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NOAA's Unified Forecast System for Sub-Seasonal Predictions: Development and operational implementation plans of Global Ensemble Forecast System v12 (GEFSv12) at NCEP

Ivanka Stajner[1], Vijay Tallapragada[1], Yuejian Zhu[1], Henrique Alves[2,1], Jeff McQueen[1], Tom Hamill[3], Jeff Whitaker[3], Georg Grell[4], and Jason Levit[1]

[1]NOAA/NWS/NCEP/Environmental Modeling Center, College Park, Maryland, United States of America
[2]I.M.Systems Group at NOAA/NWS/NCEP/EMC, College Park, Maryland, United States of America
[3]NOAA/OAR/ESRL/Physical Sciences Division, Boulder, Colorado, United States of America
[4]NOAA/OAR/ESRL/Global Systems Division, Boulder, Colorado, United States of America

NCEP has implemented the first version of the Finite Volume Cubed Sphere (FV3) dynamic core based Global Forecast System (GFS v15) into operations in June 2019, replacing the spectral model-based GFS. This is the first instantiation of NOAA's Unified Forecast System (UFS), which is being built as a comprehensive coupled Earth system model using modern tools and software infrastructure (e.g., NEMS, NUOPC, and ESMF) to support research and operations. Advancements in model physics and data assimilation are in development using CCPP and JEDI frameworks. Testing and evaluation of UFS are facilitated through the development of unified workflow and METplus capabilities. All these initiatives involve significant engagement with the research community, with emphasis on more efficient and streamlined transition of research advances to operations (R2O).

The next major operational upgrade towards UFS is for the Global Ensemble Forecast System (GEFSv12) planned for implementation later this year. Compared to the currently operational GEFS, the next GEFS version 12 incorporates the following advances: the same FV3 based global model and UFS infrastructure as in GFS, higher resolution (~25km), increased membership (31), GFSv15 physics, advanced stochastic physics perturbations (SKEB and SPPT), and 2-tiered SST approach using SST anomalies from CFSv2 as input. For the first time, GEFSv12 will provide ensemble based operational weather predictions for sub-seasonal scales with daily 00z forecasts going out to 35 days. GEFSv12 also comes with 20-year reanalysis, 30-year reforecasts and 3-year retrospective forecasts to support stakeholder needs for calibration and validation. In addition, GEFSv12 absorbs the global wave ensembles and aerosol capabilities (control member only) through one-way coupling, taking major steps towards building a unified system and simplifying NCEP's production suite.

This presentation describes the design and development of GEFSv12 and discusses results from the evaluation of the retrospective and reforecast experiments. Significant improvements were noted in both deterministic and probabilistic forecast metrics for several variables including 500

hPa geopotential height anomaly correction, 850 hPa temperature and winds, near surface variables, precipitation, tropical cyclone tracks and intensity, and modes of variability including MJO and NAO. Substantial improvements were also noted in the performance of wave ensemble and aerosol predictions.

This presentation also describes NOAA's efforts towards accelerating further development of fully coupled UFS consisting of six component models of the Earth system: the FV3 dynamical core for the atmosphere, MOM6 for the ocean, Noah MP for the land surface, GOCART for aerosols, CICE5/CICE6 for sea ice and WW3 for ocean surface waves. Combined with data assimilation advances, an ambitious goal of unifying both the high-resolution deterministic (GFSv17) and probabilistic (GEFSv13) predictions for global medium range and sub-seasonal time scales is planned to significantly advance the global prediction capabilities at NCEP.