CHRISTOPHER R. HAKKENBERG

Assistant Research Professor
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RESEARCH INTERESTS

Ecology: biodiversity, macroecology, biogeography, fire ecology, forest structure and dynamics
Remote sensing: lidar, image spectroscopy, broad-band optical time series
GIScience: geospatial analysis, ecoinformatics, data visualization
Statistics: parametric, nonparametric, spatial, hierarchical, prediction and inference
Applications: conservation, wildfire, human-environment, land cover change, urbanization

EDUCATION

2017	**PhD**	Ecology	*University of North Carolina*, Chapel Hill, NC.
2007	**MA**	Regional Studies East Asia	*Harvard University*, Cambridge, MA.
2004	**BA**	Chinese Studies	*Reed College*, Portland, OR

APPOINTMENTS

2022–	**Assistant Research Professor**	School of Informatics, Computing and Cyber Systems (SICCS), *Northern Arizona University*, Flagstaff, AZ.
2019–22	**Postdoctoral Researcher**	GEODE lab (PI: Scott Goetz), *Northern Arizona University*, Flagstaff, AZ.
2017–19	**Postdoctoral Research Fellow**	Rice Academy of Fellows & Department of Statistics, *Rice University*, Houston, TX.
	Kinder Scholar	Kinder Institute for Urban Research, *Rice University*, Houston, TX.
2014–17	**Fellow**	Earth and Space Science Program, *National Aeronautics and Space Administration (NASA)*
2014	**Instructor**	Department of Geography, *University of North Carolina*, Chapel Hill, NC.
2010–11	**University Fellow**	Forestry and Environmental Science, *Yale University*, New Haven, CT
2007–10	**Consultant**	*Solarbuzz LLC*, San Francisco, CA
2007	**Communications Assistant**	*The Nature Conservancy (TNC),* Kunming, China
2005–07	**Teaching Assistant**	Dept. of East Asian Languages and Civilizations, *Harvard University*, Cambridge, MA.
2006	**Secretary**	*Harvard Beijing Academy*, Cambridge, MA and Beijing, China
2005	**Research Intern**	*World Wildlife Fund (WWF)*, Kunming, China

PUBLICATIONS

Refereed Journal Articles *(* denotes equal contribution)*

In Print

32. Burns, P.; Kaszta, Z.; Cushman, SA; Brodie, JF; Hakkenberg, CH; Jantz, P; Deith, M; Luskin, MS; Ball, J; Mohd-Azlan, J; Burslem, D; Cheyne, SM; Haidir, I; Hearn, AJ; Slade, E Williams, PJ; Macdonald, DW; and SJ Goetz. The utility of dynamic forest structure from GEDI lidar fusion in tropical mammal species distribution models. (2025). **Frontiers in Remote Sensing.** 6, 1563430. https://doi.org/10.3389/frsen.2025.1563430
31. Clark, M.; Hakkenberg, C.R.; Bailey, T.; Burns, P. and S.J. Goetz. (2025). *Changes in Gedi-Based Measures of Forest Structure after Large California Wildfires Relative to Pre-Fire Conditions.* **Remote Sensing of Environment.**
30. Brodie, JF., Mohd–Azlan, J., Chen, C., Wearn, OR., Deith, M., Ball, J., Slade, EM., Burslem, D., Teoh, SW., Williams, PJ., Nguyen, A., Moore, JH., Goetz, SJ., Cushman, S., Hakkenberg, CR., Kaszta, Z., Burns, P., Jantz, P., Coomes, D., Reynolds, G., Helmy, OE., Rodriguez, JP., Jetz, W. and MS. Luskin. (2025). *Reply to: Causal claims, causal assumptions and protected area impact.* **Nature**. 638(8052), E42-E44. https://doi.org/10.1038/s41586-024-08513-7.
29. Kacic, P.; Gessner, U.; Hakkenberg, C.R., Holzwarth, S.; Müller, J.; Pierick, K.; Seidel, D.; Thonfeld, F.; Torresani, M; and C. Kuenzer. (2025) *Characterizing local forest structural complexity based on multi-platform and -sensor derived indicators.* **Ecological Indicators**. 170: 113085. https://doi.org/10.1016/j.ecolind.2025.113085
28. Hakkenberg, C.R.; Clark, M.; Bailey, T.; Burns, P. and S.J. Goetz. (2024). *Ladder fuels rather than canopy volumes consistently predict wildfire severity even in extreme topographic-weather conditions.* **Nature Communications Earth & Environment.** 5:721. https://doi.org/10.1038/s43247-024-01893-8
27. Cushman, S.; Kaszta, Z.; Burns, P.; Hakkenberg, C.; Jantz, P.; Macdonald, D.; Brodie, JF., Deith, M and S. Goetz. *Simulating multi-scale optimization and variable selection in species distribution modeling.* (2024). **Ecological Informatics.** 83: 102832. https://doi.org/10.1016/j.ecoinf.2024.102832
26. Burns, P., Hakkenberg C.R., and S.J. Goetz. *Multi-resolution gridded maps of vegetation structure from GEDI spaceborne lidar.* (2024). **Nature Scientific Data**. 11(1), 881. https://doi.org/10.1038/s41597-024-03668-4
25. Jia, D.; Wang, C.J.; Hakkenberg, C.R.; Numata, I.; Elmore, A.J.; and M.A. Cochrane. *Accuracy evaluation and effect factor analysis of GEDI aboveground biomass product for temperate forests in the CONUS.* (2024). **GIScience & Remote Sensing.** 61 (1) 2292374. https://doi.org/10.1080/15481603.2023.2292374
24. Hakkenberg, C.R., Atkins, J.W., Brodie, J.F., Burns, P., Cushman, S., Jantz, P., Kaszta, Z., Quinn, C.A., Rose, M.D., and S.J. Goetz. (2023). *Inferring alpha, beta, and gamma plant diversity across biomes with GEDI spaceborne lidar.* **Environmental Research: Ecology**. 2(3), 035005. https://doi.org/10.1088/2752-664X/acffcd
23. Atkins, J., P. Bhatt, L. Carrasco, E. Francis, J. E. Garabedian, C. R. Hakkenberg, B.S. Hardiman, J. Jung, A. Koirala, E. A. LaRue, S. Oh, G. Shao, A. Spiers, A. Stovall, T. Surasinghe, X. Tai, L. Zhai, T. Zhang, and K. Krause. (2023). *Integrating forest structural*

diversity measurement into ecological research. **Ecosphere.** 14(9), e4633. https://doi.org/10.1002/ecs2.4633

22. Hakkenberg, C.R., Tang, H., Burns, P., and S.J. Goetz (2023). *Canopy structure from space using GEDI lidar*. **Frontiers in Ecology and the Environment.** 21.1: 55-56. https://doi.org/10.1002/fee.2585.
21. Brodie, JF., Mohd–Azlan, J., Chen, C., Wearn, OR., Deith, M., Ball, J., Slade, EM., Burslem, D., Teoh, SW., Williams, PJ., Nguyen, A., Moore, JH., Goetz, SJ., Cushman, S., Hakkenberg, CR., Kaszta, Z., Burns, P., Jantz, P., Coomes, D., Reynolds, G., Helmy, OE., Rodriguez, JP., Jetz, W. and MS. Luskin. (2023). *Landscape-scale benefits of protected areas for tropical biodiversity*. **Nature**. 620, 807–812. https://doi.org/10.1038/s41586-023-06410-z.
20. Quinn, C.A., Burns, B., Hakkenberg, C. R., Salas, L., Pasch, B., Goetz, S. J., M. L. Clark (2023). *Soundscape components inform acoustic index patterns and refine estimates of bird species richness*. **Frontiers in Remote Sensing.** 4, 1156837. https://doi.org/10.3389/frsen.2023.1156837.
19. LaRue, E.A., R. Fahey, B. Aleveshere, J.W. Atkins, P. Bhatt, B. Buma, S. Cousins, J.M. Elliott, A. Elmore, C.R. Hakkenberg, B. Hardiman, J. Johnson, D. Kashian, A. Koirala, M. Papes, J.B. St. Hilliare, T. Surasinghe, J. Zambrano, L. Zhai, and S. Fei. (2023). *A framework for the ecological role of structural diversity*. **Frontiers in Ecology and the Environment**. 21.1: 4-13. https://doi.org/10.1002/fee.2587
18. Atkins, J.W., Costanza, J., Dahlin, K., Dannenberg, M., Elmore, A., Fitzpatrick, M., Hakkenberg, C.R., Hardiman, B., Kamoske, A., LaRue, E. McNeil, D.J., Silva, C.A., Stovall, A.E.L. and E.K. Tielens (2023). *Ecological implications of the scale-dependency of lidar-derived measures of ecosystem structure*. **Methods in Ecology and Evolution**, 00, 1– 16. https://doi.org/10.1111/2041-210X.14040
17. Dwivedi, D., A.L.D. Santos, M.A. Barnard, T.M. Crimmins, A. Malhotra, K.A. Rod, K.S. Aho, S.M. Bell, B. Bonfim, F.Q. Brearley, H. Cadillo-Quiroz, J. Chen, C.M. Gough, E.B. Graham, C.R. Hakkenberg, L. Haygood, G. Koren, E. Lilleskov, L.K. Meredith, S. Naeher, Z. Nickerson, O. Pourret, H.-S. Song, M. Stahl, N. Taş, R. Vargas, and S. Weintraub-Leff. (2022) *Biogeosciences Perspectives on Integrated, Coordinated, Open, Networked (ICON) Science*. **AGU Earth and Space Science.** 9. 3. e2021EA002119. https://doi.org/10.1029/2021EA002119
16. Wang, C.J., Elmore, A.J. Numata, I., Cochrane, M.A., Lei, S.G., Hakkenberg, C.R., Li, Y.Y., Zhao, Z.B., and Tian Y. (2022). *A framework for improving wall-to-wall canopy height mapping by integrating GEDI LiDAR*. **Remote Sensing.** 14, no. 15: 3618. https://doi.org/10.3390/rs14153618
15. Song, Y., C.J. Zajic, T. Hwang, C.R. Hakkenberg and K. Zhu (2021). *Widespread mismatch between phenology and climate in human-dominated landscapes*. **AGU Advances**. 2(4), e2021AV000431. https://doi.org/10.1029/2021AV000431
14. Hakkenberg, C.R. and S.J. Goetz (2021). *Climate mediates the relationship between plant biodiversity and forest structure across the contiguous United States*. **Global Ecology and Biogeography.** 30:2245–2258. https://doi.org/10.1111/geb.13380
13. Zhang, Y.L., C. Song, T. Hwang, K Novick, J.W. Coulston, J. Vose, M.P. Dannenberg, C.R. Hakkenberg, J. Mao, and C.E. Woodcock (2021). *Land use/cover change-induced decline in terrestrial gross primary production over conterminous United States from 2001 to 2016*. **Agricultural and Forest Meteorology.** 308, 108609. https://doi.org/10.1016/j.agrformet.2021.108609

12. Fagua, J.C., Jantz, P., Burns, P., Massey, R., Buitrago, J.Y., Saatchi, S., Hakkenberg, C.R., and S.J. Goetz. (2021). *Mapping tree diversity in the tropical forest region of Chocó-Colombia*. **Environmental Research Letters.** 16(5), 054024. https://doi.org/10.1088/1748-9326/abf58a
11. Cawse-Nicholson, K. et al. (2021). *The world of surface imaging algorithms: NASA's Surface Biology and Geology Designated Observables*. **Remote Sensing of Environment**. 257, 112349. https://doi.org/10.1016/j.rse.2021.112349
10. Hakkenberg, C.R., R.K. Peet, T.R. Wentworth, T.R. Zhu and M.P. Schafale. (2020). *Tree canopy cover constrains the fertility–diversity relationship in plant communities of the southeastern USA*. **Ecology**. 101 (10), e03119. https://doi.org/10.1002/ecy.3119
9. Smiley, K.T. and C.R. Hakkenberg*. (2020). *Race and affluence shape spatio-temporal urbanization trends in Greater Houston, 1997 to 2016*. **Land Use Policy**. 99, 105093. https://doi.org/10.1016/j.landusepol.2020.105093
8. Hakkenberg, C.R., M.P. Dannenberg, C. Song, and G. Vinci. (2020). *Automated continuous fields prediction from Landsat time series: application to fractional impervious cover*. **IEEE Geoscience and Remote Sensing Letters**. 17 (1) 132-136. https://doi.org/10.1109/LGRS.2019.2915320
7. Hakkenberg, C.R., M.P. Dannenberg, C. Song and K.B. Ensor. (2019). *Characterizing multi-decadal, annual land cover change dynamics in Houston, TX based on automated classification of Landsat imagery*. **International Journal of Remote Sensing**. 40 (2) 693-718. https://doi.org/10.1080/01431161.2018.1516318
6. Hakkenberg, C.R., K. Zhu, R.K. Peet and C. Song. (2018). *Mapping multi-scale vascular plant richness in a forest landscape with integrated LiDAR and hyperspectral remote-sensing*. **Ecology**. 99(2), 474-487. https://doi.org/10.1002/ecy.2109
5. Dannenberg, M.P, C. Song, and C.R. Hakkenberg. (2018). *A long-term, consistent land cover database for the southeastern United States using Automatic Adaptive Signature Generalization (AASG)*. **Photogrammetric Engineering & Remote Sensing**. 84 (9): 559–568. https://doi.org/10.14358/PERS.84.9.559
4. Hakkenberg, C.R., R.K. Peet, D.L. Urban, and C. Song. (2018). *Modeling plant composition as community continua in a forest landscape with LiDAR and hyperspectral remote sensing*. **Ecological Applications**. 28(1), 177-190. https://doi.org/10.1002/eap.1638
3. Dannenberg, M.P., C.R Hakkenberg, C. Song. (2016). *Consistent classification of Landsat time series with an improved automatic adaptive signature generalization algorithm*. **Remote Sensing**. 8(8), 691. https://doi.org/10.3390/rs8080691
2. Hakkenberg, C.R., C. Song, R.K. Peet, and P.S. White. (2016). *Forest structure as a predictor of tree species diversity in the North Carolina Piedmont*. **Journal of Vegetation Science**. 27(6), 1151-1163. https://doi.org/10.1111/jvs.12451
1. Hakkenberg, C.R. (2008). *Biodiversity and Sacred Sites: Vernacular Conservation Practices in Northwest Yunnan, China*. **Worldviews: Environment, Culture, and Religion**. Vol. 12, No. 1. https://doi.org/10.1163/156853508X276842

Book Chapters

5. Song, C., J. Chen, T. Hwang, A. Gonsamo, H. Croft, Q. Zhang, M.P. Dannenberg, Y. Zhang, C.R. Hakkenberg and J. Li. (2024). *Ecological Characterization of Vegetation Using Multi-Sensor Remote Sensing in the Solar Reflective Spectrum*. In: **Remote Sensing Handbook Vol. 2: Land**

Resources Monitoring, Modeling, and Mapping with Remote Sensing. Taylor and Francis. 533-575.

4. Hakkenberg, C.R., D.D. Tarasi, S.C. Cushman, and R.K. Peet. (2021). *Community - Continuum in Biogeography*. In: **International Encyclopedia of Geography: People, the Earth, Environment, and Technology**. Wiley-AAG, Oxford, UK.
3. Zhang, Q., Hakkenberg, C.R. and C. Song. (2018). *Evaluating the Effectiveness of Forest Conservation Policies with Multi-temporal Remotely Sensed Imagery*. In: **Comprehensive Remote Sensing (Volume 9): Remote Sensing Applications for Societal Benefits**. Elsevier. 39-58.
2. Hakkenberg, C.R., D.D. Tarasi, and R.K. Peet. (2017). *Community/Continuum in Biogeography*. In: **International Encyclopedia of Geography: People, the Earth, Environment, and Technology**. Wiley-AAG, Oxford, UK. 882-885.
1. Song, C., J. Chen, T. Hwang, A. Gonsamo, H. Croft, Q. Zhang, M.P. Dannenberg, Y. Zhang, C.R. Hakkenberg and J. Li. (2015). *Ecological Characterization of Vegetation Using Multi-Sensor Remote Sensing in the Solar Reflective Spectrum*. In: **Remote Sensing Handbook Vol. 2: Land Resources Monitoring, Modeling, and Mapping with Remote Sensing**. Taylor and Francis. 533-575.

Data Products and Other Publications

14. Burns, P., C. Hakkenberg, and S.J. Goetz. 2024. *Gridded GEDI Vegetation Structure Metrics and Biomass Density at Multiple Resolutions*. ORNL DAAC, Oak Ridge, Tennessee, USA. https://doi.org/10.3334/ORNLDAAC/2339
13. Mitchell J. *et al.* (2022). *Recommendation Report: Broadening the Use of NASA Datasets by the Species Distribution Modeling (SDM) Community.* NASA Understanding User Needs to Broaden Outside Use of NASA Data (UNBOUND).
12. Hakkenberg, C.R. (2021). *NEON forest and woodland plots: diversity, structure and climate.* DOI: 10.5061/dryad.vt4b8gtsj
11. Hakkenberg, C. R. (2019). *Houston Subannual Percent Impervious (SPI) Land Cover Dataset: 1997-2018*. [Data set]. Rice University-Kinder Institute: UDP. doi.org/10.25612/837.d8nxbzwj01ad.
10. Hakkenberg, C.R. (2018). *Greater Houston Land Cover Change Dataset: 1997-2017 (Version 2)* [Data set]. Rice University-Kinder Institute: Urban Data Platform. doi.org/10.25612/837.al72581lw7md.
9. Hakkenberg, C.R. (2017). *Mapping Plant Diversity and Composition Across North Carolina Piedmont Forest Landscapes Using Lidar-Hyperspectral Remote Sensing*. Ph.D. Dissertation, Curriculum for Environment and Ecology, University of North Carolina at Chapel Hill.
8. Dannenberg, M.P., Hakkenberg, C.R. and C. Song. (2016). *Automatic Adaptive Signature Generalization (AASG) in R*. DOI: 10.17632/s7c3vfr84w.1
7. Hakkenberg, C.R. (2008). *Greener Forests: Vernacular Conservation Practices and Biodiversity in Southwest China.* VDM Press.
6. Hakkenberg, C.R. (2008*). Re-articulating Literary Dissent: An Analysis of Wang Shuo's Playing for Thrills*, VDM Press.
5. Hakkenberg, C.R. (2007). 文化对话: Cultural Dialogues in *汉语世界 - The World of Chinese.* Vol. 1.

4. Tu, W. (2006). 笔论中国 [Writings on China] in S. Feng and Y. Feng, 用中文谈中国 [China Issues in Chinese Prose]. Trans. C.R. Hakkenberg. Beijing, PRC: BLCU Press.
3. Feng, S. and Y. Feng (2006). 序言 [Preface] in 文以载道: 汉语综合教程（五年级） [Writing and Truth: A Comprehensive Course in Mandarin (Level 5)]. Trans. C.R. Hakkenberg. Beijing, PRC: Higher Education Press.
2. Hakkenberg, C.R. (2005). *The Lost Voices: The Impact of the Development and Preservation Policies upon the Local People of Wudang Shan.*
1. Wu, Y. (2004). 扶贫开发与环境协调指导手册 [Harmonizing the Development of Poverty Alleviation and the Environment: A Guide Book]. Trans. C.R. Hakkenberg. Kunming, PRC: WWF and Yunnan Government Poverty Alleviation Office.

GRANTS, FELLOWSHIPS & AWARDS

External Grants (*selected*)

11. *Deriving consistent forest treatment attributes using GEDI space-borne lidar.* Contract: C.R. Hakkenberg. **Reshaping Wildfire & Fuels Reduction (ReSHAPE)**. $99,736. 02/2025-02/2027.
10. *Earth Dynamics Geodetic Explorer (EDGE) mission.* PI: H.A. Fricker, Co-PI: C.R. Hakkenberg. **NASA Earth System Explorers (ESE) Program.** $5,000,000 Step 1. *(Step 2 pending)*.
9. *Deriving continuous maps of forest structure to characterize the relationship between fuels, burn severity, and post-fire vegetation transitions across California wildfires.* PI: C.R. Hakkenberg. **NASA Global Ecosystem Dynamics Investigation (GEDI) Science Team**. (80NSSC24K0571) $499,776. 3/17/2024-3/16/2027.
8. *Quantifying carbon stocks and annual sequestration associated with Redwoods Rising improved forest management in Redwood National and State Parks.* PI: C.R. Hakkenberg. **Save the Redwoods League (SRL).** $99,667. 4/1/2024-3/31/2025.
7. *The Arizona Tree Stress Explorer and Alert System.* PI: A. Shenkin. Co-PI: C.R. Hakkenberg. **Arizona Board of Regents Grants Program Technology and Research Initiative Fund (TRIF)**. $1,259,942. 1/17/2023-1/16/2026.
6. *Timely prediction of wildfire burn severity in Californian forests with spaceborne observations of 3D vegetation structure.* (20-RP-LNU-106). PI: M. Clark; Institutional PI: C.R. Hakkenberg. **CAL FIRE California Climate Investments Forest Health Program.** $443,737 (NAU: $207,017). 4/2022 – 5/2025.
5. *Enabling and advancing biodiversity science and applications using GEDI 3D canopy structure information.* PI: S.J. Goetz. Co-I: C.R. Hakkenberg. **NASA Terrestrial Ecology – GEDI Competed Science Team** (80NSSC21K0189). $485,491, 07/2021 – 06/2024.
4. *Understanding the Impact of Land Cover/Land Use Change on Plant Diversity: Scaling from Plots to Landscapes Using Multi-Sensor Remote Sensing.* PI: C. Song, Graduate Student: C. R. Hakkenberg. **NASA Earth and Space Science Fellowship**. $90,000, 08/2014 – 07/2017.
3. *Urbanization and Biodiversity in the 21st Century American South: Tracking Regional Change from Space*. PI: C. R. Hakkenberg. **Center for the Study of the American South**, $3000. 6/1/2015 – 8/30/2015.
2. *Filling in the Gaps: Restoring Forest Ecosystems in SW China*. PI: C. R. Hakkenberg. **NSF: East Asia and Pacific Summer Institute**. (1209563). $12,500 (+ stipend and research funds), 06/01/2012 – 08/05/2012.

1. *The Lost Voices: The Impact of the Development and Preservation Policies upon the Local People of Wudang Shan*. PI: C. R. Hakkenberg. **Luce Foundation: Grant for Undergraduate Research in Chinese Studies**. $3000. 05/15/2004 – 08/15/2004.

Internal Grants

6. *Modelling biodiversity from forest structure across ecoclimatic gradients.* PI: C. R. Hakkenberg. **NSF RCN: Cross-Scale Processes Impacting Biodiversity Travel Grant** (World Biodiversity Forum 2022, Davos, Switzerland). $4150. 7/2022.
5. *Modeling forest biodiversity across the United States using airborne and spaceborne sensors.* PI: C.R. Hakkenberg. **NAU/NASA Space Grant.** $3645. 8/29/22 – 4/24/23.
4 *The Cost of Mangrove Encroachment on Tidal Salt Marsh Habitat: Quantifying the Ecological and Economic Impacts*. PI: A.M.S. Correa, Co-PIs: S.P. Egan, C.R. Hakkenberg, P.R. Hartley. **Creative Ventures Fund: InterDisciplinary Excellence Awards (IDEA)**, $75,000. 5/10/2018 – 5/9/2020.
3. *Greater Houston Land Cover Change Dataset: 1997-2017*. PI: C.R. Hakkenberg. Co-PI: K.B. Ensor. **Kinder Institute for Urban Research Urban Data Platform (UDP)**, $15,000. 3/1/2017 – 7/30/2017.
2. *Spatio-temporal Dynamics of Forest Recovery: Ecological Outcomes of Human-Environment Interactions in China's Rural Reforestation Programs*. PI: C.R. Hakkenberg. **Carolina Asia Center Pre-dissertation Asia Travel Award**, $2000 (*declined*). 2013. 6/1/2013 – 8/30/2013.
1. *Spatio-temporal dynamics of land cover change in the Piedmont, NC*. PI: C.R. Hakkenberg. **Kevin Satisky and Judith Thorn Summer Research Fellowship**. $4000. 6/1/2013 – 8/30/2013.

Fellowships, Scholarships, and Awards

9.	Rice Academy Fellowship, Rice University	2017-2019
8.	NASA-MSU Professional Enhancement Award	2012
7.	UNC Innovative Use of GIS	2012
6.	University Fellowship, Yale University	2010-2011
5.	Graduate School Fellowship, Harvard University	2005-2007
4.	Commendation for Excellence for Academic Performance, Reed College	2004
3.	Starr Foundation Chinese Scholarship	2003
2.	Starr Foundation Chinese Scholarship	2002
1.	Donald Flanders Scholarship	1999

SELECTED SCHOLARLY PRESENTATIONS

Invited Lectures

2022 "Using GEDI spaceborne lidar to model cross-biome forest biodiversity: effects of scale, sampling density, and spatial structure" *American Geophysical Union (AGU) Fall Meeting*. Chicago, IL.

"The biogeography of forest structural diversity, and its emerging geospatial applications", *UCLA Geography Colloquium*. Los Angeles, CA.

"Climate mediates the relationship between forest structural diversity and plant biodiversity", *Ecological Society of America (ESA) Annual Meeting*. Montreal, QC.

"Biodiversity and forest structure relationships across NEON's ecoclimatic gradients", *NEON Terrestrial Observation System Palooza*. remote.

2021 "Biodiversity - forest structure relationships: theory, findings, and emerging applications" *Clyde Kohn Colloquium Speaker Series,* Department of Geographical and Sustainability Sciences, University of Iowa, IA.

2019 "Subannual mapping of impervious surface in the Houston metropolitan area," *SICCS Ecoinformatics Seminar Series*, Northern Arizona University, Flagstaff, AZ.

"Automated characterization of subannual urbanization dynamics in Houston using satellite remote-sensing" *Machine Learning Seminar Series,* Rice University, Houston, TX.

"From forests to cities: spatio-temporal dynamics of complex socio-ecological systems" *Department of Geography Seminar*. University of Tennessee, Department of Geography, Knoxville, TN.

2018 "Monitoring Two Decades of Urbanization in Houston from Space" *Rice Data Science Conference*, Houston, TX.

2017 "Spatio-temporal dynamics of land cover change in the greater Houston area: 1997-2016" *NASA Data Science Day 2.0*. Johnson Space Center, Houston, TX.

"Modeling landscape turnover in vascular plant composition in heterogeneous forests." *Department of Forestry Spring Seminar Series*, University of Kentucky, Lexington, KY.

"Mapping landscape plant diversity and composition using LiDAR-hyperspectral remote sensing." *Vanzant Lecture Series*. Rice University, BioSciences. Houston, TX.

"Land cover change in Houston." *NASA Lecture Series on Sustainability,* NASA Johnson Space Center, Houston, TX.

2015 "Monitoring Biodiversity with Remote Sensing: Opportunities and Challenges." *US-China Biodiversity Workshop*. Raleigh, NC.

2014 "Tracking Forest Dynamics from Space: Remote Sensing and the History of Vegetation Mapping." *New Hope Audubon Society Invited Lecture*. Chapel Hill, NC.

Presentations

2025 "Mapping and forecasting carbon stocks and annual sequestration from Redwoods Rising". *Save the Redwoods League: Redwoods Rising Joint Meeting.*

2024 "Space lasers don't ignite wildfires, but they can help monitor fuels and reduce risk". *CALFIRE Forest Health Research Program Webinar.*

"Ladder fuels from GEDI predict wildfire severity across topographic-weather gradients" *Southwest Fire Ecology Conference,* Santa Fe, NM

2023 "Biodiversity - forest structure relationships: predicting cross-biome plant diversity with aggregated GEDI samples versus continuous airborne lidar censuses" *Ecological Society of America (ESA) Annual Meeting.* Portland, OR.

"Cross-biome biodiversity-structure relationships: multi-scale GEDI lidar predicts alpha, beta, and gamma diversity" *GEDI Completed Science Team Meeting*, College Park, MD.

2022 "GEDI sampling for biodiversity prediction", *Ecological Society of America (ESA) Annual Meeting.* Montreal, QA.

"Modelling biodiversity from forest structure across ecoclimatic gradients" *World Biodiversity*

Forum. Davos, Switzerland.

2020 "Scale Dependence in the Relationship between Forest Structural Diversity and Vascular Plant Diversity across Ecoclimatic Gradients" *American Geophysical Union (AGU) Fall Meeting*. San Francisco, CA.

"Bioclimatic constraints on the relationship between forest structure and biodiversity across all NEON sites." *Ecological Society of America (ESA) Annual Meeting*. Salt Lake City, UT.

2019 "Characterizing high-order spatio-temporal urbanization dynamics from remotely-sensed time series" *American Geophysical Union (AGU) Fall Meeting*. San Francisco, CA.

"Remote sensing for landscape ecology" *NSF Research Coordinated Network: Cross-Scale Processes Impacting Biodiversity*. Gainesville, FL.

"Automated prediction of subannual continuous fields impervious fractional cover dynamics" *Association of American Geographers (AAG) Annual Meeting*, Washington DC.

"Characterizing urbanization in Houston with satellite remote sensing," *Urban Affairs Association (UAA) Conference*. UCLA, Los Angeles, CA.

2018 "Discrete and continuous approaches to characterizing subannual urbanization dynamics from multi-scene, multi-decadal Landsat imagery" *American Geophysical Union (AGU) Fall Meeting*. Washington, DC.

"Leveraging remote sensing time series to characterize annual land-cover dynamics in greater Houston over two decades." *Association of American Geographers (AAG) Annual Meeting*, New Orleans, LA.

2017 "Spatio-temporal dynamics of land cover change in the Greater Houston Area: 1997-2017." *Smalley-Curl Institute Lecture Series*. Houston, TX.

"Houston land cover dynamics: 1997-2016." *Texas A&M Center for Texas Beaches and Shores and Kinder Institute Joint Workshop*, Galveston, TX.

"Mapping multi-scale vascular plant species richness in a Carolina Piedmont landscape using LiDAR-hyperspectral remote sensing." *Ecological Society of America (ESA) Annual Meeting*. Portland, OR.

"Multi-decadal spatio-temporal land-cover dynamics in the greater Houston area: Landsat time series generation using Automatic Adaptive Signature Generalization." *The Kinder Institute Urban Data Platform Launch*. Houston, TX.

2016 "Remotely-sensed predictive models of forest composition: community-unit classification versus continuous gradient modeling." *American Geophysical Union (AGU) Fall Meeting*. San Francisco, CA.

"Evaluating forest structure and foliar reflectance for modeling forest community properties in the NC Piedmont." *US – International Association of Landscape Ecology (US-IALE) Annual Conference*. Asheville, NC. (poster)

"Predictive models of forest community gradients using G-LiHT." *NASA Biodiversity and Ecological Forecasting Team Meeting*, Silver Spring, MD. (poster)

2015 "Modeling tree species diversity in NC Piedmont forests based on forest structure." *NASA Carbon Cycle and Ecosystems Joint Science Workshop*, College Park, MD. (poster)

"Nested Vegetation Sampling in Dense Canopy: Generating sub-meter spatial accuracy using GCP triangulation." *Southern Research Circle Poster Session*, Chapel Hill, NC. (poster)

2014 "Modeling Forest Structure and Vascular Plant Diversity in Piedmont Forests." *American Geophysical Union (AGU) Fall Meeting*. San Francisco, CA.

2013 "Village Sacred Forests as Refugia and Source Populations for Reforestation Efforts in SW China." *Ecological Society of America (ESA) Annual Meeting,* Minneapolis, MN. (poster)

2012 "Quantifying Structural and Compositional Changes in Forest Cover in NW Yunnan, China." *American Geophysical Union (AGU) Fall* Meeting, San Francisco, CA. (poster)

"A Tool for Spatially Explicit Visual Depiction of Plot-level Forest Dynamics." *UNC Innovative Use of GIS*. Chapel Hill, NC.

"Yunnan Biodiversity Preliminary Research Findings." *China-U.S. Young Scientist Forum*, Beijing, China.

"Quantifying Forest Cover Change in SW China." *US – International Association of Landscape Ecology (US-IALE) Annual Conference*, Newport, RI. (poster)

TEACHING EXPERIENCE

Instructor

2014	Summer	GEOG 112	Environmental Conservation	UNC - Geography
2012	Spring	GEOG 811	ESS Seminar*	UNC - Geography

* joint Instructor and Student

Teaching assistant

2014	Spring	ENST 203	Environmental Problems	UNC - Ecology
2013	Fall	GEOG 477	Introduction to Remote Sensing	UNC - Geography
2013	Spring	ENST 203	Environmental Problems	UNC - Ecology
2012	Fall	GEOG 370	Introduction to Geographic Information	UNC - Geography
2012	Spring	ENST 203	Environmental Problems	UNC - Ecology
2011	Fall	GEOG 370	Introduction to Geographic Information	UNC - Geography

Guest Lectures

2025	GEOG 212	Physical Mathematical and Computational Basis of Remote Sensing	UCLA
2024	GEP 380	Environmental Remote Sensing	Sonoma State University
2023	INF 620	Topics in Remote Sensing (2 classes)	Northern Arizona University
2019	GEOG 413	Remote Sensing of Environment	University of Tennessee Knoxville

Student training / mentorship

2023–	GEDI spaceborne-lidar	2 PhD students
2019–23	Species distribution modeling, Spatial statistics	1 BS; 3 PhD students
2017–19	GIS, Remote sensing accuracy assessment	1 MS student
2015–16	Plant identification, Vegetation sampling	3 BS; 4 MS students
2012	GIS, Plant identification, Vegetation sampling	1 MS student

ACADEMIC SERVICE

2019–	Member	NASA: Surface Biology and Geology Designated

		Observables Algorithms and Applications Working Groups
2021–23	Member	NASA: Understanding User Needs to Broaden Outside Use of NASA Data (UNBOUND).
2021–23	Ambassador	NSF: NEON Ambassadors Program
2019–24	Member	NSF RCN: Cross-Scale Processes Impacting Biodiversity
2019–22	Member	NSF MSB-NES: Exploring New Dimensions of Forest Ecosystems with Structural Diversity
2013–16	Co-Founder	UNC Ecology Research Symposium Committee
2013–15	Member	UNC Ecology Seminar Committee
2012–13	Senator	UNC Graduate and Professional Student Federation
2005–06	Associate Editor	Harvard Asia Quarterly

Manuscript Reviewer

AGU Advances; AGU Earth and Space Science; Animals; Castanea; Climate; Earth System Science Data; Ecohydrology; Ecological Applications; Ecological Modelling; Ecoscience; Environmental Research Letters; Environmental Sciences Europe; Forests; Harvard Asia Quarterly; Geology, Ecology, and Landscapes; Geomatics, Natural Hazards and Risk; Global Change Biology; Global Ecology and Biogeography; IEEE Geoscience and Remote Sensing Letters; International Journal of Applied Geospatial Research; ISPRS Journal of Photogrammetry and Remote Sensing; Journal of Forestry; Land Degradation & Development; Landscape Ecology; Nature Communications; Philosophical Transactions A; Physical Geography; Plants; Plant Phenome Journal; International Journal of Environmental Research and Public Health; Remote Sensing; Remote Sensing in Ecology and Conservation; Remote Sensing of Environment; Royal Society Open Science; Science of Remote Sensing; Science of the Total Environment; Sustainability

Grant Review

2024	Review Panelist	NASA [*remote*]
2022	Grant Reviewer	Belgian Remote Sensing Research Program (BELSPO) STEREO IV Programme
	Grant Reviewer	Czech Science Foundation (Grantová agentura České republiky)
2021	Review Panelist	NASA [*remote*]
2019	Review Panelist	NASA, Silver Spring, MD.
2018	Grant Reviewer	Belgian Remote Sensing Research Program (BELSPO)
	Review Panelist	NASA, Washington DC.

Report/White Paper Review

2021 NASA Biological Diversity and Ecological Forecasting:

Conference Services

2023	Session Co-chair	"Research advances in ecology across the Earth's major biomes".

		Environmental Research 2023.
	Session Organizer	GEDI space-borne lidar for global biodiversity applications", *Ecological Society of America (ESA) Annual Meeting*. Portland, OR.
2022	Session Co-organizer	"Setting a framework for using 3D structural diversity to model biodiversity and ecosystem function", *Ecological Society of America (ESA) Annual Meeting*. Montreal, QC.
2019	Session Chair	"Urbanization, Climate Change, and the Environment II," *American Geophysical Union (AGU) Fall Meeting*, San Francisco, CA.
	Session Convener	"Automating land cover change analyses of multi-temporal satellite imagery I-II," *Association of American Geographers (AAG) Annual Meeting*, Washington DC.

SELECTED MEDIA

2025 NAU Review. Wildland fires are unpredictable. NASA's spaceborne lidar is helping reduce that uncertainty.

2024 CAL FIRE TV. Space lasers don't ignite wildfires, but they can help monitor fuels and reduce risk.

America Adapts Podcast. The Science Behind Climate Adaptation with Battelle.

Houston Chronicle. Beryl has come and gone. What does the future look like for Houston and flooding?

Arizona Daily Sun. NAU professor part of finalist team for NASA Earth System Explorers Program.

The NAU Review. New NASA mission to map Earth's surface in 3D moves one step closer.

NPR KJZZ. How scientists are using a space laser to make predictions about wildfire severity.

2023 NSF NEON Observatory Blog. Monitoring Biodiversity on a Global Scale.

NBC 12 News. NAU is using lasers to assess the health of Arizona's forests.

The NAU Review. Measuring biodiversity across the U.S.—with space lasers

Phys.org. Measuring biodiversity across the US with space-borne lidar

2021 GEODE News. GEODE lab postdoctoral researcher Chris Hakkenberg named NEON ambassador in inaugural cohort

NSF NEON Observatory Blog. Meet the First Cohort of the NEON Ambassador Program

NAU Ecoinformatics News. Using NEON data to explore the relationship between biodiversity, forest structure, and climate

GEODE News. Interrelationships Between Plant Biodiversity, Forest Structure, and Climate

NSF NEON Science Blog. Exploring Interrelationships Between Plant Biodiversity, Forest Structure, and Climate

2020 Planetizen. The Social Dynamics of Houston's Urban Expansion

Urban Edge. The rapid urbanization of Houston: how it happened and why it matters

2019 Houston Public Media News. New Growth Mapping Tool Meant to Help Houston Better Prepare for Flooding

ABC News: KHOU 11. Rice University researchers use satellite images to track Houston's growth, flooding risk

Rice University News. Tracking Houston's growth from space: A new tool to fight flooding

Futurity. How will 20 years of Houston's growth affect flooding

2018 Kinder Urban Edge. Watch Two Decades of Growth in Houston

2015 UNC E3P. Chris Hakkenberg awarded prestigious NASA Earth and Space Science Fellowship

2012 UNC E3P. Student Summer Research in a Himalayan Forest, China

LANGUAGES

Native

English

Fluent

Mandarin Chinese (reading, writing, speaking)

Conversational (in decreasing order of proficiency)

Spanish, Dutch, Papiamentu