

# Mohammad Afzal Shadab

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## EXPERIENCE

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| <b>Future Faculty in Physical Sciences Fellow, Postdoctoral Research Associate</b><br>Department of Civil and Environmental Engineering, <i>Princeton University</i> | Aug 2024 - Present<br>Princeton    |
| <b>Graduate Research Assistant</b><br>Oden Institute for Computational Engineering and Sciences, <i>University of Texas at Austin</i>                                | Aug 2019 - Aug 2024<br>Austin      |
| <b>NASA Jet Propulsion Laboratory Graduate Fellow</b><br>Planetary Science Division, <i>NASA Jet Propulsion Laboratory, California Institute of Technology</i>       | June - Aug 2023<br>Pasadena        |
| <b>NASA Jet Propulsion Laboratory Graduate Fellow</b><br>Earth Science Division, <i>NASA Jet Propulsion Laboratory, California Institute of Technology</i>           | April - June 2022<br>Pasadena      |
| <b>MIT Visiting Graduate Student Researcher</b><br>Department of Mechanical Engineering, <i>Massachusetts Institute of Technology</i>                                | Oct 2018 - April 2019<br>Cambridge |
| <b>Graduate Research Assistant</b><br>Dept. of Mechanical and Aerospace Engg., <i>Hong Kong University of Science and Technology</i>                                 | Sept 2016 - Sept 2018<br>Hong Kong |

## EDUCATION

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| <b>Doctor of Philosophy   Computational Science, Engineering &amp; Mathematics</b><br>The University of Texas at Austin, United States<br><i>Title:</i> Modeling Subsurface Flow of Water in Earth and Planetary Sciences<br><i>Advisor:</i> Dr. Marc Hesse, Professor of Earth and Planetary Sciences                   | Aug 2019 – Aug 2024<br>GPA: 3.90/4.0         |
| <b>Master of Science   Computational Science, Engineering &amp; Mathematics</b><br>The University of Texas at Austin, United States<br><i>Advisor:</i> Dr. Marc Hesse, Professor of Earth and Planetary Sciences   | Aug 2019 – Aug 2021<br>GPA: 3.90/4.0         |
| <b>Master of Philosophy   Mechanical Engineering</b><br>The Hong Kong University of Science and Technology, Hong Kong<br><i>Thesis:</i> Fifth-order Finite Volume WENO in General Orthogonally-curvilinear Coordinates 📄<br><i>Advisor:</i> Dr. Kun Xu, Chair Professor of Math and Mechanical and Aerospace Engineering | Sept 2016 – Sept 2018<br>GPA: 4.0(A)/4.3(A+) |
| <b>Bachelor of Technology   Mechanical Engineering</b><br>Aligarh Muslim University, India   | Aug 2012 – June 2016<br>GPA: 9.62/10.0       |

## PEER REVIEWED PUBLICATIONS

- [8] **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.
- [7] **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.
- [6] Hiatt, E. **Shadab, M.A.**, Hesse, M., Goudge, T., Gulick, S., 2024. Limited Recharge of a Deep Groundwater Aquifer In the Southern Highlands On Early Mars, *Icarus*, Elsevier, 115774, DOI: 10.1016/j.icarus.2023.115774
- [5] **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*, Elsevier, 101573, DOI: 10.1016/j.softx.2023.101573 📄
- [4] **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*, Elsevier, 104445, ISSN 0309-1708, DOI: 10.1016/j.advwatres.2023.104445
- [3] **Shadab, M.A.** and Hesse, M.A., 2022. Analysis of gravity-driven infiltration with the development of a saturated region, *Water Resources Research (AGU)*, DOI: 10.1029/2022WR032963

- [2] **Shadab, M.A.**, Balsara, D., Shyy, W. and Xu, K., 2019. Fifth order finite volume WENO in general orthogonally - curvilinear coordinates. *Computers & Fluids* (Elsevier), 190, pp.398-424.
- [1] **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), p.637.

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#### UNDER REVIEW PUBLICATIONS (PREPRINT AVAILABLE ON REQUEST)


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- [4] **Shadab, M.A.**, Hiatt, E., Bahia, R.S., Bohacek, E.V., Steinmann, V. and Hesse, M.A., 202X. Infiltration dynamics on early Mars: Geomorphic, climatic, and water storage implications (submitted to *Geophysical Research Letters*)
- [3] **Shadab, M.A.**, Rutishauser, A., Grima, C. and Hesse, M.A., 202X. A unified kinematic wave theory for melt infiltration into firn. *arXiv preprint arXiv:2403.15996* (submitted to *Journal of Glaciology*).
- [2] Vanek, S., Labe, Z., Lauter, O., Shionalyn, K., **Shadab, M.A.**, Adasheva, E., Margevich, A., Helmberger, M.N., Ashokkumar, L., Naoukin, J., 202X. 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* 2024.
- [1] Barnes, R., ... **Shadab, M.A.**, ..., 202X. The History and Habitability of the LP 890-9 Planetary System. *Planetary Science Journal*, American Astronomical Society. (under revision)

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#### IN PREPARATION

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- [4] **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 (to be submitted to *Earth & Planetary Science Letters*)
- [3] **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 (in preparation)
- [2] **Shadab, M.A.** and Hesse, M.A., 202X. An open source discrete operator toolbox (DOT) to solve geophysical flow problems. (for *Geoscientific Model Development*)
- [1] Hesse, M.A. and **Shadab, M.A.**, 202X. *Numerical Modeling for Geoscientists* (book draft )

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#### CONTRIBUTED TALKS

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- [41] **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. 2024 AGU Fall Meeting. (submitted)
- [40] **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. 2024 AGU Fall Meeting. (submitted)
- [39] 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. 2024 AGU Fall Meeting. (submitted)
- [38] Hiatt, E., **Shadab, M.A.**, Bahia, R.S., Bohacek, E.V., Steinmann, V. and Hesse, M.A., 2024. Dynamics of Infiltration on Early Mars 2024 AGU Fall Meeting. (submitted).
- [37] 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. 2024 AGU Fall Meeting. (submitted)
- [36] 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 2024.
- [35] **Shadab, M.A.**, Vance, S.D., Styczinski M.J., Silber E.A., Crósta, A.P., Carnahan, E., Jordan, J.S. and Hesse, M.A., 2024. Evolution of Impact Generated Melt at Selk Crater. 55th Lunar & Planetary Science Conference, ID# 1317.
- [34] **Shadab, M.A.**, Hiatt, E., Bahia, R.S., Bohacek, E.V., Steinmann, V. and Hesse, M.A., 2024. Infiltration on early Mars & its implications toward aeolian-fluvial interactions. 55th Lunar and Planetary Science Conference, # 1383.

- [33] 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 2024, Abstract ID#2408.
- [32] Barnes, R., ... **Shadab, M.A.**,..., 2024. The History and Habitability of the LP 890-9 Planetary System. 2024 Astrobiology Science Conference, ID# 1498545.
- [31] 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 2024. ID# 1310
- [30] **Shadab, M.A.**, Adhikari, S. Rutishauser, A., Grima, C., and Hesse, M.A., 2023. Mechanism and factors controlling ice layer formation in glacial firn. 2023 AGU Fall Meeting.
- [29] **Shadab, M.A.**, Rutishauser, A., Grima, C., and Hesse, M.A., 2023. A unified kinematic wave theory for melt infiltration into firn. 2023 AGU Fall Meeting.
- [28] 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. 2023 AGU Fall Meeting.
- [27] **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.
- [26] **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 2023.
- [25] 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, 2023.
- [24] 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.
- [23] **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 2023, Abstract #2025.
- [22] Barnes, R., ... **Shadab, M.A.**,..., 2023. The History and Habitability of the LP 890-9 Planetary System. Biennial European Astrobiology Conference (BEACON) 2023.
- [21] **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 2023, Abstract #1736.
- [20] 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 2023, Abstract #1637.
- [19] 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 2023, Abstract #2415.
- [18] Barnes, R., ... **Shadab, M.A.**,..., 2023. History and Habitability of the LP 890-9 Planetary System. 241st American Astronomical Society Meeting 2023.
- [17] **Shadab, M.A.**, and Hesse, M.A., 2022. An extended kinematic-wave theory for infiltration in soils with declining porosity causing delayed perching. 2022 American Geophysical Union (AGU) Fall Meeting.
- [16] **Shadab, M.A.**, and Hesse, M.A., 2022. Extending Richards equation to simulate variably saturated flows. 2022 AGU Fall Meeting.
- [15] 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. 2022 AGU Fall Meeting.

- [14] **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 2022, Abstract #1775.
- [13] Hiatt, E., **Shadab, M.A.**, et al, 2022. Estimates of groundwater divides and basins on Noachian Mars. 53rd Lunar and Planetary Science Conference 2022, Abstract #2618.
- [12] **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. 2021 AGU Fall Meeting.
- [11] **Shadab, M.A.**, and Hesse, M.A., 2021. Fluid Infiltration in Unsaturated Porous Medium with The Development of a Saturated Region. 2021 AGU Fall Meeting.
- [10] Hesse, M.A., **Shadab, M.A.**, Luo, D., Shen, Y., and Hiatt, E., 2021. Investigating Groundwater Flow Dynamics using Physics Informed Neural Networks (PINNs). 2021 AGU Fall Meeting.
- [9] Hiatt, E., **Shadab, M.A.**, et al, 2021. Experimental and Numerical Investigation of Seepage Face Dynamics. 2021 AGU Fall Meeting.
- [8] Hesse, M.A., **Shadab, M.A.**, Hiatt, E., Liebeck, J., 2021. Groundwater-ocean interaction on Mars. 2021 AGU Fall Meeting.
- [7] 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. 2021 AGU Fall Meeting.
- [6] **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. 2021 SIAM Annual Meeting.
- [5] **Shadab, M.A.**, Divoux, T. and Bischofberger, I., 2020. Suppression of drop breakup in a viscoelastic bath. Bulletin of the American Physical Society.
- [4] 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. American Geophysical Society 2020 Fall Meeting.
- [3] **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), Imperial College London.
- [2] **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.
- [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).









## INVITED TALKS AND SEMINARS

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- [9] April 2024: Mathematics on Ice Forum (worldwide, virtual)  - Modeling infiltration of meltwater and formation of ice layers in glacial firn
- [8] Jan 2024: California Institute of Technology, GALCIT and Fu Research Group - A voyage through fluid mechanics
- [7] Oct 2023: Center for Planetary Systems Habitability, UT Austin - Impact generated melt foundering on icy ocean worlds
- [6] Sept 2023: Institute for Geophysics, UT Austin - Modeling the meltwater percolation and formation of ice layers in glacial firn
- [5] August 2023: NASA Jet Propulsion Laboratory, Planetary Science Division Seminar - Impact generated melt foundering on icy ocean worlds
- [4] June 2022: NASA Jet Propulsion Laboratory, Earth Science Division Seminar - Modeling meltwater percolation in Greenland's firn



- [3] June 2022: California Institute of Technology, Fu Research Group - Modeling the meltwater percolation in Greenland's firn
- [2] May 2017: 5th International Conference on Numerical Simulation for Multimaterial and Multiphysics Problems (ICNM), Beijing - Fifth Order Finite Volume WENO in General Orthogonally Curvilinear Coordinates
- [1] 2016-2017: The Hong Kong University of Science and Technology, Aeronautics Interest Group (AIG) - Workshops on Aerodynamics and Propulsion.



## HONORS AND AWARDS

|  |                         |
|--|-------------------------|
| <b>Princeton University Future Faculty in Physical Sciences Postdoctoral Fellowship</b>             | August 2024-27          |
| A postdoctoral fellowship to increase research excellence and faculty diversity  | \$75,000/year           |
| <b>UT Austin Professional Development Award</b>   | January 2024            |
| For presenting two research works conducted at UT Austin.  | \$500                   |
| <b>NASA Open Science Badge</b>    | Jan 2024                |
| Completed 5 open science modules offered by NASA TOPS Program   |                         |
| <b>AGU Cryosphere Innovation Award / Flash Freeze Competition Winner</b>                            | Dec 2023                |
| Awarded based on a two-minute pitch of innovative idea to a panel of five judges at AGU 2023.  | \$1,500                 |
| <b>UT Austin Graduate School Summer Fellowship</b>    | June - Aug 2024         |
| Awarded based on academic standing and research experience supported by recommendations.   | \$11,527                |
| <b>UT Austin Graduate School Spring Dissertation Writing Fellowship</b>                             | Jan - May 2024          |
| Granted for academic and research excellence, substantiated by recommendations.  | \$22,127                |
| <b>NASA Jet Propulsion Laboratory Graduate Fellowship</b>   | June - Aug 2023         |
| To investigate life-supporting conditions on Europa with Dr. Steve Vance at JPL.   | \$12,100                |
| <b>UT Austin Professional Development Award</b>   | October 2022            |
| For presenting two research works conducted at UT Austin.  | \$500                   |
| <b>NASA Jet Propulsion Laboratory Graduate Fellowship</b>   | April - June 2022       |
| To study effect of climate change on Greenland ice sheet with Dr. Surendra Adhikari at JPL.  | \$9,000                 |
| <b>Purdue Climate Scholar by Purdue University and Office of Naval Research</b>                   | June - Aug 2022         |
| To attend Summer Institute for Sustainability & Climate Change at Purdue University.   | \$4,000                 |
| <b>MIT - Houston Energy Innovation Student Fellow</b>   | Mar 2022 - May 2023     |
| Representing UT Austin as a liaison between MIT's Martin Trust Center and Greentown Labs.  |                         |
| <b>Lunar and Planetary Institute Career Development Award</b>                                       | Feb 2022                |
| For first author abstract and application materials submitted at LPSC 2022.  | \$1,000                 |
| <b>UT Austin Cactus Standout Award (estd. 1894)</b>   | April 2022              |
| For academic excellence and leadership contributions. Inducted into Annual Yearbook, 2022.   |                         |
| <b>Student Research Award in Planetary Habitability by Cent. for Planetary Sys. Habitability</b>  | Jan 2022                |
| For proposal on finding life-supporting conditions on Europa using computational methods.  | \$16,425                |
| <b>Outstanding Student Presenters Award by Unsaturated Zone Technical Committee, AGU</b>          | Dec 2021                |
| Third prize for oral presentation: H52D-10 Rainwater Infiltration at AGU Fall Meeting 2021.       | \$175                   |
| <b>SIAM Certificate of Recognition by Society for Industrial and Applied Mathematics</b>   | Feb 2021                |
| For outstanding service and contributions to the UT Austin Student Chapter of SIAM.  |                         |
| <b>Blue Sky Student Fellowship by University of Texas Institute for Geophysics</b>   | August 2021 - July 2022 |
| Year-long fellowship covering tuition, insurance & stipend awarded for research proposal.  | \$2,491/month           |
| <b>Best Teaching Assistant Award by Dept of Mech &amp; Aero Engg, HKUST</b>  | August 2018             |
| Awarded for MECH-1907 Introduction to Aerospace Engineering course based on student surveys and jury of professors.  | HK\$300                 |






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| <b>Judge's Award and Audience Award at MIT MEMSI Program</b>  | June 2018            |
| Awarded by MIT and Hong Kong Innovation Node to best startup idea & pitch in the program.           |                      |
| <b>Outstanding Contribution in Reviewing Recognition by Journal of Computational Physics</b>        | June 2018            |
| For being in the top 10th percentile of reviewers.  |                      |
| <b>Postgraduate Studentship by HKUST</b>  | Aug 2016 – Sept 2018 |
| Competitive stipend for research postgraduate students (M.Phil.) at HKUST.                          | \$2,150/month        |
| <b>Global Scholar Award by Sir Syed Education Society of North America</b>                          | May 2015             |
| For top 20 students of AMU based on their academic achievements and research, for higher education. | \$1,000              |
| <b>National Summer Research Fellowship by Indian Academy of Sciences</b>                            | March 2015           |
| Awarded national fellowship to pursue research in Indian research institutes like IITs/IISc.        | \$220/month          |
| <b>University Merit Scholarship by AMU Alumni Association Toronto, Canada</b>                       | March 2015           |
| Merit based scholarship for students pursuing education at AMU.                                     | \$70                 |

## RESEARCH EXPERIENCE

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|---|---------------------------------------|
| <b>Improving the Numerical Toolset for Geodynamics of Icy Oceans World</b>  | NASA Jet Propulsion Lab               |
| NASA Jet Propulsion Lab Graduate Fellow (Stipend: \$1,100/week)   | June 2023 – August 2023               |
| <i>Advisor:</i> Dr. Steven Vance  |                                       |
| <ul style="list-style-type: none"> <li>Developed a code for single phase flow in viscously compacting matrix.</li> <li>Implementing tracers into melt migration code across ice shells of icy ocean worlds.</li> <li>Developed a theoretical model, validated with simulations, for calculating time scales of melt foundering.</li> </ul>  |                                       |
| <b>Modeling Meltwater Percolation in Greenland's Firn</b>   | NASA Jet Propulsion Lab, Caltech      |
| NASA Jet Propulsion Lab Graduate Fellow (Stipend: \$900/week)   | May 2022 – July 2022                  |
| <i>Advisor:</i> Dr. Surendra Adhikari   |                                       |
| <ul style="list-style-type: none"> <li>Developed a two-dimensional, three-phase (snow/water/air), firn infiltration simulator.</li> <li>Derived and validated vertically integrated model for meltwater gravity currents.</li> <li>Formulated kinematic wave theory of firn infiltration, inverted for model parameters and investigated meltwater infiltration in Greenland.</li> </ul>                                      |                                       |
| <b>Modeling Subsurface Flow of Water in Earth and Planetary Sciences</b>  | The University of Texas at Austin     |
| Graduate Research Assistant, <i>Doctoral Thesis</i> (Stipend: \$2,609/month)  | August 2019 – Present                 |
| <i>Advisor:</i> Prof. Marc Hesse  |                                       |
| <ul style="list-style-type: none"> <li>Developed and validated a conservative finite-difference based solver in Python for simulating a 2D two-phase flow in non-deforming porous media.</li> <li>Implemented the solver to study the behavior of Post Impact Hydrothermal systems on Mars.</li> <li>Implementing the solver to investigate the melt percolation on ice masses to study effects of global warming.</li> </ul> |                                       |
| <b>Investigating Groundwater Flows using Physics Informed Neural Networks</b>    | UT Austin                             |
| <i>Independent Research</i>   | August 2020 – June 2023               |
| <i>Collaborators:</i> DingCheng Luo, Yiran Shen, Eric Hiatt, and Prof. Marc Hesse   |                                       |
| <ul style="list-style-type: none"> <li>Wrote python codes for data-driven discovery of steady-state PDE from experimental data.</li> <li>Investigated the effect of PDE regularization in PINNs and the role of PDE &amp; data misfit.</li> <li>Learned the PDE parameters and boundary conditions for the transient seepage across edge of a porous reservoir simulated using finite-differencing.</li> </ul>                |                                       |
| <b>Free Fall of a Viscous Drop in a Viscoelastic Medium</b>    | Massachusetts Institute of Technology |
| Visiting Graduate Student Researcher (Stipend: \$2,150/month)   | October 2018 – April 2019             |
| <i>Advisor:</i> Prof. Irmgard Bischofberger   |                                       |
| <ul style="list-style-type: none"> <li>Performed a literature review of computational and experimental methods for investigating drop dynamics.</li> <li>Designed the experiments and apparatus with high-speed imaging.</li> <li>Wrote MATLAB scripts for analyzing moving camera videos using template matching.</li> </ul>   |                                       |


- High-Order Finite-Volume Reconstruction in Curvilinear Coordinates**  HKUST, Hong Kong  
 Graduate Research Assistant, *M.Phil. Thesis* (Stipend: \$2,150/month) December 2016 – September 2018  
*Advisor:* Prof. Kun Xu
- Proposed a general theory for state-of-art fifth order finite volume WENO in curvilinear coordinates.
  - Derived analytical relations and developed Fortran codes along with Riemann solvers and gas-kinetic scheme.
- Modal Decomposition Techniques on a Thermoacoustic System**  HKUST & U of Cambridge  
 Collaborative Research (Stipend: \$2,150/month) September 2016 – December 2016  
*Advisor:* Prof. Larry Li
- Analyzed and compared the prominent modal decomposition techniques for developing low order models.
  - Investigated nonlinear interactions between flame & external forcing for different amplitudes & frequencies.

## TEACHING EXPERIENCE

- GEO 325C/398C Continuum Mechanics**  (Level: Graduate) Fall 2023  
 University of Texas at Austin Austin  
*Position:* Teaching Assistant, *Instructor:* Prof. Marc Hesse  
*Responsibilities:* Instructed tutorial lectures, clarified doubts on Piazza, evaluated assignments
- GEO 325M/398M Numerical Modeling in the Geosciences**  (Level: Graduate) Spring 2023  
 University of Texas at Austin Austin  
*Position:* Teaching Assistant, *Instructor:* Prof. Marc Hesse  
*Responsibilities:* Instructed tutorials and coding exercises, resolved coding/conceptual issues
- SIAM Applied Mathematics Mentorship Program Lectures (Level: Undergrad/Graduate)** Fall 2022  
 University of Texas at Austin Austin  
*Position:* Instructor  
*Responsibilities:* Conducted lectures such as Intro to  $\LaTeX$  (video available , )
- GEO 325C/398C Continuum Mechanics**  (Level: Graduate) Fall 2022  
 University of Texas at Austin Austin  
*Position:* Teaching Assistant, *Instructor:* Prof. Marc Hesse  
*Responsibilities:* Instructed tutorial lectures, clarified doubts on Piazza, evaluated assignments
- MECH-1907 Introduction to Aerospace Engineering (Level: Freshman, Sophomore)** Spring 2018  
 The Hong Kong University of Science and Technology Hong Kong  
*Position:* Teaching Assistant, *Instructor:* Prof. Rhea Liem  
*Responsibilities:* Designed & evaluated exams & HWs, instructed tutorial and two class lectures
- MECH-3690 Aerospace Engineering Laboratory (Level: Senior, Junior)** Spring 2017  
 The Hong Kong University of Science and Technology Hong Kong  
*Position:* Teaching Assistant, *Instructor:* Prof. Jinglei Yang  
*Responsibilities:* Instructed multiple class lectures and lab briefings, contributed to lab manual

For all teaching feedback reports and certificates, click .

## PEDAGOGICAL TRAINING

- Inclusive Course Design Institute 2023**  Summer 2023  
 The University of Texas at Austin Austin  
 Using Universal Design for Learning (UDL) and best-practices, designed a course from ground up.
- 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  
 Advance teaching certificate for learning and practicing techniques of good classroom teaching.

## Graduate Teaching Assistant Training Program

The Hong Kong University of Science and Technology

Learned the fundamentals of teaching assistantship and effective pedagogy.

Fall 2017 – Spring 2018

Hong Kong




## TRAVEL GRANTS AND FUNDED SHORT SCHOOLS

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|   |                |
|---|----------------|
| <b>Center for Planetary Systems' Habitability Student Travel Award</b>  | February 2024  |
| Awarded a travel grant to attend the LPSC 2024.   | \$1000         |
| <b>Early Career Travel Award by European Space Agency</b>   | September 2023 |
| Received a travel award by ESA to attend the FAIRPLAY 2023 Workshop in the Netherlands.   | €2048          |
| <b>Center for Planetary Systems' Habitability Student Travel Award</b>  | February 2023  |
| Received a travel grant to attend the LPSC 2023.  | \$1000         |
| <b>Early Career Tiny Grants - AGU Ecohydrology Committee</b>  | December 2022  |
| For early-career scientists presenting ecohydrology-related work at the AGU Fall Meeting 2022.  | \$214          |
| <b>Center for Planetary Systems' Habitability Student Travel Award</b>  | February 2022  |
| Awarded a travel grant to attend the LPSC 2022.   | \$1000         |
| <b>AGU Fall Meeting Grant</b>   | December 2021  |
| Awarded a travel grant by UT Austin to attend the AGU Fall Meeting 2021.  |                |
| <b>SIAM Student Travel Award</b>  | June 2021      |
| Awarded a student travel grant to attend the SIAM Annual Meeting 2021.  | \$650          |
| <b>ICOSAHOM Conference Travel Grant</b>   | July 2018      |
| Awarded a student travel grant to attend the International Conference on Spectral And High Order Methods at Imperial College London.                            | \$2500         |
| <b>Numerical Simulations ICNM 2017 Conference Travel Grant</b>  | July 2017      |
| Awarded full funding from HKUST for attending the 5th International Conference on Numerical Simulations for Multimaterial and Multiphysics Problems in China.   | \$2200         |
| <b>Advanced Research in Turbomachinery Summer School Grant</b>  | July 2019      |
| Received a scholarship to attend this summer school organized by the University of Florence, Italy and sponsored by ANSYS and GE.                               | €800           |
| <b>MIT StartMIT Course Grant</b>  | January 2019   |
| Received full sponsorship from MIT Martin Trust Center to attend this hands-on MIT course on entrepreneurship involving multiple trips to companies within USA. |                |
| <b>Fluid Dynamics across Scales Summer School Grant</b>   | July 2018      |
| Received full-funding from HKUST to attend the Centre for Doctoral Training in Fluid Dynamics across Scales at Imperial College London.                         | \$1000         |
| <b>MIT Entrepreneurship and Maker Skills Integrator Bootcamp Funding</b>  | June 2018      |
| Received full funding from MIT and Hong Kong Innovation Node to attend the program involving trips to startup incubators in China.                              |                |

## COMMUNITY INVOLVEMENT

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|--|----------------------------------|
| <b>AGU24 Sessions' Convener and OSPA Liaison, Three Sessions</b>               | Aug 2023 – Dec 2024              |
| Designing 3 sessions with AGU Cryo team "C24A/C41C/C43C. The Cryosphere Is for All: Overcoming Barriers to Participation in the Cryospheric Sciences" oral/poster. |                                  |
| <b>Executive Secretary and/or Reviewer, Six NASA Proposal Review Panels</b>   | Jan 2023 – Present               |
| Managing panel review, assisting group chief and reviewing the proposals in panels.  | \$1840 * 3 + \$1490 * 2 + \$1140 |
| <b>Executive Committee Member, AGU Cryosphere Division</b>                      | March 2024 – Present             |
| Serving in the Diversity, Equity, and Inclusion (DEI) and Canvassing Working groups.   |                                  |



|   |   |
|---|---|
| <b>Judge, AGU Fall Meeting Travel Award</b>   | August 2024 - Sept 2024                 |
| Reviewed cryosphere division related applications for AGU 2024 from around the world.   |   |
| <b>Judge, International Mission to Mars Engineering Design Contest</b>  | June 2024 - July 2024                   |
| Organized by Mars Society for high school students from around the world.   |   |
| <b>Young Professional Mentor, Zed Factor Fellowship Program</b>   | May 2023 - Aug 2024                     |
| Mentor rising undergraduate students in Aerospace Engineering.  |   |
| <b>Team Member, UT Austin Libraries HELIOS team</b>   | April 2023 - Aug 2024                   |
| To advance Higher Education Leadership Initiative for Open Scholarship (HELIOS).<br>Gave a speech at <b>US White House</b> on Open Science (News , Post , Video ).<br>Organizer and Panelist at the First Texas Open Science Summit .<br>Panelist at the Open Science Webinar at Navigating the New Arctic Office .<br>Panelist at Open Science Event by Intl. Federation of Library Assoc. & Inst. . |   |
| <b>Co-Chair &amp; DEI Team Lead, US Assoc. of Polar Early Career Scientists</b>   | Sept 2022 – Present                     |
| Fostering climate and DEI-conscious collaborations between academia & polar organizations.  |   |
| <b>Board Member, AGU Hydrology Section Student Subcommittee (AGU-H3S)</b>   | Jan 2023 – Present                      |
| Providing professional development & networking opportunities to early career hydrologists.   |   |
| <b>Volunteer, MIT Energy Conference</b>   | April 2023<br>\$900                     |
| Helped with organizing the conference in person in Boston.  |   |
| <b>Coordinator, Center for Planetary Systems Habitability Student Travel Award</b>  | Jan – Apr 2023                          |
| Organizing, coordinating and liaising the application process for student travel to LPSC 2023.  |   |
| <b>MIT - Houston Energy Innovation Student Fellow</b>   | March 2022 – April 2023                 |
| Creating energy innovation ecosystem considering the threat of climate change.  |   |
| <b>Volunteer / Braindate Lounge Assistant, AGU Fall Meeting 2022</b>  | Dec 2022                                |
| Facilitated collaborations between researchers and scientists through Braindate at AGU 2022.  |   |
| <b>Mentor, American Geophys. Union Earth &amp; Planetary Surface Processes (EPSP)</b>   | Oct 2022 – Present<br>Virtual           |
| Mentoring graduate students across the world for developing technical and research skills in EPSP.  |   |
| <b>Geoscience Ambassador, Jackson School of Geosciences, UT Austin</b>  | Sept 2021 - July 2022<br>Austin, USA    |
| Making geoscience accessible to broader community & promoting interdisciplinary research.   |   |
| <b>Session Chair, Society for Industrial &amp; Applied Mathematics Annual Meeting 2021</b>  | July 2021<br>Virtual                    |
| Chaired the “CP15: Machine Learning and Data Mining” Session.   |   |
| <b>President &amp; Senior Advisor, Soc. for Industrial &amp; Applied Math, Austin Chapter</b>   | Sept 2020 – Present<br>Austin, USA      |
| Spearheaded several programs & Won Best Graduate Organization at UT Austin Award.   |   |
| <b>Mentor, Mentoring365, American Geophysical Union</b>   | Aug 2021 – Present<br>Virtual           |
| Facilitating an exchange of professional knowledge, skills, and experiences in Earth and space sciences.  |   |
| <b>Mentor, SIAM Applied Mathematics Mentorship</b>  | Jan 2021 – Present<br>Austin, USA       |
| Conceptualized the program and mentoring UT students for applied math concepts and prospects.   |   |
| <b>Volunteer, Lunar and Planetary Science Conference 2022</b>   | March 2021<br>Houston, USA              |
| Managed a virtual and an in-person session and moreover conference logistical tasks.  |   |
| <b>Mentor, Sir Syed Global Scholar Award</b>  | Jan 2016 – Present<br>Aligarh, India    |
| Mentoring top AMU students from humble backgrounds for US grad school applications.   |   |
| <b>Zonal Head &amp; College Head Ambassador, Smilyo Educational Charitable Society</b>  | Jan 2014 – Jan 2015<br>New Delhi, India |
| Managed multi-university teams & provided educational resources to not-so-privileged.   |   |

## REVIEWER FOR TECHNICAL JOURNALS

**Geoscience:** Computational Geoscience, Water Resources Research, Geophysical Research Letters   
, Journal of Geophysical Research - Planets

**Numerical Methods:** Journal of Computational Physics, Geoscientific Model Development, Computer and Fluids

## SKILLS

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**Languages:** C, C++, Fortran 77/90, Python (SciPy, NumPy, Matplotlib, Pandas, Pytorch, Tkinter, Tensorflow, GUI programming, Webscraping), HTML, MATLAB, Mathematica, Shell Scripting, L<sup>A</sup>T<sub>E</sub>X, High Performance Computing (SLURM)

**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

**OS:** Linux, Windows, Mac

## STUDENT MEMBERSHIP

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American Geophysical Union

Association of Polar Early Career Scientists

Society for Industrial and Applied Mathematics

American Physical Society

## MEDIA COVERAGE

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**Understanding ice layer formation to estimate sea level rise - UT [↗](#), AAAS [↗](#), Phys.org [↗](#)** Sept 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 [↗](#)** Feb 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 [↗](#)** Aug 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** April 2022  
UT Austin Website (front cover) [↗](#), [↗](#) & [↗](#), Phys.org [↗](#), Times of India [↗](#), Bailey Universe [↗](#)

**Outstanding Student Presentation Award at AGU 2021 - UT Austin [↗](#)** April 2022  
For outstanding student presentation on Rainwater Infiltration in AGU Fall Meeting 2021.

**CPSH Travel Grant Sends 11 Students to LPSC - UT Austin [↗](#)** March 2022  
For travel grant of \$1,000 from Center for Planetary Systems Habitability to attend LPSC 2022.

**Lunar & Planetary Institute Career Devel. Award News - UT Austin [↗](#), LPI News [↗](#)** Feb 2022  
For outstanding first-authored work on fate of water on early Mars submitted at LPSC conference.

**How To Stay Productive While in Quarantine - Oden Institute Feature Article [↗](#)** March 2021  
For academic & research achievements and service at Oden Institute during quarantine.

## OPEN SOURCE SOFTWARES

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- [6] **Shadab, M.A.**, Adhikari, S., Rutishauser, A., Grima, C. and Hesse, M.A. (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 (v1.0). Zenodo. <https://doi.org/10.5281/zenodo.11398273>
- [4] **Shadab, M.A.**, Hiatt, E., and Hesse, M.A., 2022. mashadab/polubarinova-kochina-solutions: P-k tool v1.1 (v1.1). Zenodo. <https://doi.org/10.5281/zenodo.74786522>
- [3] **Shadab, M.A.**, Luo, D., Shen, Y., Hiatt, E., and Hesse, M.A., 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. DOI: 10.5281/zenodo.6558260. URL: <https://github.com/mashadab/hyperbolic-infiltration-theory>
- [1] **Shadab, M.A.**, 2021. Reservoir-Simulator. Zenodo. DOI: <https://doi.org/10.5281/zenodo.6581752>. URL: <https://github.com/mashadab/Reservoir-Simulator>