

Siya Shao, PhD

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RESEARCH INTERESTS

Plant-microbe interaction, ecosystem modeling, mycorrhizal fungi, global change biology, biogeochemical cycles, enhanced rock weathering, carbon sequestration

PROFESSIONAL EXPERIENCE

2026-present **Assistant Professor, Department of Microbiology, University of Tennessee, Knoxville**

2023-2026 **Postdoctoral Researcher, Lawrence Berkeley National Laboratory (funded by University of Arizona)**

Advisors: Dr. William Riley (LBNL), Dr. Scott Saleska (University of Arizona)

Research project: Integrating **mineral dissolution kinetics** into an ecosystem model to investigate **biota–mineral interactions** for optimized **enhanced rock weathering** as a climate mitigation strategy; extending this framework into **digital twins** of ecosystem evolution for land restoration and Mars terraforming.

2021-2023 **Postdoctoral Researcher, Dartmouth College**

Advisors: Dr. Caitlin Hicks Pries (Dartmouth College), Dr. Benjamin Sulman (Oak Ridge National Laboratory)

Research project: Testing mechanisms of how different mycorrhizal associations affect forest **soil carbon-nitrogen cycling** to inform forest management.

EDUCATION

2015-2021 **Ph.D., Geography, McGill University**

Advisors: Dr. Nigel Roulet (McGill University), Dr. Jianghua Wu (Memorial University of Newfoundland)

Thesis: *Modeling microbial dynamics and nutrient cycles in ombrotrophic peatlands*

2012-2015 **M.S., Global Environmental Change, Beijing Normal University**

Advisor: Dr. Jing Zhang

Thesis: *Evaluating the influence of aerosol direct radiative effects on global terrestrial ecosystem carbon cycle*

PUBLICATIONS

Peer-reviewed publications (listed in reverse chronological order)

1. **Shao, S.**, Shortt, Z.*, Sulman, B., & Hicks Pries, C. (2025). Modeling mycorrhizal carbon costs in temperate forests: the impacts of functional diversity and global change factors. *Journal of Geophysical Research: Biogeosciences*, 130(10), e2025JG009198, doi: 10.1029/2025JG009198. Invited contribution to “**Biogeosciences Leaders of Tomorrow**” Special Collection. (* indicates mentored student)
 - Featured on AGU’s Eos Research Spotlight: *How Plant-Fungi Friendships Are Changing*
2. Zhang, C., Ke, W., Hicks Pries, C., Montañó-López, F., Ridgeway, J., Wang, L., Yin, Y., Ye, S., Song S., Liu X., Dou X., Guo X., Li M., **Shao S.**, Lv S., Zheng Y., Lin G. (2025), Higher nitrification and lower consumption drive higher N₂O effluxes in estuarine than non-estuarine mangrove wetlands. *Environmental Research Letters*. 20(4), 044022, doi: 10.1088/1748-9326/adbdde
3. **Shao, S.**, Sulman, B. (2024), Eco-evolutionary insights into microbial litter decomposition. *New Phytologist*. 243: 825–827, doi: 10.1111/nph.19746
4. **Shao, S.**, Wurzbürger, N., Sulman, B., Hicks Pries, C. (2023). Ectomycorrhizal effects on decomposition are highly dependent on fungal traits, climate, and litter properties: A model-based assessment. *Soil Biology and Biochemistry*. 184, 109073, doi: 10.1016/j.soilbio.2023.109073
5. **Shao, S.**, Wu, J., He, H., Moore, T.R., Bubier, J., Larmola, T., Juutinen, S. and Roulet, N.T. (2023). Ericoid mycorrhizal fungi mediate the response of ombrotrophic peatlands to fertilization: a modeling study. *New Phytologist*. 238, 80–95. doi: 10.1111/nph.18555
6. **Shao, S.**, Wu, J., He, H., Roulet, N. (2022). Integrating McGill Wetland Model (MWM) with peat cohort tracking and microbial controls. *Science of The Total Environment*, 806, 151223, doi: 10.1016/j.scitotenv.2021.151223
7. **Shao, S.**, Zhang, J., Zhou, L., Qiao, Y. (2018), Impacts of Aerosol Direct Radiative Effect on Carbon Cycle in Global Terrestrial Ecosystem, *Journal of Natural Resources*, 33(1): 37-51, doi: 10.11849/zrzyxb.20161109.
8. **Shao, S.**, Zhang, J., Zhou, L., Xue, W. (2017). Aerosol effects on global surface solar radiation based on Fu-Liou modeling and satellite observations, *Resources Science*, 39(3): 513-521, doi: 10.18402/resci.2017.03.13.
9. Zhang, J. Lyu, Z., **Shao, S.**, Li, F., Yang, S., Song, W., Li. W., Li. S., Chin Li. (2016). Effects of aluminum toxicity induced by acid deposition on pine forest ecosystem in Longli of Guizhou Province,

southwestern China. *Chinese Geographical Science*, 26(4): 495–507, doi: 10.1007/s11769-015-0763-0.

10. **Shao, S.**, Zhang, J. (2015). All-sky direct radiative effects of urban aerosols in Beijing and Shanghai, China, *Atmospheric and Oceanic Science Letters*, 8, 295–300, doi:10.3878/AOSL20150017.

Selected manuscripts in review or advanced preparation

11. Shi, X., Ricciuto, D., Wang, Y., Hanson, P., Mao, J., Luo, Y., Xu, X., Hui, D., He, H., **Shao, S.**, Hussain, A., Sun, Q., Qiu, C., Ito, A., Melton, J., Burke, E., Joos, F., Zhuang, Q., Dai, Y., & Lu, X. SPRUCE-MIP: multi-model intercomparison of northern peatland carbon cycle over a peatland site (*in review*)
12. Yang, S., Tang, J., Li Z., **Shao, S.**, Zhang, L., Yuan, K., Wu, Q., Hodgkins, S., Wilson, R., Zhu, Q., Grant, R., Riley, W., Saleska, S., Rich, V., Varner, R., Temporal Variability in the Causal Dynamics of Methanogenesis and Methanotrophy in a High-Latitude Fen Peatland (*in review*)
13. Rocci, K. S., **Shao, S.**, Sulman, B. N., Aguilar-Trigueros, C. A., DeLancey, L. C., Edwards, J., Frey, S. D., Kivlin, S. N., Limbu, S. P., Morrison, E. W., Poelen, J., Shulman, H., Zanne, A., Zhang, H., & Camenzind, T. Aligning measured and modeled fungal traits for improved understanding of fungal controls on soil carbon cycling (*in prep*).
14. **Shao, S.**, Riley, W., Grant, S., Li Z., Yang, S., Tang, J., Beerling, D., Taylor, L., Zhang, L., Saleska, S., Biological processes govern carbon removal during enhanced rock weathering (*in prep*)
15. **Shao, S.**, Sulman B., Hicks Pries C., Inclusion of Mycorrhizal Functional Diversity Improved Ecosystem Model Predictions on Soil Nitrogen Cycles (*in prep*)
16. Esquivel, K. E., Sohng, J., O’Geen, A. T., Ben-Israel, M., Whiteaker, S., Schmidt, R., Georgiou, K., Li, Z., **Shao, S.**, Maxbauer, D. P., Planavsky, N. J., Montañez, I. P., Pett-Ridge, J., Sokol, N. W. Beyond Weathering: Combining Organic and Inorganic Soil-Based Carbon Drawdown (*Perspective manuscript: pre-submission inquiry submitted to Nature Geoscience*)

GRANT AND FUNDING CONTRIBUTIONS

Co-PI, Department of Energy, Genesis Mission

“Transforming subsurface prediction with an autonomous, multi-agent AI workflow for multi-scale coupled bio-hydrogeochemical modeling”

\$585K; Phase I through 2026-2027.

Contributor, University of Arizona, Big Idea Challenge Proposal

“From early Earth to Mars: Advancing an integrated “Landscape Terraformation science” of how life

transforms planets with a multi-scale collaborative digital twinning of Biosphere 2"
\$250K; Funded through 2025-2027.

PRESENTATIONS

Invited talks

1. **Shao, S.**, Sulman, B., Hicks Pries, C., How mycorrhizal fungi shape ecosystem biogeochemical cycles: insights from mycorrhizae-explicit modeling efforts [B25B-05] presented at the Fall Meeting, AGU, New Orleans LA, USA (December 2025)
2. **Shao, S.**, Representing plant–microbe–mineral interactions in ecosystem models: does added complexity enable new insights? Research seminar at Savannah River Ecology Laboratory (attended virtually), University of Georgia, Aiken, SC, USA (December 2025)
3. **Shao, S.**, Riley, W., Grant, S., Saleska, S., Modeling enhanced rock weathering with field validation: Unveiling ecological and geochemical interactions in ecosystems. Lawrence Berkeley - Lawrence Livermore National Lab mini-workshop on soils CDR MRV, Berkeley, CA (July 2025)
4. **Shao, S.**, Riley, W., Grant, S., Saleska, S., Modeling Enhanced Rock Weathering with Field Validation: Unveiling Ecological and Geochemical Interactions in Croplands. BGC Meeting (attended virtually), Lawrence Livermore National Laboratory, Livermore, CA (Feb 2025)
5. **Shao, S.**, The development of McGill Wetland Model (MWM). Peatland modeling workshop (attended virtually), Exeter, UK (March 2024)
6. **Shao, S.**, Sulman, B., Hicks Pries, C., The importance of mycorrhizal fungi through the lens of modeling. Ecology, Evolution, Environment & Society (EEES) graduate program of Dartmouth College, Hanover, NH (October 2023)
7. **Shao, S.**, Sulman, B., Hicks Pries, C., Wu, J., He, H., Roulet, N., From peatlands to forests: the importance of mycorrhizal fungi through the lens of modeling. Environmental Sciences Division, Oak Ridge National Laboratory, Oak Ridge, TN (June 2023)
8. **Shao, S.**, Wu, J., He, H., Roulet, N., Modeling responses of ombrotrophic peatlands to environmental changes-the significance of ericoid mycorrhizal fungi. Next-Generation Ecosystem Experiments (NGEE) Arctic monthly conference call (attended virtually) (Jan 2021)
9. **Shao, S.**, Wu, J., He, H., Roulet, N., Modeling biogeochemical cycles in northern ombrotrophic peatlands-the significance of plant-microbe interaction. SPRUCE all-hand meeting (attended virtually), Oak Ridge National Laboratory, Oak Ridge, TN (Nov 2020)

Selected conference presentations

10. **Shao, S.**, Riley, W., Grant, R., Zhen, L., Yang, S., Tang, J., Saleska, S. Modeling Enhanced Rock Weathering with Field Validation: Unveiling Ecological and Geochemical Interactions in Croplands, abstract [B11B-05] presented at the Fall Meeting, AGU, New Orleans LA, USA (December 2025)
11. **Shao, S.**, Riley, W., Grant, R., Saleska, S. Simulating enhanced rock weathering using the ecosys model: validation with US Corn Belt field data, abstract [B11H-1426] presented at the Fall Meeting, AGU, Washington DC, USA (December 2024)
12. **Shao, S.**, Sulman, B., Hicks Pries, C. Modeling mycorrhizal carbon costs in temperate forests: the impacts of functional diversity and global change factors, abstract [B31D-03] presented at the Fall Meeting, AGU, San Francisco, CA, USA (December 2024)
13. **Shao, S.**, Sulman, B., Hicks Pries, C. How climate, nitrogen deposition, and resource partitioning affect the carbon cost of different mycorrhizal strategies, abstract [B21J-208] presented at the Fall Meeting, AGU, San Francisco, CA, USA (December 2023)
14. **Shao, S.**, Sulman, B., Hicks Pries, C. Inclusion of Mycorrhizal Functional Diversity Improved Ecosystem Model Predictions on Soil Nitrogen Cycles, abstract [B21J-2081] presented at the Fall Meeting, AGU, San Francisco, CA, USA (December 2023)
15. **Shao, S.**, Sulman, B., Hicks Pries, C. How do different nitrogen acquisition strategies of mycorrhizal fungi affect soil carbon cycling? A model-based assessment, abstract [B23D-03] presented at the Fall Meeting, AGU, Chicago, IL, USA (December 2022)
16. **Shao, S.**, Sulman, B., Wurzbarger, N., Hicks Pries, C. Seasonality in temperature and litterfall along with nitrogen preference of ectomycorrhizal fungi may determine the strength of the Gadgil effect, abstract [PS 30-110] presented at the ESA Annual Meeting, Montreal, QC, Canada (August 2022)
17. **Shao, S.**, Wu, J., Roulet, N. Response of ombrotrophic peatlands to environmental changes: role of nutrient cycling mediated by plant-microbe interactions, abstract [B21D-08] presented virtually at the Fall Meeting, AGU, New Orleans, LA, USA (December 2021)
18. **Shao, S.**, Roulet, N., Moore, T., Larmola, T., Wu, J. The potential significance of ericoid mycorrhizal fungi in ombrotrophic peatlands: a modeling study, abstract [B096-0003] presented virtually at 2020 Fall Meeting, AGU, San Francisco, CA, USA (Dec 2020)
19. **Shao, S.**, Roulet, N., Wu, J. Integrating McGill Wetland Model (MWM) with microbial controls and nutrient dynamics, abstract [B23L-2512] presented at 2019 Fall Meeting, AGU, San Francisco, CA, USA (Dec 2019)

TEACHING AND MENTORING EXPERIENCE

- 2025-present **PhD Student Committee Member**, Memorial University of Newfoundland
Serving as a supervisory committee member for two PhD students Yueyue Xing and Celestine Neba Suh (PI: Dr. Jianghua Wu), focusing on advancing the McGill Wetland Model (MWM) for wetland biogeochemical simulations.
- 2022-2024 **Project Advisor**, Dartmouth College
Mentored undergraduate Zachary Shortt in a research project “When do mixed mycorrhizal forest have the lowest carbon cost for nitrogen uptake”, guiding him through model simulation design and data analysis. This resulted in one manuscript published in *JGR Biogeosciences*.
- 2023 **Guest lecturer**, Dartmouth College
Gave guest lecture talk of “Introduction to modeling environmental systems” to the course BIOL 26 (Global Change Biology) with positive feedback for making complex topics engaging and interesting.
- 2015-2020 **Teaching Assistant and Guest Lecturer**, McGill University
- Courses: GEOG 203 (Environmental Systems), GEOG 501 (Modelling Environmental Systems), GEOG 321 (Climatic Environments), GEOG 205 (Global Change: Past, Present and Future), GEOG 407 (Issues in Geography)
 - Conducted tutoring sessions, assessed assignments and presentations, and provided targeted feedback to enhance student learning outcomes.
 - Gave guest lectures on ecosystem modeling and mentored students in building environmental system models in GEOG 501 and GEOG 407, resulting in improved student comprehension and practical modeling skills.

HONORS AND AWARDS

- 2025 **Invited Author, Next Generation Leaders Special Collection, JGR Biogeosciences**
 Selected by the Editorial Board and AGU's *Biogeosciences* Section as a **future research leader** to contribute an invited manuscript to the journal's special collection on the **next 20 years of biogeosciences research** (published).
- 2020 Graduate Excellence Fund Dissertation Writing Award, McGill University, \$4,000
- 2018 Graduate Excellence Fund Dissertation Writing Award, McGill University, \$17600
- 2017 Professor Emeritus Ben Garnier Fellowship, McGill University, \$4,600
- 2014 Outstanding Leadership Award, Beijing Normal University, \$500

SERVICES

Professional services:

Selected Member, MicrobeNet^Net (NSF AccelNet Project), 2025–present

Selected to join a global network advancing international collaboration in plant–microbe interaction research. Contributing to a working group focused on integrating fungal traits into soil biogeochemical models.

Session Convener, AGU Fall Meeting 2025, New Orleans

Session B068: *Peatland Carbon Cycling: Trace Gas Fluxes, Net Ecosystem Exchange, Decomposition, and Respiration*

Co-conveners: *Daniel Ricciuto, Xiaoying Shi, and Randall Kolka*

Session Convener, AGU Fall Meeting 2022, Chicago

Session B25I: *The Effect of Plant Communities and Their Microbial Associations on Soil Biogeochemistry*

Co-conveners: *Caitlin Hicks Pries*

Journal editorial board:

Frontiers in Environmental Science

Journal Review:

Nature Microbiology, Nature Water, Nature Communications, Communications Earth and Environment, Global Change Biology, New Phytologist, Geophysical Research Letters, Geoscientific Model Development, Journal of Advances in Modeling Earth Systems, Geoderma, Catena, JGR Biogeosciences, Functional Ecology, Frontiers in Forests and Global Change

Professional society memberships:

2025-present, MicrobeNet^Net

2025-present, Mycological Society of America
 2024-present, MathPeat INI Network
 2022-present, Canadian Society for Ecology and Evolution
 2019-present, C-PEAT
 2019-present, Ecological Society of America
 2019-present, American Geophysical Union

Outreach & Broader Impact:

- Science Day Volunteer, Dartmouth College (2023)
 Led hands-on soil science activities for 5th–10th grade students during Dartmouth’s annual Science Day, introducing participants to what soil is, why it matters, and how scientists study soils.

TECHNICAL SKILLS

Software and Programing:

Proficient in Fortran, Python, MATLAB, R, Stella, and C. Experienced in Linux environments and high-performance computing systems. Currently developing knowledge-guided machine learning (KGML) surrogates from process-based model outputs and experimental data to build digital twins. Familiar with GPU-accelerated workflows for fast emulation of long-term ecosystem processes.

Additional Training:

2025 NERSC Nways to GPU Programming Bootcamp (3-day online workshop), National Energy Research Scientific Computing Center (NERSC) in collaboration with the OpenACC Organization and NVIDIA, USA

2022 Community Terrestrial Systems Model (CTSM) mini-Tutorial Training (2-day online workshop), University Corporation for Atmospheric Research (UCAR), USA

OTHER PROFESSIONAL EXPERIENCE

2018-2019 **Research Assistant**
 United Nation Environmental Program (UNEP)-McGill partnership, Montreal, Canada
 Reviewed methodologies for UNEP to assess environmental risks and impacts.

2018 **Policy Analyst**
 OECD (Organisation for Economic Co-operation and Development), Paris, France
 Reviewed Chinese agricultural policies on grain reserves and distribution. Compiled land-use climate policies from China, India, and Brazil.

2017 **Research and Development Advisor**
 Cuso-International, Ottawa, ON
 Researched sustainable tourism and climate adaptation policies in Myanmar.

REFERENCES

William Riley (Postdoc Advisor)

Senior Scientist, Climate and Ecosystem Sciences Division, Lawrence Berkeley National Laboratory

Email: [wj Riley@lbl.gov](mailto:wjriley@lbl.gov)

Scott Saleska (Postdoc Advisor)

Professor, Department of Ecology and Evolutionary Biology, University of Arizona

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Caitlin Hicks Pries (Postdoc Advisor)

Associate Professor, Department of Biological Sciences, Dartmouth College

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Benjamin Sulman (Postdoc Advisor)

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Nigel Roulet (PhD Advisor)

Professor, Department of Geography, McGill University

Email: nigel.roulet@mcgill.ca

Jianghua Wu (PhD Advisor)

Professor, Sustainable Resource Management, Memorial University of Newfoundland

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