Maxwell B. Joseph

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Experience

Senior data scientist

Planet Labs (2023-present)

- Estimated global forest aboveground biomass by integrating spaceborne lidar, optical satellite imagery, synthetic aperture radar, and deep learning models.
- Maintained and contributed to a variety of internal libraries focused on using deep learning to solve image-to-image regression problems in Earth observation.
- Led the validation and intercomparison of global forest data products against *in situ* and remotely sensed benchmark data.

Data scientist

Natural Capital Exchange (2021-present)

- Led the development of continental scale models of forest structure, biomass, and loss.
- Integrated modern geospatial data science tooling into existing workflows including dask, xarray, and the STAC (Spatiotemporal Asset Catalog) specification.
- Communicated the work of the data team both internally and externally to diverse stakeholders.

Research data scientist

Earth Lab, University of Colorado, Boulder (2016-2021)

- Developed Bayesian and machine learning methods to answer critical science questions with large scale earth observation data around wildfire, other natural hazards, the built environment, wildlife population dynamics, and disease ecology.
- Mentored undergraduate and graduate students, and collaborated with post-doctoral and faculty researchers across multiple departments.
- Synthesized data and software needs of an interdisciplinary research group, providing best practices and tooling for large scale earth science in the cloud.

Open science architect

North Central Climate Adaptation Science Center, University of Colorado, Boulder (2018-2021)

- Developed open source climate data tools to support resource management decisions.
- Built partnerships between academic, nonprofit, and federal stakeholders to address key data needs.

Education

University of Colorado, Boulder Ph.D. 2010 - 2016 Department of Ecology and Evolutionary Biology

University of California, Davis B.S. 2004 - 2008 Wildlife, Fish, and Conservation Biology

Skills

Bayesian statistics (spatiotemporal statistics, hierarchical Bayesian models, state-space models, data integration), **machine learning** (sequence models, computer vision, tabular data, self-supervised learning, active learning, science-based eep learning, data fusion), **Earth observation data** (Optical imagery from

Sentinel 2, Landsat, Planetscope, GOES; Synthetic Aperture Radar from Sentinel 1; Land cover data; large scale observation networks including NEON and USFS FIA), and **ecology** (occupancy modeling, mark-recapture, N-mixture modeling, distance sampling, spatial capture-recapture).

Tools

Python, R, bash, Stan, pytorch, fastai, xarray, pandas, geopandas, dask, pytest, mlflow, git, GitHub, tidyverse, stars, testthat, and JAGS.

Preprints

- Stephens JJ, **Joseph MB**, Iglesias V, Tuff TA, Mahood AL, Rangwala I, Wolken J, Balch JK. Fires of Unusual Size: Future of Extreme and Emerging Wildfires in a Warming United States (2020-2060). Authorea Preprints. 2023 Dec 10.
- Knapp RA, Wilber MQ, Byrne AQ, **Joseph MB**, Smith TC, Rothstein AP, Grasso RL, Rosenblum EB. Evolutionary rescue and reintroduction of resistant frogs allows recovery in the presence of a lethal fungal disease. bioRxiv. 2023:2023-05.
- Wasser L, Palomino J, Herwehe L, Quarderer N, McGlinchy J, Balch J, **Joseph MB**. Student-Directed Learning in the Open Earth & Environmental Data Science Classroom. https://osf.io/preprints/xdj4z/
- **Joseph MB**, Pavlacky DC, Bartuszevige AM. Data fusion for abundance estimation: community science augments systematically collected removal-in-time distance sampling data. bioRxiv. 2021 Jan 1.
- Graves SJ, Marconi S, Stewart D, Harmon I, Weinstein BG, Kanazawa Y, Scholl VM, **Joseph MB**, McClinchy J, Browne L, Sullivan MK. Data science competition for cross-site delineation and classification of individual trees from airborne remote sensing data. bioRxiv. 2021 Jan 1.

Peer-reviewed publications

- Wiedinmyer C, Kimura Y, McDonald-Buller EC, Emmons LK, Buchholz RR, Tang W, Seto K, **Joseph MB**, Barsanti KC, Carlton AG, Yokelson R. The Fire Inventory from NCAR version 2.5: An updated global fire emissions model for climate and chemistry applications. EGUsphere. 2023 Feb 27;2023:1-45.
- Mahood AL, **Joseph MB**, Spiers AI, Koontz MJ, Ilangakoon N, Solvik KK, Quarderer N, McGlinchy J, Scholl VM, St Denis LA, Nagy C. Ten simple rules for working with high resolution remote sensing data. Peer Community Journal. 2023;3.
- Spiers AI, Royle JA, Torrens CL, **Joseph MB**. Estimating species misclassification with occupancy dynamics and encounter rates: A semi-supervised, individual-level approach. Methods in Ecology and Evolution. 2022 Apr 22.
- Balch JK, Abatzoglou JT, **Joseph MB**, Koontz MJ, Mahood AL, McGlinchy J, Cattau ME, Williams AP. Warming weakens the night-time barrier to global fire. Nature. 2022 Feb;602(7897):442-8.
- Fagre AC, Cohen LE, Eskew EA, Farrell M, Glennon E, **Joseph MB**, Frank HK, Ryan SJ, Carlson CJ, Albery GF. Assessing the risk of human-to-wildlife pathogen transmission for conservation and public health. Ecology Letters. 2022 Mar 22.
- Knapp RA, **Joseph MB**, Smith TC, Hegeman EE, Vredenburg VT, Erdman Jr JE, Boiano DM, Jani AJ, Briggs CJ. Effectiveness of antifungal treatments during chytridiomycosis epizootics in populations of an endangered frog. PeerJ. 2022 Jan 5;10:e12712.
- Nagy RC, Balch JK, Bissell EK, Cattau ME, Glenn NF, Halpern BS, Ilangakoon N, Johnson B, **Joseph MB**, et al. Harnessing the NEON data revolution to advance open environmental science with a diverse and data-capable community. Ecosphere. 2021 Dec;12(12):e03833.

- Albery GF, Becker DJ, Brierley L, Brook CE, Christofferson RC, Cohen LE, Dallas TA, Eskew EA, Fagre A, Farrell MJ, Glennon E, Guth S, **Joseph MB**, Mollentze N, Neely BA, Poisot T, Rasmussen AL, Ryan SJ, Siefert S, Sjodin AR, Sorrell EM, Carlson CJ. The science of the host–virus network. Nature microbiology. 2021 Dec;6(12):1483-92.
- Albery GF, Turilli I, **Joseph MB**, Foley J, Frere CH, Bansal S. From flames to inflammation: how wildfires affect patterns of wildlife disease. Fire Ecology. 2021 Dec;17(1):1-7.
- Kitzes J, Blake R, Bombaci S, Chapman M, Duran SM, Huang T, **Joseph MB**, Lapp S, Marconi S, Oestreich WK, Rhinehart TA. Expanding NEON biodiversity surveys with new instrumentation and machine learning approaches. Ecosphere. 2021 Nov;12(11):e03795.
- Solvik K, Bartuszevige AM, Bogaerts M, **Joseph MB**. Predicting Playa Inundation Using a Long Short-Term Memory Neural Network. Water Resources Research. 2021 Nov;57(12):e2020WR029009.
- Scholl VM, McGlinchy J, Price-Broncucia T, Balch JK, **Joseph MB**. Fusion neural networks for plant classification: learning to combine RGB, hyperspectral, and lidar data. PeerJ. 2021 Jul 29;9:e11790.
- Gadeken KR, **Joseph MB**, McGlinchy J, Karnauskas KB, Wall CC. Predicting subsurface sonar observations with satellite-derived ocean surface data in the California Current Ecosystem. Plos one. 2021 Aug 20;16(8):e0248297.
- Iglesias V, Braswell AE, Rossi MW, **Joseph MB**, McShane C, Cattau M, Koontz MJ, McGlinchy J, Nagy RC, Balch J, Leyk S. Risky development: Increasing exposure to natural hazards in the United States. Earth's future. 2021 Jul;9(7):e2020EF001795.
- Qiang Y, Buttenfield BP, **Joseph MB**. How to measure distance on a digital terrain surface and why it matters in geographical analysis. Geographical Analysis. 2021 Jul;53(3):588-622.
- Fagre AC, Cohen LE, Eskew EA, Farrell M, Glennon E, **Joseph MB**, Frank HK, Ryan SJ, Carlson CJ, Albery GF. Assessing the risk of human-to-wildlife pathogen transmission for conservation and public health. Ecology Letters. 2022 Mar 22.
- McGlinchy J, Muller B, Johnson B, **Joseph MB**, Diaz J. Fully Convolutional Neural Network for Impervious Surface Segmentation in Mixed Urban Environment. Photogrammetric Engineering & Remote Sensing. 2021 Feb 1;87(2):117-23.
- **Joseph MB**, Knapp RA. Using visual encounter data to improve capture–recapture abundance estimates. Ecosphere. 2021 Feb;12(2):e03370.
- Spiers AI, Royle JA, Torrens CL, **Joseph MB**. Estimating occupancy dynamics and encounter rates with species misclassification: a semi-supervised individual-level approach. BioRxiv. 2021 Jan 1.
- **Joseph MB**. Neural hierarchical models of ecological populations. Ecology Letters. 2020 Apr;23(4):734-47.
- Basey JM, Francis CD, **Joseph MB**. Motivation Strategies and Exiting Class by Students in Inquiry-Oriented Biology Labs. Teaching & Learning Inquiry. 2020 Oct 6;8(2):128-39.
- Balch JK, Iglesias V, Braswell AE, Rossi MW, **Joseph MB**, Mahood AL, Shrum TR, White CT, Scholl VM, McGuire B, Karban C. Social-environmental extremes: Rethinking extraordinary events as outcomes of interacting biophysical and social systems. Earth's Future. 2020 Jul;8(7):e2019EF001319.
- Denis LA, Hughes AL, Diaz J, Solvik K, **Joseph MB**, Balch JK. 'What I Need to Know is What I Don't Know!': Filtering Disaster Twitter Data for Information from Local Individuals. Proceedings of 17th International Conference on Information Systems for Crisis Response and Management 2020.
- Diaz J, St Denis LA, **Joseph MB**, Solvik K, Balch JK. Classifying Twitter Users for Disaster Response: A Highly Multimodal or Simple Approach?. Proceedings of the Information Systems for Crisis Response and Management Conference (ISCRAM 2020) 2020.

- Scholl VM, Cattau ME, **Joseph MB**, Balch JK. Integrating national ecological observatory network (NEON) airborne remote sensing and in-situ data for optimal tree species classification. Remote Sensing. 2020 Jan;12(9):1414.
- McGlinchy J, Johnson B, Muller B, **Joseph MB** and Diaz J, 2019. Application of UNet Fully Convolutional Neural Network to Impervious Surface Segmentation in Urban Environment from High Resolution Satellite Imagery. In IGARSS 2019-2019 IEEE International Geoscience and Remote Sensing Symposium (pp. 3915-3918). IEEE.
- Ranjeva SL, Mihaljevic JR, **Joseph MB**, Giuliano AR and Dwyer G, 2019. Untangling the dynamics of persistence and colonization in microbial communities. The ISME journal, pp.1-13.
- Diaz J, and **Joseph, MB**, 2019. Predicting property damage from tornadoes with zero-inflated neural networks. Weather and Climate Extremes, 25, p.100216.
- **Joseph MB**, Rossi MW, Mietkiewicz NP, Mahood AL, Cattau ME, St. Denis LA, Nagy RC, Iglesias V, Abatzoglou JT, Balch JK. 2019. Spatiotemporal prediction of wildfire size extremes with Bayesian finite sample maxima. Ecological Applications e01898.
- Scherer RD, Hansen EC, **Joseph MB**, Wack RF. 2019. Estimating relationships between size and fecundity in the threatened giant gartersnake in semi-natural and agricultural wetlands. Population Ecology 61(2): 141-149.
- Kueneman JG, Bletz MC, McKenzie VJ, Becker CG, **Joseph MB**, Abarca JG, Archer H, Arellano AL, Bataille A, Becker M, Belden LK, Crottini A, Geffers R, Haddad CFB, Harris RN, Holden WM, Hughey M, Jarek M, Kearns PJ, Kerby JL, Kielgast J, Kurabayashi A, Longo AV, Loudon A, Medina D, Nuñez JJ, Perl RGB, Pinto-Tomás A, Rabemananjara FCE, Rebollar EA, Rodríguez A, Rollins-Smith L, Stevenson R, Tebbe CC, Asensio GV, Waldman B, Walke JB, Whitfield SM, Zamudio KR, Chaves IZ, Woodhams DC, Vences M. 2019. Community richness of amphibian skin bacteria correlates with bioclimate at the global scale. Nature ecology & evolution. 3(3): 381.
- Wasser L, **Joseph MB**, McGlinchy J, Palomino J, Korinek, N, Holdgraf C, Head T. 2019. EarthPy: a Python package that makes it easier to explore and plot raster and vector data using open source Python tools. Journal of Open Source Software 4(43):1886.
- **Joseph MB**, Knapp RA. 2018. Disease and climate effects on individuals drive post-reintroduction population dynamics of an endangered amphibian. Ecosphere 9 (11).
- Miller DA, Grant EH, Muths E, Amburgey SM, Adams MJ, **Joseph MB**, Waddle JH, Johnson PT, Ryan ME, Schmidt BR, Calhoun DL, et al. Quantifying climate sensitivity and climate-driven change in North American amphibian communities. Nature communications. 9(1):3926.
- Wall CC, Karnauskas K, **Joseph MB**, McGlinchy J, Johnson BR. 2018. Navigating noise when comparing satellite and acoustic remote sensing data. The Journal of the Acoustical Society of America. 144(3): 1744-1745.
- Johnson BR, McGlinchy J, Cattau M, **Joseph MB** and Scholl V, 2018, September. Harnessing commercial satellite technologies to monitor our forests. In Remote Sensing and Modeling of Ecosystems for Sustainability XV (Vol. 10767, p. 1076702). International Society for Optics and Photonics.
- Orlofske SA, Flaxman S, **Joseph MB**, Fenton A, Melbourne B, Johnson PTJ. 2017. Experimental investigation of alternative transmission functions: quantitative evidence for the importance of non-linear transmission dynamics in host-parasite systems. Journal of Animal Ecology 87(3).
- **Joseph MB**, Stutz WE, Johnson PTJ. 2016. Multilevel models for the distribution of hosts and symbionts. PLOS ONE 11(11): e0165768.
- Manlove KR, Walker JG, Craft ME, Huyvaert KP, **Joseph MB**, Miller RS, Nol P, Patyk KA, O'Brien D, Walsh DP, Cross PC. 2016. "One Health" or Three? Publication silos among the one health disciplines. PLoS Biology 14:4.

- Grant EHC, Miller DAW, Schmidt BR, Adams MJ, Amburgey SM, Chambert T, Cruickshank SS, Fisher RN, Green DM, Hossack BR, Johnson PTJ, **Joseph MB**, Rittenhouse TAG, Ryan ME, Waddle JH, Walls SC, Bailey LL, Fellers GM, Gorman TA, Ray AM, Pilliod DS, Price SJ, Saenz D, Sadinski W, Muths E. 2016. Quantitative evidence for the effects of multiple drivers on continental-scale amphibian declines. Scientific reports 6.
- Johnon PTJ, Wood CL, **Joseph MB**, Preston DL, Haas SE, Springer YP. 2016. Habitat heterogeneity drives the host-diversity-begets-parasite-diversity relationship: evidence from experimental and field studies. Ecology Letters 19: 7.
- Hannon ER, Kinsella JM, Calhoun DM, **Joseph MB**, Johnson PT. Endohelminths in bird hosts from Northern California and an analysis of the role of life history traits on parasite richness. The Journal of Parasitology. 2016 Apr 1;102(2):199-207.
- **Joseph MB**, Preston DL, Johnson PT. Integrating occupancy models and structural equation models to understand species occurrence. Ecology. 2016 Mar;97(3):765-75.
- Wilkins MR, Shizuka D, **Joseph MB**, Hubbard JK, Safran RJ. 2015. Multimodal signaling in the North American barn swallow: a phenotype network approach. Proceedings of the Royal Society B 282: 20151574.
- Mihaljevic JR, **Joseph MB**, Johnson PTJ. 2015. Using multi-species occupancy models to improve the characterization and understanding of metacommunity structure. Ecology 96(7): 1783–1792.
- Mihaljevic JR, **Joseph MB**, Orlofske SA, Paull SH. 2014. The scaling of host density with richness affects the direction, shape, and detectability of diversity-disease relationships. PLoS ONE 9(5): e97812.
- **Joseph MB**, Mihaljevic JR, Orlofske SA, Paull SH. 2013. Does life history mediate changing disease risk when communities disassemble? Ecology Letters, 16(11): 1405-1412.
- **Joseph MB**, Mihaljevic JR, Arellano AL, Keuneman JG, Preston DL, Cross PC, Johnson PTJ. 2013. Taming wildlife disease: bridging the gap between science and management. Journal of Applied Ecology 50(3): 702-712.
- McMahon TA, Brannelly LA, Chatfield MWH, Johnson PTJ, **Joseph MB**, McKenzie VJ, Richards-Zawacki CL, Venesky MD, Rohr JR. 2012. Chytrid fungus Batrachochytrium dendrobatidis has nonamphibian hosts and releases chemicals that cause pathology in the absence of infection. Proceedings of the National Academy of Sciences of the United States of America 110(1): 210-215.
- **Joseph MB**, Piovia-Scott J, Lawler SP, Pope KL. 2011. Indirect effects of introduced trout on Cascades frogs (Rana cascadae) via shared aquatic prey. Freshwater Biology 56 (5): 828-838.
- **Joseph MB**, Gentles M, Pearse IS. 2011. The parasitoid community of Andricus quercuscalifornicus and its association with gall size, phenology, and location. Biodiversity and Conservation 20 (1): 203-216.
- Karban R, Hodson A, Gruner DS, Lewis EE, Karban J, **Joseph MB**, Mata T, Strong DR. 2011. Lack of susceptibility of soil-inhabiting Platyprepia virginialis caterpillars, a native arctiid, to entomopathogenic nematodes in nature. Entomologia Experimentalis et Applicata 140 (1): 28-34.

Other publications

- Exact sparse conditional autoregressive models in Stan. 2016. Stan case studies.
- Course notes & material: hierarchical Bayesian modeling for ecologists. 2016.
- Blog. 2013-present. Open lab notebook with content around applying and teaching Bayesian statistics, R, and scientific computing. http://mbjoseph.github.io

- GitHub @mbjoseph. 2012-present. Statistical resources and integrated templates for reproducible research. https://github.com/mbjoseph
- Joseph MB. 2009. Searching for Pratt. Alpinist 27.

Software

- neonhs: an R package to simplify working with NEON's hyperspectral imagery. https://github.com/earthlab/neonhs
- Climate futures toolbox (cft): easy climate data access (MACA v2) to support climate scenario planning. https://github.com/earthlab/cft
- smapr: an R package for acquisition and processing of NASA SMAP data. https://github.com/ropensci/smapr
- eddi: an R package for acquisition and processing of NOAA Evaporative Demand Drought Index data. https://github.com/earthlab/eddi
- leri: an R package for acquisition and processing of NOAA Landscape Evaporative Response Index data. https://github.com/earthlab/leri
- streamstats: a Python client for the USGS StreamStats API. https://github.com/earthlab/streamstats
- earthpy: a Python library for working with spatial raster and vector data. https://github.com/earthlab/earthpy
- Earth Lab Docker stack, including Dockerfiles on GitHub and registered images on Docker Hub.

Teaching experience

Spring 2016: Instructor Bayesian hierarchical modeling graduate course, University of Colorado, Boulder

Spring 2016: TA Ecology, University of Colorado, Boulder

Fall 2015: TA Biometry, University of Colorado, Boulder

Summer 2015: TA General Biology Lab II, University of Colorado, Boulder

Summer 2015: Curriculum development: Introduction to Quantitative Inference and Thinking, University of Colorado, Boulder

Spring 2015: TA Introduction to Quantitative Inference and Thinking, University of Colorado, Boulder

Spring 2015: TA General Biology Lab II, University of Colorado, Boulder

Fall 2014: TA General Biology Lab I, University of Colorado, Boulder

Summer 2014: TA General Biology Lab II, University of Colorado, Boulder

Spring 2011: TA General Biology Lab II, University of Colorado, Boulder

Fall 2010: TA General Biology Lab I, University of Colorado, Boulder

Awards, Grants, and Fellowships

2020: NSF Macroscale Resilience: Assessing the recovery of western U.S. forests to compound disturbance by linking observations—from trees to ecoregions (co-PI)

2019: NSF HDBE The Creeping Disaster along the Coast: Built Environment, Coastal Communities and Population Vulnerability to Sea Level Rise (senior personnel)

2019: NSF HDR DSC: Earth Data Science Corps - Fulfilling Workforce Demand at the Intersection of Environmental Science and Data Science (senior personnel)

2019: NSF CAREER: Fire impacts on forest carbon recovery in a warming world: training the next generation of Earth analysts by exploring a missing scale of observations (senior personnel)

2018: DOI/USGS CU Boulder NC CASC: Driving innovation in co-producing science to help resource managers in the North Central region adapt to a changing world (senior personnel)

2015: CIRTL (Center for the Integration of Teaching, Research, and Learning) Network associate, TIGER (Teaching Institute for Graduate Education Research) ROAR (Research on Academic Retention) in statistics, University of Colorado, Boulder

2013: City of Boulder Open Space and Mountain Parks Research Grant

2012-2013: Boulder County Parks and Open Space Small Grants Program

2012: Beverly Sears Graduate Student Grant

2012: USGS Amphibian Specialist Group ARMI Initiative Seed Grant

2012: University of Colorado Museum of Natural History Graduate Research Grant

2011-2014: National Science Foundation Graduate Research Fellowship

2011-2012 University of Colorado Ecology and Evolutionary Biology Graduate Research Grant

2011: Chicago Herpetological Society Graduate Research Grant

2011: American Society of Ichthyologists and Herpetologists Gaige Award

2011: University of California Santa Barbara Valentine Eastern Sierra Reserve Graduate Research Grant

Media coverage

Chris Baraniuk. 2018. The quest to predict - and stop - the spread of wildfires. BBC Future.

Susan Moran. 2014. Tag, you're it! Advances in radio and satellite tagging reveal the secret lives of animals. Science News for Students, Society of Science.

Marty Durlin. 2013. The Chorus of the Leopard frogs. Radio show and interview KVNF.