Photo by M. Cosh

MEASURING WHAT MATTERS

AGU HYDROLOGY SECTION NEWSLETTER

JUNE 2025

On the cover:
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AGU's Commitment to Diversity, Equity and Inclusion

Billy Williams & Ashanti Edwards

Overview

As a global, non-partisan scientific organization, AGU has a rich history of advancing ethical and inclusive science and applying it to benefit humanity. Our strategic plan holds diversity as a core AGU value in the pursuit of our mission.

We believe an inclusive science culture strengthens scientific progress, broadens perspectives, and ensures that all voices are heard. Our dedication to inclusive science guides our initiatives, partnerships, and support for scientists at every career stage. As one example of many, AGU integrates these values throughout our publishing processes and practices.

Advancing Diversity, Equity and Inclusion in Practice

AGU's strategic plan centers around three overarching goals that guide all of the organization's work. The second goal is:

Promote and exemplify an inclusive scientific culture

An inclusive scientific culture is essential for addressing the scientific and societal challenges that face our planet and humanity. Welcoming the participation of underrepresented groups is not just an issue of ethics — it produces better research. In the next decade, AGU will continue to support and exemplify a scientific culture where individuals from all backgrounds are equitably included. We will assure that diversity, inclusion, equity, ethics and cultural awareness are sewn into the fabric of all our activities.

To meet this goal, we will:

1. Increase the diversity of the talent pool so that individuals of all backgrounds are equitably included and valued.
2. Lead in defining and promoting the ethics, responsibility and associated competencies required of a scientist in the 21st century.
3. Assure that diversity, inclusion, equity, ethics and cultural awareness are embedded and represented in all AGU programs, honors, governance and operations.
4. Foster an inclusive research, engagement and education culture that supports, recognizes and rewards discovery and solution-based science, including that derived through Indigenous Knowledges.

Contacts: Billy Williams, Executive Vice President, Ethics and Organizational Advancement, bwilliams@agu.org, or Ashanti Edwards, Director, Ethics and Organizational Advancement, aedwards@agu.org.

To be involved with diversity, equity, and inclusion in the Hydrology Section, please contact Sooyeon Yi and Dan Myers of our Justice, Equity, Diversity, and Inclusion committee at aguhydrojedi@gmail.com. The committee meets monthly and is planning conference events and outreach programs.

This issue:

On the cover:

This month's cover shows a SNOTEL site in Utah, monitoring soil moisture and snowpack—an image from M. Cosh of the USDA (p. 8). It reflects this issue's theme: "Measuring What Matters", highlighting how hydrologists decide what to monitor, model, and prioritize—from physical systems to societal purpose.

FELLOW SPEAKS

Li Li 李黎

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Department of Civil and Environmental Engineering, Pennsylvania State University

Dr. 李黎 and team during field work in Coal Creek at Colorado mountains. The picture shows the solidarity of scientists bundling together and the joy of doing science.

Sometimes I marvel at the winding paths our lives take. Amid life's randomness, within the limits of our initial and boundary conditions, what steers us forward? Each of us, wherever and whenever we are, is shaped by pivotal moments with important choices. For me, making the right choices, choices that resonate with what truly excites me amid distracting voices, is vital, because our superpower lies in what love to do.

I remember high school, the moment of choosing between STEM and the humanities. A chorus of voices—some gentle, others insistent—claimed that girls were not good at STEM. Yet I recall that sheer joy of cracking an "impossible" geometry proof, watching every puzzle piece snap into place. I chose to listen to that joy.

I remember college, the moment of weighing pursuing graduate school in the United States. Why leave a comfortable life and move to a distant country with completely different culture and language, people asked. Yet inside me, there was this overwhelming yearning to venture farther, to explore something new, free, and inspiring. I chose to listen to that yearning.

I remember graduate school, the moment of debating whether to switch from experimental to computational work. There were whispers about my lack of computational experience, about the risks of losing financial support and student status. Yet I recall that thrill of being awestruck when watching, for the first time, streams of numbers spilling out from a few lines of painstakingly crafted code—time and space unspooling from abstract equations right in front of my eyes. I chose to listen to that thrill.

Each of us is singular in a cosmic sense. There is not another copy of any of us with our exact genes. Not now. Not in the past. Not in the future. Each of us is an expression of the universe. We all carry our own unique superpowers. No one—not parents, priests, professors, poets, nor philosophers—knows us well enough to prescribe how we shall choose our paths. We must listen, attentively, to ourselves, and choose for ourselves.

An anchored inner voice becomes a necessity in an era of turmoil and chaos, when "political language is designed to make lies sound truthful and murder respectable, and to give an appearance of solidity to pure wind." (Orwell, 1946). A cacophony of voices tells us that we are wrong, that we are not worthy.

We must listen to guard our soul and remember who we are. We are society's truth-seekers: teachers, learners, writers, thinkers. Truth is beauty, wonder, and infinity. It is the light that we turn on in the temporary, finite darkest moments. Over the long, meandering river of human history, it is truth and love that have prevailed, even if not at every turn.

Reference:
George Orwell, 1946. Politics and the English language.

AWARDEE SPEAKS

Katie Mountjoy

McMaster University

Collecting diatom samples along the Beaver River.

One of my research interests that emerged through my thesis work involves diatoms, which are fascinating microscopic algae found almost anywhere there's water, including lakes, rivers, and streams, as well as oceans and even in soils. Most people have probably seen some before without the need for a microscope, as the "slime" often found coated on wet rocks and other submerged surfaces is actually colonies of diatoms.

One of the most remarkable characteristics of diatoms to me is their great innate ability to absorb and sequester carbon dioxide (~20–25% of global carbon fixation), although despite their immense importance in the carbon cycle, many knowledge gaps still exist regarding their photosynthetic processes and which species are most effective at carbon fixation, particularly amongst freshwater diatoms (which maybe isn't so surprising as it's been estimated there could be up to 1 million species of diatoms!). I'm interested in which species are optimal for carbon dioxide absorption and their potential as a nature-based carbon dioxide removal (CDR) solution, which could be an effective mitigation measure to offset climate change.

One of my research interests that emerged through my thesis work involves diatoms, which are fascinating microscopic algae found almost anywhere there's water, including lakes, rivers, and streams, as well as oceans and even in soils.

To explore this avenue of research further, I'm collecting freshwater diatom samples to bring back to the lab in order to explore their photosynthetic processes more closely. As a starting point, I travelled to the shores of Georgian Bay—a section of Lake Huron in the Great Lakes Region—at the foot of the Bruce Peninsula in Ontario, Canada, which is part of the UNESCO Niagara Escarpment Biosphere Reserve noted for its large tracts of pristine, undisturbed land; wide range of habitats that include wetlands, woodlands, oak savannahs, alvars, and coastline; and ample biodiversity.

I also stopped to collect samples along two rivers that feed into the bay, the Sydenham and Beaver rivers, which act as important spawning grounds for fish such as trout and salmon. Fish ladders have been implemented in both rivers to aid in the annual upstream migration of these fish, which travel to the rivers in droves, presumably signifying a very productive food web base and (hopefully!) a great abundance and diversity of diatoms.

I want to thank the AGU Hydrology Section again for making this research experience possible, as it was a great opportunity to get my feet wet (literally!) with new skills and experiences in the hydrological sciences and expand my research depths!

Saving Lives and Livelihoods: Satellite-based Flood Forecasts in South Sudan for Humanitarian Response.

Karyn Tabor, Kim Slinski, Shahriar Pervez, Gideon Galu, Chris Shitote, Amy McNally, Mike Budde, Jim Verdin

South Sudan is one of the most food insecure countries in the world due to a combination of social and environmental factors. Returnees and migrants fleeing neighboring countries with growing political instability and conflict have settled in South Sudan, increasing the number of people vulnerable to weather hazards and food insecurity.

South Sudan has experienced devastating floods in four of the past five years (2019-2023). Above average precipitation in early 2024, a slow recession of flooding during the dry season, and large volumes of water being released from Lake Victoria all raised concerns of another year of extensive flooding in the region. However, the extent and location of inundated areas remained highly uncertain due to the lack of information of flow releases from dams upstream along the Victoria Nile River. The Famine Early Warning Systems Network (FEWS NET) Decision Support Team and United States Agency for International Development (USAID) Disaster Response Team needed to know which areas were likely to flood in the coming months to prepare to relocate refugee camps, if necessary, and allocate humanitarian assistance.

Generating an accurate forecast is challenging in data poor regions of the world such as South Sudan where in-situ weather station data is limited and unreliable, and there is a scarcity of reliable field data to validate satellite imagery.

Fortunately, an increasing number of satellites are available from the US and European space agencies to improve the accuracy of forecast models. FEWS NET scientists from National Aeronautics and Space Administration (NASA) Goddard Space Flight Center (GSFC) and U.S. Geological Survey (USGS) Earth Resources Observation and Science (EROS) Center built a model to meet the needs of the international Technical Working Group supporting the United Nations Office for the Coordination of Humanitarian Affairs (UN OCHA).

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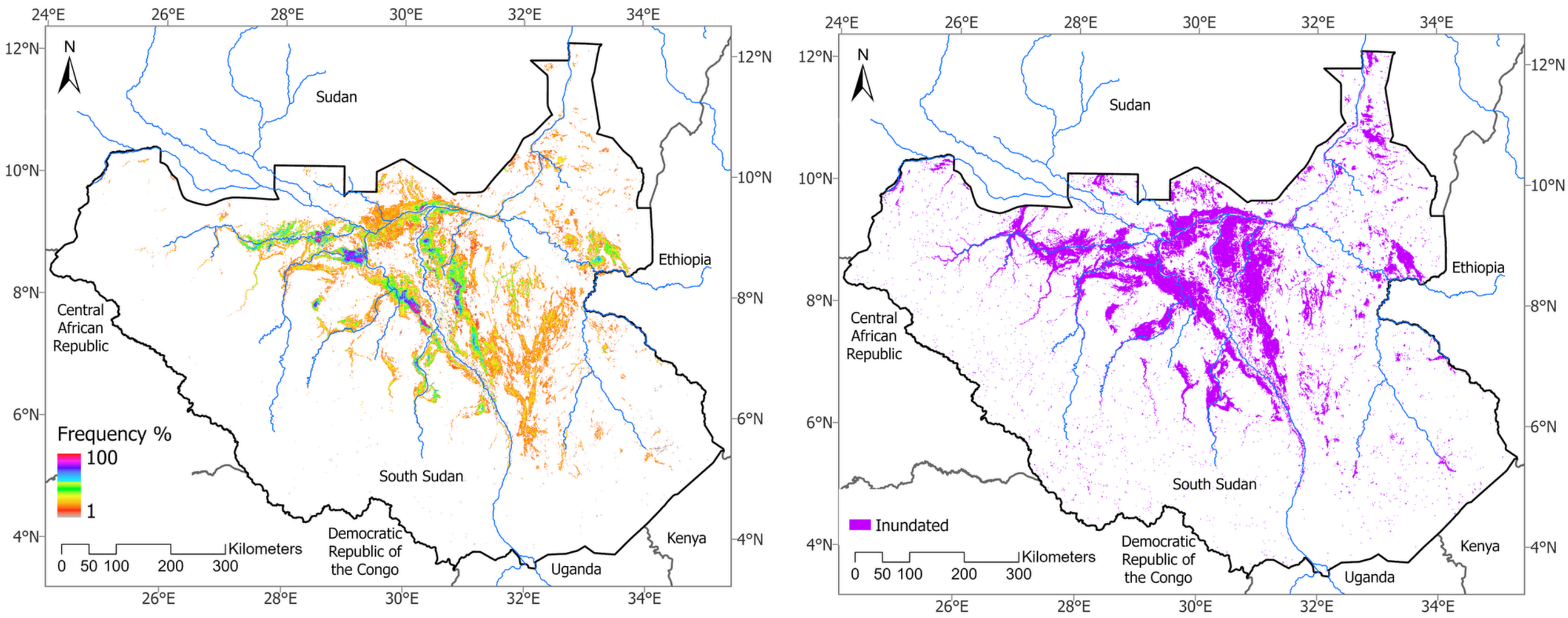


Figure 1: Left panel: map of predicted flooding (72,882 km^2 based on 2020 analog year) for September of 2024 with April initial conditions shown with historical frequency of flooding for each pixel. Right panel: shows the map of observed flooding (72,515 km^2) in September of 2024 from Visible Infrared Imaging Radiometer Suite flood product.

FEWS NET scientists relied on the Visible Infrared Imaging Radiometer Suite (VIIRS), Climate Hazards Group InfraRed Precipitation with Station (CHIRPS), Landsat, hydrological model forecasts (FEWS NET Land Data Assimilation System-forecasts), and radar altimetry data to rapidly develop a 3–6-month statistical forecast model of the spatial likelihood of inundation using historical frequency of inundation derived from VIIRS flood products. By June 2024, the team accurately forecasted a September inundation area of 73,000 km^2, predicting that approximately 11,000 hectares of cropland and 830,000 people would be vulnerable to flooding. The working group, in turn, advised the South Sudan Flood Preparedness and Response Taskforce, co-led by the Ministry of Humanitarian Affairs and OCHA.

The USAID Juba office saved time and money by avoiding costly relocations for the refugees and mission staff in Juba. Furthermore, informed by FEWS NET's independent assessment of food insecurity, the U.S. government delivered $600 million USD in humanitarian assistance to help the estimated 65-70 percent of the population of South Sudan increase their coping capacity in the face of continued economic crises, violence, and natural hazards.

Challenges in Unifying Physically Based and Machine Learning Simulations

Shahryar K. Ahmad, Sujay V. Kumar, Clara Draper, Rolf H. Reichle

This study provides a critical look at the promise of machine learning (ML) to improve land surface models (LSMs) using satellite data. We examined the deep learning (DL)-driven differentiable parameter learning (dPL) framework for its ability to generalize calibration of the Noah-MP LSM using SMAP soil moisture observations. The DL-optimized parameters led to only modest improvements in soil moisture estimates compared to the original Noah-MP model, and introduced large positive biases in the drier regions of the western US. Performance was significantly worse than with the traditional genetic algorithm (GNA)-based optimization (Figure 1a-c).

We also found that non-physical scaling and bias correction factors —often used to make ML models more general—were preferentially learned by the dPL over the physical parameters, limiting the ability to transfer the optimized parameters to the land model. However, simulation of dPL over a more uniform soil moisture regime of western US improved its predictability, yielding 48% lower bias compared to the simulation over the entire CONUS (Figure 1d-f).

We thus present a framework to explore the limits of DL emulators and potential pitfalls in their implementation for modeling land surface states. A key challenge we highlight is a core for the differentiable modeling paradigm in remote sensing hydrology: integrating satellite data into data-based models in a way that enhances—rather than overrides—underlying physical processes. Addressing these challenges is essential to advancing ML-based calibration frameworks that can better learn and represent the constraints of physical models.

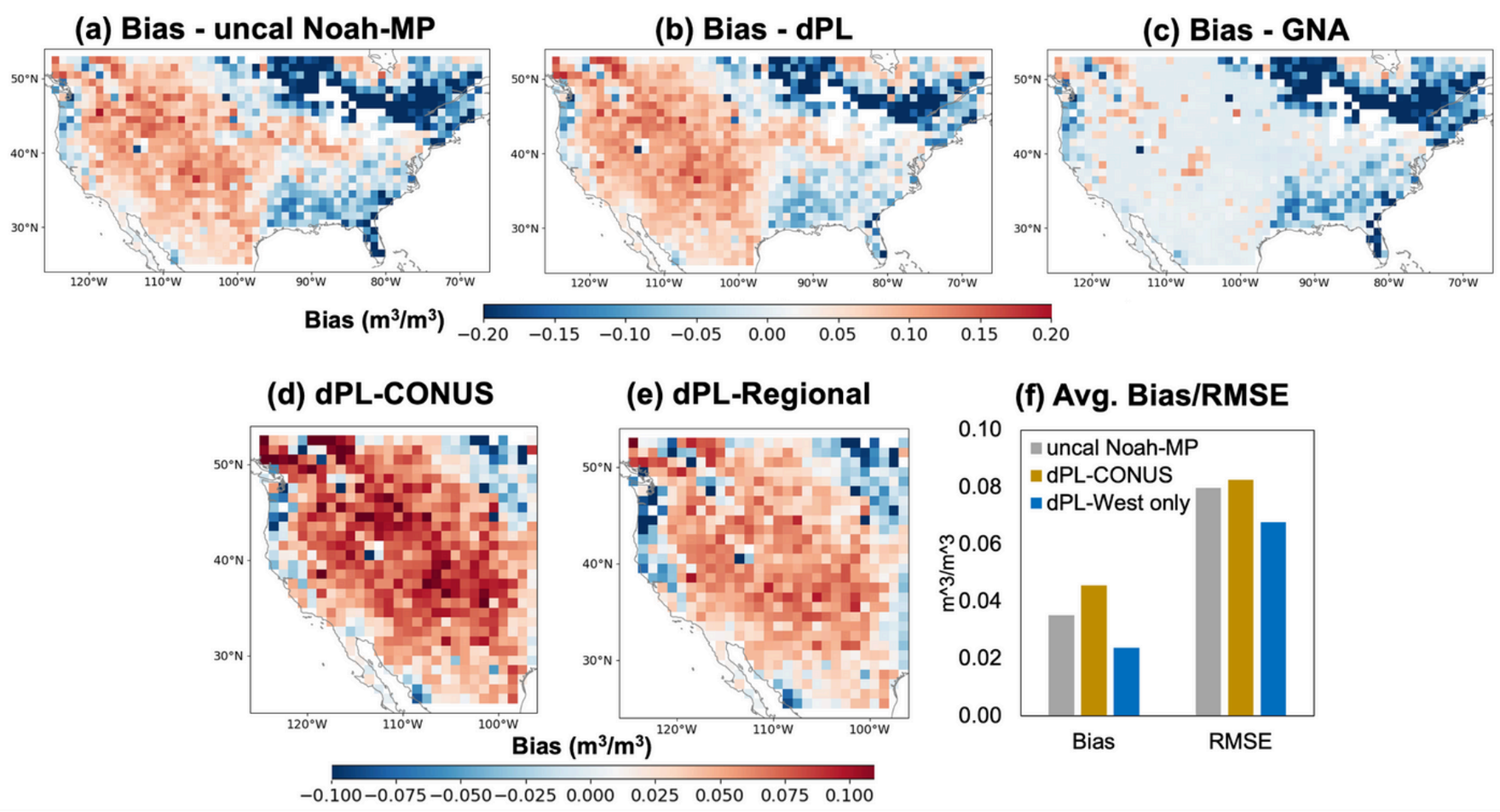


Figure 1. Time-averaged bias of soil moisture (m3/m3) from Noah-MP using (a) uncalibrated, (b) dPL-optimized, & (c) GNA-optimized Noah-MP parameters. Metrics are computed against SMAP observations. Bottom panel shows comparison of the bias using dPL-optimized parameters over (d) the entire CONUS & (e) the western-CONUS only domains. (f) Western CONUS averages of timeseries bias & RMSE.

Reference: Ahmad, SK, et al. 2025. Challenges in Unifying Physically Based and Machine Learning Simulations Through Differentiable Modeling: A Land Surface Case Study.Geophys. Res. Lett., 52(4), e2024GL112893. https://doi.org/10.1029/2024GL112893

TECHNICAL COMMITTEE

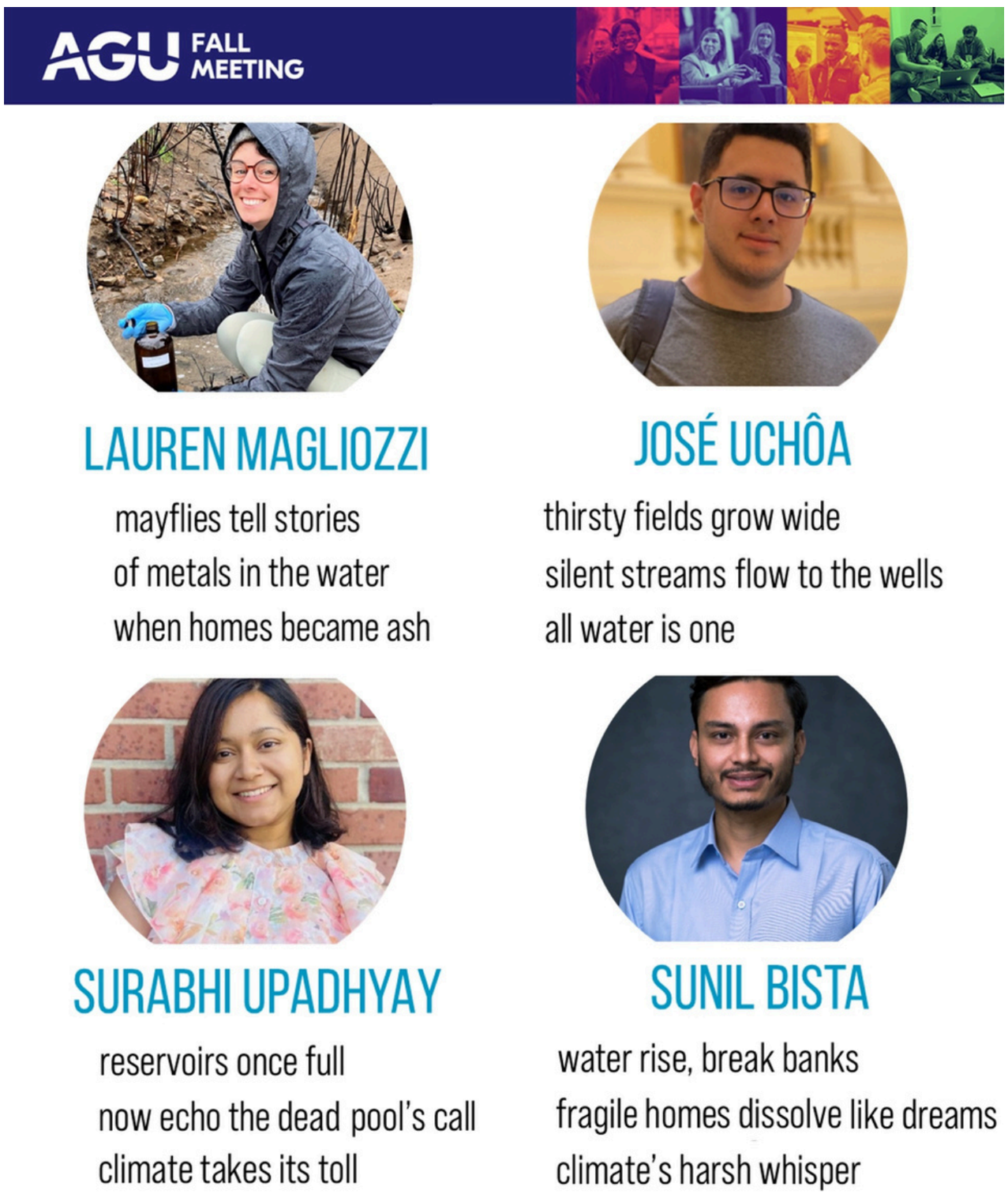
Water Quality

Emine Fidan, Frederick Cheng, Sushant Mehan

The AGU Water Quality Technical Committee continues to promote research and engagement that deepens our understanding of water quality and its critical links to environmental and societal health. As we build momentum toward the 2025 Annual Meeting (AGU25), we are excited to reflect on recent highlights.

Congratulations to our 2024 #HaikuYourResearch Award Winners

The annual #HaikuYourResearch competition once again showcased the creativity and insight of early career researchers. This year, we received 17 submissions that distilled complex water quality research into poetic form. We extend our warmest congratulations to this year's award winners: Lauren Magliozzi, José Uchôa, Surabhi Upadhyay, and Sunil Bista. Their compelling haikus brought clarity and imagination to the science of water quality.



Check out past #HaikuYourResearch winners on our website!

Recognizing Excellence in Hydrology

We are thrilled to celebrate Kim Van Meter, the 2024 recipient of the AGU Hydrologic Sciences Early Career Award. Her research on the legacies of human activities on water quality exemplifies innovation and dedication in the field of hydrologic science—congratulations, Kim!

Looking Ahead to AGU25

The committee is pleased to continue several of our longstanding and well-attended technical sessions at AGU24, including:

- Frontiers in Water Quality Science
- Water Quality and Watersheds: From Scientific Innovations to Actions
- Advancements in Watershed Modeling to Support Water Management
- Undergraduate Research on Water Quality and Resources

These sessions consistently highlight exciting developments and foster cross-disciplinary dialogue within the AGU community.

Stay Connected

Visit our website for updates, resources, and opportunities to engage with our community.

We look forward to seeing you in New Orleans this December!

SISTER ORGANIZATION

U.S. Department of Agriculture

Michael Cosh, USDA-ARS-Hydrology and Remote Sensing Laboratory

There are many intersections between hydrology and agriculture. The United States Department of Agriculture has many programs and projects with seek to document the value and importance of hydrologic information.

Image: A SNOTEL site in Utah, monitoring soil moisture and snowpack. Photo by M. Cosh.

The Natural Resources Conservation Service Soil Climate Analysis Network (SCAN) has its ancestry back the early 1990's when it initiated the Soil Moisture/Soil Temperature Pilot project to start monitoring soil moisture and temperature nationally in a single platform. In addition, the SNOTEL (Snow Telemetry) network monitors snowpack and soil moisture across the western states to support water supply forecasting.

The U.S. Forest Service is one of the largest federal land holders in the U.S. with large tracts of forest and rangelands. Water status for this land is crucial to measure as it directly informs wildland fire risk. Monitoring and estimation of fuel moisture, including consideration of soil moisture and drought, help inform the National Fire Danger Rating System.

The National Agricultural Statistical Service in coordination with NASA Goddard Space Flight Center and George Mason University operate the Crop-CASMA (Crop Condition and Soil Moisture Analytics) geospatial portal which produces and archives crop and soil moisture products, including a 1km soil moisture product which informs farmers and operators about the available soil moisture for crop decision making.

The Global Reservoirs and Lakes Monitor (G-REALM), operated by the Foreign Agricultural Service, provides near real time products for water supply from large fresh water bodies, which is critical to understanding agricultural water availability. This effort seeks to understand water usage and availability around the world, as it impacts food security.

Lastly, the Agricultural Research Service has several national programs which are centered on water quantity and quality like soil water availability, water modeling, surface water management, and precision agriculture. A recent effort is the Long-Term Agroecosystem Research Network which is a coordination of nineteen locations and watersheds across the U.S., seeking to understand the impacts of management practices on long term agricultural landscapes.

Image: Irrigation of a corn field on the Eastern Shore of Maryland. Many agricultural fields depend on irrigation to provide sufficient water. Photo by M. Cosh.

Community Resources

Unlock powerful resources to help you grow in your career

Take full advantage of tools and opportunities designed specifically to support your professional growth—don't miss out!

- AGU Career Guidance: virtual advice from those who understand career struggles.
- Resource Guides:
  - Careers in Geosciences Resource Guide
  - Graduate School Resource Guide
- AGU Weekly eNewsletter: delivered to your inbox every Thursday!

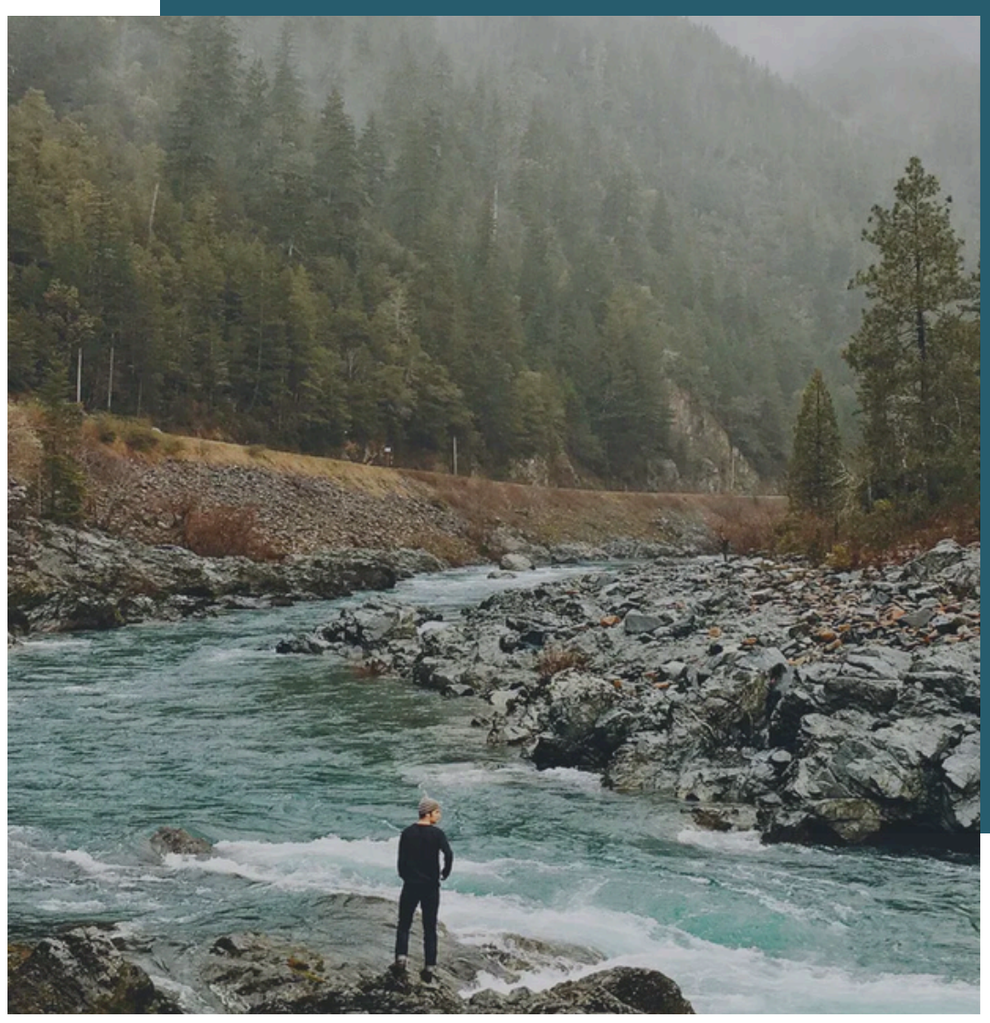
Impacted AGU Member Support Community

AGU has set up a community on AGU Connect for members impacted by job and funding losses. Please share this with your Section members. Participants can use this forum to share information and resources with one another. Our global community is dedicated to advancing discovery in Earth and space sciences for the benefit of humanity and the environment-and we do that best by lifting up one another. You may also want to add this information to your Section newsletters or other modes of communication. If you have any questions, please reach out to AGU's Section Support Team (agu-SectionHelp@agu.org).

Open Channel

Email:

agu.hydro.news@gmail.com



CALL FOR CONTRIBUTORS: SCIENCE TO SOLUTIONS

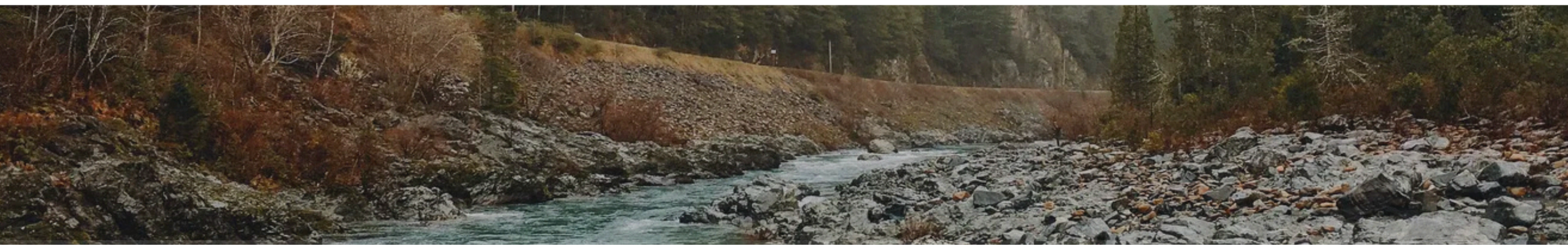
Have a story of hydrology making real-world impact? We're seeking contributions that connect science with policy, practice, and community—through citizen science, interdisciplinary work, communication, and more. Nominate yourself or a colleague to share meaningful work, inspire others, and help bridge hydrology and solutions.

Submit your nominations: agu.hydro.news@gmail.com.

ANONYMOUS COMMENT JAR

Favorite part of this issue? Thoughts on future issues? Nominations for contributions?

Drop your comments in the jar (HERE)—anonymously if you prefer.



Community Links

AGU Hydrology Section

Website: connect.agu.org/hydrology
BlueSky: @hydrology-agu.bsky.social
X: @Hydrology_AGU

Technical Committee Links

HYDROLOGY SECTION JUSTICE, EQUITY, DIVERSITY, AND INCLUSION (JEDI) COMMITTEE

Website: connect.agu.org/hydrology/about/tc-committees/hydrojedi

HYDROLOGY SECTION STUDENT SUBCOMMITTEE (H3S)

Website: agu-h3s.org
X: @AGU_H3S
LinkedIn: @american-geophysical-union-hydrology-section-student-subcommittee-h3s

PRECIPITATION

Website: connect.agu.org/hydrology/about/tc-committees/pretech
Facebook: AGU Precipitation
X: @AGUPrecip
Instagram: @AGU_precipitation
Linkedin: AGU Precipitation

UNSATURATED ZONE

Website: connect.agu.org/hydrology/about/tc-committees/unsat
X: @UnsatHydro

SOIL PROCESSES AND CRITICAL ZONE

Website: connect.agu.org/biogeosciences/tc-committees/soils-spcztc

ECOHYDROLOGY

Website: connect.agu.org/hydrology/about/tc-committees/ecohydrologymain
X: @AGUecohydro

REMOTE SENSING

Website: connect.agu.org/hydrology/about/tc-committees/remote-sensing
LinkedIn: AGU Hydrology Section's Remote Sensing Technical Committee group

GROUNDWATER

Website: connect.agu.org/hydrology/about/tc-committees/groundwater
X: @AGU_GWHydro

CATCHMENT HYDROLOGY

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