CIROH's NextGen Research Lightning Talks

November 28, 2023
2:30-3:30pm CT
Zoom Link:
https://ua-edu.zoom.us/j/82361910524?pwd=NHlWN0lvZjllWXFDYytVZ3piVnU3dz09&from=addon
Passcode: 635066
Meeting ID: 823 6191 0524

1) Sean Trim (sean.trim@usask.ca), University of Saskatchewan, Canada

Title: Integrating SUMMA with NextGen: Refractoring SUMMA to improve modularity and interoperability
Description:
This talk focuses on the recent advances to the NextGen framework as it pertains to the hydrology code SUMMA. This includes steps already accomplished and those currently in progress. Modern object-oriented refactoring techniques in Fortran are highlighted that allow an effective implementation of the BMI standard for use with NextGen.

2) Kyle Klenk (kyle.klenk@usask.ca), University of Saskatchewan, Canada

Title: Use of the Actor Model to Improve Parallelization in the NextGen Framework
Description:
We develop a proof of concept for using the actor model of concurrent programming to improve parallelization, modularity, and fault tolerance in the NextGen framework. Our goal is to optimize the performance and resource usage when computing many basins at once. We demonstrate the actor model's application to SUMMA with results and future directions for further integration into the NextGen framework.

3) Ashley van Beusekom (ashley.vanbeusekom@usask.ca), University of Saskatchewan, Canada

Title: Separation of concerns in hydrologic modeling: The use of industry-standard numerical solvers in the NextGen framework
Description:
This presentation demonstrates capabilities to separate concerns in hydrological modelling such that hydrologists can focus on the model physics and numerical analysts can focus on the solvers. The approach provides modularity by separating physics from numerix: The "physics" modules calculate fluxes and derivates of fluxes w.r.t. relevant state variables, and the "numerix" modules (industry-standard solvers) integrate state variables over a discrete time interval. The approach also provides interoperability in the sense that the numerix modules can be used for multiple process formulations in NextGen. The approach is demonstrated for multi-decadal SUMMA simulations over North America by coupling the SUMMA physics with the

industry-standard SUNDIALS solver. The approach provides a space for the applied math community to evaluate alternative numerical solvers in the NextGen framework.

4) Aniket Gupta (aniiketgupta@arizona.edu), University of Arizona

Title: Improving the NextGen's Predictability of Groundwater Discharge in the Southwestern US under the CFE+Noah-OWP-Modular Configuration

Description:

Recent studies using the operational National Water Model (NWM V2.1) show that streamflow forecasting has a much lower accuracy under arid and semiarid climates including the US Southwest. NOAA's NextGen is an architectural framework, through which the best model (depending upon their performance) can be selected for a specific catchment with maximum flexibility. NextGen provides a configuration, in which Conceptual Functional Equivalent (CFE) model can be coupled to Noah-OWP-Modular. We propose that CFE+Noah-OWP-Modular configuration can be improved with representations of plant hydraulics, surface ponding, and preferential flow under the NextGen framework. We highly recommend adopting the current and future developments of Noah-MP (Noah-OWP-Modular) under NextGen (CFE+Noah-OWP-Modular) to improve the National simulation framework.

5) Mohamed Ismaiel Ahmed (mohamedismaiel.ahmed@ucalgary.ca), University of Calgary, Canada

Title: A model Agnostic Prairie Pothole Module for NextGen Hydrological Modelling Frameworks

Description:

The Hysteretic Depressional Storage (HDS) runoff generation module demonstrates superior performance compared to traditional runoff generation modules in simulating streamflow within a prairie watershed. HDS is a model-agnostic prairie pothole module designed for easy integration into the NextGen frameworks to effectively simulate the streamflows of the complex prairie pothole regions. The forthcoming evaluation of HDS in a CIROH-IJC project will assess its ability to predict streamflow in the Souris, and St. Mary and Milk River basins.

6) Ashley van Beusekom (ashley.vanbeusekom@usask.ca), University of Saskatchewan, Canada

Title: Towards representing glacier dynamics in NextGen

Description:

This presentation will summarize initial progress in developing a model-agnostic representation of glaciers and a strategy to couple the glacier model in NextGen.

7) Patrick J. Clemins (patrick.clemins@uvm.edu), University of Vermont

Title: Using NextGen to Create Ensembles of Hydrology Inputs for Assessment and Impact

Description:

This work is planning to use a hydrology model within the NextGen framework to generate an ensemble of reasonable hydrologic inputs to water quality impact / assessment models. A recently developed 7-day harmful algal bloom forecast for the northern part of Lake Champlain is used as a case study.

8) Ximing Cai (xmcai@illinois.edu), University of Illinois

Title: Incorporating a new reservoir function with rainfall-runoff models
Description:
We demonstrate a key advance in the development of watershed hydrologic models by coupling a recently developed generic reservoir operation model (GDROM) with conceptual rainfall-runoff models. To examine improvements in the model performance obtained via the coupling, we examine the modelled internal fluxes of the watershed model, as well as the watershed outflow which is usually examined by the status-quo approach. In this way, we show how coupling a reasonable reservoir component improves the internal structure and parameterization of a watershed hydrologic model.

9) Josh Sturtevant (joshau_sturtevant@mines.edu), Colorado School of Mines

Title: Experimental Use of the NextGen Water Resources Modeling Framework for Streamflow Prediction in Clear Creek, Colorado
Description:
Recent efforts at the Office of Water Prediction and within the CIROH community have expanded to include the development of auxiliary resources to support the use of NextGen. Many of these data, tools, and workflows were first revealed at the CIROH Developers and Users Conference in May 2023 including, for example, NextGen in a Box. To date, however, there has been limited deployment of these capabilities, despite there being much to learn (for both developers and modelers) from experimental use. Here, we explore the deployment and use of the NextGen Framework for experimental streamflow modeling of Clear Creek near Golden, Colorado. We present the end-to-end development of a CFE model, and its inputs used for near real-time streamflow prediction and discuss the current technical challenges with using NextGen for real-time, over-the-loop forecasting. Lastly, we will highlight how the CIROH Hydrologic Prediction Testbed will be used for benchmarking and evaluating CIROH research efforts for objectives such as streamflow prediction.

10) Arpita Patel (apatel54@ua.edu), The University of Alabama

Title: Community NextGen and Infrastructure Advancements
Description:
We are advancing the community version of the NextGen framework itself and providing infrastructure to execute simulations using the framework.