HYDROGEOCHEMICAL RESPONSE OF EXPERIMENTAL EVERGLADES TREE ISLANDS (FLORIDA, USA): IDENTIFYING FEEDBACK MECHANISMS ASSOCIATED WITH EARLY TREE GROWTH AND DIFFERING GEOLOGIC MATERIALS

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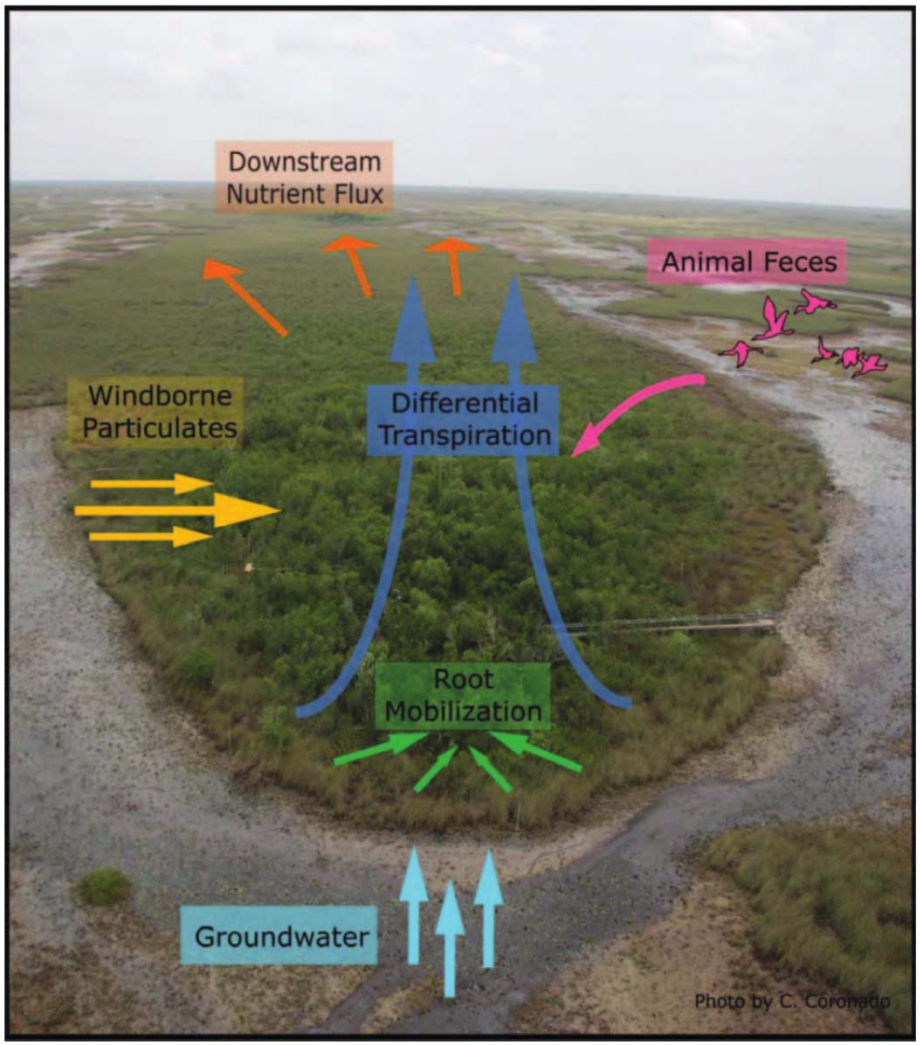
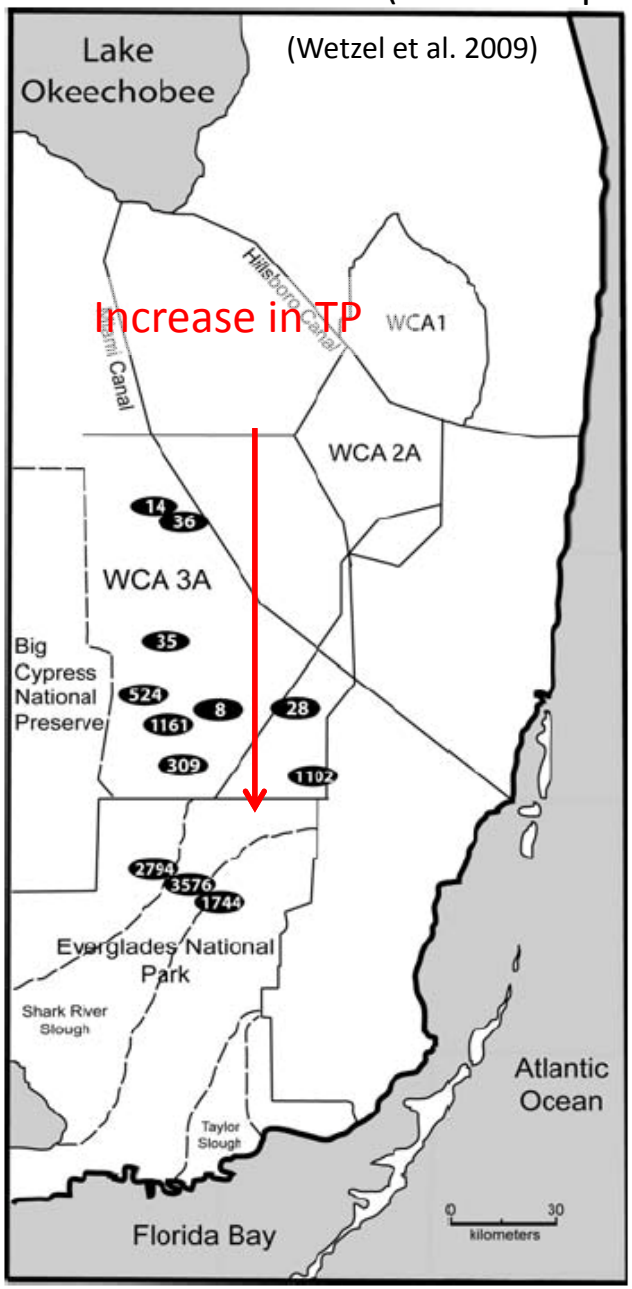
Tree islands in the Everglades are nutrient hot spots which can be supported by numerous mechanisms

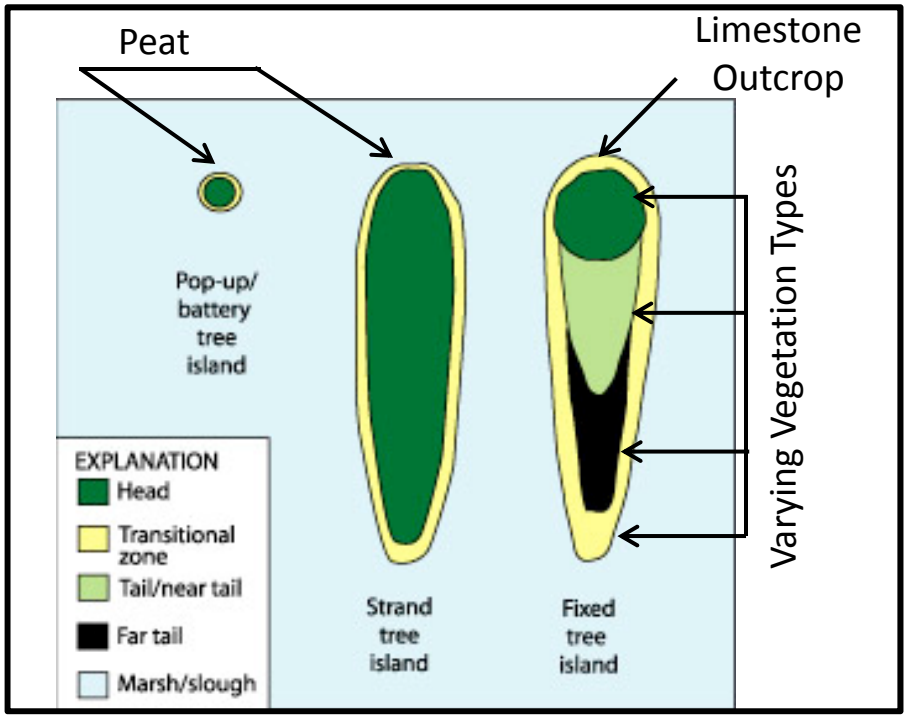


Wetzel PR, Sklar FH, Coronado CA, Troxler TG, Krupa SL, Sullivan PL, Ewe S, Price RM, Newman S, Orem WH. 2011. **Biogeochemical processes on tree islands in the greater Everglades: Initiating a new paradigm**. Critical Reviews in Environmental Science and Technology 41, 670 — 701. DOI: 10.1080/10643389.2010.530908

Soil Total Phosphorus Concentrations (g m^{-2}) on Tree Island Heads (0-10cm depth)

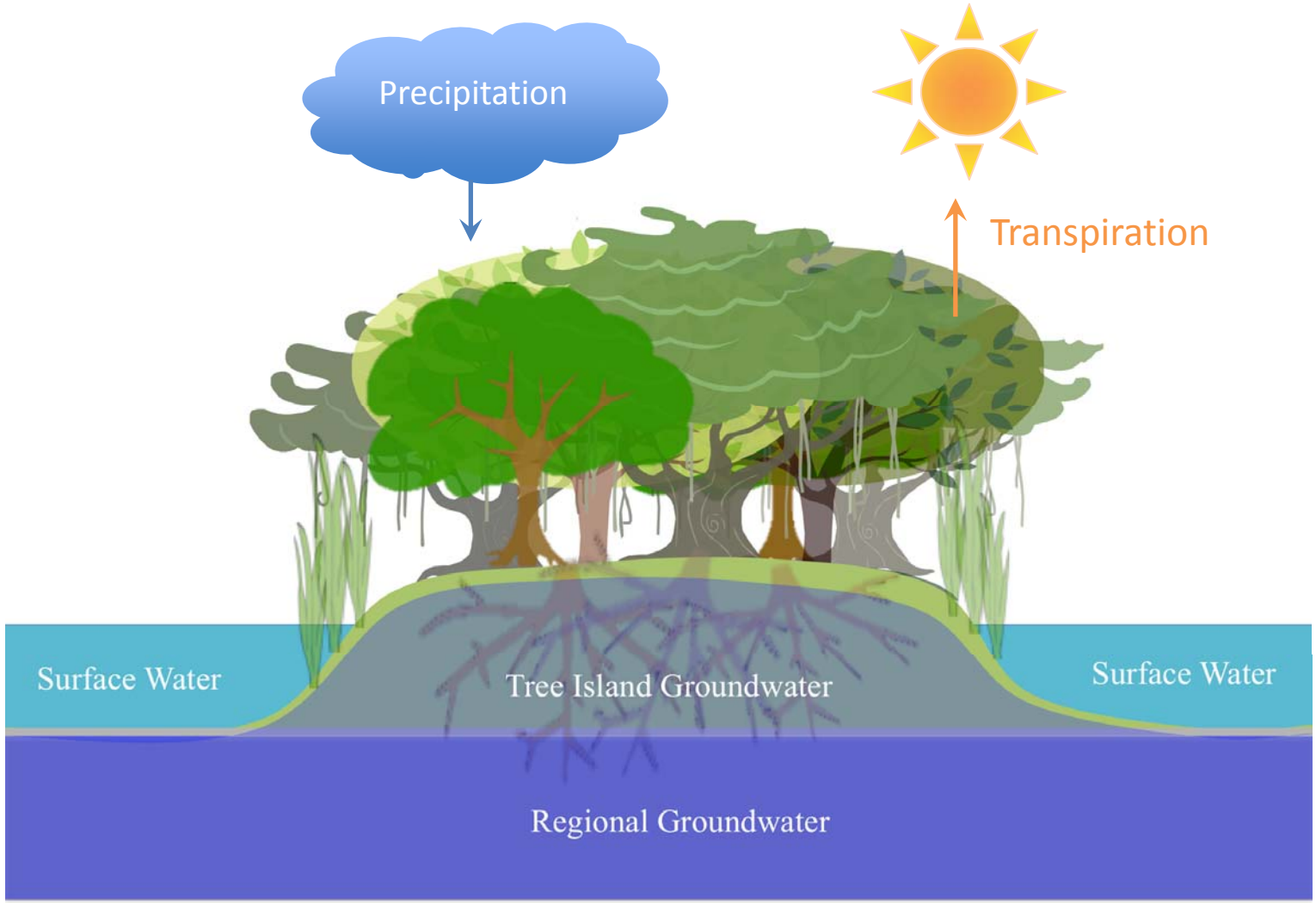


Tree island nutrient and ion concentrations and lithology vary across the Everglades

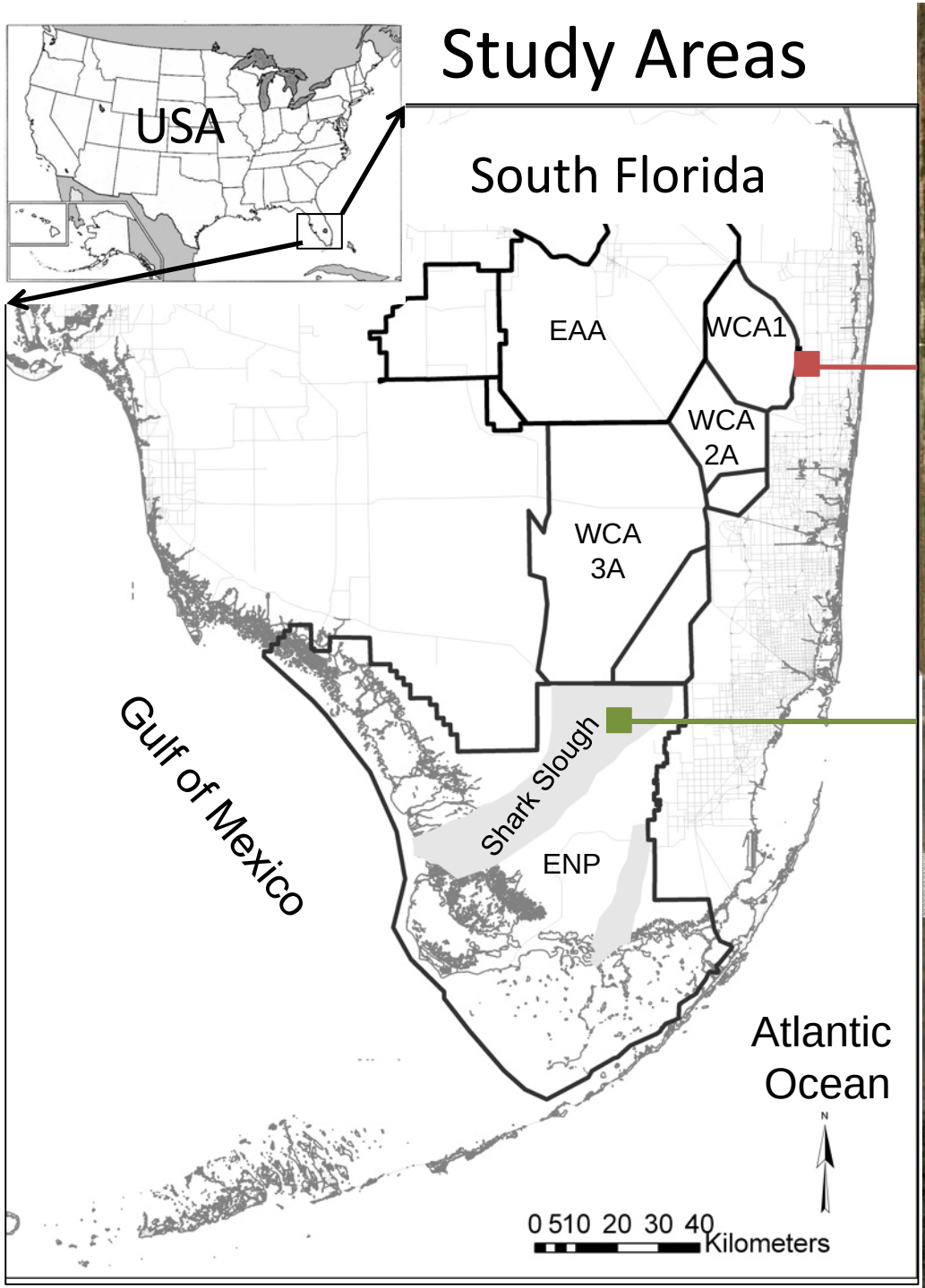


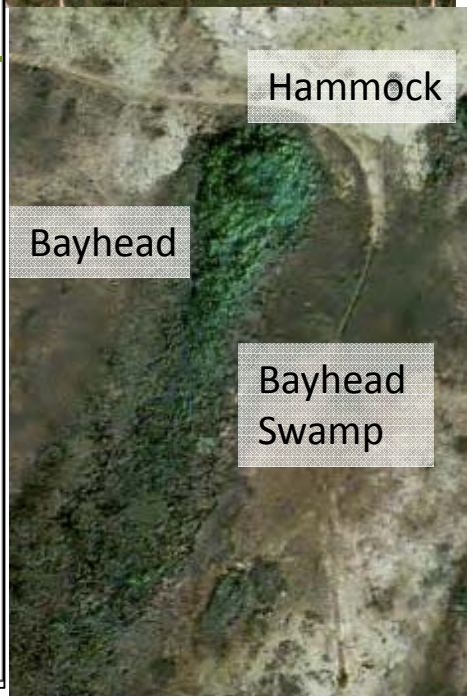
Goal

To define the relationships between groundwater-surface water interactions, plant-water uptake, and ion and nutrient concentrations on tree islands across the Everglades



Study Areas





LILA

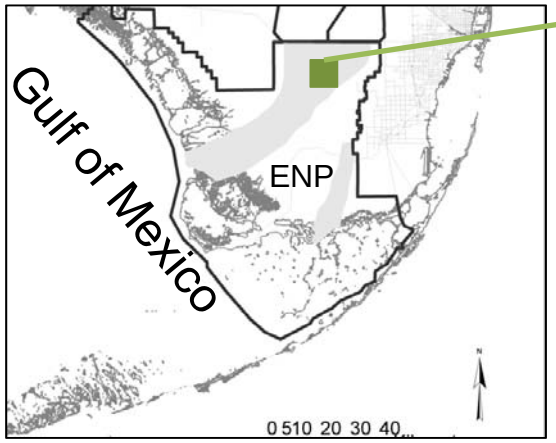
- Large physical model of the Everglades
- Located at the edge of Loxahatchee National Wildlife Reserve
- Contains 8 tree Islands
- Tree Islands were planted in 2006 and 2007

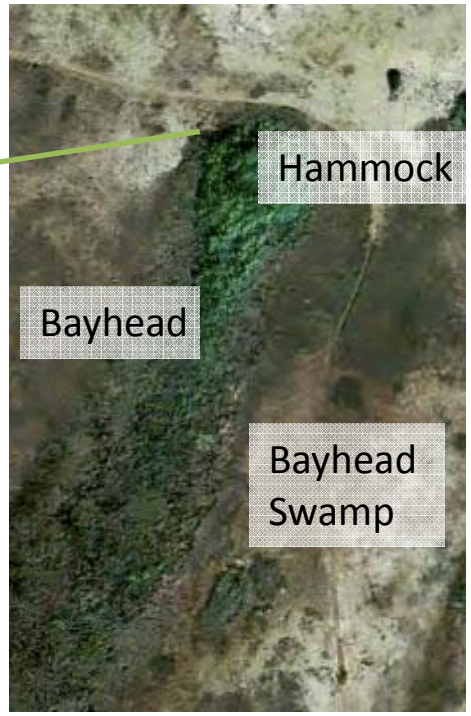
Satinleaf

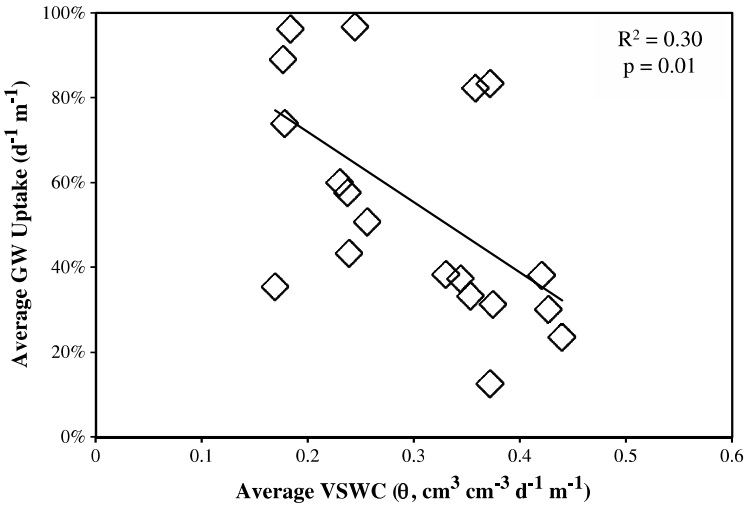
- Located in Everglades National Park
- Teardrop in Shape
- Contains 3 differing plant communities

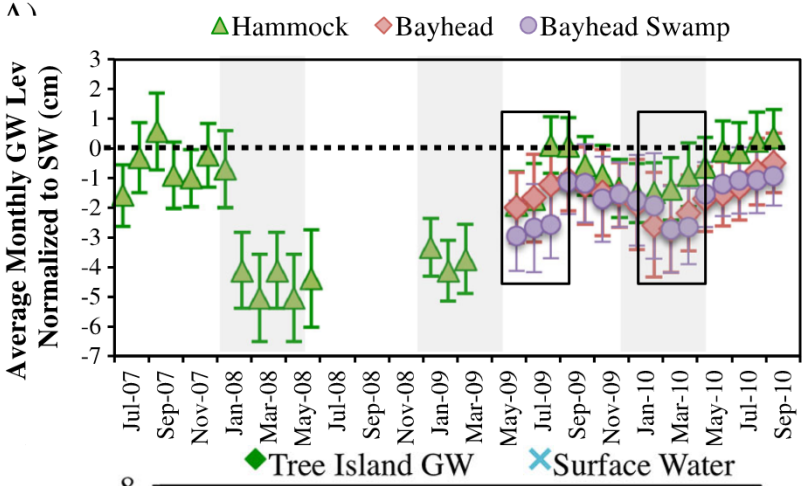
Findings from Satinleaf…

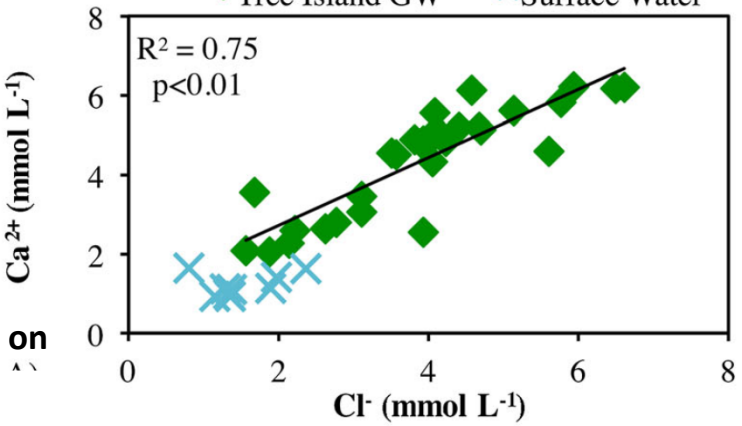
GW uptake by trees was enhanced during the dry periods which resulted in drawdown in the water table under the island which concentrated ions in TI groundwater and supported the potential precipitation of calcium carbonate.







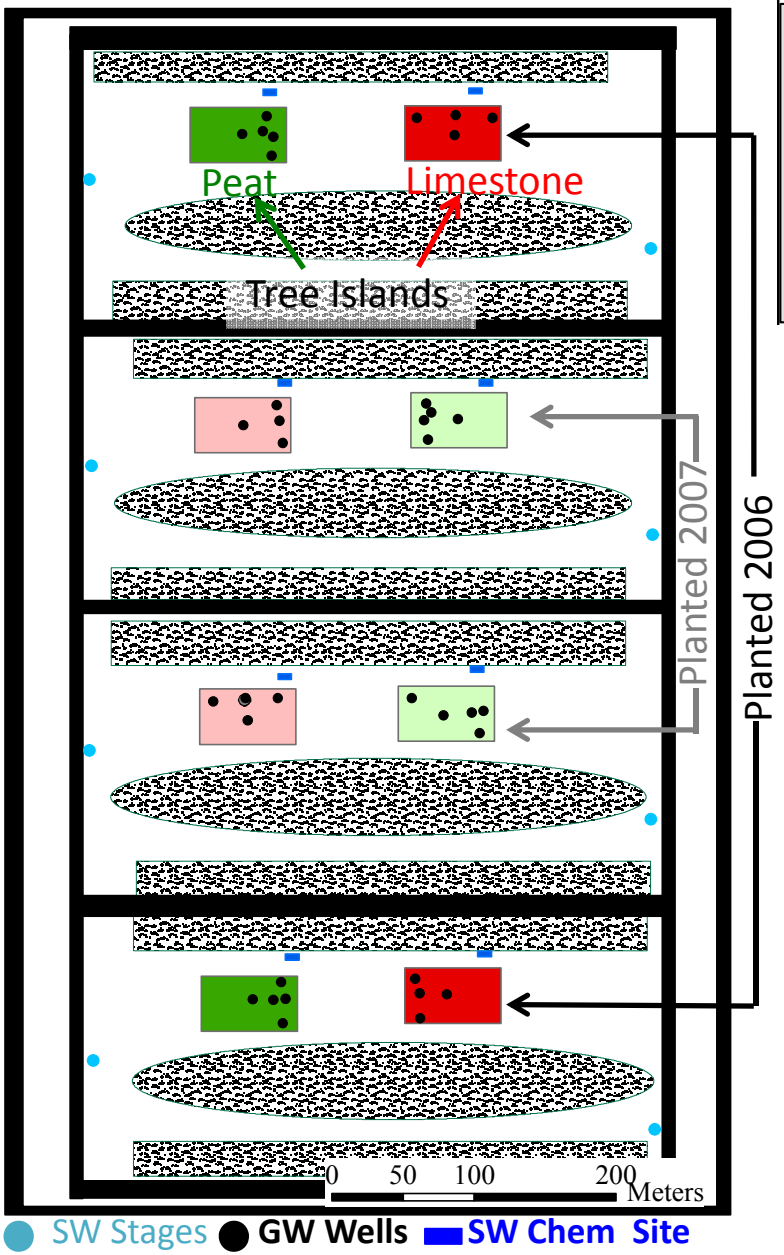




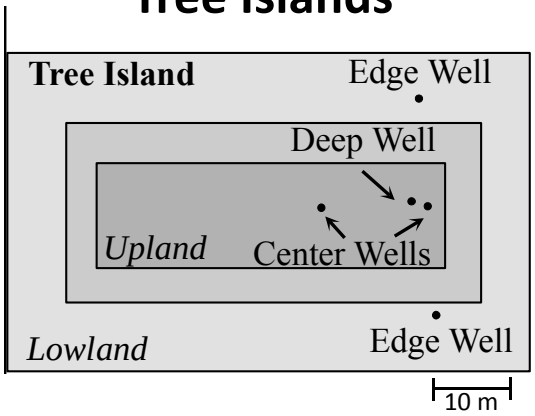
Sullivan PL, Engel V, Ross MS, Price RM. 2013. **The influence of vegetation on the hydrodynamics and geomorphology of a tree island in Everglades National Park (FL, USA).** Ecohydrology. DOI: 10.1002/eco.1394

Groundwater and Surface Water Monitoring Locations At LILA

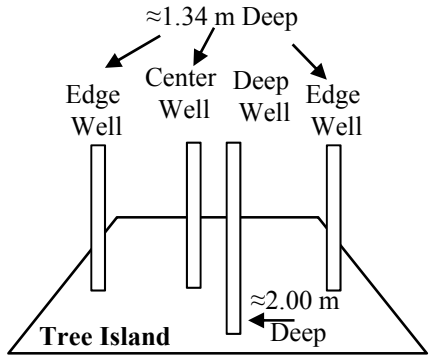
LILA



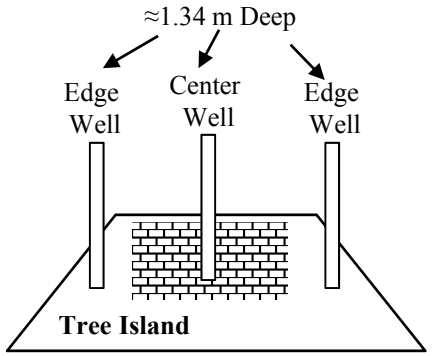
Tree Islands



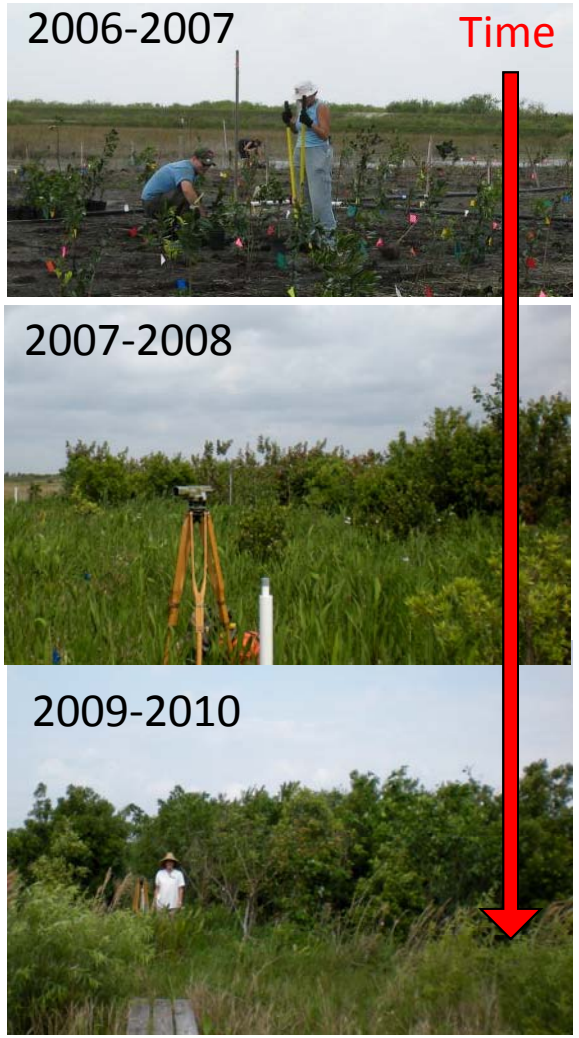
Peat Island



Limestone Island



Growth of Trees



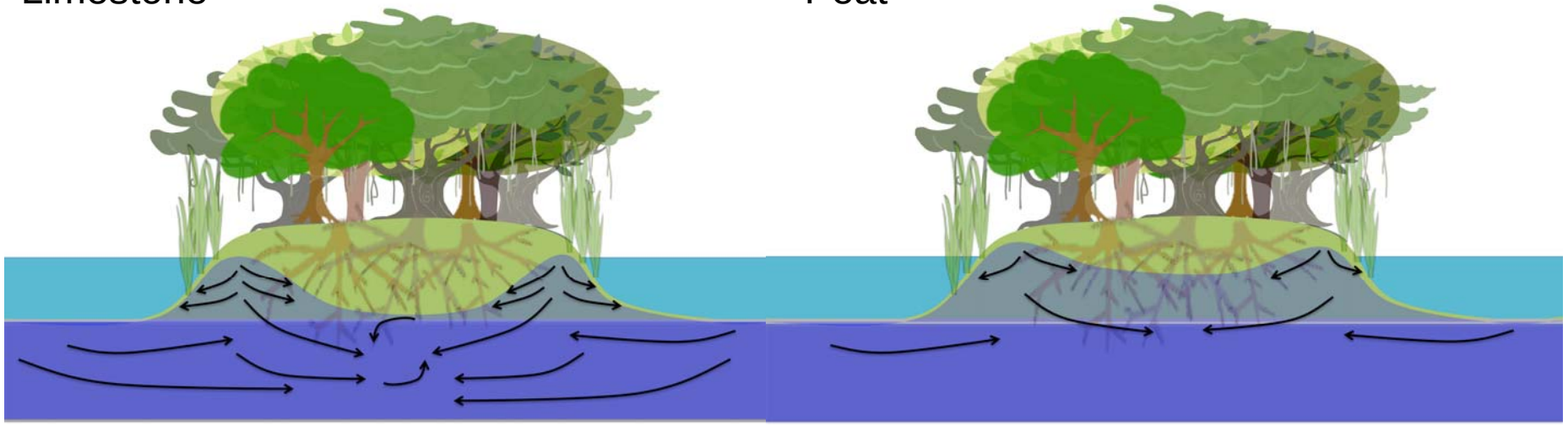
Conceptual Model

Predominant direction of GW flow
just after trees were planted

Predominant direction of GW flow 3 years later

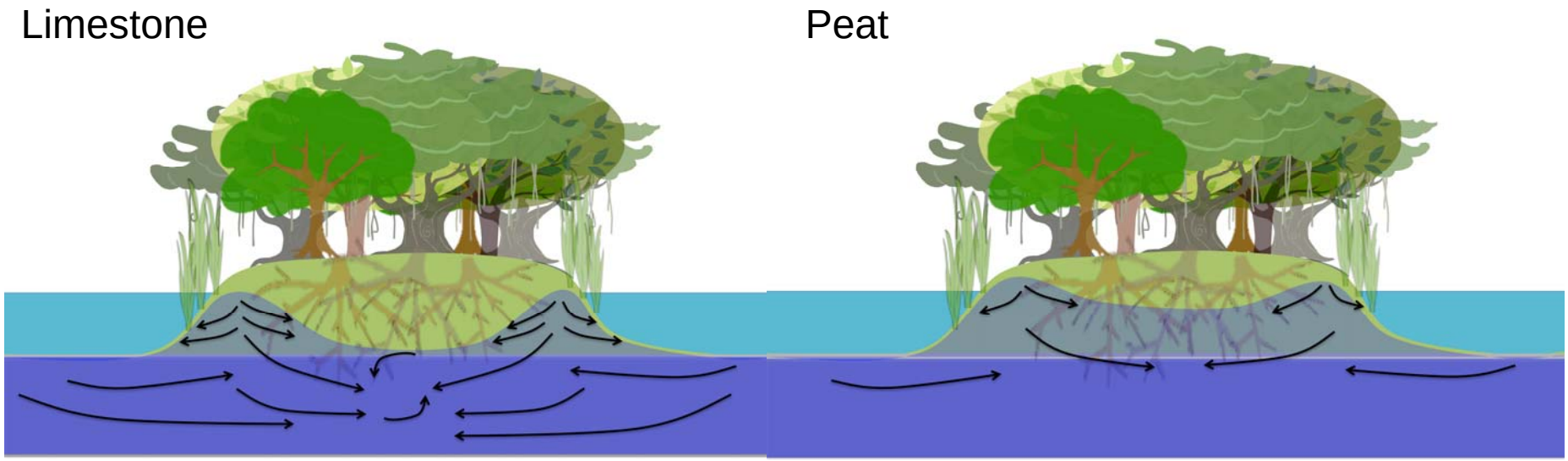
Limestone

Peat

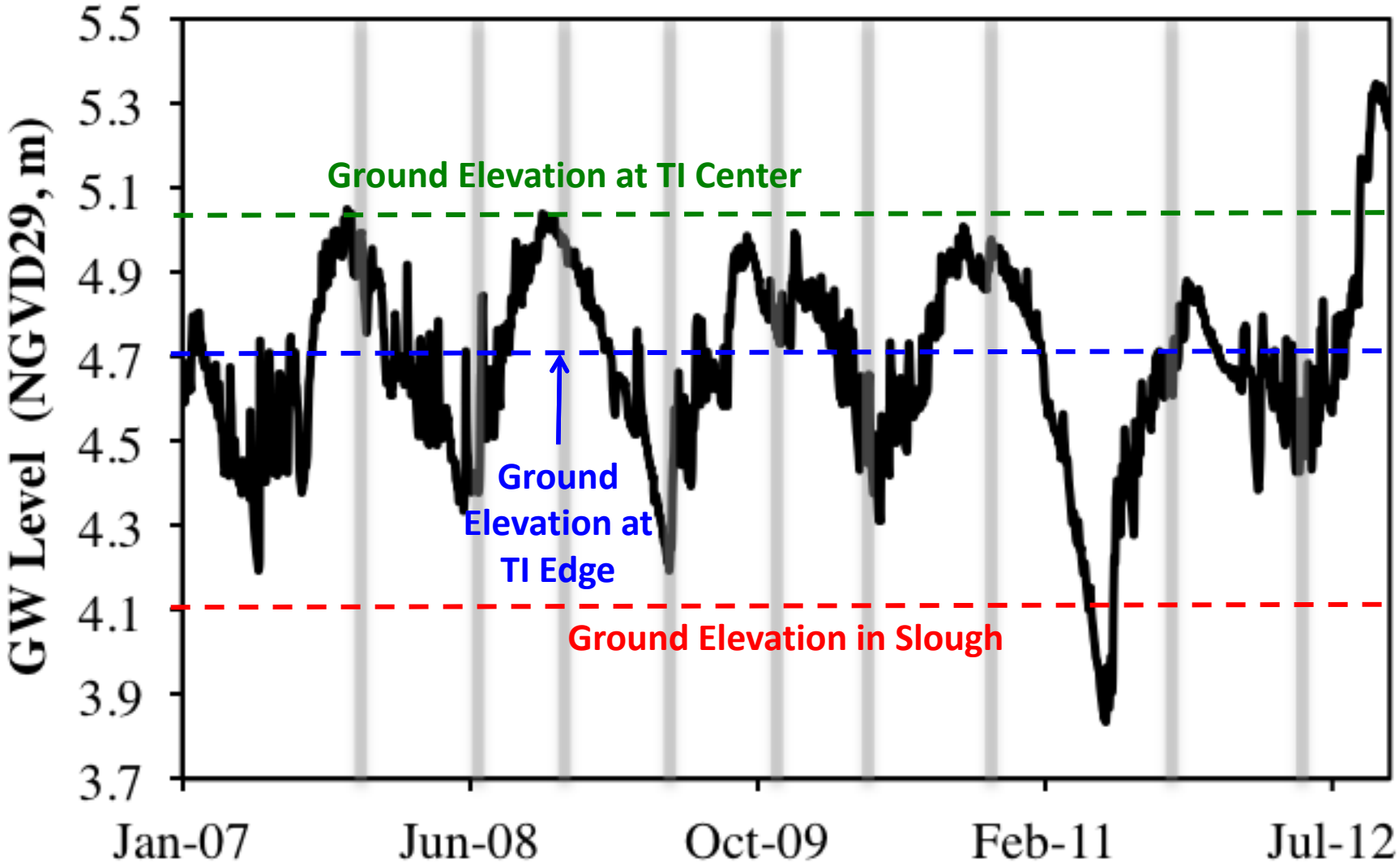


Sullivan PL, Price RM, Ross MS, Scinto LJ, Stoffella SL, Cline E, Drechel TW, Sklar FH. 2011. **Hydrologic processes of tree islands in the Everglades: Tracking the effects of tree establishment and growth**. Hydrogeology Journal 19, 367-378.DOI: 10.1007/s10040-010-0691-0

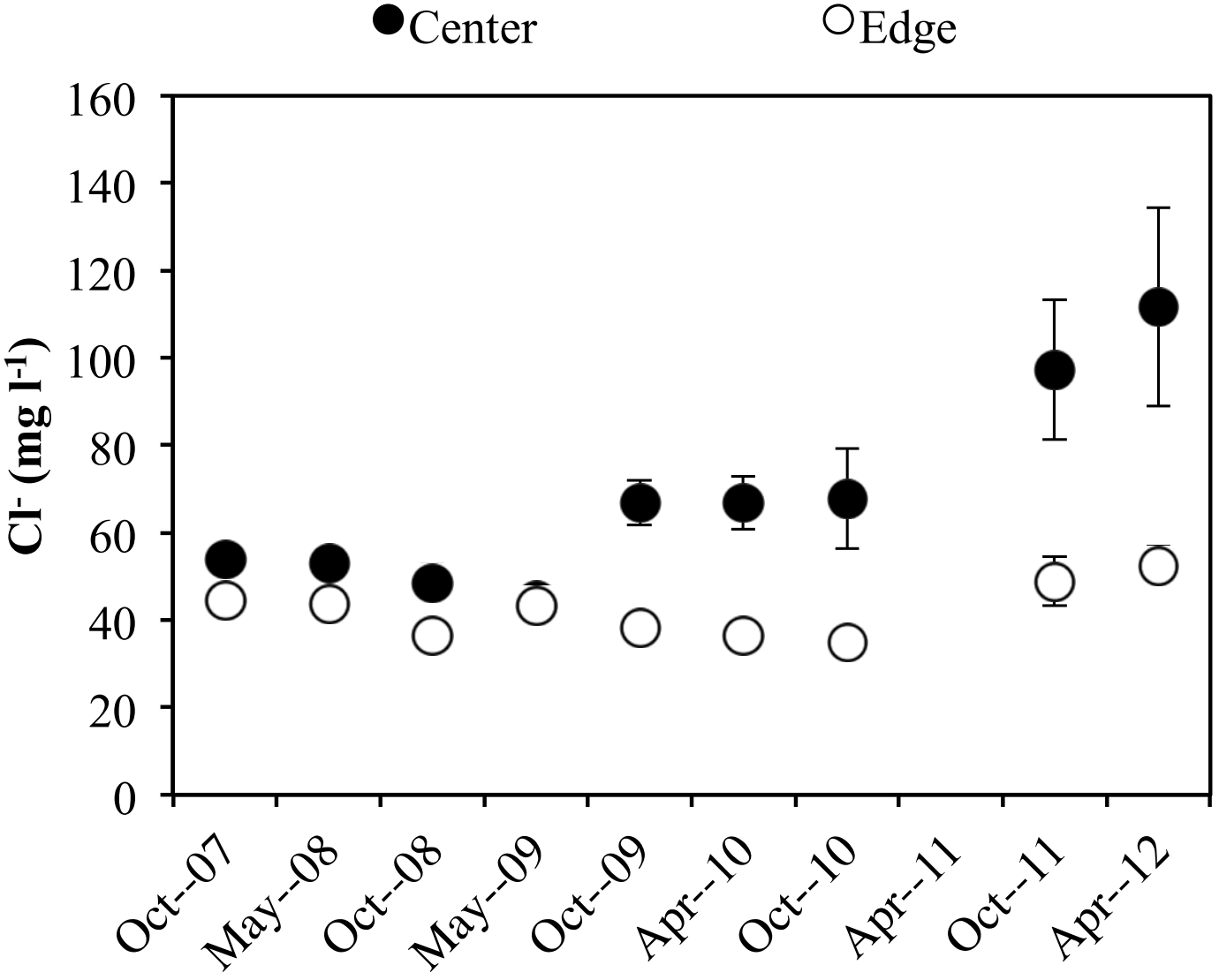
- What is the TI hydrogeochemical response associated with early tree growth and differing geologic materials
- Does its support our conceptual model?
- How can it help us to elucidate TI evolution on the landscape?



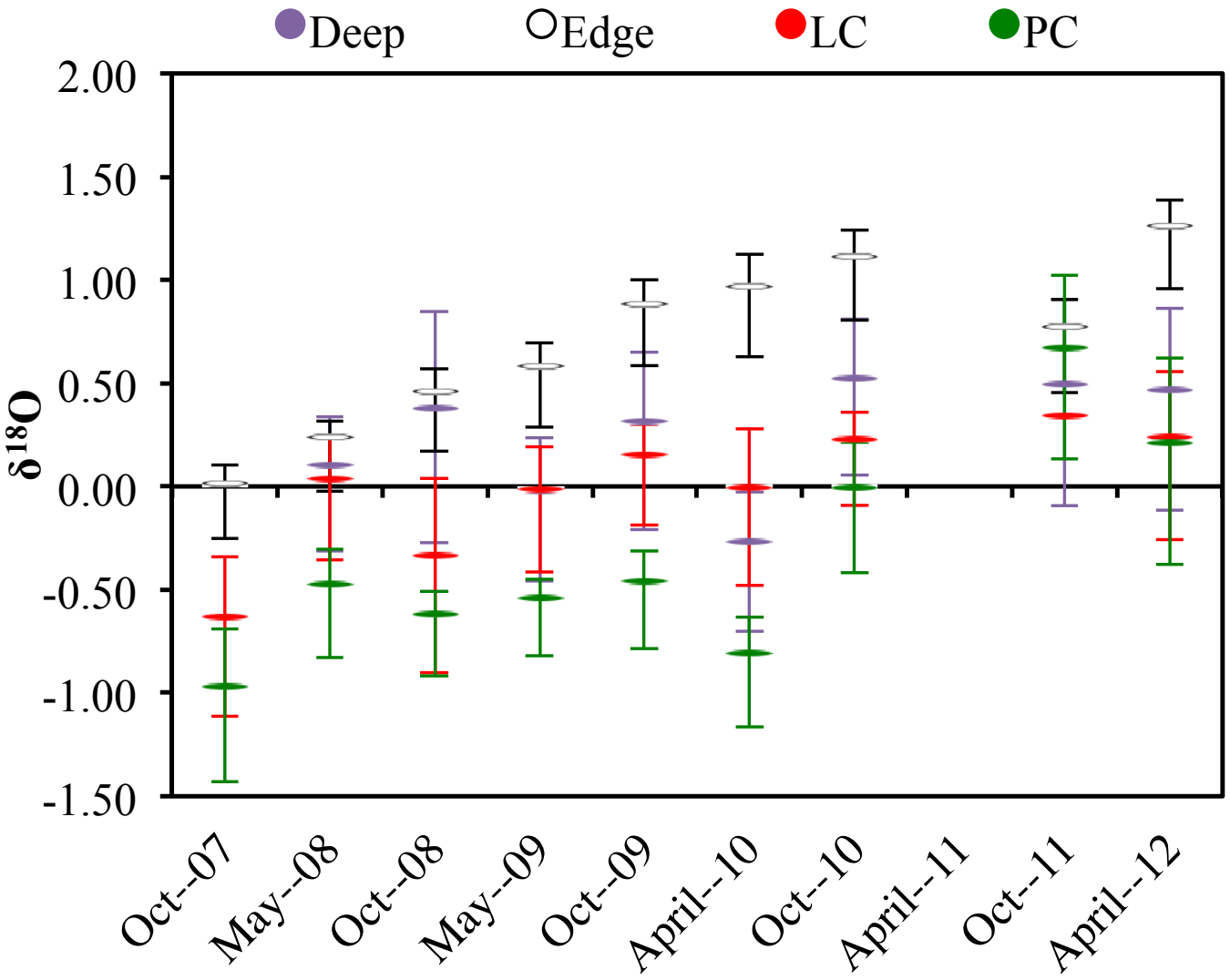
Groundwater samples were collected at the height of the wet (October) and dry season (April/May)



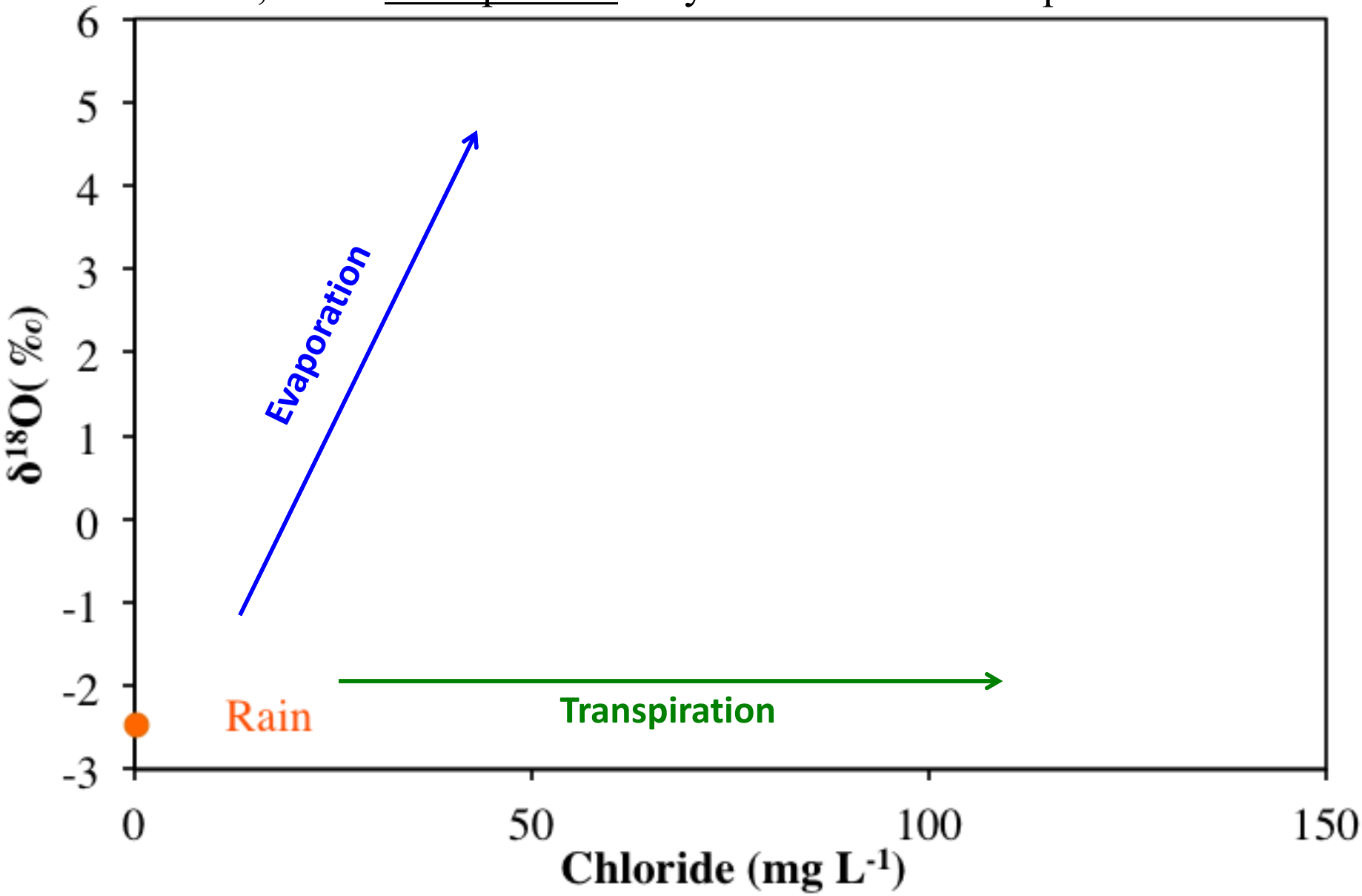
Increased concentrations of the non-reactive tracer Cl^- in TI **Center** compared to the Edge groundwater indicates concentrating effect over time



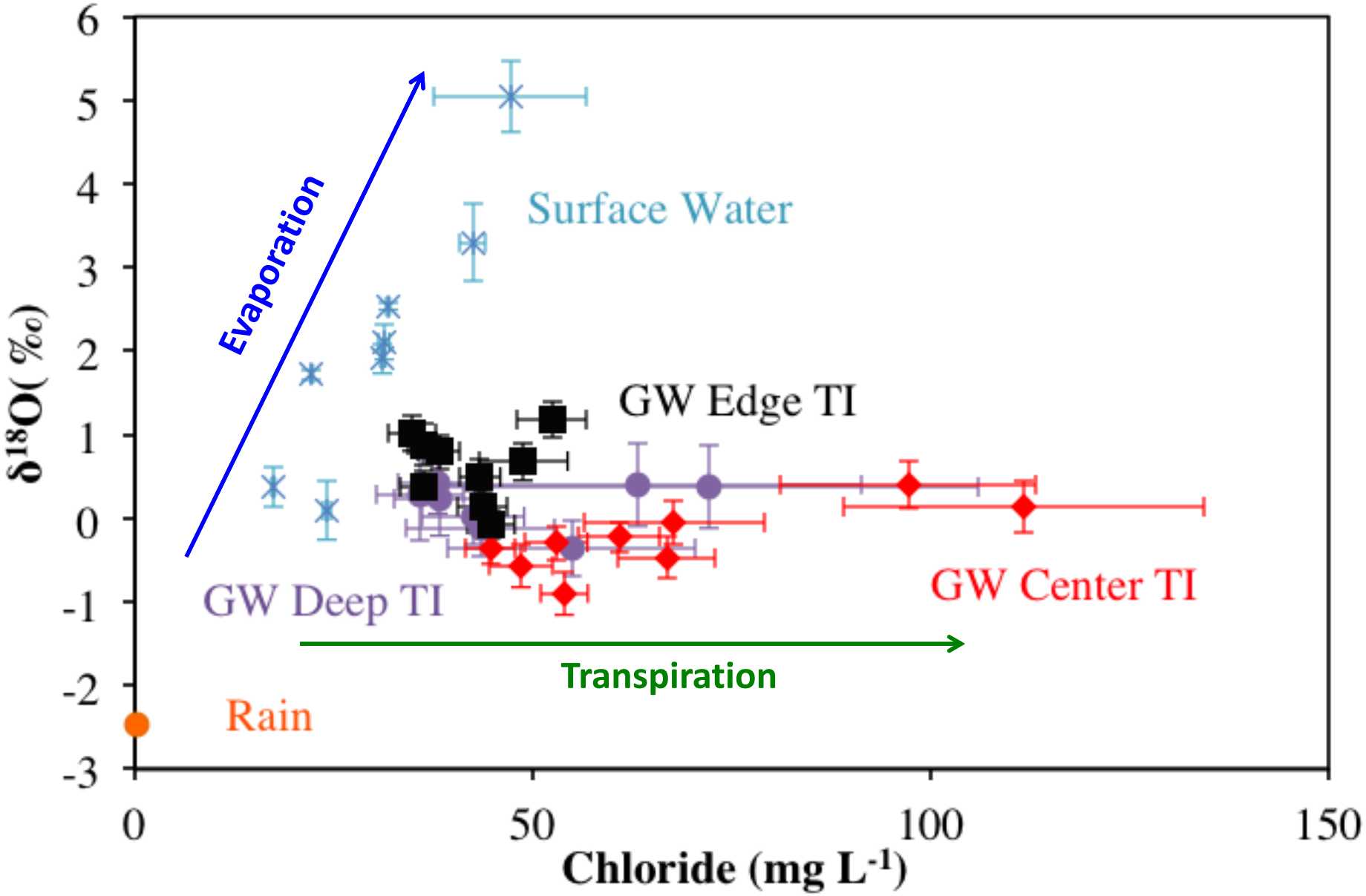
A strong enrichment of GW isotopic values were observed on the **EDGE** over time but to a lesser degree in the **peat** and **limestone** **centers**, while **Deep** groundwater had value between the edge and center.

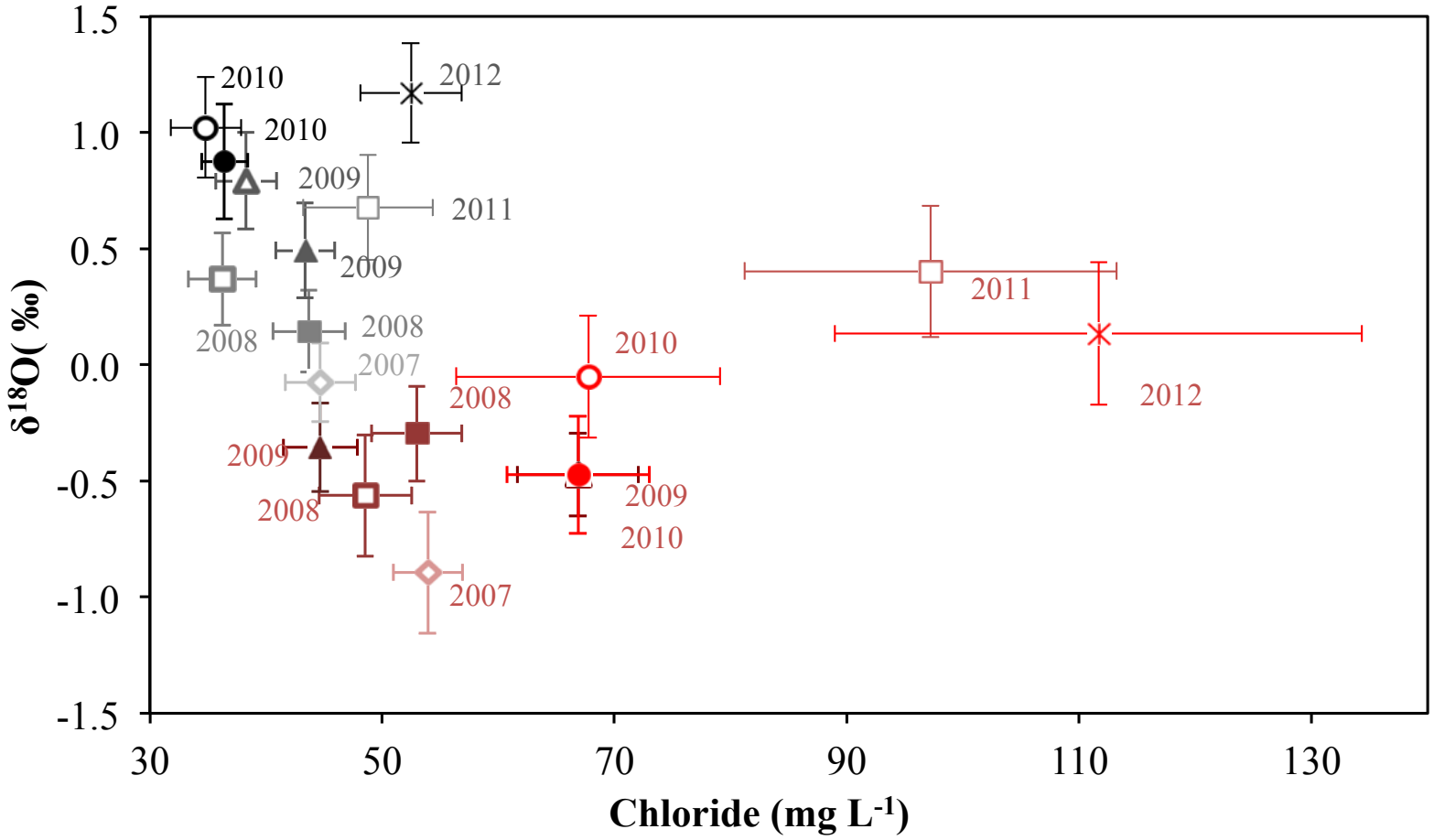


Evaporation influences the water isotopic values and Cl^- composition of water, while Transpiration only effects the Cl^- composition

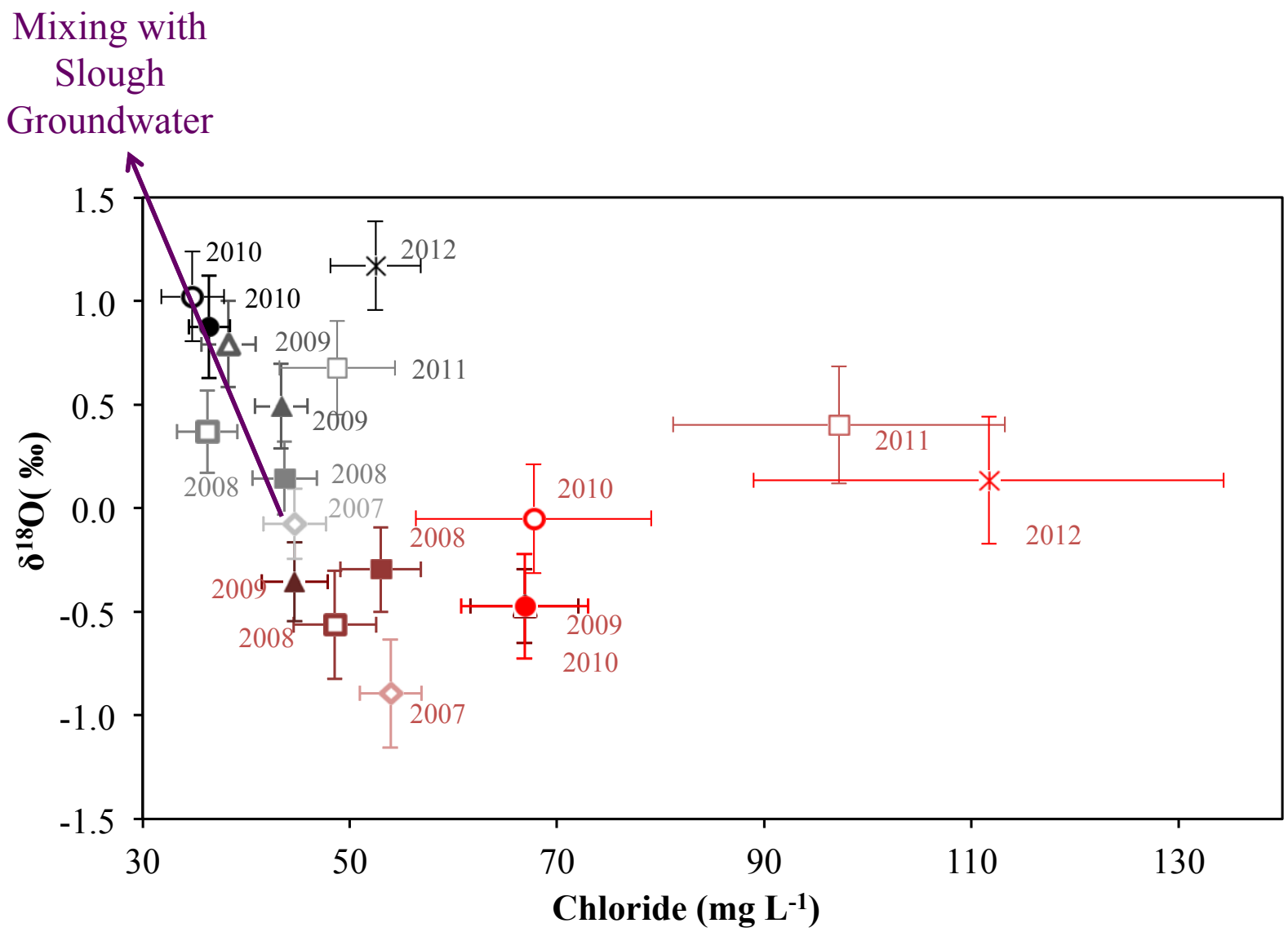


GW in **center** of the tree islands is mainly governed by transpiration, **SW** is mainly governed by evaporation, while GW at the **Edges** of the islands and **Deep** GW fall between SW and TI center GW





Open symbols represent wet season, closed symbols represent dry season



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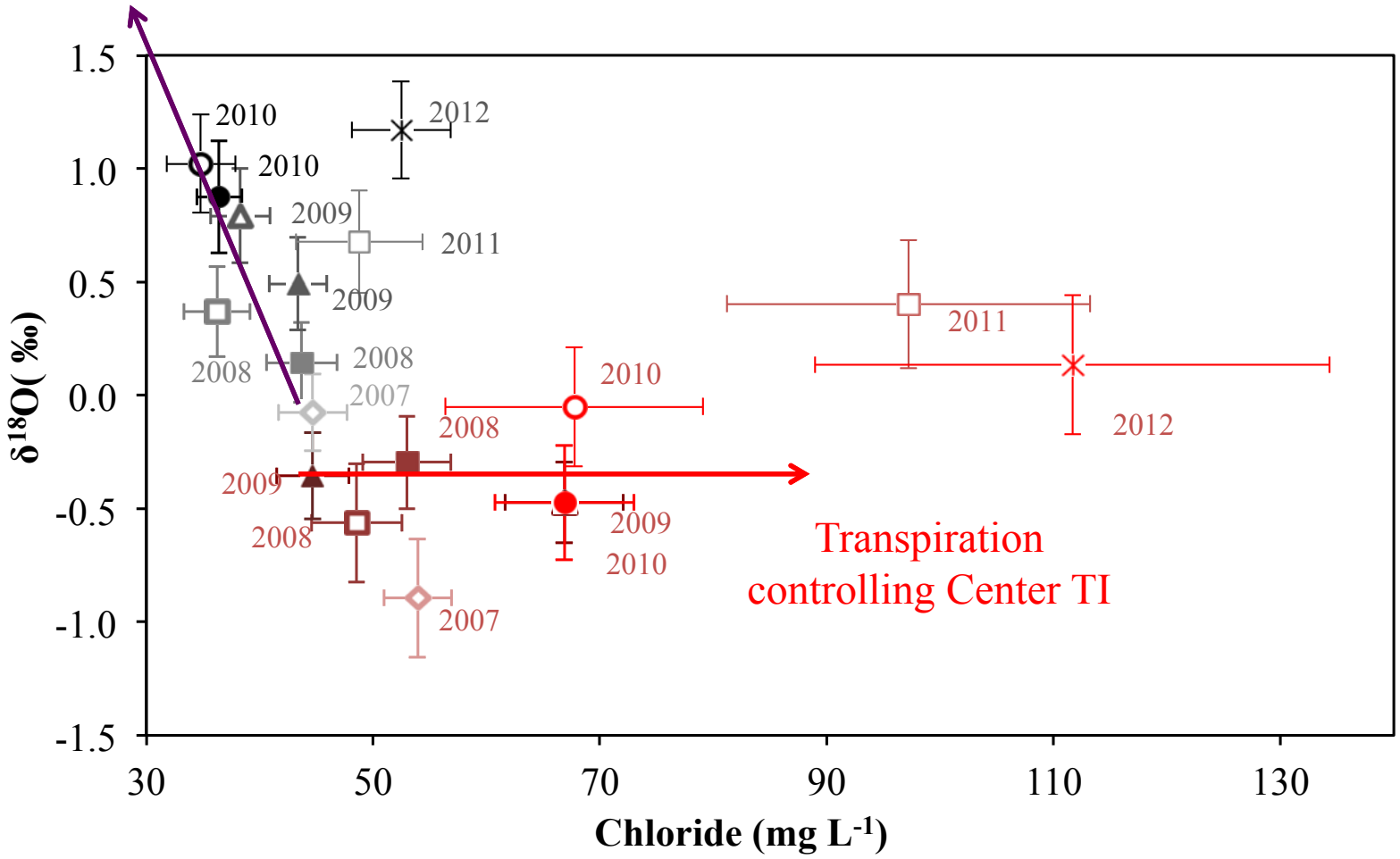
Edge GW Mixing with
Slough Groundwater



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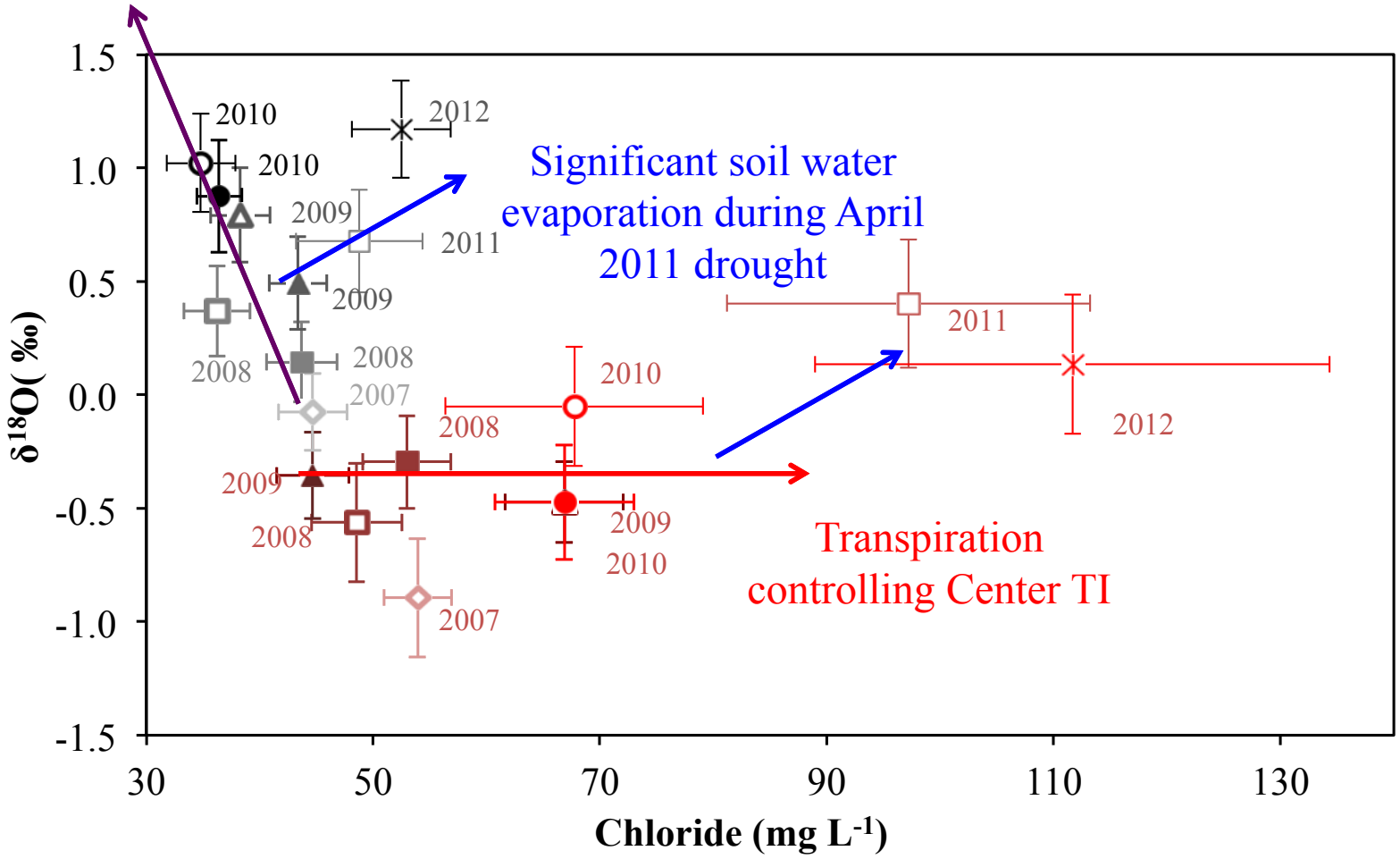
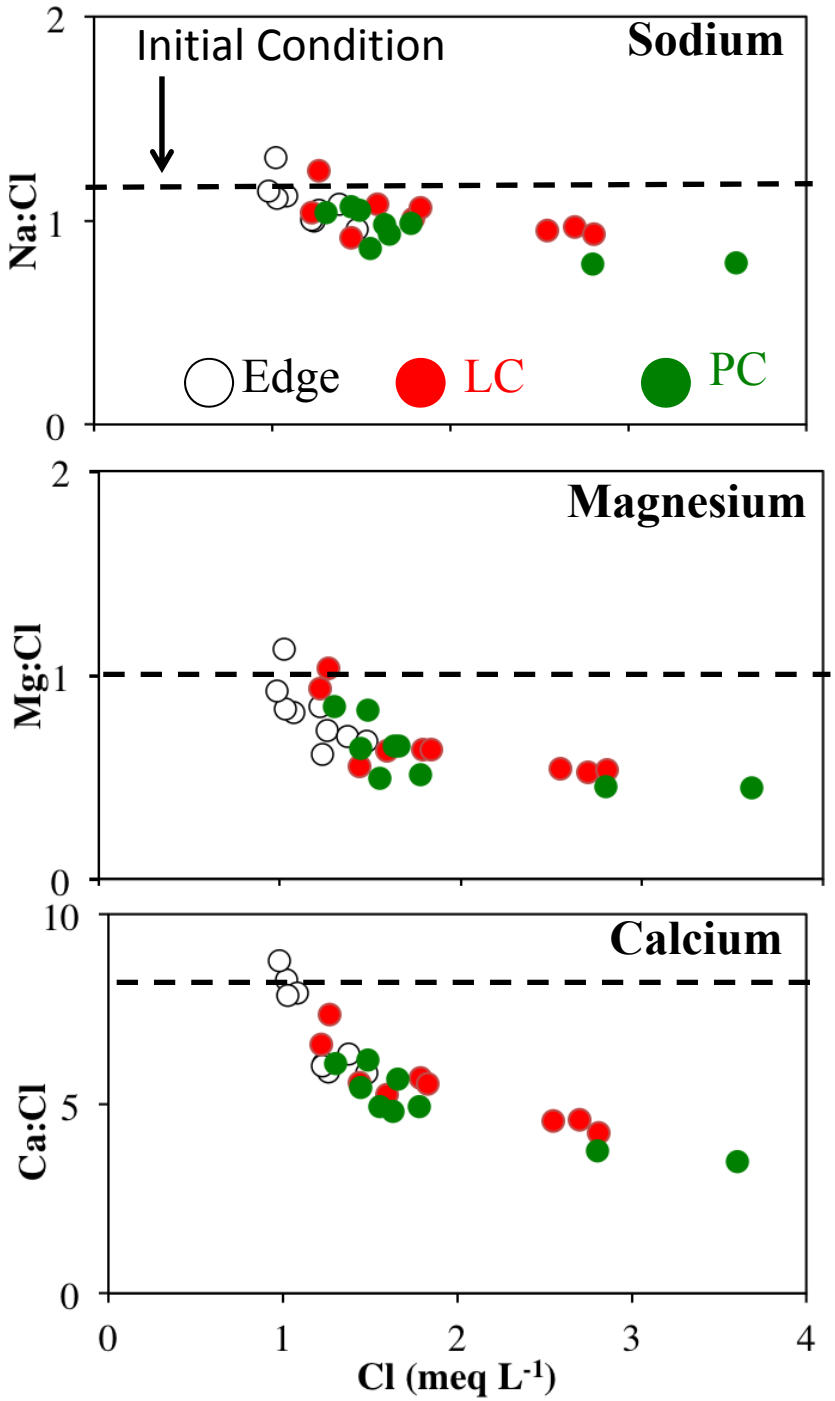


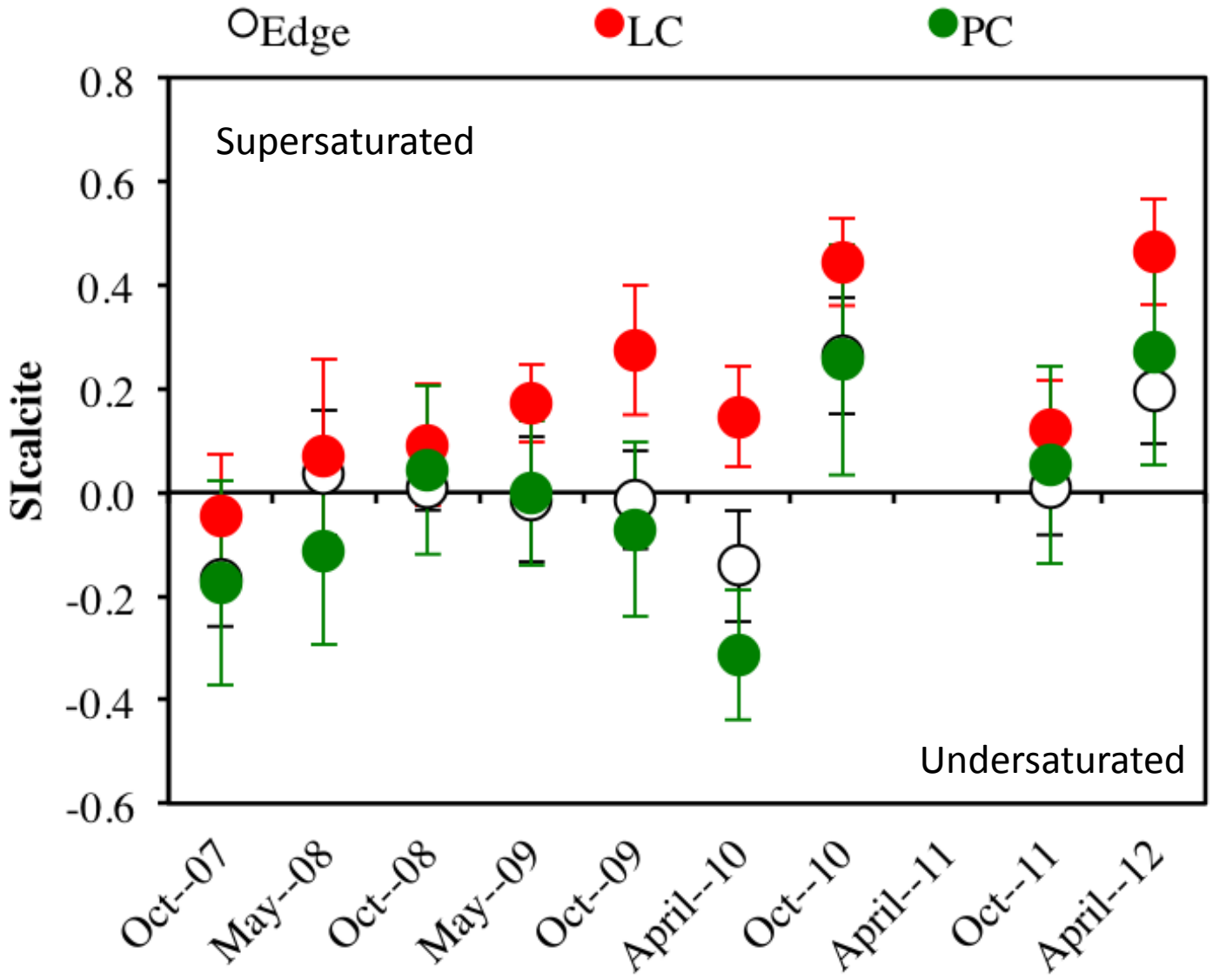
Open symbols represent wet season, closed symbols represent dry season

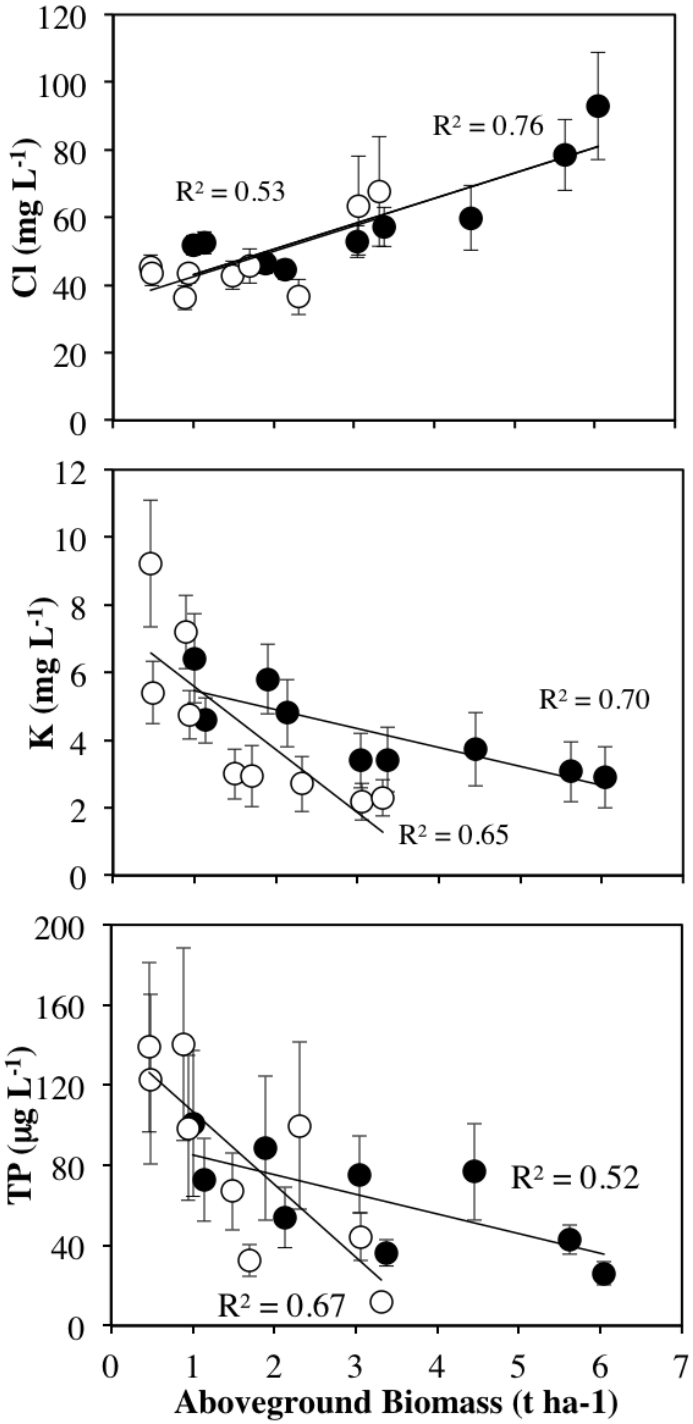
The ratio of Na^+ and Mg^{2+} to Cl^- concentrations remained fairly constant over the study, conversely Ca^{2+}:Cl^- declined.

This suggests Ca^{2+} is being removed from solution and potentially precipitated out as calcium carbonate, adsorbed to surfaces or taken up by plants.



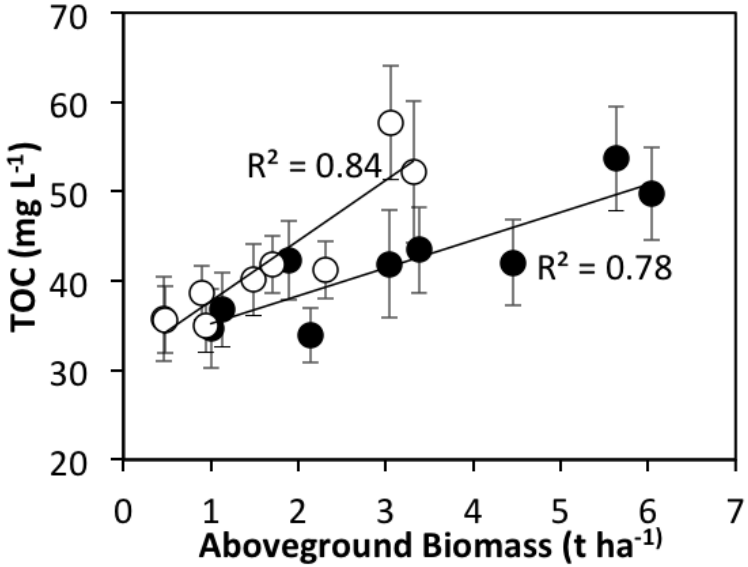
In general the saturation indices favor mineral precipitation with respect to calcite over time





Increase in aboveground biomass was positively correlated with an increase in major ions (Cl, Na, Mg and Ca) and TOC concentrations but negatively correlated with K and TP concentrations

● Planting-1 ○ Planting-2



Conclusion

Early tree growth and differing geologic material govern the hydrogeochemical conditions on tree islands

- Non-reactive tracers support conceptual model of groundwater-surface water interaction
- Transpiration by trees concentrates ions in the groundwater and support calcite precipitation within 2 years of establishing the forest, especially on limestone islands
- Tree growth and elevated GW ion concentrations are concurrent with an increase in TOC over time
- Early tree growth likely sequesters macronutrients such as TP and K in with biomass

This Research Was Made Possible With Funding From:

Questions?

Contact me @ plsullivan@ku.edu