Weiming Hu

Assistant Professor in Geography
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RESEARCH KEYWORDS AND FOCI

Extreme Event Forecasting (heatwave, precipitation, and flooding). Renewable Energy Forecasting. Artificial Intelligence.

EDUCATION

Ph.D. in Geography 2021
The Pennsylvania State University
University Park, U.S.A.
Thesis: Uncertainty Quantification for Photovoltaic Energy Production Using Analog Ensemble

M.Sc. in Geography 2018
The Pennsylvania State University
University Park, U.S.A.
Thesis: Short-Term Temperature Prediction Using Adaptive Computing on Dynamic Scales

B.Eng. in Geography 2016
Wuhan University, China

EMPLOYMENT

Assistant Professor 2023.9 - Present
Geography Program, School of Integrated Sciences
James Madison University

Machine Learning Scientist 2023.2 - 2023.8
Machine Learning Postdoctoral Researcher 2021.9 - 2023.1
Center for Western Weather and Water Extremes,
Scripps Institution of Oceanography,
University of California, San Diego

Research / Teaching Assistant 2016.8 - 2021.8
Department of Geography and the Institute for Computational and Data Sciences,
The Pennsylvania State University

PUBLICATIONS

Peer-Reviewed Journal Articles

- Vanalli, C., Howerton, E., Yang, F., Tran, T.N.A. and **Hu, W.**. People & Data: Solving planetary challenges together Authors. Frontiers in Environmental Science, 12, p.1332844. Link. 2024
- **Hu, W.**, Ghazvinian, M., Chapman, W.E., Sengupta, A., Ralph, F.M. and Delle Monache, L.. Deep Learning Forecast Uncertainty for Precipitation over Western US. Monthly Weather Review. Link. 2023
- **Hu, W.**, Cervone, G., Young, G. and Delle Monache, L.. Machine Learning Weather Analogs for Near-Surface Variables. Boundary-Layer Meteorology, pp.1-25. Link. 2023

- **Hu, W.**, Cervone, G., Merzky, A., Turilli, M. and Jha, S.. A new hourly dataset for photovoltaic energy production for the continental USA. Data in Brief, 40, p.107824. Link. 2022
- Bodini, N., **Hu, W.**, Optis, M., Cervone, G. and Alessandrini, S.. Assessing boundary condition and parametric uncertainty in numerical-weather-prediction-modeled, long-term offshore wind speed through machine learning and analog ensemble. Wind Energy Science, 6(6), pp.1363-1377. Link. 2021
- Yu, M., Xu, F., **Hu, W.**, Sun, J. and Cervone, G.. Using Long Short-Term Memory (LSTM) and Internet of Things (IoT) for localized surface temperature forecasting in an urban environment. IEEE Access, 9, pp.137406-137418. Link. 2021
- Calovi, M., **Hu, W.**, Cervone, G. and Delle Monache, L.. NAM-NMM Temperature Downscaling Using Personal Weather Stations to Study Urban Heat Hazards. GeoHazards, 2(3), pp.257-276. Link. 2021
- Fanfarillo, A., Roozitalab, B., **Hu, W.** and Cervone, G.. Probabilistic forecasting using deep generative models. GeoInformatica, 25, pp.127-147. Link. 2021
- **Hu, W.** and Cervone, G.. Dynamically Optimized Unstructured Grid (DOUG) for Analog Ensemble of numerical weather predictions using evolutionary algorithms. Computers & Geosciences, 133, p.104299. Link. 2019

Peer-Reviewed Book Chapters

- **Hu, W.**, Cervone, G. and Young, G.,. Theory of spatiotemporal deep analogs and their application to solar forecasting. In Artificial Intelligence in Earth Science (pp. 205-246). Elsevier. Link. 2023
- **Hu, W.**, Cervone, G., Turilli, M., Merzky, A., and Jha, S.. "A scalable solution for running ensemble simulations for photovoltaic energy", Recent Advancement in Geoinformatics and Data Science, Xiaogang Ma, Matty Mookerjee, Leslie Hsu, Denise Hills. Geological Society of America. Link. 2023
- Calovi, M., **Hu, W.**, Clemente-Harding, L., Cervone, G.. Forecasting extreme weather events and associated impacts: Case Studies, in Astitha, M., Nikolopoulo, E., eds., Extreme Weather Forecasting: State of the Science, Uncertainty and Impacts. ISBN: 978-0-12-820124-4. Elsevier Science. Link 2022

Peer-Reviewed Conference Proceedings

- **Hu, W.**, Cervone, G., Young, G., Delle Monache, L.. "Machine Learning Guided Weather Analogs", EarthCube Annual Meeting, 2021. (10.5281/zenodo.5496385). Link. 2021
- **Hu, W.**, Young, G., Clemente, L. and Cervone, G.. Empirical Inverse Transform Function for Ensemble Forecast Calibration. NCAR Technical Notes NCAR/TN-567+ PROC, p.12. Link. 2021
- Balasubramanian, V., Turilli, M., **Hu, W.**, Lefebvre, M., Lei, W., Modrak, R., Cervone, G., Tromp, J., Jha, S.. Harnessing the Power of Many: Extensible Toolkit for Scalable Ensemble Applications. 2018 IEEE International Parallel and Distributed Processing Symposium (IPDPS). IEEE. link. 2018
- Li, H., Hu, W., Yao, J. and Zhang, W.. Anti-excessive filtering model based on sliding window. In 2015 2nd International Conference on Electrical, Computer Engineering and Electronics (pp. 1002-1007). Atlantis Press. Link. 2015

Scientific Software

- **Hu, W.**, Cervone, G., Clemente-Harding, L., Calovi, M.. PAnEn: Parallel Analog Ensemble. Zenodo. https://doi.org/10.5281/zenodo.3384321. Link. 2019

SELECTED RESEARCH PROJECTS

Geospatial Interpolation with AI

Learning Complex Topography for Spatial Interpolation of Precipitation with Attention 2022 - Present

- Sponsor: Bulletin 120, California Department of Water Resources
- Objectives: Using an Attention-based Deep Learning network for quantitative estimation of hourly precipitation with heterogeneous data including gauge measurements and topographic datasets.

Extreme Precipitation Forecasting
Deep Learning Forecast Uncertainty for Precipitation over Western US 2021 - 2022

- Sponsor: California Atmospheric River (AR) Program
- Objectives: Using Unet for post-processing 0-5-day daily accumulated precipitation forecasts from West WRF and producing forecast uncertainty for extreme events. Generating operational forecast products using the pre-trained Machine Learning models.

Extreme Heat Forecasting
NAM-NMM Temperature Downscaling Using Personal Weather Stations 2019 - 2021

- Sponsor: Office of Naval Research (ONR) award #N00014-16-1-2543
- Objectives: Using Analog Ensemble for downscaling temperature forecasts from NAM-NMM to block level using crowd-sourced weather data.

Weather Analog Forecasting
An Scalable Implementation of Parallel Analog Ensemble with Machine Learning 2017 - 2021

- Sponsor: U.S. Army Geospatial Center
- Objectives: An efficient and scalable implementation of the Analog Ensemble technique for its flexible deployment on supercomputers and its convenient integration into research workflows.
- Deliverables: A C++/R implementation of Analog Ensemble, *PAnEn* [1], and its extension R module, *RAnEnExtra* [2].

Ensemble Simulation
Co-Design of Scalable Cyberinfrastructure for Complex Ensemble Simulations 2017 - 2020

- Sponsor: National Science Foundation of U.S.A.
- Co-developed with the RADICAL team at Rutgers University
- Objectives: Designing an end-to-end solution for ensemble-based science problems to provide robust, cross-platform, and scalable generation of ensemble simulations.
- Deliverables: An hourly ensemble simulation dataset for photovoltaic energy production over the continental USA.

CONFERENCES AND PRESENTATIONS

- **Hu, W.**, Ghazvinian, M., Sengupta, A., Pan, M., Delle Monache L.. Enhancing Regional Quantitative Precipitation Forecasts Using Machine Learning in Western US Watersheds. Talk. American Meteorological Society 104th Annual Meeting. Baltimore, MD and online. Link 2024
- Boschee, A., Corringham, T., **Hu, W.**. Predicting Flood Damages using Machine Learning and National Flood Insurance Program Data. Poster. American Meteorological Society 104th Annual Meeting. Baltimore, MD and online. Link 2024
- Bano Medina, J. L., Sengupta, A., Delle Monache, L., **Hu, W.**, Watson-Parris, D.. Harnessing Data-driven Neural Weather Models for Climate Attribution: A Case Study of the Oroville Dam Atmospheric River Episode of February. Talk. American Meteorological Society 104th Annual Meeting. Baltimore, MD and online. Link 2024
- **Hu, W.**. Free Software for Environmental Open Science. Talk. Free Software Foundation. LibrePlanet 2023. Boston, MA and online. Link 2023
- Ghazvinian, M., Delle Monache L., **Hu, W.**, Sengupta, A., Weihs, R., F. Steinhoff, D., Simpson, M., Martin Ralph, F.. Calibration of West-WRF Ensemble Quantitative Precipitation Forecasts Using Deep Learning and Limited Training Sample Size. Poster. American Meteorological Society 103rd Annual Meeting. Denver, CO and online. Link. 2023

[1] PAnEn: https://weiming-hu.github.io/AnalogsEnsemble/
[2] RAnEnExtra: https://weiming-hu.github.io/RAnEnExtra/

- **Hu, W.**, Ghazvinian, M., Chapman, W., Sengupta, A., Delle Monache L., Martin Ralph, F.. Deep Learning Forecast Uncertainty for Precipitation over Western US. Talk. American Geophysical Union 2022 Fall Meeting. Chicago, IL. Link. 2022
- **Hu, W.**, Cervone, G., Young., G., Delle Monache, L.. Machine Learning Weather Analogs for Renewable Forecasting. Talk. American Geophysical Union 2022 Fall Meeting. Chicago, IL. Link. 2022
- **Hu, W.**. How to Learn the Unobservable – Deep Learning Forecast Uncertainty for Precipitation over Western US. Talk. Summertime Talks from Oceanography Postdocs. San Diego, CA. 2022
- **Hu, W.**, Trusel, L., Yu, M., Cervone, G.. Quantifying Linkages between Navigational Conditions and Maritime Traffic in the Arctic. Poster. American Geophysical Union 2021 Fall Meeting. New Orleans, LA. Link. 2021
- **Hu, W.**, Cervone, G., Young, G. Delle Monache, L.. Machine Learning Guided Weather Analogs. Talk. 2021 EarthCube Annual Meeting. Virtual. Link 2021
- **Hu, W.**. Empirical Inverse Transform Function for Ensemble Forecast Calibration. Talk. 2021 Annual Software Engineering Assembly (now Improving Scientific Software) Conference. Virtual. Link. 2021
- Bodini, N., Optis, M., **Hu, W.**, Cervone, G.. Machine Learning and Analog Ensemble Techniques for Temporal Extrapolation of Wind Resource Uncertainty. Joint Presentation. American Meteorological Society 101st Annual Meeting 2021. Virtual. Link. 2021
- **Hu, W.**, Cervone, G.. Predictability Index for Renewable Energy and Uncertainty Quantification with Analog Ensemble. eLightning Presentation. American Geophysical Union 2020 Fall Meeting. Virtual. Link. 2020
- Yu, M., Xu, F., **Hu, W.**, Sun, J., Cervone, G.. Using Long Short-Term Memory (LSTM) and Internet of Things (IoT) for Localized Surface Temperature Forecasting in an Urban Environment. Poster. American Geophysical Union 2020 Fall Meeting. Virtual. Link. 2020
- Bodini, N., **Hu, W.**, Optis, M., Cervone, G.. Machine Learning and Analog Ensemble Techniques for Temporal Extraction of Wind Resource Uncertainty. eLightning Presentation. American Geophysical Union 2020 Fall Meeting. Virtual. Link. 2020
- **Hu, W.**, Cervone, G., Turilli, M., Merzky, A., Jha, S.. Predictability Assessment of Photovoltaic Solar Energy Production with Analog Ensemble. ePoster. JpGU-AGU Joint Meeting. Link. 2020
- **Hu, W.**, Cervone G., Clemente-Harding L., Calovi M.. Parallel Analog Ensemble: The Power of Weather Analogs. ePoster. JpGU-AGU Joint Meeting. Link. 2020
- Sidel, A., **Hu, W.**, Calovi, M., Cervone, G.. Heat Wave Identification Using an Operational Weather Model and Analog Ensemble. Poster. American Meteorological Society 100th Annual Meeting 2020. Boston, MA. Link. 2020
- Calovi, M., Cervone, G., Clemente-Harding, L., **Hu, W.**. Extreme Heat Identification with High Spatio-Temporal Resolution Using the Analog Ensemble Technique. Talk. American Geophysical Union 2019 Fall Meeting. San Francisco, CA. Link. 2019
- Fanfarillo, A., Roozitalab, B., **Hu, W.**, Cervone, G.. Analog Ensemble Probabilistic Forecasting using Deep Generative Models. ePoster. American Geophysical Union 2019 Fall Meeting. San Francisco, CA. Link. 2019
- **Hu, W.**, Cervone, G.. "Empirical Inverse Transform Function for Ensemble Forecast Member Selection". Poster. American Geophysical Union 2019 Fall Meeting. San Francisco, CA. Link. 2019
- **Hu, W.**, "Using a Genetic Algorithm for Optimal Location Finding in Weather Predictions". Talk. Penn State GIS Day. University Park, PA. Link. 2019
- Cervone, G., **Hu, W.**, Calovi, M.. Extreme values forecasting using an Analog Ensemble. Talk. SCRIPPS Institute, University of California, San Diego, CA. 2019
- **Hu, W.**. A Review on Analog Ensemble and the HPC Implementation. Talk. Chinese Meteorological Center. Beijing, China. 2019
- **Hu, W.**. Uncertainty Quantification with Analog Ensemble at Scale. Talk. 2019 Annual Software Engineering Assembly (now Improving Scientific Software) Conference. Boulder, CO. Link. 2019
- **Hu, W.**, Cervone, G., Balasubramanian, V., Turilli, M., Jha, S.. A High-Performance Computing System for Probabilistic Weather Forecasts. Poster. Institute of CyberScience Symposium 2019:

Artificial Intelligence and Machine Learning in Science and Society. University Park, PA. 2019

- **Hu, W.**, Cervone, G., Balasubramanian, V., Turilli, M., Jha, S.. A High-Performance Computing System for Probabilistic Weather Forecasts. Poster. American Geophysical Union 2018 Fall Meeting. Washington, D.C. Link. 2018
- Calovi, M., Cervone, G., Delle Monache, L., **Hu, W.**. GFS Downscaling Using Personal Weather Stations for Heat Wave Vulnerability. Poster. American Geophysical Union 2018 Fall Meeting. Washington, D.C. Link. 2018
- Cervone, G., Calovi, M., Clemente-Harding, L., **Hu, W.**. An Analog Ensemble for Photovoltaic Energy Forecasts. Talk. Penn State Center for Advanced Data Assimilation and Predictability Techniques Seminar. Link. 2018
- Calovi, M., Cervone, G., Delle Monache, L., **Hu, W.**. GFS Downscaling Using Personal Weather Stations for Heat Wave Vulnerability. Talk. Penn State GIS Day. University Park, PA. Link. 2018
- **Hu, W.**, Cervone, G.. A High-Resolution Photovoltaic Energy Production Simulator With A Probabilistic Approach. Poster. Graduate Climate Conference. Pack Forest, WA. Link. 2018
- **Hu, W.**, Cervone, G., Jha, S., Balasubramanian, V., Turilli, M.. Automatic Unstructured Grid Refinement Using Machine Learning for the Analog Ensemble of Numeric Weather Prediction. Poster. EarthCube Projects All Hands Meeting. Washington, DC. Link. 2018
- **Hu, W.**, Cervone, G., Jha, S., Balasubramanian, V., Turilli, M.. Automatic Unstructured Grid Refinement Using Machine Learning for the Analog Ensemble of Numeric Weather Prediction. Poster. Institute of Cyberscience Symposium 2018: Harnessing the Power of Data. University Park, PA. Link. 2018
- **Hu, W.**, Cervone, G., Jha, S., Balasubramanian, V., Turilli, M.. Short-Term Temperature Predictions Using Adaptive Computing on Dynamic Scales. Poster. American Geophysical Union 2017 Fall Meeting. Now Orleans, LA. Link. 2017
- **Hu, W.**, Cervone, G.. Short-Term Probabilistic Photovoltaic Power Prediction Using Analog Ensemble. Poster. Energy Days. University Park, PA. Link. 2017
- **Hu, W.**. Local Humidity Prediction Using an Analog Ensemble. Talk. Association of American Geographers Annual Meeting. Boston, MA. Link. 2017

WORKSHOPS

- **Hu, W.**. Analog Ensemble and Deep Analogs for Quantitative Precipitation Forecasting. Envisioning the future of Machine Learning and GIS. State College, PA. Hybrid. Link. 2023
- Osenga, E., Arnott, J., **Hu, W.**. Career Pathways and the Graduate School Question. Aspen Global Change Institute. Basalt, CO. Hybrid. 2022
- **Hu, W.**, Clemente-Harding, L., Cervone, G.. Parallel Analog Ensemble Forecasts with Ensemble Toolkit on HPC. Workshop. 2019 Annual Software Engineering Assembly (now Improving Scientific Software) Conference. Boulder, CO. Link. 2019
- Clemente-Harding, L., Delle Monache, L., Cervone, G., Calovi, M., **Hu, W.**, Shahriari, M.. The Analog Ensemble Technique for Probabilistic Forecasts. Workshop. Software Engineering Assembly (SEA) Conference and Tutorials. Boulder, CO. Link. 2018

TEACHING AND MENTORING

Courses Taught

- JMU GEOG 215, Introduction to GIS
- JMU GEOG 469, Applications of GIS in Human and Environmental Topics
- PSU GEOG 365, Introduction to GIS Programming
- PSU GEOG 160 WEB, Mapping Our Changing World

Guest Lecturer

- EMSC 100S, College of Earth and Mineral Sciences First Year Seminar Fall 2020, Fall 2022

Mentor

- Azara Boschee, B.Sc. Student in Meteorology, Saint Cloud State University 2023
- Samuel Dahl, B.Sc. Student in Hydrology and Atmospheric Science, University of Arizona 2022
- Jeremy Diaz, Ph.D. Student in Geography, Penn State 2019 - 2020
- Alon Sidel, B.Sc. Candidate in Meteorology and Atmospheric Science, Penn State 2019 - 2020
- Hanzhou Chen, M.Sc. Student in Geography, Penn State 2018

Harrisonburg, VA, U.S.A. - Last Update: February 21, 2024