A Continental Water Model for All | College of Engineering

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USU Hydrologist is part of national team of experts working to improve water modeling tools

News Release — Logan, UT — Feb. 11, 2019 — Understanding the movement and availability of water locally and across the country is of paramount importance to both economic productivity and the human health of the nation.

Decades of hydrology and computer science advances have allowed researchers to simulate U.S. water flow at high resolution on a continental scale for the first time, and a new $3.8 million National Science Foundation project led by Colorado School of Mines and Utah State University aims to put those state-of-the-science hydrologic models into the hands of a much broader audience.

Not only will HydroFrame allow field hydrologists to seamlessly test their own observations against national research and operational models – no software engineering background or supercomputer required – but farmers, city planners, forest managers, teachers and others will also be able to access the best hydrologic information available today through an easy-to-use online portal.

The grant from NSF’s Office of Advanced Cyberinfrastructure brings together computer scientists and hydrologists from seven institutions — Colorado School of Mines, University of Colorado, Boise State University, University of Arizona, Utah State University, the San Diego Supercomputer Center at the University of California San Diego and the Consortium of Universities for the Advancement of Hydrologic Science, known as CUAHSI.

David Tarboton, a USU professor, joins a national team working to improve water modeling tools.

At Utah State University, co-principal investigator David Tarboton is focusing on enabling interoperability between the national community hydrologic modeling framework being developed and HydroShare — a web-based hydrologic information system that allows users to share and publish data and models in a variety of flexible formats and to make information available citable, shareable and discoverable.

Tarboton serves as principal investigator for the development of Hydroshare which is operated by CUAHSI and serves as cyberinfrastructure for the hydrologic research community.

"I am excited to be part of this effort to enable access to advanced modeling capability,” said Tarboton. “I think that the computational modeling functionality that this project developed, when coupled with the HydroShare collaboration data and model repository will revolutionize the questions that researchers can ask with models and the way that they can collaboratively use models to advance understanding of large scale hydrologic systems.”

Forming the HydroFrame research team are experts in hydrologic processes, hydrologic model development, uncertainty quantification, data and workflow management, high-performance computing, performance portability and education and outreach.

A project led by Utah State University and Colorado School of Mines makes hydrologic models accessible to broader audiences.

“Having access to decadal, national-scale simulations is an unprecedented resource for both the hydrologic
community and the much broader community of people working in water-dependent systems, whether that’s biological systems, energy or food production,” said Reed Maxwell, Rowlinson Professor of Hydrology at Mines and principal investigator on the project. “All hydrology builds on itself, and these simulations will enable the community to address research and operational questions about water availability and dynamics from the watershed to continental scale.”

The research team is focusing its efforts on two specific modeling systems. The Weather Research and Forecasting Hydrologic (WRF-Hydro) system, managed by the National Center for Atmospheric Research, can be configured to represent hydrological processes at continental, regional and local scales, depending on the questions being asked and purpose being addressed. It also serves as the basis for the National Water Model, which simulates streamflow over the entire continental U.S. and is run by the National Oceanic and Atmospheric Administration.

The other system, ParFlow, can also be scaled to run at the local, regional or continental scale but uses a more general subsurface flow solution scheme optimized for parallel computing and operates in a research capacity. Both are run on industry-leading science and research supercomputers, the complex systems requiring thousands of cores to operate.

Over the four-year project, researchers plan to both improve access to the models and further improve the models themselves, through additional computer science research as well as additional input from the larger hydrologic community.

“These modeling systems are the best reconstruction of the hydrology of the whole continent over the past decade we have,” Maxwell said. “We’ve already shown proof of concept – now, we want to bring the hydrologic community together and provide seamless access to not only just the results of these simulations but also input into how the simulations could be used in science or even shape how these models work.”

David Tarboton focuses on HydroShare, a web-based hydrologic information system that allows users can share and publish data.

The project also includes a significant educational and community engagement component, led by CUAHSI and Mines’ Integrated GroundWater Modeling Center. Engagement efforts will target both scientific users and K-12 communities. Classroom tools could include teacher portals, pre-packaged videos and educational modules on different hydrologic systems.

In general, three types of users are envisioned for HydroFrame:

1. Non-hydrologists, such as farmers, city planners, flood forecasters and forest managers, who need hydrologic information but aren’t and shouldn’t need to be hydrology experts: An online portal will provide those users with easy-to-access pre-processed datasets that can be visualized and plotted using built-in tools that require no computer science or hydrology background.

2. Hydrologists without computer science expertise: These users will be given greater access to the data, with the ability to ask more specific questions but without having to run the model themselves.

3. Hydrologists already working at the interface with computer science: These power users will be able to directly interact with the hydrologic models and generate simulations on the fly, perhaps by integrating their own watershed-scale models into the platform or testing new modeling ideas and inputs on a continental scale.

The NSF Office of Advanced Cyberinfrastructure supports and coordinates the development, acquisition and provision of state-of-the-art cyberinfrastructure resources, tools and services essential to the advancement and transformation of science and engineering. The award was jointly supported by the Cross-Cutting Activities Program of the Division of Earth Sciences within the NSF Directorate for Geosciences.

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