

Marie C. McGraw, Ph.D.

Jupiter Intelligence

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Google Scholar

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Current Position

06/2025 - present	Climate Insight Scientist Jupiter Intelligence, Boulder, CO, USA Research topics: physical climate risk, socioeconomic impacts of climate risk, climate tipping points, extreme events
06/2025 - present	Affiliate Research Scientist Cooperative Institute for Research in the Atmosphere (CIRA), Colorado State University, Fort Collins, CO, USA

Education

10/2015 - 03/2019	Ph.D., Atmospheric Science , Colorado State University, Fort Collins, CO, USA Advisor: Elizabeth Barnes Dissertation: “A Causal Discovery-Based Approach to Understanding Arctic-Midlatitude Dynamics”
06/2013 - 10/2015	M.S., Atmospheric Science , Colorado State University, Fort Collins, CO, USA Advisor: Elizabeth Barnes Thesis: “Seasonal Sensitivity of the Eddy-Driven Jet Response to Tropospheric Heating in an Atmospheric General Circulation Model”
09/2008 - 06/2012	B.Sc., Mechanical Engineering , Massachusetts Institute of Technology, Cambridge, MA, USA

Previous Research Experience

08/2022 - 06/2025	Research Scientist I Cooperative Institute for Research in the Atmosphere (CIRA), Colorado State University, Fort Collins, CO, USA Research topics: machine learning and tropical cyclone prediction, uncertainty quantification for machine learning in geosciences
07/2021 - 07/2022	Postdoctoral Research Associate Cooperative Institute for Research in the Atmosphere (CIRA), Colorado State University, Fort Collins, CO, USA Research topics: machine learning and tropical cyclone prediction, uncertainty quantification for machine learning in geosciences
06/2019 - 06/2021	Postdoctoral Research Associate , University of Washington, Seattle, WA, USA Department: Atmospheric Sciences Research topics: sea ice forecasting, extreme sea ice loss Advisor: Prof. Cecilia Bitz
06/2013 - 05/2019	Graduate Research Assistant , Colorado State University, Fort Collins, CO, USA Department: Atmospheric Sciences Research topics: atmospheric dynamics, climate modeling, causal discovery and atmospheric sciences, statistical modeling, extratropical-polar climate variability Advisor: Prof. Elizabeth Barnes

Awards

2023 **Visiting scholar**, Data-Driven Atmospheric and Water Dynamics Group, University of Lausanne, Lausanne, Switzerland

Publications

Under Review

- M.S. Gomez, S. Ganesh Sudheesh, **M. McGraw**, F.I.-H. Tam, I. Azizi, S. Darmon, M. Feldmann, S. Bourdin, L. Poulain-Auzéau, S.J. Camargo, J. Lin, D. Chavas, C.-Y. Lee, R. Gupta, A. Jenney, and T. Beucler: *TCBench: A Benchmark for Tropical Cyclone Track and Intensity Forecasting at the Global Scale*. Under review at *ML: Earth*. Preprint available at arXiv:<https://arxiv.org/abs/2601.23268>.

Peer-Reviewed

16. Ganesh Sudheesh, S., F.I.-H. Tam, M.S. Gomez, **M. McGraw**, M. DeMaria, K. Musgrave, A. Gerhardus, J. Runge, and T. Beucler: Multidata Causal Discovery for Statistical Hurricane Intensity Forecasting. *Weather and Forecasting*, **41**, <https://doi.org/10.1175/WAF-D-25-0208.1>.
15. Fernandez, M., E.A. Barnes, R.J. Barnes, M. DeMaria, **M. McGraw**, G. Chirokova, L. Lu: Predicting tropical cyclone track forecast errors using a probabilistic neural network. Accepted 02/2025 for publication in *Artificial Intelligence in the Earth Systems*.
14. 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>.
13. 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>.
12. McGovern, A., and coauthors (inc. **M. McGraw**) (2023): Trustworthy artificial intelligence for environmental sciences: An innovative approach for summer school. *Bull. Amer. Meteorol. Soc.*, **104**, <https://doi.org/10.1175/BAMS-D-22-0225.1>.
11. 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>.
10. **McGraw, M.C.**, E. Blanchard-Wrigglesworth, R.P. Clancy, and C.M. Bitz (2022): Understanding the predictability of Arctic sea ice loss on subseasonal timescales. *J. Climate*, **35**, doi:10.1175/JCLI-D-21-0301.1.
9. Gonzalez, A.O., I. Ganguly, **M.C. McGraw**, and J. Larson (2022): Rapid dynamical evolution of ITCZ events over the east Pacific. *J. Climate*, **35**, doi:10.1175/JCLI-D-21-0216.1.
8. Clancy, R.P., C.M. Bitz, E. Blanchard-Wrigglesworth, **M.C. McGraw**, and S. M. Cavallo (2021): A cyclone-centered perspective on the drivers of asymmetric patterns in the atmosphere and sea ice during Arctic cyclones. *Journal of Climate*, **34**, doi:10.1175/JCLI-D-21-0093.1.
7. **McGraw, M.C.** and E.A. Barnes (2020): New Insights on Subseasonal Arctic-Midlatitude Causal Connections from a Regularized Regression Model. *Journal of Climate*, **33**, doi:10.1175/JCLI-D-19-0142.1.

6. **McGraw, M.C.**, C.F. Baggett, C. Liu, and B.D. Mundhenk (2019): Changes in Arctic moisture transport over the North Pacific associated with sea ice loss. *Climate Dynamics*, **54**, doi:10.1007/s00382-019-05011-9.
5. 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*, **30**, doi:10.1002/env.2540.
4. **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.
3. Woollings, T., E. Barnes, B. Hoskins, Y.-O. Kwon, R.W. Lee, C. Li, E. Madonna, **M. McGraw**, T. Parker, R. Rodrigues, C. Spensberger, K. Williams (2018): Daily to decadal modulation of jet variability. *J. Climate*, **31**, doi:10.1175/JCLI-D-17-0286.1.
2. **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.
1. **McGraw, M.C.**, and E.A. Barnes (2016): Seasonal sensitivity of the eddy-driven jet to tropospheric heating in an idealized AGCM. *J. Climate*, **29**, doi:10.1175/JCLI-D-15-0723.1.

In Preparation

- **McGraw, M.C.**, K.D. Haynes, C.J. Slocum, I. Ebert-Uphoff, K.D. Musgrave, and J.A. Knaff: Exploring tropical cyclone structure and evolution with AI-based synthetic passive microwave data. In preparation for submission to *Artificial Intelligence in the Earth Systems*, summer 2026.

Technical Reports and Other Publications

- Contributing author: Pricing the tipping point: The economic impact of an AMOC collapse. *Jupiter Intelligence*. April 2026
- Contributing author: Climate risk in Ethiopia. *Jupiter Intelligence and the United Nations Development Programme*. March 2026
- Contributing author: Climate risk in the Middle East and North Africa. *Jupiter Intelligence and First Abu Dhabi Bank*. February 2026
- Contributing author: Katrina After 20 Years — What We’ve Learned and How it Could Happen Again. *Jupiter Intelligence*. August 2025
- 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.
- Samarasinghe, S., **M. McGraw**, E. Barnes, and I. Ebert-Uphoff (2017): A study of causal links between the Arctic and the midlatitude jet-streams. *Proceedings of the Seventh International Workshop on Climate Informatics (CI 2017)*, NCAR Technical Note NCAR/TN-536+PROC.

Selected Presentations

Invited

- 2025 **Keynote Presentation**, Gordon Research Conference on Machine Learning for Actionable Climate Science, 06/2025. *Causality, Uncertainty, and Interpretability in Machine Learning for Climate Science*. **M. McGraw**, I. Ebert-Uphoff, and K. Musgrave.

- 2023 **Seminar**, ITU “AI for Good” Seminar Series, 03/2023. *AI for Tropical Meteorology: Challenges and Opportunities*. T. Beucler and **M.C. McGraw**.
- 2022 **Presentation**, 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.
- Seminar**, Data-Driven Atmospheric and Water Dynamics Group, University of Lausanne, Switzerland. *Machine learning and tropical cyclone forecasting*. **McGraw, M.C.**, K.D. Musgrave, and I. Ebert-Uphoff.
- 2019 **Seminar**, Department of Atmospheric Sciences, University of Washington, Seattle, WA. *Using causal discovery to explore Arctic-midlatitude dynamics*. **McGraw, M.C.**, and E.A. Barnes.
- 2018 **Seminar**, NCAR Climate Variability and Change group, Boulder, CO. *A causal discovery approach to Arctic-midlatitude dynamics*. **McGraw, M.C.**, and E.A. Barnes.

Submitted

- 2026 **Houston Forum on Climate Linked Economics**, AMS Annual Meeting, 01/2026. *Estimating Flood Risk for an Atlantic Meridional Overturning Circulation Collapse: A Study of Climate Tipping Points in Climate Risk Modeling*. **M. McGraw**, J. Rogers, and H. Hampson.
- 2025 **24th AI Conference, AMS Annual Meeting**, New Orleans, LA, USA. *Exploring Tropical Cyclone Structure and Evolution with AI-Based Synthetic Passive Microwave Data*. **McGraw, M.C.**, K. Haynes, K.D. Musgrave, I. Ebert-Uphoff, C.J. Slocum, and J.A. Knaff.
- 2024 **36th AMS Conference on Hurricanes and Tropical Meteorology**, Long Beach, CA. *Applications of a Machine Learning Model for Estimating Tropical Cyclone Track and Intensity Forecast Uncertainty*. DeMaria, M., E.A. Barnes, M. Fernandez, R.J. Barnes, **M. McGraw**, G. Chirokova, L. Lu, P. Santos, and W.A. Hogsett.
- 36th AMS Conference on Hurricanes and Tropical Meteorology**, Long Beach, CA. *Exploring Tropical Cyclone Structure and Evolution with AI-based Synthetic Passive Microwave Data*. **McGraw, M.C.**, K. Haynes, K.D. Musgrave, C.J. Slocum, I. Ebert-Uphoff, and J.A. Knaff.
- 36th AMS Conference on Hurricanes and Tropical Meteorology**, Long Beach, CA. *TCBench: A Platform for the Data-Driven Prediction of Tropical Cyclones* (poster). Gomez, M.S., **M. McGraw**, L. Poulain-Auzeau, F. I. H. Tam, S.G. Sudheesh, S.J. Camargo, D.R. Chavas, Y. Cohen, and T. Beucler.
- 23rd AI Conference, AMS Annual Meeting**, Baltimore, MD, USA. *Exploring Tropical Cyclone Structure and Evolution with AI-based Synthetic Passive Microwave Data* (poster). **McGraw, M.C.**, K. Haynes, K.D. Musgrave, I. Ebert-Uphoff, C.J. Slocum, and J.A. Knaff.
- 23rd AI Conference, AMS Annual Meeting**, Baltimore, MD, USA. *Causal Feature Selection for Tropical Cyclone Intensity Forecasting*. Beucler, T.G., S. Ganesh Sudheesh, F. I.-H. Tam, M. S. Gomez, **M. McGraw**, M. DeMaria, K.D. Musgrave, A. Gerhardus, and J. Runge

- 2023 **22nd AI Conference, AMS Annual Meeting**, Denver, CO, USA. *What can machine learning methods tell us about the tropical cyclone intensity forecasting problem?* **McGraw, M.C.**, K.D. Musgrave, J.A. Knaff, C.J. Slocum, and I. Ebert-Uphoff.
- 22nd AI Conference, AMS Annual Meeting**, Denver, CO, USA. *Using AI To Quantify Uncertainty on Tropical Cyclogenesis.* Baldwin, M.R., C. Slocum, and **M. McGraw**.
- 22nd AI Conference, AMS Annual Meeting**, Denver, CO, USA. *Creating and Evaluating Uncertainty Estimates with Neural Networks for Environmental-Science Applications.* Haynes, K., R. Lagerquist, **M. McGraw**, K. Musgrave, and I. Ebert-Uphoff.
- 22nd AI Conference, AMS Annual Meeting**, Denver, CO, USA. *Classifying and Addressing Bias in AI/ML for the Earth Sciences.* McGovern, A., A. Bostrom, D.J. Gagne II, I. Ebert-Uphoff, K. Musgrave, **M. McGraw**, and R. Chase.
- 5th Special Symposium on Tropical Meteorology and Tropical Cyclones, AMS Annual Meeting**, Denver, CO, USA. *A Machine Learning Model for Estimating Tropical Cyclone Track and Intensity Forecast Uncertainty.* DeMaria, M., E.A. Barnes, R.J. Barnes, **M. McGraw**, L. Lu, G. Chirokova, and S.N. Stevenson.
- 2022 **Tackling Climate Change with Machine Learning Workshop, NeurIPS 2022**, remote. *Statistical adjustment of decadal climate predictions using deep learning.* Sospreda-Alfonso, R., Exenberger, J., Dang, K., and **M.C. McGraw** (spotlight presentation).
- 35th AMS Conference on Hurricanes and Tropical Meteorology**, New Orleans, LA, USA. *What can machine learning tell us about the tropical cyclone intensity forecasting problem?* **McGraw, M.C.**, K.D. Musgrave, J.A. Knaff, C.J. Slocum, and I. Ebert-Uphoff.
- 2021 **European Geophysical Union Annual Meeting**, Vienna, Austria. *Drivers of the spatial pattern of Arctic sea ice response to Arctic cyclones.* Clancy, R.P., C.M. Bitz, E. Blanchard-Wrigglesworth, and **M.C. McGraw**.
- 34th AMS Conference on Hurricanes and Tropical Meteorology**, remote. *Causal links between eastern Pacific ITCZ shifts and boundary layer dynamics.* Gonzalez, A.O., I. Ganguly, and **M.C. McGraw**.
- 2020 **American Geophysical Union Annual Meeting**, remote. *Extreme sea ice loss on subseasonal timescales in S2S forecast models* (poster). **McGraw, M.C.**, E. Blanchard-Wrigglesworth, R.P. Clancy, and C.M. Bitz.
- American Geophysical Union Annual Meeting**, remote. *Causal links between eastern Pacific ITCZ shifts and boundary layer dynamics.* Gonzalez, A.O., I. Ganguly, and **M.C. McGraw**.
- American Geophysical Union Annual Meeting**, remote. *Drivers of the spatial pattern of Arctic sea ice response to Arctic cyclones.* Clancy, R.P., C.M. Bitz, E. Blanchard-Wrigglesworth, and **M.C. McGraw**.
- 2019 **American Geophysical Union Annual Meeting**, San Francisco, CA. *Evaluating very rapid sea ice loss events in dynamical model forecasts* (poster). **McGraw, M.C.**, E. Blanchard-Wrigglesworth, R.P. Clancy, and C.M. Bitz.

- 2018 **American Geophysical Union Annual Meeting**, Washington, DC. *Using causal discovery to explore Arctic-midlatitude dynamics*. **McGraw, M.C.**, and E.A. Barnes.
- NCAR Climate Variability and Change Working Group Meeting**, Boulder, CO. *Causal discovery and midlatitude jet variability*. **McGraw, M.C.**, and E.A. Barnes.
- 2017 **American Geophysical Union Annual Meeting**, New Orleans, LA. *Revisiting causal links between the Arctic and midlatitudes*. **McGraw, M.C.**, and E.A. Barnes.
- 7th International Workshop on Climate Informatics**, Boulder, CO. *A study of causal links between the Arctic and the midlatitude jet-streams* (spotlight presentation). Samarasinghe, S., **M.C. McGraw**, E.A. Barnes, and I. Ebert-Uphoff (co-first author with S. Samarasinghe).
- 21st AMS Conference on Atmospheric and Oceanic Fluid Dynamics**, Portland, OR. *Causal links between the Arctic and the midlatitude jets*. **McGraw, M.C.**, and E.A. Barnes.
- 21st AMS Conference on Atmospheric and Oceanic Fluid Dynamics**, Portland, OR. *Multi-scale response of moisture flux to projected sea ice loss* (poster). **McGraw, M.C.**, C.F. Baggett, C. Liu, B.D. Mundhenk, and E.A. Barnes.
- NCAR Climate Variability and Change Working Group Meeting**, Boulder, CO. *Comparing lagged regression and Granger causality in climate science*. **McGraw, M.C.**, and E.A. Barnes.
- 2016 **American Geophysical Union Annual Meeting**, San Francisco, CA. *Comparing the forced response to volcanic eruptions against internal variability in climate models* (poster). **McGraw, M.C.**, and E.A. Barnes.
- SPARC Dynamical Variability Workshop**, Helsinki, Finland. *Understanding the forced response to volcanic eruptions in climate models within the context of internal variability*. **McGraw, M.C.**, and E.A. Barnes.
- NCAR Climate Variability and Change Working Group Meeting**, Boulder, CO. *Understanding the forced response to volcanic eruptions in climate models*. **McGraw, M.C.**, and E.A. Barnes.
- 2015 **SPARC Storm Tracks Workshop**, Grindelwald, Switzerland. *Seasonal sensitivity of the eddy-driven jet to tropospheric heating in an idealized AGCM* (poster). **McGraw, M.C.**, and E.A. Barnes.
- 20th AMS Conference on Atmospheric and Oceanic Fluid Dynamics**, Minneapolis, MN. *Seasonal sensitivity of the eddy-driven jet to tropospheric heating in a simple model* (poster). **McGraw, M.C.**, and E.A. Barnes.

Teaching, Mentoring, Outreach, & Service

- Public Talks** **Colorado Climate Week**, 2026. *This Year's Snowpack and Colorado's Climate Resilience*.
- 100-Hour Weather and Climate Livestream**, 2025. *Artificial Intelligence and Tropical Cyclone Forecasting*.

Mentoring	Marshall Baldwin, NOAA Hollings Scholar program, Cooperative Institute for Research in the Atmosphere, 2022
	Julia Shates, NSF REU program, Atmospheric Science, Colorado State University, 2014
Education and Teaching	Workshop Mentor, Climate Change AI, 2026
	Team Mentor, Climate Change AI Summer School, 2022
	Guest Lecturer, NSF AI2ES Summer School on Trustworthy AI, 2022
	Instructor, Trustworthy AI Hackathon, 2022
	Graduate Teaching Assistant, Objective Analysis for Atmospheric Sciences, 2018
	Graduate Teaching Assistant, Atmospheric Dynamics I, 2015
Professional Service	Proposal reviewer, NASA Postdoctoral Program, 2026
	Program Committee member, Tackling Climate Change with Machine Learning Workshop, NeurIPS, 2023 - 2024
	Session chair, American Meteorological Society AI Conference, 2023 - 2024
	Panel reviewer, National Science Foundation Office of Advanced Cyberinfrastructure, FY2023
	Diversity, Equity and Inclusion Committee member, University of Washington, 2019 - 2021
	Proposal reviewer (ad-hoc), National Science Foundation, 2019 - present
	Peer reviewer: <i>Journal of Climate</i> , <i>Geophysical Research Letters</i> , <i>Nature Climate Change</i> , <i>Weather and Climate Dynamics</i> , <i>Journal of Geophysical Research: Atmosphere</i> , <i>Earth System Dynamics</i> , <i>Quart. J. Roy. Meteorol. Soc</i> , <i>Weather and Forecasting</i> , <i>Artificial Intelligence in the Earth Systems</i> , <i>Atmospheric Science Letters</i> , <i>Bull. Amer. Meteorol. Soc.</i> , <i>Nature Communications</i> , <i>Journal for Advances in Modeling in Earth Systems</i>

Workshops, Tutorials, & Summer Schools

2024	6th NOAA Workshop on Leveraging AI in Environmental Sciences , Boulder, CO.
2023	Front Range Tropical Cyclone Workshop , Boulder, CO.
	5th NOAA Workshop on Leveraging AI in Environmental Sciences , virtual.
2022	Front Range Tropical Cyclone Workshop , Fort Collins, CO.
	4th NOAA Workshop on Leveraging AI in Environmental Sciences , virtual.
	Trustworthy Artificial Intelligence for Environmental Science Summer School , virtual.
	Aspen Global Change Institute Workshop on Earth System Modeling with Machine Learning and Big Data , Aspen, CO. Travel funded.

- 2021 **3rd NOAA Workshop on Leveraging AI in Environmental Sciences**, virtual.
 Trustworthy Artificial Intelligence for Environmental Science Summer School, virtual.
- 2019 **CMIP6 Hackathon**, Boulder, CO. Travel funded.
- 2018 **8th International Workshop on Climate Informatics**, Boulder, CO.
 CESM Polar Modeling Workshop, Boulder, CO. Travel funded.
- 2017 **7th International Workshop on Climate Informatics**, Boulder, CO.
- 2016 **NCAR Community Earth System Model Tutorial**, Boulder, CO. Travel funded.
 SPARC Dynamical Variability Workshop, Helsinki, Finland. Travel funded.
- 2015 **SPARC Storm Tracks Workshop**, Grindelwald, Switzerland. Travel funded.