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Development of a Coupled Subseasonal-to-Seasonal Prediction Model Using Community-based Unified Forecast System for NCEP Operations

Yan Xue[1], Dorothy Koch[1], Vijay Tallapragada[2], Avichal Mehra[2], Fanglin Yang[2], Cristiana Stan[3], James Kinter[3], Jeffrey Whitaker[4], Farida Adimi[1], Tara Jensen[5], Jun Wang[2], Daryl Kleist[2], Michael Barlage[2], Jian-Wen Bao[4], and Ivanka Stajner[2]

[1]NOAA/NWS/OSTI, Silver Spring, United States of America (yan.xue@noaa.gov)
[2]NOAA/NWS/NCEP/EMC, College Park, United States of America
[3]George Mason University, Fairfax, United States of America
[4]NOAA/OAR/PSL, Boulder, United States of America
[5]NCAR and Developmental Testbed Center, Boulder, United States of America

The Unified Forecast System (UFS) is a community-based coupled Earth modeling system, designed to support the Weather Enterprise and also be the source system for NOAA's operations. NOAA's Unified Forecast System Research to Operations Project (UFS-R2O) aims to develop the next generation coupled Global Forecast System (GFS v17)/Global Ensemble Forecast System (GEFS v13) targeting operational implementation in FY24. The Project is part of the larger UFS community and includes scientists from NOAA Labs and Centers, NCAR, UCAR, NRL and several U.S. universities.

The UFS is targeted to be a six-way coupled Earth prediction system, consisting of the FV3 dynamical core with the Common Community Physics Package (CCPP) for the atmosphere, MOM6 for the ocean, CICE6 for the sea ice, WW3 for ocean waves, Noah-MP for the land surface and GOCART for aerosols. Currently, four of the six model components have been coupled using the Community Mediator for Earth Prediction Systems (CMEPS). All the components of the coupled system will be initialized with a weakly coupled data assimilation system based on the Joint Effort for Data Assimilation Integration (JEDI) framework. A 30-year coupled reanalysis and reforecast will be conducted for model calibration and post-processing forecast products. The UFS is the basis for the future updates of the deterministic GFS medium-range weather forecast up to 16 days, the ensemble GEFS subseasonal forecast up to 45 days, and the seasonal forecasts up to one year using the new Seasonal Forecast System (SFS) planned to replace the operational Climate Forecast System (CFSv2).

Several prototypes of a four-way coupled atmosphere-ocean-ice-wave model have been built and tested with a C384 horizontal grid (~25km) and 64 vertical levels for the atmospheric model, and a ¼ degree tripolar grid for the ocean and ice model components. The presentation will highlight the results of these prototype runs. The UFS-R2O Project has made the latest UFS prototype (S2Sp5)

output available on Amazon Web Services (AWS). Researchers interested in the S2S prediction and model development are invited to evaluate the UFS S2Sp5 data. Analysis of the data may include process-based evaluations, diagnostic measures that reveal coupled feedback processes, model biases and S2S forecast skill estimations. To identify and prioritize key metrics in evaluating the UFS applications, the UFS-R2O Project is soliciting community inputs through a online survey and UFS Evaluation Metric Workshop in Feb 2021. The metrics will be incorporated into the METplus verification tools for both research and operation.

A few more prototypes are planned beyond S2Sp5 which include increasing the vertical resolution of the atmospheric model to 127 vertical levels, the transition of land model from Noah to Noah-MP, inclusion of aerosol component, advanced physics suites as well as stochastic physics parameterizations to account for uncertainties in each model component. Coarser and higher resolution configurations along with coupled ensemble prototypes are also being built in order to evaluate the resolution-dependence of forecast biases and to assess the benefit vs cost of higher resolution. The development code is available on Github, and the UFS community contributes to the development through a R2O process.