

Evapotranspiration (ET) in Big Cypress National Preserve, South Florida

Barclay Shoemaker and Mike Duever



National Park Service
U.S. Department of the Interior



Acknowledgements

South Florida Water Management District

Steve Krupa

Cynthia Gefvert



U.S. Geological Survey

Christian Lopez

Troy Bernier

Dave Sumner



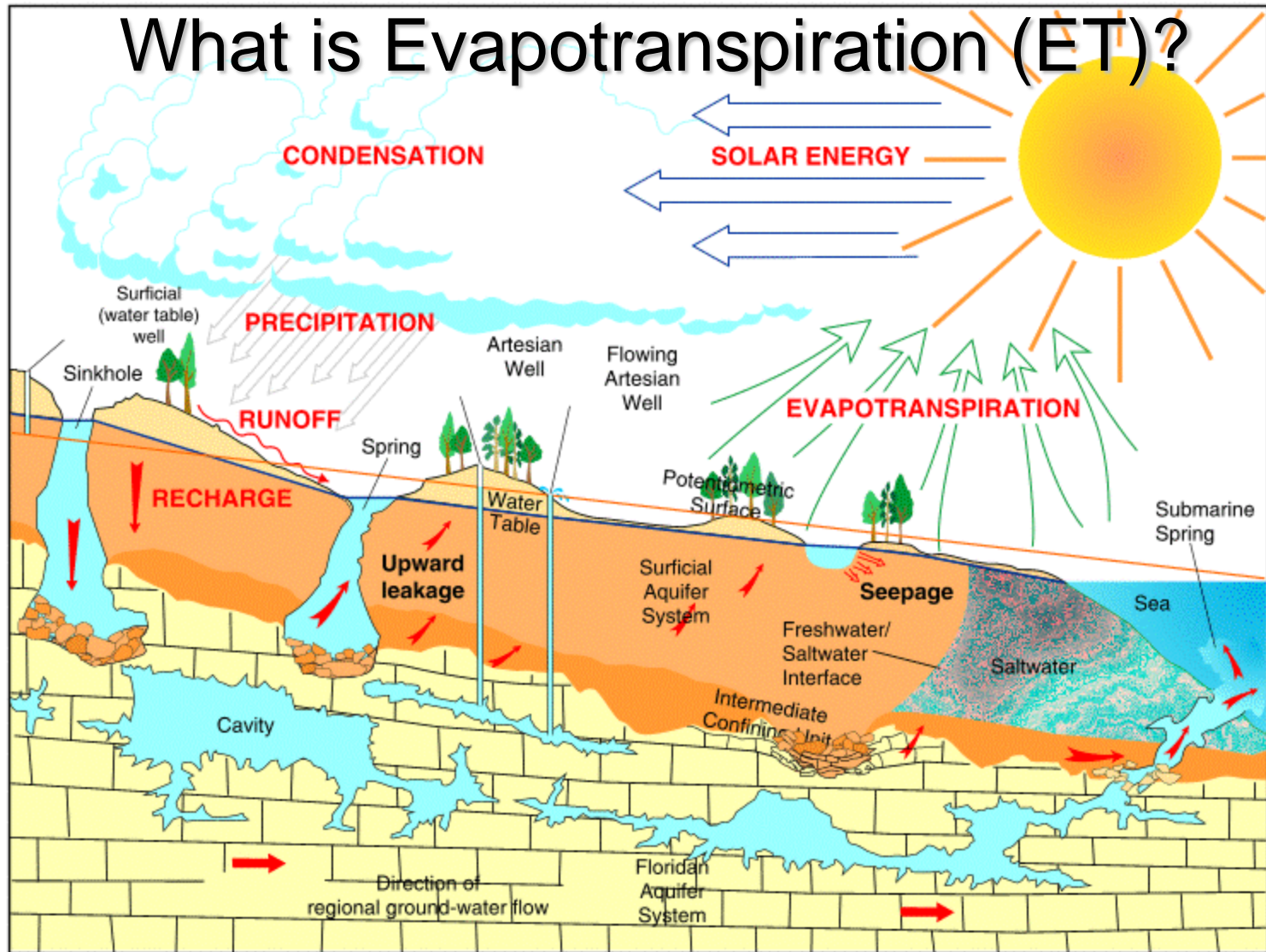
Big Cypress National Preserve

Damon Doumlele

National Park Service
U.S. Department of the Interior



What is Evapotranspiration (ET)?



→ FLOW PATH

Figure 4. The hydrologic cycle.

What factors control ET?

Atmospheric Resistance

Canopy Resistance

Available Energy

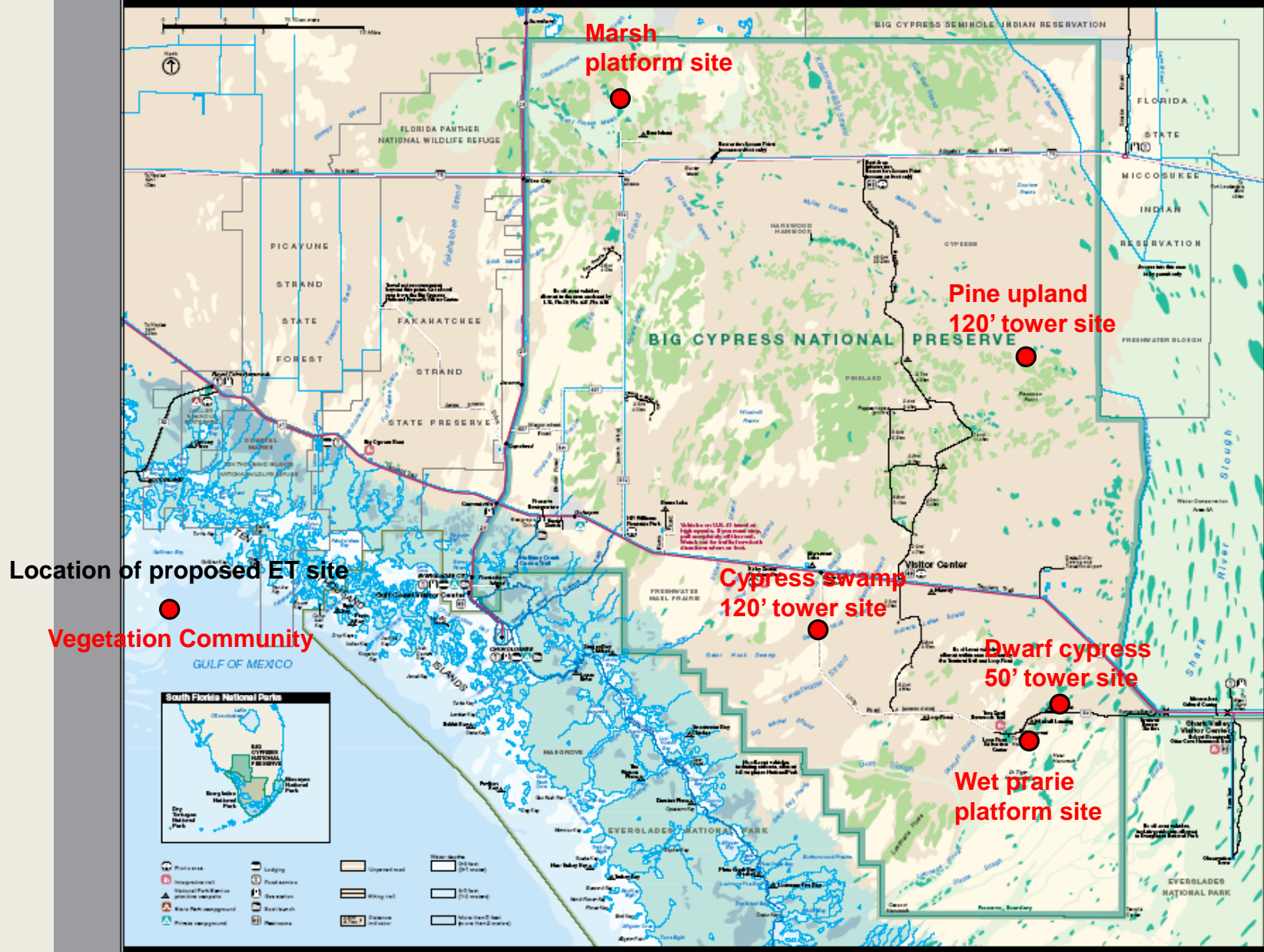
Available Water

Photo taken by Patrick Lynch (SFWMD)

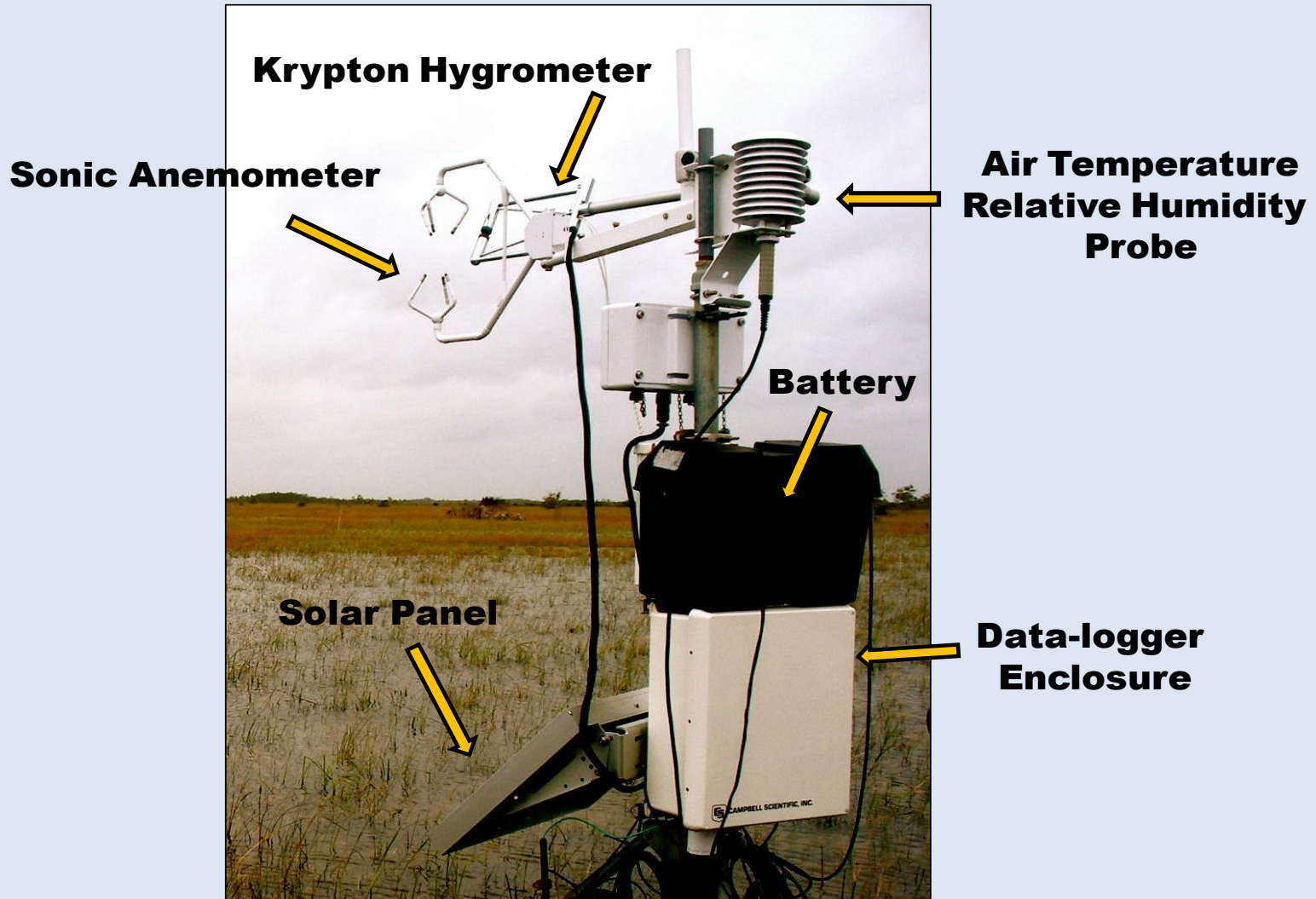
Big Cypress

Color key to ecosystems

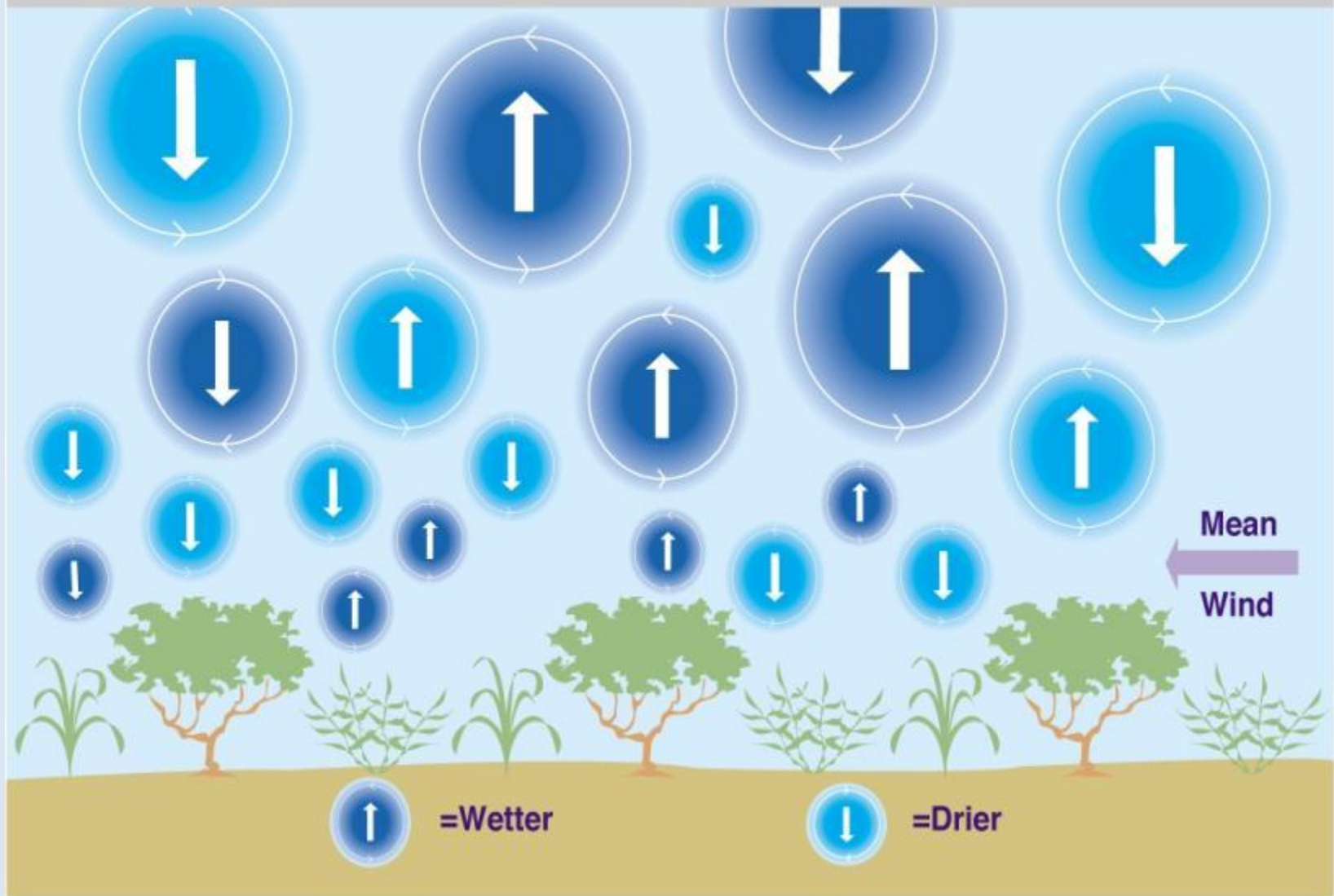
	Cypress		Floral		Roadwater Straggle		Wet prairie		Developed or Disturbed land
	Wetland		Marsh		Coastal Marsh		Wet prairie		Wet prairie



EDDY-COVARIANCE SENSORS



TURBULENT FLUX OF WATER VAPOR



Modified from Standard (2000)

An aerial photograph of a tall, lattice-structured tower situated in a dense forest of dwarf cypress trees. The tower is equipped with various scientific instruments at different heights. A yellow arrow points from the text 'Sap flow (Bovard, FGCU)' to a specific location on the forest floor near the base of the tower. Another yellow arrow points from the text 'Surface-water temperature' to a small white marker on the ground. The forest floor is covered with a mix of green and brown vegetation, indicating some tree mortality or stress.

Dwarf Cypress (55' tower)

- Measures ET
- Net radiation
- Solar radiation
- Rainfall
- Wind speed and direction
- Surface/groundwater stage
- Ground-water temperature
- Surface-water temperature
- Air temperature
- Relative humidity
- Sap flow (Bovard, FGCU)

Photo taken by Patrick Lynch (SFWMD)

Cypress Swamp (120' tower)

- Measures ET
- Net radiation
- Solar radiation
- Rainfall
- Wind speed and direction
- Surface/groundwater stage
- Ground-water temperature
- Surface-water temperature
- Air temperature
- Relative humidity
- Soil temperature
- Soil heat flux
- Soil moisture
- Sap flow (Bovard, FGCU)



Photo taken by Patrick Lynch (SFWMD)



Photo taken by Patrick Lynch (SFWMD)

Pine Upland (120' tower)

- Measures ET
- Net radiation
- Solar radiation
- Rainfall
- Surface/groundwater stage
- Ground-water temperature
- Surface-water temperature
- Air temperature
- Relative humidity
- Soil moisture
- Soil temperature
- Soil heat flux
- Sap Flow (Bovard)



Wet Prairie

- Measures ET
- Net radiation
- Solar radiation
- Rainfall
- Surface/groundwater stage
- Ground-water temperature
- Surface-water temperature
- Air temperature
- Relative humidity
- Soil heat flux
- Soil moisture
- Soil temperature

Marsh

- Measures ET and CO₂
- Net radiation
- Solar radiation
- Rainfall
- Surface/groundwater stage
- Ground-water temperature
- Surface-water temperature
- Air temperature
- Relative humidity
- Soil temperature
- Soil heat flux



Photo taken by Patrick Lynch (SFWMD)

QAQC

30-minute raw data

EC
Low anemometer count
Undefined covariance
Spiking
Low hygrometer voltage
Inadequate fetch

BR
B~-1
LE counter to Δe
low Δe or ΔT

Correct default
hygrometer coefficient
based on vapor density

Coordinate rotation
Tanner & Thurtell 1969;
Baldocchi, Hicks, & Meyers 1988

Vapor density correction to LE
Webb, Pearman, & Leuning 1980

Krypton hygrometer oxygen LE
correction
Tanner, Swiatek, and Greene 1993

Sonic-to-sensible heat correction
Schotanus, Nieuwstadt, & de Bruin
1983

Energy-budget closure via Bowen ratio
Twine et al. 2000 – daily or 30-minute

LE & H

Gap-fill

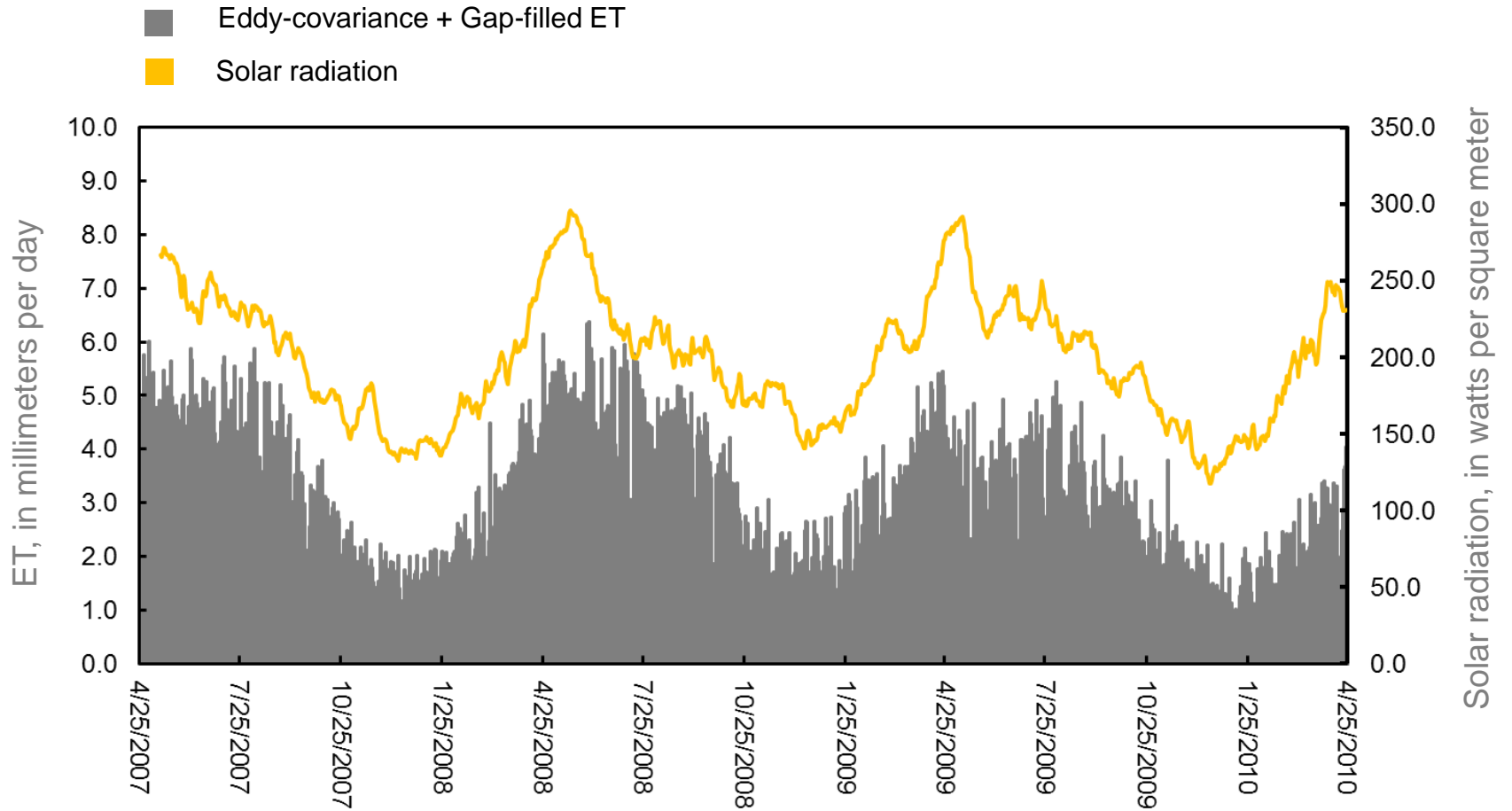
Gap-filling missing ET

- Priestley-Taylor equation

$\alpha = \text{regression-defined constant}$

$$PLE = \alpha \frac{\Delta}{\Delta + \gamma} (Ae)$$

Cypress Swamp



Annual ET totals

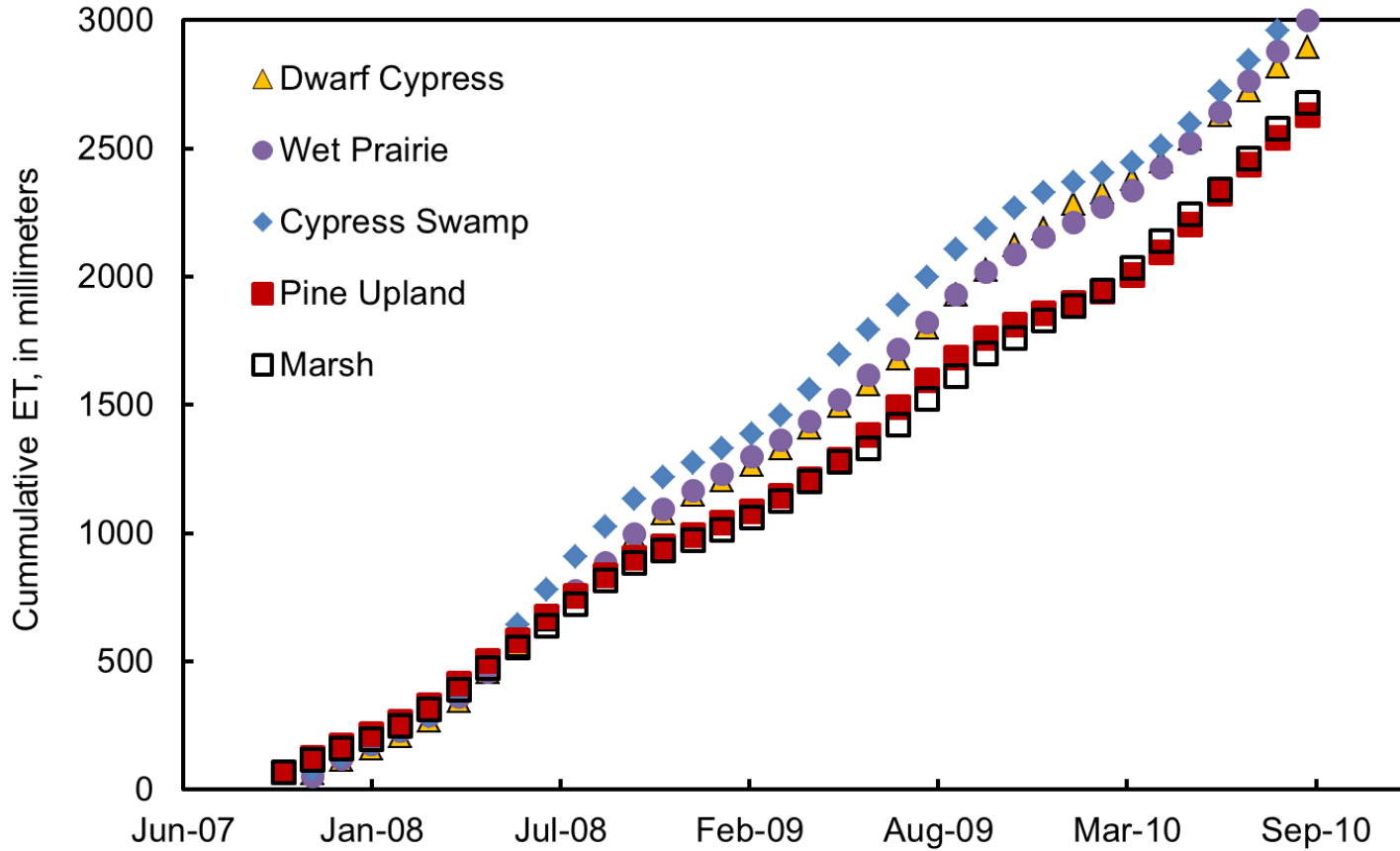
Total ET, in millimeters			
Site	Year 1 ¹	Year 2 ²	Year 3 ³
Dwarf cypress	976	1075	959
Wet prairie	1017	1019	1106
Cypress swamp	1179	1115	1025
Pine upland	876	909	996
Marsh	816	840	1068

Year 1: April 2007 to March 2008

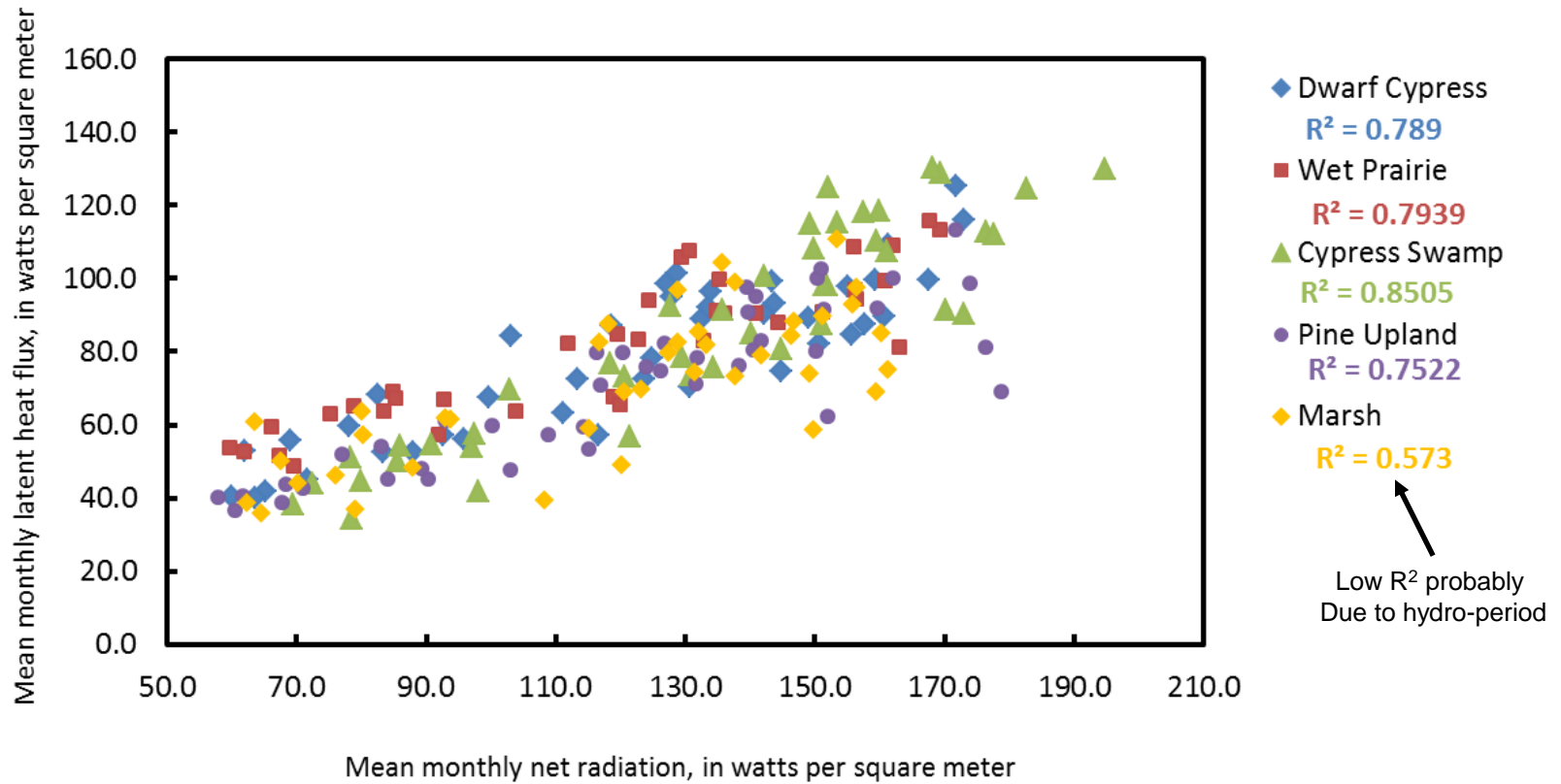
Year 2: April 2008 to March 2009

Year 3: April 2010 to March 2008

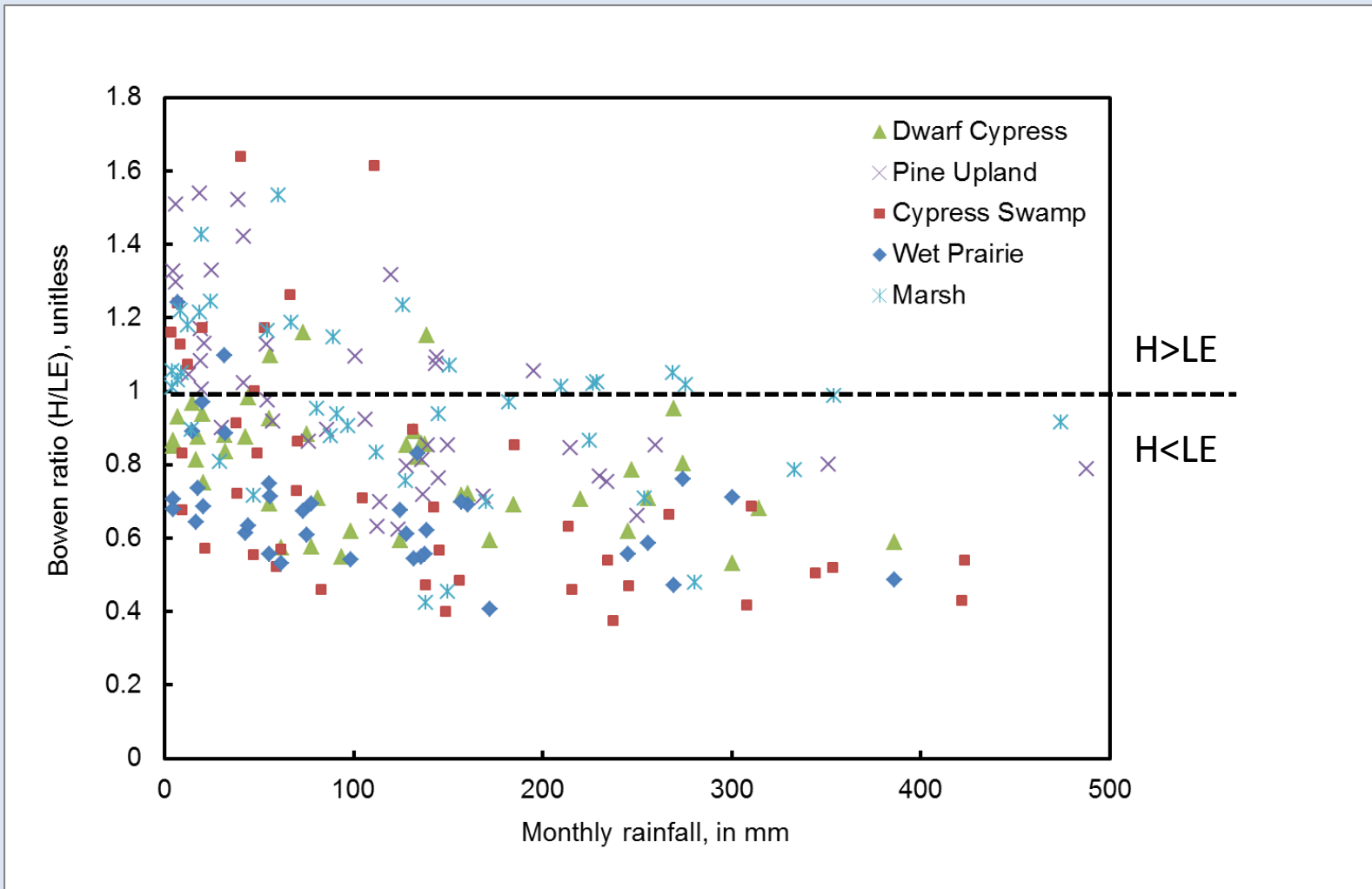
Cumulative ET



Net Radiation versus LE (5 sites)

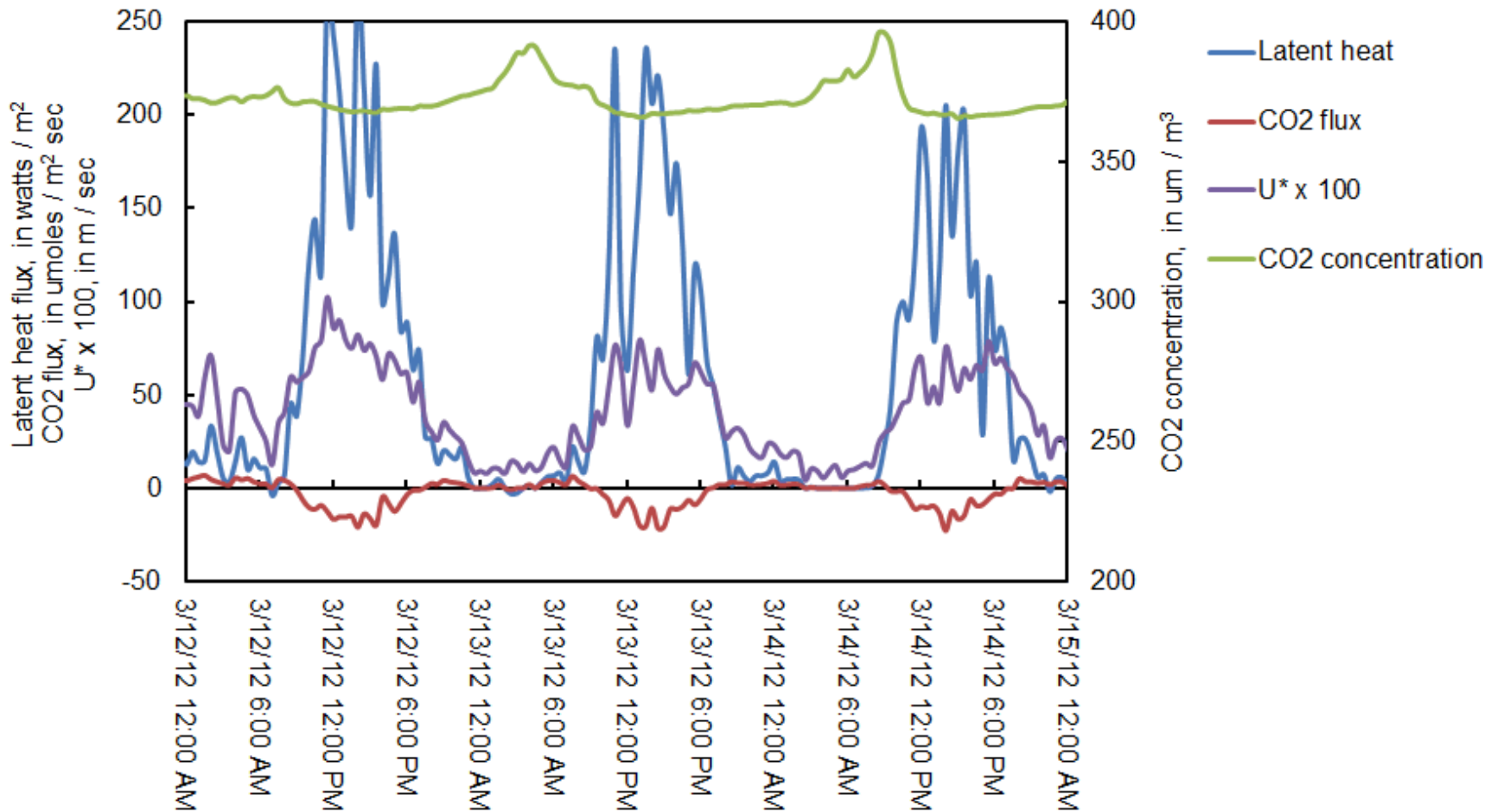


Bowen Ratios versus Rainfall



ET depends on water availability

Carbon Cycling at Pine Upland



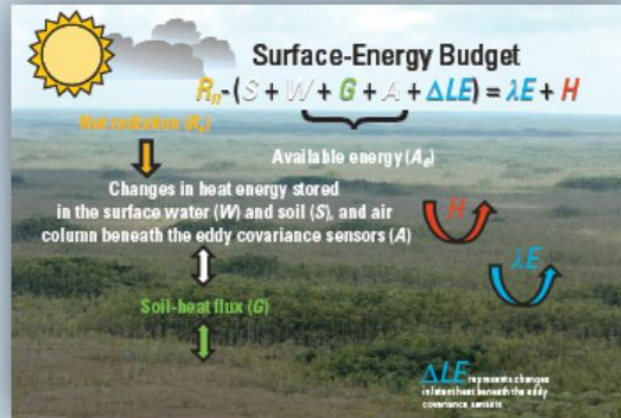
Conclusions

- 1. ET ranged from about 32” to 46” per year.**
- 2. Annual ET difference between Marsh and Cypress Swamp site as large as 15”**
- 3. Available energy and water explains most ET variability.**

Any questions? Email Barclay at bshoemak@usgs.gov

Prepared in cooperation with the South Florida Water Management District as part of the U.S. Geological Survey Greater Everglades Priority Ecosystems Science Program

Evapotranspiration over Spatially Extensive Plant Communities in the Big Cypress National Preserve, Southern Florida, 2007–2010



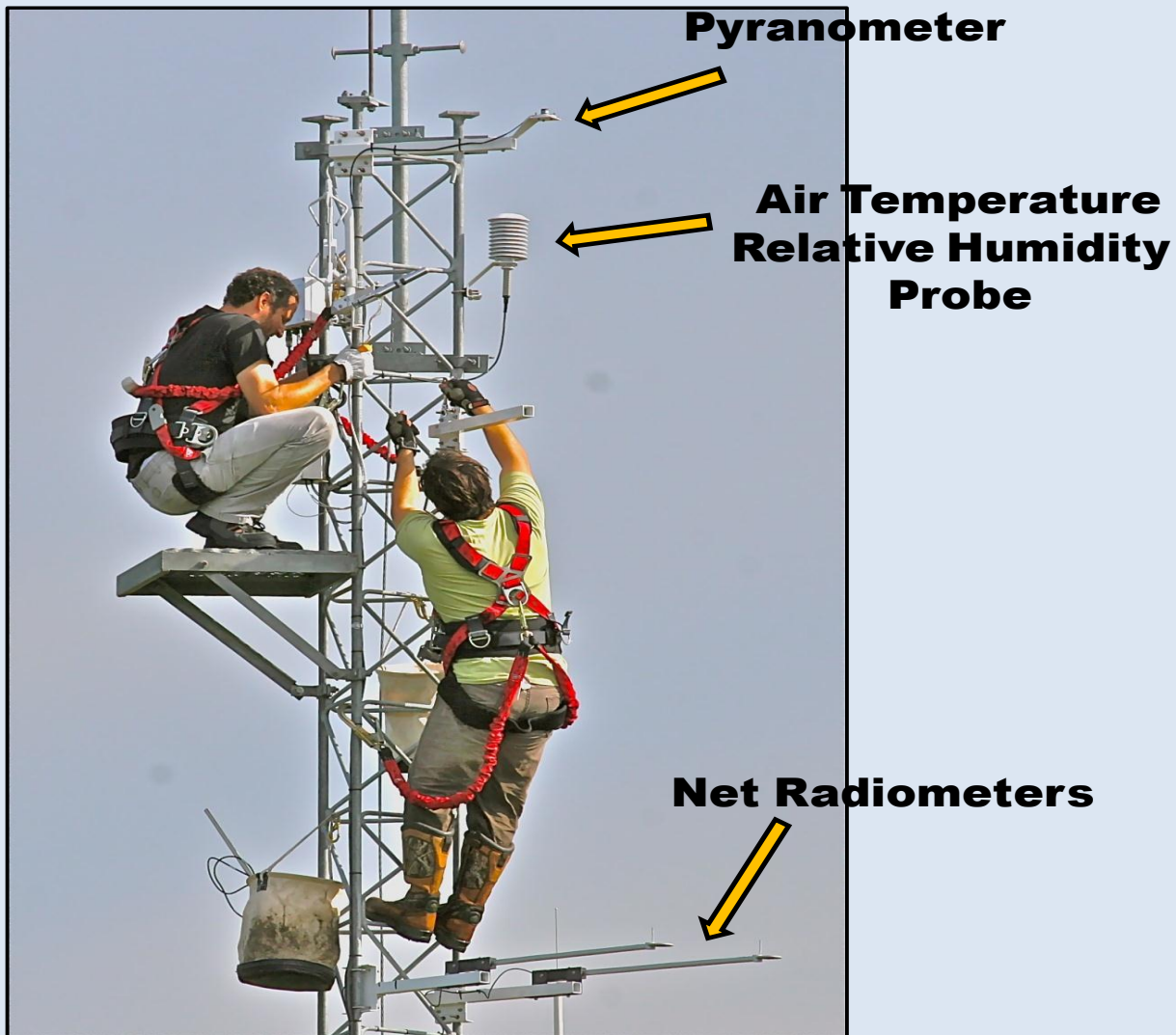
Scientific Investigations Report 2011–5212

U.S. Department of the Interior
U.S. Geological Survey

<http://www.usgs.gov/>

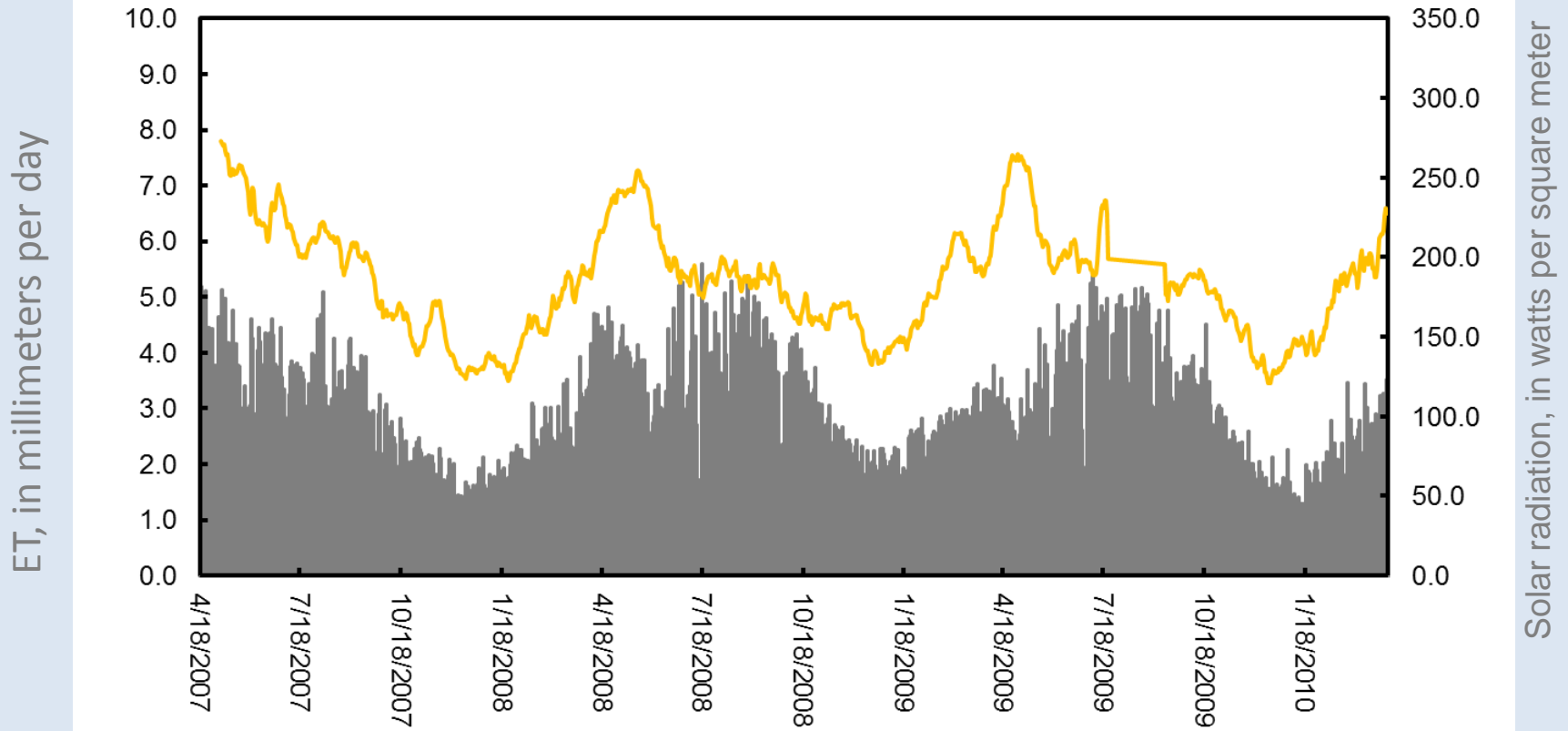
<http://sites.google.com/site/floridaetwiki/reports-and-papers>

WISH US LUCK AND THANKS !

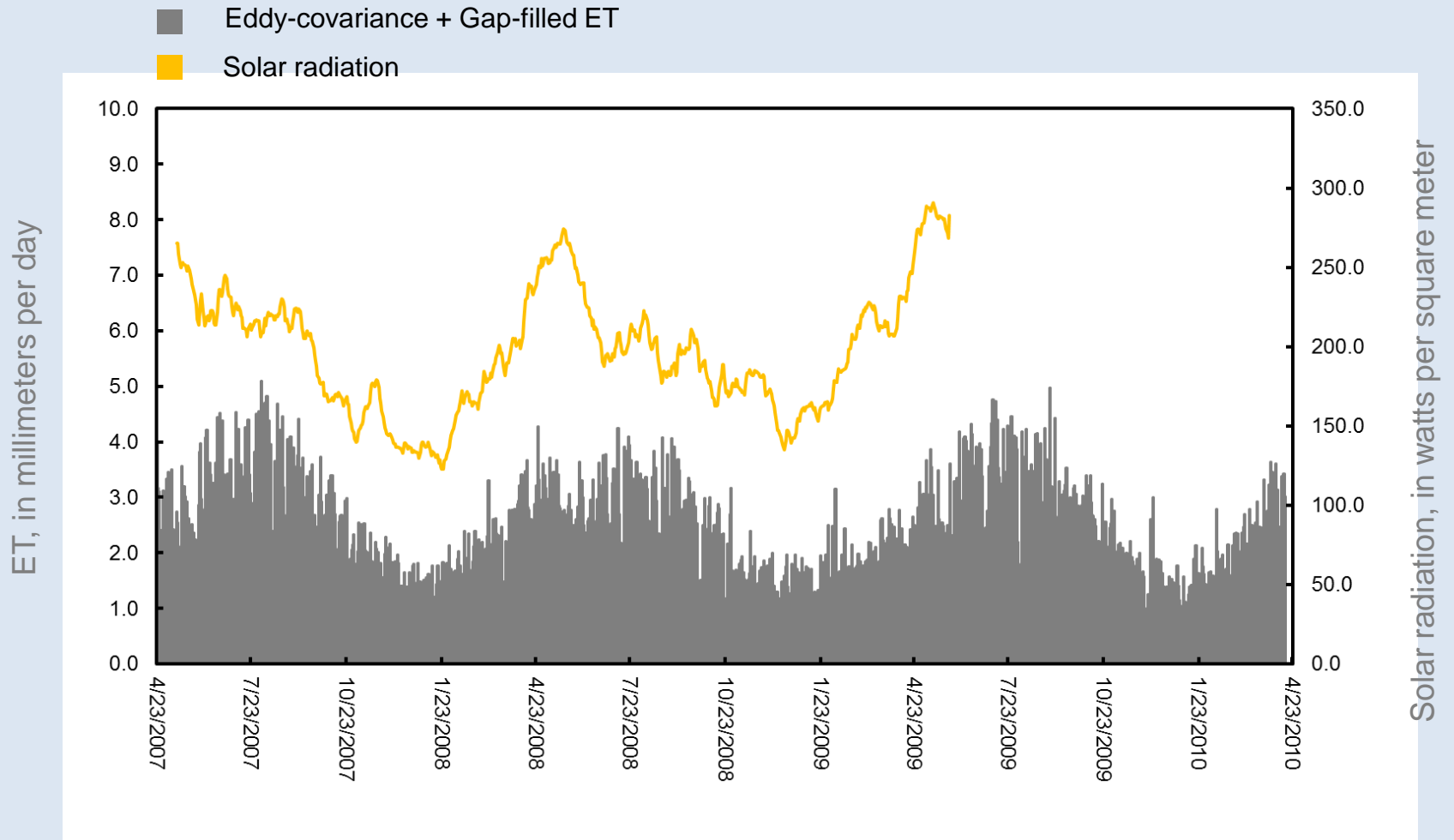


Dwarf Cypress

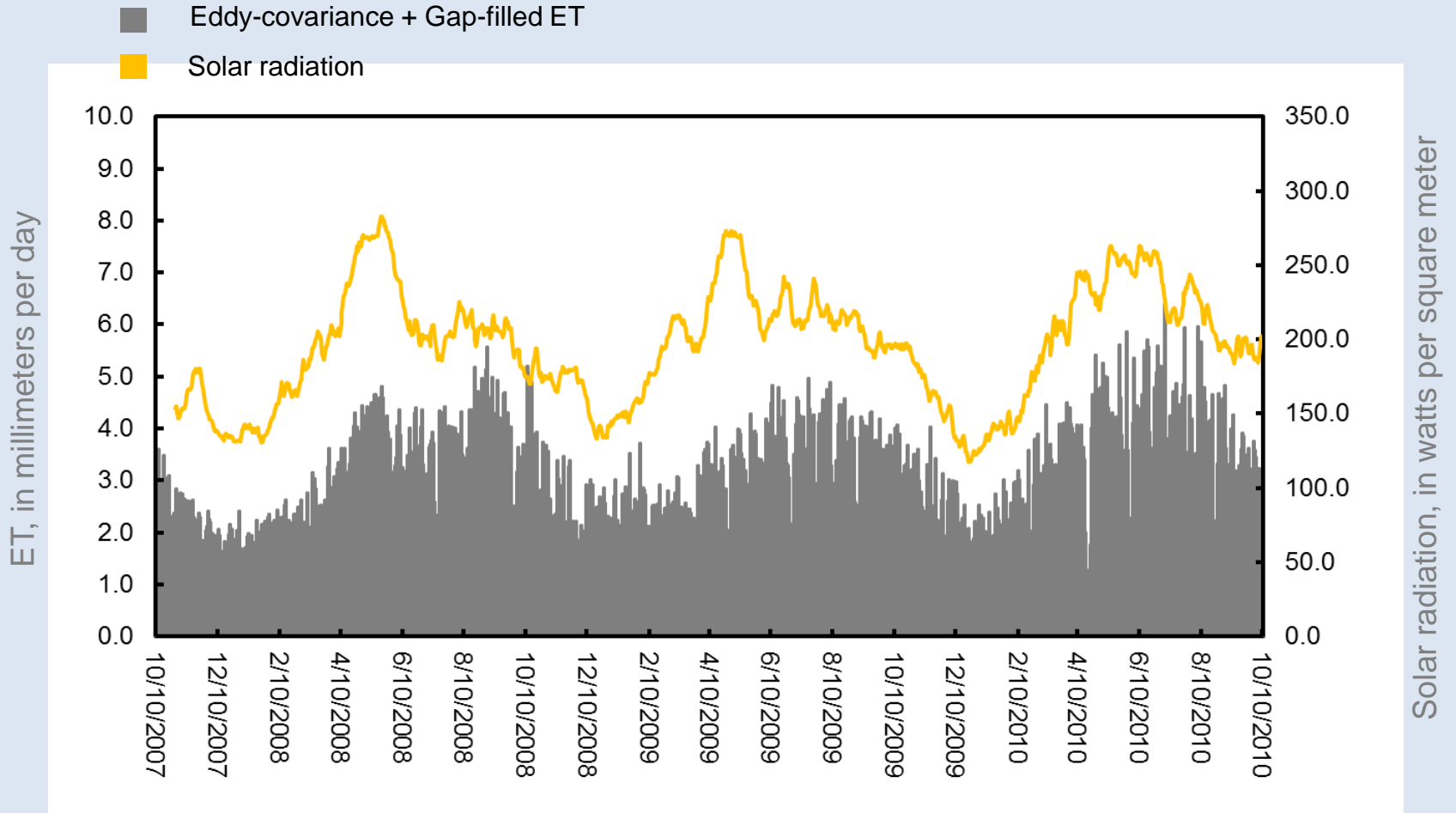
- Eddy-covariance + Gap-filled ET
- Solar radiation



Pine Upland

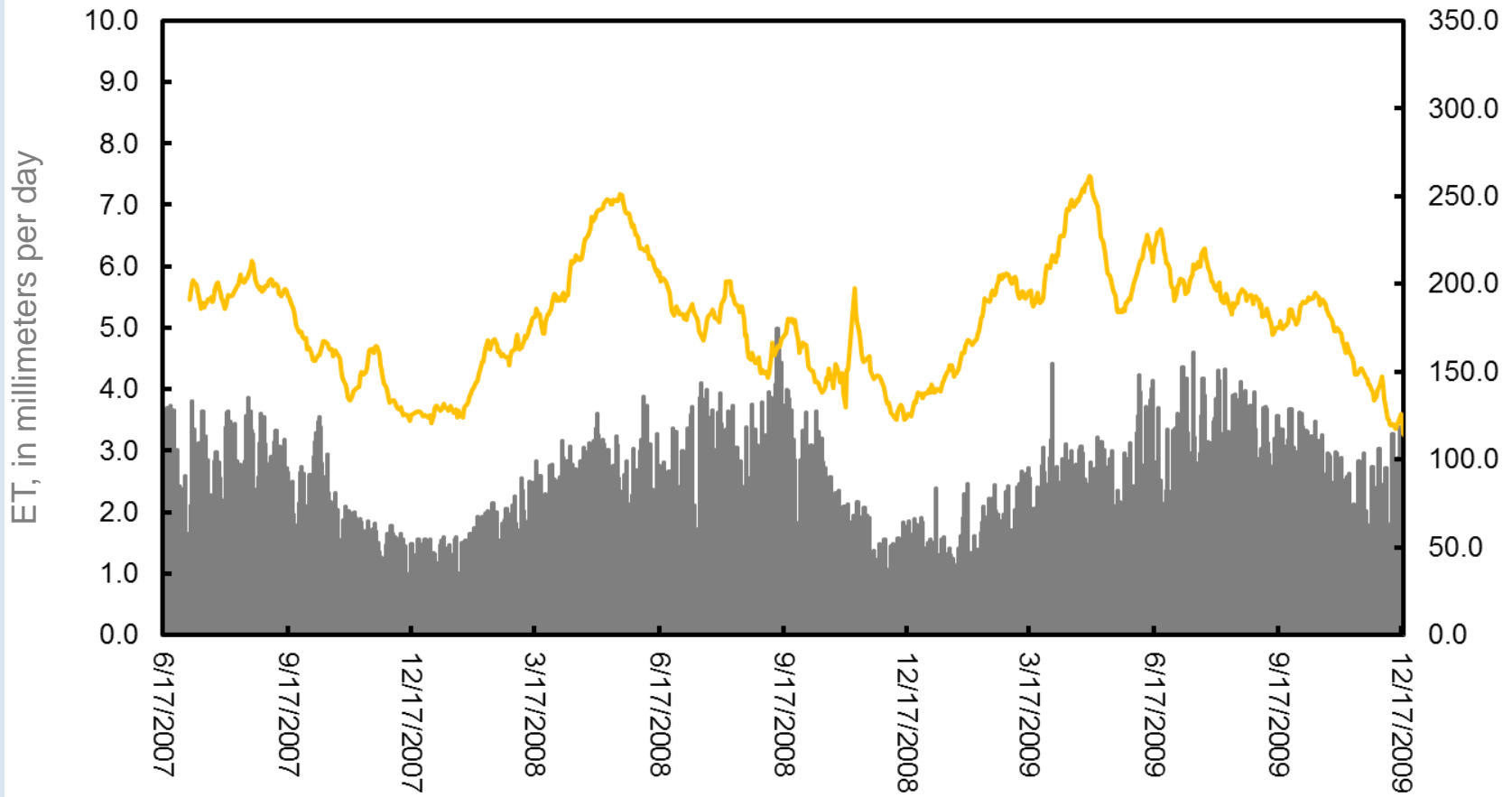


Wet Prairie



Marsh

- Eddy-covariance + Gap-filled ET
- Solar radiation



Solar radiation, in watts per square meter