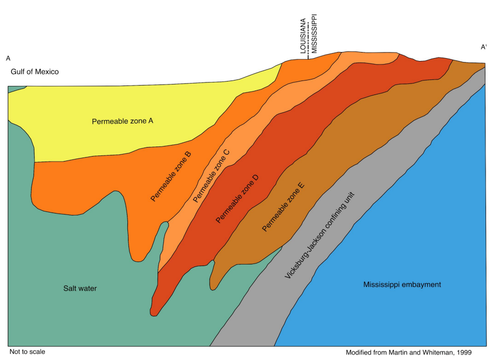
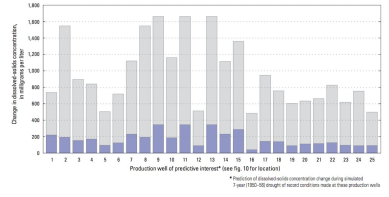
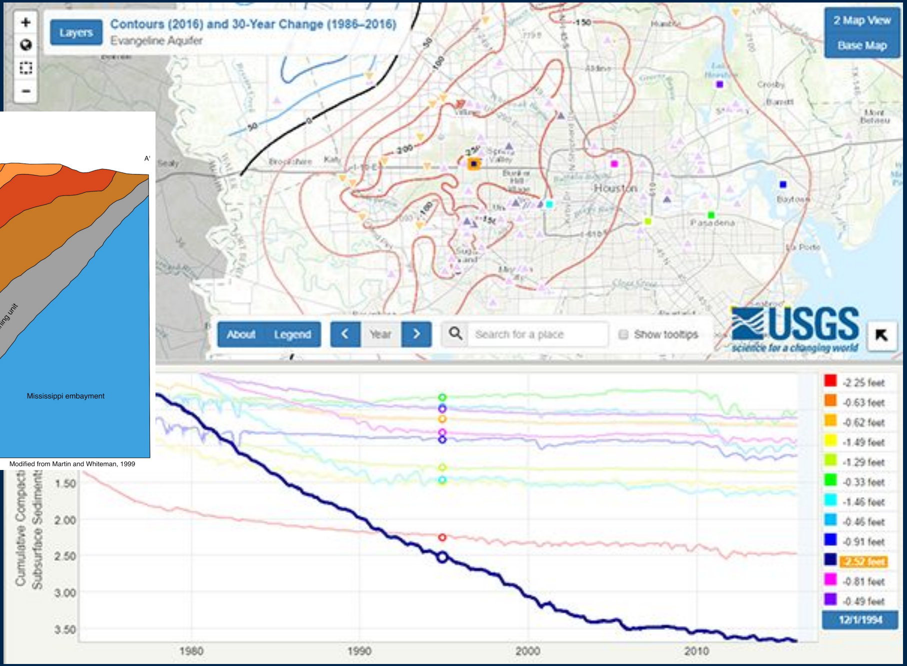
Developing a Regional Model of the Coastal Lowlands Aquifer System (CLAS)

Louisiana Water Resources Commission Meeting
Baton Rouge, LA
July 25, 2018

Linzy K. Foster – TX WSC
Brian R. Clark – LMG WSC
Leslie Duncan – LMG WSC
Natalie Houston – TX WSC
Andrew Teeple – TX WSC







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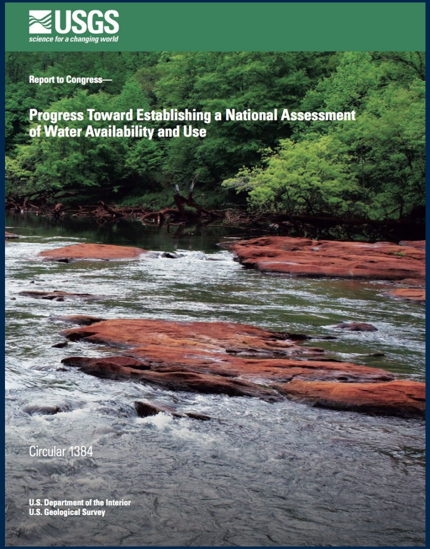
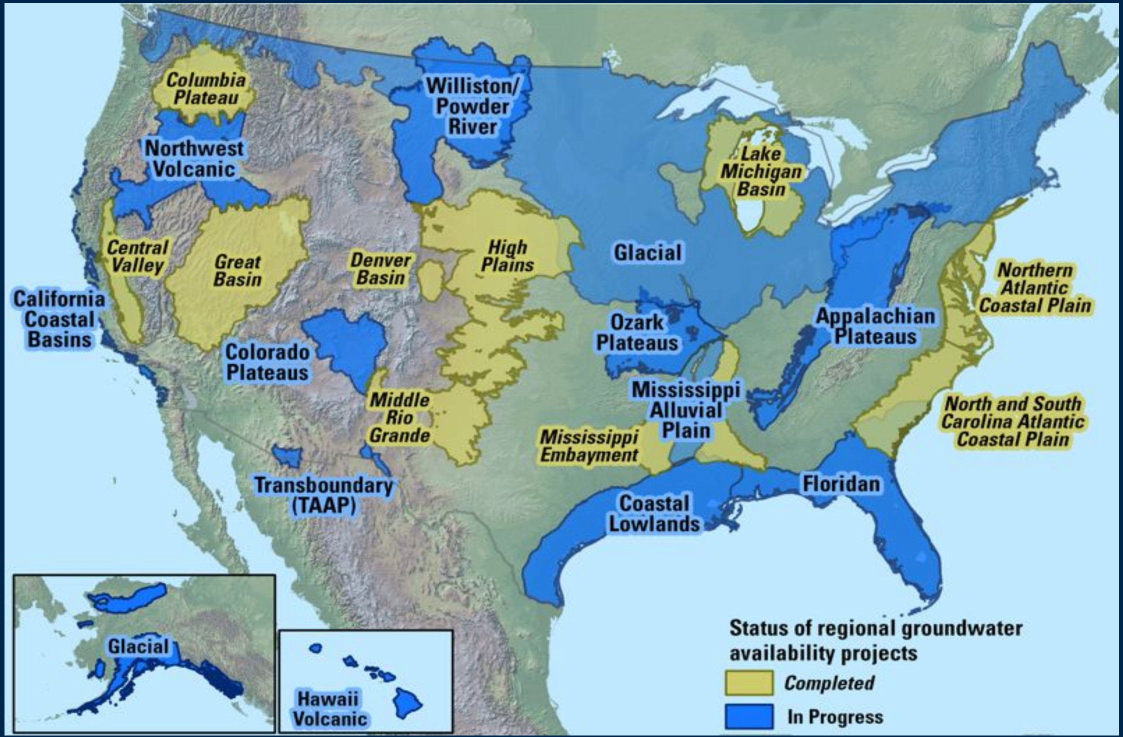


USGS National Study Goals



- Document anthropogenic effects on water levels, storage, and streams
- Explore climate variability impacts
- Evaluate adequacy of data networks

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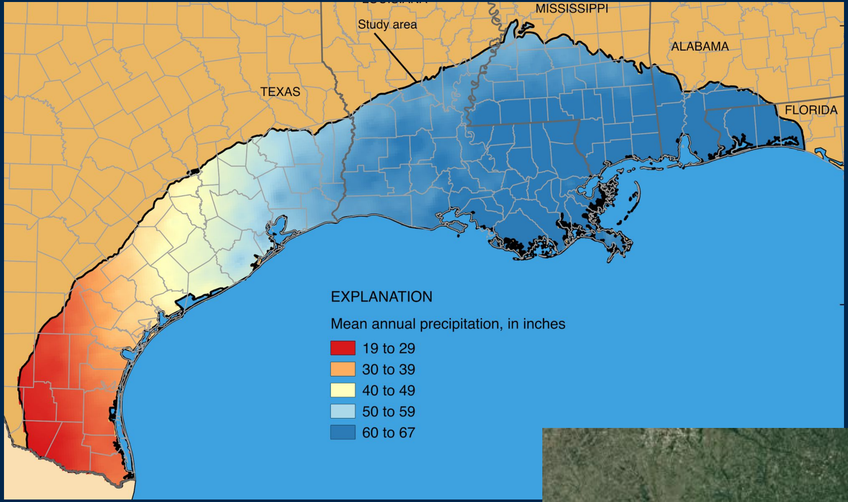
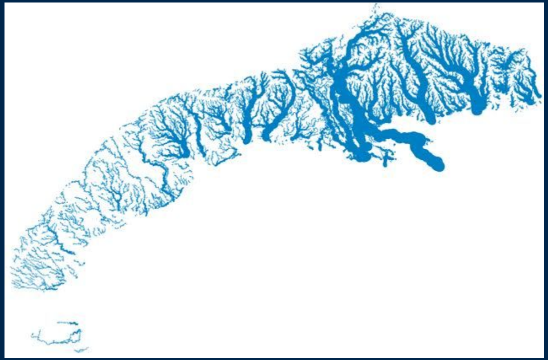
Coastal Lowlands Aquifer System (CLAS)

- 5 states
- 140,000 mi^2
- **4th** in groundwater for public supply
- **5th** as private domestic supply
- Houston (#4), Baton Rouge, New Orleans, Mobile





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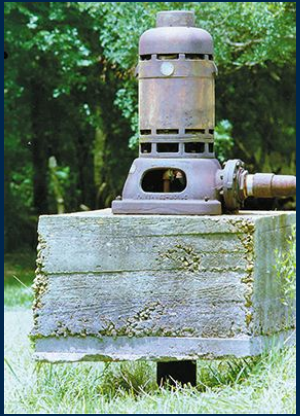
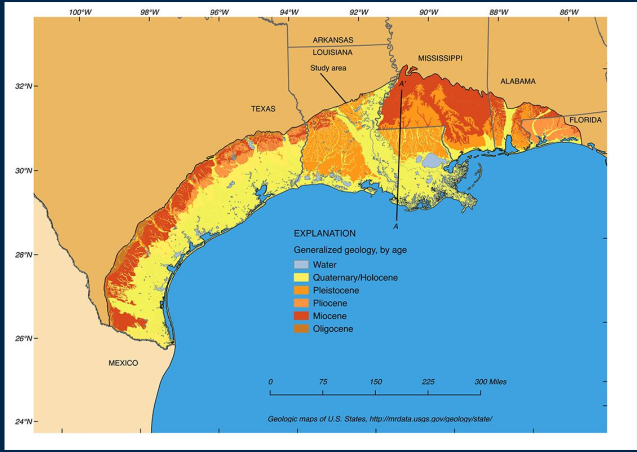
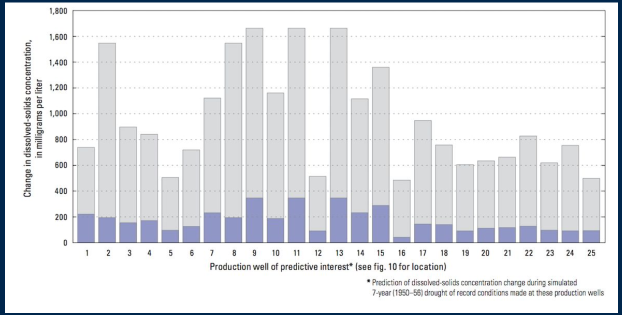
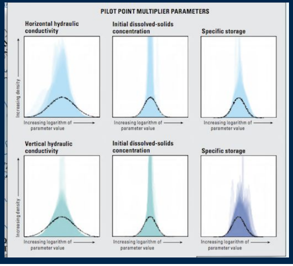
CLAS Groundwater Availability Story

- Subsidence
- Uncertainty analysis
- Quantify worth of improved datasets









pyEMU

python modules for model-independent FOSM (first-order, second-moment) (a.k.a linear-based, a.k.a. Bayes linear) uncertainty analyses and data-worth analyses, non-linear uncertainty analyses and interfacing with PEST and PEST++. pyEMU now also has a pure python (pandas and numpy) implementation of ordinary kriging for geostatistical interpolation.

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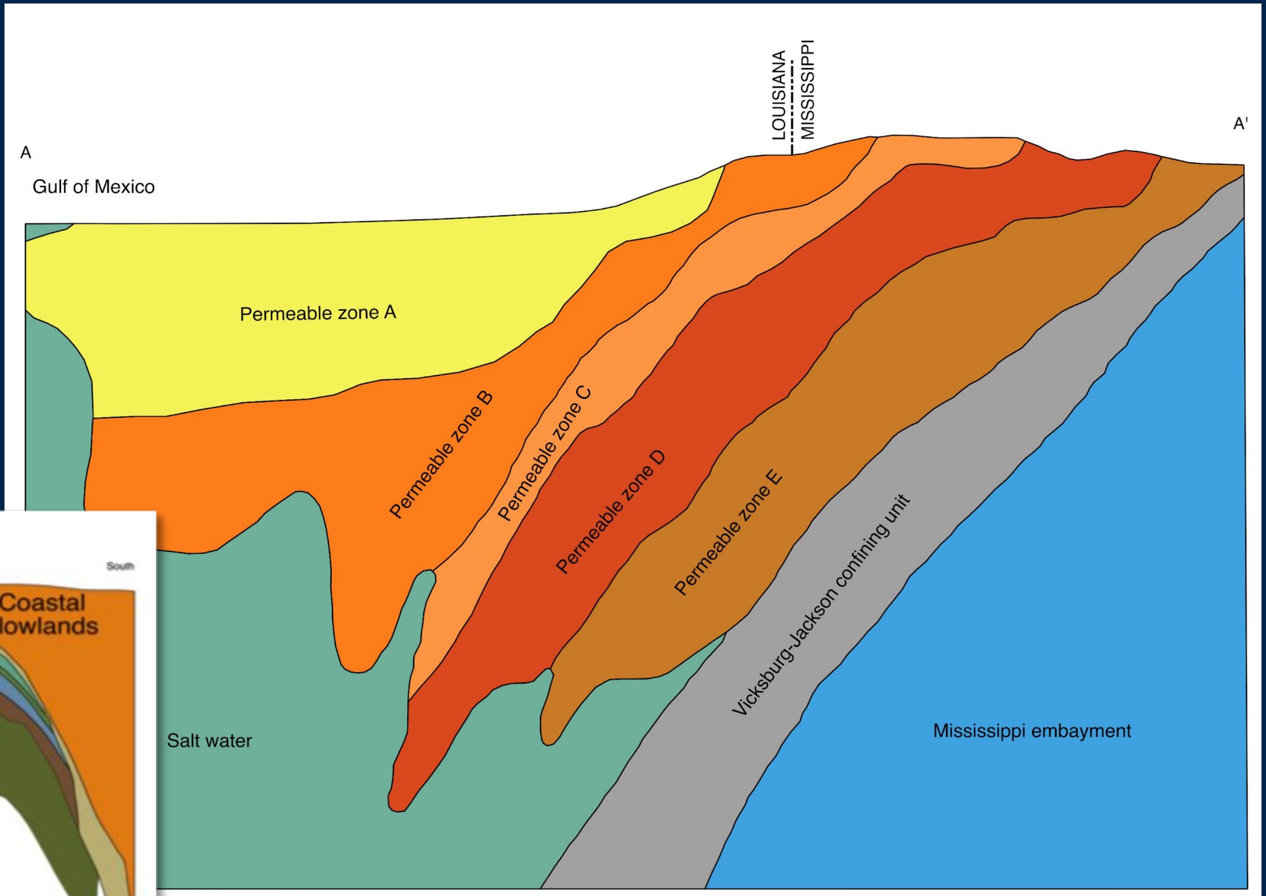
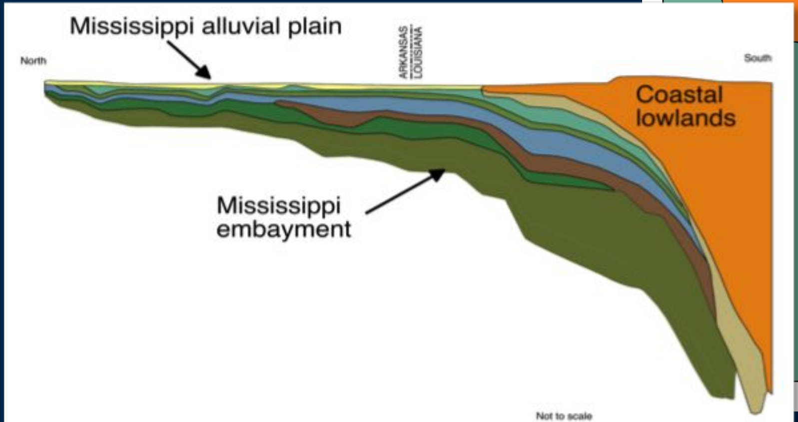
System geometry - historical

- unconsolidated
- 7 layers
- Overlies Mississippi embayment



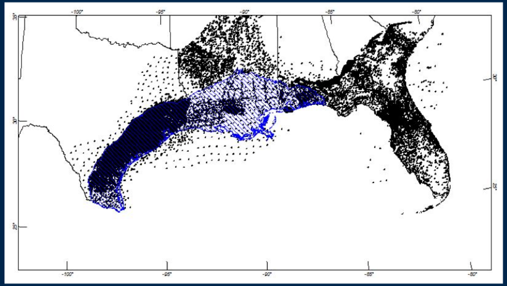
Modified from Martin and Whiteman, 1999

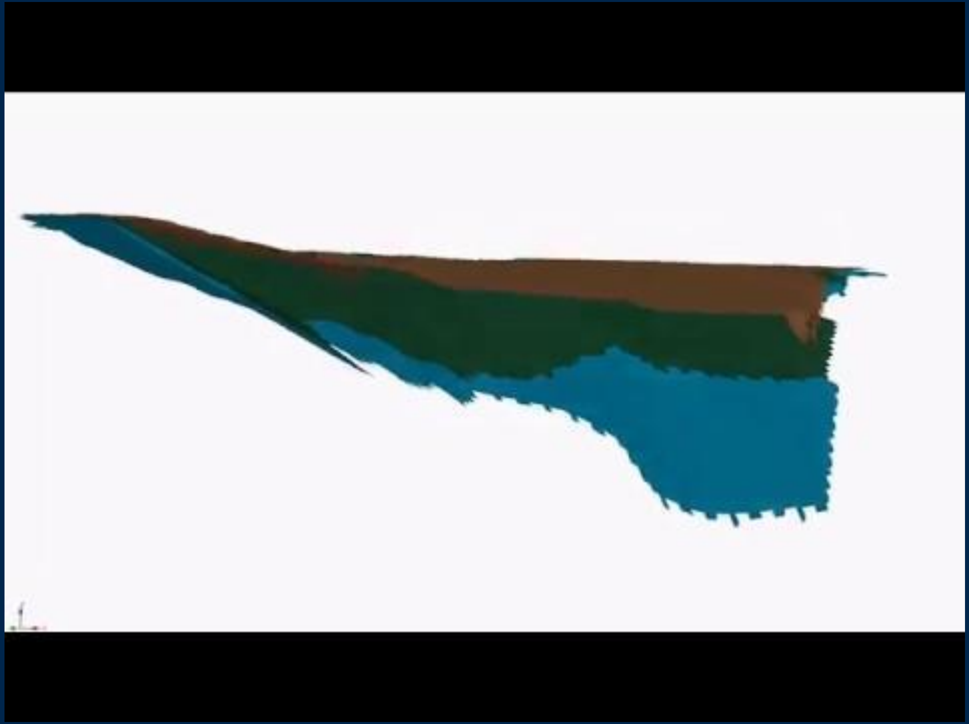


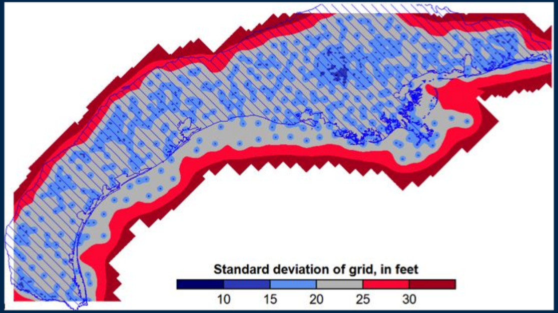
Modified from Grubb, 1998

System geometry - current

- Conceptualized as continuous units across the study area
- Aquifer delineations
- Chicot, Evangeline, Burkeville Confining Unit, Jasper, Catahoula
- Data Release FY18







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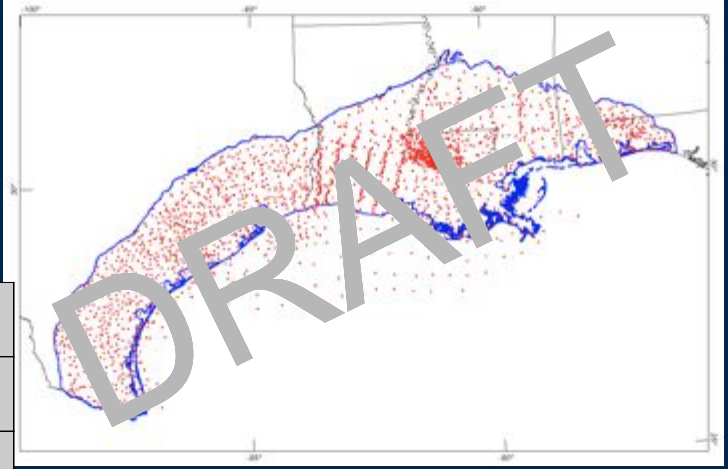
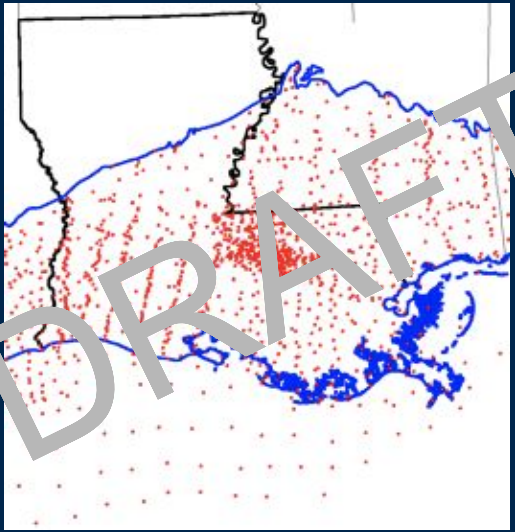
Hydrogeologic Data Compilation

State	Alabama	Florida	Louisiana	Mississippi	Texas	Totals
Total Wells	114	602	**1741**	247	66035	68739
Total Wells with Framework Data	113	142	**1455**	222	1062	2994
Total Individual Picks	721	848	**[illegible]604**	1913	10501	31587
Sources	[illegible]GS GS[illegible] [illegible]SGS	[illegible] USGS	**INTERA** **LGS** **USGS**	MDEQ USGS	INTERA USGS	





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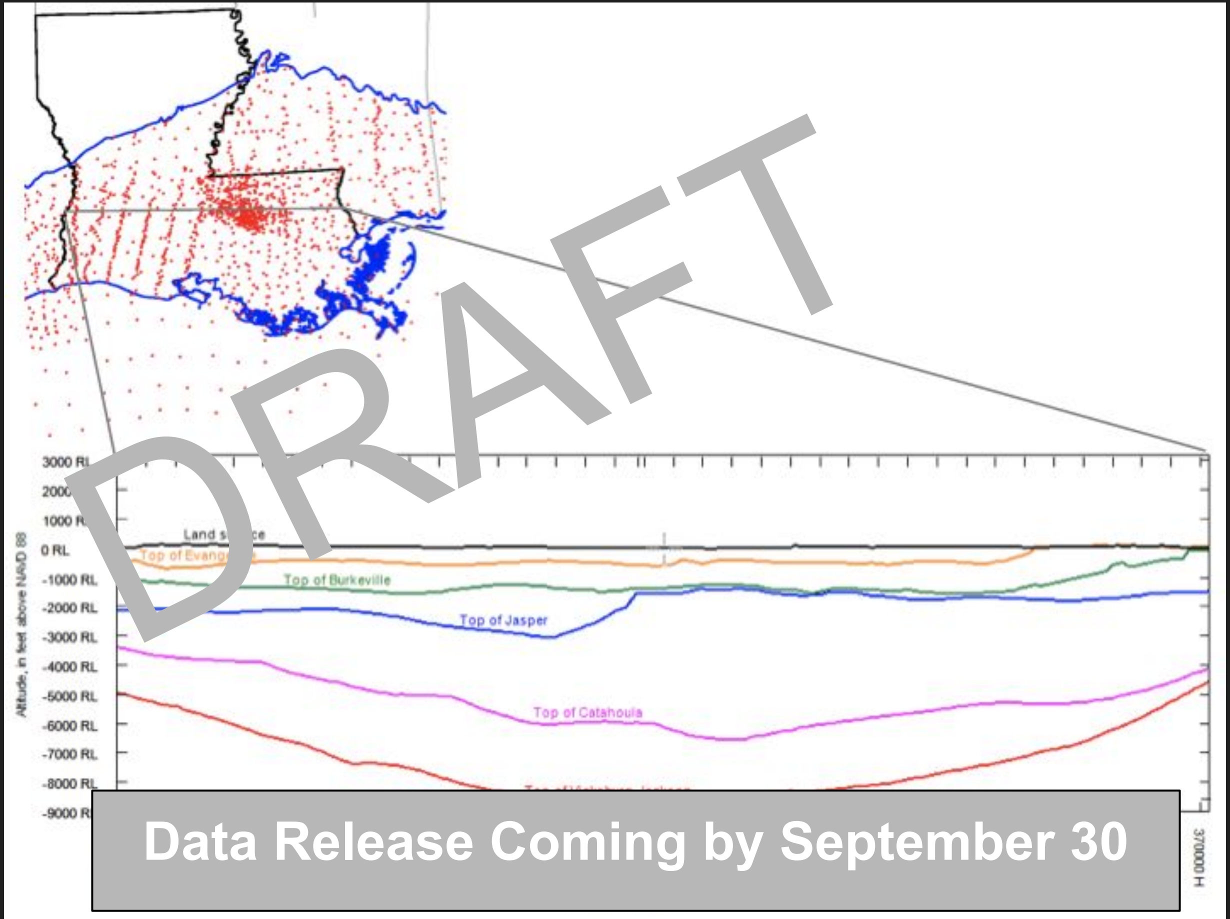
LA Stratigraphic Data and Aquifer Equivalents



Data Release Coming by September 30

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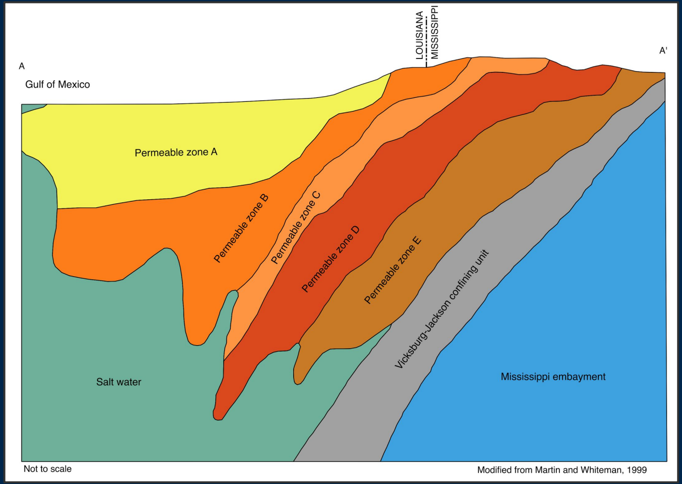
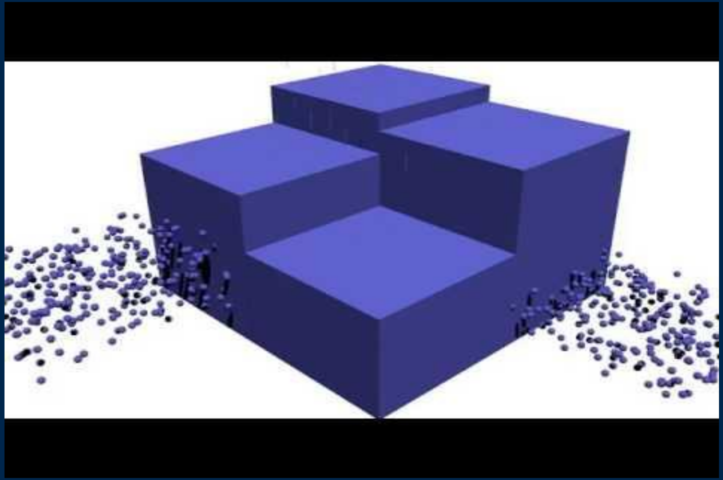
Traditional development

Conceptual model



Data



Calibration
(History-Matching)

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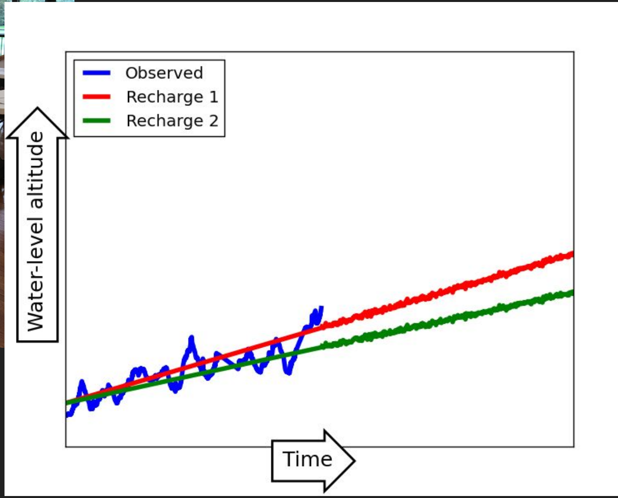
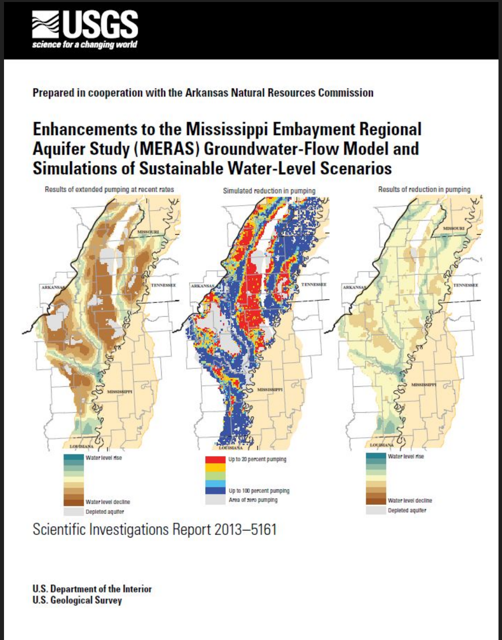
Traditional development

Meetings

Forecast/scenarios





Report

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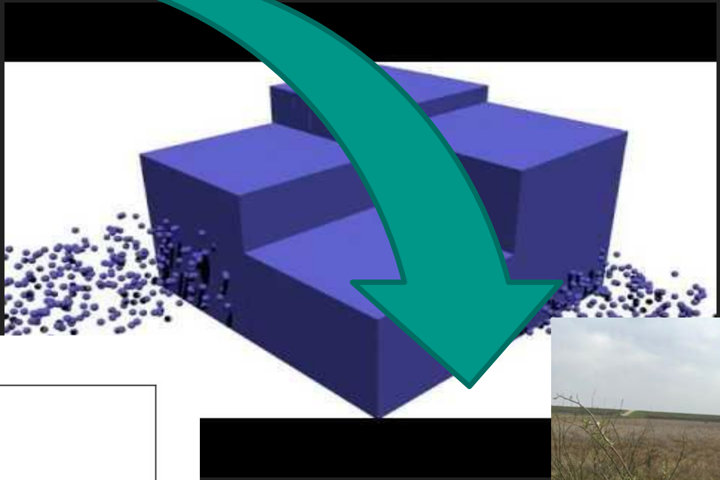
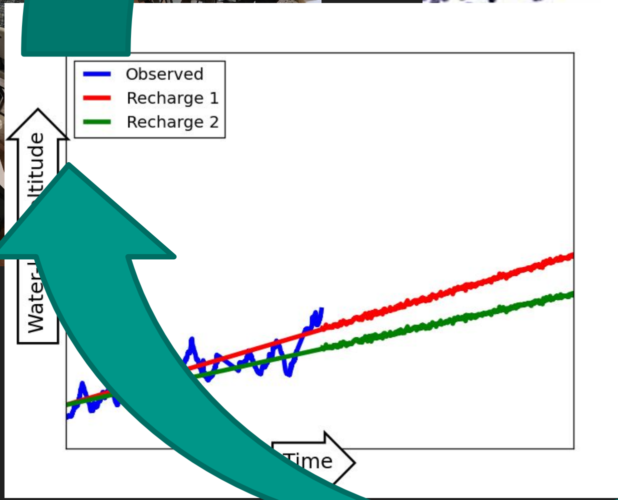
Forecast development

model…



Meetings



Forecasts

Data

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Forecast-first Modeling

Forecast First: An Argument for Groundwater Modeling in Reverse *by Jeremy White, USGS*

Groundwater
Volume 55, Issue 5,

"... by focusing on the forecasts, a more robust analysis of the *appropriate level of complexity* can be undertaken (e.g., Guthke 2017), where complexity is driven not only by the ability to reproduce the past, but also simultaneously *by the need to provide **robust** estimates of forecast uncertainty.*

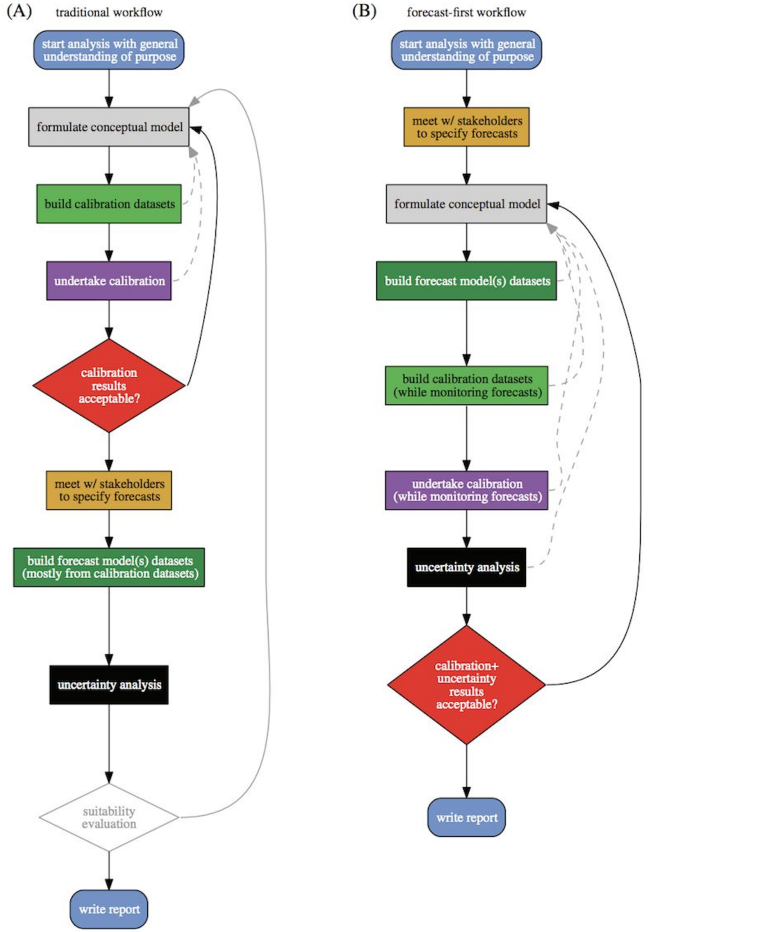
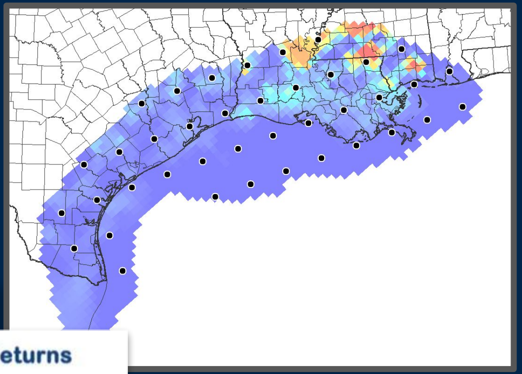
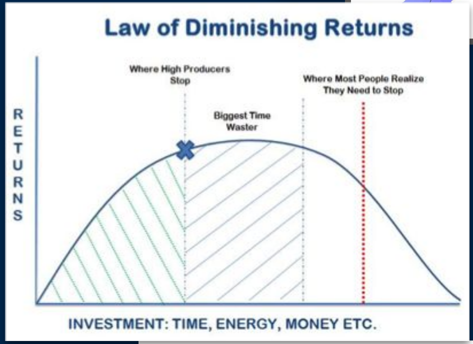


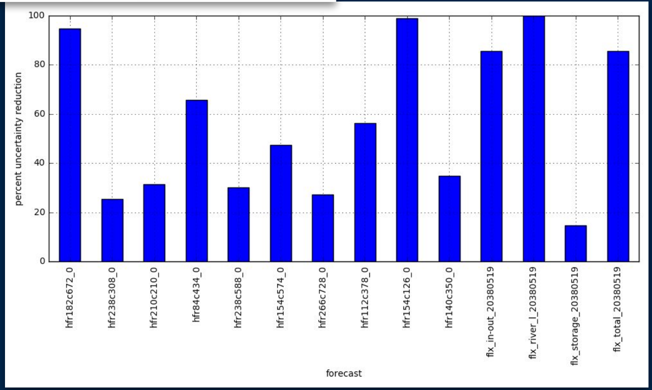
Figure 1. A comparison of a traditional modeling analysis workflow for groundwater modeling analyses (A) and the proposed, forecast-first workflow (B). Dashed, gray edges represent optional steps that may be required. The suitability evaluation (Jakeman et al. 2006) is an explicit, but optional step in the traditional workflow. However, in the forecast-first workflow, the suitability evaluation is happening implicitly during each step of the analysis.

85% Model

1. Use existing models
2. Pull together historical data (water levels, baseflows, etc) and information on the system (***prior***)
3. Quantities of Interest (QoIs)
4. Build forecast “model”
5. Uncertainty Quantification
6. Add in new dataset, repeat & compare
7. Condition/history-match/calibration, final predictive scenarios, assess







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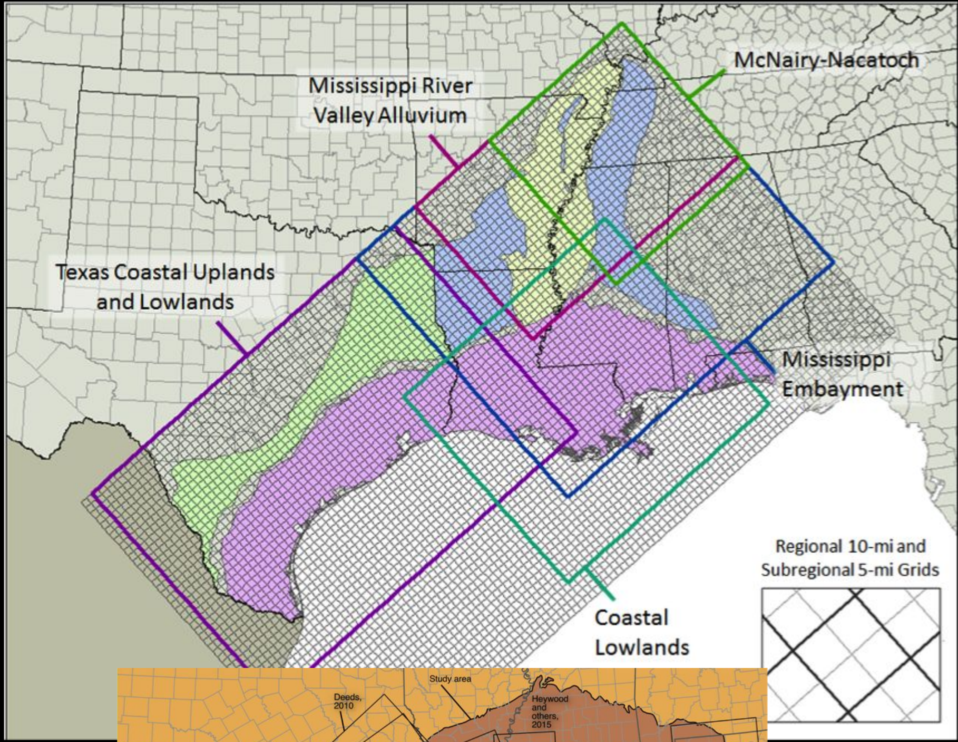
Previous Models

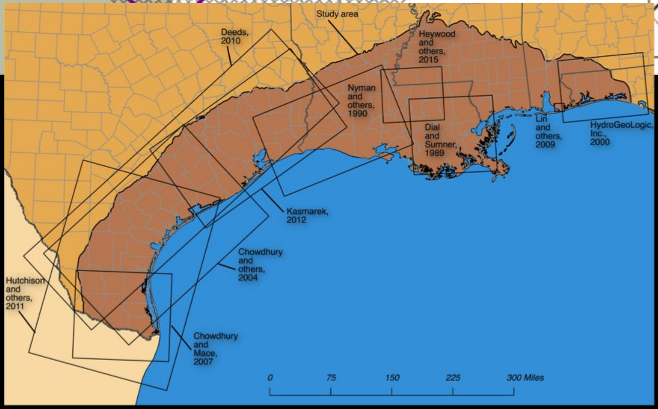
Several models in study area

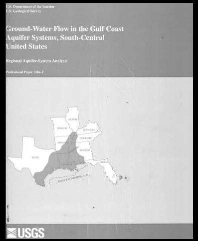
Regional Aquifer System Analysis (RASA) model

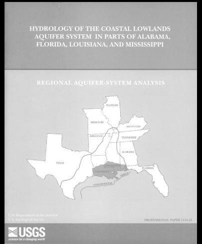
Converted to transient for 1985 - 2010 with

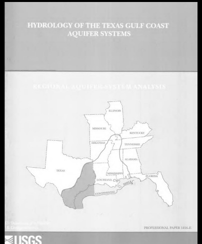
- simplistic water-use estimates
- retaining original framework (7 layers or permeable zones)

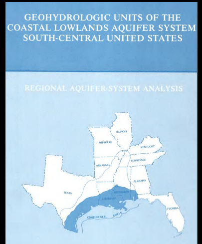






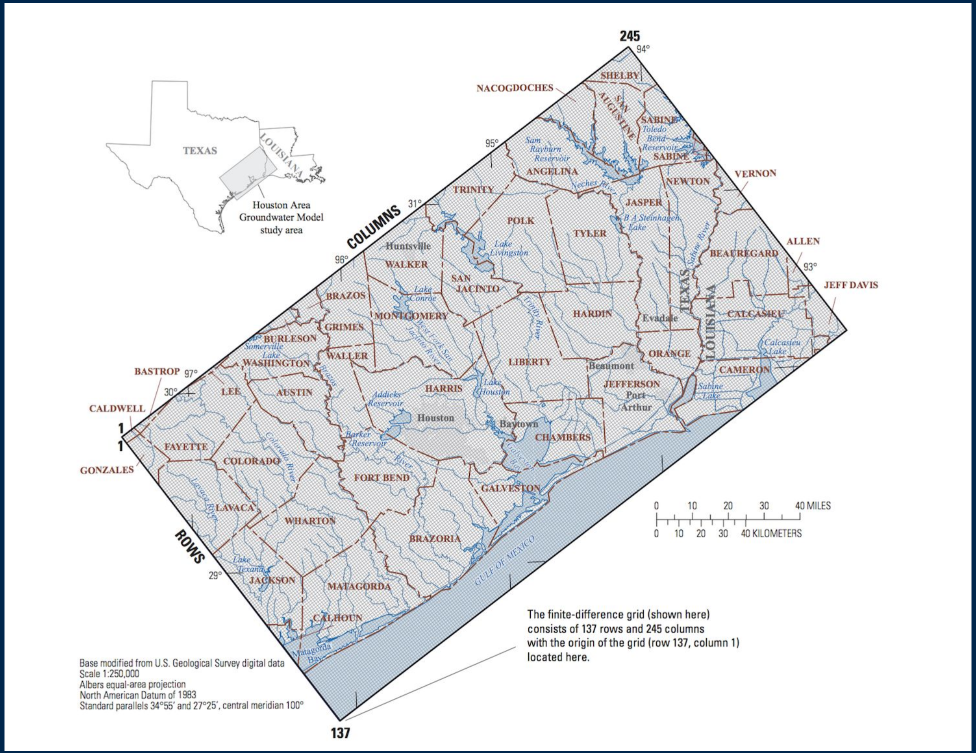


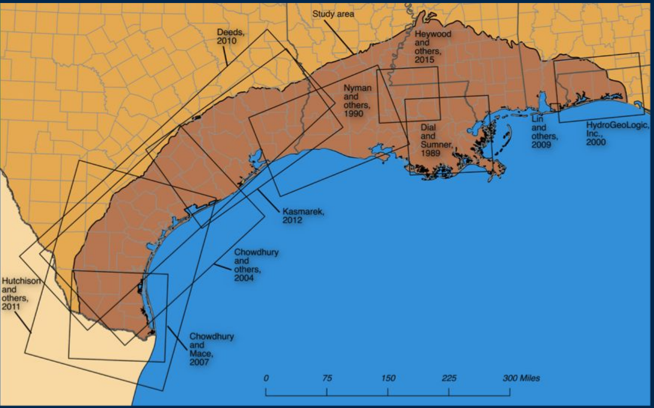




Texas Groundwater Availability Models (GAMs)

- 1 mile by 1 mile grids
- Pre-development to 2000 - 2012
- Layers consistent with aquifers
- Various boundary conditions (WEL) and levels of calibration





Texas Water Development Board

Current Model

MODFLOW 6 consistent with National Water Model Grid

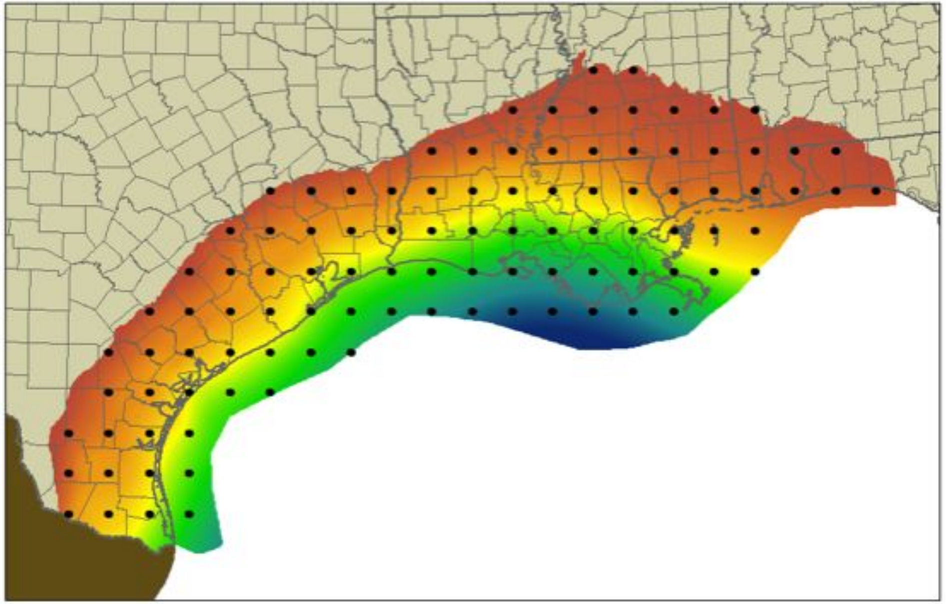
Converted to transient for 1900 - 2015

Pilot Points every 60 km

Parameters (HK, VK, Ss, Sy, Recharge and Pumping)

pyEMU and PEST++

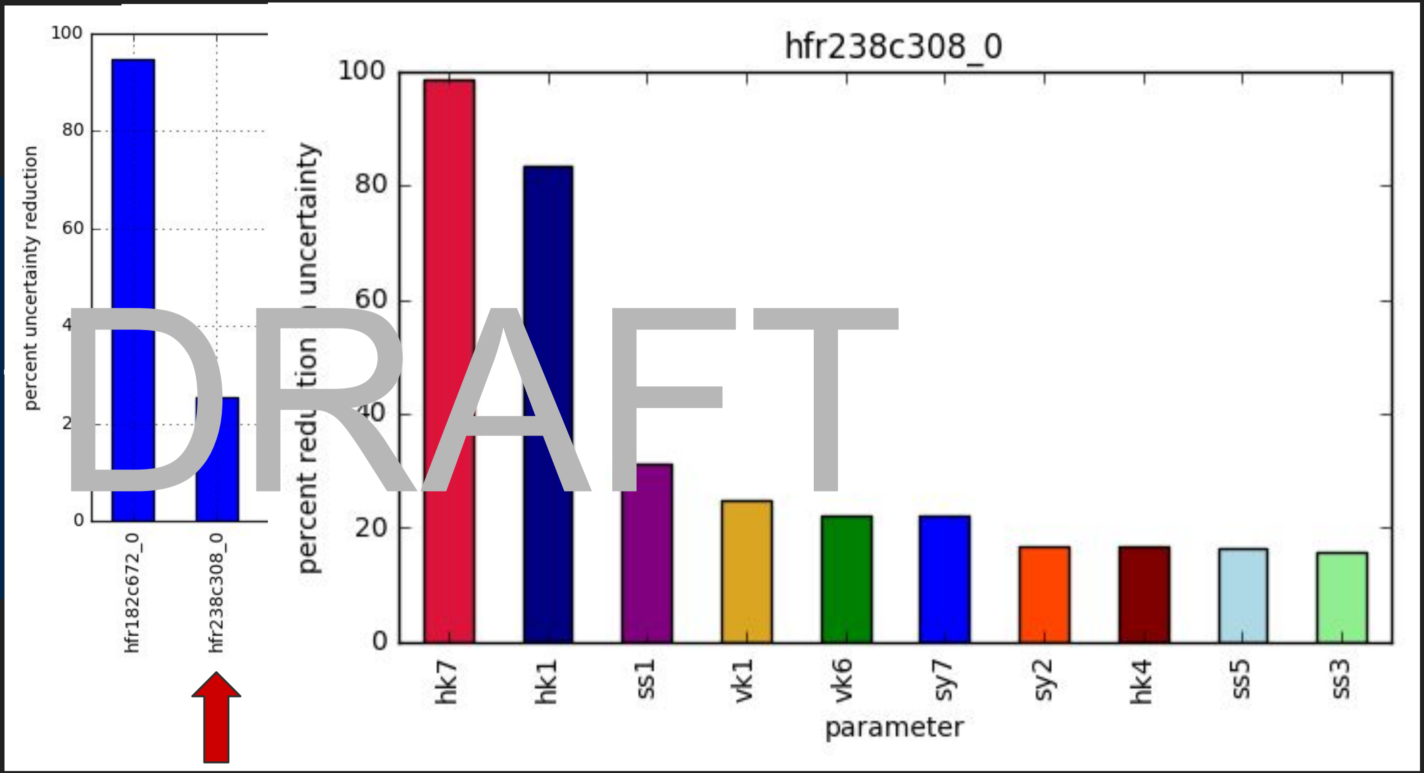
Water levels as obs for predictions currently



Pilot point spacing for aquifer properties - horizontal and vertical hydraulic conductivities, specific storage, and specific yield

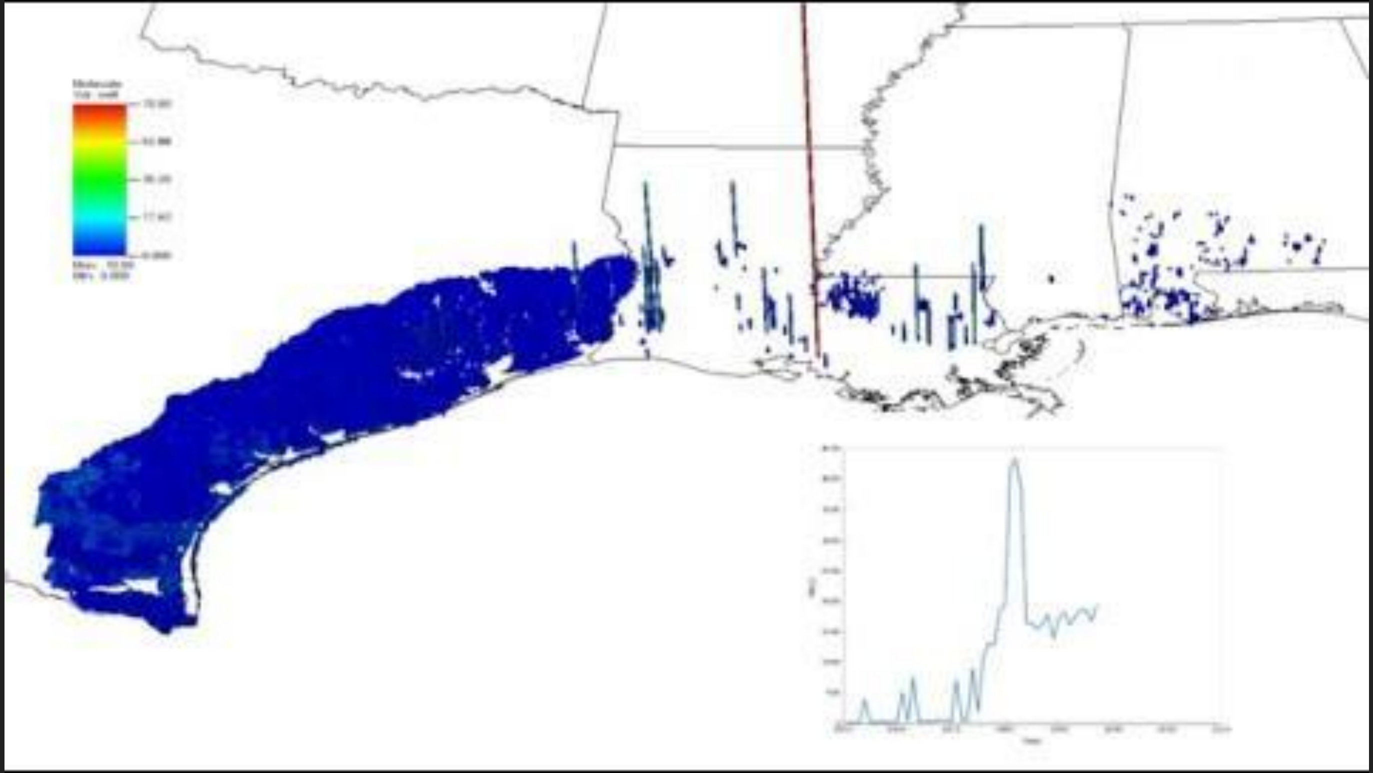
Forecast Uncertainty

Hydraulic conductivity most important parameter



DRAFT

Water use



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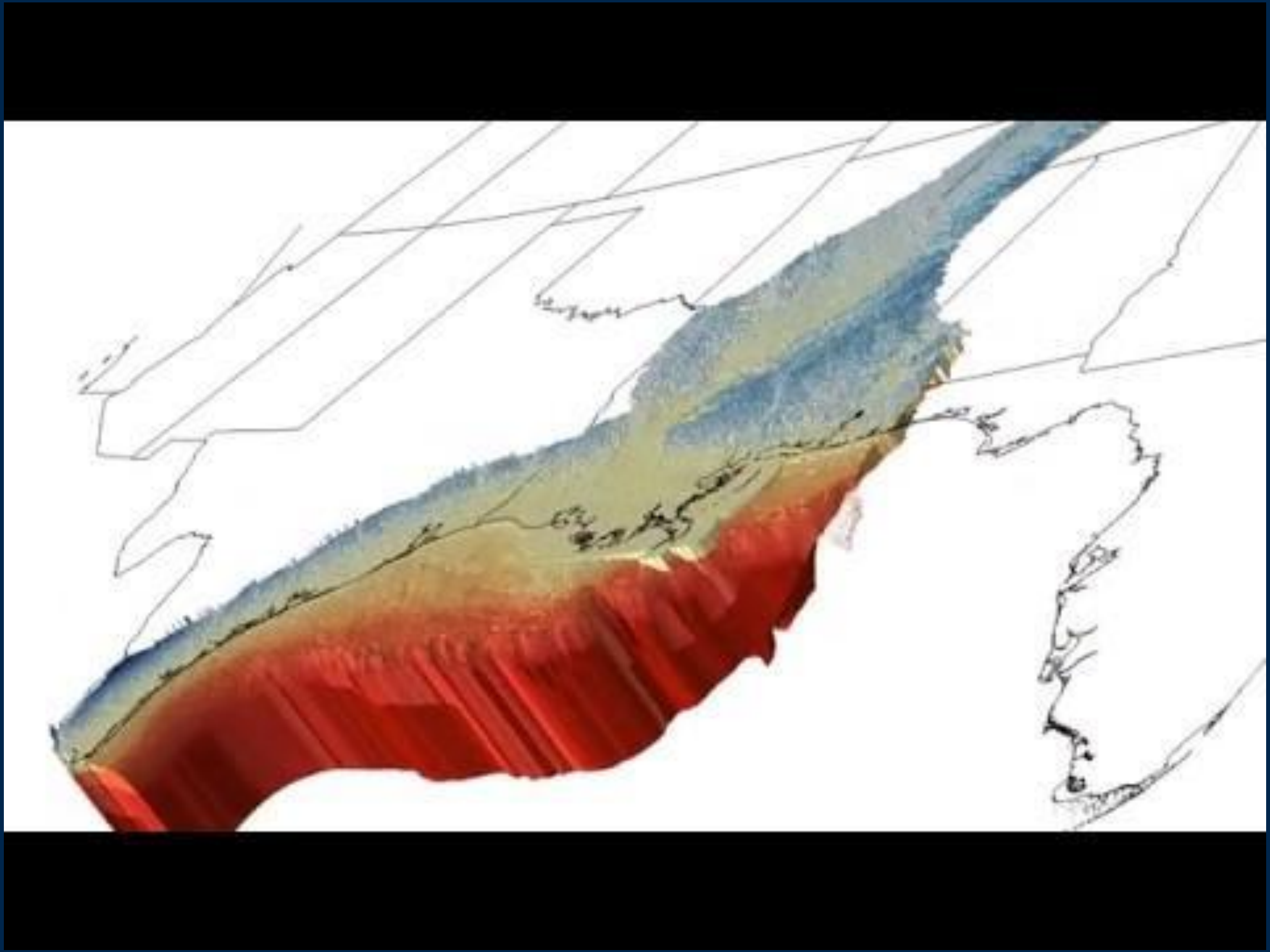
Next Steps

- QoIs
- Prior
- Next round of data integration - UQ
- SFR
- CSUB



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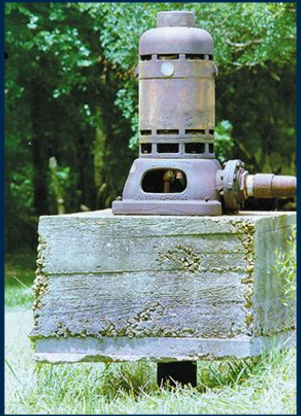
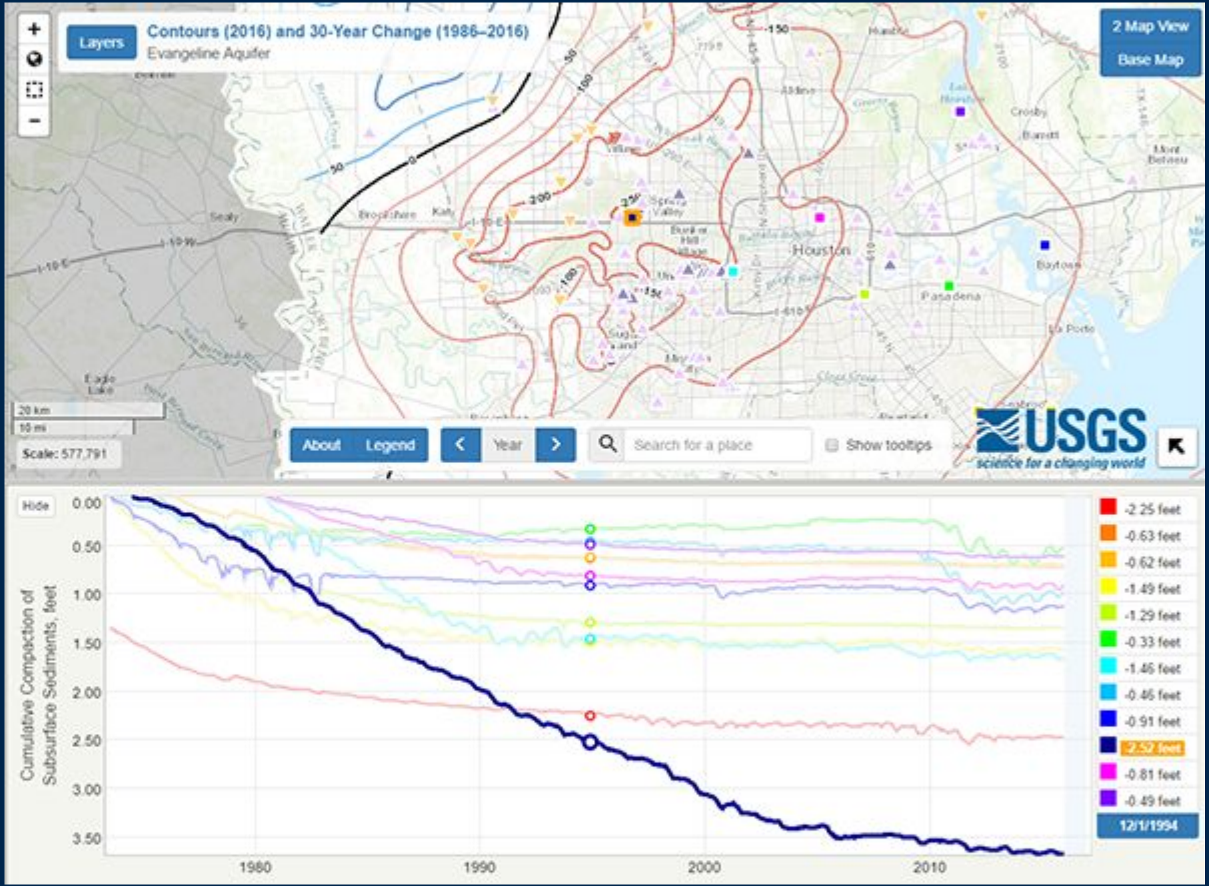
Land-surface subsidence

https://txpub.usgs.gov/houston_subsidence/home/



CSUB Package for MODFLOW 6 (J. Hughes)



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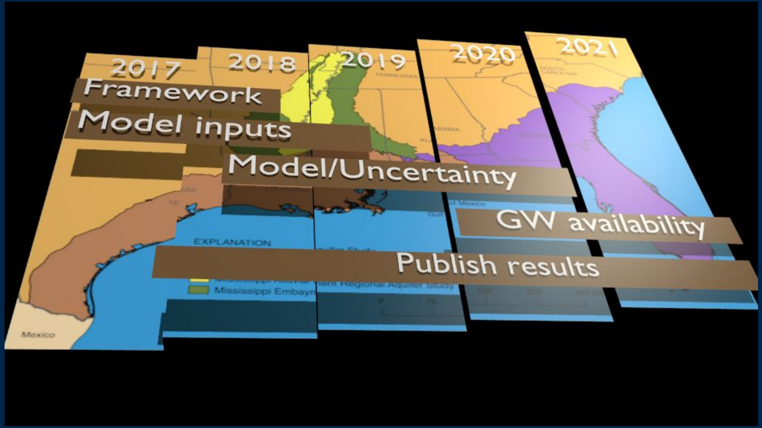
Timeline



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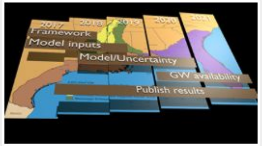
CLAS Regional Groundwater Availability Study

Timeline

Home | Study Area Map | Water-Use Map | Methods | Timeline | Deliverables | Staff

The project is designed to span five years. The first year is focused on data compilation for framework development, water use, and history-matching criteria as well as the beginning construction of initial model datasets, including both the history-matching (calibration) model datasets and the forecast/scenario model datasets. The second year will be focused on updating the conceptual model, completion of initial model datasets, development of the prior uncertainty distributions for the model parameters, preliminary uncertainty analysis, and refinement/construction of more complex model datasets. The third and fourth years will be focused on conditioning of the model to historical data, application of non-linear uncertainty analysis, initial evaluation of both groundwater availability and the monitoring network, and publication of these results. The fifth year will be used to focus the modeling analysis on the topic of groundwater availability in regards to status and trends and future projections, as well as completing publication of the remaining products (professional paper and fact sheet).



Study Component	FY17				FY18				FY19				FY20				FY21			
	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4
Task 1: Framework																				
Task 2: Conceptual and Numerical Models and Input Datasets																				
Task 3: Conditioning of Numerical Model, Predictions Under Uncertainty																				
Task 4: Groundwater Availability Assessment																				
Communication																				
Web Presence																				
Stakeholder Engagement Presentations																				
Project Updates																				
Products																				
SIR Framework/Conceptual Model/Model Datasets and Construction																				
Journal Article (new SUB package for MODFLOW6)																				
Journal article (conditioning, uncertainty and scenarios)																				
Data Releases (part of data management)										2										
Professional Paper -- groundwater availability, water budget, predictions																				
Fact Sheet																				
GWWebFlow Stochastic Model Viewer																				

Contacts:

Brian – brclark@usgs.gov

Linzy – lfoster@usgs.gov

Leslie – lduncan@usgs.gov

https://www2.usgs.gov/water/lowermississippigulf/lmgweb/clas/index.html