and the irregular bottom is presented using generalized terrain-following coordinates. FVCOM is one of the NOS selected community ocean models for NOS

hydrodynamic forecast systems. LMHOFS operates within the NOS Coastal Ocean Modeling Framework (COMF) and has four daily nowcast and forecast cycles at 00, 06, 12, and 18 UTC.

LMHOFS' bathymetry has a minimum depth of 0.5m and maximum depth of 271.4m. The unstructured model grid has 90,806 nodes and 171,377 elements. The cell size ranges from 50m to 2.5km, with higher resolution along the shoreline and in the shallow western basin and coarser resolution for the open waters in both lakes. The model has 21 vertical sigma layers.

The surface meteorological forcing for the nowcast cycles is provided by short-term weather forecast guidance from NOAA's hourly updated High-Resolution Rapid Refresh (HRRR) atmospheric forecast modeling system, and surface forcing for the forecast cycles is generated from NCEP's Global Forecast System (GFS) forecast guidance. Water level open boundary at St. Mary's River is generated from real time observations at St. Mary station of CO-OPS' National Water Level Observation Network (NWLON). USGS Real-time river discharge observations drive the model for both the nowcast and forecast cycles.

4. Dissemination of New Product Outputs

Fields and station forecast guidance from CIOFS and LMHOFS will be available in netCDF format on CO-OPS THREDDS server

https://opendap.co-ops.nos.noaa.gov/thredds/catalog.html
ftp://tidepool.nos.noaa.gov/pub/outgoing/ofs

And on NCEP Web services

https://nomads.ncep.noaa.gov
ftp://ftpprd.ncep.noaa.gov
Under directory structure:
pub/data/nccf/com/nos/prod/ciofs.YYYYMMDD
pub/data/nccf/com/nos/prod/lmhofs.YYYYMMDD

Web products of CIOFS and LMHOFS are currently displayed in developmental mode here:
https://tidesandcurrents.noaa.gov/ofs/dev/ciofs/ciofs.html
https://tidesandcurrents.noaa.gov/ofs/dev/lmhofs/lmhofs.html

After it is transitioned to production, it will be displayed here:

https://tidesandcurrents.noaa.gov/ofs/ciofs/ciofs.html
https://tidesandcurrents.noaa.gov/ofs/lmhofs/lmhofs.html

There are two types of model output files:

- field/gridded output file which includes hourly three-dimensional gridded data:
  nos.{OFS}.fields.nHHH.YYYYMMDD.tCCz.nc
   Where HHH is 001,002,006
  nos.ciofs.fields.fHHH.YYYYMMDD.tCCz.nc
   Where HHH is 001, 002, 003,...,048
  nos.lmhofs.fields.fHHH.YYYYMMDD.tCCz.nc
   Where HHH is 000,001, 002, 003,...,120

- station/point output data with 6 minutes interval. Water level, surface wind, water temperature, water salinity and currents are the preliminary output variables:
  nos.{OFS}.stations.(now|fore)cast.YYYYMMDD.tCCz.nc
   Where YYYYMMDD is year, month, day
   Where CC is cycle (00,06,12,18) and OFS is ciofs or lmhofs

- Additionally, the following forcing condition files are also available for rerun and research purpose,

 * nos.{OFS}.roms.tides.*YYYYMMDD*.t*HH*z.nc - tide forcing
 * nos.{OFS}.obc.*YYYYMMDD*.t*HH*z.nc - open boundary forcing
 * nos.{OFS}.river.YYYYMMDD.tHHz.nc - river forcing
 * nos.{OFS}.met.forecast.YYYYMMDD.tHHz.nc - surface forcing for forecast cycle
 * nos.{OFS}.met.nowcast.YYYYMMDD.tHHz.nc - surface forcing for nowcast cycle
 * nos.{OFS).hflux..forecast.YYYYMMDD.tHHz.nc - surface heat flux forcing for forecast (FVCOM-based models)
 * nos.{OFS}.hflux..nowcast.YYYYMMDD.tHHz.nc - surface heat flux forcing for nowcast (FVCOM-based models)
 * nos.{OFS}.{forecast,nowcast}.YYYYMMDD.tHHz.in - runtime model run input file
 * nos.{OFS}.{forecast,nowcast}.YYYYMMDD.tHHz.log - runtime model run output log file

Forecast guidance from both CIOFS and LMHOFS are used by commercial, recreational mariners, fisherman, emergency

managers, search and rescue responders, and NWS marine weather forecasters. The development and implementation of CIOFS is a joint project between the NOS/Office of Coast Survey (OCS), the NOS/Center for Operational Oceanographic Products and Services (CO-OPS), and NWS/NCEP/NCO. Rutgers University provided technical support for ROMS. The development and implementation of LMHOFS is a joint project of the NOS/Center for Operational Oceanographic Products and Services (CO-OPS), the NOS/Office of Coast Survey (OCS), the Great Lake Environmental Research Laboratory (GLERL), NWS/NCEP/NCEP Central Operations (NCO) and the FVCOM development group at the University of Massachusetts, Dartmouth. CIOFS and LMHOFS are monitored 24 x 7 by both NCO/NCEP and CO-OPS Continuous Real-Time Monitoring System (CORMS) personnel.

As part of NCEP's standard 30-day parallel testing, the output products from NCO parallel runs will be available here: https://para.nomads.ncep.noaa.gov/pub/data/nccf/com/nos/para/

Delayed mode long-term archives on National Centers for Environmental Information (NCEI) NOMADS are available here: https://www.ncei.noaa.gov/thredds/model/model.html

NCEP urges all users to ensure their decoders can handle changes in content order and volume changes. These elements may change with future NCEP model implementations. NCEP will make every attempt to alert users to these changes before implementation.

Any questions, comments or requests regarding this implementation should be directed to the contacts below. We will review any feedback and decide whether to proceed.

If you have any questions concerning these changes, please contact:
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For questions regarding the dataflow aspects, please contact:
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NWS National Service Change Notices are online at:

https://www.weather.gov/notification/

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