Marie C. McGraw, Ph.D.

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Summary

I am an atmospheric scientist with over 10 years of analyzing weather and climate model output, and creating statistical and artificial intelligence models of weather and climate hazards. I love the intersection of weather and climate, data science, and data-driven models, and I'm passionate about deriving actionable insights from big data.

Research Experience

Research Scientist, Cooperative Institute for Research in the Atmosphere, Fort Collins, CO
2021-present

- Led effort using statistical modeling, principal component analysis, and time series forecasting to develop explainable and physics-guided models for tropical cyclone evolution from AI-generated satellite datasets.
- Member of the NSF AI Institute for Earth Science; worked on cross-disciplinary teams to develop uncertainty quantification guidelines for neural network models in Earth sciences, categorize bias in AI models for Earth science tasks, and educational efforts for trustworthy AI.
- **Products:**
  - Developer and visualization expert for tropical cyclone neural network forecast model; model is currently in National Hurricane Center's research-to-operations pipeline for testing in the 2025 hurricane forecast season;
  - Developer for several products related to hurricane forecast improvements related to rare and extreme event forecasting at the National Hurricane Center;
  - Developer of Jupyter notebook-based AI education materials for the NOAA Center for Artificial Intelligence, covering topics such as convolutional neural networks, data preprocessing, and extreme event analysis;

Postdoctoral Researcher, University of Washington, Seattle, WA
2019-2021

Quantified forecast skill during and after extreme sea ice loss events in weather models and advised related student projects.

Graduate Researcher, Colorado State University, Fort Collins, CO
2013-2019

- Developed statistical and causal inference-based models to study climate variability and change;
- First author or co-first author for 6 publications on various topics in climate modeling, climate variability, and statistical forecasting of climate;
- Teaching assistant for statistics and data analysis in atmospheric science.

Education

10/2013 - 03/2019 **Ph.D., Atmospheric Science**, Colorado State University, Fort Collins, CO, USA. Dissertation: "A Causal Discovery-Based Approach to Understanding Arctic-Midlatitude Dynamics"

09/2008 - 06/2012 **B.Sc., Mechanical and Ocean Engineering**, Massachusetts Institute of Technology, Cambridge, MA, USA

Skills

Datasets: Highly experienced with complex geospatial datasets, including climate model output such as CMIP5/6, forecasts from numerical and AI weather models, reanalysis products like ERA5, and satellite data
Programming: Python, including data science and machine learning tools (Pandas, xArray, scikit-learn, Tensorflow, Keras, and pyTorch), parallelization tools like Dask and joblib, and visualization libraries like Matplotlib, seaborn, and plotly; some SQL experience
Modeling and Data Science: geospatial analysis, extreme event analysis, probabilistic models, time series forecasting, causal inference and Bayesian modeling.
Software: git, Linux, Docker
Languages: Spanish (B2-C1), French (A2)

Awards and Invited Presentations

Invited Seminar, ITU "AI for Good" Seminar Series, 03/2023. *AI for Tropical Meteorology: Challenges and Opportunities*. T. Beucler and **M.C. McGraw**.

Visiting Researcher, Université de Lausanne, 01-03/2023. Received a travel award of $20,000 to visit UNIL.

Invited Speaker, Aspen Global Change Institute Workshop on Earth System Modeling with Machine Learning and Big Data, 06/2022. *Causality and Interpretability*. **McGraw, M.C.**, and I. Ebert-Uphoff.

Spotlight Presentation, Tackling Climate Change with Machine Learning Workshop, NeurIPS 2022, 12/2022. *Statistical adjustment of decadal climate predictions using deep learning*. Sospreda-Alfonso, R., Exenberger, J., Dang, K., and **M.C. McGraw**.

Selected Publications (15 total)

Peer-Reviewed

6. V. Eyring, W.D. Collins, and coauthors (inc. **M. McGraw**) (2024): Pushing the Frontiers in Climate Modeling and Analysis with Machine Learning. *Nature Climate Change*, **14**, 916-928, `https://doi.org/10.1038/s41558-024-02095-y`.

5. McGovern, A., A. Bostrom, **M. McGraw**, R.J. Chase, D.J. Gagne II, I. Ebert-Uphoff, K. Musgrave, and A. Schumacher (2024): Identifying and Categorizing Bias in AI/ML for Earth Sciences, *Bull. Amer. Meteorol. Soc.*, **105**, `https://doi.org/10.1175/BAMS-D-23-0196.1`.

4. Haynes, K., R. Lagerquist, **M. McGraw**, K. Musgrave, and I. Ebert-Uphoff (2023): Creating and evaluating uncertainty estimates with neural networks for environmental-science applications. *Artificial Intelligence for Earth Systems*, **1**, `https://doi.org/10.1175/AIES-D-22-0061.1`.

3. **McGraw, M.C.** and E.A. Barnes (2020): New Insights on Subseasonal Arctic-Midlatitude Causal Connections from a Regularized Regression Model. *Journal of Climate*, doi:10.1175/JCLI-D-19-0142.1.

2. Samarasinghe, S., **M.C. McGraw**, E.A. Barnes, and I. Ebert-Uphoff (2019): A study of links between the Arctic and the midlatitude jet-streams using Granger and Pearl causality. *Environmetrics,* doi:10.1002/env.2540.

1. **McGraw, M.C.**, and E.A. Barnes (2018): Memory matters: A case for Granger causality in climate variability studies. *J. Climate*, **31,** doi:10.1175/JCLI-D-17-0334.1. item **McGraw, M.C.**, E.A. Barnes, and C. Deser (2016): Reconciling the observed and modeled Southern Hemisphere circulation response to volcanic eruptions. *Geophys. Res. Lett.,* doi:10.1002/2016GL069835.

Non Peer-Reviewed

· Sospreda-Alfonso, R., Exenberger, J., Dang, K., and **M.C. McGraw**: Statistical adjustment of decadal climate predictions using deep learning. *Tackling Climate Change with Machine Learning Workshop*, NeurIPS 2022.