Yuhan Rao, Ph.D.
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Research Scientist
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APPOINTMENTS

2022-present	*Research Scientist,* North Carolina Institute for Climate Studies (NCICS), NC State University, Asheville, NC, USA
2019-2022	*Postdoctoral Research Scholar*, NCICS, NC State University, Asheville, NC, USA
2018-2019	*Doctoral Career Consultant*, The Graduate School, University of Maryland, College Park, MD, USA
2014-2019	*Research Assistant,* Cooperative Institute for Climate and Satellites, University of Maryland, College Park, MD, USA
2011-2014	*Research Assistant,* Beijing Normal University, Beijing, China

EDUCATION

Ph.D. in **Geographical Sciences**   August 2019

University of Maryland, College Park   Maryland, U.S.

M. E. in **Cartography and Geographical Information Engineering**   July 2014

Beijing Normal University   Beijing, China

B. S. in **Statistics**   July 2011

Beijing Normal University   Beijing, China

GRANTS AND FUNDED PROJECTS

2023-2024	<u>Co-PI</u> for the NSF *"Workshop on Atmospheric and Urban Digital Twins (AUDT)"* ($49,999)
2022-2025	<u>Co-PI</u> for the NSF FAIR Open Science Research Coordination Network "*FAIR in ML, AI Readiness, and Reproducibility*" ($1,260,000)
2021-2024	<u>PI</u> for the NOAA Climate Program Office project "*Developing an In-Situ Satellite Blended Marine Air Temperature Dataset Using Artificial Intelligence"* ($336,443)
2021-2022	<u>PI</u> for NOAA Cloud Pathway project "Climate Observatory - Analyzing and Visualizing NOAA Satellite Climate Data Records on the Cloud" ($5,000)
2021-2022	<u>Co-I</u> for the NC State University Data Science Initiative project "Think and Do: A Workshop to Advance Open Climate Data Science in North Carolina" ($10,000)

2021	<u>PI</u> for ESIP Lab Innovation project "*Cloud-based Open Science Machine Learning Tutorials for Earth Science*" ($10,000)
2019	<u>PI</u> for ESIP FUNding Friday project "*Building Machine Learning Tutorials for Earth and Space Science Applications*" ($5,000)

OTHER RESEARCH PROJECTS

2021-present	(Co-PI) *Assessing CMIP6 simulation land components using satellite-based climate data records*
2019-present	(PI) *Creating Global Blended Surface Temperature Data Using Station Measurements and Satellite Observations*
2014-2019	(Research Assistant) *Validating GOES-R Land Surface Temperature Product Using Ground Campaign and Station Data*
2013-2014	(Research Assistant) *Monitoring plant phenological change using remotely sensed data*
2012-2014	(Research Assistant) *Influence of Climate Change on Human Health and the Adaption Mechanism*
2011-2013	(Research Assistant) *Research of Key Technologies of Global Land Cover Mapping*

PUBILICATIONS

Whitepapers, Technical Reports, Pre-prints, and Book Chapters

1. **Rao, Y.,** Redmon, R., Dale, K., Haupt, S. E., Hopkinson, A., Bostrom, A., ... & Kihn, E. A. (2023). Developing Digital Twins for Earth Systems: Purpose, Requisites, and Benefits. *arXiv preprint arXiv:2306.11175*.

2. Stall, S., Cervone, G., Coward, C., Cutcher-Gershenfeld, J., Donaldson, T. J., Erdmann, C., Hanson, B., Holm, J., King, J. L., Lyon, L., MacNamara, D. P., McGovern, A., McGranaghan, R., Narock, A. A., Parker, M. S., Peng, G., **Rao, Y.,** Ryan, E., Sedora, B., Shekhar, S., Vrouwenvelder, K., Waller, L., Wirz, C. (2023). Ethical and Responsible Use of AI/ML in the Earth, Space, and Environmental Sciences. *ESS Open Archive*. doi: 10.22541/essoar.168132856.66485758/v1

3. Voisin, N., Bennett, A., Fang, Y., Nearing, G., Nijssen, B., **Rao**, **Y** (2021). A science paradigm shift is needed for Earth and Environmental Systems Sciences (EESS) to integrate Knowledge-Guided Artificial Intelligence (KGAI) and lead new EESS-KGAI theories. United States: N. p., 2021. Web. doi:10.2172/1769651.

4. Chen, J., **Rao, Y**., Zhu., X. (2018). Spatiotemporal Data Fusion to Generate Synthetic High Spatial and Temporal Resolution Satellite Images. In Remote Sensing Time Series Image Processing (pp. 65-88). CRC Press.

Peer Reviewed Journal Articles (* denotes corresponding author or co-first author)

1. McGovern, A., Gagne, D. J., Wirz, C. D., Ebert-Uphoff, I., Bostrom, A., **Rao, Y**., ... & Peterson, T. (2023). Trustworthy Artificial Intelligence for Environmental Sciences: An Innovative Approach for Summer School. *Bulletin of the American Meteorological Society*.

2. Dong, Q., Chen, X., Chen, J., Yin, D., Zhang, C., Xu, F., **Rao, Y.**, Shen, M., Chen, Y. and Stein, A., 2022. Bias of area counted from sub-pixel map: Origin and correction. *Science of Remote Sensing*, *6*,. https://doi.org/10.1016/j.srs.2022.100069

3. Watson-Parris, D., **Rao, Y.,** Olivié, D., Seland, Ø., Nowack, P., Camps-Valls, G., Stier, P., Bouabid, S., Dewey, M., Fons, E. and Gonzalez, J., 2022. ClimateBench v1. 0: A benchmark for data-driven climate projections. *Journal of Advances in Modeling Earth Systems*, p.e2021MS002954.

4. Jiang, N., Shen, M., Ciais, P., Campioli, M., Peñuelas, J., Körner, C., Cao, R., Piao, S., Liu, L., Wang, S., Liang, E., Delpierre, N., Soudani, K., **Rao, Y.,** and co-authors (2022). Warming does not delay the start of autumnal leaf coloration but slows its progress rate. *Global Ecology and Biogeography*.

5. Jain, S., Mindlin, J., Koren, G., Gulizia, C., Steadman, C., Langendijk, G.S., Osman, M., Abid, M.A., **Rao, Y.** & Rabanal, V. (2022). Are We at Risk of Losing the Current Generation of Climate Researchers to Data Science? *AGU Advances*, *3*(4), https://doi.org/10.1029/2022AV000676

6. Hills, D. J., Damerow, J. E., Ahmmed, B., Catolico, N., Chakraborty, S., Coward, C. M., Crystal-Ornelas, R., Duncan, W. D., Goparaju, L. N., Lin, C., Liu, Z., Mudunuru, M. K., **Rao, Y.**, Rovetto, R. J., Sun, Z., Whitehead, B. P., Wyborn, L., & Yao, T. (2022). Earth and Space Science Informatics Perspectives on Integrated, Coordinated, Open, Networked (ICON) Science. *Earth and Space Science*. https://doi.org/10.1029/2021ea002108

7. Sun, Z., Sandoval, L., Crystal-Ornelas, R., Mousavi, S.M., Wang, J., Lin, C., Cristea, N., Tong, D., Carande, W.H., Ma, X. and **Rao, Y.** (2022). A review of Earth Artificial Intelligence. *Computers & Geosciences*. https://doi.org/10.1016/j.cageo.2022.105034

8. Wang, S., **Rao, Y.**, Chen, J., Liu, L., & Wang, W. (2021). Adopting "Difference-in-Differences" Method to Monitor Crop Response to Agrometeorological Hazards with Satellite Data: A Case Study of Dry-Hot Wind. *Remote Sensing*, *13*(3), 482.

9. Runkle, J. D., Sugg, M. M., Leeper, R. D., **Rao, Y.**, Matthews, J. L., & Rennie, J. J. (2020). Short-term effects of specific humidity and temperature on COVID-19 morbidity in select US cities. *Science of the Total Environment*, *740*, 140093

10. Wang, S., Chen, J., **Rao, Y**., Liu, L., Wang, W., & Dong, Q. (2020). Response of winter wheat to spring frost from a remote sensing perspective: Damage estimation and influential factors. *ISPRS Journal of Photogrammetry and Remote Sensing*, *168*, 221-235.

11. Shen, M., Jiang, N., Peng, D., **Rao, Y**., Huang, Y., Yang, W., Zhu, X., Cao, R., Chen, X., Chen, J., Miao, C., & Tang, Y. (2020). Can changes in autumn phenology facilitate earlier green-up date of northern vegetation? *Agricultural and Forest Meteorology*, *291*, 108077.

12. Zhang, C., Ma, L., Chen, J., **Rao, Y.,** Zhou, Y., & Chen, X. (2019). Assessing the impact of endmember variability on linear spectral mixture analysis (LSMA): a theoretical and simulation analysis. *Remote Sensing of Environment*, *235*, 111471.

13. **Rao, Y.,** Liang, S., Wang, D., Yu, Y., Song, Z., Zhou, Y., ... & Xu, B. (2019). Estimating daily average surface air temperature using satellite land surface temperature and top-of-atmosphere radiation products over the Tibetan Plateau. *Remote Sensing of Environment*, *234*, 111462.

14. Liu, Y., Yu, Y., Yu, P., Wang, H., & **Rao, Y.** (2019). Enterprise LST algorithm development and its evaluation with NOAA 20 data. *Remote Sensing*, *11*(17), 2003.

15. Li, Y., Chen, J., & **Rao, Y**. (2018). A practical sampling method for assessing accuracy of detected land cover/land use change: Theoretical analysis and simulation experiments. *ISPRS Journal of Photogrammetry and Remote Sensing*, *144*, 379-389.

16. **Rao, Y**., Liang, S., & Yu, Y. (2018). Land Surface Air Temperature Data Are Considerably Different Among BEST-LAND, CRU-TEM4v, NASA-GISS, and NOAA-NCEI. *Journal of Geophysical Research: Atmospheres*, *123*(11), 5881-5900.

17. Chen, J., **Rao, Y**., Shen, M., Wang, C., Zhou, Y., Ma, L., ... & Yang, X. (2016). A simple method for detecting phenological change from time series of vegetation index. *IEEE Transactions on Geoscience and Remote Sensing*, *54*(6), 3436-3449.

18. Lu, M., Chen, J., Tang, H., **Rao, Y**., Yang, P., & Wu, W. (2016). Land cover change detection by integrating object-based data blending model of Landsat and MODIS. *Remote Sensing of Environment*, *184*, 374-386.

19. **Rao, Y**., Zhu, X., Chen, J., & Wang, J. (2015). An improved method for producing high spatial-resolution NDVI time series datasets with multi-temporal MODIS NDVI data and Landsat TM/ETM+ images. *Remote Sensing*, *7*(6), 7865-7891.

20. Li, J., **Rao, Y**., Sun, Q., Wu, X., Jin, J., Bi, Y., ... & Liu, W. (2015). Identification of climate factors related to human infection with avian influenza A H7N9 and H5N1 viruses in China. *Scientific Reports*, *5*(1), 1-9.

21. Wang, Y., **Rao, Y**., Wu, X., Zhao, H., & Chen, J. (2015). A method for screening climate change-sensitive infectious diseases. *International journal of environmental research and public health*, *12*(1), 767-783.

22. Wang, C., Cao, R., Chen, J., **Rao, Y**., & Tang, Y. (2015). Temperature sensitivity of spring vegetation phenology correlates to within-spring warming speed over the Northern Hemisphere. *Ecological Indicators*, *50*, 62-68.

23. Chen, X., Li, W., Chen, J**., Rao, Y**., & Yamaguchi, Y. (2014). A combination of TsHARP and thin plate spline interpolation for spatial sharpening of thermal imagery. *Remote Sensing*, *6*(4), 2845-2863.

24. Chen, X., Li, W., Chen, J., Zhan, W., & **Rao, Y**. (2014). A simple error estimation method for linear-regression-based thermal sharpening techniques with the consideration of scale difference. *Geo-spatial Information Science*, *17*(1), 54-59.

25. Fan, B., Guo, L., Li, N., Chen, J., Lin, H., Zhang, X., Shen, M., **Rao, Y**., Wang, C., & Ma, L. (2014). Earlier vegetation green-up has reduced spring dust storms. *Scientific reports*, *4*(1), pp.1-6.

Peer-reviewed Conference Proceedings

1. Wang, J., Cao, X., Chen, J., Liu, D., & Rao, Y. (2015, July). A quantitative assessment of multiple scattering in plant-soil mixtures and the implications on nonlinear spectral unmixing models. In *2015 IEEE International Geoscience and Remote Sensing Symposium (IGARSS)* (pp. 1757-1760). IEEE.

2. Rao, Y., Chen, J., Chen, X., & Wang, J. (2013, July). Quantitative assessment of the different methods addressing the endmember variability. In *2013 IEEE International Geoscience and Remote Sensing Symposium-IGARSS* (pp. 3317-3320). IEEE.

SELECTED PRESENTATIONS

1. [Understanding the community's need for AI-ready open environmental data](). NCAR CISL Webinar, April 2022, Virtual.

2. [What we wish we had learned in Graduate School - a data management training roadmap for graduate students](). DataONE Webinar, November 2020, Virtual

3. Integrating long term satellite data and in situ observations to study snow-albedo-temperature feedback over the Tibetan Plateau. 2019 ESIP Summer Meeting, 2019, Tacoma, WA, U.S.

4. Assessing the Uncertainty and Stability of Model Simulated and Satellite Land Surface Temperature. *2019 Living Planet Symposium*, 2019, Milan, Italy

5. Estimating Daily Surface Air Temperature Using Satellite Land Surface Temperature and Top-of-Atmosphere Radiation Products over the Tibetan Plateau. *2019 ESIP Winter Meeting*, 2019, Bethesda, MD, U.S.

6. Cross-comparison of Land Surface Temperature Product between JPSS and GOES-R mission: Towards the Enterprise Algorithm. *NOAA JPSS Annual Science Team Conference*, 2018, College Park, MD, U.S.

7. (***Invited***) Land surface temperature products validation for GOES-R and JPSS missions: status and challenges. *International Workshop on Fiducial Reference Temperature Measurements*, 2017, Teddington, UK

8. Will enhanced spring vegetation activity under a warming climate amplify drought in the summer: A Perspective from 2012 US Drought. *AGU Fall Meeting*, 2017, New Orleans, LA, U.S.

9. A Bayesian Maximum Entropy (BME) framework for generating high spatial resolution surface temperature dataset combining various satellite products and ground measurements. *Joint EUSTACE-GlobTemperature User Workshop*, 2017, Lisbon, Portugal

10. Enhanced spring vegetation activity increase the risk of summer drought in North America. *NCAR-CGD Research Report*, 2017, Boulder, CO, U.S.

11. Land Surface Temperature Retrieval for Himawari-8 Advanced Himawari Imager (AHI) data. *JpGU-AGU Joint Meeting*, 2017, Chiba, Japan

12. Inter-comparison of global gridded land surface air temperature products. *AGU Fall Meeting*, 2016, San Francisco, CA, U.S.

13. Status of Land Surface Temperature Product Development at NOAA/NESDIS/STAR: Towards an enterprise LST algorithm and production. *GlobTemperature 4th User Consultation Meeting*, 2016, Lisbon, Portugal

14. Inter-comparison of Land Surface Temperature Retrieval Algorithm Using Remotely Sensed Microwave Data. *GlobTemperature 3rd User Consultation Meeting*, 2015, Reading, UK

15. Quantitative assessment of the different methods addressing the endmember variability. *International Geoscience and Remote Sensing Symposium*, 2013, Melbourne, Australia

PATENT

Cui, X., **Rao**, **Y**., Chen, j., Cao, X. "Method for Generating High Spatial Resolution NDVI ime Series Data." Application No: AU 2012101249 A4. Granted Date: 2012.08.17 by Australian Patent Office.

TEACHING & MENTORING EXPERIENCES

Instructor, University of Maryland, College Park

- GEOG373: *Geographic Information Systems* (Winter 2019)
- GEOG306: *Introduction to Quantitative Methods for the Geographic Environmental Sciences* (Summer 2019, Winter 2020, Summer 2020)

Guest lecturer, University of Maryland, College Park

- GEOG442/642: *Biogeography and Environmental Change* (Fall 2017)
- GEOG421: *Changing Geographies of China* (Fall 2018)
- GEOG672: *Biophysics of Optical Remote Sensing* (Fall 2018)

Teaching Assistant, University of Maryland, College Park

- GEOG373: *Geographic Information Systems* (Winter 2018)

Teaching Assistant, Beijing Normal University

- BNU007841: *Field Methods in Remote Sensing* (2012-2014)

TRAINING

2018, Associate Certificate, *University Teaching & Learning Program*, Teaching & Learning Transformation Center, University of Maryland, College Park

2018, *Diversity and Inclusion in University Teaching*, 2018, University of Maryland, College Park

2017, NCAR *Community Earth System Model Tutorial*, Boulder, CO, U.S.

2016, NASA Jet Propulsion Laboratory Center for Climate Sciences Summer School, "*Using Satellite Observations to Advance Climate Models*", Pasadena, CA, U.S.

FELLOWSHIPS, HONORS, AND AWARDS

2021, *Excellence in Outreach and Service*, North Carolina Institute for Climate Studies

2021, *Impact Scholar*, North Carolina State University

2020, *Catalyst Award*, Earth Science Information Partners

2019-2020, *Community Fellowship*, Earth Science Information Partners

2019, *Best Scientific Speaker*, 2019 NOAA CoRP Science Symposium

2018-2019, *Community Fellowship*, Earth Science Information Partners

2018, *Best Student Poster Award*, 2018 NOAA JPSS Annual Science Team Conference

2018, *Third Place,* Three-Minute Thesis (3MT) Competition, University of Maryland

2014-2018, *Chinese Government Scholarship*, China Scholarship Council

2017, *Graduate Student Research Fellowship*, National Center for Atmospheric Research (NCAR),

2016, *Baker Award for Outstanding Achievement*, Department of Geographical Sciences, University of Maryland

2013, *National Scholarship*, Ministry of Education, China

2012, *Best Presentation Award*, 5th Japan-China-Korea Graduate Student Forum

2012, *First place,* 20th "BNU Cup" Student Research Competition, Beijing Normal University

2010, *Meritorious Winner*, Mathematical Contest in Modeling/Interdisciplinary Contest in Modeling of America.

SERVICES & VOLUNTEERS

Conferences, Workshops & Projects

2021-present, co-chair, NOAA Workshop on Leveraging AI in Environmental Sciences

2021-2024, Scientific Steering Committee, Future Earth project "Analysis, Integration and Modeling of the Earth System"

2021-present, co-chair, ESIP Data Readiness Cluster

2022, co-chair, 11th International Conference on Climate Informatics

University Service

2018-2019, Representative, University Senate - Campus Affairs Committee, University of Maryland, College Park

2017-2018, Chair, Dean's Graduate Student Advisory Council, College of Behavior and Social Sciences, University of Maryland, College Park

2015-2018, Representative, Department Advisory Committee, Department of Geographical Sciences, University of Maryland, College Park

2016-2017, Representative, Graduate Committee, Department of Geographical Sciences, University of Maryland, College Park

2011-2013, President, Graduate Student Association, Academy of Disaster Reduction and Emergency Management, Beijing Normal University, Beijing

2009-2010, President, Undergraduate Student Association, School of Mathematical Sciences, Beijing Normal University, Beijing

Professional Society Service

2020-2022, Honors and Recognition Committee, American Geophysical Union (AGU)

2018-2021, Section Executive Committee, Global Environmental Change (GEC), American Geophysical Union (AGU)

2019, co-chair, Austin Challenge Early Career Committee, American Geophysical Union

2019-2020, co-chair, AGU Students and Early Career Scientists Conference Committee

Journal reviewer

Global Change Biology, IEEE Geoscience and Remote Sensing Letters, IEEE Transactions on Geoscience and Remote Sensing, ISPRS Journal of Photogrammetry and Remote Sensing, Remote Sensing, Remote Sensing of Environment

Professional society membership

American Geophysical Union, American Meteorological Society, American Association for the Advancement of Science, American Society for Photogrammetry and Remote Sensing

Volunteer experiences

2017 – 2019, Project volunteer, *Smithsonian Environment Research Center*, Edgewater, MD

2017, "*Sharing the Science*" Program, *American Geophysical Union*

2010 – 2014, Field Guide, *Beijing Bird Watching Association* (an NGO), Beijing, China

2009 – 2014, Lecturer/Environmental interpretation, *Green Camp* (an NGO), Beijing, China

2013, Environmental education intern, *Jane Goodall Institute (Beijing)* (an NGO), Beijing, China