Mohammad Afzal Shadab

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Hydrology | *Cryosphere* | *Planetary Habitability* | *Mathematical Modeling* | *Computational Science*

Positions Held

Future Faculty in the Physical Sciences Postdoctoral Fellow — 2024- Present
Departments of Civil and Environmental Engineering and Geosciences, *Princeton University* — Princeton

Graduate Research Assistant — 2019-24
Oden Institute for Computational Engineering and Sciences, *University of Texas at Austin* — Austin

NASA-JPL Graduate Fellow — Summer 2023
Planetary Science Division, *NASA Jet Propulsion Laboratory, California Institute of Technology* — Pasadena

NASA-JPL Graduate Fellow — Spring 2022
Earth Science Division, *NASA Jet Propulsion Laboratory, California Institute of Technology* — Pasadena

MIT Visiting Graduate Student Researcher — 2018-19
Department of Mechanical Engineering, *Massachusetts Institute of Technology* — Cambridge

Graduate Research Assistant — 2016-18
Dept. of Mechanical and Aerospace Engg., *Hong Kong University of Science and Technology* — Hong Kong

Education

Doctor of Philosophy | ***Computational Science, Engineering & Mathematics*** — 2024
The University of Texas at Austin, United States
Title: Modeling Subsurface Flow of Water in Earth and Planetary Sciences
Advisor: Dr. Marc Hesse, Professor of Earth and Planetary Sciences

Master of Science | ***Computational Science, Engineering & Mathematics*** — 2021
The University of Texas at Austin, United States — GPA: 3.90/4.0
Advisor: Dr. Marc Hesse, Professor of Earth and Planetary Sciences

Master of Philosophy | ***Mechanical Engineering*** — 2018
The Hong Kong University of Science and Technology — GPA: 4.0(A)/4.3(A+)
Thesis: Fifth-Order Finite Volume WENO in General Orthogonally-Curvilinear Coordinates
Advisor: Dr. Kun Xu, Chair Professor of Mathematics and Mechanical & Aerospace Engg.

Bachelor of Technology | ***Mechanical Engineering*** — 2016
Aligarh Muslim University, India — GPA: 9.62/10.0

Grants

How Earth's Ocean World informs other Ocean Worlds? Leveraging scientific discoveries from the International Ocean Discovery Program (Pending) - ***NASA ROSES'24 Interdisciplinary Consortia for Astrobiology Research***
Co-I (leading the geophysical modeling team) - $449,288 to PU, 7/2025-7/2030

Sustaining the Community Firn Model - ***NASA ROSES'24 Support for Open-Source Tools, Frameworks, and Libraries***
Collaborator (implementing enthalpy formation in CFM and validating), $0 to PU, 1/2025-1/2028

Carbon Dioxide Removal through Enhanced Rock Weathering Deployments with Smallholder Rice Paddy Farmers in India (Pending) - ***Milkywire Climate Transformation Fund***
Collaborator (on coupled hydrologic & reactive transport modeling) - $0 to PU, 4/2025-7/2026

Oxidant Transport into Europa's Internal Ocean by Brine Migration Through the Outer Ice Shell - ***Research Award in Planetary Habitability by UT Center for Planetary Systems Habitability***
PI - $16,425, 08/2022-12/2022

Research Experience

Modeling and Understanding Large-Scale Integrated Soil and Firn Hydrology Princeton University
Future Faculty in the Physical Sciences Postdoctoral Fellow 2024- Present
Advisor: Prof. Reed Maxwell, *Collaborator*: Prof. Howard Stone

- Learning basics of ParFlow hydrologic model, overland flow modeling, and Community Land Model.
- Analyzing effect of capillary forces on large scale hydrology using ParFlow with Community Land Model.
- Developing and implementing multidimensional melt percolation and ice layer formation in firn.
- Extending conventional vertically-integrated models for unconfined aquifers to firn aquifers using scaling analysis and solving PDEs (semi-)analytically.

Reactive Transport Modeling of Enhanced Weathering in Soils for CO_2 Removal Princeton University
Research Collaborator Summer 2024- Present
Project Lead: Dr. Jacob Jordan (Mati Carbon - XPRIZE Carbon Removal Winner 2025)

- Assisting in development of a chromatographic theory to represent transport and exchange of cation assemblages through a soil column beneath an enhanced rock weathering deployment.
- Constructed the analytic solutions for different cases involving wave propagation and coded them in Matlab.
- Validating the solutions using PHREEQC geochemical modeling software.

Modeling Subsurface Flow of Water in Earth and Planetary Sciences UT Austin
Graduate Research Assistant, *Doctoral Thesis* 2019-24
Advisor: Prof. Marc Hesse

- Developed and validated a conservative finite-difference based discrete operator toolbox in Python for simulating 1D/2D two-phase flow in non-deforming porous media.
- Implemented the solver to investigate the melt percolation on ice masses and formation of ice layers.
- Formulated kinematic wave theories for infiltration in soil and firn to understand the physics of the process and compare the performance & improve existing models.

Vadose Zone and Groundwater Hydrology on Early Mars UT Austin
Collaborative Research 2020- Present
Collaborators: Eric Hiatt, Dr. Rickbir Bahia (ESA), Dr. Eleni Bohacek (ESA), and Prof. Marc Hesse

- Utilized kinematic wave infiltration theory to study infiltration into Martian regolith to investigate its effects on surface geomorphological & water budget evolutions, and estimate water residence times in vadose zone.
- Developed theoretical groundwater (GW) model for deep crustal aquifer on a spherical shell with vertical heterogeneity and estimated GW residence times.
- Assisted ESA collaborators implement infiltration process in Martian aeolian-fluvial interaction (MAFI) model.

Improving the Numerical Toolset for Geodynamics of Icy Oceans World Jet Propulsion Lab
NASA Jet Propulsion Lab Graduate Fellow Summer 2023
Advisor: Dr. Steven Vance

- Developed multidimensional model and code for single phase flow in viscously compacting matrix, i.e., convecting ice sheet with pore fluid, in cylindrical coordinates.
- Implemented tracers to track organics during melt migration across ice shells of icy ocean worlds.
- Formulated a theoretical model for calculating time scales of melt migration & validated with simulations.

Modeling Meltwater Percolation in Greenland's Firn Jet Propulsion Lab
NASA Jet Propulsion Lab Graduate Fellow Spring 2022
Advisor: Dr. Surendra Adhikari

- Developed a three-phase (snow/water/air) firn hydrology simulator in 1D.
- Derived and validated vertically integrated model for meltwater gravity currents without phase change.
- Estimated field parameters using kinematic wave theory and investigated meltwater infiltration in Greenland.

Investigating Groundwater Flows using Physics Informed Neural Networks UT Austin
Collaborative Research 2020-23
Collaborators: DingCheng Luo, Yiran Shen, Eric Hiatt, and Prof. Marc Hesse

- Wrote python codes for data-driven discovery of steady-state PDE from experimental data.
- Investigated the effect of PDE regularization in PINNs and the role of PDE & data misfit.

- Learned the PDE model parameters and boundary conditions for the transient seepage across edge of a porous reservoir simulated using finite-element method based model (FEniCS).

Free Fall of a Viscous Drop in a Viscoelastic Medium Massachusetts Institute of Technology
Visiting Graduate Student Researcher 2018-19
Advisor: Prof. Irmgard Bischofberger

- Performed a rheological characterization of viscoelastic polymers to estimate their Deborah numbers.
- Designed the drop dynamics experiments and apparatus with high-speed imaging.
- Wrote Matlab scripts for analyzing moving camera videos without fixed reference using template matching.

High-Order Finite-Volume Methods in Curvilinear Coordinates HKUST, Hong Kong
Graduate Research Assistant, *M.Phil. Thesis* 2016-18
Advisor: Prof. Kun Xu

- Proposed a high order finite volume spatial reconstruction technique in curvilinear coordinates.
- Derived analytical relations, implemented in CFD codes and validated fifth order of spatial accuracy.

Low Order Model Development of a Thermoacoustic System HKUST, Hong Kong
Collaborative Research Fall 2016
Collaborators: Prof. Peter Schmid (Imperial), Prof. Simone Hochreb (Cambridge), Prof. Larry Li

- Analyzed and compared the prominent modal decomposition techniques such as POD, DMD and FFT.
- Investigated the interaction between flame & external acoustic forcing with variable amplitudes & frequencies.

Teaching Experience

Wintersession 2025 Analyzing Remote Sensing Data with QGIS (Undergrad/Graduate) Winter 2025
Princeton University Princeton
Position: Instructor
Responsibilities: Developed course content and conducted a hands-on Wintersession on fundamentals of QGIS, remote sensing, and data visualization

GEO 325C/398C Continuum Mechanics (Graduate) Fall 2022, 2023
University of Texas at Austin Austin
Position: Teaching Assistant, *Instructor*: Prof. Marc Hesse
Responsibilities: Taught tutorial lectures, clarified concepts on Piazza, evaluated assignments

GEO 325M/398M Numerical Modeling in the Geosciences (Graduate) Spring 2023
University of Texas at Austin Austin
Position: Teaching Assistant, *Instructor*: Prof. Marc Hesse
Responsibilities: Conducted tutorials and coding exercises, resolved coding/conceptual issues

SIAM Applied Mathematics Mentorship Program Lectures (Undergrad/Graduate) Fall 2022
University of Texas at Austin Austin
Position: Instructor
Responsibilities: Designed and conducted lectures such as Intro to LaTeX (,)

MECH 1907 Introduction to Aerospace Engineering (Freshman, Sophomore) Spring 2018
The Hong Kong University of Science and Technology Hong Kong
Position: Teaching Assistant, *Instuctor*: Prof. Rhea Liem
Responsibilities: Designed & evaluated exams & HWs, taught tutorial and two class lectures

MECH 3690 Aerospace Engineering Laboratory (Senior, Junior) Spring 2017
The Hong Kong University of Science and Technology Hong Kong
Position: Teaching Assistant, *Instuctor*: Prof. Jinglei Yang
Responsibilities: Taught multiple class lectures and lab briefings, contributed to lab manual

For all teaching feedback reports and certificates, click .

Pedagogical Training

Teaching Transcript Program Fall 2024 – Present
Princeton University Princeton
Workshops and discussions on teaching and academic careers, and teaching observations.

Inclusive Course Design Institute 2023 Summer 2023
The University of Texas at Austin Austin
Designed a course from ground up using Universal Design for Learning (UDL) and best practices.

Inclusive Classrooms Leadership Certificate Seminar Series Spring 2023
The University of Texas at Austin Austin
Learned strategies for developing and sustaining an inclusive classroom along with course design.

Advanced Teaching Preparation Series Certificate Spring, Fall 2022
The University of Texas at Austin Austin
Learned and practiced techniques of good classroom teaching.

Graduate Teaching Assistant Training Program 2017-18
The Hong Kong University of Science and Technology Hong Kong
Learned the fundamentals of teaching assistantship and effective pedagogy.

Skills

Languages: C, C++, Fortran 77/90, Python (SciPy, NumPy, Matplotlib, Pandas, Pytorch, Tkinter, Tensorflow, GUI programming, Webscraping), HTML, Matlab, Mathematica, Shell Scripting, LaTeX, High Performance Computing (SLURM), FEniCS
General Software: AutoCAD, SolidWorks, ANSYS, Fluent, COMSOL Multiphysics, TecPlot, ParaView, Microsoft Office, Git, Travis CI, Docker
Geoscience Software: Hydrus, VPLanet, QGIS, QGreenland, ENVI, PlanetProfile, PHREEQC, ParFlow, CLM
OS: Linux, Windows, Mac

Honors and Awards

Princeton University Future Faculty in the Physical Sciences Fellowship 2024-27
A postdoctoral fellowship to increase research excellence and faculty diversity

Polar Science Early Career Community Office Polar Partnership Networking Award 2025-26
Funding award to conduct research on effect of US administration's policies on US-based polar ECRs.

NASA Open Science Badge 2024
Completed five modules on open science including tools offered by NASA TOPS Program.

AGU Cryosphere Innovation Award / Flash Freeze Competition Winner 2023
Awarded based on a two-minute pitch of innovative idea to a panel of five judges at AGU 2023.

UT Austin Graduate School Summer Fellowship Summer 2024
Awarded summary salary and tuition based on academic standing and research experience.

UT Austin Graduate School Spring Dissertation Writing Fellowship Spring 2024
Received spring semester salary and tuition for academic and research excellence.

NASA Jet Propulsion Laboratory Graduate Fellowship Summer 2023
To investigate life-supporting conditions on Europa with Dr. Steve Vance at JPL.

Purdue Climate Scholar by Purdue University and Office of Naval Research Summer 2022
To attend Summer Institute for Sustainability & Climate Change at Purdue University.

NASA Jet Propulsion Laboratory Graduate Fellowship Spring 2022
To study effect of climate change on Greenland ice sheet with Dr. Surendra Adhikari at JPL.

MIT - Houston Energy Innovation Student Fellow 2022-23
Representing UT Austin as a liaison between MIT's Martin Trust Center and Greentown Labs.

Lunar and Planetary Institute Career Development Award 2022
For first author abstract and application materials submitted at LPSC 2022.

UT Austin Cactus Standout Award 2022
For academic excellence and leadership contributions. Inducted into UT Annual Yearbook 2022.

Outstanding Student Presenters Award by Unsaturated Zone Technical Committee, AGU 2021
For oral presentation: *H52D-10 Rainwater Infiltration* at AGU Fall Meeting 2021.

Blue Sky Student Fellowship by University of Texas Institute for Geophysics 2021-22
Year-long fellowship covering tuition, insurance & stipend awarded for research proposal.

Certificate of Recognition by Society for Industrial and Applied Mathematics 2021
For outstanding service and contributions to the UT Austin Student Chapter of SIAM.

Best Teaching Assistant Award by Dept of Mech & Aero Engg, HKUST 2018
Awarded for *MECH-1907 Introduction to Aerospace Engineering* course.

Judge's Award and Audience Award at MIT MEMSI Program 2018
Awarded by MIT and Hong Kong Innovation Node for best startup idea & pitch in the program.

Recognitions in Reviewing 2018, 2023
Outstanding Contribution in Reviewing Recognition by *Journal of Computational Physics*.
Mentioned in *Geophysical Research Letters*, *Journal of Geophysical Research - Planets* .

Postgraduate Studentship by HKUST 2016-18
Competitive stipend for research postgraduate students (M.Phil.) at HKUST.

Global Scholar Award by Sir Syed Education Society of North America 2015
For top 20 students of AMU based on their academic achievements and research, for higher education.

National Summer Research Fellowship by Indian Academy of Sciences Summer 2015
Awarded national fellowship to pursue research in Indian research institutes like IITs/IISc.

University Merit Scholarship by AMU Alumni Association Toronto, Canada 2015
Merit based scholarship for students pursuing education at AMU.

Travel Grants And Funded Short Schools

AGU Cryosphere Section Student Travel Grant for Diversity (CryoStuD) 2024
Travel grant for uplifting traditionally marginalized scientists to present research at AGU'24.

Center for Planetary Systems' Habitability Student Travel Award 2022, 2023, 2024
Awarded a travel grant to attend the LPSC.

UT Austin Professional Development Awards 2022, 2024
For presenting two research works conducted at UT Austin.

Early Career Travel Award by European Space Agency 2023
Recieved a travel award to attend the FAIRPLAY 2023 Workshop in the Netherlands.

Early Career Tiny Grants - AGU Ecohydrology Committee 2022
For early-career scientists presenting ecohydrology-related work at the AGU Fall Meeting 2022.

SIAM Student Travel Award 2021
Awarded a student travel grant by SIAM to attend the SIAM Annual Meeting 2021.

ICOSAHOM Conference Travel Grant 2018
Awarded a student travel grant to attend the International Conference on Spectral And High Order Methods at Imperial College London.

Numerical Simulations ICNM 2017 Conference Travel Grant 2017
Awarded full funding for attending the 5th International Conference on Numerical Simulations for Multimaterial and Multiphysics Problems in China.

Advanced Research in Turbomachinery Summer School Grant Summer 2019
Received a scholarship to attend this summer school organized by the University of Florence, Italy and sponsored by ANSYS and GE.

MIT StartMIT Course Grant Winter 2019
Received full sponsorship from MIT Martin Trust Center for this course on entrepreneurship.

Fluid Dynamics across Scales Summer School Grant Summer 2018
Received funding to participate in the Centre for Doctoral Training in Fluid Dynamics across Scales at Imperial College London.

MIT Entrepreneurship and Maker Skills Integrator Bootcamp Funding Summer 2018
Received full funding from MIT and Hong Kong Innovation Node to attend the program.

Invited Talks and Seminars

[12] December 2025: AGU Fall Meeting, Session: *From Snowflakes to Runoff: Firn and Surface Mass Balance Processes*

[11] April 2025: NASA Jet Propulsion Laboratory, *Earth Science Division Seminar*

[10] April 2025: Princeton University, *Solid Earth Geosciences Brown Bag Seminar*

[9] April 2024: Mathematics on Ice Forum

[8] Jan 2024: California Institute of Technology - *Graduate Aerospace Laboratories (GALCIT) and Fu Research Group*

[7] Oct 2023: The University of Texas at Austin - *Center for Planetary Systems Habitability*

[6] Sept 2023: The University of Texas Institute for Geophysics

[5] August 2023: NASA Jet Propulsion Laboratory, *Planetary Science Division Seminar*

[4] June 2022: NASA Jet Propulsion Laboratory, *Earth Science Division Seminar*

[3] June 2022: California Institute of Technology, *Fu Research Group*

[2] May 2017: 5th International Conference on Numerical Simulation for Multimaterial and Multiphysics Problems

[1] 2016-2017: The Hong Kong University of Science and Technology - *Aeronautics Interest Group (AIG)*

Peer Reviewed Publications

[13] **Shadab, M.A.**, Rutishauser, A., Grima, C. and Hesse, M.A, 2025. A unified kinematic wave theory for melt infiltration into firn. *Journal of Glaciology*, 60pp.
https://doi.org/10.1017/jog.2025.10055

[12] **Shadab, M.A.**, Hiatt, E., Bahia, R.S., Bohacek, E.V., Steinmann, V. and Hesse, M.A., 2025. Infiltration dynamics on early Mars: Geomorphic, climactic, and water storage implications, *Geophysical Research Letters*, 52, e2024GL111939, 11+12pp.
https://doi.org/10.1029/2024GL111939

[11] Barnes, R., ... **Shadab, M.A.**,..., 2025. History and habitability of the LP 890-9 planetary system, *The Planetary Science Journal*, 6(1), p.25, 13pp.
https://www.doi.org/10.3847/PSJ/ad94dc

[10] Vanek, S., ..., **Shadab, M.A.**,..., 2024. Exploring the past, present, and future of USAPECS: Lessons from a decade of supporting early career research across national and international polar networks. *Arctic Yearbook*, 14pp.
https://arcticyearbook.com/

[9] **Shadab, M.A.**, Adhikari, S., Rutishauser, A., Grima, C. and Hesse, M.A., 2024. A mechanism for ice layer formation in glacial firn. *Geophysical Research Letters*, 51(15), p.e2024GL109893, 12+37pp.
https://doi.org/10.1029/2024GL109893

[8] **Shadab, M.A.** and Hesse, M.A., 2024. A hyperbolic-elliptic PDE model and conservative numerical method for gravity-dominated variably-saturated groundwater flow. *Advances in Water Resources*, p.104736, 17pp. https://doi.org/10.1016/j.advwatres.2024.104736

[7] Hiatt, E. **Shadab, M.A.**, Hesse, M., Goudge, T., Gulick, S., 2024. Limited recharge of the southern highlands aquifer on early Mars, *Icarus*, 408, p.115774, 10+16pp. https://doi.org/10.1016/j.icarus.2023.115774

[6] **Shadab, M.A.**, Hiatt, E. and Hesse, M.A., 2023. PKgui: A GUI software for Polubarinova-Kochina's solutions of steady unconfined groundwater flow, *SoftwareX*, 24, p.101573, 5+5pp. https://doi.org/10.1016/j.softx.2023.101573

[5] **Shadab, M.A.**, Luo, D., Hiatt, E., Hiatt, E. and Hesse, M.A., 2023. Investigating steady unconfined groundwater flow using physics informed neural networks, *Advances in Water Resources*, 177, p.104445, 16+18pp. https://doi.org/10.1016/j.advwatres.2023.104445

[4] **Shadab, M.A.** and Hesse, M.A., 2022. Analysis of gravity-driven infiltration with the development of a saturated region, *Water Resources Research*, 58(11), p.e2022WR032963, 27pp. https://doi.org/10.1029/2022WR032963

[3] **Shadab, M.A.**, Balsara, D., Shyy, W. and Xu, K., 2019. Fifth-order finite volume WENO in general orthogonally - curvilinear coordinates. *Computers & Fluids*, 190, 26pp. https://doi.org/10.1016/j.compfluid.2019.06.031

[2] **Shadab, M.A.**, Ji, X. and Xu, K., 2018. Fifth-order finite volume WENO on cylindrical grids. *Spectral and High Order Methods for Partial Differential Equations (Springer)*, 10pp. https://doi.org/10.1007/978-3-030-39647-3_51

[1] **Shadab, M.A.** and Baig, M.F., 2017. Investigation and control of unstart phenomenon in scramjets. *In 21st AIAA International Space Planes and Hypersonics Technologies Conference* (p. 2298), 16pp. https://doi.org/10.2514/6.2017-2298

Under Review

[1] **Shadab, M.A.**, Vance, S.D., Silber, E A., Crósta, A.P., Carnahan, E., Jordan, J.S., Hesse, M.A., 202X. Rapid migration of impact melt through ocean world ices: Selk crater on Titan and Mannann'an crater on Europa. (Under review in *Earth and Planetary Science Letters*)

In Preparation

[8] **Shadab, M.A.** and Maxwell, R.M., 202X. Effects of soil capillarity on multidimensional, integrated surface-subsurface hydrology at different spatial scales. (for *Water Resources Research*)

[7] **Shadab, M.A.**, Stone, H.A., and Maxwell, R.M., 202X. Heat advection dominated gravity currents in cold firn. (for *Journal of Fluid Mechanics*)

[6] **Shadab, M.A.**, Hiatt, E. and Hesse, M.A., 202X. Analytical solutions of a low-aspect-ratio unconfined aquifer on a spherical shell: Application to early Mars. (for *Journal of Geophysical Research - Planets*)

[5] **Shadab, M.A.** and Hesse, M.A., 202X. An open source discrete operator toolbox (DOT) to solve geophysical flow problems. (for *Geoscientific Model Development*)

[4] Hiatt, E. **Shadab, M.A.**, Hesse, M., Goudge, T., Gulick, S., 202X. Transient groundwater models suggest short lived recharge events on early Mars. (for *Nature Geoscience*)

[3] Hiatt, E. **Shadab, M.A.**, 202X. Experimental and numerical investigations of seepage face dynamics: A physics solution. (for *Journal of Fluid Mechanics*)

[2] Jordan, J.S., **Shadab, M.A.**, et al., 202X. On the storage and transport of anthropogenic alkalinity in porous media: Soil as a chromatographic column, (for *American Journal of Science*)

[1] Hesse, M.A. and **Shadab, M.A.**, 202X. Numerical modeling for geoscientists. (book draft)

Extended Conference Abstracts

[11] Hiatt, E., **Shadab, M.A.** et al., 2025. Transient Groundwater Recharge of Early Mars' Groundwater Systems & Subsequent Climate Constraints *56th Lunar and Planetary Science Conference*, #2629, 2pp.

[10] **Shadab, M.A.** et al., 2024. Evolution of impact generated melt at Selk crater: Effect of phase change, percolation, and viscous foundering. *55th Lunar and Planetary Science Conference*, #1317, 2pp.

[9] **Shadab, M.A.** et al., 2024. Infiltration on early Mars & its implications toward aeolian-fluvial interactions. *55th Lunar and Planetary Science Conference*, #1383, 2pp.

[8] Hiatt, E., **Shadab, M.A.**, Gulick, S.P.S., Goudge, T. and Hesse, M.A., 2024. Martian lakes: a critical requirement for transient groundwater models. *55th Lunar and Planetary Science Conference*, #2408, 2pp.

[7] **Shadab, M.A.**, Hiatt, E. and Hesse, M.A., 2023. A deep crustal aquifer model for southern highlands of Noachian Mars shows groundwater age and near-surface dynamics. *NASA Exploration Science Forum*, 2pp.

[6] **Shadab, M.A.**, Hiatt, E. and Hesse, M.A., 2023. A deep crustal aquifer model for southern highlands of Noachian Mars shows groundwater age and near-surface dynamics. *Brines Across the Solar System: Ancient and Future Brines Conference*, #2025, 2pp.

[5] **Shadab, M.A.**, Hiatt, E. and Hesse, M.A., 2023. Investigating groundwater dynamics and residence times on early Mars using unconfined aquifer model with vertical heterogeneity. *54th Lunar and Planetary Science Conference*, #1736, 2pp.

[4] Hesse, M.A., **Shadab, M.A.** and Hiatt, E., 2023. Time scales for terminal groundwater drainage from the southern highlands on Mars. *54th Lunar and Planetary Science Conference*, #1637, 2pp.

[3] Hiatt, E., **Shadab, M.A.** and Hesse, M.A., 2023. Planetary scale groundwater and surface water interaction on early Mars. *54th Lunar and Planetary Science Conference*, #2415, 2pp.

[2] **Shadab, M.A.**, Hiatt, E., and Hesse, M.A., 2022. Estimates of Martian mean recharge rates from analytic groundwater models. *53rd Lunar and Planetary Science Conference*, #1775, 2pp.

[1] Hiatt, E., **Shadab, M.A.**, Gulick, S.P.S., Hesse, M.A., Goudge, T. and Hesse 2022. Estimates of groundwater divides and basins on Noachian Mars. *53rd Lunar and Planetary Science Conference*, #2618, 2pp.

Open Source Software

[8] **Shadab, M.A.** et al., 2025. Infiltration-on-early-Mars (v1.0.1). Zenodo. `https://doi.org/10.5281/zenodo.14742437`

[7] **Shadab, M.A.** et al., 2024. unified-kinematic-wave-theory (v1.0). Zenodo. `https://doi.org/10.5281/zenodo.13936153`

[6] **Shadab, M.A.** et al., 2024. mashadab/ice-layer-formation: v1.0.0, Zenodo. `https://doi.org/10.5281/zenodo.12706191`

[5] **Shadab, M.A.** and Hesse, M. A., 2024. mashadab/VarSatFlow: v1.0, Zenodo. `https://doi.org/10.5281/zenodo.11398273`

[4] **Shadab, M.A.** et al., 2023. mashadab/PKgui (v1.0.1), Zenodo. `https://doi.org/10.5281/zenodo.8034146`

[3] **Shadab, M.A.** et al., 2021. PINNs for unconfined groundwater flow (v1.0), Zenodo. `https://doi.org/10.5281/zenodo.5803542`

[2] **Shadab, M.A.** and Hesse, M.A., 2022. Gravity driven infiltration with the development of a saturated region (v1.0), Zenodo. `https://doi.org/10.5281/zenodo.6558260`

[1] **Shadab, M.A.**, 2021. Reservoir-Simulator, Zenodo. `https://doi.org/10.5281/zenodo.6581752`

Conference Abstracts

[38] **Shadab, M.A.**, Adhikari, Stevens, C.M., Rennermalm, A., Xiao, J., and Hesse, M.A., 2025. Modeling large-scale multi-dimensional infiltration and ice layer formation in Greenland firn, *AGU Fall Meeting* (submitted, invited talk).

[37] **Shadab, M.A.**, Stone, H.A., Maxwell, R.M., 2025. A theoretical and numerical model for unconfined aquifers in cold snow and firn, *AGU Fall Meeting* (submitted).

[36] **Shadab, M.A.**, Jadallah, N., Maxwell, R.M., 2025. Effects of soil capillarity on multidimensional, integrated surface-subsurface hydrology at different spatial scales, *AGU Fall Meeting* (submitted).

[35] Ishraque, F., **Shadab, M.A.**, Lauter, O., Adasheva, E. and Labe, Z.. 2025. Empowering polar science community: A decade of USAPECS in supporting early career researchers globally, *AGU Fall Meeting* (submitted).

[34] **Shadab, M.A.**, Adhikari, S., Stevens, C.M. and Hesse, M.A., Maxwell, R.M., 2025. Multi-scale multi-dimensional infiltration in glacial firn and mechanism of ice layer and chunk formation. *North-East Glaciology Meeting*, Cornell University.

[33] **Shadab, M.A.**, Adhikari, S., Stevens, C.M. and Hesse, M.A., Maxwell, R.M., 2024. Multi-scale multi-dimensional infiltration in glacial firn and mechanism of ice layer and chunk formation. *Rutgers Climate Symposium*.

[32] **Shadab, M.A.**, Adhikari, S. Rutishauser, A., Grima, C., Stevens, C.M. and Hesse, M.A., 2024. Multi-scale multi-dimensional infiltration in glacial firn and mechanism of ice layer and chunk formation, *AGU Fall Meeting*.

[31] **Shadab, M.A.**, Vance, S.D., Silber E.A., Crósta, A.P., Carnahan, E., Jordan, J.S. and Hesse, M.A., 2024. Evolution of impact generated melt at Selk crater, *AGU Fall Meeting*.

[30] Helmberger, M.N., Labe, Z., **Shadab, M.A.**, Lauter, O., Vanek, S., Adasheva, E. and Ashokkumar, L. 2024. Empowering polar science community: A decade of USAPECS in supporting early career researchers globally, *AGU Fall Meeting*.

[29] Hiatt, E., **Shadab, M.A.**, Bahia, R.S., Bohacek, E.V., Steinmann, V. and Hesse, M.A., 2024. Dynamics of infiltration on early Mars, *AGU Fall Meeting*.

[28] Hiatt, E., **Shadab, M.A.**, Gulick, S.P.S., Goudge, T. and Hesse, M.A., 2024. Transient groundwater models suggest short lived recharge events on early Mars, *AGU Fall Meeting*.

[27] Hiatt, E., **Shadab, M.A.**, Gulick, S.P.S., Goudge, T. and Hesse, M.A., 2024. Constraining early Mars paleoclimate forcing via groundwater modeling as limited by observed geomorphology, *Texas Area Planetary Science (TAPS) Meeting*.

[26] Barnes, R., ... **Shadab, M.A.**,..., 2024. The History and Habitability of the LP 890-9 Planetary System. *Astrobiology Science Conference*, #1498545.

[25] Adasheva, E., Ashokkumar, L., Helmberger, M.N., Labe, Z., Lauter, O., **Shadab, M.A.**, Vanek, S., 2024. Exploring the past, present, and future of USAPECS: Lessons from a decade of supporting early career research across national and international polar networks, *Arctic Congress*, #1310

[24] **Shadab, M.A.**, Adhikari, S. Rutishauser, A., Grima, C., and Hesse, M.A., 2024. Mechanism of ice layer formation in glacial firn and factors controlling its depth. Gordon Research Conference.

[23] **Shadab, M.A.**, Adhikari, S. Rutishauser, A., Grima, C., and Hesse, M.A., 2024. Mechanism of ice layer formation in glacial firn and factors controlling its depth. Flow and Transport in Permeable Media Gordon Research Seminar

[22] **Shadab, M.A.**, Adhikari, S. Rutishauser, A., Grima, C., and Hesse, M.A., 2023. Mechanism and factors controlling ice layer formation in glacial firn, *AGU Fall Meeting*.

[21] **Shadab, M.A.**, Rutishauser, A., Grima, C., and Hesse, M.A., 2023. A unified kinematic wave theory for melt infiltration into firn, *AGU Fall Meeting*.

[20] Ashokkumar, L., Labe, Z., **Shadab, M.A.**, Lauter, O., Schreiber, E., Weinberg, E., 2023. Advancing inclusion, diversity, equity, and accessibility (IDEA) in the polar sciences by USAPECS, *AGU Fall Meeting*.

[19] **Shadab, M.A.**, Hiatt, E., Bahia, R.S., Bohacek, E.V., Steinmann, V. and Hesse, M.A., 2023. Infiltration on early Mars and its implications toward aeolian-fluvial interactions, *Fluvial-Aeolian Interactions on Planetary Surfaces (FAIRPLAY) Workshop, European Space Agency*.

[18] Hiatt, E., **Shadab, M.A.**, et al, 2023. Limited recharge of the southern highlands aquifer on early Mars, *Texas Area Planetary Science Meeting (TAPS)*, #TAPS2023-55.

[17] Vance, S.D. Carnahan, E., **Shadab, M.A.**, Hesse, M.A., Silber, E.A., Crosta, A.P., 2023. Impact foundering and material transport through ice shells of various compositions, *Impact Processes as a Path to Habitability of Planetary Habitability Workshop, Brazil*.

[16] Barnes, R., ... **Shadab, M.A.**,..., 2023. The history and habitability of the LP 890-9 planetary system, *Biennial European Astrobiology Conference (BEACON)*.

[15] Barnes, R., ... **Shadab, M.A.**,..., 2023. History and habitability of the LP 890-9 planetary system, *241st American Astronomical Society Meeting*.

[14] **Shadab, M.A.**, and Hesse, M.A., 2022. An extended kinematic-wave theory for infiltration in soils with declining porosity causing delayed perching, *AGU Fall Meeting*.

[13] **Shadab, M.A.**, and Hesse, M.A., 2022. Extending Richards equation to simulate variably saturated flows, *AGU Fall Meeting*.

[12] Hiatt, E. **Shadab, M.A.**, Hesse, M., Goudge, T., Gulick, S., 2022. Limited recharge on early Martian aquifers: Numeric & analytic recharge rate estimates as constrained by geomorphic and geochemical observations, *AGU Fall Meeting*.

[11] **Shadab, M.A.**, Grima, C., Rutishauser, A., and Hesse, M.A., 2021. Analytical solutions for melt percolation in ice masses and a pathway to ice lens formation, *AGU Fall Meeting*.

[10] **Shadab, M.A.**, and Hesse, M.A., 2021. Fluid infiltration in unsaturated porous medium with the development of a saturated region, *AGU Fall Meeting*.

[9] Hesse, M.A., **Shadab, M.A.**, Luo, D., Shen, Y., and Hiatt, E., 2021. Investigating groundwater flow dynamics using physics informed neural networks (PINNs), *AGU Fall Meeting*.

[8] Hiatt, E., **Shadab, M.A.**, et al, 2021. Experimental and numerical investigation of seepage face dynamics, *AGU Fall Meeting*.

[7] Hesse, M.A., **Shadab, M.A.**, Hiatt, E., Liebeck, J., 2021. Groundwater-ocean interaction on Mars, *AGU Fall Meeting*.

[6] Hiatt, E., **Shadab, M.A.**, et al, 2021. Numerical modeling of the formation of Hellas Planitia with focus on spatio-temporal scales required for hydrologic equilibration, *AGU Fall Meeting*.

[5] **Shadab, M.A.**, Luo, D., Shen, Y., Hiatt, E., and Hesse, M.A., 2021. Investigating fluid drainage from the edge of a porous reservoir using Physics Informed Neural Networks, *SIAM Annual Meeting*.

[4] **Shadab, M.A.**, Divoux, T. and Bischofberger, I., 2020. Suppression of drop breakup in a viscoelastic bath, *Bulletin of the American Physical Society*.

[3] Hiatt, E., **Shadab, M.A.** et al., 2020. Groundwater filling times for large impact basins on early Mars and implications for the onset of post impact hydrothermal systems, *AGU Fall Meeting*.

[2] **Shadab, M.A.**, Ji, X. and Xu, K., 2018. Fifth-order finite-volume WENO on cylindrical grids: Flux evaluation using Riemann solvers and gas-kinetic scheme, *In International Conference on Spectral And High Order Methods (ICOSAHOM)*.

[1] **Shadab, M.A.**, and Xu, K., 2017. Fifth-order finite volume WENO in orthogonally-curvilinear coordinates. *In 5th International Conference on Numerical Simulations for Multimaterial and Multiphysics Problems*.

SERVICE

AGU25 Sessions' Early Career Convener, Four Sessions 2025
Convening *C040 - Cryosphere Is for All, P041 - The New Mars Underground VIII, C040 - The End of The Golden Era of Polar Science in the US?, U014 - Navigating Broader Impacts in Current Political Climate*

Mentor, Interagency Arctic Research Policy Committee Mentorship program 2024-25
Providing career counseling and skills training. Virtual

AGU24 Sessions' Convener and OSPA Liaison and Judge, Three Sessions 2024
Designing oral/poster/e-lightening sessions with AGU Cryo team titled *C24A/C41C/C43C The Cryosphere Is for All: Overcoming Barriers to Participation in the Cryospheric Sciences* at AGU24.

Executive Secretary and/or Reviewer, Seven NASA ROSES Review Panels 2023- Present
Managed panel reviews or reviewed proposals in panels, receiving honorariums

Executive Committee Member, AGU Cryosphere Division 2024- Present
Serving in the Diversity, Equity, and Inclusion (DEI) and Canvassing Working groups. Virtual

Judge, AGU Fall Meeting Travel Award Fall 2024
Reviewed cryosphere division related applications for AGU 2024 from around the world. Virtual

Judge, International Mission to Mars Engineering Design Contest Summer 2024
Organized by Mars Society for high school students from around the world. Virtual

Young Professional Mentor, Zed Factor Fellowship Program 2023-24
Mentor rising undergraduate students in aerospace engineering. Virtual

Team Member, UT Austin Libraries HELIOS team 2023-24
To advance Higher Education Leadership Initiative for Open Scholarship (HELIOS).
Gave a speech at ***US White House*** Listening Sessions on Open Science (News, Post, Video).
Panelist at multiple open science events , , . Austin

Co-Chair & DEI Team Lead, US Assoc. of Polar Early Career Scientists 2022- Present
Fostering climate and DEI-conscious collaborations between academia & polar organizations. Virtual

Board Member, AGU Hydrology Section Student Subcommittee (AGU-H3S) 2023- Present
Providing professional development & networking opportunities to early career hydrologists. Virtual

Volunteer, MIT Energy Conference 2023
Assisted in organizing in-person sessions at the conference. Boston

Coordinator, Center for Planetary Systems Habitability Student Travel Award Spring 2023
Organized, coordinated and liaised the application process for student travel to LPSC 2023. Austin

MIT - Houston Energy Innovation Student Fellow 2022-23
Cultivated & supported energy innovation startup ecosystem considering threat of climate change. Austin

Volunteer / Braindate Lounge Assistant, AGU Fall Meeting 2022 2022
Facilitated collaborations between researchers and scientists through Braindate at AGU 2022. San Francisco

Mentor, American Geophys. Union Earth & Planetary Surface Processes (EPSP) 2022- Present
Mentoring graduate students across the world to develop technical and research skills in EPSP. Virtual

Geoscience Ambassador, Jackson School of Geosciences, UT Austin 2021-22
Making geoscience accessible to broader community & promoting interdisciplinary research. Austin

Session Chair, Society for Industrial & Applied Mathematics Annual Meeting 2021
Chaired the *CP15: Machine Learning and Data Mining* Session. Virtual

President & Senior Advisor, SIAM Chapter of UT Austin 2020-23
Spearheaded several programs & won Best Graduate Organization at UT Austin Award. Austin

Mentor, Mentoring365, American Geophysical Union 2021- Present
Facilitating an exchange of professional knowledge, skills, and experiences in Earth and space sciences. Virtual

Mentor, SIAM Applied Mathematics Mentorship 2021-23
Conceptualized the program and mentoring UT students for applied math concepts and prospects. Austin

Volunteer, Lunar and Planetary Science Conference 2022 2021
Managed a virtual and an in-person session and moreover conference logistical tasks. Houston

Mentor, Sir Syed Global Scholar Award 2016- Present
Mentoring top AMU students from humble backgrounds for US grad school applications. Virtual

Zonal Head & College Head Ambassador, Smilyo Educational Charitable Society 2014-15
Managed multi-university teams & provided educational resources to not-so-privileged. New Delhi, India

Reviewer

Geoscience: Computational Geoscience, Water Resources Research, Geophysical Research Lett., J. of Geophysical Research, Biosystems Engineering, J. of Hydrometeorology, Discover Geoscience (Springer Nature)
Numerical Methods: Journal of Computational Physics, Geoscientific Model Development, Computer and Fluids, Engineering with Computers, SoftwareX

Media Coverage

$50 million XPRIZE carbon removal awarded to Mati - Time, Washington Post, AP news 2025
On carbon removal work using enhanced rock weathering led by Mati Carbon (XPRIZE website).

Is Mars Storing its Water Underground? - Universe Today, SciTech Daily, Astrobiology 2025
Article on the work on infiltration on Early Mars.

Grad students find missing link in early Martian water cycle - UT, AAAS, Phys.org 2025
For the collaborative research on Infiltration on early Mars done in collaboration with ESA.

History and Habitability of the LP 890-9 Planetary System - Astrobiology 2024
For the collaborative work on the habitability of exoplanetary system LP 890-9.

Understanding ice layer formation to estimate sea level rise - UT, AAAS, Phys.org 2024
For the thesis work on understanding ice layer formation done in collaboration with NASA-JPL.

Little groundwater recharge in ancient Mars aquifer - UT, EurekAlert AAAS, Phys.org 2024
For the collaborative work with Eric Hiatt on water on early Mars.

Fulfilling my NASA dream - Sir Syed Global Scholar Award Story of the Month 2022
On my post-baccalaureate experience towards landing a graduate fellowship at NASA JPL.

Mars may have less water than previously estimated - Multiple news outlets 2022
UT Austin Website (front cover), & , Phys.org, Times of India, Bailey Universe

Outstanding Student Presentation Award at AGU 2021 - UT Austin 2022
For outstanding student presentation on Rainwater Infiltration in AGU Fall Meeting 2021.

CPSH Travel Grant sends 11 students to LPSC - UT Austin 2022
For travel grant from Center for Planetary Systems Habitability to attend LPSC 2022.

Lunar & Planetary Institute Career Devel. Award News - UT Austin, LPI News 2022
For outstanding first-authored work on fate of water on early Mars at LPSC conference.

How to stay productive while in quarantine - Oden Institute Feature Article 2021
For academic & research achievements and service at Oden Institute during quarantine.

Memberships

American Geophysical Union
International Glaciological Society
Association of Polar Early Career Scientists
Society for Industrial and Applied Mathematics
American Physical Society