

Seasonal Water Chemistry and Spectral Reflectance in Coastal Mangroves



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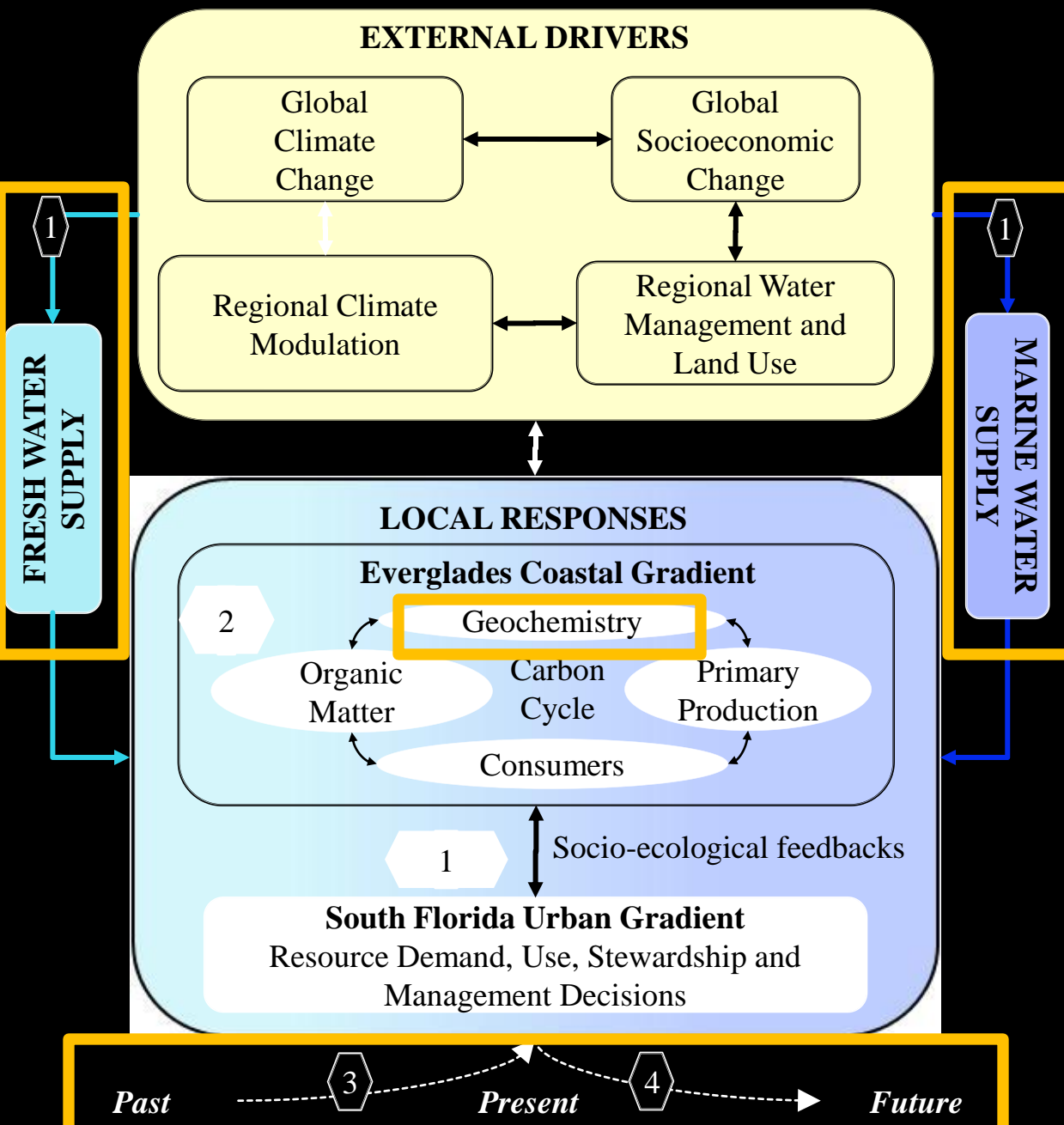


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Multi-Scaled Socio-Ecology of the Everglades

FCE III Conceptual Framework



FCE III LTER Goals:

- ① **Water:** How do water management decisions interact with climate change to determine freshwater distribution?
- ② **Carbon:** How does the balance of fresh and marine water supplies regulate C uptake, storage, and fluxes by influencing water residence time, nutrient availability, and salinity?
- ③ **Legacies:** How does historic variability in the relative supply of fresh and marine water modify ecosystem sensitivity to further change?
- ④ **Scenarios:** What are alternative socio-ecological futures for South Florida under contrasting climate change and water management scenarios?

Research Question

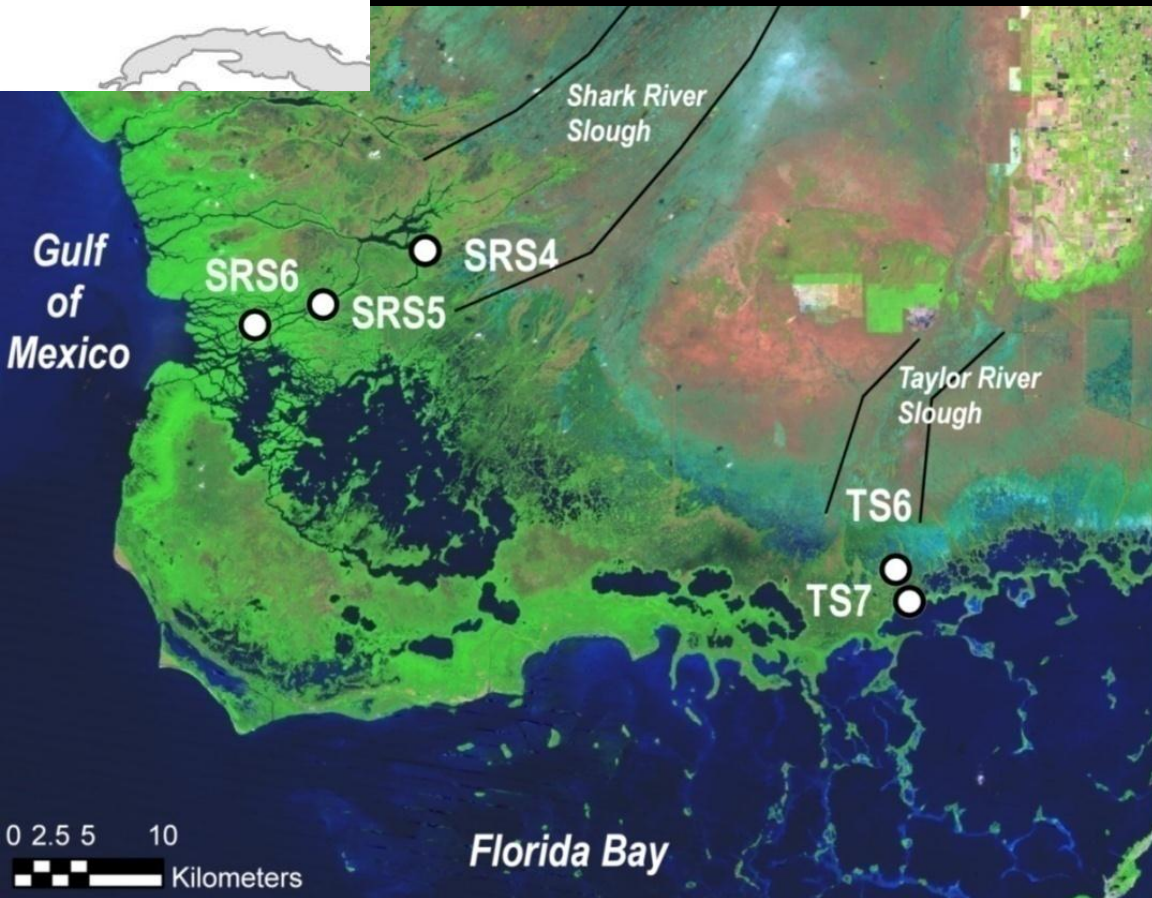
- Can water quality be estimated and monitored using remote sensing?
 - Provide spatial estimates of water quality across various mangrove communities and identify seasonal trends using electro-magnetic spectral signatures

Spoiler Alert

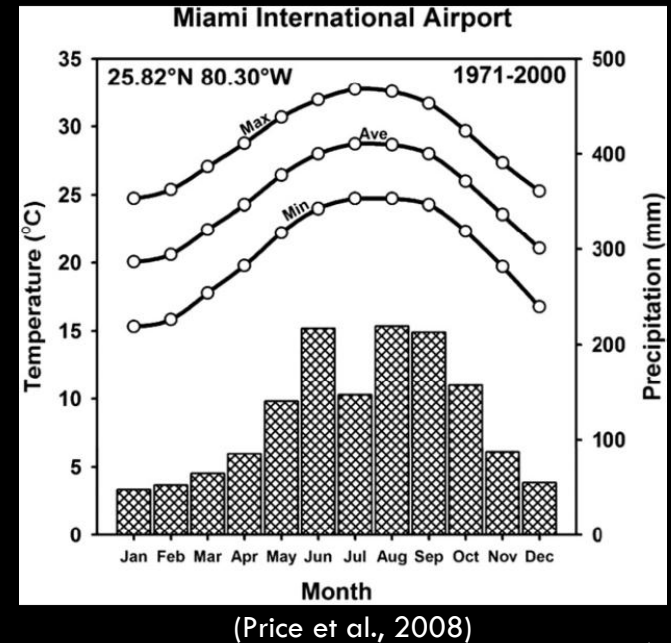
- Water chemistry estimated from leaf spectra
- Leaf-level and satellite-level data show comparable results



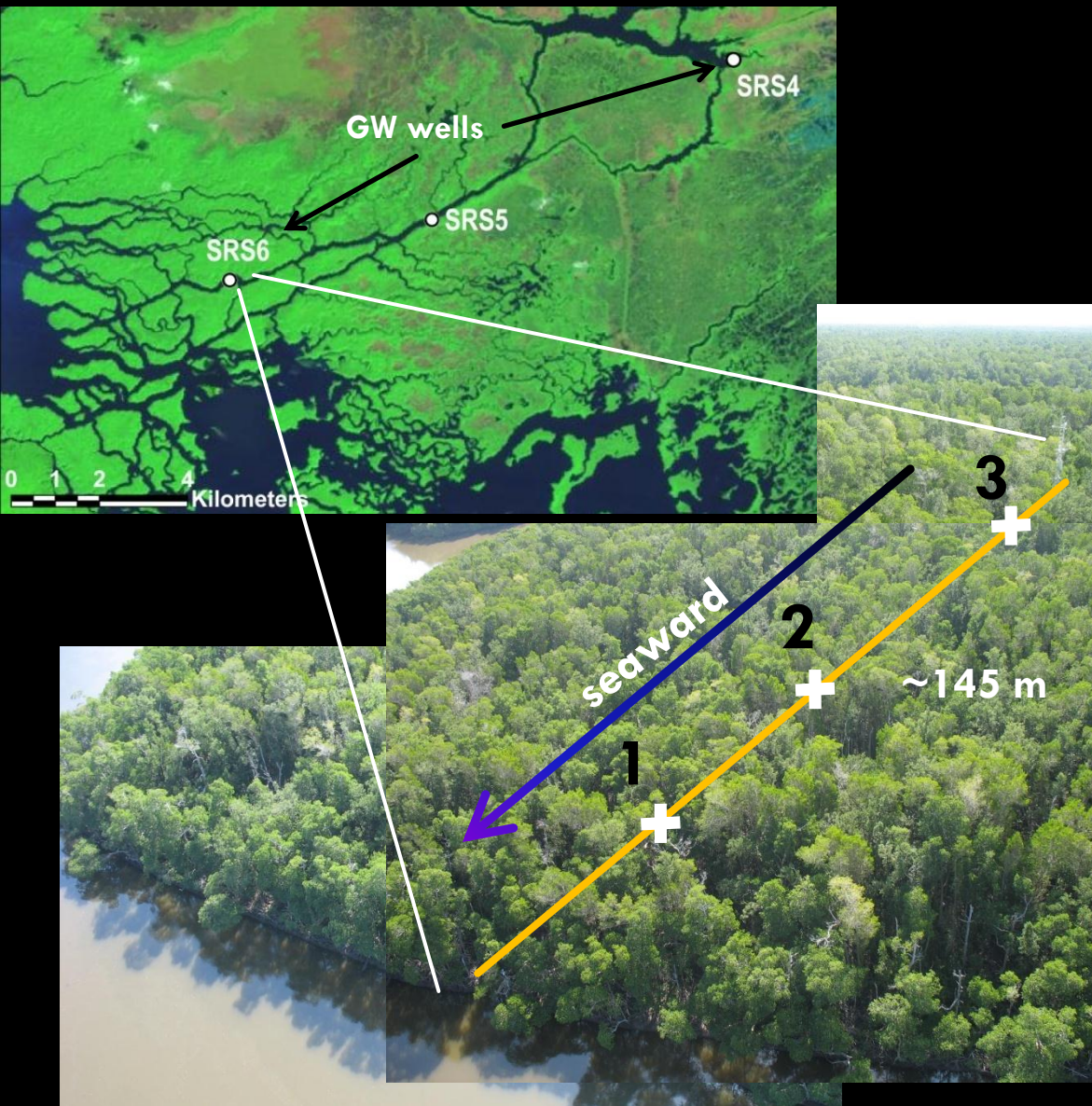
Everglades Overview



- Restoration
- Sea-level Rise
- Salt water Intrusion
- Rain \approx ET
 - \sim 60-80% during wet season (May-Oct)



Everglades-Shark River



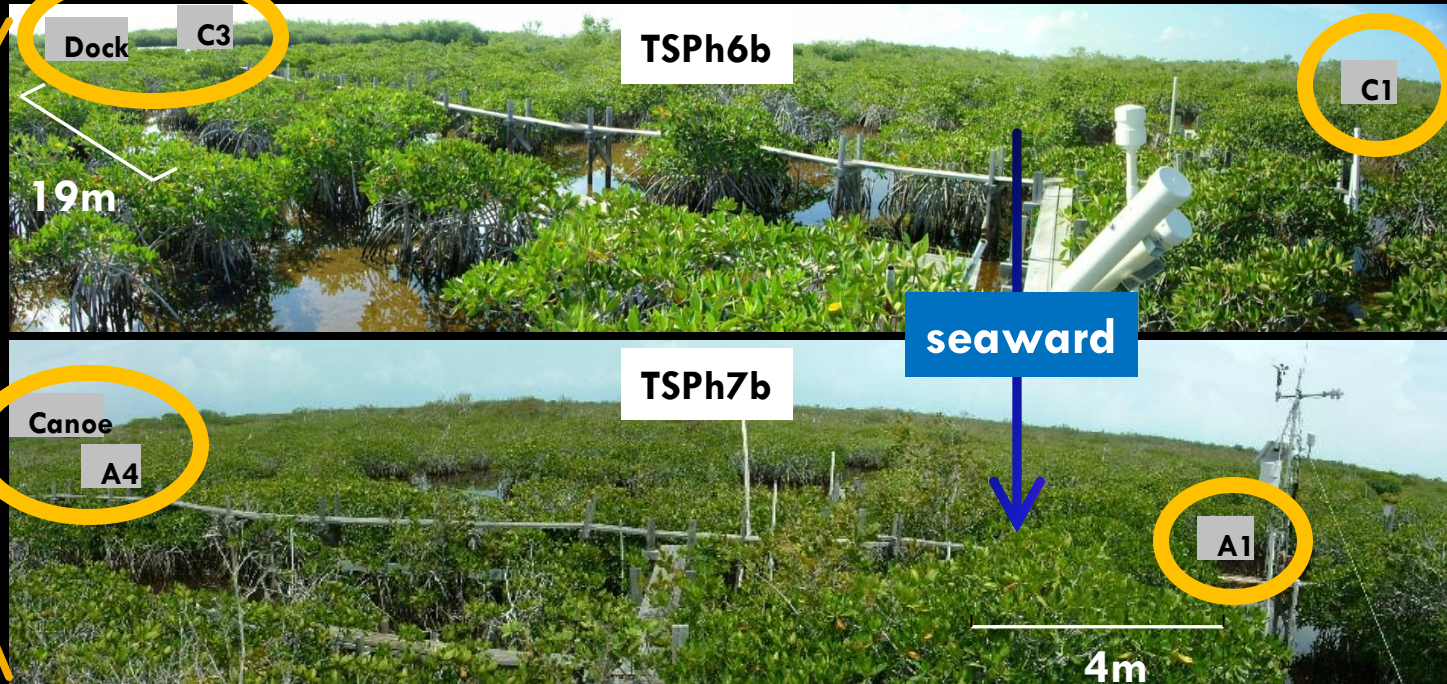
SITE LAYOUT

- Red, black and white mangroves (tall)
- Bedrock groundwater
- Pore water at 85 cm and 20cm depth

HYDROLOGY/ METEOROLOGY

- Eddy-covariance tower (SRS6)
- SW/GW level

Everglades-Taylor River



Courtesy of Xavier Zapata

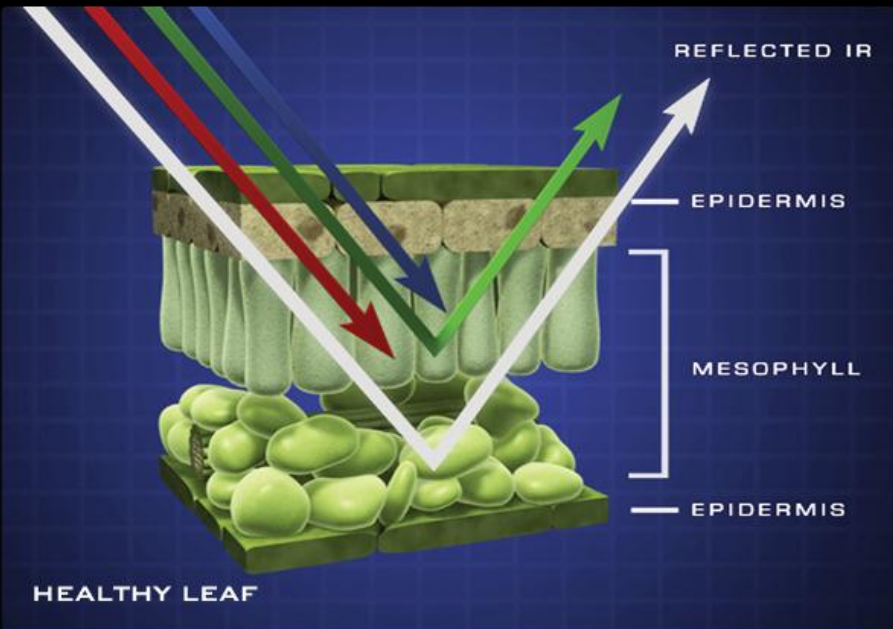
SITE LAYOUT

- Red mangroves (dwarf)
- Top of bedrock GW wells
- Pore water at 20cm depth

HYDROLOGY/METEOROLOGY

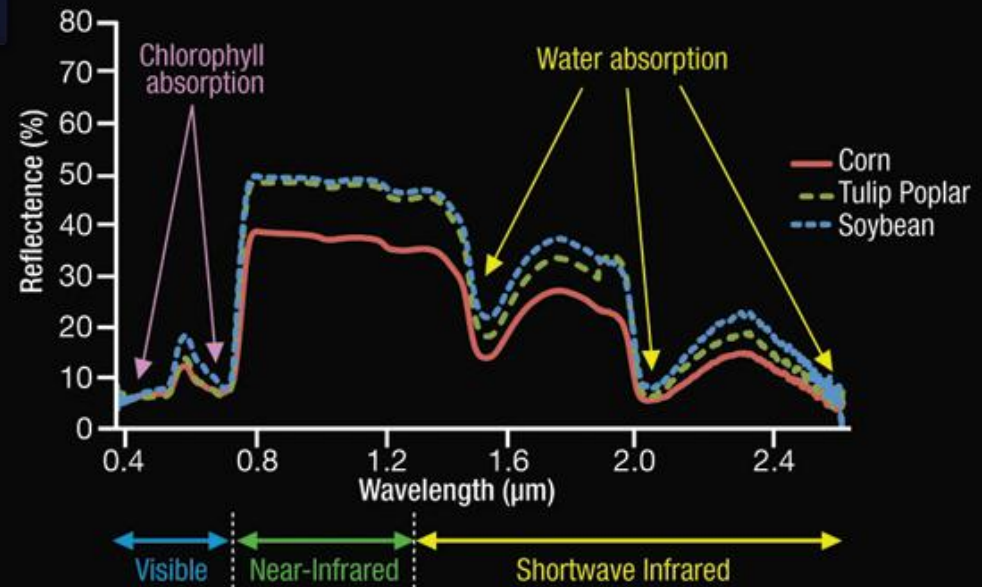
- Weather station (TsPh7)
- SW/GW level

Vegetation Reflectance



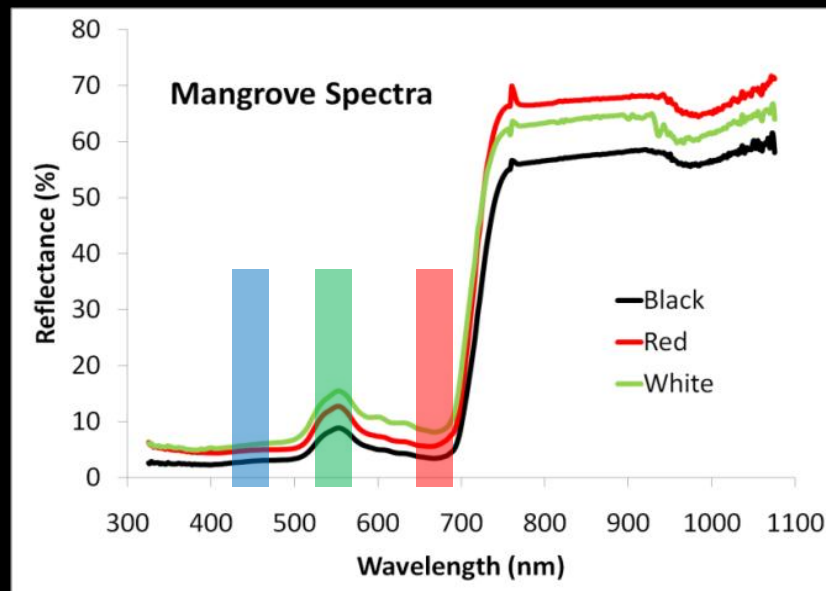
www.missionscience.nasa.gov

- Based on vegetation structure
- Δ environment \approx Δ structure \approx Δ spectra
- Used to calculate spectral vegetation indices



Spectral Vegetation Indices (SVI)

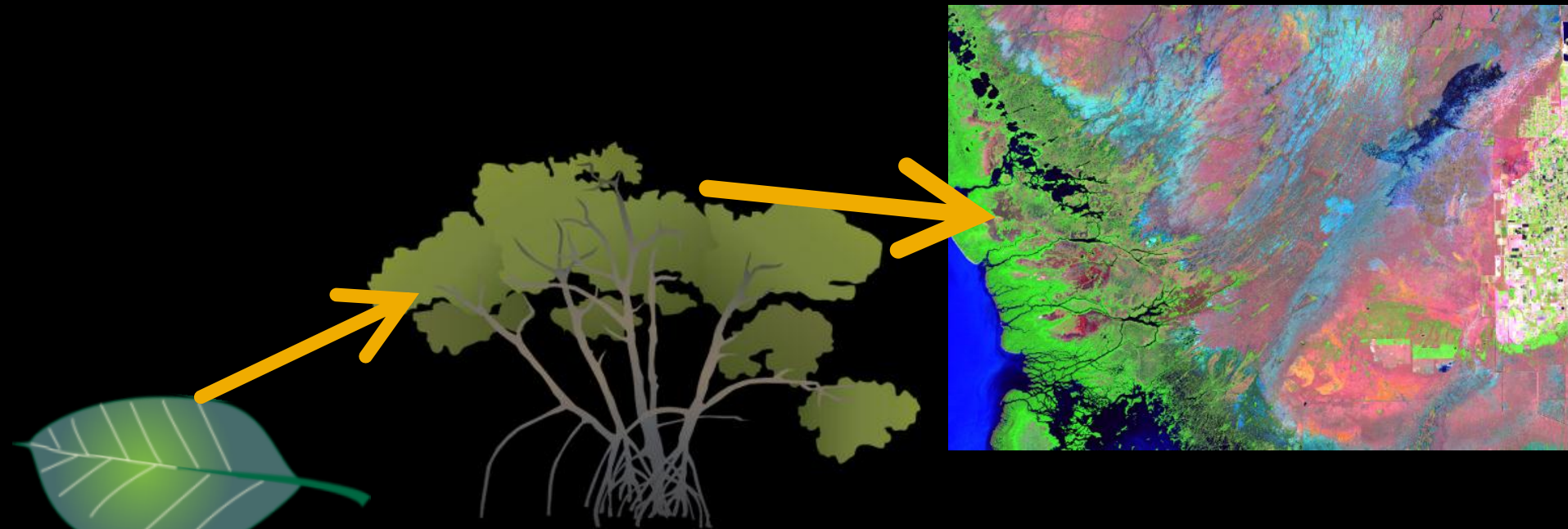
- Band combinations based on various wavelengths of the measured EM spectra
- Related to changes in the chemical and structural features
- Maximize sensitivity & minimize noise



SVI used in study

- EVI
 - [Total Nitrogen]
- REIP slope
 - [Ca²⁺]
- Rff_r
 - [Cl⁻¹]
- RE3
 - [SO₄²⁻]
- D705/722
 - [Total Phosphorus]

Field to regional upscaling



■ Leaf-scale

■ Canopy-scale

■ Regional-scale

Site/local hydrology

- Water quality
- Water availability
- Field spectra

upscaling

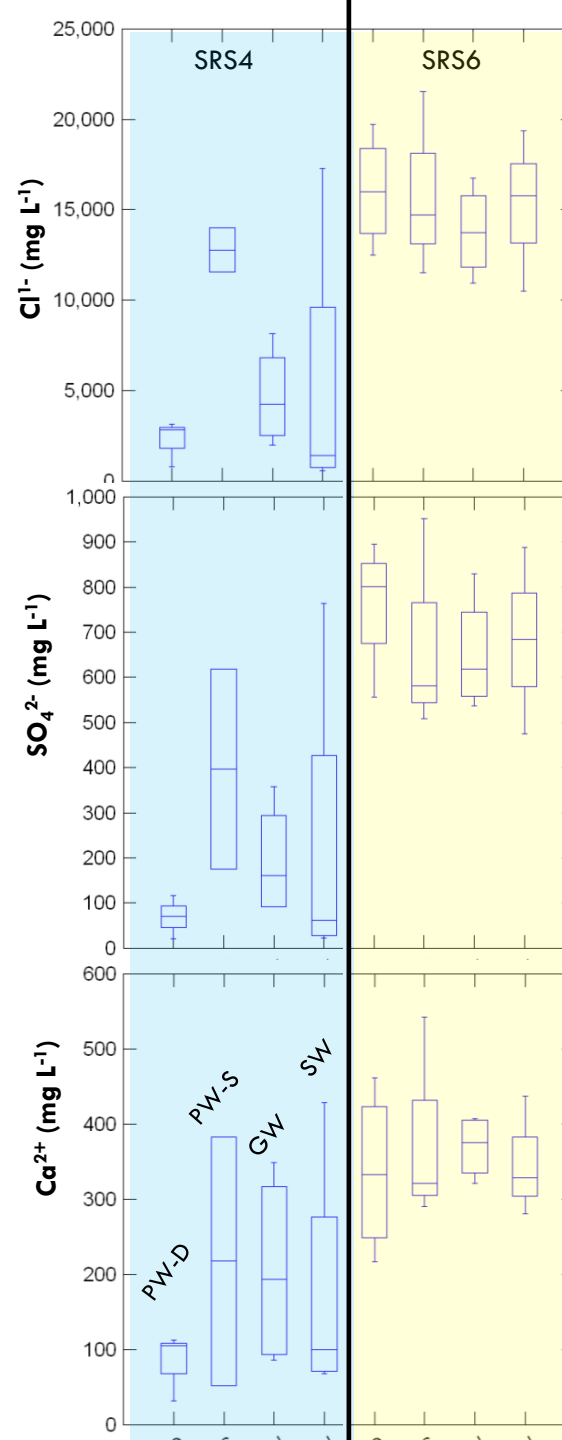
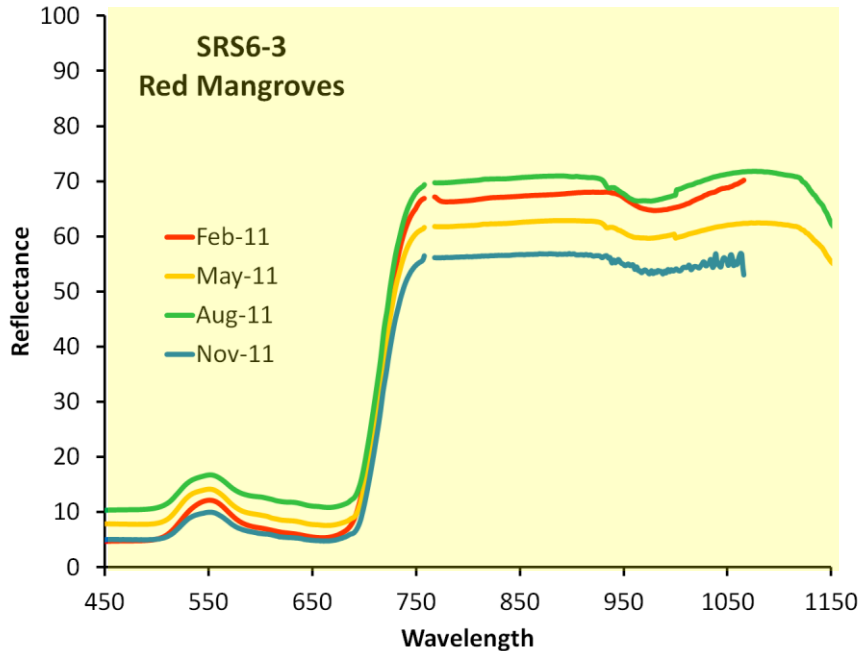
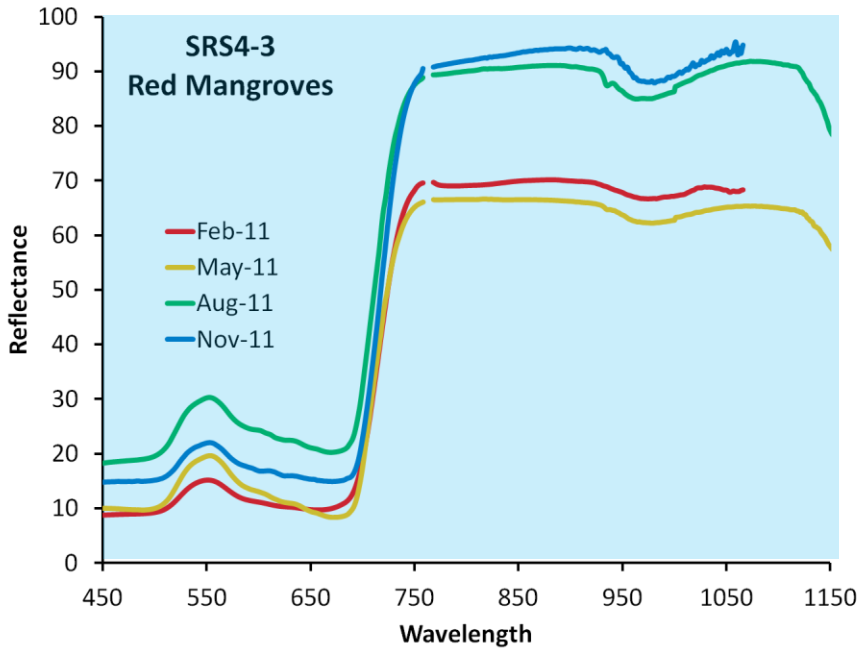
Regional hydrology

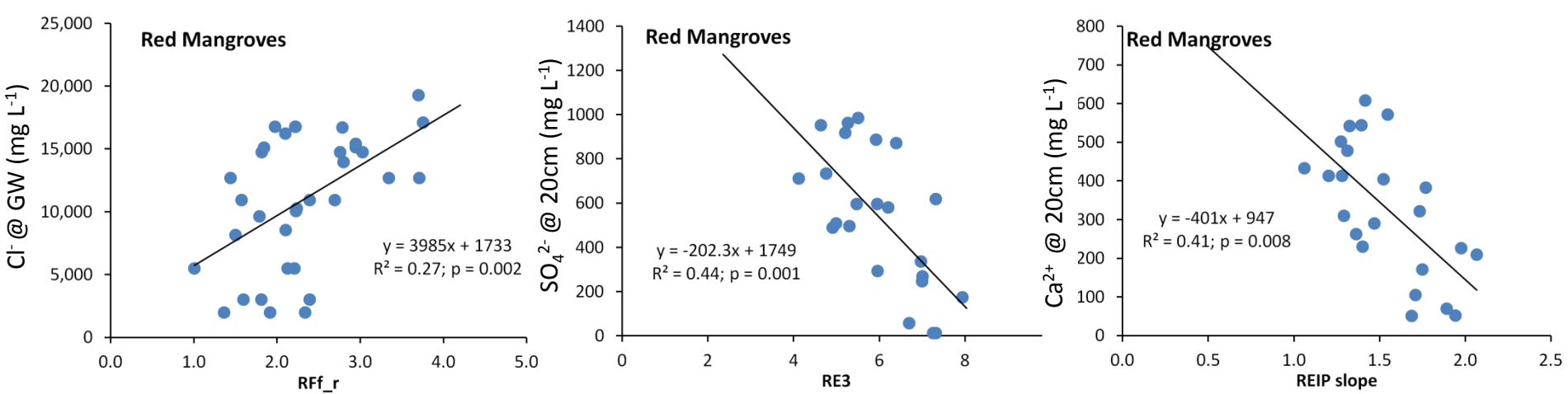
- Water quality
- Water availability
- Satellite spectra

groundtruthing

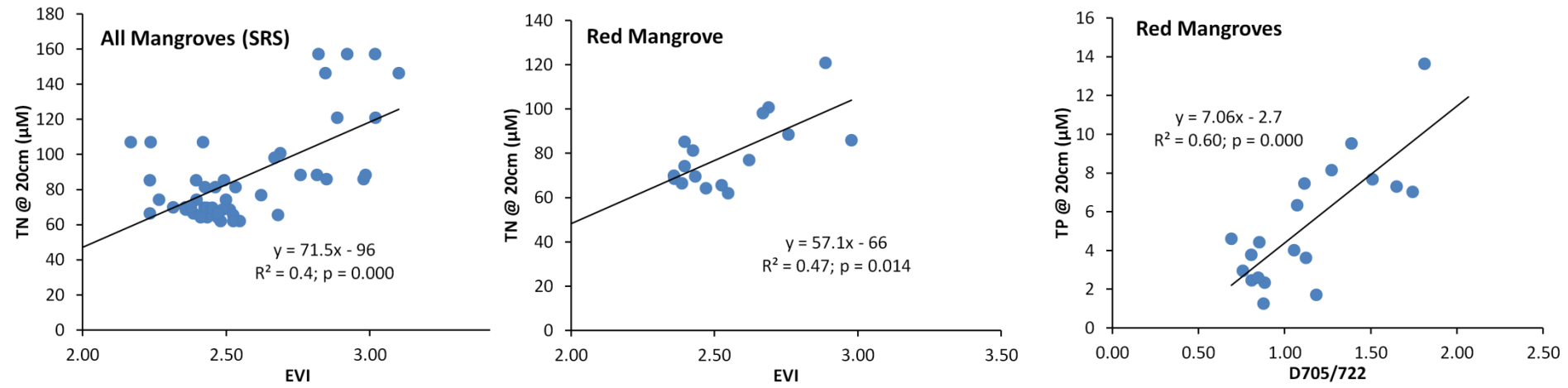
Results

- Δ spectra attributed to seasonal variability in water chemistry
- > variability at SRS4

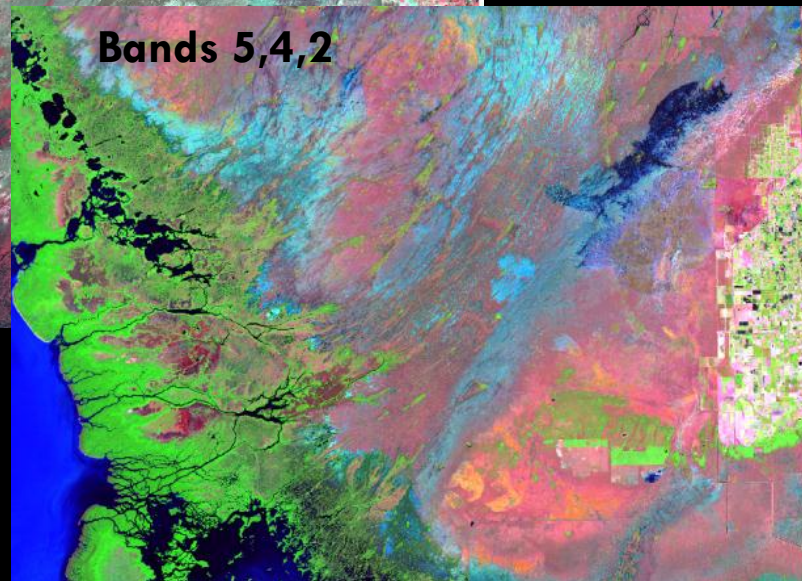
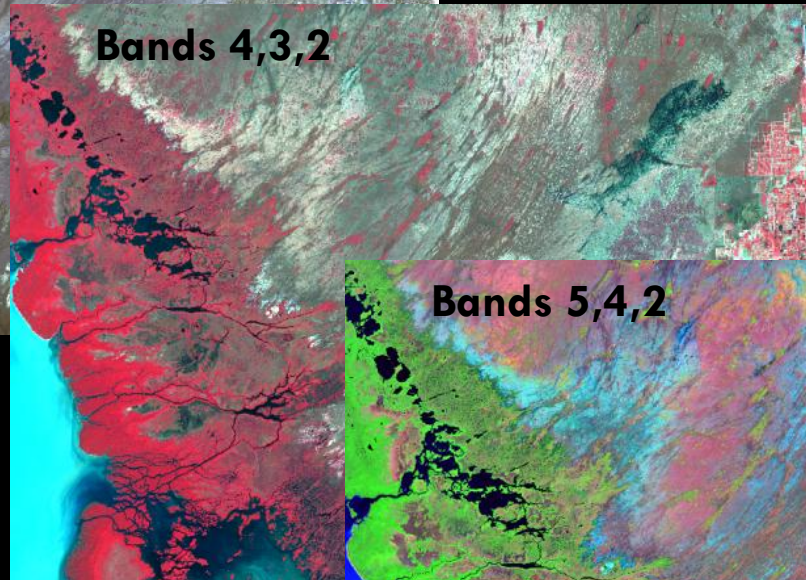
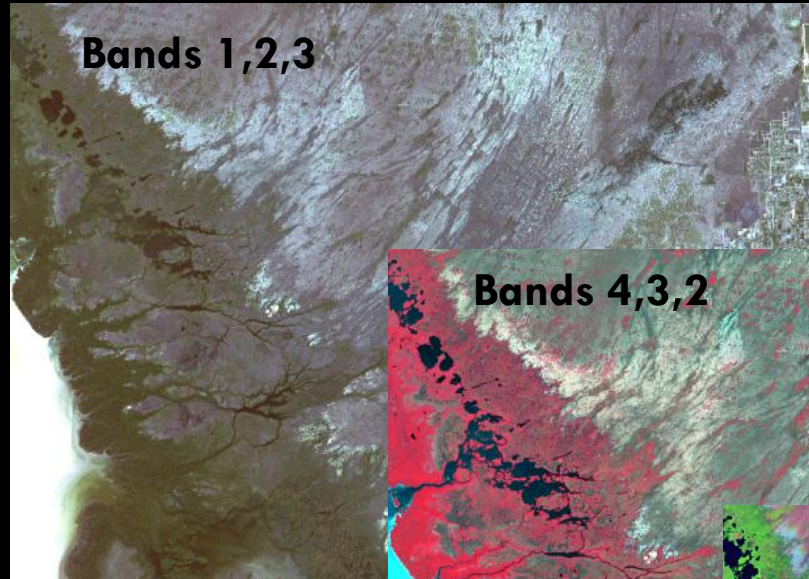




■ Significant correlations between SVIs and ion and nutrient concentrations

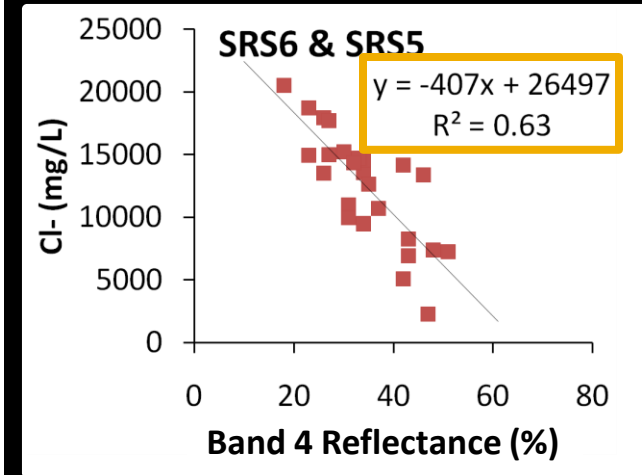
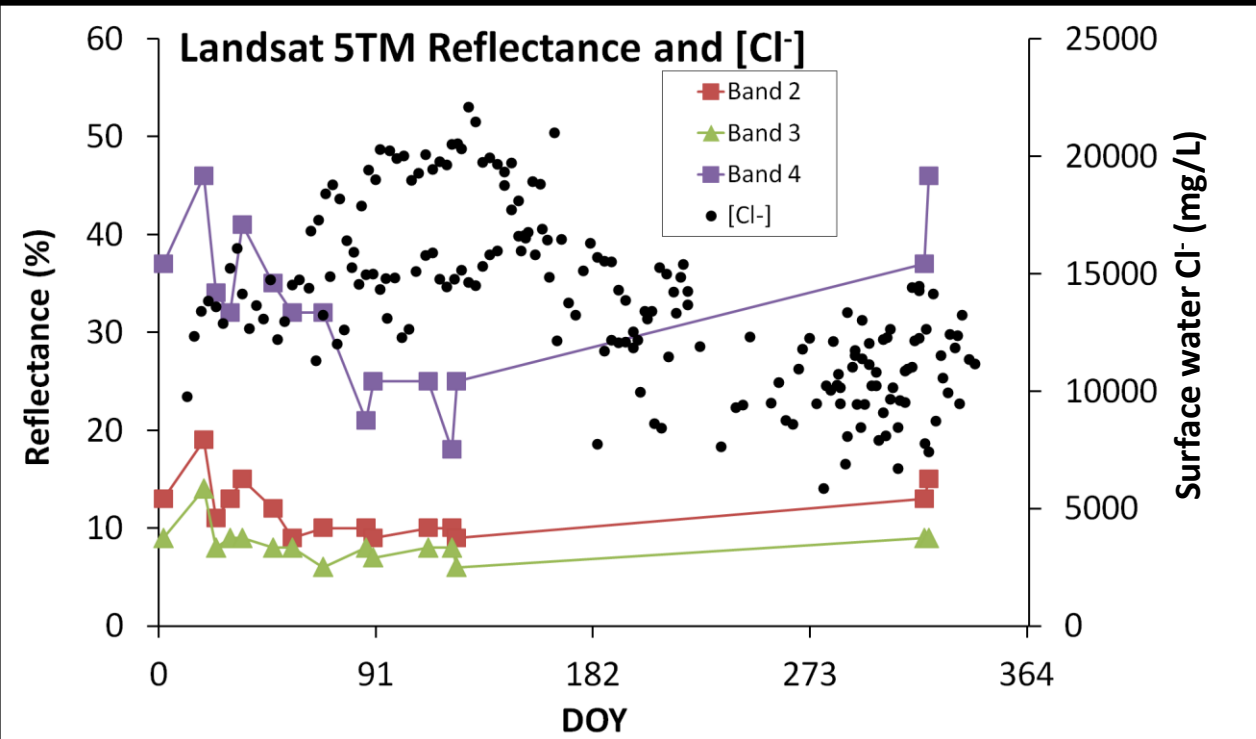


Satellite acquisitions

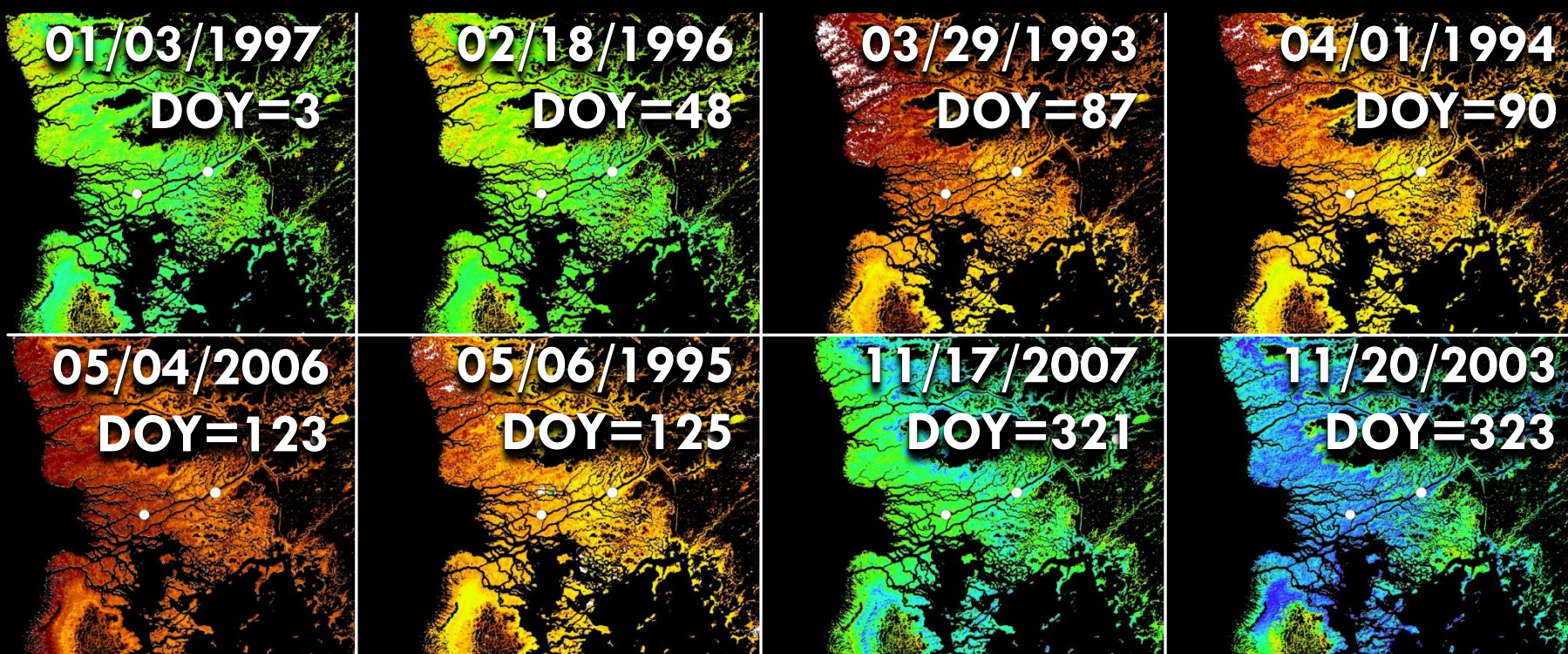


- Landsat 5TM
 - 30m x30m grid
 - 6 bands + 1 thermal
 - 14 day repeat
- 15 images from 1993-2009

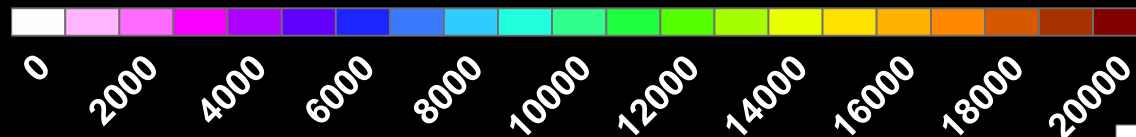
Satellite-Level Reflectance



- Decrease in NIR (band4) with increase in [Cl⁻]
- Strong correlations ($p < 0.05$) with SRS 5&6 sites



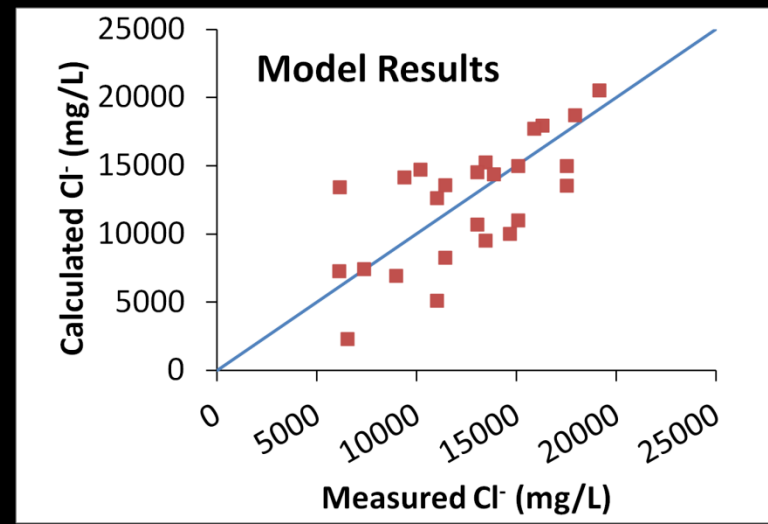
Cl⁻ (mg/L)

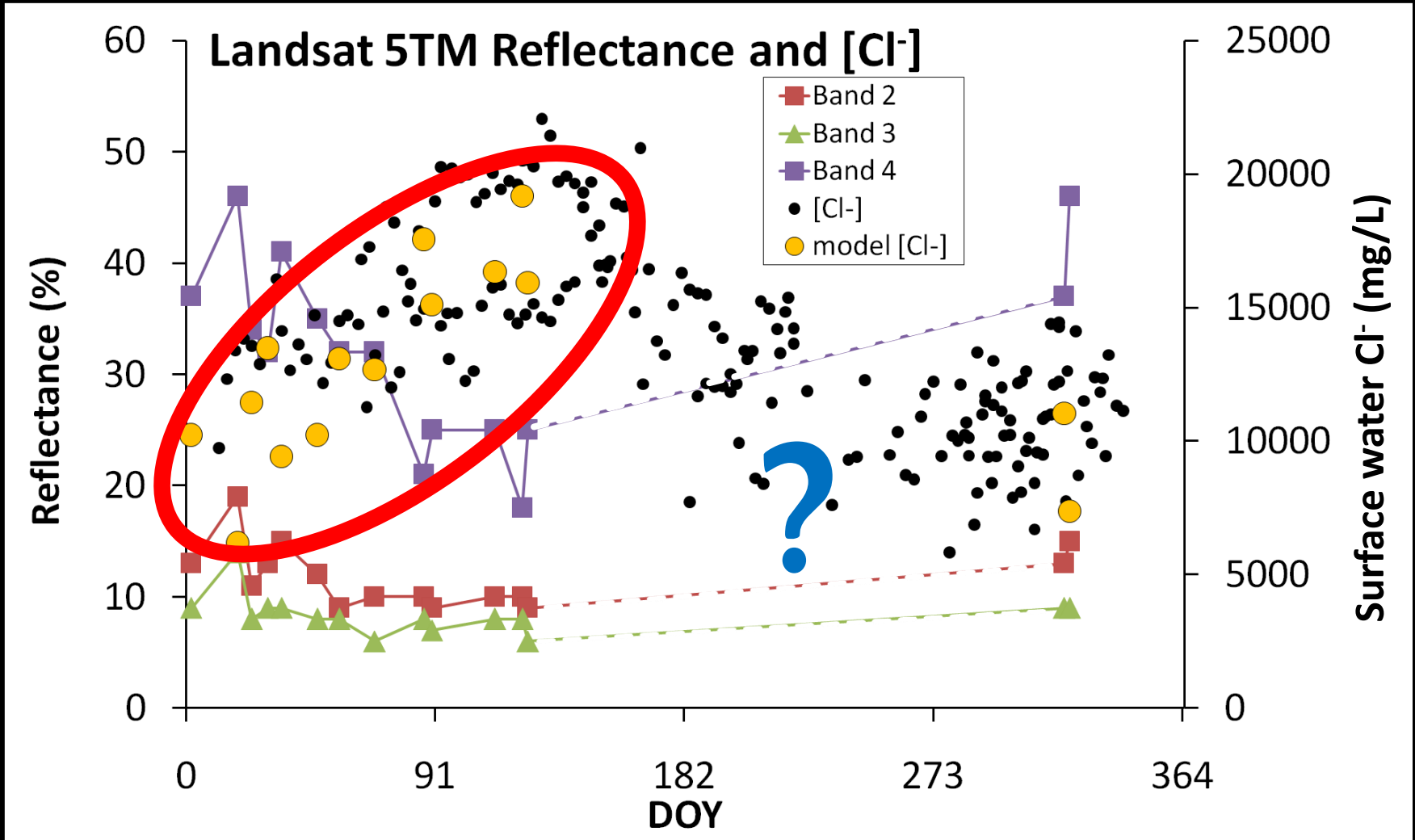


■ Seasonal [Cl⁻] variations

- Low [Cl⁻] in wet season
- High [Cl⁻] in dry season

■ Downstream gradient





Summary

- Leaf-level and satellite-level data show comparable results
- Seasonal spectral trends associated with changes in water chemistry

Future Directions

- Additional data to improve model
- Decadal changes through times
 - Landsat legacy (1970s-2000s)
- Use stressed conditions to better constrain satellite ET estimates
- Extrapolate to the Caribbean and elsewhere



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Questions