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Public Information Statement 20-07
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From: Grant Cooper
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Subject: Soliciting Comments on the Changes to Product Timeliness
Associated with Upgrade of Global Ensemble Forecast System Version 12.0
Model Implementation through April 14, 2020

The Environmental Modeling Center (EMC) is proposing to upgrade the
Global Ensemble Forecast System (GEFS) from Version 11.3 to Version 12.0
in the 4th quarter (Q4) of fiscal year 2020 (FY20). This is the first
upgrade to GEFS in five years.

This Public Information Statement (PNS) provides background on the
scientific and technical changes associated with the GEFS v12.0 and seeks
comments on this proposed upgrade through April 14, 2020. If we proceed
towards this upgrade, a Service Change Notice will be issued at least 30
days prior to the implementation of this upgraded product.

Background:

GEFS v12.0 will significantly expand the scientific and technical
capabilities of the GEFS with substantial improvements to the
probabilistic forecast skill. In particular, GEFS v12.0 significantly
reduces the biases and increases the ensemble spread compared to GEFS
v11.3. The resources required to run GEFS v12.0 are also significantly
higher, requiring both an increase in node usage on the Weather and
Climate Operational Supercomputing System (WCOSS) and up to a one-hour
delay in the delivery of data beyond forecast day 8. Details are
provided below.

The upgrade to GEFS will include the following scientific advancements:

- Replace the spectral dynamical core with the Finite Volume Cubed Sphere (FV3) dynamical core.
- New perturbation techniques including Stochastic Perturbation of Physical Tendencies (SPPT) and Stochastic Kinetic Energy Backscatter (SKEB).

- Upgrade the physical parameterization schemes to those implemented with GFS v15.1 including new Geophysical Fluid Dynamics Laboratory (GFDL) microphysics.
- Expand the number of ensemble members from 21 to 31.
- Couple with the global wave ensembles (one-way).
- Couple with the global aerosols (control member-only).
- Increase model horizontal resolution to 0.25 degree (~25 km) and maintain the same resolution out to 16 days forecast each cycle, (the current system operates at ~33 km resolution and reduces it to ~50 km after day 8).
- For the first time, provide the capability for weeks 3 - 4 forecast guidance once a day at 0000 Coordinated Universal Time (UTC) cycle, by extending the forecast length to 35 days with the same resolution of ~25 km.

Highlights of the scientific benefits based on the preliminary evaluation of retrospective experiments with GEFS v12.0 for a three year period include:

- Useful ensemble mean forecast skill extended by 0.6 days (from 9.8 to 10.4 days).
- Much reduced RMS errors and increased spread for Northern Hemisphere 850 hPa and 2-m temperature (error reduced by about 15-20% for 48-hour forecasts).
- Significant improvements to contiguous U.S. (CONUS) probabilistic Quantitative Precipitation Forecast (QPF) scores (Brier Skill Score) by 25-30% for days 1-5 forecasts for all precipitation thresholds.
- Significant reduction in errors (by 5% for 5-day forecast) and an increase in ensemble spread for tropical cyclone tracks (much desired outcome as GEFS v11.3 is considered notoriously under-dispersive).
- Significant reduction of tropical cyclone intensity errors (30-40% error reduction for 24-120 hours forecast).
- Much improved wave forecasts from Global Wave Ensembles coupled to GEFS v12.0.
- Significant improvements to global aerosols forecasts.
- Extend forecast skill and predictability of large scale indices including Madden-Julian Oscillation (MJO) and North Atlantic Oscillation (NAO) by about 2-3 days compared to operational Climate Forecast System (CFSv2).

Apart from the science benefits, coupling with waves and aerosols will allow us to simplify the operational modeling suite and deliver these products earlier instead of running them as downstream systems.

Computational constraints prevent GEFS v12.0 from completing within the same time slot used by the current operational GEFS v11.3. GEFS v12.0 requires significantly more resources with longer runtimes, mainly due to increased resolution (0.25 degree), coupling to waves, and larger ensemble membership (31) along with new dynamical core (FV3) and operational Global Forecast System (GFS) physics. The current operational GEFS (v11.3) is started approximately an hour after the GFS analysis is complete, and it takes an hour to complete the 16-day ensemble forecast. EMC is proposing to adjust the run times for GEFS v12.0 in the operational system by expanding from one hour to three hours. The product delays will be somewhat mitigated by starting GEFS v12.0 an hour earlier than GEFS v11.3.

Following are the impacts of this proposed change on the timelines of GEFS product availability:

- The delivery of GEFS v12.0 products at forecast hour 192 will be unchanged. Products from earlier forecast hours will be available earlier in the cycle, and products from later forecast hours will be available later.
- The last product (16-day forecast) will be delivered approximately one hour later than the current operational products.
- Products for 16-35 day forecasts (each day at 0000 UTC cycle only, new addition to GEFS v12.0) will be delivered approximately three hours after the 16-day forecast product.

The following modeling systems will be impacted by the delay of forecast products from day 8 to day 16:

- Products for ensemble tropical cyclone tracker will be delayed by about 15 minutes (8-10 day forecasts).
- North American Ensemble Forecast System (NAEFS) products beyond day 8 will be progressively delayed by about 7.5 minutes per day, a maximum delay of 60 minutes for day-16 forecast products.
- Model Analysis and Guidance (MAG) web page for GEFS will have product display beyond day 8 delayed progressively by about 7.5 minutes per day, a maximum delay of 60 minutes for day-16 forecast products.
- The Meteorological Development Laboratory's (MDL's) Ensemble Kernel Density Model Output Statistics (EKDMOS) has an "early" run that harnesses GEFS, followed by a later run that uses GEPS (CMCE). MDL proposes to turn off the early run of EKDMOS and use the later run by switching off the 0000 UTC and 1200 UTC runs of EKDMOS.

NBM will have to make adjustments to only use the 0600 UTC and 1800 UTC EKDMOS/BMOS runs. Users will be alerted via the mos_info list that the

data will no longer be available for these cycles. The delay in GEFS is not expected to impact the 0000 UTC and 1200 UTC runs of the National Blend of Models (NBM), and no NBM coding changes are anticipated.

This change will have no impact on CPC weeks 2-3 products (CPCI-GEFS).

The change will also not affect downstream modeling systems that use the 192-hour forecast products or earlier, or alternatively are triggered an hour after the last GEFS product is created.

In addition to the run-times and product availability, certain forecast products from GEFS v11.3 will be discontinued to reduce the footprint on dissemination of GEFS v12.0 products. EMC has already issued a separate PNS (https://www.weather.gov/media/notification/pns19-37gefs_product_removal.pdf) describing the removal of certain products from the GEFS v12.0 in anticipation of this proposed change.

Without these adjustments, it will not be possible to implement GEFS v12.0 as planned and realize its full suite of benefits. If the GEFS upgrade is not transitioned into operations in FY20, the next opportunity to do so will be in FY22-FY23 due to a needed pause in implementations resulting from planned supercomputer upgrades.

For comments or questions regarding products from GEFS Version 12.0, please contact:

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