



# Modeling coastal wetlands in the E3SM Land Model

Benjamin N. Sulman

Sophie LaFond-Hudson, Kewei Chen, Shannon Jones, and Jesús Gomez Velez

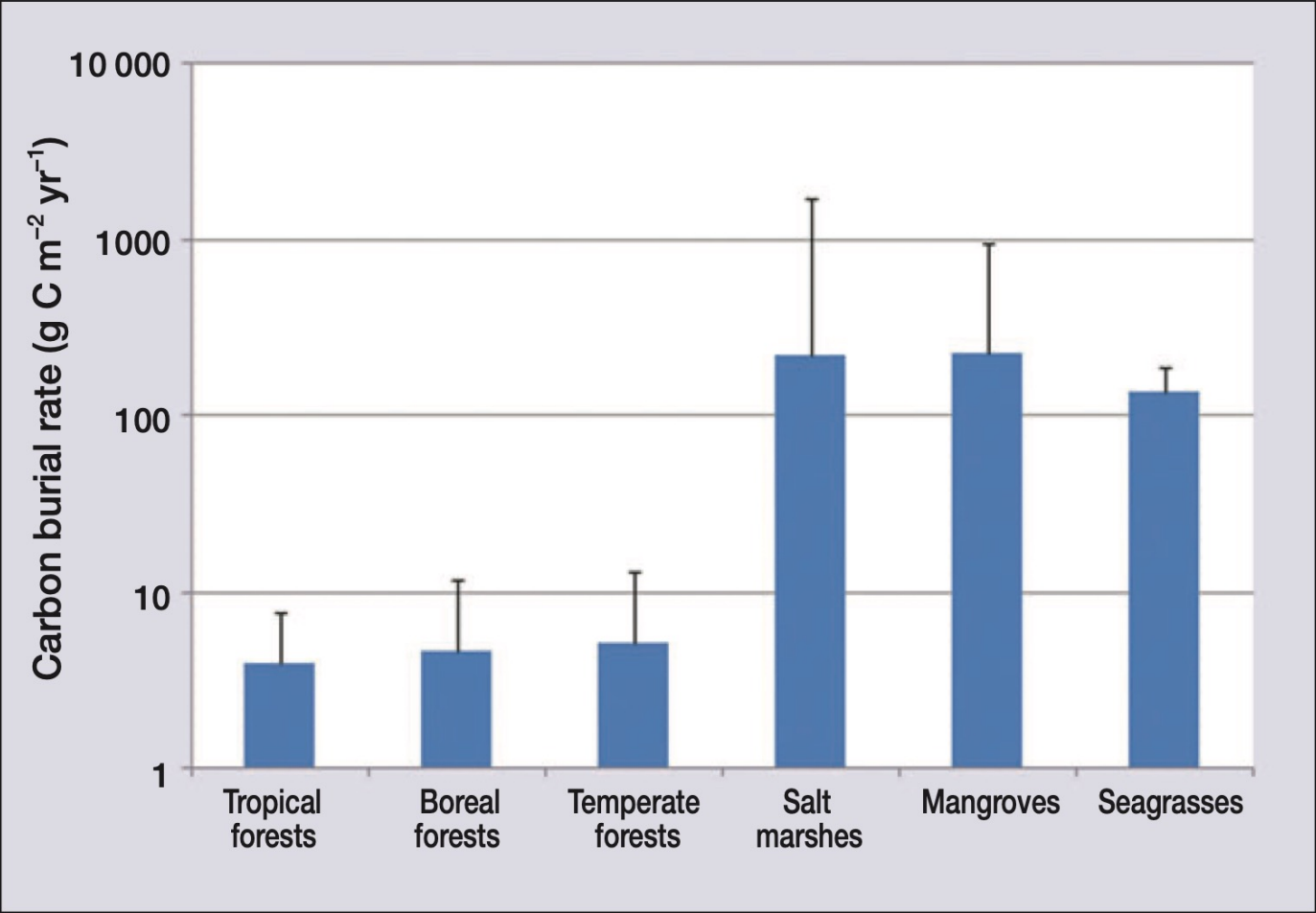


U.S. DEPARTMENT OF  
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# Coastal wetlands are some of the most productive ecosystems on Earth and provide multiple ecosystem services



McLeod et al., 2011

Storm surge protection, flood mitigation



Recreation, habitat, water quality improvement

# Coastal wetlands are also vulnerable to sea level rise and saltwater intrusion

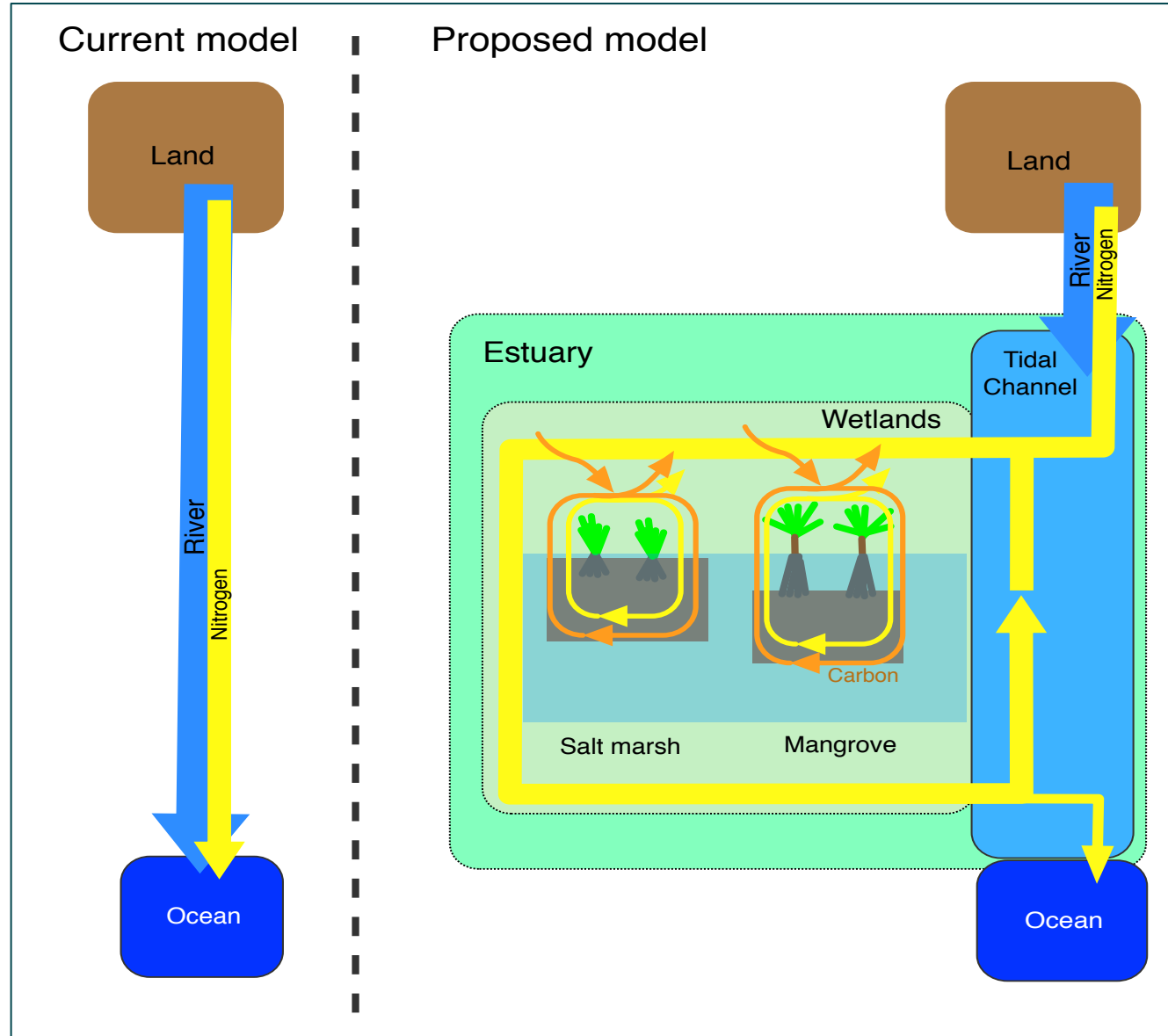
Healthy site (H)



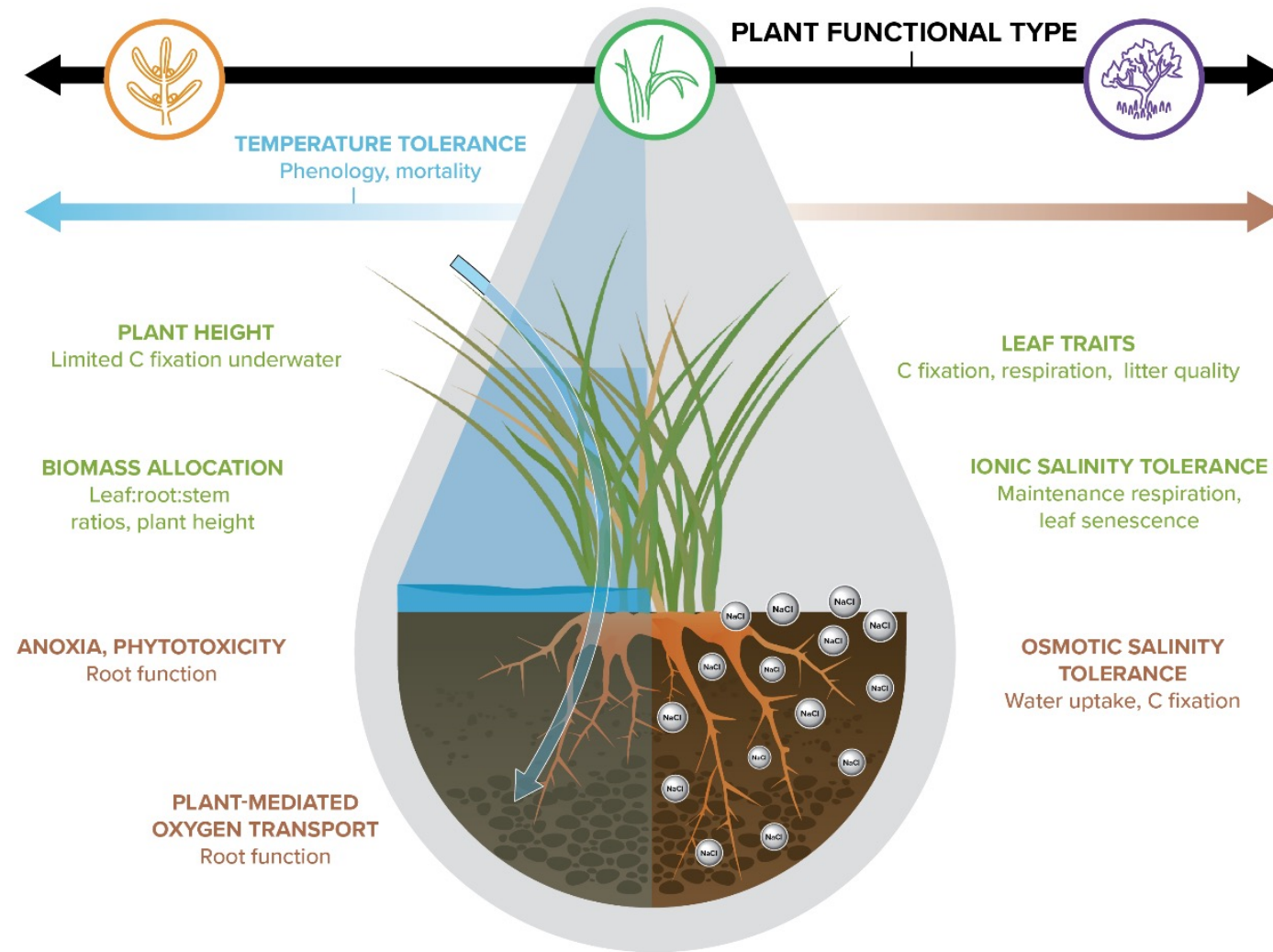
Die-back site (D)



# E3SM lacks representation of coastal wetland vegetation, biogeochemistry, and hydrological interactions

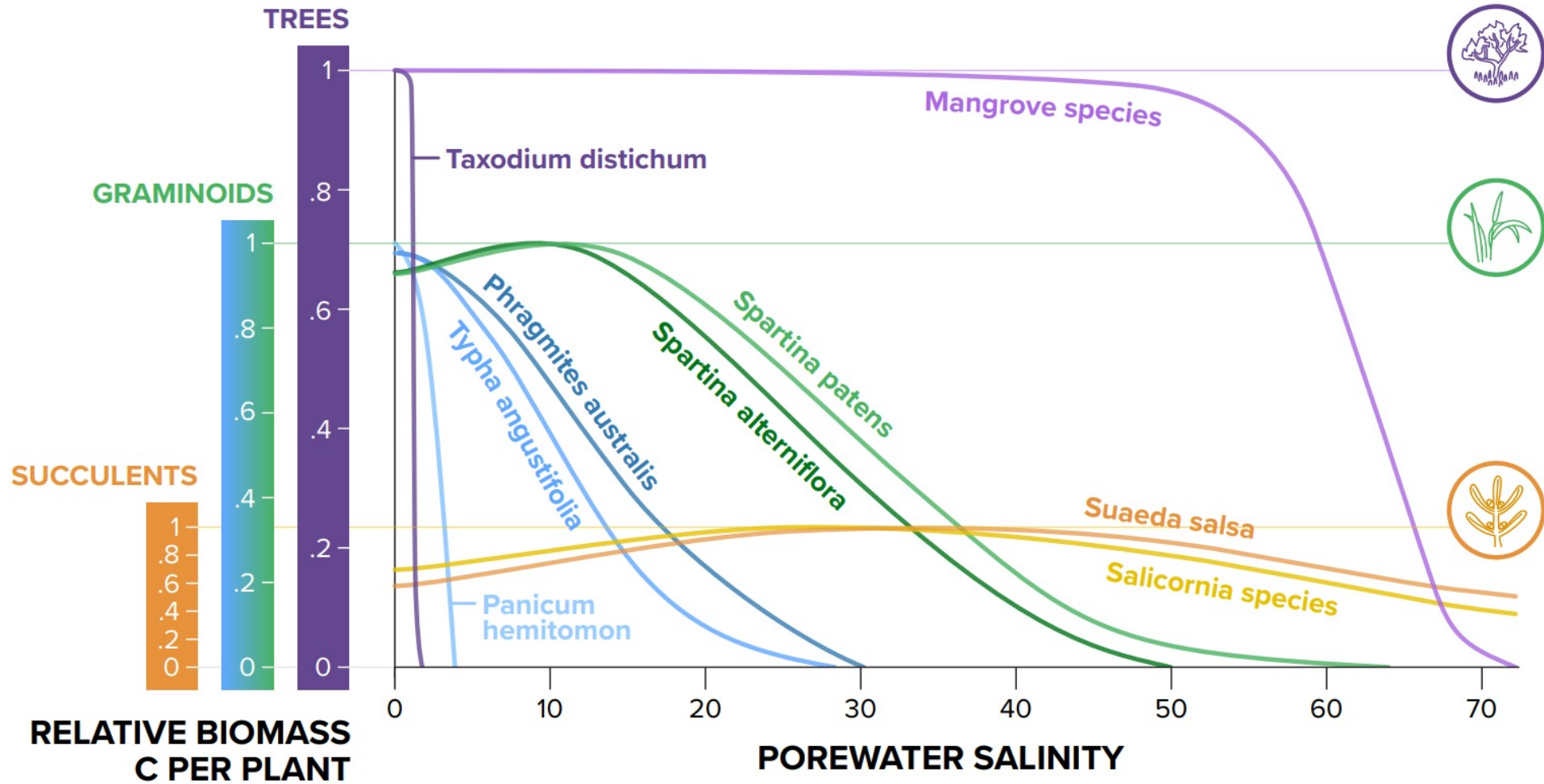


# Coastal wetland vegetation

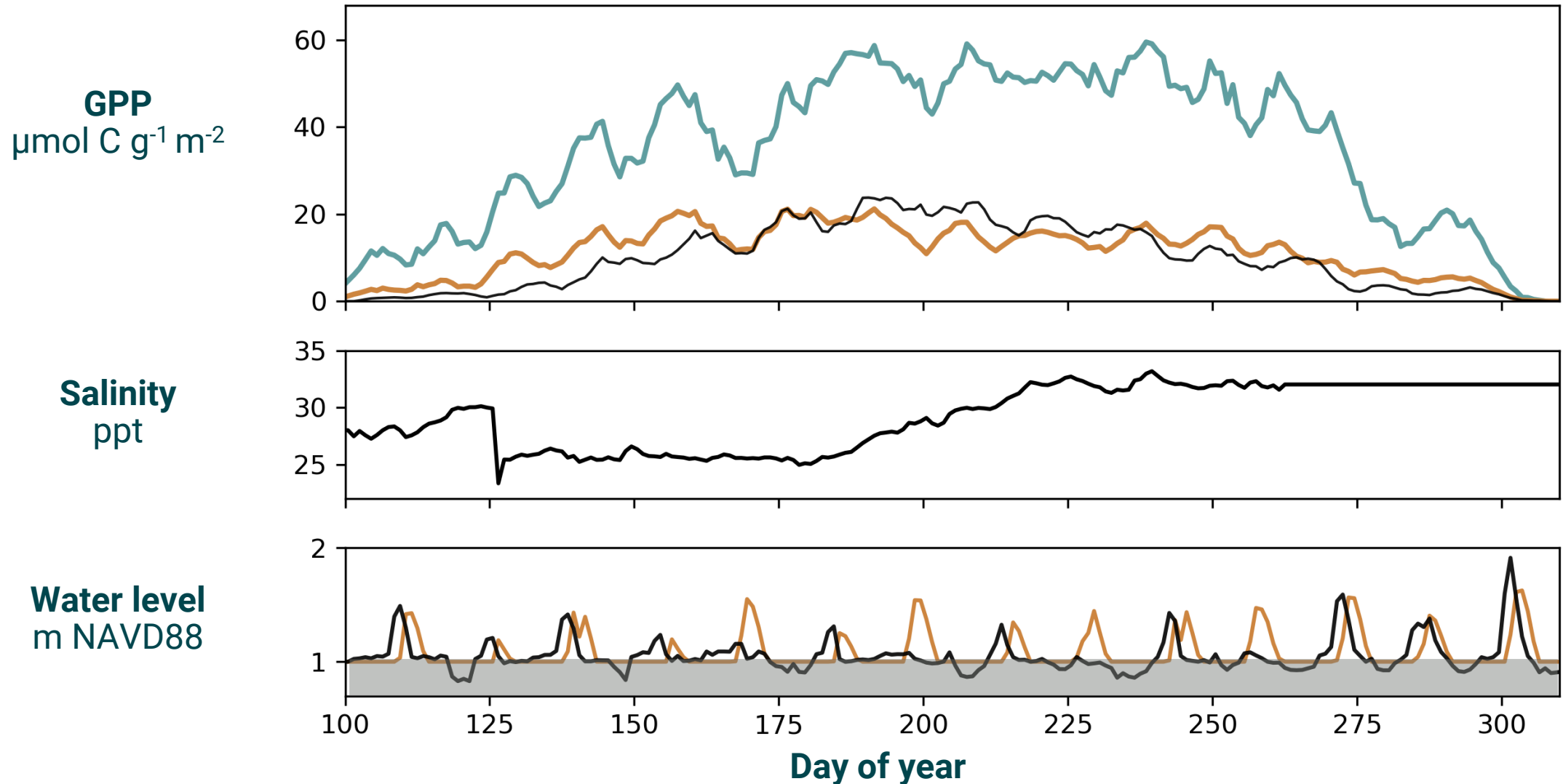


LaFond-Hudson and Sulman, 2022, New Phytologist

# Model development: PFT-specific salinity responses

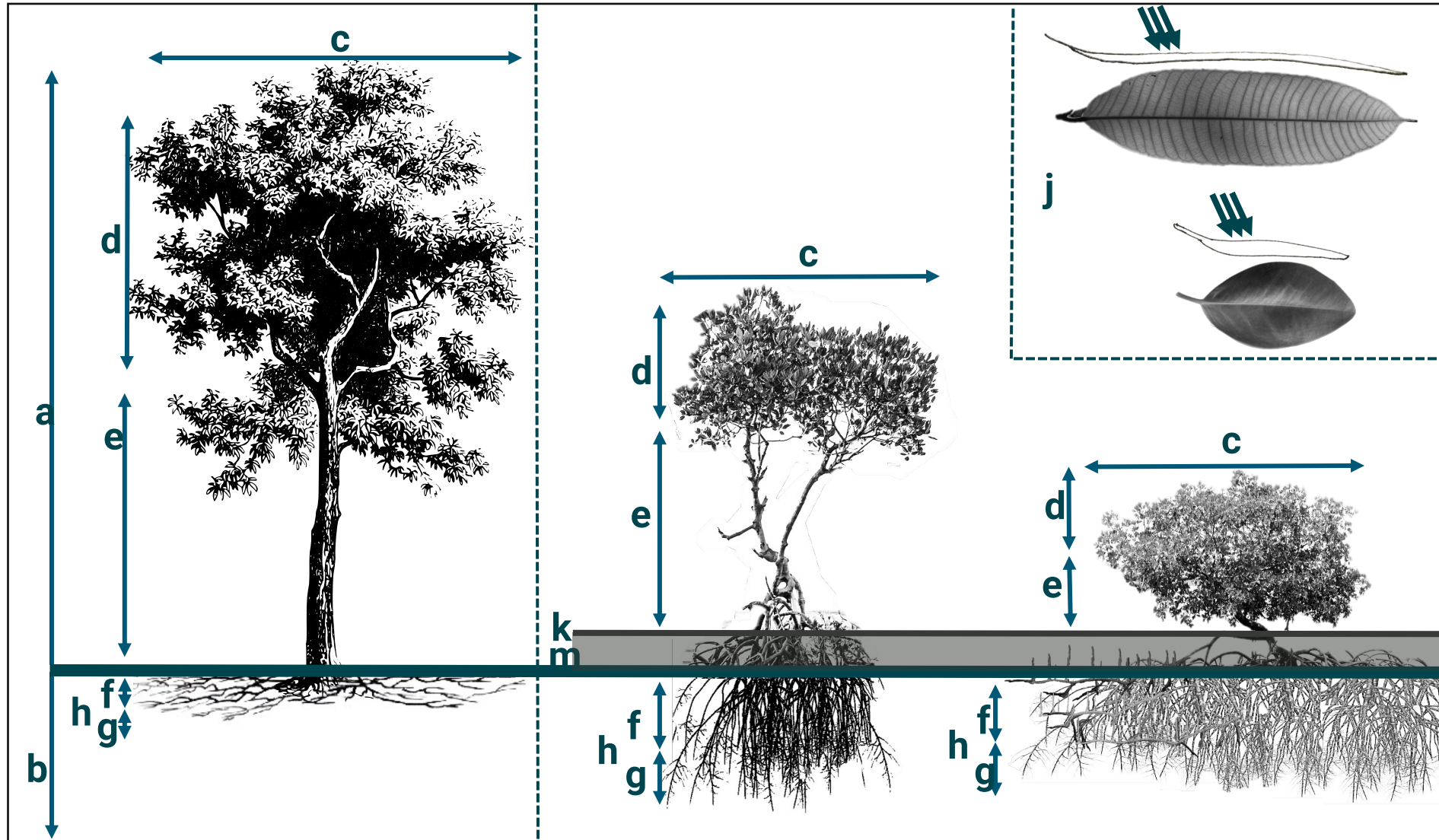


# Salinity response improves model accuracy for salt marshes



— Default model — Salinity and flood response — Data

# Developing a mangrove plant functional type



Tropical Evergreen Tree

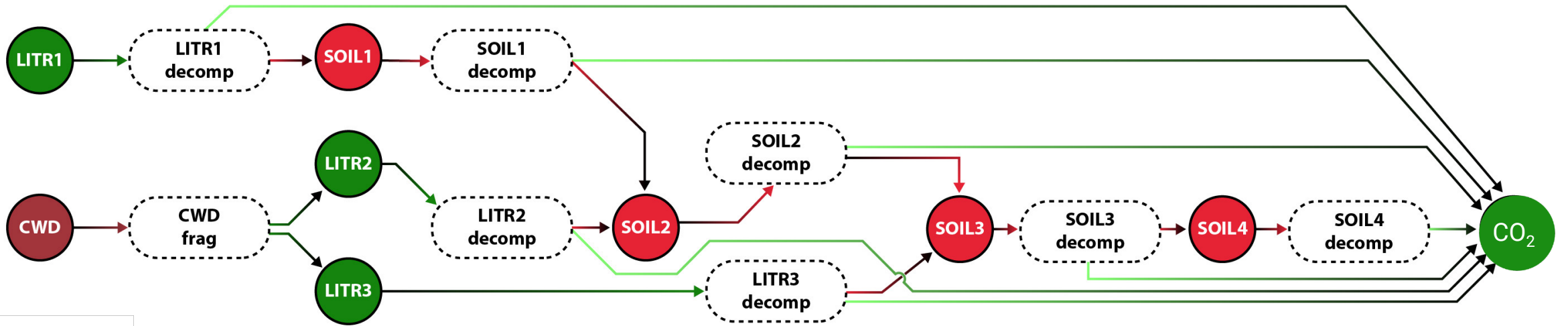
Mangrove Tree

Mangrove Scrub

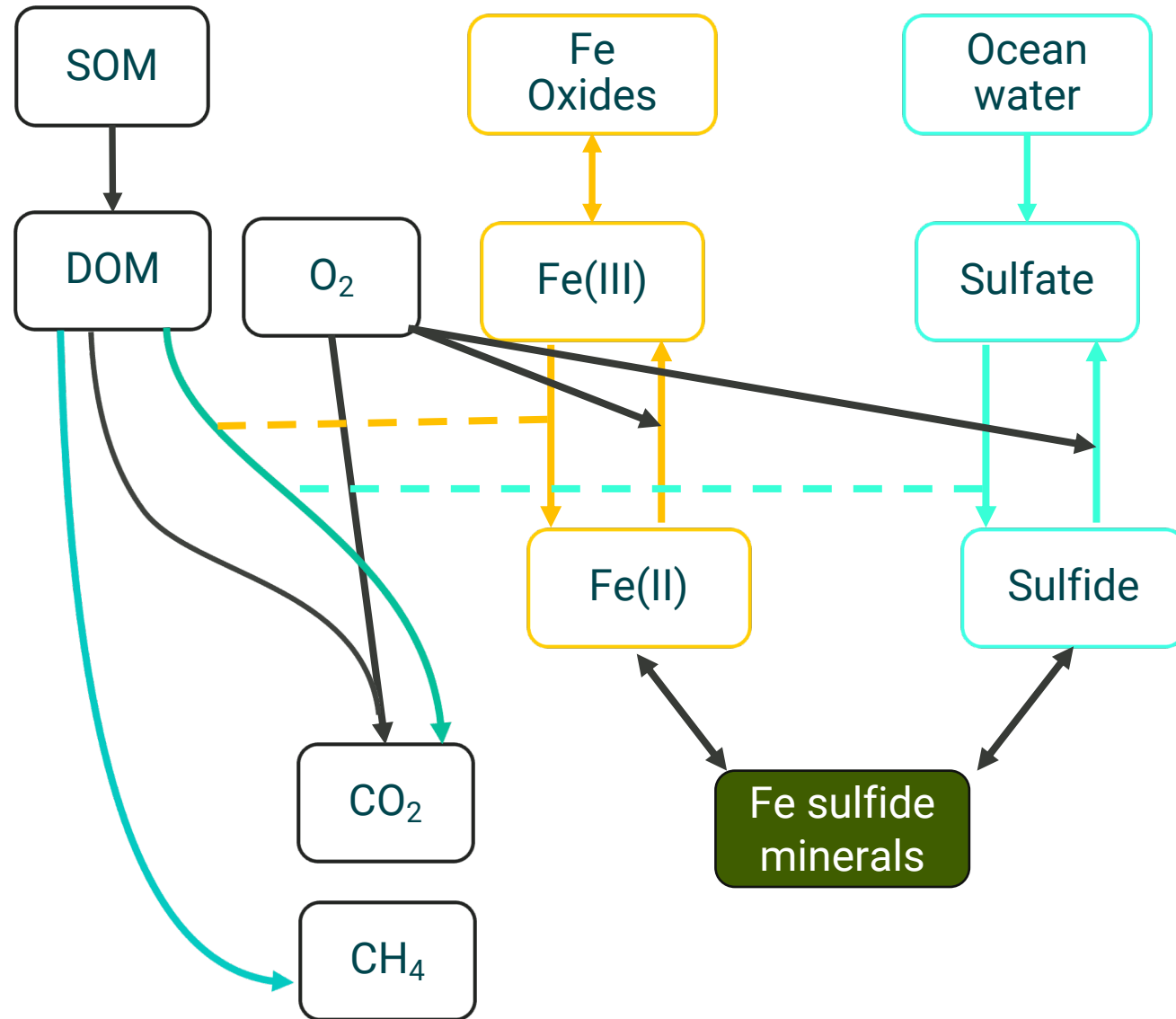
# Modeling coastal wetland biogeochemistry



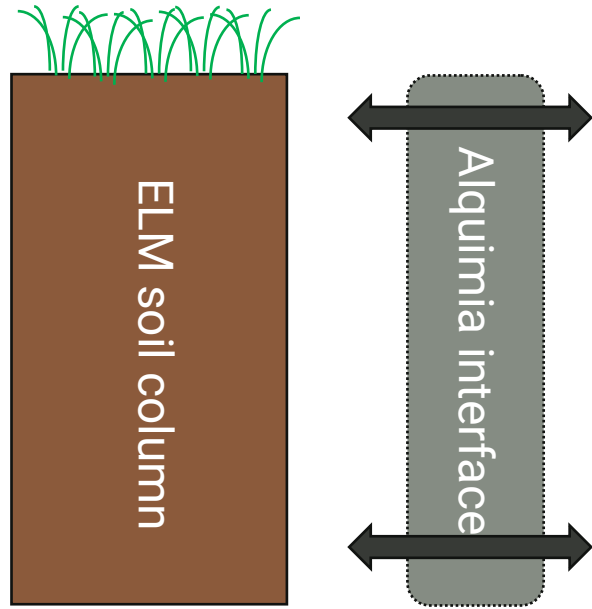
# E3SM Land Model biogeochemistry



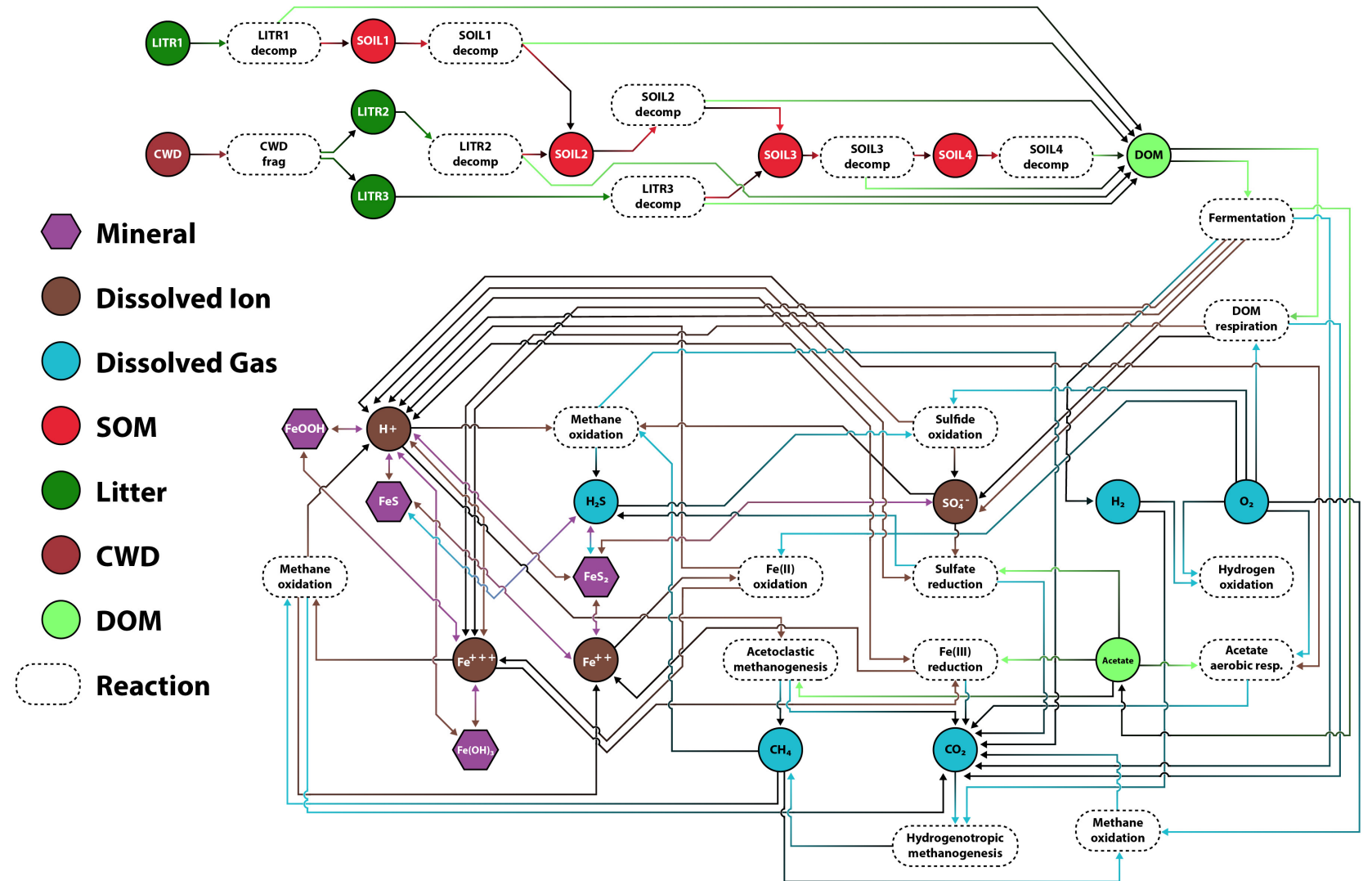
# Sulfur and iron redox cycles drive coastal wetland biogeochemistry



# We coupled the E3SM Land Model to the PFLOTRAN reactive transport model to simulate hydro-biogeochemical interactions.



## ELM-PFLOTRAN Decomposition and Redox Reaction Network



Sulman et al., 2024, JAMES  
(Sulman ECA project)

# A little more detail about ELM-PFLOTRAN implementation

ELM vegetation,  
hydrology, etc.



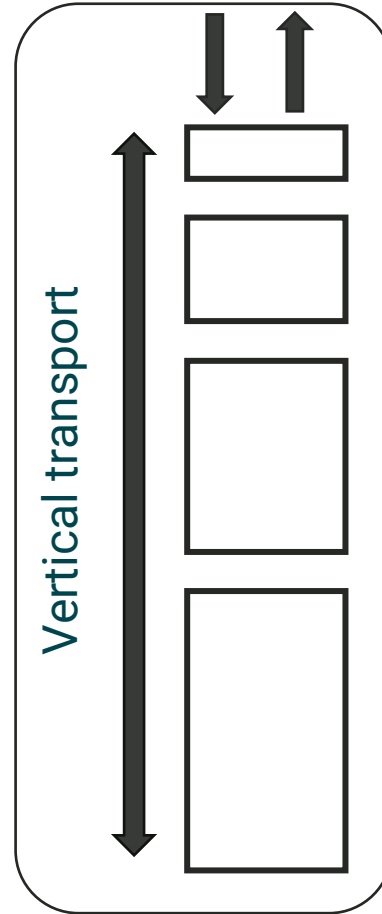
Hydro, litter inputs



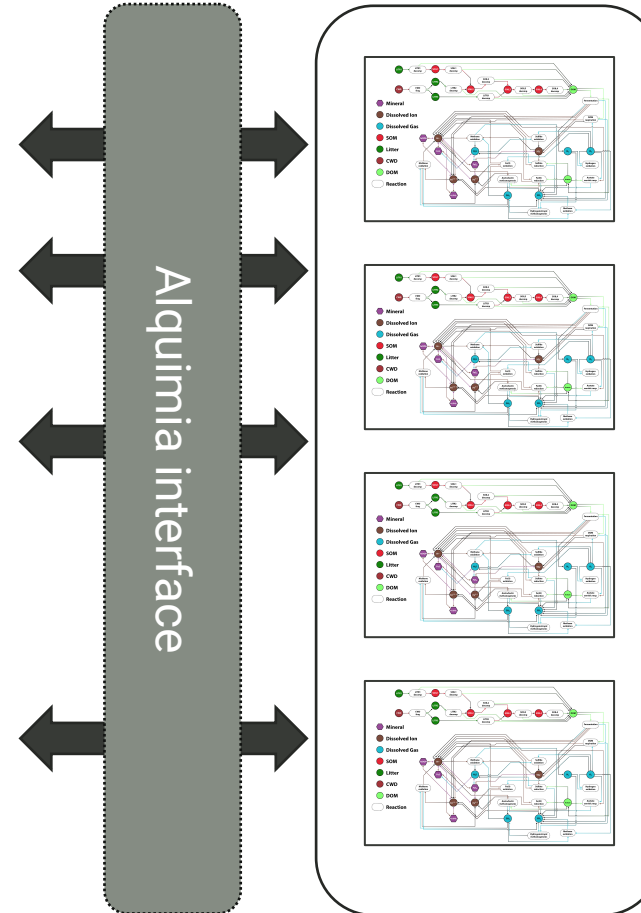
Nutrients, salinity



ELM External  
Model Interface

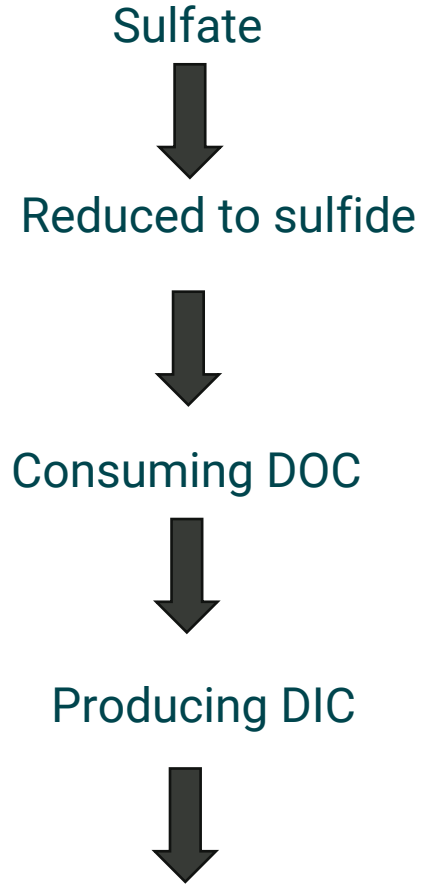


Alquimia/PFLOTRAN:  
BGC updated

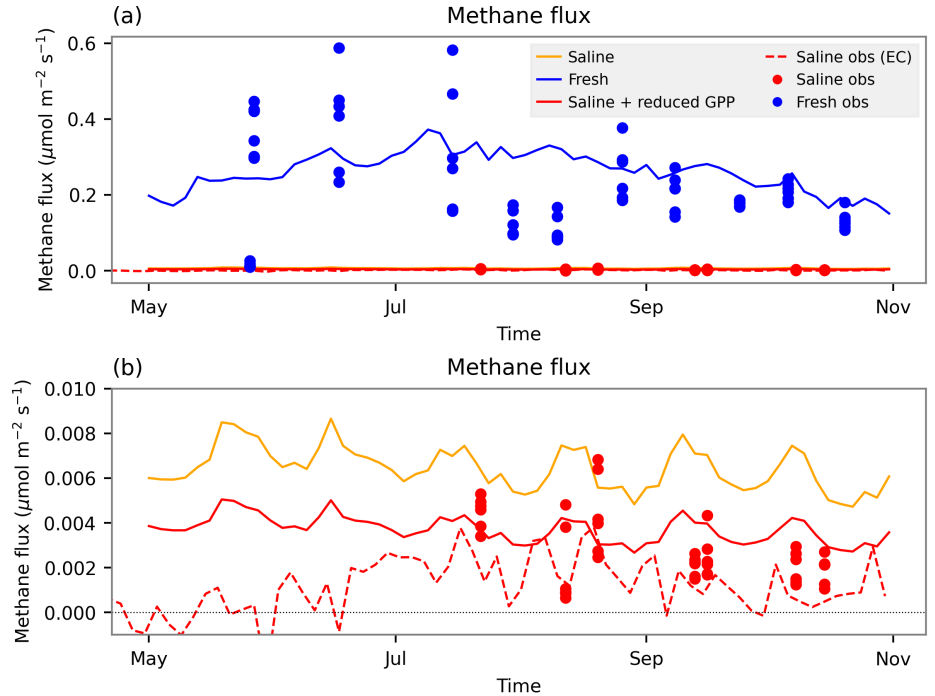
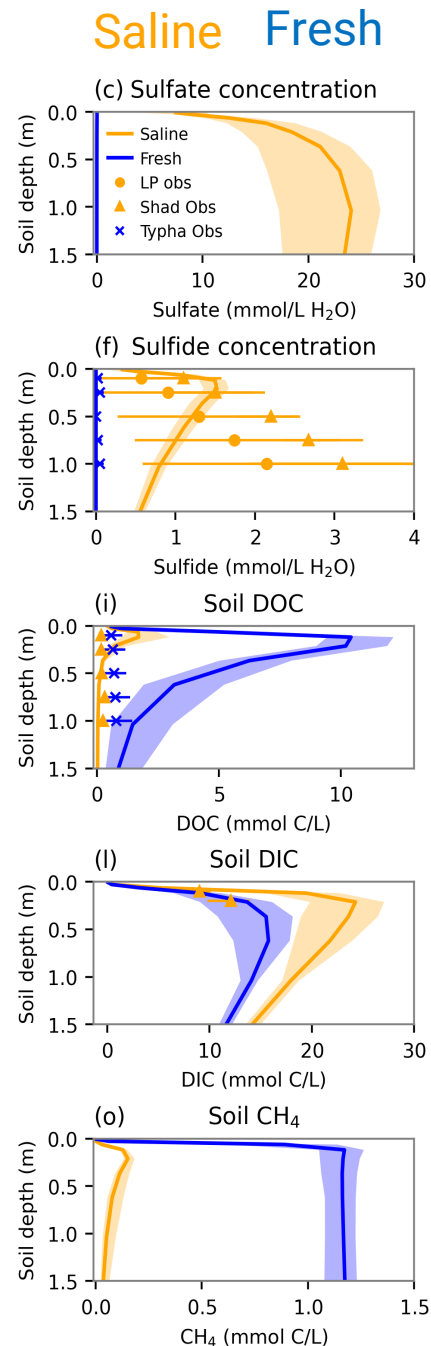


Reaction network defined  
in PFLOTRAN input deck

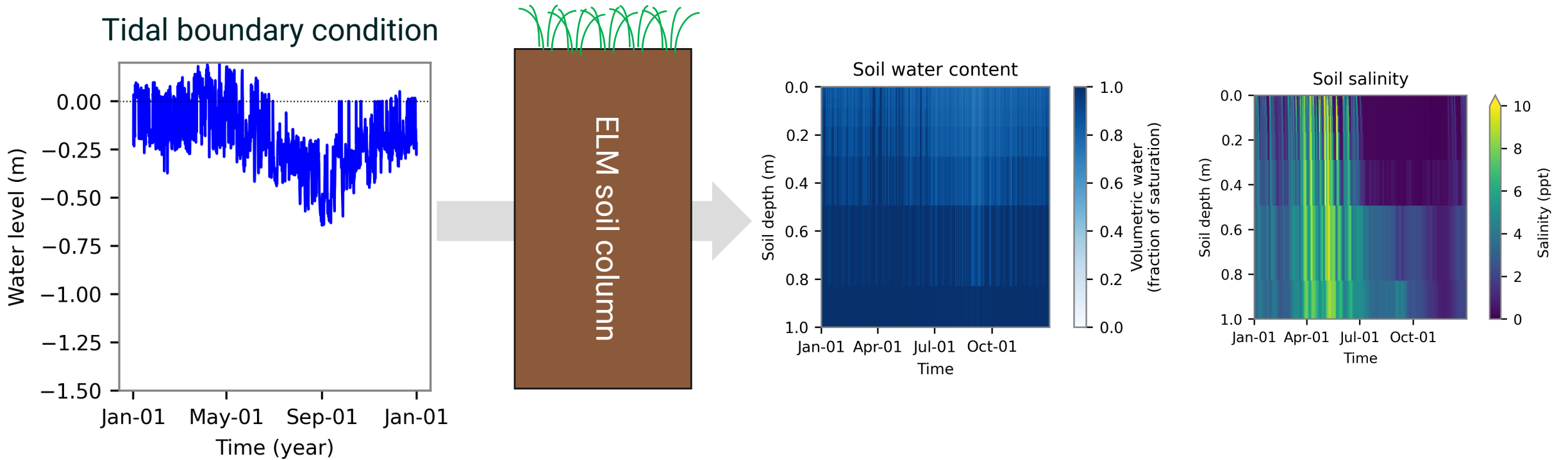
# Biogeochemistry in fresh and saline simulations



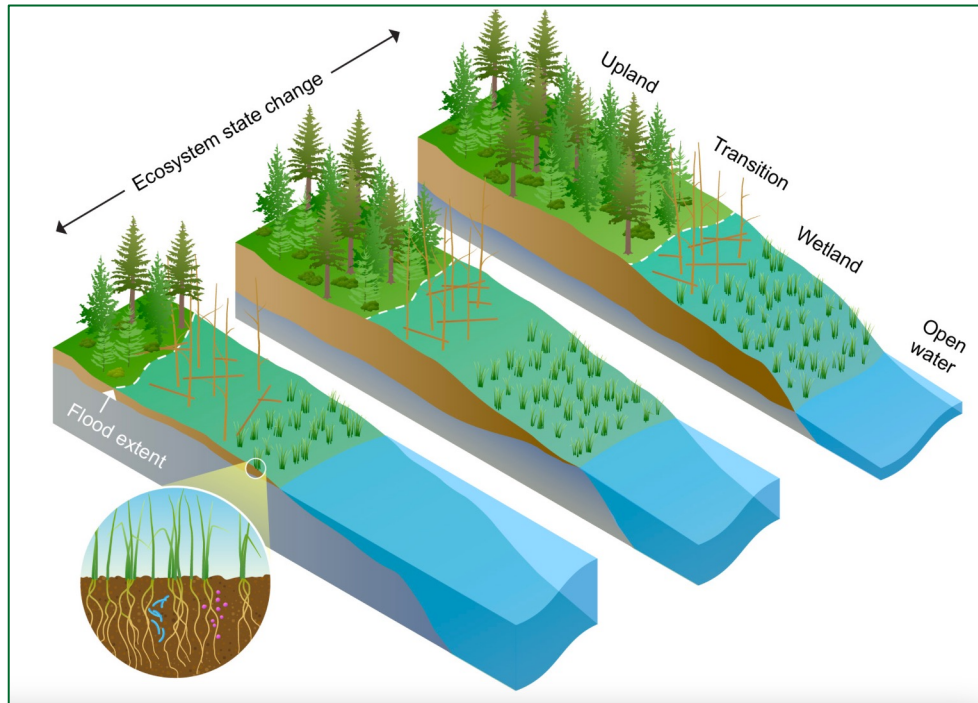
Reducing methane production and increasing oxidation



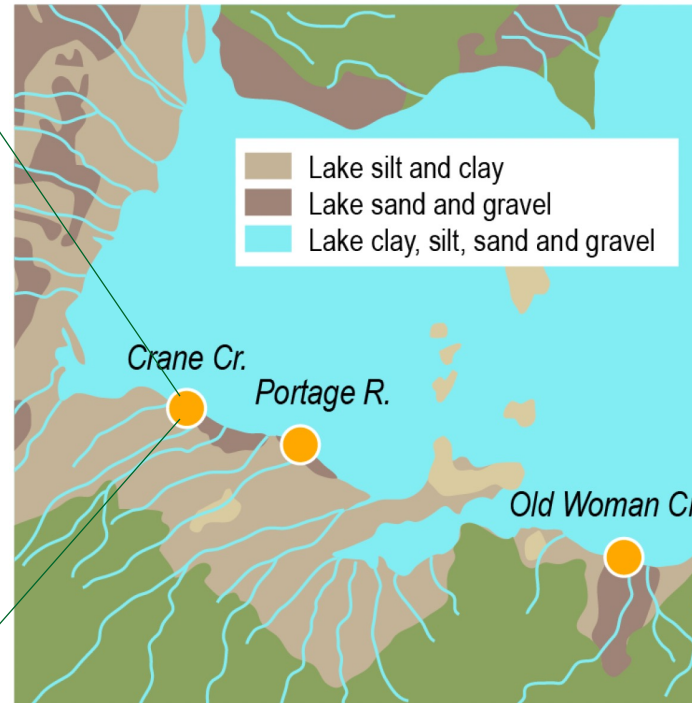
# We use a coastal setup of the E3SM Land Model that uses a hydrological boundary condition to drive water level and salinity.



# Applying this model framework across multiscale gradients in the COMPASS-FME project

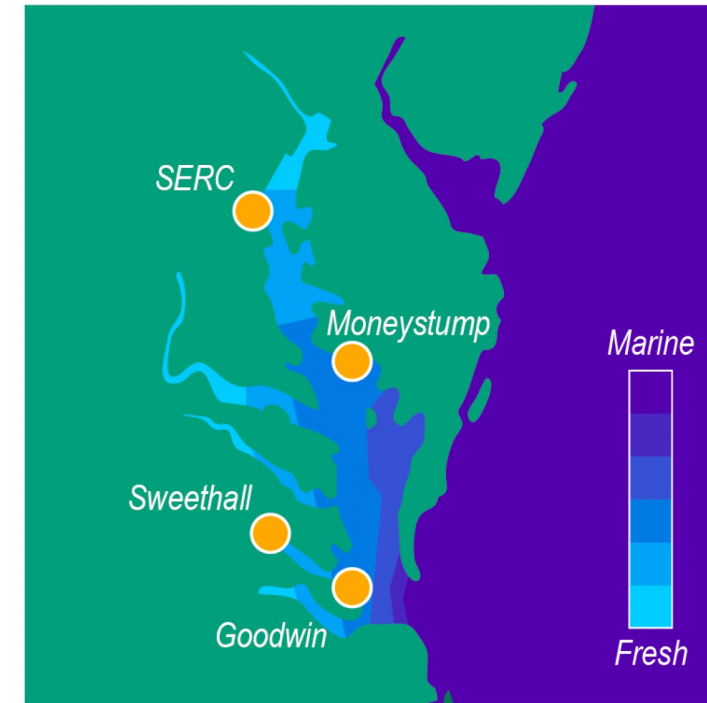


WESTERN LAKE ERIE BASIN



Sediment gradient

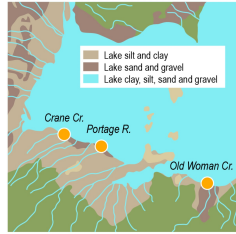
CHESAPEAKE BAY



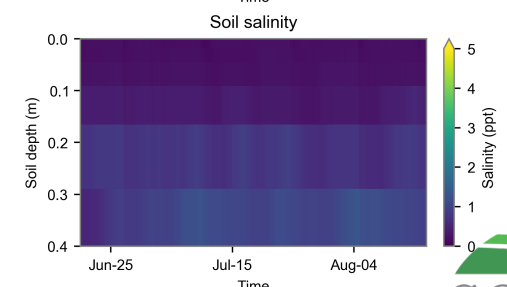
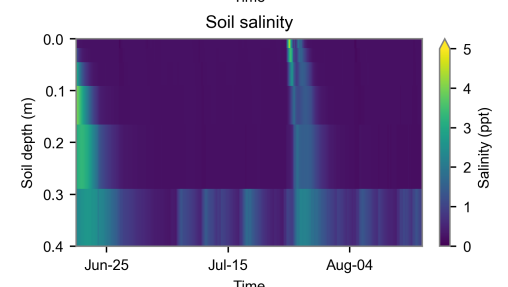
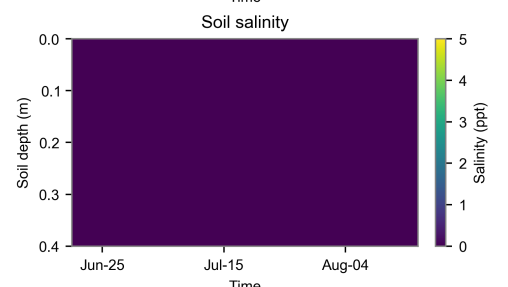
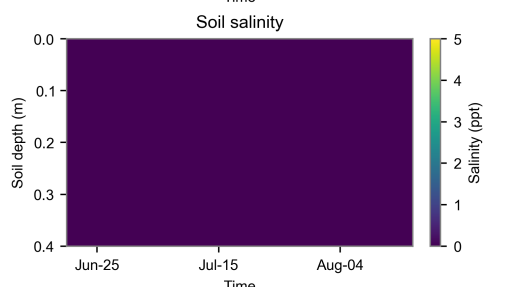
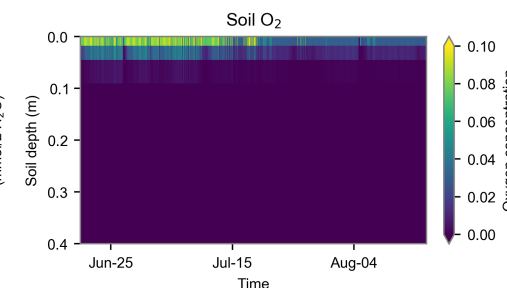
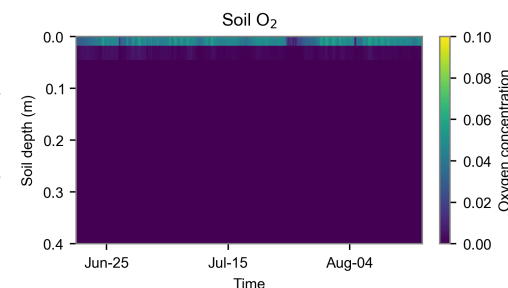
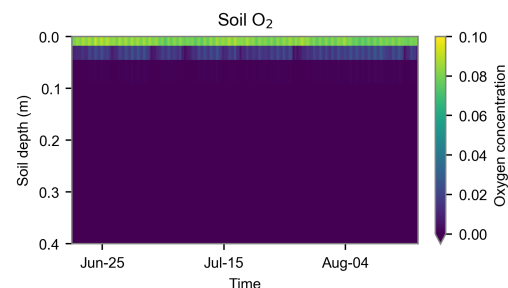
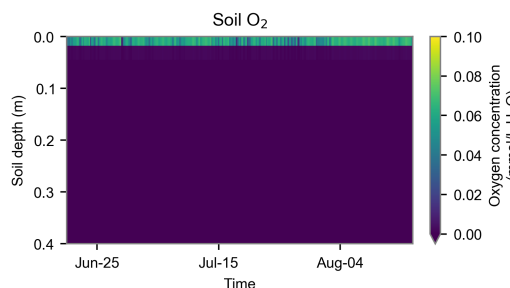
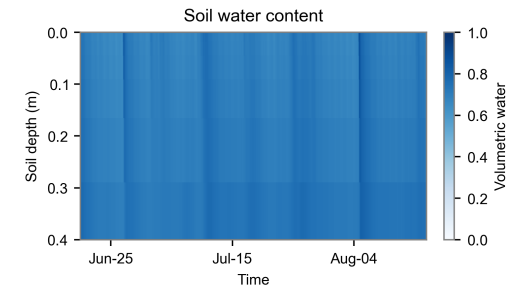
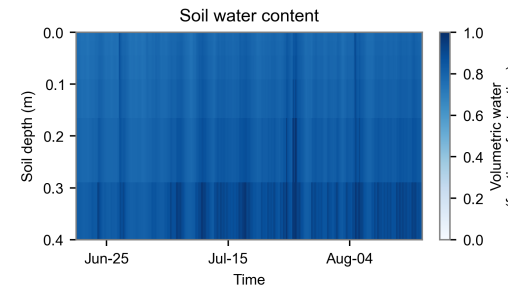
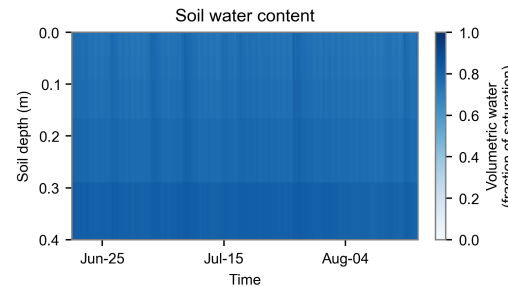
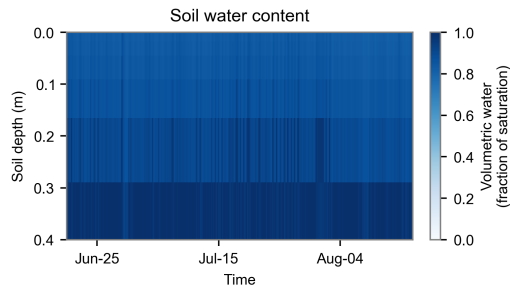
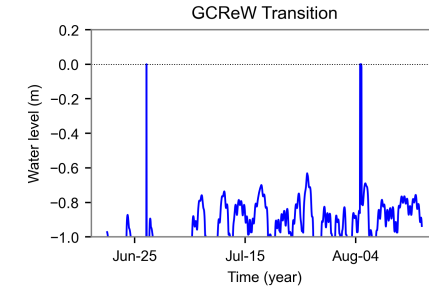
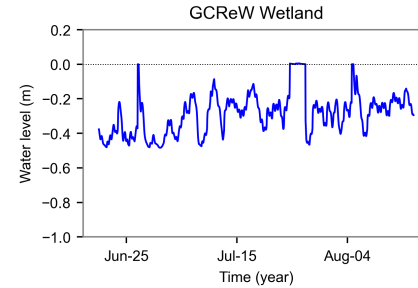
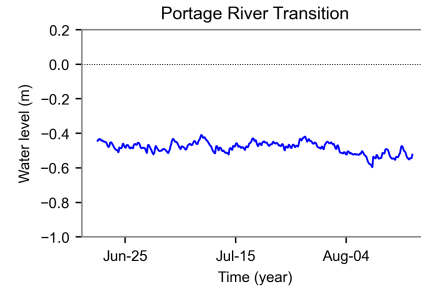
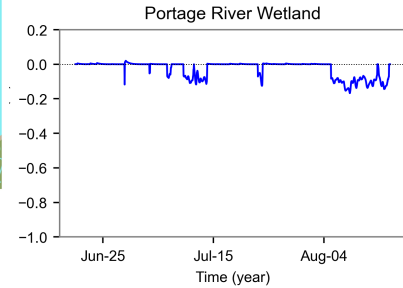
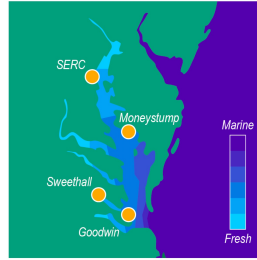
Salinity gradient

# COMPASS-FME: Hydrology and salinity patterns drive cross-site variability

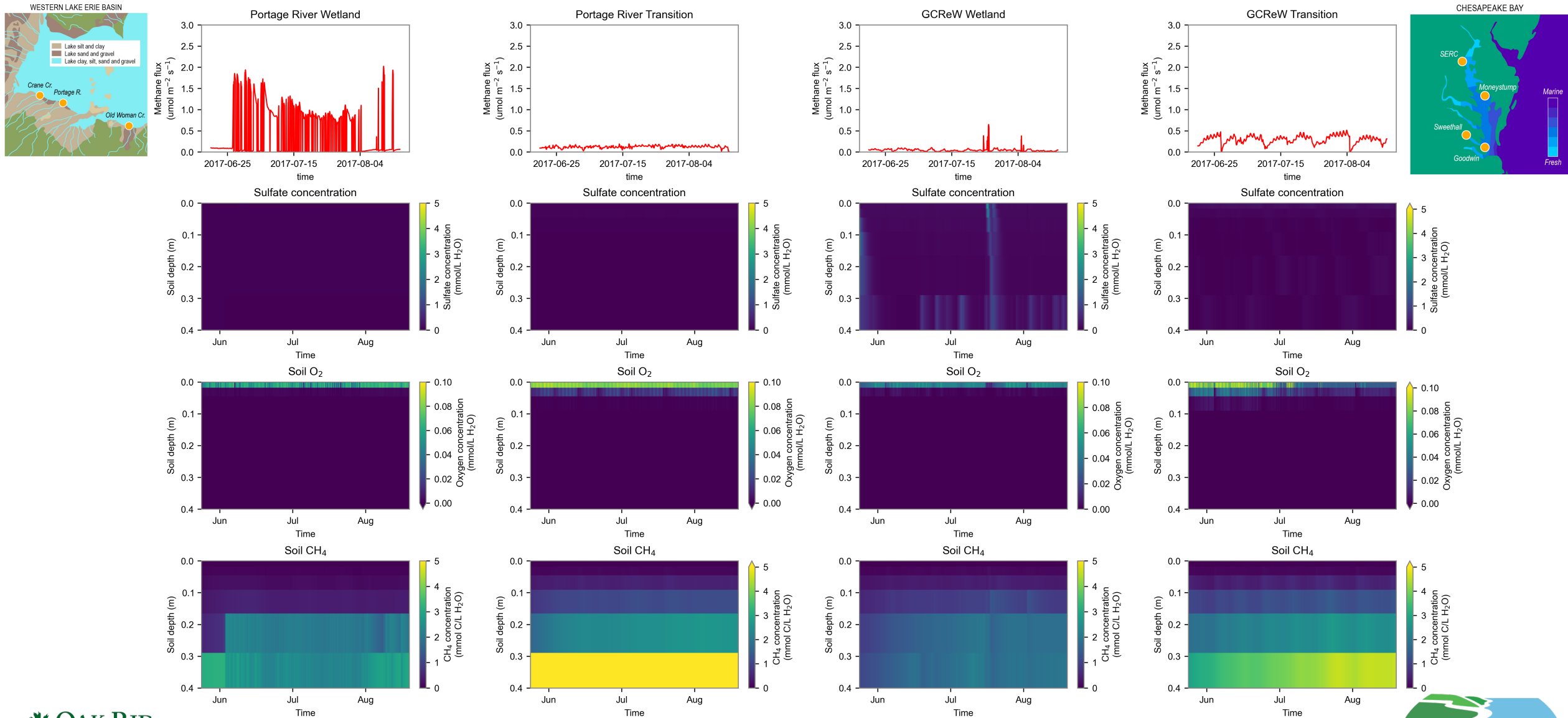
WESTERN LAKE ERIE BASIN



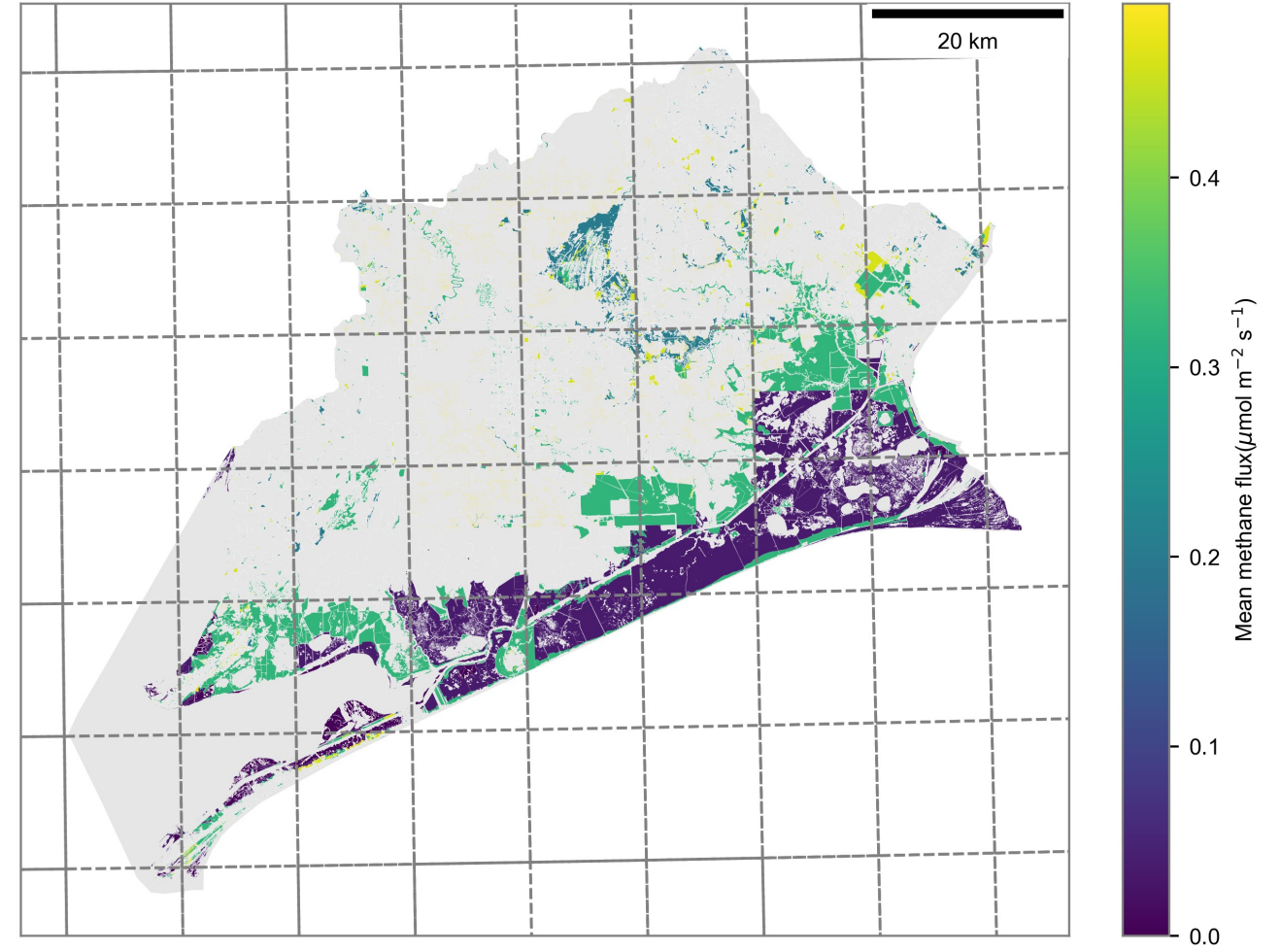
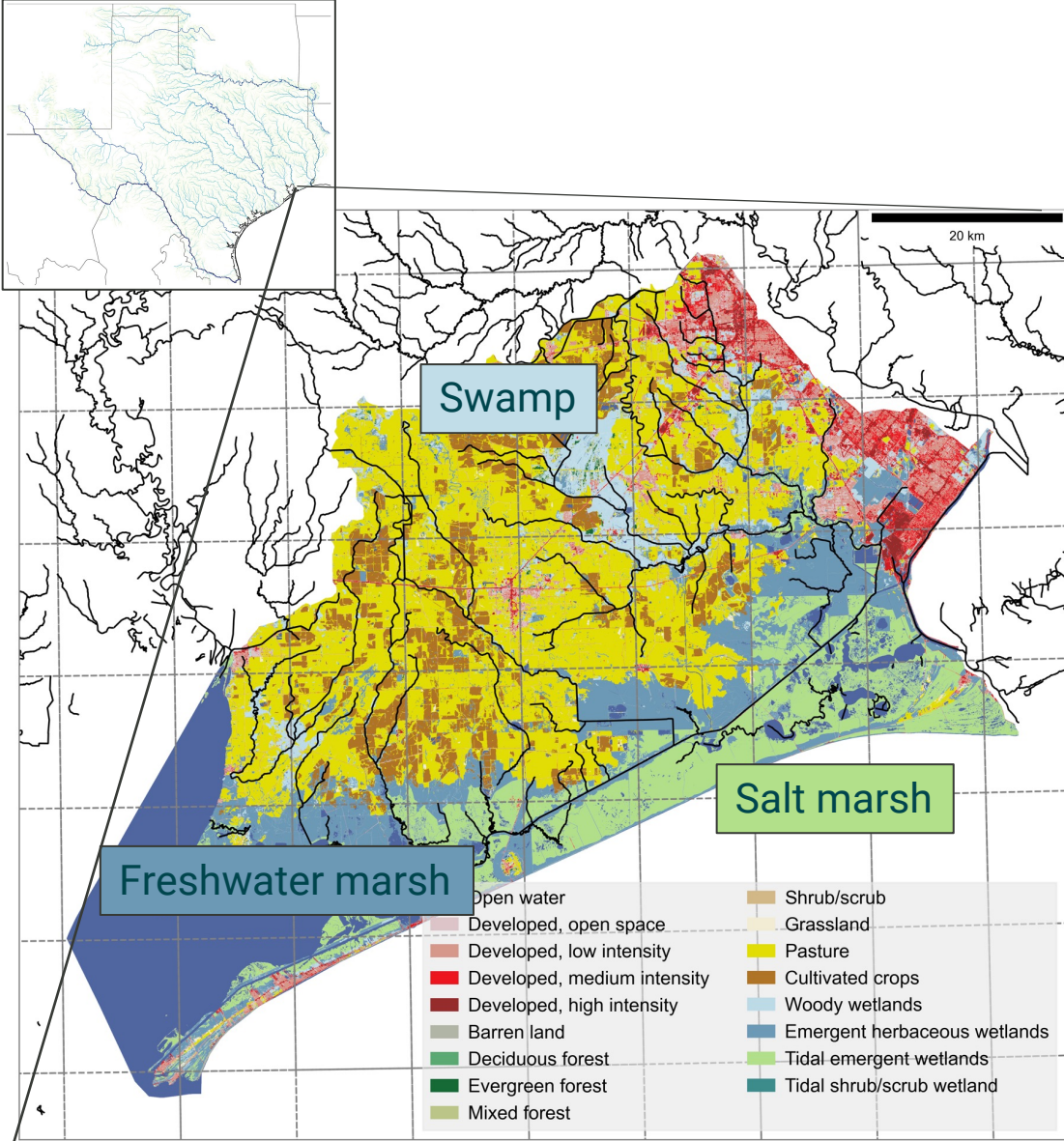
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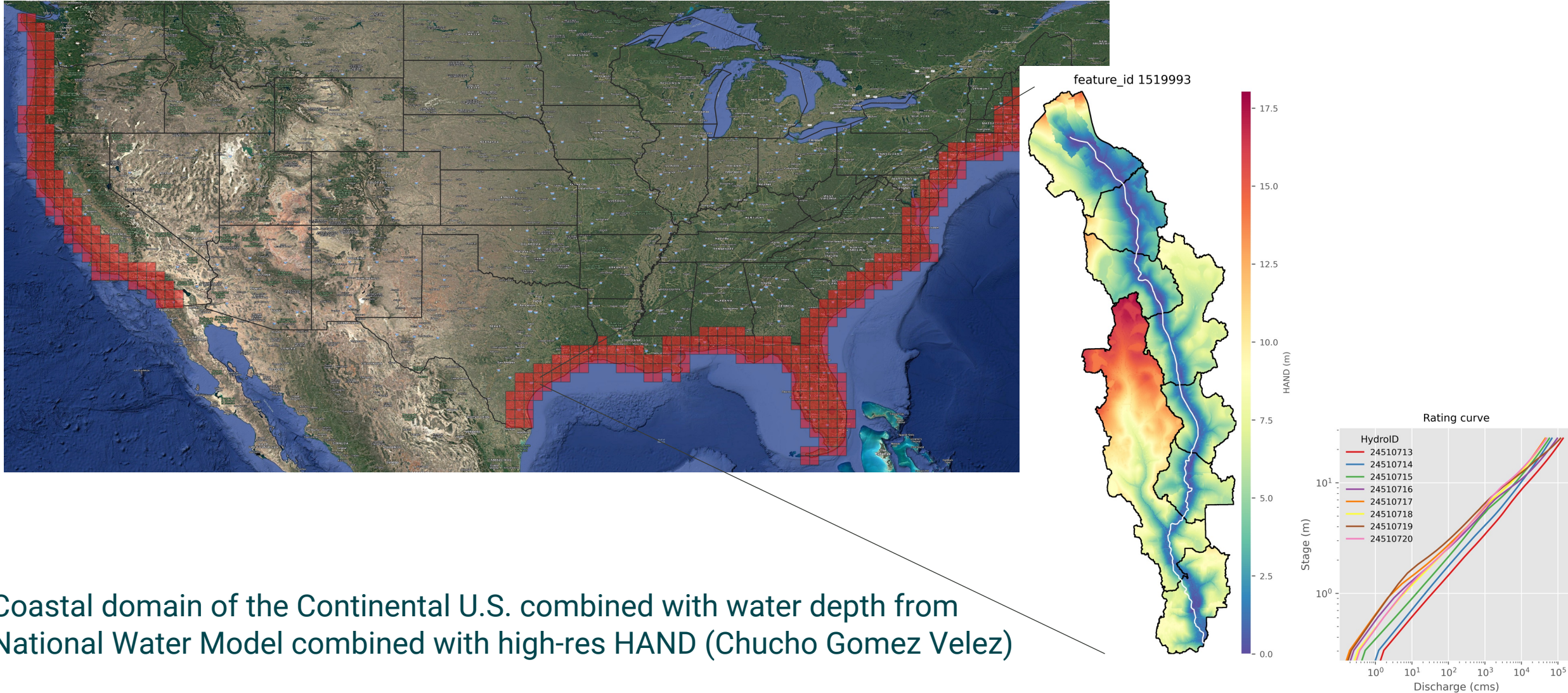
# The model captures the impact of cross-site contrasts in drivers on biogeochemical cycling and surface gas fluxes



# Scaling up to regional scales using wetland maps



# And eventually to the continental scale using larger-scale hydrology and wetland spatial data



Coastal domain of the Continental U.S. combined with water depth from National Water Model combined with high-res HAND (Chucho Gomez Velez)

# New vegetation and biogeochemistry capabilities allow more accurate representation of coastal regions across scales

ELM-PFLOTTRAN Decomposition and Redox Reaction Network

