Renato Kerches Braghiere, Ph.D.

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Professional Appointments

2022 – Present **Research Scientist** at California Institute of Technology

Division of Geological and Planetary Sciences, Pasadena, CA, USA & **Research Scientist Affiliate** to the Water & Ecosystems Group (329F) at NASA Jet Propulsion Lab

2019 – 2022 **Post-Doctoral Research Scientist** at NASA Jet Propulsion Lab

Joint Institute for Regional Earth System Science and Engineering, UCLA/ NASA Jet Propulsion Laboratory, Pasadena, CA, USA.

2018 – 2019 **Post-Doctoral Research Fellow** at *Institut National de la Recherche Agronomique* (INRAE)

Joint Research Unit Functional Ecology & Soil Biochemistry & Agro-Ecosystems, INRAE, Campus SupAgro, Montpellier, France.

Education

2013 – 2018 **Doctor of Philosophy** in Atmosphere, Oceans and Climate

Department of Meteorology, **University of Reading**, Reading, UK.
Thesis title: "Improving the treatment of vegetation canopy architecture in Land Surface Models"
Advisors: Dr. Tristan Quaife; Co-supervisor: Dr. Emily Black

2011 – 2013 **Master of Science** in Atmospheric Sciences

Department of Atmospheric Sciences, **University of São Paulo**, São Paulo, Brazil.
Dissertation title: "Evaluation of CO_2, Sensible and Latent Heat Turbulent Fluxes as Function of Aerosol Optical Depth over the Deforestation Arch in the Legal Brazilian Amazon"
Advisor: Prof. Dr. Márcia Akemi Yamasoe

2007 – 2010 **Bachelor of Science** in Meteorology

Department of Atmospheric Sciences, **University of São Paulo**, São Paulo, Brazil.

Visiting Scientist

Sept, 2019 **Visiting Scientist** at ORNL

The Oak Ridge National Laboratory, Oak Ridge, Tennessee, USA.

Apr – Jun, 2015 **Visiting Scientist** at ICTP

The Abdus Salam International Centre for Theoretical Physics, Trieste, Italy.

Honours and Awards

2014 **Outstanding M.Sc. Dissertation** – Department of Meteorology

University of São Paulo, Brazil.

Grants

2022 **INCyTE Lab Exchange Fellowship** – University of Montana, USA.

2021 **Critical Zone Initiative** – Resnick Institute, Caltech, USA.

2020 **Postdoctoral NASA/ABoVE fellowship** – NASA JPL, USA.

2019 **Postdoctoral DOE/NASA fellowship** – NASA JPL, USA.

2017 **Postdoctoral EU H2020 fellowship** – INRAE, France.

2013 **Ph.D. CAPES fellowship** – University of Reading, UK.

2011 **M.Sc. CAPES fellowship** – University of São Paulo, Brazil.

2009 **Undergraduate CAPES fellowship** – University of São Paulo, Brazil.

2008 **Undergraduate Santander fellowship** – University of São Paulo, Brazil.

Peer Reviewed Publications

Ma, A. L., Ma, S., Bloom, A. A., Norton, A. J., Yin, Y., Levine, P. A., **Braghiere, R. K.**, Parazoo, N. C., Worden, J. R., Schimel, D. S., Miller, C. E., Watts, J. D., Quetin, G. R., Donatella, Z., & Euskirchen, E. S. (2023). Resolving the Carbon-Climate Feedback Potential of Wetland CO2 and CH4 Fluxes in Alaska. *Global Biogeochemical Cycles*, *37*(9), e2022GB007524. https://doi.org/10.1029/2022GB007524

Massoud, E. C., Hoffman, F., Shi, Z., Tang, J., Alhajjar, E., Barnes, M., **Braghiere, R. K.**, Cardon, Z., Collier, N., Crompton, O., Dennedy-Frank, P. J., Gautam, S., Gonzalez-Meler, M. A., Green, J. K., Koven, C., Levine, P., MacBean, N., Mao, J., Mills, R. T., … Zarakas, C. (2023). Perspectives on Artificial Intelligence for Predictions in Ecohydrology. *Artificial Intelligence for the Earth Systems*. https://doi.org/10.1175/AIES-D-23-0005.1

Braghiere, R. K., Wang, Y., Gagné-Landmann, A., Brodrick, P. G., Bloom, A. A., Norton, A. J., Ma, S., Levine, P., Longo, M., Deck, K., Gentine, P., Worden, J. R., Frankenberg, C., & Schneider, T. (2023). The Importance of Hyperspectral Soil Albedo Information for Improving Earth

System Model Projections. *AGU Advances*, *4*(4), e2023AV000910. https://doi.org/10.1029/2023AV000910

Norton, A. J., Bloom, A. A., Parazoo, N. C., Levine, P. A., Ma, S., **Braghiere, R. K.**, & Smallman, T. L. (2023). Improved process representation of leaf phenology significantly shifts climate sensitivity of ecosystem carbon balance. *Biogeosciences*, *20*(12), 2455–2484. https://doi.org/10.5194/BG-20-2455-2023

Wang, Y., **Braghiere, R. K.**, Longo, M., Norton, A. J., Köhler, P., Doughty, R., et al. (2023). Modeling Global Vegetation Gross Primary Productivity, Transpiration and Hyperspectral Canopy Radiative Transfer Simultaneously Using a Next Generation Land Surface Model—CliMA Land. *Journal of Advances in Modeling Earth Systems*, *15*(3), e2021MS002964. https://doi.org/10.1029/2021MS002964

Braghiere R.K., Fisher J B, Miner K R, Miller C E, Worden J R, Schimel D S and Frankenberg C 2023 Tipping point in North American Arctic-Boreal carbon sink persists in new generation Earth system models despite reduced uncertainty *Environ. Res. Lett.* **18** 025008. https://doi.org/10.1088/1748-9326/acb226

Li F, Hao D, Zhu Q, Yuan K, **Braghiere R.K.**, He L, Luo X, Wei S, Riley W J, Zeng Y, Chen M and Fa Li C 2022 Vegetation clumping modulates global photosynthesis through adjusting canopy light environment *Glob. Chang. Biol.* **00** 1–16. https:// doi.org/10.1111/gcb.16503

Braghiere, R.K., Fisher, J.B., Allen, K., Brzostek, E., Shi, M., Yang, X., Ricciuto, D.M., Fisher, R.A., Zhu, Q., Phillips, R.P., 2022. Modeling global carbon costs of plant nitrogen and phosphorus acquisition. J. Adv. Model. Earth Syst. e2022MS003204. https://doi.org/10.1029/2022MS003204

Wang, Y., Köhler, P., **Braghiere, R.K.**, Longo, M., Doughty, R., Bloom, A.A., Frankenberg, C., 2022. GriddingMachine, a database and software for Earth system modeling at global and regional scales. *Sci. Data* 9, 1–11. https://doi.org/10.1038/s41597-022-01346-x

Wang, Y., Köhler, P., He, L., Doughty, R., **Braghiere, R. K.**, Wood, J. and Frankenberg, C. (2021). Testing stomatal models at stand level in deciduous angiosperm and evergreen gymnosperm forests using CliMA Land (v0.1), *Geosci. Model Dev.*, 1–35, *doi:10.5194/gmd-2021-154*

Braghiere, R. K., Fisher, J. B., Fisher, R. A., Shi, M., Steidinger, B. S., Sulman, B. N., Soudzilovskaia, N. A., Yang, X., Liang, J., Peay, K. G., Crowther, T. W. and Phillips, R. P. (2021). Mycorrhizal Distributions Impact Global Patterns of Carbon and Nutrient Cycling, *Geophys. Res. Lett.*, 48(19), *doi:10.1029/2021GL094514*

Braghiere, R. K., Wang, Y., Doughty, R., Sousa, D., Magney, T., Widlowski, J.-L., … et al. (2021). Accounting for canopy structure improves hyperspectral radiative transfer and sun-induced chlorophyll fluorescence representations in a new generation Earth System model. *Remote Sensing of Environment*, *261*, 112497. *doi:10.1016/j.rse.2021.112497*

Braghiere, R. K., Quaife, T., Black, E., Ryu, Y., Chen, Q., Kauwe, M. G. De, & Baldocchi, D. (2020). Influence of sun zenith angle on canopy clumping and the resulting impacts on

photosynthesis. *Agricultural and Forest Meteorology*, *291*(May), 108065. *doi:10.1016/j.agrformet.2020.10065*

Braghiere, R. K., Gérard, F., Evers, J., Pradal, C. and Pages, L., 2020: Simulating the effects of water limitation on plant biomass using a 3D functional-structural plant model of shoot and root driven by soil hydraulics, *Annals of Botany*, *doi:10.1093/aob/mcaa059*

Braghiere, R. K., Yamasoe, M. A., do Rosário, N. M., da Rocha, H., de Souza Nogueira, J. and de Araújo, A. C., 2020: Characterization of the radiative impact of aerosols on CO_2 and energy fluxes in the Amazon deforestation arch using artificial neural networks, *Atmos. Chem. Phys.*, 20(6), 3439–3458, *doi:10.5194/acp-20-3439-2020*

Braghiere, R. K., Quaife, T., Black, E., He, L. and Chen, J. M., 2019: Underestimation of Global Photosynthesis in Earth System Models Due to Representation of Vegetation Structure, *Global Biogeochem. Cycles*, 33(11), 1358–1369, *doi:10.1029/2018GB006135*

Hogan, R. J., Quaife, T., and **Braghiere, R.**, 2018: Fast matrix treatment of 3-D radiative transfer in vegetation canopies: SPARTACUS-Vegetation 1.1, *Geosci. Model Dev.*, 11, 339-350. *doi:10.5194/gmd-11-339-2018*

Book chapter

Yamasoe, M. A., Rosario, N. E., Costa, T. S., **Braghiere, R. K.**, Leiva, E. A., Zanchi, F. B., Silva, B. L., Morais, J. C., 2015. Medições e Estimativas Numéricas da Irradiância Solar Descendente em Superfície – Estudos de Casos em Humaitá, AM, in: *Ciência das mudanças climáticas e sua interdisciplinaridade* by Ambrizzi, T., Jocobi, P. R., Dutra, L. M. Annablume, São Paulo, p. 282.

Expert Reviewer

IPCC, 2014: Climate Change 2014: Synthesis Report. Contribution of Working Groups I, II and III to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change [Core Writing Team, R.K. Pachauri and L.A. Meyer (eds.)]. IPCC, Geneva, Switzerland, 151 pp.

Languages

- **Portuguese** Native speaker
- **English** Advanced
- **Spanish** Advanced
- **French** Intermediate

Programming skills

- **Python/Julia** Advanced
- **Fortran** Advanced
- **C++** Advanced
- **MATLAB** Advanced
- **Java** Intermediate
- **R** Intermediate

Synergistic Activities & Professional Development

Mar, 2020 **CLM/CTSM Workshop** NCAR, USA.

Feb, 2019 **CLM/CTSM Tutorial** NCAR, USA.

Jun, 2017 **4th ICOS Summer School** Hyytiälä, Finland.

Jun, 2016 **Flux Course 2016** Boulder, Colorado, USA.

Apr – Jul, 2015 Visiting period at the **International Centre for Theoretical Physics, UN** Trieste, Italy.

Oct, 2014 Environment YES **NERC Workshop** Syngenta, Bracknell, UK.

Jun, 2014 **INRA Summer School** 2014, Transfer and Interactions between ecosystems University of Bordeaux, France.

Apr, 2014 Earth System Science **NERC Spring School** 2014
University of Lancaster, UK.

Oct, 2012 **Workshop** in Hydrological Modelling. By Texas A&M University, USA, at University of São Paulo.

Oct, 2012 **Workshop** in Chemical Modelling.
By NOAA, USA, at University of São Paulo.

Presentations

2023

Hyperspectral Soil Albedo in Earth System Models **KISS Workshop: Understanding and Empowering Soil Management as a Climate Change Mitigation Option.** Pasadena, CA 28 Aug – 01 Sep

Unveiling CliMA-Land: Advancing Land Modeling for Climate Research **Institute of Computing for Climate Science Summer School 2023.** Cambridge, UK 10-14 Jul

Carbon Costs of Plant Nutrient Acquisition Improve Present-Day Carbon Cycle Estimates and Limit CO_2 Fertilization Effect **European Geophysical Union meeting 2023.** Vienna, Austria 14-19 Apr

2022

Hyperspectral Soil Albedo in Earth System Models Significantly Impacts Climate Simulations **American Geophysical Union meeting 2022.** Chicago, USA 12-16 Dec

Global Carbon Costs of Nitrogen and Phosphorus Acquisition. **New Phytologist Early Career Scientist Symposium**. Tartu, Estonia.

2021

CMIP6 Carbon Cycle in Arctic-Boreal Ecosystems: Uncertainties and Projections. **American Geophysical Union meeting 2021**. Online Everywhere. 14 December

CMIP6 Carbon Cycle Uncertainties in Arctic-Boreal Ecosystems. **ABoVE Science Team Meeting**. Virtual meeting, USA. 11 May

Simulating the effects of water limitation on crop biomass production using a functional-structural plant 3D model of shoot and root driven by soil hydraulics. **Invited Speaker** SupAgro, Virtual INRAE, Montpellier, France. 06 May

Global Carbon Costs of Phosphorus Acquisition: Outcomes from the P-enabled FUN model. **Invited Speaker** NGEE-Tropics, Virtual Lawrence Berkeley National Laboratory. 19 April

Better representing vegetation canopy structure in Earth System Models. **European Geophysical Union virtual meeting 2021**. 19 April

Climate Change Impacts on Mycorrhizae Amplify Nitrogen Limitation on Global Plant Growth. **CESM Land Model and Biogeochemistry working group virtual meeting**. 25 February

2020

Considering the effects of canopy structure on hyperspectral radiative transfer and terrestrial photosynthesis. **American Geophysical Union meeting 2020**. Online Everywhere. 9 December

Better representing vegetation canopy structure in Earth System Models. NASA-JPL, Pasadena, California, USA. **Invited Speaker**. https://youtu.be/_D9g0Nt8LFs 10 September

Adding different explicit spatial representations of plant symbiotic status in CLM. Boulder, Colorado, USA. **CLM Group Meeting 2020**. 03 March

2019

Considering carbon costs of plant phosphorus acquisition in Earth System Models. **American Geophysical Union meeting 2019**. San Francisco, CA, USA. 9 December

From the atmosphere to the land surface: improving representations of atmosphere-biosphere interactions. NASA-JPL, Pasadena, California, USA. **Invited Speaker**. 11 February

2017

Improving the treatment of vegetation canopy architecture in radiative transfer schemes. Department of Meteorology, University of Reading, UK. **Departmental Seminar**. 27 June

2016

Evaluating radiative transfer schemes treatment of vegetation canopy architecture in land surface models. **European Geophysical Union meeting 2016**. Vienna, Austria. 28 April

2015

Improving Land Surface Model treatment of vegetation canopy architecture**. Quo Vadis**. Department of Meteorology. University of Reading, UK. March

Improving Land Surface Model treatment of vegetation canopy architecture. ICTP, Trieste, Italy. (**Invited**) http://indico.ictp.it/event/7444/ . 20 March.

2014

The Effects of Canopy Stand Structure on Ecosystem Functioning. University of Lancaster, Lancaster, UK. **Spring School**

2012

Evaluation of CO_2 Flux Modification as Function of Aerosol Optical Depth in the Bananal Island, Tocantins, Brazil. Poster. **International Radiation Symposium**. Berlin, Germany. 10 August

2011

Avaliação da Fração da Radiação Fotossinteticamente Ativa Absorvida pela Floresta Tropical Primária na Amazônia. Poster. **XV Simpósio Brasileiro de Sensoriamento Remoto**. Curitiba, Brazil. 4 May

2010

Evaluation of Photosynthetically Active Radiation Fraction Absorbed by Primary Tropical Forest in the Amazon during the Dry Season of 2007. Poster. **AGU - The Meeting of the Americas**. Foz do Iguaçu, Brazil. 12 August

Avaliação da Fração da Radiação Fotossinteticamente Ativa Absorvida pela Floresta Tropical Primária na Amazônia. Poster. **XV Simpósio de Iniciação Científica do IAG**. Sao Paulo, Brazil

2009

Avaliação da Qualidade do Ar para a Região Metropolitana de Campinas. Poster. 17º Simpósio Internacional de Iniciação Científica da USP. Avaliação da Qualidade do Ar para a Região Metropolitana de Campinas. **XIV Simpósio de Iniciação Científica do IAG**. Sao Paulo, Brazil

Professional Services

Reviewer for: Journal of Geophysical Research: Biogeosciences; Remote Sensing of Environment; Climate Resilience and Sustainability; Water Resources Research; Geoscientific Model Development; Global Change Biology; New Phytologist; Remote Sensing.

Expert reviewer for NASA Carbon Program Panel, DOE Panel

Public Outreach & Volunteer Experience

"Carbon emitting ecosystems and how open access makes research more equitable, transparent, and impactful" for IOP Publishing August 2023

"The Fungi Economy Series" for Scientific American Podcast August 2023

"Climate change affects key tree-fungi interactions" – Purdue University 29 November 2021

Amazon Tall Tower Observatory (ATTO) project – Blog post about Amazon Research 06 July 2021

Including vegetation structure improves photosynthesis in land surface models 17 June 2020

Trees have 'more power' to fight climate change 20 December 2019

4th ICOS Summer School 7 July 2017

The impact of vegetation structure on global photosynthesis 30 June 2017

Instructor, 'Alegria de Crescer' High School, Capivari, Sao Paulo, Brazil September 2016

Taught '*Science as a career*'

Instructor, Sao Paulo State University, UNESP-Bauru, Sao Paulo, Brazil September 2016

Taught '*PhD: Each is a unique journey*'

Memberships & Affiliations

European Geophysical Union; American Geophysical Union

List of Referees

1) Individual Referee

Name: Prof. Christian Frankenberg
Position: Caltech Professor and JPL Scientist
Address: 203 Linde+Robinson
Mail Code 131-24
Pasadena, CA, 91125
Telephone number: +1 (626) 395 2331
E-mail address: cfranken@caltech.edu

2) Individual Referee

Name: Dr. David Schimel
Position: JPL Principal Scientist
Address: 4800 Oak Grove Dr.
MS 233-200
Pasadena, CA, 91109
Telephone number: +1 (818) 354 6803
E-mail address: david.schimel@jpl.nasa.gov

3) Individual Referee

Name: Prof. Tapio Schneider
Position: Caltech Professor and JPL Scientist
Address: 1200 E. California Blvd.
Mail Code 131-24
Pasadena, CA, 91125
Telephone number: +1 (626) 395-6143
E-mail address: tapio@caltech.edu

4) Individual Referee

Name: Dr. Joshua B. Fisher
Position: Associate Professor at Chapman University
Telephone number: +1 (821) 354-0934
E-mail address: joshbfisher@gmail.com

5) Individual Referee

Name: Dr. Frédéric Gerard

Position: Junior Scientist (CRN)
Address: Eco&Sol - Department of Environment and Agronomy
French National Institute for Agricultural Research
2, Place Pierre Viala – Campus SupAgro
Montpellier 34060
France
Telephone number: +33 (0) 499 613 024
E-mail address: frederic.gerard@inrae.fr

6) Individual Referee

Name: Dr. Tristan Quaife
Position: Associate Professor
Address: Department of Meteorology
5th floor Lyle Building University of Reading
Reading RG6 6BX
United Kingdom
Telephone number: +44 (0) 118 378 8743
E-mail address: t.l.quaife@reading.ac.uk

7) Individual Referee

Name: Prof. Dr. Marcia Akemi Yamasoe
Position: Professor Doctor
Address: Instituto de Astronomia, Geofísica e Ciências Atmosféricas
Universidade de São Paulo
Rua do Matão, 1226 - Cidade Universitária
São Paulo – SP 05508-900
Brazil
Telephone number: +55 (11) 3091 4682
E-mail address: marcia.yamasoe@iag.usp.br