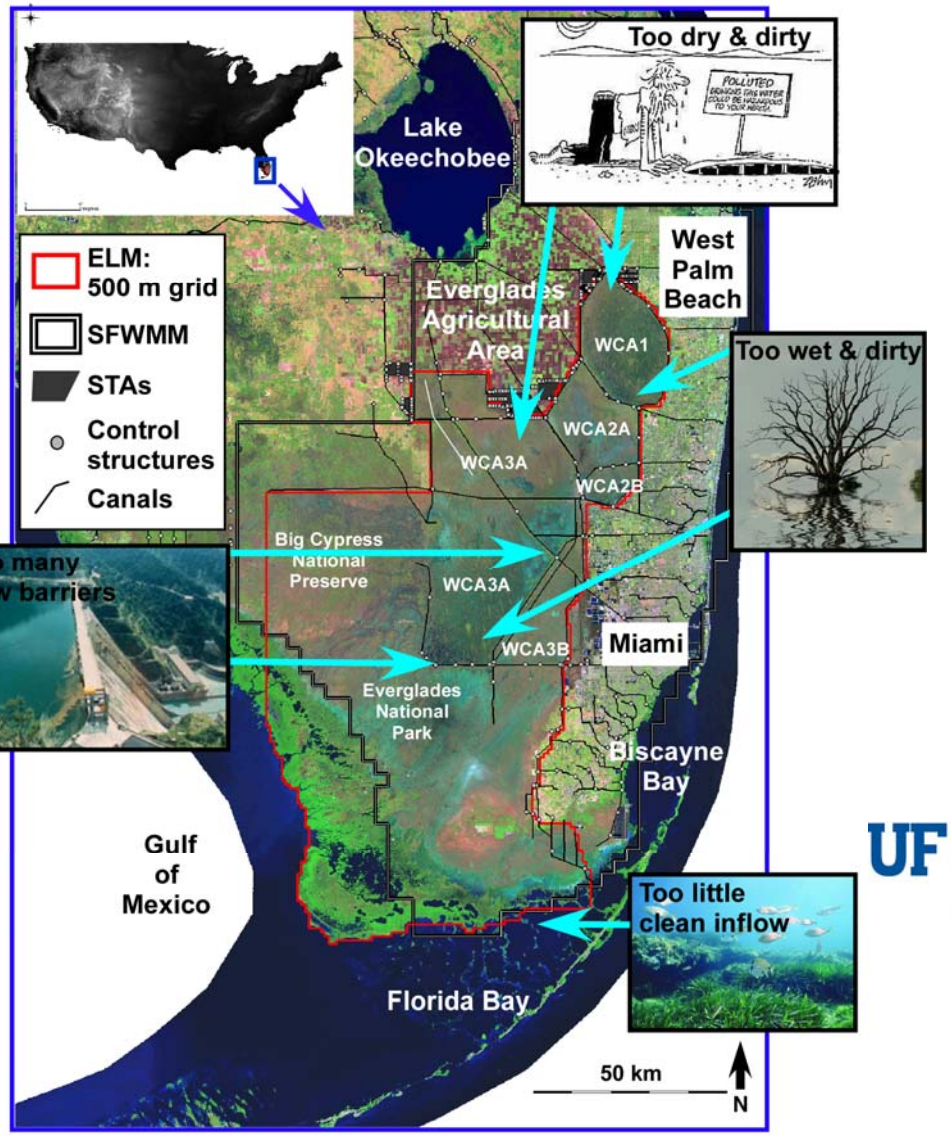
# Soil oxidation and phosphorus storage changes resulting from a range of restoration optionss

GEER 2015

H. Carl Fitz - EcoLandMod, Inc.
Todd Z. Osborne – IFAS, U. Florida
Steve E. Davis – Everglades Foundation

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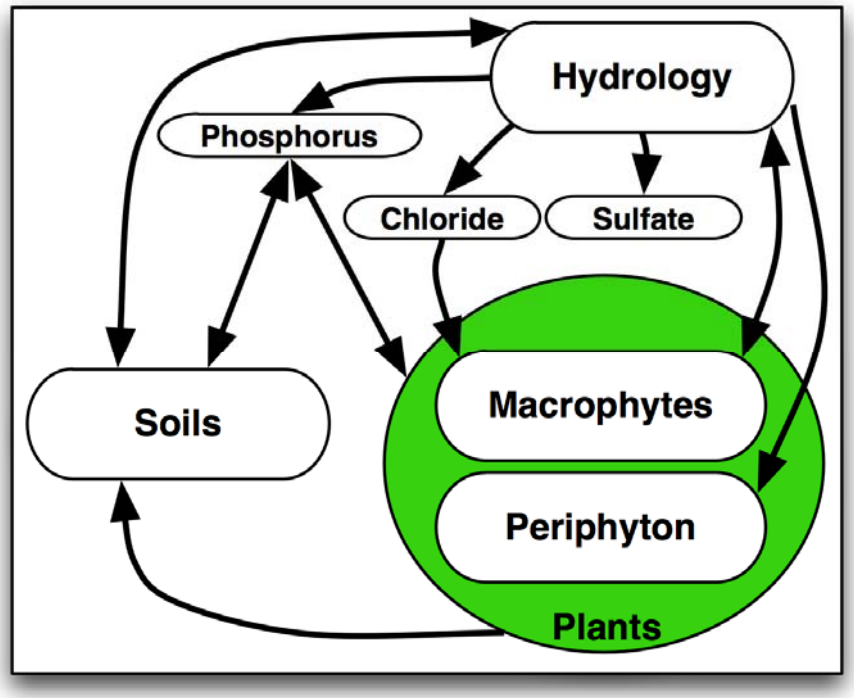
UF UNIVERSITY of FLORIDA
IFAS


FCE LTER

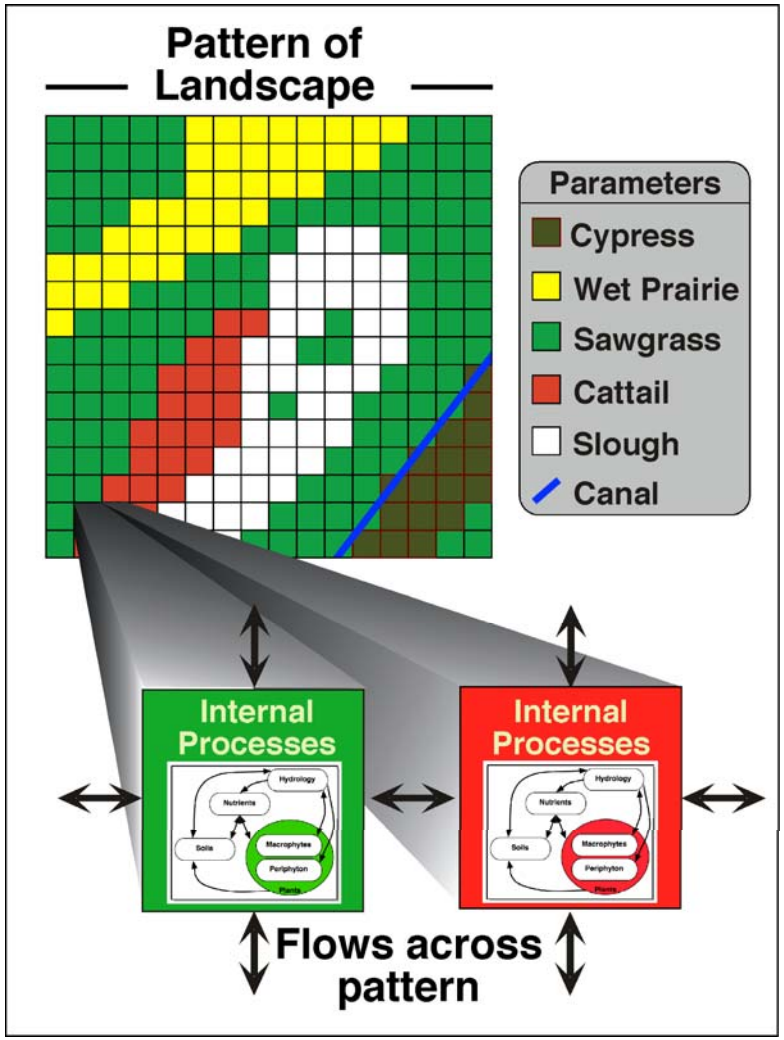
# ELM Design:
# Integrating ecological interactions

- **Ecosystem model, integrating dynamic processes of hydrology, biogeochemistry, & plant biology**

- **Arrows denote flows of carbon, water, & phosphorus, and information feedbacks among modules**



# ELM Design:
# Pattern-process spatial interactions




- Landscape ***pattern*** (of habitats) affects local ecosystem ***processes***

- ***Processes*** affect landscape ***pattern*** (via habitat succession)

- Canals represented by exact vectors, dynamic canal-marsh interactions; managed flows at point water control structures

- Integrated surface-ground water exchanges

# ELM performace assessments

- **Scalable** model, depending on project objectives
  - Info here on regional (10,000 $km^2$) application at 500 m grid resolution
- Statistics on **calibration/validation** (history-matching)
  - Stage:  Median (82 stations): bias= 0 cm; NS Efficiency= 0.61
  - Water quality (median, 78 stations):
    - Phosphorus: marsh= 0 $mg \cdot L^{-1}$, canals= 0 $mg \cdot L^{-1}$
    - Chloride: marsh= 8 $mg \cdot L^{-1}$, canals= 13 $mg \cdot L^{-1}$
    - Sulfate:  marsh= 0 $mg \cdot L^{-1}$, canals= -2 $mg \cdot L^{-1}$
  - Other ecological metrics
    - Range of analyses at multiple scales (cattail, soil accretion, …)
- Summer/fall 2015: undergoing **major upgrade** to ELM v3.0
  - Assimilate multiple sources of new research & monitoring data
  - Extend historical Period of Simulation to 1981 – 2012

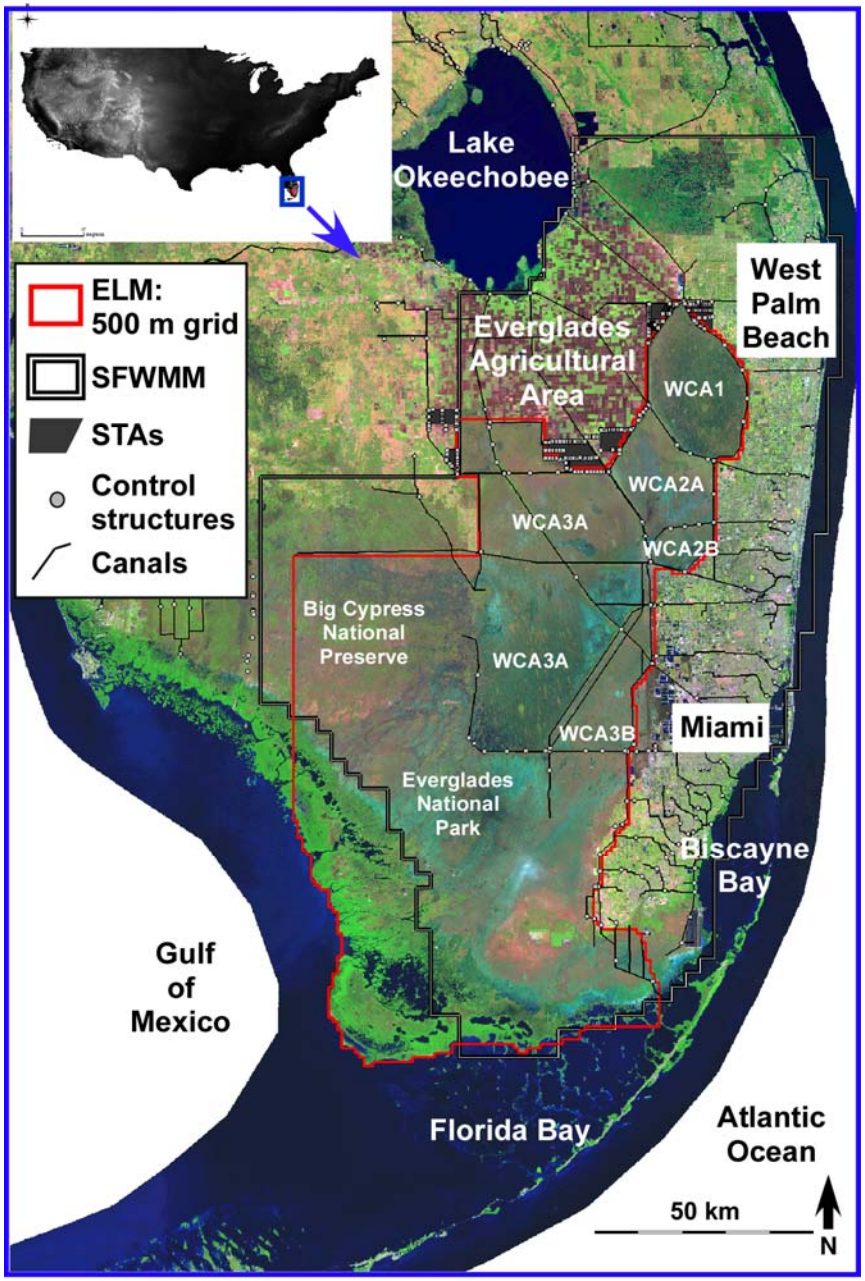
# ELM review

- **National Research Council (2006, 2008, 2010)**
  - **Stressed overall need for integrated hydrologic, ecological, & water quality models for CERP evaluations**
- **Mitsch, Band, & Cerco (2007) – internationally-recognized panel, review of ELM for application to CERP**
  - **Model is "...*robust and will produce a unique contribution, with an integrated ecosystem paradigm, to understand and predict potential outcomes of Everglades restoration projects*..."**
- **CERP Interagency Modeling Center review of ELM (2008)**
  - **"... *IMC suggests using ELM as the primary water quality model...*" for DECOMP**
  - **ELM is Open Source, w/ comprehensive, hierarchical documentation**
  - **Peer-reviewed manuscripts in journals, books**

# *ELM application:*

## Synthesis of Everglades Research and Ecosystem Services (SERES) Project


**ELM: Relative comparisons of hydro-ecological responses to Everglades restoration scenarios**

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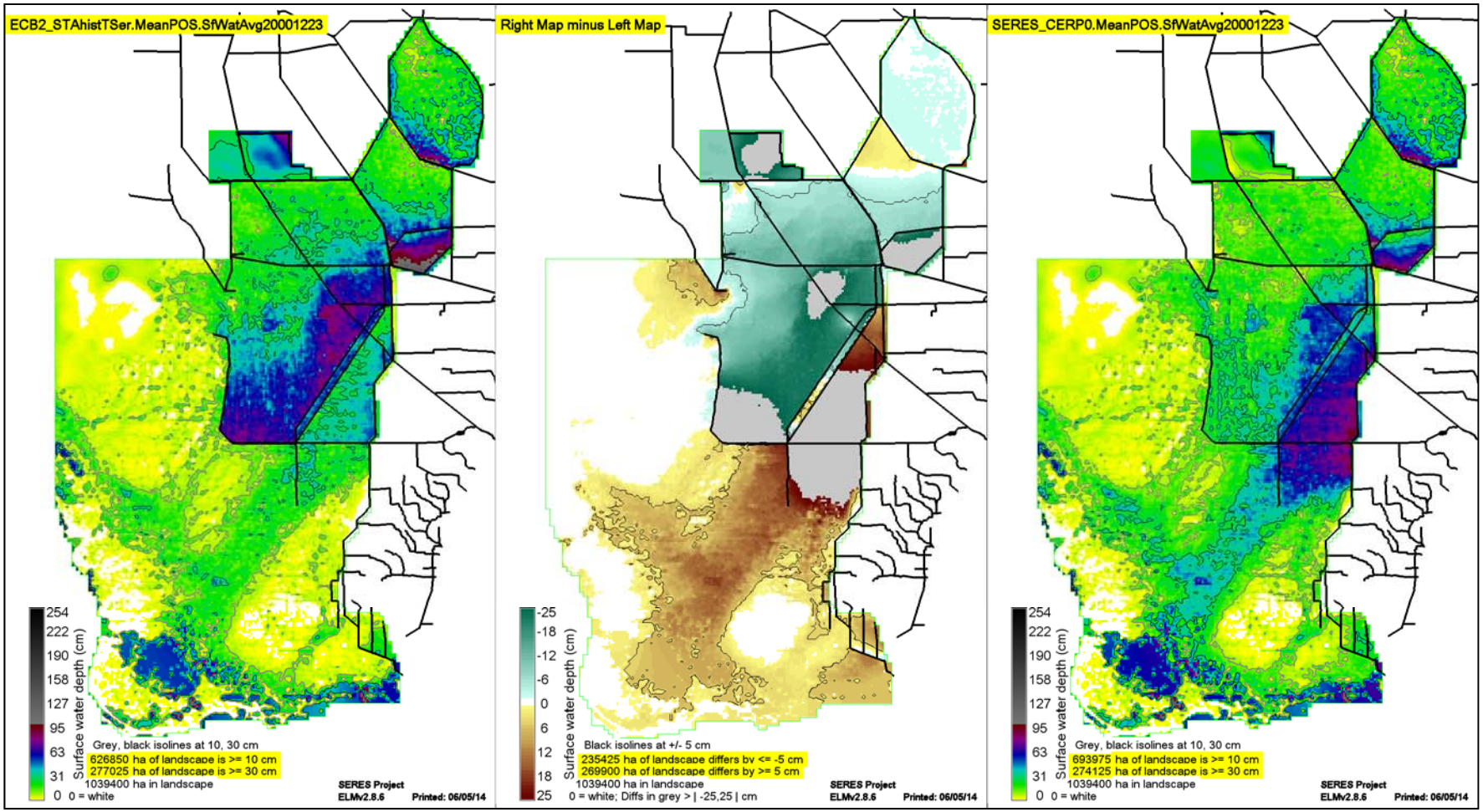
# ELM application for SERES Project

- **Compare ECBase, CERP0, and 3 other scenarios of varying levels of storage and decomp relative to CERP0**
- **Water management**
  - **SFWMM v6.0 (~10 km$^2$ grid) applied water management rules to distribute water (T. Van Lent, Everglades Foundation)**
  - **ELM v2.8.6 (0.25 km$^2$ grid) was driven by SFWMM (point) water control structure flows, and then simulating landscape/canal flows of water and phosphorus**
- **Hydro-Ecological Performance Measures**
  - **Spatio-temporal: Greater Everglades; Summaries of (36-yr)Period-Of-Simulation, and wet/dry/avg rainfall year snapshots**
  - **Soils: peat accretion, soil P accumulation, soil P conc. (used to drive periphyton model (PERIMOD – E. Gaiser))**
  - **Water quality: surface water P conc. (sulfate not used)**
  - **Plants (unused): macrophyte & periphyton biomass & succession**
  - **Hydrology (unused): surface water depths & velocities**

# SERES Example Performance Measure: Surface water depth

**Base** **CERP0 – Base** **CERP0**

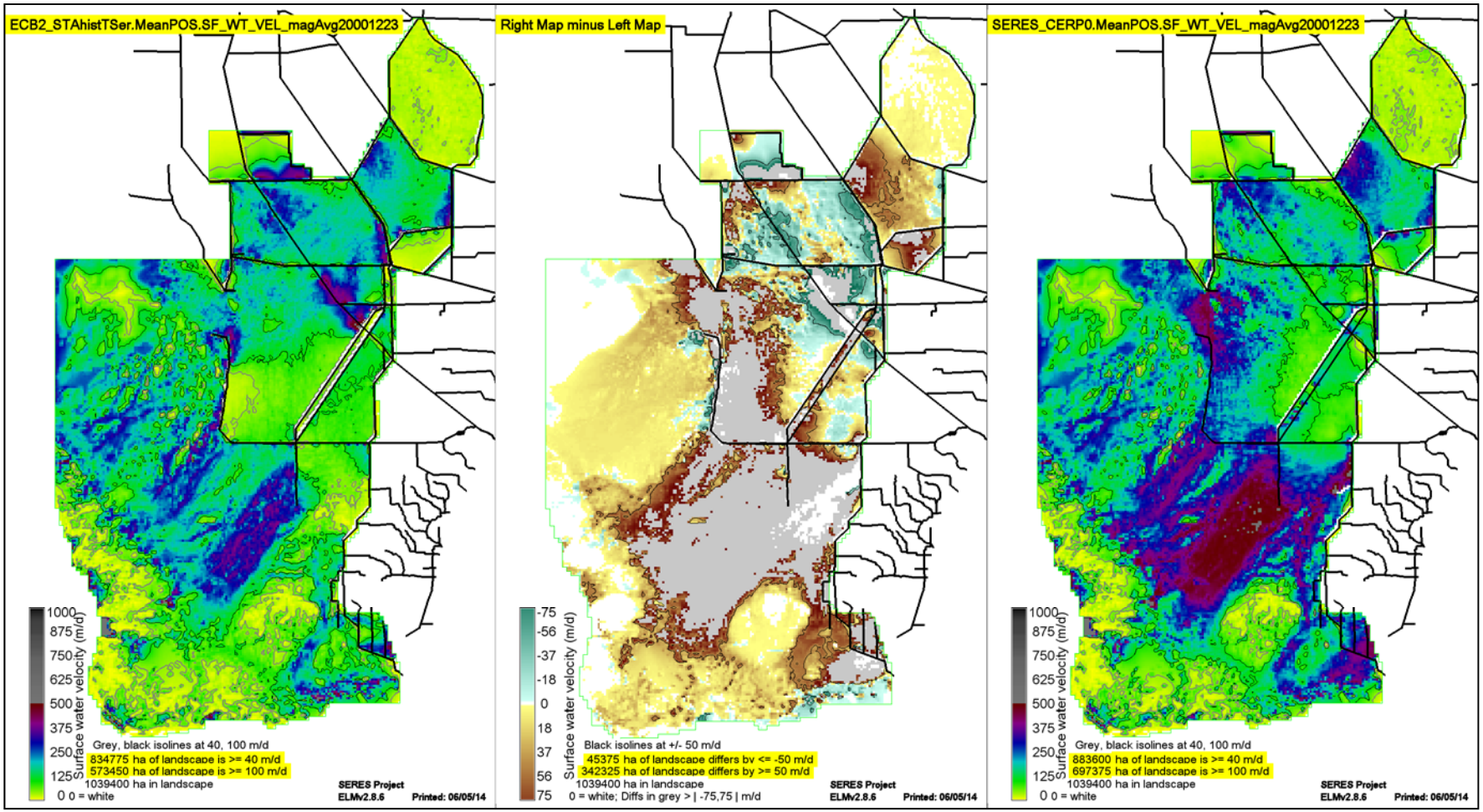



**Green/Blue Difference =**

**CERP0 lower depth than Base**

# SERES Example Performance Measure: Surface water flow velocity

**Base** **CERP0 – Base** **CERP0**

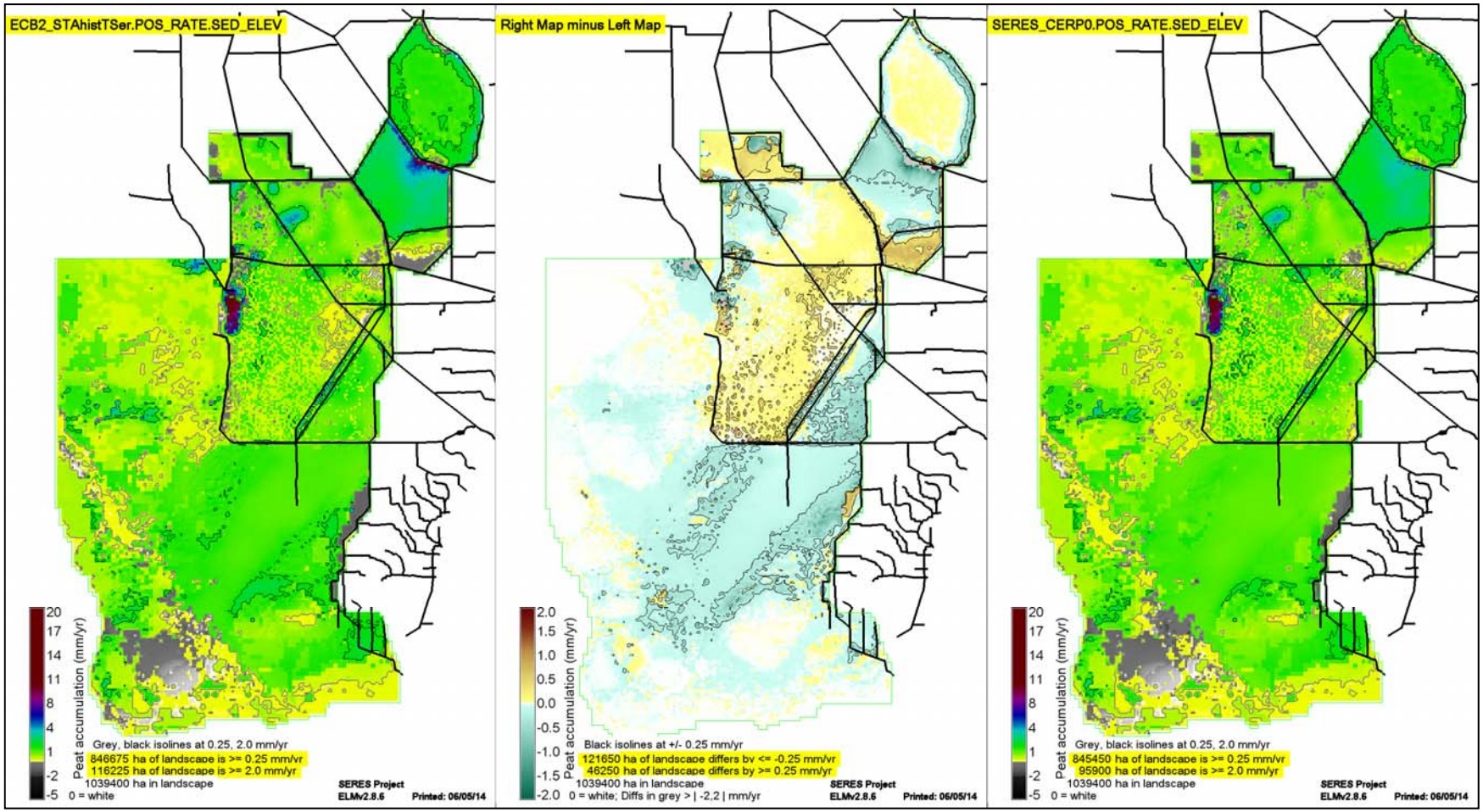



**Green/Blue Difference =**

**CERP0 lower velocity than Base**

# SERES Example Performance Measure: Peat accretion rate

**Base** **CERP0 – Base** **CERP0**

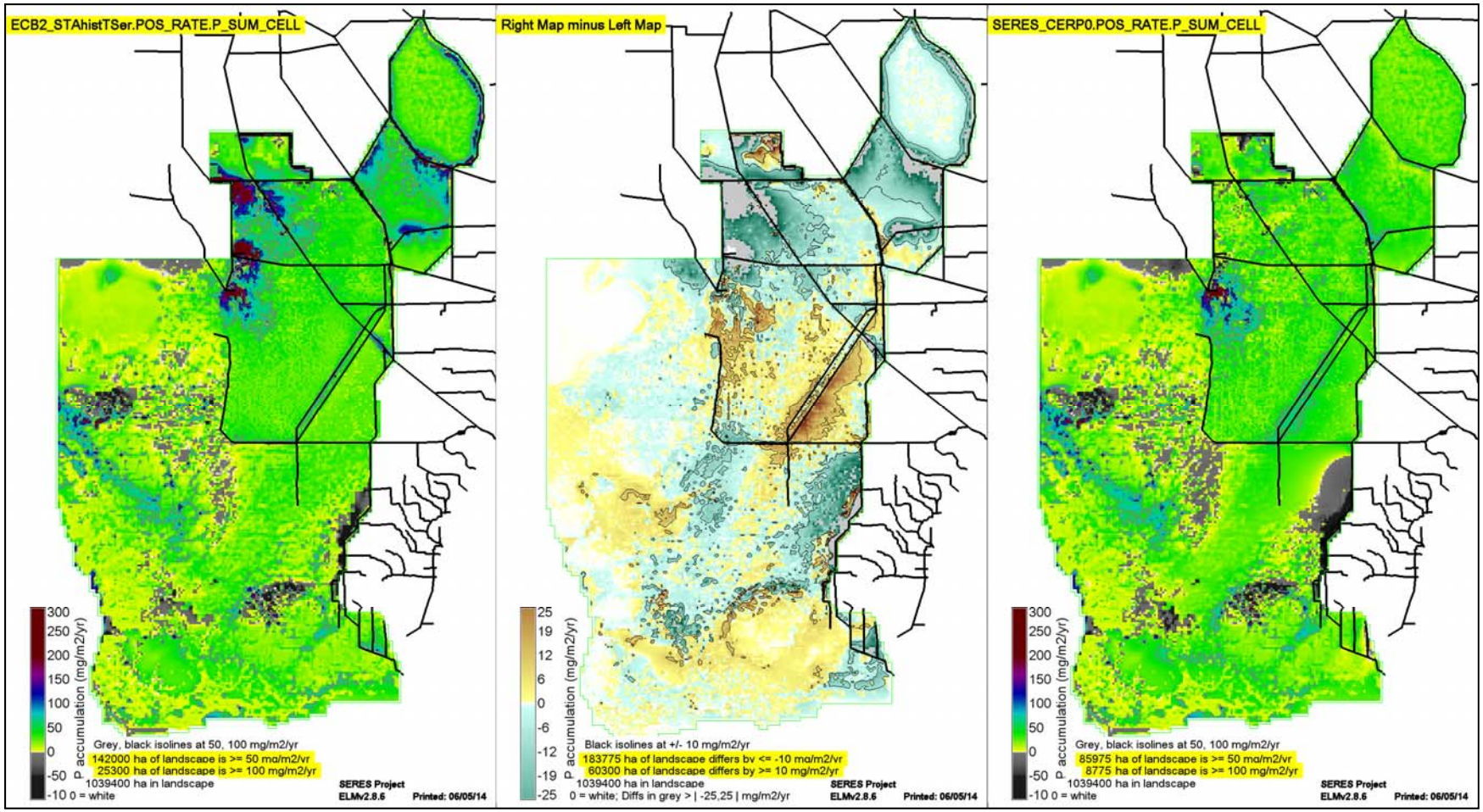



**Green/Blue Difference =**

**CERP0 lower peat accretion than Base**

# SERES Example Performance Measure:
# P accumulation rate

**Base** **CERP0 – Base** **CERP0**

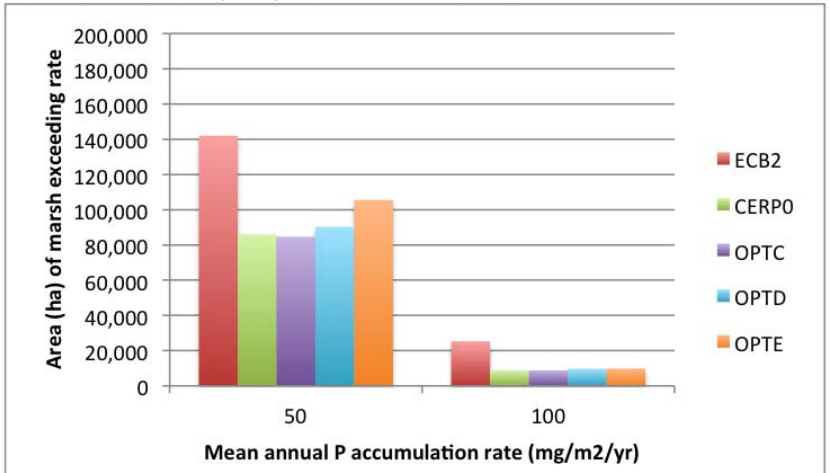



**Green/Blue Difference =**

**CERP0 lower P accumulation than Base**

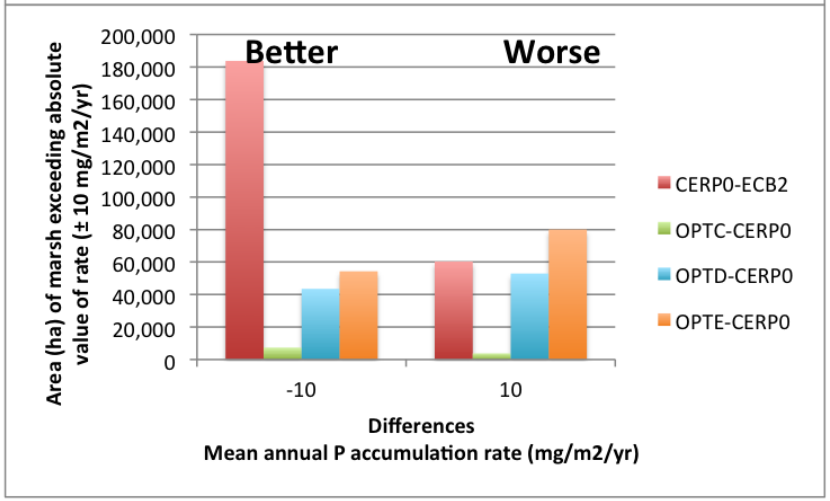
# SERES Example Performance Measure Summary: P accumulation rate

**Simulated P accumulation rate** in the SERES regional domain of ELM.
Period of Simulation (POS) mean rate. The total domain area is 1,039,400 ha.




For each scenario,
shows area of marsh that exceeds two selected eutrophication criterea values.

*Note that the areas summed here do not necessariy reflect direct spatial differences among simulations, whereas the below summaries of difference maps reflect direct cell-cell comparisons between each scenario.*

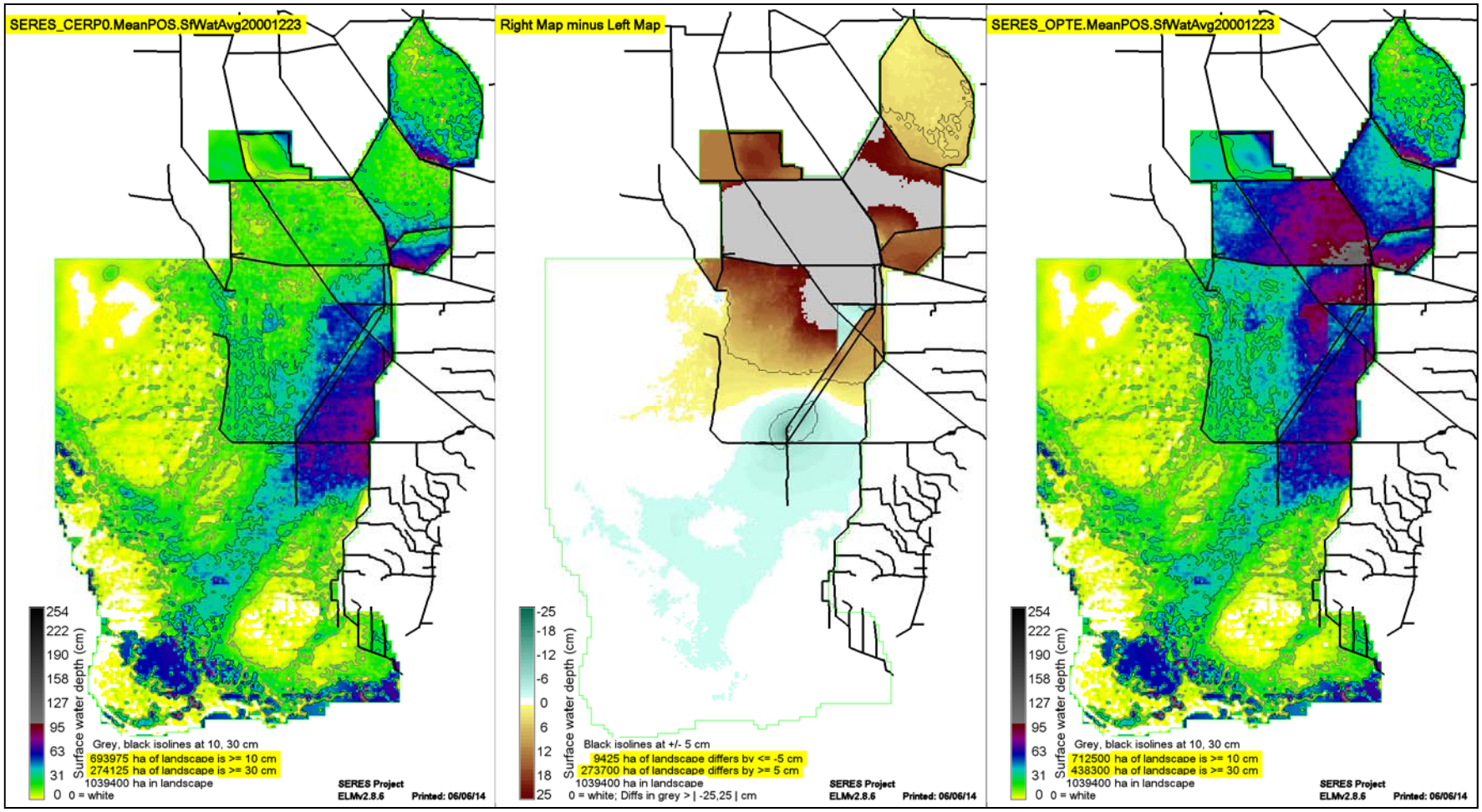



For each scenario,
shows area of marsh that has a lower (neg difference) rate relative to ECB or CERP0, and area of marsh that has a higher (pos difference) rate relative to ECB or CERP0.

*Note that the difference criteria are not related to the eutrophication criterea above, and may reflect differences between simulations that have rates less than the eutrophication criterea value(s).*

# SERES Example Performance Measure: Surface water depth

**CERP0** **OPTE – CERP0** **OPTE**

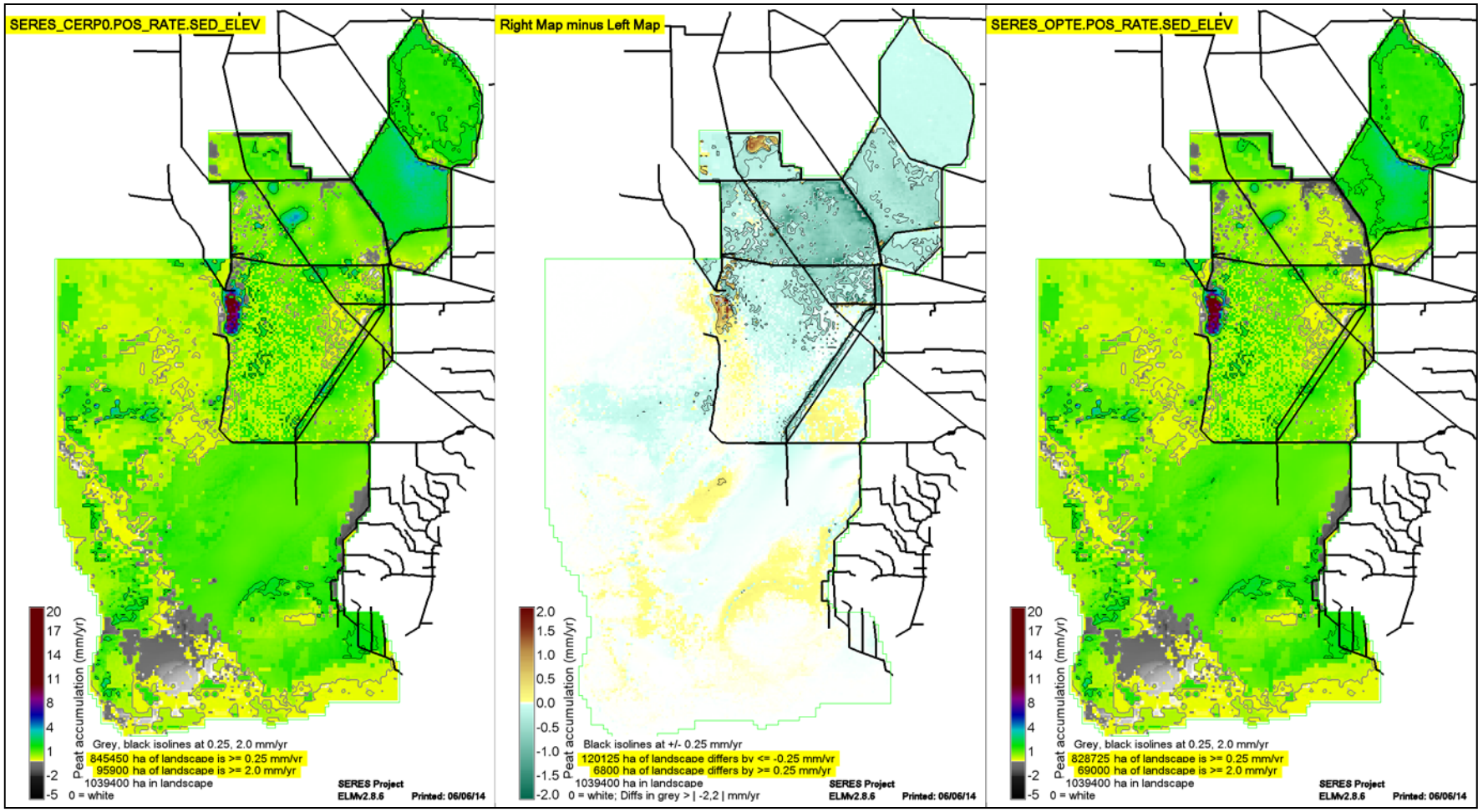



**Green/Blue Difference =**

**OPTE lower depth than CERP0**

# SERES Example Performance Measure: Peat accretion rate

**CERP0** **OPTE – CERP0** **OPTE**

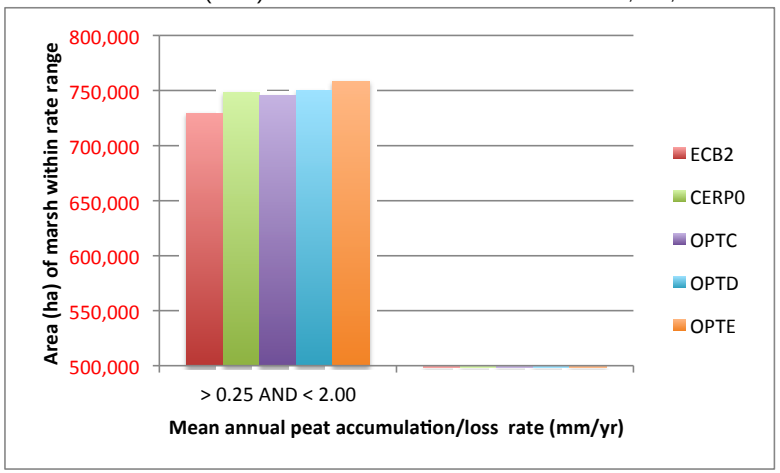



**Green/Blue Difference =**

**OPTE lower peat accretion than CERP0**

# SERES Example Performance Measure Summary: Peat accretion rate

**Simulated peat accumulation/loss rate** in the SERES regional domain of ELM. Period of Simulation (POS) mean rate. The total domain area is 1,039,400 ha.




For each scenario, shows area of marsh that has peat accumulation rates falling between the targeted lower and upper values.

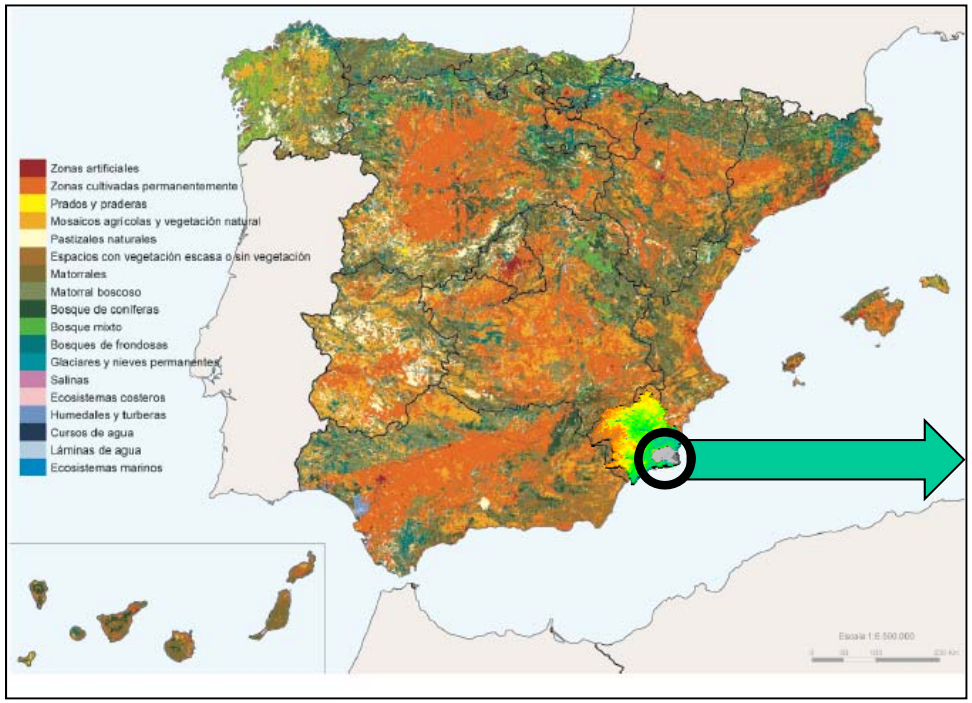
*Note that the areas summed here do not necessariy reflect direct spatial differences among simulations, whereas the below summaries of difference maps reflect direct cell-cell comparisons between each scenario.*

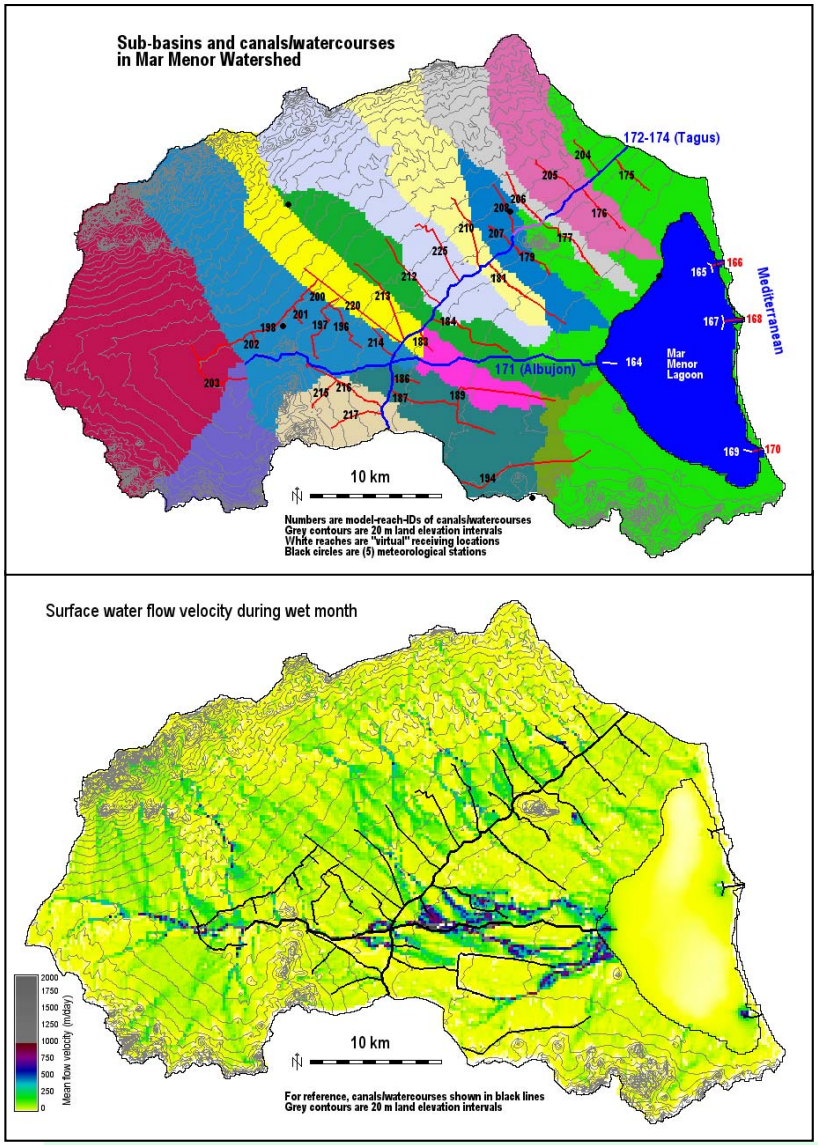
# SERES OPTions of increased storage and decomp:

- **All restoration OPTions generally showed overall improvements relative to the ECB for soil and other ecosystem metrics…**
- **… with important spatial variability.**
- **Evaluations by multi-disciplinary team revealed the desirability of increased levels of feasible storage options.**

# *EcoLandMod application:*

## Mar Menor watershed, southeast Spain: Social drivers of sustainable water resources

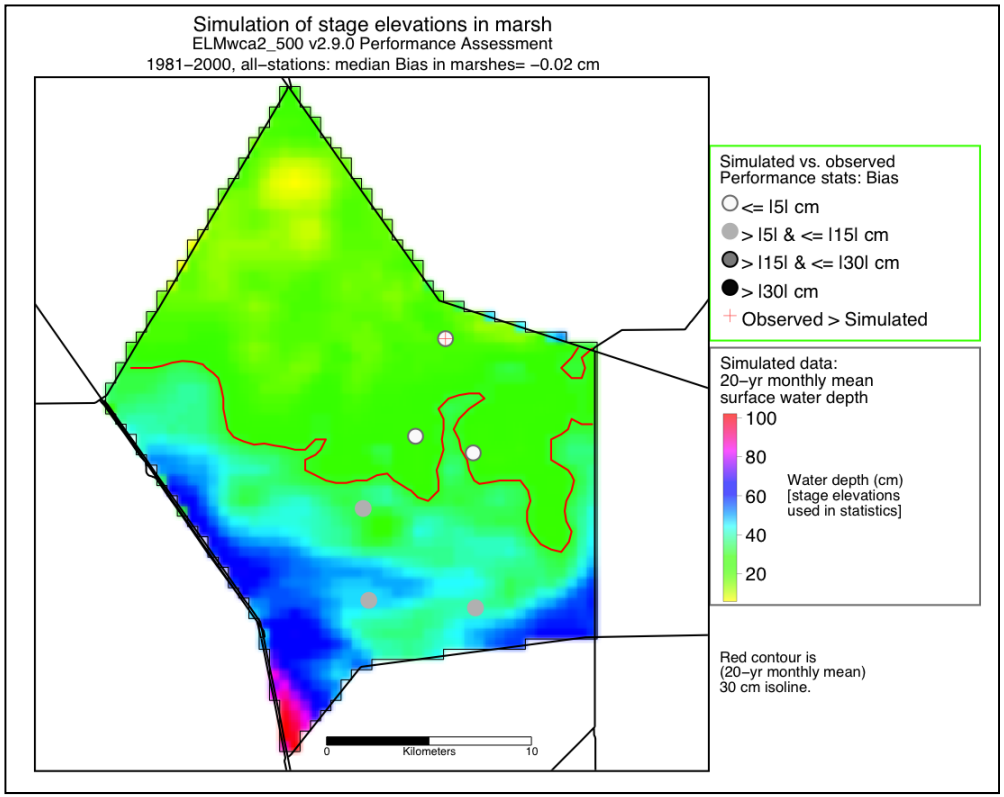



*(with Noelia Guiata, Universidad de Alcalá)*

# *ELM application:*

## Incorporating Wading Bird Habitat Suitability into the Everglades Landscape Model (ELM): a Proof-of-Concept Exercise using Water Management Scenarios in WCA2A

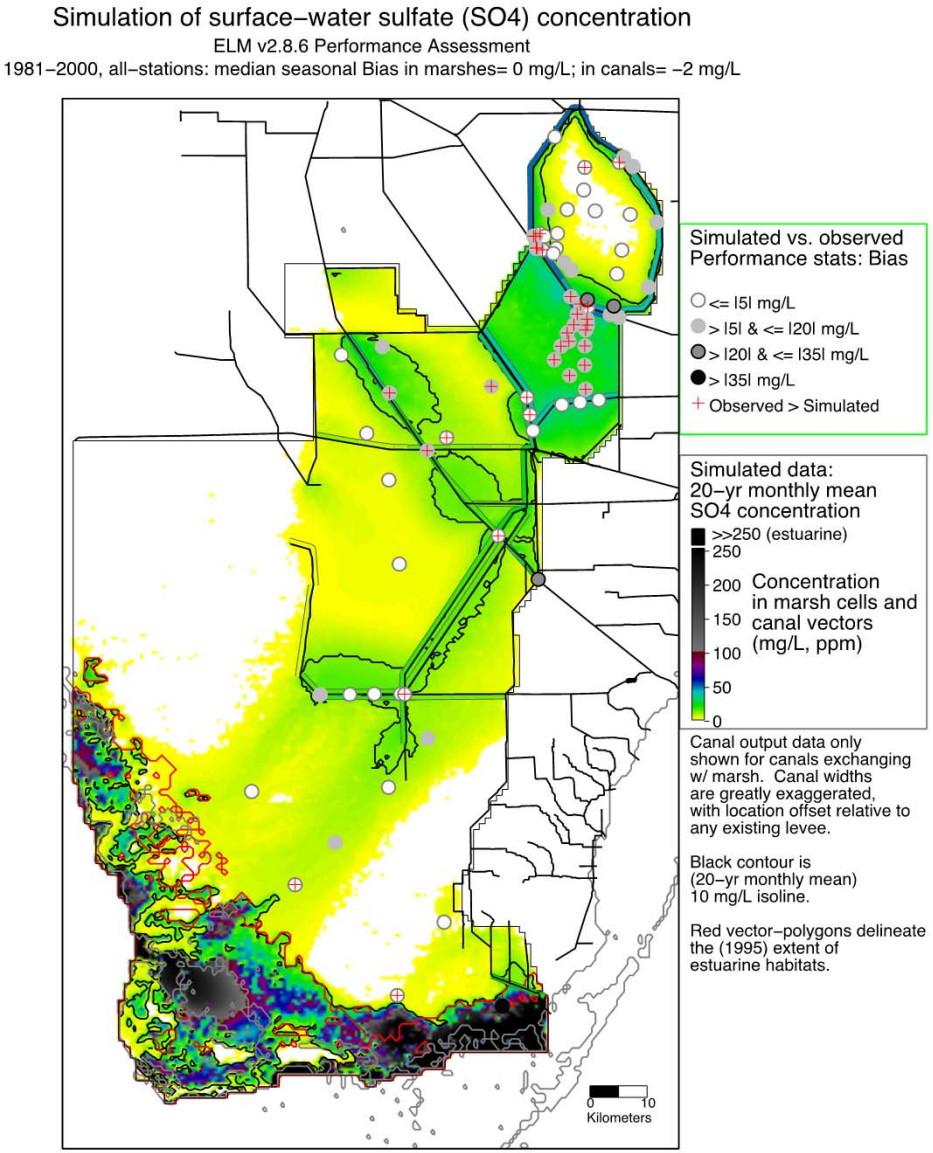



*(with Sue Newman, Mark Cook, Colin Saunders, Fred Sklar, Christa Zweig, Michael Manna, et al., SFWMD)*

# *ELM application:*

## Modeling Sulfur Reductions to the Everglades Using Applications of the Everglades Landscape Model

***(with Bill Orem, Matthew Varonka, David Krabbenhoft, et al., USGS)***

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## *ELM application:*

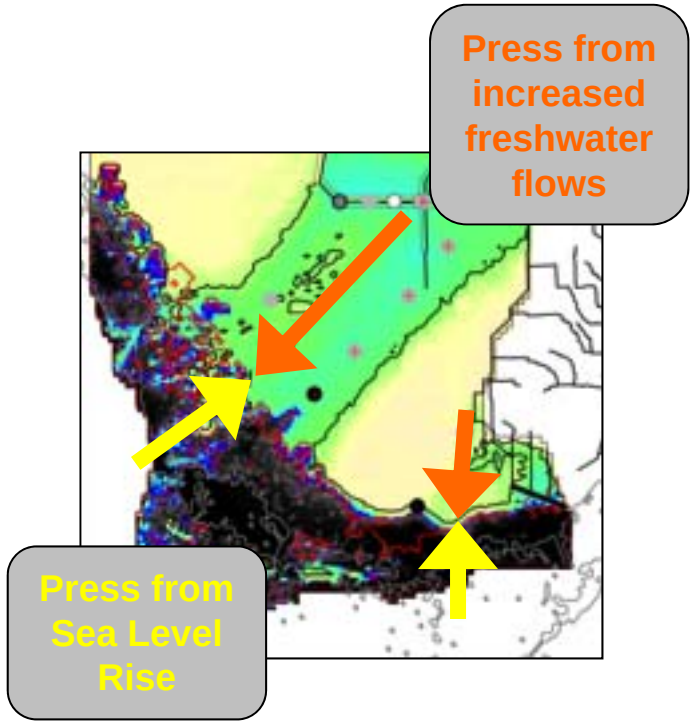
**Florida Coastal Everglades LTER:**

**Hydro-ecological responses to**

**-- increased freshwater flows**

**-- & Sea Level Rise**

***(with Mark Rains, USF, and many others in FCE LTER)***




**Simulated chloride concentrations**