# Advancing Technology Readiness to Address Climate Risks in the Water Sector

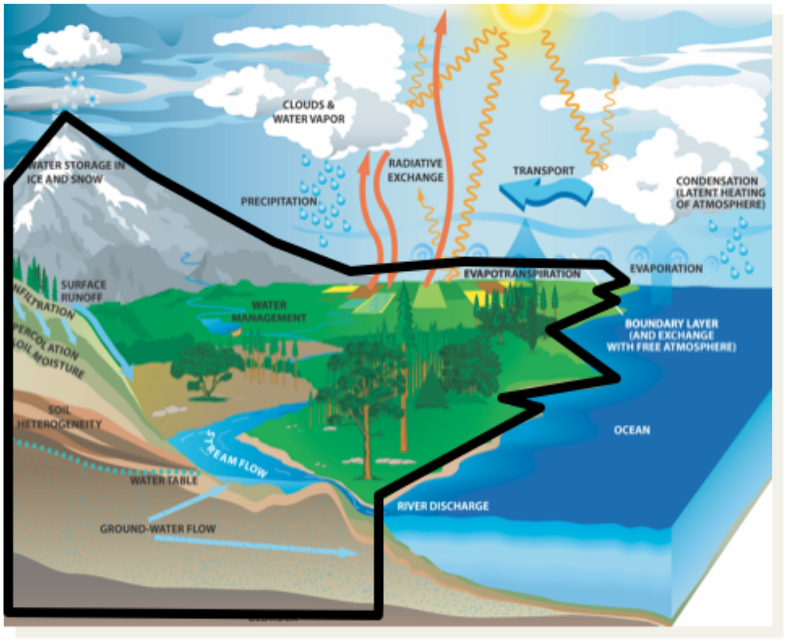
Climate change is altering the amount and timing of water reaching our rivers and streams. To continue to manage systems effectively and minimize risks, water managers and planners conduct climate impact assessments, which use computer models of the atmosphere and the land surface to project future changes, their associated risks to water systems, and to assess opportunities for adaptation. New technologies in climate downscaling and hydrologic modeling are helping to translate changes in global climate to local-scale hydrologic impacts more effectively.

## THE CHALLENGE

The research community has made substantial scientific advances in understanding impacts of climate variability and change on water resource systems; however, the opportunities exist to improve the technical readiness and usability of climate downscaling and hydrologic modeling science to support adaptive water resources planning. The goal of this project is to increase the value of emerging science advances in climate downscaling and hydrologic modeling for water resources planning and management.

## FACING THIS CHALLENGE

Scientists and engineers in RAL's Hydrometeorological Applications Program at the National Center for Atmospheric Research are collaborating with NASA Goddard Space Flight Center and partners at three universities (U. of Washington, U. of Alabama, and U. of Saskatchewan) to develop more computationally efficient tools and data resources for both researchers and practitioners. With funding from NASA's Advanced Information System Technology program, the team is working to increase the readiness of emerging technologies and science through extending capabilities of the NASA Land Information System (LIS). LIS currently provides a software framework for high performance terrestrial hydrology modeling and data assimilation used by interagency partners. This project adds a suite of modeling LIS-compatible tools and datasets that enhance its ability to evaluate future climate change impacts on water systems.

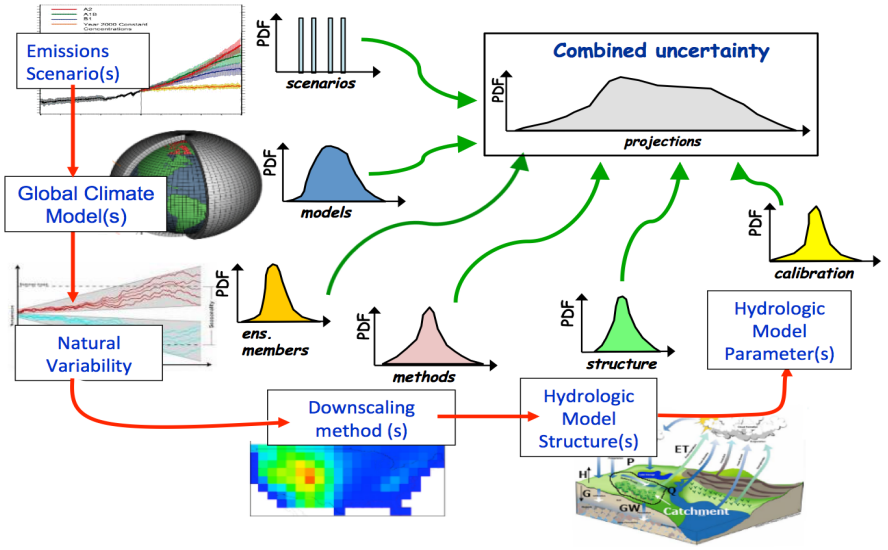



The NASA Land Information System simulates states and fluxes at the land surface (black outline).

## TECHNOLOGY ADVANCES

Specific work elements underway include:

- *Advance climate downscaling tools.* Extend statistical and downscaling techniques of ICAR and GARD to provide climate change scenarios as input to LIS.
- *Extend and refine hydrologic modeling capacities in LIS.* Incorporate a new hydrologic modeling framework, the Structure for Unifying Multiple Modeling Alternatives (SUMMA), the mizuRoute streamflow routing scheme to enable more flexible evaluation of future streamflow.
- *Tailor model output to increase applicability.* Engage practitioners in the water management community throughout the project to design guidance and tools relevant to water planners and managers.




Climate change is occurring globally, but changes are felt locally. This project uses a chain-of-models approach that more efficiently connects models and captures the combined uncertainty throughout the model

- *Employ information theory and machine learning.* Navigate modeling options and guide future investment priorities by applying advanced concepts of information theory and machine learning which leverage process-level tradeoffs, uncertainty decomposition, and network analysis.

## MOVING FORWARD

- Improvements in modeling and workflow tools have improved the reproducibility and transferability of complicated downscaling and land surface modeling and analysis systems.
- Parallelization has enabled simulations to run ~1000 times faster, and improved sub-setting capabilities now support more high-resolution spatial information.
- A new flexible modeling framework will expand applicability of LIS to varied Earth system modeling contexts.
- LIS-compatible future climate inputs and simulations will enhance use of LIS to project future water resources.

## MORE INFORMATION


Clark et al., 2015a: A unified approach for process-based hydrologic modeling: 1. Modeling concept. *Water Resources Research*, **51,** 4, 2498-2514, doi: 10.1002/2015wr017198

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## PROJECT TEAM AND WEBSITE

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