UNIVERSITY OF ALBERTA

Drought Effect on Carbon Sequestration in a Tropical Dry Forest

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Outline

1. Introduction to Tropical Dry Forests (TDFs)
2. Study Objectives
3. Costa Rica Study Site
4. General Methods
5. Results
6. Conclusions

TDFs Background

- Tropical dry forests (TDFs) cover 42% of all tropical ecosystems.
- One of most threatened tropical ecosystems.
- Much less knowledge of mechanisms affecting TDFs, compared to humid forests.
- Currently, there is limited knowledge of variability and controls on fluxes in TDFs.
- It limits our ability to predict CO_2 cycling due to natural and anthropogenic disturbances in these ecosystems.

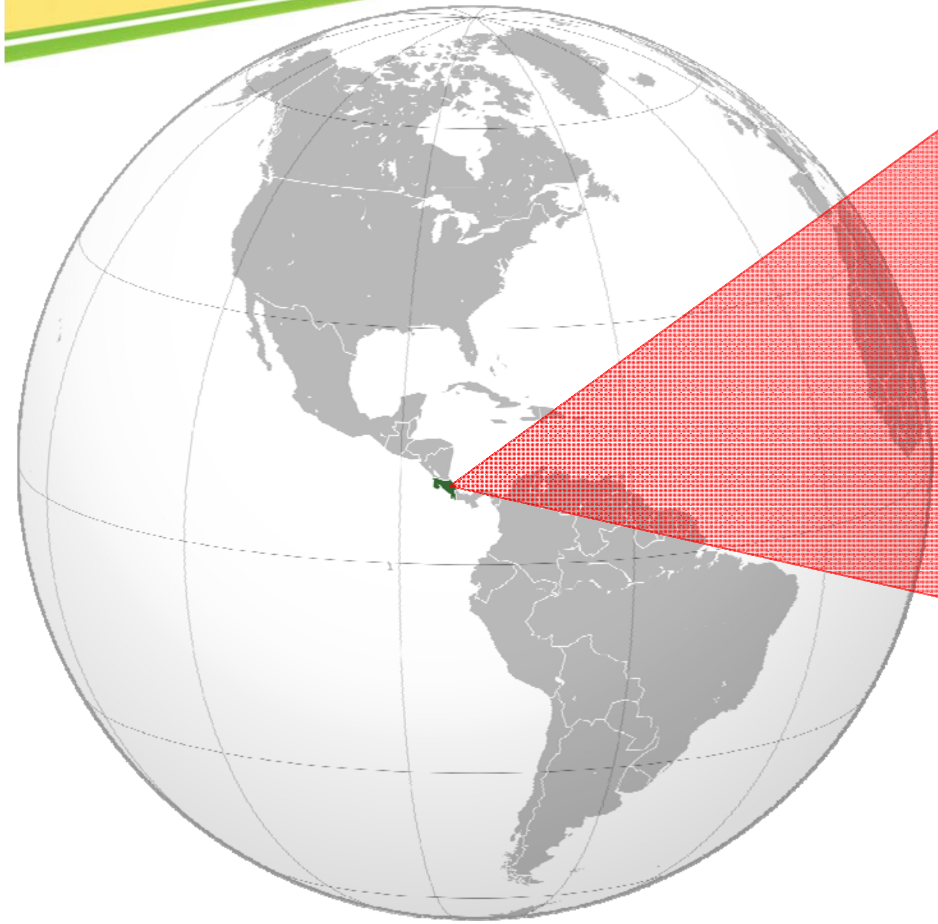
Study Objectives

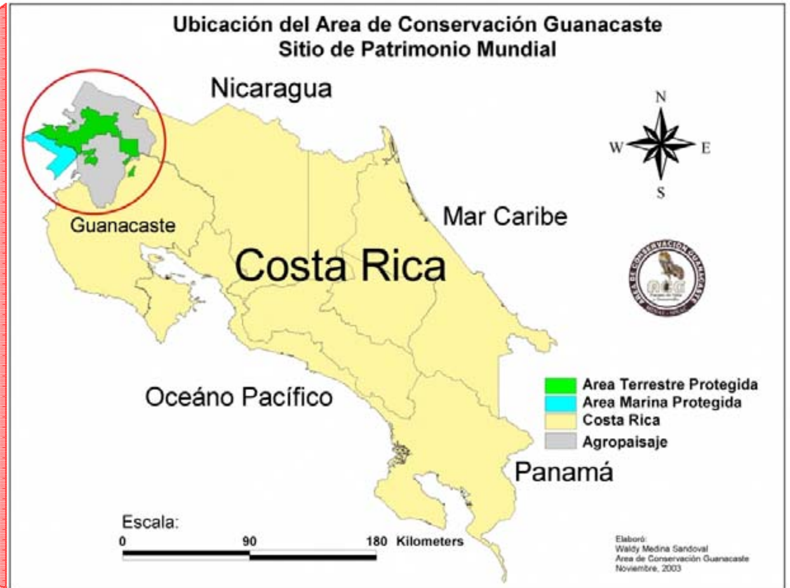
- Contribute by monitoring and measuring of ecosystem productivity in a Costa Rican Tropical Dry Forest:

1. **Examine the temporal coupling of the main processes of CO_2 exchange, Gross Photosynthetic Production (GPP) and ecosystem respiration (R_{eco}) with the seasonal change in the availability of water in the TDF.**

2. **Analyze the relation of CO_2 fluxes with environmental (PAR, air humidity, air temperature, and soil moisture) and phenological variables.**

Study Site





Ubicación del Area de Conservación Guanacaste
Sitio de Patrimonio Mundial
Nicaragua
Guanacaste
Costa Rica
Mar Caribe
Oceáno Pacífico
Panamá
N
W
E
S
Area Terrestre Protegida
Area Marina Protegida
Costa Rica
Agropaisaje
Escala:
0
90
180 Kilometers
Elaboró:
Waldy Medina Sandoval
Area de Conservación Guanacaste
Noviembre, 2003

Santa Rosa Environmental Monitoring Super Site

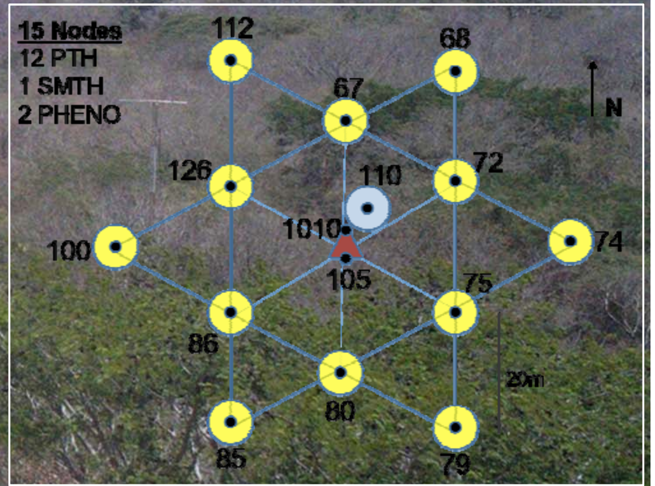
- Study site located at Santa Rosa National Park, Guanacaste, Costa Rica
  - (10° 50.473 N, 85° 37.048 W).
- Intermediate stage Tropical Dry Forest.
- Mean annual temperature:
  - 26.6^{o}C
- Mean precipitation:
  - 1390.8 mm/yr
- Dry season:

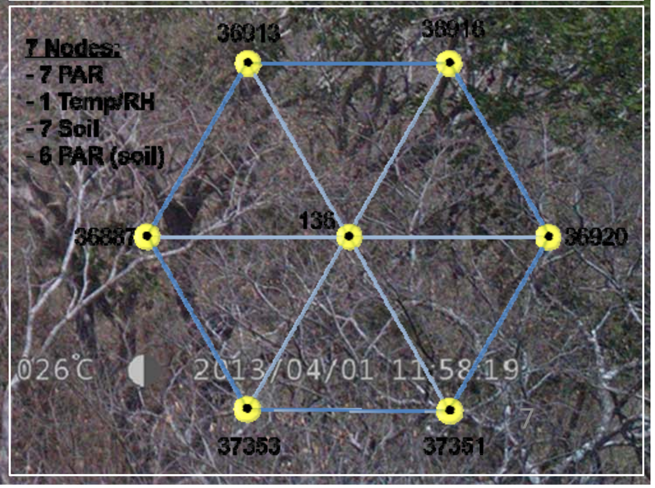
  December – April

Bushnell

Santa Rosa Environmental Monitoring Super Site

- **Equipped with:**
  - Eddy Covariance system
  - Meteorological station
  - Phenology Tower
  - Wireless Sensor Network (WSN)

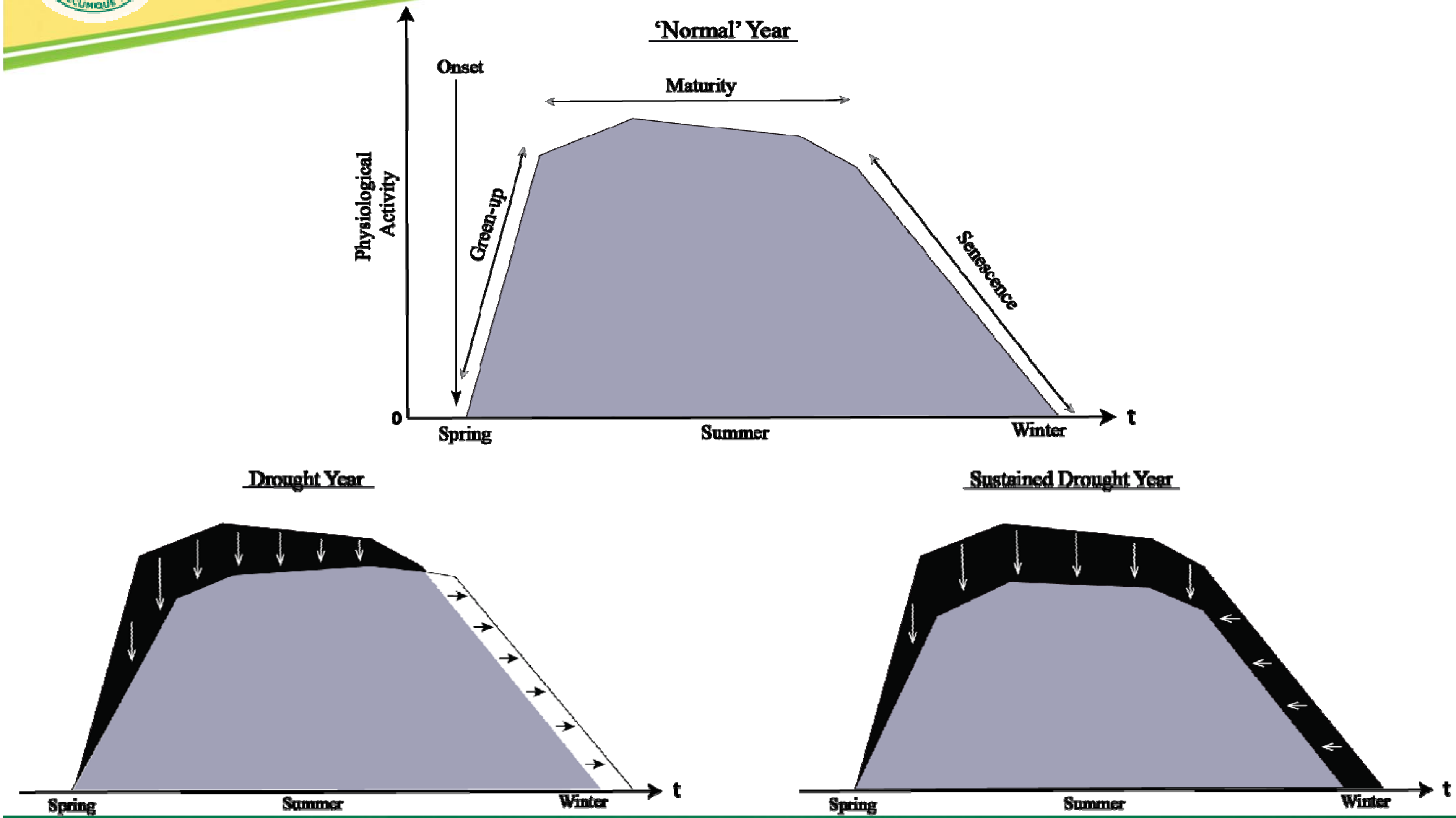




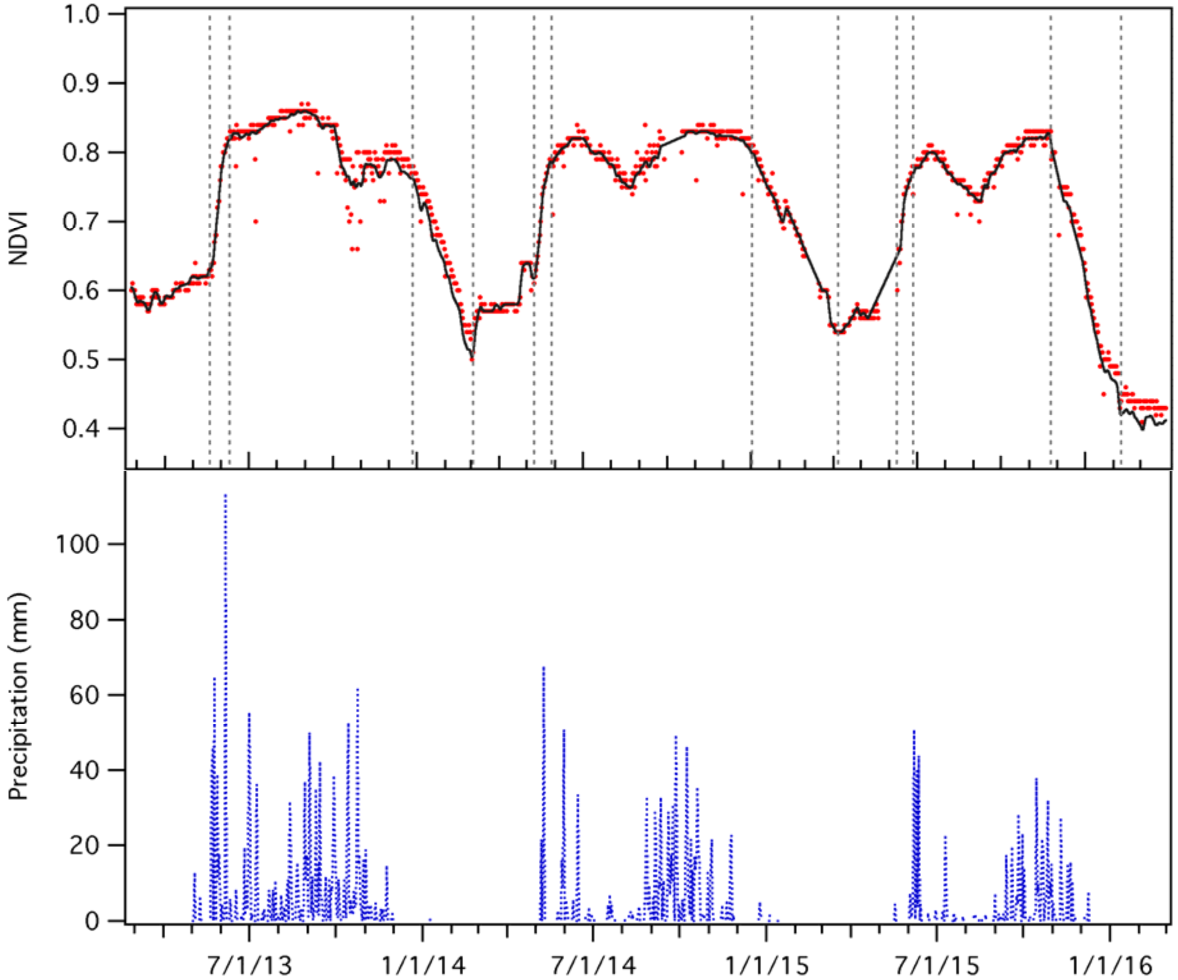
General Methods

- Flux measurements processed using LICOR's EddyPRO® and IBM's Stream Analytics software.
- Flux partitioned using light response curves following methods outlined by Hutyra et al., (2007).
- Flux gap-filling done following methods outlined by Reichstein et al., (2005).
- Proximal remote sensing data and meteorological data processed and stored through Enviro-Net web portal (www.enviro-net.org).

Altered Phenology by Drought



Results: Phenology 2013-2016



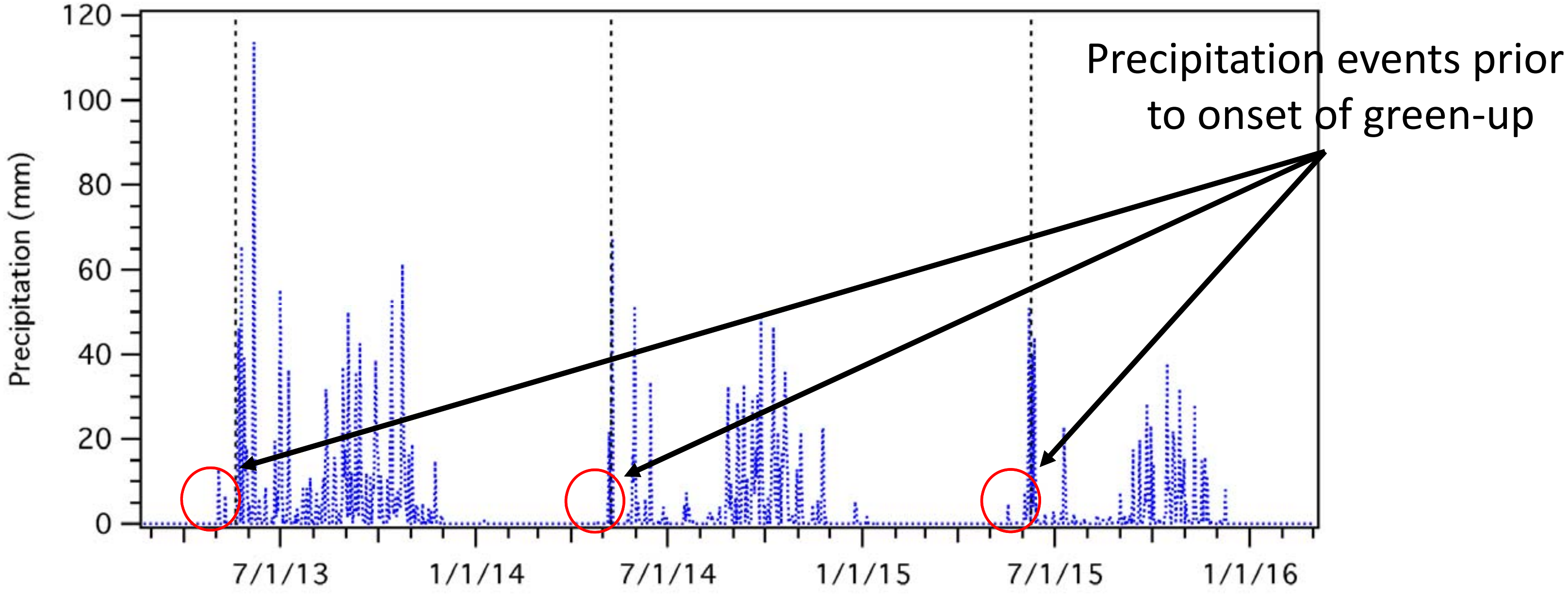
Phenology 2013-2016

+ve values = early onset
-ve values = delayed onset

Phenology 2013-2015 Seasons					
	2013 Season	**2014 Season**	**2015 Season**	**Δ Onset (2013-2014) (days)**	**Δ Onset (2013-2015) (days)**
Start of Green-up	2013/05/20	2014/05/09	2015/06/09	11	-20
Start of Maturity	2013/06/10	2014/05/28	2015/06/27	13	-17
Start of Senescence	2013/12/27	2014/01/02	2015/11/24	-6	33
End of Season	2014/03/03	2015/04/06	2016/02/09	-34	22

Phenology 2013-2015 Seasons			
Length of Greenup	21	19	18
Length of Maturity	200	219	150
Length of Senescence	66	94	77
Green-up to Senescence	287	332	245

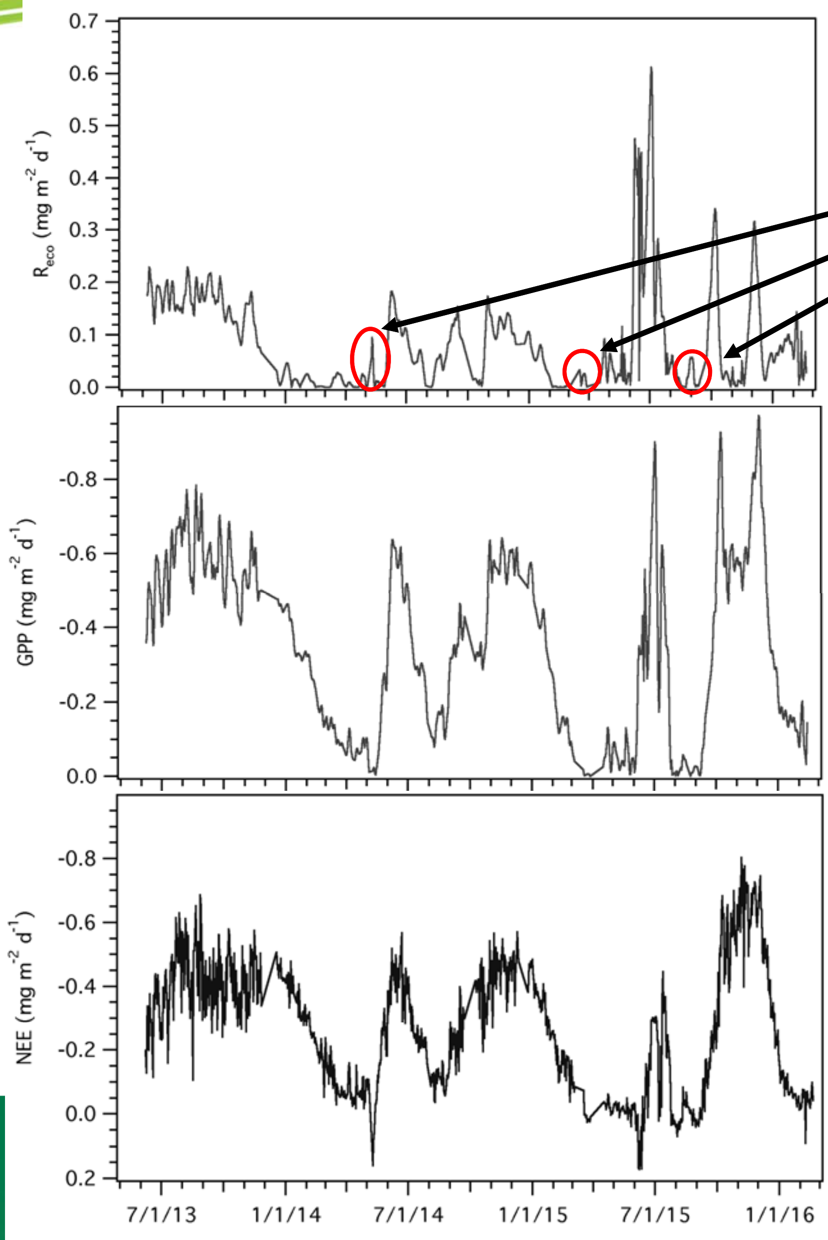
Phenology 2013-2016



	2013 Precipitation (mm)	2014 Precipitation (mm)	2015 Precipitation (mm)
Green-up	347.2	86.619	156.3
Maturity	1123.024	938.576	487.8
Senescence	0.6	2.03	9.9
Prior to Season	20.5	22.01	20.9
Seasonal Total	1470.8	1027.2	654.0

Fluxes 2013-2016

- Seasonal time series of net ecosystem exchange (NEE), photosynthetic production (GPP), and ecosystem respiration (R_{eco}) during the 2013-2015 seasons.

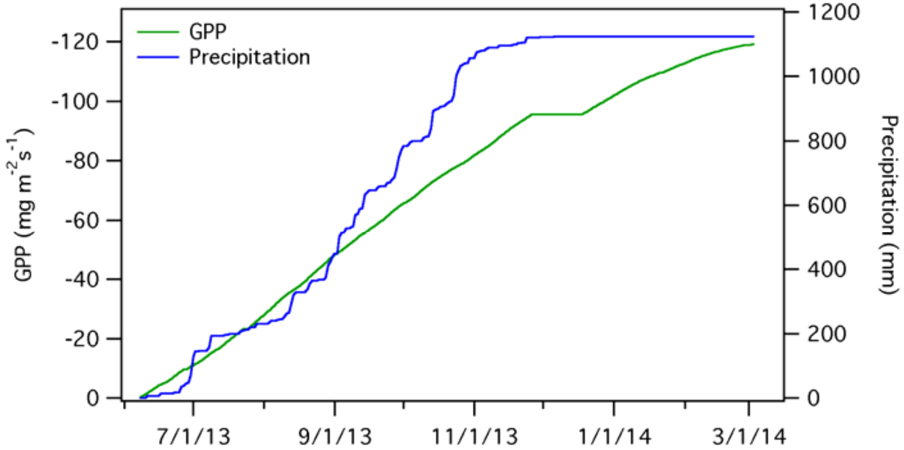


R_{eco} = NEE

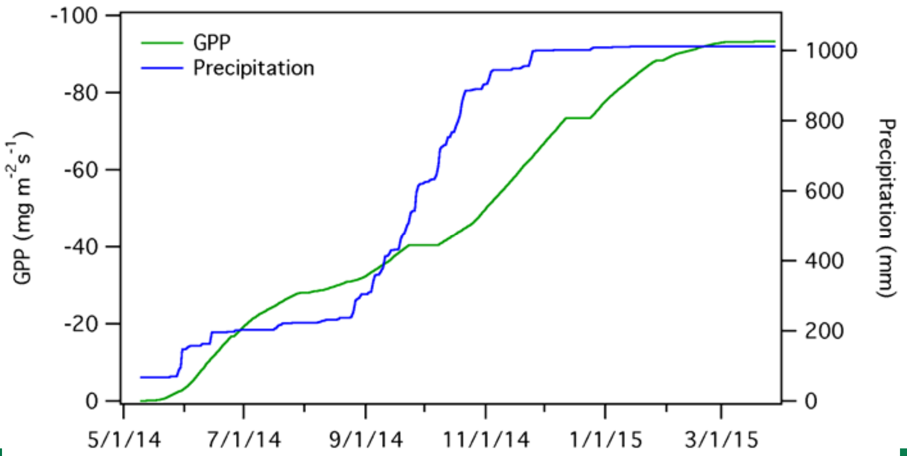
+ve NEE = loss of carbon
-ve NEE = carbon uptake

GPP and Precipitation 2013-2016

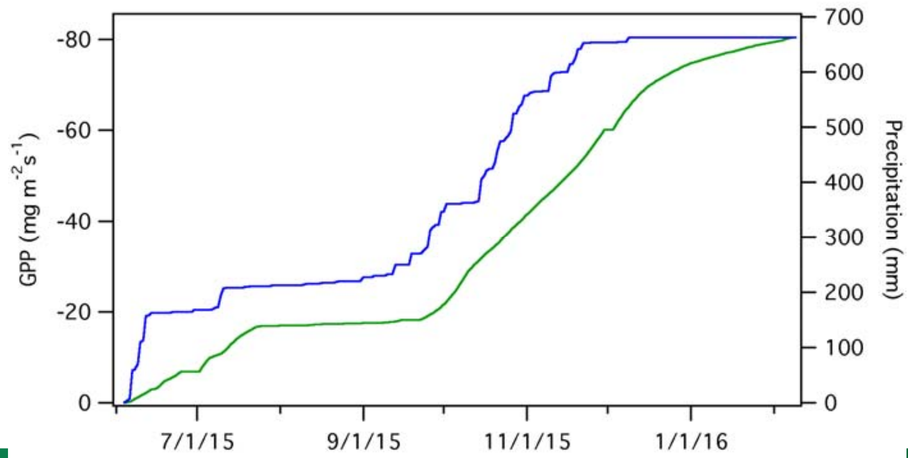
- 2013



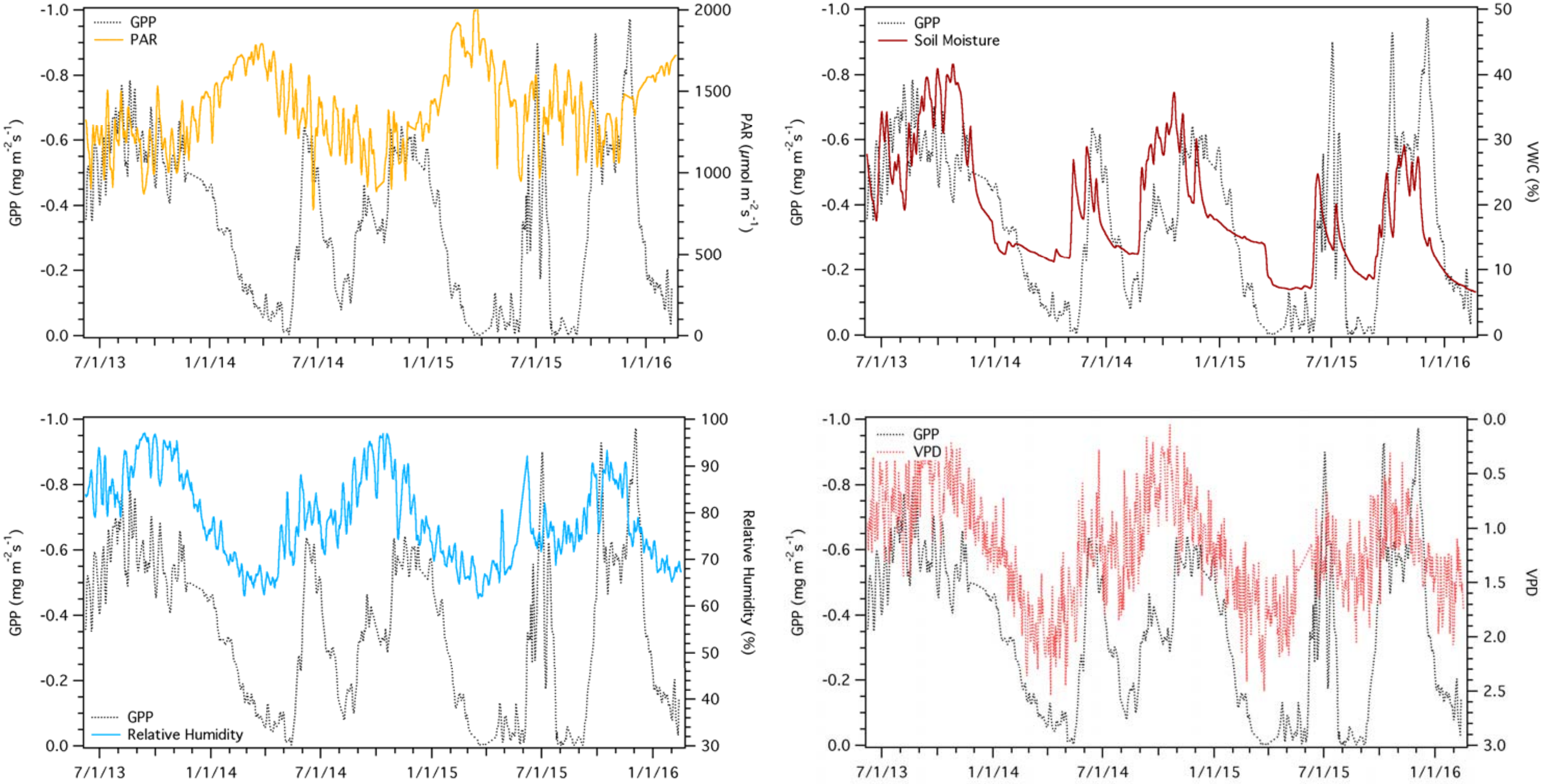
- 2014



- 2015

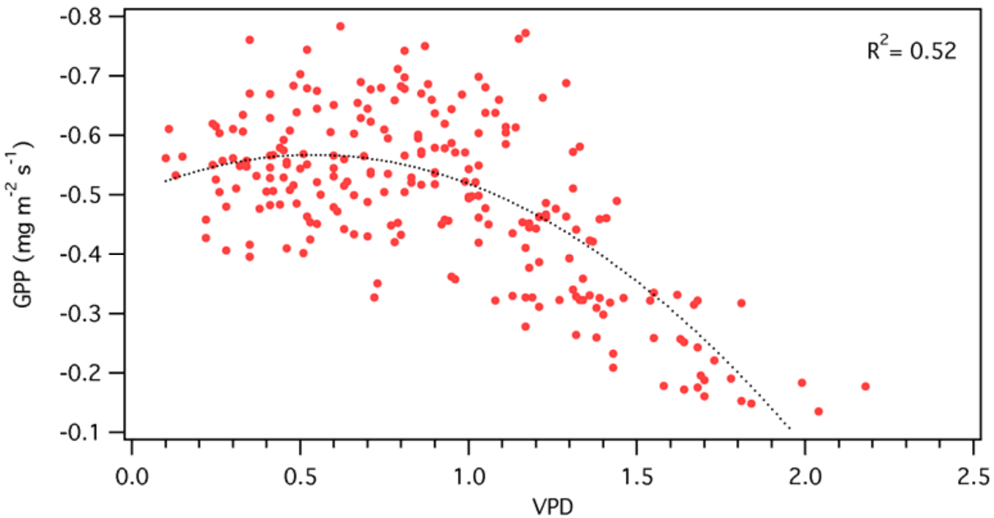


Meteorological Variables

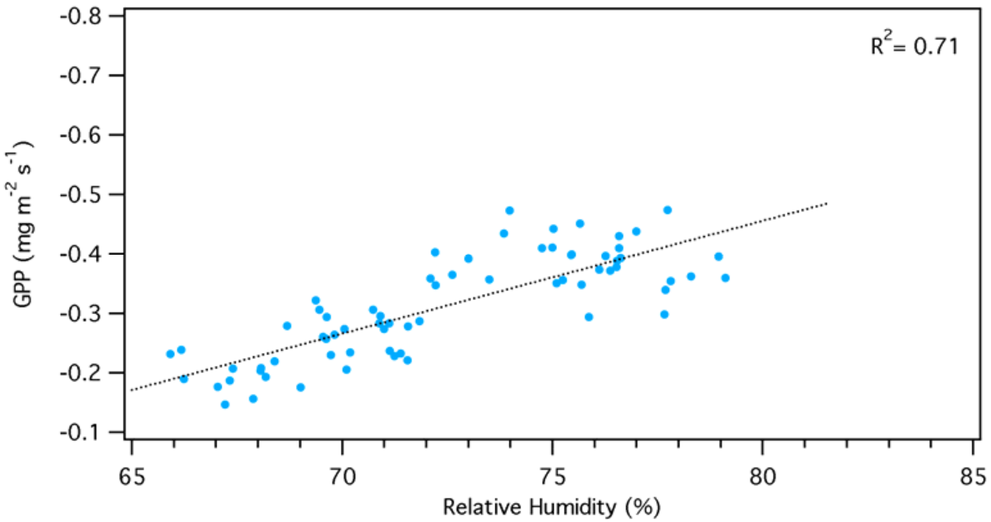


Productivity Relationships 2013

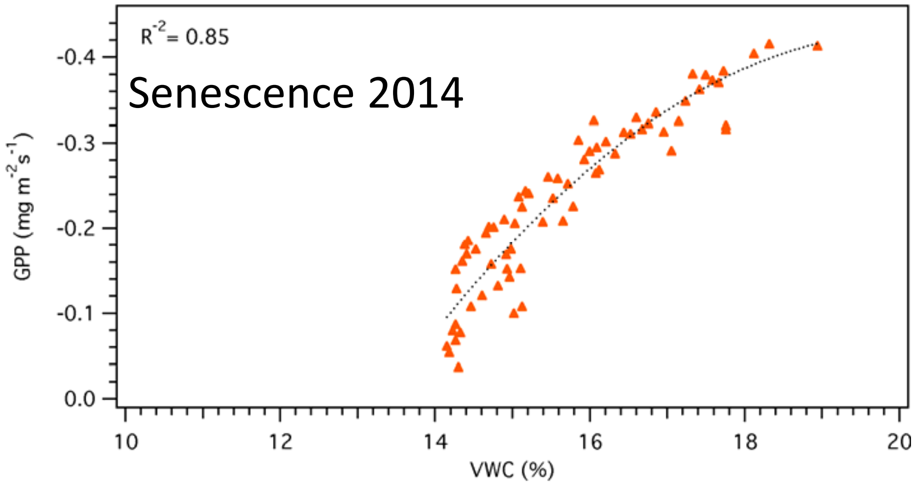
- 2013 seasonal relationship
  VPD vs. GPP

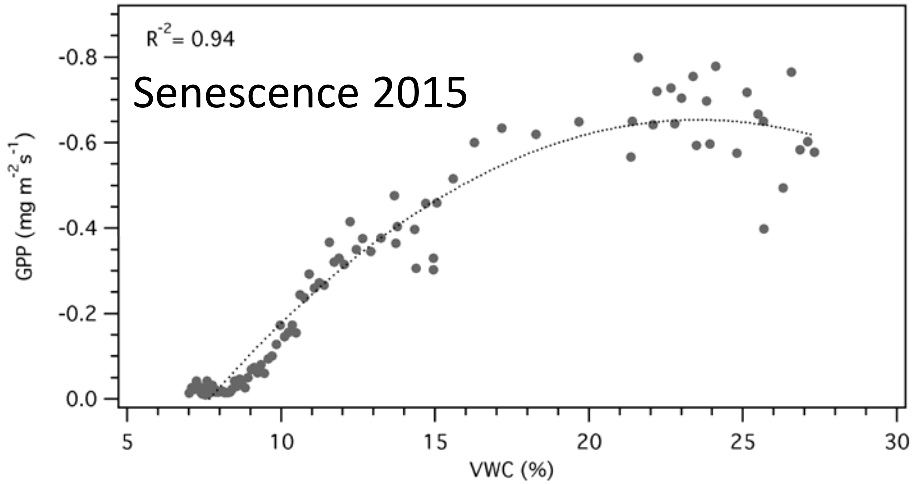


- 2013 senescence relationship
  RH vs. GPP

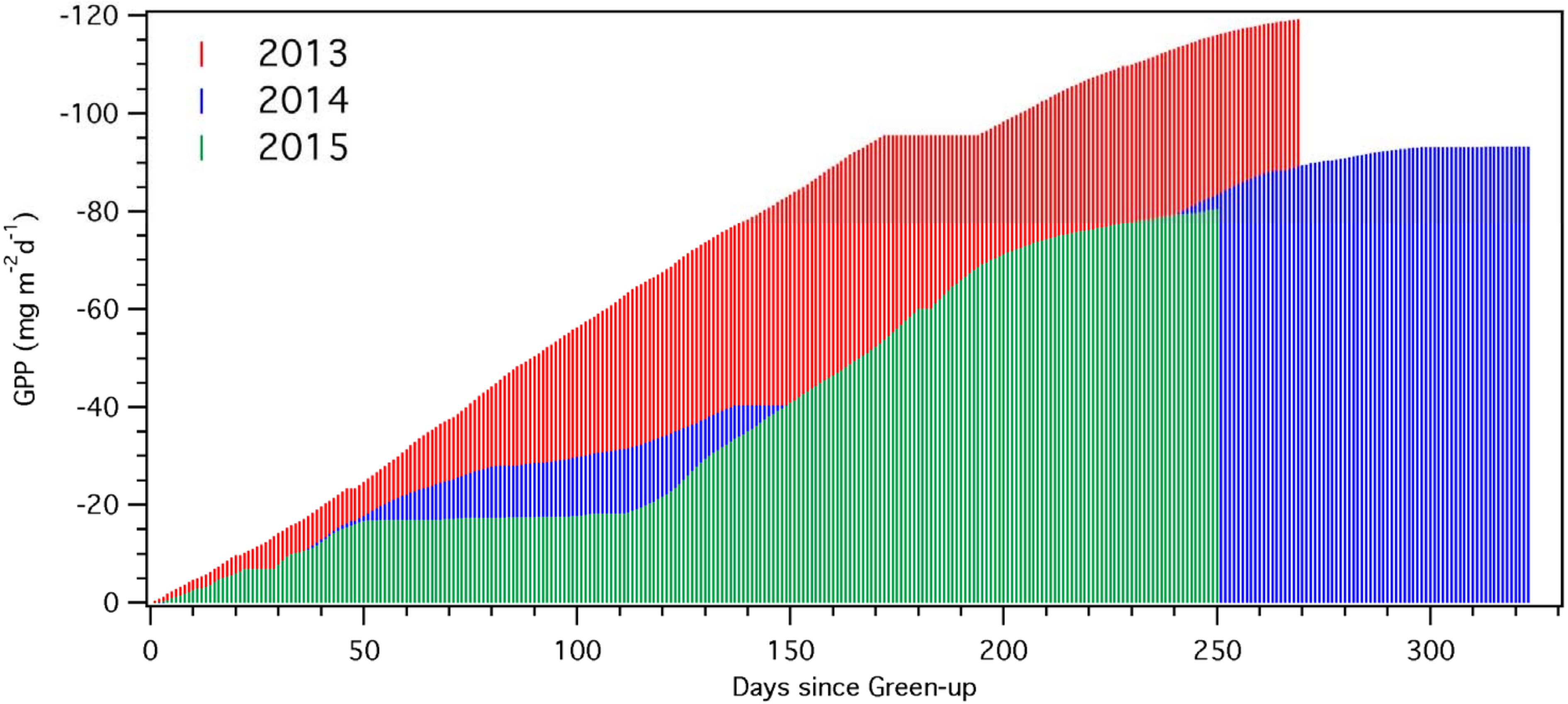


Productivity relationships in Drought





GPP seasonal Accumulation



Conclusions

- **Water availability is the main limiting factor in TDF.**
  - Normal year → VPD or RH
  - Drought year → Soil water moisture

- **TDF can respond to drought by extending their growth season (extend maturity and senescence) but will not reach productivity levels of 'normal' years.**

- **Severe drought can lead to a substantial reduction in productivity and growth cycle length.**

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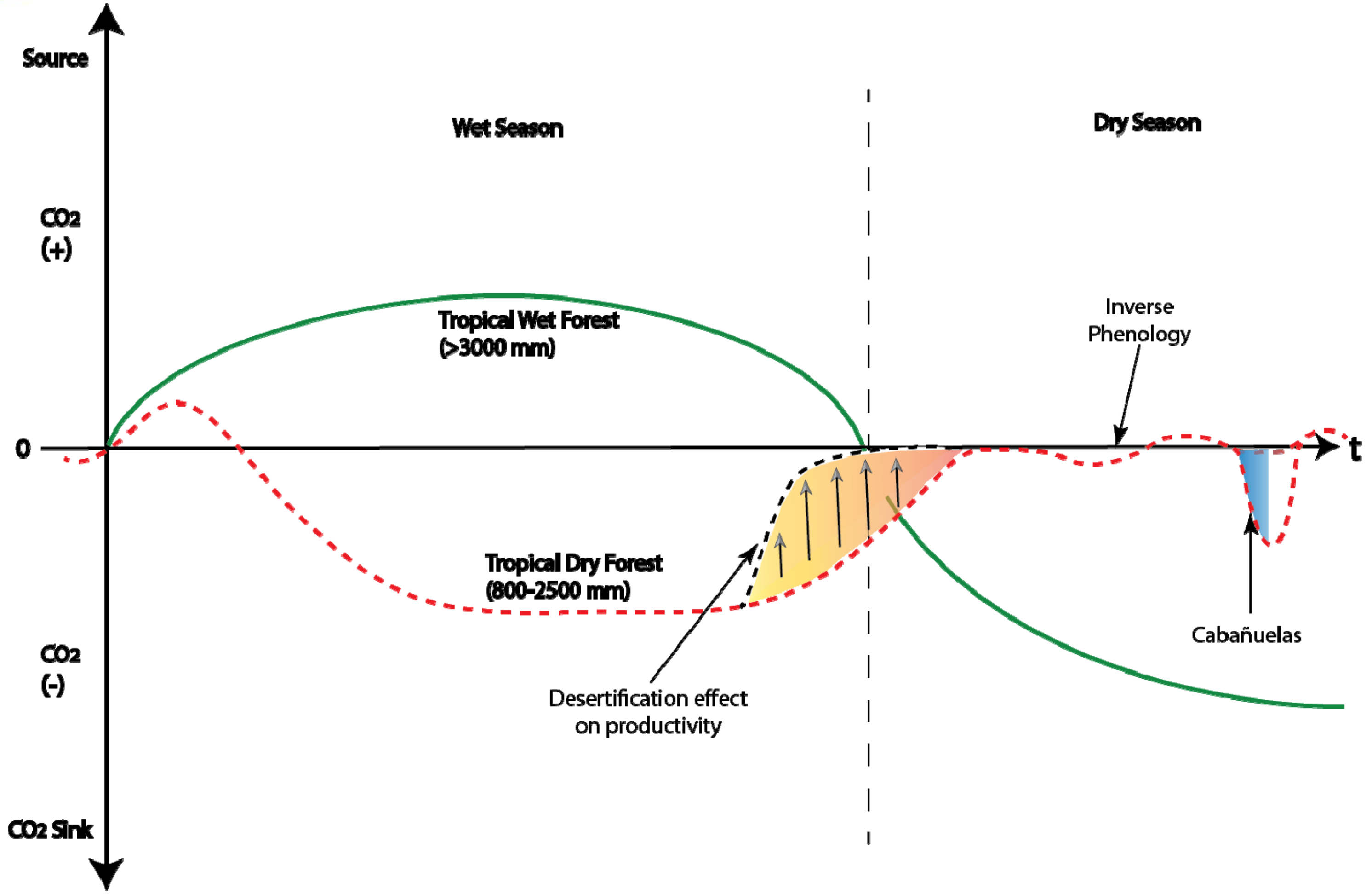
THANK YOU!!

TDF Phenology



Productivity from Remote Sensing