

# 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

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

## Experience

<b>National Renewable Energy Lab</b> , Senior Researcher / Software Engineer	Golden, CO
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.	Jan 2022 – present
<ul style="list-style-type: none"> <li>Optimized NSRDB pipeline, reducing reprocessing time by 80%</li> <li>Extended NSRDB coverage from 60°N to full polar region, broadening its applicability.</li> <li>Incorporated temperature-sensitive snowy albedo model into NSRDB to improve surface radiation accuracy.</li> <li>Developed cloud property estimation and radiative transfer models to enhance NSRDB data fidelity.</li> <li>Publicly released SUP3R framework, consisting of comprehensive suite for feature engineering, data handling, model prototyping, training, and inference.</li> <li>Developed novel GAN-based downscaling methods for SUP3R project, increasing speed of downscaling 300x over dynamical approaches.</li> <li>Led applications of SUP3R to generate high-resolution wind resource data over Ukraine, Southeast Asia, and South America from coarse ERA5 inputs.</li> <li>Applied SUP3R to produce high-resolution climate projections for the US and assess impact of urban heat islands on energy demand.</li> </ul>	
<b>Cornell University</b> , Post-Doctoral Fellow	Ithaca, NY

Designed and carried out research in areas of global and regional climate modeling, computer vision, weather forecasting, and COVID modelling.

- Developed tools for detecting hurricane conditions in satellite images using computer vision techniques.

- 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**

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**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**

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**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

<b>Potential effects of climate change and solar radiation modification on renewable energy resources</b>	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	
<b>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</b>	Nov 2024
Grant Buster, Jordan Cox, Brandon N. Benton, Ryan King	
arXiv preprint arXiv:2411.05952	
<b>Integration of a Physics-Based Direct Normal Irradiance (DNI) Model to Enhance the National Solar Radiation Database (NSRDB)</b>	Dec 2023
Yu Xie, Manajit Sengupta, Jaemo Yang, Grant Buster, Brandon Benton, Aron Habte, Yangang Liu	
<a href="https://doi.org/10.1016/j.solener.2023.112195">doi.org/10.1016/j.solener.2023.112195</a> (Solar Energy)	
<b>Super-resolution for Renewable Energy Resource Data with Wind from Reanalysis Data (Sup3rWind) and Application to Ukraine</b>	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)	
<b>High-Resolution Meteorology with Climate Change Impacts from Global Climate Model Data Using Generative Machine Learning</b>	April 2024
Grant Buster, Brandon N. Benton, Andrew Glaws, Ryan King	
<a href="https://doi.org/10.1038/s41560-024-01507-9">doi.org/10.1038/s41560-024-01507-9</a> (Nature Energy)	
<b>Intrinsic Century-Scale Variability in Tropical Pacific SSTs and Their Influence on Western US Hydroclimate</b>	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	
<b>Minor Impacts of Major Volcanic Eruptions on Hurricanes in Dynamically-Downscaled Last Millennium Simulations</b>	Sept 2022
Brandon N Benton, Marc J Alessi, Dimitris A Herrera, Xiaolu Li, Carlos M Carrillo, Toby R Ault	
Climate Dynamics	
<b>Approximate Mean-Field Equations of Motion for Quasi-2D Bose-Einstein Condensate Systems</b>	Nov 2012
Mark Edwards, Michael Krygier, Hadayat Seddiqi, Brandon Benton, Charles W Clark	
Physical Review E	
<b>Prototyping Method for Bragg-Type Atom Interferometers</b>	Oct 2011
Brandon Benton, Michael Krygier, Jeffrey Heward, Mark Edwards, Charles W Clark	
Physical Review A	
<b>Momentum-Space Engineering of Gaseous Bose-Einstein Condensates</b>	March 2011
Mark Edwards, Brandon Benton, Jeffrey Heward, Charles W Clark	
Physical Review A	