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1. Introduction

- Land/atmosphere processes are complex and important to lower atmospheric evolution
- Many important hydrologic processes are missing or over-simplified in current Land Surface Models (LSMs)
- The current NOAA National Water Model (NWM) (based on WRF-Hydro) includes these processes, but is not yet coupled to the Rapid Refresh Forecast System (RRFS)



2. The Coupled RRFS-NWM System

RRFS

- The Rapid Refresh Forecast System (RRFS) is the next-generation high-resolution numerical weather prediction (NWP) model
- **RRFS** is replacing the RAP/HRRR model The current version, RAPv5/HRRRv4, became operational in Dec 2020



Physics	SCHEME
PBL/Turbulence	MYNN-EDMF
Surface Layer	MYNN
Microphysics	Thompson-Eidhammer
Aerosols	Thompson-Eidhammer
Shallow Convection	MYNN-EDMF
Gravity Wave Physics	UGWP.v1: Small Scale and Turbulent Orographic Form Drag
Land Model	Noah-MP
Land Use	VIIRS
Large Lakes	FVCOM (or CLM
Small Lakes	FLake
Near-Surface Sea Temperature	NSST
Long and Short Wave Radiation	RRTMG²

NWM

- The National Water Model (NWM) utilizes atmosphere and land data to calculate soil moisture/runoff (terrain routing grid) and stream inflows (channel/reservoir grid)
- The NWM is based on WRF-Hydro, which ingests forcing from various data/verification sources and atmosphere models, including the GFS, RAP, and HRRR
- WRF-Hydro works with the existing **Noah-MP LSM**
- We started with 1km/1km routing/land grids and moved to 300m/3km routing/land grids

RRFS-NWM Coupling

- The new RRFS-NWM model follows the United Forecast System (UFS), based on **ESMF/NUOPC's community** modeling infrastructure framework
- All components exchange data via NUOPC Connectors, which regrid data when necessary **RRFS** includes the atmosphere
- and FV3 dynamical core The Common Community Physics Package (CCPP)
- includes many packages including the NoahMP LSM



which is not ideal and may not conserve mass/energy

- Large cold biases over water in the coupled model were identified, and due to improper flags between water and atmosphere
- To address the issues related to bilinear interpolation, we moved from a 1km/1km routing/land grid to a 300m/3km routing/land grid to allow grid redistribution, a superior remapping technique which enables conserving mass/energy and a more direct coupling between model components

- Compare soil moisture, surface T, and latent/sensible fluxes to observations
- Run a longer "real-time demo" time period during spring 2023
- Check in a model version that is available to the community
- Feed insights into RRFS model development
- Submit 1-2 manuscripts on this work

- Complete the 15-20 Jun 2019 test period uncoupled and coupled (v3) runs