

CHRISTOPHER R. HAKKENBERG

Assistant Research Professor
 School of Informatics, Computing, and Cyber Systems (SICCS)
 Northern Arizona University

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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 Review/Revision***

26. Cushman, S.; Kaszta, Z.; Burns, P.; Hakkenberg, C.; Jantz, P.; Macdonald, D.; and S. Goetz. Simulating multi-scale optimization and variable selection in species distribution modeling. **Ecological Informatics**.
25. Wang, C.J.; Jia, D.; 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. **ISPRS Journal of Photogrammetry and Remote Sensing**.
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. *GEDI spaceborne lidar predicts alpha, beta, and gamma diversity across biomes*. **Environmental Research: Ecology**.

In Print

23. Brodie, J.F., Mohd–Azlan, J., Chen, C., Wearn, O.R., Deith, M., Ball, J., Slade, E.M., Burslem, D., Teoh, S.W., Williams, P.J., Nguyen, A., Moore, J.H., Goetz, S.J., Cushman, S., Hakkenberg, C.R., Kaszta, Z., Burns, P., Jantz, P., Coomes, D., Reynolds, G., Helmy, O.E., Rodriguez, J.P., Jetz, W. and M.S. Luskin. (2023). *Landscape-scale benefits of protected areas for tropical biodiversity*. **Nature**.
22. 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). *Measuring forest structural diversity: advances, limitations, and possibilities*. **Ecosphere**.
21. 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**.
20. 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>.
19. 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>
18. 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>
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

8. *Mechanical treatments for reducing large wildfire severity: where it works, where it doesn't, and what it means for management priorities in the wildland-urban interface*. PI: C.R. Hakkenberg. **NASA Interdisciplinary Research in Earth Science (IDS)**. (*pending*) \$1,194,639. 6/2023-6/2026.
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 “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.
- “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 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-LALE) 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)

PUBLISHED DATASETS

- 2019 Houston Subannual Percent Impervious Land Cover Dataset: 1997-2018
- 2018 Greater Houston Land Cover Change Dataset: 1997-2018
- 2015 Duke Forest (Blackwood) NASA G-LiHT vegetation sampling*
- 2012 NSF EAPSI NW Yunnan sacred forest vegetation sampling
- * County record for *Fraxinus caroliniana* and *Acer rubrum* var. *trilobum* (Orange, NC).

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

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|------|--------|----------|----------------------------------------|-----------------|
| 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

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|-------------|--------------------------------------------------------------------------|-----------------|
| 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

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|-------|--------|------------------------------------------------------------------------------------|
| 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
2021–23	Ambassador	NSF NEON Ambassadors Program
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; 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 Organizer, “GEDI space-borne lidar for global biodiversity applications”, <i>Ecological Society of America (ESA) Annual Meeting</i> , Portland, OR.
	Session Co-chair, “Advances in cross-biome ecology”. <i>Environmental Research 2023</i> .
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) Annual Meeting</i> , Washington

DC.

SELECTED MEDIA

- 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. [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