# Plant Water Relations: Regional Synthesis and Messaging

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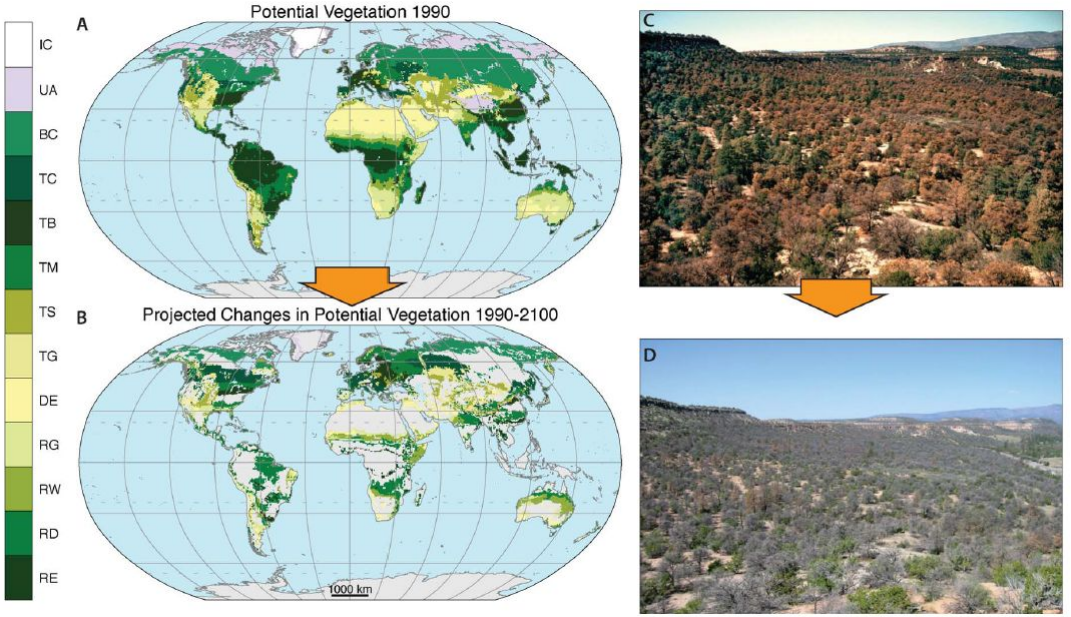
UF: M. Wightman, T. Martin, C. Gonzalez-Benecke, E. Jokela, W. Cropper

Pine Integrated Network: Education, Mitigation, and Adaptation project (PINEMAP) is a Coordinated Agricultural Project funded by the USDA National Institute of Food and Agriculture, Award #2011-68002-30185

# WHY DO WE CARE ABOUT PLANT WATER RELATIONS?

On underestimation of global vulnerability to tree mortality and forest die-off from hotter drought in the Anthropocene

Craig D. Allen,[1,†] David D. Breshears,[2] and Nate G. McDowell[3]

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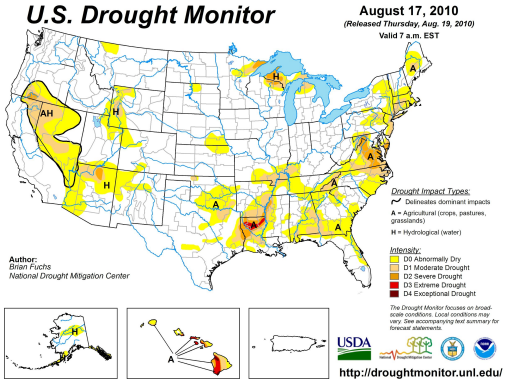
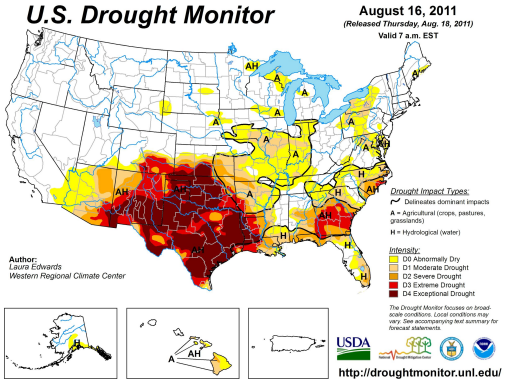
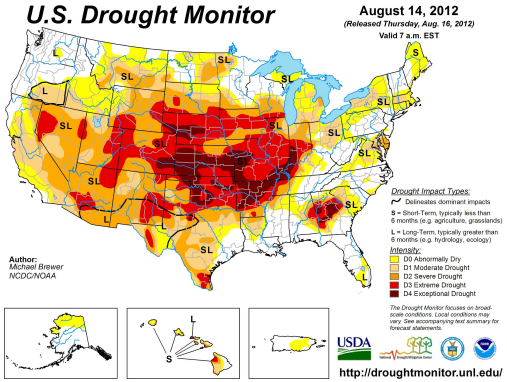
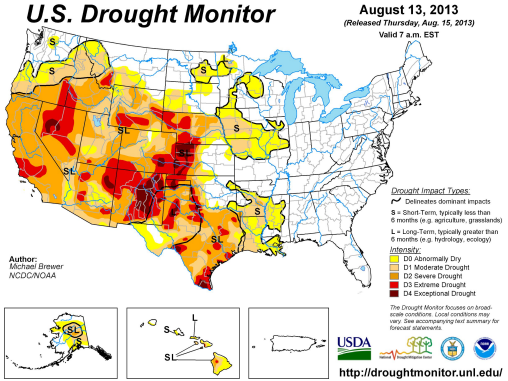
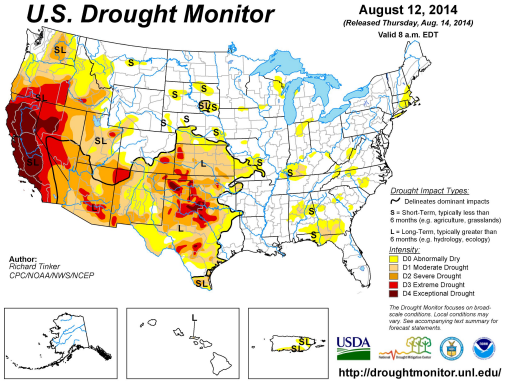
# Less Rain = Less Productivity?

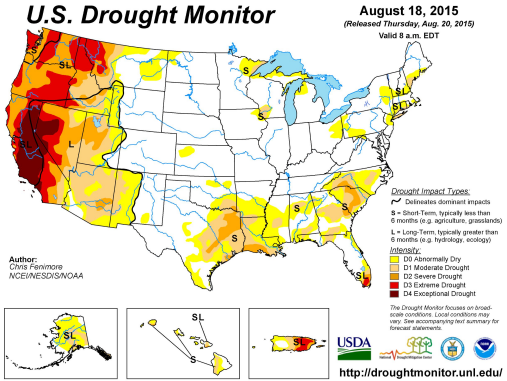
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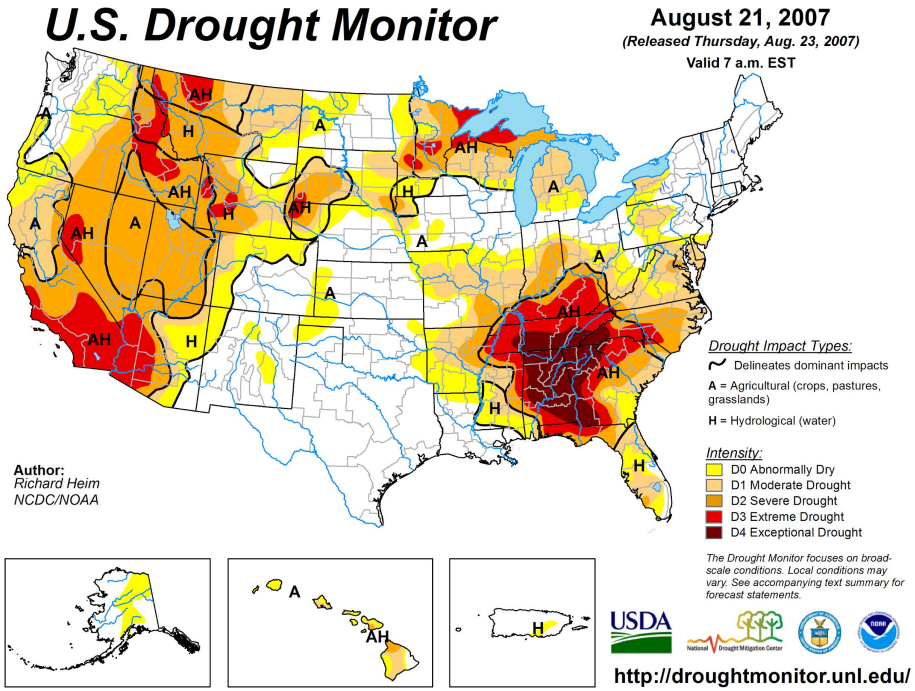
# It happens here too...

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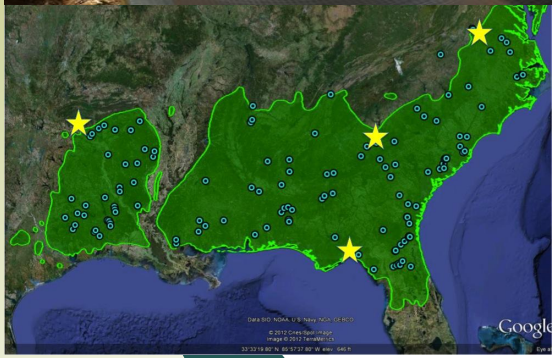

## Tier 3 Study

4 Sites, est. 2003-2008

Throughfall Reduction x Fertilization

Study: Spring 2012 - Dec.2015

| | Precip. (mm) | Annual Mean Temp. | Jan. Min Temp | Aug. Max Temp |
|---|---|---|---|---|
| Virginia | 1120 | 13.6 | −4.4 | 30.6 |
| Georgia | 1220 | 16.1 | 0.0 | 31.6 |
| Florida | 1450 | 19.4 | 7.3 | 31.1 |
| Oklahoma | 1300 | 16.6 | −1.6 | 34.2 |

Table adapted from Will et al. (2015) Forests 6(6): 2014-2028.

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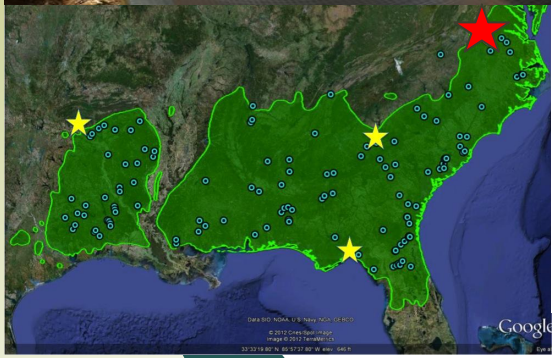
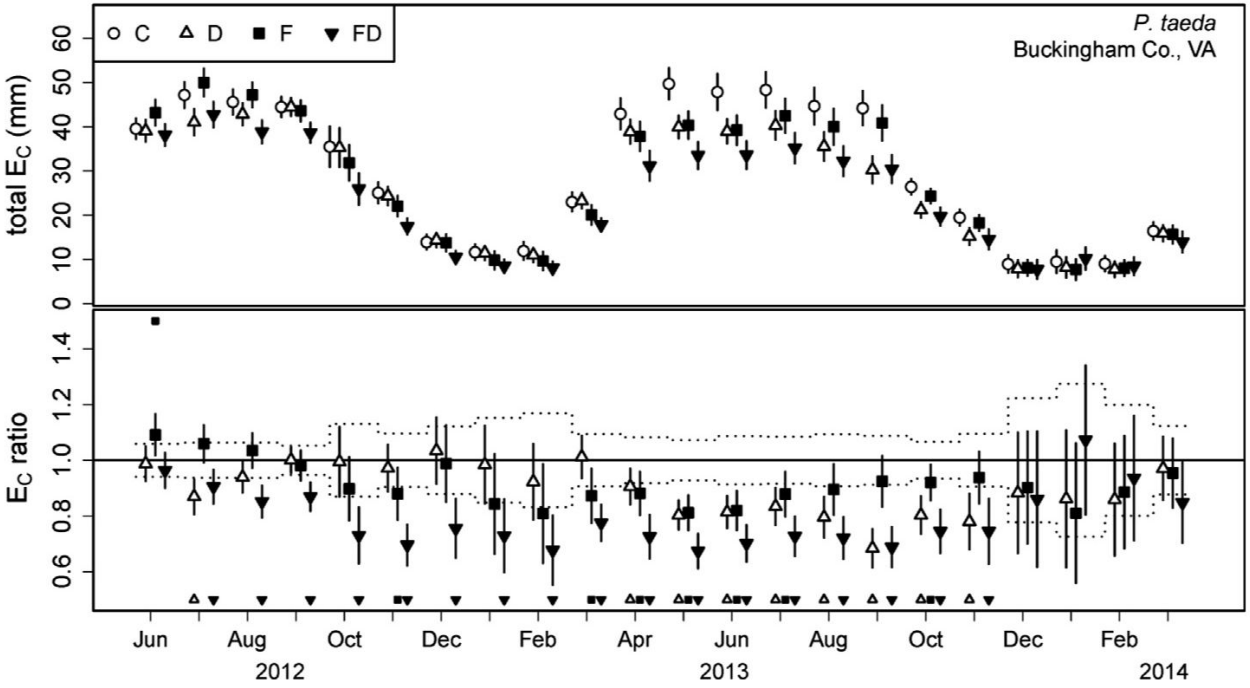
# Virginia

Fertilization intensifies drought stress: Water use and stomatal conductance of *Pinus taeda* in a midrotation fertilization and throughfall reduction experiment

Eric J. Ward[a,*], Jean-Christophe Domec[a,b], Marshall A. Laviner[c], Thomas R. Fox[c], Ge Sun[d], Steve McNulty[d,e], John King[a], Asko Noormets[a]



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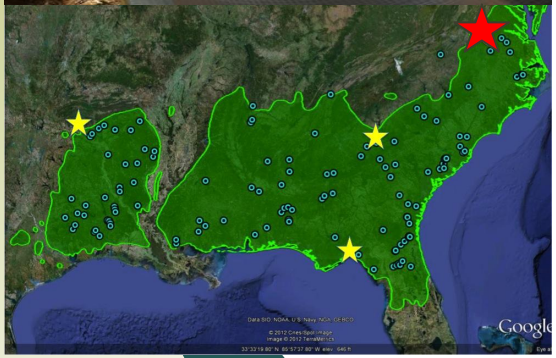

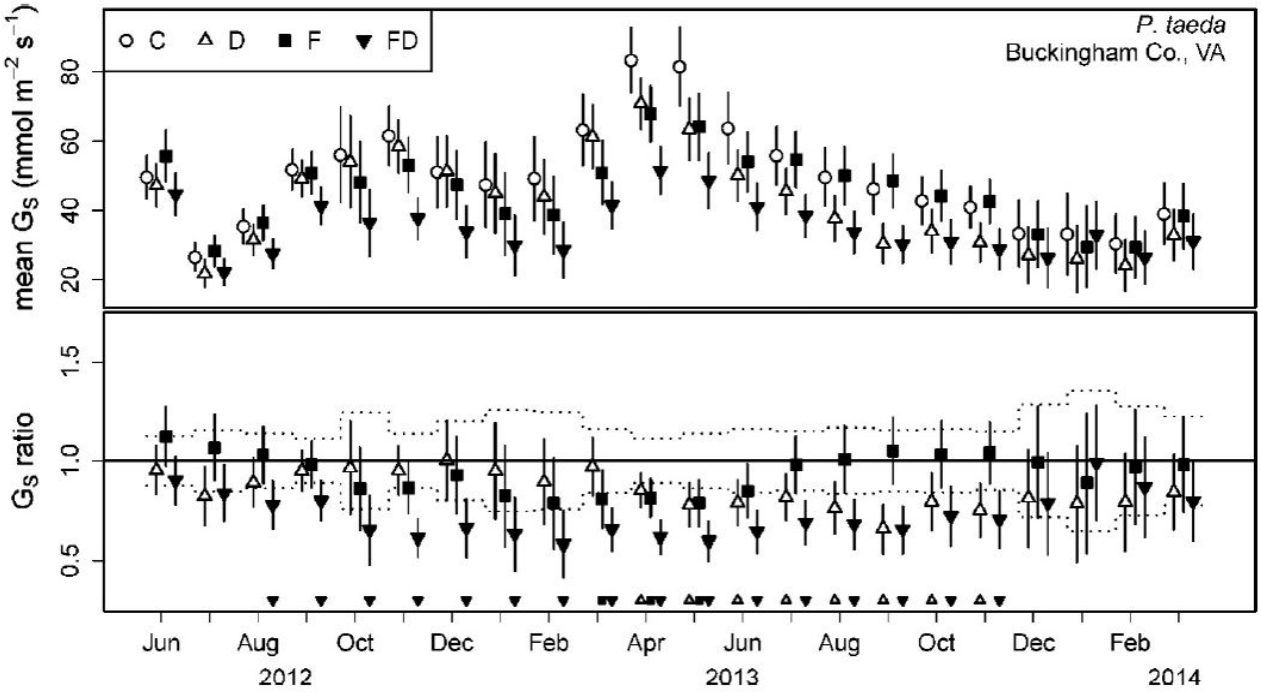


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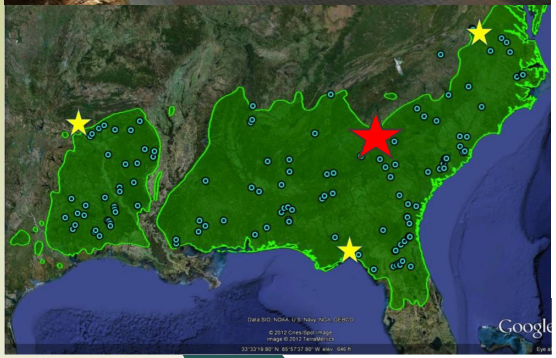
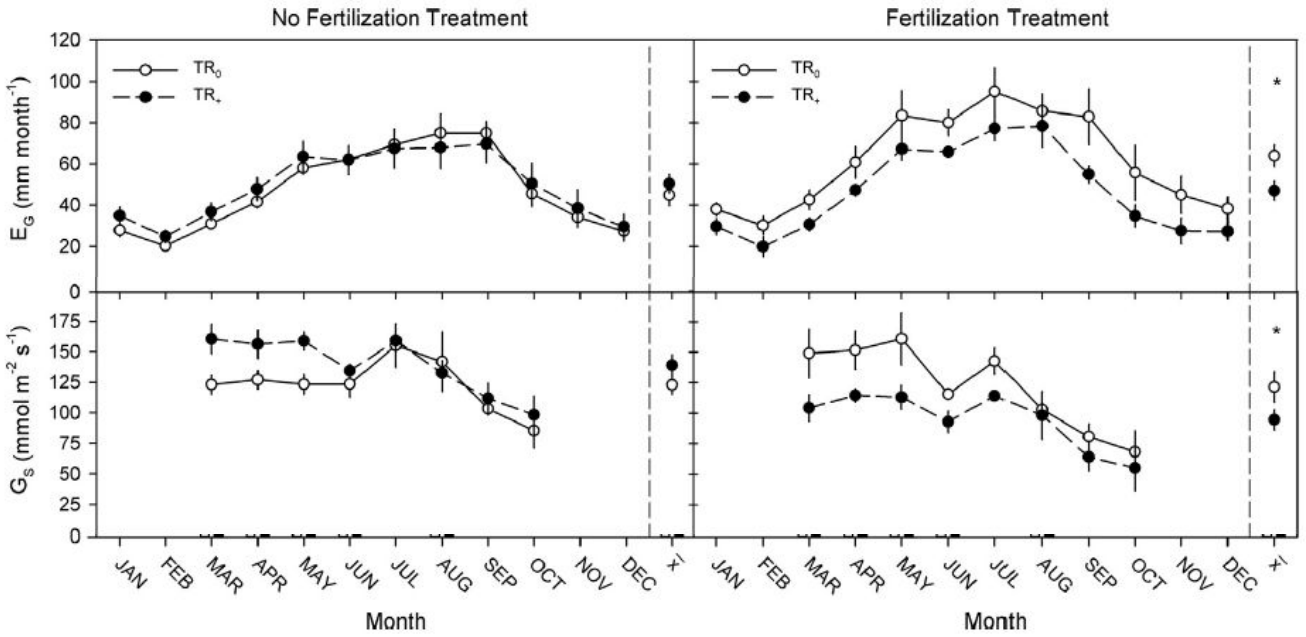
# Georgia

Fertilization increases sensitivity of canopy stomatal conductance and transpiration to throughfall reduction in an 8-year-old loblolly pine plantation

Stan M. Bartkowiak [a], Lisa J. Samuelson [a,*], Mary Anne McGuire [b], Robert O. Teskey [b]

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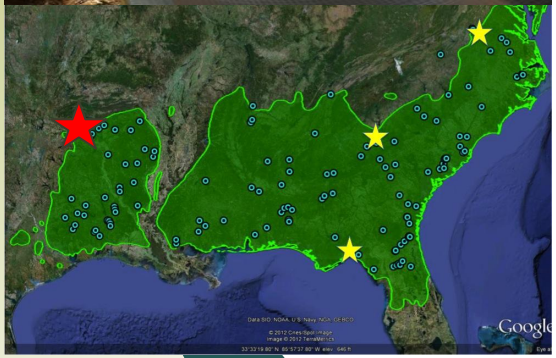
# Oklahoma



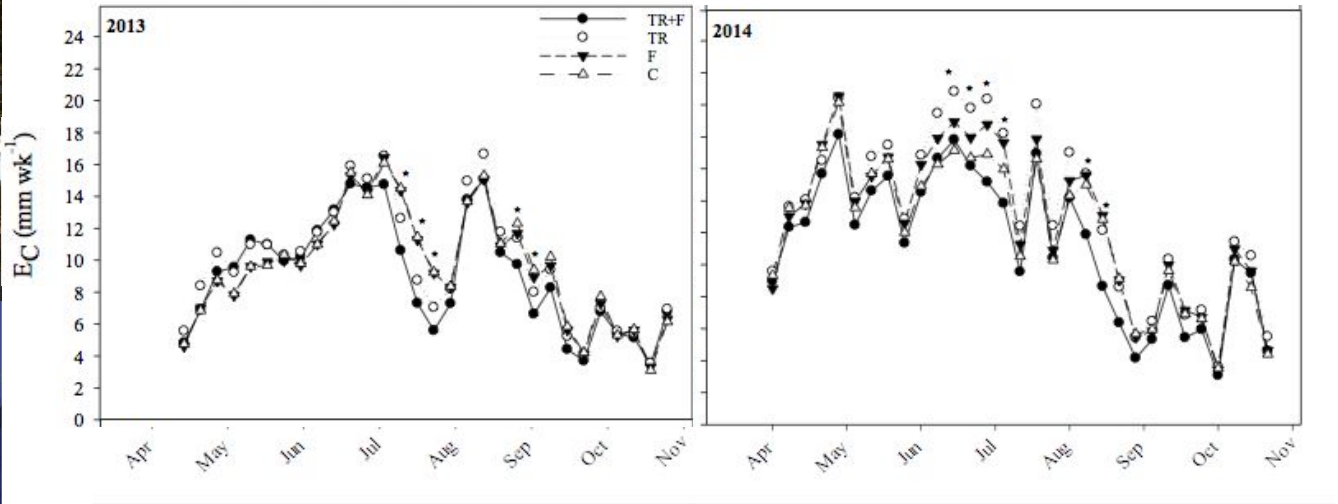



Figure adapted from A. Maggard

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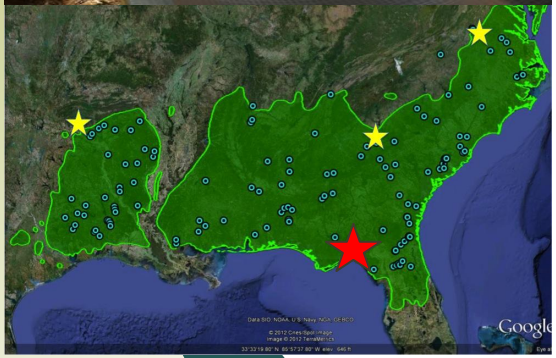
# Florida



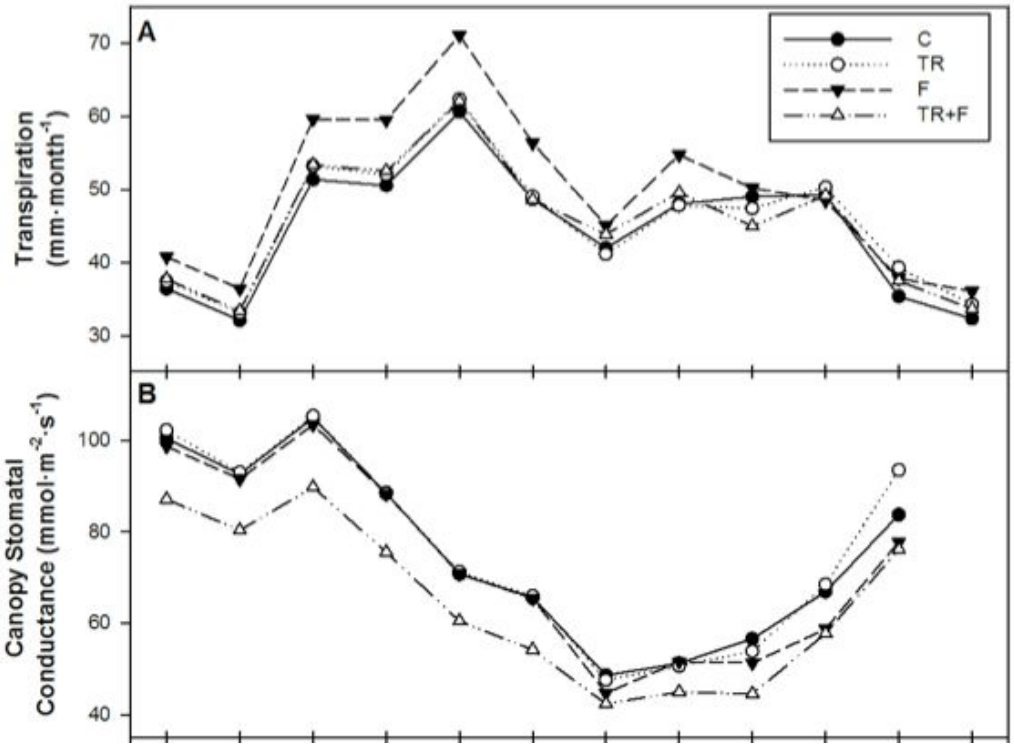



Figure adapted from M. Wightman

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# What we need in a sap flux synthesis

- A consistent method of dealing with non-random missingness in data
  - Too many sensors to avoid outages
  - Not enough sensors that mean rates are unaffected by outages
  - Leverage understanding of stomatal regulation

- Account for stand development and interannual variability in climate
  - Scaling from probe to canopy
  - Stomatal responses to light, VPD and soil moisture

- A propagation of uncertainty to the canopy scale on a monthly time step
  - This is the kind of information useful to regional models

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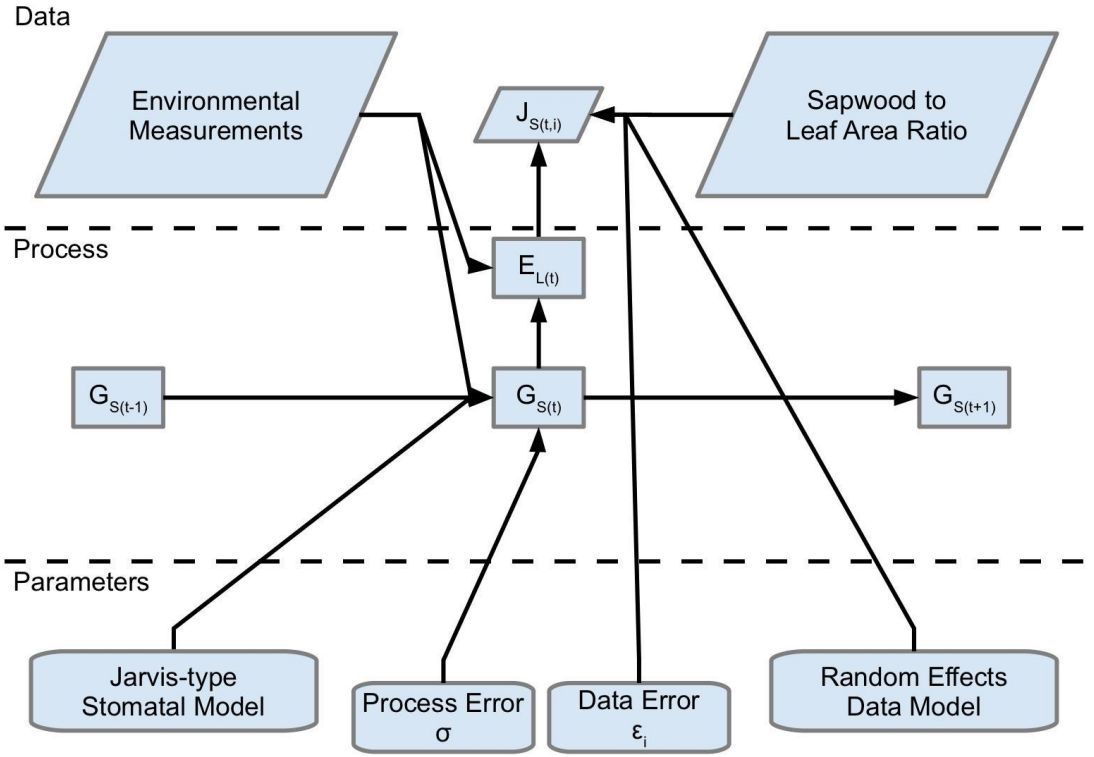
# State-Space Canopy Conductance (StaCC) Model

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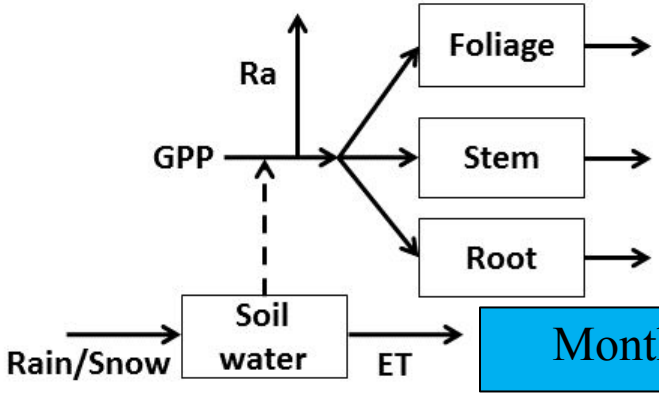
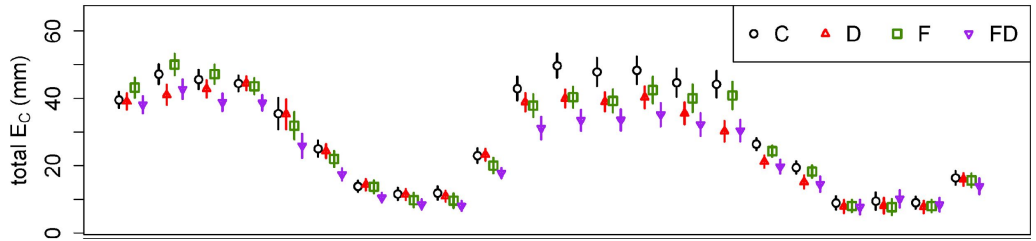
# Assimilation in Regional 3-PG Model




Annual
Plot Level
Biomass Estimates

Monthly Plot Level Transpiration Estimates

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# Further Research

Hydraulic Vulnerability Curves (VA)

- Measured hydraulic conductivity across water potential range 0-5 MPa on 2 coarse roots and 2 branches per plot (8 per treatment) during Jan-March 2016.
- Potential proximal explanation for observed patterns of sap flux.

Physiological Phenotyping (GA)

- Measuring sap flux on 120+ individuals in fertilized (non-TR) plots Apr-Jun 2016
- DNA fingerprinting of individuals to explore links between genetic and physiological variability
- Provides additional information on tree and plot level uncertainties in sap flux synthesis

Photo: John Seiler

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# Messaging on Water Relations

## Scientists

How does a 30% reduction of throughfall impact $G_S$, water potential and hydraulic vulnerability?

Do these effects interact with those of fertilization?

## Public

Will droughts reduce growth? Does fertilization make this better or worse?

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# Messaging on Water Relations

## Scientists

Are there observable changes in hydraulic conductance or vulnerability profiles with throughfall reduction, fertilization or their combination?

## Public

Will droughts kill trees?

Does fertilization make them more vulnerable?

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# Messaging on Water Relations

## Scientists

Can modeling efforts incorporate water relations research into regional assessments and projections?

## Public

What does this research mean for the region and the future?

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# Discussion Questions

1. Who are our target audiences?
2. How do we convey concept of water stress when mortality is a rare event and carbon reserves buffer interannual variability in growth?
3. How do we deal with the need for site specific silviculture in our messages about water stress?
4. What do we suggest about future research?

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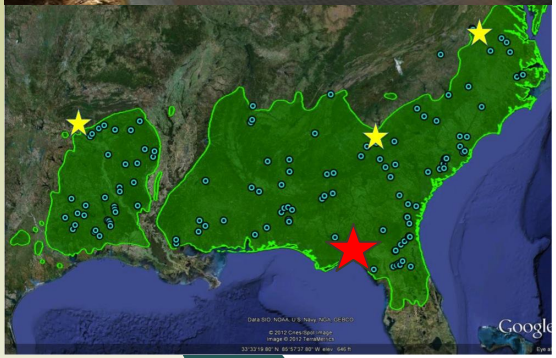

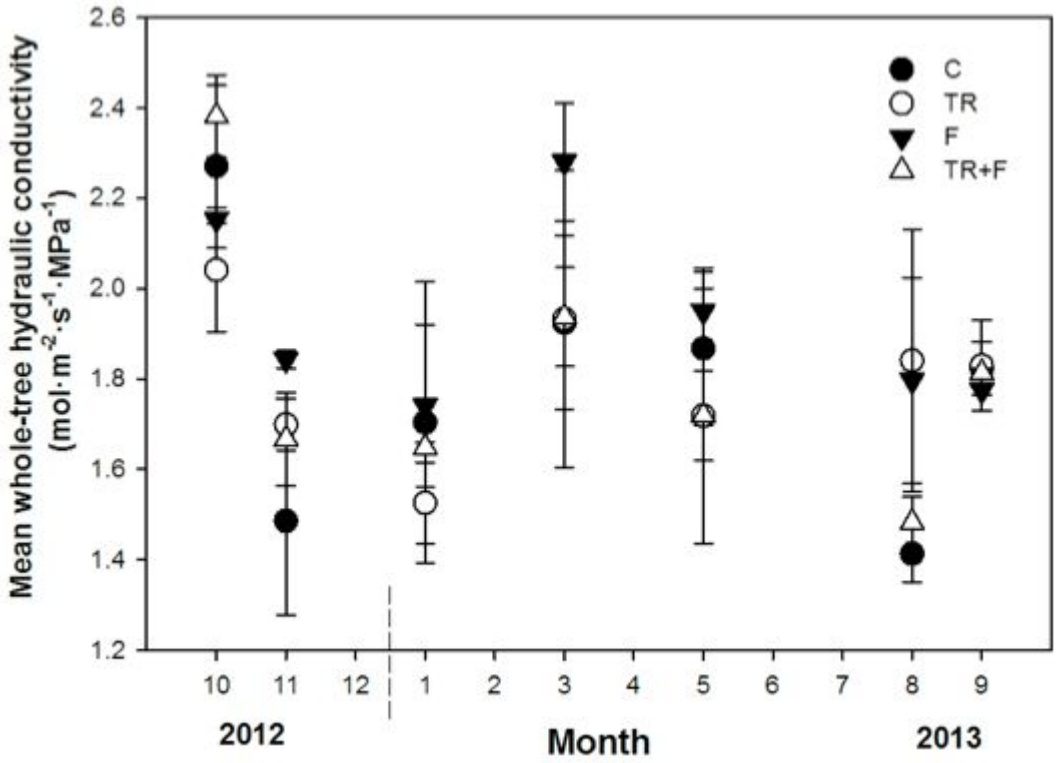


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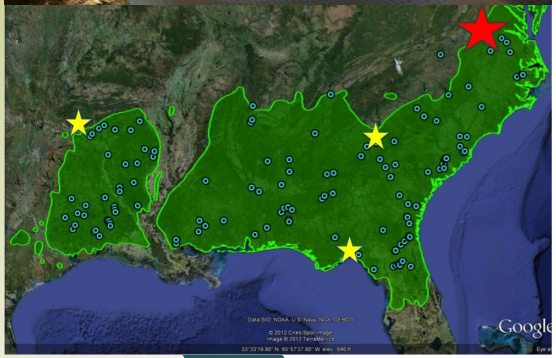

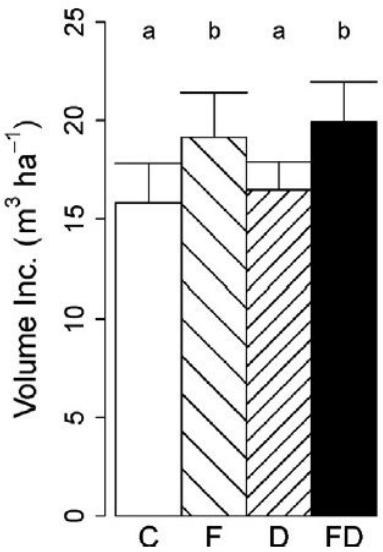


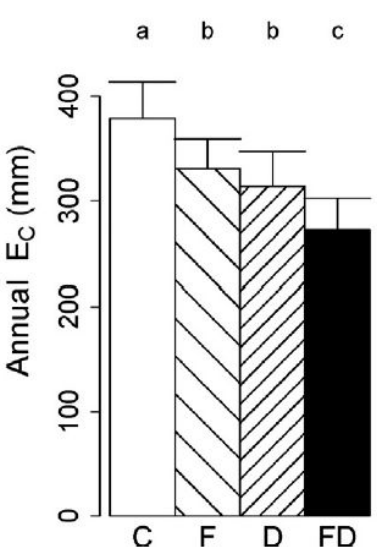


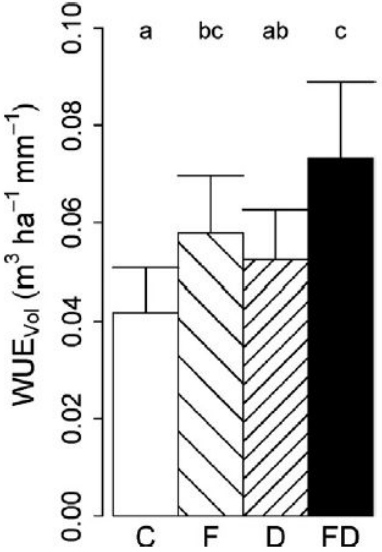


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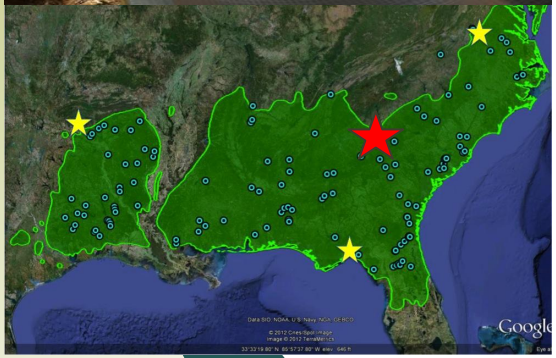

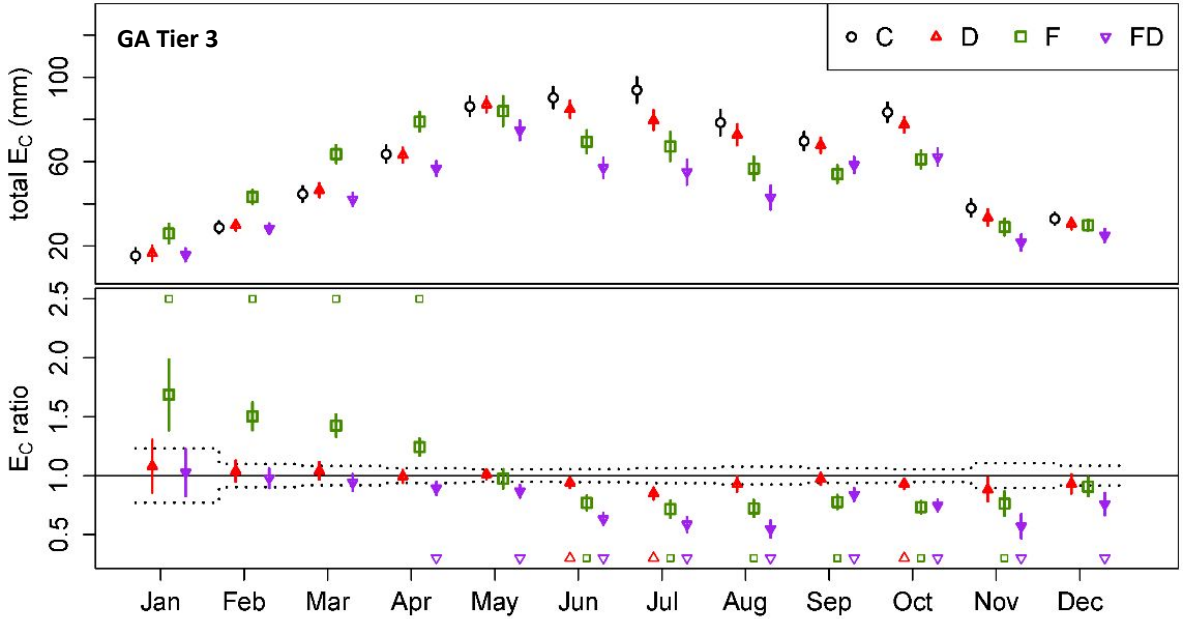


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