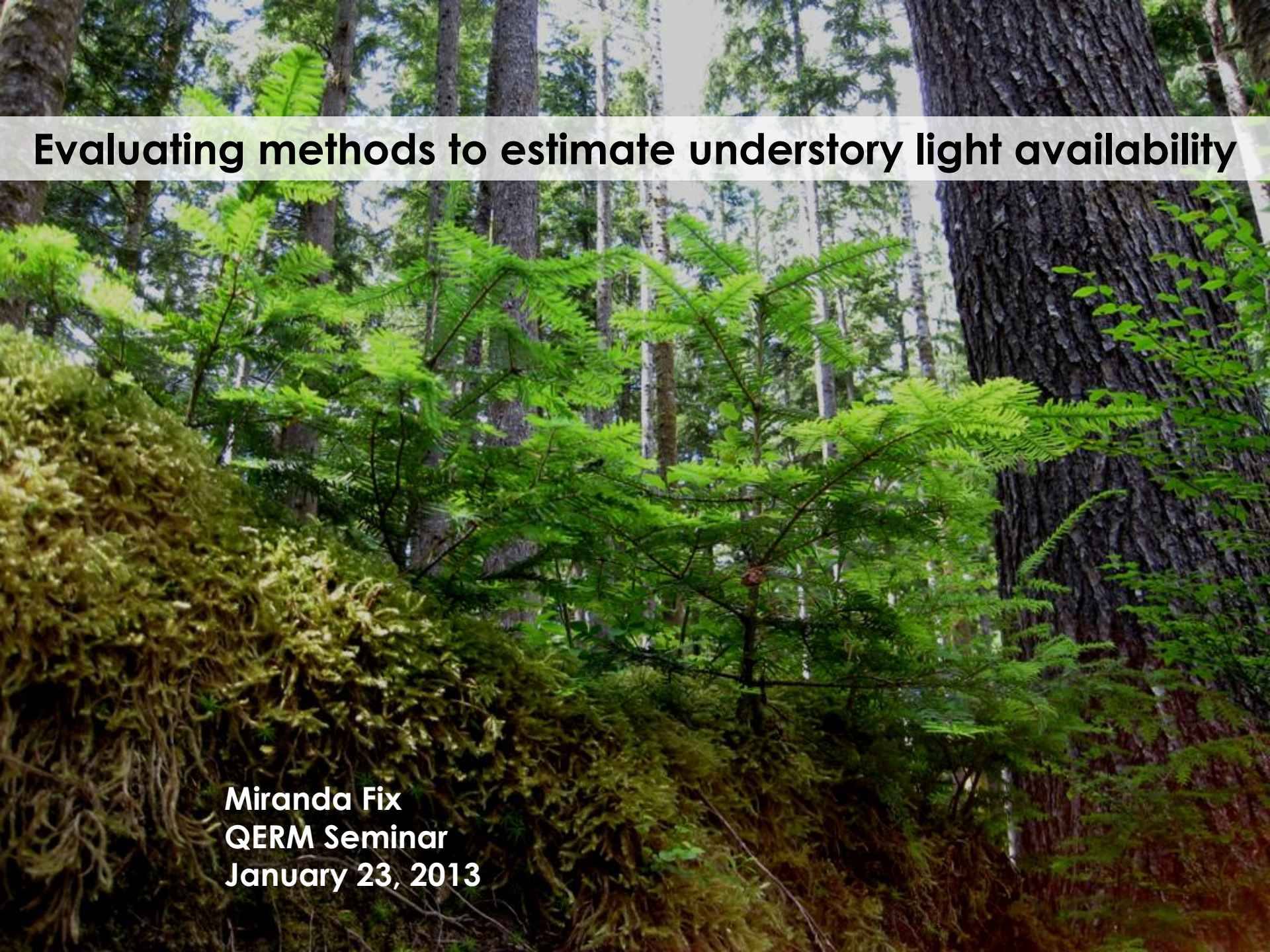
Evaluating methods to estimate understory light availability



Miranda Fix
QERM Seminar
January 23, 2013

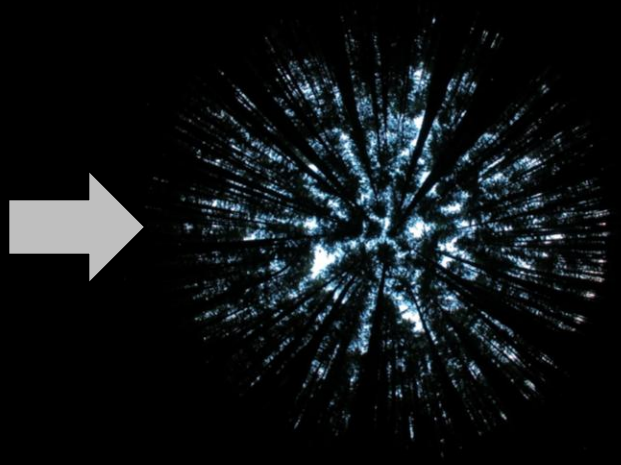
Understory light – Why do we care?

- We can control it to some degree with management
  - Might like to achieve target light conditions to promote establishment and growth of seedlings
- Obviously light (PAR) is required for photosynthesis
  - It can be the limiting factor for some species
- But how much light does each species require, and what kind (direct / diffuse)? What is the ideal spatial and temporal distribution of this light?
  - In order to answer these questions, we must be able to accurately characterize understory light environments

Method #1
Hemispherical Photography (HP)

- Indirect method
- One (average) value per photo
- Can only take photos in overcast conditions or at dawn/ dusk
- Sensitive to exposure, thresholding, image quality, etc.
- Inexpensive

Method #1
Hemispherical Photography (HP)



GLA

% Canopy Openness
% Transmitted Total
% Transmitted Direct
% Transmitted Diffuse

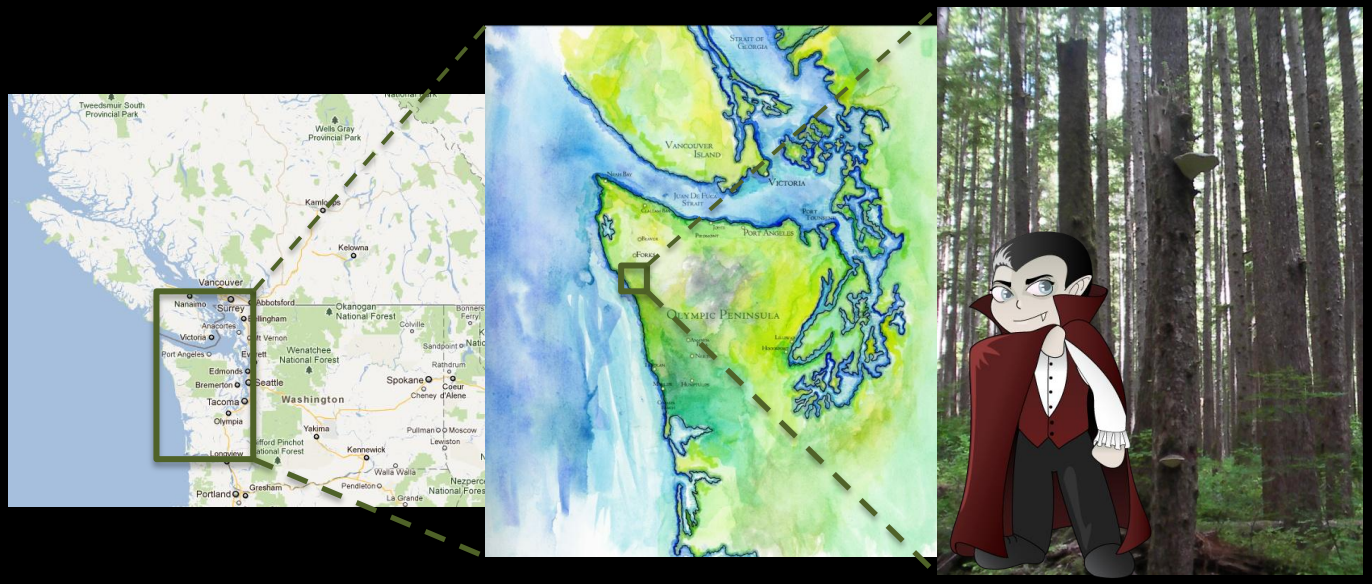
Diffuse Light & Low-light environments

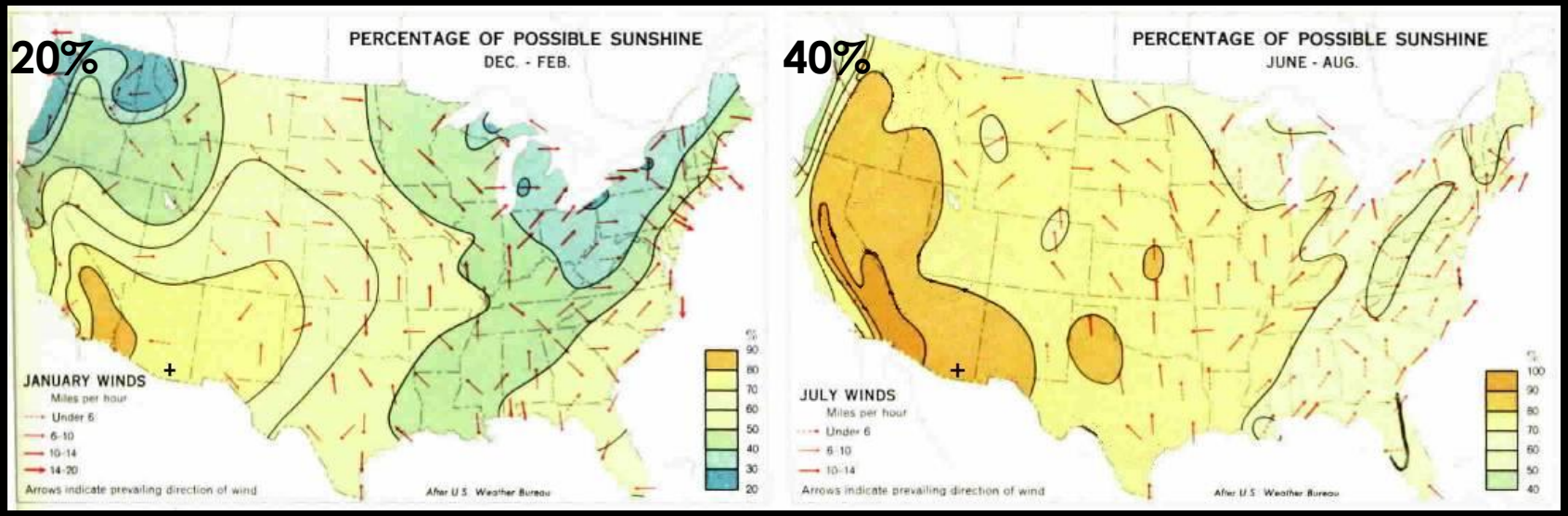
- Aside from infrequent, short, intense bursts of direct light (sunflecks), understory plants rely on (and acclimate to) diffuse light
- Diffuse light may be a better predictor of growth*
- Past studies have found that hemispherical photography was less reliable in deeply shaded environments and requires further evaluation**

* Kobe and Hogarth 2007; Tang et al. 1992

**Machado and Reich 1999; Promis et al. 2012

Forks, WA: Home of vampires and diffuse light

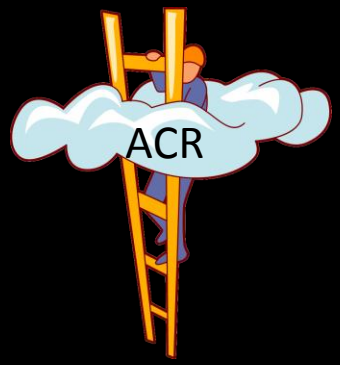


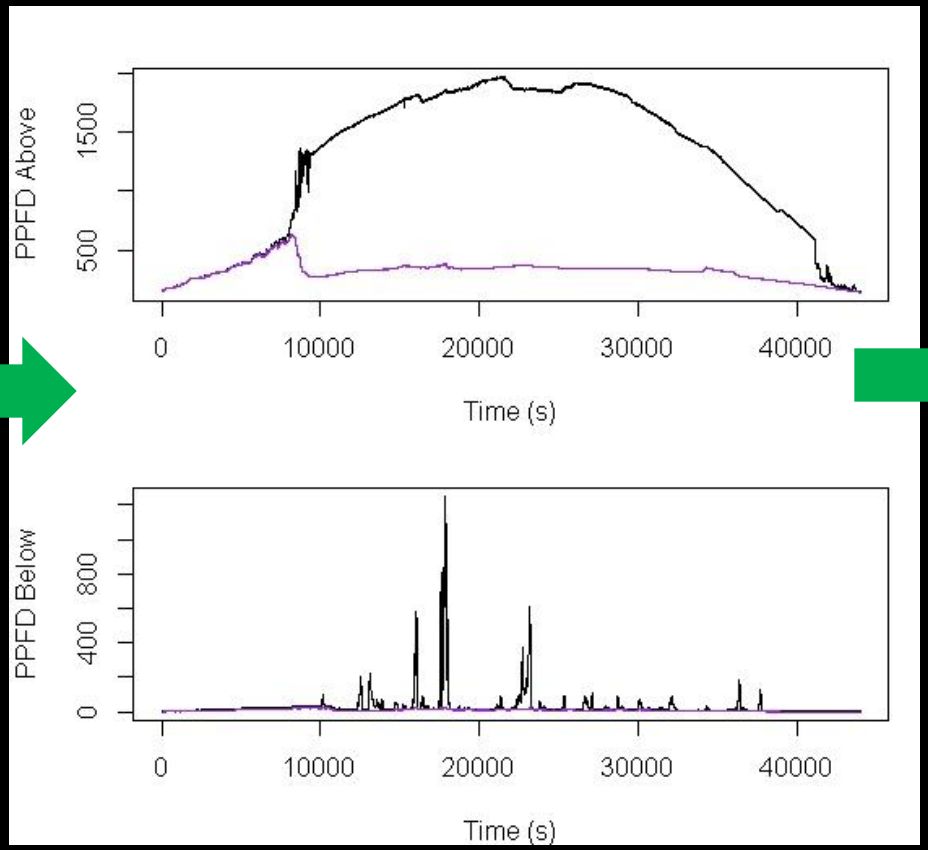


Method #2
BF3 Sunshine Sensor

- Direct method
- Instantaneous values, can log continuously up to 1 Hz for an extended period
- Measures total and diffuse PPFD
- Requires above-canopy reference
- Expensive

Method #2
BF3 Sunshine Sensor



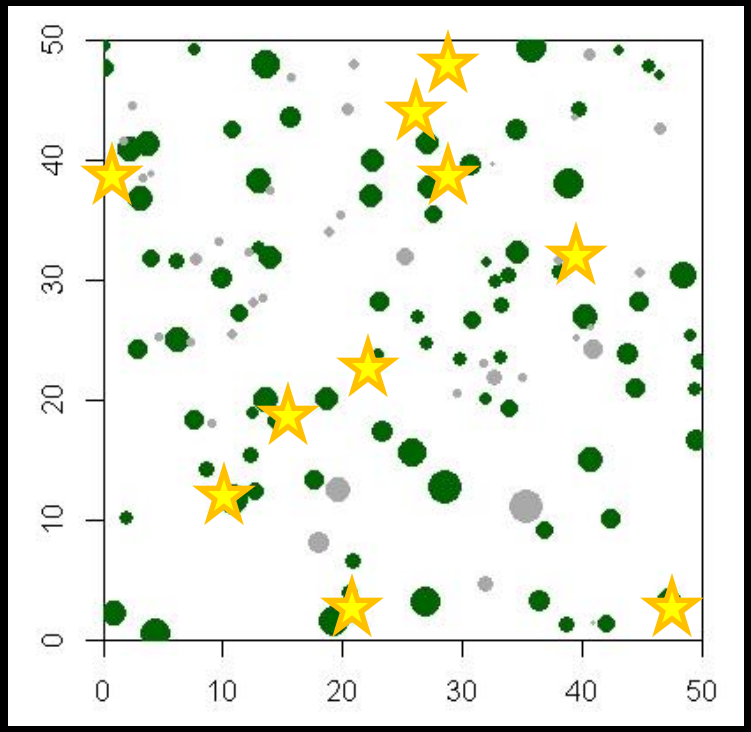


% Transmitted Total
% Transmitted Direct
% Transmitted Diffuse

Study Objectives (Part I)

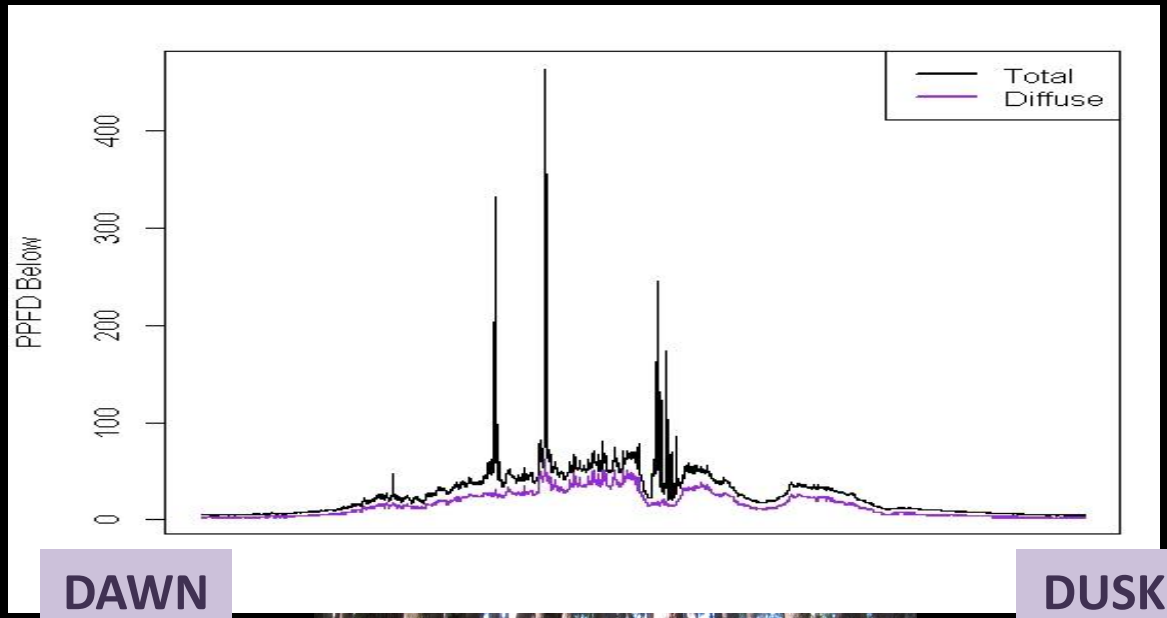
- Compare hemispherical photography to the BF3
  + Compare integrative to instantaneous BF3
- Make recommendations and estimate errors
- Describe the understory light environment in our study plot, including sunfleck distributions

Study Design



- Representative 50 x 50 m plot
  - Even-aged *Tsuga heterophylla*
- Stratified Random Sampling
  - Original strata determined by hem-photos in 5m grid
  - 3 Low + 3 Medium + 4 High =10
- Dawn & Dusk hem-photos + Whole-day BF3 sampling
  - 2-3 days per location, July-Sep
  - Variety of weather conditions

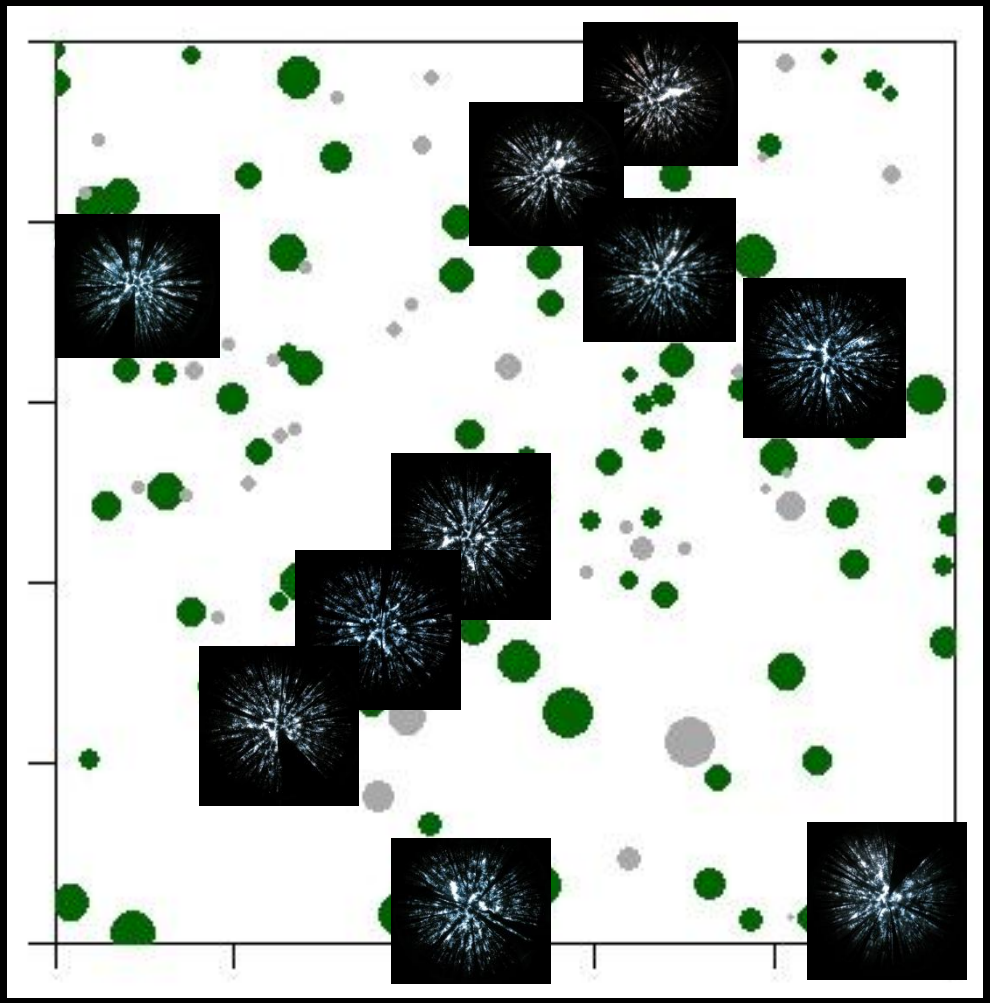
Sampling Procedure

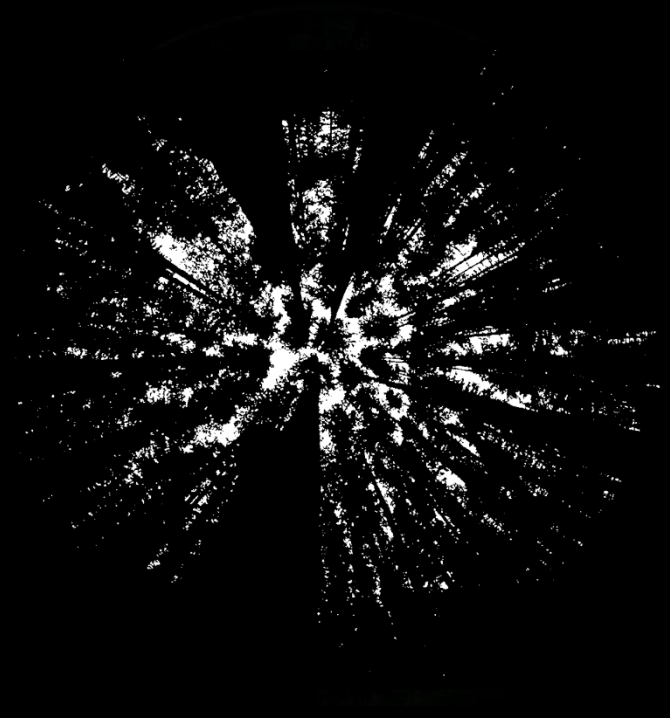


DAWN

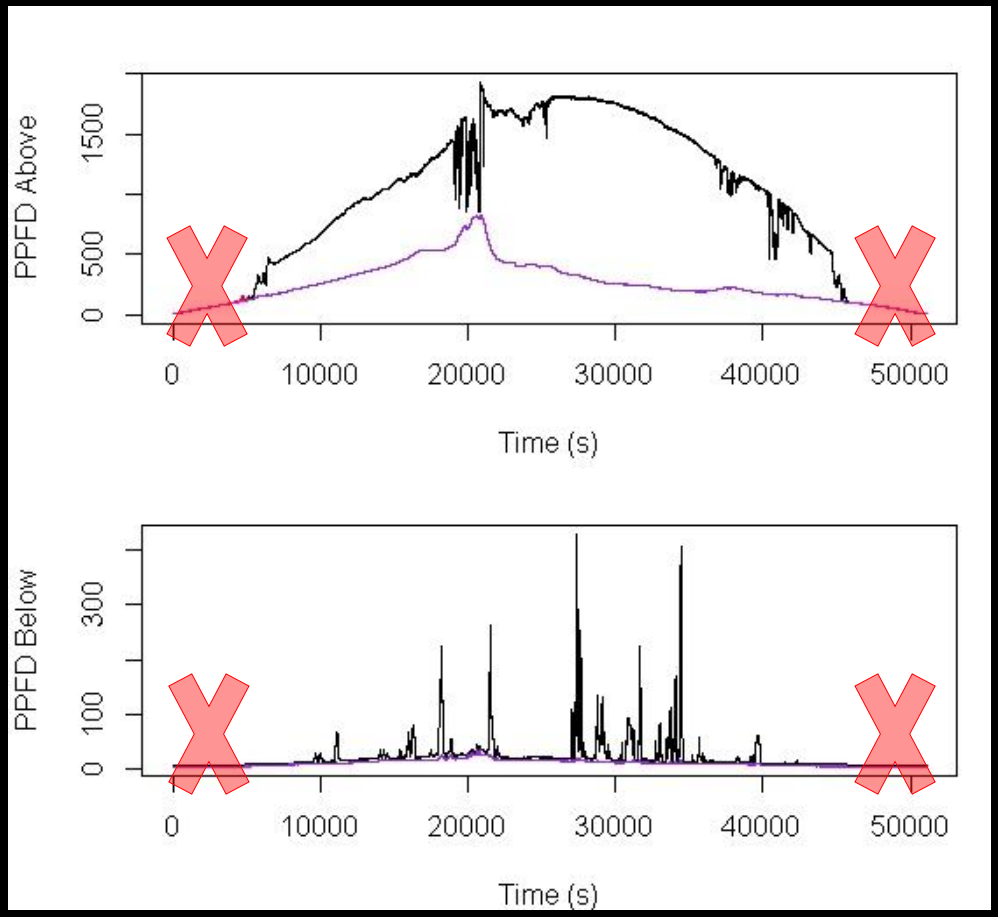
DUSK

Data: Hemispherical Photography





Data: BF3 Sunshine Sensor



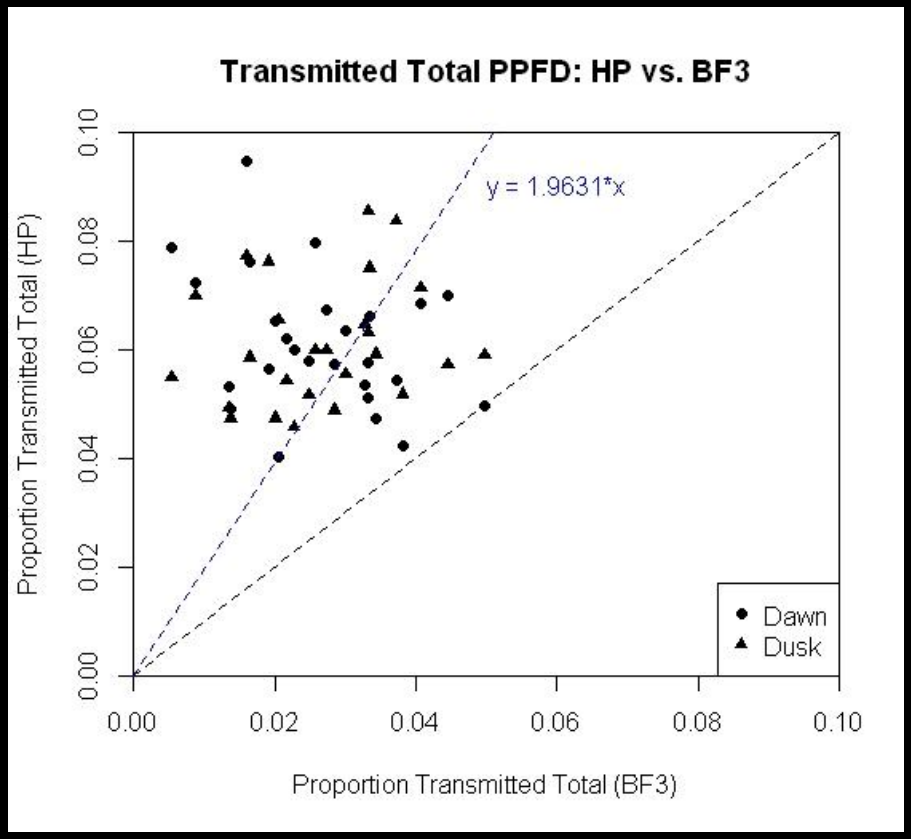
Transmitted Total:

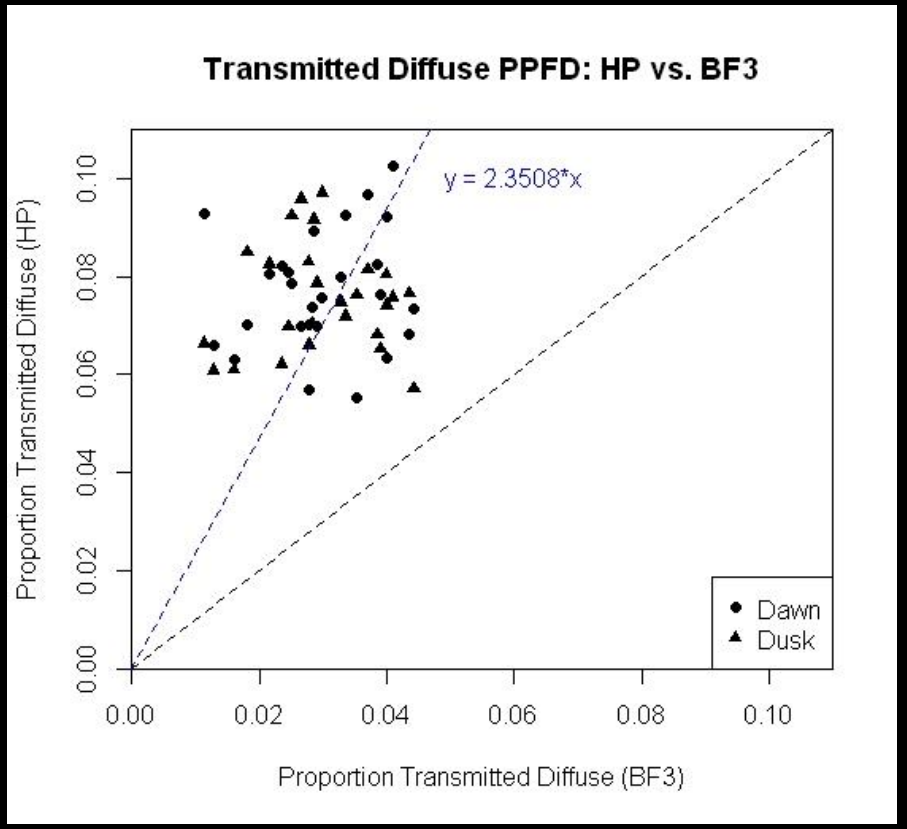
$$\frac{\sum \text{Total Below}}{\sum \text{Total Above}}$$

Transmitted Diffuse:

$$\frac{\sum \text{Diffuse Below}}{\sum \text{Diffuse Above}}$$

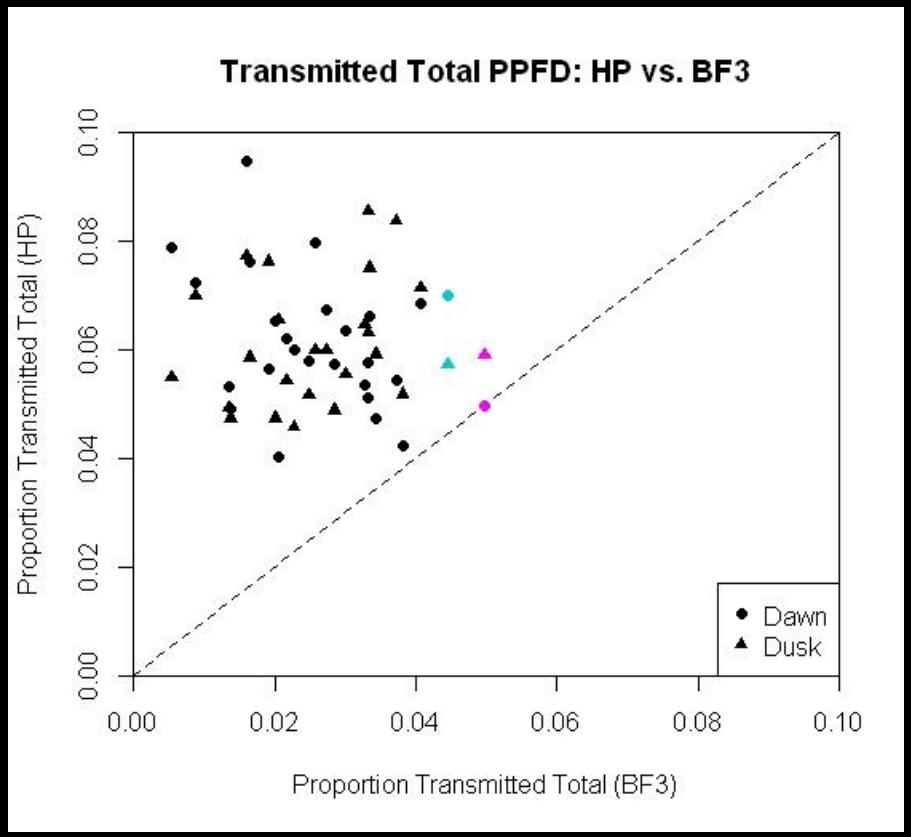
Results

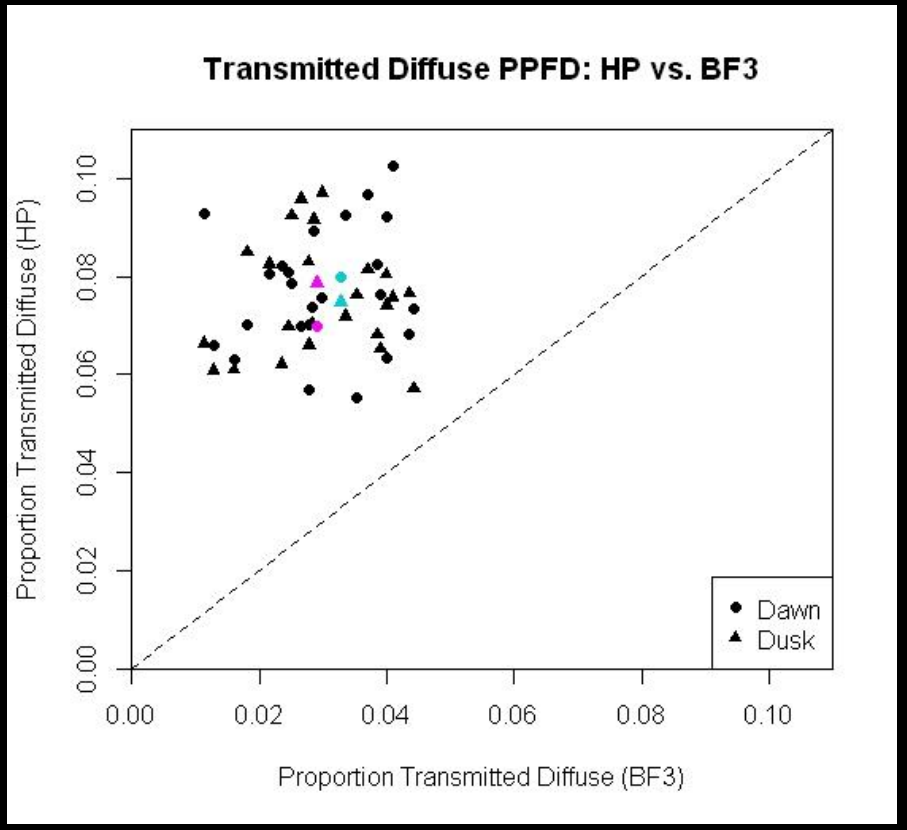




Hemispherical photography overestimates the proportion of both Total and Diffuse light that is transmitted to the understory

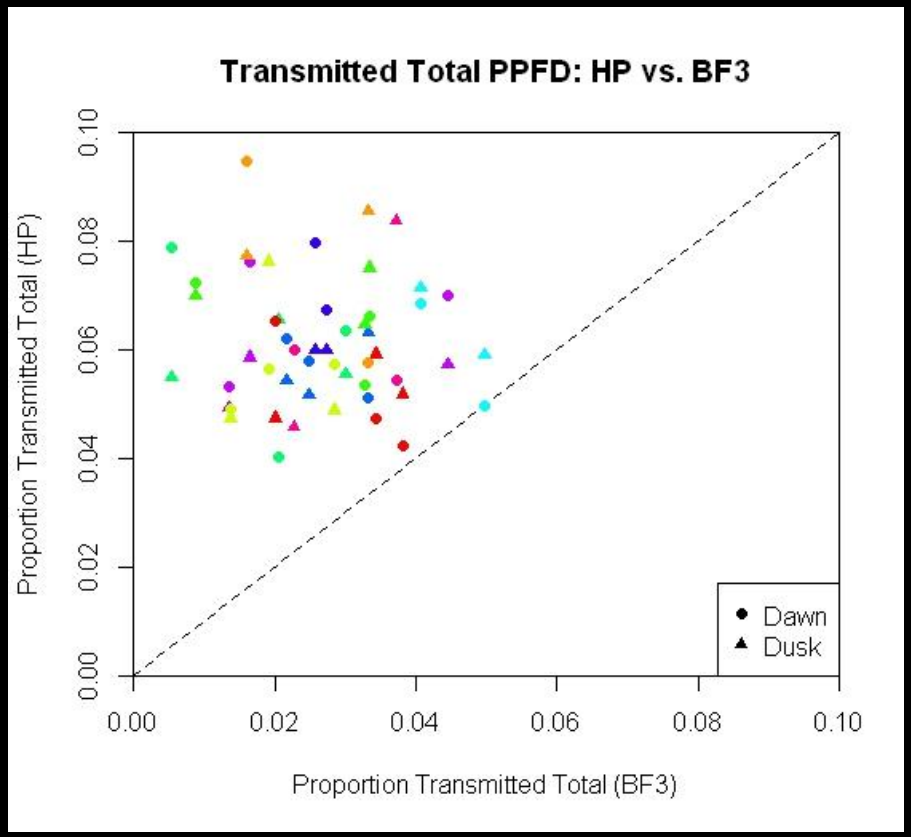
Results

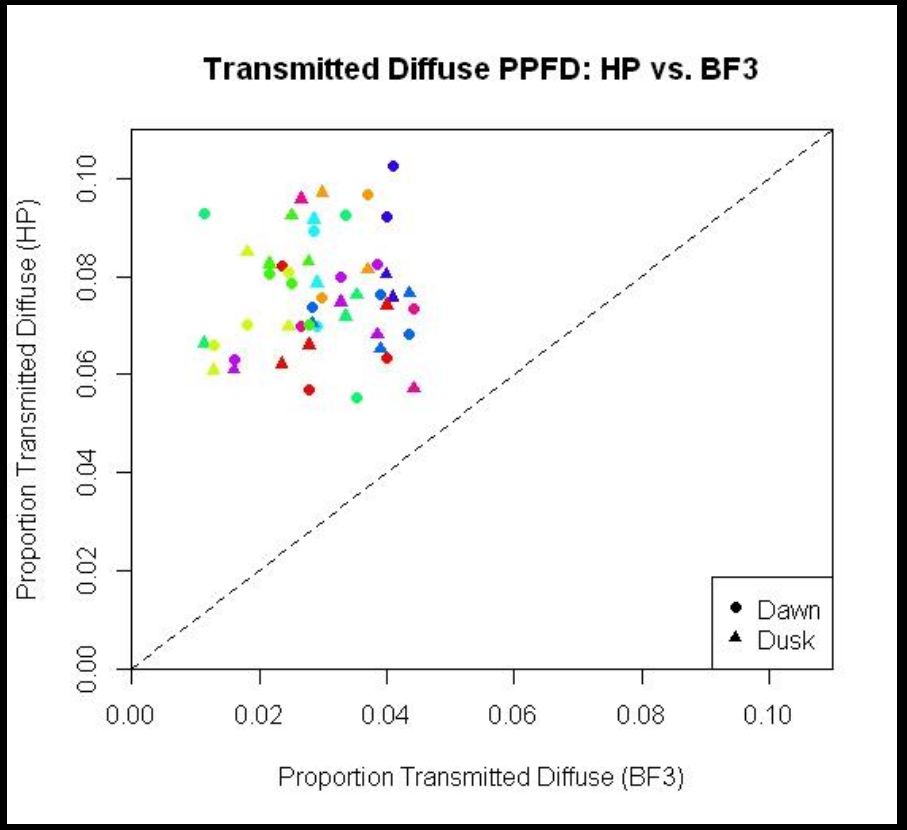




Example Dawn-Dusk pairs

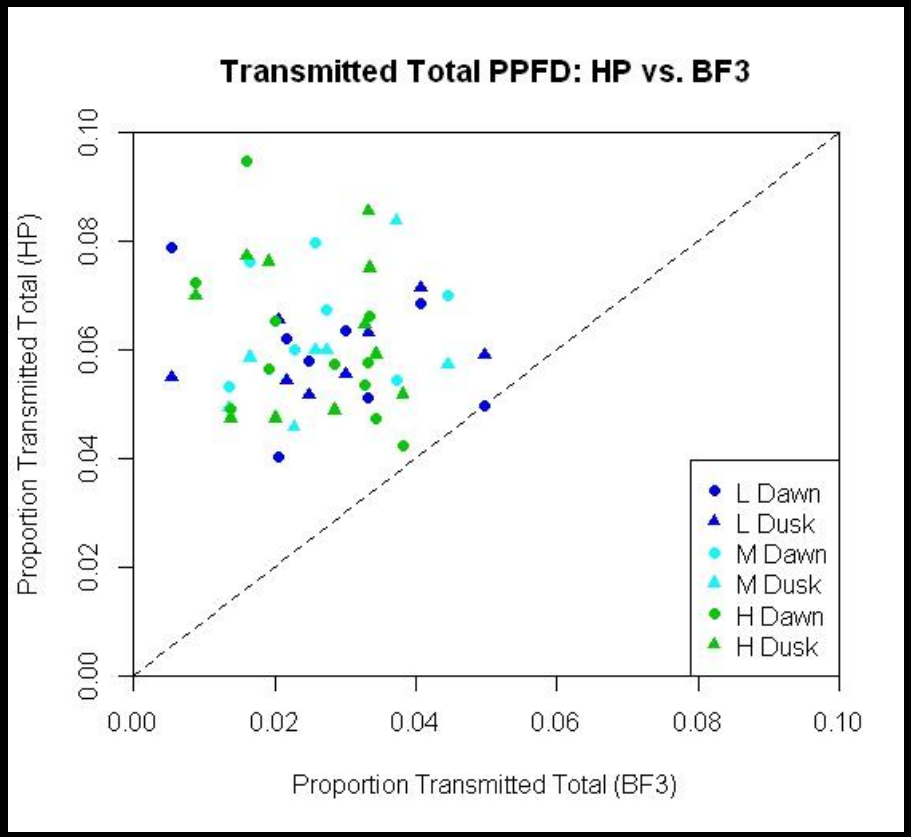
Results

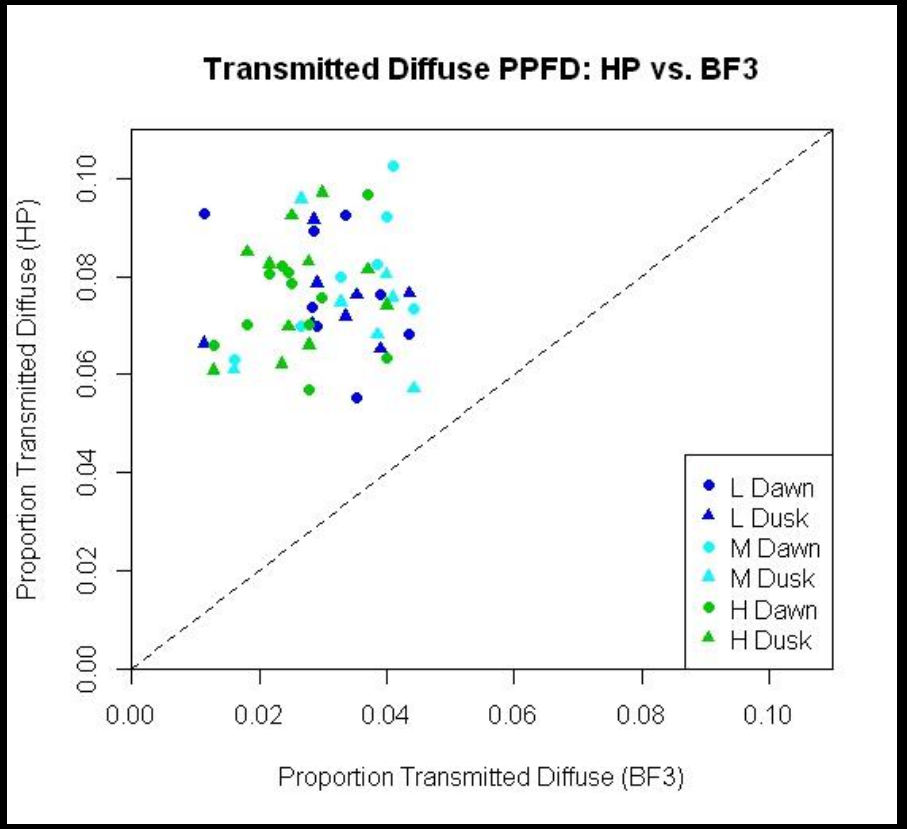




Locations

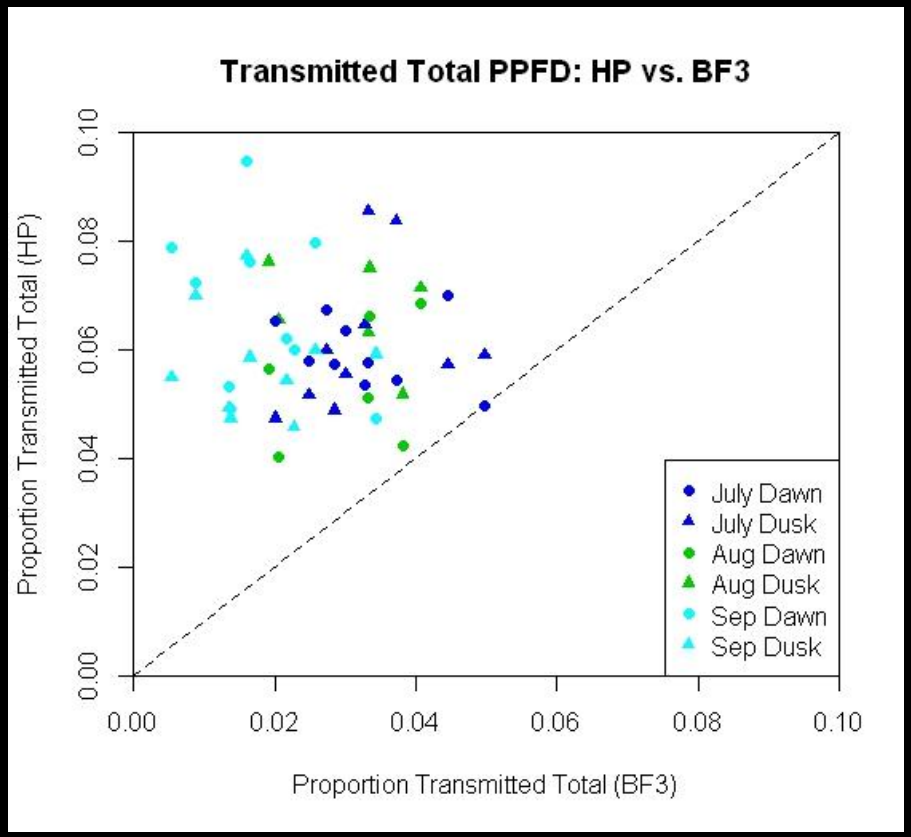
Results

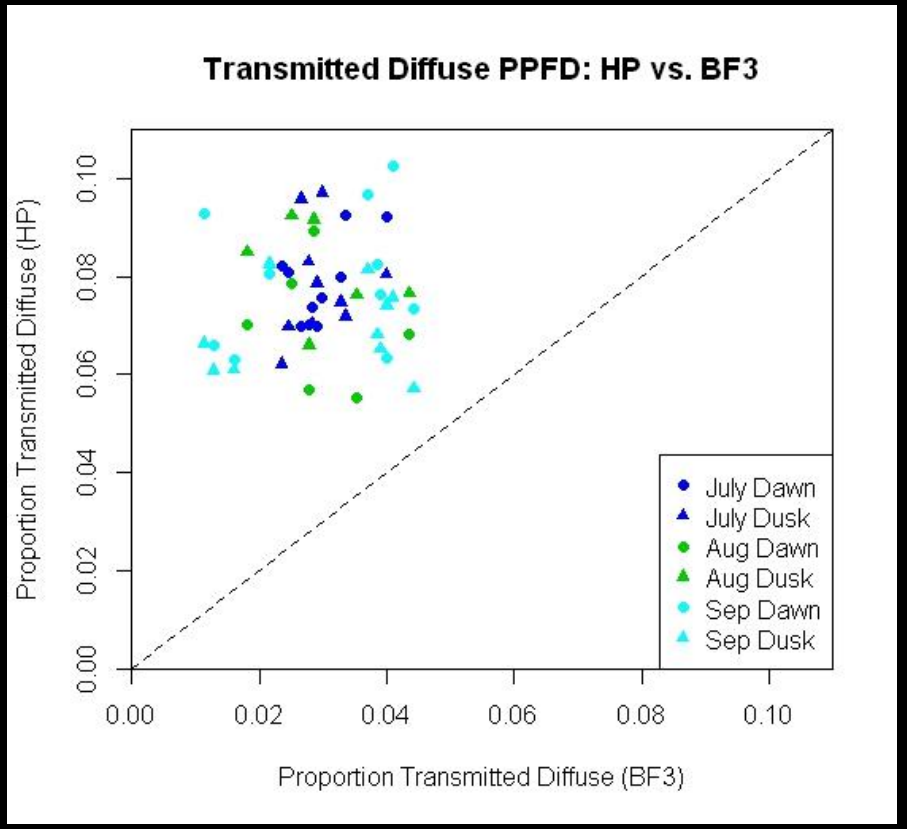




Location Strata

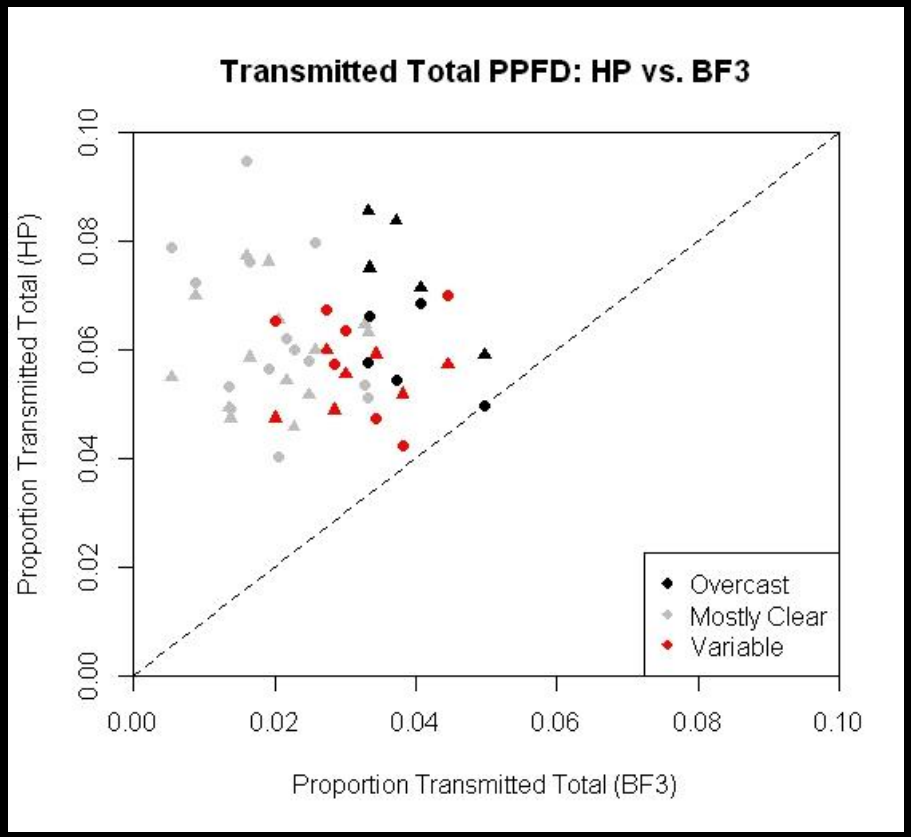
Results

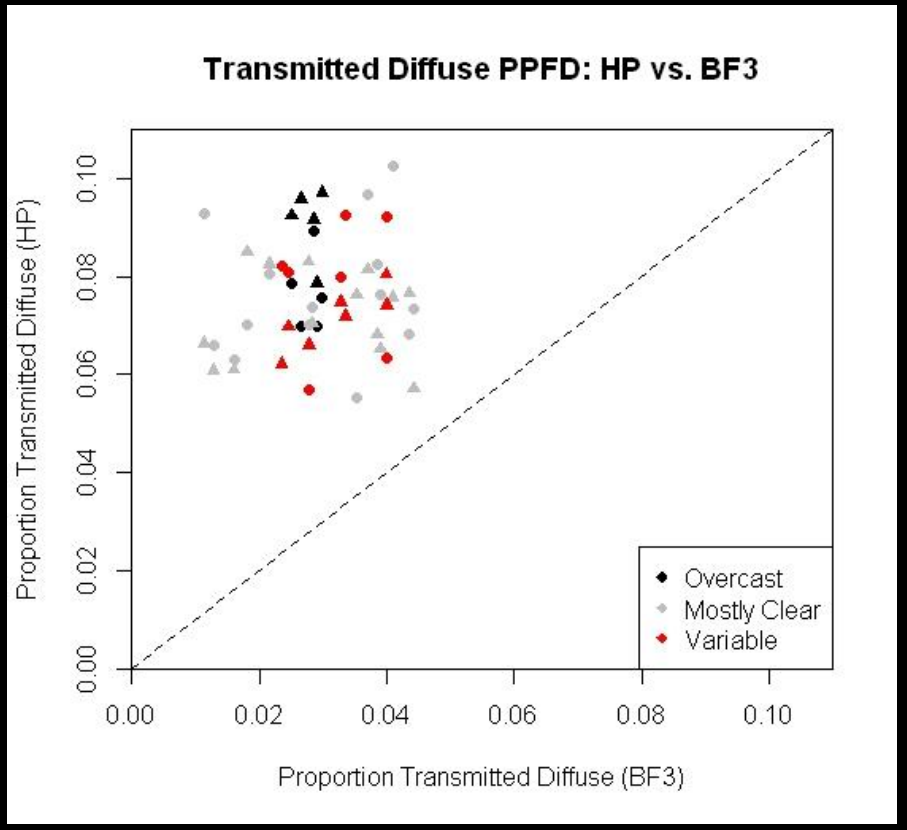




Month

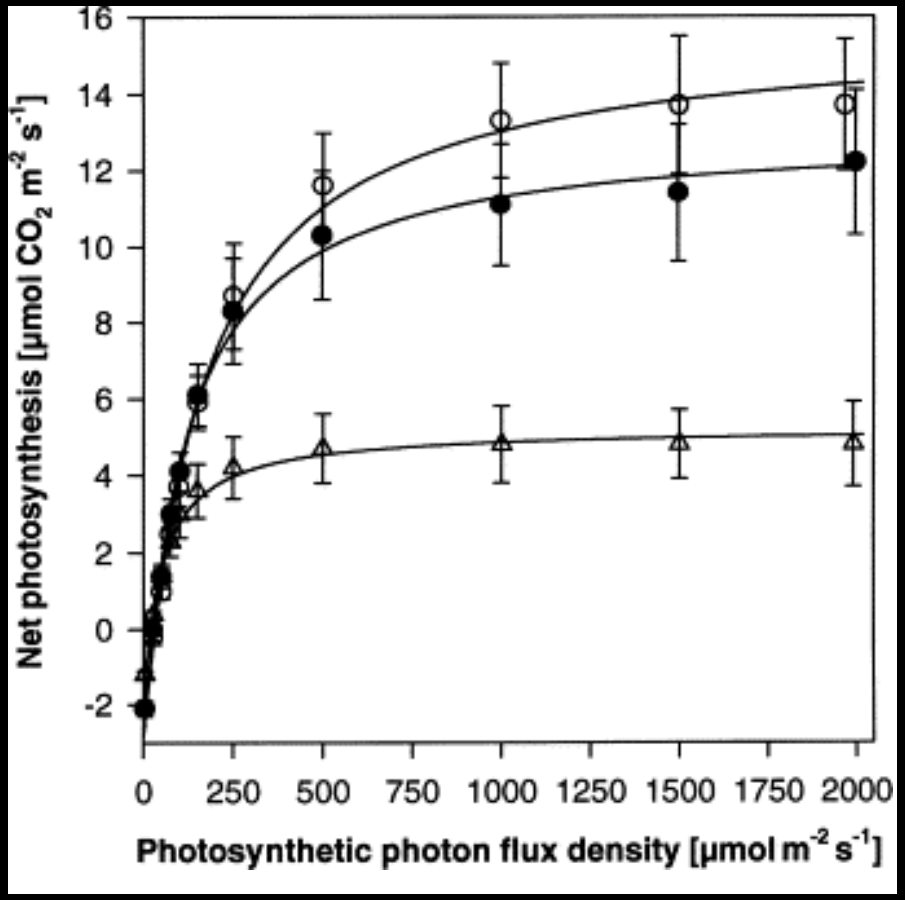
Results



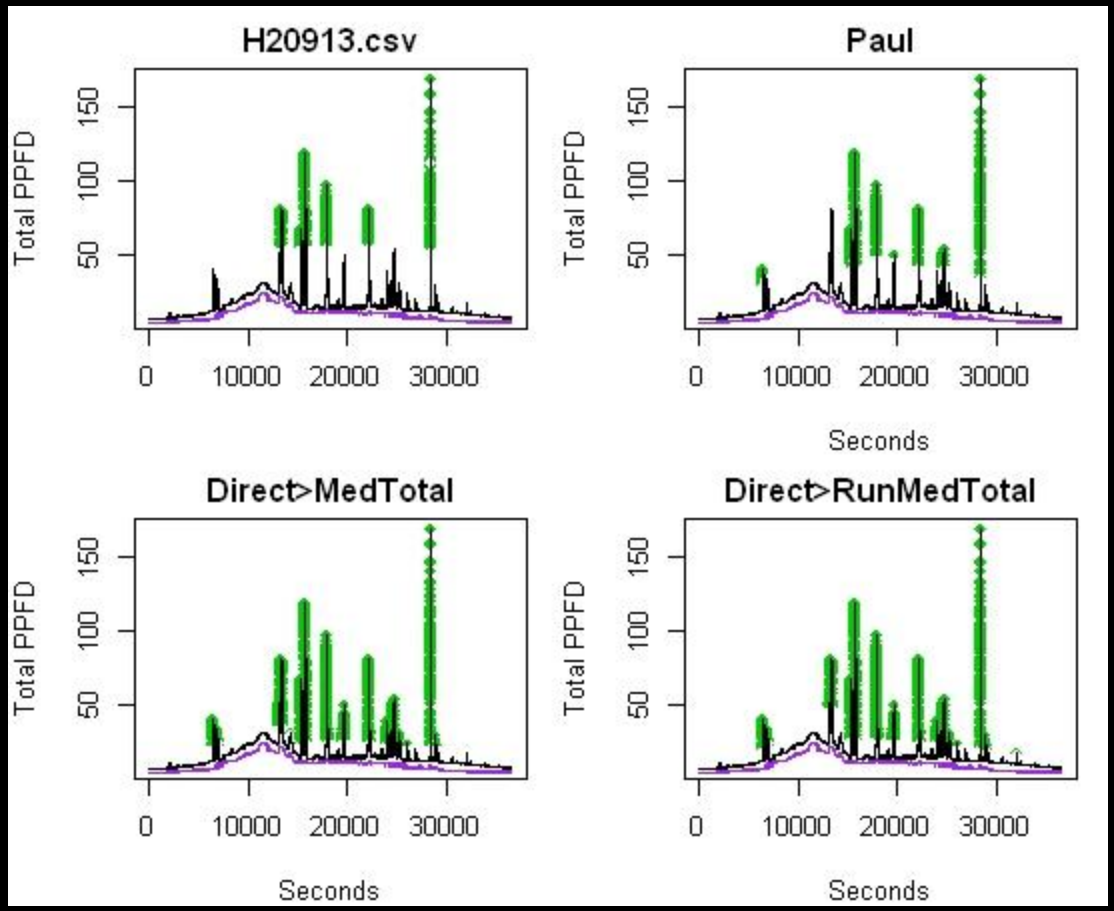


Weather

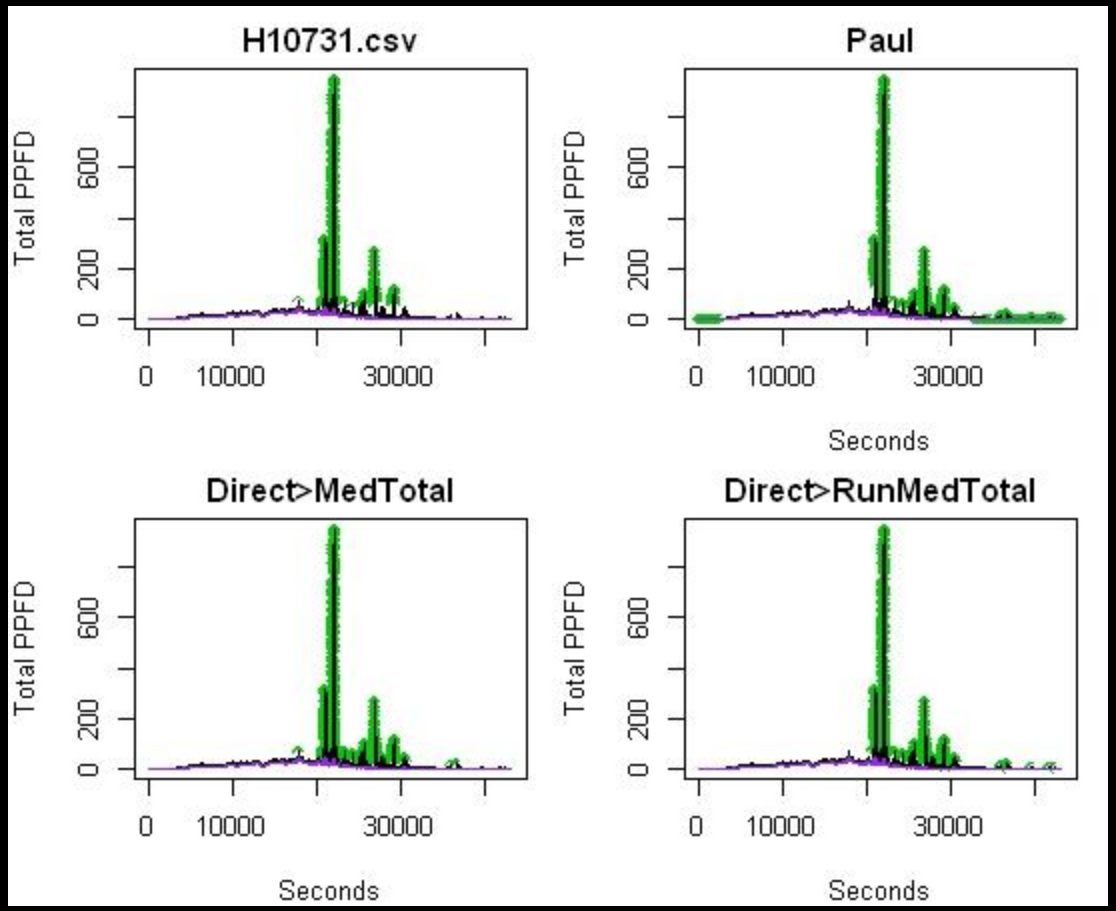
Results – sunflecks



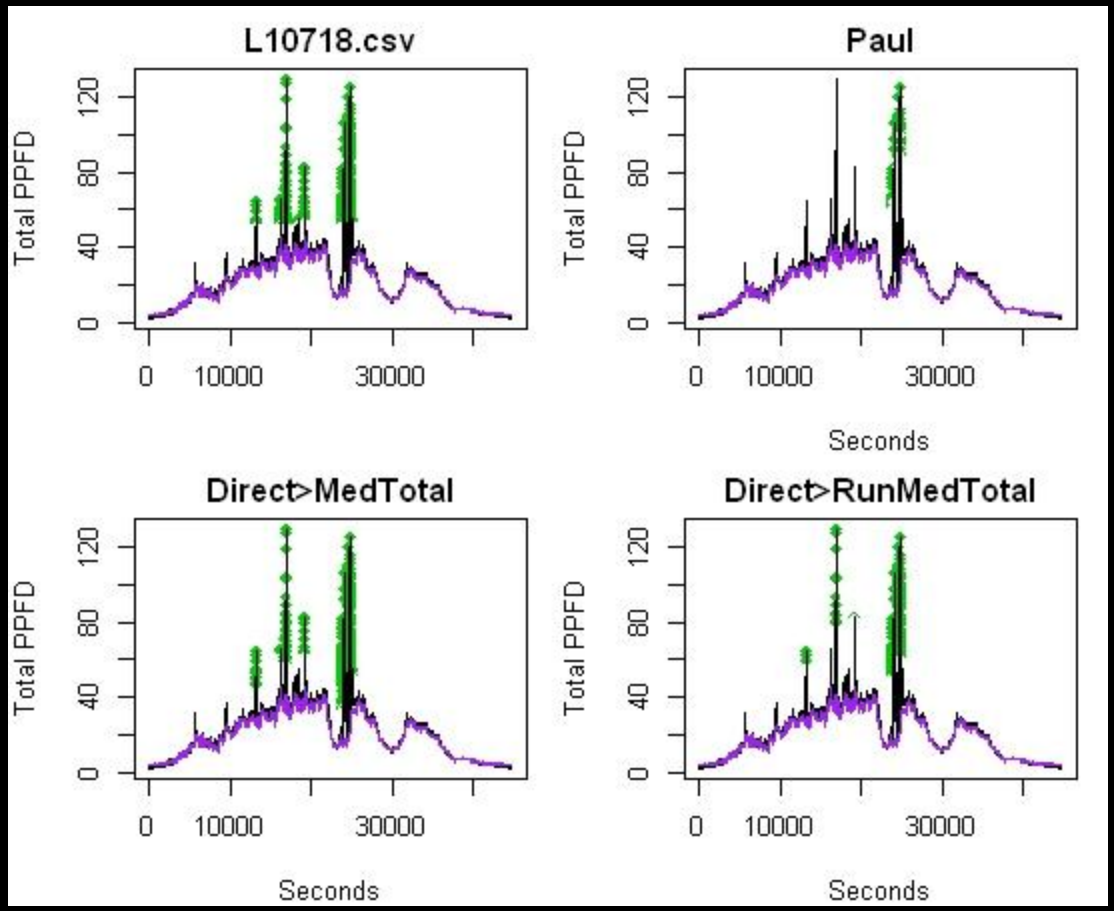
Results – sunflecks



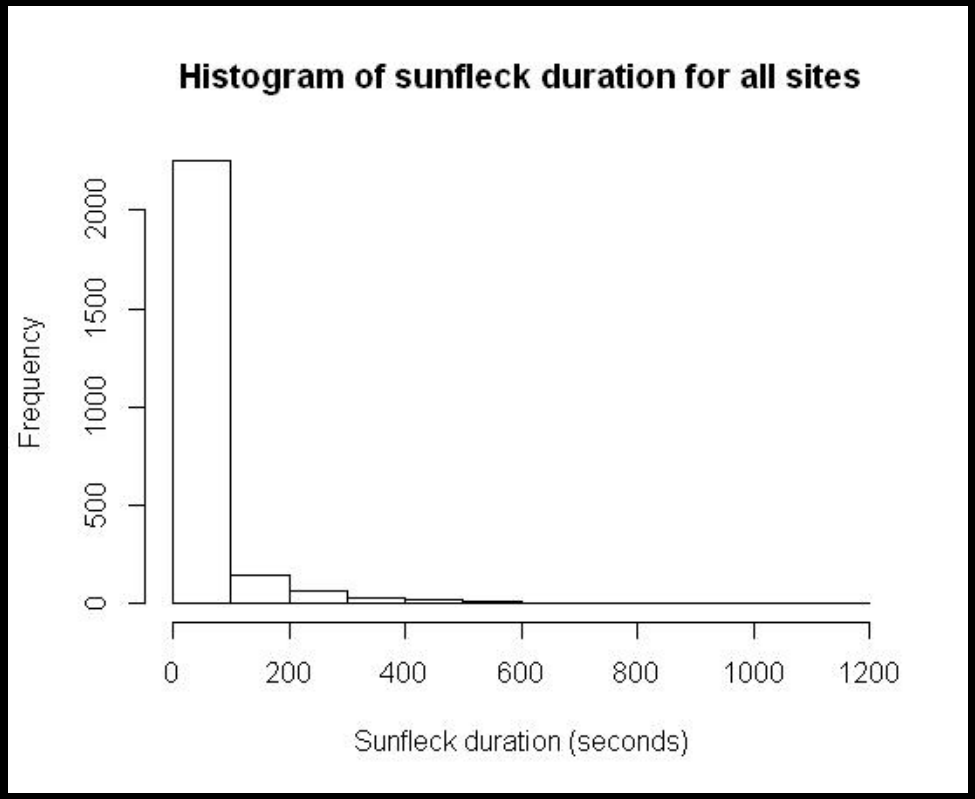
Results – sunflecks



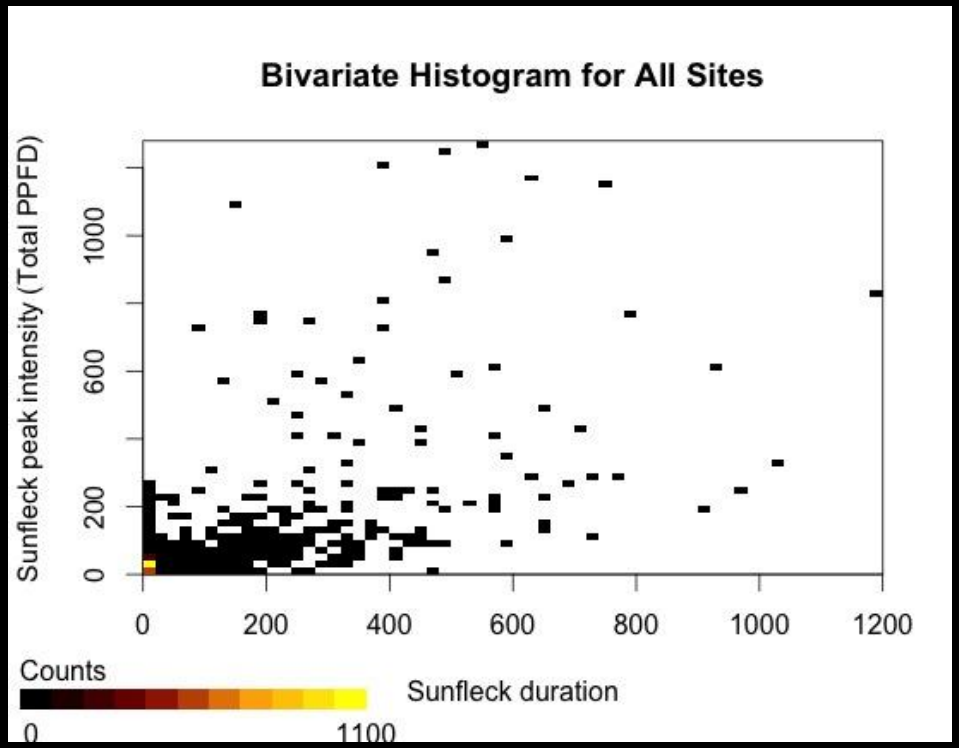
Results – sunflecks

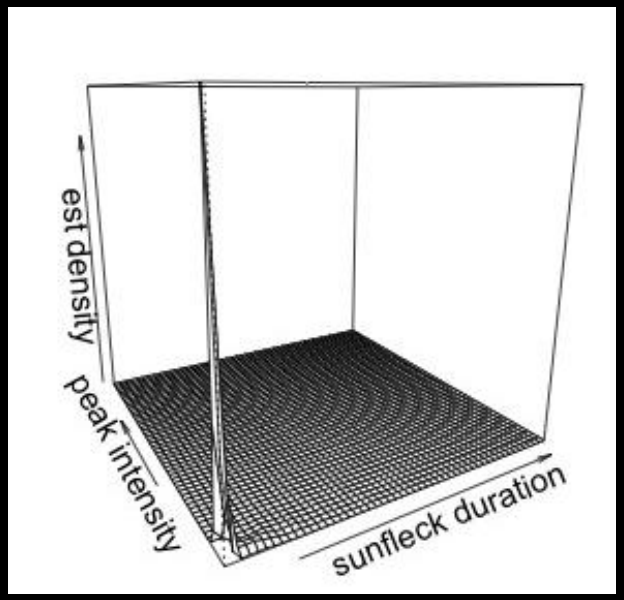


Results – sunflecks



Results – sunflecks





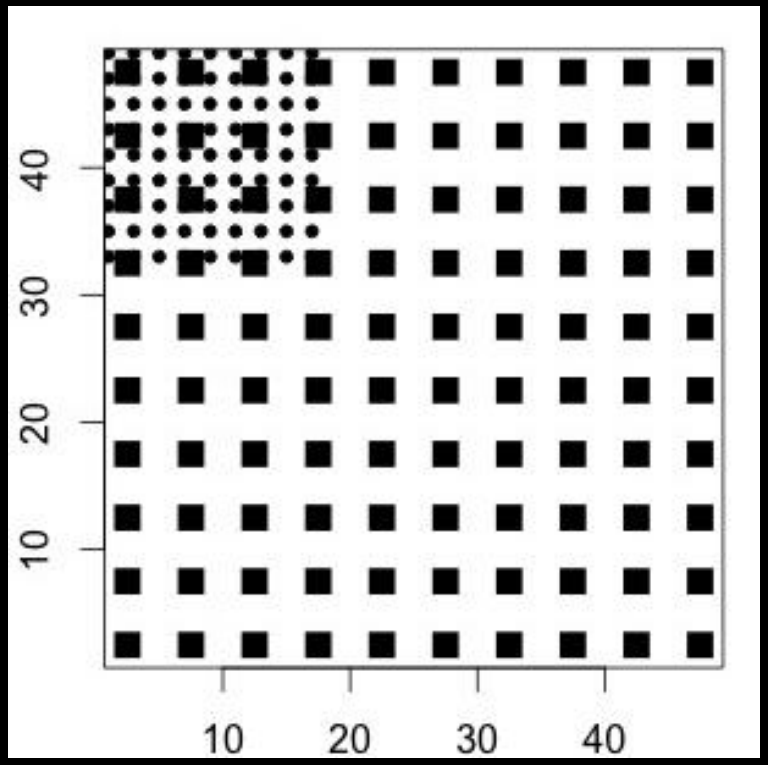
The SQURL

The SQURL

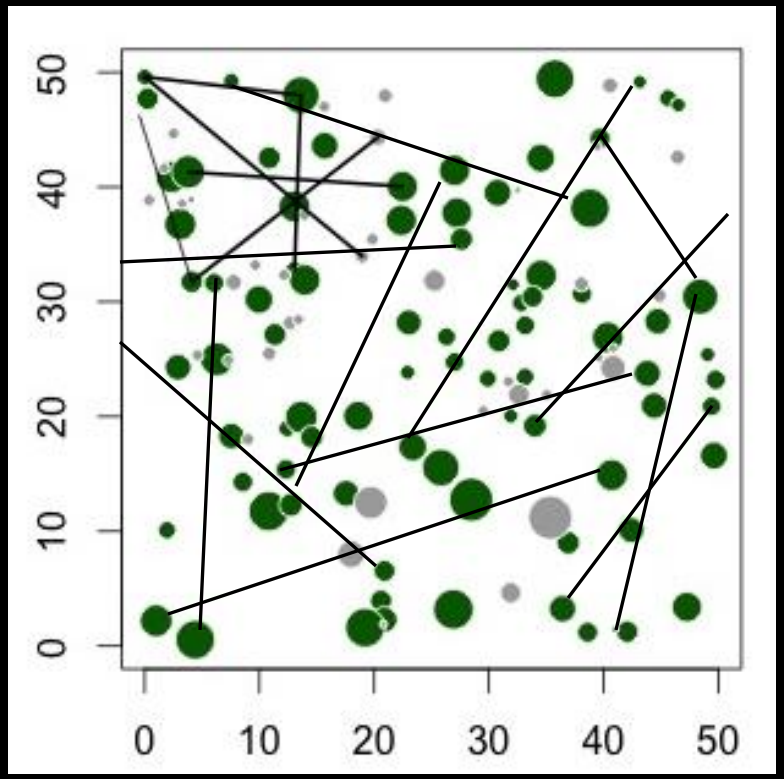
http://youtu.be/K-lrPTrm9FY http://youtu.be/iOIMS8osunw

Spatial Sampling

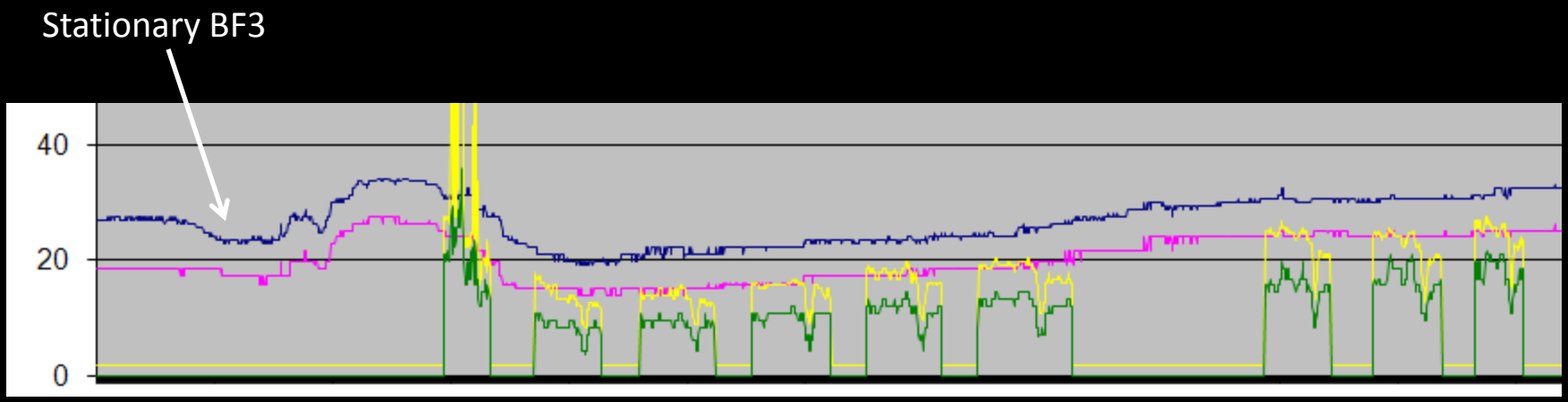
Grid HP



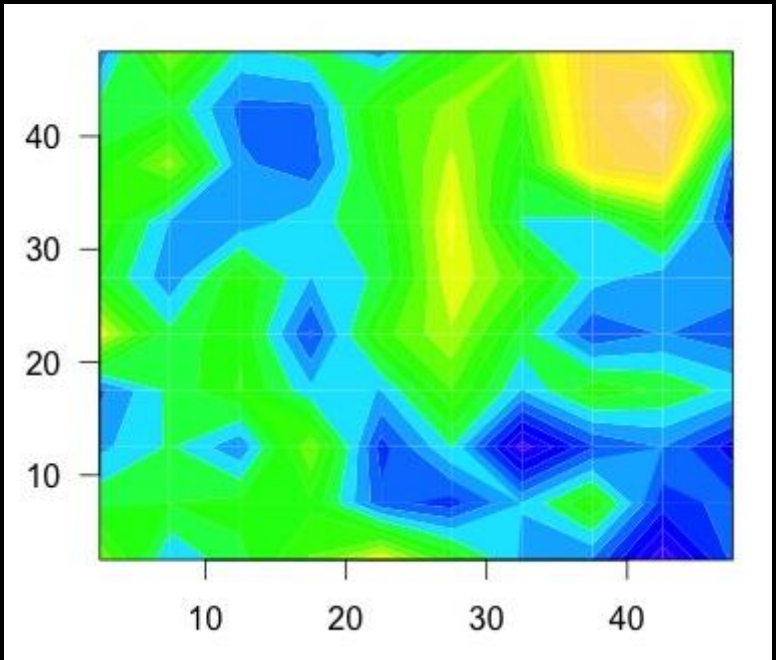
Transect BF3



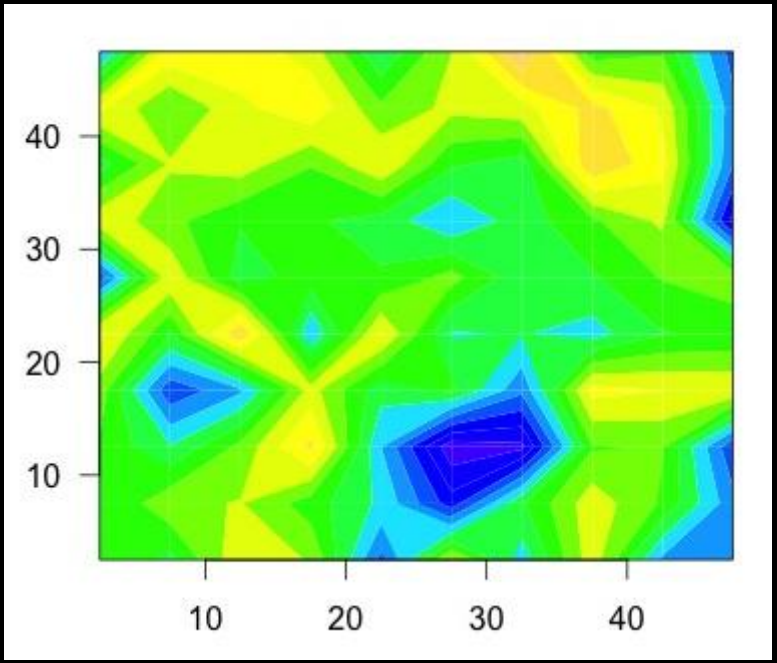
Spatial Sampling



Preliminary Results:
Hemispherical Photography 5m grid

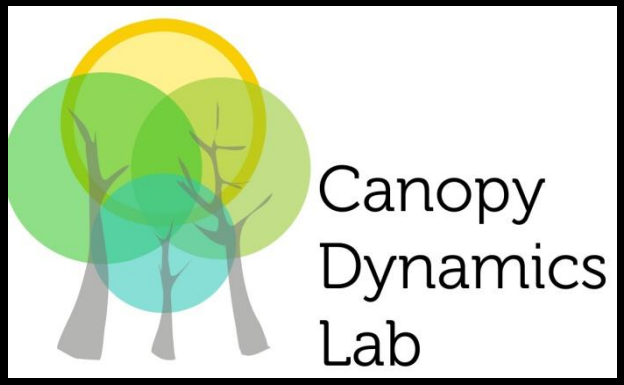


Direct



Diffuse

Acknowledgements



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Questions?