Tackling tough water resource problems in karst aquifers using models

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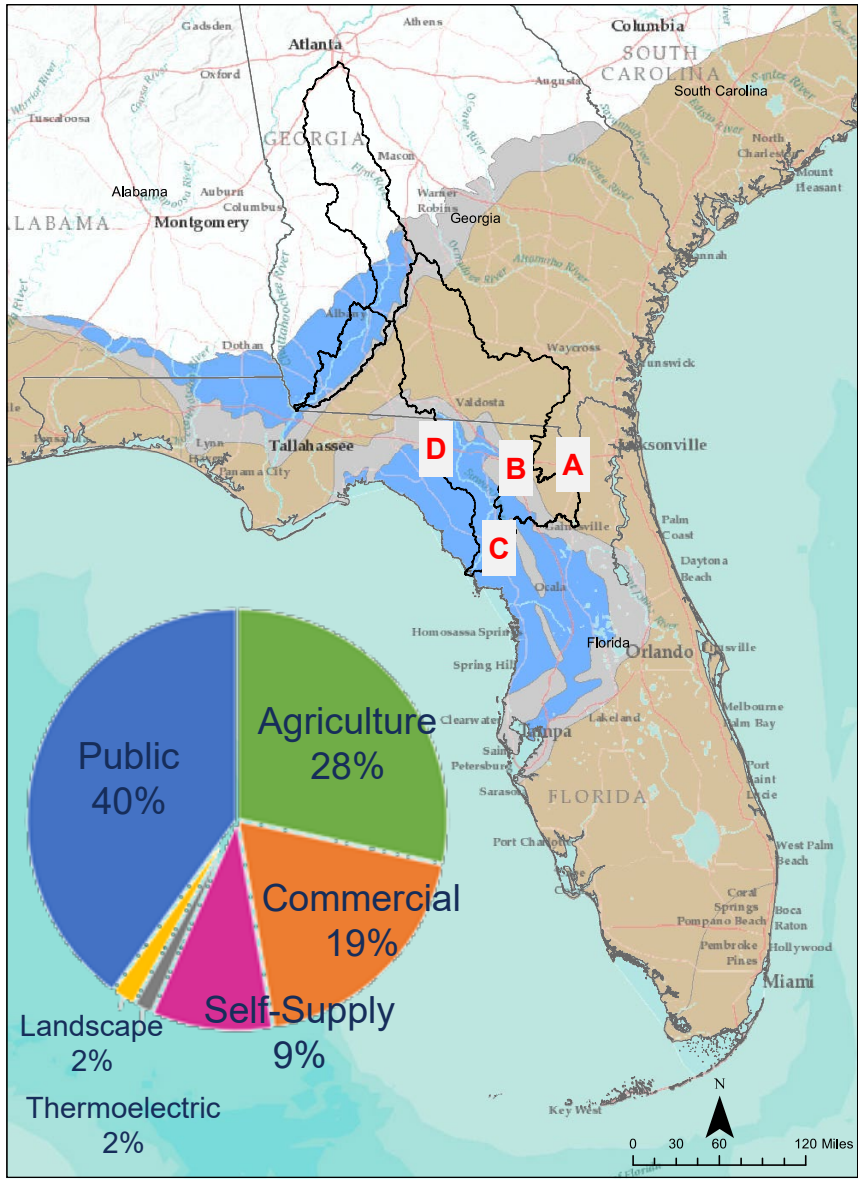
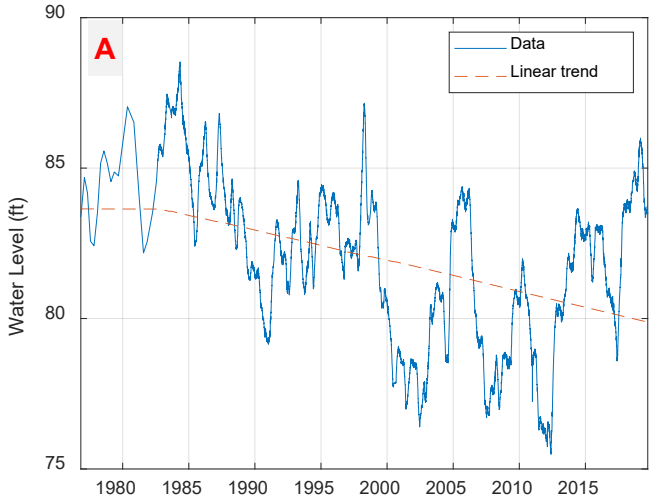
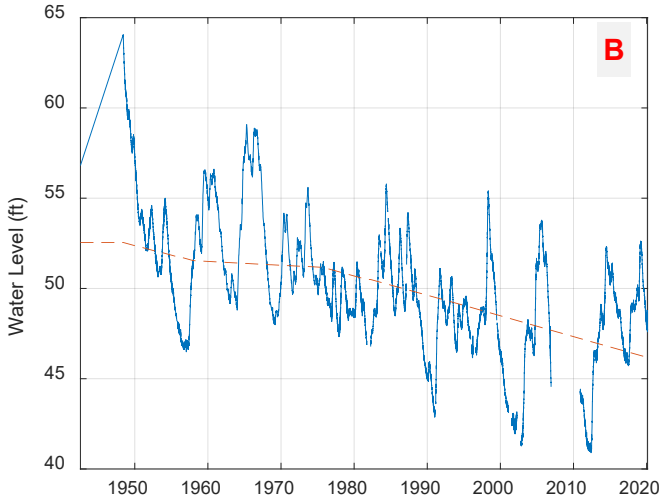
Highly productive

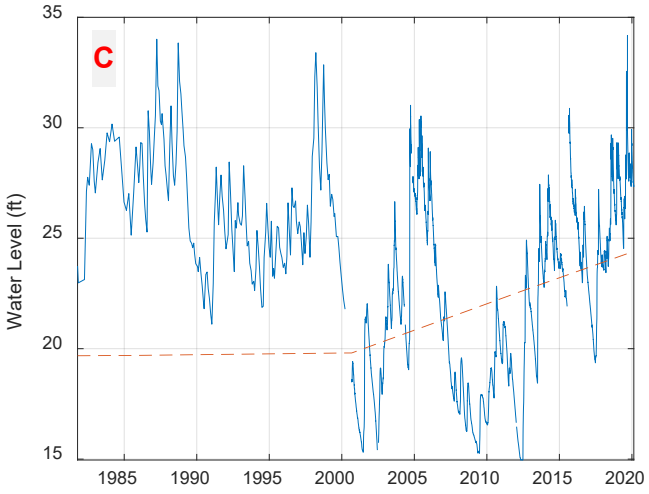
Susceptible to contamination

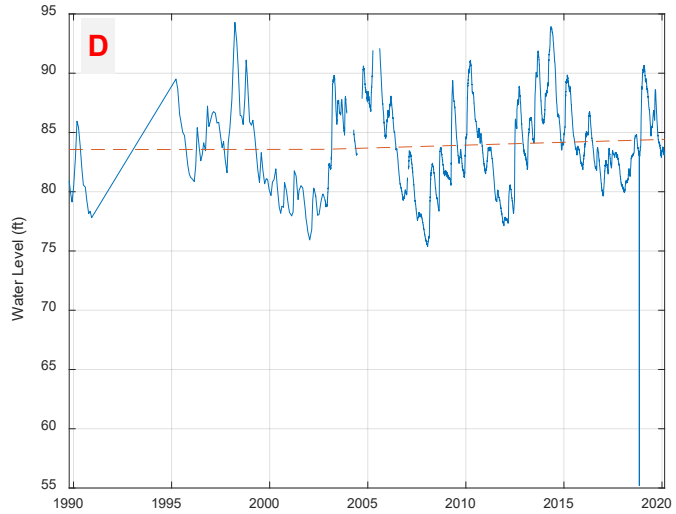
Observed Water Levels



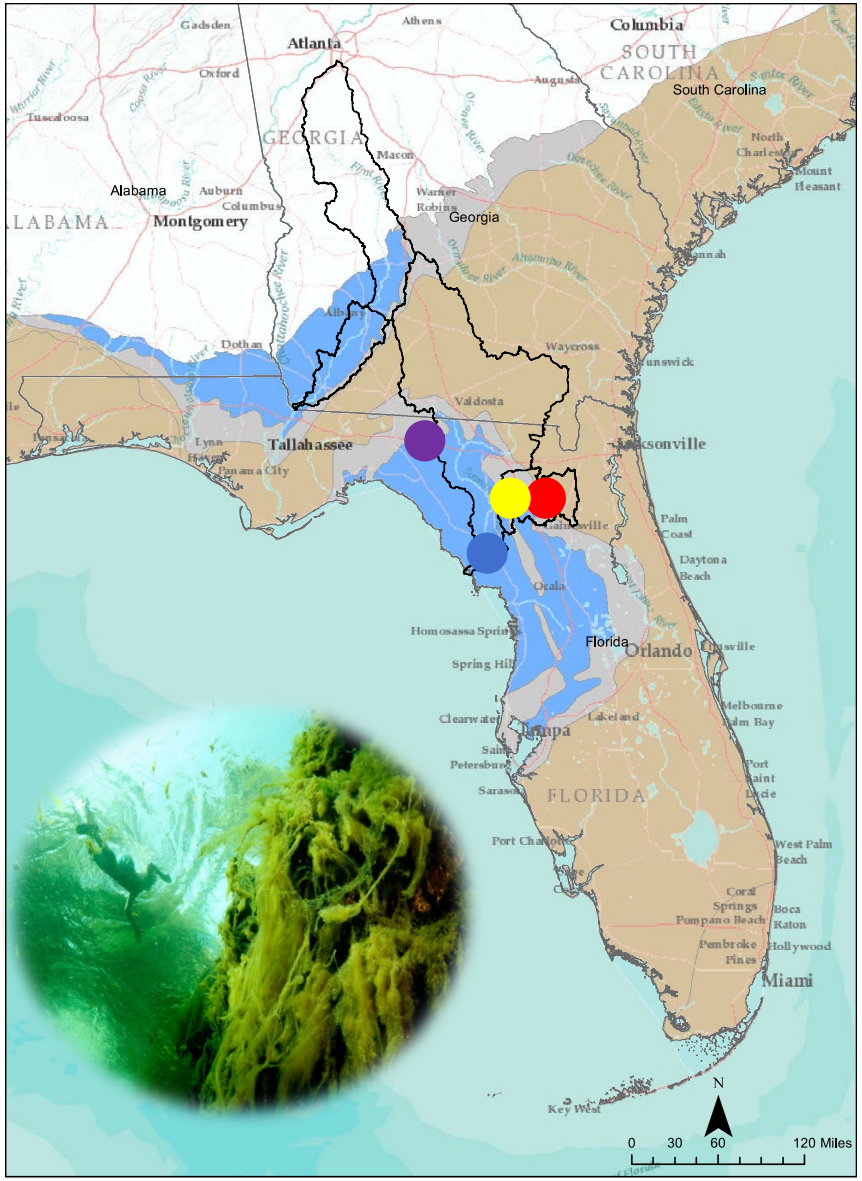


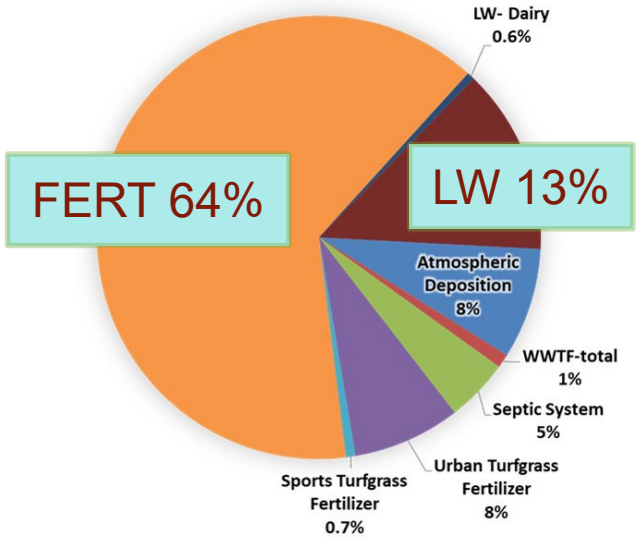




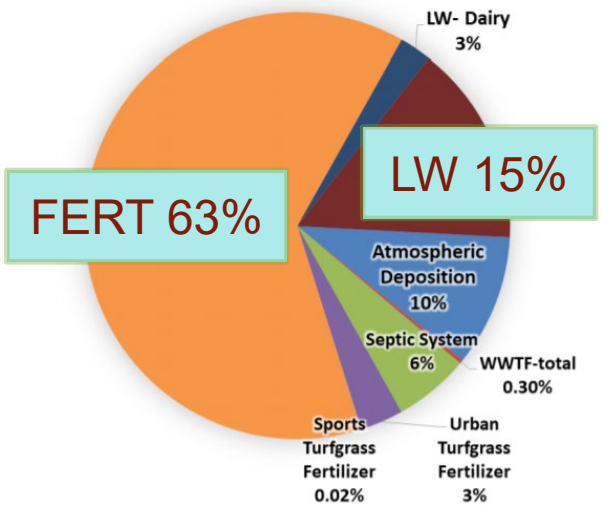


Water Quality

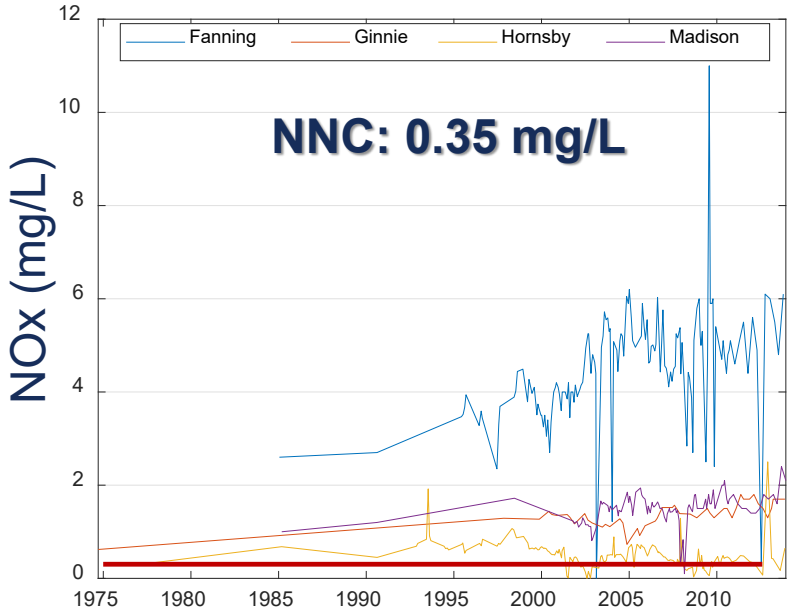




Hornsby Spring



Devils spring system



Priority Springs

Fanning spring

Madison spring

Ginnie spring

Hornsby spring

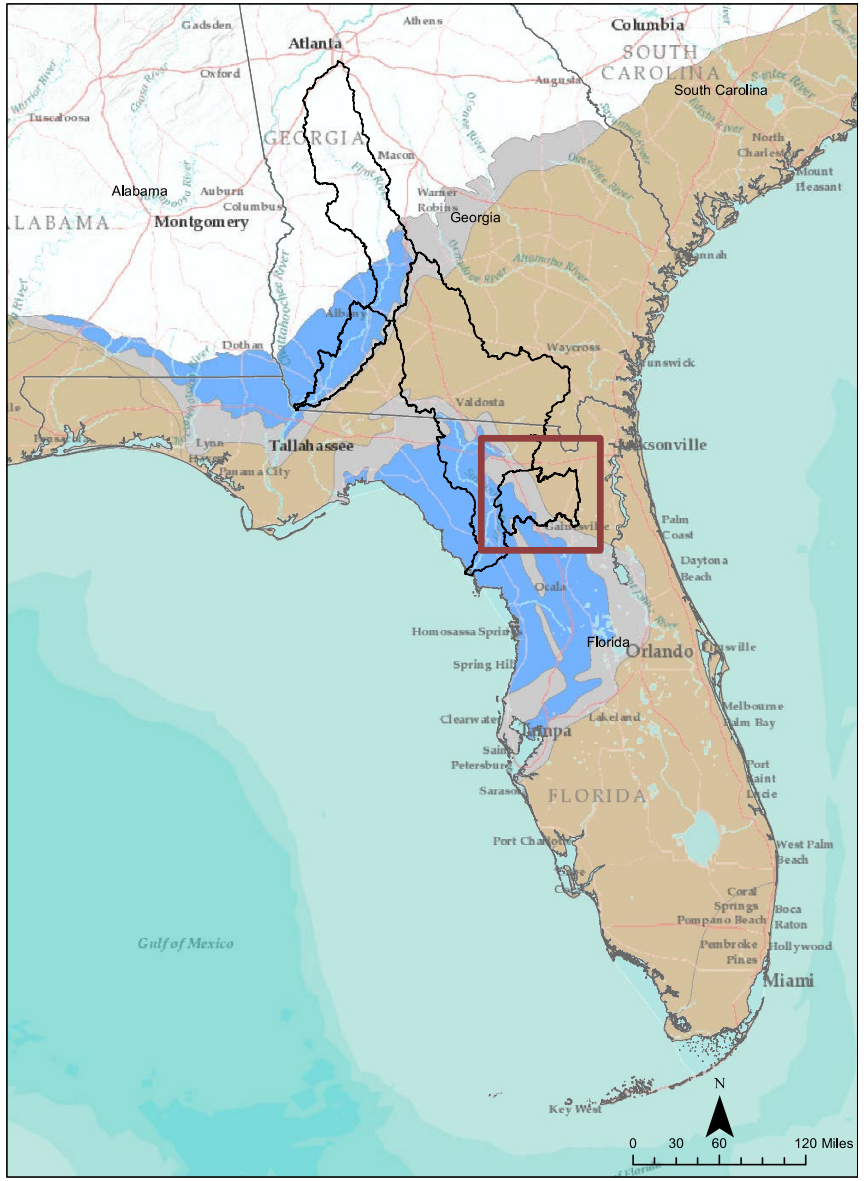
Key Questions

1. Can we reduce nutrient loads to the FAS while maintaining economic sustainability?
2. What role does climate play in groundwater levels?
3. Can we meet that numeric nutrient criteria?

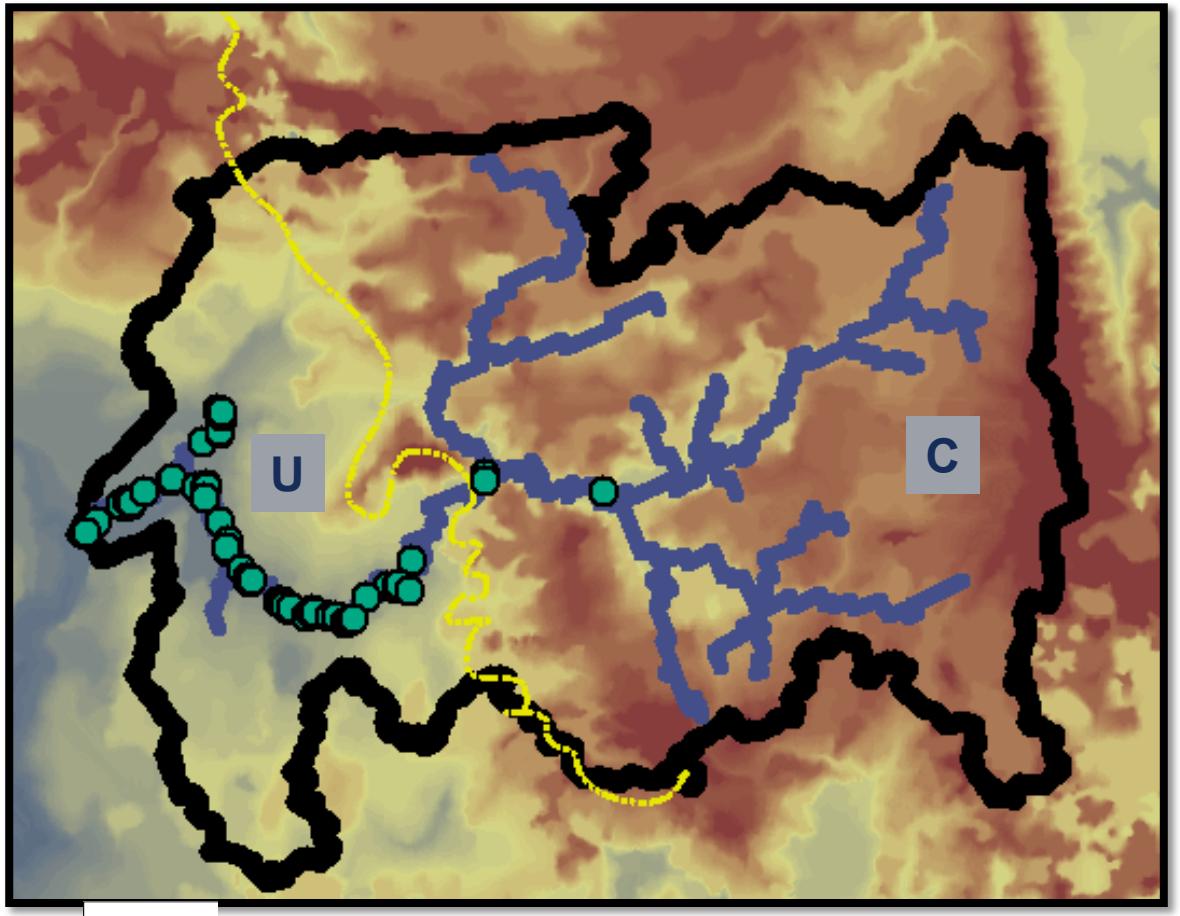
FACETS
Floridan Aquifer Collaborative Engagement for Sustainability

Complex problems. Do we need complex models to solve them?

Study Site



Santa Fe River basin



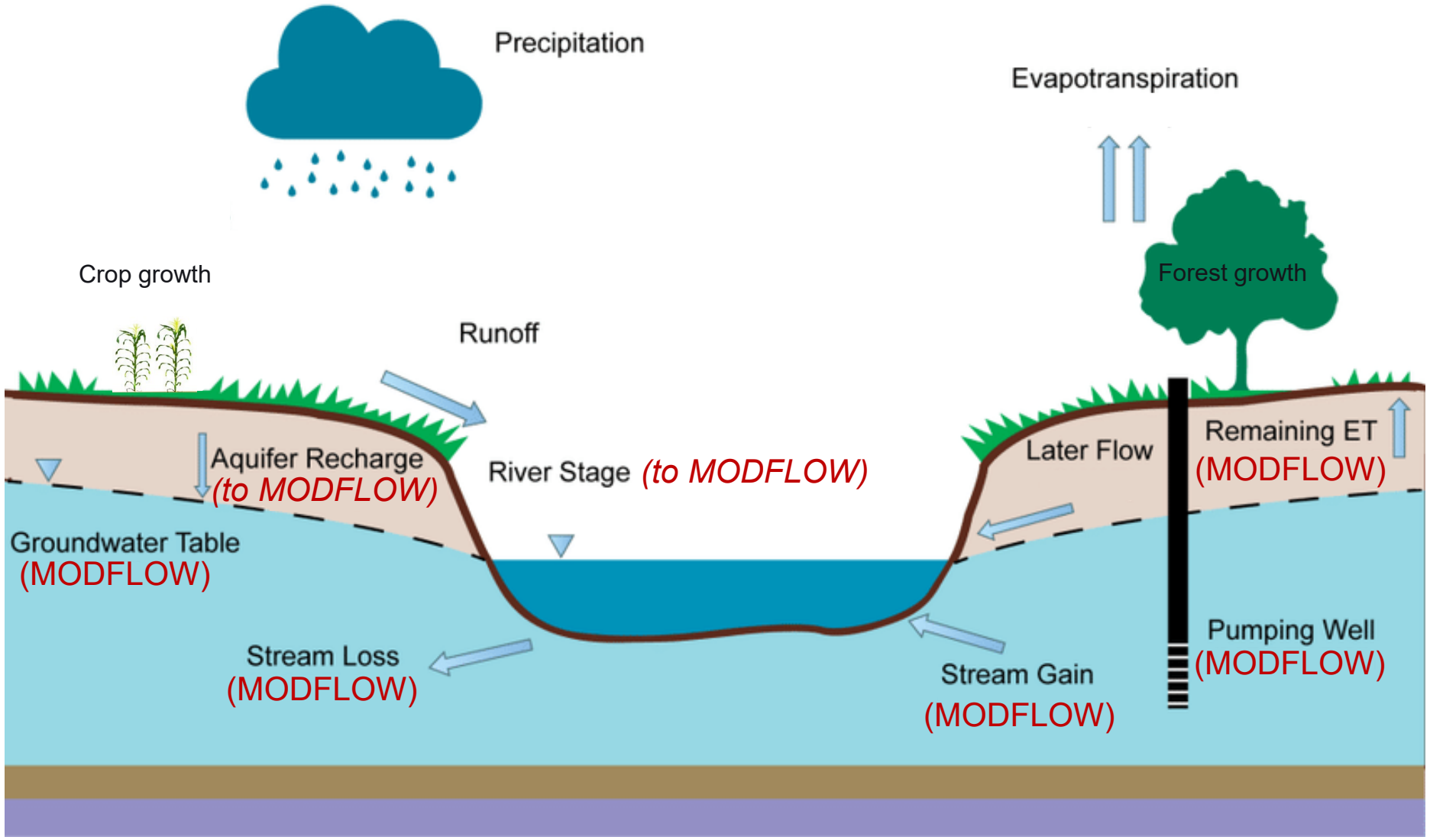
76 m
0

Springs

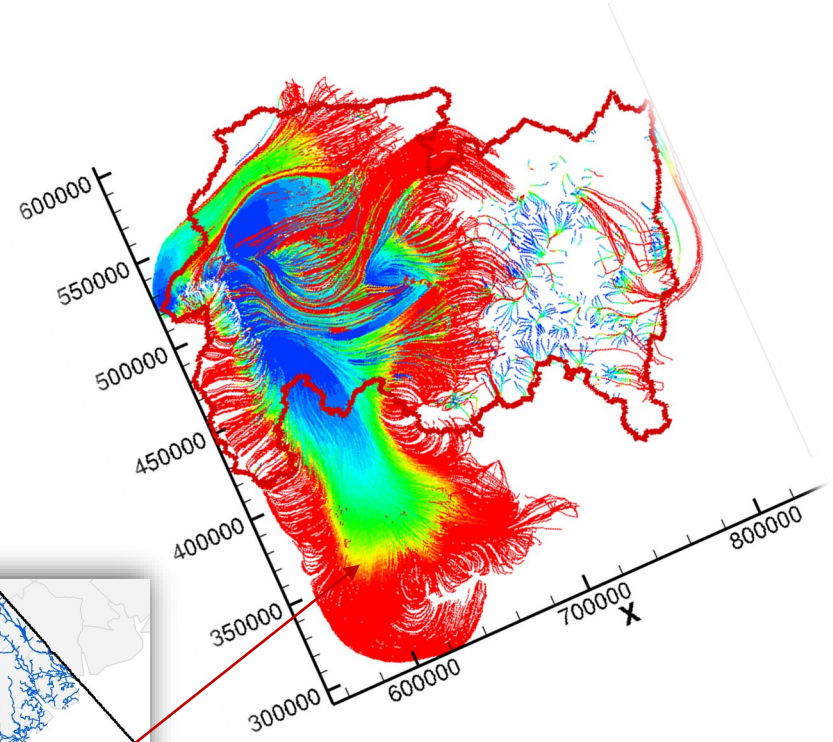
Rivers

- Heavy agriculture
- Abundance of data
- Springs
- Confined/unconfined conditions

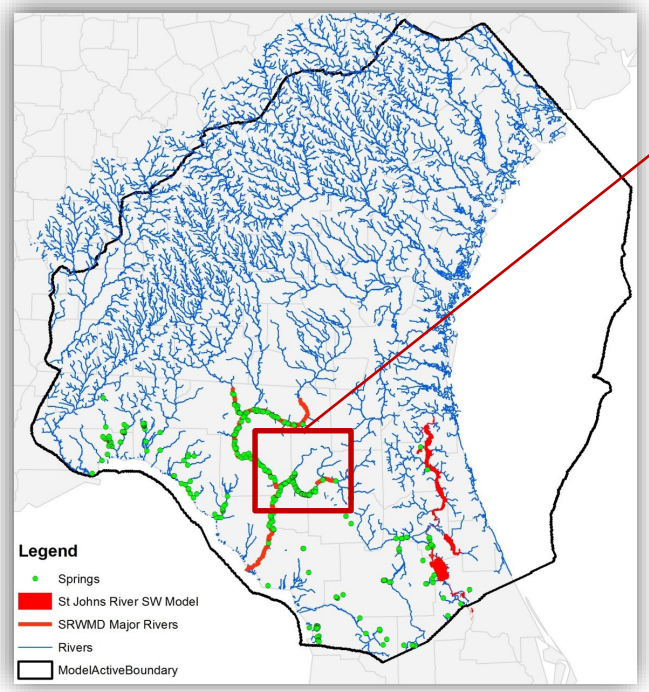
SWAT
+
MODFLOW



Model Development – BRIEFLY!



NFSEG



SWAT

- Partitioned calibration
- SWAT Model only
  - 4 river stations
- SUFI-2 / NSE objective
- Calibration: ~~2000-2005~~
- Validation: ~~2006-2010~~

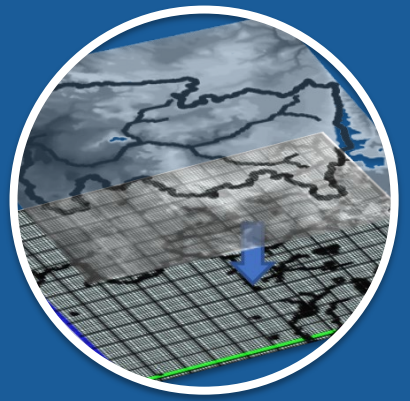
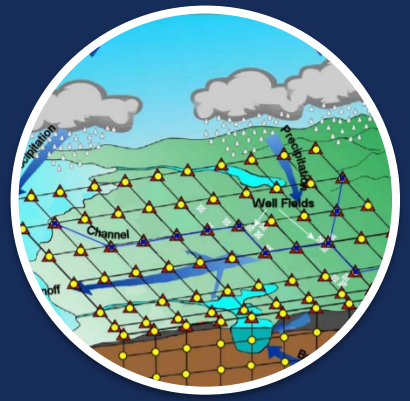
MODFLOW

- Calibrated
- Steady State→Transient
  - High/Low water years

Model Comparison Hierarchy

FULLY INTEGRATED

COUPLED BUT INDEPENDENT

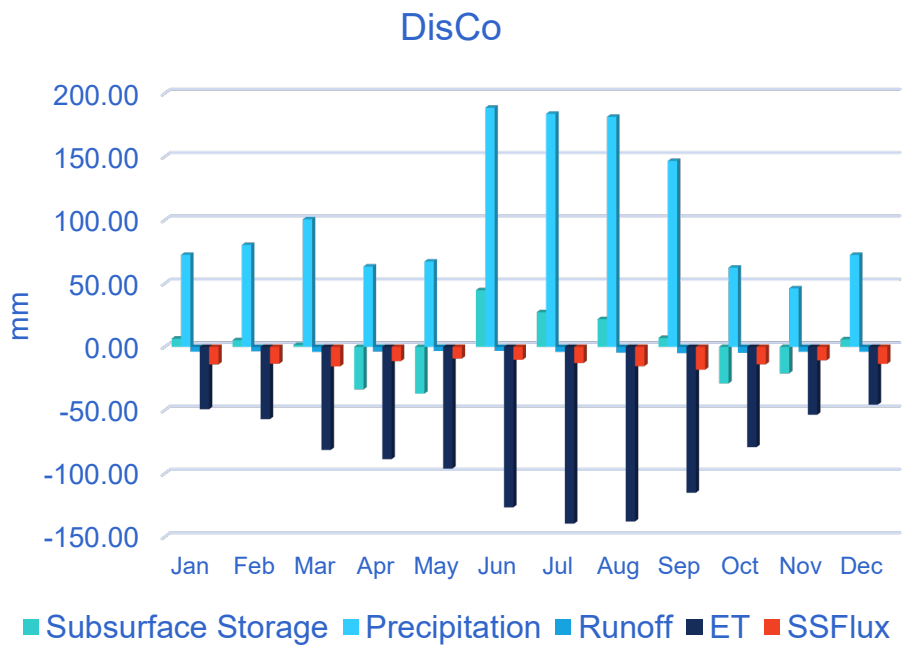
SWAT	SWAT-MODFLOW	DisCo
		
• Tipping bucket groundwater • Semi-empirical	• Only communication between river cells • Recharge to MODFLOW via HRU	• Runoff and subsurface saturation linked • Richards Equation

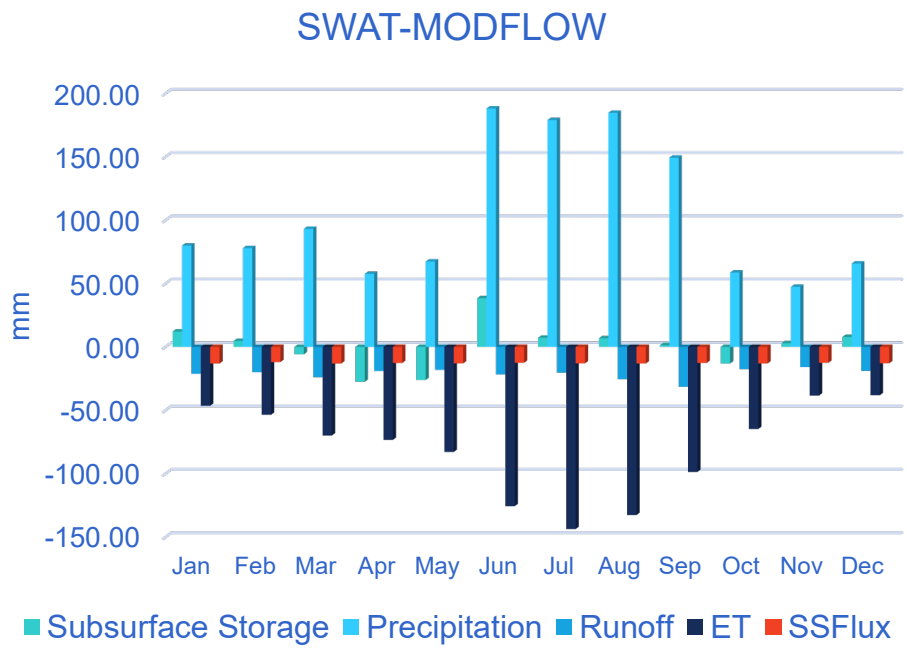
- Curve numbers
- HRU discretization

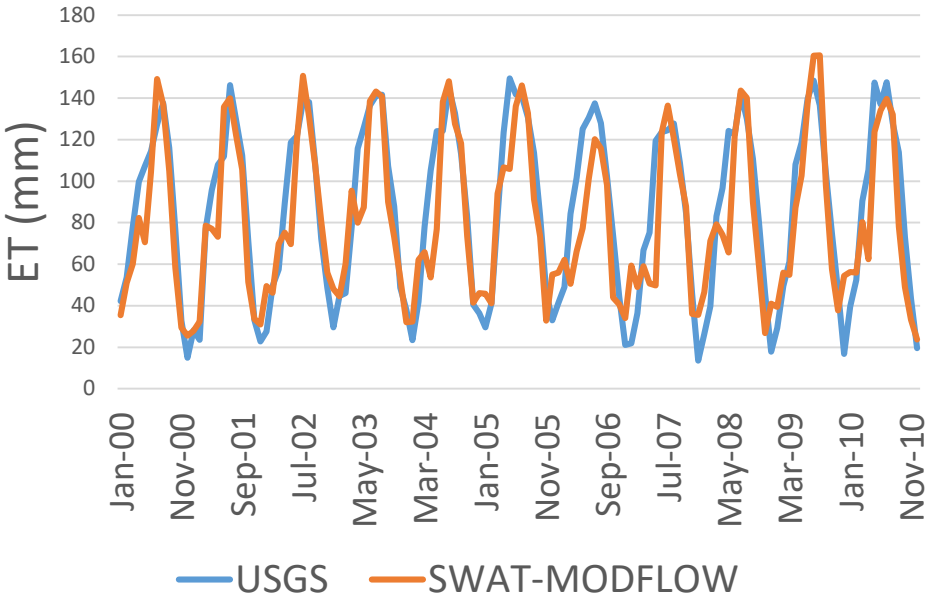
Darcy's Law (GW)

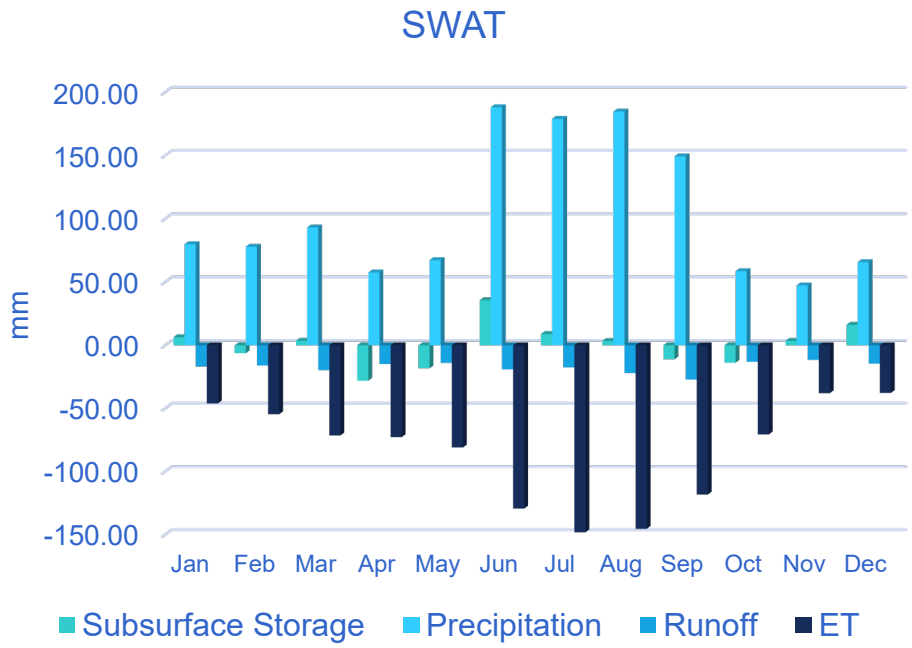
NLDAS gridded climate data

Results: Water Balances





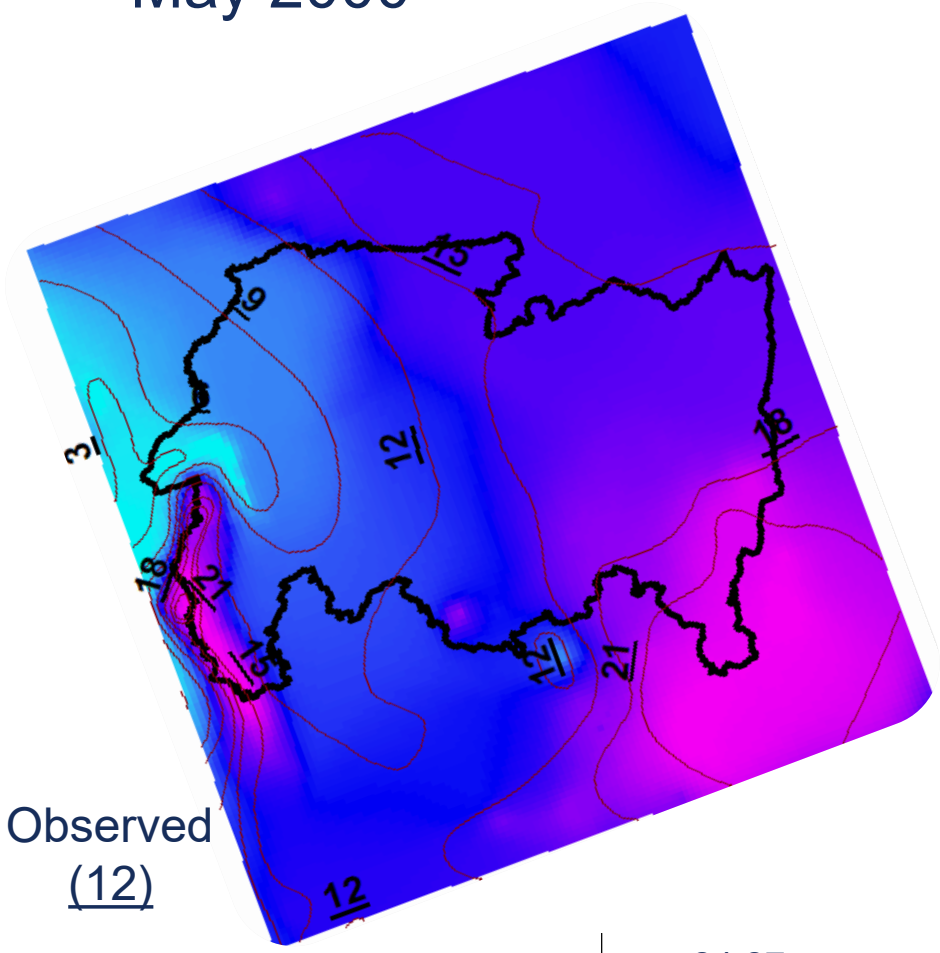


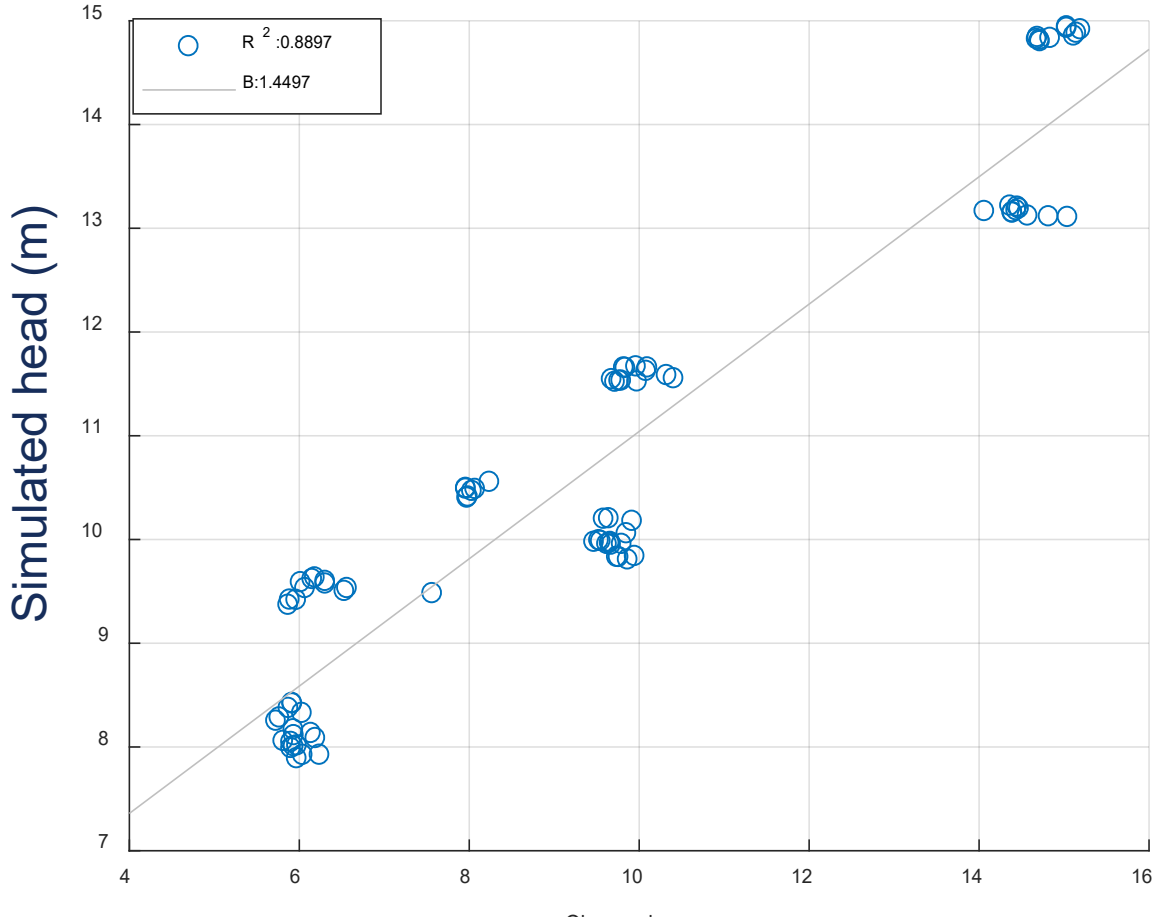


Results: Groundwater

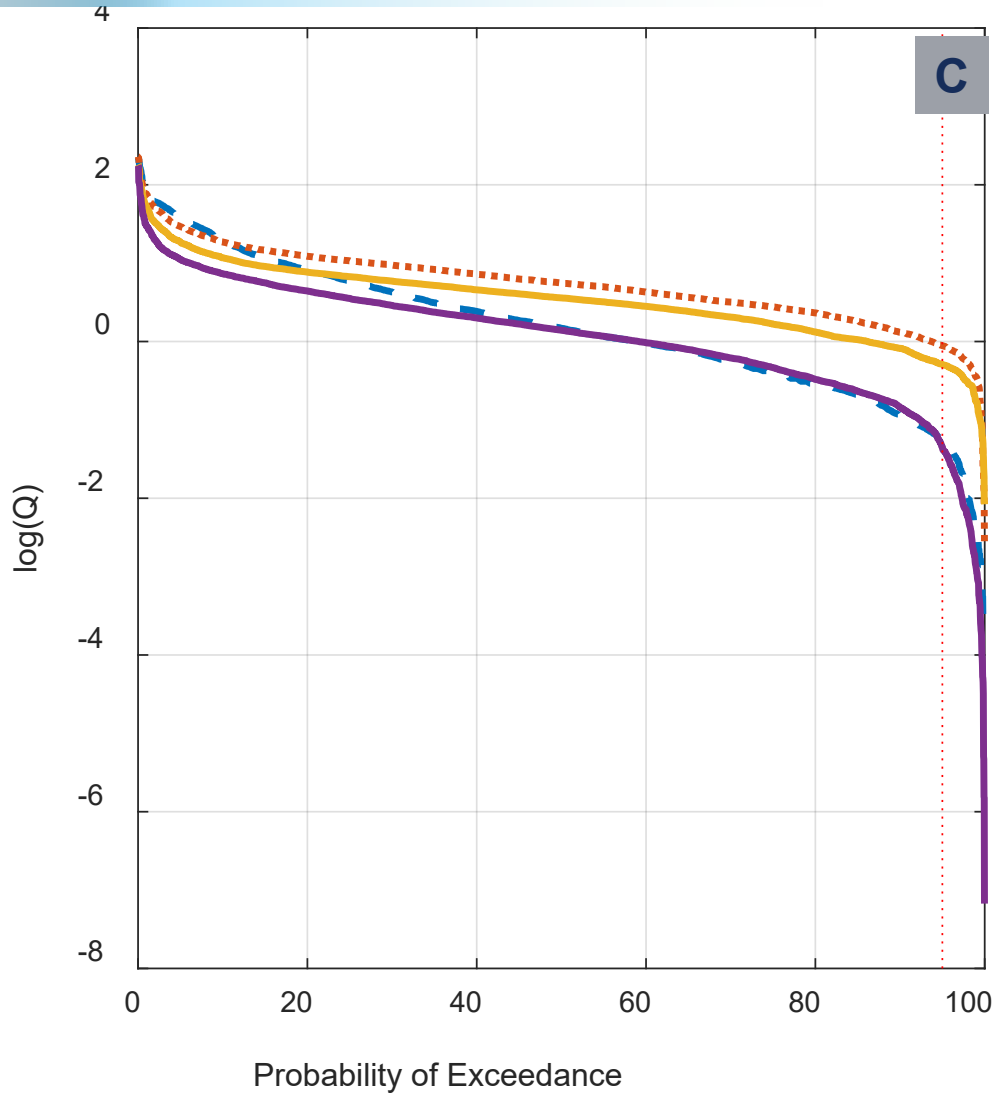
- Spatial dynamics are good
- Temporal dynamics are stagnant at times

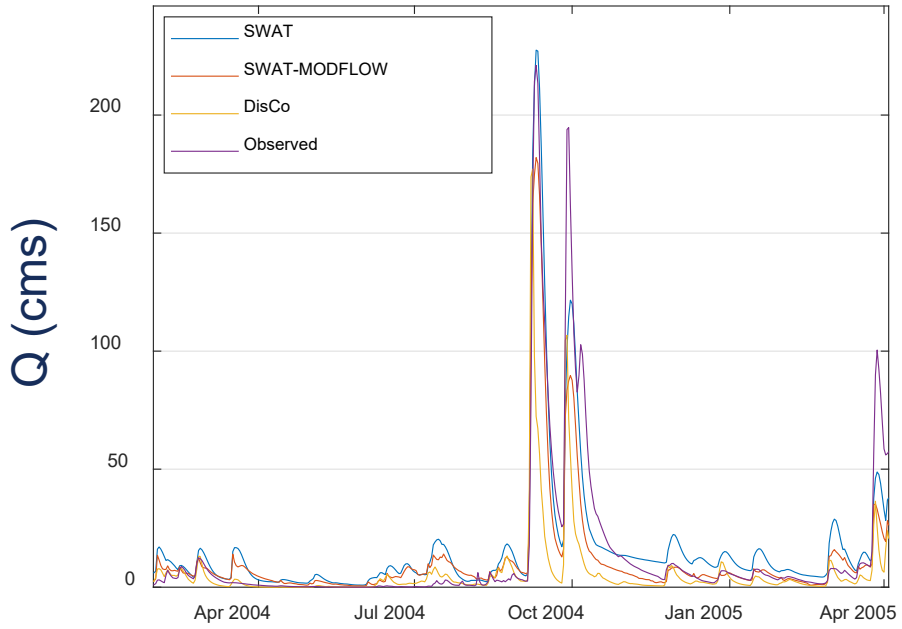
May 2000

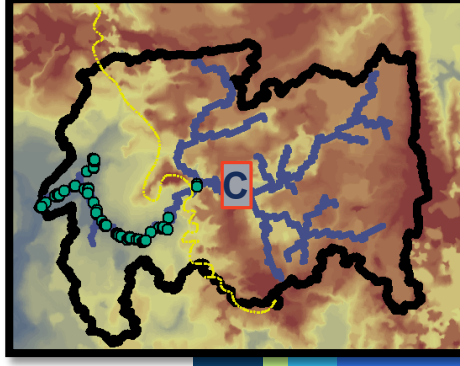


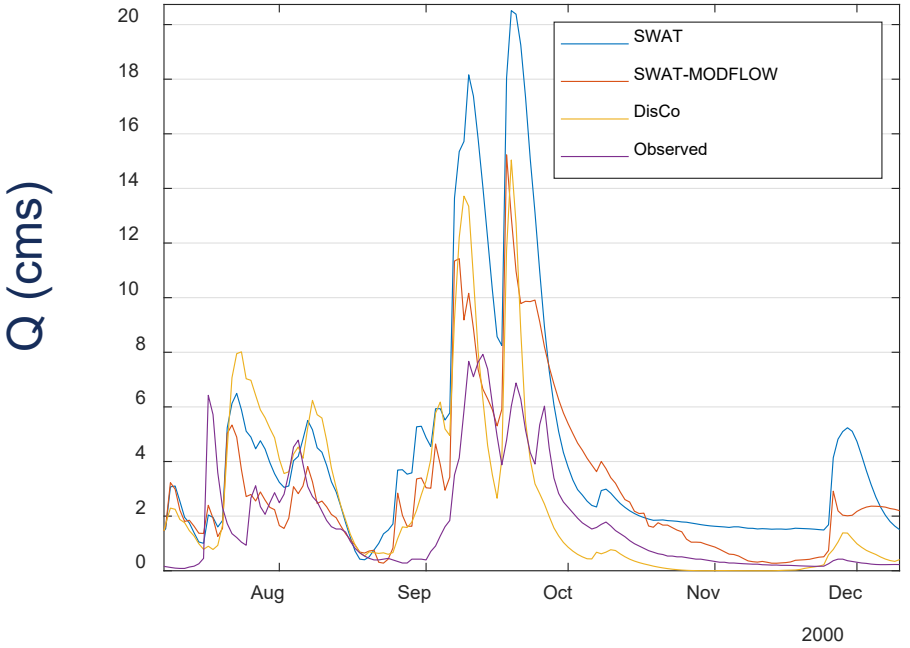


Results: Calibration



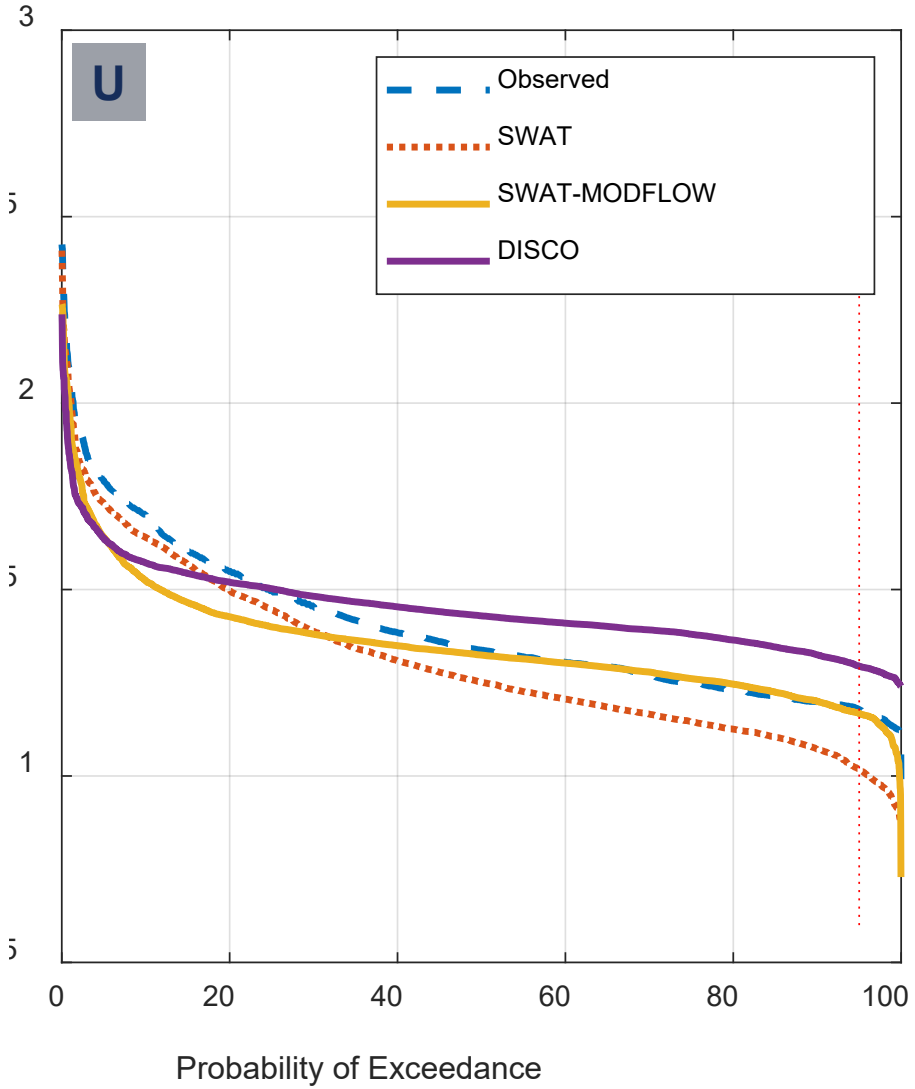


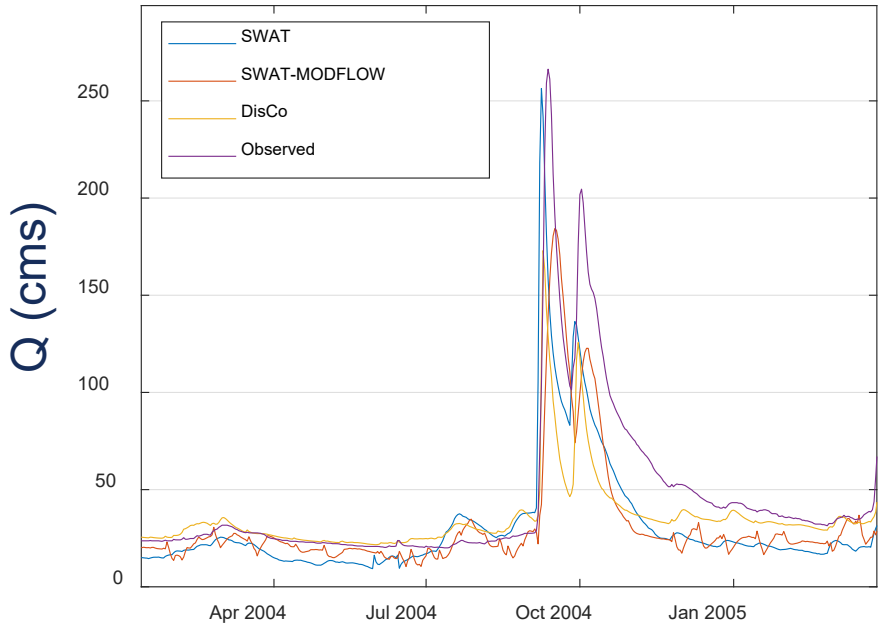


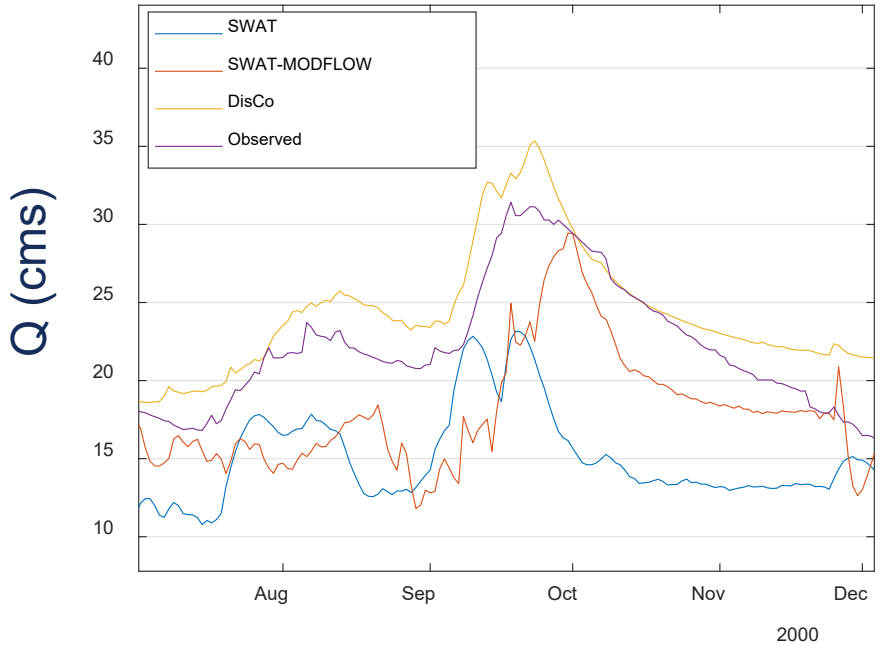


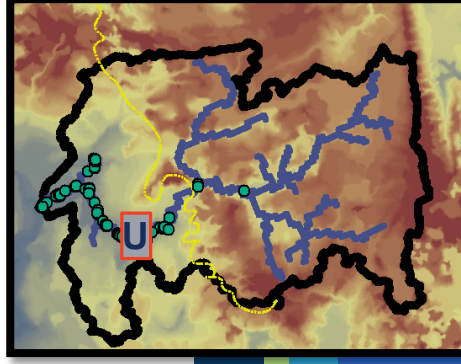
	SWAT	SWAT-MODFLOW	DISCO	OBSERVED
MEAN	7.37	6.12	3.08	7.00
STD	11.73	11.33	7.62	17.34
NSE	0.60	0.63	0.62	

Results: Calibration









	SWAT	SWAT-MODFLOW	DISCO	OBSERVED
MEAN	24.03	24.29	29.09	28.56
STD	18.38	13.85	10.19	20.37
NSE	0.54	0.59	0.41	

Land Cover

NLDAS ➡ 2017 USDA

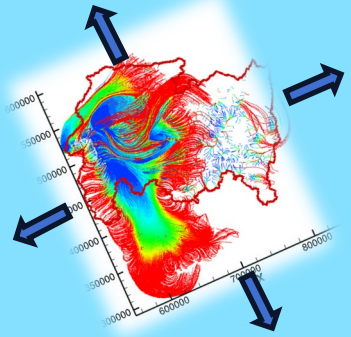
- Improved resolution of crops
- Aggregated urban to reduce HRU

Enhanced surface runoff

- Previously tied to NFSEG rivers
- Increased river runoff and basin aggregation
- Enhance coupling

Groundwater Domain

- Increased groundwater contributing area
- More aligned with DisCo



Conclusions

- SWAT-MODFLOW performed well for the application it was designed for
- Other models, fully integrated and more simplistic, did not necessarily provide improved performance
- For some applications, SWAT could be a reasonable alternative in karst environments
- All models still have issues reproducing recessions in fluviokarst environments
  - Geologic vs hydraulic controls
  - Significance?