

CHRISTOPHER R. HAKKENBERG

Assistant Research Professor
 School of Informatics, Computing, and Cyber Systems (SICCS)
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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: multivariate, spatial, hierarchical, nonparametric, prediction and inference

Applications: conservation, wildfire, human-environment, land cover change, urbanization

EDUCATION

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

APPOINTMENTS

2022–	Assistant Research Professor	School of Informatics, Computing and Cyber Systems (SICCS), <i>Northern Arizona University</i> , Flagstaff, AZ.
2019–22	Postdoctoral Researcher	GEODE lab (PI: Scott Goetz), <i>Northern Arizona University</i> , Flagstaff, AZ.
2017–19	Postdoctoral Research Fellow	Rice Academy of Fellows & Department of Statistics, <i>Rice University</i> , Houston, TX.
	Kinder Scholar	Kinder Institute for Urban Research, <i>Rice University</i> , Houston, TX.
2014–17	Fellow	Earth and Space Science Program, <i>National Aeronautics and Space Administration (NASA)</i>
2014	Instructor	Department of Geography, <i>University of North Carolina</i> , Chapel Hill, NC.
2011–14	Teaching Assistant	Departments of Geography and Ecology, <i>University of North Carolina</i> , Chapel Hill, NC
2010–11	University Fellow	Forestry and Environmental Science, <i>Yale University</i> , New Haven, CT
2007–10	Consultant	<i>Solarbuzz LLC</i> , San Francisco, CA
2007	Communications Assistant	<i>The Nature Conservancy (TNC)</i> , Kunming, China
2005–07	Teaching Assistant	Dept. of East Asian Languages and Civilizations, <i>Harvard University</i> , Cambridge, MA.
2006	Secretary	<i>Harvard Beijing Academy</i> , Cambridge, MA and Beijing, China
2005	Research Intern	<i>World Wildlife Fund (WWF)</i> , Kunming, China

PUBLICATIONS***Refereed Journal Articles*** (* denotes equal contribution)***In Print***

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**.
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.
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.
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.
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

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.

Other Publications and Data Products

11. 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).
10. 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.
9. 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.
8. 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.

7. Dannenberg, M.P., Hakkenberg, C.R. and C. Song. (2016). *Automatic Adaptive Signature Generalization (AASG) in R*. DOI: 10.17632/s7c3vfr84w.1
6. Hakkenberg, C.R. (2008). *Greener Forests: Vernacular Conservation Practices and Biodiversity in Southwest China*. VDM Press.
5. Hakkenberg, C.R. (2008). *Re-articulating Literary Dissent: An Analysis of Wang Shuo's Playing for Thrills*, VDM Press.
4. Hakkenberg, C.R. (2007). 文化对话: Cultural Dialogues in *汉语世界 - The World of Chinese*. Vol. 1.
3. 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.
2. 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.
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

10. *Earth Dynamics Geodetic Explorer (EDGE) mission*. PI: H.A. Fricker, Co-PI: C.R. Hakkenberg. **NASA Earth System Explorers (ESE) Program** (*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**. \$499,776
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**. \$97,667.
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 Satsky and Judith Thorn Summer Research Fellowship**. \$4000. 6/1/2013 – 8/30/2013.

Fellowships, Scholarships, and Awards

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| 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

- 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*
- 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.
- 2019 “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.
- “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 Annual Meeting: Cross-Scale Processes Impacting Biodiversity. University of Florida, 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*. University of California, Los Angeles (UCLA).
- 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.
- “Mapping landscape turnover in plant diversity and composition with G-LiHT.” *NASA Biodiversity and Ecological Forecasting Team Meeting*, Washington DC.
- “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.
- “Mapping plant diversity and composition in Duke Forest.” *NASA Biodiversity and Ecological Forecasting Team Meeting*, Washington DC. (poster)
- 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.
- “NSF EAPSI 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

Student training / mentorship

2019 –	Species distribution modeling, spatial statistics (1 BS; 3 PhD students)	Flagstaff, AZ
2017 – 2019	GIS, remote sensing accuracy assessment (1 MS student)	Houston, TX
2015 – 2016	Plant identification, vegetation sampling (3 BS; 4 MS students)	Chapel Hill, NC
2012	GIS, plant identification, vegetation sampling (1 MS student)	Yunnan, China

ACADEMIC SERVICE

2021	Advisory team	NASA: Understanding User Needs to Broaden Outside Use of NASA Data (UNBOUND).
2021–	Ambassador	NSF: NEON Ambassadors Program
2019–	Member	NASA: Surface Biology and Geology Designated Observables Algorithms Working Group
2019–	Member	NASA: Surface Biology and Geology Designated Observables Applications Working Group

2019–	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

Manuscript Reviewer

AGU Advances; Animals; Castanea; Climate; 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; 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

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 [<i>remote</i>]
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: Current State of Knowledge and Considerations for the Next Decade.
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Conference Services

2023	Session Co-chair	“Research advances in ecology across the Earth’s major biomes”. <i>Environmental Research 2023</i> .
	Session Organizer	GEDI space-borne lidar for global biodiversity applications”, <i>Ecological Society of America (ESA) Annual Meeting</i> . Portland, OR.
2022	Session Co-organizer	“Setting a framework for using 3D structural diversity to model biodiversity and ecosystem function”, <i>Ecological Society of America (ESA) Annual Meeting</i> . Montreal, QC.
2019	Session Chair	“Urbanization, Climate Change, and the Environment II,” <i>American Geophysical Union (AGU) Fall Meeting</i> , San Francisco, CA.
	Session Convener	“Automating land cover change analyses of multi-temporal satellite imagery I-II,” <i>Association of American Geographers (AAG)</i>

Annual Meeting, Washington DC.

SELECTED MEDIA

- 2023 NSF NEON Observatory Blog. [Monitoring Biodiversity on a Global Scale.](#)
The NAU Review. [Measuring biodiversity across the U.S.—with space lasers](#)
Phys.org. [Measuring biodiversity across the US with space-borne lidar](#)
- 2021 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](#)
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. [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