ANDREW BENNETT

CONTACT
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EDUCATION

University of Washington   Sept. 2016 - Mar. 2021
Ph.D. - Department of Civil and Environmental Engineering
Hydrology and hydrodynamics, Advisor: Bart Nijssen
Dissertation: Applications of information theory and machine learning for hydrologic modeling

University of Wisconsin, La Crosse   Sept. 2008 - May 2013
Bachelor of Science - Physics and Mathematics

PROFESSIONAL
EXPERIENCE

University of Arizona   Sept. 2021 - Present
Postdoctoral Research Associate - Department of Hydrology and Atmospheric Sciences

University of Washington   Apr. 2021 - Sept. 2021
Research Scientist - Department of Civil and Environmental Engineering

Oak Ridge National Laboratory   Oct. 2013 to Aug. 2016
Research Associate - Computer Science and Mathematics Division

University of Wisconsin, La Crosse   Jan. 2012 to May 2013.
Physics Tutor

STUDENT
MENTORING

Peter Sumner JISAO Summer Intern   Summer 2017
Project: Google Earth Analysis of Soil Moisture
          and Landslide Risk in the Pacific Northwest

Tushar Khurana Undergraduate Research Assistant   Fall 2018
Project: Information Theoretic Analysis of Hydrological Land Surface Models

Adi Stein Undergraduate Research Assistant   Spring 2019- Summer 2021
Project: Developing spatially-consistent and process-aware
          bias-correction methods for streamflow simulations

TEACHING

Instructor University of Arizona HWRS 401/501   Fall 2022
Tools for Data Handling and Analysis in Water, Weather, & Climate

Guest lecturer University of Saskatchewan GEOG 825   Winter 2022
Process Based Modeling

Guest lecturer University of Saskatchewan GEOG 825   Fall 2020
Meteorologic Forcing Data

Excercise development CUAHSI Virtual Snow Modeling   Fall 2019
Snow modeling with SUMMA

SEMINARS

Workshop speaker Knowledge Guided Machine Learning Workshop   Summer 2021
Embedding neural networks to simulate turbulent heat

fluxes in a process-based hydrologic modeling framework

Seminar University of Arizona TRIPODS Seminar — **Spring 2021**
Embedding neural networks into physics-based hydrologic models

Seminar University of Washington Data Science Seminar — **Winter 2020**
Embedding neural networks into large Earth systems models

Public speaker Puget Sound Programming Python Meetup — **Winter 2019**
Algorithms, information and the environment

Workshop instructor WaterHackWeek — **Spring 2019**
MetSim: A python library for meteorological data simulation

AWARDS & HONORS	**Bureau of Reclamation Science and Technology Project of the year**: Developing process-based and spatially consistent approaches for correcting streamflow biases in watershed hydrology simulations	**2022**
	WRR Editors' Choice Award: Deep Learned Process Parameterizations Provide Better Representations of Turbulent Heat Fluxes in Hydrologic Models	**2021**
	AGU Outstanding Student Presentation Award A coupled approach to incorporating deep learning into process-based hydrologic modeling	**2020**
	EGU Outstanding Student Poster and Pico Award A process network based approach to model intercomparison using SUMMA ensembles	**2019**
	COMAP Mathematical Contest in Modeling Honorable Mention	**2013**

<table>
<tr><td>SERVICE</td><td>Session Convener
Frontiers in Hydrology Meeting: "Emphasizing F, I and R in FAIR hydrology: Bottlenecks and solutions to making hydrologic science more reproducible"</td><td>June 2022</td></tr>
<tr><td></td><td>Poster Judge
University of Arizona - El Dia de la Agua y la Atmosphera</td><td>March 2022</td></tr>
<tr><td></td><td>Travel Grant Committee
Pennsylvania State University - HydroML Symposium</td><td>March 2022</td></tr>
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Reviewer

- Earth and Space Science
- Geophysical Research Letters
- Hydrologic Processes
- Hydrologic & Earth Systems Science
- Journal of Hydrology
- Journal of Advances in Modeling Earth Systems
- Journal of Open Source Software
- Stochastic Environmental Research and Risk Assessment
- Water Resources Resources

SOFTWARE & TECHNICAL SKILLS	**Programming Languages:** Bash, C, Fortran, Python, Java, Javascript, Julia, R, LaTeX
	Technologies: git, NetCDF, HPC systems, Python packaging (pypi, conda), automake, pytorch, tensorflow

Open Source Development Experience:
- **SUMMA**: https://github.com/NCAR/summa
- **pysumma**: https://github.com/UW-Hydro/pysumma
- **bmorph**: https://github.com/UW-Hydro/bmorph
- **MetSim**: https://github.com/UW-Hydro/MetSim
- **ParFlow**: https://github.com/parflow/parflow
- **LIVVkit**: https://github.com/LIVVkit/LIVVkit
- **Eclipse ICE**: https://gitlab.eclipse.org/eclipse/ice/ice

EXTERNAL
FUNDING

in review **Climate Change AI Innovations Grant** March 2023
Lead PI: AI for Open Source Risk Assessment: Globally Synchronous Climate Disasters
Total award: $150,000

in review **NOAA Weather Prediction Office** November 2022
PI: Advancing UFS Forecast Model Evaluation and Improvement for S2S Hydrometeorological Prediction
in the Western States
Total award: $989,000

ESIP - Machine Learning Tutorial August 2022
Lead PI: High resolution predictions of global snow using recurrent neural networks
Total award: $5,000

BOOK CHAPTERS
& MONOGRAPHS

Bennett, Andrew. "AI for Physics-inspired Hydrology Modeling". *Earth Science Artificial Intelligence*,
edited by Ziheng Sun, Nicoleta Cristea, and Pablo Rivas, Accepted, Elsevier, 2022, chapter 12.

PEER-REVIEWED
PUBLICATIONS

Maghami, I., A. van Beusekom, Hay L., Li Z., **Bennett, A.**, Y. Choi, Nijssen B., D. Tarboten, and
Goodall J.L. "Building Cyberinfrastructure for the Reuse and Reproducibility of Complex Hydrologic
Modeling Studies". *Environmental Modelling & Software*, 2022, in review.

Hull, R., E. Leonarduzzi, L. De La Fuente, H. V. Tran, **Bennett, A.**, P. Melchior, R. M. Maxwell, and L. E.
Condon. "Using simulation-based inference to determine the parameters of an integrated hydrologic model:
a case study from the upper Colorado River basin". *Hydrology and Earth System Sciences Discussions*,
2022, pp. 1–38. https://doi.org/10.5194/hess-2022-345.

Bennett, Andrew and Bart Nijssen. "Explainable AI uncovers how neural networks learn to regionalize
in simulations of turbulent heat fluxes at FluxNet sites". *Water Resources Research*, 2022, in revision.

Knoben, W. J. M., M. P. Clark, J. Bales, **Bennett, A.**, S. Gharari, et al. "Community Workflows to
Advance Reproducibility in Hydrologic Modeling: Separating model-agnostic and model-specific configu-
ration steps in applications of large-domain hydrologic models". *Water Resources Research*, vol. n/a, n/a,
e2021WR031753 2021WR031753, e2021WR031753. *https://agupubs.onlinelibrary.wiley.com/doi/pdf/10.1029/2021*
https://doi.org/https://doi.org/10.1029/2021WR031753.

Cristea, Nicoleta C., **Bennett, Andrew**, Bart Nijssen, and Jessica D. Lundquist. "When and where are
multiple snow layers important for simulations of snow accumulation and melt?" *Water Resources Research*,
vol. n/a, n/a, e2020WR028993. *https://agupubs.onlinelibrary.wiley.com/doi/pdf/10.1029/2020WR028993*,
https://doi.org/https://doi.org/10.1029/2020WR028993.

Lumbrazo, Cassie, **Andrew Bennett**, William Currier, Bart Nijssen, and Jessica Lundquist. "Evalu-
ating Multiple Canopy-Snow Unloading Parameterizations in SUMMA With Time-Lapse Photography
Characterized by Citizen Scientists". *Water Resources Research*, vol. 58, no. 6, 2022, e2021WR030852.
https://doi.org/https://doi.org/10.1029/2021WR030852.

Bennett, Andrew, Adi Stein, Yifan Cheng, Bart Nijssen, and Marketa McGuire. "A process-conditioned and spatially consistent method for reducing systematic biases in modeled streamflow". *Journal of Hydrometeorology*, 2022. https://doi.org/10.1175/JHM-D-21-0174.1.

Beusekom, Ashley E. Van, Lauren E. Hay, **Andrew R. Bennett**, Young-Don Choi, Martyn P. Clark, Jon L. Goodall, Zhiyu Li, Iman Maghami, Bart Nijssen, and Andrew W. Wood. "Hydrologic Model Sensitivity to Temporal Aggregation of Meteorological Forcing Data: a Case Study for the Contiguous USA". *Journal of Hydrometeorology*, 2021. https://doi.org/10.1175/JHM-D-21-0111.1.

Bennett, Andrew and Bart Nijssen. "Deep Learned Process Parameterizations Provide Better Representations of Turbulent Heat Fluxes in Hydrologic Models". *Water Resources Research*, vol. 57, no. 5, 2021. https://doi.org/https://doi.org/10.1029/2020WR029328.

Clark, Martyn P., Reza Zolfaghari, Kevin R. Green, Sean Trim, Wouter J. M. Knoben, **Andrew Bennett**, Bart Nijssen, Andrew Ireson, and Raymond J. Spiteri. "The numerical implementation of land models: Problem formulation and laugh tests". *Journal of Hydrometeorology*, 2021. https://doi.org/10.1175/JHM-D-20-0175.1.

Choi, Young-Don, Jonathan L. Goodall, Jeffrey M. Sadler, Anthony M. Castronova, **Andrew Bennett**, et al. "Toward Open and Reproducible Environmental Modeling by Integrating Online Data Repositories, Computational Environments, and Model Application Programming Interfaces". *Environmental Modelling & Software*, 2020.

Nearing, Grey S, Benjamin L Ruddell, **Andrew R Bennett**, Cristina Prieto, and Hoshin V Gupta. "Does Information Theory Provide a New Paradigm for Earth Science? Hypothesis Testing". *Water Resources Research*, vol. 56, no. 2, 2020.

Bennett, Andrew R., Joseph J. Hamman, and Bart Nijssen. "MetSim: A Python package for estimation and disaggregation of meteorological data". *Journal of Open Source Software*, vol. 5, no. 47, 2020. https://doi.org/10.21105/joss.02042.

Lipscomb, William H, Stephen F Price, Matthew J Hoffman, Gunter R Leguy, **Andrew R Bennett**, Sarah L Bradley, Katherine J Evans, Jeremy G Fyke, Joseph H Kennedy, Mauro Perego, et al. "Description and evaluation of the Community Ice Sheet Model (CISM) v2. 1". *Geoscientific Model Development*, vol. 12, no. 1, 2019.

Bennett, Andrew, Bart Nijssen, Gengxin Ou, Martyn Clark, and Grey Nearing. "Quantifying Process Connectivity With Transfer Entropy in Hydrologic Models". *Water Resources Research*, vol. 55, no. 6, 2019. https://doi.org/10.1029/2018WR024555.

Evans, Katherine J, Joseph H Kennedy, Dan Lu, Mary M Forrester, Stephen Price, Jeremy Fyke, **Andrew R Bennett**, Matthew J Hoffman, Irina Tezaur, Charles S Zender, et al. "LIVVkit 2.1: automated and extensible ice sheet model validation". *Geoscientific Model Development*, vol. 12, no. 3, 2019.

Billings, Jay Jay, **Andrew R Bennett**, Jordan Deyton, Kasper Gammeltoft, Jonah Graham, Dasha Gorin, Hari Krishnan, Menghan Li, Alexander J McCaskey, Taylor Patterson, et al. "The eclipse integrated computational environment". *SoftwareX*, vol. 7, 2018.

Kennedy, Joseph H, **Andrew R Bennett**, Katherine J Evans, Stephen Price, Matthew Hoffman, William H Lipscomb, Jeremy Fyke, Lauren Vargo, Adrianna Boghozian, Matthew Norman, et al. "LIVVkit: An extensible, python-based, land ice verification and validation toolkit for ice sheet models". *Journal of Advances in Modeling Earth Systems*, vol. 9, no. 2, 2017.

Selected
conference
presentations

Bennett, A., B. Horowitz, E. Leonarduzzi, H. Tran, L. Condon, P. Melchior, and R. Maxwell. "Surrogate modeling of the hydrologic cycle to advance on-demand seasonal prediction capabilities across the Continental United States". *AGU Frontiers in Hydrology Meeting*. 2022.

Bennett, A. and B. Nijssen. "Informing Machine Learning Models with Hydrologic Theory: A Case Study in Land-Atmosphere Interactions". *AGU Fall Meeting.* 2021.

Bennett, A., M. Bassiouni, and B. Nijssen. "Searching for new physics: Using explainable AI to understand deep learned parameterizations of turbulent heat fluxes". *AGU Fall Meeting.* 2021.

Bennett, A. and B. Nijssen. "Searching for new physics: Using explainable AI to understand deep learned parameterizations of turbulent heat fluxes". *EGU General Assembly.* 2021, https://doi.org/https://doi.org/10.5194/egusphere-egu21-3516.

Bennett, A. and B. Nijssen. "A coupled approach to incorporating deep learning into process-based hydrologic modeling". *AGU Fall Meeting 2020.* 2020, https://doi.org/https://doi.org/10.1002/essoar.10504849.1.

Bennett, A. and B. Nijssen. "Hard to measure, hard to model: Using information theory to understand turbulent heat fluxes (invited)". *EGU General Assembly 2020.* 2020, https://doi.org/https://doi.org/10.5194/egusphere-egu2020-5957.

Bennett, A., B. Nijssen, Y. Cheng, A. Stein, and M. McGuire. "Post-processing Hydrologic Model Output for Water Resources Studies: A Spatially-consistent, Process-based Correction Method". *EGU General Assembly 2020.* 2020, https://doi.org/https://doi.org/10.5194/egusphere-egu2020-6036.

Bennett, A., J. Lundquist, J. Hamman, and B. Nijssen. "Leveraging Open Source Platforms to Foster Computational Thinking". *University of Washington Teaching and Learning Symposium.* 2020.

Bennett, Andrew, B. Nijssen, and G.S. Nearing. "Dynamic process connectivity for model diagnostics, evaluation, and intercomparison". *AGU Fall Meeting.* 2019.

Bennett, A., B. Nijssen, G.S. Nearing, and M.P. Clark. "A process network based approach to model intercomparison using SUMMA ensembles". *EGU General Assembly.* 2019.

Bennett, A., B. Nijssen, G.S. Nearing, and M.P. Clark. "Information theoretic fingerprinting of hydrologic Models". *AGU Fall Meeting.* 2018.

Bennett, A., B. Nijssen, and M.P. Clark. "Fingerprinting hydrologic models by identifying coupling structures". *SIAM Mathematics of Planet Earth.* Invited talk, 2018, Invited talk.

Bennett, A., B. Nijssen, O. Chegwidden, A. Wood, and M.P. Clark. "What Makes Hydrologic Models Differ? Using SUMMA to Systematically Explore Model Uncertainty and Error". *AGU Fall Meeting.* 2017.