Abstract

The overarching goal of this collaborative effort is to improve the NCEP Climate Forecast System (CFS) forecast skill by enhancing the representation of soil-hydrology-vegetation interactions through the use of the new community Noah-MP (Multiple-Parameterization) land surface model (LSM). Numerous studies have illustrated the substantial influence of land-atmosphere interactions on seasonal-to interannual prediction. Soil moisture memory has been identified as a key in determining seasonal predictability in climate forecast systems. Improving soil-moisture related processes (e.g., evaporation, runoff, and groundwater) is important for potentially enhancing seasonal predictability of temperature and precipitation, which has direct benefit to the other MAPP call for "Research to Advance Understanding, Monitoring, and Prediction of Droughts".

Compared to the earlier version CFS v1, CFS v2 slightly improved 2-m temperature prediction, but not precipitation anomaly. The Noah LSM used in the CFS v2 has been shown to produce low soil moisture with too high seasonal amplitude, which raises significant concerns about the residence times of soil moisture and reduces credibility of coupling with the atmosphere. The prediction skill of the next generation NCEP CFS v3 can be enhanced through improving the Noah LSM with the Multiple-Parameterization (Noah-MP) modeling framework, which has been well tested and verified in seasonal regional climate simulations. Developed from prior NOAA CPPA support, the Noah-MP is a new-generation community LSM and treats key components of the land system with optional degrees of complexity. Since its first release in 2011 (Noah-MP v1), a number of model enhancements have been made to the Noah-MP v2 including added parameterization options for water-table physics, for canopy radiation and turbulence, modifications to snow schemes, and new soil-moisture stress functions in the photosynthesis model among others. Those enhancements are important to accurately represent land-atmosphere interactions and soil moisture memory in climate models.

This proposal will leverage on the ongoing work of the NCEP/EMC land team regarding the testing of Noah-MP v1 in CFS v2 and further evaluate and improve the newly released community Noah-MP v2, and address the overall scientific and operational questions: ***To what degree can a more accurate representation of soil-hydrology-vegetation interactions improve CFS seasonal predictions?*** We will collaborate with the NCEP, CFS, and Climate Test Bed teams to perform the following work: **Task1:** Benchmark performance of CFS v2 hindcast using different land models for a selection of nine years using the NCEP verification metrics; **Task 2**: Explore Noah-MP physics-ensemble forecasting by conducting numerous uncoupled GLDAS and coupled CFS hindcast experiments with different configurations of Noah-MP physics options; **Task 3**: Analyze ensemble spread and determine an optimal set of Noah-MP physics options that can maximize the CFS forecast evaluation metrics. We will ascertain whether an optimal set of Noah-MP physics exists and, if so, how it should be used in CFS; and **Task 4**: Understand the impact of soil-hydrology-vegetation interactions on seasonal prediction skill.