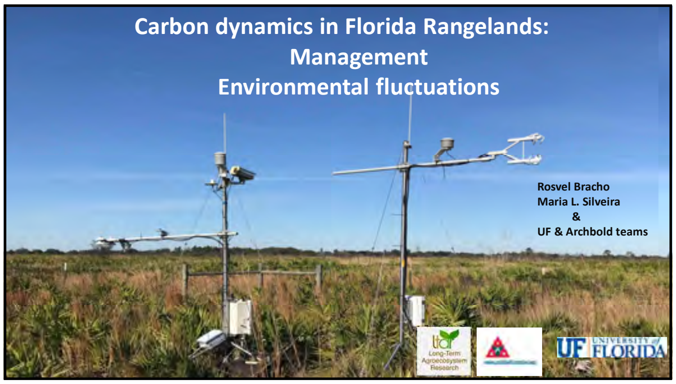
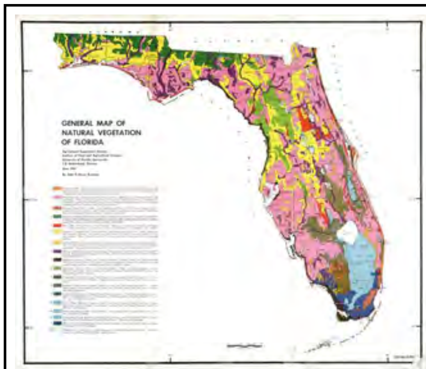


1



Rangelands in FL ~ 3.1 Mha . Association of long-leaf-slash pine grasses, saw palmetto and small trees

~ 1.6 Mha non-forested areas from the center of the state down to the Everglades hold 2/3 State's cattle (Vendramini et al 2006)

Managed by combining prescribed fire and mechanical brush control to improve forage quality

Rangelands support livestock, wildlife, water conservation, carbon sequestration, cultural heritage, and support to threatened species

2

Native Pine Flatwood Rangeland

- Used for dry pregnant beef cows during winter
- High biomass production
- Fire occurs naturally every 3 - 4 years
- Land managers use prescribed burning every 4 years
  - ↓ saw-palmetto plants ,↑ forage production
  - ↓ occurrence of uncontrolled fire
- Mechanical control ↓presence of palmetto


3

How management of FL rangelands -fire and mechanical control- and environmental fluctuations affect:

Carbon storage and carbon exchange dynamics

Biomass production

NEP, GPP, R_{ECO} (R_{SOIL})

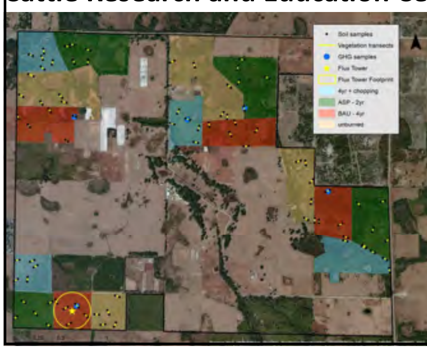
Evapotranspiration (ET)

Species composition

Soil C and nutrients

4

Cattle Research and Education Center (UF)



Experimental area:

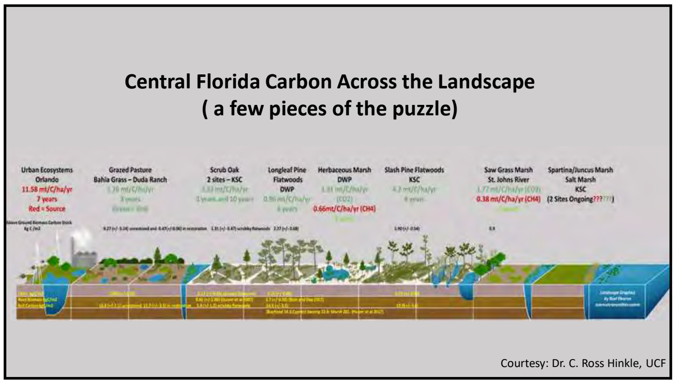
- Randomized block design
- 4 blocks 4 experimental units-treatments. Treatments imposed in 2019
- Total of 400 ha
- 5 transects (50 m) for sampling

5

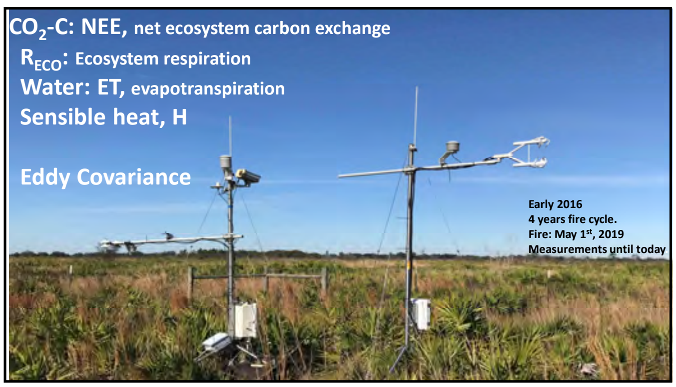
What do we expect in terms of Carbon dynamics?

- South Florida rangelands are a carbon sink under current management practices.
- Rangelands can be a carbon source during fire and extreme drought years.
- Fast vegetation and carbon uptake recovery after fire.
- Soil green house gases (GHG) emissions increase after fire.

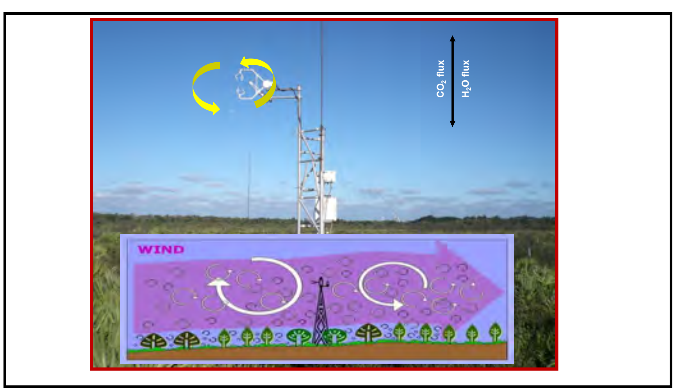
6


Central Florida Carbon Across the Landscape
(a few pieces of the puzzle)
Urban Ecosystems
Orlando
11.58 mt/C/ha/yr
7 years
Red = Source
Grazed Pasture
Bahia Grass – Duda Ranch
Scrub Oak
2 sites – KSC
Longleaf Pine
Flatwoods
DWP
Herbaceous Marsh
DWP
0.66mt/C/ha/yr (CH4)
Slash Pine Flatwoods
KSC
Saw Grass Marsh
St. Johns River
0.38 mt/C/ha/yr (CH4)
Spartina/Juncus Marsh
Salt Marsh
KSC
(2 Sites Ongoing??????)
Courtesy: Dr. C. Ross Hinkle, UCF

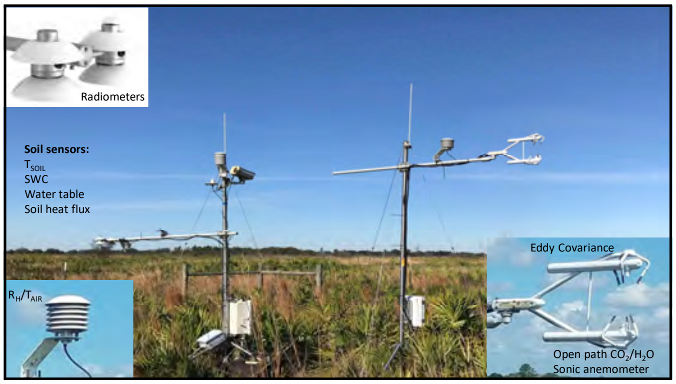
7


CO_2-C: NEE, net ecosystem carbon exchange
R_{ECO}: Ecosystem respiration
Water: ET, evapotranspiration
Sensible heat, H
Eddy Covariance
Early 2016
4 years fire cycle.
Fire: May 1st, 2019
Measurements until today

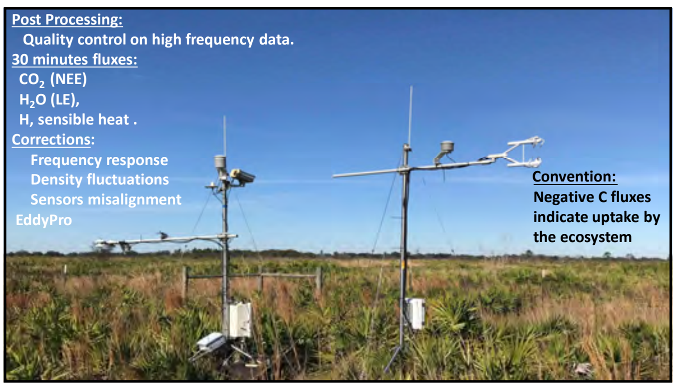
8


CO_2 flux
H_2O flux
WIND

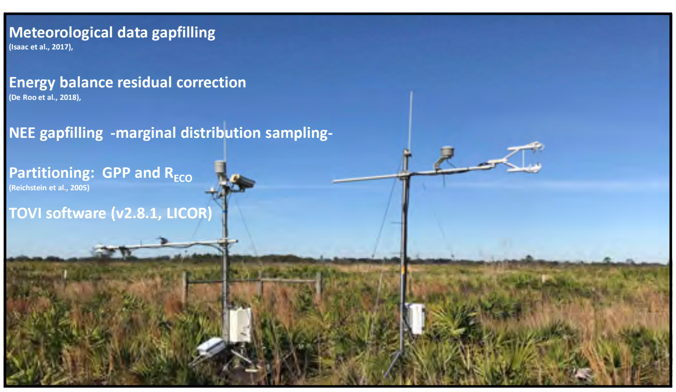
9


Radiometers
Soil sensors:
T_{SOIL}
SWC
Water table
Soil heat flux
R_H/T_{AIR}
Eddy Covariance
Open path CO_2/H_2O
Sonic anemometer

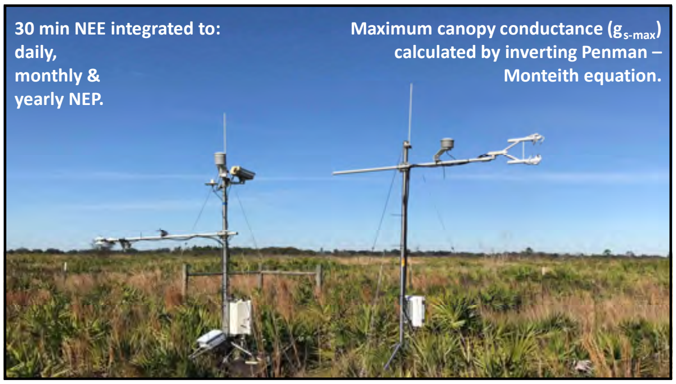
10


Post Processing:
Quality control on high frequency data.
30 minutes fluxes:
CO_2 (NEE)
H_2O (LE),
H, sensible heat .
Corrections:
Frequency response
Density fluctuations
Sensors misalignment
EddyPro
Convention:
Negative C fluxes
indicate uptake by
the ecosystem

11


Meteorological data gapfilling
(Isaac et al., 2017),
Energy balance residual correction
(De Roo et al., 2018),
NEE gapfilling -marginal distribution sampling-
Partitioning: GPP and R_{ECO}
(Reichstein et al., 2005)
TOVI software (v2.8.1, LICOR)

12



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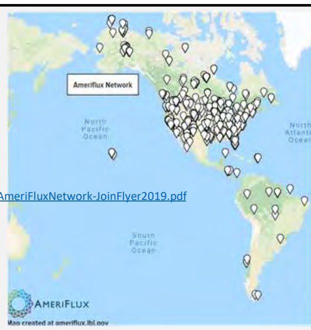
ONA Joined Ameriflux early 2020

https://ameriflux.lbl.gov/about/about-ameriflux/

https://ameriflux.lbl.gov/wp-content/uploads/2019/11/AmeriFluxNetwork-JoinFlyer2019.pdf

- https://ameriflux.lbl.gov/sites/siteinfo/US-ONA#overview



14

Soil greenhouse gases emissions

14 days intervals -8.00 and 11.00 AM- to account for diurnal GHG emissions variation (Parkin and Venterea, 2010).

Air samples collected at 0, 10, 20 and 30 minutes.

Samples analyzed into a GC (7890B GC system Agilent Technologies) for CO_2, CH4, and N_2O

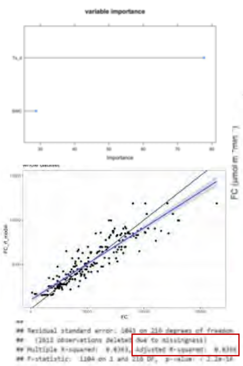
Fluxes calculated per chamber based on changes in gas concentration with time of chamber closure.

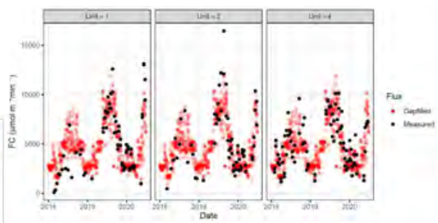
T_{SOIL} & soil moisture collected simultaneously.

15

Soil Respiration

Gapfilled using random Forest strategy

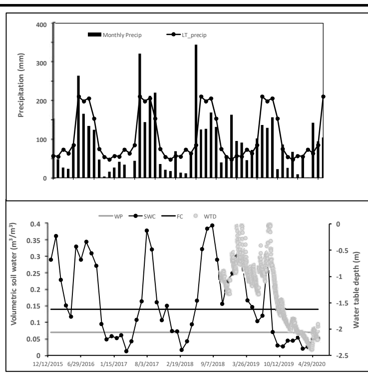




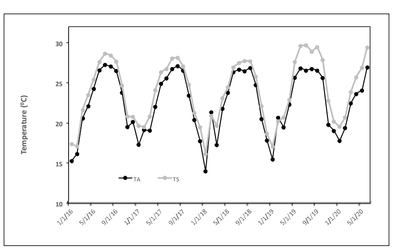
16

RESULTS

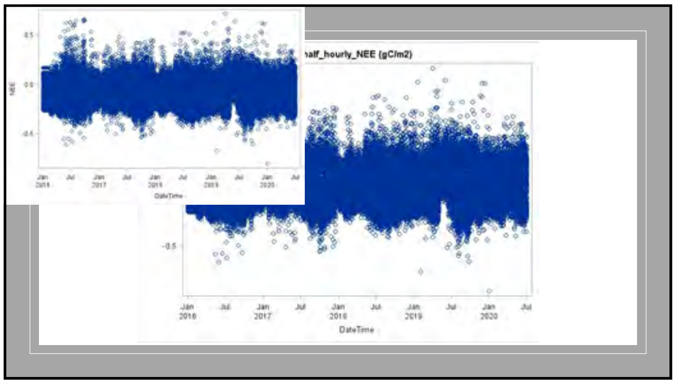
Climatic variability



17



18



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Annual Carbon fluxes (g C/m^2)

Year	NEP	GPP	R_{ECO}	R_{SOIL}	ET(mm)	Precip
2016	-408.96	-1853.99	1445.03	NA	1050	1089
2017	-327.19	-1749.45	1422.26	NA	1021	1121
2018	-368.78	-1860.73	1491.95	605.16	1069	1309
Average	-368.31 ± 40.88	-1821.39 ± 62.40	1453.08 ± 35.53			
2019	-181.75	-2032.92	1851.17	807.51	1026	1147

20

Fire effects on Carbon stocks
gC/m^2

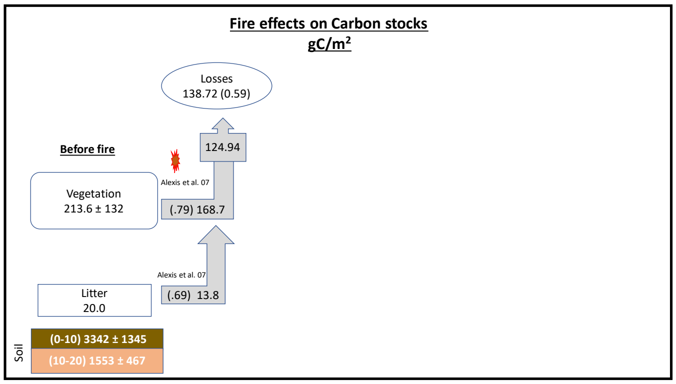
Before fire

Vegetation
213.6 ± 132

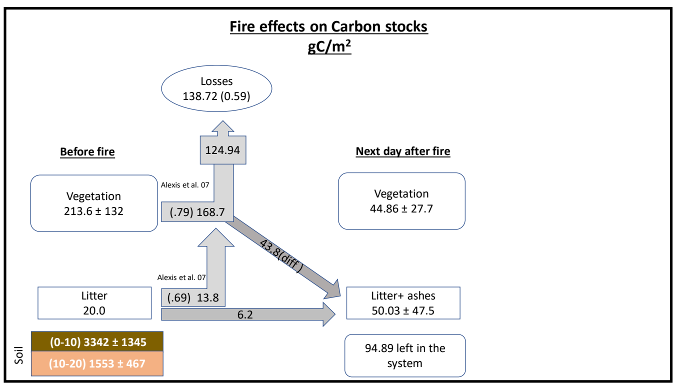
Litter
20.0

Soil
(0-10) 3342 ± 1345
(10-20) 1553 ± 467

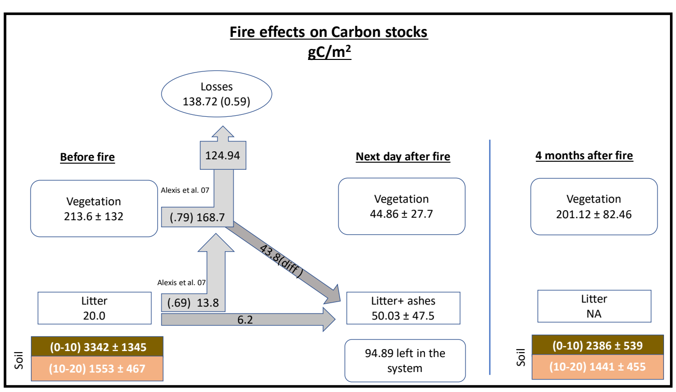
21


Fire effects on Carbon stocks
gC/m²
Losses
138.72 (0.59)
124.94
Before fire
Alexis et al. 07
Vegetation
213.6 ± 132
(.79) 168.7
Alexis et al. 07
Litter
20.0
(.69) 13.8
Soil
(0-10) 3342 ± 1345
(10-20) 1553 ± 467

22


Fire effects on Carbon stocks
gC/m²
Losses
138.72 (0.59)
124.94
Before fire
Next day after fire
Alexis et al. 07
Vegetation
213.6 ± 132
(.79) 168.7
Vegetation
44.86 ± 27.7
43.8(diff.)
Alexis et al. 07
Litter
20.0
(.69) 13.8
6.2
Litter+ ashes
50.03 ± 47.5
Soil
(0-10) 3342 ± 1345
(10-20) 1553 ± 467
94.89 left in the system

23


Fire effects on Carbon stocks
gC/m²
Losses
138.72 (0.59)
124.94
Before fire
Next day after fire
4 months after fire
Alexis et al. 07
Vegetation
213.6 ± 132
(.79) 168.7
Vegetation
44.86 ± 27.7
Vegetation
201.12 ± 82.46
43.8(diff.)
Alexis et al. 07
Litter
20.0
(.69) 13.8
6.2
Litter+ ashes
50.03 ± 47.5
Litter
NA
Soil
(0-10) 3342 ± 1345
(10-20) 1553 ± 467
94.89 left in the system
Soil
(0-10) 2386 ± 539
(10-20) 1441 ± 455

24

Carbon balance in a 4 years fire cycle (BAU) (g C/m²)

Prefire Avg NEP
-368.31

Fire year NEP
-181.75

Loss in productivity
186.56

Four years NEP
-1286.69

Loss in productivity
186.56

Lost by ignition
138.72

NECB = - 961.41 gC/m²

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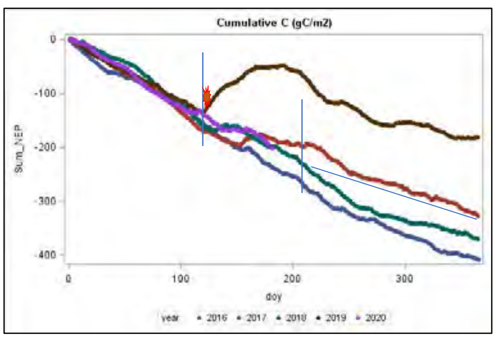
Seasonal C Fluxes



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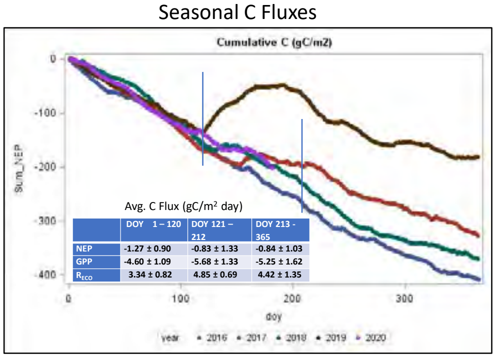
Seasonal C Fluxes



Avg. C Flux (gC/m² day)

	DOY 1 – 120	DOY 121 – 212	DOY 213 - 365
NEP	-1.27 ± 0.90	-0.83 ± 1.33	-0.84 ± 1.03
GPP	-4.60 ± 1.09	-5.68 ± 1.33	-5.25 ± 1.62
R_{ECO}	3.34 ± 0.82	4.85 ± 0.69	4.42 ± 1.35

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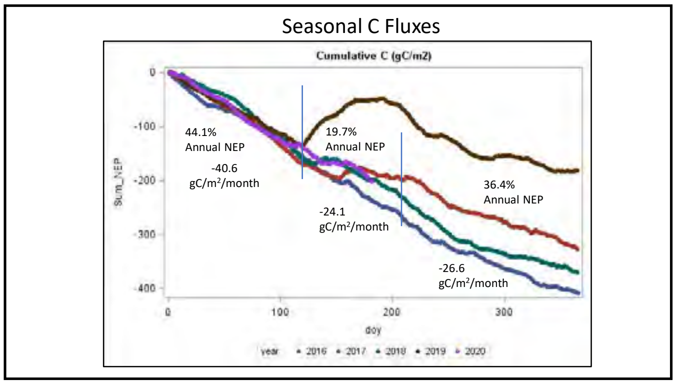
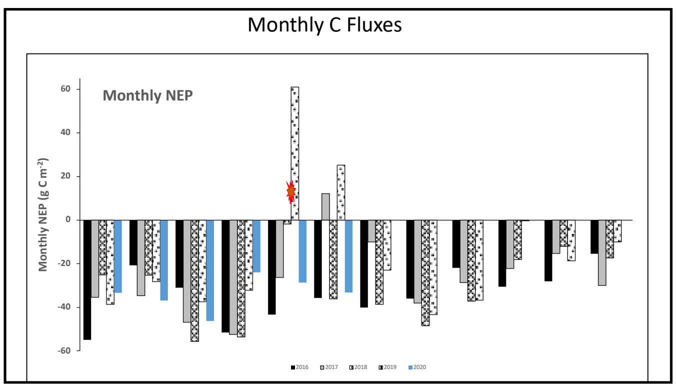
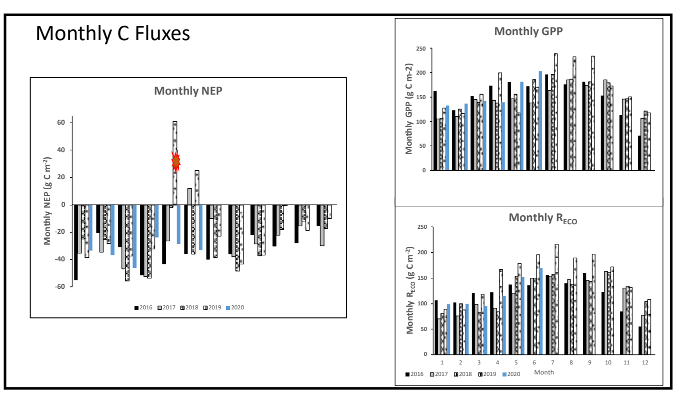

Seasonal C Fluxes
Cumulative C (gC/m2)
Sum_NEP
44.1%
Annual NEP
-40.6
gC/m²/month
19.7%
Annual NEP
-24.1
gC/m²/month
36.4%
Annual NEP
-26.6
gC/m²/month
doy
year 2016 2017 2018 2019 2020

28


Monthly C Fluxes
Monthly NEP
Monthly NEP (g C m⁻²)
2016 2017 2018 2019 2020

29


Monthly C Fluxes
Monthly NEP
Monthly NEP (g C m⁻²)
Monthly GPP
Monthly GPP (g C m-2)
Monthly R_ECO
Monthly R_ECO (g C m⁻²)
Month
2016 2017 2018 2019 2020

30

Drivers on monthly Carbon fluxes

Carbon Flux	Coefficient	Estimate	R^2	P-Value
NEP	Intercept	-6.3400	0.30	0.447
	Rg	-0.055		**0.0006**
	Precipitation	0.068		**0.003**
GPP	Intercept	9.776	0.63	0.58
	T_S	5.626		**<0.0001**
	SWC	61.369		**<0.0001**
R_{ECO}	Intercept	-24.727	0.63	0.168
	T_S	5.876		**<0.0001**
	SWC	49.422		**0.039**

Rg= Monthly global radiation
SWC = Average Volumetric soil water
T_S= Monthly soil temperature
Model P value < 0.001

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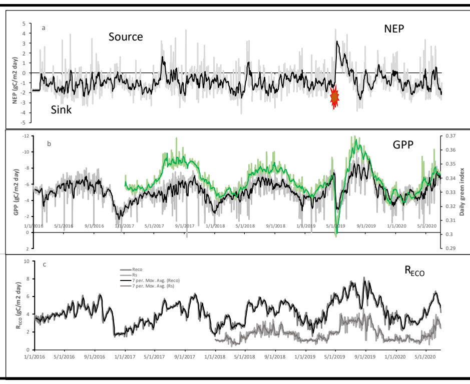
Daily Carbon Fluxes



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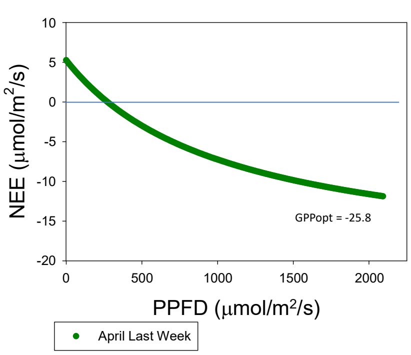
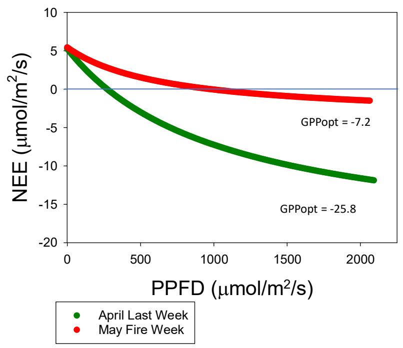
Light response pre & post fire



$$NEE_{day} = \frac{\propto \cdot PPFD}{-(PPFD/PPFD_{max}) + (\propto \cdot PPFD/GPP_{opt})} + R_d$$

33

Light response
pre & post fire



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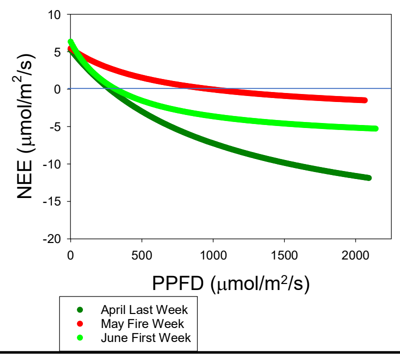
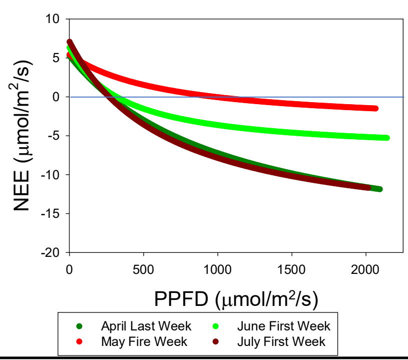
Light response
pre & post fire



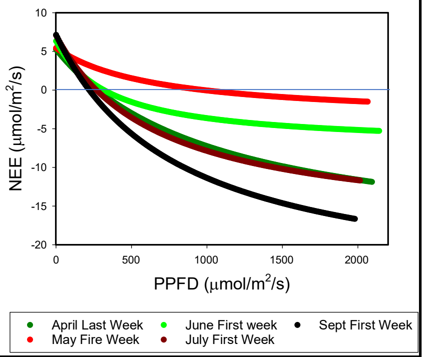
35

Light response
pre & post fire



36

Light response pre & post fire



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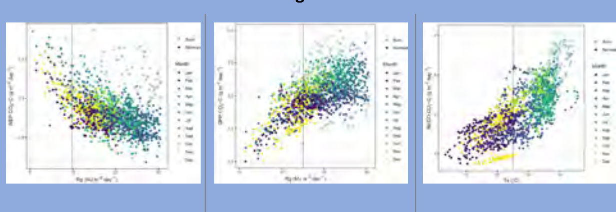
Drivers daily Carbon Fluxes

tree regression

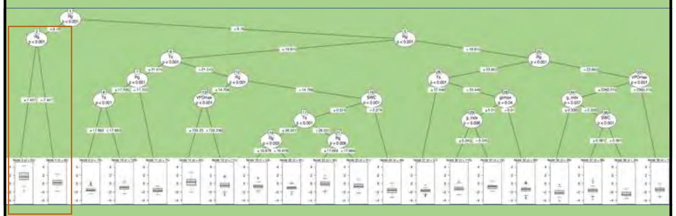


38

Drivers on daily NEP

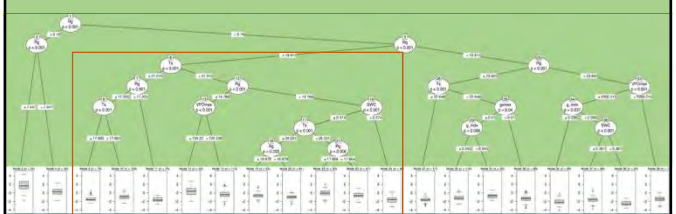
39

Drivers on daily NEP



40

Drivers on daily NEP



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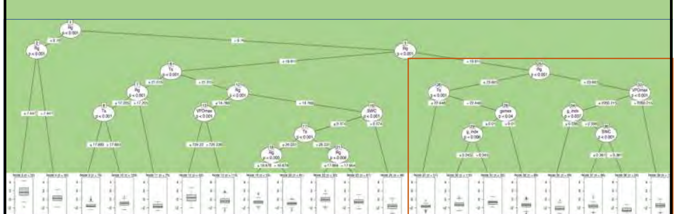
Drivers on daily NEP



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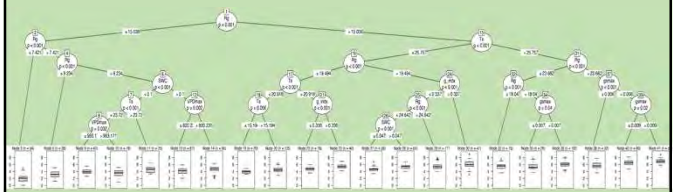
Drivers on daily GPP



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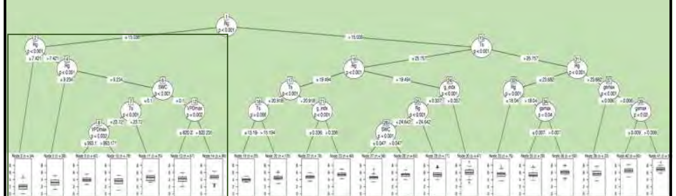
Drivers on daily GPP



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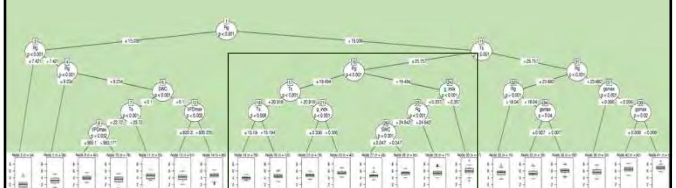
Drivers on daily GPP



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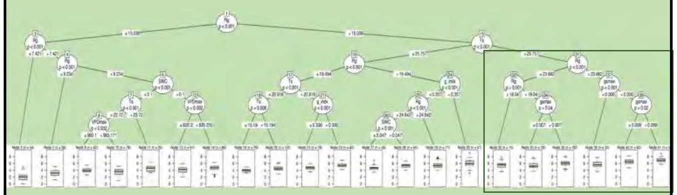
Drivers on daily GPP



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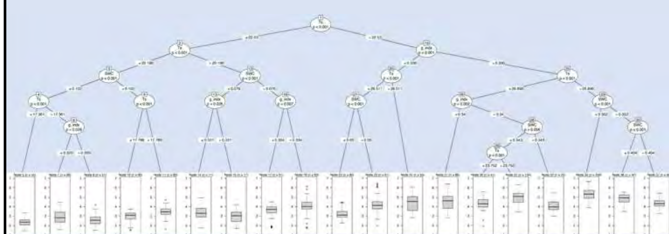
Drivers on daily R_{ECO}



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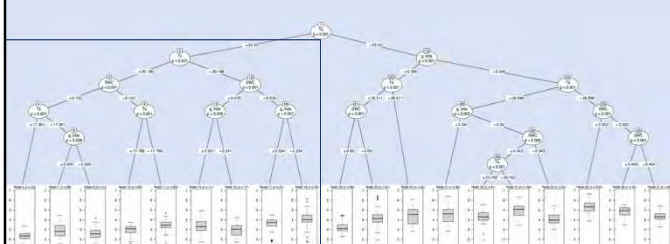
Drivers on daily R_{ECO}



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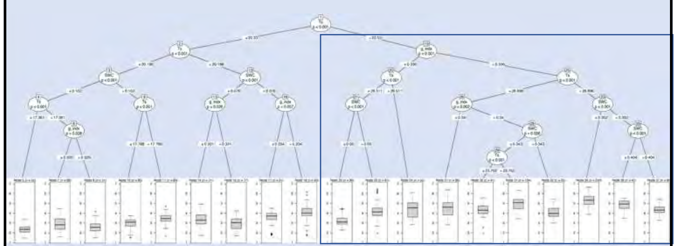
Drivers on daily R_{ECO}



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Conclusions

- Florida rangelands:
  - a strong Carbon sink close to 10 MgC/ha under the four years fire cycle
  - carbon source during the fire year.
  - a C sink even under extended drought conditions
  - Photosynthetic capacity is recovered within the next 3 – 4 months after fire
- Aboveground carbon in vegetation is recovered by four months after fire

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Future Research Questions

How fire, grazing & climatic fluctuations interact to control rangelands carbon balance?

Warming equivalent? Warming potential

CH_4

N_2O

51

RCREC LTAR team

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- João Sanchez
- Rosvel Bracho
- Maria Silveira
- Raoul Boughton
- Brent Sellers
- João Vendramini
- Philipe Moriel

- Students:
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- Dipti Rai (Ph.D.)

- Former research assistants:
- Vinícius Gomes
- Carolina Braga Brandani
- Britt Smith
- Kacey Aukema
- Lucas Zanini
- Igor Machado

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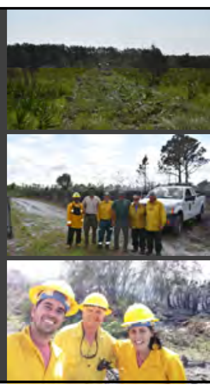
Thank you!



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