Mohammad M. Amirian

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Google Scholar | GitHub | LinkedIn | Home Page

Research Profile

Applied mathematician and statistician studying phytoplankton physiology, marine primary production, and ocean carbon cycling. I combine mechanistic models, statistical inference, and machine learning with experimental and observational data. Some of my research contributions are a memory-based extension of microbial growth models, a mathematical formulation of phytoplankton photoinhibition, the open-source R package *piCurve*, and the photosynthesis–irradiance database *piData*. My current work develops methods for surface-ocean pCO_2 reconstruction and predictive uncertainty quantification.

Academic Appointments

2026–present
May

Postdoctoral Fellow
New York City College of Technology, City University of New York, USA

- Develop statistical and machine-learning approaches for surface-ocean pCO_2 reconstruction and uncertainty quantification.
- Work with the Terra Data to Insights Lab & LEAP at Columbia University.

2025–2026
Aug –May

Postdoctoral Fellow
Dalhousie University, Halifax, Canada
Marine Microbial Macroecology Lab, Department of Oceanography

- Model phytoplankton photosynthetic responses to irradiance and environmental variability.
- Develop the *piData* compilation and *piCurve* software for photosynthesis–irradiance analysis.

Education

2020–2025
Jan –Aug

PhD in Statistics, Dalhousie University, Canada
Thesis: *Modelling Phytoplankton Growth Rates under Changing Resource Conditions*.
Supervisor: Dr. Andrew J. Irwin.

2013–2016
Sep –Mar

Master's Degree in Applied Mathematics, Tarbiat Modares University, Iran
Thesis: *Fractional Calculus Models of Complex Dynamics in Biological Elements.*

2009–2013
Sep –Sep

Bachelor's Degree in Pure Mathematics, Malayer University, Iran.

Publications

Peer-reviewed journal articles: published and accepted

2026

K Kam, E Devred, S Clay, **MM Amirian**, D Atamanchuk, D.W.R Wallace. *Resolving satellite-in situ mismatches in Net Primary Production using high-frequency in situ bio-optical observations in the subpolar Northwest Atlantic,* arXiv:2604.08634 | Remote Sensing; Accepted.

2026

ZV Finkel, AJ Irwin, **MM Amirian**, S Sharoni, MJ Follows. *A macromolecular evaluation of the growth rate hypothesis in the ocean,* Proceedings B; Accepted.

2026

P Fahimi, **MM Amirian**, AJ Irwin, ZV Finkel. *Carbon-to-ATP ratios across the kingdoms of life,* iScience. 10.1016/j.isci.2026.116849.

2026 S Sharoni, K Inomura, S Dutkiewicz, O Jahn, ZV Finkel, AJ Irwin, **MM Amirian**, E Monier, MJ Follows. *Biochemical remodeling of phytoplankton cell composition under climate change,* Nat. Clim. Chang. 10.1038/s41558-026-02598-w.

2025 D Croteau, S Guérin, M Savoie, N Donaher, **MM Amirian**, M Babin , DA Campbell, J Lavaud. *Nonphotochemical quenching and beyond: multi-layered photoprotection shapes light-stress tolerance across seasonal niches in Arctic diatoms,* Front. Photobio.:10.3389/fphbi.2025.1745893.

2025 **MM Amirian**, E Devred, ZV Finkel, AJ Irwin. *Parameterization of Photoinhibition for Phytoplankton.* Commun. Earth & Environ: 10.1038/s43247-025-02686-3.

2025 E Devred, S Clay , T Perry, **MM Amirian**, AJ Irwin, Z Finkel. *Net primary production in the Labrador Sea between 2014 and 2022 derived from ocean colour remote sensing based on ecological regimes.* Remote Sensing of Environment:10.1016/j.rse.2025.114713.

2023 L Eftekhari, **MM Amirian**. *Stability analysis of fractional order memristor synapse-coupled Hopfield neural network with ring structure.* Cognitive Neurodynamics:10.1007/s11571-022-09844-9.

2022 **MM Amirian**, AJ Irwin, Z Finkel. *Extending the Monod Model of Microbial Growth with Memory.* Front. Mar. Sci.: 10.3389/fmars.2022.963734.

2020 **MM Amirian**, I Towers, Z Jovanoski, AJ Irwin. *Memory and mutualism in species sustainability: a time-fractional Lotka-Volterra model with harvesting.* Heliyon, 6(8): 04816. 10.1016/j.heliyon.2020.e04816.

2020 M Khalighi, **MM Amirian**, A Malek. *A new approach to solving multiorder time-fractional advection-diffusion-reaction equations using BEM and Chebyshev matrix.* Mathematical Methods in the Applied Sciences, 44(4): 10.1002/mma.6352.

2019 **MM Amirian**, Y Jamali. *The concepts and applications of fractional order differential calculus in modeling of viscoelastic systems: a primer.* Critical Reviews^{TM} in Biomedical Engineering, 47(4): 10.1615/CritRevBiomedEng.2018028368.

Accepted workshop paper

2026 G Accarino, **MM Amirian**, TH Heimdal, AR Fay, GA McKinley, V Acquaviva. *Learning Calibrated and Samplable Predictive Distributions of Surface-Ocean* ΔpCO_2 *Using Tabular Diffusion Models*, Representations for the Physical Sciences (RPS) Workshop, NeurIPS 2026. Accepted.

Manuscripts under review

2026 SB Pollara, ME Roberts, R Stevens-Green, J LaRoche, L Jabre, E Rowland, CE McBride, RE Sipler, S Clay, E Devred, **MM Amirian**, ZV Finkel, AJ Irwin, J Young, M Mars-Brisbin, EM Bertrand. *Low proteomic investment in carbon fixation facilitates the success of Phaeocystis in the Labrador Sea,* Under review, The ISME Journal.

2026 D Donno, I Epicoco, M Cafaro, G Accarino,**MM Amirian**, V Acquaviva, P Nassisi, D Iovino, A Bracco, S Masina, P Gentine. *NEPTUNE: An AI model for global ocean seasonal forecasting.* arXiv:2609.08606 | Under review, Nature Computational Science.

2026 **MM Amirian**, AJ Irwin. *piCurve: an R package for photosynthesis–irradiance modeling, surface irradiance estimation, and phytoplankton absorption,* GitHub: version 0.4.5. Under review, Methods in Ecology and Evolution. Preprint: arXiv:2508.14321.

2026 **MM Amirian**, ZV Finkel, E Devred, AJ Irwin. *A Compilation of Marine Photosynthesis–Irradiance Data from* ^{14}C *Incubation Experiments,* doi: 10.5281/zenodo.21908199 | Under review, Earth System Science Data.

Other preprints

2018 A Mazarei, **MM Amirian**, G Riazi, Y Jamali. *The Role of Topology in the Synchronization of Neuronal Networks Based on the Hodgkin-Huxley Model.* arXiv:1812.02297.

Manuscripts in preparation

2026 **MM Amirian**, P Fahimi, ZV Finkel, E Devred, S Clay, AJ Irwin. *Ecophysiological modeling of marine photosynthesis: a hybrid model* (in prep.)

2026 **MM Amirian**, E Devred, V Acquaviva, ZV Finkel, AJ Irwin. *Latitudinal, Seasonal, and Diel Variation in Marine Phytoplankton Photophysiology and Its Effects on Net Primary Production* (in prep.)

Research Software and Datasets

piCurve — Open-source R package for fitting and analysing phytoplankton photosynthesis–irradiance curves, including photoinhibition, surface irradiance estimation, and phytoplankton absorption. Developer and maintainer.

piData — Compilation of marine photosynthesis–irradiance measurements from ^{14}C incubation experiments, developed for Fisheries and Oceans Canada. Data and code repository.

Research Supervision and Mentoring

2026–present **Co-mentor, master's student**, Columbia University.
Symbolic regression methods for global pCO_2 reconstruction.

2025–present **Research mentor, PhD student**, Dalhousie University.
Quantifying mathematical sources of uncertainty in net primary production estimates.

2023 **Research supervisor, independent researcher**.
Fractional-order models of neural dynamics and stability analysis; collaboration resulted in a publication in *Cognitive Neurodynamics*.

Teaching Experience

Course instructor, Dalhousie University

2025 **STAT 1060: Introductory Statistics for Science and Health Sciences**.
- Fall section 01 & 02; class size: ∼#480 students

2024 **STAT 1060: Introductory Statistics for Science and Health Sciences**.
- Summer A; class size: ∼#170 students

Teaching assistant, Dalhousie University

2022–2024 **STAT 2060**: Introduction to Probability and Statistics.

2022, 2024 **STAT 1060**: Introductory Statistics for Science and Health Sciences.

2021 **MATH 1290**: Engineering Mathematics II; **MATH 2300**: Mathematical Modeling.

2020 **STAT 2450**: Introduction to Data Mining with R.

Conference Contributions

2026 **MM Amirian**, G Accarino, V Acquaviva, *Improving Global Ocean Surface pCO_2 Prediction Using Biogeographic Residual Correction,* American Geophysical Union

2026 G Accarino, **MM Amirian**, V Acquaviva, *Beyond Point Predictions: Diffusion-Based Probabilistic Reconstruction of Global Surface Ocean pCO_2,* American Geophysical Union

2026 **MM Amirian**, E Devred, S Clay, Z Finkel, AJ Irwin. *A compilation of photosynthetic rate incubation experiments and analysis using common models* CBIOMES Annual Meeting, Flatiron Institute, NY, USA.

2026 **MM Amirian**, P Fahimi, Z Finkel, E Devred, S Clay, AJ Irwin. *Ecophysiological Modeling of Marine Photosynthesis.* Ocean Science Meeting .

2025 **MM Amirian**, P Fahimi, Z Finkel, E Devred, S Clay, AJ Irwin. *Ecophysiological Modeling of Marine Photosynthesis.* CBIOMES Annual Meeting, Flatiron Institute, NY, USA.

2024 K Kam, E Devred, S Clay, **MM Amirian**, AJ Irwin, D Atamanchuk, D.W.R Wallace. *Re-evaluating methodologies for estimating marine primary productivity in the Labrador Sea using satellite and in situ observations* Ocean Optics Conference.

2023 **MM Amirian**, JT Siddons, AJ Irwin. *Extending the Monod model of microbial growth with memory and an application to phytoplankton community dynamics.* ASLO Meeting.

2023 **MM Amirian**, Z Finkel, AJ Irwin. *A New Model of Phytoplankton Photoinhibition.* CDOGS Annual Meeting, Dalhousie.

2022 **MM Amirian**, JT Siddons, AJ Irwin. *Quantify the Cell Memory and Its Influence on Phytoplankton Resource Competition.* CBIOMES Annual Meeting, Flatiron Institute, NY, USA.

2021 **MM Amirian**, AJ Irwin. *Extending the Monod Model of Microbial Growth with Memory.* CBIOMES Annual Meeting, Flatiron Institute, NY, USA.

2020 **MM Amirian**, AJ Irwin. *A New Mechanistic Growth Model: Monod-Memory.* CBIOMES Annual Meeting, Flatiron Institute, NY, USA.

2015 **MM Amirian**, Y Jamali. *Fractional Calculus Applied to Model Cell Viscoelasticity.* 22nd Iranian Conference on Biomedical Engineering (ICBME) - Mathematics in Biomedical Engineering.

2015 **MM Amirian**, Y Jamali. *Prediction of Local Measurement of Cell Viscoelasticity with Fractional Calculus Approach.* 3rd Dubai International Conference on New Approaches in Sciences Engineering & Technology, 2015 December 9-10 Zayed University.

2015 **MM Amirian**, A Mazarei. *Prediction of Action Potential in Neuron with Fractional Calculus Approach.* 3rd Dubai International Conference on New Approaches in Sciences Engineering & Technology, Zayed University, December 9–10.

Workshop Talks and Tutorials

Oct. 2025 **Modelling Primary Production**, Faculty of Science, Split, Croatia.
Delivered a tutorial on *piCurve* and a research talk on phytoplankton photoinhibition modelling.

Mar. 2025 **Modelling Primary Production**, Flatiron Institute, New York, USA.
Participated in the workshop and jointly presented with Andrew Irwin on quantifying the effects of photoinhibition on photosynthetic rate.

Technical Expertise

Programming: R (advanced); working knowledge of Python, Julia, and MATLAB.
Statistical modelling: Generalised additive models, mixed-effects models, Bayesian modelling,

regularisation, and nonlinear model fitting.
Machine learning: Predictive modelling with tidymodels, XGBoost, random forests, and kernel methods.
Scientific computing: Differential-equation modelling, parallel computing, data processing, and visualisation.
Research tools: LaTeX, Jupyter, and Pluto.

Awards and Research Support

Scholarships and travel support

2022 **Travel Grant**, Faculty of Graduate Studies, Dalhousie University.

2019 **Biomedicine Discovery Scholarship**, Monash University. Awarded; not taken up.

2019 **Tuition Fee Scholarship**, University of New South Wales. Awarded; not taken up.

Research assistantship

2019 **Doctoral research assistantship**, Department of Mathematics and Statistics, Dalhousie University; support over 4.5 years.

Academic distinctions

2013 **National M.Sc. Entrance Examination (Konkour), Iran**
Ranked 237th in applied mathematics and 261st in pure mathematics among 9,230 candidates (top 3% nationally).

Academic Service

Journal peer review: *Environmental Management*; *Ecological Informatics*; *Qualitative Theory of Dynamical Systems*; *Scientific Reports*; *Biogeosciences*.

Research Communication

2025 Coverage of phytoplankton photoinhibition research in CBIOMES and ScienMag. Author of a Springer Nature Behind the Paper article.

Languages

Farsi (native) & English (fluent)

References

Andrew J. Irwin — PhD advisor
Department of Mathematics and Statistics,
Dalhousie University, Canada
A.irwin@dal.ca

Zoe V. Finkel — Research collaborator
Department of Oceanography,
Dalhousie University, Canada
Zfinkel@dal.ca

Emmanuel Devred — Research collaborator
Fisheries and Oceans Canada, DFO,
Dartmouth, Canada
Emmanuel.devred@dfo-mpo.gc.ca

Sarah Chisholm — Teaching reference
Department of Mathematics and Statistics,
Dalhousie University, Canada
Sarahchisholm@dal.ca