Hailun Ni, Ph.D.

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EDUCATION

2020 **Ph.D. in Energy Resources Engineering,** Stanford University, US
Dissertation: *Quantifying CO_2 capillary heterogeneity trapping through experiments, data analysis, and simulation*
Advisor: Sally M. Benson, Professor

2015 **B.S. & M.Sc. in Energy Resources Engineering,** Stanford University, US

RESEARCH

2023 – Present **Research Assistant Professor at the Gulf Coast Carbon Center,** Bureau of Economic Geology, UT Austin, US
- Manages the Sand Tank Lab and conducts intermediate-scale sand tank experiments
- Specializes in multiphase fluid flow, data analysis, and reservoir simulation
- Research interests focus on CO_2 geologic storage, including plume migration and stabilization, CO_2 capillary heterogeneity trapping, fault leakage behavior, and time-lapse seismic monitoring

2020 – 2023 **Postdoctoral Fellow in CO_2 Storage,** Bureau of Economic Geology, UT Austin, US
- Conducted lab-scale acoustic sensing and light transmission visualization experiments with sand tanks
- Performed reservoir invasion percolation simulations with Permedia
- Built machine learning models to predict CO_2 trapping based on domain heterogeneity

2015 – 2020 **Research Assistant in CO_2 Storage,** Benson Lab, Stanford University, US
- Conducted high-pressure multiphase coreflooding experiments with an X-ray CT scanner
- Performed core- and field-scale reservoir simulations with Eclipse and MRST
- Implemented unsupervised machine learning on experimental data to gain further insights
- Built a reduced physics macroscopic percolation simulator in Matlab

2019 **Summer Intern in Data Analysis,** ExxonMobil Upstream Research Company, US
- Compiled data from a large number of water injection wells in the US from various databases
- Employed Matlab and Tableau to analyze the compiled data to investigate feasibility of large-scale CO_2 storage using saltwater disposal industry as analog

2018 **Landmark Intern in Machine Learning,** Halliburton, US
- Constructed geologic models using DecisionSpace and ran flow simulations to generate training data
- Applied machine learning using Python to predict oil production based on well placement

SELECTED PUBLICATIONS

Journal Publications

1. **Hailun Ni,** Andrew Feitz, Eric Tenthorey, Hadi Nourollah, Katherine Romanak, Claire Patterson, and Susan Hovorka. "Laboratory sand tank modeling of the Brumbys Fault CO_2 controlled release field experiment." *Geophysical Research Letters* 52, no. 6 (2025): e2024GL113918.

2. **Hailun Ni,** Boxiao Li, Nihal Darraj, Bo Ren, Catrin Harris, Prasanna G. Krishnamurthy, Idris Bukar, Steffen Berg, Jeroen Snippe, Philip Ringrose, T. A. Meckel, Samuel Krevor, and Sally Benson. "The impact of capillary heterogeneity on CO_2 flow and trapping across scales." *Earth-Science Reviews* (2025): 105257.

3. Hongsheng Wang, **Hailun Ni,** Tao Bai, Ting Xiao, Ruichang Guo, Yuntian Teng, Seyyed A. Hosseini, and Susan D. Hovorka. "Failure Analysis–Informed Risk Assessment Framework for Geological Carbon Storage Using Numerical Simulation and Machine Learning." *SPE Journal* (2025): 1-15.

4. Achyut Mishra, **Hailun Ni,** Seyed Ahmad Mortazavi, and Ralf R. Haese. "Performance assessment of graph theory towards predicting fluid flow in rocks across multiple spatial scales." *Advances in Water Resources* (2025): 105045.

5. Jose Eduardo Ubillus, **Hailun Ni,** David DiCarlo, and Tip Meckel. "Experimental Investigation of Buoyant Flow in Realistic Bedforms With Heterogeneous Wettability." *SPE Journal* 30, no. 03 (2025): 1538-1548.

6. Jose Eduardo Ubillus, Sahar Bakhshian, **Hailun Ni,** David DiCarlo, and Tip Meckel. "Informing field-scale CO_2 storage simulations with sandbox experiments: The effect of small-scale heterogeneities." *International Journal of Greenhouse Gas Control* 141 (2025): 104318.

7. **Hailun Ni,** Alexander P. Bump, and Sahar Bakhshian. "An experimental investigation on the CO_2 storage capacity of the composite confining system." *International Journal of Greenhouse Gas Control* 134 (2024): 104125.

8. Achyut Mishra, **Hailun Ni,** Seyed Ahmad Mortazavi, and Ralf R. Haese. "Graph theory based estimation of probable CO_2 plume spreading in siliciclastic reservoirs with lithological heterogeneity." *Advances in Water Resources* 189 (2024): 104717.

9. Bo Ren, James Littlefield, Cunqi Jia, **Hailun Ni,** and Ian Duncan. "Impact of Pressure-Dependent Interfacial Tension and Contact Angle on Capillary Heterogeneity Trapping of CO_2 in Storage Aquifers." *SPE Journal* 29, no. 08 (2024): 4442-4458.

10. **Hailun Ni**, Sahar Bakhshian, and T. A. Meckel. "Effects of grain size and small-scale bedform architecture on CO_2 saturation from buoyancy-driven flow." *Scientific Reports* 13, no. 1 (2023): 2474.

11. Alexander P. Bump, Sahar Bakhshian, **Hailun Ni**, Susan D. Hovorka, Marianna I. Olariu, Dallas Dunlap, Seyyed A. Hosseini, and Timothy A. Meckel. "Composite confining systems: Rethinking geologic seals for permanent CO_2 sequestration." *International Journal of Greenhouse Gas Control* 126 (2023): 103908.

12. Sahar Bakhshian, Alexander P. Bump, Shaunak Pandey, **Hailun Ni**, and Susan D. Hovorka. “Assessing the potential of composite confining systems for secure and long-term CO_2 retention in geosequestration.” Scientific Reports 13.1 (2023): 21022.

13. **Hailun Ni**, and T. A. Meckel. “Characterizing the effect of capillary heterogeneity on multiphase flow pulsation in an intermediate-scale beadpack experiment using time series clustering and frequency analysis.” *Water Resources Research* 57, no. 11 (2021): e2021WR030876.

14. **Hailun Ni**, Olav Møyner, Kuncho D. Kurtev, and Sally M. Benson. “Quantifying CO_2 capillary heterogeneity trapping through macroscopic percolation simulation.” *Advances in Water Resources* 155 (2021): 103990.

15. **Hailun Ni**, and Sally M. Benson. “Using unsupervised machine learning to characterize capillary flow and residual trapping.” *Water Resources Research* 56, no. 8 (2020): e2020WR027473.

16. **Hailun Ni,** Maartje Boon, Charlotte Garing, and Sally M. Benson. “Predicting CO_2 residual trapping ability based on experimental petrophysical properties for different sandstone types.” *International Journal of Greenhouse Gas Control* 86 (2019): 158-176.

Conference Publications

1. D. B. Sevindik, **Hailun Ni**, Ryosuke Okuno, and Hirotake Kitagawa. “Physical sand tank analog modeling to de-risk a CO_2 injection field experiment.” In *Proceedings of the SPE Annual Technical Conference and*

Exhibition (2025).

2. **Hailun Ni**, Andrew Feitz, Eric Tenthorey, Hadi Nourollah, Katherine Romanak, Claire Patterson, and Susan Hovorka. “Physical sand tank analog modeling to de-risk a CO_2 injection field experiment.” In *Proceedings of the 17th Greenhouse Gas Control Technologies Conference* (2024).

3. Jose Ubillus, **Hailun Ni**, Sahar Bakhshian, David DiCarlo, and Tip Meckel. “Impact of small-scale heterogeneity on field-scale CO_2 migration and trapping.” In *Proceedings of the 17th Greenhouse Gas Control Technologies Conference* (2024).

4. **Hailun Ni**, and T. A. Meckel. “Effects of flow pulsation on CO_2 buoyant migration and capillary trapping.” In *Proceedings of the 16th Greenhouse Gas Control Technologies Conference* (2022).

5. **Hailun Ni**, Ricardo Braganca, Nicola Tisato, and T. A. Meckel. “Monitoring CO_2 plume migration with lab-scale ultrasonic experimental setup.” In *Proceedings of the 16th Greenhouse Gas Control Technologies Conference* (2022).

6. Alexander Bump, Sahar Bakhshian, **Hailun Ni**, Susan Hovorka, Mariana Olariu, Dallas Dunlap, and Seyyed Hosseini. “Composite confining systems: rethinking geologic seals for permanent CO_2 sequestration.” In *Proceedings of the 16th Greenhouse Gas Control Technologies Conference* (2022).

7. **Hailun Ni**, Ganeswara Dasari, Gary Teletzke, and Apostolos Saris. “Evaluating technical feasibility of gigaton scale CO_2 storage using produced water disposal data in US Gulf Coast.” In *Proceedings of the 15th Greenhouse Gas Control Technologies Conference* (2021).

8. Maartje Boon, **Hailun Ni**, and Sally M. Benson. “Observations of the impact of mm-cm scale lamination on the migration and trapping of CO_2 in reservoir rocks.” In *Proceedings of the 15th Greenhouse Gas Control Technologies Conference* (2021).

9. **Hailun Ni**, Maartje Boon, Charlotte Garing, and Sally Benson. “Effects of correlation length and lamination direction on CO_2 residual trapping ability for different sandstone types.” In *Proceedings of the 14th Greenhouse Gas Control Technologies Conference* (2018).

10. Maartje Boon, **Hailun Ni**, Charlotte Garing, and Sally Benson. "Effect of capillary induced flow on CO_2 residual trapping." In *Proceedings of the 14th Greenhouse Gas Control Technologies Conference* (2018).

Patents

Shang Zhang, Greg Brumbaugh, **Hailun Ni**, Gaetan Bardy, and Harold Walters. “Simulating hydraulic fracturing geometry propagation using a differential stress and pattern-based model.” WO2020226647, World Intellectual Property Organization, 12 November 2020.

SELECTED PRESENTATIONS

Conferences Oral Presentations

Hailun Ni. “How to Best Model Multiscale Capillary Heterogeneity for Geologic CO_2 Storage.” *17th Annual International Conference on Porous Media (InterPore2025)*, 2025, Albuquerque, USA.

Hailun Ni, Andrew Feitz, Eric Tenthorey, Hadi Nourollah, Katherine Romanak, Claire Patterson, and Susan Hovorka. “Physical sand tank analog modeling to de-risk a CO_2 injection field experiment.” *17th Greenhouse Gas Control Technologies Conference (GHGT-17),* 2024, Calgary, Canada.

Jose Ubillus, **Hailun Ni**, Sahar Bakhshian, David DiCarlo, and Tip Meckel. "Impact of small-scale heterogeneity on field-scale CO_2 migration and trapping." *17th Greenhouse Gas Control Technologies Conference (GHGT-17),* 2024, Calgary, Canada.

Jose Ubillus, **Hailun Ni**, Sahar Bakhshian, David DiCarlo, and Tip Meckel. "Impact of Small-Scale Heterogeneity on Field-Scale Simulations of CO_2 Geologic Storage." *SPE-AAPG-SEG's Carbon Capture, Utilization, and Storage Conference (CCUS2024)*, 2024, Houston, US.

Hailun Ni, Andrew Feitz, Eric Tenthorey, Hadi Nourollah, and Susan Hovorka. "Using sand tank experiments to model and de-risk CO_2 geological storage." *SPE-AAPG-SEG's Carbon Capture, Utilization, and Storage Conference (CCUS2024)*, 2024, Houston, US.

Hailun Ni, Andrew Feitz, Eric Tenthorey, Hadi Nourollah, and Susan Hovorka. "Using sand tank experiments to model and de-risk CO_2 geological storage." *CO2CRC CCUS Symposium*, 2023, Melbourne, Australia.

Jose Ubillus, **Hailun Ni**, David DiCarlo, and Tip Meckel. "Experimental investigation of CO_2 buoyant flow saturation in ripple bedforms." *SPE-AAPG-SEG's Carbon Capture, Utilization, and Storage Conference (CCUS2023)*, 2023, Houston, US.

Hailun Ni, and Tip Meckel. "Effects of flow pulsation on CO_2 buoyant migration and capillary trapping." *16th Greenhouse Gas Control Technologies Conference (GHGT-16),* 2022, Lyon, France.

Hailun Ni, Sahar Bakhshian, Anthony Zuniga, and T. A. Meckel. "Predicting CO_2 gravity-driven drainage saturation using machine learning." *AGU Fall Meeting,* 2021, New Orleans, US.

Hailun Ni, Ganeswara Dasari, Gary Teletzke, and Apostolos Saris. "Evaluating technical feasibility of gigaton scale CO_2 storage using produced water disposal data in US Gulf Coast." *15th Greenhouse Gas Control Technologies Conference (GHGT-15),* 2021, Abu Dhabi, UAE.

Hailun Ni, and Sally M. Benson. "A novel clustering workflow to do data mining on CO_2/water coreflooding data." *AGU Fall Meeting,* 2019, San Francisco, US.

Hailun Ni, Maartje Boon, Charlotte Garing, and Sally M. Benson. "Effects of correlation length and lamination direction on CO_2 residual trapping ability for different sandstone types." *14th Greenhouse Gas Control Technologies Conference (GHGT-14),* 2018, Melbourne, Australia.

Conference Poster Presentations

Hailun Ni, Nihal Darraj, Catrin Harris, and Idris Bukar. "How to Best Model the Impact of Capillary Heterogeneity on CO_2 Flow and Trapping Across Scales." *SPE-AAPG-SEG Carbon Capture, Utilization, and Storage (CCUS2025) Conference,* 2025, Houston, US.

Jose Ubillus, **Hailun Ni**, Sahar Bakhshian, David DiCarlo, and T. A. Meckel. "A laboratory and simulation study on the impact of small-scale heterogeneity on field-scale CO_2 plume migration and trapping." *AGU Fall Meeting,* 2024, Washington, D.C., US.

Hailun Ni, Alex Bump, and Sahar Bakhshian. "Composite confining system for CO_2 geologic storage: comparing experimental and simulation results." *AGU Fall Meeting,* 2024, Washington, D.C., US.

Hailun Ni, Jose Ubillus, Alex Bump, David DiCarlo, and T. A. Meckel. "Using multiphase sand tank experiments to investigate the effect of heterogeneities on CO_2 capillary trapping." *AGU Fall Meeting,* 2023, San Francisco, US. eLightening presentation.

Ubillus, Jose, **Hailun Ni**, Sahar Bakhshian, David DiCarlo, and T. A. Meckel. "Experimental Investigation and Modelling of the Impact of Small-Scale Heterogeneities in Geologic Carbon Storage." *AGU Fall Meeting,* 2023, San Francisco, US.

Hailun Ni, Ricardo Braganca, Nicola Tisato, and Tip Meckel. "Monitoring CO_2 plume migration with lab-scale ultrasonic experimental setup." *16th Greenhouse Gas Control Technologies Conference (GHGT-16),* 2022, Lyon, France.

Hailun Ni, Sahar Bakhshian, Anthony Zuniga, and T. A. Meckel. "Predicting CO_2 gravity-driven drainage saturation using machine learning." *AAPG's Carbon Capture, Utilization, and Storage Conference (CCUS2022),* 2022, Houston, US.

Hailun Ni, Maartje Boon, Charlotte Garing, and Sally M. Benson. "Characterizing CO_2 residual trapping through experiments." *10th International Conference on Porous Media & Annual Meeting (InterPore2018)*, 2018, New Orleans, US. Poster and Poster Pitch Oral Presentation.

Hailun Ni, and Sally M. Benson. "Characterizing CO_2 capillary heterogeneity trapping through macroscopic percolation simulation." *9th International Conference on Porous Media & Annual Meeting (InterPore2017)*, 2017, Rotterdam, The Netherlands. Poster and Poster Pitch Oral Presentation.

TEACHING & ADVISING

Instructor

CO_2 injection and storage in geological formations, The University of Texas at Austin

- 17 undergraduate and graduate students — Fall 2025 – 2026
- 17 undergraduate and graduate students — Spring 2023 – 2024
- 18 undergraduate and graduate students — Spring 2022 – 2023
- 12 undergraduate and graduate students — Spring 2021 – 2022

Supervisor

- M.S., Thesis Committee, Jose Eduardo Ubillus, *Laboratory Experiments and Modeling to Evaluate Critical CO_2 Saturation for Geologic Carbon Storage*, The University of Texas at Austin — 2024

Reader

- M.S., Thesis Committee, Chinemerem Clement Okezie, *Calibrating Performance Predictions for Large-Scale Injection*, The University of Texas at Austin — 2024
- M.S., Thesis Committee, Angela Luciano, *Leveraging Class I Wells as an Analog for Class VI in the Gulf Coast*, The University of Texas at Austin — 2023

PROFESSIONAL SERVICES

Reviewer for conferences, journals, and proposals: 2019 – Present

- AAPG International Conference & Exhibition 2022
- Advances in Water Resources
- Applied Energy
- Discover Applied Sciences
- Elsevier
- Fuel
- Geophysical Research Letters
- German-Israeli Foundation for Scientific Research and Development
- International Journal of Greenhouse Gas Control
- SPE Journal
- Transport in Porous Media
- Water Resources Research
- World CCUS Conference 2025

Session chair for conferences:

- GCSSEPM Foundation Perkins-Rosen Research Conference 2024
- AGU Fall Meeting 2023
- AAPG's Carbon Capture, Utilization, and Storage Conference 2022

AWARDS

- Fellow, Edwin Allday Centennial Chair in Subsurface Geology 2025 – Present
- Best Poster in Site Simulation, Design, and Engineering:
  SPE-AAPG-SEG CCUS Conference 2025
- Tinker Family BEG Publication Award, Exemplary Publication of Scientific
  or Economic Impact, for timely and foundational work toward CO_2 storage security 2024
- CO2CRC CCUS Symposium Young Scientist Award 2023