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Service Change Notice 23-124 Updated
National Weather Service Headquarters Silver Spring MD
220 PM EDT Mon Apr 22 2024

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From: Ben Kyger, Director
 NCEP Central Operations

Subject: Updated: Upgrade of the Surge and Tide Operational Forecast System (STOFS): Effective May 14, 2024

Updated to reflect the new implementation date of May 14, 2024 and to update version number to v2.1.7.

On or about Tuesday, May 14, 2024 beginning with the 1200 Coordinated Universal Time (UTC) cycle, the National Centers for Environmental Prediction (NCEP) will be upgrading the Surge and Tide Operational Forecast System (STOFS) to v2.1.7.

STOFS v2.1.7 represents a major upgrade of the STOFS modeling system. It was last upgraded in January 2023. STOFS v2.1.7 contains several enhancements improving model performance, resolution, and coverage. It includes upgrades to the global modeling system (STOFS-2D-Global) and to the three-dimensional (3D) component for the Atlantic basin (STOFS-3D-Atlantic).

Model upgrades for STOFS-2D-Global (ADCIRC-based) include:

- Inclusion of bias correction at station locations where National Ocean Service (NOS)/CO-OPS observations are available. This bias correction a) computes the bias at these stations by subtracting the combined (storm surge + tide) water level forecast guidance from the observed water level; b) removes this hourly bias from the current cycle's 6-hour nowcast; c) averages the bias over 5 days using the most recent five (5) days of nowcasts and observations; and d) removes this average bias from the future forecast guidance (with a 12-hour linear interpolation from current bias to average bias). This post-processing bias correction is implemented in STOFS-2D-Global in the same way that Extra-Tropical Storm Surge (ETSS) implements it (also called "anomaly", which is the same as the negative bias). Note that no gridded bias correction is implemented in this version of STOFS-2D-Global.

- Improved temporal resolution for GFS forcing, by including hourly Global Forecast System (GFS) forcing out to 5 days in the forecast, then 3-hourly from five (5) days to 7.5 days in the forecast. Previously, 3-hourly GFS forcing was used for the entire forecast period.

- Improvements to coastal topography, bathymetry, friction values, and the mesh, for improved accuracy of water level forecast guidance. Specifically, there are improvements to the bottom boundary conditions (friction, topography, and bathymetry), and a few mesh nodes were adjusted for improvement in performance. Also, a model output station was added at a relatively new tide gauge at NOS/CO-OPS Bremerton, WA (9445958).

Model upgrades for STOFS-3D-Atlantic (SCHISM-based) include:

- Major improvements to the mesh in the watersheds, including better resolving of river channels to enhance watershed flow and connectivity and to minimize ponding. The mesh in coastal areas such as the Great South Bay and Shinnecock Bay is also improved for enhanced accuracy of water level forecast guidance.

- Incorporation of satellite altimetry observations, specifically absolute dynamic topography (ADT), to improve open ocean boundary conditions and overall accuracy. Also, xGEOID20b is used instead of North American Vertical Datum 1988 (NAVD88) to improve model initialization and vertical datum referencing. Station output will remain in NAVD88, while gridded output (e.g., *field*.nc and *.grib2) will be referenced to xGEOID20b.

- Extending the forecast horizon from 48 to 96 hours into the future.

- Expanding the model coverage east and north to include the St. Lawrence River and improve boundary conditions and overall accuracy, especially in the Gulf of Maine.

New and existing data files for STOFS-2D-Global and STOFS-3D-Atlantic will remain at their current location on the NOAA Operational Model Archive and Distribution Service (NOMADS)/FTP/PRD web services at:

<ftp://ftp.ncep.noaa.gov/pub/data/nccf/com/stofs/prod/>
<https://www.ftp.ncep.noaa.gov/data/nccf/com/stofs/prod>
<https://nomads.ncep.noaa.gov/pub/data/nccf/com/stofs/prod/>

Below are the changes to the files on NOMADS and FTP/PRD web services:

A. File additions and file name changes:

- Additional forecast hours for STOFS-3D-Atlantic CONUS East and Puerto Rico (this data will also be made available via the existing NOMADS Grib Filter and OPeNDAP applications):

stofs_3d_atl.tCCz.conus.east.f{hour}.grib2
stofs_3d_atl.tCCz.puertori.f{hour}.grib2

Where {hour} = {49, 50, 51, ..., 96}, and tCCz is forecast cycle: CC = 12.

- The following STOFS-3D-Atlantic files experience file name changes, increased temporal resolution, and/or an extended forecast horizon that results in additional files:

stofs_3d_atl.tCCz.f001_024.field2d.nc and
stofs_3d_atl.tCCz.f025_048.field2d.nc become:
stofs_3d_atl.tCCz.field2d_fh1_hh2.nc

Where {fh1_hh2} = {f001_012, f013_024, f025_036, f037_048, f049_060,
f061_072, f073_084, f085_096}, and tCCz is forecast cycle: CC = 12.

stofs_3d_atl.tCCz.n001_024.field2d.nc becomes:
stofs_3d_atl.tCCz.field2d_nh1_hh2.nc

Where {nh1_hh2} = {n001_012, n013_024}, and tCCz is forecast cycle: CC
= 12.

stofs_3d_atl.tCCz.fields.out2d_forecast_day1.nc and
stofs_3d_atl.tCCz.fields.out2d_forecast_day2.nc become:
stofs_3d_atl.tCCz.fields.out2d_fh1_hh2.nc

Where {fh1_hh2} = {f001_012, f013_024, f025_036, f037_048, f049_060,
f061_072, f073_084, f085_096}, and tCCz is forecast cycle: CC = 12.

stofs_3d_atl.tCCz.fields.out2d_nowcast.nc becomes:
stofs_3d_atl.tCCz.fields.out2d_nh1_hh2.nc

Where {nh1_hh2} = {n001_012, n013_024}, and tCCz is forecast cycle: CC
= 12.

B. Timeliness changes:

- For the STOFS-2D-Global model, the Gridded Binary version two (GRIB2) and Standard Hydrometeorological Exchange Format (SHEF) products will be delivered up to 20 minutes later. The NetCDF products will be delivered up to 30 minutes later, while the htp NetCDF files will be delivered up to 15 minutes earlier.

- For the STOFS-3D-Atlantic model, the SHEF and NetCDF products will be delivered up to 45 minutes later, and the GRIB2 products will be delivered up to 70 minutes later.

C. File size changes:

- The expanded domain east and north and some SCHISM code input/output (I/O) changes increase the following STOFS-3D-Atlantic file sizes:

stofs_3d_atl.tCCz.fields.cwl.maxele.nc
stofs_3d_atl.tCCz.conus.east.cwl.grib2
stofs_3d_atl.tCCz.puertori.cwl.grib2

Where tCCz is forecast cycle: CC = 12.

- The reduction in the station number from 342 to 108 or 107 decreases the following file sizes:

stofs_3d_atl.tCCz.fcast.station.profile.nc
stofs_3d_atl.tCCz.ncast.station.profile.nc

```
stofs_3d_atl.tCCz.points.cwl.temp.salt.vel.nc
stofs_3d_atl.tCCz.points.cwl.nc
stofs_3d_atl.tCCz.points.cwl.shef
```

Where tCCz is forecast cycle: CC = 12.

- The addition of stations increases the following file sizes:

```
stofs_2d_glo.tCCz.points.cwl.shef
stofs_2d_glo.tCCz.points.htp.shef
stofs_2d_glo.tCCz.points.swl.shef
```

Where tCCz is forecast cycle: CC = 00, 06, 12, and 18.

- The increase in coverage to north of the Aleutian Islands increases the following file sizes:

```
stofs_2d_glo.tCCz.alaska.cwl.grib2
stofs_2d_glo.tCCz.alaska.htp.grib2
stofs_2d_glo.tCCz.alaska.swl.grib2
stofs_2d_glo.tCCz.alaska.f{hour}.grib2
```

Where {hour} = {0, 1, 2, 3, ...,180}, and tCCz is forecast cycle: CC = 00, 06, 12, and 18.

- The removal of coverage in the Gulf of California decreases the following file sizes:

```
stofs_2d_glo.tCCz.conus.west.cwl.grib2
stofs_2d_glo.tCCz.conus.west.htp.grib2
stofs_2d_glo.tCCz.conus.west.swl.grib2
stofs_2d_glo.tCCz.conus.west.f{hour}.grib2
```

Where {hour} = {0, 1, 2, 3, ...,180}, and tCCz is forecast cycle: CC = 00, 06, 12, and 18.

D. File content changes:

- The Bremerton, WA and many other stations are added to the following STOFSS-2D-Global files:

```
stofs_2d_glo.tCCz.points.cwl.nc
stofs_2d_glo.tCCz.points.htp.nc
stofs_2d_glo.tCCz.points.swl.nc
stofs_2d_glo.tCCz.points.cwl.shef
stofs_2d_glo.tCCz.points.htp.shef
stofs_2d_glo.tCCz.points.swl.shef
```

Where tCCz is forecast cycle: CC = 00, 06, 12, and 18.

- Dimension parameters (such as node, nele, nbou, nvel, and max_nvell) are changing in the following STOFSS-2D-Global files due to the ADCIRC model grid change and the adjustment of a few mesh nodes:

stofs_2d_glo.tCCz.fields.cwl.nc
stofs_2d_glo.tCCz.fields.htp.nc
stofs_2d_glo.tCCz.fields.swl.nc

Where tCCz is forecast cycle: CC = 00, 06, 12, and 18.

- A new processID "21", which is Extra-tropical Storm Surge Atlantic Domain (3D), is used for the following STOFS-3D-Atlantic GRIB2 files:

stofs_3d_atl.tCCz.conus.east.f{hour}.grib2
stofs_3d_atl.tCCz.puertori.f{hour}.grib2
stofs_3d_atl.tCCz.conus.east.cwl.grib2
stofs_3d_atl.tCCz.puertori.cwl.grib2

Where {hour} = {1, 2, 3, ..., 96}, and tCCz is forecast cycle: CC = 12.

- Due to the change of the vertical datum referencing to xGEOID20b for the STOFS-3D-Atlantic model, the number of stations is reduced from 342 to 108 or 107 (i.e., xGEOID20b to NAVD88 or MLLW conversion is not available for some stations). The affected files are:

stofs_3d_atl.tCCz.fcast.station.profile.nc
stofs_3d_atl.tCCz.ncast.station.profile.nc
stofs_3d_atl.tCCz.points.cwl.temp.salt.vel.nc
stofs_3d_atl.tCCz.points.cwl.nc
stofs_3d_atl.tCCz.points.cwl.shef

Where tCCz is forecast cycle: CC = 12.

- The following files have new variables:

Variable crs is added to provide the Coordinate Reference System (CRS) definition in the following file:

stofs_3d_atl.tCCz.fields.cwl.maxele.nc

Where tCCz is forecast cycle: CC = 12.

Variables crs, SCHISM_hgrid_face_x, SCHISM_hgrid_face_y, SCHISM_hgrid_edge_x, SCHISM_hgrid_edge_y, evaporationRate, precipitationRate, windStressX, and windStressY are added in the following files:

stofs_3d_atl.tCCz.fields.out2d_nhhh1_hhh2.nc
stofs_3d_atl.tCCz.fields.out2d_fhhh1_hhh2.nc

Where {nhhh1_hhh2} = {n001_012, n013_024}, {fhhh1_hhh2} = {f001_012, f013_024, f025_036, f037_048, f049_060, f061_072, f073_084, f085_096}, and tCCz is forecast cycle: CC = 12.

- A new type source "HMIFR" is used for these STOFS-3D-Atlantic SHEF files:

stofs_3d_atl.tCCz.points.cwl.shef

Where tCCz is forecast cycle: CC = 12.

- The Advanced Weather Interactive Processing System (AWIPS) header is changing from "TIBEP" to "TIBEA" in these STOfS-3D-Atlantic SHEF files:

stofs_3d_atl.tCCz.points.cwl.shef

Where tCCz is forecast cycle: CC = 12.

- The coverage increases to north of the Aleutian Islands in the following files:

stofs_2d_glo.tCCz.alaska.cwl.grib2
stofs_2d_glo.tCCz.alaska.htp.grib2
stofs_2d_glo.tCCz.alaska.swl.grib2
stofs_2d_glo.tCCz.alaska.f{hour}.grib2

Where {hour} = {0, 1, 2, 3, ...,180}, and tCCz is forecast cycle: CC = 00, 06, 12, and 18.

- The coverage for Gulf of California is removed in the following files:

stofs_2d_glo.tCCz.conus.west.cwl.grib2
stofs_2d_glo.tCCz.conus.west.htp.grib2
stofs_2d_glo.tCCz.conus.west.swl.grib2
stofs_2d_glo.tCCz.conus.west.f{hour}.grib2

Where {hour} = {0, 1, 2, 3, ...,180}, and tCCz is forecast cycle: CC = 00, 06, 12, and 18.

A consistent parallel feed of STOfS v2.1.7 data is available on the NCEP sites at the following URLs:

<https://nomads.ncep.noaa.gov/pub/data/nccf/com/stofs/para/>
<https://www.ftp.ncep.noaa.gov/data/nccf/com/stofs/para/>
<ftp://ftp.ncep.noaa.gov/pub/data/nccf/com/stofs/para/>
https://para.nomads.ncep.noaa.gov/pub/data/nccf/naaaport/stofs_2d_glo/

NCEP urges all users to ensure their decoders can handle changes in content order, changes in the scaling factor component within the product definition section (PDS) of the GRIB files, 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.

For questions concerning science changes, please contact:

Greg Seroka
Coastal Marine Modeling Branch
Coast Survey Development Laboratory
NOAA/NOS/Office of Coast Survey
Silver Spring, MD
gregory.seroka@noaa.gov

For questions regarding the data flow aspects of these datasets, contact:

Tony Salemi
NCEP Central Operations Dataflow Team Lead (Acting)
College Park, MD
ncep.pmb.dataflow@noaa.gov

National Service Change Notices are online at:

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

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