H31V-1791: Exploring Hydrothermal impacts of heterogeneous model configuration in the Next Generation Water Resources Modeling Framework

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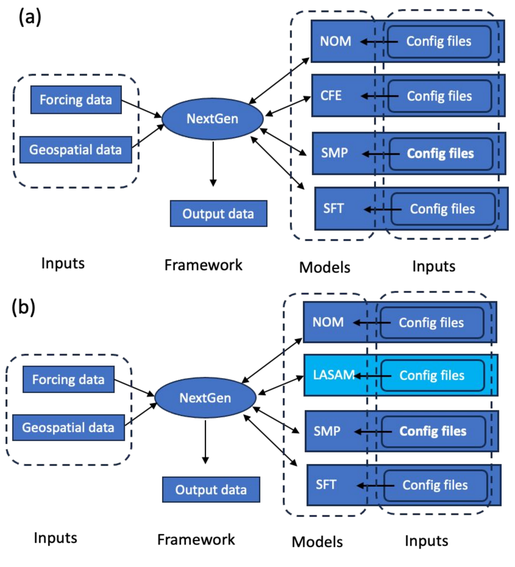
I. Role of Soil Moisture

- The vertical distribution of soil moisture significantly impacts the infiltration capacity of hydrologic models and the heat transport within soil thermal models
- Choosing an approach to simulate soil moisture dynamics holds substantial implications for predicting streamflow and soil moisture availability
- Frozen soils and those with high moisture content prevent vertical water movement, leading to an increased potential for high runoff

II. NextGen Framework

Next Generation Water Resources Modeling Framework (NextGen[1]) is a language- and model-agnostic framework. NextGen allows to use heterogeneous modeling approach (i.e., run a mosaic of surface and subsurface models in a single basin comprised of 10s-100s sub-catchments).

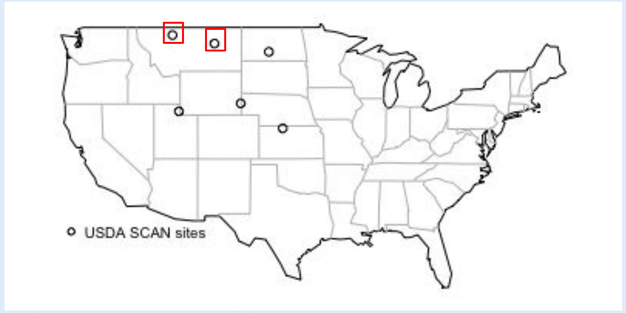


Schematics illustrating the setup of two formulations: hydrologic model CFE[2] (a), and hydrologic model LASAM[3] (b).

Physics-based hydrologic models demonstrate a better representation of soil moisture dynamics compared to conceptual models

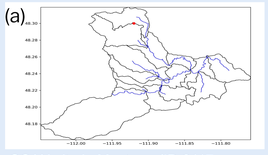
V. Field sites

- USDA SCAN sites for evaluating NextGen formulations against observations
- Arid/semi-arid environment in seasonally frozen regioins



USDA Soil Climate Analysis Network (SCAN)

VI. Results



SCAN site in Montana (ID 2117; HUC12-100302030705)

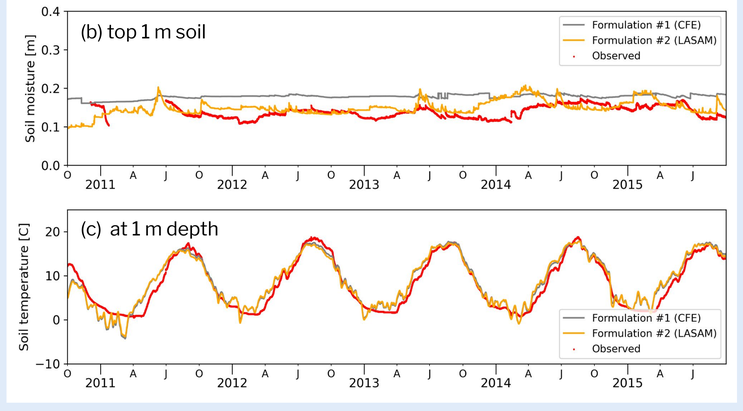
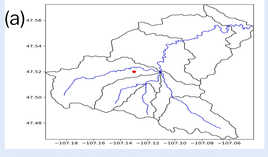


Fig. 1: Observed vs simulated soil moisture (a) and soil temperature (b). LASAM (in yellow) more effectively captures soil moisture dynamics as compared to CFE(in grey).



SCAN site in Montana (ID 2121; HUC12-100401041801)

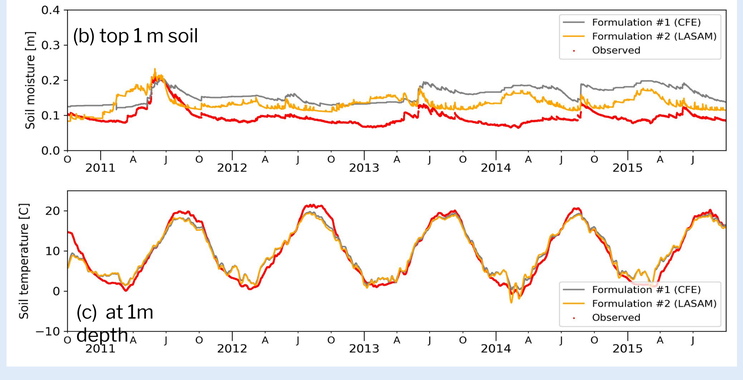
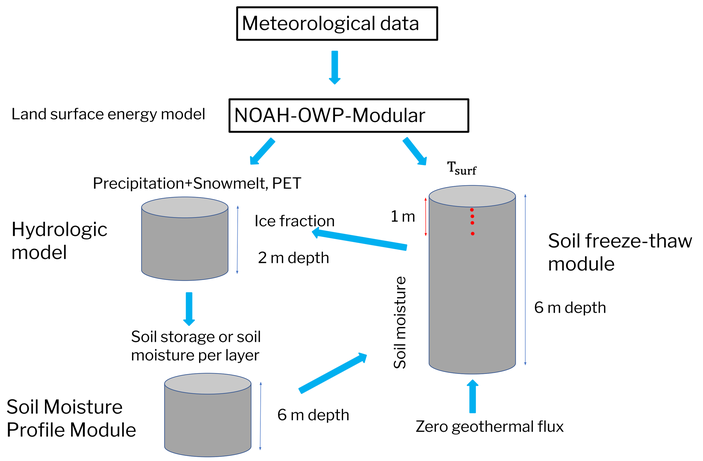


Fig. 2: Observed vs simulated soil moisture (a) and soil temperature (b). LASAM (in yellow) more accurately captures soil moisture dynamics than CFE (in grey).

III) Models



A schematic illustration of of models coupling

The formulations designed here used two distinct hydrologic models:

- **Physics-based hydrologic model:**
  - Model name: Lumped Arid/Semi-Arid Model (LASAM[3])
  - Description: LASAM based on LGAR[4] is a simplified physics-based model developed to simulate infiltration into layered soils and compares well against widely-used Richards' equation, showcasing its effectiveness in capturing hydrologic processes in arid/semi-arid environments
- **Conceptual hydrologic model:**
  - Model name: Conceptual Functional Equivalent (CFE[2])
  - CFE is a simplified conceptual model designed to be functionally equivalent to the NOAA's National Water Model.

IV) Summary

- Evaluated the quality of hydrologic models coupled with soil freeze-thaw and surface models running in the NextGen framework
- Physics-based hydrologic models better represent the evolution of near-surface soil moisture dynamics as compared to conceptual models
- The quality of the results/comparison will improve with systematic calibration, which is not performed here.

REFERENCES:

[1]https://github.com/NOAA-OWP
[2]https://github.com/NOAA-OWP/cfe
[3]https://github.com/NOAA-OWP/LGAR-C
[4]La Follette, P., Ogden, F. L., & Jan, A. (2023). Layered Green and Ampt infiltration with redistribution. *Water Resources Research*, 59, e2022WR033742. https://doi.org/10.1029/2022WR033742

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