

Brandon N. Benton, PhD

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Summary

Senior Researcher at the National Renewable Energy Lab with a focus on enhancing physical modeling through integration of physics-based and machine learning methods. Lead developer on large codebases with users from 50+ institutions and 50+ countries. Publications and presentations relating to generative machine learning, renewable resource modeling, and earth system modeling. Proven ability to lead interdisciplinary teams, develop innovative solutions, and communicate complex scientific concepts effectively.

Education

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| PhD | Cornell University , Physics | Ithaca, NY |
| | <ul style="list-style-type: none"> Thesis: Analysis of Low-Frequency Climate Variability Through Computational Modeling and Tree-Ring Data Synthesis | Jan 2016 – Jan 2019 |
| MS | Cornell University , Physics | Ithaca, NY |
| | <ul style="list-style-type: none"> Thesis: VR Quadcopter Telepresence Proposal | Jan 2012 – Jan 2016 |
| BS | Georgia Southern University , Physics | Statesboro, GA |
| | <ul style="list-style-type: none"> Thesis: Prototyping Method for Bragg-type Atom Interferometers Honors: Magna cum laude, University Honors Program | Jan 2008 – Jan 2012 |

Experience

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| National Renewable Energy Lab , Senior Researcher / Software Engineer | Golden, CO |
| <p>Lead developer for the National Solar Radiation Database (NSRDB) and Super Resolution for Renewable Energy Resource Data (SUP3R). NSRDB integrates MERRA-2 reanalysis data, GOES satellite observations, and physical modeling to generate high-resolution solar resource data, and has 300,000+ annual users from 50+ countries. SUP3R leverages generative machine learning to produce high-resolution meteorological data, with applications in wind and solar resource data generation and climate projections, and has users from 50+ institutions and 20+ countries.</p> <ul style="list-style-type: none"> Optimized NSRDB pipeline, reducing reprocessing time by 80% Extended NSRDB coverage from 60°N to full polar region, broadening its applicability. Incorporated temperature-sensitive snowy albedo model into NSRDB to improve surface radiation accuracy. Developed cloud property estimation and radiative transfer models to enhance NSRDB data fidelity. Publicly released SUP3R framework, consisting of comprehensive suite for feature engineering, data handling, model prototyping, training, and inference. Developed novel GAN-based downscaling methods for SUP3R project, increasing speed of downscaling 300x over dynamical approaches. Led applications of SUP3R to generate high-resolution wind resource data over Ukraine, Southeast Asia, and South America from coarse ERA5 inputs. Applied SUP3R to produce high-resolution climate projections for the US and assess impact of urban heat islands on energy demand. | Jan 2022 – present |
| Cornell University , Post-Doctoral Fellow | Ithaca, NY |
| <p>Designed and carried out research in areas of global and regional climate modeling, computer vision, weather forecasting, and COVID modelling.</p> <ul style="list-style-type: none"> Developed tools for detecting hurricane conditions in satellite images using computer vision techniques. | Jan 2020 – Jan 2022 |

- Developed AWS interface to allow general public to perform climate simulations.
- Planned and developed hyperlocal weather forecasting system designed to improve winter-storm emergency response and enhance natural disaster coordination for New York state's rural communities.
- Led team of four undergraduate students using this code to perform on-demand weather forecasting for Tompkins County.
- Led research on effect of heat anomalies injected into aquaplanet SSTs and surface fields on polar vortex.
- Built custom compartmental infectious disease model including asymptomatic, symptomatic, hospitalization, and death projections for entire United States.
- Updated and improved complex database of tree ring information from variety of disparate, obscure, and hard-to-access data sources.

Independent Researcher, Data Scientist

Ithaca, NY

Jan 2012 – Jan 2021

- Designed and built working quadcopter with GPS-enabled navigation, remote control capability, and computer control interfaces.
- Developed Twitch bot to filter offensive content in channels, achieving 98% success rate and currently in use on Twitch channel.

Cornell University, Graduate Teaching Assistant

Ithaca, NY

Jan 2012 – Jan 2019

- Instructed classes in Climate & Energy, Computer Graphics, Numerical Analysis, and Fundamentals of Physics.
- Prepared examinations and classroom materials.
- Led class projects and lab sessions.

Cornell University, PhD Researcher

Ithaca, NY

Jan 2013 – Jan 2019

- Designed and carried out research in areas of fluid dynamics, condensed matter, and climate science.
- Developed and implemented numerical models to simulate complex physical systems.
- Analyzed large datasets using statistical and machine learning techniques.
- Published findings in peer-reviewed journals and presented at international conferences.

Strengths

High Performance Computing: NCAR's Yellowstone/Cheyenne, NREL's Eagle/Kestrel, PBS, SLURM, Linux

Physics: Meteorology, Earth Systems, Condensed Matter, Fluid Dynamics

Programming: Python, Bash, Mathematica, MATLAB, C++, Fortran

Python Tools: Xarray, Scikit-learn, Keras, Cartopy, Tensorflow, Pytorch, Numpy, Pandas, Dask

Earth Systems Data / Modeling: CMIP6, ERA5, HRRR, WRF, CESM

Mathematics: Differential Equations, Statistics, Finite Difference Methods, Calculus, Linear Algebra

Publications

On the effectiveness of neural operators at zero-shot weather downscaling.

April 2025

Saumya Sinha, Brandon Benton, Patrick Emami
Environmental Data Science

The influence of cloud cover on the reliability of satellite-based solar resource data

Feb 2025

Yu Xie, Manajit Sengupta, Jaemo Yang, Aron Habte, Grant Buster, Brandon Benton, Michael Foster, Andrew Heidinger, Yangang Liu
Renewable and Sustainable Energy Reviews

Potential effects of climate change and solar radiation modification on renewable energy resources	Jan 2025
Andrew Kumler, Ben Kravitz, Caroline Draxl, Laura Vimmerstedt, Brandon Benton, Julie K Lundquist, Michael Martin, Holly Jean Buck, Hailong Wang, Christopher Lennard, Ling Tao Renewable and Sustainable Energy Reviews	
Tackling extreme urban heat: a machine learning approach to assess the impacts of climate change and the efficacy of climate adaptation strategies in urban micro-climates	Nov 2024
Grant Buster, Jordan Cox, Brandon N. Benton, Ryan King arXiv preprint arXiv:2411.05952	
Integration of a Physics-Based Direct Normal Irradiance (DNI) Model to Enhance the National Solar Radiation Database (NSRDB)	Dec 2023
Yu Xie, Manajit Sengupta, Jaemo Yang, Grant Buster, Brandon Benton, Aron Habte, Yangang Liu doi.org/10.1016/j.solener.2023.112195  (Solar Energy)	
Super-resolution for Renewable Energy Resource Data with Wind from Reanalysis Data (Sup3rWind) and Application to Ukraine	July 2024
Brandon N. Benton, Grant Buster, Pavlo Pinchuk, Andrew Glaws, Ryan N. King, Galen Maclaurin, Ilya Chernyakhovskiy arXiv preprint arXiv:2407.19086. Wind Energy (Under Review)	
High-Resolution Meteorology with Climate Change Impacts from Global Climate Model Data Using Generative Machine Learning	April 2024
Grant Buster, Brandon N. Benton, Andrew Glaws, Ryan King doi.org/10.1038/s41560-024-01507-9  (Nature Energy)	
Intrinsic Century-Scale Variability in Tropical Pacific SSTs and Their Influence on Western US Hydroclimate	Dec 2022
Colin P Evans, Sloan Coats, Carlos M Carrillo, Xiaolu Li, Marc J Alessi, Dimitris A Herrera, Brandon N Benton, Toby R Ault Geophysical Research Letters	
Minor Impacts of Major Volcanic Eruptions on Hurricanes in Dynamically-Downscaled Last Millennium Simulations	Sept 2022
Brandon N Benton, Marc J Alessi, Dimitris A Herrera, Xiaolu Li, Carlos M Carrillo, Toby R Ault Climate Dynamics	
Approximate Mean-Field Equations of Motion for Quasi-2D Bose-Einstein Condensate Systems	Nov 2012
Mark Edwards, Michael Krygier, Hadayat Seddiqi, Brandon Benton, Charles W Clark Physical Review E	
Prototyping Method for Bragg-Type Atom Interferometers	Oct 2011
Brandon Benton, Michael Krygier, Jeffrey Heward, Mark Edwards, Charles W Clark Physical Review A	
Momentum-Space Engineering of Gaseous Bose-Einstein Condensates	March 2011
Mark Edwards, Brandon Benton, Jeffrey Heward, Charles W Clark Physical Review A	