

Final Report for DOE Award # DE- SC0010039*: Carbon Dynamics Of Forest Recovery Under A Changing Climate: Forcings, Feedbacks, And Implications For Earth System Modeling**Kristina J. Anderson-Teixeira (Smithsonian)**

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*Note: This award was initially through the University of Illinois (DE-SC0008085) and subsequently moved to the Smithsonian (DE-SC0010039).

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Summary of Award Activity*Forest Carbon Database (ForC-db) Development*

To advance understanding of C dynamics of forests globally, we compiled a new database, the Forest C database (ForC-db), which contains data on ground-based measurements of ecosystem-level C stocks and annual fluxes along with disturbance history. This database currently contains 18,791 records from 2009 sites, making it the largest and most comprehensive database of C stocks and flows in forest ecosystems globally. The tropical component of the database will be published in conjunction with a manuscript that is currently under review (Anderson-Teixeira *et al.*, in review). Database development continues, and we hope to maintain a dynamic instance of the entire (global) database.

Data Synthesis & Analysis

We have used the tropical component of ForC-db to characterize C cycling in tropical forests varying in age and disturbance history (Anderson-Teixeira *et al.*, in review). Specifically, we present ensemble C budgets for young, intermediate, and mature tropical forests and examine age trends in biomass and other C cycle variables.

We expect that ForC-db will continue to prove useful for a variety of purposes related to model benchmarking and quantifying the contribution of forests to the global C cycle. For instance, we anticipate collaborations with the NGEE-tropics modeling team (e.g., Chonggang Xu, LANL) to use the tropical component of the database for model benchmarking.

Forest Succession Modeling

To understand how elevated CO₂ affect the long-term dynamics of forest regrowth, we modeled the dynamics of forest recovery using the mechanistic size- and age- structured Ecosystem Demography model (ED2; Miller *et al.*, in press). We applied the model to Duke Forest, drawing upon data from the FACE experiment, age chronosequence, and eddy flux towers for model parameterization and evaluation. We show that elevated CO₂ is likely to increase the rate of biomass accumulation and community turnover and to alter the successional pathway and mature forest composition. Model predictions of mature forest biomass and ecosystem-atmosphere exchange of CO₂ and H₂O are sensitive to assumptions about nitrogen

limitation; both the magnitude and persistence of the ecosystem response to elevated CO₂ are reduced under N limitation. Regardless, our model simulations demonstrate that elevated CO₂ will result in a general acceleration of forest regeneration while altering the course of successional change and having a lasting impact on forest ecosystems.

Review Paper

This award supported a review of evidence regarding the influence of climate and CO₂ on the dynamics of forest recovery (Anderson-Teixeira *et al.*, 2013). Multiple lines of evidence – including global-scale patterns in forest recovery dynamics; forest responses to experimental manipulation of CO₂, temperature, and precipitation; forest responses to the climate change that has already occurred; ecological theory; and ecosystem and earth system models – all indicated that the dynamics of forest recovery are sensitive to climate. This implies that altered dynamics of forest recovery will result in positive and negative feedbacks to climate change.

Outcomes

Publications

Anderson-Teixeira, KJ, Wang, MMH, McGarvey, JC, LeBauer, DS (in review) Carbon dynamics of mature and regrowth tropical forests derived from a pantropical database (TropForC-db). *Global Change Biology*.

Miller, A.D., Dietze, M.D., DeLucia, E.H., Anderson-Teixeira, K.J. (in press). Alteration of forest succession and carbon cycling under elevated CO₂. *Global Change Biology*. DOI: 10.1111/gcb.13077

Anderson-Teixeira, KJ, Miller, AD, Mohan, JE, Hudiburg, T, Duval, BD, DeLucia, EH (2013). Altered dynamics of forest recovery under a changing climate. *Global Change Biology*, 19, 2001-2021. DOI: 10.1111/gcb.12194

Data Publication

Anderson-Teixeira, KJ, Wang, MMH, McGarvey, JC, LeBauer, DS (pending manuscript acceptance). Data from: Carbon dynamics of mature and regrowth tropical forests derived from a pantropical database (TropForC-db). Dryad Digital Repository.

Conference Contributions

Anderson-Teixeira, K.J., Miller, A.D., Wang, M., McGarvey, J., Dietze, M., LeBauer, D., Duval, B.D., DeLucia, E.H. (April 2015) Carbon Dynamics of Forest Recovery under a Changing Climate: Forcings, Feedbacks, and Implications for Earth System Modeling. TES/SBR Joint Investigators Meeting, Potomac, MD.

Wang, Maria, K.J. Anderson-Teixeira. (August 2015) ForC-db - A Global Forest Carbon Database. Smithsonian Conservation Biology Institute Student Research Symposium, Washington, D.C.

Anderson-Teixeira, K.J., Miller, A.D., McGarvey, J., Dietze, M., LeBauer, D., Duval, B.D., DeLucia, E.H. (May 2014) Carbon Dynamics of Forest Recovery under a Changing

Climate: Forcings, Feedbacks, and Implications for Earth System Modeling. TES/SBR Joint Investigators Meeting, Potomac, MD.

Miller, A.D., Dietz, M., DeLucia, E., Anderson-Teixeira, K.J. (Dec 2013). American Geophysical Union Fall Meeting, San Francisco, CA.

Anderson-Teixeira, K.J., Miller, A.D., Duval, B.D., DeLucia, E.H. (May 2013) Carbon Dynamics of Forest Recovery under a Changing Climate: Forcings, Feedbacks, and Implications for Earth System Modeling. TES/SBR Joint Investigators Meeting, Potomac, MD.

Anderson-Teixeira, K.J., Miller, A.D., Mohan, J.E., Hudiburg, T., Duval, B.D., DeLucia, E.H. (Feb 2013) Altered dynamics of forest recovery under a changing climate. North American Carbon Program Meeting, Albuquerque, NM.

Organized Conference Sessions

"Forest dynamics under a changing climate and their long-term context"; American Geophysical Union Fall Meeting (Dec. 2012) (Anderson-Teixeira, DeLucia, & Duval)

"Dynamics of global forests under a changing climate"; American Geophysical Union Fall Meeting (Dec. 2013) (Anderson-Teixeira, McMahon, & Dettlo)

"Global forest dynamics and interactions with a changing climate"; American Geophysical Union Fall Meeting (Dec. 2014) (Anderson-Teixeira, McMahon, & Dettlo)

Researchers Supported

Adam Miller (postdoctoral research associate; August 2012- October 2015; UIUC and SI portions of grant)

Maria Wang (research assistant; July 2014-October 2015)

Jennifer McGarvey (research assistant; July 2013-July 2014)

Moein Azimi (undergraduate research assistant; May 2012-June 2014; UIUC portion of grant)