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The Common Community Physics Package CCPP: unifying physics across NOAA and NCAR models using a common software framework

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After many years of independent development work that has led to largely incompatible model components among the different U.S. agencies, model unification has become a central effort of the near future. NOAA is engaged in the development of a Unified Forecast System (UFS) for addressing operational prediction at all scales, from hours to seasonal. Similarly, NCAR recently launched the SIMA (System for Integrated Modeling of the Atmosphere) project for WRF, MPAS and CESM. Often misunderstood, the term unification does not mean having a monolithic model to use for all applications but having a software infrastructure that permits the exchange of components between models.

Model unification is a huge undertaking as it touches most, if not all, components of a modeling system. A central aspect in this process of unification is the interoperability of the physical parameterizations across the different models. In this context, the Global Model Test Bed (GMTB) with staff at NOAA's Global Systems Division (GSD) and at NCAR has been tasked to develop a collection of physical parameterizations and a software framework, called the Common Community Physics Package (CCPP), that facilitates the transition of innovations from the research community to operations to advance the UFS. The recent agreement made between NOAA and NCAR to jointly develop the CCPP framework places the CCPP framework in the heart of several of the U.S. flagship models as a single, standardized way to interface physics with models of the atmosphere (and other compartments of the Earth system). Additionally, NCAR is developing a new Model Independent Chemistry Module (MICM), which will employ the CCPP framework to connect a chemistry model to various community models.

While the development of CCPP is centered around the NOAA and NCAR models SCM (GMTB single-column model), FV3 (Finite-Volume Cubed-Sphere), WRF (Weather Research and Forecasting model), MPAS (Model for Prediction Across Scales) and CESM (Community Earth System Model), the CCPP framework and the collection of physics and chemistry codes are becoming available to users and developers worldwide. This opens the door to a wider involvement of modeling communities and will accelerate the addition and transfer of physics improvements between these models, which is considered as a key factor for the success of NOAA's next generation global prediction system.

In this contribution, we will provide a brief overview of the general concept of the CCPP, present the technical design and the requirements for parameterizations to be considered as CCPP-compliant, and describe the connection and integration of CCPP with the host model. We will also touch upon the challenges in designing a flexible modeling framework across different models while maintaining high computational performance.