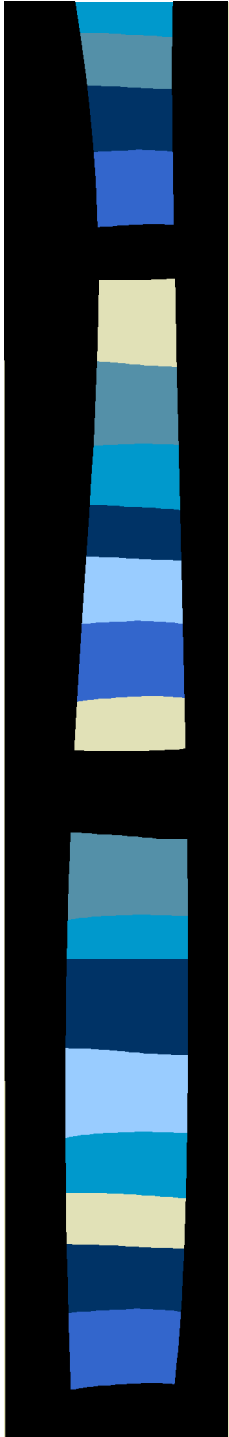


# Effect of Stomatal Sunfleck Responsiveness on Daily Gas Exchange in Understory Saplings Growing in a FACE Experiment



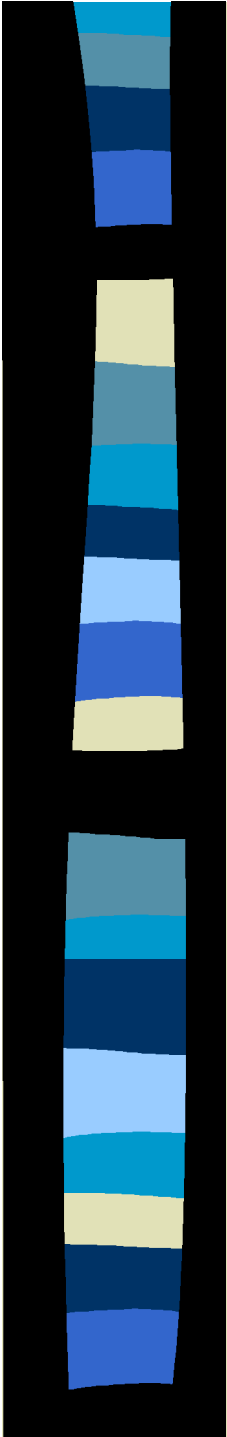
Elke Naumburg, David S. Ellsworth,  
Gabriel Katul  
Duke University, Brookhaven Natl. Lab.



- ◆ imagine sunfleck picture
- ◆ understory carbon gain is function of utilizing light efficiently
- ◆ light is variable

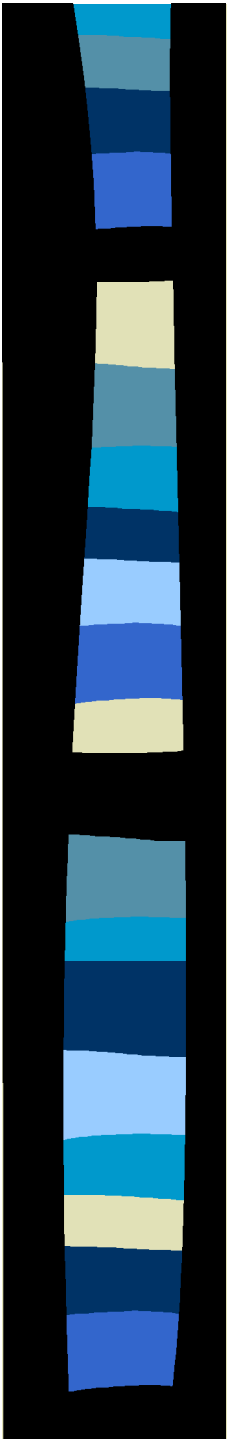
# Introduction

Therefore, to be efficient, photosynthesis needs to rapidly respond to increases in light intensity



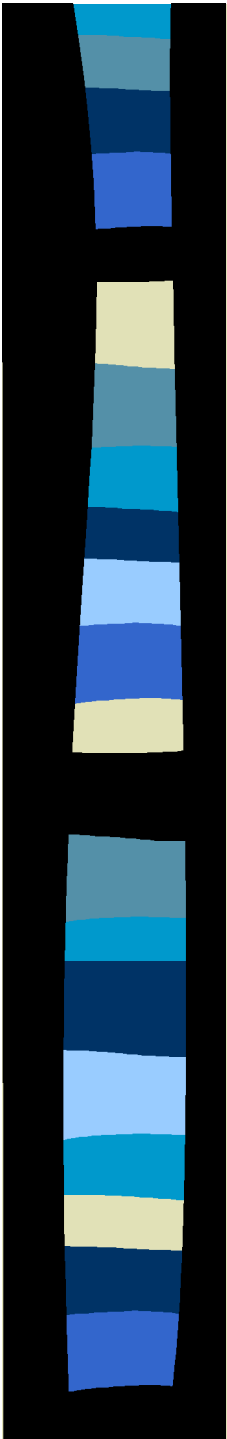
# Limitations

- ◆ Photosynthetic enzyme activation states (Rubisco)
  - ❖ can limit up to 10 min under saturating light
- ◆ Stomatal conductance
  - ❖ respond relatively slowly
  - ❖ can limit up to 40 min under saturating light



# Previously

- ◆ Measured stomatal and photosynthetic dynamics on 4 species
- ◆ 2 shade tolerant:
  - ❖ Red maple (*Acer rubrum* L.)
  - ❖ Flowering dogwood (*Cornus florida* L.)
- ◆ 2 shade intolerant:
  - ❖ Sweetgum (*Liquidambar styraciflua* L.)
  - ❖ Tulip-poplar (*Liriodendron tulipifera* L.)





# Previously

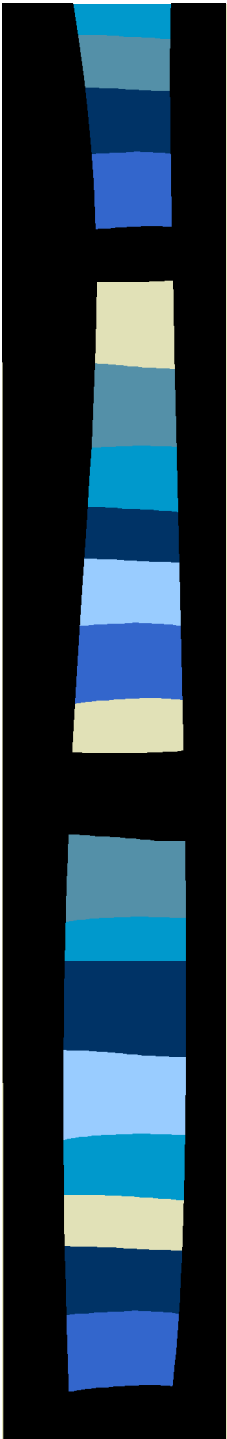
- ◆ Free Air Carbon Dioxide Enrichment facility in Duke Forest, NC (ambient CO<sub>2</sub>, ambient + 200 ppm CO<sub>2</sub>)
- ◆ 16 year-old loblolly pine plantation
- ◆ Abundant hardwood understory

# Stomatal Responsiveness

	Opening	Closing
Red maple	fast	fast
Dogwood	slow	slow
Sweetgum	slowest	slowest
Tulip-poplar	fast	slow

# Prediction

In a light regime with infrequent sunflecks, tulip-poplar will have the least stomatal limitations to sunfleck photosynthesis





# The Model

(Pearcy et al. 1997)

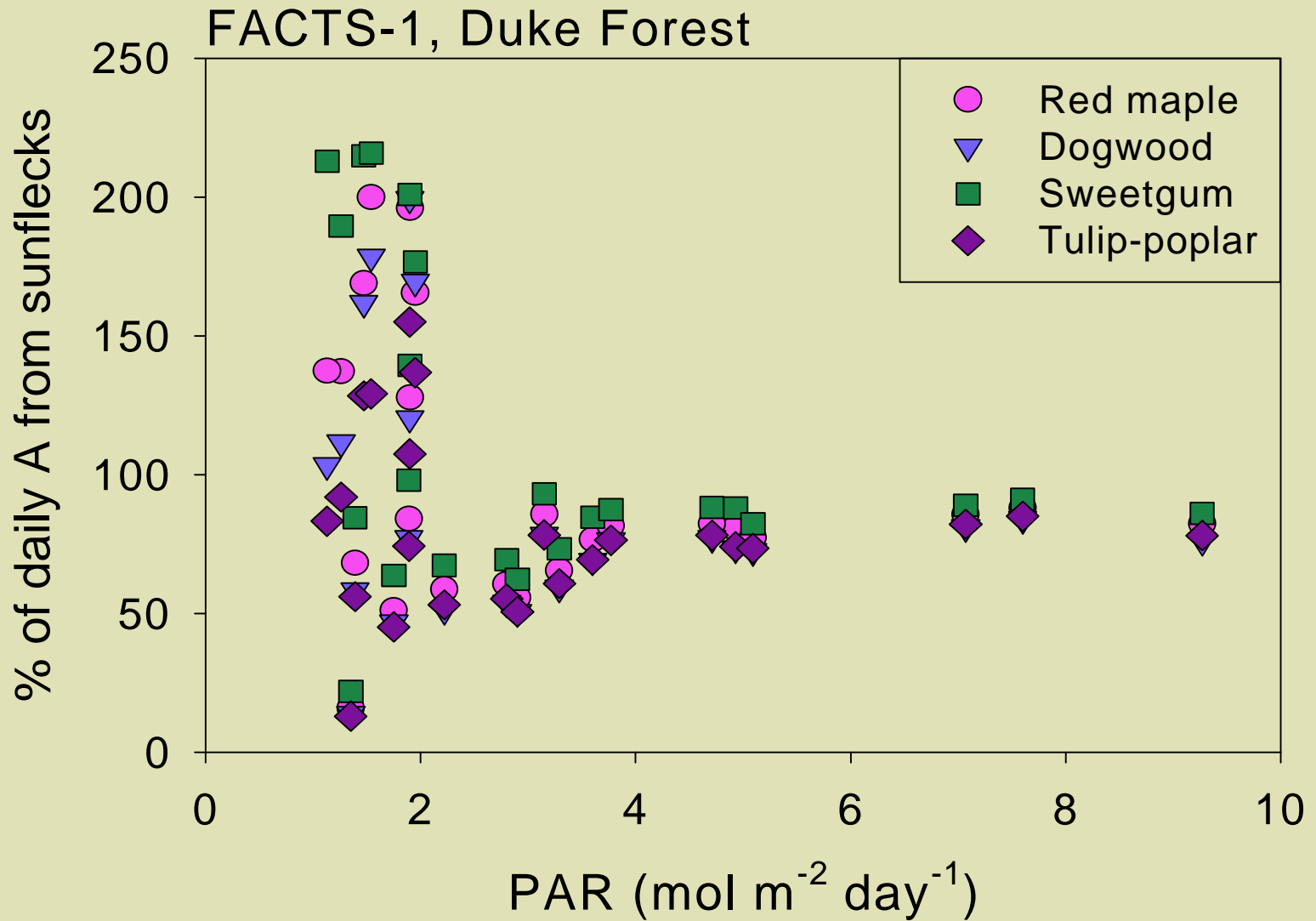
- ◆ Incorporates dynamic responses of stomata and photosynthetic enzymes to changes in light intensity
- ◆ Parameterized for each species and growth  $[\text{CO}_2]$  using:
  - ❖ light and  $\text{CO}_2$  response curves
  - ❖ gas exchange data from controlled light experiments



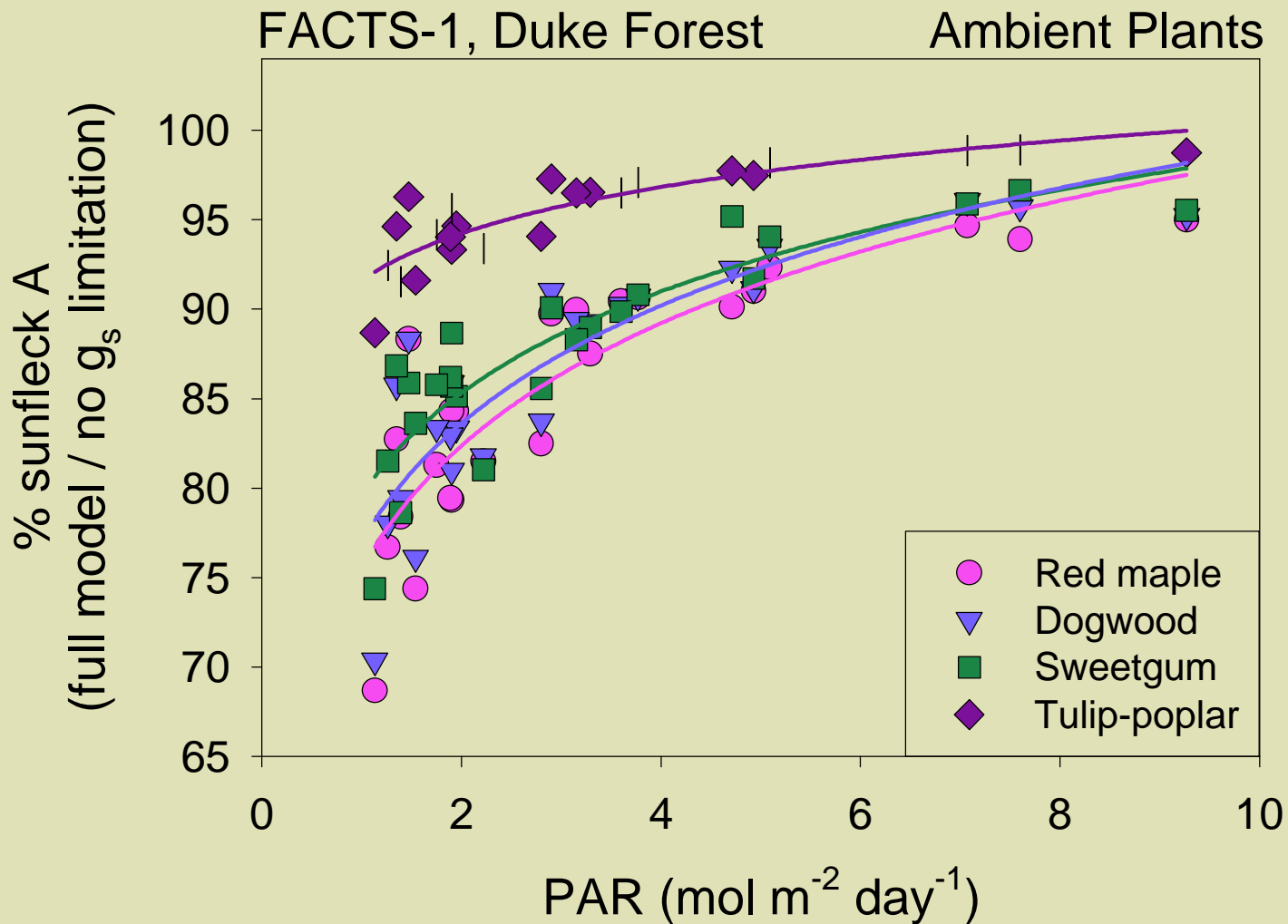
# Model Scenarios

- ◆ Two different model scenarios:
  - ❖ Full model; both stomatal, biochemical limitations
  - ❖ No stomatal limitation model; only biochemical limitations
- ◆ Light data from study site
  - ❖ 24 locations
  - ❖ 5 second intervals for 11 hours
  - ❖ PAR ranging from 1.1 to 9.3 mol m<sup>-2</sup> day<sup>-1</sup> (2-17%)

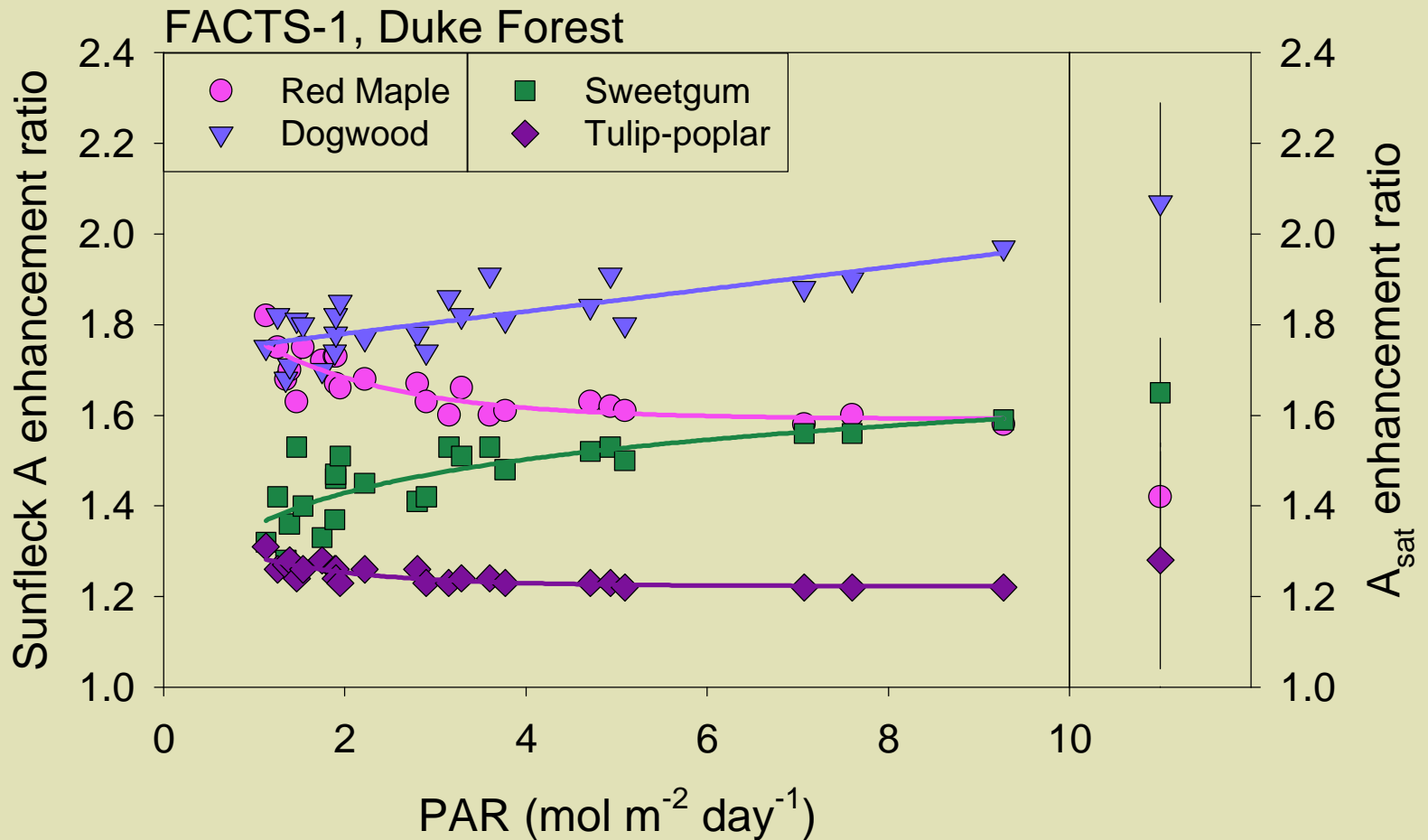
# Importance of Sunflecks



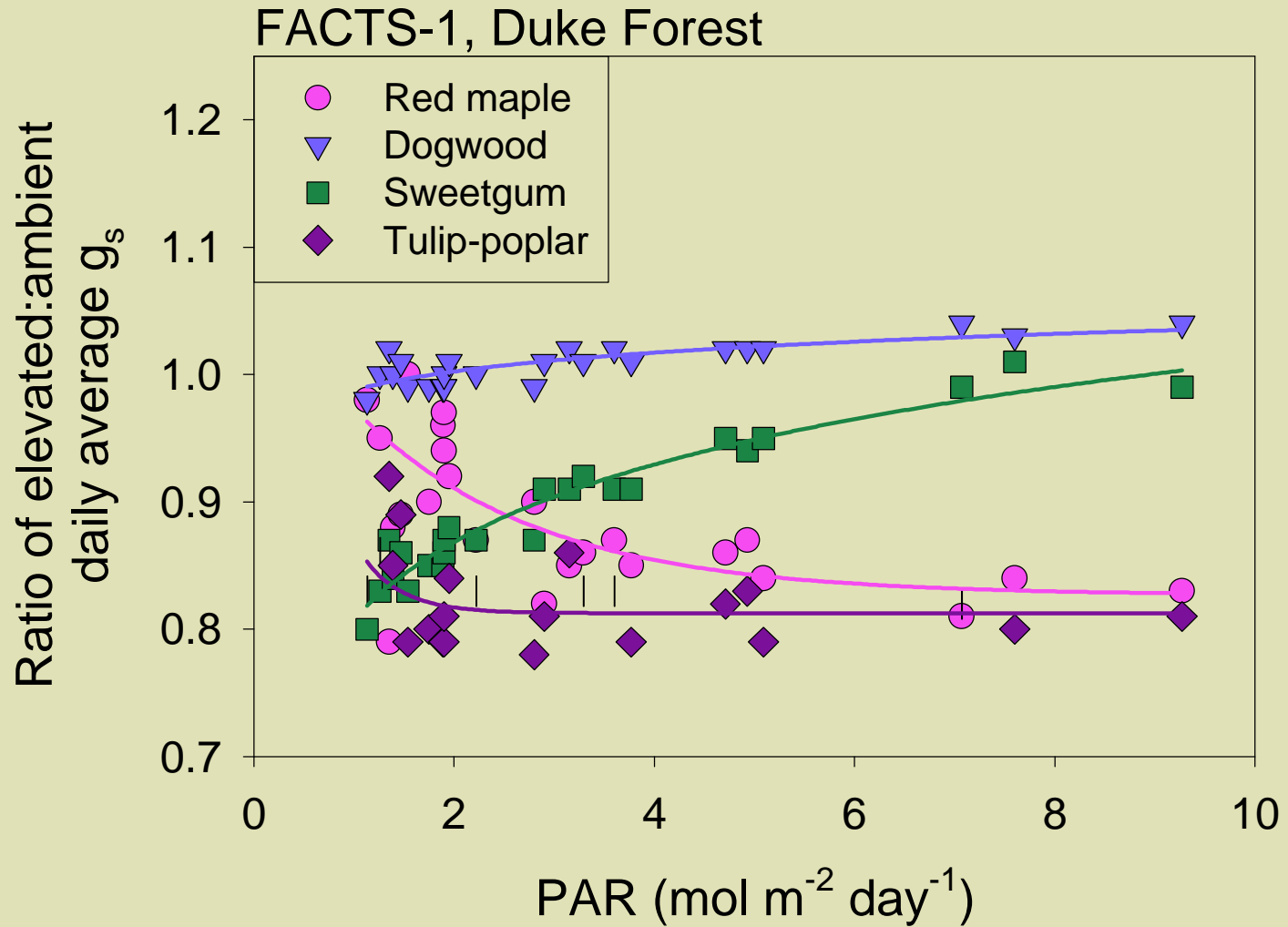
# Effect of Stomatal Limitation on Sunfleck Photosynthesis



# Photosynthetic Enhancement by CO<sub>2</sub>



# Stomatal Response



# Conclusions

- ◆ Differences in stomatal responsiveness affects daily sunfleck photosynthesis (up to 30% ↓)
- ◆ Subtle differences in stomatal behavior under elevated CO<sub>2</sub> can affect daily sunfleck photosynthesis ( $\Delta$  enhancement ratio up to 0.2)
- ◆ These effects are strongest under low daily PAR



# Consequently,...

...estimates of understory carbon gain need to account for stomatal limitations to sunfleck photosynthesis