

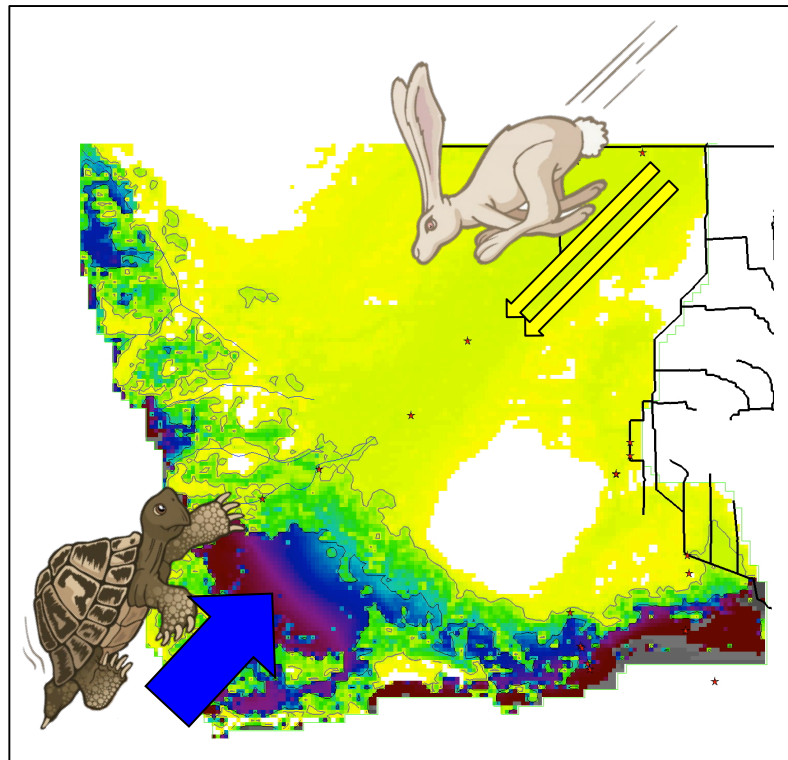
Tortoise or Hare? Landscape Hydro-Ecological Interactions From Presses (Sea Level Rise) and Pulses (Freshwater flows) In the Coastal Everglades



GEER 2019

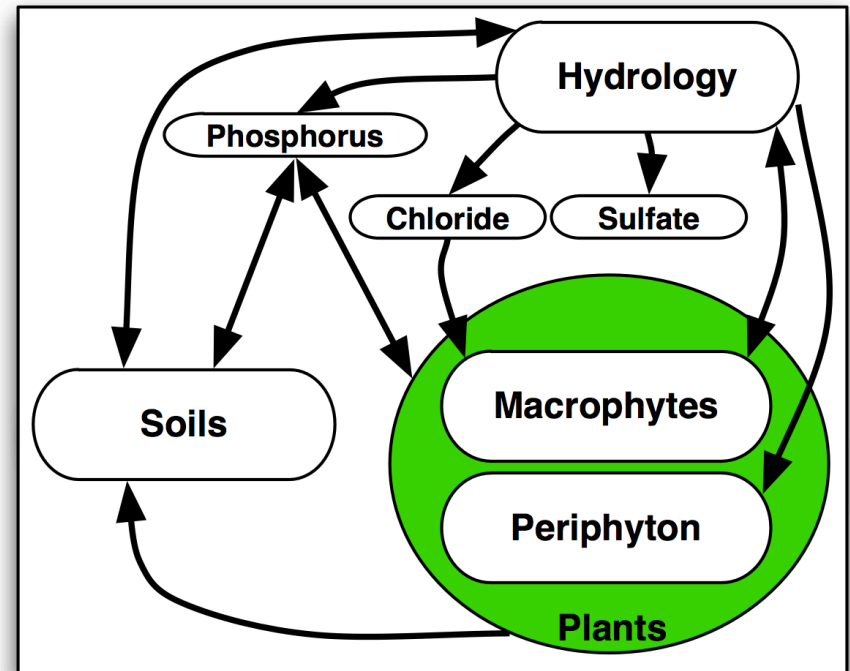
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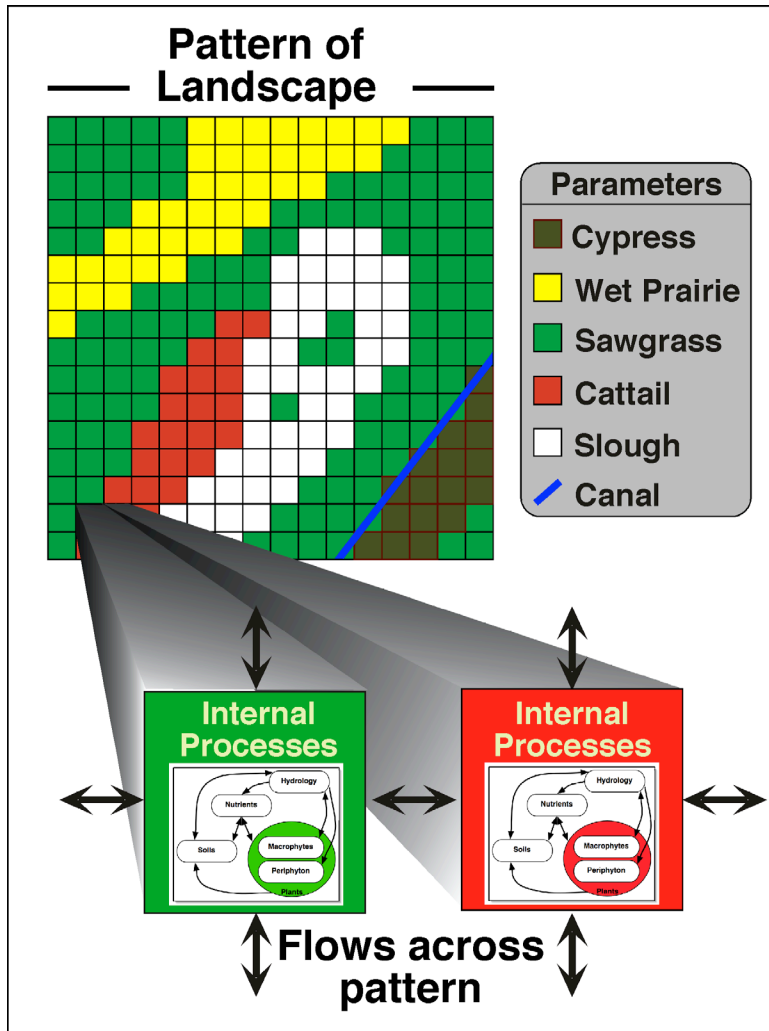


ELM Design: Integrating ecological interactions

- 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/rivers represented by exact vectors, dynamic **canal/river-marsh** interactions; managed flows at point water **control structures**
- Integrated **surface-ground water** exchanges

ELM skill, refinement

- **Peer reviews** over past 20+ years
 - Research journals: (Ecol Model; Restor Ecol; Crit Rev Env Sci Tec; Sust Water Qual Ecol; ...)
 - CERP-application review panels: (Mitsch et al. Independent Panel; CERP Interagency Modeling Center Panel; USACE certification)
- **Updating-refining to new ELM v3.0** (work in progress)
 - Extending Period-Of-Simulation (was thru 2000, now 2005, soon 2015)
 - Assimilating multiple new/refined data sources (esp. coastal glades)
 - Maps: Habitats, soils, coastal river/creek topology, ...
 - FCE/other monitoring (e.g., salinity, TP, depth, ...)
 - FCE/other research (e.g., soil processes, macrophytes/diatoms/periphyton, net ecosystem production, ...)
- **Skill assessment** updates - run ELM-standard stats
 - Have improved model skill in coastal/tidal regions, ongoing ...
 - 1-year target for most improvements for formal update(s)

This application:

- Compare landscape responses among 36-yr scenarios of **restoration flows** and Sea Level Rise (**SLR**) combos
- Scenario games bookends
 - § **CERP0_std** is Scenario Base, restoration flows standard
 - § **CERP0_SLR:** **Annual SLR = 2 cm/yr** applied to CERP0 coastal boundary; no management change/response
 - § **CERP0_SLR_2xflow:** **Annual SLR = 2 cm/yr** applied to CERP0 coastal boundary; **~2x CERP0 structure flows** to southern glades
- Simulating water management & ecology
 - § **SFWMM** managed flows (CERP0 from Everglades Foundation)
 - § **ELM** driven by SFWMM (point) water control structures, then simulates finer scale hydrology and ecological dynamics
- Hydro-ecological Performance Measures
 - § **Water** depths & flow velocities
 - § **Floc P & surface water chloride** concentrations
 - § **Soil** processes
 - § **Succession** among habitats (& diatom communities; see Mazzei)

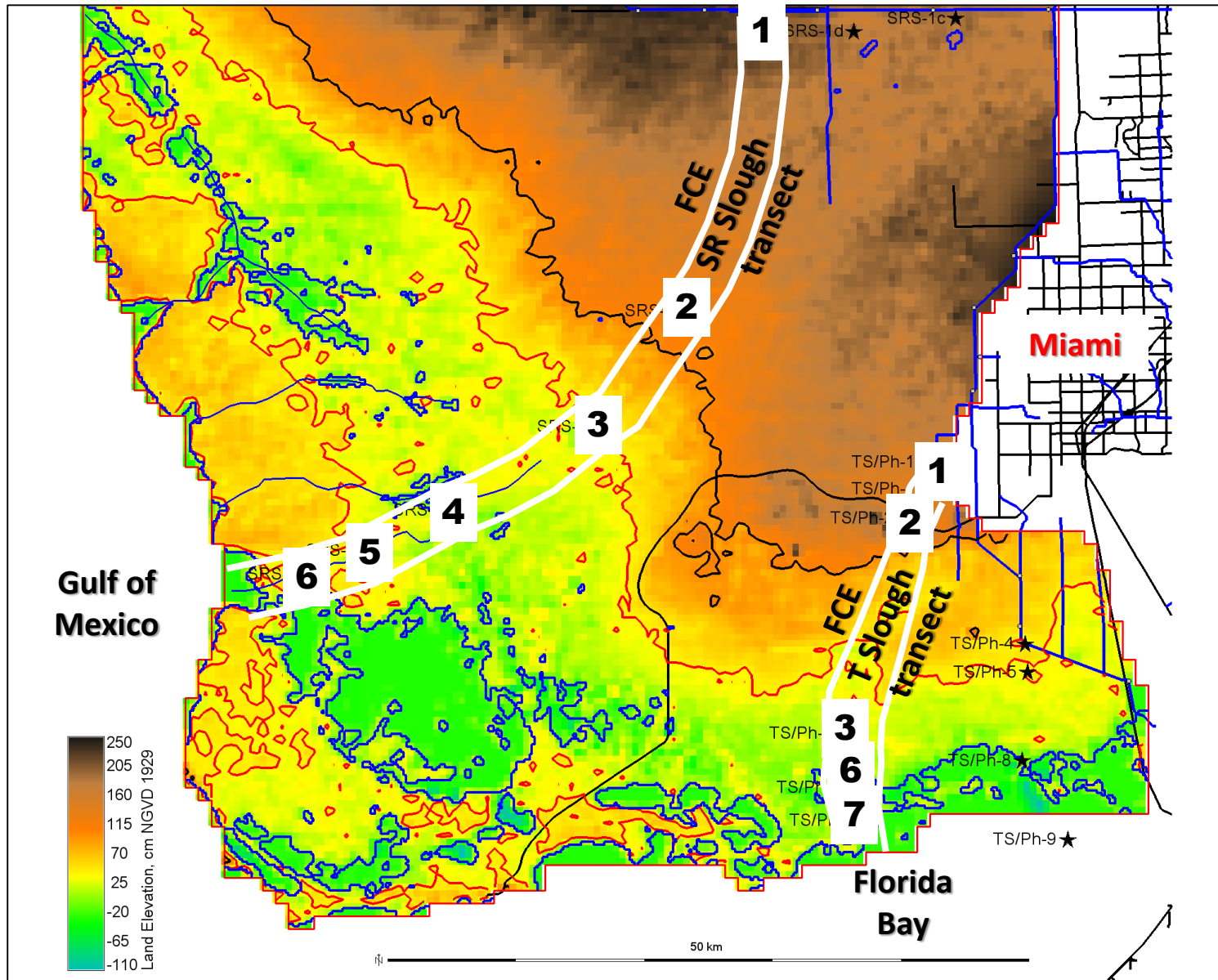
Water budgets

- Showing total (rain, gwater, seepage, overland, structure) inflows into freshwater component of ENP increased by ~1.2X under CERP0_SLR_2xflow vs. CERP0_SLR

Water budget inflows and outflows for selected basins, in units of annual mean flows per basin (thousands of acre-feet). **Future scenarios assume climate stationarity, repeat the 1965-2000 climate years.**




	569.2 km ² WCA1	429.0 km ² WCA2A	1977.8 km ² WCA3A	2976 km ² 3Basins	2976 km ² Net 3Basins	2344.5 km ² ENP_fresh
CERP0_IN	1,095	1,688	4,317	7100.2		7,050
CERP0_OUT	1,094	1,688	4,314	7096.7	3.5	6,923
CERP0_SLR_IN	1,095	1,688	4,317	7100.0		7,137
CERP0_SLR_OUT	1,094	1,688	4,314	7096.5	3.5	6,841
CERP0_SLR_2xflow_IN	1,093	1,902	5,195	8189.3		8,662
CERP0_SLR_2xflow_OUT	1,090	1,894	5,185	8168.7	20.7	8,178

Everglades National Park (model subdomain)

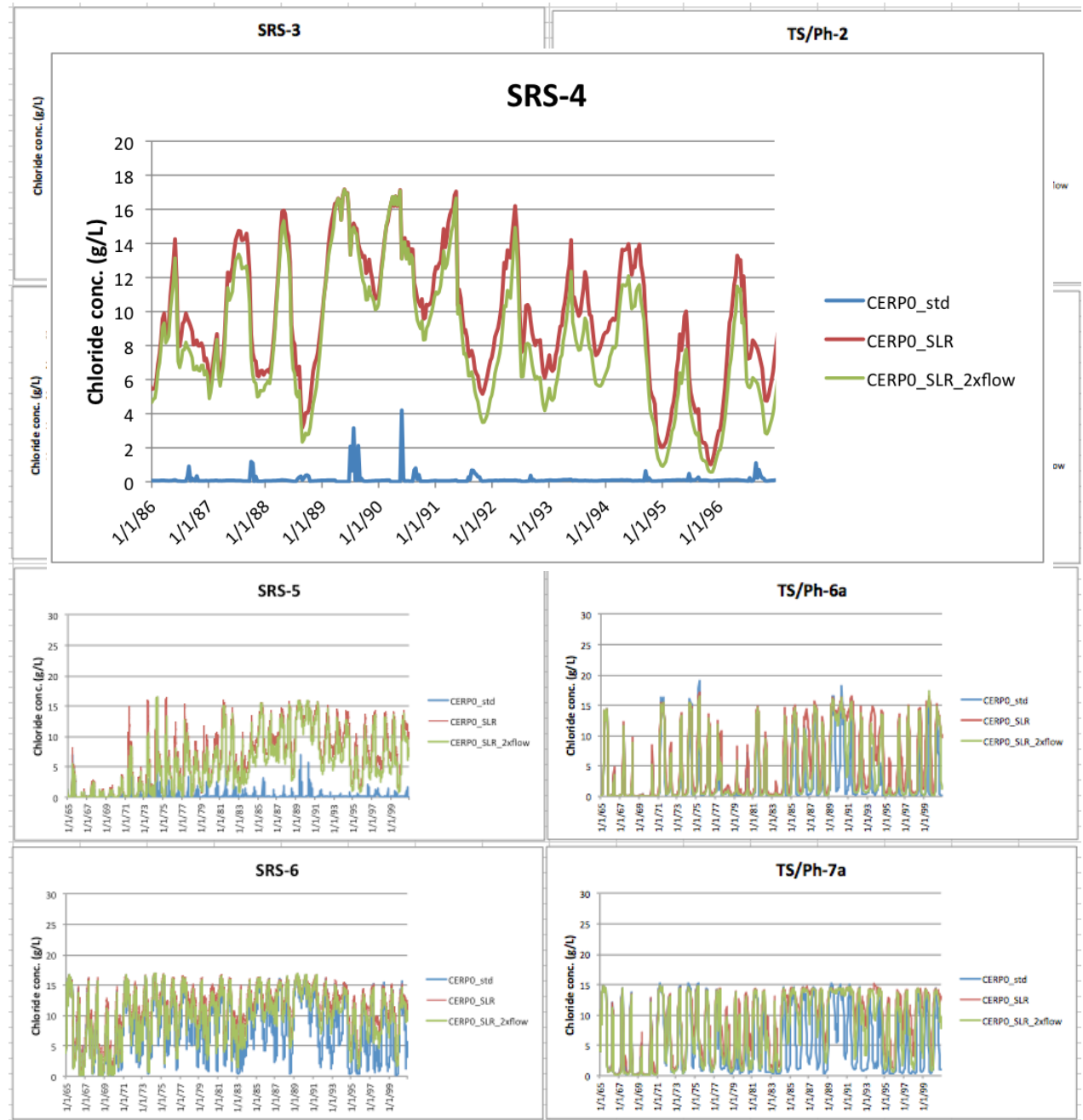


Freshwater
Flows

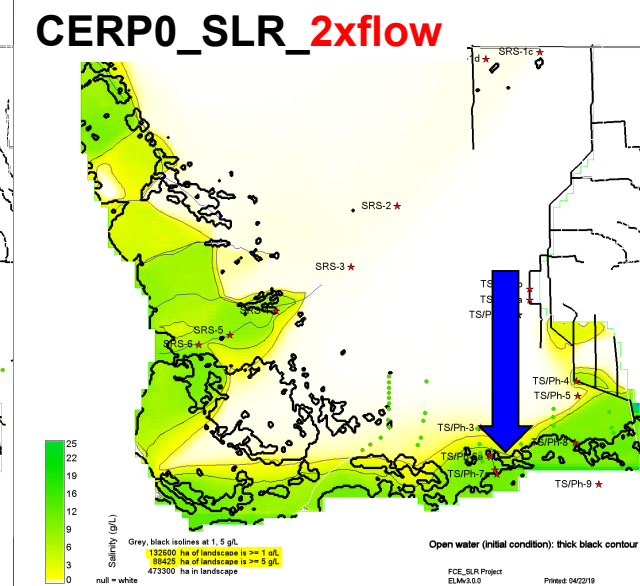
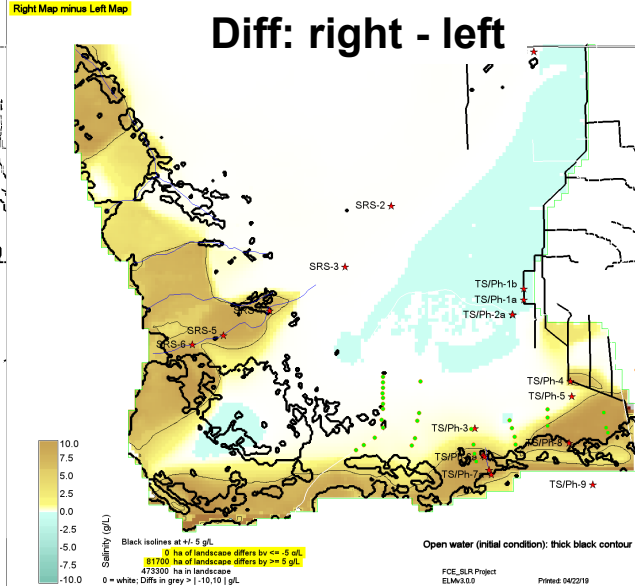
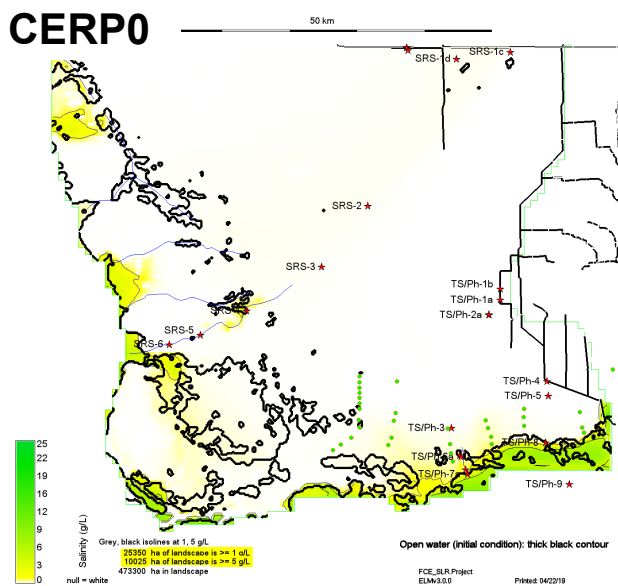
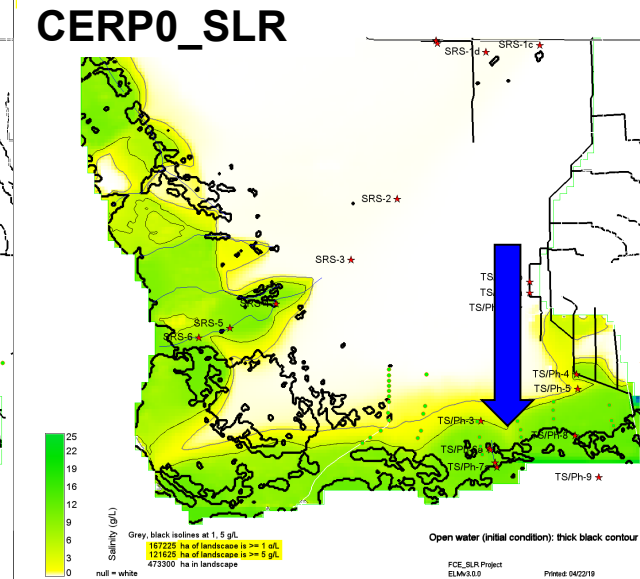
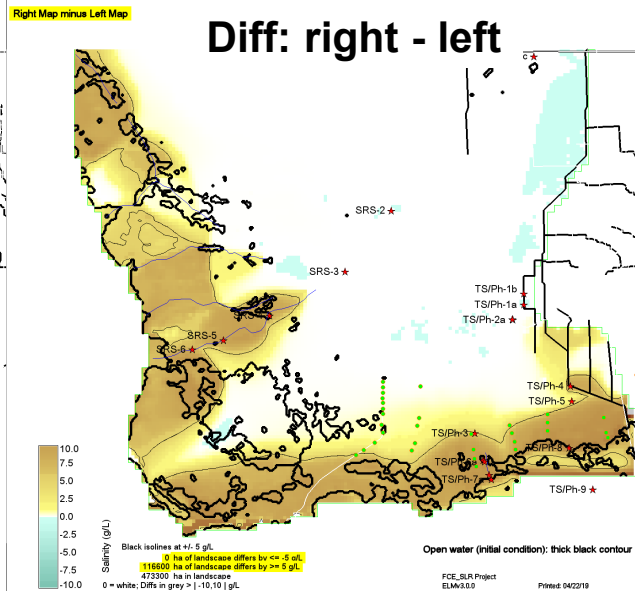
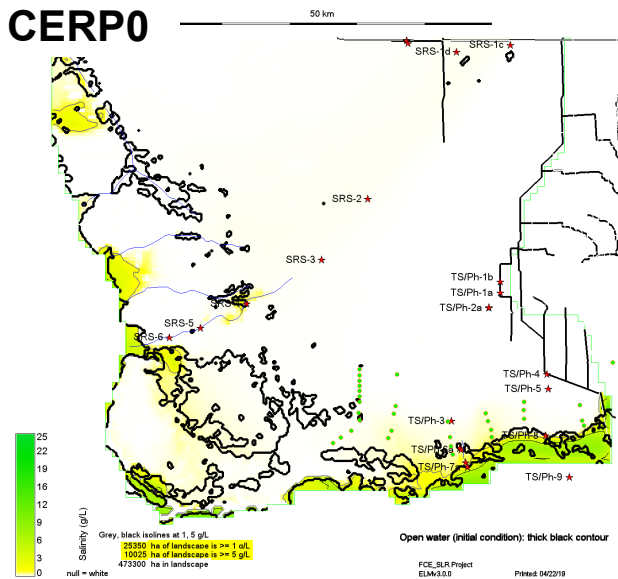
Surface water
chloride, 36yr:

CERPO_std; 
CERPO_SLR; 
CERPO_SLR_2xflow 

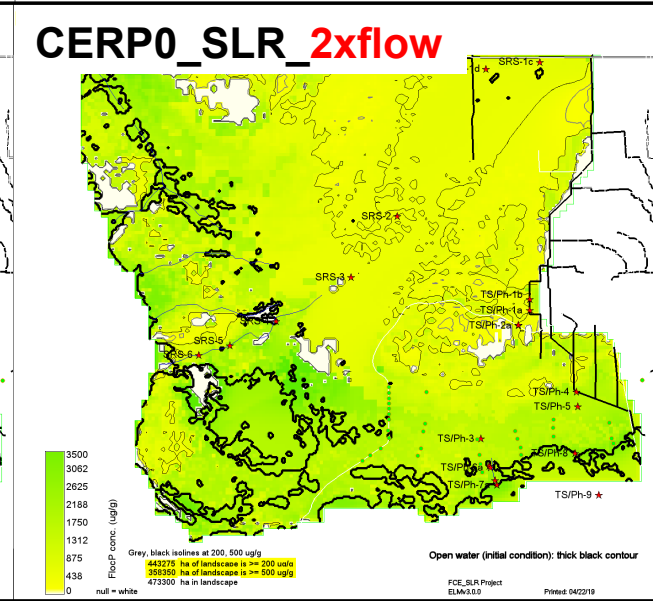
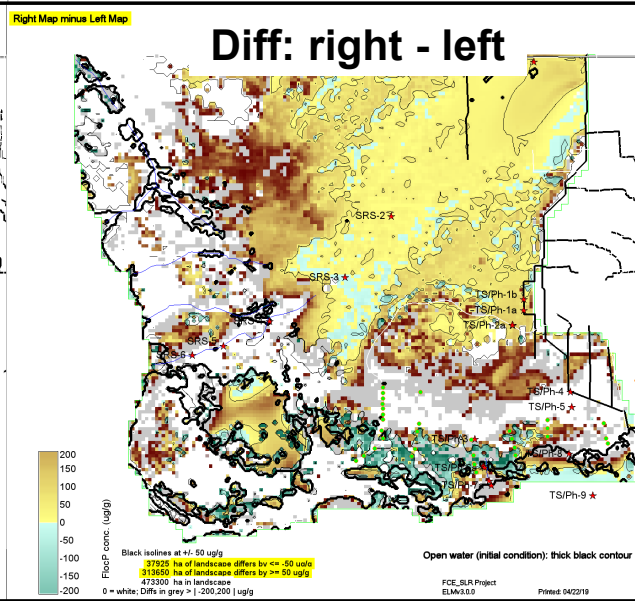
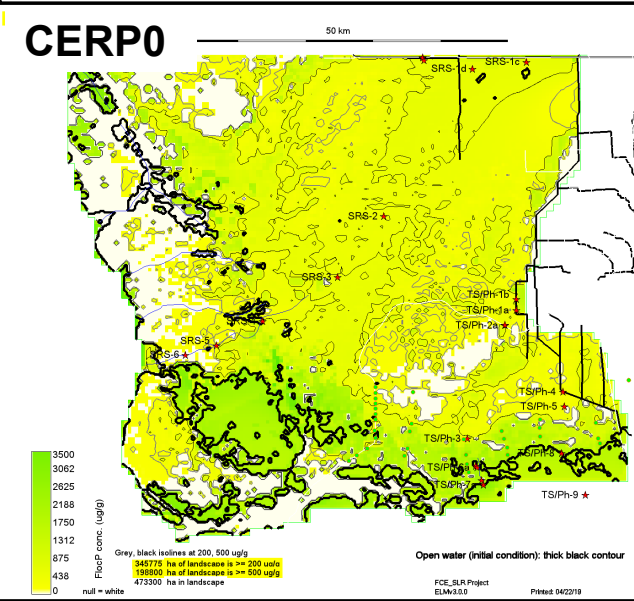
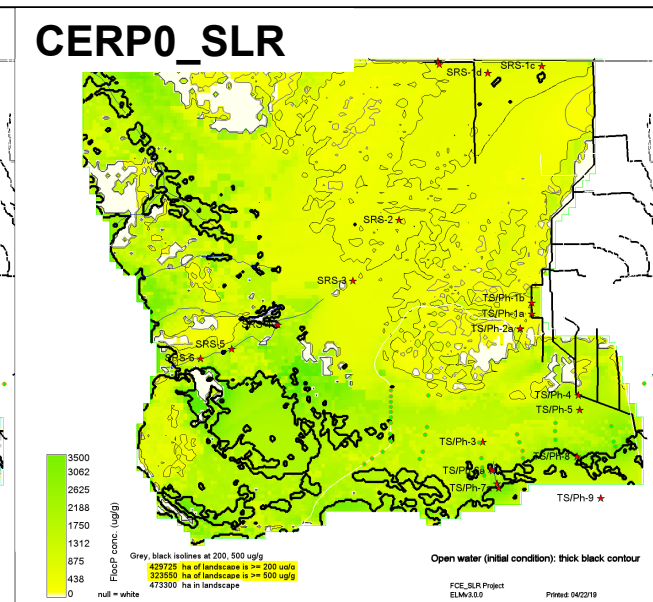
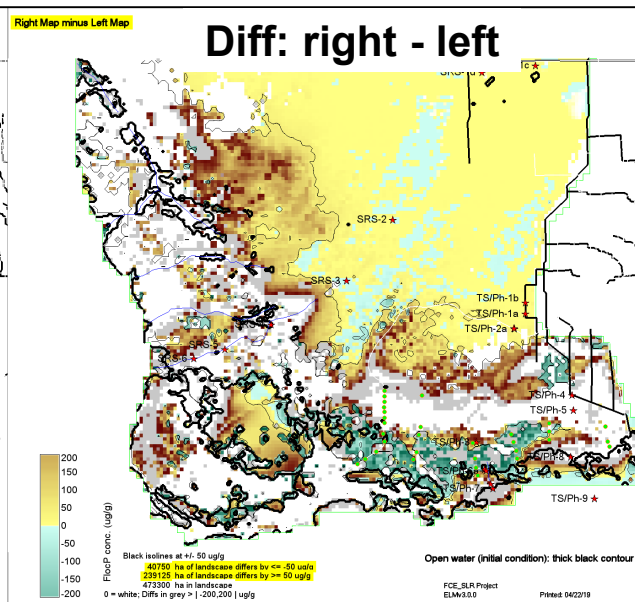
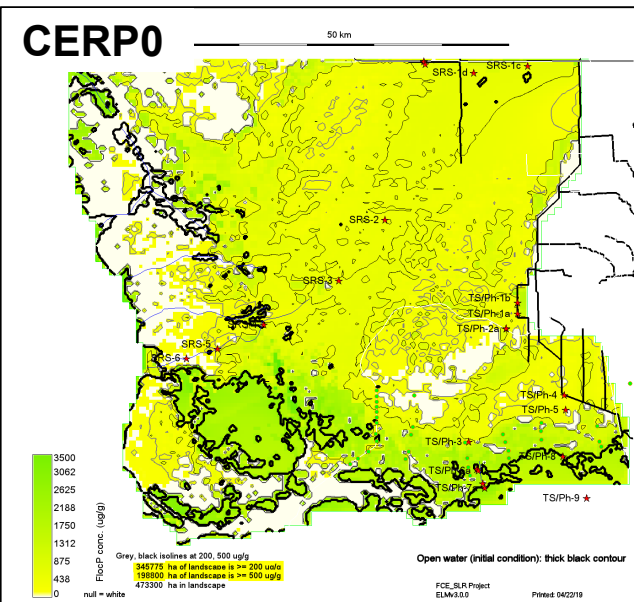
Coastal
Tidal



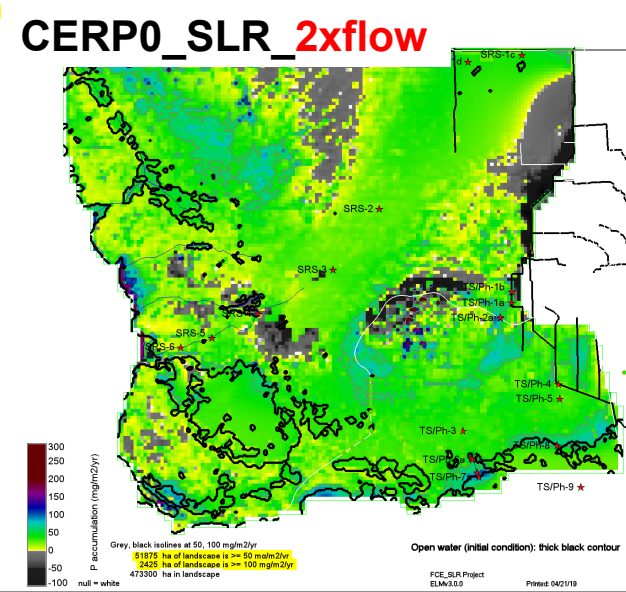
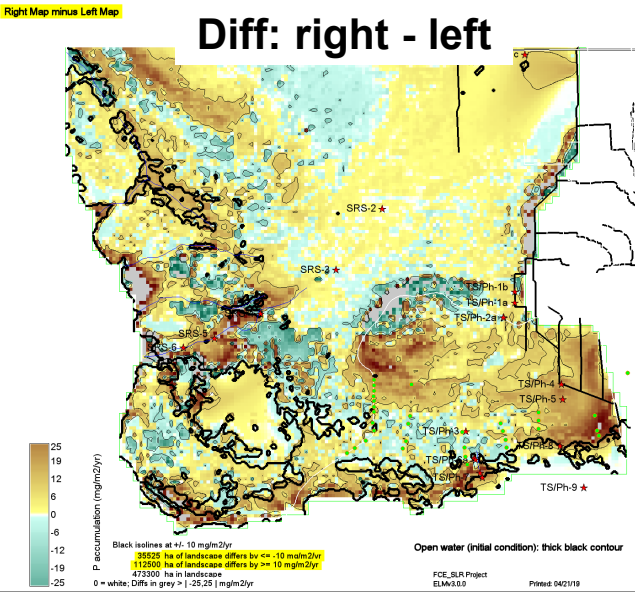
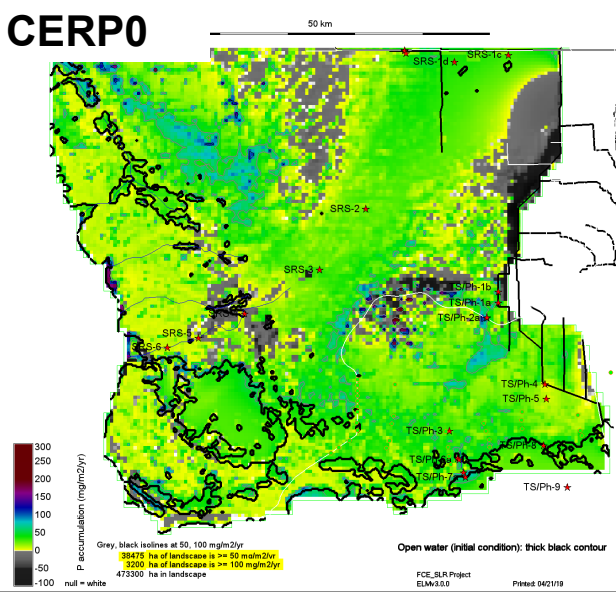
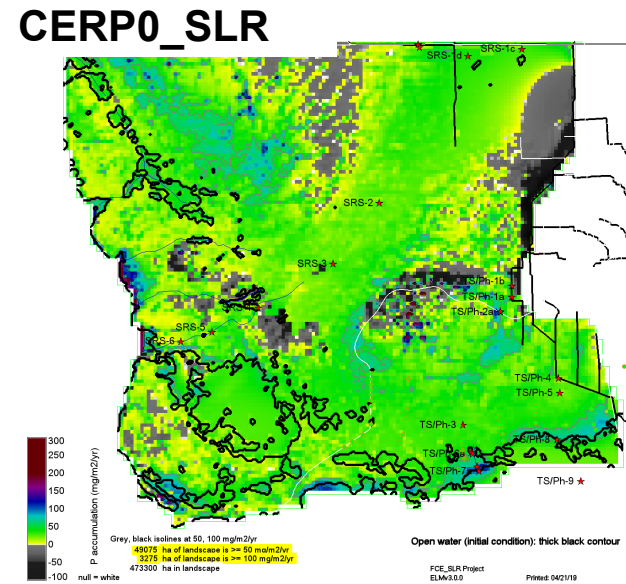
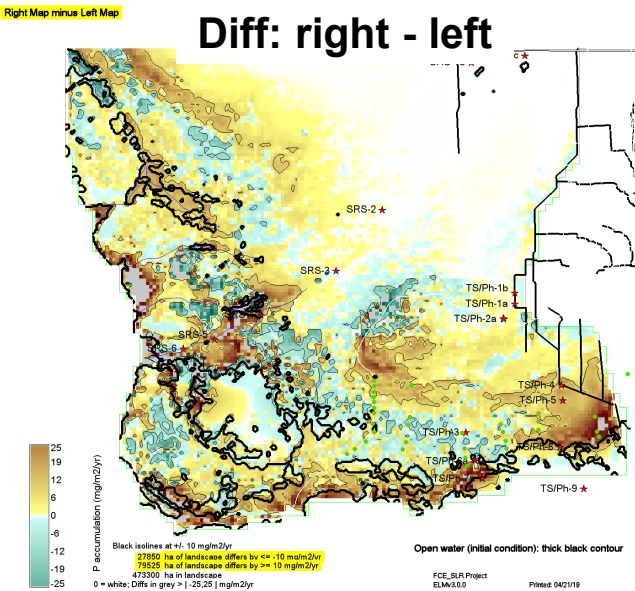
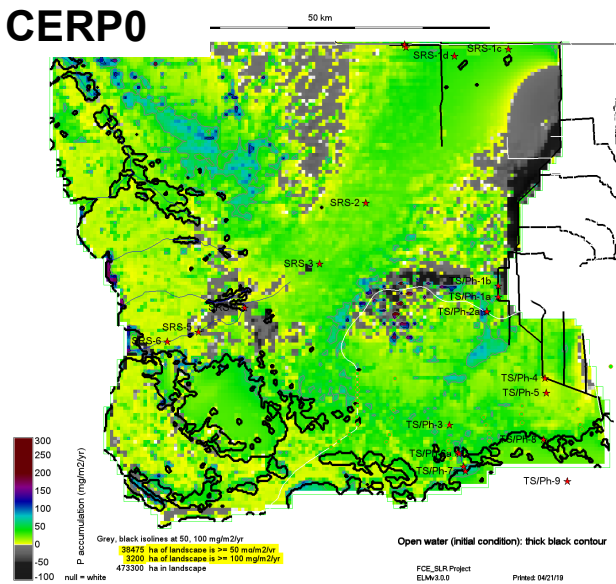
Surface water chloride – end of wet season, last year of sim



Floc P concentration – end of wet season, last year of sim

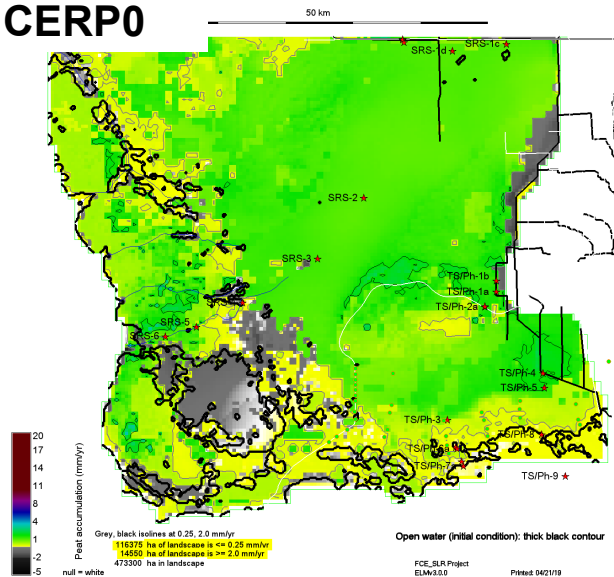


P accumulation – Period of Simulation



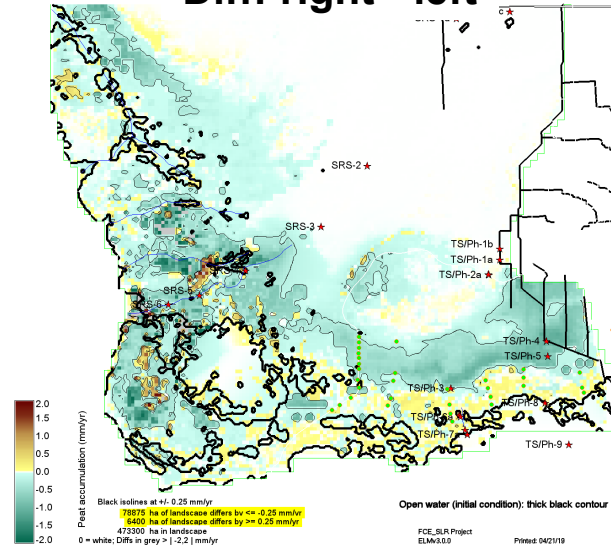
Peat accretion – Period of Simulation

CERP0

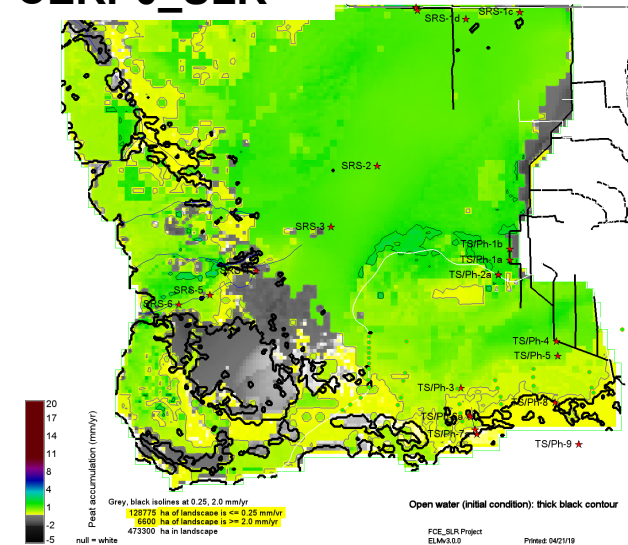


Right Map minus Left Map

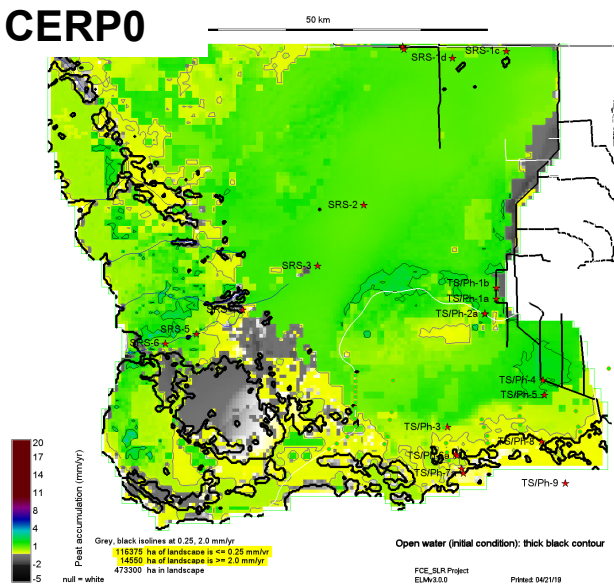
Diff: right - left



CERP0_SLR

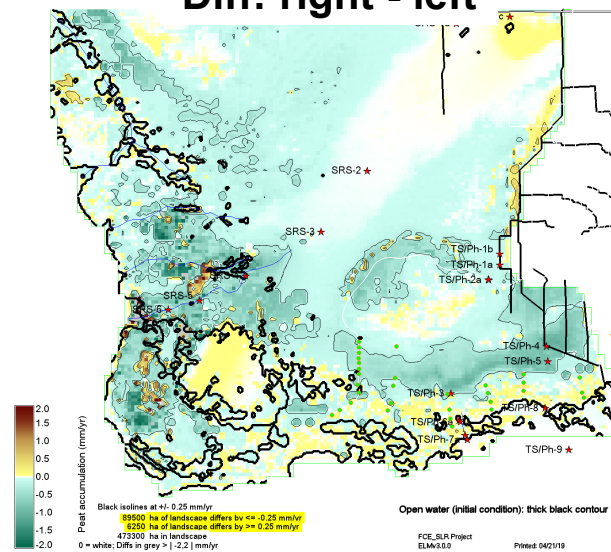


CERP0

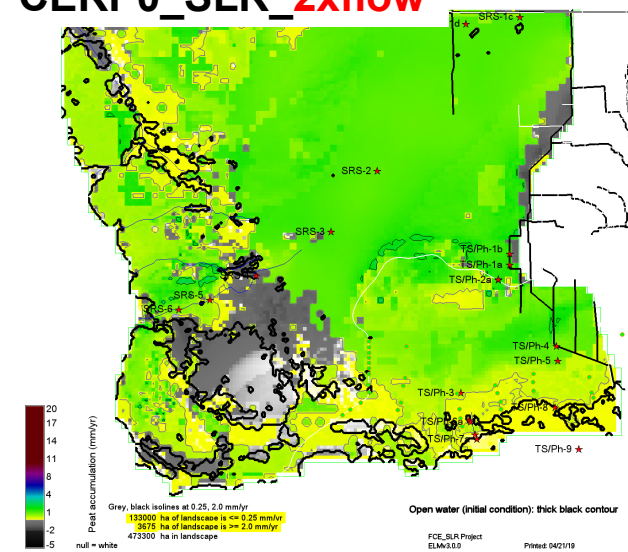


Right Map minus Left Map

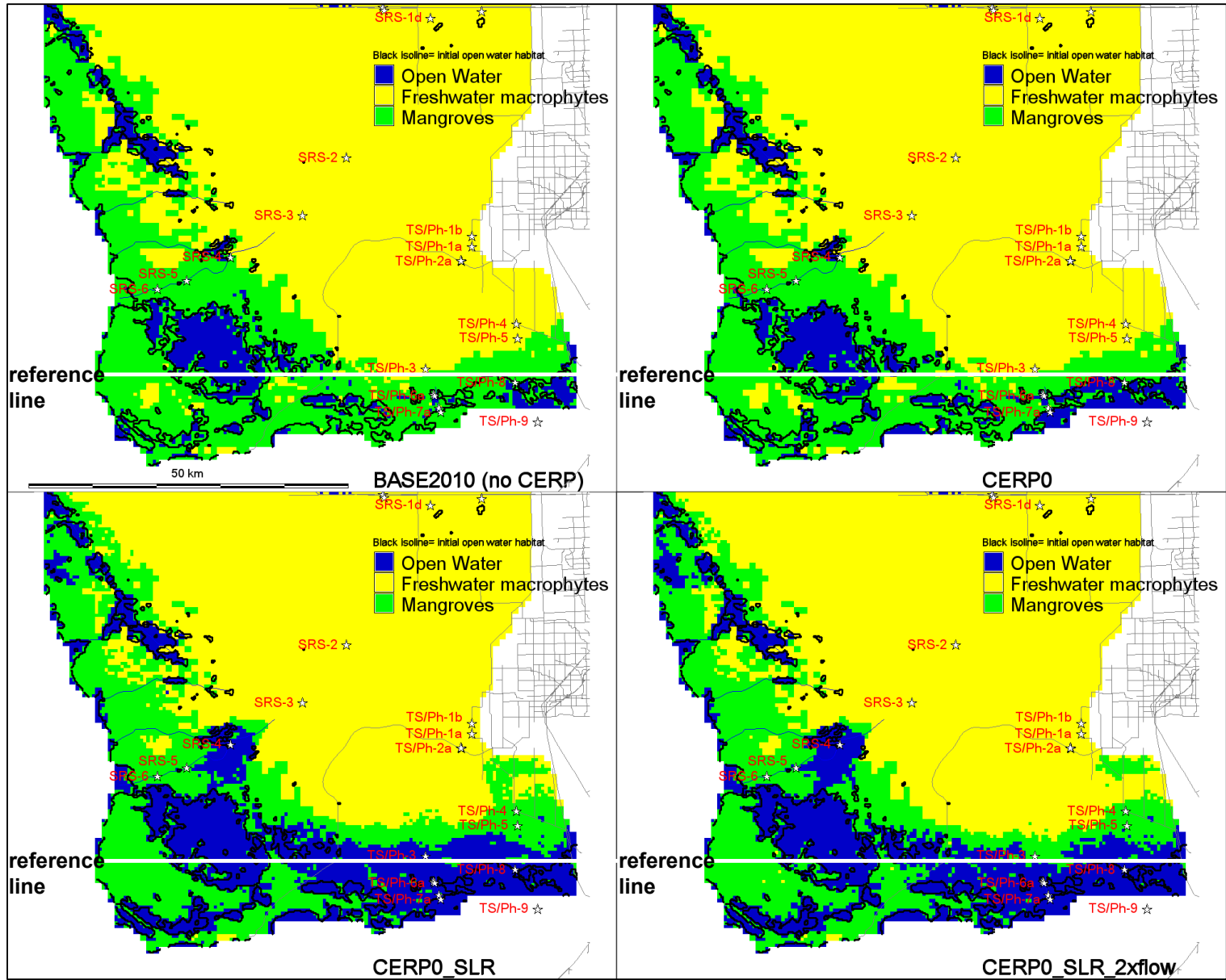
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CERP0_SLR_2xflow

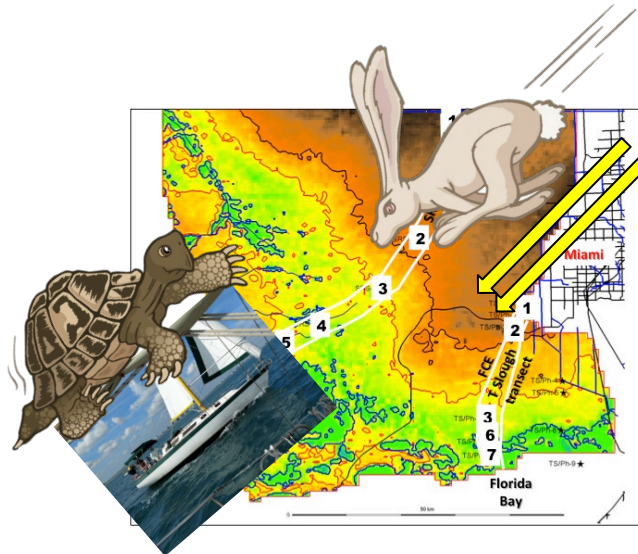


Habitat succession, end of wet season, last year of sim



Summary-ELM scenario games

- Incremental SLR (~60cm/36yr) led to gradual ecosystem changes
- With standard CERP exposed to this SLR, coastal ecotone patterns of salinity, P, soil processes, and mangroves & open-water habitats moved inland
- Additional (CERP+) flows slightly counteracted this movement, depending on spatial location, flow paths
- The tortoise of SLR probably “wins”, but the hare’s additional pulses of freshwater flows pushes back to a meaningful extent



ELM updating...

- Assimilating multiple monitoring & experimental results from **FCE LTER** program
- ELM: **Extrapolate** local-scale research understanding across heterogeneous landscapes & multiple decades (aka spatio-temporal integration)
- **Iterative process**, leading to improved models, and to refined hypotheses

