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 Experience & Public lectures

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

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

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

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

Awards & Honors

AGU Outstanding Student Presentation Award **2020**
EGU Outstanding Student Poster and Pico Award **2019**
COMAP Mathematical Contest in Modeling Honorable Mention **2013**

Service

Reviewer

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

Software & Technical Skills

Programming Languages:
Bash, Fortran, Python, Java, Javascript, Julia, R, LaTeX

Technologies:
git, NetCDF, HPC systems, Python packaging (pypi, conda), automake, pytorch, tensorflow

Model 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
- **LIVVkit**: https://github.com/LIVVkit/LIVVkit
- **Eclipse ICE**: https://gitlab.eclipse.org/eclipse/ice/ice

Publications

Knoben, Wouter Johannes Maria, Martyn P. Clark, Jerad Bales, **Bennett, Andrew**, S. Gharari, et al. "Community Workflows to Advance Reproducibility in Hydrologic Modeling:nbsp; Separating model-agnostic and model-specific configuration steps in applications of large-domain hydrologic models". *Earth and Space Science Open Archive* (2021): 42. <https://doi.org/10.1002/essoar.10509195.1>.

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* in revision (2021).

Lumbrazo, Cassie, **Andrew Bennett**, William Currier, Bart Nijssen, and Jessica Lundquist. "Evaluating multiple canopy-snow unloading parameterizations in SUMMA with time-lapse photography characterized by citizen scientists". *Water Resources Research* in revision (2021).

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* in revision (2021).

Cristea, Nicoleta, **Andrew Bennett**, Bart Nijssen, and Jessica Ludquist. "Models with multiple snow layers are essential to improve snow predictions in current and future climate". *Water Resources Research* in revision (2021).

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).

Bennett, Andrew and Bart Nijssen. "Deep Learned Process Parameterizations Provide Better Representations of Turbulent Heat Fluxes in Hydrologic Models". *Water Resources Research* 57.5 (2021).

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).

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* 56.2 (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* 5.47 (2020).

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* 12.1 (2019).

Bennett, Andrew, Bart Nijssen, Gengxin Ou, Martyn Clark, and Grey Nearing. "Quantifying Process Connectivity With Transfer Entropy in Hydrologic Models". *Water Resources Research* 55.6 (2019).

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* 12.3 (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* 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* 9.2 (2017).

Selected conference presentations

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.

Bennett, A. and B. Nijssen. "A coupled approach to incorporating deep learning into process-based hydrologic modeling". *AGU Fall Meeting 2020*. 2020.

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.

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.

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.

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.