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PNSWSH

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Subject: Soliciting Comments on the Proposed Upgrade of the GFS through
August 31, 2020

The Environmental Modeling Center (EMC) is proposing to upgrade the NWS operational Global Forecast System (GFS) and Global Data Assimilation System (GDAS) from v15.3 to v16 in February 2021. The upgrade will improve model forecast performance and provide enhanced products. The NWS is seeking comments on the proposed changes to GFS.v16 through August 31, 2020.

Proposed changes to the GFSv16 include:

- Increasing the number of vertical layers from 64 to 127 and extending model top from 54 km to 80 km.
- Improving physical parameterizations:
 - Updated Planetary Boundary Layer (PBL) scheme, namely a scale-aware Turbulent Kinetic Energy Based Moist Eddy-Diffusivity Mass-Flux (sa-TKE-EDMF) parameterization for vertical turbulent mixing.
 - Introduction of a new parameterization of sub-grid scale gravity-wave physics.
 - Updated radiation package to improve solar radiation absorption by water clouds and a revised cloud overlap assumption for radiation calculation.
 - Revised ground heat flux calculation over snowpack.
 - Improved cloud microphysics for computing ice cloud effective radius.
- Introducing the current operational stand-alone global deterministic wave model Multi_1 (wave_multi_1.v3.3) as a component in the GFS, coupled using a one-way coupling scheme where the atmospheric model provides winds to the WAVEWATCH III model using the UFS framework.

Proposed changes to the GDASv16 include:

- Use observational precipitation to spin up the Global Land Data Assimilation System (GLDAS) in the GDAS cycle to provide more realistic land initial conditions.

- Use a Local Ensemble Kalman Filter (LETKF) with model space localization and linearized observation operator to replace the Ensemble Square Root Filter (EnSRF).
- Apply a new 4-Dimensional Incremental Analysis Update (4D-IAU) technique.
- Turn on Stochastic Kinetic Energy Backscatter (SKEB) scheme in GDAS ensemble forecasts.
- Update variational Quality Control (QC).
- Apply Hilbert curve to aircraft data.
- Apply correlated observation error for CrIS over sea surfaces and IASI over sea and land.
- Update aircraft bias correction with safeguards.
- Assimilate AMSU-A channel 14 and ATMS channel 15 without bias correction.
- Assimilate CSR data from ABI_G16, AHI_Himawari8, and SEVIRI_M08.
- Assimilate AVHRR from NOAA-19 and Metop-B for near sea-surface temperature (NSST).
- Upgrade to Community Radiative Transfer Model (CRTM) v2.3.0.

The proposed coupling of the atmosphere model to WAVEWATCH III in GFSv16 will retire the stand-alone, deterministic global wave forecasting system Multi_1. Although the new GFS-Wave component will inherit many characteristics of the current stand-alone wave prediction system, the following changes are expected to bring significant improvements to the wave guidance provided to the NWS:

- Full integration of the wave pre-processing, forecast and post-processing workflow into the GFS global-workflow.
- New Global spatial grid mosaic as follows:
 - Increasing global core resolution from 1/2 degree to 1/6 degree in the northern hemisphere, and from 1/2 degree to 1/4 degree in the southern hemisphere.
 - Increasing Arctic Polar grid resolution from 18 km to 9 km.
 - Including wave-current interactions.
 - Improving physics optimized to the new atmospheric forcing.

Proposed changes in GFS model output, post-processed fields, and downstream products include the following:

- Changing format of forecast output history files from binary (nemsio) to netCDF with zlib compression. The number of vertical layers will be increased from 64 to 127 layers. Data volume will be reduced by about 60 percent.
- Expanding gridded binary (GRIB) products to include more standard pressure layers in the upper stratosphere and the mesosphere. Data volume will increase for almost all GRIB products by about 25 percent, including the pgrb2 and pgrb2b files.
- Unification: all 3-D fields in pgrb2 files will have the same 41 standard isobaric layers for all forecast hours, including analysis time.
- Adding several new products including ceiling, instantaneous total column cloud fraction, instantaneous cloud fraction at low/middle/high cloud, 1- and 4-km radar reflectivity, radar reflectivity at model layer 1 and 2.

- Adding additional fields in the pgrb2 dataset for generating initial conditions and boundary conditions for downstream applications. They are plant canopy surface water, soil moisture at 0-0.1, 0.1-0.4, 0.4-1, 1-2 m below ground level, sea ice thickness, surface roughness, sea ice skin temperature, soil type, vegetation type and frictional velocity.
- Replacing filtered Shuelli SLP with unfiltered one using the same ID (PRMSL)
- Replacing legacy synthetic nadir GOES 12/13 with synthetic nadir ABI GOES-R products.
- Moving most isobaric specific humidity records will be moved from the pgrb2b dataset to the pgrb2 dataset.
- Moving GTG and Icing severity from gfs.tHHz.gtg_0p25.ffff.grib2 and gfs.tHHz.pgrb2.0p25.ffff respectively to a new file gfs.tHHz.wafs_0p25.fff.grib2. Additionally, the output pressure levels are changed from model pressure levels to International Civil Aviation Organization (ICAO) standard levels in this new file only.
- Delaying product delivery for Synthetic Geostationary Orbiting Environmental Satellite (GOES) products.
- Changing labeling of time averaged cloud fraction at low/middle/high cloud from TCDC to LCDC, MCDC, HCDC.
- Changing Icing Severity GRIB2 parameter from 234 to 37, mnemonics from ICSEV to ICESEV.
- Removing 16 levels of isobaric specific humidity from pgrb2b.

Please refer to an earlier product removal Public Information Statement (PNS) for the details of other product removals:

https://www.weather.gov/media/notification/pns20-17gfs_product_removal.pdf

- Several updates will be made to GFS station time series Binary Universal Form for the Representation of meteorological data (BUFR) output:
 - Increasing the vertical levels from 64 to 127 levels.
 - Removing adjustment of temperature, humidity, surface pressure, and sea level pressure from model terrain to local station terrain.
 - Changing surface evaporation value and unit from watts/m² (surface latent heat net flux) to kg/m² (evaporation).

Wave model forecast output, post-processed fields and downstream products will be modified as follows:

- All products from legacy grids awk, enp, wna, nww3, wam, will be removed.
- All wave steepness files (wstp) will be removed.
- All 4-arcmin gridded data will be removed.
- The Alaska 10-arcmin data will be removed, replaced by a full Arctic 9km.
- Binary forcing files will be removed.
- CSV bulletins will be removed.

A complete list of wave products removed from the existing global wave forecast system at NCEP, as well as details of how product removal will affect data disseminated via NOAAPort, is provided in the following PNS:

https://www.weather.gov/media/notification/pdf2/pns20-33multi_1_removal.pdf

With this upgrade, NCEP will terminate products proposed and announced in the above two product removal PNS forms from its Web Services. We encourage users to take this opportunity to migrate to other products.

In preparation for the operational implementation of GFS v16, EMC is currently running a real-time parallel with fully cycled data assimilation. Real-time output from this parallel are made available through both NOAAPort and NCEP Web Services and can be found at:

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

The real-time data will be available at best effort and with variable timing of output availability.

EMC is also conducting retrospective experiments covering the past one and half years for a comprehensive evaluation of the GFS v16 implementation.

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

<https://www.emc.ncep.noaa.gov/users/meg/gfsv16/>

This page includes relevant links to various evaluation and verification websites.

Send comments on this proposal through August 31, 2020 to:

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The NWS will evaluate all comments to determine whether to proceed with this upgrade. If approved, a Service Change Notice will be issued giving a minimum of 30 days' notice of the implementation date.

National Public Information Statements are online at:

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

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