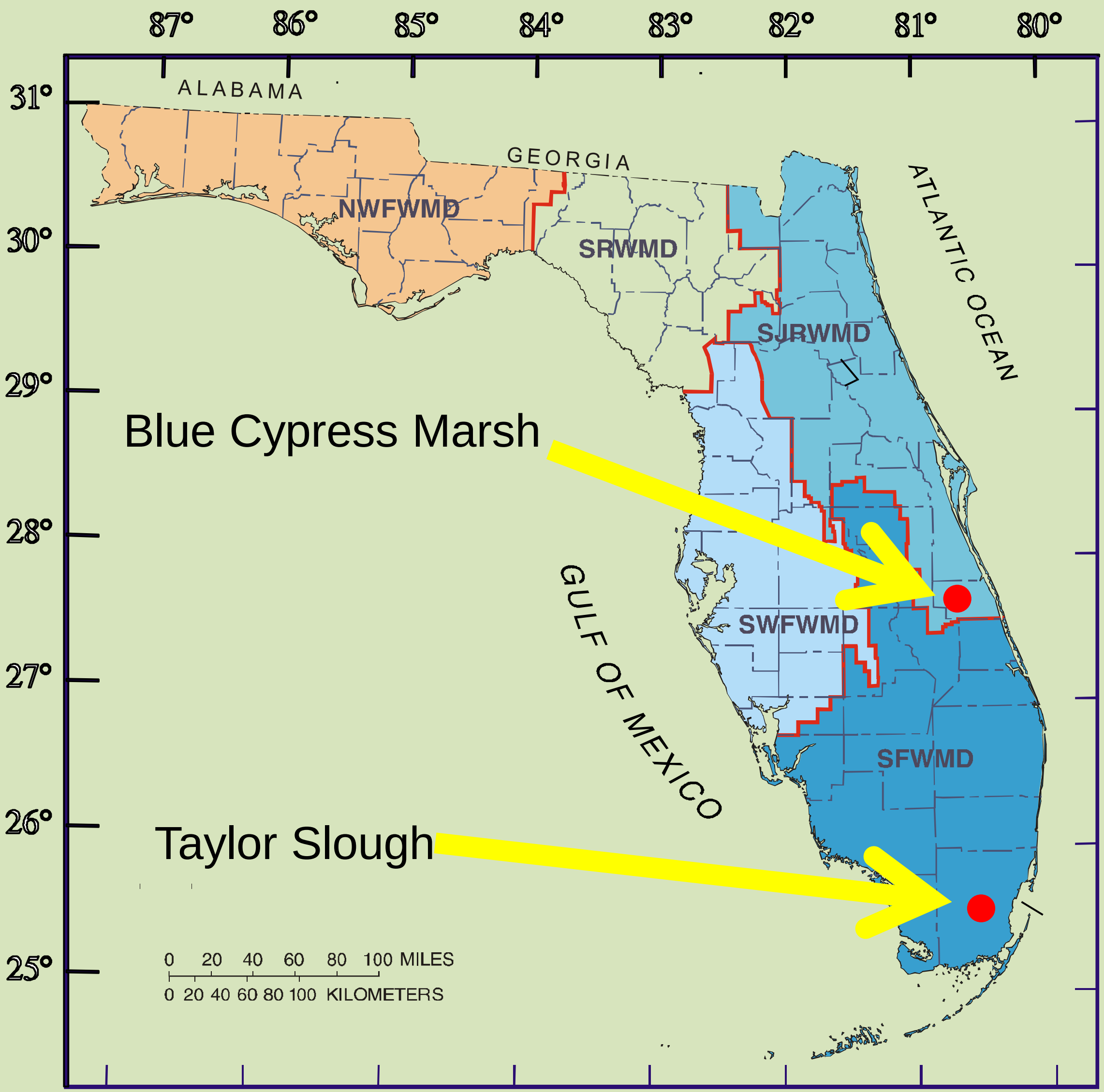
Role of hydroperiod and fire on carbon dynamics of a subtropical peat marsh

David Sumner
US Geological Survey
Caribbean-Florida Water Science Center

Scott Graham and Ross Hinkle
University of Central Florida
Department of Biology

Blue Cypress marsh



Headwaters of St. Johns River

Thick (> 3 meters) peat soils

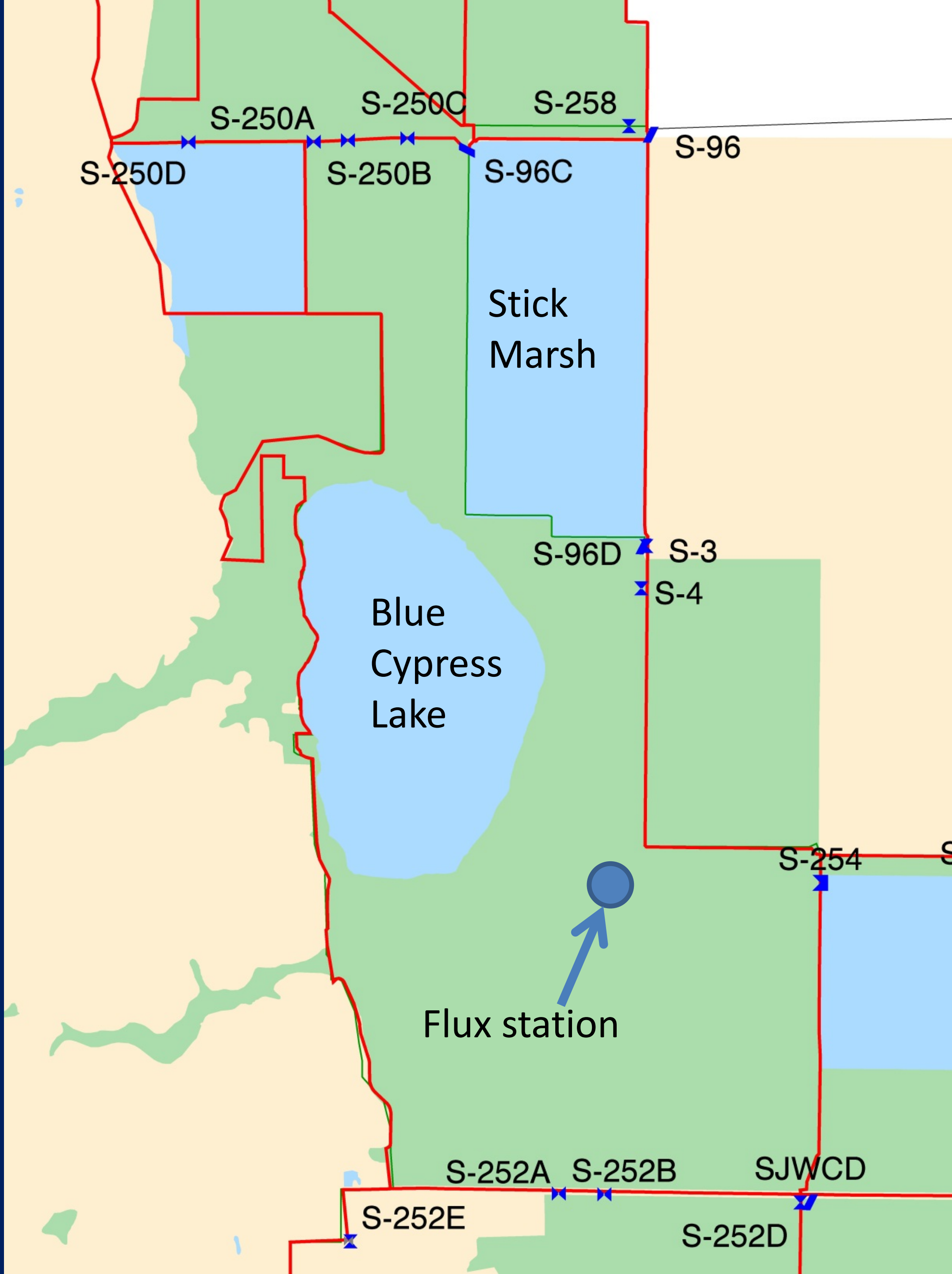
Underlain by clay

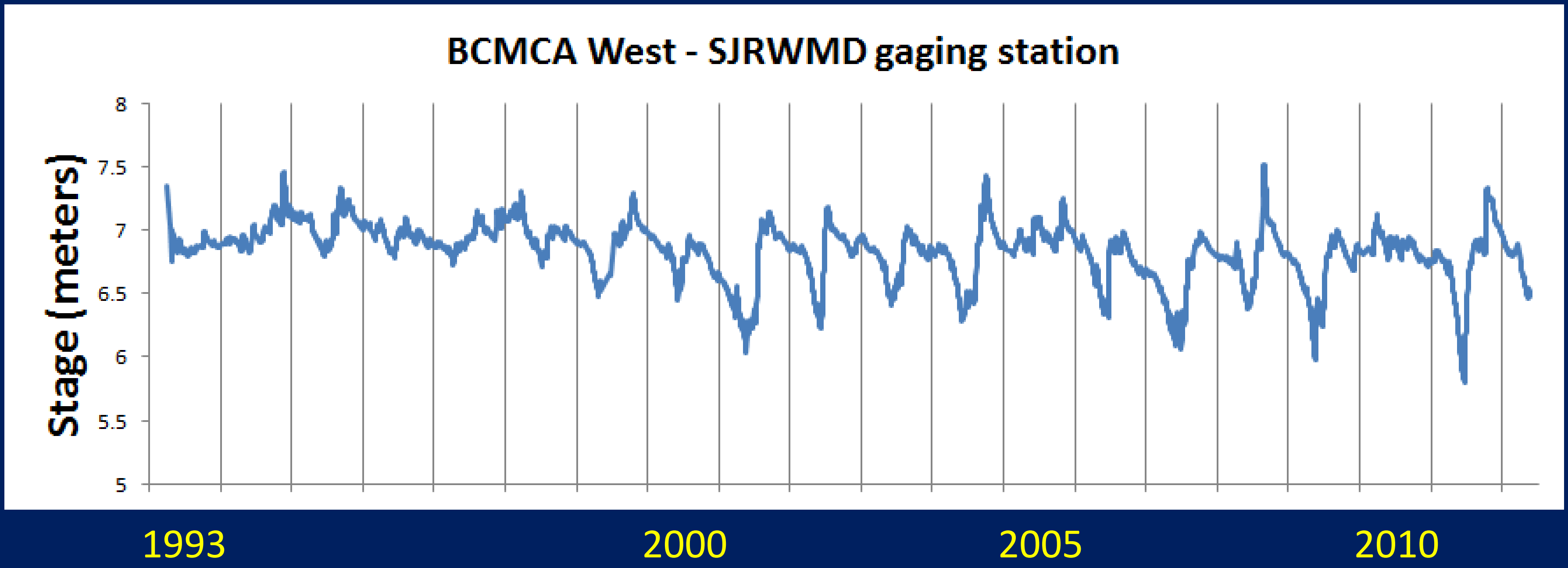
Active water level management

Predominantly sawgrass cover with invasive willows

Sawgrass in marsh is tall and dense compared to sawgrass in much of Everglades

Blue Cypress marsh within headwaters of the St. Johns River



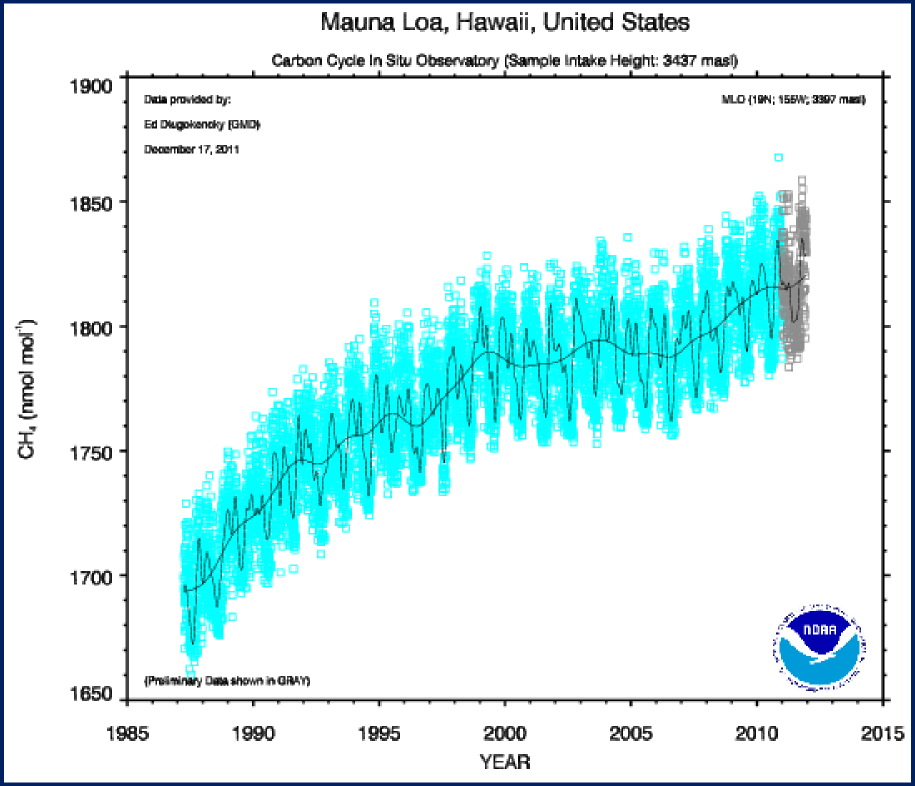


Water management change apparent in year 1999 and thereafter

Stage variability has increased markedly – intra-year stage range has increased from average of 50 to 90 cm.

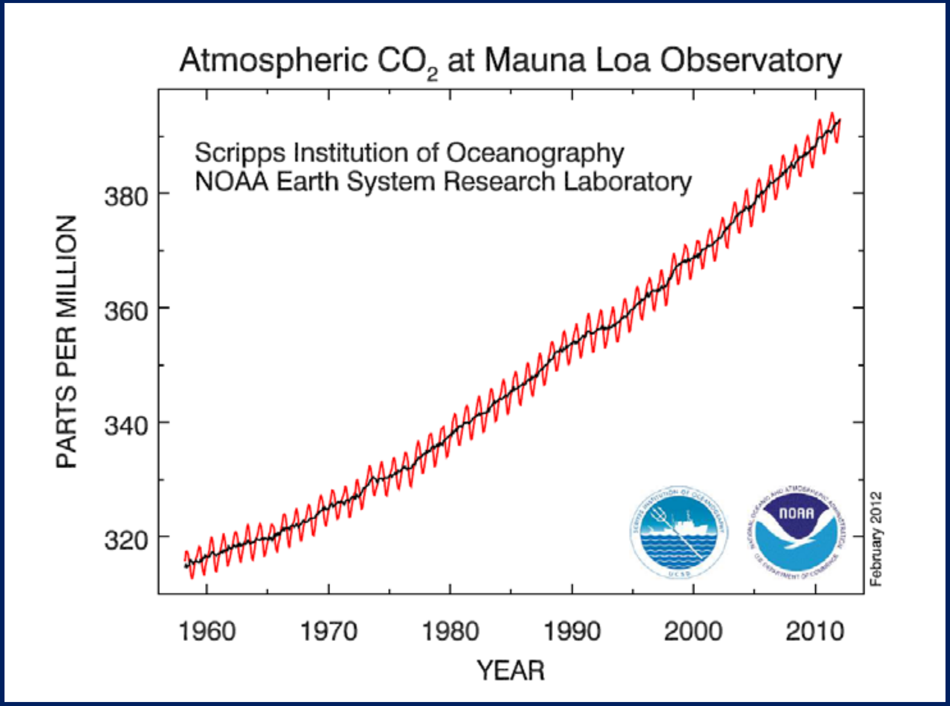
Fires in 2001, 2008, and 2014

Why measure carbon fluxes ?



1. CO_2 and CH_4 are important greenhouse gases – relate fluxes to environment, landscape, and management
   ….. carbon credits

2. Topographic loss or gain



Why measure carbon fluxes ?

1. CO_2 and CH_4 are important greenhouse gases

2. Topographic loss or gain/nutrients

Organic N converts via:

Mineralization/Nitrification

↓

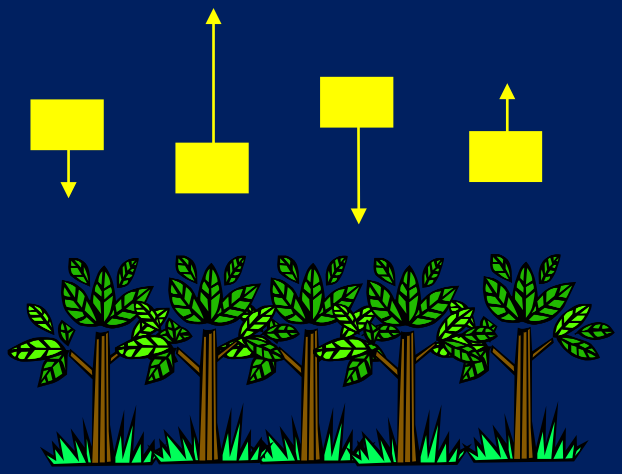
Nitrate

Mass and heat fluxes

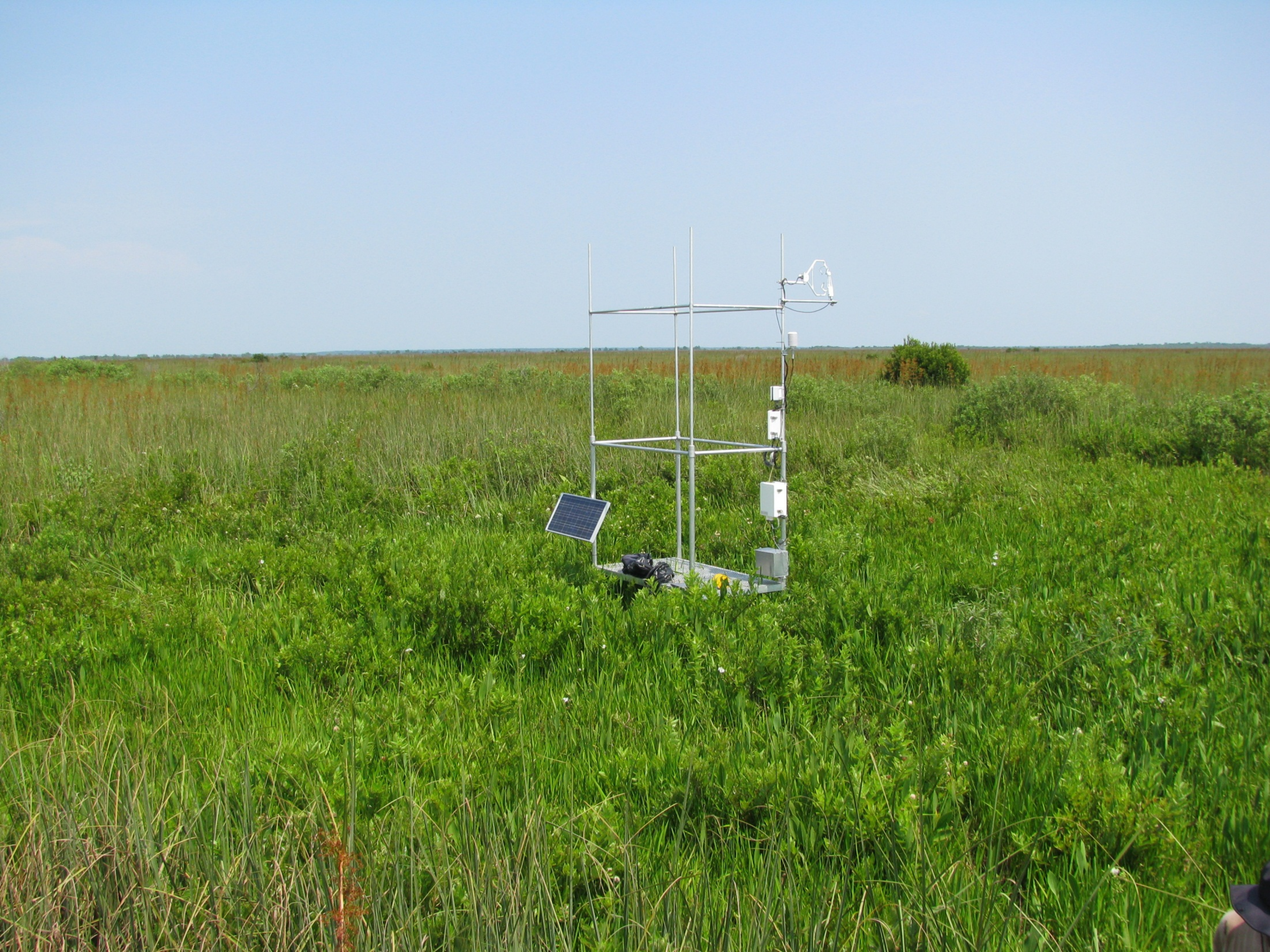
Eddy covariance method

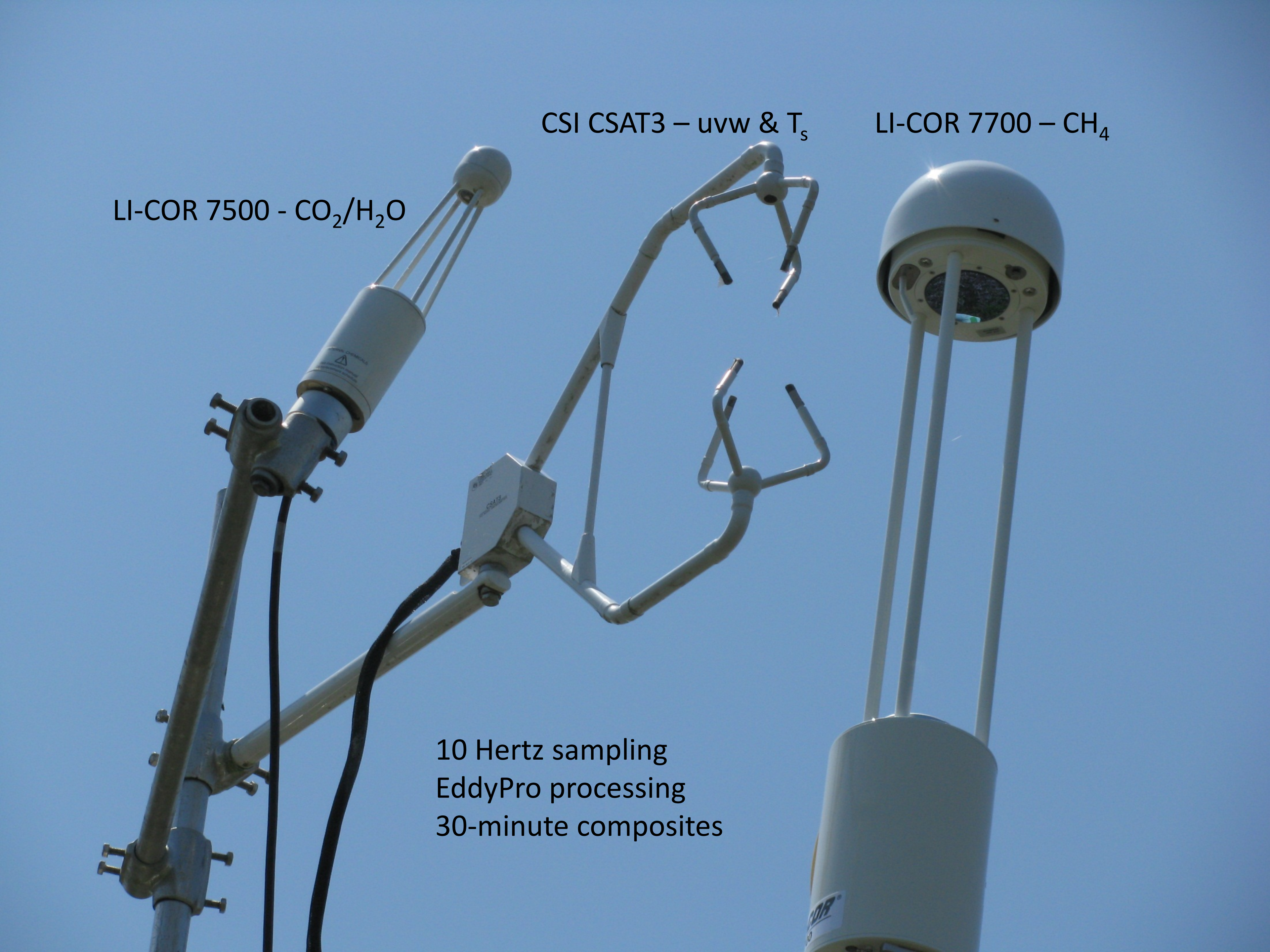
Net ecosystem exchange (NEE) = $C_{CO2}w$ = mean(c_{CO2}' w')

= cov (C_{CO2} ,w)



c_{CO2} = vapor density
w = vertical wind speed
' = fluctuation about average





CSI CSAT3 – uvw & T_s
LI-COR 7700 – CH_4
LI-COR 7500 - CO_2/H_2O
10 Hertz sampling
EddyPro processing
30-minute composites

Gap-filling & partitioning NEE to Photosynthesis and Respiration (ER)

Day

$$NEE = \frac{-\alpha \; PPFD \; NEE_{max}}{\alpha \; PPFD + NEE_{max}} + ER_d$$

Light response curve
Parameters (α, NEE_{max} & ER) defined monthly
based on regression with daytime half-hour NEE data

Night

ER_n = Lloyd&Taylor function of Ta and water level; likewise, daily CH4 flux

Carbon exchange strongly impacted by hydroperiod

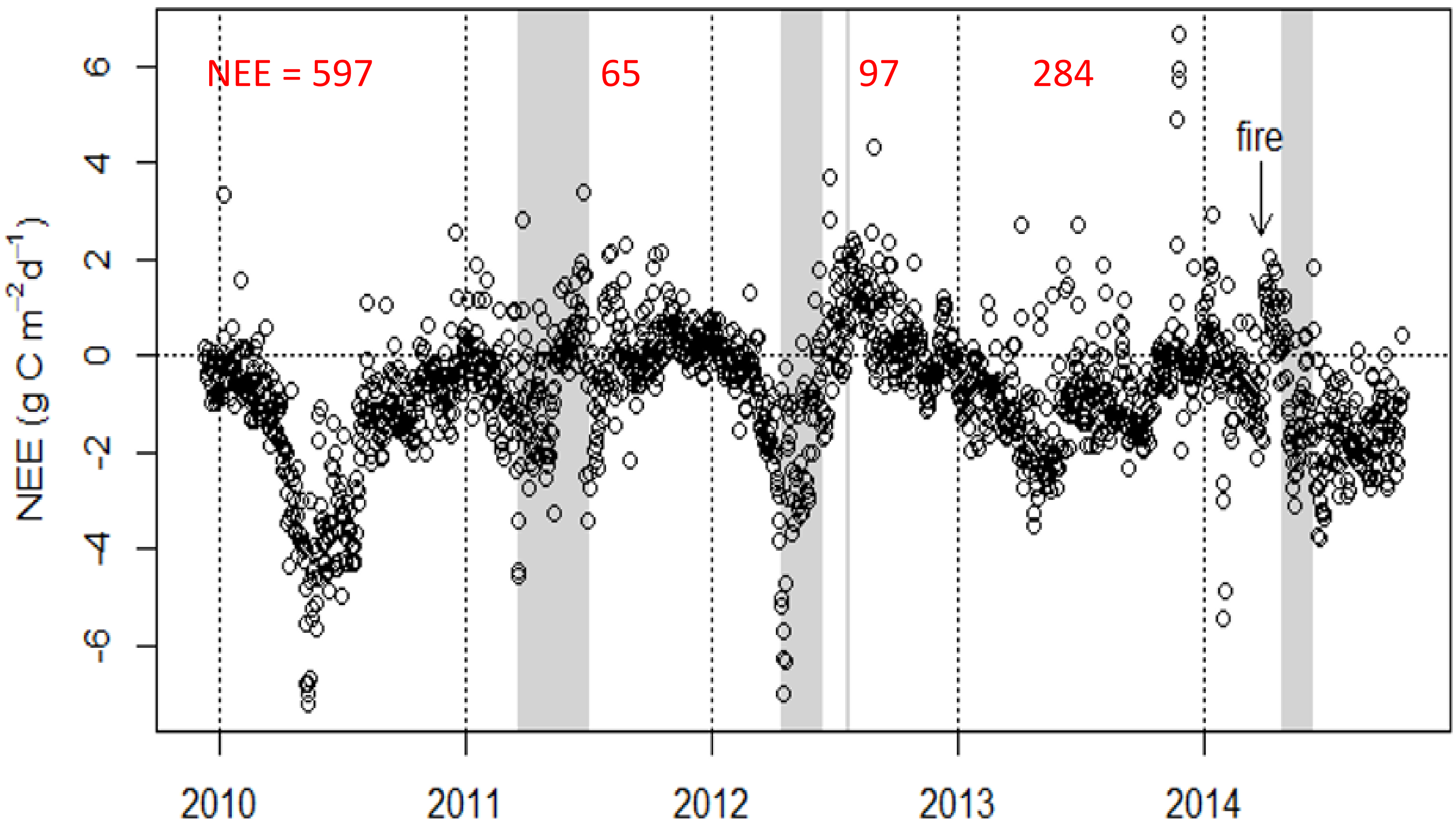
When marsh is wet:

Heterotrophic respiration is low

therefore, net CO2 sequestration is high

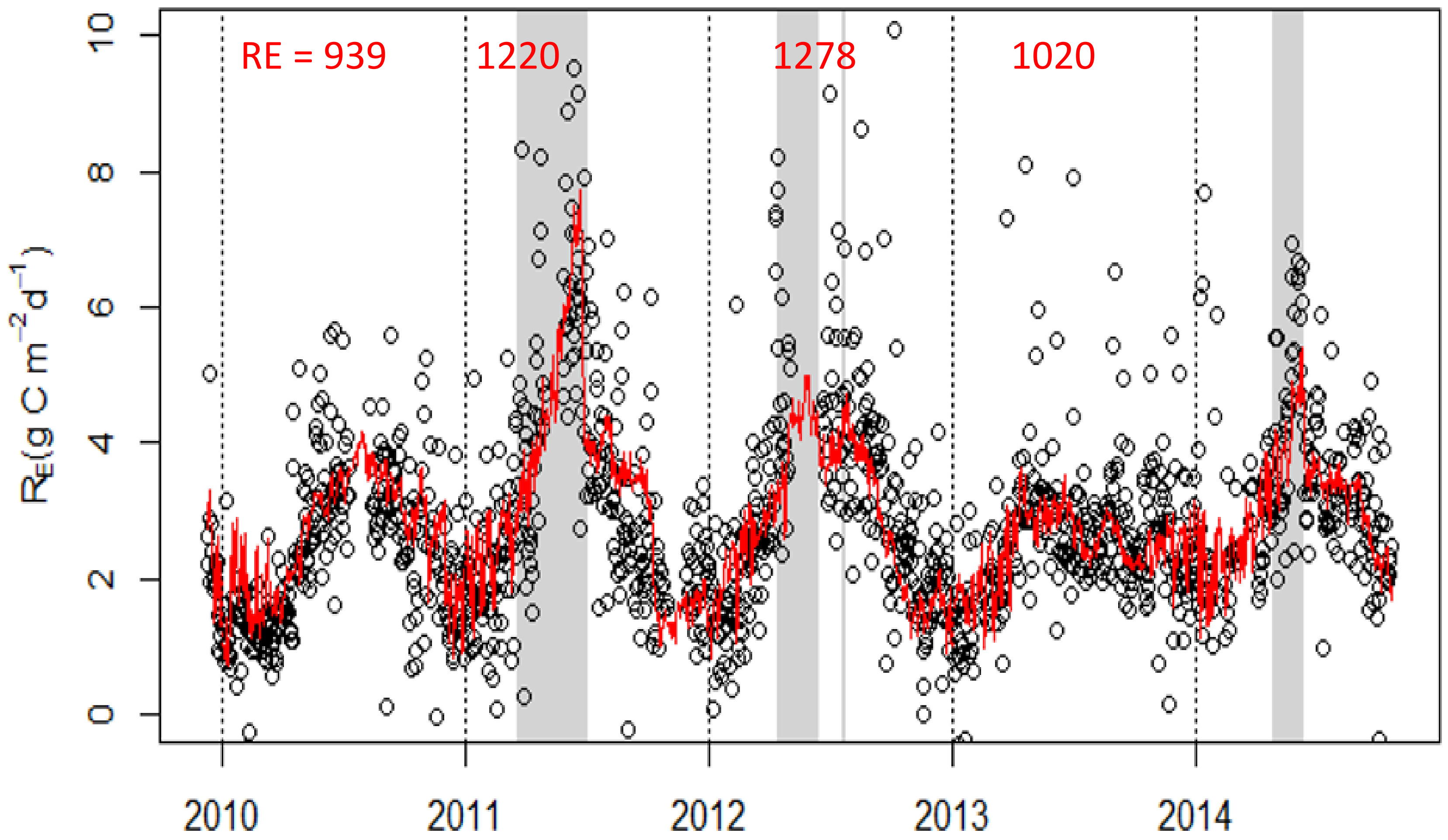
but methane release enhanced

Blue Cypress marsh – NEE



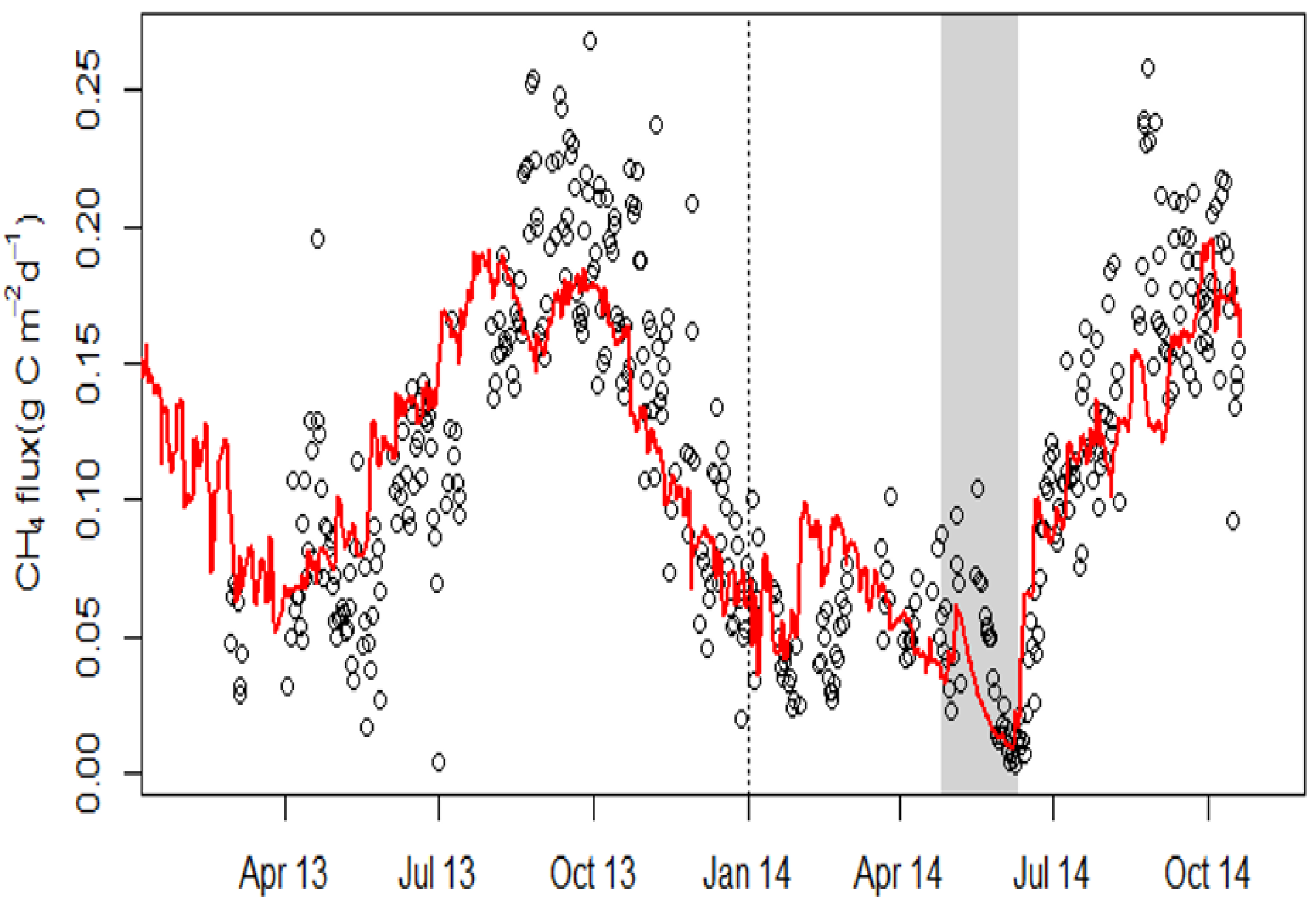
Blue Cypress marsh – R_n

One size fits all function of temperature and water level



Blue Cypress marsh – CH_4

One size fits all function of temperature and water level



2010 - 33 g C/m^2

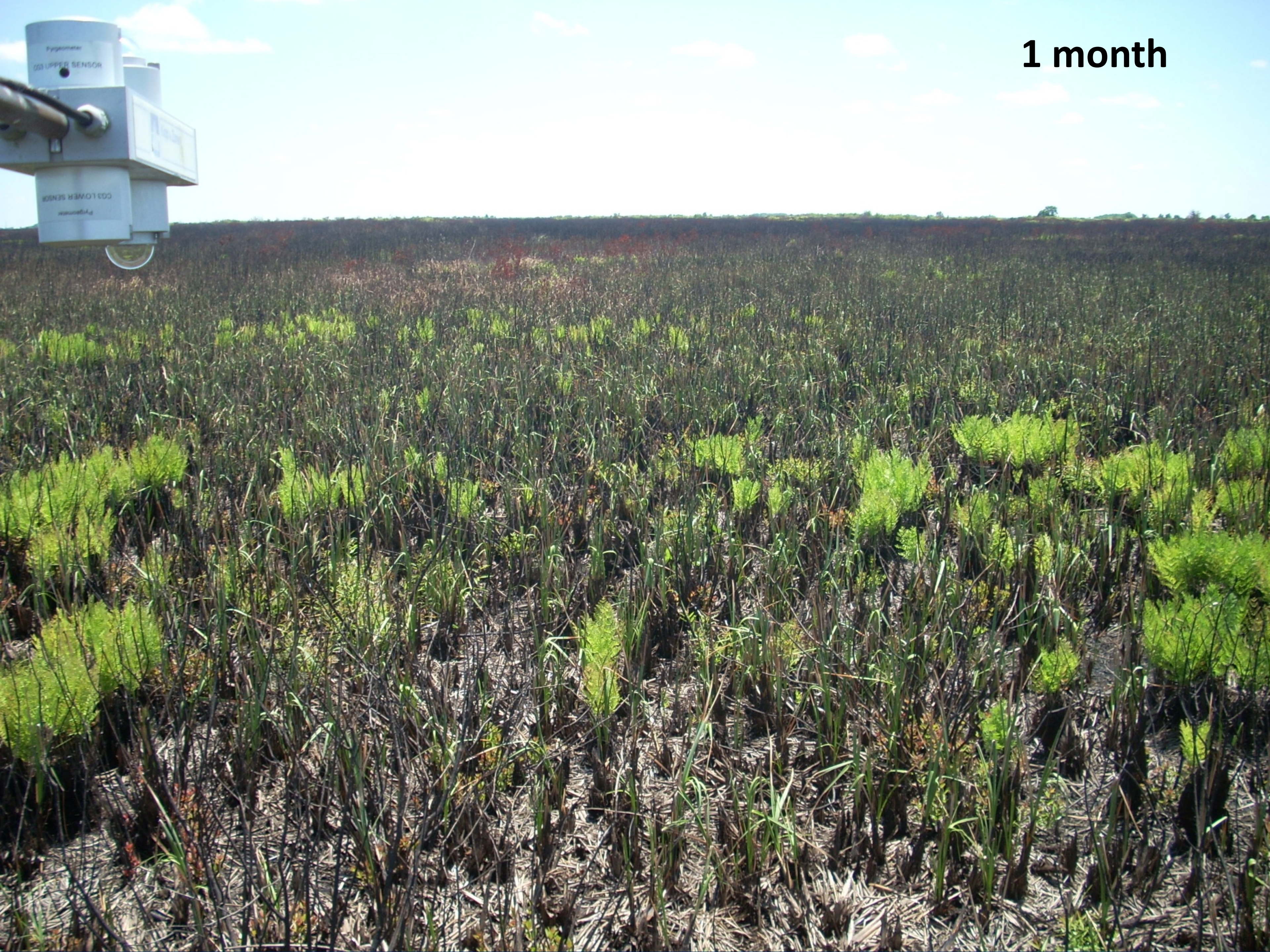
2011 – 26

2012 – 32

2013 - 44

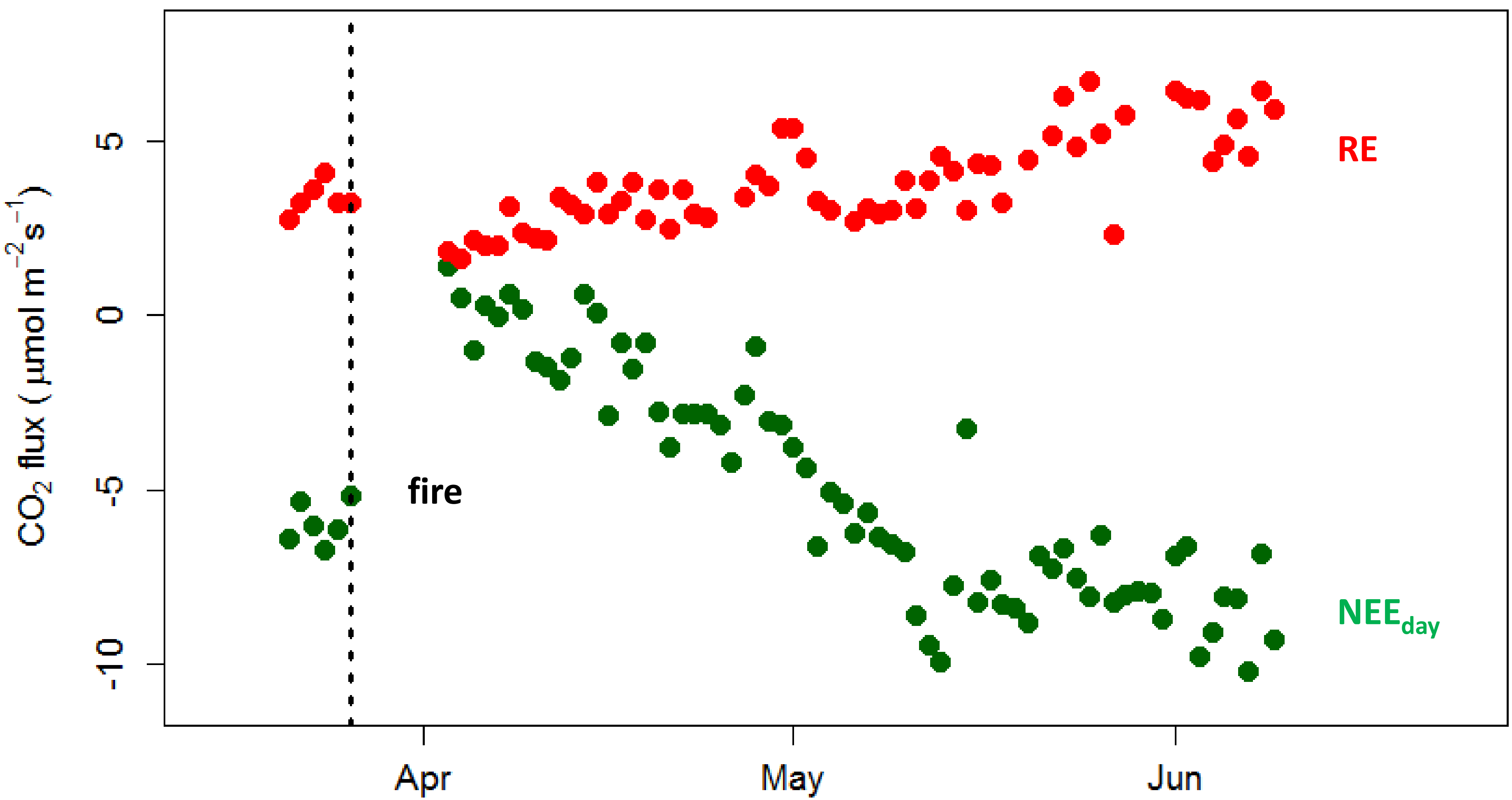
Before March 2014 fire
2,248 g DM m^{-2}


Post March 2014 fire
318 g DM m^{-2}

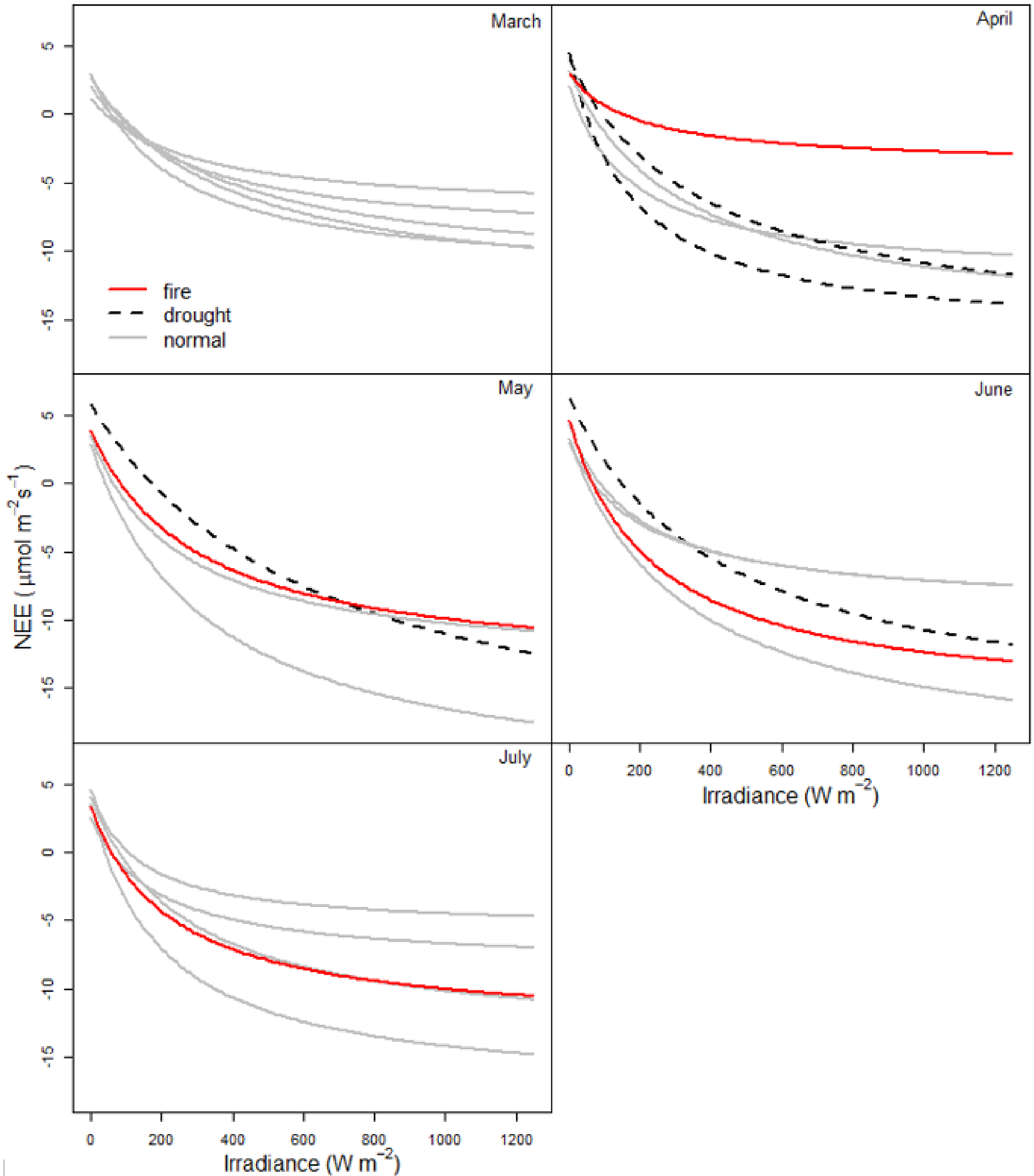

1 month


4 months

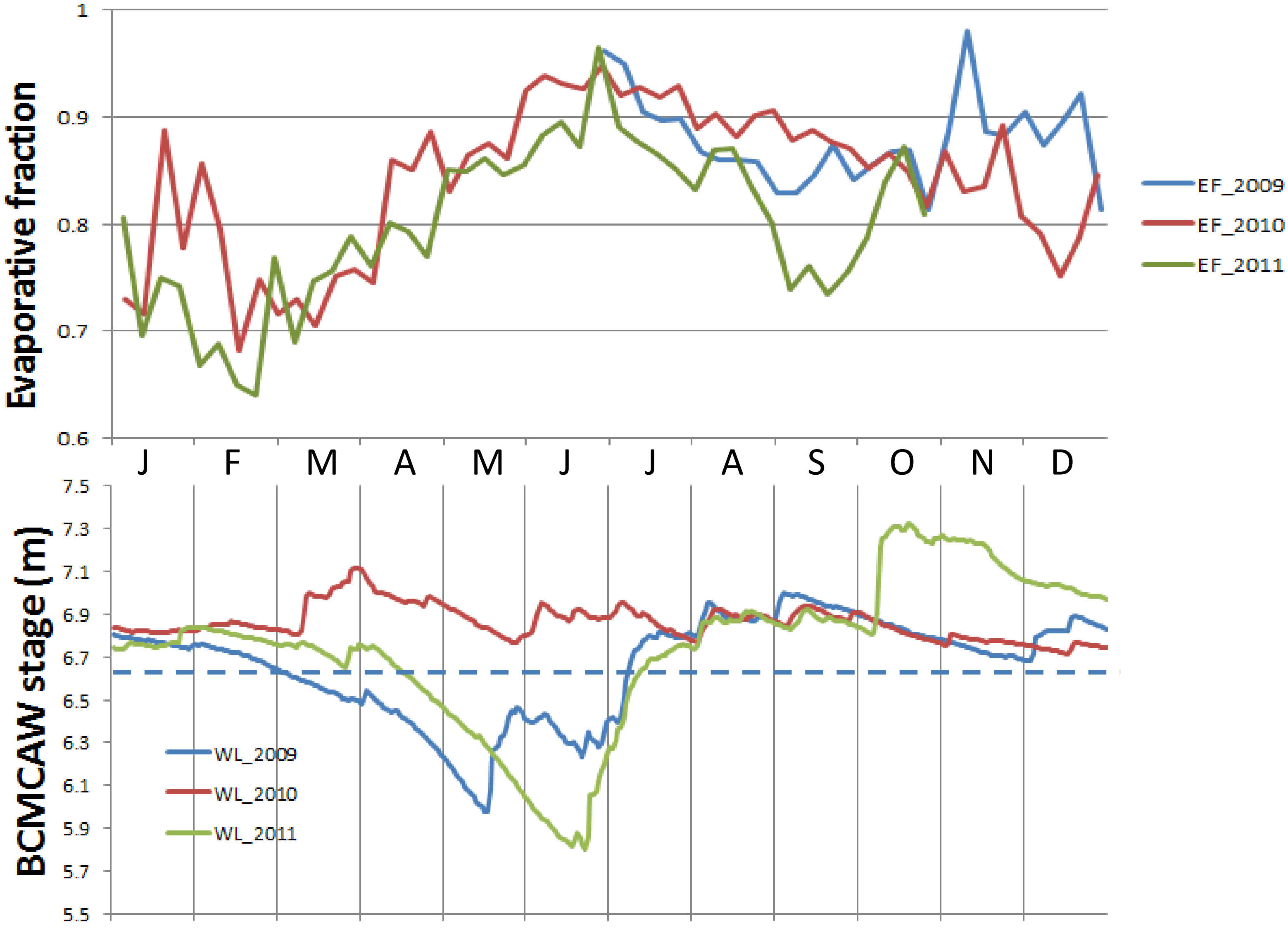
Rapid recovery from fire



Impact of fire on light response curves



ET was modestly impacted by low water levels



Questions ?

Long- and short hydroperiod marsh comparison

Schedlbauer et al., 2010	Blue Cypress marsh	
Agricultural & Forest Meteorology		
Sawgrass & muhly grass	Sawgrass	
Canopy height of 0.73 m	2 to 3 m – very dense	
Hydroperiod: 4-month (2008)	9-month (2011) to 12-month (2010)	
Shallow (0.14 m) marl soils over limestone	Deep (3.4 m) peat soils over clay	
	Year2010	*Year2011*
NEP = 50	597	65
R = 446	939	1,220
GEP = 496	1,537	1,285
CH4 = ?	33	26

All flux units are in: g C / m^2 / year

Inundation suppresses productivity	Inundation has little impact on productivity
Substantial canopy submergence	Slight canopy submergence

Climate change

Higher temperature → increased loss of C via respiration and methane releases

Greater frequency of droughts -> increased loss of C via respiration, but lower methane releases

More fires – loss of vegetation during spring 2014 fire = 963 g C/m2 or 3.2 years

Insolation – cloud cover changes ?

Water management can mitigate climate change impacts