Weiming Hu

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Institute for Computational and Data Sciences
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CURRENT POSITION AND RESEARCH FOCI

Ph.D. Candidate. Development and application of Artificial Intelligence, Machine Learning and High Performance Computing methods for ensemble weather forecasting and uncertainty quantification for renewable energy.

Proficient in C++, Python and R programming, with emphasis on parallel computing at scale (OpenMP and OpenMPI) using supercomputers (Cheyenne, Summit, Wrangler, Penn State Roar).

EDUCATION

Ph.D. in Geography with Minor in Computer Science   2021 (expected)
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 Remote Sensing and Geoinformatics   2016
Wuhan University, China

RESEARCH EXPERIENCES

Arctic in Hot Water
Quantifying Maritime Transport under Declining Sea Ice and Increasing Geopolitical Tension   2020 - Present

- Sponsor: Center for Security Research and Education, Pennsylvania State University.
- Objectives: Using machine learning to quantify linkages between changing sea ice coverage and maritime traffic in the Arctic Ocean, and to assess recent and future changes in Arctic maritime traffic with Earth system models.
- Responsibilities: Evaluation of Earth system model simulation for its applicability in Arctic maritime traffic projection and implementation of a machine learning algorithm for maritime traffic simulation and forecast.

Wind Resource Assessment with Analog Ensemble
Offshore Wind Resource Assessment for California Pacific Outer Continental Shelf   2019 - Present

- Sponsor: Bureau of Ocean Energy Management of U.S.A.
- Objectives: Presenting a state-of-art wind resource dataset for the outer continental shelf off the coast of California and assessing the predictability of the uncertainty with WRF ensemble simulations.

- Responsibilities: Integration of Analog Ensemble as a method for uncertainty quantification for comparison with other machine-learning based methods and the deployment of Analog Ensemble on the NREL supercomputer, Eagle.

Parallel Analog Ensemble
The Power of Weather Analogs   2017 - Present

- 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.
- Responsibilities: Main developer and maintainer of the Analog Ensemble implementation. Current deliverables include a C++/R implementation of Analog Ensemble, *PAnEn* [1], and its extension R module, *RAnEnExtra* [2].

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

- Sponsor: National Science Foundation of U.S.A.
- Co-developed with RADICAL team at Rutgers University
- Objectives: Designing an end-to-end solution for ensemble-based science problems that are robust, scalable, and extensible in sizes of ensembles, the computational requirement, and the computational platforms.
- Responsibilities: Python implementation and test of such a solution with Analog Ensemble for photovoltaic energy assessment on the NCAR supercomputer, Cheyenne.

PUBLICATIONS

Peer-Reviewed Articles

- Fanfarillo, A., Roozitalab, B., **Hu, W.**, Cervone, G.. Probabilistic forecasting using deep generative models. Geoinformatica (2020). https://doi.org/10.1007/s10707-020-00425-8. Link.   2020
- **Hu, W.**, Del Vento, D., & Su, S. (Eds.). Proceedings of the 2020 Improving Scientific Software Conference (No. NCAR/TN-564+PROC). doi:10.5065/p2jj-9878. Link.   2020
- **Hu, W.**, Cervone, G.. Dynamically Optimized Unstructured Grid (DOUG) for Analog Ensemble of numerical weather predictions using evolutionary algorithms. Computers & Geosciences. 2019 Dec 1;133:104299. Link.   2019
- Li, H., **Hu, W.**, Yao, J., Zhang, W.. Anti-excessive filtering model based on sliding window. 2015 2nd International Conference on Electrical, Computer Engineering and Electronics. Atlantis Press. link.   2015

Under Review

- Calovi, M., **Hu, W.**, Delle Monache, L., Cervone, G.. Downscaled temperature prediction using VGI and the Analog Ensemble technique.   2020
- (Book chapter - Invited) Calovi, M., **Hu, W.**, Clemente-Harding, L., Cervone, G.. On Extreme weather forecasting: state of the science, uncertainty and impacts. Edited by Marina Astitha and Efthymios Nikolopoulos, Elsevier.   2020

In Preparation

- **Hu, W.**, Cervone, G., Young, G.. Weather Analogs with a Learnable Similarity Metric for Renewable Resource Forecasting.   2020

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

- Sidel, A., **Hu, W.**, Calovi, M., Cervone, G.. Heat wave identification using an operational weather model and analog ensemble. 2020
- Bodini, N., **Hu, W.**, Optis, M., Cervone, G.. Assessing Uncertainty in Numerical Weather Prediction Modeled Long-Term Offshore Wind Speed Through Machine Learning and Analog Ensemble. 2020
- Calovi, M., **Hu, W.**, Cervone, G.. Spatio-temporal downscaled prediction of extreme heat wave using the Analog Ensemble technique. 2020

Other Work

- **Hu, W.**, Cervone, G., Clemente-Harding, L., Calovi, M.. PAnEn: Parallel Analog Ensemble. Zenodo. https://doi.org/10.5281/zenodo.3384321. Link. 2019
- Balasubramanian, V., Turilli, M., **Hu, W.**, Lefebvre, M., Lei, W., Cervone, G., Tromp, J., Jha, S.. Harnessing the Power of Many: Extensible Toolkit for Scalable Ensemble Applications. arXiv preprint arXiv:1710.08491. link. 2017

CONFERENCES

- 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 Extration 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.**, 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) 2018 Conference and Tutorials. Boulder, CO. Link.   2018

TEACHING EXPERIENCES

Instructor

- GEOG 365, Introduction to GIS Programming   Fall 2019
- GEOG 160 WEB, Mapping Our Changing World   Spring 2020

Guest Lecturer

- EMSC 100S, EMS First Year Seminar   Fall 2020

Mentor

- Jeremy Diaz, Ph.D. Student in Geography, PSU   2019 - 2020
- Alon Sidel, B.Sc. Candidate in Meteorology and Atmospheric Science, PSU   2019 - 2020
- Hanzhou Chen, M.Sc. Student in Geography, PSU   2018

AWARDS AND HONORS

- Academic Enrichment Award from the Knight Fund in the Department of Geography ($190).   2020
- Free Software Foundation Scholarship to attend LibrePlanet 2020, Boston, MA ($500).   2020
- Ruby S. Miller Endowment for Geographic Excellence ($500).   2019
- Research covered by Penn State News. Link   2019
- 2019 Open Science Grid User School Scholarship at Madison, WI ($1,000).   2019
- Third place in the Penn State Graduate Exhibition poster competition,
  Physical Sciences & Mathematics section ($100). Link.   2019
- Research covered by Penn State News. Link.   2018
- Ruby S. Miller Endowment for Geographic Excellence ($200). Link.   2018
- Sustainable Energy Fund for EnergyPath 2018 ($400). Link.   2018
- 12th Annual Graduate Climate Conference Scholarship ($325). Link.   2018
- First place (out of 46) in 2018 Institute of CyberScience Symposium
  Student Poster Competition ($750).   2018
- Research covered by Penn State News. Link.   2017
- "Jiwei Era" Top 10 (out of 200) New Remote Sensing Star Award Nomination, Wuhan University.   2015
- First-class (1 out of 40) scholarship in Geoinformatics, Wuhan University ($300).   2013, 2015

CERTIFICATES

- Graduate Student Online Teaching Certificate. Penn State World Campus. Link.   2019

ACADEMIC SERVICES AND OUTREACH ACTIVITIES

- Program Chair, *SEA's Improving Scientific Software Conference and Tutorials.* Link.   2021
- Program Committee, *SEA's Improving Scientific Software Conference and Tutorials.* Link. 2020
- Research Intern, *Chinese Meteorological Administration.* Beijing, China.
  Host: Dr. Kan Dai   2019
- Mentor, *Mentor-Mentee matching program in geography.*   2019
- Co-Chair, *GEOlab prospective graduate student selection committee.*   2018, 2019
- Liason, *The Outstanding Student Awards program at AGU 2018 Fall Meeting.*   2018, 2019
- Visitor, *International Research Institute of Disaster Science*, Tohoku Univeristy. Japan.
  Host: Dr. Shunichi Koshimura   2018
- Research Intern, *Foothills Laboratory at National Center of Atmospheric Research.* Boulder, CO.
  Host: Dr. Guido Cervone   2017, 2018
- Student Representative, *Graduate student representative in Geography, Penn State.*   2017

State College, PA, U.S.A. - December 9, 2020