RICHARD J. NORBY

September 15, 2022

Address

116 Morningside Drive
Oak Ridge, TN 37830

Contact:

Tel.: (865) 603-0752
E-mail: rnorby@utk.edu

Education

Ph.D., University of Wisconsin-Madison, Forestry and Botany, 1981
B.A., Carleton College, Chemistry, 1972

Positions

Environmental Sciences Division, Oak Ridge National Laboratory
- Research Fellow Emeritus, 2022 -
- Corporate Research Fellow, 2007 - 2020
- Distinguished R&D Staff Member, 2001 - 2007
- Senior Research Staff Member, 1996 - 2001
- Research Staff Member, 1987-1996
- Research Associate, 1985 -1987
- University of Tennessee Research Associate, 1983-1985
- U.S. DOE Postdoctoral Research Training Program, 1981-1983

University of Tennessee, Knoxville
- Research Professor, Department of Ecology & Evolutionary Biology, 2022 – present
- Adjunct Faculty, Department of Ecology & Evolutionary Biology, 1986 - 2021
- Joint Professor, Center for Interdisciplinary Research and Graduate Education, 2011-present
- Research Associate, Graduate Program in Ecology, 1983-1985

University of Birmingham (UK)
- Honorary Professor, School of Geography, Earth and Environmental Sciences, 2022 –
- Distinguished Visiting Fellow, Institute for Advanced Studies, 2019 -2020

UK Met Office
- Senior Science Supervisor, AmazonFACE project, 2021 – present

University of Wisconsin-Madison
- Research Assistant, Department of Forestry, 1978-1981
- Research Assistant, Department of Botany, 1977-1978

Professional Activities

Editor and Trustee, *New Phytologist*, 1997-
Associate Editor, *Journal of Plant Ecology*, 2008 - 2016

Editorial Board, *Ecological Applications*, 1998 – 2002

Member, Advisory Group, Birmingham Institute of Forest Research, University of Birmingham (UK), 2020 -

Member, Scientific Steering Group, AmazonFACE, 2014 -

Member, AGU Fellows Selection Committee, 2018 - 2021

Co-chair, Research Priorities for Tropical Ecosystems Under Climate Change Workshop, U.S. Department of Energy, Office of Science, Office of Biological and Environmental Research, June, 2012.

Member, Science Steering Group for the North American Carbon Program, 2005 - 2008

Secretary, National Technical Advisory Committee, National Institute for Global Environmental Change, 2002

Task Leader, Global Change and Terrestrial Ecosystems, Focus 1, 1997- 2003

Member, Scientific Steering Committee, Terrestrial Ecosystem Responses to Atmospheric and Climatic Change (NSF network activity), 2001- 2007

Member, Planning Committee and Science and Facility Writing Team, Terrestrial Ecosystem Research Facility (DOE), 2001

Panel member, NASA Carbon Cycle Science peer review panel, 2004

Panel member, National Institute for Global Environmental Change, southeastern region, 1997-1998

Organizer of NSF/DOE Workshop, "Phosphorus Cycling in Terrestrial Ecosystems: Advancing our fundamental understanding through a model-data connection", Townsend, Tennessee, May, 2016; New Phytologist Symposium, "Stoichiometric Flexibility in Terrestrial Ecosystems Under Global Change", Oracle, Arizona, September, 2011; New Phytologist Symposium, "Carbon Cycling in Tropical Ecosystems", Guangzhou, China, November, 2009; New Phytologist Symposium "Functional Genomics of Environmental Adaptation in *Populus*", Gatlinburg, Tennessee, October, 2004; TERACC workshop, "Interactions Between Increasing CO_2 and Temperature in Terrestrial Ecosystems", Lake Tahoe, California, April, 2003; GCTE/New Phytologist Symposium, "Fine Root Dynamics and Global Change: An Ecosystem Perspective", Townsend, Tennessee, October, 1999.

Contributing author, "Climate Change Impacts on Forests", In: Climate Change 1995. Contribution of Working Group II to the Second Assessment Report of the Intergovernmental Panel on Climate Change. Cambridge University Press, 1996.

External Reviewer, EPRI/DOE Forest Response to CO_2 Research Program

External Reviewer, U.S. EPA Global Change Research Program

Consultant to the DOE/NSF/USDA Collaborative Research in Plant Biology Program Advisory Committee, 1992

Visiting Scientist, Estonian Academy of Sciences, Tartu, Estonia, U.S.S.R., 1989.

Rapporteur, SCOPE workshop, CO_2 and Climate Change, Washington, D.C., 1993.

Rapporteur, Interagency Workshop: Biological Response to Environmental Change, Woods Hole, Massachusetts, 1987

Rapporteur, CO_2 Research Conference: Carbon Dioxide, Science, and Consensus, Institute for Energy Analysis, Berkeley Springs, West Virginia, 1982.

Participant in environmental impact study of Columbia Generating Station, Portage, Wisconsin, 1979-1981.

Reviewer for *Acta Oecologica, American Journal of Botany, Annales des Sciences Forestières, Annals of Botany; Atmospheric Environment; Biogeochemistry; Canadian Journal of Forest Research; Ecological Applications; Ecology*; *Ecology Letters;*

Ecosystems; Environmental and Experimental Botany; Environmental Pollution, Forest Science; Functional Ecology; Functional Plant Biology; Global Biogeochemical Cycles; Global Change Biology; Global and Planetary Change; International Journal of Plant Science; Journal of Ecology; Journal of Environmental Quality; Nature; Nature Climate Change; New Phytologist; Oecologia; Oikos; Plant and Soil; Plant, Cell and Environment; Plant Physiology; Proceedings of the National Academy of Sciences; Science; Soil Science Society of America Journal; Tree Physiology; *Trees; Trends in Ecology and Evolution; Urban Atmosphere*; *Water, Air and Soil Pollution*; Academic Press; Oxford University Press; Springer-Verlag; International Geosphere-Biosphere Programme; National Science Foundation; U.S. Environmental Protection Agency; U.S. Forest Service; U.S. Department of Energy; U.S. Department of Agriculture; U.S. Agency for International Development; U.S.-Israel Binational Science Foundation; National Acid Deposition Assessment Program; National Institute for Global Environmental Change; U.K. National Environmental Research Council, Dutch National Research Council, Swiss National Science Foundation, Israel Science Foundation

Outreach Activities

Organizer of class on global change, Oak Ridge Institute for Continued Learning, 2000
Treasurer, University of Tennessee Arboretum Society, 1996 – 1999
Lecturer, Traveling Lecture Program, Oak Ridge Institute for Science and Education, U.S. Department of Energy, 1987- 1993

Research Activities

Ecosystem responses to atmospheric and climatic change
Effects of atmospheric CO_2 enrichment on tree growth and forest metabolism
Carbon and nitrogen cycling in forest ecosystems
Forest tree physiology and plant physiological ecology
Synthesis of experimental results for use in models

Membership in Professional Societies

American Association for the Advancement of Science
American Geophysical Union
Association of Tropical Biology and Conservation
Ecological Society of America

Awards and Honors

Distinguished Career Service Award, United States Department of Energy, April 2020
Highly Cited Researcher, 2018-2021, Clarivate Analytics
Fellow, American Geophysical Union, 2017
Fellow, Ecological Society of America, 2016
Significant Event Award, Oak Ridge National Laboratory, 2015
Outstanding Mentor Award, U. S. Department of Energy Office of Science, 2007
UT-Battelle Award for Outstanding Accomplishment in Science and Technology, 2004
Fellow, American Association for the Advancement of Science, 1995
Scientific Achievement Award, Environmental Sciences Division, Oak Ridge National Laboratory, 1992
Society of Technical Communications, Award of Merit for Technical Publication, 1989 and 1998; Award of Distinguished Technical Communication and Best of Show – Print, 2014

E. B. Fred Fellow, University of Wisconsin-Madison, 1977
Westinghouse Science Talent Search semi-finalist, 1968
Sigma Xi
Xi Sigma Pi

Teaching Experience

Lectures as part of core curriculum in Ecology & Evolutionary Biology, University of Tennessee-Knoxville, 2009
Organizer of class on global change, Oak Ridge Institute for Continued Learning, 2000
Lecturer, Traveling Lecture Program, Oak Ridge Institute for Science and Education, U.S. Department of Energy, 1987- 1993

Student supervision

Postdoctoral advisees (current affiliation): Anthony Walker (ORNL), Victoria Sloan (University of Bristol), Colleen M Iversen (ORNL), Jeffery M. Warren (ORNL), Aimee T. Classen (University of Michigan), Shiqiang Wan (Hebei Universitry), Tim J. Tschaplinski (ORNL),
PhD. Dissertation advisee: Colleen M. Iversen, University of Tennessee; Kristine Cabugao, University of Tennessee; Daniela Yaffar (University of Tennessee)
PhD Committees: Jessica Bryant Moore (UTK), Emmi Felker-Quinn (UTK), Milena Holmgren (UTK), Sue Natali (SUNY-StonyBrook), Elizabeth O'Neill (UTK), Johnna Sholtis (Texas Tech Univ.), Katie Stuble (UTK), Lina Taneva (Univ. Illinois-Chicago), Rebecca Trueman (Univ. Illinois-Chicago)
MS committees: Cayenne Engle (UTK), Travis Belote (UTK)
Numerous summer undergraduate participants and post-B.S. interns at ORNL

Publications

ORCID: 0000-0002-0238-9828

2022

Ellsworth D, Crous K, De Kauwe M, Verryckt L, Goll D, Zaehle S, Bloomfield K, Ciais P, Cernusak L, Domingues T, Dusenge E, Garcia S, Guerrieri R, Ishida FY, Janssens I, Kenzo T, Ichie T , Medlyn B, Meir P, Norby R, Reich P, Rowland L, Santiago L , Sun Y, Uddling J, Walker A, Weerasinghe L, van de Weg M, Zhang YB, Zhang JL, Wright IJ. 2022 Convergence in phosphorus constraints to photosynthesis in forests around the world. *Nature Communications*, 13, 5005. DOI:10.1038/s41467-022-32545-0

Iversen CM, Latimer J, Brice DJ, Childs J, Vander Stel HM, Defrenne CE, Graham J, Griffiths NA, Malhotra A, Norby RJ, Oleheiser KC, Phillips JR, Salmon VG, Sebestyen SD, Yang X, Hanson PJ. 2022. Whole-Ecosystem Warming Increases Plant-Available Nitrogen and Phosphorus in an Ombrotrophic Bog. *Ecosystems*, DOI: 10.1007/s10021-022-00744-x

Norby RJ, Warren JM, Iversen CM, Childs J, Jawdy SS, Walker AP. 2022. Forest stand and canopy development unaltered by 12 years of CO_2 enrichment. *Tree Physiology* 42: 428-220. DOI: 10.1093/treephys/tpab107.

Pan Y, Jackson RB, Hollinger DY, Phillips OL, Nowak RS, Norby RJ, Oren R, Reich PB, Lüscher A, Mueller KE, Owensby C, Birdsey R, Hom J, Luo Y. 2022. Contrasting responses

of woody and grassland ecosystems to increased CO_2 as water supply varies. *Nature Ecology and Evolution* 6:315+. DOI: 10.1038/s41559-021-01642-6.

2021

Cabugao KG, Yaffar D, Stenson N, Childs J, Phillips J, Mayes MA, Yang X, Weston DJ, Norby RJ. 2021. Bringing function to structure: Root-soil interactions shaping phosphatase activity throughout a soil profile in Puerto Rico. *Ecology and Evolution* 11:1150-1164, DOI: 10.1002/ece3.7036.

Cusack DF, Addo-Danso S, Agee EA, Andersen KM, Arnaud M, Batterman SA, Brearley FQ, Ciochina M, Cordeiro AL, Dallstream C, Diaz-Toribio MH, Dietterich LH, Fisher JB, Fleischer K, Fortunel C, Fuchslueger L, Guerrero-Ramirez N, Kotowska M, Lugli LF, Marín C, McCulloch LA, Maeght JL, Metcalfe D, Norby RJ, Oliveira RS, Powers JS, Reichert T, Smith SW, Smith-Martin C, Soper F, Toro L, Umana MN, Valverde-Barrantes O, Weemstra M, Werden L, Wong M, Wright SJ, Yaffa D. 2021. Tradeoffs and synergies in tropical forest root traits for nutrient and water acquisition: field and modeling advances. *Frontiers in Forests and Global Change* – Forest Soils. DOI: 10.3389/ffgc.2021.704469.

Dale VH, Post M, Norby RJ. 2021. Resolution of Respect: Jerry S. Olson (1928–2021). *Bulletin of the Ecological Society of America*, e01879. DOI: 10.1002/bes2.1879

Martins NP, Fuchslueger L, Fleischer K, Andersen KM, Assis RL, Baccaro FB, Camargo PB, Cordeiro AL, Grandis A, Hartley IP, Hofhans F, Lugli LF, Lapola DM, Menezes JG, Norby RJ, Rammig A, Rosa JS, Schaap KJ, Takeshi B, Valverde-Barrantes OJ, Quesada CA. 2021. Fine roots stimulate nutrient release during early stages of leaf litter decomposition in a Central Amazon rainforest. *Plant and Soil* 469:387-303. DOI: 10.1007/s11104-021-05148-9.

Menezes J, Garcia S, Grandis A, Nascimento H, Domingues TF, Guedes A, Aleixo I, Camargo P, Campos J, Damasceno A, Dias-Silva R, Fleischer K, Kruijt B, Longhi A, Martins N, Meir P, Norby RJ, Pereira I, Portela B, Rammig A, Ribeiro AG, Lapola DM, Quesada CA. 2021. Changes in leaf functional traits with leaf age: When do leaves decrease their photosynthetic capacity in Amazonian trees? *Tree Physiology*, DOI: 10.1093/treephys/tpab042

Norby RJ. 2021. Comment on "Increased growing-season productivity drives earlier autumn leaf senescence in temperate trees". *Science* 371: eabg1438, DOI: 10.1126/science.abg1438

Salmon VG, Brice DJ, Bridgham S, Childs J, Graham J, Griffiths NA, Hofmockel K, Iversen CM, Jicha TM, Kolka RK, Kostka JE, Malhotra A, Norby RJ, Phillips JR, Ricciuto D, Schadt CW, Sebestyen SD, Shi X, Walker AP, Warren JM, Weston DJ, Yang X, Hanson PJ. 2021. Nitrogen and phosphorus cycling in an ombrotrophic peatland: A benchmark for assessing change. *Plant and Soil* 466: 649-674. DOI: 10.1007/s11104-021-05065-x

Shi X, Ricciuto DM, Thornton PE, Xu X, Yuan F, Norby RJ, Walker AP, Warren J, Mao J, Hanson PJ, Meng L, Weston D, Griffiths NA. 2021. Extending a land-surface model with Sphagnum moss to simulate responses of a northern temperate bog to whole ecosystem warming and elevated CO_2. *Biogeosciences* 18: 467-486. DOI: 10.5194/bg-18-1-2021.

Walker AP, De Kauwe MG, Bastos A, Belmecheri S, Georgiou K, Keeling RF, McMahon SM, Medlyn BE, Moore DJP, Norby RJ, Zaehle S, Anderson-Teixeira KJ, Battipaglia G, Brienen RJW, Cabugao KG, Cailleret M, Campbell E, Canadell JG, Ciais P, Craig ME, Ellsworth DS, Farquhar GD, Fatichi S, Fisher JB, Frank DC, Graven H, Gu L, Haverd V, Heilman K, Heimann M, Hungate BA, Iversen CM, Joos F, Jiang M, Keenan TF, Knauer J, Körner C, Leshyk VO, Leuzinger S, Liu Y, MacBean N, Malhi Y, McVicar TR, Penuelas J, Pongratz J, Powell AS, Riutta T, Sabot MEB Schleucher J, Sitch S, Smith WK, Sulman B, Taylor B, Terrer C, Torn MS, Treseder KK, Trugman AT, Trumbore SE, van Mantgem PJ, Voelker SL, Whelan ME, Zuidema PA. 2020. Integrating the evidence for a terrestrial carbon sink caused by increasing atmospheric CO_2. *New Phytologist* 229: 2413-2445, DOI: 10.1111/nph.16866.

Yaffar D, Defrenne CE, Cabugao KG, Kivlin SN, Childs J, Carvajal N, Norby RJ. 2021. Trade-offs in phosphorus acquisition strategies of five common tree species in a tropical forest of Puerto Rico. *Frontiers in Forests and Global Change,* 4(85), doi: 10.3389/ffgc.2021.698191.

Yaffar D, Wood TE, Reed SC, Branoff BL, Cavaleri MA, Norby RJ. 2021. Experimental warming and its legacy effects on root dynamics following two hurricane disturbances in a wet tropical forest. *Global Change Biology* 27: 6423-6435. DOI: 10.1111/gcb.15870

2020

Cordeiro AL, Norby RJ, Andersen KM, Valverde-Barrantes O, Fuchslueger L, Oblitas E, Hartley IP, Iversen CM, Gonçalves NB, Takeshi B, Lapola DM, Quesada CA.2020. Fine-root dynamics vary with soil depth and precipitation in a low nutrient tropical forest in the Central Amazonia. *Plant-Environment Interactions* 1:3-16, DOI:10.1002/pei3.10010.

Hanson PJ, Griffiths NA, Iversen CM, Norby RJ, Sebestyen SD, Phillips JR, Chanton JP, Kolka RK, Malhotra A, Oleheiser KC, Warren JM, Shi X, Yang X, Mao J, Ricciuto DM. 2020. Rapid net carbon loss from a whole-ecosystem warmed peatland. *AGU Advances* AGA220032, DOI: 10.1029/2020AV000163.

Koven CD, Knox RG, Fisher RA, Chambers JQ, Christoffersen BO, Davies SJ, Detto M, Dietze MC, Faybishenko B, Holm J, Huang MY, Kovenock M, Kueppers LM, Lemieux G, Massoud E, McDowel NG, Muller-Landau HC, Needham JF, Norby RJ, Powell T, Rogers A, Serbin SP, Shuman JK, Swann ALS, Varadharajan C, Walker AP, Wright SJ, Xu CG. 2020. Benchmarking and parameter sensitivity of physiological and vegetation dynamics using the Functionally Assembled Terrestrial Ecosystem Simulator (FATES) at Barro Colorado Island, Panama *Biogeosciences,* **17,** 3017-3044.

Yaffar D, Norby RJ. 2020. A historical and comparative review of 50 years of root data collection in Puerto Rico. *Biotropica* 52: 563-576, DOI:10.1111/btp.1277

2019

Fleischer K, Rammigl A, De Kauwe MG, Walker AP, Domingues TF, Fuchslueger L, Garcia S, Goll DS, Grandis A, Jiang MK, Haverd V, Hofhansl F, Holm JA, Kruijt B, Leung F, Medlyn BE, Mercado LM, Norby RJ, Pak B, von Randow C, Quesada CA, Schaap KJ, Valverde-Barrantes OJ, Wang YP, Yang XJ, Zaehle S, Zhu Q, Lapola DM. 2019. Amazon forest response to CO_2 fertilization dependent on plant phosphorus acquisition. *Nature Geoscience* 12: 736-+. DOI:10.1038/s41561-019-0404-9

Norby RJ, Childs J, Hanson PJ, Warren JM. 2019. Rapid loss of an ecosystem engineer: *Sphagnum* decline in an experimentally warmed bog. *Ecology and Evolution* 9:12571-12585. DOI: 10.1002/ece3.5722.

Norby RJ, Sloan VL, Iversen CM, Childs J. 2019. Controls on fine-scale spatial and temporal variability of plant-available inorganic nitrogen in a polygonal tundra landscape. *Ecosystems* 22: 528-543. DOI: 10.1007/s10021-018-0285-6.

Pereira IS, Nascimento HEM, Vicari MB, Disney M, DeLucia EH, Domingues T, Kruijt B, Lapola D, Meir P, Norby RJ, Ometto JPHB, Quesada CA, Rammig A, Hofhansl F. 2019. Performance of laser-based electronic devices for structural analysis of Amazonian terra-firme forests. *Remote Sensing* 11: 510. DOI:10.3390/rs11050510

Song J, Wan S, and 57 co-authors including Norby RJ. 2019. A meta-analysis of 1119 manipulative experiments on terrestrial carbon cycling responses to global change. *Nature Ecology and Evolution* 3: 1309-1320. https://doi.org/10.1038/s41559-019-0958-3.

Walker AP, De Kauwe MG, Medlyn BE, Zaehle S, Iversen CM, Asao S, Guenet B, Harper A, Hickler T, Hungate BA, Jain AK, Luo Y, Lu X, Lu M, Luus K, Megonigal JP, Oren R, Ryan E, Shu S, Talhelm A, Wang Y-P, Warren JM, Werner C, Xia J, Yang B, Zak DR, Norby RJ. 2019. Decadal biomass increment in early secondary succession woody ecosystems is increased by CO_2 enrichment. *Nature Communications* 10: 454. DOI: 10.1038/s41467-019-08348-1

Yang X, Ricciuto DM, Thornton PE, Shi X, Xu M, Hoffman F, Norby RJ. 2019. The effects of phosphorus cycle dynamics on carbon sources and sinks in the Amazon region: a modeling study using ELM v1. *Journal of Geophysical Research: Biogeosciences 124.* DOI: 10.1029/2019JG005082.

2018

Gonzalez-Meler MA, Poghosyan A, Sanchez-de Leon Y, Dias de Olivera E, Norby RJ, Sturchio NC. 2018. Does elevated atmospheric CO_2 affect soil carbon burial and soil weathering in a forest ecosystem? *PeerJ* 6: e5356. DOI: 10.7717/peerj.5356.

Iversen CM, Childs J, Norby RJ, Ontl TA, Kolka RK, Brice DJ, McFarlane KJ, Hanson PJ. 2018. Fine-root growth in a forested bog is seasonally dynamic, but shallowly distributed in nutrient-poor peat. *Plant and Soil* 424:123-143. DOI: 10.1007/s11104-017-3231-z.

Sánchez-de León Y, Wise DH, Lugo-Pérez J, Norby RJ, James SW, Gonzalez-Meler MA.2018. Endogeic earthworm densities increase in response to higher fine-root production in a forest exposed to elevated CO_2. Soil Biology and Biochemistry 122: 31-38.

2017

Cabugao KG, Timm CM, Carrell AA, Childs J, Lu TS, Pelletier DA, Weston DJ, Norby RJ. 2017. Root and rhizosphere bacterial phosphatase activity varies with tree species and soil phosphorus availability in Puerto Rico tropical forest. *Frontiers in Plant Science* 8:1834. doi: 10.3389/fpls.2017.01834

De Kauwe MG, Medlyn BE, Walker AP, Zaehle S, Asao S, Guenet B, Harper A, Hickler T, Jain A, Luo Y, Lu C, Luus K, Parton WJ, Shu S, Wang YP, Werner C, Xia J, Pendall E, Morgan JA, Ryan EM, Carrillo Y, Dijkstra FA, Norby RJ. 2017. Challenging terrestrial biosphere models with data from the long-term multi-factor Prairie Heating and CO_2 Enrichment experiment. *Global Change Biology* DOI: 10.1111/gcb.13643.

Griffiths NA, Hanson PJ, Ricciuto DM, Iversen CM, Jensen AM, Malhotra A, McFarlane KJ, Norby RJ, Sargsyan K, Sebestyen SB, Shi X, Walker AP, Ward EJ, Warren JM, Weston DJ. 2017. Temporal and spatial variation in peatland carbon cycling and implications for interpreting responses of an ecosystem-scale warming experiment. *Soil Science Society of America Journal* 81: 1668-1688. DOI:10.2136/sssaj2016.12.0422

Liu S, Bond-Lamberty B, Boysen LR, Ford JD, Fox A, Gallo K, Hatfield J, Henebry GM, Liu Z, Loveland TR, Norby RJ, Sohl T, Steiner AL, Huntington TG, Yuan W, Zhang Z, Zhao S. 2017. Grand challenges in understanding the interplay of climate and land changes. *Earth Interactions* Paper 21-002, doi: 10.1175/EI-D-16-0012.1

Norby RJ, De Kauwe MG, Walker AP, Werner C, Zaehle S, Zak DR. 2017. Comment on "Mycorrhizal association as a primary control of the CO_2 fertilization effect". *Science* 355: 358. https://doi.org/10.1126/science.aai7976.

Norby RJ, Gu L, Haworth IC, Jensen AM, Turner BL, Walker AP, Warren JM, Weston DJ, Xu C, Winter K. 2017. Informing models through empirical relationships between foliar phosphorus, nitrogen and photosynthesis across diverse woody species in Panama. *New Phytologist* 215:1425-1437.doi: 10.1111/nph.14319.

Norby RJ, Iversen CM. 2017. Introduction to a Virtual Issue on root traits. *New Phytologist* 215: 5-8.

Walker AP, Carter KR, Gu L, Hanson PJ, Malhotra A, Norby RJ, Sebestyen SD, Wullschleger SD, Weston DJ. 2017 Biophysical drivers of seasonal variability in Sphagnum gross primary production in a northern temperate bog. *Journal of Geophysical Research: Biogeosciences* 10.1002/2016JG003711.

Weston DJ, Turetsky MR, Johnson MG, Granath G, Lindo Z, Belyea LR, Rice SK, Hanson DT, Engelhardt KAM, Schmutz J, Dorrepaal E, Euskirchen ES, Stenøien HK, Szövényi P, Jackson M, Piatkowski BT, Muchero W, Norby RJ, Kostka JE, Glass JB, Rydin H, Limpens J, Tuittila E-S, Ullrich KK, Carrell A, Benscoter BW, Chen J-G, Oke TA, Nilsson MB, Ranjan P, Jacobson D, Lilleskov EA, Clymo RS, Shaw AJ. The Sphagnome Project: enabling ecological and evolutionary insights through a genus-level sequencing project. *New Phytologist*: doi:10.1111/nph.14860

2016

Langford Z, Kumar J, Hoffman FM, Norby RJ, Wullschleger SD, Sloan VL, Iversen CM. 2016. Mapping arctic plant functional type distributions in the Barrow Environmental Observatory using WorldView-2 and LiDAR datasets. *Remote Sensing* 8: Article number 733

Mao J, Ricciuto DM, Thornton PE, Warren JM, King AW, Shi X, Iversen CM, Norby RJ. 2016. Evaluating the Community Land Model in a pine stand with shading manipulations and $^{13}CO_2$ labeling. *Biogeosciences* 13: 641-657.

Medlyn BE, De Kauwe MG, Zaehle S, Walker AP, Duursma RA, Luus K, Mishurov M, Pak B, Smith B, Wang YP, Yang X, Crous KY, Drake JE, Gimeno TE, Macdonald CA, Norby RJ, Power SA, Tjoelker MG, Ellsworth DS. 2016. Using models to guide field experiments: a priori predictions for the CO_2 response of a nutrient- and water-limited native Eucalypt woodland. *Global Change Biology* 22: 2834-2851.

Norby RJ, De Kauwe MG, Domingues TF, Duursma RA, Ellsworth DS, Goll DS, Lapola DL, Luus KA, MacKenzie AR, Medlyn BE, Pavlick R, Rammig A, Smith B, Thomas R, Thonicke K, Walker AP, Yang X, Zaehle S. 2016. Model-data synthesis for the next generation of forest FACE experiments. *New Phytologist* 209: 17-28.

Schädel C, Bader MKF, Schuur EAG, Biasi C, Bracho R, Capek P, De Baets S, Diakova K, Ernakovich J, Estop-Aragones C, Graham DE, Hartley IP, Iversen CM, Kane E, Knoblauch C, Lupascu M, Martikainen PJ, Natali SM, Norby RJ, O'Donnell JA, Roy Chowdhury T, Santruckova H, Shaver G, Sloan VL, Treat CC, Turetsky MR, Waldrop MP, and Wickland KP. 2016. Potential carbon emissions dominated by carbon dioxide from thawed permafrost soils. *Nature Climate Change* 6: 950-+

2015

Heikoop JM, Throckmorton HM, Newman BD, Perkins GB, Iversen CM, Chowdhury TR, Romanovsky V, Graham DE, Norby RJ, Wilson CJ, Wullschleger SD. 2015. Isotopic identification of soil and permafrost nitrate sources in an Arctic tundra ecosystem. *Journal of Geophysical Research: Biogeosciences* 120: 1000-1017.

Hockaday, WC, Gallagher ME, Masiello CA, Baldock JA, Iversen CM, Norby RJ. 2015. Forest soil carbon oxidation state and oxidative ratio increase in response to elevated CO_2. *Journal of Geophysical Research – Biogeosciences* 120: 1797-1811.

Iversen CM, Sloan VL, Sullivan PF, Euskirchen ES, McGuire AD, Norby RJ, Walker AP, Warren J, Wullschleger SD. 2015. The unseen iceberg: Plant roots in arctic tundra. *New Phytologist* 205:34-58.

Mao J, Ricciuto DM, Thornton PE, Warren JM, King AW, Shi X, Iversen CM, Norby RJ. 2015. Evaluating the Community Land Model in a pine stand with $^{13}CO_2$ labeling and shading manipulations. *Biogeosciences Discussion* 12: 6971-7015, doi:10.5194/bgd-12-6971-2015.

McCormack ML, Dickie IA, Eissenstat DM, Fahey TJ, Fernandez CW, Guo D, Helmisaari H-S, Hobbie EA, Iversen CM, Jackson RB, Leppälammi-Kujansuu J, Norby RJ, Phillips RP, Pregitzer KS, Pritchard SG, Rewald B, Zadworny M. 2015. Redefining fine roots improves understanding of below-ground contributions to terrestrial biosphere processes. *New Phytologist* 207:505-518.

Medlyn BE, Zaehle S, De Kauwe MG, Walker AP, Dietze MC, Hanson PJ, Hickler T, Jain AK, Luo Y, Parton W, Prentice IC, Thornton PE, Wang S, Wang YP, Weng E, Iversen CM,

McCarthy HR, Warren JM, Oren R, Norby RJ. 2015. Using ecosystem experiments to improve vegetation models. *Nature Climate Change* 5: 528-534.

Treat C, Natali SM, Ernakovich J, Iversen CM, Lupascu M, McGuire AD, Norby RJ, Roy Chowdhury T, Richter A, Santruckova H, Schädel C, Schuur EAG, Sloan VL, Turetsky M, Waldrop M. 2015. A pan-Arctic synthesis of CH_4 and CO_2 production from anoxic soil incubations. *Global Change Biology* DOI: 10.1111/gcb.12875.

Walker AP, Zaehle S, Medlyn BE, De Kauwe MG, Asao S, Hickler T, Parton W, Ricciuto D, Wang YP, Wårlind D, Norby RJ. 2015. Predicting long-term carbon sequestration in response to CO_2 enrichment: How and why do current ecosystem models differ? *Global Biogeochemical Cycles* 29: 476-495.

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Invited(*) and contributed talks since 2005

*"Pretreatment carbon cycling assessment will aid detection of responses to elevated CO_2 in the AmazonFace experiment", INTECOL, Geneva Switzerland, August 2022

*"Sphagnum-shrub interactions in a changing climate", Ecological Society of America annual meeting, Montreal Canada, August 2022.

"Root traits and soil characteristics provide predictive relationships with root phosphatase activity in the Luquillo Experimental Forest, Puerto Rico", Annual meeting, Association of Tropical Biology and Conservation, Cartagena, Colombia, July 2022.

*"New evidence for an effect of elevated CO_2 on NPP in BIFoR FACE". Conference on 'Transforming our Understanding of Global Forests' , Birmingham Institute of Forest Research, Birmingham, UK, June 2022.

*"Trees, Forests, and Global Change; Will trees 'save the planet?'". Carleton College Reunion, Northfield, MN, June 2022

"Tree Growth in an Oak Woodland Exposed to Elevated Atmospheric CO_2". American Geophysical

Union annual meeting, New Orleans LA, December 2021.

*"An Historical Perspective on Elevated CO_2 Research: Early insights guiding today's research agenda" DOE Environmental System Science Principal Investigator Virtual Meeting, May 2020.

*"Challenges and opportunities in assessment of forest response to elevated atmospheric CO_2", Institute for Advanced Studies, University of Birmingham (UK), January 2020.

"Root-soil interactions throughout the soil column at forested sites in Puerto Rico differing in soil phosphorus and the implications for linking root function with root distribution in models" American Geophysical Union annual meeting, San Francisco, CA, December 2019.

*"An Historical Perspective on Elevated CO_2 Research: Early insights guiding today's research agenda" BIFoR Annual Meeting, University of Birmingham (UK), September 2019.

"Growth, cover, and productivity of *Sphagnum* decline sharply with experimental warming in a forested peatland" American Geophysical Union annual meeting, Washington DC, December 2018.

*"Models and measurements: Nutrient interactions in tropical forests and their responses to climate change" Appalachian State University, September 2018.

*"An Historical Perspective on Elevated CO_2 Research: Early insights guiding today's research agenda" Ecological Society of America annual meeting, New Orleans, LA, August 2018.

"Process-Data-Models of C-N-P in Leaves-Roots-Soil" DOE Environmental System Science Principal Investigator Meeting, Potomac, MD, April 2018.

*"Carbon Fluxes at the AmazonFACE Research Site" American Geophysical Union annual meeting, New Orleans LA, December 2017

"Fine-Root Production in an Amazon Rain Forest: Deep Roots are an Important Component of Net Primary Productivity" American Geophysical Union annual meeting, New Orleans LA, December 2017

*"The AmazonFACE experiment: A window to the future of the Amazon rainforest" Johns Hopkins University, Baltimore, MD, October 2017.

* "Modeling and measuring phosphorus at the root-soil interface for improved representation of tropical forests in Earth system models", Annual meeting, Association for Tropical Biology and Conservation, Merida, Mexico, July 2017

* "The NGEE-Tropics Field Campaign to Inform the ACME Land Model Phosphorus Module", The Future of Tropical Forests in Asia", National Technical University, Singapore, November 2016

* "The NGEE-Tropics field campaign to inform the ACME Land Model phosphorus module." Workshop, Nutrient Limitation on Land: How accurate are our global land models? Yangling, China, June 2016

*"The DOE NGEE-Tropics Research Program: Model-inspired measurements of phosphorus at the root-soil interface." Annual meeting, Luquillo Long-Term Ecological Research Program, El Yunque National Forest, Puerto Rico, June 2016

*"Guiding the next generation of forest FACE experiments with lessons from the past." European Geosciences General Assembly, Vienna Austria, April 2016.

*"Model-inspired measurements of phosphorus at the root-soil interface", DOE Environmental System Science Principal Investigator Meeting, Potomac, MD, April 2016.

*"Model-experiment interaction to improve representation of phosphorus limitation in land models", American Geophysical Union annual meeting, San Francisco CA, December 2015.

"Foliar phosphorus concentration exerts stronger control of photosynthesis than does nitrogen

across diverse woody species in Panama", Ecological Society of America annual meeting, Baltimore, MD, August 2015.

"Relationships between foliar phosphorus, nitrogen and photosynthesis across diverse woody species in Panama", Association of Tropical Biology and Conservation annual meeting, Honolulu HI, July 2015.

*"The Amazon-FACE Experiment: High Hopes, High Hurdles", Carnegie Institution Department of Global Ecology, Stanford, CA, April 2015

*"Accelerating the connection between experiments and models: The FACE-MDS experience", American Geophysical Union annual meeting, San Francisco CA, December 2014.

*"The SPRUCE Experiment: Learning from the past to better predict the future", Ecological Society of America annual meeting, Sacramento, CA, August 2014.

*"The OCCAM experiment: Was a multi-factor experiment the best approach for revealing responses to atmospheric and climatic change?" INTERFACE workshop, "Using results from global change experiments to inform land model development and calibration"; Beijing, China, May 12, 2014.

*"How to Start a Big Experiment". 5th International Forum for Young Ecologists; Kaifeng, China, May 16, 2014.

*"The science plan for an Amazon FACE experiment" Jet Propulsion Laboratory, Pasadena, CA, January 2014; University of Birmingham, Birmingham, UK, March 2014.

"Plant and soil nitrogen relationships across polygonal ground at Barrow, Alaska" Annual meeting, Ecological Society of America, Minneapolis, Minnesota, August 2013.

*" NGEE Arctic Project: A Model-Inspired Study of Climate Feedbacks in High-Latitude Ecosystems" Arctic LTER winter meeting, Woods Hole, MA, March, 2013.

*"From tundra to tropics and points in between: providing data for climate change models" Ecology & Evolutionary Biology Department, University of Tennessee-Knoxville, February, 2013; Intercollege Graduate Degree Program in Ecology, Penn State University, March, 2013; Conservation Ecology Seminar series, University of Michigan, March, 2013.

*"Model synthesis of data from free-air CO_2 enrichment experiments" Annual meeting, American Geophysical Union, San Francisco, CA, December 2012.

*"Carbon-nitrogen interactions in CO_2-enriched ecosystems: An experimentalist's view on model-data integration." Distinguished Ecologist Lecture Series, Michigan Technological University, Houghton, Michigan, October 2012.

*"Forest responses to elevated atmospheric CO_2 : Lessons from FACE experiments" International Symposium on The Role of Ecological Institute, National Ecological Institute, Seoul, South Korea, September 2011.

*"Carbon dynamics in an oldfield ecosystem: Was a multi-factor experiment the best approach for revealing responses to atmospheric and climatic change?" Annual meeting, Ecological Society of America, Austin, Texas, August 2011.

*"Forest NPP in FACE experiments", Workshop on Forest Sensitivity to CO_2, University of Sydney, Sydney, Australia, August, 2011.

*"Forest responses to elevated CO_2: Lessons from a decades-long research program" keynote address at International Scientific Conference, "Functions and Services of Biodiversity", University of Göttingen, Germany, June 2011

* "Temperate Tree FACE Studies: Lessons from a decades-long research program" CO_2 Symposium, Smithsonian Tropical Research Institute, Panama City, Panama, March 2011.
"Leaf and nitrogen distribution in sweetgum canopies after 12 years of CO_2 enrichment" Ecological Society of America annual meeting, Pittsburgh, PA, August 2010
*"Where did the carbon go? The 12-year saga of the Oak Ridge FACE experiment" University of Sheffield, UK, May 2010
*"Where did the carbon go? The 12-year saga of the Oak Ridge FACE experiment" University of York, UK, March 2010.
*"Long-term data from FACE experiments provide a benchmark for ecosystem response models" Ecological Society of America annual meeting, Albuquerque, NM, August 2009.
*Nitrogen Limitation is Reducing the Enhancement of NPP by Elevated CO_2 in a Deciduous Forest. Annual meeting, American Geophysical Union, San Francisco, CA, December 2008.
"Ten-year record of forest response to elevated CO_2 provides evidence for declining NPP and growth". Ecological Society of America annual meeting Milwaukee, WI, August, 2008
*"CO_2 fertilization and the global carbon cycle" DOE Global Change Education Program annual meeting, Knoxville, TN, June 2008
*Will CO_2 fertilization of forests counteract global warming? Tennessee Tech University, Cookeville, TN, April 2008
*"Single-factor and Multi-factor Experiments: Multiple Issues, Multiple Approaches" DOE conference, Exploring Science Needs for the Next Generation of Climatic Change and Elevated CO_2 Experiments in Terrestrial Ecosystems. Washington, DC, April 2008.
*Will CO_2 fertilization of forests counteract global warming? Tennessee State University, Nashville, TN, February 2008
*"Uncertainties: Ecosystem responses to climate change…and their feedbacks to the Carbon Cycle" ORNL symposium: Carbon Cycle, Biosequestration, and Ecosystem Response to Climate Change. Oak Ridge, TN, Jan 2008
*"Open-Top Chambers for Investigating Ecological Responses to Atmospheric and Climatic Change" American Society of Agronomy annual meeting, New Orleans, LA, November 2007
*"Net primary productivity and nitrogen uptake in forest FACE experiments" EcoFizz meeting, Sydney, Australia, Sept. 2007
*"Will CO_2 fertilization counteract global warming?" Nature Conservancy Climate Change Science Conference, Portland OR, Sept. 2007
*"Will CO_2 fertilization counteract global warming? Lessons from forest FACE experiments" University of Georgia, Athens, GA. Oct 2006
"Nitrogen uptake and net primary productivity in four forest FACE experiments". Annual meeting, Ecological Society of America, Memphis, Tennessee, August, 2006.
*"Global Change and Terrestrial Ecosystems: Do Trees Matter?" Oak Ridge Institute for Continued Learning, Oak Ridge TN, Feb. 2006
*"Forest Responses to Elevated Atmospheric CO_2". Chinese Academy of Sciences and Peking University, Beijing, China, September 2005
*"Forests in a CO_2-rich world: Old questions, new challenges". Keynote address, International Botanical Congress, Vienna, Austria, July 2005

Funded Proposals (as Principal Investigator)

“Free-Air CO_2 Enrichment (FACE) Experiment synthesis activities”; DOE, $677,000, 2012-2015.

“Partitioning in Trees and Soil”; DOE; $775,000, 2010-2012.

“Benchmarking Ecosystem Response Models with Experimental Data from Long-term CO_2 Enrichment Experiments”; NCEAS; $84,450, 2008-2010.

"Free-Air CO_2 enrichment of a Deciduous Forest"; DOE (TCP); $1,100,000 per year; 1999-continuing.

"Community and Ecosystem Response to Global Change: Interactive Effects of Atmospheric Carbon Dioxide, Surface Temperatures, and Soil Moisture "; DOE (PER); $371,000 per year; 2002- continuing.

“Forest FACE Synthesis Workshop”; TERACC; $2500; 2005

“Forest FACE Synthesis Workshop: U.S. Forest Service; $10,000; 2002

"Root Dynamics and Global Change Symposium "; New Phytologist Trust; $30,000; 1999.

"Free-Air Enrichment of a Closed-Canopy Deciduous Forest "; NSF (TECO); $1,200,000; 1996-1999.

"A Free-Air CO_2 Exposure Facility in a Deciduous Forest "; ORNL Director's R&D Fund; $760,000; 1996-1997.

"Temperature and CO_2 Interactions in Trees "; DOE (TCP); $600,000 per year; 1995-1998.

"Temperature Adjustments in Sugar Maple: Implications for Forest Succession in a Warmer Climate "; DOE (PER); $195,000/year; 1994-1997.

"Temperature-Controlled Open-Top Chambers for Global Change Research "; ORNL Exploratory Funds Program; $102,000; 1992-1993.

"Interactions Between Elevated CO_2 and Drought Stress in Tree Seedlings "; EPA; $100,000; 1990.

"Use of D/H and $^{18}O/^{16}O$ Variations in Plant Leaf Water to Monitor Biophysical Responses to Increased Concentrations of Atmospheric CO_2"; ORNL Exploratory Funds Program; $76,000;1989.

"Tree Responses to CO_2 Enrichment in the Field "; DOE (TCP); $2,353,000; 1988-1994."Optimum Nitrogen Nutrition in Short-Rotation Sycamore Plantations "; DOE Biofuels Program; $190,000 - $325,000 per year; 1987-1992.