PINEMAP Year 4 Progress Report 2

April 2015
Aim 1 (Silviculture & Ecophysiology)

This is the final Aim progress report for year 4 (March 1, 2014-February 28, 2015). The information provided in these reports is used to track Aim-level outputs and outcomes over the course of the project and to fulfill NIFA reporting requirements via the annual continuation proposals and REEport progress report.

The purpose of this report is to gather information on progress since the previous progress report in September 2014.

To streamline this process, information reported in September 2014 is provided below, so you will simply need to review and update each section as necessary.

Please return the completed report to Grace no later than April 10.

OUTCOMES/IMPACTS

Outcomes and ***Impacts*** are tangible results for stakeholders and society that the project has produced to advance on the societal challenge (e.g., ***changes in knowledge, actions, or conditions*** that result from project activities). Outcomes and impacts are similar, but impacts are typically longer-term; outcomes are used as a nearer-term proxy for impacts.

Describe how Aim-level activities, results, findings, techniques, or products contribute to project-level outcomes and impacts (e.g., changes in knowledge, actions, or conditions resulting from activities).

A narrative has been drafted below. Please modify or update as necessary.

Aim 1 activities contribute to project-level outcomes and impacts primarily through the establishment and measurement of carbon and nutrient pools and fluxes on a three-tiered monitoring network. The data generated from this network will quantify the climatic, soils, and

management impacts on carbon sequestration in planted pine ecosystems and provide data necessary for the Aim 2 team to build and verify stand- to regional-level models that simulate pine forest dynamics under varying climate. These data and simulations will form the core of the PINEMAP Decision Support System which will provide landowners and managers the tools necessary to make decisions about managing planted pine for increased carbon sequestration, enhanced fertilizer efficiency, and resilience to altered disturbance regimes.

OUTPUTS

Outputs are activities, events, services, and products that reach people.

Products

Products include published or in press peer-reviewed publications; other written materials such as white papers, research summaries, fact sheets, or popular press articles; audio or video products; etc.

The lists below summarize year 4 (March 1, 2014-February 28, 2015) products reported in the September 2014 Progress Report. Please update as necessary and highlight in yellow any new products added to the list for the April 2015 Progress Report.

Peer-reviewed publications

Albaugh, T.J., L.C. Kiser, T.R. Fox, H.L. Allen, R.A. Rafael, and J. L. Stape. 2014. Ecosystem nutrient retention after fertilization of Pinus taeda. Forest Science. http://dx.doi.org/ 10.5489/forsci.13-159.

Domec, J-C, Ward EJ, Oishi AC, Palmroth S, Radecki A, Bell DM, Miao G, Gavazzi M, Johnson DM, King JS, McNulty SG, Oren R, Sun G, Noormets A (2015) Conversion of natural forests to managed forest plantations impacts tree response to climatic variable and affects negatively tree resistance to prolonged droughts. *Forest Ecology and Management*: In press

Elliot, J.R. and T.R. Fox. 2014. Ammonia volatilization following fertilization with urea or ureaform in a thinned loblolly pine plantation. Soil Science Society of America Journal.
78:1469-1473.

Gonzalez-Benecke, C.A., E.J. Jokela, W.P. Cropper, Jr., R.G. Bracho, and D.J. Leduc. 2014. Parameterization of the 3-PG model for *Pinus elliottii* stands using alternative methods to estimate fertility rating, biomass partitioning and canopy closure. *Forest Ecology and Management* 327:55-75.

Gonzalez-Benecke, C.A., S.A. Gezan, T.J. Albaugh, H.L. Allen, H.E. Burkhart, T.R. Fox, E.J. Jokela, C.A. Maier, T.A. Martin, R.A. Rubilar, and L.J. Samuelson. 2014. Local and general above-stump biomass functions for loblolly and slash pine trees. *Forest Ecology and Management*, 334:254-276.

Heim, B, J.R. Seiler and B.D. Strahm. 2015. Root Non-Structural Carbohydrates and their Relationship with Autotrophic Respiration of Loblolly Pine (Pinus taeda L.). Communications in Soil Science and Plant Analysis. 46:7, 904-912, DOI:10.1080/00103624.2015.1011752

Noormets A, Epron D, Domec JC, McNulty SG, Fox TD, Sun G, King JS (2015) Effects of forest management on productivity and carbon sequestration: a review. *Forest Ecology and Management*: In review

Raymond, J., T. Fox and B. Strahm. 2014. Can enhanced efficiency fertilizers affect the fate of nitrogen in loblolly pine plantations. *Better Crops*. 98(2):4-6.

Sabatia, C.O., and H.E. Burkhart. 2014. Predicting site index of plantation loblolly pine from biophysical variables. *Forest Ecology and Management* 326: 142-156. http://dx.doi.org/10/1016.j.foreco.2014.04.019

Samuelson, L.J., C.J. Pell, T.A. Stokes, S. Bartkowiak, M. Akers, M. Kane, M. McGuire, D. Markewitz, and R.O. Teskey. 2014. Two-year throughfall and fertilization effects on leaf physiology and growth of loblolly pine in the Georgia Piedmont. *Forest Ecology and Management* 330:29-37. http://dx.doi.org/10.1016/j.foreco.2014.06.030

Templeton, B.S., J.R. Seiler, J.A. Peterson, M. Tyree. 2015. Environmental and stand management Influences on Soil CO_2 Efflux across the Range of Loblolly Pine. For. Ecol and Manag. doi:10.1016/j.foreco.2015.01.031

Ward EJ, Domec JC, Laviner MA, Fox TD, Sun G, McNulty SG, King JS, Noormets A (2015) Fertilization simulates drought. Water use and stomatal conductance of loblolly pine (*Pinus taeda*) in a factorial fertilization and throughfall reduction experiment. *Forest Ecology and Management*: In press

Watt, M. R. Rubilar, M. Kimberley, D. Kriticos, V. Emhart, O. Mardones, M. Acevedo, M. Pincheira, J. Stape, T.Fox. 2014. Using season measurements to inform ecophysiology: Extracting cardinal growth temperatures for process based growth models of five eucalyptus species/crosses from simple field trials. *New Zealand Journal of Forestry Science* 44:9. http://www.nzjforestryscience.com/contents/44/1/9

Zhai, L., Jokela E.J., Gezan S., and Vogel J.G. 2015. Family, Environment and Silviculture Effects in Pure- and Mixed-Family Stands of Loblolly (Pinus taeda L.) and Slash (P. elliottii Engelm var. ellitotttii) Pine. *Forest Ecology and Management*

Zhao, D., M. Kane, R. Teskey, D. Markewitz, D. Greene, B. Borders. 2014. Impact of management on nutrients, carbon, and energy in aboveground biomass components of mid-rotation loblolly pine (*Pinus taeda* L.) plantations. *Annals of Forest Science*. 71: 843-851. http://dx.doi.org/10.1007/s13595-014-0384-2.

Theses/Dissertations

Bartkowiak, S.M. 2015. Fertilization effects on water use of 8-year-old loblolly pine (*Pinus taeda* L.) vary with throughfall treatment. M.S. Thesis, Auburn University, Auburn, AL. (Samuelson)

Clark, Z.S. 2014. Non-planted vegetation attributes and developmental patterns in loblolly pine plantations under varying cultural intensity and stand density. M.S. Thesis, The University of Georgia, Athens, GA. (Kane)

Wightman, M. 2014. The impact of fertilization and throughfall reduction on Pinus taeda water relations and growth. M.S. Thesis, University of Florida, Gainesville, FL. (Martin)

Wilson, E. 2014. The drought response of physiological and structural traits in loblolly pine (*P. taeda* L.) clones with a focus on mesophyll conductance to CO_2. M.S. Thesis, Texas A&M University, College Station, TX. (West and Vogel)

Other publications

None reported in Sept 2014 report (April 2014- Sept 2014)

Maggard, A., Boby, L., Megalos, M. 2014. Southern Pine Plantations Store Carbon: Insights for Forest Landowners. SREF Publication Series. SREF-FM-0019.

Audio/video products

None reported in Sept 2014 report (April 2014- Sept 2014)

Events/Activities

Events/activities include presentations (oral and poster) given at meetings or conferences; workshops/trainings/courses conducted; and experiments/surveys/data collection conducted.

The table(s) below summarizes year 4 (March 1, 2014-February 28, 2015) events/activities reported in the September 2014 Progress Report.

Please update as necessary and highlight in yellow items added to the list for the April 2015 Progress Report.

Presentations

Author(s)/Presenter(s)	Title	Type	Date	Venue/Location
Akers, M.K.	PINEMAP Update: PMRC 2014 Annual Meeting	Presentation (Meeting)	July 17, 2014	2014 PMRC Annual Advisory Committee Meeting, Athens, GA
Ausmus, C.J., A.O. Maggard, R.E. Will, D.S. Wilson, T.C. Hennessey, and C.R. Meek	Response of soil CO_2 efflux in a mid-rotation loblolly pine (Pinus taeda L.) exposed to extreme drought conditions	Poster Presentation	May 14-16, 2014	PINEMAP Annual Meeting, Athens, GA
Ausmus, C., A. Maggard, C. Meek, R. Will, D. Wilson, and T. Hennessey	Response of soil CO_2 efflux in a mid-rotation loblolly pine (Pinus taeda L.) exposed to extreme drought conditions	Poster Presentation	October 8-11, 2014	Society of American Foresters Annual Meeting, Salt Lake City, UT
Bartkowiak SM, Samuelson LJ	Potential impacts of climate change on transpiration and hydraulic properties of 7-year-old loblolly pine.	Poster Presentation	August 5-9, 2013	98th Ecological Society of America Meeting
Bartkowiak SM, Samuelson LJ	Interactive Effects of Throughfall Exclusion and Nutrient Availability on Sap Flux and Hydraulic Properties of 7-Year-Old Loblolly Pine	Poster Presentation	May 14-16, 2014	PINEMAP Annual Meeting, Athens, GA
Bartkowiak SM, Samuelson LJ	Impacts of reduced precipitation and nutrient availability on loblolly pine	Oral Presentation	October 8-11, 2014	2014 SAF National Convention, Salt Lake City, UT
Bartkowiak SM, Samuelson LJ, Akers M, McGuire MA, Teskey RO	The Impact of Fertilization on Canopy-Level Processes of 9-Year-Old Loblolly Pine Varies With Throughfall Treatment	Poster Presentation	March 3-5, 2015	18th Biennial Southern Silvicultural Research Conference, Knoxville, TN
Clark, Z., M. Kane, D. Zhao, D. Markewitz, and M. Akers	Effects of stand density, management intensity, and site preparation technique on non-planted vegetation growth and developmental patterns in loblolly pine plantations	Poster Presentation	May 14-16, 2014	PINEMAP Annual Meeting, Athens, GA
Domec JC, Noormets A, Stout	Aquaporin-mediated reduction in root hydraulic conductivity	poster	May 6-7, 2014	DOE TES/SBR PI meeting, Potomac, MD

A, King JS, Radecki A, Sun G, McNulty SG, Miao G, Zietlow DR, Ward EJ.	impacts whole stand water use and carbon assimilation: Scaling and modeling the effect of sea level rise from roots to the ecosystem.	presentation		
Domec JC, Noormets A, Stout A, King JS, Radecki A, Sun G, McNulty SG, Miao G, Zietlow DR, Ward EJ	Aquaporin-mediated reduction in root hydraulic conductivity impacts whole stand water use and carbon assimilation: Scaling and modeling the effect of sea level rise from roots to the ecosystem.	oral presentation	April 7-10, 2014	International Symposium: Evapotranspiration: Challenges in Measurement and Modeling from Leaf to the Landscape Scale and Beyond. ASABE, Raleigh, NC
Domec JC, Ward E (presenter), Noormets A, Stout A, King JS, Sun G, McNulty SG, Miao G, Zietlow DR, Palmorth S.	Conversion of natural forests to managed forests and its effect on water balance,transpiration and resistance to drought across different scales	Oral presentation	March 4, 2015	18th Biennial Southern Silvicultural Research Conference, Knoxville, TN.
Gonzalez-Benecke, C.A.	Physiological processes predicting growth for slash pine	oral presentation	September 17-18	17th annual meeting Forest Biology Research Cooperative, Perry, Florida
Gonzalez-Benecke, C.A.	Predicting climate change impacts on slash pine productivity in SE United States using physiological process based model 3-PG	oral presentation	July 28-30, 2014	3rd International Conference on Earth Science & Climate Change, San Francisco, California
Gonzalez-Benecke, C.A.	Parameterization of 3-PG model for slash pine trees: Assessing climate change effects on stand dynamics and productivity	oral presentation	October 5-11, 2014	24th IUFRO World Congress, October 5-11, Salt Lake City, Utah
Gonzalez-Benecke, C.A. S.A. Gezan, T.J. Albaugh, H.L. Allen, H.E. Burkhart, T.R. Fox, E.J. Jokela, C.A. Maier, T.A. Martin, R.A. Rubilar, and L.J. Samuelson	Local and general biomass functions for loblolly and slash pine trees	Poster	October 5-11, 2014	24th IUFRO World Congress, October 5-11, Salt Lake City, Utah
Laviner, A. and T.R. Fox	Litter Decomposition and Nitrogen Fluxes Following Fertilization and Rainfall Exclusion Treatments	Poster Presentation	May 14-16, 2014	PINEMAP Annual Meeting, Athens, GA
Laviner, A. and T.R. Fox	Litter Decomposition Following Fertilization and Throughfall Exclusion Treatments in Loblolly Pine	Poster Presentation	November 2-5, 2014	Soil Science Society of America Annual Meetings, Long Beach, CA
Laviner, A. and T.R. Fox	Six Month Litter Decomposition Following Fertilization and Throughfall Exclusion Treatments in Loblolly Pine	Poster Presentation	March 2-5, 2015	18th Biennial Southern Silvicultural Research Conference, Knoxville, TN
Lin, W., A. Noormets, J.C. Domec, J. King, G. Sun, and S. McNulty	Isotopic estimates of water use efficiency: a high-throughput a-cellulose extraction method for softwood and its application	Poster Presentation	May 14-16, 2014	PINEMAP Annual Meeting, Athens, GA
Lin, W., A. Noormets, J.C. Domec, J. King, G. Sun, and S. McNulty	Seasonality of soil respiration partitioning coefficient at different Tier II sites	Poster Presentation	May 14-16, 2014	PINEMAP Annual Meeting, Athens, GA
Maggard, A.O., R.E. Will, C.R. Meek, C. Ausmus, and	Physiological mechanisms related to drought mortality of mid-rotation loblolly pine (*Pinus taeda* L.)	Poster Presentation	May 14-16, 2014	PINEMAP Annual Meeting, Athens, GA

D.S. Wilson				
Maggard, A.O., R.E. Will, C.R. Meek, C. Ausmus, and D.S. Wilson	Physiological mechanisms related to drought mortality of mid-rotation loblolly pine (*Pinus taeda* L.)	Poster Presentation	October 8-11, 2014	Society of American Foresters Annual Meeting, Salt Lake City, UT
Maggard, A.O. and R.E. Will	Tier III. Methods and findings for the PINEMAP Oklahoma Site	Oral Presentation	November 14, 2014	Southeastern Forest and Climate Change Workshop, Little Rock, AR
Maggard, A.O.	The effects of decreased water availability on loblolly pine (*Pinus taeda* L.) productivity and the interaction between fertilizer and drought	Oral Presentation	March 4, 2015	18th Biennial Southern Silvicultural Research Conference, Knoxville, TN
Maier, C.A., D. McInnis, and K.H. Johnsen	Partitioning root and heterotrophic respiration from soil CO_2 efflux in two loblolly pine clones that differ in growth efficiency and carbon allocation	Poster Presentation	May 14-16, 2014	PINEMAP Annual Meeting, Athens, GA
Markewitz, D.	Droughts experiments in the Amazon and USA Southeast.	Presentation	June 4, 2014	Universidade Federal Rural de Amazonas and Embrapa Amazonia Oriental, Belem, Brazil.
Martin, T.A.	PINEMAP Outcome Themes: CO_2 mitigation through productivity and resilience	Presentation	May 14, 2014	PINEMAP Annual Meeting, Athens, GA
McElligott, K.M., J.R. Seiler, and B.D. Strahm	Fertilization and Throughfall Reduction Effects on Soil Respiration as Mediated by Extracellular Enzyme Activity and Litter Decomposition	Poster Presentation	May 14-16, 2014	PINEMAP Annual Meeting, Athens, GA
McElligott, K.M., B.D. Strahm, and J.R. Seiler	Fertilization and Throughfall Reduction Effects on Soil CO_2 Efflux and Litter Decomposition as Mediated by Extracellular Enzyme Activity	Poster Presentation	November 2-5, 2014	Soil Science Society of America Annual Meetings, Long Beach, CA
McElligott, K., B. Strahm, and J. Seiler	Fertilization and Throughfall Reduction Effects on Soil CO_2 Efflux and Controls of Decomposition	Oral Presentation	March 2-5, 2015	18th Biennial Southern Silvicultural Research Conference, Knoxville, TN
Meek, C.R., R.E. Will, D.S. Wilson, and J. Vogel	Fertilization decreases soil CO_2 efflux of mid-rotation loblolly pine (*Pinus taeda* L.) stands in southeastern Oklahoma	Poster Presentation	May 14-16, 2014	PINEMAP Annual Meeting, Athens, GA
Meek, C.R., R.E. Will, D.S. Wilson, and J. Vogel	Fertilization decreases soil CO_2 efflux of mid-rotation loblolly pine (*Pinus taeda* L.) stands in southeastern Oklahoma	Poster Presentation	October 8-11, 2014	Society of American Foresters Annual Meeting, Salt Lake City, UT
Noormets A	Carbon and water cycling in loblolly pine. (Field tour for Southern University Global Sustainability Initiative's summer interns. Instructor: E. Reyes from ECU.)	Field tour	July 24, 2014	US-NC2 research site at Parker Tract, Washington County, NC
Noormets A, Gavazzi M, Domec JC, Sun G, Zietlow DR	Field trip to Parker Tract Eddy Flux Water and Carbon Flux Study. (part of: International Symposium: Evapotranspiration: Challenges in Measurement and Modeling from Leaf to the Landscape Scale and Beyond, ASABE, Raleigh, NC.	Field trip	April 10, 2014	US-NC2 research site at Parker Tract, Washington County, NC

Noormets A, Epron D, Domec JC, McNulty SG, Fox TD, Sun G, King JS.	Trade-off between forest productivity and carbon sequestration in soil		March 3-4, 2015	18th Biennial Southern Silvicultural research Conference. Knoxville, TN
Noormets A, Epron D, Domec JC, McNulty SG, Fox TD, Sun G, King JS	Effects of forest management on productivity and carbon sequestration: a review		Jan 26-30, 2015	NACP and AmeriFlux Joint Meeting. Washington D.C
Pell, C.J. and L.J. Samuelson	Long-term interactive effects of throughfall exclusion and fertilization on physiology of loblolly pine (*Pinus taeda* L.)	Poster Presentation	May 14-16, 2014	PINEMAP Annual Meeting, Athens, GA
Pell, C.J. and L.J. Samuelson	Long-term Effects of Throughfall Reduction and Fertilization on Leaf Physiology of Loblolly Pine	Poster Presentation	October 8-11, 2014	2014 SAF National Convention, Salt Lake City, UT
Pell, C.J., L.J. Samuelson, M.K. Akers, M. Kane, M. McGuire, R.O. Teskey	Effects of Fertilization and Three Years of Throughfall Reduction on Leaf Physiology of Loblolly Pine	Oral Presentation	March 3-4, 2015	18th Biennial Southern Silvicultural research Conference. Knoxville, TN
Qi, J. and D. Markewitz.	Drier Summers: Effects on Deep Soil Carbon and Hydrology	Poster Presentation	November 3-6, 2013	Soil Science Society of America Annual Meeting Tampa, FL
Qi, J. and D. Markewitz.	Drier Summers: Effects on Deep Soil Carbon and Hydrology	Poster Presentation	February 24-25, 2014	Soil Science Society of Georgia Annual Meeting, Athens, GA
Qi, J. and D. Markewitz.	Drier Summers: Effects on Deep Soil Carbon and Hydrology	Poster Presentation	February 19-21, 2014	Symposium of Warnell School of Forestry and Natural Resources, UGA
Qi, J. and D. Markewitz.	Drier Summers: Effects on Deep Soil Carbon	Poster Presentation	July 16-17, 2014	PMRC Annual Meeting Athens, GA
Qi, J. and D. Markewitz	Effect of Wetting/Drying Cycles on Deep Soil Carbon in a Southeastern US Loblolly Pine Plantation	Poster Presentation	May 14-16, 2014	PINEMAP Annual Meeting, Athens, GA
Qi, J. and D. Markewitz.	Drier Summers: Effects on Deep Soil Carbon	Poster Presentation	October 8-11, 2014	2014 SAF National Convention, IUFRO World Congress, Salt Lake City, UT
Subedi, S. and T.R. Fox	Baseline Fertility Rating Assessment in the 3-PG Model for Loblolly Pine Plantations Across the Southeastern United States	Poster Presentation	May 14-16, 2014	PINEMAP Annual Meeting, Athens, GA
Strahm, B., J. Seiler, B. Heim, R. Will, C. Ausmus, J. Vogel, G. Lokuta, and E. Jokela	Partitioning Soil Respiration to Quantify Net Ecosystem Productivity: A Regional Analysis of Fertilization and Drought in Loblolly Pine.	Oral Presentation	November 2-5, 2014	Soil Science Society of America International Annual Meeting, Long Beach, CA
Teskey, R.	Scenarios for PINEMAP Simulations	Presentation	May 14, 2014	PINEMAP Annual Meeting, Athens, GA
Vogel, J.G.	Bringing it together: *How to Think About* the timing and application of technologies to optimize pine productivity	Presentation	Dec 12, 2014	Western Gulf Silvicultural Technology Exchange, Louisiana Technological University, Shreveport, LA.
Vogel, J.G., Markewitz D., Amateis R., Laviner M., Jokela E.J., Grunwald S., Sun G., Noormets A., Akers M.,	The Carbon Measurement Protocol of the Pine Integrated Network: Education, Mitigation, and Adaptation Project	Poster presentation	October 10, 2014	014 SAF National Convention, IUFRO World Congress, Salt Lake City, UT

Strahm B., Bacon A., Fox T., Gonzalez-Benecke C., Kane M., West J., Meek C., Will R., Wilson D., Samuelson L.				
Ward E.J., Domec JC, Sun G, McNulty SG, King JS, Noormets A.	Transpiration and Canopy Conductance of Loblolly Pine with Fertilization and Throughfall Exclusion: Early Results from PINEMAP.	oral presentation	April 7, 2014	International Symposium: Evapotranspiration: Challenges in Measurement and Modeling from Leaf to the Landscape Scale and Beyond. ASABE, Raleigh, NC
Ward, E.J.	Cross-site Integration of Sap Flux Data.	Oral Presentation	May 15 2014	PINEMAP Annual Meeting, Athens, GA
Ward, E.J. JC Domec, MA Laviner, TR Fox, S McNulty, G Sun, JS King, DM Bell, and A Noormets	Imagining Future Forests: What models can Learn from Field Data	Poster Presentation	Dec 18 2015	American Geophysical Union Fall Meeting, San Francisc,o CA
Ward, E.J. JC Domec, MA Laviner, TR Fox, S McNulty, G Sun, JS King, A Noormets	Transpiration and Canopy Conductance of Loblolly Pine with Fertilization and Throughfall Exclusion: Early Results from PINEMAP.	Oral presentation	March 4, 2015	18th Biennial Silvicultural Research Conference, Knoxville, TN
Will, R.E., Meek, C., Maggard, A.	Field tour of Oklahoma PINEMAP Tier III site	Field Tour	January 27, 2015	Four state SAF meeting, Texarkana, TX
Wightman, M., T. Martin, and C. Gonzalez-Benecke	The Impact of Fertilization and Throughfall Exclusion on loblolly pine (*Pinus taeda*) Growth and Water Use	Poster Presentation	May 14-16, 2014	PINEMAP Annual Meeting, Athens, GA
Wilson, E., Vogel J.G. and J.B. West.	The effects of water stress on variability in mesophyll conductance of loblolly pine (*Pinus taeda* L.) leaves	Poster Presentation	August 9th, 2013	Ecological Society of America Meeting
Wilson, E., Vogel J.G. and J.B. West	Variability of mesophyll conductance to CO_2 and coordination of physiological traits in loblolly pine (*P. taeda*, L.)	Oral Presentation	May 22nd, 2014	Ecological Integration Symposium, College Station, TX
Wilson, E.S., J.B. West, J.G. Vogel, A. Volder, M. Wigley, and J.C. Domec	The drought response of physiological and structural traits in loblolly pine (*P. taeda* L.) clones with a focus on mesophyll conductance to CO_2	Poster Presentation	May 14-16, 2014	PINEMAP Annual Meeting, Athens, GA
Yang, J., C.M. Luedtke, M.K. Akers, M. McGuire, and R.O. Teskey	Effects of throughfall exclusion and fertilization on soil CO_2 efflux in a loblolly pine (*Pinus taeda*) plantation	Poster Presentation	May 14-16, 2014	PINEMAP Annual Meeting, Athens, GA
Yang, J., C.M. Luedtke, M.K. Akers, M. McGuire, Doug P. Aubrey and R.O. Teskey	Effects of throughfall exclusion and fertilization on soil CO_2 efflux and its components in a loblolly pine (*Pinus taeda*) plantation	oral presentation	Aug 10-15, 2014	99th Ecological Society of America Meeting
Yang, J., C.M. Luedtke, M.K. Akers, M. McGuire, Doug P. Aubrey and R.O. Teskey	Soil CO2 efflux and its components responded differently to throughfall exclusion and fertilization in a loblolly pine (Pinus taeda) plantation	Poster Presentation	Dec 15-19, 2014	American Geophysical Union Meeting, San Francisco, CA

Zhang, Y., West J.B., Will R.E. and J.G. Vogel.	Effects of fertilization and drought on substrate decomposition and inorganic nitrogen concentration in a managed loblolly pine forest	Poster Presentation	Dec. 10th2013	American Geophysical Union Meeting, San Francisco, CA
Zhang, Y., J. Vogel, and J. West	Effect of climate change and forest management on wood mass loss in a southeastern US loblolly pine forest	Poster Presentation	May 14-16, 2014	PINEMAP Annual Meeting, Athens, GA
Zhao, D., M. Kane, R. Teskey, T.R. Fox, T.J. Albaugh, H.L. Allen, J. Stape, R. Rubilar	Maximum Response of loblolly pine plantations to increased culture	oral presentation	July 17, 2014	PMRC Advisory Committee Meeting, Athens, GA
Zhao, D., M. Kane, R. Teskey, T.R. Fox, T.J. Albaugh, H.L. Allen, J. Stape, R. Rubilar	Why should we develop site-specific silvicultural management for loblolly pine plantations?	Oral presentation	March 4, 2015	18th Biennial Silvicultural Research Conference
Zietlow D, Noormets A, King JS, Sun G.	Energy and Water Balance of Contrasting Land uses of Forested Wetlands in North Carolina's Lower Atlantic Coastal Plain	oral presentation	April 7-10, 2014	International Symposium: Evapotranspiration: Challenges in Measurement and Modeling from Leaf to the Landscape Scale and Beyond. ASABE, Raleigh, NC

Trainings, workshops, and courses

Aim 1 (Silviculture/Ecophysiology) Trainings, workshops, and courses

NREM 3101 visited the Oklahoma Tier III site for an afternoon to learn about carbon cycling and global change (May 26, 2014).

Experiments, surveys, and data collection

Title	Time Frame	Description
Tier I Legacy Experiments	Ongoing	The Tier I legacy network consists of hundreds of existing silviculture experiments and growth-and-yield plots that blanket the region and provide extensive, spatially explicit information on regional variability and productivity. Industry/university cooperative research installations to include in the Tier I legacy experiments have been identified and archived data from these sites has been uploaded into the TerraC database.
Tier II Active Experiments	Ongoing	The Tier II active experiments network consists of 127 sites distributed throughout the Southeast. These sites were selected to represent the range of climate, geology, and soil conditions in the Southeast and span a range of plantation ages (5 to more than 25 years) covering a progression of stand development. Principle treatments represented in the network include planting density, thinning, fertilization, and competition control. Sampling on all or a subset of locations in this network include biomass and carbon inventory; soil sampling; tree canopy light interception measurements; wood core sampling for $^{13}C/^{18}O$ analysis to determine water use efficiency; and assessments of soil carbon emissions, nitrous oxide emissions, and nitrogen uptake efficiency. Data collection from Tier II sites is ongoing.
Tier III Throughfall Exclusion x Fertilization Experiments	Ongoing	The Tier III throughfall exclusion x fertilization network is made up of four research sites situated at the edges of the native range of loblolly pine. The four sites, located in McCurtain County, Oklahoma; Taylor County, Florida; Taliaferro County, Georgia; and Buckingham County, Virginia, capture the current range-wide variability of climate, precipitation, and productivity (Figure 3). The research sites range in planting date from 2003 to 2008, are unthinned, and were planted with a mix of genetic sources appropriate for each region. Treatments at the four Tier III sites consist of a factorial experiment: ● Control (no treatment) ● Fertilizer: fertilizer additions to achieve “optimum” nutrition ● Throughfall exclusion: panels installed in understory to divert 30% of throughfall off the plot ● Fertilizer + throughfall exclusion: combined fertilizer and throughfall exclusion treatment Researchers at each Tier III site are measuring tree and stand growth, above and below ground carbon, changes in soil nutrient and water availability, whole-tree water use, leaf area development and canopy light capture, and soil carbon dioxide (CO_2) efflux (partitioned into autotrophic and heterotrophic respiration).

PROGRESS NARRATIVE

Provide a brief summary of progress on each deliverable/task/input/output listed below. Please provide a *brief* summary of progress on each deliverable/task/input/output listed below. In many cases, a one sentence summary may suffice. If there is no progress update on an item, leave blank. Please highlight additions in yellow. Please do not include any figures or tables, but please do include quantifiable measurements, if available (i.e., # of plots measured, # of samples, # of runs, # of people reached, etc.)

Sap Flux Regional Analyses

Input: Soil Moisture assessment and standard index (8/31/14)

Internal web meeting conducted on 7/25/2013. Group decision was to proceed with approach to gap filling using 12 cm wireless probes at VA site at other sites for use in cross-site sap flux analyses.

Task: TerraC formats and 2013 data (8/31/14)

The data and meta data sheets according templates for tier 1, 2 and 3 sites have been uploaded into TerraC. TerraC has been redesigned to make it more user-friendly and allow easy download of data to PCs of members of Pinemap. The datasets contain: (1) Ecosystem measurements (observations) representing soil, vegetation (trees), atmosphere, (2) Estimated (calculated) data (such as net primary productivity), and (3) extracted environmental covariates from geospatial layers (e.g., climate data, soil and topographic data).
Sap flux data through 9/30/2013 has been uploaded to TerraC. Tier III meteorological and biometric data are currently in template development and will be uploaded no later than 5/31/15, as well as sap flux data through 9/31/2014.

Deliverable: 2013 FL, GA, VA analyses (8/31/14)

Analyses completed and manuscripts in preparation for FL and GA. VA manuscript in preparation for submission to journal by Oct 1, 2014. Uses continuous half-hourly sap flux measurements of 80 trees from June, 2012 until March 2014 (>32,000 data points) and associated stand-level biometric data and meteorological data
VA Tier 3 manuscript re-submitted with major revisions to Forest Ecology and Management (3/31/2015)

Task: Initial meeting on improving LAI (11/30/14)

A conference call was held to discuss LAI measurements to standardize across sites.

Task: Data through 9/30/14 in TerraC with LAI corrections (12/1/14)
Data submitted to University of Florida and is being input into TerraC.

Task: Standardize sapwood calculation radial corrections (2/28/14)
Protocols for carbon sampling, tree core collection, biomass sampling, precipitation collection for isotopes, GHG flux, and heterotrophic and autotrophic soil respiration, and IPAR-LAI protocols have been finalized and uploaded to the PINEMAP intranet site where they will serve as a reference for field work and data collection on Tier II and III sites. Standardized metadata and spreadsheets have been created.
Radial corrections estimated for Florida in M. Wightman's M.S. thesis. Data collected in one tree per plot for other sites in growing season 2014, will be analyzed for cross-site analyses.

Output: Ec monthly estimates to Aim 2 (2/28/15)
Independent estimates from GA and VA sites currently being used to develop models. Standardized estimates for cross site analysis awaiting all relevant data streams to be available in TerraC.

Deliverable: OK gas exchange, growth, and EC daily (5/31/15)
Data are being analyzed and a manuscript prepared.

Deliverable: OK VPD relationship (8/31/15)
Data are being analyzed.

Task: Data through 9/30/14 in TerraC (12/1/15)
Sapflux data have been submitted.

Output: EC monthly through 9/30/15 (2/28/16)
No progress reported Sept 2014.

Deliverable: Final cross-site analysis of E_C, G_S (2/28/16)
No progress reported Sept 2014.

Soil respiration regional analysis

Output: R_S to modeling via existing (8/31/14)
No progress reported Sept 2014.

Output: R_H/R_S to modeling via Tier III synthesis (8/31/14)
Sampling of R_H/R_S is ongoing across the Tier II network.

At the GA Tier III installation: Measurements were made of soil CO2 efflux and its components—autotrophic CO2 efflux, heterotrophic CO2 efflux and CO2 efflux from the ectomycorrhizal hyphae.

Output: RH/RS to modeling via Tier II synthesis (2/28/15?)
At least three Tier II sites in each sub-region were identified for Rh vs. Ra measurements using the established PINEMAP protocol. Equipment has been installed for late summer measurements.

Input: DayCent sensitivity analysis from modeling (2/28/15)
DayCent has been calibrated at tier 3 sites using available measured data, specifically NPP. Validation efforts for tier 3 sites are underway before the model can be regionalized.

Task: R_S validate (2/28/15)
A region-wide dataset of R_S has been reanalyzed. A four-parameter model (temperature, temperature x moisture, bulk density, soil nitrogen) explains 56% of the variance in R_S. A simple one-parameter model (temperature) explains 48% of the variance in R_S. Multiple datasets from across the region are being combined and analyzed to validate and further current models.

Task: R_H/R_S further exploration (2/28/15)
A study to investigate how R_H/R_S changes with stand age and season has been installed in central Virginia within the Appomattox-

Buckingham State Forest (close to the Tier III installation). Three replications of four loblolly pine age classes (2-3, 7-9, 16-18, and 23-25 years-old) are being measured using established PINEMAP protocols. Data from this study will be used to further inform the AIM 2 models. This study will be completed by July 2015.

A study to investigate how soil microbial processes and litter chemistry are linked to decomposition was established at the Virginia Tier III site in July 2014 and will be completed by May 2015. Data collected from this study include soil CO_2 efflux, leaf litter structural carbohydrate and lignin content, soil (0-10 cm) nutrient content, litter and soil microbial and extracellular enzyme activity, and macroinvertebrate abundance and diversity.

Deliverable/output: R_S and R_H/R_S confirmation to modeling (5/31/15)
No progress reported Sept 2014.

Tier II regional analyses

Input: Do we need CH_4 and N_2O (8/31/14)
It was decided that we do need these estimates for younger forests and that this will be the focus of field efforts early next year.

Input: Tier II inventory extracted from Tier I (8/31/14)
Approach is under development.
Extractions of soil properties (n=18) from the Soil Survey Geographic (gSSURGO) Database and climate data (PRISM and Idaho Geospatial has been completed for tier I and II sites. Extractions of MACA climate data are ongoing since MACA data just recently were compiled.

Task: Bulk density pedotransfer functions (8/31/14)
Approach is under development

Task: Bulk density variation PINEMAP NRCS (11/30/14)
This deadline is dependent on the next item but will likely be met.

Output: Aboveground metrics to TerraC (11/30/14)
Field measurements are ongoing but this deadline will be met.

Deliverable: Complete field sampling (2/28/15)
This deadline will likely be met.
Tier II field sampling is complete in the Auburn/UGA and Western Gulf sub-regions.

Deliverable: Complete ½ plots into TerraC (5/1/15)
This deadline is being extended.

Output: To modeling groups (5/1/15)
This deadline is being extended.

Deliverable: Bulk density papers (2/28/15)
More than 1200 direct observations of soil bulk density (Db) from the PINEMAP Tier II Network have been combined with more than 2700 direct observations in the southeastern United States from the National Cooperative Soil Survey. This extensive database is being used to create pedotransfer functions using Random Forest models with two goals in mind: (1) to predict missing Db values that are needed to estimate soil C and N contents of the Tier II installations, and (2) to understand the nature of variation and depth dependence of Db in forest ecosystems. Results from this modeling exercise will be compiled as a manuscript that will be submitted for publication by June of 2015.

A study designed to quantify the depth dependence and actual variability of Db at the plot level was established in North Florida in Dec 2014 and will be completed by May 2015. Soils from different taxonomic Orders (Spodosols and Ultisols) are being intensively sampled for Db (n=100) at each of four depths corresponding to the PINEMAP Tier II sampling depths (0-10; 10-20; 20-50; and 50-100 cm). A combination of traditional statistics and geostatics are being conducted to quantify Db uncertainty and our ability to accurately measure elemental contents of forest soils.

Deliverable: Final analysis all plots (8/31/15)
This deadline will likely be met.

Output: To modeling groups (8/31/15)
This deadline will likely be met.

Deliverable: C analysis of existing data (Jason V.) (11/30/15)
This deadline will likely be met.

Deliverable: Carbon upscaling kriging (Sabine) (2/28/16)
This deadline will likely be met.

Regionalize estimates of WUE for application in 3-PG and WaSSI
No progress reported Sept 2014.

BROAD IMPACTS

Provide a short narrative describing broad impacts (i.e., far-reaching and possibly unanticipated outcomes resulting from PINEMAP work). Specifically, please highlight leveraged funds and/or partnerships with other projects/external collaborations.
No broad impact narrative was provided Sept 2014.

TRAINING

A CUMULATIVE list of all Aim 1 undergraduate and graduate students, postdocs, and technical/research personnel trained under this project and descriptions of their research focus and/or role in the project is provided below. Additions/ changes from the Sept 2014 progress report are highlighted in blue.
Please update as necessary and highlight in yellow any updates made for the April 2014 Progress Report.

Last name	First name	Position	University	Role
Akers	Madison	Research Staff	UGA	Coordinating baseline measurements on Tier II sites and overseeing installation and data collection on the Georgia Tier III site
Albaugh	Tim	Research Staff	NCSU	Evaluating impacts of weed control and fertilization on loblolly pine using the 3-PG model
Alvarez	Jose	Postdoc	NCSU	Evaluating changes in loblolly pine leaf area due to silvicultural treatments as a component of the 3-PG model
Ausmus	Casey	M.S. Student	OSU	Research focus: determine the effects of fertilizer and water availability on tree physiological processes
Bacon	Allan	Post-Doc	UF	Modeling regional and plot level controls on the central tendencies and uncertainties of soil bulk density and their implications to the chemical budgets of soils and forest ecosystems. Assisting in the regional analysis ecosystem carbon and nitrogen budgets across the Tier II Network.
Baggett	Brittany	Undergraduate Intern	Univ. of W. FL	2013 Undergraduate Fellow; working with Adam Maggard at OSU
Barringer	Hollie	Undergraduate Research Assistant	TAMU	Assisted in implementing carbon monitoring protocol
Barron	Stephan	Undergraduate Intern	Auburn	2014 undergraduate fellow; working with Stan Bartkowiak and Lisa Samuelson. Focus area: Sap flow and leaf/stand level physiology.
Bartkowiak	Stan	M.S. Student	Auburn	Research focus: measuring sap flux at the Georgia Tier III site
Bartkowiak	Stan	Research Staff	Auburn	Monitoring sap flux and canopy level processes at the Georgia Tier III site
Bass	Allison	undergraduate intern	UNC Wilmington/ NCSU	2014 undergraduate fellow; working with Wen Lin, and Michael Gavazzi. Focus area: Soil carbon dynamics
Brown	Robert	M.S. Student	UGA	Research focus: estimate proportion of heterotrophic respiration vs. autotrophic respiration of forest soils.
Clark	Joe	M.S. Student	Auburn	Research focus: assessing relationships among intercepted radiation, LAI, photosynthetic capacity, phenology, and productivity in loblolly pine
Clark	Zach	M.S. Student	UGA	Research focus: assessing developmental pattern of understory vegetation on Tier II installations
Cucinella	Josh	Research Staff	UF	Coordinating baseline measurements on Tier II sites and overseeing installation and data collection

				on the Florida Tier III site
Diamond	Amanda	Undergraduate Intern	VT	2013 Undergraduate Fellow; working with Madison Akers at UGA
Faison	Andrew	Undergraduate Intern	VSU	2012 Undergraduate Fellow; assisted Jay Raymond at Virginia Tech with investigating the mechanisms nitrogen dynamics and uptake efficiencies of N containing fertilizers in loblolly pine plantations using stable isotope (15N) techniques.
Few	John	Undergraduate Intern	VSU	2013 Undergraduate Fellow; working with Asko Noormets at NCSU
Fields	Anthony	Undergraduate Intern	VSU	2013 Undergraduate Fellow; working with Maxwell Wightman at UF
Frye	Sam	Research Staff	VT	Assisting with soil CO2 efflux and N2O measurements and installation and data collection on Tier II and III sites.
Gonzalez	Carlos	Research Associate	UF	Ecophysiology and Carbon Balance Modeling; support of tree transpiration measurements for Tier III; use of 3PG model to assess the effect of climate change in productivity of loblolly pine plantations in SE U.S.
Gregory	Bethany	Undergraduate Intern	VT	2012 Undergraduate Fellow; helped Andy Laviner at Virginia Tech with a study on environmental manipulation of fertilization, drought, and thinning in loblolly pine plantations.
Hancock	Amanda	Undergraduate Research Assistant	TAMU	Carbon monitoring protocol implementation for Tier II sites.
Hardison	Alex	Undergraduate Intern	OSU	2014 Undergraduate Fellow; working with Adam Maggard at OSU
He	Dongmei	Visiting Chinese PhD student	TAMU	Effect of soil aggregrates on soil C stabilization in different families of loblolly pine
Heim	Brett	M.S. Student	VT	Research focus: separating heterotrophic and autotrophic respiration components of soil CO_2 efflux
Heinemann	Bob	Research Coordinator	OSU	Assists with site maintenance and data collection on Oklahoma Tier III site.
Holeman	Randy	Research Specialist	OSU	Assists with site maintenance and data collection on Oklahoma Tier III site.
Ingwers	Miles	Ph.D. Student	UGA	
Jackson	Colin	Undergraduate Intern	OSU	2013 Undergraduate Fellow; working with Jay Raymond at VT
Jarvis	Rebecca	Undergraduate Intern	VT	2012 Undergraduate Fellow; assisted Wen Lin at North Carolina State University with quantifying the growth rate of loblolly pine, and analyze its sensitivity to temperature and precipitation dynamics.
K.C.	Dipesh	Postdoctoral Fellow	OSU	Tier III data inventory and TerraC database management
Kinnerly	Will	Undergraduate Intern	VT	2012 Undergraduate Fellow; helped Brett Heim at Virginia Tech with experimental manipulations of belowground metabolic activity in order to separate microbial respiration from plant respiration
Laguer Martinez	Doris	Undergraduate Intern	University of Puerto Rico	2014 Undergraduate Fellow; working with (Jill) Ji Qi at UGA; learned about forest soil carbon and hydrology
Laviner	Andy	Ph.D. Student	VT	Coordinating baseline measurements on Tier II sites and overseeing installation and data collection on VA Tier III site; research focus is water use efficiency in loblolly pine
Lewis	Wilson	Research Technician	UF	Assists with Tier III measurements and Tier II sample collection and lab processing
Lin	Wen	Ph.D. Student	NCSU	Research focus: water use efficiency in loblolly pine using 12C/13C ratios in wood
Luedtke	Cody	Ph.D. Student	UGA	Research focus: Soil CO2 efflux
Maggard	Adam	Ph.D. Student	OSU	Research focus: ecophysiology on Tier II and III sites

McElligott	Kristin	Ph.D. Student	VT	Research focus: mechanisms controlling total soil CO_2 efflux and heterotrophic and autotrophic soil respiration
Medsker	Teresa	M.S. Student	OSU	Research focus: belowground processes affected by fertilization and water availability
McConaghy	Scott	Undergraduate Intern	Kansas State	2013 Undergraduate Fellow; working with Yang Zhang at TAMU
Meek	Casey	Research Staff	OSU	Assisting with ecophysiological and process measurements at Tier II and III sites
Meeks	April	M.S. Student	NCSU	Incorporating competing vegetation in 3-PG model
Mitchell	Samuel	Undergraduate Intern	TAMU	Assisting graduate student in research
Nagel	Greg	Undergraduate Research Assistant	TAMU	Carbon monitoring protocol implementation at Tier II sites
Parisher	Josh	Undergraduate Research Assistant	TAMU	Carbon monitoring protocol implementation at Tier II sites
Pell	Charles	M.S. Student	Auburn	Research focus: ecophysiology at the Georgia Tier III site.
Pike	Jason	Research Staff	OSU	Assisting with installation, maintenance, and data collection on Tier III sites
Qi	Jill	Ph.D. Student	UGA	Research focus: soil water and deep soil carbon responses under rain throughfall treatment at Tier III sites
Raymond	Jay	Ph.D. Student	VT	Research focus is N uptake efficiency of enhanced efficiency N fertilizers using 15N stable isotopes
Rutemiller	Paul	Undergraduate Intern	VT	2013 Undergraduate Intern; working with Chris Maier at the USFS
Ryland	Rachel	Undergraduate Research Assistant	UGA	Received training in field sampling of trace gases at the Georgia Tier III installation and has been trained in laboratory techniques for soil gas analysis on the gas chromatograph
Seyle	Jacob	Undergraduate Research Assistant	NCSU	Assists with processing soil samples from Tier2 soil respiration plots in the northern subregion, makes sapflow probes for Tier 3 installations, analyzes growth responses of trees at Tier 2 sites to historic drought events. /AN/
Sherrod	Charles Allen	Undergraduate Research Assistant	UGA	Received training in field sampling of soil at the Georgia Tier III installation and has been trained in laboratory techniques for soil sample preparation and analysis
Shrestha	Raj	Postdoctoral Research Scientist	VT	Soil greenhouse gas (CO2, N2O, CH4) flux across soil moisture and management gradients
Barros	Bruce	M.S. Student	UGA	Research focus: Transpiration predictions with 3-PG model (Tier III)
Seyle	Jacob	Undergraduate Research Assistant	NCSU	Heterotrophic respiration, coarse woody decomposition, making sapflow probes for Tier 3 sites. /AN/
Stebler	Elaine	Research Staff	OSU	Coordinating baseline measurements on Tier II sites and overseeing installation and data collection on the Oklahoma Tier III site
Stokes	Tom	Research Staff	Auburn	Assisting with data collection on Tier II and III sites
Subedi	Santosh	Ph.D. Student	VT	Research focus: identifying an improved method to determine fertility rating for 3-PG
Thompson	Ian	Undergraduate Research Assistant	NCSU	Heterotrophic respiration, coarse woody decomposition, making sapflow probes for Tier 3 sites. /AN/
Vial	Sara	Undergraduate Research Assistant	VT / NCSU	2014 Undergraduate fellow, working with Wen Lin. Focus area: Radial growth and drought sensitivity in Tier2 sites.
Ward	Eric J.	Post-Doc	NCSU	Measuring and modeling forest water and carbon cycles, including quantifying uncertainty in key

				processes; working with both Aim 1 and 2 to integrate data and models such as 3PG and WaSSI-C across scales; assisting with data collection and analysis of water fluxes at the Virginia Tier III site.
Wightman	Maxwell	M.S. Student	UF	Research focus: Ecophysiology of drought response on FL Tier III site
Wigley	Madison	Undergraduate Research Assistant	TAMU	Carbon monitoring protocol implementation for Tier II sites
Wilson	Elizabeth	M.S. Student	TAMU	Research focus: understanding the effects of mesophyll conductance on isotopic signatures in leaves
Yancey	Fletcher	Research Technician	UF	Coordinates Tier III sap flux measurements and assists with Tier II sample collection and lab processing
Yang	Jinyan	Ph.D. Student	UGA	Research focus: Heterotrophic and autotrophic components of soil respiration
Zhai	Lu	MS	TAMU	Research focus: Family and culture effects on ecosystem C and N dynamics
Zhang	Yang	Ph.D. Student	TAMU	Research focus: Carbon and nitrogen cycling response to drought at the OK Tier III site