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September 3, 2011

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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
ORNL Corporate Fellow, 2007 - present
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

Joint Professor, Center for Interdisciplinary Research and Graduate Education, 2011-present

Adjunct Faculty, Department of Ecology & Evolutionary Biology, 1986-present
Research Associate, Graduate Program in Ecology, 1983-1985

University of Wisconsin-Madison

Research Assistant, Department of Forestry, 1978-1981
Research Assistant, Department of Botany, 1977-1978

Professional Activities

Environment Section Editor and Manager of U.S. office, *New Phytologist*, 1997-
Associate Editor, *Journal of Plant Ecology*, 2008 -
Editorial Board, *Ecological Applications*, 1998 - 2002
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 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 CO₂ 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 CO₂ 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, CO₂ and Climate Change, Washington, D.C., 1993.

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

Rapporteur, CO₂ 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 Plant Biology*; *Global Biogeochemical Cycles*; *Global Change Biology*; *Global and Planetary Change*; *International Journal of Plant Science*; *Journal of Environmental Quality*; *Nature*; *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*; *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.

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 CO₂ 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
Ecological Society of America

Awards and Honors

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
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): Colleen M Iversen (ORNL), Jeffery M. Warren
(ORNL), Aimee T. Classen (University of Tennessee), Shiqiang Wan (Chinese Academy
of Sciences), Tim J. Tschaplinski (ORNL),
PhD. Dissertation advisee: Colleen M. Iversen, University of Tennessee
PhD Committees: Katie Stuble (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

2011

Brosi GB, McCulley RL, Bush LP, Nelson JA, Classen AT, Norby RJ. 2011. Effects of multiple climate change factors on the tall fescue-fungal endophyte symbiosis: infection frequency and tissue chemistry. *New Phytologist* 189: 797-805.

Chen X, Post WM, Norby RJ, Classen AT. 2011. Modeling soil respiration and variations in source components using a multi-factor global climate change experiment. *Climatic Change* 107: 459-480.

Garten CT, Iversen CM, Norby RJ. 2011. Litterfall ¹⁵N abundance indicates declining soil nitrogen availability in a free-air CO₂-enrichment experiment. *Ecology* 92: 133-139.

Iversen CM, Hooker T, Classen AT, Norby RJ. 2011. Net mineralization of N at deeper soil depths as a potential mechanism for sustained forest production under elevated [CO₂]. *Global Change Biology* 17: 1130-1139.

Kardol P, Reynolds WN, Norby RJ, Classen AT. 2011. Climate change effects on soil microarthropod abundance and community structure. *Applied Soil Ecology* 47: 37-44.

Luo Y, Melillo JM, Niu S, Beier C, Clark J, Davidson E, Dukes J, Evans RD, Field CB, Czimczik C, Keller M, Kimball BA, Kueppers L, Norby RJ, Peline S, Pendall E, Rastetter E, Six J, Smith M, Tjoelker MG, Torn MS. 2011. Coordinated approaches to quantify long-term ecosystem dynamics in response to global change. *Global Change Biology* 17: 843-854.

Norby RJ. 2011 Carbon cycling in tropical ecosystems. *New Phytologist* 189: 893-894.

Norby RJ, Zak DR. 2011. Ecological lessons from free-air CO₂ enrichment (FACE) experiments. *Annual Review of Ecology, Evolution, and Systematics* 42: 181-203.

Warren JM, Norby RJ, Wullschleger SD. 2011. Elevated CO₂ enhances leaf senescence during extreme drought in a temperate forest. *Tree Physiology* 31:117-130.

Warren, JM, Pötzelsberger E, Wullschleger SD, Thornton PE, Hasenauer H, Norby RJ. 2011. Ecohydrological impact of reduced stomatal conductance in forests exposed to elevated CO₂. *Ecohydrology* 4: 196-210.

2010

Amthor JS, Hanson PJ, Norby RJ, Wullschleger SD. 2010. A comment on “Appropriate experimental ecosystem warming methods by ecosystem, objective, and practicality” by Aronson and McNulty”. *Agricultural and Forest Meteorology* 150: 497-498.

Castro HF, Classen AT, Austin EE, Norby RJ, Schadt CW. 2010. Precipitation regime is the major driver of changes in soil microbial community structure over CO₂ and temperature in a multifactorial climate change experiment. *Applied and Environmental Microbiology* 76: 999-

1007.

Calfapietra C, Ainsworth EA, Beier C, De Angelis P, Ellsworth DS, Godbold DL, Hendrey GR, Hickler T, Hoosbeek MR, Karnosky DF, King J, Körner C, Leakey ADB, Lewin KF, Liberloo M, Long SP, Lukac M, Matyssek R, Miglietta F, Nagy J, Norby RJ, Oren R, Percy KE, Rogers A, Scarascia Mugnozza G, Stitt M, Taylor G, Ceulemans R. 2010. Challenges in elevated CO₂ experiments on forests. *Trends in Plant Science* 15: 5-10.

Classen AT, Norby RJ, Company CE, Sides KE, Weltzin JF. 2010. Climate change alters seedling emergence and establishment in an old-field ecosystem. *PLoS ONE* 5: e13476.

Kardol P, Company CE, Souza L, Norby RJ, Weltzin JF, Classen AT. 2010. Climate change effects on plant biomass alter dominance patterns and community evenness in an experimental old-field ecosystem. *Global Change Biology* 16: 2676-2687.

Norby RJ, Warren JM, Iversen CM, Medlyn BE, McMurtrie RE. 2010. CO₂ enhancement of forest productivity constrained by limited nitrogen availability. *Proceedings of the National Academy of Sciences* 107: 19368-19373.

Souza L, Belote RT, Kardol P, Weltzin JF, Norby RJ. 2010. CO₂ enrichment increased forest understory biomass and accelerates successional development of an understory community. *Journal of Plant Ecology* 3: 33-39.

2009

Engel EC, Weltzin JF, Norby RJ, Classen AT. 2009. Responses of an old-field plant community to interacting factors of elevated [CO₂], warming, and soil moisture. *Journal of Plant Ecology* 2: 1-11.

Franklin O, McMurtrie RE, Iversen CM, Crous KY, Finzi A, Tissue D, Ellsworth D, Oren R, Norby RJ. 2009. Forest fine-root production and nitrogen use under elevated CO₂: Contrasting responses in evergreen and deciduous trees explained by a common principle. *Global Change Biology* 15: 132-144.

Garten CT Jr., Classen AT, Norby RJ. 2009. Soil moisture surpasses elevated CO₂ and temperature in importance as a control on soil carbon dynamics in a multi-factor climate change experiment. *Plant and Soil* 319: 85-94.

Norby RJ. 2009. Introduction to a virtual special issue: probing the carbon cycle with ¹³C. *New Phytologist* 184: 1-3.

Villalpando SN, Williams RS, Norby RJ. Elevated air temperature alters an old-field insect community in a multifactor climate change experiment. *Global Change Biology* 15: 930-942.

2008

Ainsworth EA, Beier C, Calfapietra C, Ceulemans R, Durand-Tarfid M, Godbold DL, Hendrey GR, Hickler T, Kaduk J, Karnosky DF, Kimball BA, Körner C, Koornneef M, Lafarge T, Leakey ADB, Lewin KF, Long SP, Manderscheid R, McNeil DL, Mies TA, Miglietta F, Morgan JA, Nagy J, Norby RJ, Norton RM, Percy KE, Rogers A, Soussana JF, Stitt M,

Weigel HJ, White JW. 2008. Next generation of elevated [CO₂] experiments with crops: A critical investment for feeding the future world. *Plant, Cell and Environment* 31: 1317-1324.

Garten CT Jr., Classen AT, Norby RJ, Brice, DJ, Weltzin JF, Souza L. 2008. Role of N₂-fixation in constructed old-field communities under different regimes of [CO₂], temperature, and water availability. *Ecosystems* 11:125-137.

Iversen CM, Ledford J, Norby RJ. 2008. CO₂ enrichment increases carbon and nitrogen input from fine roots in a deciduous forest. *New Phytologist* 179: 837-847.

Iversen CM, Norby RJ. 2008. Nitrogen limitation in a sweetgum plantation: Implications for carbon allocation and storage. *Canadian Journal of Forest Research* 38:1021-1032.

McMurtrie RE, Norby RJ, Medlyn BE, Dewar RC, Pepper DA, Reich PB, Barton CVM. 2008. Why is plant-growth response to elevated CO₂ amplified when water is limiting but reduced when nitrogen is limiting? A growth-optimisation hypothesis. *Functional Plant Biology* 35: 521-534.

Natali SM, Sanudo-Wilhelmy SA, Norby RJ, Finzi AC, Lerdau MT. 2008. Increased mercury in forest soils under elevated carbon dioxide. *Oecologia* 158: 343-354.

2007

Dermody O, Weltzin JF, Engel EC, Allen P, Norby RJ. 2007. How do elevated [CO₂], warming, and reduced precipitation interact to affect soil moisture and LAI in an old field ecosystem? *Plant and Soil* 301: 255-266.

Finzi AC, Norby RJ, Calfapietra C, Gallet-Budynek A, Gielen B, Holmes WE, Hoosbeek MR, Iversen CM, Jackson RB, Kubiske ME, Ledford J, Liberloo M, Oren R, Polle A, Pritchard S, Zak DR, Schlesinger WH, Ceulemans R. 2007. Increases in nitrogen uptake rather than nitrogen-use efficiency support higher rates of temperate forest productivity under elevated CO₂. *Proceedings of the National Academy of Sciences* 104: 14014-14019.

Hyvönen R, Ågren GI, Linder S, Persson T, Cotrufo MF, Ekblad A, Freeman M, Grelle A, Janssens IA, Jarvis PG, Kellomäki S, Lindroth A, Loustau D, Lundmark T, Norby RJ, Oren R, Pilegaard K, Ryan MG, Sigurdsson BD, Strömberg M, van Oijen M, Wallin G. 2007. The likely impact of elevated [CO₂], nitrogen deposition, increased temperature, and management on carbon sequestration in temperate and boreal forest ecosystems. A literature review. *New Phytologist* 163: 463-480.

Körner C, Morgan J, Norby R. 2007. CO₂ fertilization When, where, how much? pp. 9-21 In Canadell JG, Pataki DE, Pitelka LF (eds) 'Terrestrial Ecosystems in a Changing World', Springer, Berlin.

Monson RK, Trahan N, Rosenstiel TN, Veres P, Moore D, Wilkinson M, Norby RJ, Volder A, Tjoelker MG, Briske DD, Karnosky DF, Fall R. 2007. Isoprene emission from terrestrial ecosystems in response to global change: minding the gap between models and observations.

Philosophical Transactions of the Royal Society A: Mathematical, Physical and Engineering Sciences **365**: 1677-1695.

Norby RJ, Rustad LE, Dukes JS, Ojima DS, Parton WJ, Del Grosso SJ, McMurtrie RE, Pepper DA. 2007. Ecosystem Responses to Warming and Interacting Global Change Factors. pp. 23-36 In Canadell JG, Pataki DE, Pitelka LF (eds) 'Terrestrial Ecosystems in a Changing World', Springer, Berlin.

Norby R., Slater H. 2007. *New Phytologist* and the environment. *New Phytologist* 174: 1–3.

Wan S, Norby RJ, Ledford J, Weltzin JF. 2007. Responses of soil respiration to elevated CO₂, air warming, and changing soil water availability in an old-field grassland. 2007. *Global Change Biology* 13: 2411-2424.

2006

Norby RJ, Iversen CM. 2006. Nitrogen uptake, distribution, turnover, and efficiency of use in a CO₂-enriched sweetgum forest. *Ecology* 87:5-14.

Norby RJ, Wullschleger SD, Hanson PJ, Gunderson CA, Tschaplinski TJ, Jastrow JD. 2006. CO₂ enrichment of a deciduous forest: The Oak Ridge FACE Experiment. pp. 231-251 In: *Managed Ecosystems and CO₂: Case Studies, Processes, and Perspectives* (Nösberger J, Long SP, Norby RJ, Stitt M, Hendrey GR, Blum H, editors). *Ecological Studies*, Vol. 187. Springer, Berlin.

Nösberger J, Long SP, Norby RJ, Stitt M, Hendrey GR, Blum H (Eds.) 2006. *Managed Ecosystems and CO₂: Case Studies, Processes, and Perspectives*. *Ecological Studies*, Vol. 187. Springer, Berlin. 459 p.

2005

DeLucia EH, Moore DJ, Norby RJ. 2005. Contrasting responses of forest ecosystems to rising atmospheric CO₂: implications for the global C cycle. *Global Biogeochemical Cycles* 19: GB3006.

DeLucia EH, Moore DJ, Hamilton JG, Thomas RB, Springer CJ, Norby RJ. 2005. The changing role of forests in the global carbon cycle: responding to elevated carbon dioxide in the atmosphere. pp. 179-214 In: Lal R, Duxbury J, Steward BA Hansen DO, eds. *Climate Change and Global Food Security*, CRC Press.

Hanson PJ, Wullschleger SD, Norby RJ, Tschaplinski TJ, Gunderson CA. 2005. Importance of changing CO₂, temperature, precipitation, and ozone on carbon and water cycles of an upland oak forest: incorporating experimental results into model simulations. *Global Change Biology* 11: 1402-1423.

Jastrow JD, Miller RM, Matamala R, Norby RJ, Boutton TW, Rice CW, Owensby CE. 2005. Elevated atmospheric CO₂ increases soil carbon. *Global Change Biology* 11: 2057-2064.

Norby RJ, Joyce LA, Wullschleger SD. 2005. Modern and future forests in a changing atmosphere. pp. 394-414 In: Ehleringer JR, Cerling TE, Dearing MD, eds, A History of Atmospheric CO₂ and Its Effects on Plants, Animals, and Ecosystems. Springer, New York.

Norby RJ, DeLucia EH, Gielen B, Calfapietra C, Giardina CP, King JS, Ledford J, McCarthy HR, Moore DJP, Ceulemans R, De Angelis P, Finzi AC, Karnosky DF, Kubiske ME, Lukac M, Pregitzer KS, Scarascia-Mugnozza GE, Schlesinger WH, Oren R. 2005. Forest response to elevated CO₂ is conserved across a broad range of productivity. Proceedings of the National Academy of Sciences 102:18052-18056.

2004

Belote RT, Weltzin JF, Norby RJ. 2004. Differential invasive species responses to CO₂ enrichment in a forest understory community. New Phytologist 161: 827-835.

Harrison KG, Norby RJ, Post WM, Chapp EL. 2004. Soil C accumulation in a white oak CO₂-enrichment experiment via enhanced root production. Earth Interactions 8(14): 1-15.

Johnson DW, Cheng W, Joslin JD, Norby RJ, Edwards NT, Todd DE Jr. 2004. Effects of elevated CO₂ on nutrient cycling in a sweetgum plantation. Biogeochemistry 69:379-403.

King JS, Hanson PJ, Bernhardt E, DeAngelis P, Norby RJ, Pregitzer KS. 2004. A multi-year synthesis of soil respiration responses to elevated atmospheric CO₂ from four forest FACE experiments. Global Change Biology 10: 1027-1042.

Matamala R, González-Meler MA, Jastrow JD, Norby RJ, Schlesinger WH. 2004. Response to comment on "Impacts of fine root turnover on forest NPP and soil C sequestration potential". Science 304: 1745d.

Norby RJ. 2004. Forest responses to a future CO₂-enriched atmosphere. pp. 158-159 In: W. Steffen et al. (eds.) Global Change and the Earth System: A Planet Under Pressure. Springer, Berlin.

Norby RJ, Luo Y. 2004. Evaluating ecosystem responses to rising atmospheric CO₂ and global warming in a multi-factor world. New Phytologist 162:281-294.

Norby RJ, Ledford J, Reilly CD, Miller NE, O'Neill EG. 2004. Fine-root production dominates response of a deciduous forest to atmospheric CO₂ enrichment. Proceedings of the National Academy of Sciences 101: 9689-9693.

Sholtis JD, Gunderson CA, Norby RJ, Tissue DT. 2004. Persistent stimulation of photosynthesis by elevated CO₂ in a sweetgum (*Liquidambar styraciflua* L.) forest stand. New Phytologist 162: 343-354.

Wan S, Norby RJ, Pregitzer KS, Ledford J, O'Neill EG. 2004. CO₂ enrichment and warming of the atmosphere enhance both productivity and mortality of maple tree fine roots. New Phytologist 162: 437-446.

2003

BassiriRad H, Constable JVH, Lussenhop J, Kimball BA, Norby RJ, Oechel WC, Reich PB, Schlesinger WH, Zitzer S, Sehtiya HL, Silim S. 2003 Widespread foliage $\delta^{15}\text{N}$ depletion under elevated CO_2 : inferences for the nitrogen cycle. *Global Change Biology* 9: 1582-1590.

George K, Norby RJ, Hamilton JG, DeLucia EH. 2003. Fine-root respiration in a loblolly pine and sweetgum forest growing in elevated CO_2 . *New Phytologist* 160: 511-522.

Marland G, Pielke RA Sr. , Apps M, Avissar R, Betts RA, Davis KJ, Frumhoff PC, Jackson ST, Joyce LA, Kauppi P, Katzenberger J, MacDicken KG, Neilson RP, Niles JO, Niyogi DS, Norby RJ, Pena N, Sampson N, Xue Y. 2003. The climatic impacts of land surface change and carbon management, and the implications for climate-change mitigation policy. *Climate Policy* 3:149-157.

Matamala R, González-Meler MA, Jastrow JD, Norby RJ, Schlesinger WH. 2003. Impacts of fine root turnover on forest NPP and soil C sequestration potential. *Science* 302: 1385-1387.

Norby RJ, Sholtis JD, Gunderson CA, Jawdy SS. 2003. Leaf dynamics of a deciduous forest canopy: no response to elevated CO_2 . *Oecologia* 136:574-584.

Norby RJ, Hartz-Rubin J, Verbrugge MJ. 2003. Phenological responses in maple to experimental atmospheric warming and CO_2 enrichment. *Global Change Biology* 9: 1792-1801.

Sinsabaugh, RL, Saiya-Cork K, Long T, Osgood MP, Neher DA, Zak DR, Norby RJ. 2003. Soil microbial activity in a *Liquidambar* plantation unresponsive to CO_2 -driven increases in primary productivity. *Applied Soil Ecology* 24: 263-271.

Williams RS, Lincoln DE, Norby RJ. 2003. Development of gypsy moth larvae feeding on red maple saplings at elevated CO_2 and temperature. *Oecologia* 137:114-122.

Zak DR, Holmes WE, Finzi AC, Norby RJ, and Schlesinger WH. 2003. Soil nitrogen cycling under elevated CO_2 : A synthesis of forest FACE experiments. *Ecological Applications* 13: 1508-1514.

2002

Edwards NT, Tschaplinski TJ, Norby RJ. 2002. Stem respiration increases in CO_2 -enriched trees. *New Phytologist* 155: 239-248.

Gunderson CA, Sholtis JD, Wullschleger SD, Tissue DT, Hanson PJ, Norby RJ. 2002. Environmental and stomatal control of photosynthetic enhancement in the canopy of a sweetgum (*Liquidambar styraciflua* L.) plantation during three years of CO_2 enrichment. *Plant, Cell and Environment* 25: 379-393.

Norby RJ, Hanson PJ, O'Neill EG, Tschaplinski TJ, Weltzin JF, Hansen RT, Cheng W, Wullschleger SD, Gunderson CA, Edwards NT, Johnson DW. 2002. Net primary productivity of a CO_2 -enriched deciduous forest and the implications for carbon storage. *Ecological Applications* 12:1261-1266

Rustad LE, Norby RJ. 2002. Temperature Increase: Effects on Terrestrial Ecosystems. pp. 575-581, In: H. A. Mooney and J. G. Canadell (eds.), The Earth System: Biological and Ecological Dimensions of Global Environmental Change. Vol. 2 in Encyclopedia of Global Environmental Change. John Wiley and Sons, Chichester.

Wullschleger SD, Gunderson CA, Hanson PJ, Wilson KB, Norby RJ. 2002. Sensitivity of stomatal and canopy conductance to elevated CO₂ concentration BB interacting variables and perspectives of scale. *New Phytologist* 153: 485-496.

Wullschleger SD, Tschaplinski TJ, Norby RJ. 2002. Plant water relations at elevated CO₂ B implications for water-limited environments. *Plant, Cell and Environment* 25: 319-331

2001

Johnson, D. W., R. J. Norby, and B.A. Hungate. 2001. Effects of elevated CO₂ on nutrient cycling in forests. pp. 237-252 In: D. F. Karnosky, R. Ceulemans, G. E. Scarascia-Mugnozza, and J. L. Innes (eds.), The Impact of Carbon Dioxide and Other Greenhouse Gases on Forest Ecosystems. CABI, Wallingford, UK.

Karnosky, D. F., Gielen, B., Ceulemans, R., Schlesinger, W. H., Norby, R. J., Oksanen, E., Matussek, R. and Hendrey G. R. 2001. FACE systems for studying the impacts of greenhouse gases on forest ecosystems. pp. 297-324 In: D. F. Karnosky, R. Ceulemans, G. E. Scarascia-Mugnozza, and J. L. Innes (eds.), The Impact of Carbon Dioxide and Other Greenhouse Gases on Forest Ecosystems. CABI, Wallingford, UK

Norby, R. J., K. Ogle, P. S. Curtis, F.-W. Badeck, A. Huth, G. C. Hurtt, T. Kohyama, and J. Peñuelas. 2001. Aboveground growth and competition in forest gap models: An analysis for studies of climatic change. *Climatic Change* 51: 415-447.

Norby, R. J., D. E. Todd, J. Fults, and D. W. Johnson. 2001. Allometric determination of tree growth in a CO₂-enriched sweetgum stand. *New Phytologist* 150: 477-487.

Norby, R. J., K. Kobayashi, and B. A. Kimball. 2001. Rising CO₂ - future ecosystems. *New Phytologist* 150: 215-221.

Norby, R. J., M. F. Cotrufo, P. Ineson, E. G. O'Neill, and J. G. Canadell. 2001. Elevated CO₂, litter quality, and decomposition: A synthesis. *Oecologia* 127: 153-165.

Rustad L. E., Campbell J. L., Marion G. M., Norby R. J., Mitchell M. J., Hartley A. E., Cornelissen J. H. C., Gurevitch J., and GCTE-NEWS. 2001. A meta-analysis of the response of soil respiration, net nitrogen mineralization, and aboveground plant growth to experimental ecosystem warming. *Oecologia* 126:543B562.

Wullschleger S. D. and R. J. Norby. 2001. Sap velocity and canopy transpiration for a 12-year-old sweetgum stand exposed to free-air CO₂ enrichment. *New Phytologist* 150: 489-498.

2000

- Canadell, J., Norby, R. J., Cotrufo, M. F., and Nösberger, J., editors. 2000. Litter Quality and Decomposition Under Elevated Atmospheric CO₂. Plant and Soil, vol. 224.
- Carter, G. A., R. Bahadur, and R. J. Norby. 2000. Effects of elevated atmospheric CO₂ and temperature on leaf optical properties in *Acer saccharum*. Environmental and Experimental Botany 43: 267-273.
- Gunderson, C. A., R. J. Norby, R. J., and S. D. Wullschleger. 2000. Acclimation of photosynthesis and respiration to simulated climatic warming in northern and southern populations of *Acer saccharum*: laboratory and field evidence. Tree Physiology 20: 87-96.
- Gunter, L. E., G. A. Tuskan, C. A. Gunderson, and R. J. Norby. 2000. Genetic variation and spatial structure in sugar maple (*Acer saccharum* Marsh.) and implications for predicted global-scale environmental change. Global Change Biology 6: 335-344.
- Norby, R.J. 2000. Atmospheric CO₂ and ecosystem feedback between carbon and nitrogen cycles: synthesis of an integrated experiment. Ecological Applications 10:1-2.
- Norby, R. J. and R. B. Jackson. 2000. Root dynamics and global change: seeking an ecosystem perspective. New Phytologist 147: 3-12.
- Norby, R. J., R. B. Jackson, and A. H. Fitter, editors. 2000. Root Dynamics and Global Change: An Ecosystem Perspective. New Phytologist Trust, Cambridge.
- Norby R.J., T. M. Long, J. S. Hartz-Rubin, and E. G. O'Neill. 2000. Nitrogen resorption in senescing tree leaves in a warmer, CO₂-enriched atmosphere. Plant and Soil 224: 15-29.
- Williams, R. S., R. J. Norby, and D. E. Lincoln. 2000. Effects of elevated CO₂ and temperature-grown red and sugar maple on gypsy moth performance. Global Change Biology 6: 685-695.

1999

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Invited(*) and contributed talks since 2005

*"Forest responses to elevated atmospheric CO₂: 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 CO₂, University of Sydney, Sydney, Australia, August, 2011.
 - *"Forest responses to elevated CO₂: 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" CO₂ Symposium, Smithsonian Tropical Research Institute, Panama City, Panama, March 2011.
 - "Leaf and nitrogen distribution in sweetgum canopies after 12 years of CO₂ 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 York, UK, March 2010
 - *"Where did the carbon go? The 12-year saga of the Oak Ridge FACE experiment" University of Sheffield, UK, May 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 CO₂ in a Deciduous Forest. Annual meeting, American Geophysical Union, San Francisco, CA, December 2008.
 - "Ten-year record of forest response to elevated CO₂ provides evidence for declining NPP and growth". Ecological Society of America annual meeting Milwaukee, WI, August, 2008
 - *"CO₂ fertilization and the global carbon cycle" DOE Global Change Education Program annual meeting, Knoxville, TN, June 2008
 - *Will CO₂ 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 CO₂ Experiments in Terrestrial Ecosystems. Washington, DC, April 2008.
 - *Will CO₂ 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 CO₂ fertilization counteract global warming?" Nature Conservancy Climate Change Science Conference, Portland OR, Sept. 2007
 - *"Will CO₂ 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 CO₂". Chinese Academy of Sciences and Peking University, Beijing, China, September 2005

*"Forests in a CO₂-rich world: Old questions, new challenges". Keynote address, International Botanical Congress, Vienna, Austria, July 2005

Funded Proposals (as Principal Investigator)

"Partitioning in Trees and Soil"; DOE; \$775,000, 2010-2012.

"Benchmarking Ecosystem Response Models with Experimental Data from Long-term CO₂ Enrichment Experiments"; NCEAS; \$84,450, 2008-2010.

"Free-Air CO₂ 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 CO₂ Exposure Facility in a Deciduous Forest "; ORNL Director's R&D Fund; \$760,000; 1996-1997.

"Temperature and CO₂ 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 CO₂ and Drought Stress in Tree Seedlings "; EPA; \$100,000; 1990.

"Use of D/H and ¹⁸O/¹⁶O Variations in Plant Leaf Water to Monitor Biophysical Responses to Increased Concentrations of Atmospheric CO₂"; ORNL Exploratory Funds Program; \$76,000; 1989.

"Tree Responses to CO₂ 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.