

# Sunlight and flooding/drought conditions dominate carbon fluxes in wetlands across the Southeastern United States

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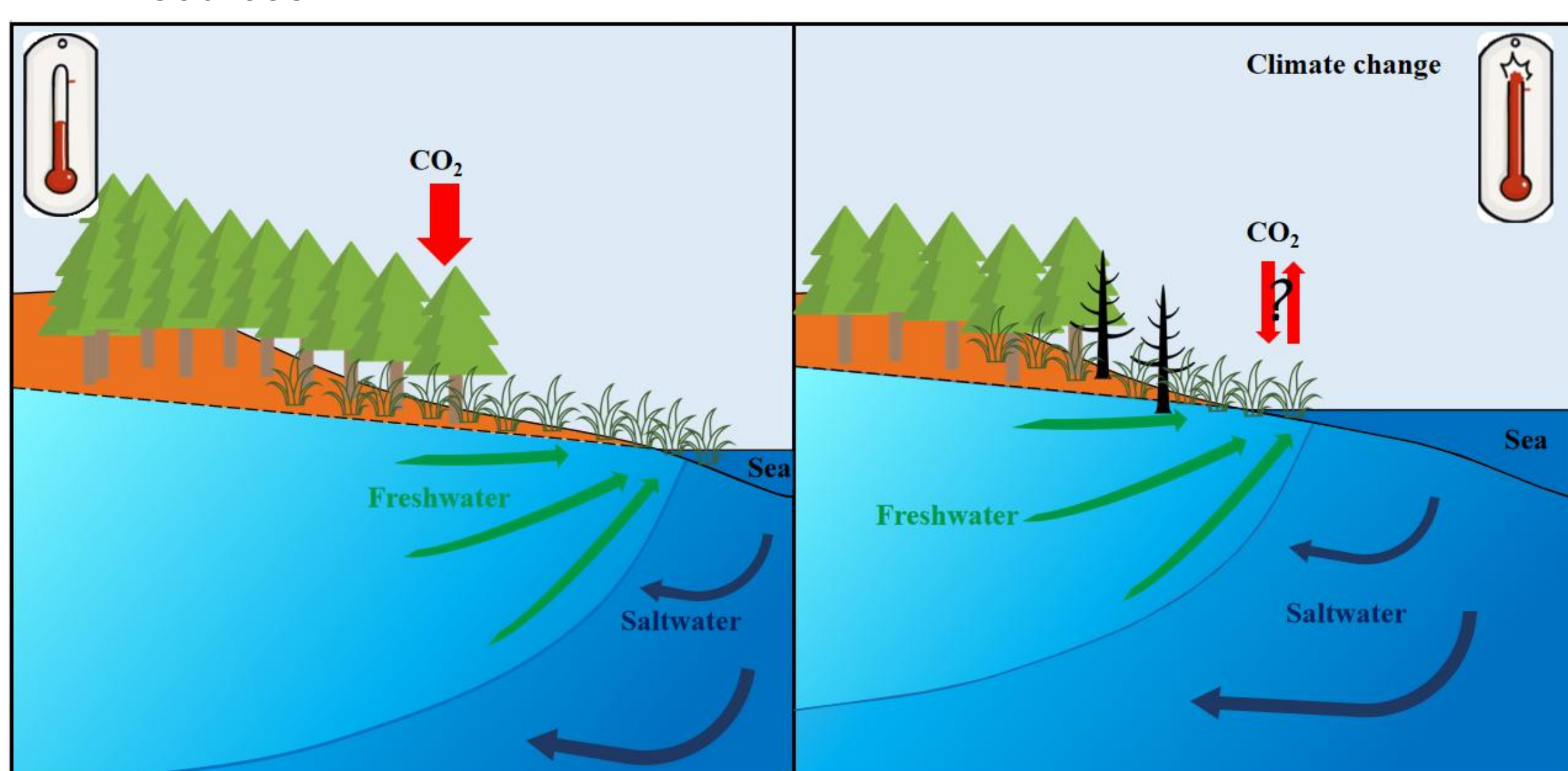
## Introduction

### Wetland ecosystems

- Highly productive and biologically diverse ecosystems
- Water line is within 0.3 m of the top soil zone for at least two weeks in the growing season (NRC, 1995)
- While they only cover 6% of the earth's land surface, wetlands provide myriads of ecosystem services:
  - storing one-third of the organic carbon on the planet,
  - water quality enhancement,
  - erosion control, and
  - maintaining stream flow

### Climate change threats

- Global warming and sea level rise
  - may dramatically alter the roles of wetlands in the carbon cycle
  - potentially transforming wetlands from carbon sinks into carbon sources



### Research Questions

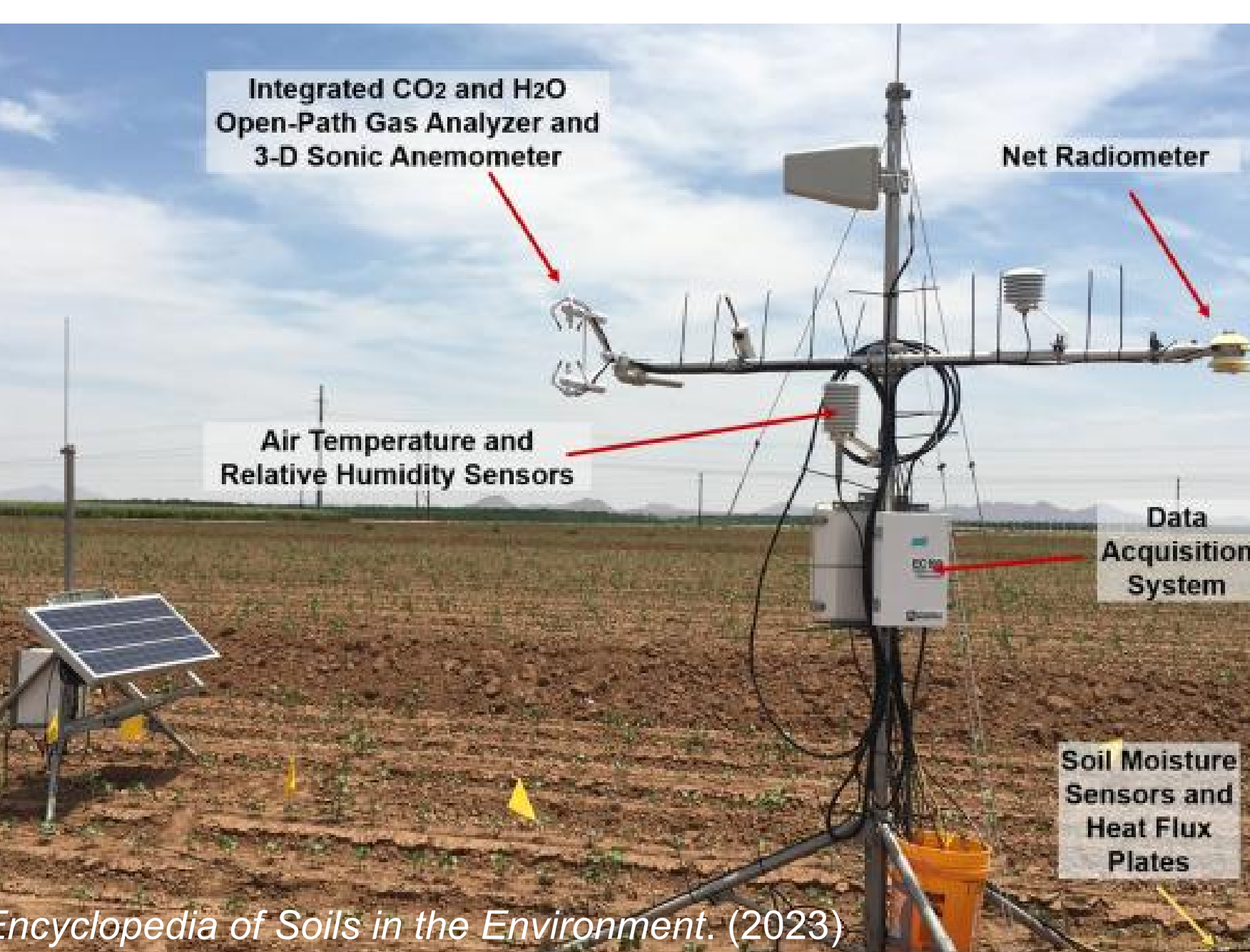
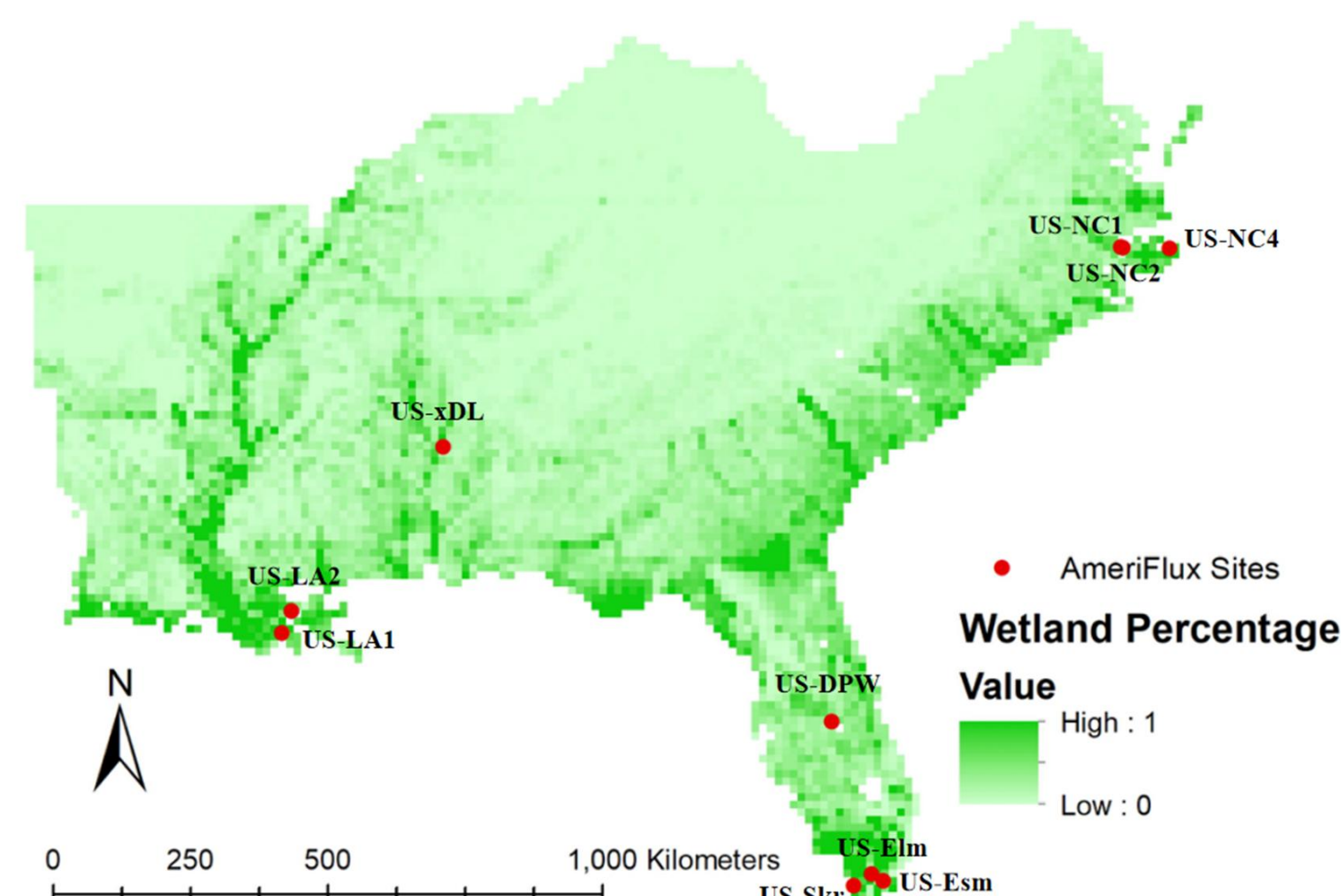
- What are the key climatological variables influence wetland CO<sub>2</sub> fluxes?
- What are the wetland CO<sub>2</sub> flux patterns over the entire Southeastern United States (SE US)?

## Flux Tower Data for Model Training

### AmeriFlux

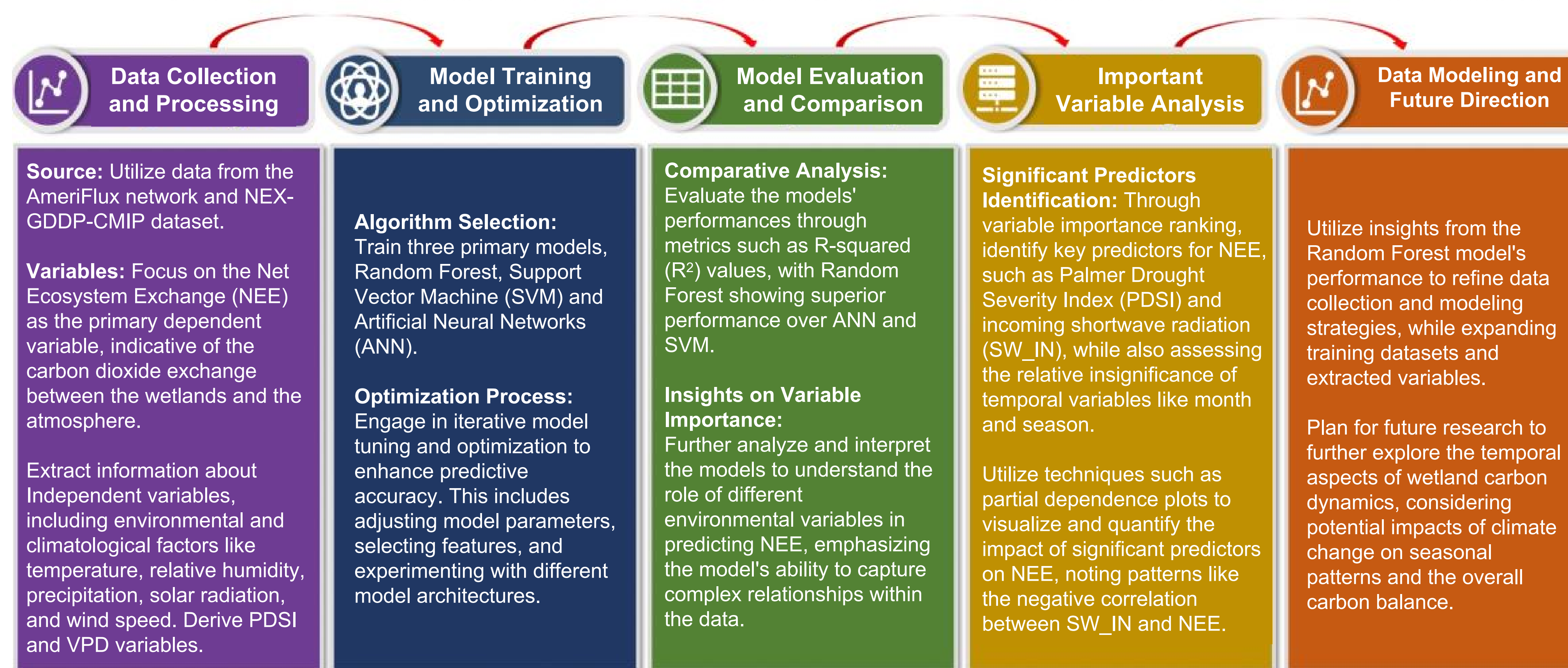
- 10 wetland sites
- Covering a range of wetland types under various climatic and hydrological conditions
- NEE (Net Ecosystem Exchange of CO<sub>2</sub>)

Spatial distribution of wetlands over the SE US calculated from the National Wetland Inventory (NWI).



- Eddy covariance technique
- Carbon (CO<sub>2</sub> and CH<sub>4</sub>) and energy (water vapour) fluxes
- Environmental variables (e.g., air temperature, precipitation, wind speed, incoming shortwave radiation)

## Workflow



## Spatial Climate Data for Model Application

### NEX-GDDP-CMIP

- The NASA Earth Exchange (NEX) Global Daily Downscaled Projections (GDDP) dataset
- Outputs from 35 CMIP6 GCM (Global Climate Model) models
- Historical experiment and four SSP scenarios (our project focuses on the historical, SSP245, and SSP585 scenarios).

### Variables

- hurs** (Near-Surface Relative Humidity),
- pr** (Mean of the daily precipitation rate),
- rsds** (Surface Downwelling Shortwave Radiation)
- sfcWind** (Daily-Mean Near-Surface Wind Speed), and
- tas** (Daily Near-Surface Air Temperature)

### Derived Variables

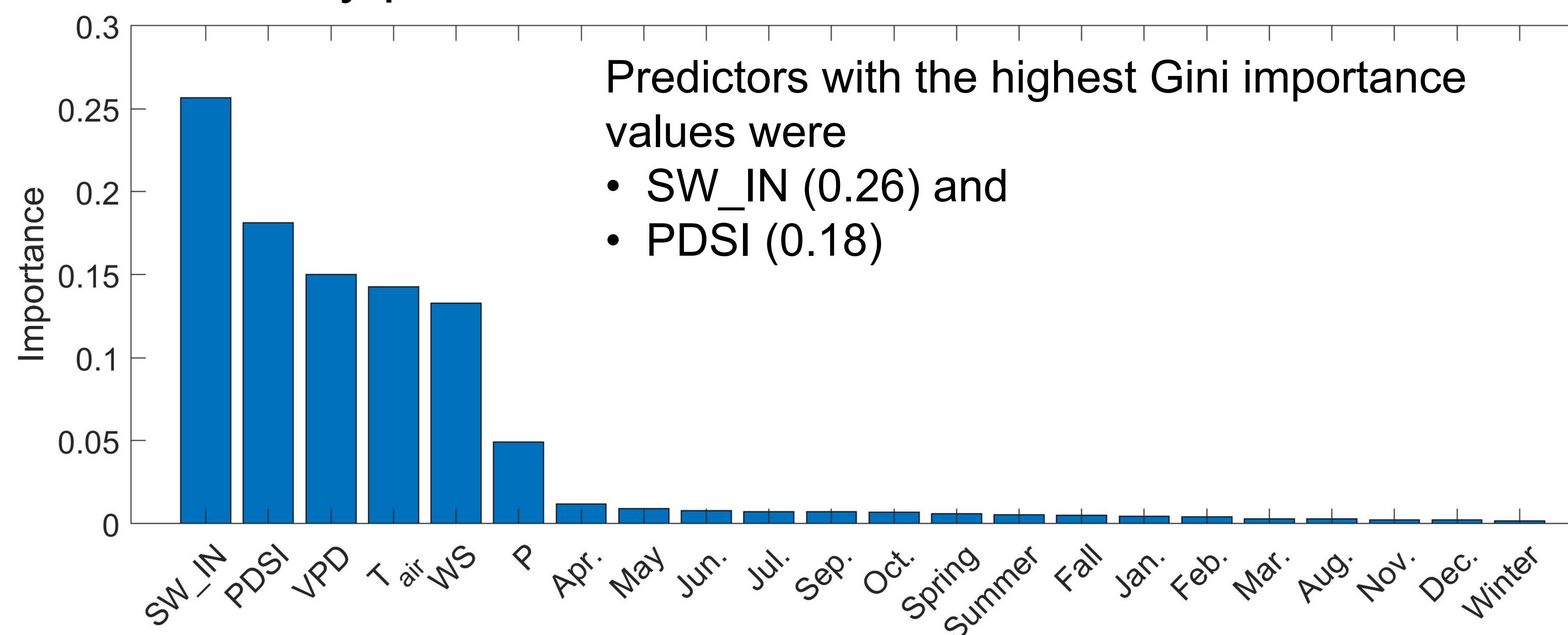
- VPD** (Vapor Pressure Deficit): the difference (deficit) between the amount of moisture in the air and how much moisture the air can hold when it is saturated
- PDSI** (Palmer Drought Severity Index): quantifying flooding/drought conditions

Table 1. CMIP6 models included in downscaled archive

Model	Variant	hurs <sup>5</sup>	huss	pr	rlds	rsds	sfcWind	tas <sup>4</sup>
ACCESS-CM2	r1i1p1f1							
ACCESS-ESM1-5	r1i1p1f1							

## Key Finding 1

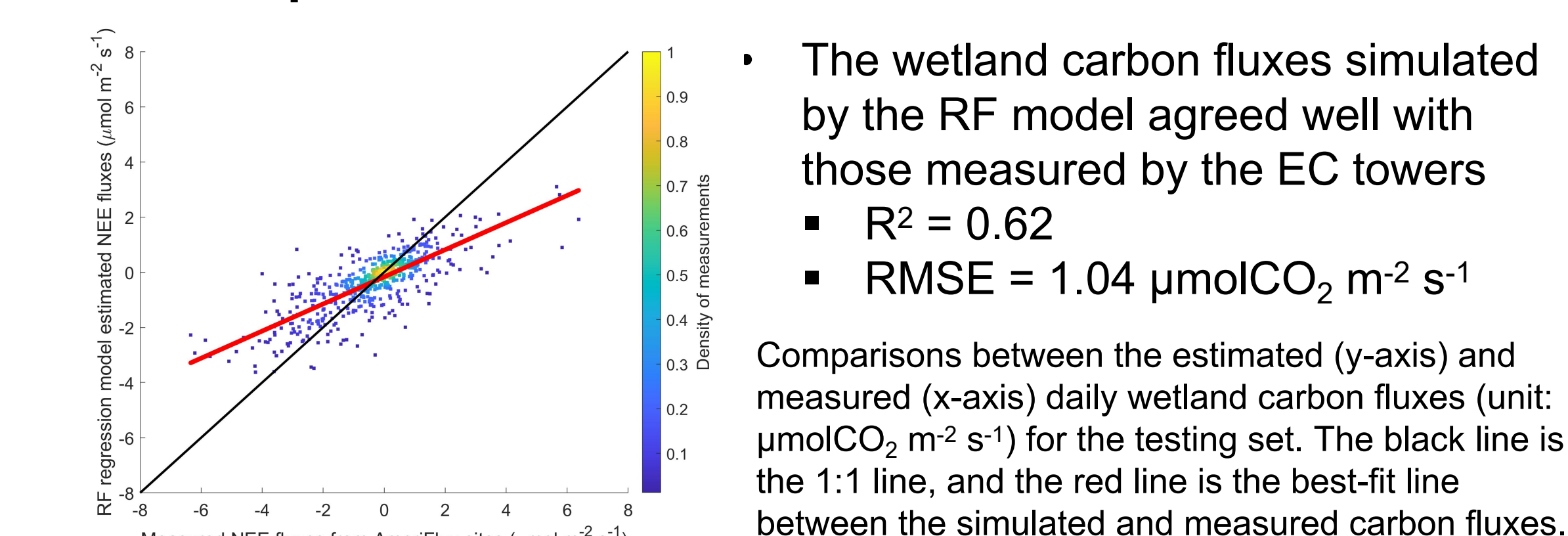
### Incoming shortwave radiation and Palmer Drought Severity Index are key predictors of wetland carbon fluxes



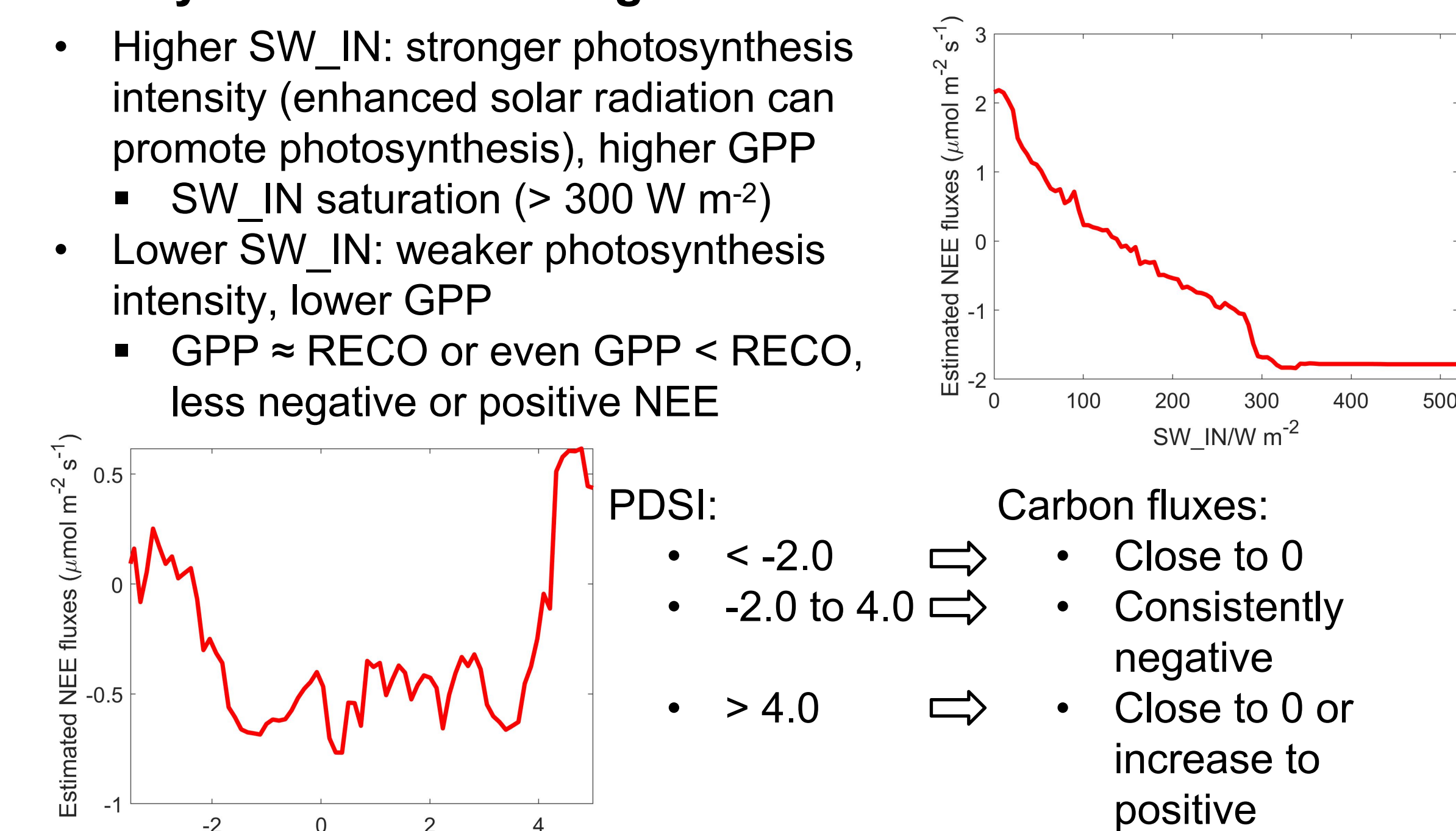
The variable importance analysis in the RF regression model. The x-axis lists explanatory variables ranked in descending order of importance: incoming shortwave radiation (SW\_IN), Palmer Drought Severity Index (PDSI), vapor pressure deficit (VPD), air temperature (T<sub>air</sub>), wind speed (WS), precipitation (P), 12 months (January to December), and 4 seasons (Spring to Winter).

## Results

### Model performance at the 10 AmeriFlux sites

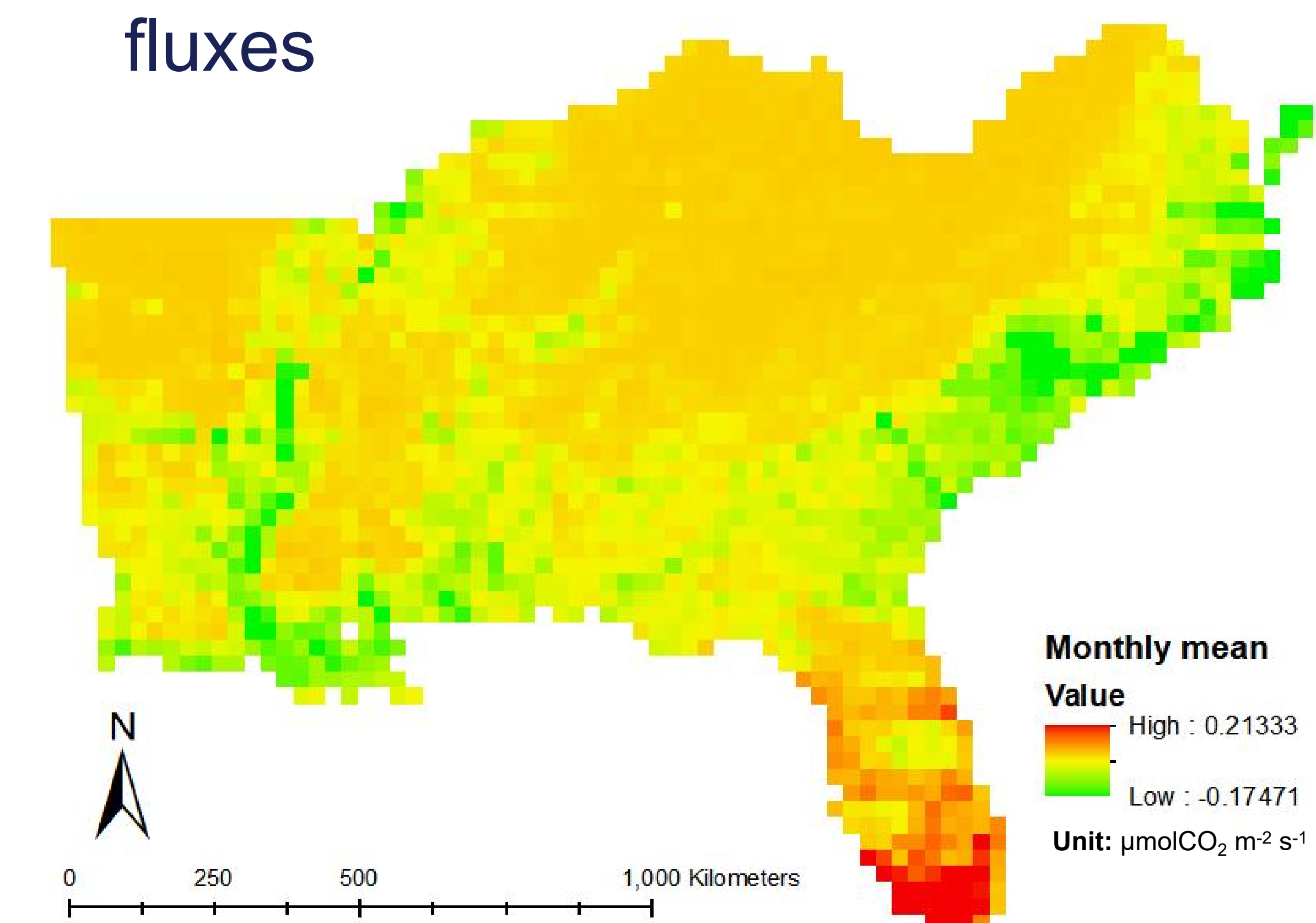


### Key variables affecting wetland carbon fluxes



## Key Finding 2

### High-spatial-resolution and long-term estimates of wetland CO<sub>2</sub> fluxes



The monthly climatological mean of wetland CO<sub>2</sub> fluxes (unit: μmolCO<sub>2</sub> m<sup>-2</sup> s<sup>-1</sup>) across the SE US during 1950-2014 estimated by the random forest regression model at a high spatial resolution of 0.25° × 0.25°.

- Spatial Resolution:** 0.25° × 0.25°
- Temporal Resolution:** monthly
- Period:** 1950-2014 (65 years)
- Future projections (2015-2100) is under way!**