PINEMAP WaSSI MACA Modeling updates

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What have we done?

- Model Loblolly Pine Forest
  - 17 yrs old in NC with measured LAI, WUE based on eddy covariance measurements at NC-2 Ameriflux site
    - WUE= 2.54 g C/m2/kg H2O
  - 7 yrs old WUE =1.9 g C/m2/kg H2O

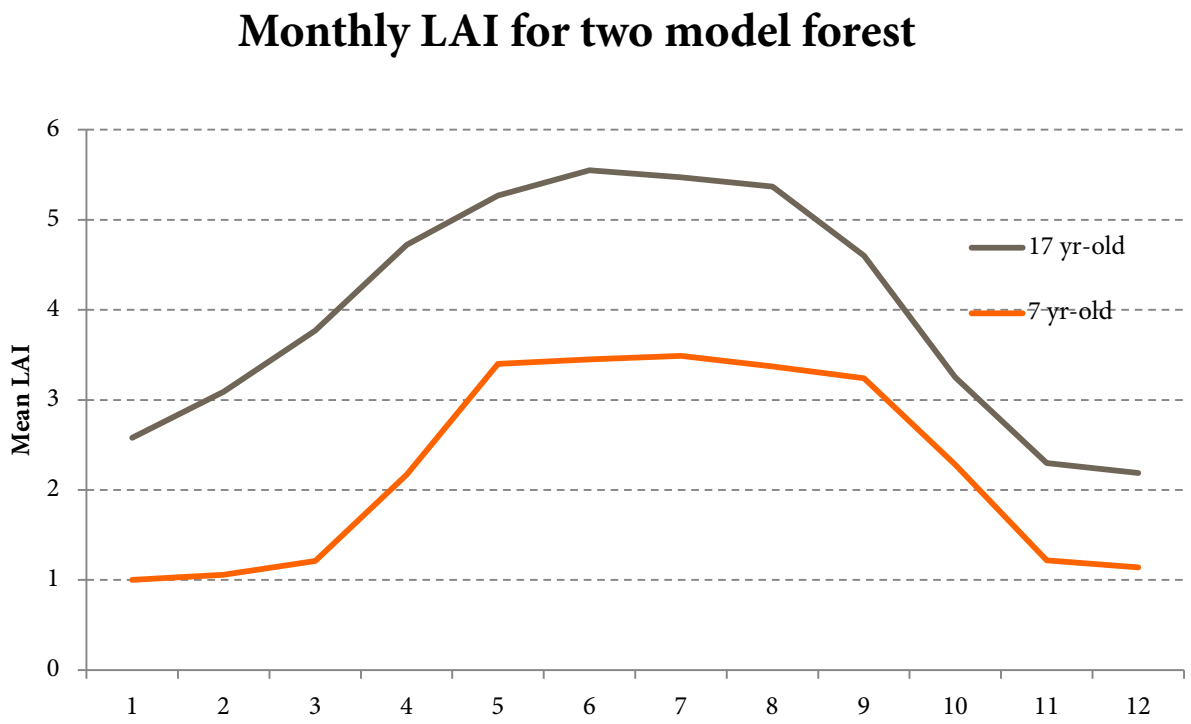
- Have ran the model for 20 MACA GCMs (Charts an Maps) and two different scenarios (RCP4.5 and RCP8.5) for the PINEMAP region
  - Monthly outputs for ET, Q, GEP

- Have ran WaSSI for all National Forests systems (Two scenarios and 20 GCMs) (draft MS ready)

Model Forest

$$ET = 0.725*PET + 5.0*LAI$$

R^2=0.86, RMSE = 14, n =120



Definitions: Time Periods Used

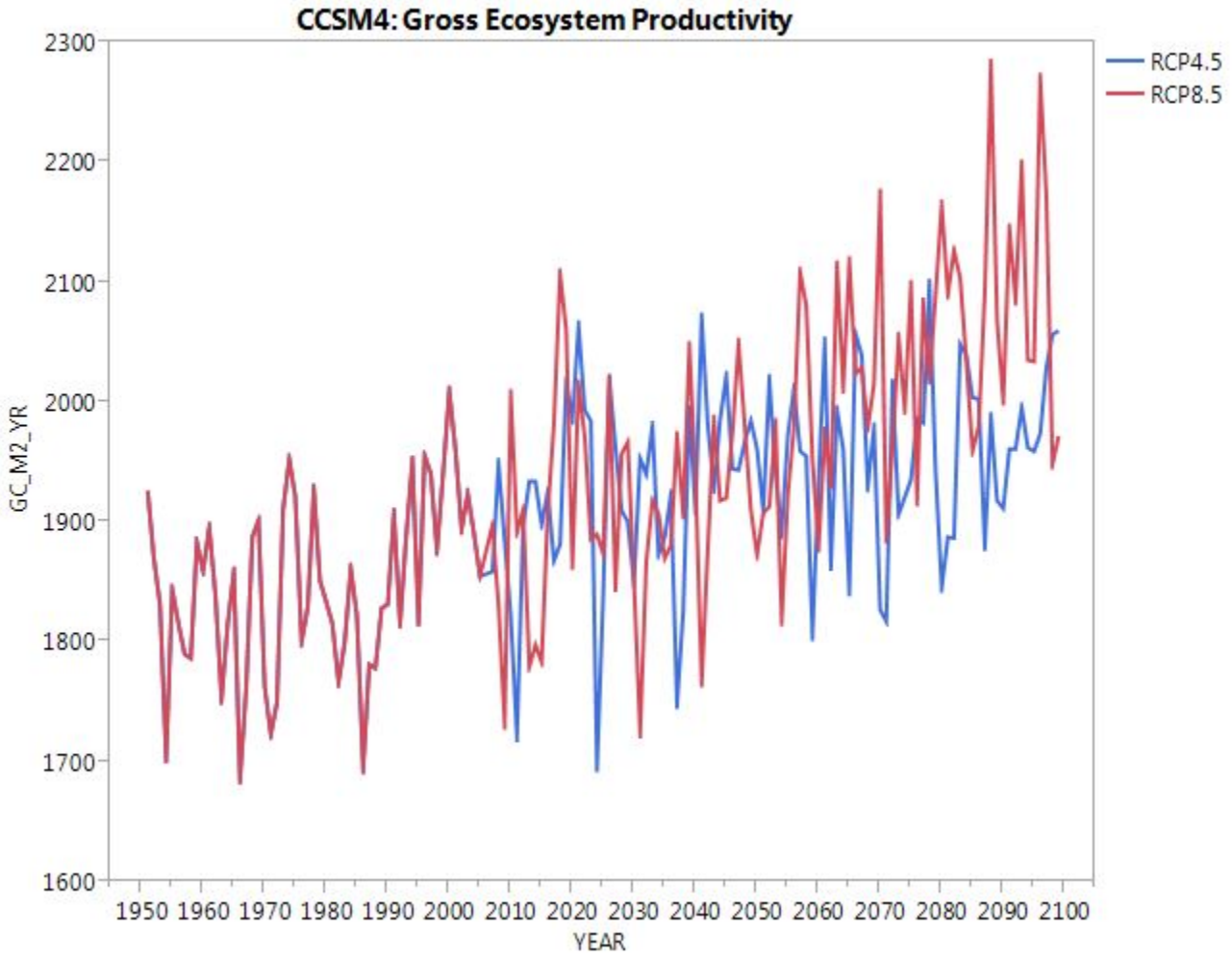
- Historical data (1986-2005):
  - Based on gridded observations
- Model baseline (1950-2005):
  - reference period for calculating future changes
  - same statistics as actual years (1979-2009) from training data
- Model future periods (2020-2039, 2040-2059, 2060-2079, 2080-2099):
  - To assess climate, take averages over at least 20 yrs

How does this apply to PINEMAP models?

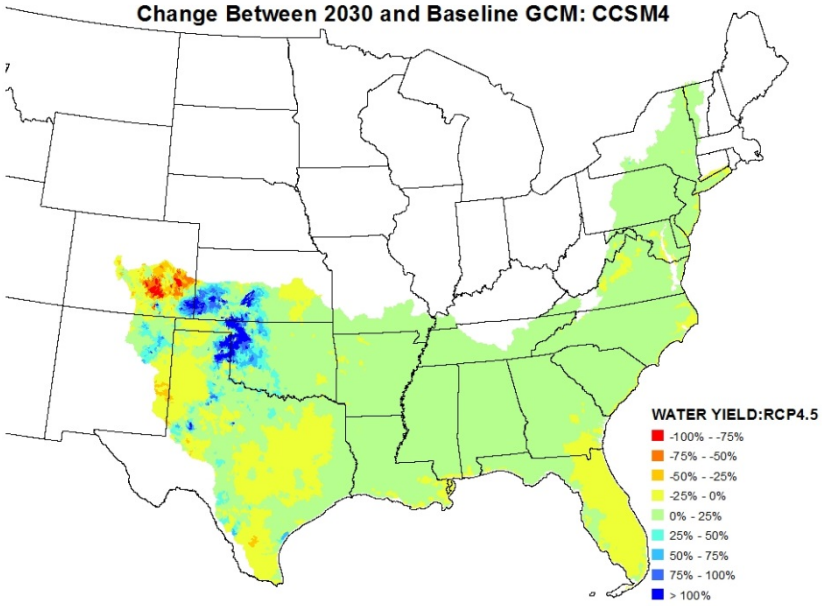
Example with WaSSI:

- Step 1: run with a historical dataset (PRSIM data)
- Step 2: run with baseline dataset. Compare model baseline output to historical output (Step 1) to generate error statistics.
- Step 3: run with projections data per model, per RCP, and per 20 yr time slice for future periods
- Step 4: compute difference between step 3 and step 2
- Step 5: calculate mean of these differences across all models per rcp and per 20 yr future time slice
- Step 6: add mean of the differences back to the historical map of GEP or Q (from Step 1)
- Step 7: repeat steps 5 and 6 except with std. deviation

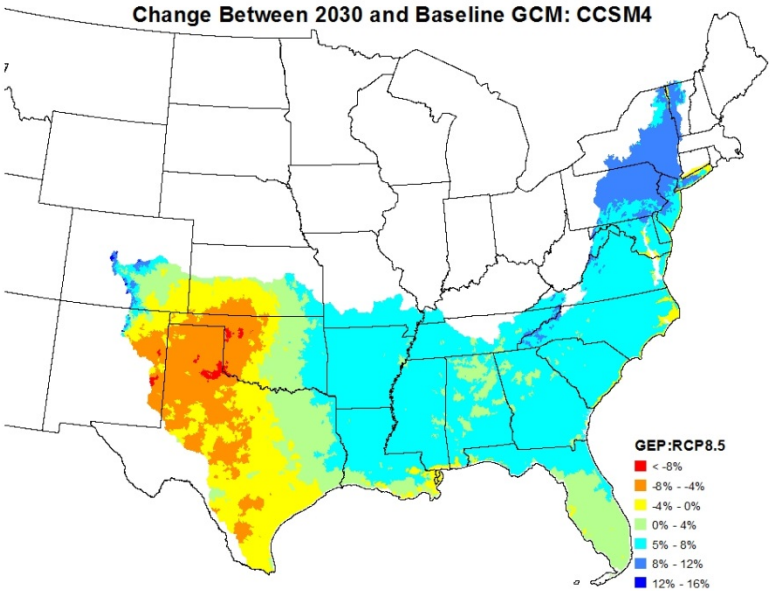
Modeled GEP


CCSM4: Gross Ecosystem Productivity
RCP4.5
RCP8.5
GC_M2_YR
2300
2200
2100
2000
1900
1800
1700
1600
1950 1960 1970 1980 1990 2000 2010 2020 2030 2040 2050 2060 2070 2080 2090 2100
YEAR

Modeled GEP

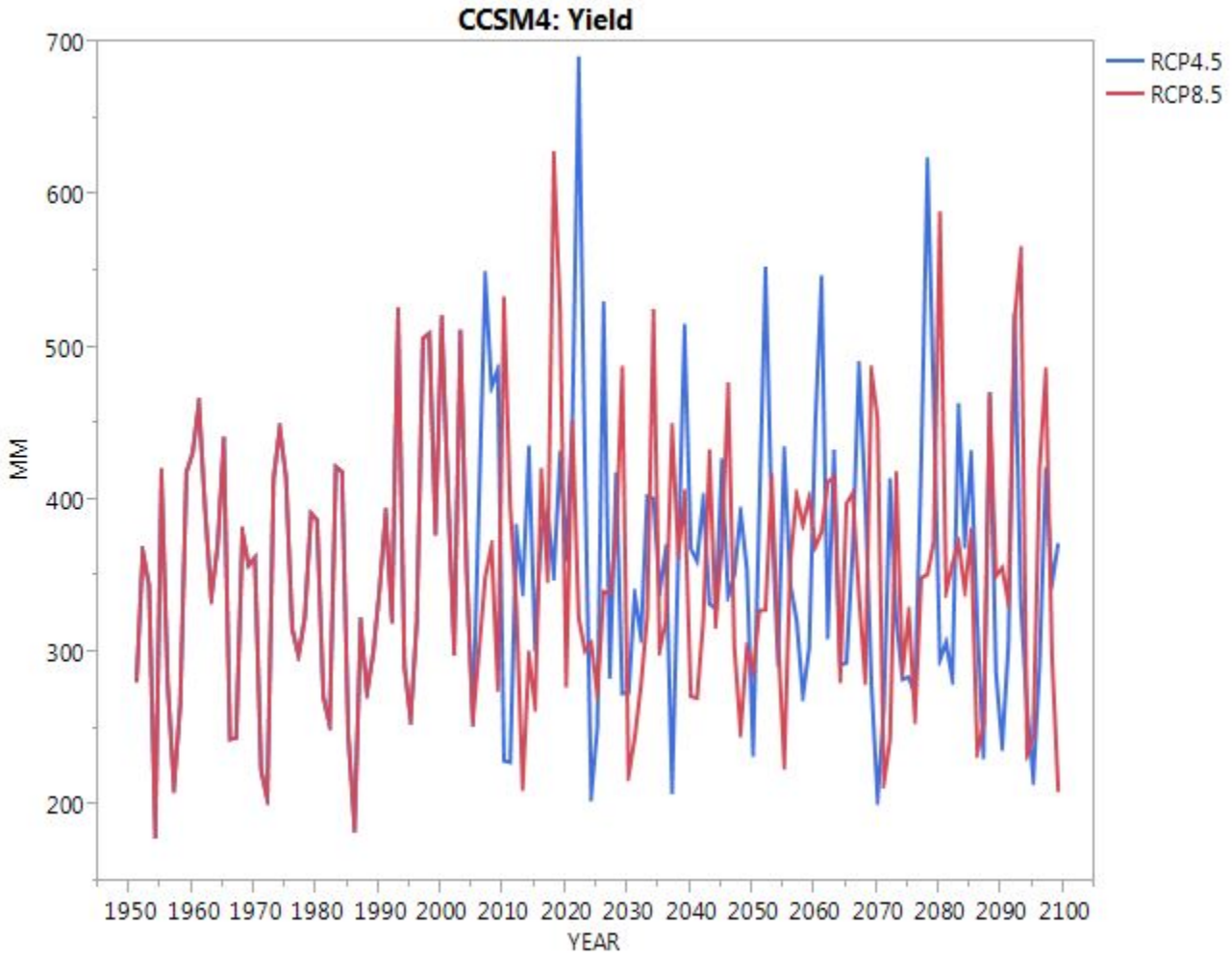


RCP4.5

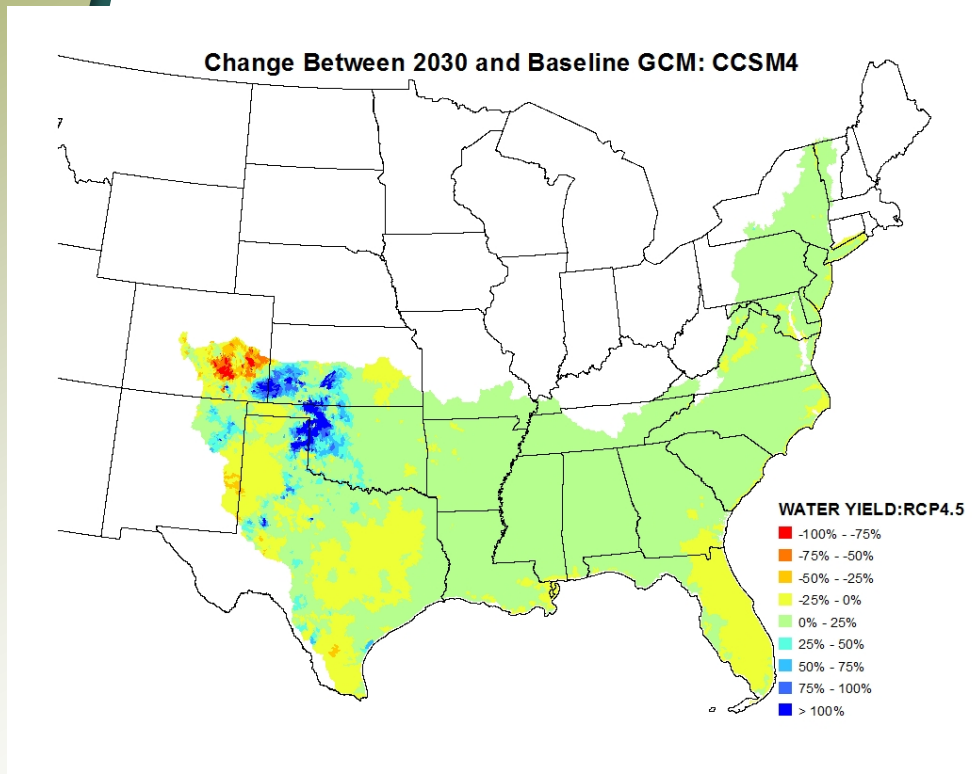


RCP8.5

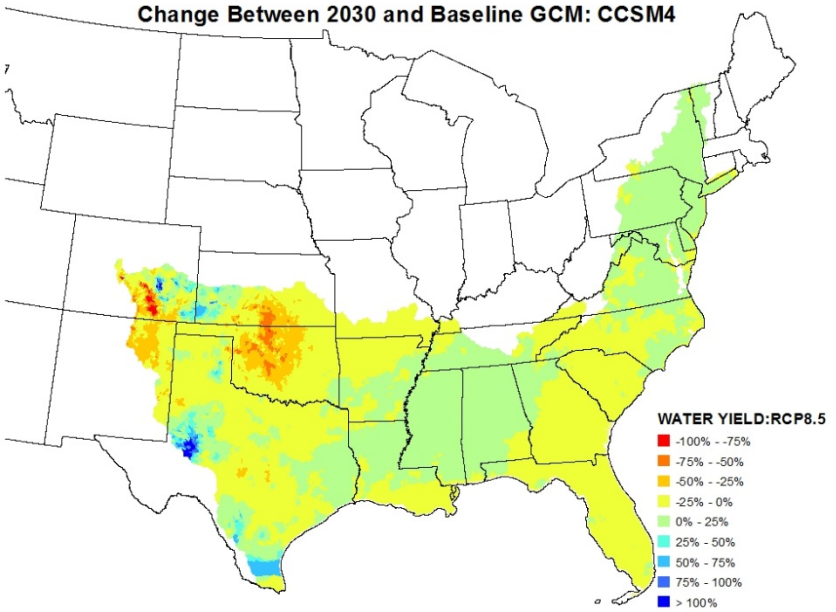
Modeled Water Yield



Modeled Water Yield



RCP4.5

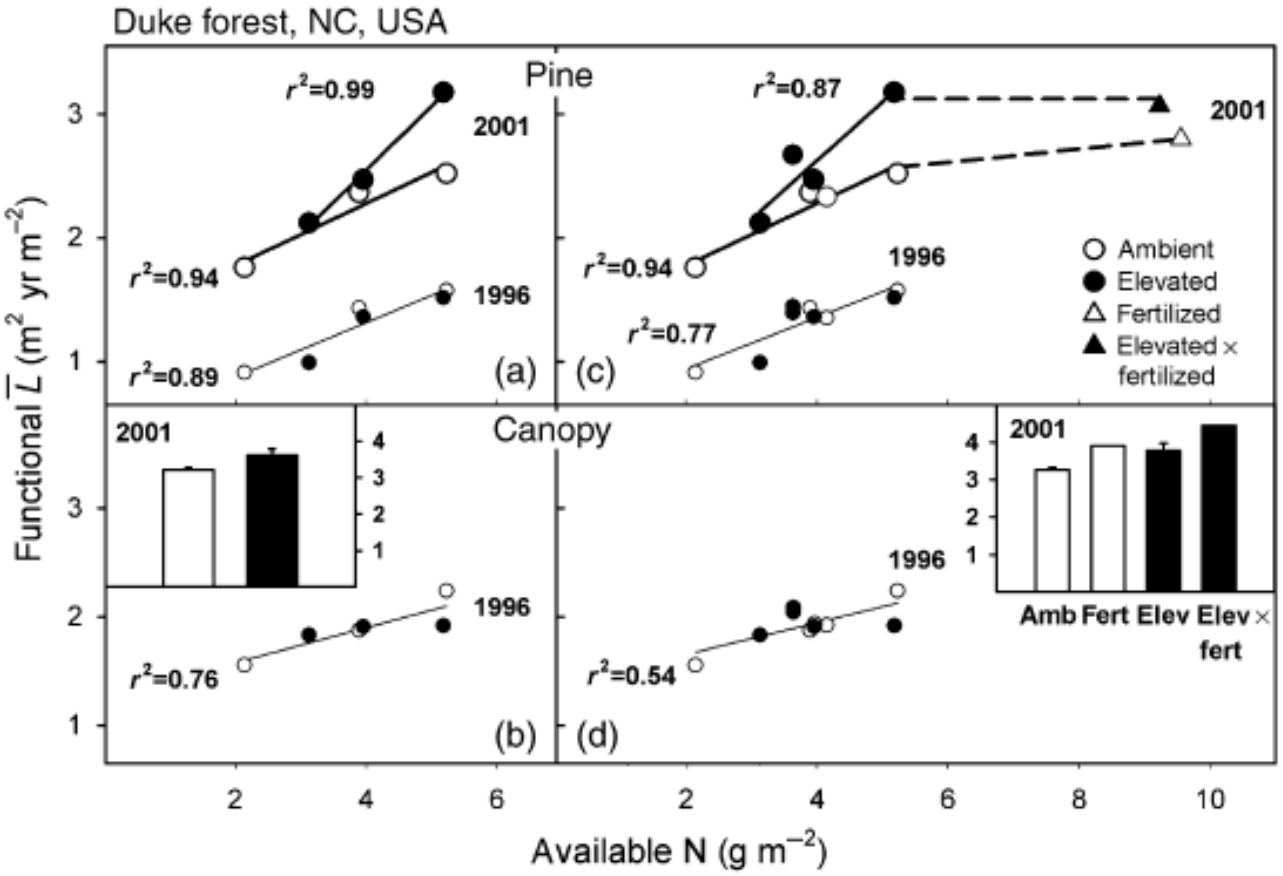


RCP8.5

Next steps

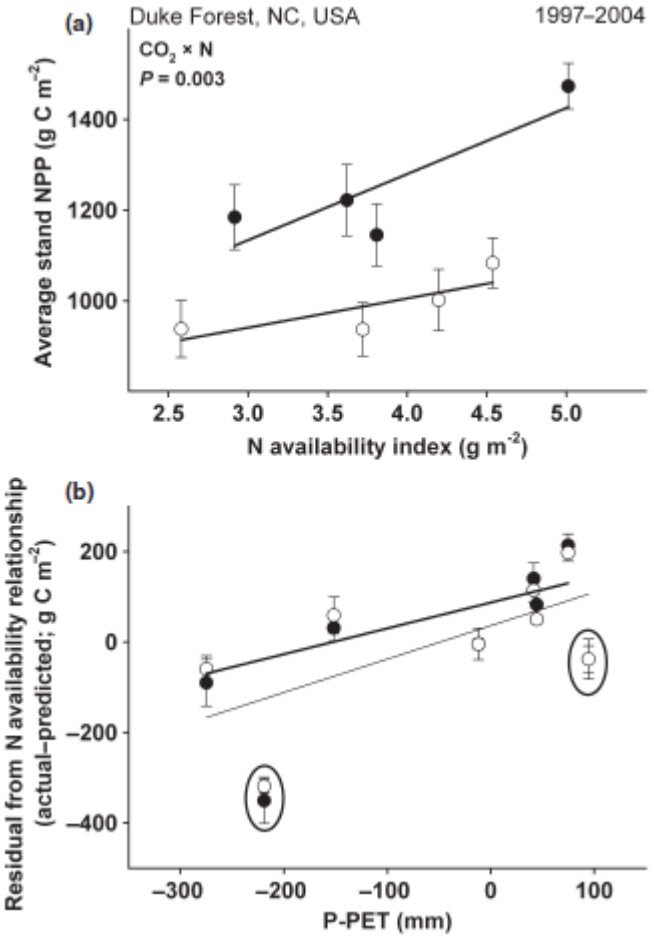
- Priority: develop model loblolly pine forests with CO_2 fertilization with altered WUE and LAI
  - Young stands
  - Mature stands

Elevated CO_2 Effects on LAI



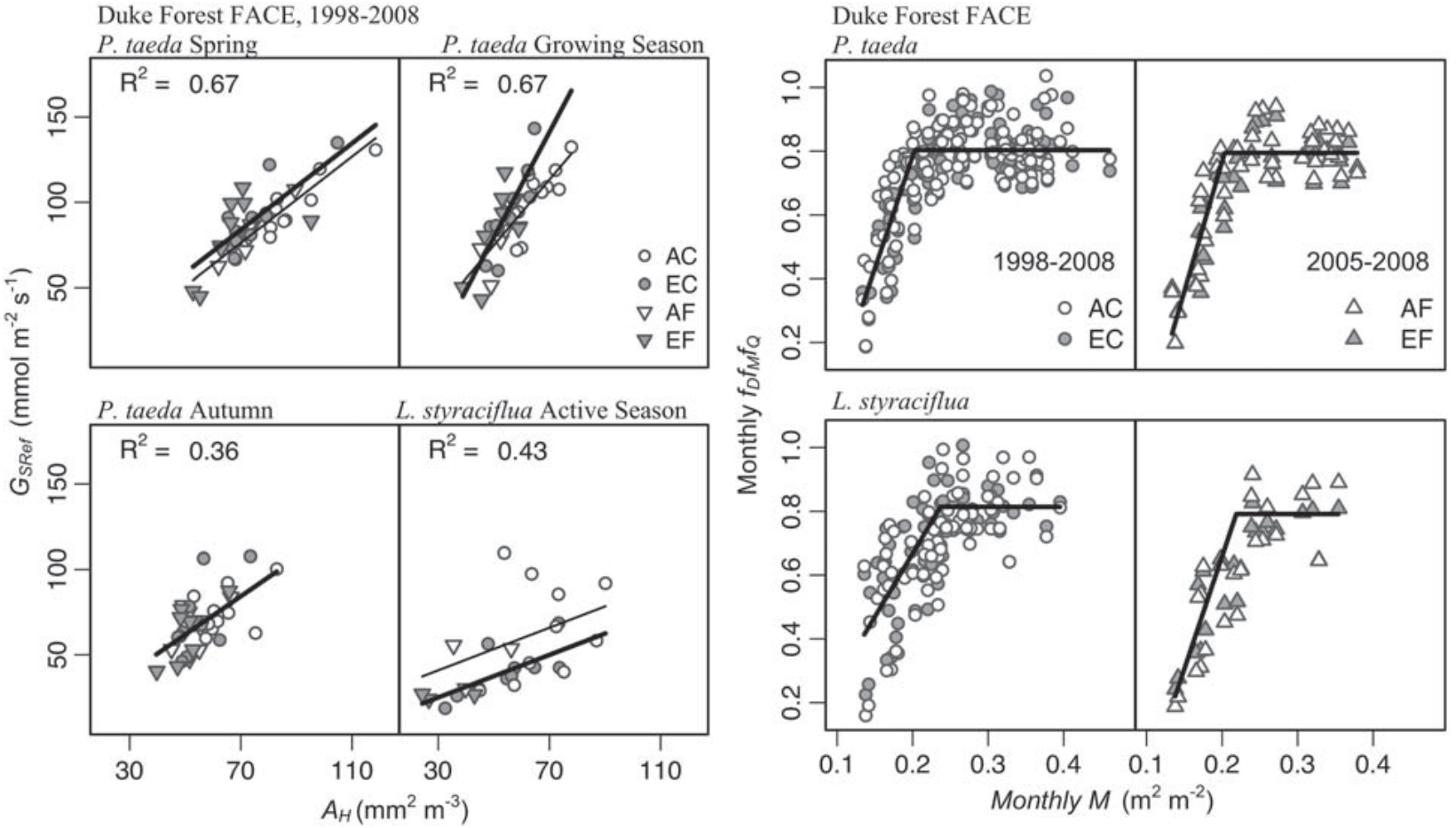
McCarthy et al. 2007

Elevated CO_2 Effects on NPP



McCarthy et al. 2010

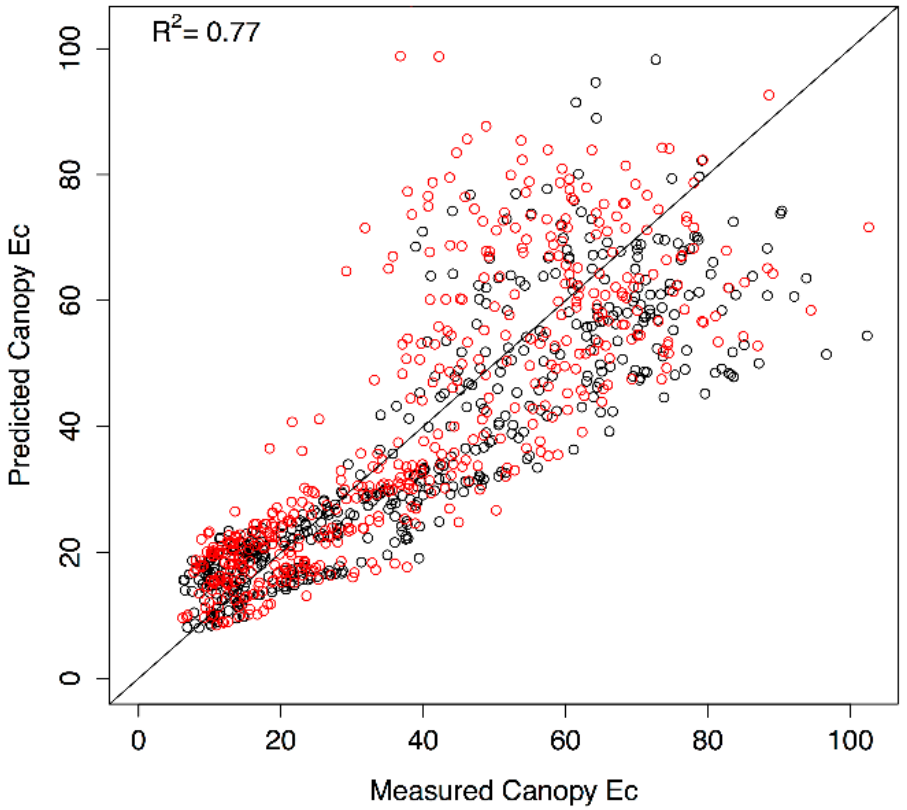
Elevated CO_2 Effects on Transpiration



Ward et al. 2013

Modeling Transpiration

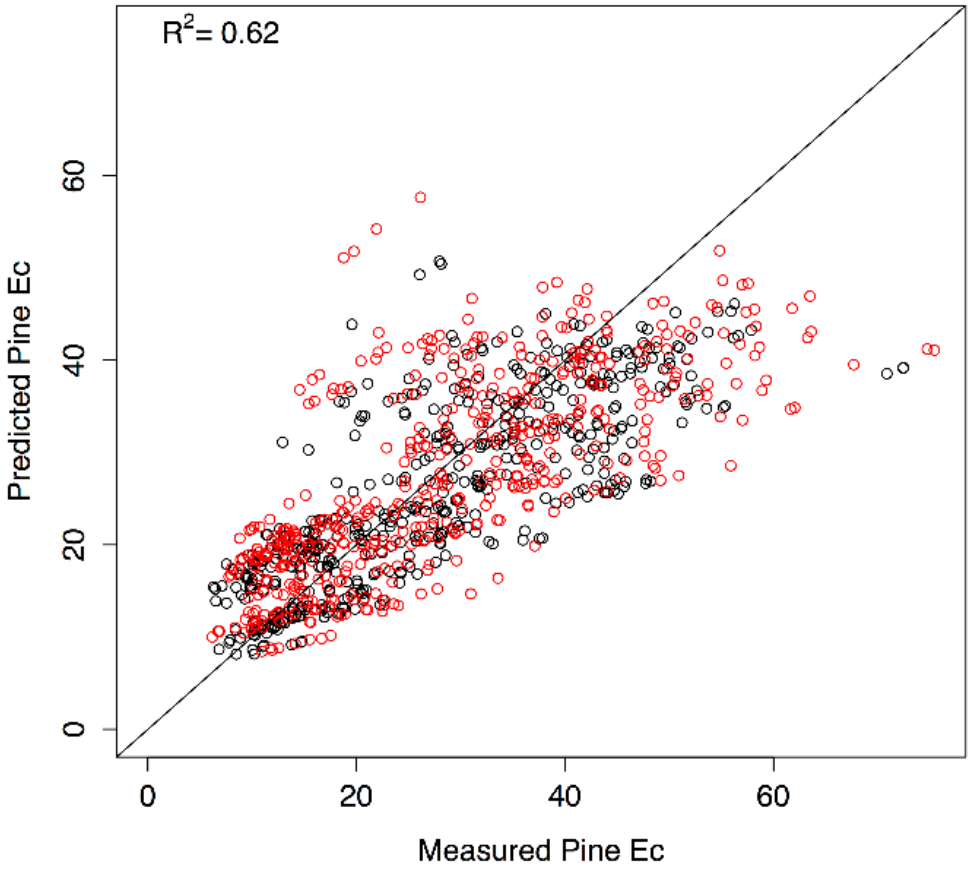
Canopy no CO_2 Effect



log(Ec) ~ log(P)+log(LAI)+log(PET)+log(VWC)

Modeling Transpiration

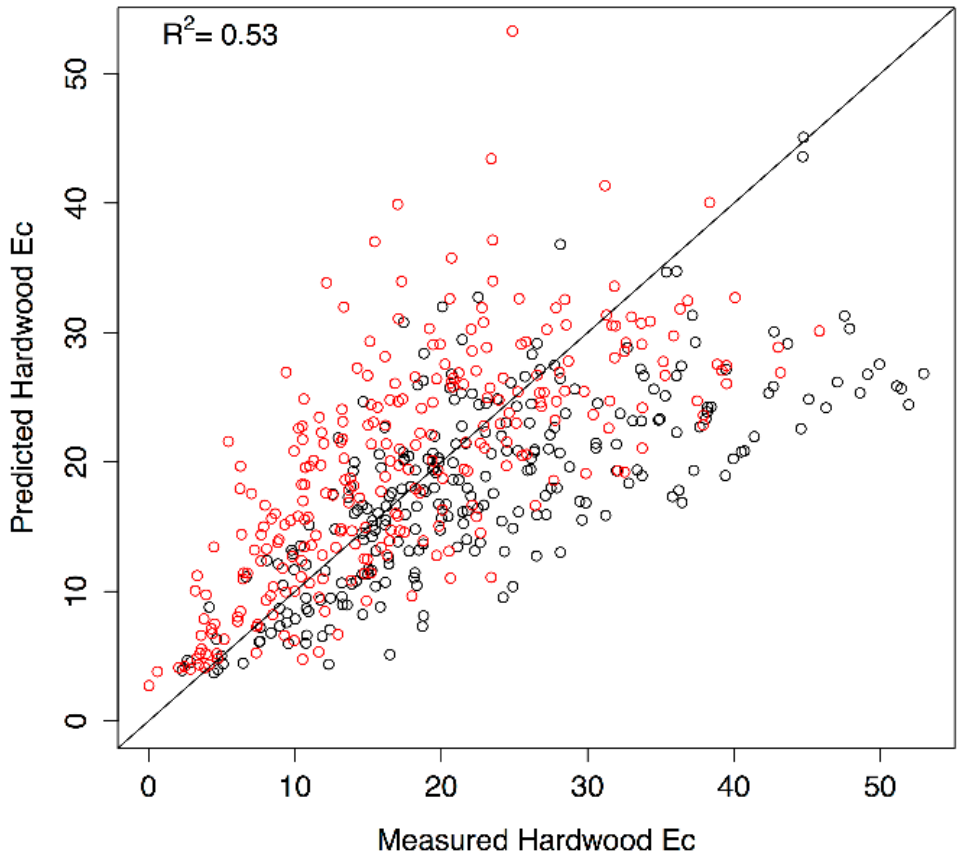
Pine no CO_2 Effect



log(Ec) ~ log(P)+log(LAI)+log(PET)+log(VWC)

Modeling Transpiration

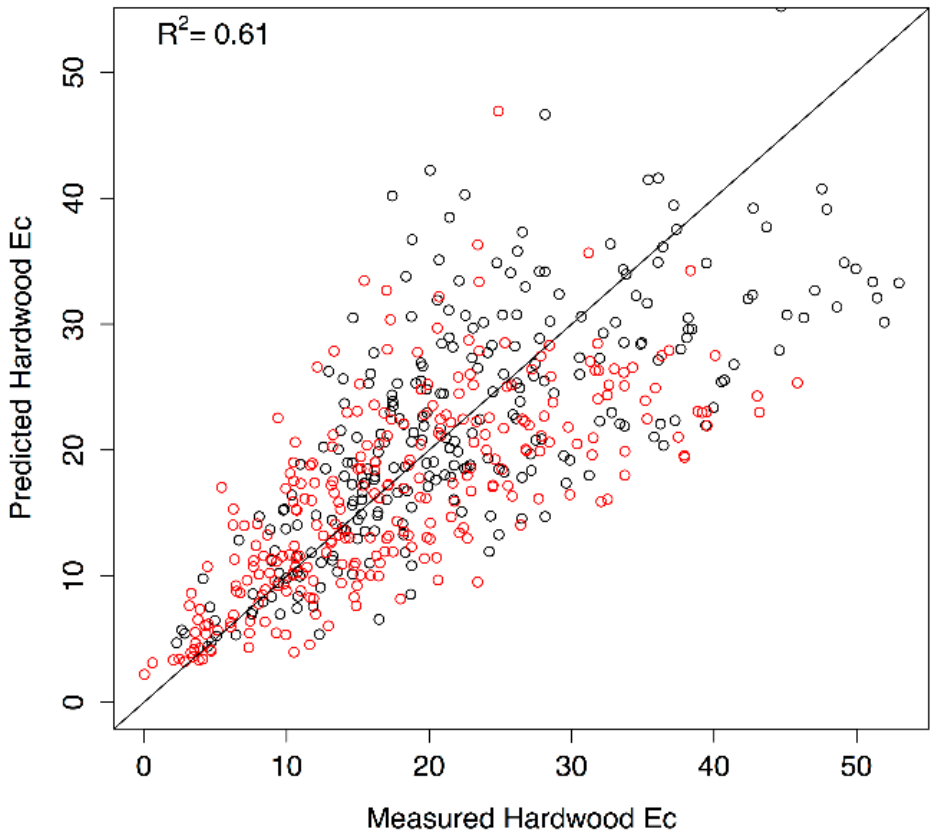
Hardwood no CO_2 Effect



log(Ec) ~ log(P)+log(LAI)+log(PET)+log(VWC)

Modeling Transpiration

HW with CO_2 Effect



log(Ec) ~ log(P)+log(LAI)+log(PET)+log(VWC)+CO_2

Next Steps: CO_2 Effects

- Improve on bias of Ec model, incorporation of Ic and Es
- Examine variation in WUE estimated as annual NPP/Ec
  - Can scale to GPP if we assume a constant CUE (NPP/GPP)
  - 3PG has same assumption inherent to it
  - Can do separately for pines and hardwoods
- Develop model loblolly pine forests with CO_2 fertilization with altered WUE and LAI, as a basic 'two-leaf' model
  - Young stands
  - Mature stands
- Run the WaSSI models and compare to historical and baseline (20 GCMs*2 Scenarios*2 Ages = 80 runs)