

# PAUL ALEXANDER LEVINE

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## PROFESSIONAL EXPERIENCE

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### **Jet Propulsion Laboratory**

*Postdoctoral researcher*

January, 2020 – present

*Pasadena, CA*

- Conduct independent research on interactions between the terrestrial carbon and water cycles within the Earth system under a changing climate
- Collaborate with other scientists on a range of projects researching Earth system science, land surface modeling, observational data assimilation, and model complexity

### **University of California, Irvine**

*Teaching Assistant*

September, 2014 – June, 2016

*Irvine, CA*

- Assisted with undergraduate teaching in the Department of Earth System Science
- Led regular weekly discussion sections and occasional lectures for the main course
- Responsible for working with students to plan and implement final group projects for small seminars in global and local environmental issues

### **Go Go Techs, Inc.**

*Information Technology Consultant*

March, 2010 – May, 2013

*Santa Monica, CA*

- Design and deploy IT solutions for small businesses and home users
- Provide ongoing consultation services and technical support
- Assisted doctors' offices and small medical practices with transitioning to or upgrading electronic medical records systems

### **University of California, Los Angeles**

*Teaching Assistant*

January, 2007 – December, 2009

*Los Angeles, CA*

- Assisted with undergraduate teaching in the Department of Geography
- Led weekly laboratory sections for courses in remote sensing and geographic information systems
- Created and evaluated hands-on laboratory activities for courses in remote sensing and geographic information systems

### **Woven Music**

*Multimedia Artist*

December, 2002 – August, 2004

*Los Angeles, CA*

- Designed and implemented interactive video projection system for live musical performance
- Performed in small- to medium-sized venues throughout the USA

### **University of California Marine Sciences Institute**

*Research Associate*

June, 2000 – November, 2002

*Mammoth Lakes, CA*

- Conducted research project on the benthic ecosystem of Mono Lake, CA
- Responsible for field and laboratory work, and analysis of results

## EDUCATION

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**University of California, Irvine** Irvine, CA

Ph.D in Earth System Science, **2019**

M.S. in Earth System Science, **2016**

Advised by Dr. James T. Randerson

Dissertation title: Land-atmosphere feedbacks in the energy, water, and carbon cycles of Earth system models

Awarded NASA Earth and Space Science Fellowship 16-EARTH16F-0196

**University of California, Los Angeles** Los Angeles, CA

M.A. in Geography, **2007**

Advised by Dr. Yongkang Xue

Thesis title: Remote sensing of land cover and climatology in relation to the population genomics of *Anopheles gambiae* in Cameroon, Central Africa

**Brown University** Providence, RI

B.A. in Geology/Biology, **2000**

Concurrent major in Computer Music and Multimedia

Elected to Sigma Xi: the Scientific Research Honor Society

## HIGHLIGHTED ABILITIES AND INTERESTS

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- Broad knowledge of Earth system science, with specific expertise in terrestrial hydrology and ecology, biosphere-atmosphere feedbacks, and climate change.
- Ability to communicate science to audiences with a broad range of prior knowledge, including colleagues at scientific conferences, primary school through college students as a teaching assistant and classroom volunteer, and NPR listeners as the managing editor of *The Loh Down on Science*.
- Experience managing projects that require a thorough understanding of client needs and the ability to provide effective solutions, as both a professional IT consultant and as a volunteer project manager for Seed Consulting Group.
- Computer programming experience using C, Fortran, Python, Julia, IDL, Matlab, and R programming languages, with a track record of learning new languages as needed.
- Expertise with an array of analytical methods, including data assimilation, particularly of a broad array of remotely sensed data in terrestrial ecology models, Earth system models, image classification, machine learning, and evolutionary optimization algorithms.
- Experience using a range of high performance computing (HPC) systems, from the Department of Energy's supercomputing platforms to small-scale Linux clusters.
- Diagnose and repair hardware and software in Macintosh, Windows, and Unix-like computer systems; configure and administer TCP/IP networks.
- Ability to conduct scientific field work, including under strenuous conditions and in remote locations, including wilderness first aid and CPR training.
- Conversational Spanish, basic German.
- Play piano, keyboards, percussion, and drums, including sight reading and sight singing.
- Maintenance and repair of bicycles and cycling components.

## SYNERGISTIC ACTIVITIES

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- Participant in the development of the the open-source Carbon Data-Model Framework (CARDAMOM) and Climate Modeling Alliance (CliMA)
- Group meeting coordinator for the Water & Ecosystems Group at the Jet Propulsion Laboratory
- Volunteer consultant and project manager for the Seed Consulting Group, providing *pro bono* consulting services to the American Red Cross and the Surfrider Foundation
- Attended 2020 virtual training course New Advances in Land Carbon Cycle Modeling through Northern Arizona University
- Contributor to the Reducing Uncertainties in Biogeochemical Interactions Through Synthesis and Computing (RUBISCO), a Science Focus Area in the Department of Energy concentrated on quantifying uncertainties in biogeochemical processes in Earth system models
- Contributor to the open-source International Soil Radiocarbon Database (ISRaD), an international consortium of researchers using observations of carbon-14 to study soil processes
- Honorary fellow in the Machine Learning and Physical Sciences (MAPS) US National Science Foundation Research Traineeship program at UC Irvine
- Writer and managing editor for *The Loh Down on Science*, a science radio program hosted by Sandra Tsing Loh and syndicated by National Public Radio
- Selected to attend the 2017 ComSciCon National Workshop at Harvard University for graduate student leaders in science communication
- Participant in Climate Literacy Empowerment and Inquiry (CLEAN) Education, a 501(c)(3) non-profit dedicated to teaching the science of climate change to local primary- and secondary-school students
- Co-founder of UC Irvine School of Physical Sciences school-based council for Diverse Educational Community and Doctoral Experience (DECADE), an initiative dedicated to fostering an environment of diversity and inclusivity for graduate students
- Attended San Diego Supercomputing Center 2015 Summer Institute: HPC for the Long Tail of Science
- Attended 2014 JPL Center for Climate Sciences Summer School for remote sensing in climate research
- Attended 2014 Community Earth System Model (CESM) tutorial at the National Center for Atmospheric Research

## JOURNAL PUBLICATIONS

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**Levine, P.A.**, A.A. Bloom, A.G. Konings, S. Ma, N. Parazoo, J.R. Worden, M. Worden, S.R. Worden, *in prep.*, Variable responses to trends in carbon dioxide and climate across watersheds in the Amazon, *in prep*

**Levine, P.A.**, A.A. Bloom, R.K. Braghiere, A.G. Konings, A.J. Norton, S. Ma, M. Worden, *in prep.*, A model-data fusion framework of sufficient complexity for constraining carbon, water, and energy cycles with observations (CARDAMOM 3.0) *in prep*

**Levine, P.A.**, A.A. Bloom, K.W. Bowman, A.G. Konings, J.T. Reager, J.R. Worden, *in prep.*, Water stress dominates 21<sup>st</sup>-century tropical carbon uptake variability, *in review*

Yang, Y., A.A. Bloom, S. Ma, **P.A. Levine**, *et al.*, 2021, CARDAMOM-FluxVal Version 1.0: a FLUXNET-based Validation System for CARDAMOM Carbon and Water Flux Estimates, *Geoscientific Model Development*15, 1789—1802, doi:10.5194/gmd-15-1789-2022

Massoud, E.C., A.A. Bloom, M. Longo, J.T. Reager, **P.A. Levine**, J.R. Worden 2021, Information content of soil hydrology in the Amazon as informed by GRACE, *Hydrology and Earth System Sciences*, 26, 1407–1423, doi:10.5194/hess-26-1407-2022

Famiglietti, C.A., T.L. Smallman, **P.A. Levine**, *et al.* 2021, Optimal model complexity for terrestrial carbon cycle prediction, *Biogeosciences*, doi:10.5194/bg-2020-478

Mamalakis, A., J.T. Randerson, J.Y. Yu, M.S. Pritchard, G. Magnúsdóttir, P. Smyth, **P.A. Levine**, S. Yu, and E. Foufoula-Georgiou, 2021, Zonally contrasting shifts of the tropical rain belt in response to climate change, *Nature Climate Change*, 11, 143–151, doi:10.1038/s41558-020-00963-x

Shi, Z., S.D. Allison, Y. He, **P.A. Levine**, A.M. Hoyt, J. Beem-Miller, Q. Zhu, W.R. Weider, S.E. Trumbore, and J.T. Randerson, 2020, The age distribution of global soil carbon inferred from radiocarbon measurements, *Nature Geoscience*, 13, 555–559, doi:10.1038/s41561-020-0596-z

Lawrence, C.R., J. Beem-Miller, A.M. Hoyt [*et al.*, including **P.A. Levine**], 2020, An open source database for the synthesis of soil radiocarbon data: International Soil Radiocarbon Database (ISRaD) version 1.0, *Earth System Science Data*, doi:10.5194/essd-12-61-2020

**Levine, P.A.**, J.T. Randerson, Y. Chen, M.S. Pritchard, M. Xu, and F.M. Hoffman, 2019, Soil Moisture Variability Intensifies and Prolongs Eastern Amazon Temperature and Carbon Cycle Response to El Niño–Southern Oscillation, *Journal of Climate*, 32:4, 1273–1292, doi:10.1175/JCLI-D-18-0150.1

**Levine, P.A.**, J.T. Randerson, S.C. Swenson, and D M. Lawrence, 2016, Evaluating the strength of the land–atmosphere moisture feedback in Earth system models using satellite observations, *Hydrology and Earth System Science*, 20, 4837–4856, doi:10.5194/hess-20-4837-2016

Rian, S., Y. Xue, G.M. MacDonald, M.B. Touré, Y. Yu, F. De Sales, **P.A. Levine**, S. Doumbia, C.E. Taylor, 2009, Analysis of climate and vegetation characteristics along the savanna-desert ecotone in Mali using MODIS data, *GIScience & Remote Sensing*, 46:4, 424–450, doi:10.2747/1548-1603.46.4.424

## DATABASE CONTRIBUTIONS

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Lawrence, C.R., J. Beem-Miller, A.M. Hoyt [*et al.*, including **P.A. Levine**], 2019, The International Soil Radiocarbon Database v1.0, doi:10.5281/zenodo.2613911

## CONFERENCE PRESENTATIONS

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**Levine, P.A.**, A.A. Bloom, K.W. Bowman, N. Parazoo, J.T. Reager, J.R. Worden, M. Worden, and A.G. Konings, 2021, Merging multiple observational data streams to constrain carbon uptake and water loss in the Amazon basin, Abstract 216-02 presented at 2022 Frontiers in Hydrology Meeting, AGU, 19–24 Jun.

**Levine, P.A.**, A.A. Bloom, A.G. Konings, M. Worden, N. Parazoo, R.K. Braghiere, A.J. Norton, S. Ma, J.R. Worden, and J.T. Reager, 2022 Merging multiple observational data streams to constrain carbon uptake and water loss in the Amazon basin, Abstract EGU22-10625 presented at 2022 EGU General Assembly, 23–27 May,

Worden, M., C.A. Famiglietti, A.G. Konings, **P.A. Levine**, and A.A. Bloom, 2022 Accounting for carbon allocation shifts after drought improves NBE predictions, Abstract EGU22-10760 presented at 2022 EGU General Assembly, 23–27 May,

**Levine, P.A.**, A.A. Bloom, K.W. Bowman, N. Parazoo, J.T. Reager, J.R. Worden, M. Worden, and A.G. Konings, 2021, 21<sup>st</sup>-century variability in tropical terrestrial water-carbon cycling observed from satellite measurements of gravity, chlorophyll fluorescence, and atmospheric CO<sub>2</sub>, Abstract B13B-01 presented at 2021 Fall Meeting, AGU, 13–17 Dec.

M. Worden, **P.A. Levine**, A.A. Bloom, and A.G. Konings, 2021, Can accounting for carbon allocation shifts due to drought improve tropical land C sink prediction? Abstract B55F-1258 presented at 2021 Fall Meeting, AGU, 13–17 Dec.

S. Worden, R. Fu, J.R. Worden, A.A. Bloom, and **P.A. Levine**, 2021, Quantifying ET Over the Congo Basin Using a Combination of Remotely-sensed and Surface Measurements, Abstract H54D-02 presented at 2021 Fall Meeting, AGU, 13–17 Dec.

Norton, A., A.A. Bloom, N. Parazoo, **P.A. Levine**, S. Ma, R.K. Braghieri, 2021, The Impacts of a Climate-Sensitive Leaf Phenology Model on Predicting the Terrestrial Carbon Cycle using the CARDAMOM Framework, Abstract B25I-1602 presented at 2021 Fall Meeting, AGU, 13–17 Dec.

Ma, S., A.A. Bloom, G.R. Quetin, [*et al.*, including **P.A. Levine**], 2021, Resolving the carbon-climate feedback potential of high latitude wetland CO<sub>2</sub> and CH<sub>4</sub> exchanges, Abstract A11D-11 presented at 2021 Fall Meeting, AGU, 13–17 Dec.

Hoyt, A. M., C.R. Lawrence, J. Beem-Miller, [*et al.*, including **P.A. Levine**], 2021, Improving Constraints on Soil Carbon Cycling Using Community-Based Databases, ASA, CSSA, SSSA International Annual Meeting, Salt Lake City, UT.

**Levine, P.A.**, A.A. Bloom, K.W. Bowman, A.G. Konings, J. Liu, M. Longo, V. Meyer, N. Parazoo, G.R. Quetin, J.T. Reager, and J.W. Worden, 2020, Hydrologic limitations on tropical terrestrial carbon fluxes in a model-data fusion framework, Abstract GC019-02 presented at 2020 Fall Meeting, AGU, 1–17 Dec.

Randerson, J.T., J. Wang, S. Hantson, Z. Shi, N. Hemming-Schroeder, Y. Li, and **P.A. Levine**, 2020, Do carbon cycle models of the terrestrial biosphere need a Revelle factor when simulating carbon storage rates from increasing levels of gross primary production?, Abstract B024-02 presented at 2020 Fall Meeting, AGU, 1–17 Dec.

Mamalakis, A., E. Foufoula-Georgiou, J.T. Randerson, J.Y. Yu, M.S. Pritchard, G. Magnusdottir, **P.A. Levine**, S. Yu, and P. Smyth, 2020, Zonally variable response of the intertropical convergence zone and energy flux equator in CMIP6 future climate, Abstract A189-0003 presented at 2020 Fall Meeting, AGU, 1–17 Dec.

Bloom, A.A., J. Au, K.W. Bowman, [*et al.*, including **P.A. Levine**], 2020, Observing, resolving and predicting the terrestrial carbon cycle and its sensitivity to climate, Abstract B011-09 presented at 2020 Fall Meeting, AGU, 1–17 Dec.

Famiglietti, C.A., T.L. Smallman, S. Flack-Prain, [*et al.*, including **P.A. Levine**], 2020, Optimal model complexity for terrestrial carbon cycle prediction using model-data fusion, Abstract B117-06 presented at 2020 Fall Meeting, AGU, 1–17 Dec.

Liu, J., K.W. Bowman, A.A. Bloom, [*et al.*, including **P.A. Levine**], 2020, Contrasting sensitivities and vulnerabilities of terrestrial biosphere carbon cycle to climate anomalies across tropical south America, Abstract GC019-04 presented at 2020 Fall Meeting, AGU, 1–17 Dec.

**Levine, P.A.**, J.T. Randerson, Q. Zhu, W.J. Riley, A.M. Hoyt, S.E. Trumbore, Z. Shi, and F.M. Hoffman, 2019, Soil organic carbon stocks and radiocarbon ages as multiple constraints on the rate of carbon sequestration, Abstract B11B-06 presented at 2019 Fall Meeting, AGU, San Francisco, CA, 9–13 Dec.

Mamalakis, A., E. Foufoula-Georgiou, J.T. Randerson, J.Y. Yu, M.S. Pritchard, G. Magnusdottir, **P.A. Levine**, S. Yu, and P. Smyth, 2019, Zonally asymmetric response of the intertropical convergence zone to the RCP8.5 scenario, Abstract A33S-3095 presented at 2019 Fall Meeting, AGU, San Francisco, CA, 9–13 Dec.

Shi, Z., S.D. Allison, J.T. Randerson, Y. He, **P.A. Levine**, A.M. Hoyt, and S.E. Trumbore, 2019, The age of global soil carbon and implications for sequestration potential, Abstract B41C-08 presented at 2019 Fall Meeting, AGU, San Francisco, CA, 9–13 Dec.

Randerson, J.T., **P.A. Levine**, Y. Chen, N. Andela, and D.C. Morton, 2019, The influence of land-atmosphere moisture coupling on net ecosystem exchange and fire responses to forcing by ENSO, Abstract B13B-01 presented at 2019 Fall Meeting, AGU, San Francisco, CA, 9–13 Dec.

**Levine, P.A.**, J.T. Randerson, Q. Zhu, W.J. Riley, A.M. Hoyt, S.E. Trumbore, Z. Shi, S.D. Allison, and F.M. Hoffman, 2019, Global Radiocarbon Observations Constrain the Soil Carbon Sink in the Energy Exascale Earth System Model, Presented at 2019 Chapman Conference: Understanding Carbon Climate Feedbacks, AGU San Diego, Calif., 26–29 Aug.

Randerson, J.T., M. Mu, **Levine, P.A.**, A.M. Hoyt, W.J. Riley, F.M. Hoffman, and S.E. Trumbore, 2019, The carbon-climate feedback from sea level rise, Presented at 2019 Chapman Conference: Understanding Carbon Climate Feedbacks, AGU San Diego, Calif., 26–29 Aug.

Hoyt, A.M., C.A. Sierra, C.R. Lawrence [*et al.*, including **P.A. Levine**], 2019, Radiocarbon as a Constraint on Global Soil Carbon Cycling, Presented at 2019 Chapman Conference: Understanding Carbon Climate Feedbacks, AGU San Diego, Calif., 26–29 Aug.

**Levine, P.A.**, J.T. Randerson, Q. Zhu, W.J. Riley, A.M. Hoyt, S.E. Trumbore, Z. Shi, S.D. Allison, and F.M. Hoffman, 2019, Global radiocarbon observations suggest a reduced soil carbon sink in the Energy Exascale Earth System Model, Presented at 2019 CESM Land Model and Biogeochemistry Working Group Meetings, NCAR, Boulder, Colo., 11–13 Feb.

**Levine, P.A.**, J.T. Randerson, Q. Zhu, W.J. Riley, A.M. Hoyt, S.E. Trumbore, Z. Shi, S.D. Allison, and F.M. Hoffman, 2018, Global carbon-14 observations constrain rates of soil organic matter decomposition in the Energy Exascale Earth System Model, Abstract B33B-03 presented at 2018 Fall Meeting, AGU, Washington, D.C., 10–14 Dec.

Mueller, N., A.J. Rigden, E.E. Butler, P.J. Huybers, **P.A. Levine**, J.T. Randerson, 2018, Correlated soil moisture and temperature extremes and potential biases in climate impact projection, Abstract GC54A-04 presented at 2018 Fall Meeting, AGU, Washington, D.C., 10-14 Dec.

Xu M., F.M. Hoffman, S. Mahajan, J. Mao, **P.A. Levine**, 2018, Oceanic drivers for tropical terrestrial carbon cycle and extreme, Abstract GC13B-07 presented at 2018 Fall Meeting, AGU, Washington, D.C., 10-14 Dec.

Xu M., F.M. Hoffman, **P.A. Levine**, N. Collier, 2018, ENSO Effects on the Terrestrial Carbon Cycle in the Tropics, Abstract BG04-A016 presented at 2018 Asia Oceania Geosciences Society Annual Meeting, AOGS, Honolulu, Hawaii, 3–8 Jun.

**Levine, P.A.**, M. Xu, Y. Chen, J.T. Randerson, and F.M. Hoffman, 2018, Soil moisture variability intensifies and prolongs eastern Amazon temperature and carbon cycle response to ENSO in CLM4.5, Presented at the 23rd Annual CESM Workshop, Biogeochemistry Working Group Session, NCAR, Boulder, Colo., 18–20 Jun.

**Levine, P.A.**, M. Xu, Y. Chen, J.T. Randerson, and F.M. Hoffman, 2017, Remote SST Forcing and Local Land-Atmosphere Moisture Coupling as Drivers of Amazon Temperature and Carbon Cycle Variability, Abstract H42B-08 presented at 2017 Fall Meeting, AGU, New Orleans, Louisiana, 11-15 Dec.

**Levine, P.A.**, J.T. Randerson, D.M. Lawrence, and S.C. Swenson, 2016, Evaluating land-atmosphere moisture feedbacks in Earth system models with spaceborne observations, Abstract H51I-1635 presented at 2016 Fall Meeting, AGU, San Francisco, Calif., 11-15 Dec.

Hoffman, F.M., M. Xu, N. Collier, C. Xu, B.O. Christoffersen, Y. Luo, D.M. Ricciuto, **P.A. Levine**, J.T. Randerson, 2016, Development of a tropical ecological forecasting strategy for ENSO based on the ACME modeling framework, Abstract B42A-08 presented at 2016 Fall Meeting, AGU, San Francisco, Calif., 11-15 Dec.

**Levine, P.A.**, C. De Linage, I. Velicogna, and J.T. Randerson, 2014, Global spaceborne assessment of the relationship between terrestrial water storage and evaporative demand, Abstract H24F-02 presented at 2014 Fall Meeting, AGU, San Francisco, Calif., 15-19 Dec.