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To:           Subscribers:  
              -NOAA Weather Wire Service  
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              -NOAAPort  
              Other NWS Partners, Users and Employees

From:         Bob Maxson, Acting Director  
              National Centers for Environmental Prediction

Subject: Upgrade NCEP Global Forecast Systems (GFS) to V15.1: Effective  
June 12, 2019

Effective on or about Wednesday, June 12, 2019, beginning with the 1200 Coordinated Universal Time (UTC) run, the National Centers for Environmental Prediction (NCEP) will upgrade the Global Forecast Systems (GFS) from version 14 to 15.1.

NOAA/NWS selected the finite-volume cubed-sphere (FV3) dynamical core as the Next Generation Global Prediction System (NGGPS). The FV3 was developed by the Geophysical Fluid Dynamics Laboratory (GFDL) under NOAA's Office of Atmospheric Research (OAR). The current operational GFS Version 14 has a spectral dynamical core. The GFS version 15.1 uses the FV3 dynamical core and improved physics parameterizations.

GFS Version 15.1 maintains a horizontal resolution of 13 km and has 64 levels in the vertical extending up to 0.2 hPa. It uses the same physics package as the current operational GFS, except for:

- Replacement of Zhao-Carr microphysics with the more advanced GFDL microphysics
- Updated parameterization of ozone photochemistry with additional production and loss terms
- Newly introduced parameterization of middle atmospheric water vapor photochemistry
- Revised bare soil evaporation scheme
- Modified convective parameterization scheme to reduce excessive cloud top cooling.

The Environmental Modeling Center (EMC) has conducted three years of retrospective experiments, including the real-time parallel, covering the past 3.5 years for a comprehensive evaluation of the 2nd quarter fiscal year (FY) 2019 GFS implementation. GFS V15 shows equal or improved forecast skills in many areas, especially for 500-hPa height anomaly correlations, precipitation diurnal cycle and ETS score over the contiguous U.S. (CONUS), surface 2m temperature, stratospheric ozone and water vapor, and hurricane intensity over all basins. Several individual case studies illustrate the model occasionally produces excessive snow in

the medium range. EMC also noted a persistent cold bias that increases with forecast time. EMC will continue to explore ways to address these issues.

Evaluation of both the real-time and retrospective parallels can be found at:

<https://www.emc.ncep.noaa.gov/users/meg/fv3gfs/>

The site above includes relevant links to various evaluation and verification websites.

A real-time feed of the GFS V15 output is available on para NOAA Operational Model Archive and Distribution System (NOMADS) for both NCEP Web services and NOAAPort output at:

<https://para.nomads.ncep.noaa.gov>

and on the Model Analysis and Guidance website here:

<https://mageval.ncep.noaa.gov/>

A summary of major changes to the data assimilation and model output contents include:

- Changes to data assimilation
- Product changes to file names, directory structure, and internal file parameters
- Product delivery timing changes differing more than five minutes
- Product volume changes
- Removal of NOAAPort/Satellite Broadcast Network (SBN) products.

Changes to Data Assimilation:

- Add Infrared Atmospheric Sounding Interferometer (IASI) moisture channels
- Add Advanced Technology Microwave Sounder (ATMS) all-sky radiances
- Add Megha-Tropiques SAPHIR data
- Add Advanced Scatterometer (ASCAT) data from MetOp-B
- Upgrade the use of Cross-Track Infrared Sounder (CrIS) radiances
- Add Meteosat-11 SEVIRI channels 5 and 6
- Add NPP OMPS profile and total column ozone
- Monitor NOAA-19 SBUV/2, Metop-C AMSUA and MHS, GOES-17 AMVs
- Add ability to read drifting and moored buoy data
- Update quality control for GOES atmospheric motion vector (AMV) winds
- Upgrade specific humidity perturbation and statistics physics tendency perturbation with new parameter settings in ensemble forecast; statistical kinetic energy backscattering perturbation is excluded
- Remove digital filter and storm relocation
- Increase horizontal resolution of the ensemble part of the hybrid data assimilation from 35 km to 25 km
- Update the Near Sea Surface Temperature scheme to apply Sea Surface Temperature climatology tendency to the foundation temperature and reduce background error correlation length from 450~800 km down to 100 km.

## Changes to Product Output on Web Services:

With this upgrade, the following changes occur on either the NCEP web services:

<https://nomads.ncep.noaa.gov/pub/data/nccf/com/>  
<ftp://ftpprd.ncep.noaa.gov/pub/data/nccf/com/>

or on the NWS web services:

<https://tgftp.nws.noaa.gov/SL.us008001/ST.opnl/>  
<ftp://tgftp.nws.noaa.gov/SL.us008001/ST.opnl/>

## Changes to directory structures on the NCEP Web services:

- Major change to the GFS, GDAS and EnKF sub-directory structure:

```
gfs.YYYYMMDDCC -> gfs.YYYYMMDD/CC  
gdas.YYYYMMDDCC -> gdas.YYYYMMDD/CC  
enkf.YYYYMMDD/CC -> enkfgdas.YYYYMMDD/CC
```

Where YYYYMMDD is year, month, and day. Where CC is cycle.

- The EnKF sub-directory structure is changing where each member is a unique directory:

```
enkf.YYYYMMDD/CC/FILE -> enkfgdas.YYYYMMDD/CC/memXXX/FILE
```

Where XXX is the member from 001, 002, ..., 080.

## Changes to the Output File Names on the NCEP Web Services:

- The EnKF files will no longer include memXXX in the file name. That information will now be obtained from the sub-directory:

```
gdas.tCCz.sfcf009.memXXX.nemsio -> gdas.tCCz.sfcf009.nemsio
```

- The Surface Flux (sflux) file name will change to include a leading 0 for forecast hours below 100, which will match all other file naming structures. Name changes are as follows:

```
gfs.tCCz.sfluxgrbFF.grib2 -> gfs.tCCz.sfluxgrbFFF  
gdas.tCCz.sfluxgrbFF.grib2 -> gdas.tCCz.sfluxgrbFFF
```

Where FF and FFF are the 2- and 3-digit forecast hours.

- The GDAS near sea surface temperature analysis nemsio file (gdas.tCCz.nstanl.nemsio) will be merged into the surface analysis nemsio file (gdas.tCCz.sfcanl.nemsio).

## Changes to Variables on the NCEP Web Services:

- Time averaged and accumulated max/min variables will be removed from surface flux (sflux) files at forecast hour 000 because these fields do

not have physical meaning at this time step:

gfs.tCCz.sfluxgrbffff.grib2

- The sflux files will have additional variables for forecast 000 only. These variables already exist in later forecast hours. To see the entire list, users are encouraged to compare index files for current operational products with the parallel data on para NOMADS.

- The pressure GRIB (pgrb) files will have both variable and level additions. Users are encouraged to check the index files on para NOMADS. Variable and level changes will have corresponding changes to NOMADS grib filter and OpenDAP services:

gfs.tCCz.pgrb2.1p00.ffff  
gfs.tCCz.pgrb2.0p50.ffff  
gfs.tCCz.pgrb2.0p25.ffff  
gfs.tCCz.pgrb2b.0p50.ffff  
gfs.tCCz.pgrb2b.0p25.ffff  
gfs.tCCz.pgrb2b.1p00.ffff

The following changes will be made to GFS station Binary Universal Form for the Representation of Meteorological Data (BUFR) soundings:

- Only non-hydrostatic vertical velocity VVEL (cm/s) will be included. Hydrostatic vertical velocity OMEGA (Pa/s) will be removed.

- A new BUFR sounding station will be added (999390 40.19N, 113.47W DGWY 11 Dugway Prov Grd Ld 1296).

- The elevation at Station (488100 22.82N 104.97E 11 Ha Giang Vietnam 117) will be changed from 10 m to 117 m.

Product and File Additions to NCEP Web Services:

NCEP wants to highlight two potentially impactful changes to the vertical velocity (VVEL) and accumulated precipitation (PCP) variables. To keep in line with the direction of the NCEP modeling suite unification, these variables are changing. In order to provide users with enough lead time, both the legacy and new variables will be included in GFS V15. We encourage users to migrate to the new variables described below. In the near future, the legacy products will be removed.

- A second vertical velocity field will be included in the output files and written out by the model as DZDT (m/s). The GFS V15 treats DZDT as a prognostic variable. The vertical velocity VVEL (pascal/s) found in the current operational product is now derived from DZDT using the hydrostatic approximation.

- New total precipitation and convective precipitation, with continuous accumulation, will be added to the output.

Examples of the new variables:

APCP:surface:0-10 day acc fcst  
ACPCP:surface:0-10 day acc fcst

- The following output files will have increased temporal resolution from 12-hourly to 3-hourly after forecast hour 240:

gfs.tCCz.pgrb2.1p00.fFFF  
gfs.tCCz.pgrb2.0p50.fFFF  
gfs.tCCz.pgrb2.0p25.fFFF  
gfs.tCCz.pgrb2b.0p50.fFFF  
gfs.tCCz.pgrb2b.0p25.fFFF  
gfs.tCCz.pgrb2b.1p00.fFFF  
gfs.tCCz.sfluxgrbFFFF.grib2

Where FFF is forecast hour greater than 240.

- A new cyclone tracker file will be added to the NCEP websites. It contains three parameters for depicting cyclone phases based on Hart (2003), where parameter B for cyclone thermal symmetry and parameters -Vt(lower) and -Vt(upper) for cyclone thermal winds. File will be located under directory structure:

/com/ens\_tracker/prod/gfs.YYYYMMDD/CC/tctrack

With file name: avnop.tCCz.cyclone.trackatcfunix

Product Removal from NWS Web Services, with Substitutes on the NCEP Web Services:

- The 0.5-degree files labeled for the National Polar-Orbiting Operational Environmental Satellite System (NPOESS) will be removed. Users can find replacement files on the NCEP websites.

File names that will be removed match:  
fh.0FFF\_tl.press\_gr.0p5deg\_pt.npoess

Replacement files on the NCEP web services:  
gfs/prod/gfs.YYYYMMDD/CC/gfs.tCCz.pgrb2.0p5.fFFF  
gfs/prod/gfs.YYYYMMDD/CC/gfs.tCCz.pgrb2b.0p5.fFFF

- The GFS NEMSIO files will be removed from NWS web services. Users can find the exact files on the NCEP web services. File names that will be removed:

ST.expr/MT.gfs\_CY.CC/RD.YYYYMMDD/PT.bin\_DF.offh.anal\_tl.sigma  
ST.expr/MT.gfs\_CY.CC/RD.YYYYMMDD/PT.bin\_DF.offh.anal\_tl.sfsig

Exact replacement files on the NCEP web services:  
gfs.YYYYMMDD/CC/gfs.tCCz.atmanl.nemsio  
gfs.YYYYMMDD/CC/gfs.tCCz.sfcanl.nemsio

- The cyclone tracker file on the NWS Website will be moved to the NCEP website. This file provides the basic hurricane track information such as location and intensity. The names that will be removed:

avn.tCCz.cyclone.trackatcfunix

Exact file replacement path on NCEP web services:  
ens\_tracker/prod/gfs.YYYYMMDD/CC/tctrack/

Product Removal from NCEP Web Services:

- The ENKF atmospheric analysis for each ensemble member will be removed from the NCEP web services with file names like:

gdas.tCCz.ratmanl.memFFF.nemsio  
gdas.tCCz.atmf006s.memFFF.nemsio  
gdas.tCCz.atmf009s.memFFF.nemsio

In the future, NCEP will be terminating the lower resolution products from its web services and encouraging users to migrate to higher resolution output.

- The Archive TAR output products will be removed from directory:

/com/arkv/prod/ncartar/ with filenames like:

ncargdas.20190324.tar obs.\${date}.tar

Users can find replacement products in the GDAS directory containing "pgrb2" and "bufr\_d" respectively.

Product Timing and Volume Changes:

- The data volume per file will increase for most output. This includes about a 50 percent increase in the "pgrb2" and "pgrb2b" files and up to a 200 percent increase in the "nemsio" files.

- The current operational GFS V14 is run at a coarser horizontal resolution beyond forecast hour 240; GFS V15 will run at a uniform, high resolution throughout the entire forecast length up to 384 hours. As a result, the delivery of all GFS products after 240 hours of forecast will be delayed. The last products at forecast hour 384 will be delayed by up to 20 minutes.

Due to restructuring of some model processes, the following timing changes will also take place on the NCEP web services:

These files will be up to 80 minutes early:

gfs.tCCz.goessimpgrb2.1p00.fFFF  
gfs.tCCz.goessimpgrb2fFFF.grd221

These files will be up to 15 minutes early:

gdas.tCCz.pgrb2.0p25.fFFF  
gdas.tCCz.pgrb2.1p00.fFFF  
memMMM/gdas.tCCz.sfcfFFF.nemsio (for some members)  
gdas.tCCz.atmfFFF.nemsio  
gdas.tCCz.sfcfFFF.nemsio  
gdas.tCCz.sfluxgrbFFF.grib2

Changes to Products on NOAAPort/SBN:

Product Changes:

- The 20km CONUS grid will be changed to use "Grid-relative" winds to interpolate (U and V) winds for map projection Lambert-Conformal. The resolution and component flags will be changed from 48 to 56 and the latitude of the South Pole will be changed from 0 to 90 degrees south (-90.000) in Grid Definition Template section (PDT 3.30).
- The additional variables for vertical velocity (DZDT) and continuous precipitation (e.g., APCP, ACPCP) will not be added to NOAAPort/SBN at this time. In the near future, we will advertise a multi-cycle test dissemination of duplicate DZDT and PCP so that users can prepare for this change.
- NCEP plans to remove the legacy variables (VVEL and 6-hourly accumulated precipitation) as early as the 2020 upgrade. Users can begin testing the new variables here:

[https://para.nomads.ncep.noaa.gov/pub/data/nccf/noaaport/gfs\\_newprecip/](https://para.nomads.ncep.noaa.gov/pub/data/nccf/noaaport/gfs_newprecip/)

Product Removals:

In 2014, NCEP added higher resolution grids to NOAAPort to replace the legacy lower resolution. Please see this notice for World Meteorological Organization (WMO) information on the new grids:

[https://www.weather.gov/media/notification/tins/tin14-54gfs\\_noaaport.pdf](https://www.weather.gov/media/notification/tins/tin14-54gfs_noaaport.pdf)

As advertised, the following low-resolution products will now be removed from NOAAPort/SBN:

#	Grid Resolution	Area	Map Projection
-	-----	----	-----
#199	2.5 km	Guam	Mercator
#225	80 km	Hawaii	Mercator
#160	47 km	Alaska	North Polar Stereographic
#161	0.5 degree	Puerto Rico	Latitude/Longitude
#213	95 km	Alaska	Polar Stereographic
#254	40 km	Pacific Region	Mercator

The WMO headers for grid 160, 161, 213, 225 and 254 are listed at:

[https://www.nco.ncep.noaa.gov/pmb/changes/gfs\\_removal\\_grids.shtml](https://www.nco.ncep.noaa.gov/pmb/changes/gfs_removal_grids.shtml)

Users of grid 199 (Guam) output are encouraged to use HiresW Guam products as a replacement available on the NCEP website under "hiresw." A full list of grid 199 WMO headers being removed can be found here:

[https://www.nco.ncep.noaa.gov/pmb/codes/GRIB2/wmo\\_headers\\_for\\_GUAM\\_199/wmo\\_headers\\_awips\\_guam\\_grid\\_199](https://www.nco.ncep.noaa.gov/pmb/codes/GRIB2/wmo_headers_for_GUAM_199/wmo_headers_awips_guam_grid_199)

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.

A real-time feed of the GFS V15 output is available on para NOMADS for both NCEP Web services and NOAAPort output here:

<https://para.nomads.ncep.noaa.gov>

and graphical output is available on the Model Analysis and Guidance (MAG) here:

<https://mageval.ncep.noaa.gov/>

NCEP will evaluate all comments to determine whether to proceed with this upgrade.

For questions regarding these model changes, please contact:

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