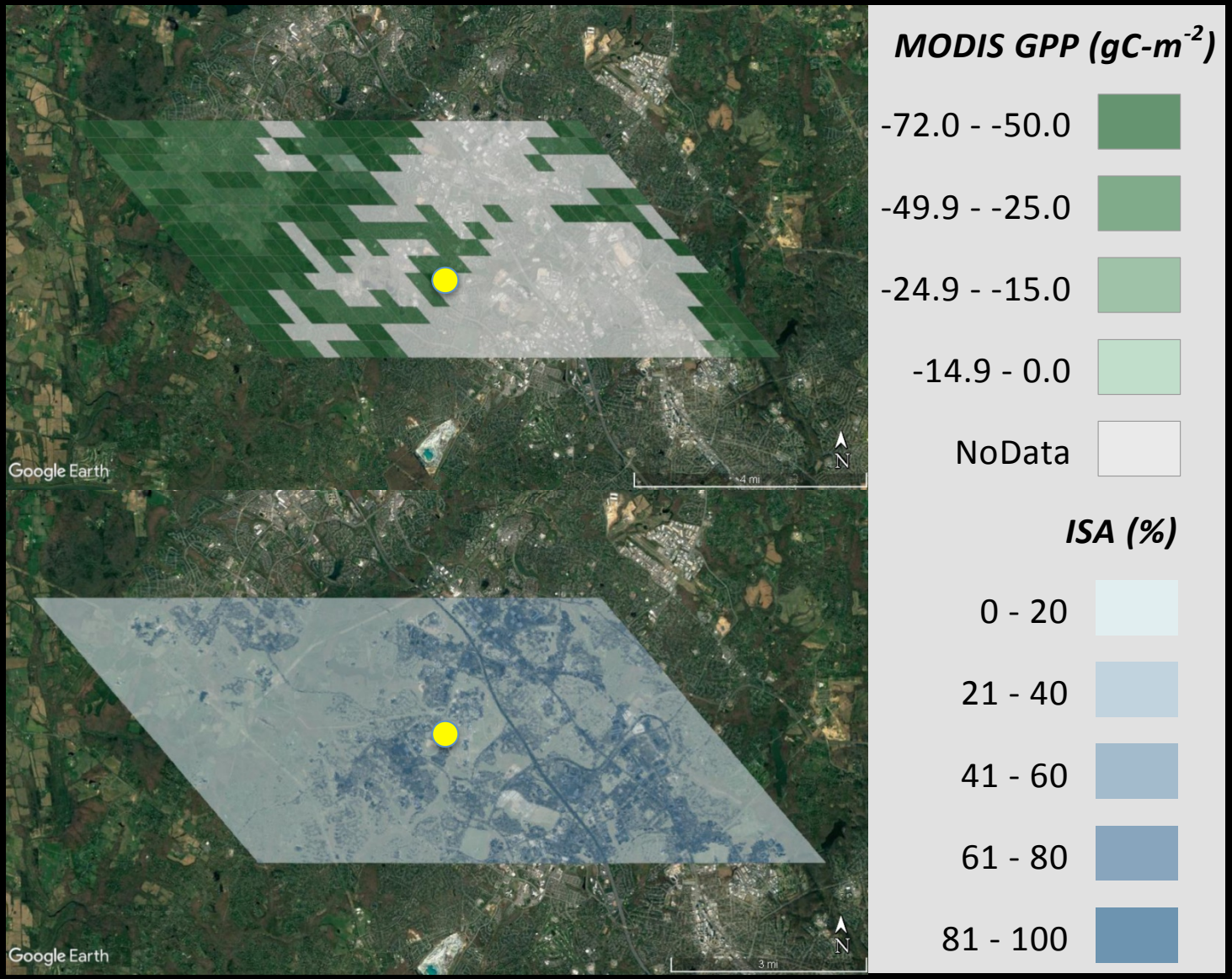
Urban Biosphere Fluxes

Lucy R. Hutyra, Irene Palazzoli, & Conor Gately

CO2USA – October 25, 2018

Not a biological void



What is the urban biosphere doing?

Science of the Total Environment 592 (2017) 366–372

Contents lists available at ScienceDirect

Science of the Total Environment

journal homepage: www.elsevier.com/locate/scitotenv

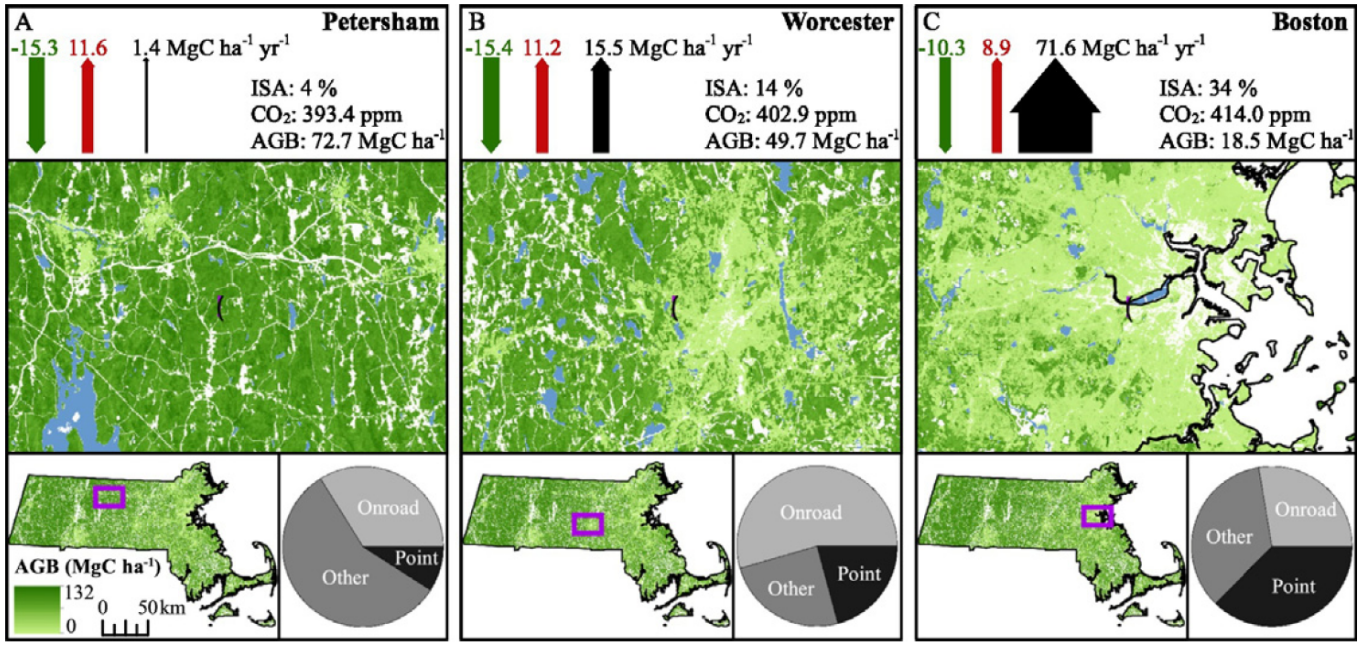
Accounting for urban biogenic fluxes in regional carbon budgets

Brady S. Hardiman [a,b,*,1], Jonathan A. Wang [b,1], Lucy R. Hutyra [b], Conor K. Gately [b], Jackie M. Getson [b], Mark A. Friedl [b]

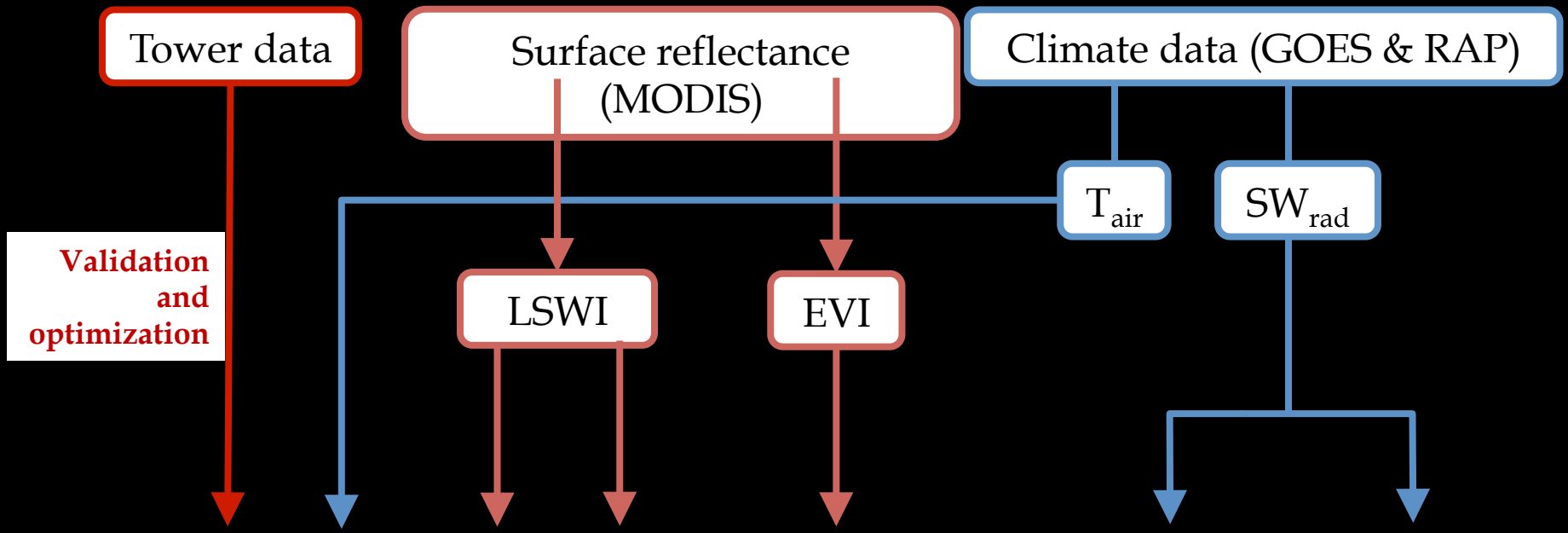
[a] Department of Forestry & Natural Resources, Division of Environmental & Ecological Engineering, Purdue University, 715 W State St, West Lafayette, IN 47907, USA
[b] Department of Earth and Environment, Boston University, 685 Commonwealth Avenue, Boston, MA 02215, USA

HIGHLIGHTS

- Urban areas occupy 1/3 of MA; urban biogenic fluxes are generally ignored by models.
- Boston biomass is 1/4 of nearby rural biomass, C fluxes are 2× rural rates.
- Urban biogenic C fluxes can be up to 14% of urban anthropogenic C emissions.
- Diurnal and seasonal asymmetry of biogenic fluxes results in biased flux estimates.
- Regional carbon cycle models that omit urban vegetation may be incomplete.



VPRM



Mahadevan et al. 2008; Hardiman et al. 2017

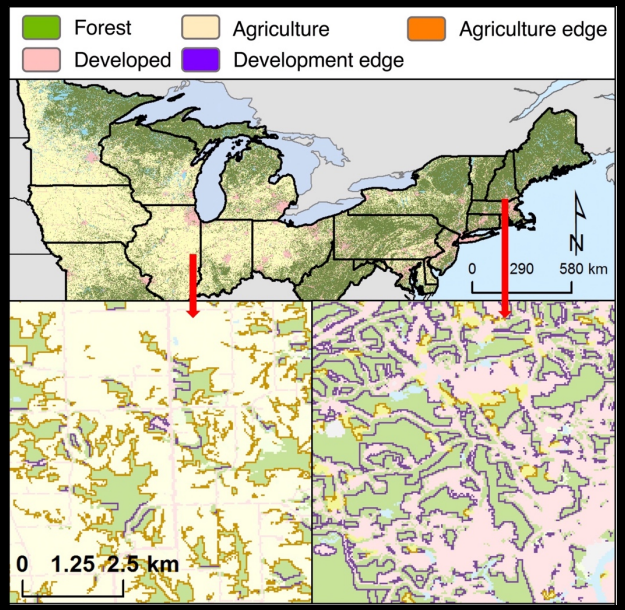
What is the urban biosphere doing?

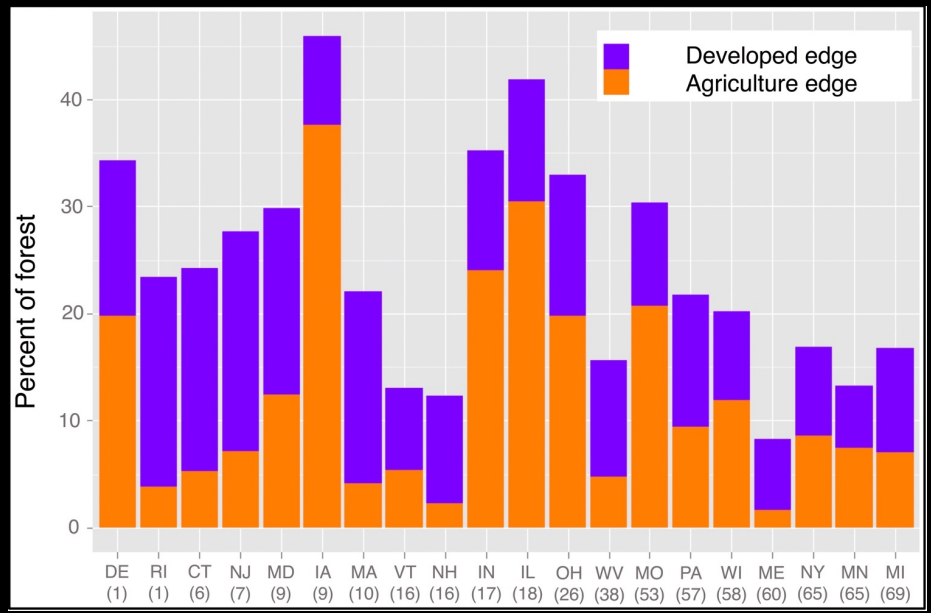
Piecing together the fragments: elucidating edge effects on forest carbon dynamics

Ian A Smith[1]*, Lucy R Hutyra[1], Andrew B Reinmann[1], Julia K Marrs[1], and Jonathan R Thompson[2]

Forest fragmentation is pervasive throughout the world's forests, impacting growing conditions and carbon (C) dynamics through edge effects that produce gradients in microclimate, biogeochemistry, and stand structure. Despite the majority of global forests being <1 km from an edge, our understanding of forest C dynamics is largely derived from intact forest systems. Edge effects on the C cycle vary by biome in their direction and magnitude, but current forest C accounting methods and ecosystem models generally fail to include edge effects. In the mesic northeastern US, large increases in C stocks and productivity are found near the temperate forest edge, with over 23% of the forest area within 30 m of an edge. Changes in the wind, fire, and moisture regimes near tropical forest edges result in decreases in C stocks and productivity. This review explores differences in C dynamics observed across biomes through a trade-offs framework that considers edge microenvironmental changes and limiting factors to productivity.

Front Ecol Environ 2018; doi: 10.1002/fee.1793





What is the urban biosphere doing?

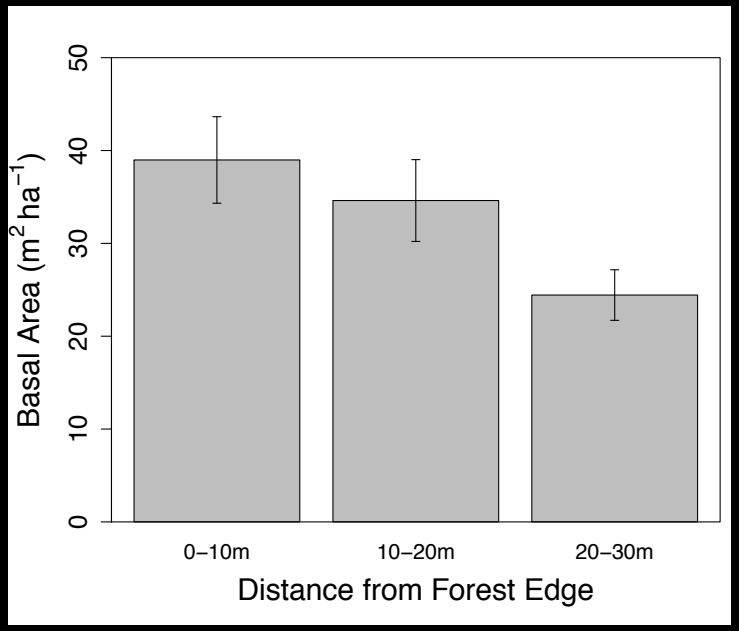
PNAS

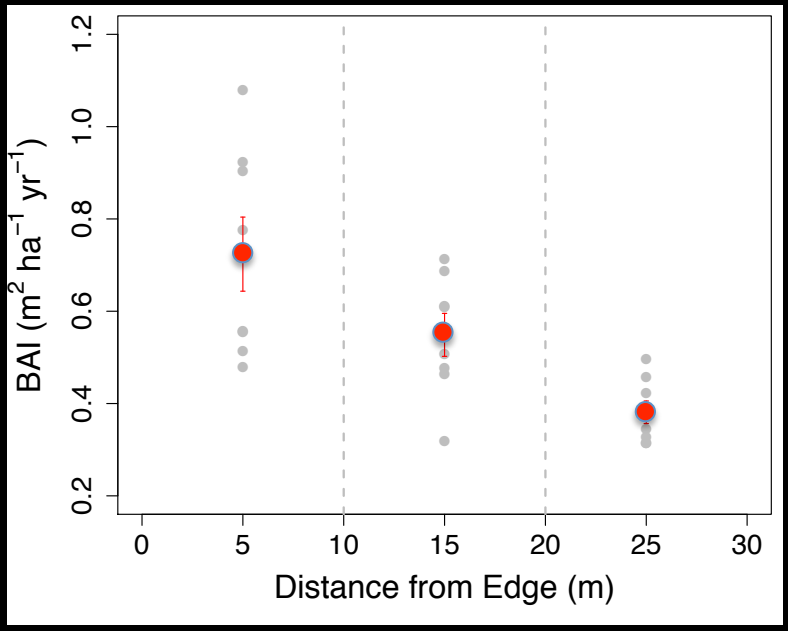
Edge effects enhance carbon uptake and its vulnerability to climate change in temperate broadleaf forests

Andrew B. Reinmann[a,1] and Lucy R. Hutyra[a]

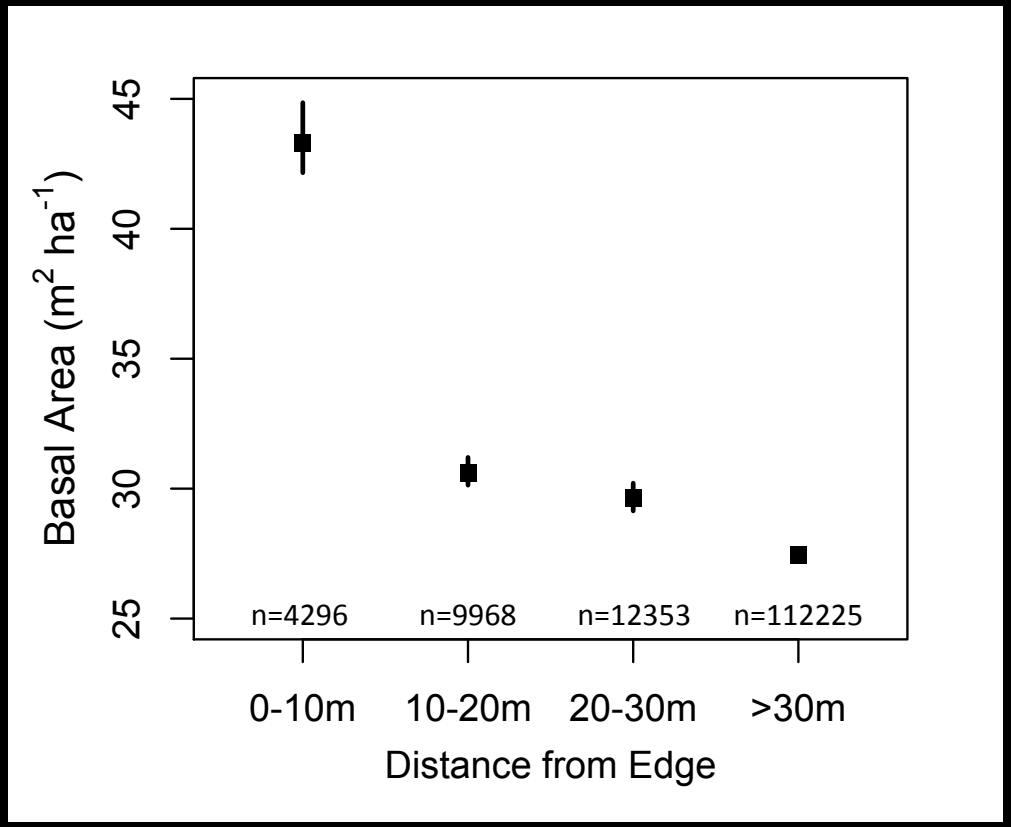
[a]Department of Earth and Environment, Boston University, Boston, MA 02215

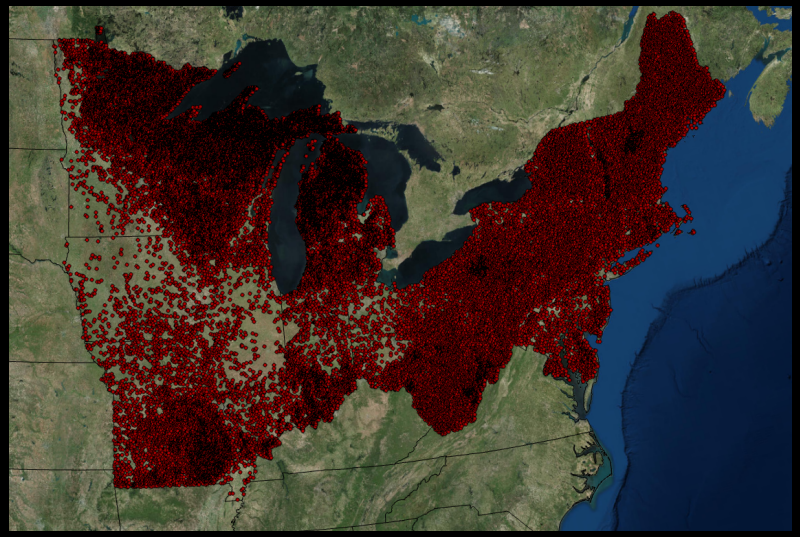
Edited by Oskar Franklin, International Institute for Applied Systems Analysis, Laxenburg, Austria, and accepted by Editorial Board Member Gregory P. Asner November 16, 2016 (received for review July 26, 2016)





What is the urban biosphere doing?

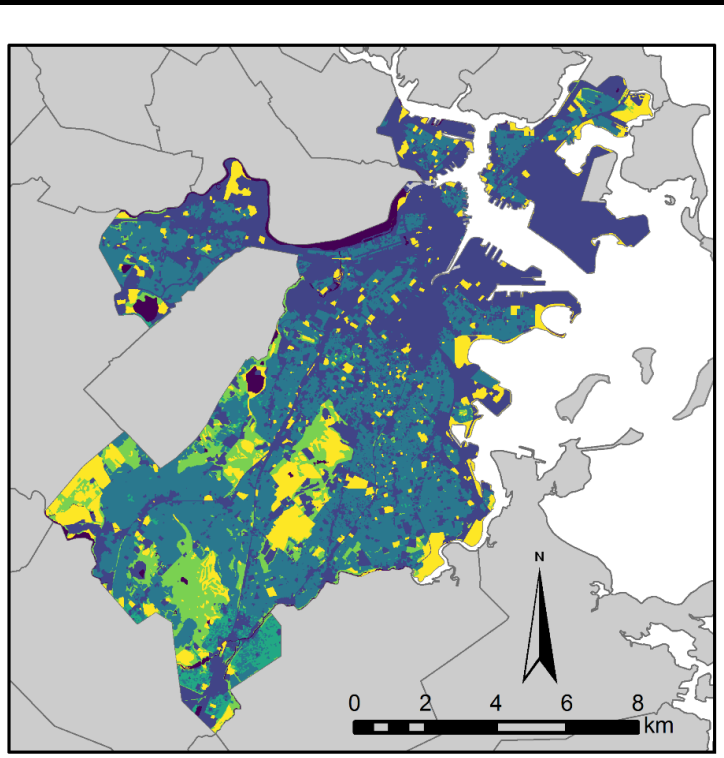


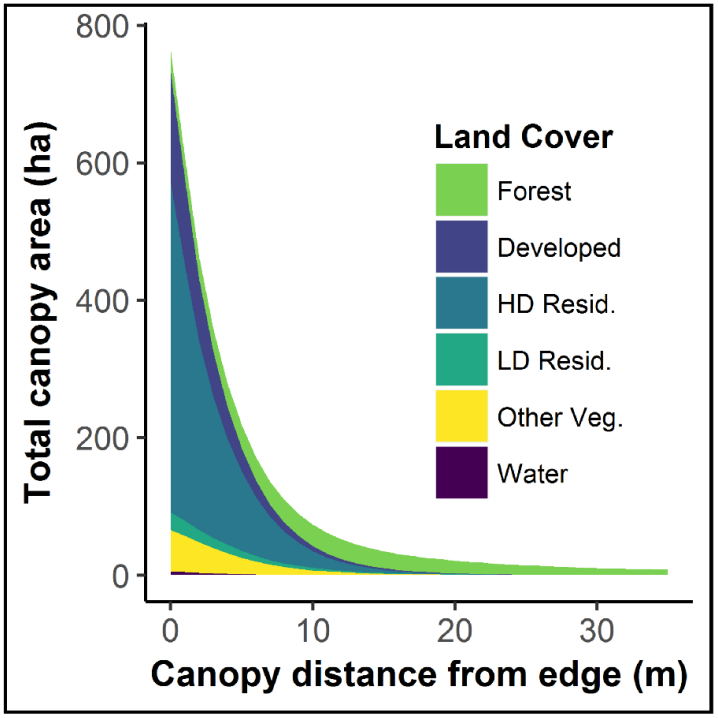


We are still explore the regional variations and mechanistic underpinnings, but the MA results not a fluke...

Morreale et al. in prep

What is the urban biosphere doing?



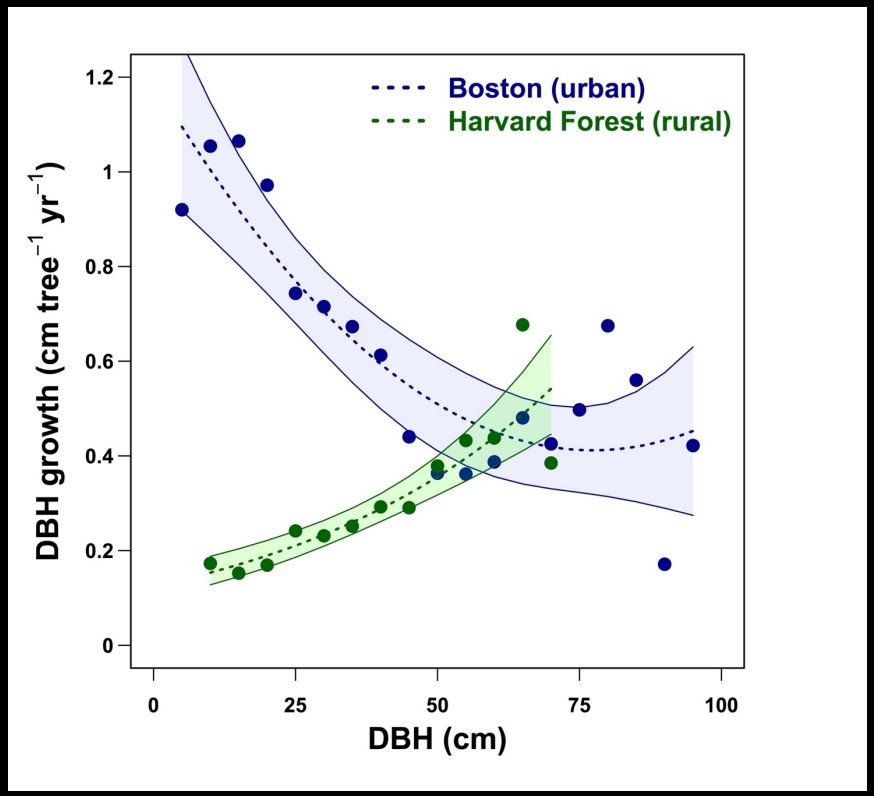


Check out his poster!

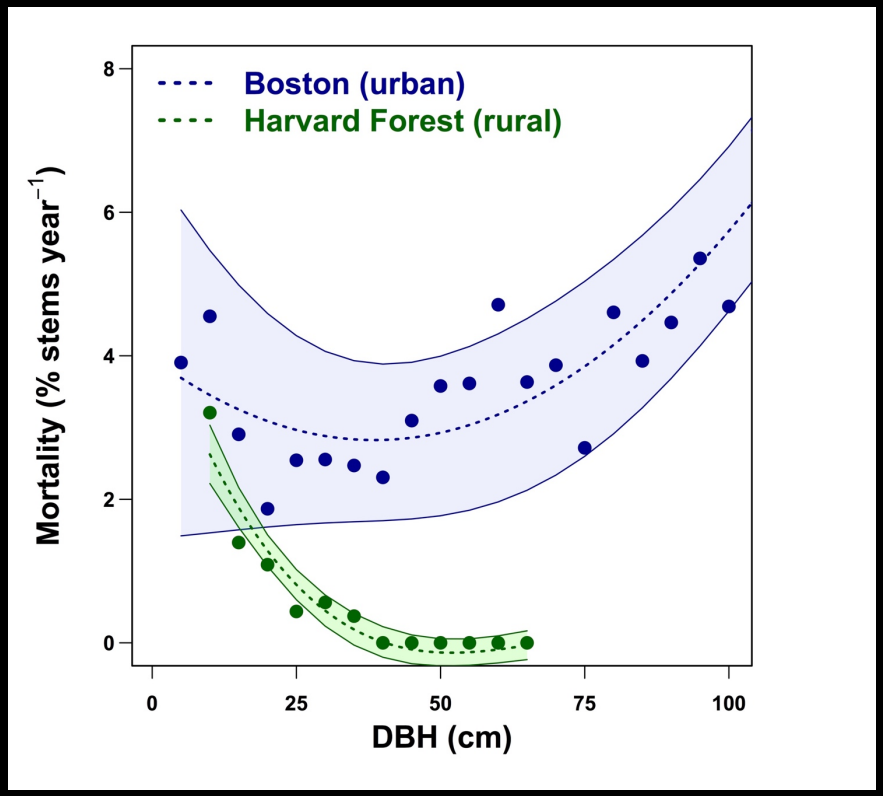
Trlica et al. in prep

What is the urban biosphere doing?

Live Fast!
Street tree growth rates (0.78 ± 0.02 cm tree^{-1} yr^{-1}) are higher than rural forested trees (0.02 ± 0.01 cm tree^{-1} yr^{-1}).

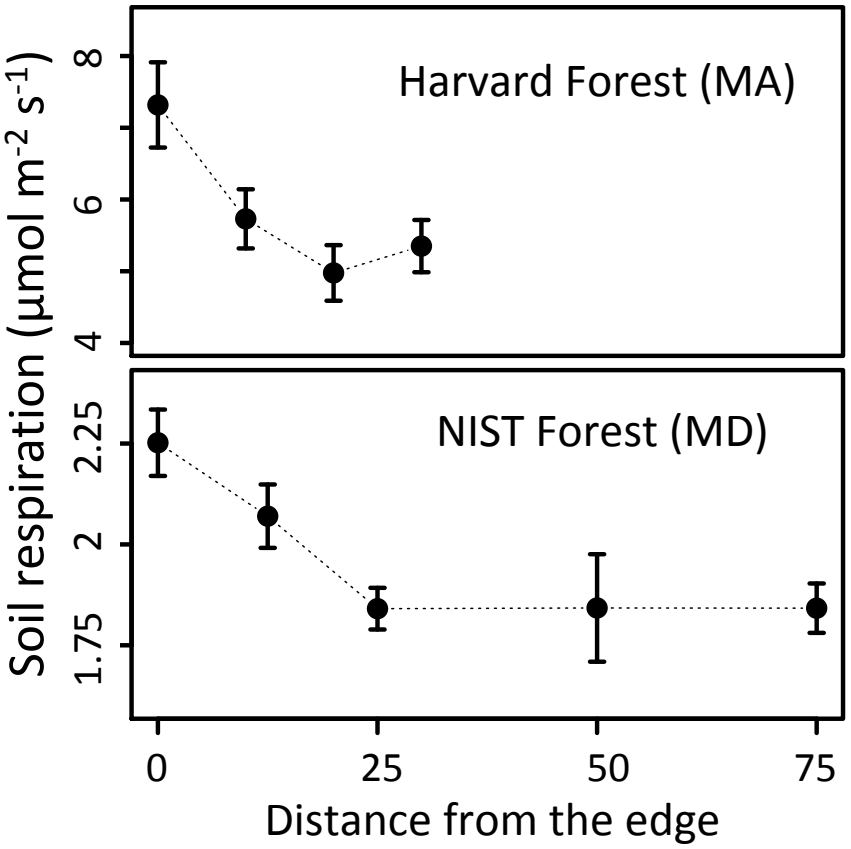


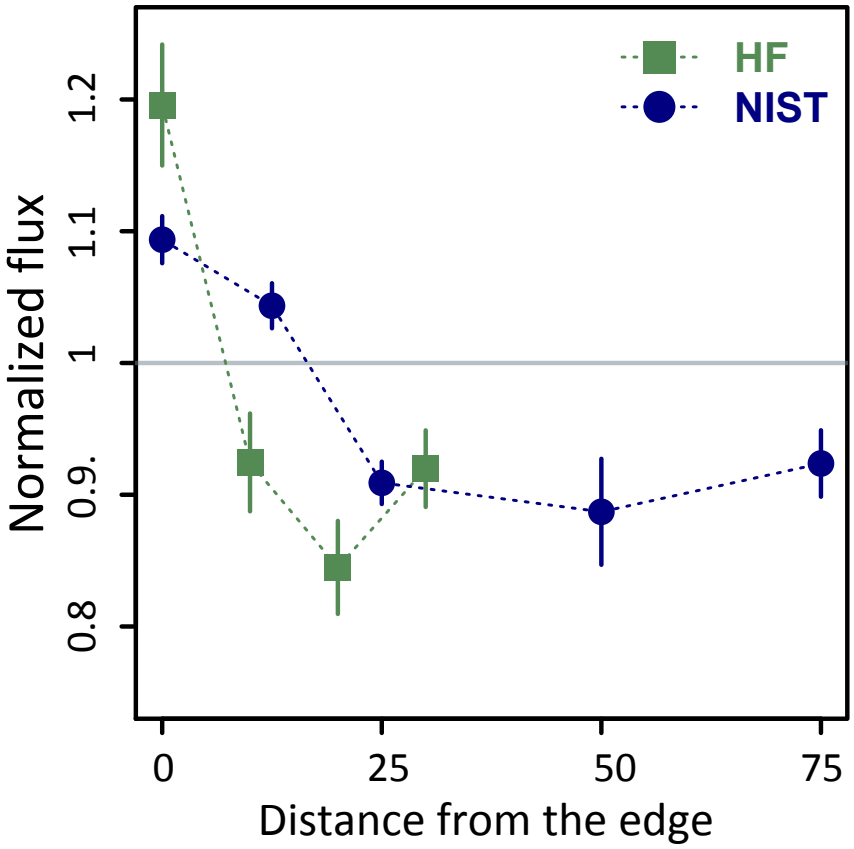
Die Young!
Street tree mortality rates (3.1 ± 0.2% stems yr$^{-1;}$ 2006-2014) were more than double non-urban rates (1.4 ± 0.04% yr^{-1})



Smith et al. in review

What is the urban biosphere doing?





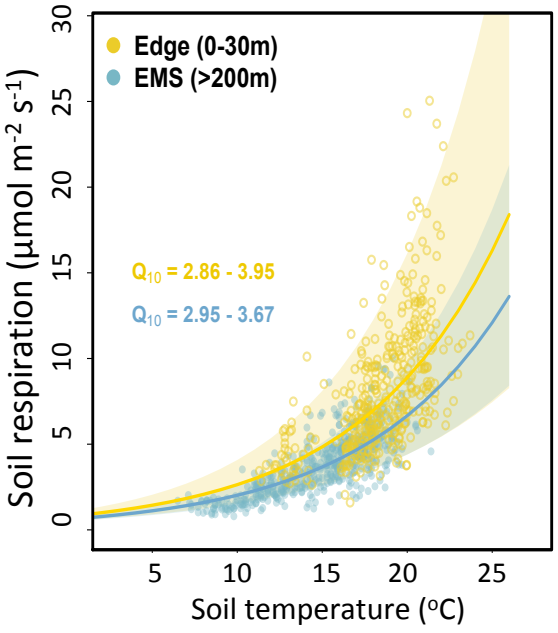
Smith et al. in prep

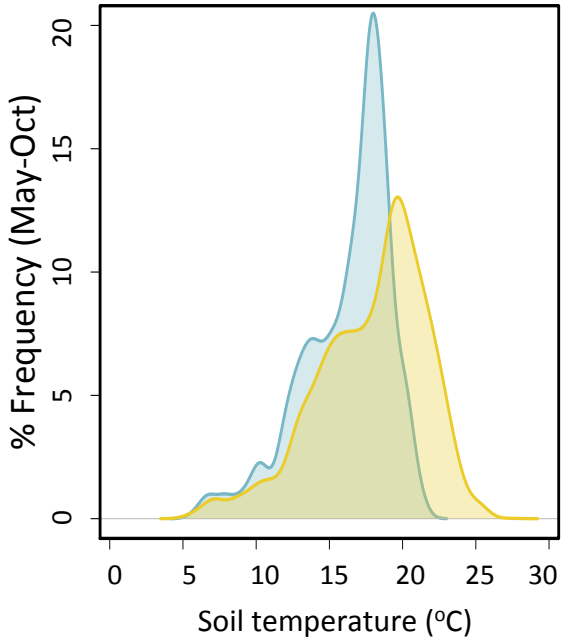
What is the urban biosphere doing?

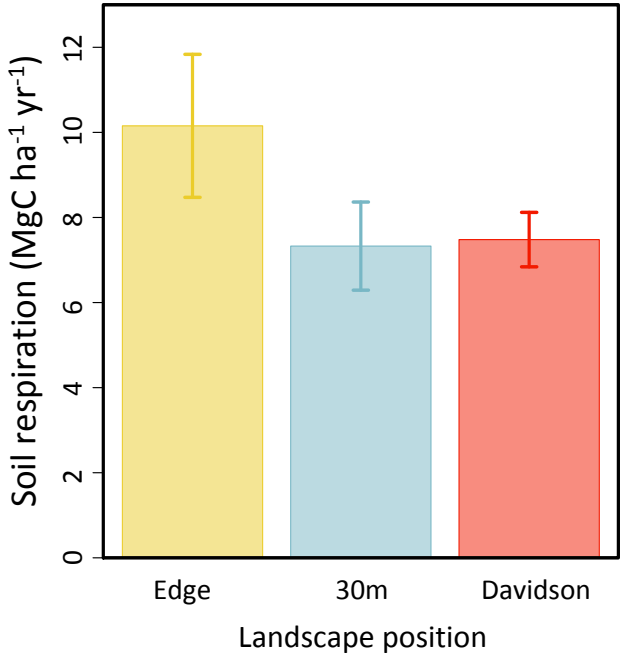
Temperature response of soil respiration is unchanged

Soil temperatures near the edge are higher

30% increase in soil respiration rates near edge (HF)

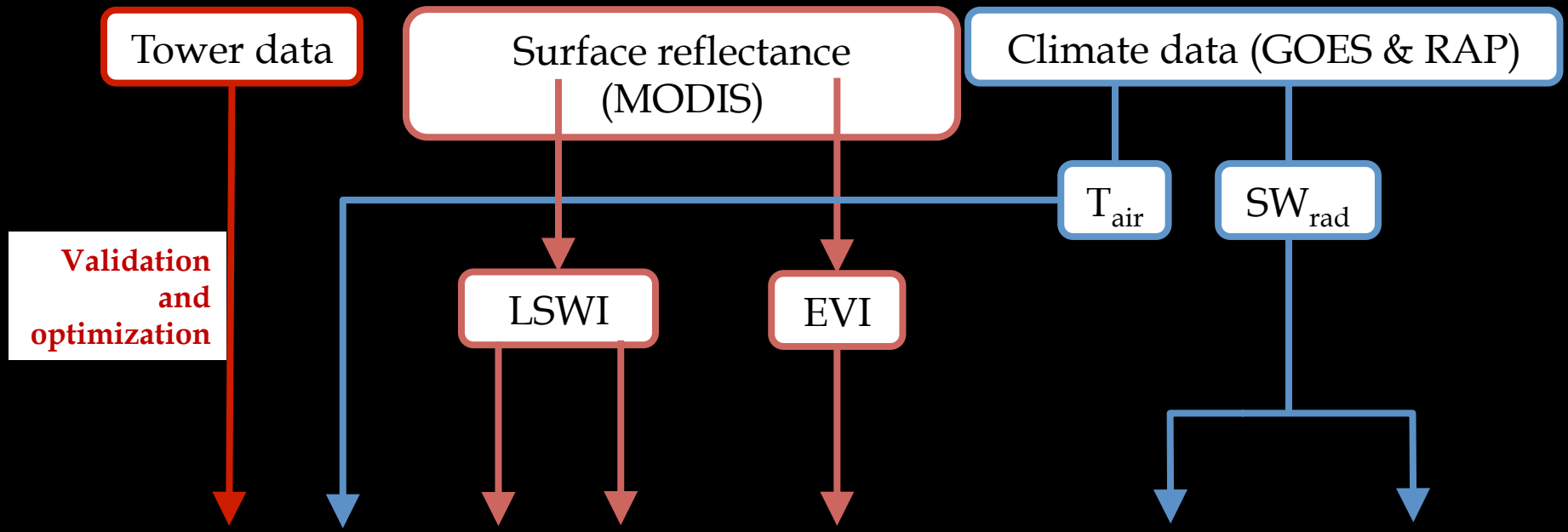






Smith et al. in prep

Does VPRM capture these mechanisms? **NO!**



Mahadevan et al. 2008; Hardiman et al. 2017

But, the estimated fluxes for Boston make sense

VPRM is a work in progress…

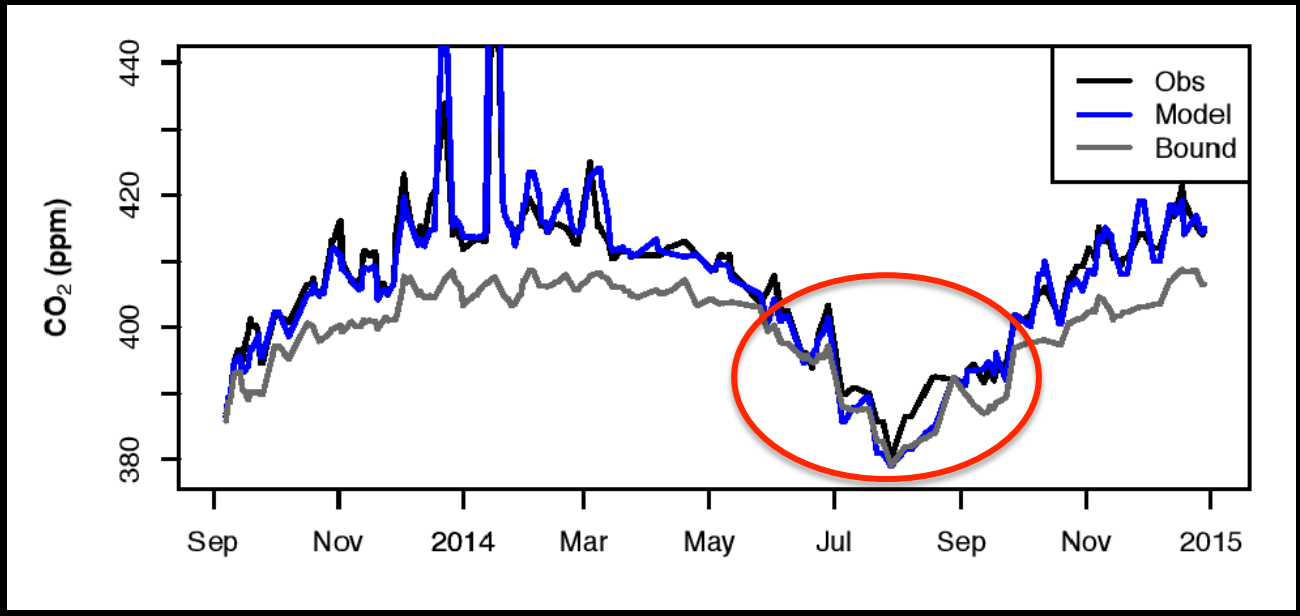
PNAS

Anthropogenic and biogenic CO_2 fluxes in the Boston urban region

Maryann Sargent[a,1], Yanina Barrera[a], Thomas Nehrkorn[b], Lucy R. Hutyra[c], Conor K. Gately[a,c], Taylor Jones[a], Kathryn McKain[d], Colm Sweeney[d], Jennifer Hegarty[b], Brady Hardiman[c,e], and Steven C. Wofsy[a]

[a]School of Engineering and Applied Sciences, Harvard University, Cambridge, MA 02138; [b]Atmospheric and Environmental Research, Inc., Lexington, MA 02421; [c]Department of Earth and Environment, Boston University, Boston, MA 02215; [d]Global Monitoring Division, Earth System Research Laboratory, National Oceanic and Atmospheric Administration, Boulder, CO 80305; and [e]Department of Environmental and Ecological Engineering, Purdue University, West Lafayette, IN 47907

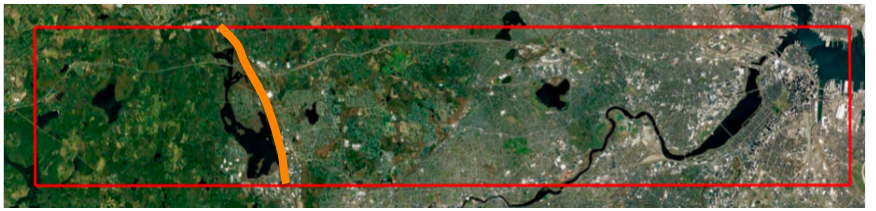
Edited by Ronald C. Cohen, University of California, Berkeley, CA, and accepted by Editorial Board Member A. R. Ravishankara May 25, 2018 (received for review March 5, 2018)

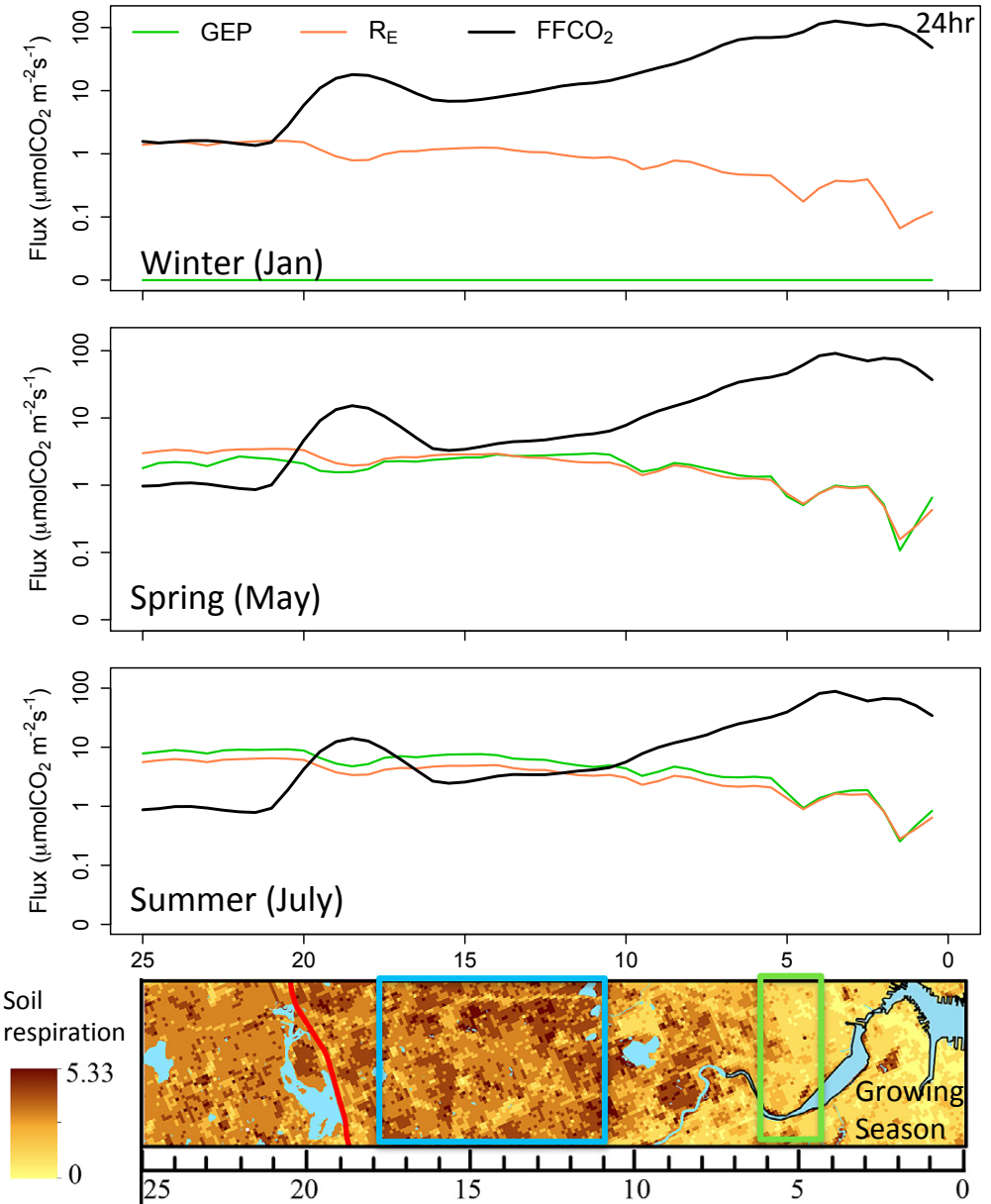


Seasonal Dynamics

July VPRM R_E = 4.3
measured R_s = 3.6

July VPRM R_E = 1.8
measured R_s = 1.5

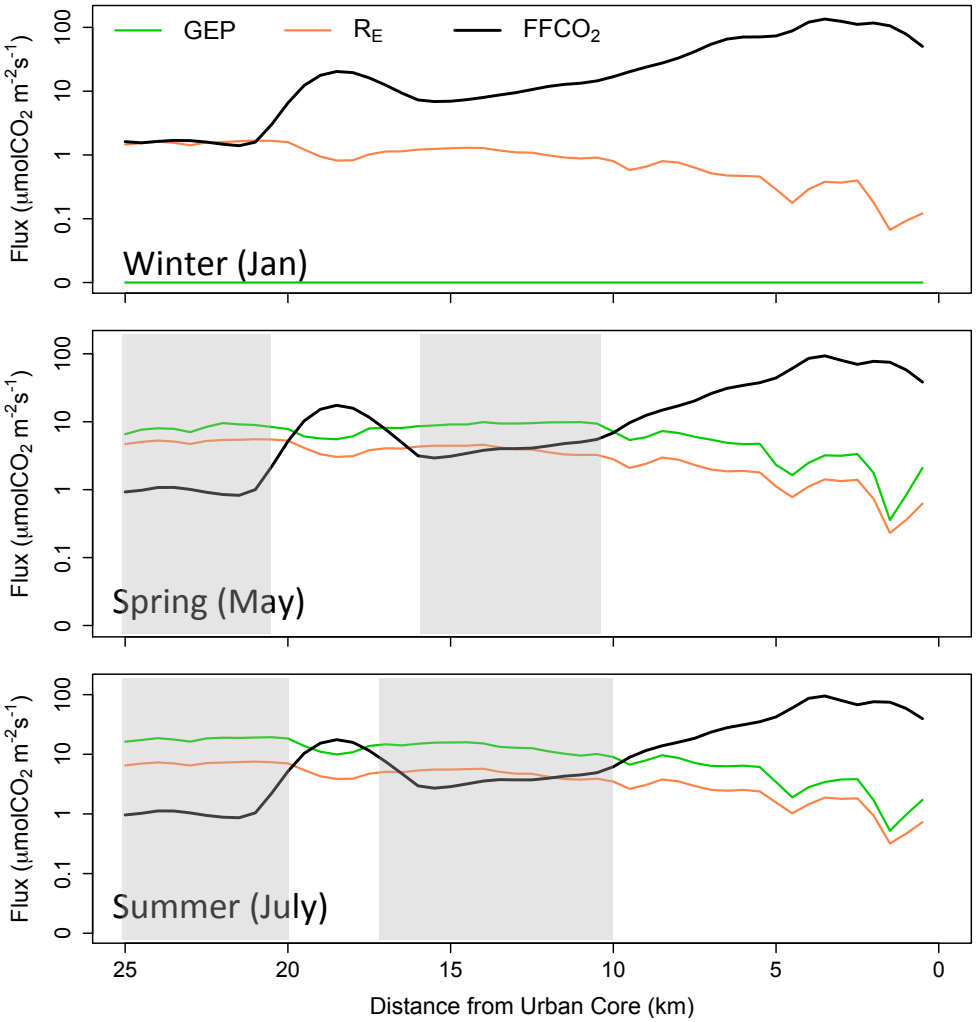




Seasonal & Diurnal Dynamics

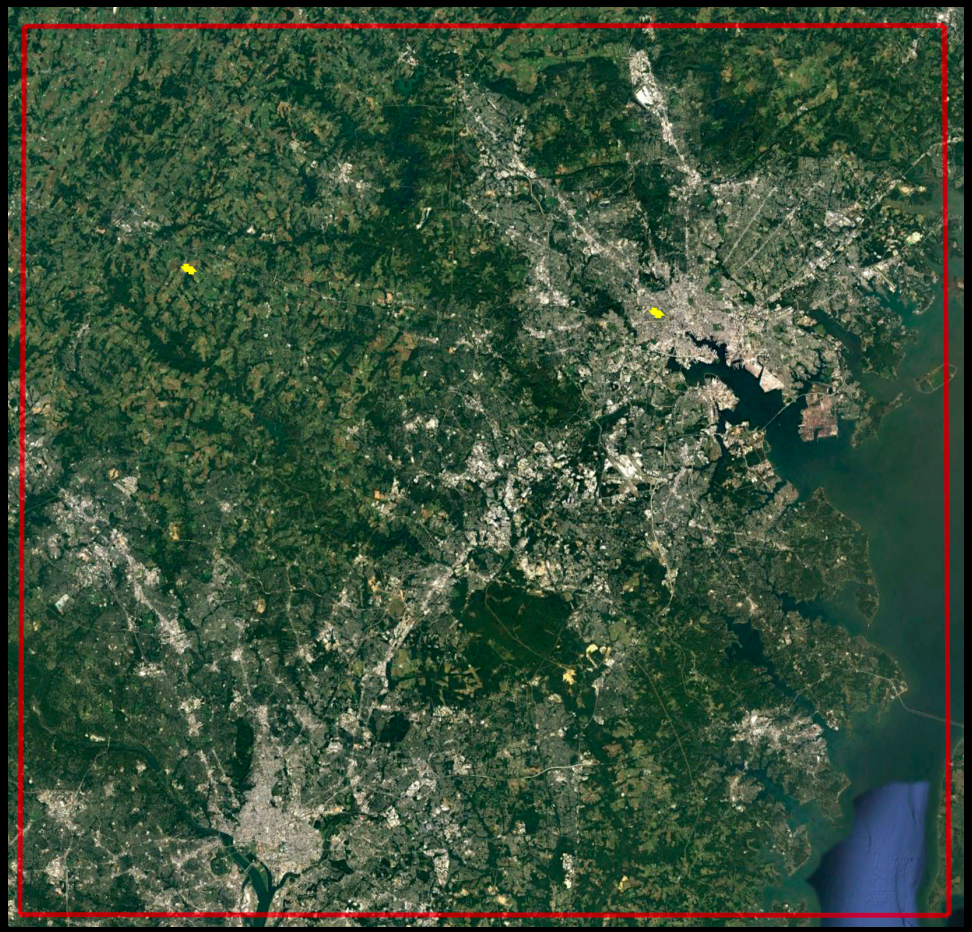
Highways, agriculture, golf courses, high density residential development

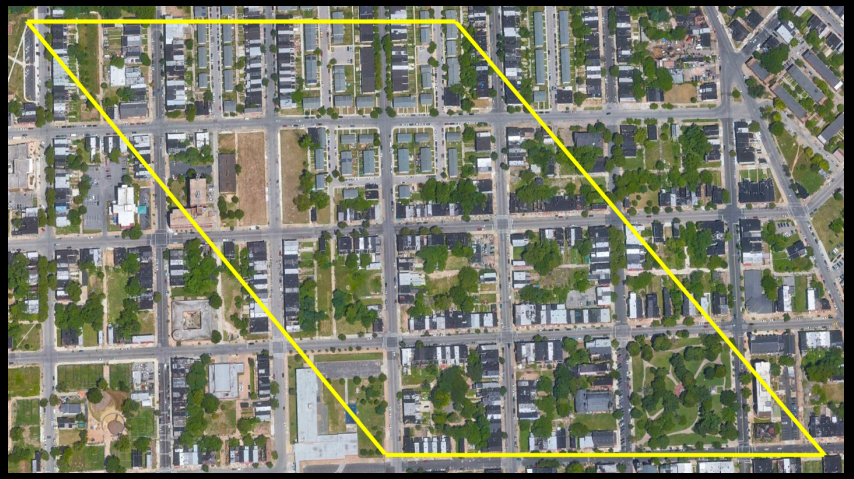
Fertilized, irrigated greenness increases the GEP estimates. Temperature model for R, but large export of dead organic material…



11am – 4pm local time

Other CO2USA Runs - Baltimore

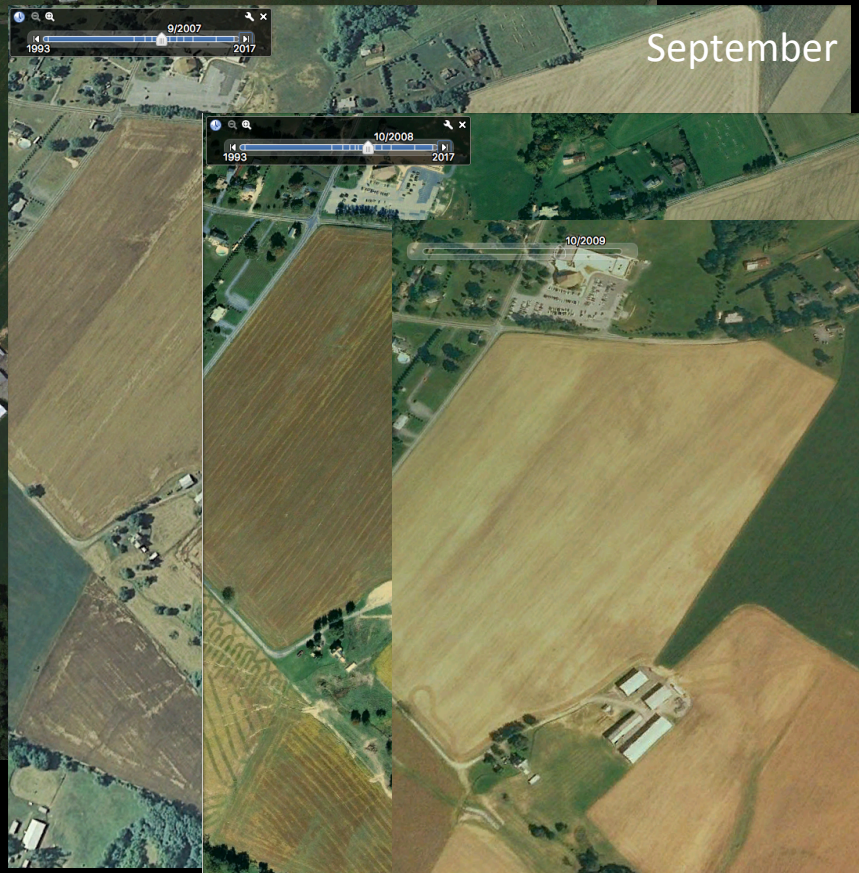




Other CO2USA Runs - Baltimore

April

August

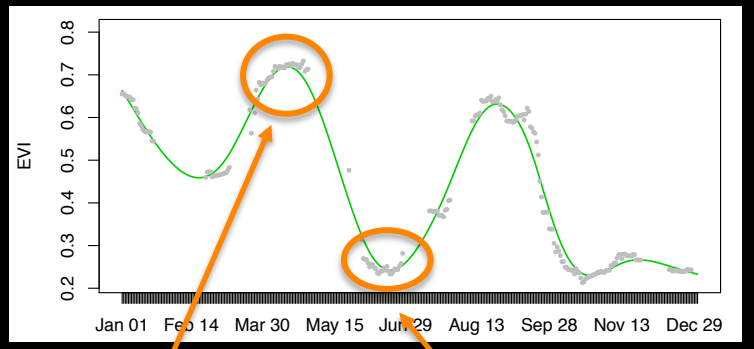


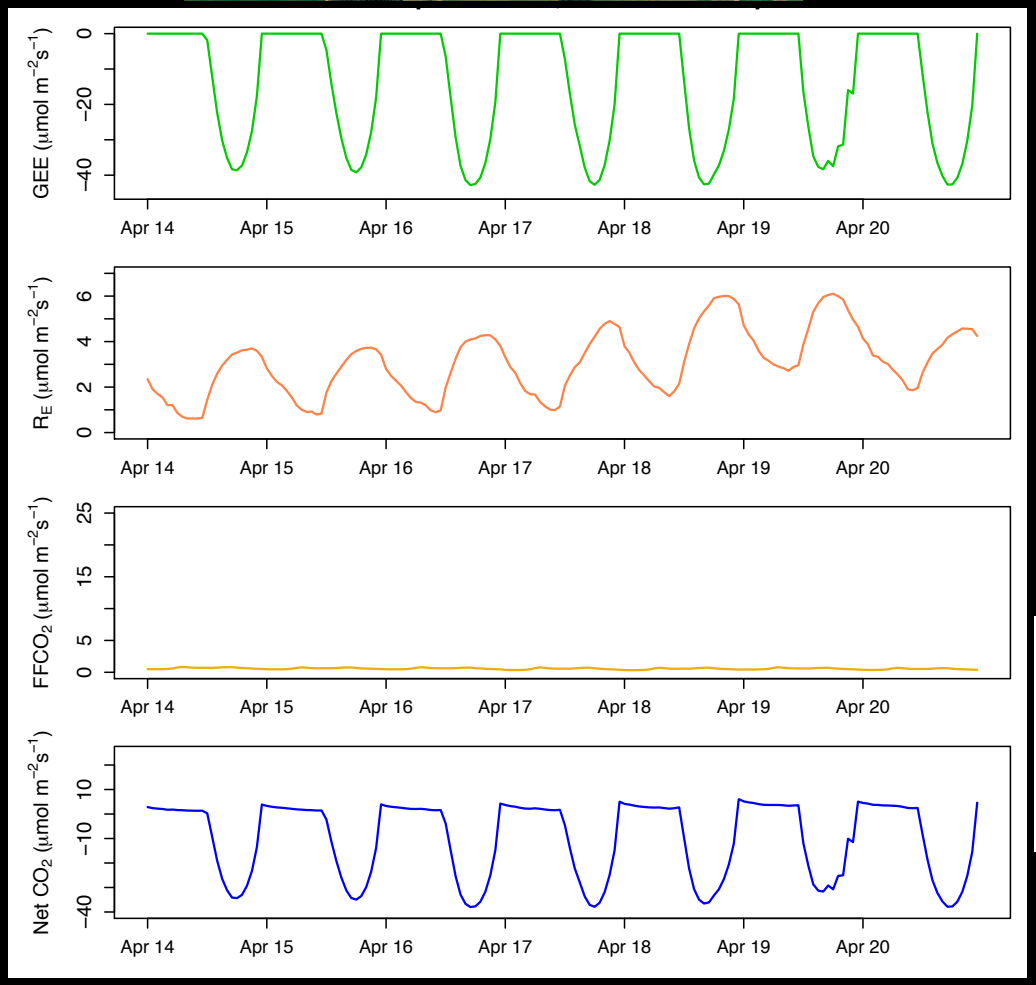
September

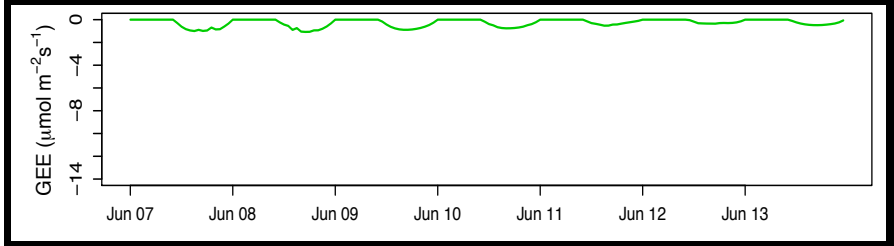
October

A different October

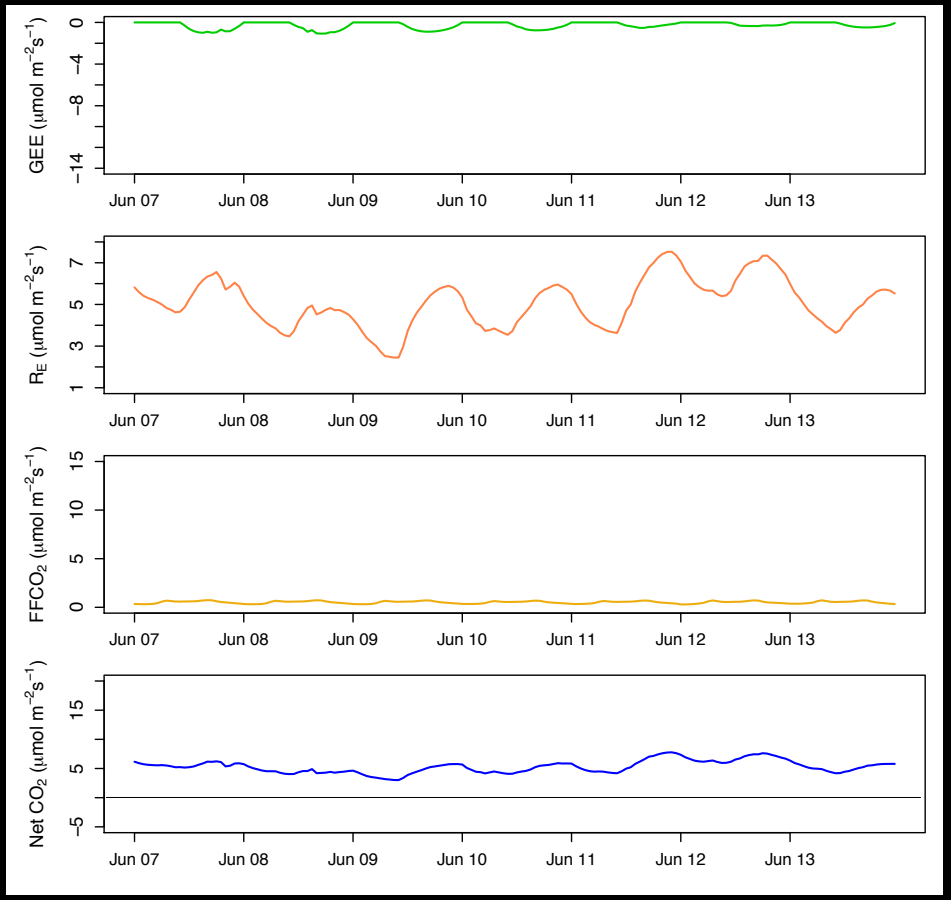
Other CO2USA Runs - Baltimore

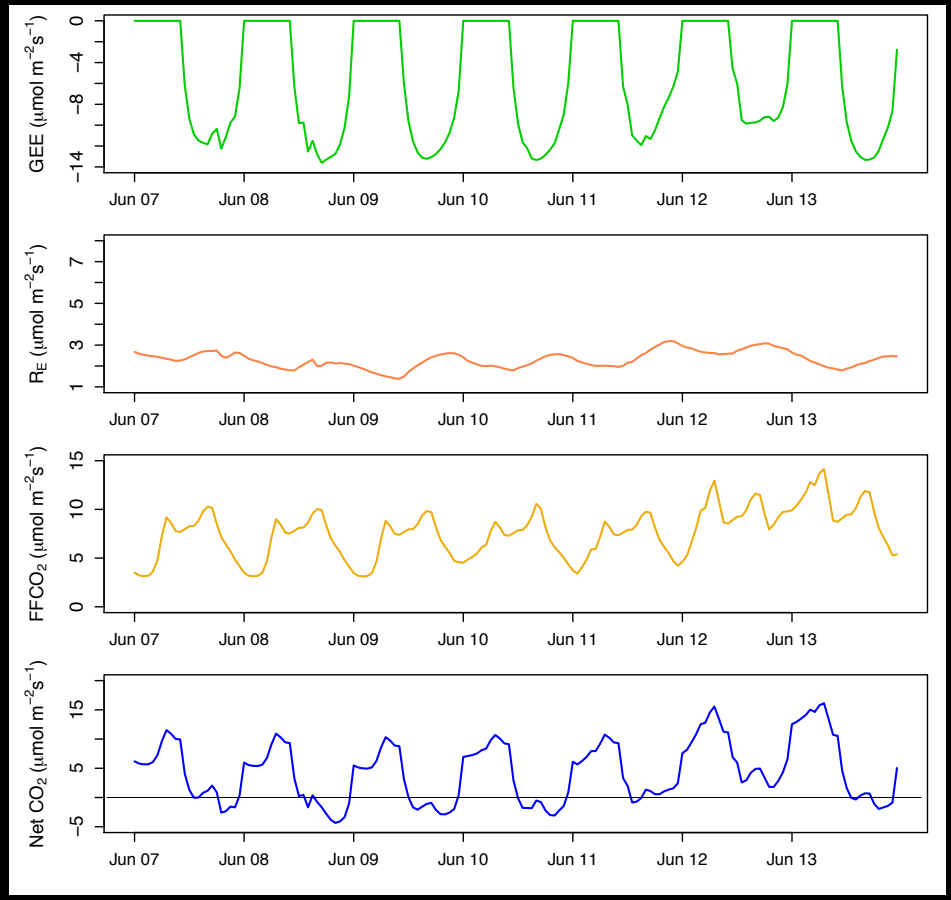






Other CO2USA Runs - Baltimore

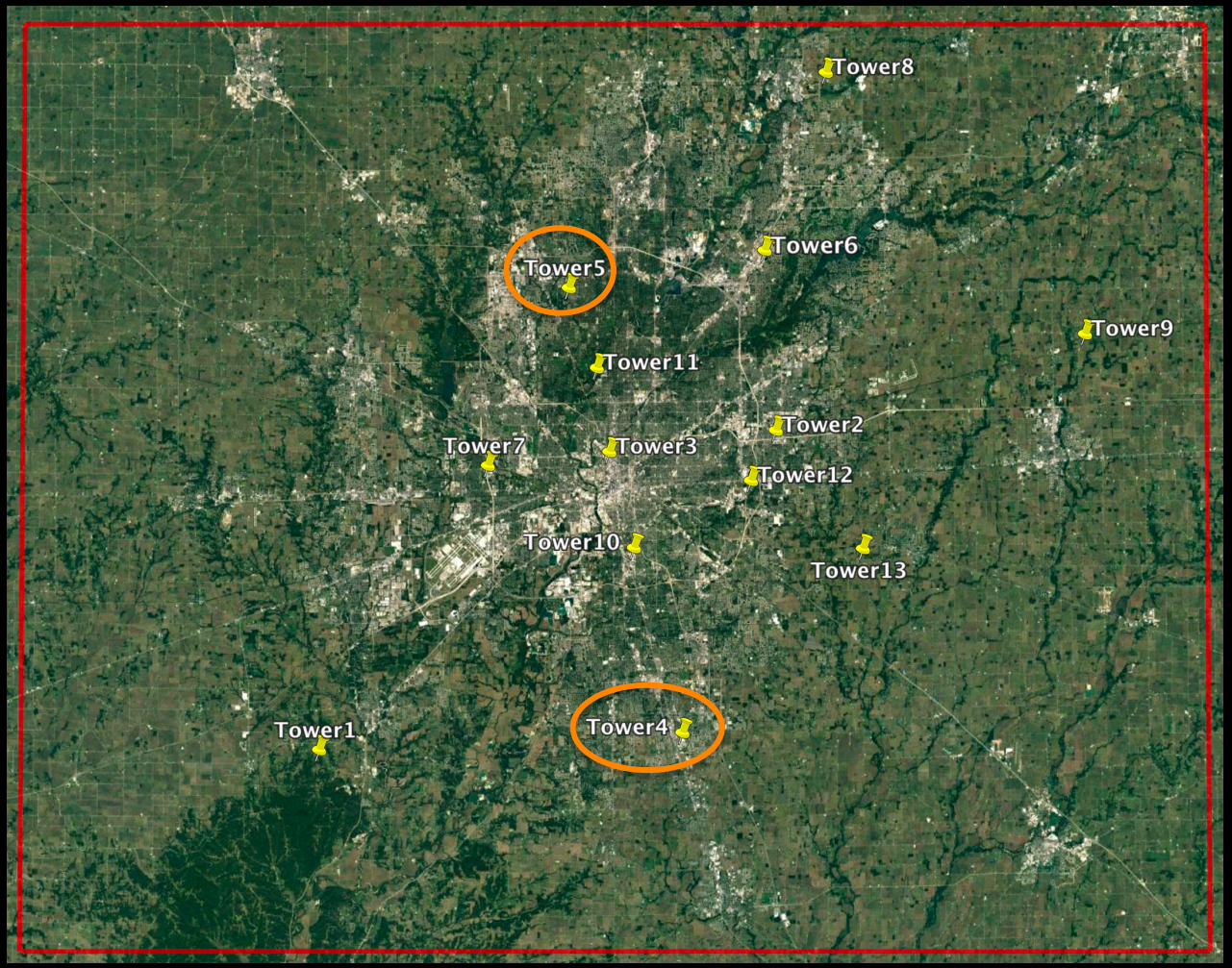




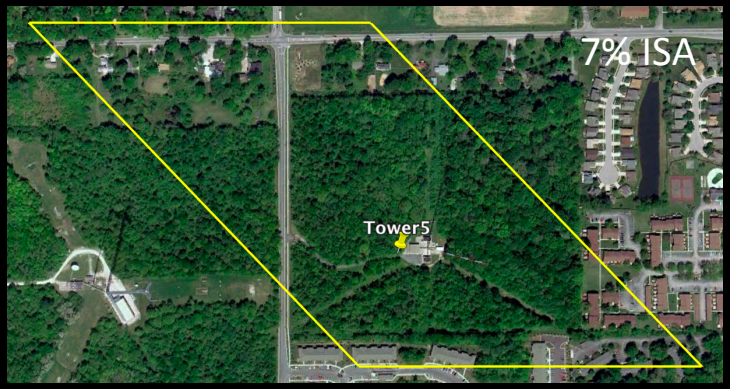
Other CO2USA Runs

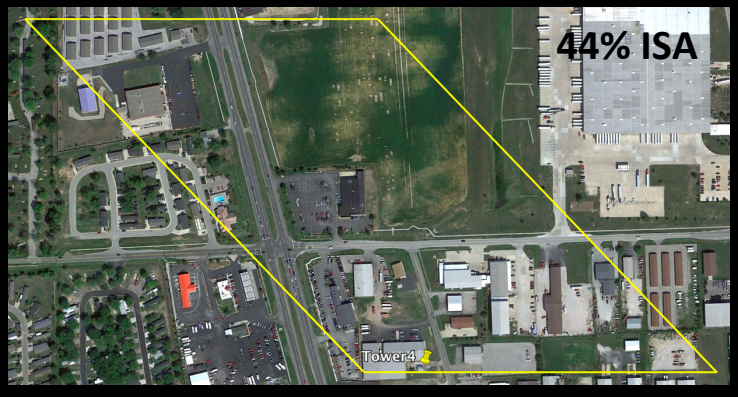
Salt Lake City

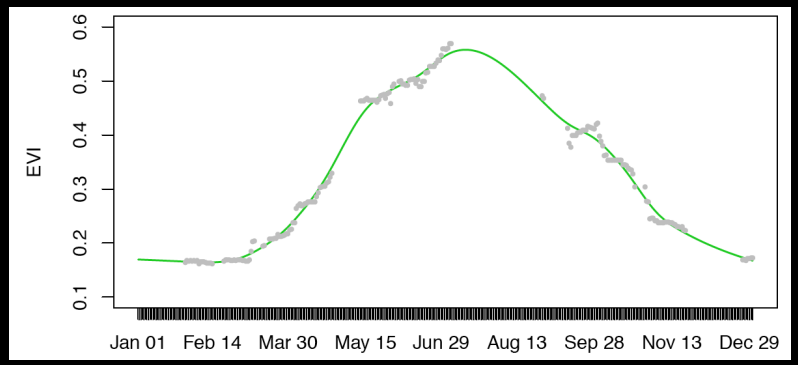
Indianapolis

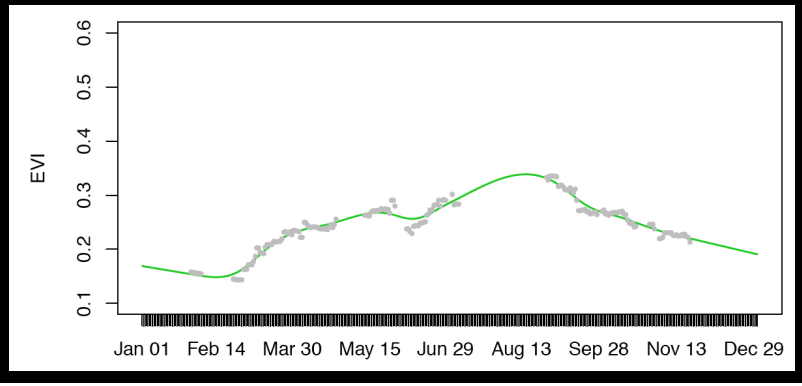


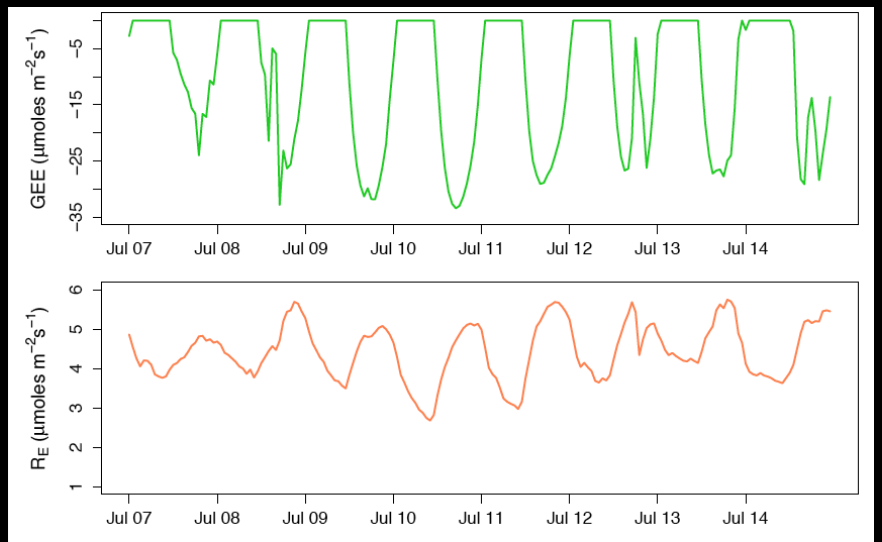
Other CO2USA Runs - Indy

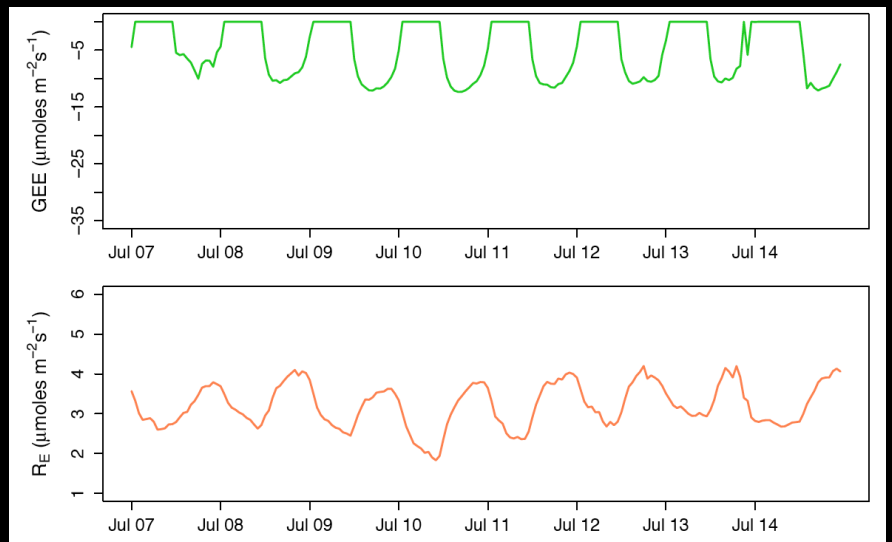






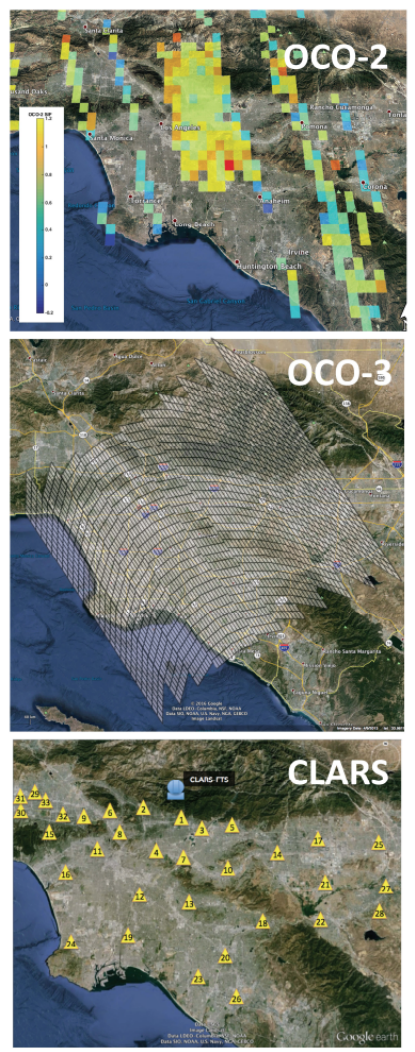




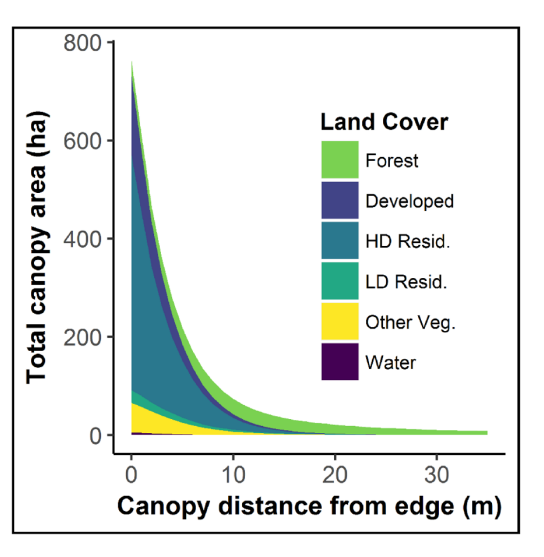


Next steps to "better" model what the urban biosphere doing?

Parazoo et al. in LA



Better characterization of fragmentation & pixel heterogeneity



More empirical observations for parameterization & validation