A CLIMATE-INFORMED DECISION SUPPORT SYSTEM FOR APPRAISING ADAPTION MEASURES TO REDUCE FLOODING RISKS FOR SE TEXAS

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PROJECT OVERVIEW

- Funded by NOAA CPO Coca-SARP
  - Integrate climate information to select adaptation measures
  - Improve resilience of water supply infrastructures
- Specific Aims
  - Assess flooding risk in Jefferson/Orange Counties under future climates
  - Evaluate adaptive measures to forestall water supply disruptions
  - Appraise cost-effectiveness of adaptive measures
    - considering climate and indirect impacts of flooding on regional economy

HIGHLIGHTS OF TODAY'S TALK

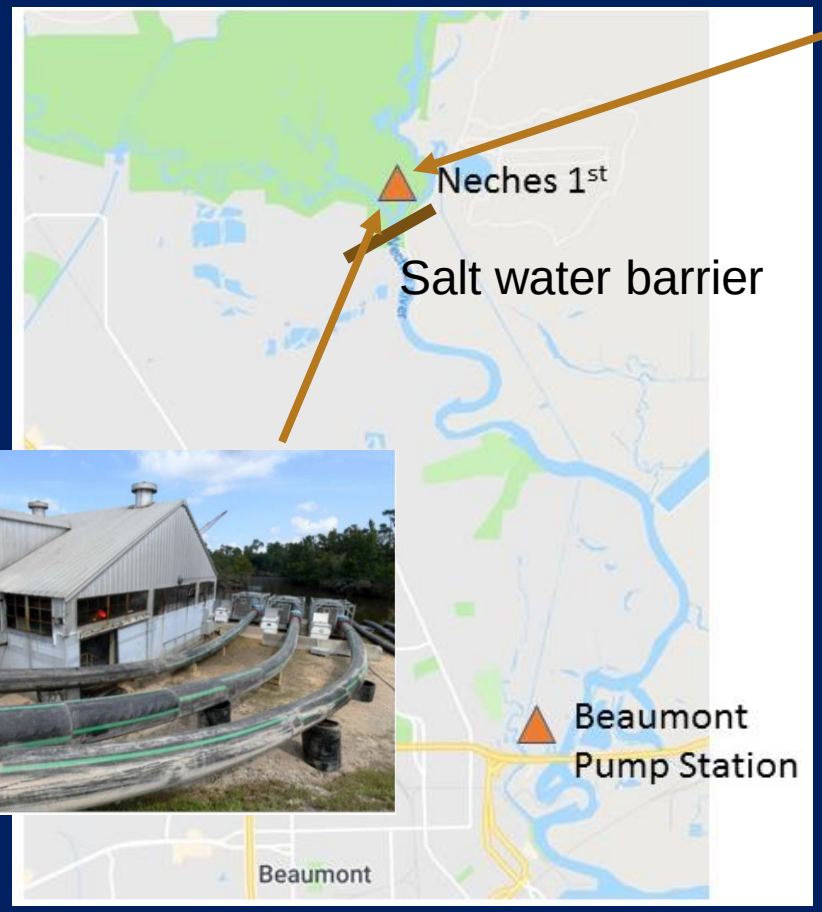
- Motivations and goals
- Climate-informed flood risk assessment framework
- Coupled modeling system and case studies
- Concluding remarks

MOTIVATIONS

- Home of major energy producers
  - 11% of US petrochemical employment

- Jefferson and Orange Counties
  - Often overlooked by policy makers

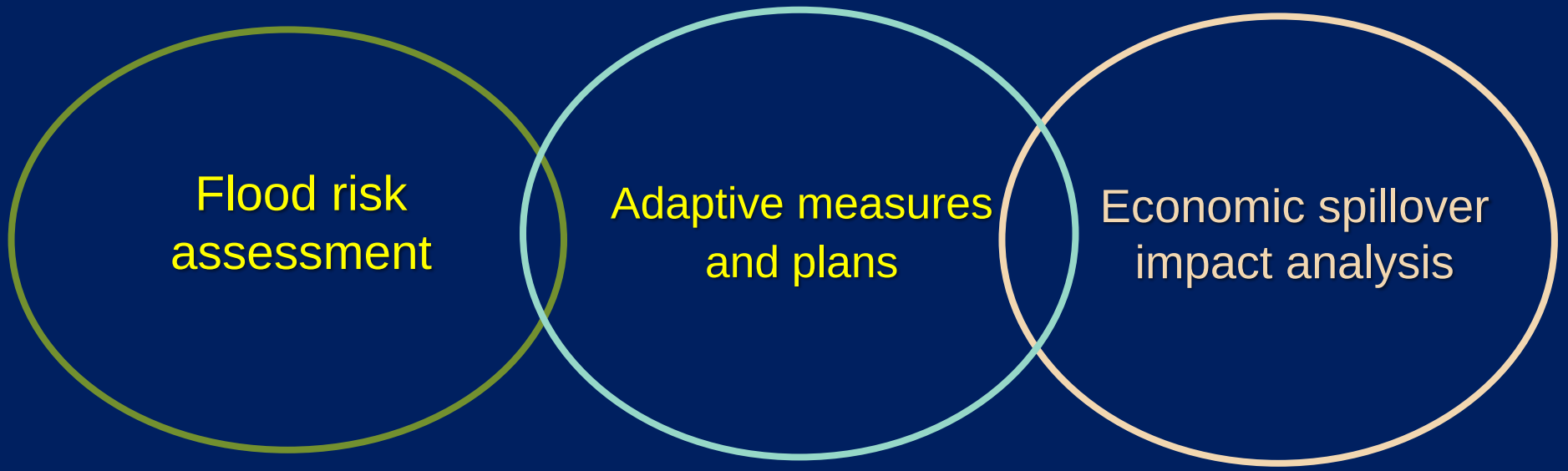
FLOOD AND WATER DISRUPTION



Hurricane Harvey

- LNVA pumping stations flooded
- Beaumont had water supply disrupted for 12 days

GOALS AND APPROACHES

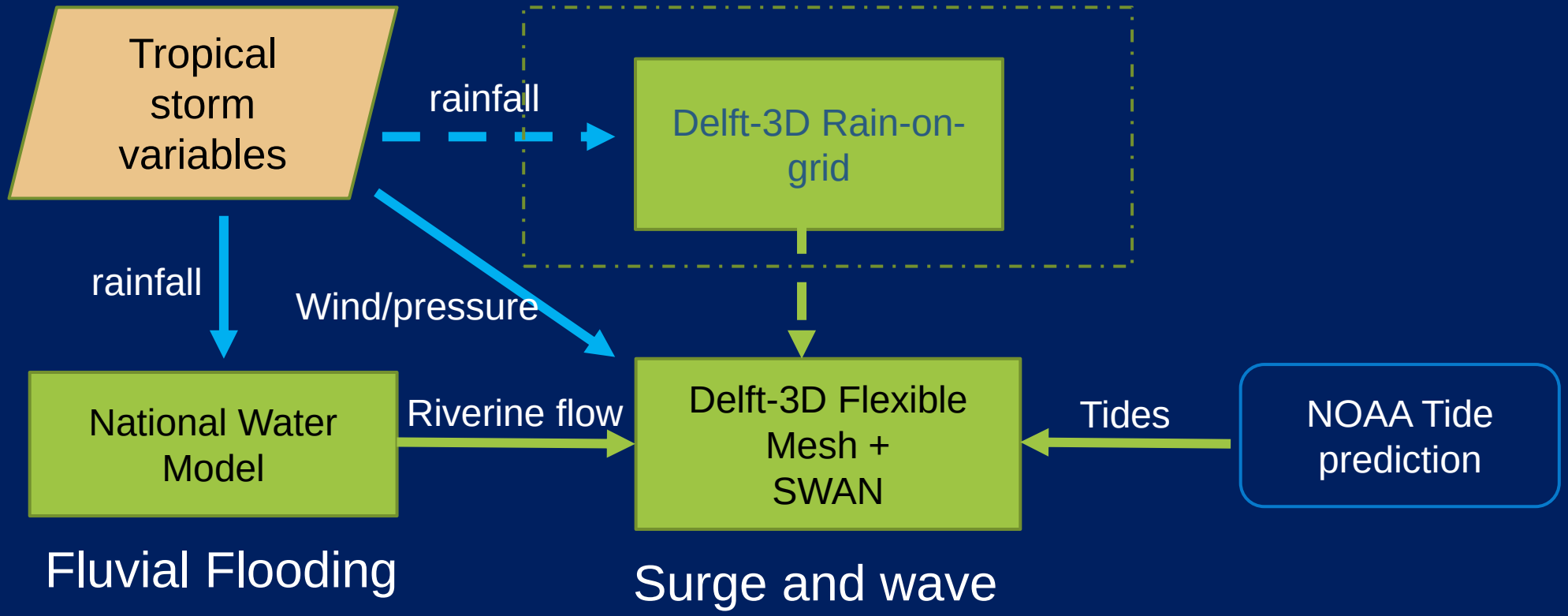


- Estimate frequency of storms
  - in current/future climates
- Hydrodynamic model simulation of perturbed storms

- Appraise and prioritize spending

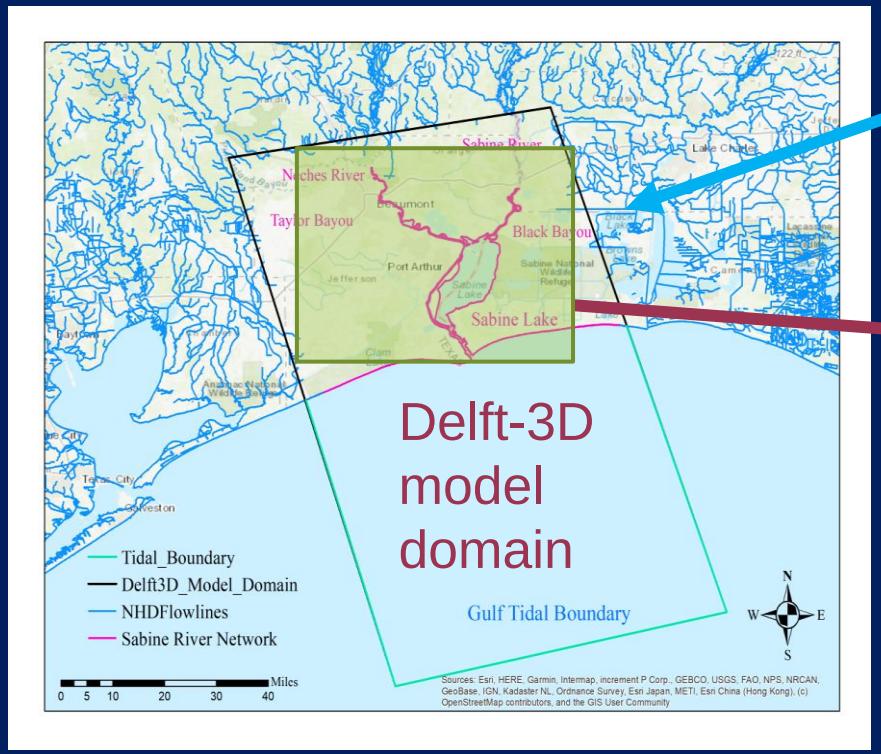
- Quantify impacts of water woes
- Gather empirical data through survey and interviews

COUPLED MODELING SYSTEM

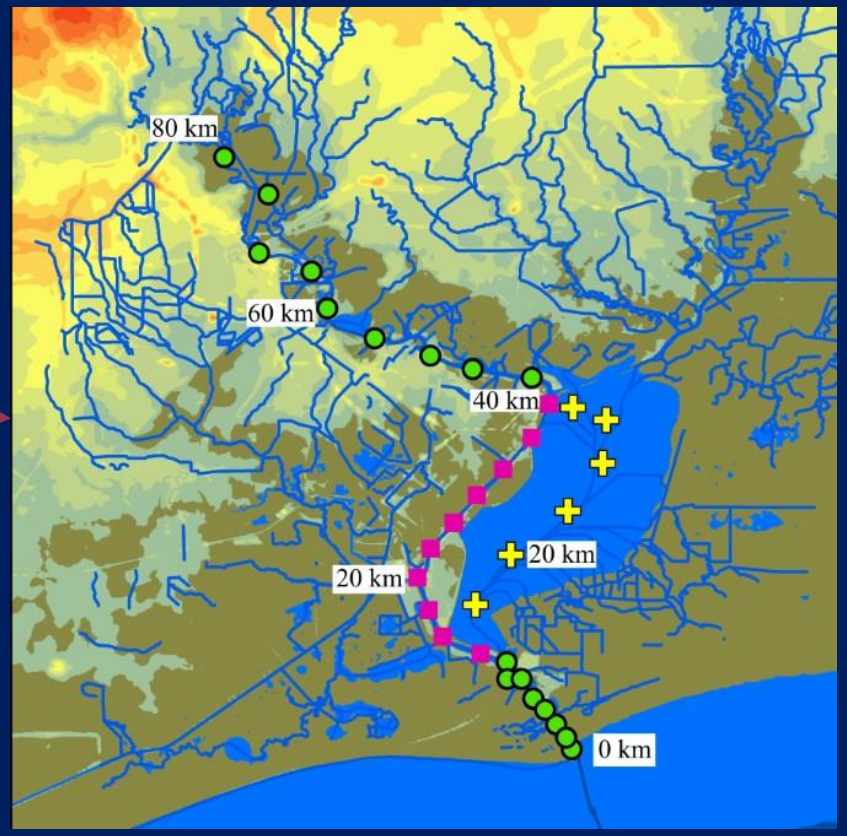


COUPLED MODELING SYSTEM

- Offline version of National Water Model set up for the region



NWM reaches



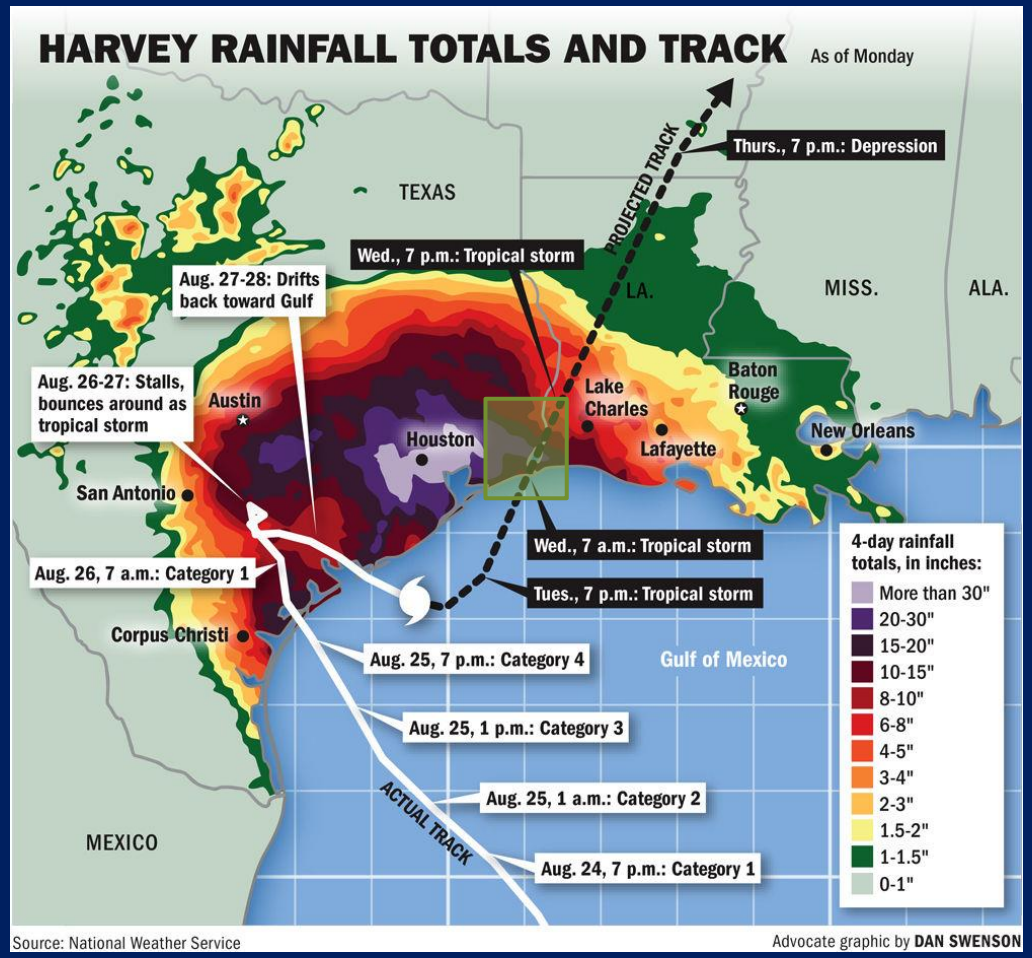
SIMULATION AND SCENARIO ANALYSIS

- Reconstruction of flooding during 3 major tropical storms
  - Hurricanes Rita (2005), Ike (2008), and Harvey (2017)
  - NWM analysis + Deflt-3D + SWAN
  - Wind and pressure from North American Regional Reanalysis (NARR)
  - Stage-IV gridded precipitation data
- Assessment of compound effects
  - Contrasting genesis of flooding and compound factors
  - Inform model configuration for assessing risks of future flooding

RESEARCH QUESTIONS

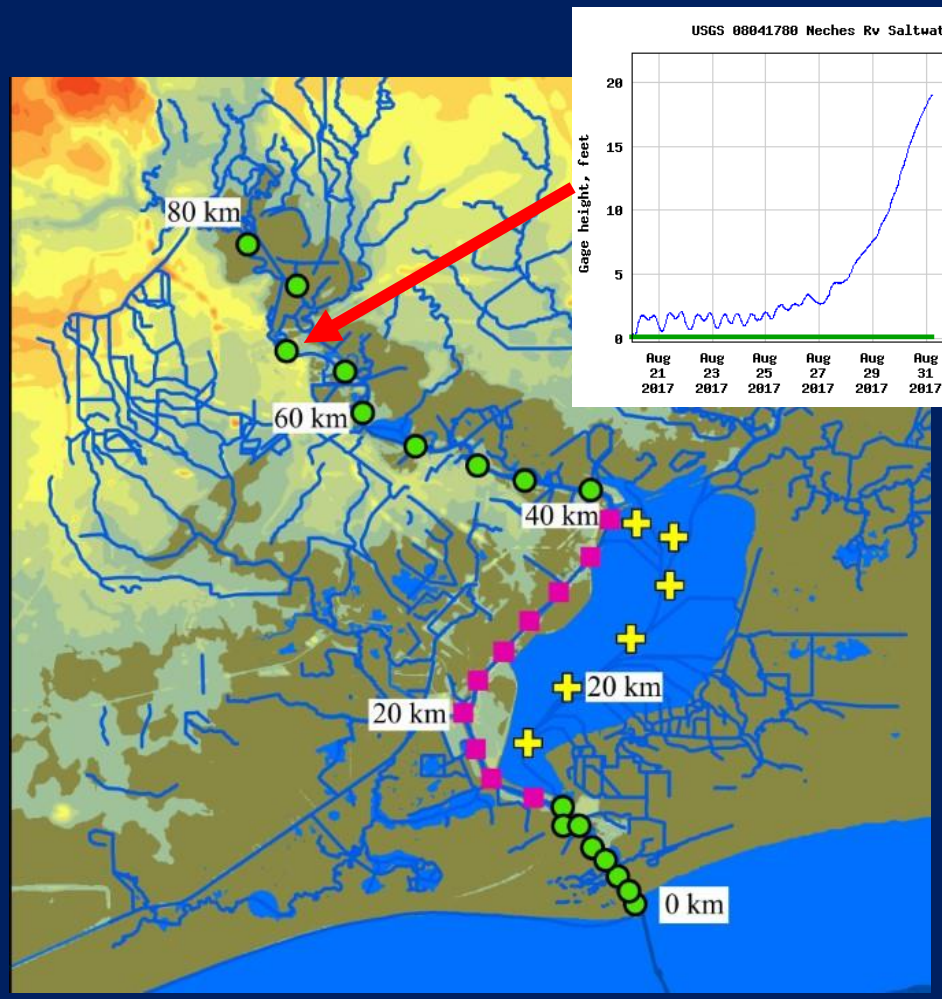
- Contrasts in so-called compounding factors among storms
- Hurricane Harvey
  - Impact of initial small surge on the flood intensity nearshore/inland
  - Relative contributions of upstream inflow and local rainfall
- Hurricane Rita
  - Impact of rainfall during landfall and how it varies spatially

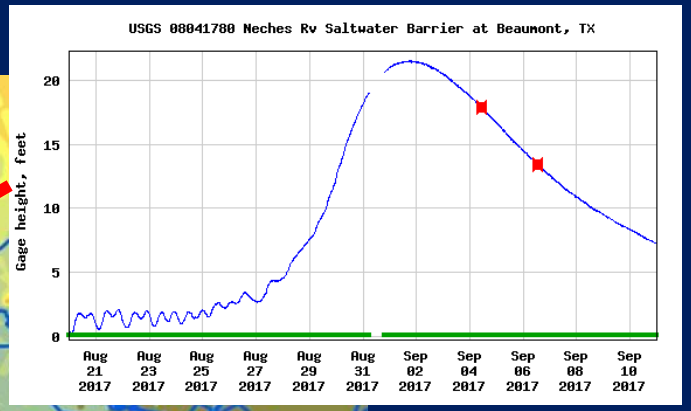
HURRICANE HARVEY



- Peak rainfall right in the BPA region
  - ~60” near Nederland, TX
- Rainfall dominating inundation
  - Some effects of earlier surge

HURRICANE HARVEY

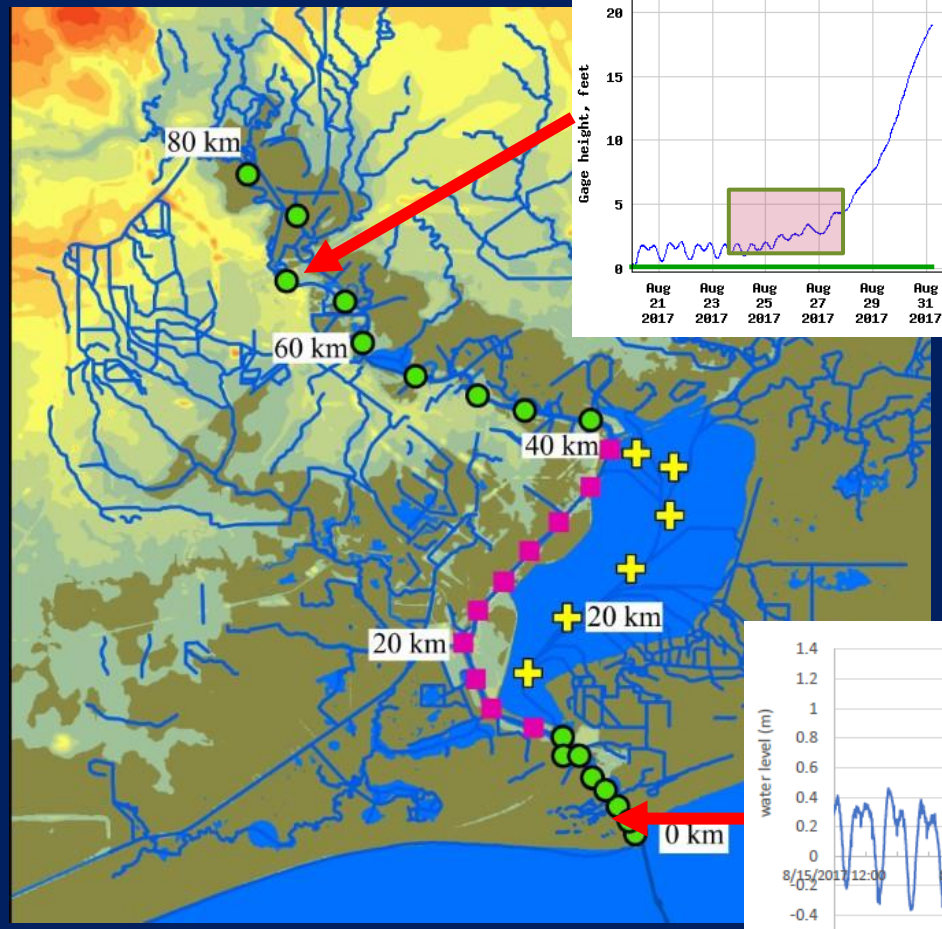


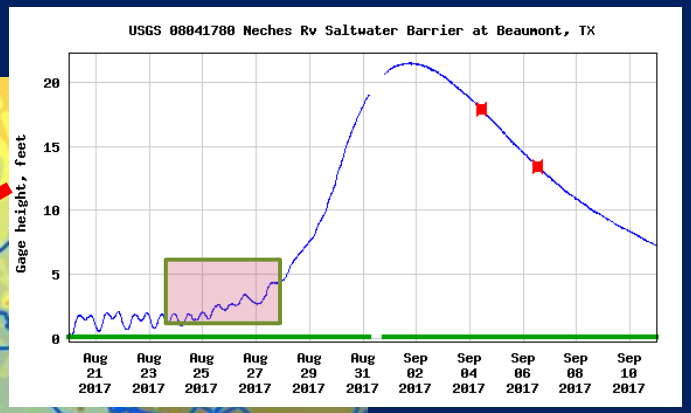


Large inflow along the Neches

Small surge (~ 1m) on Aug 26-27

HURRICANE HARVEY





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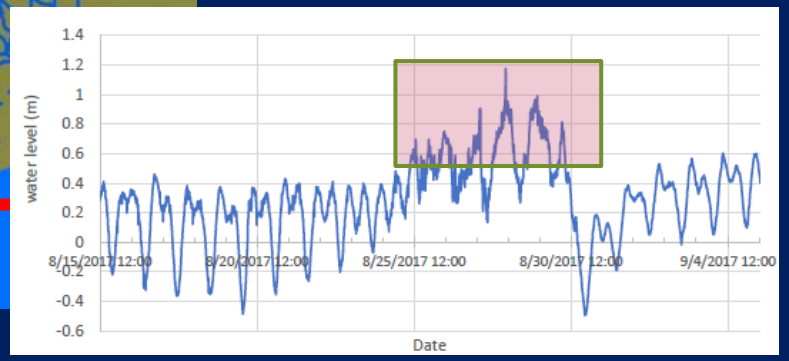
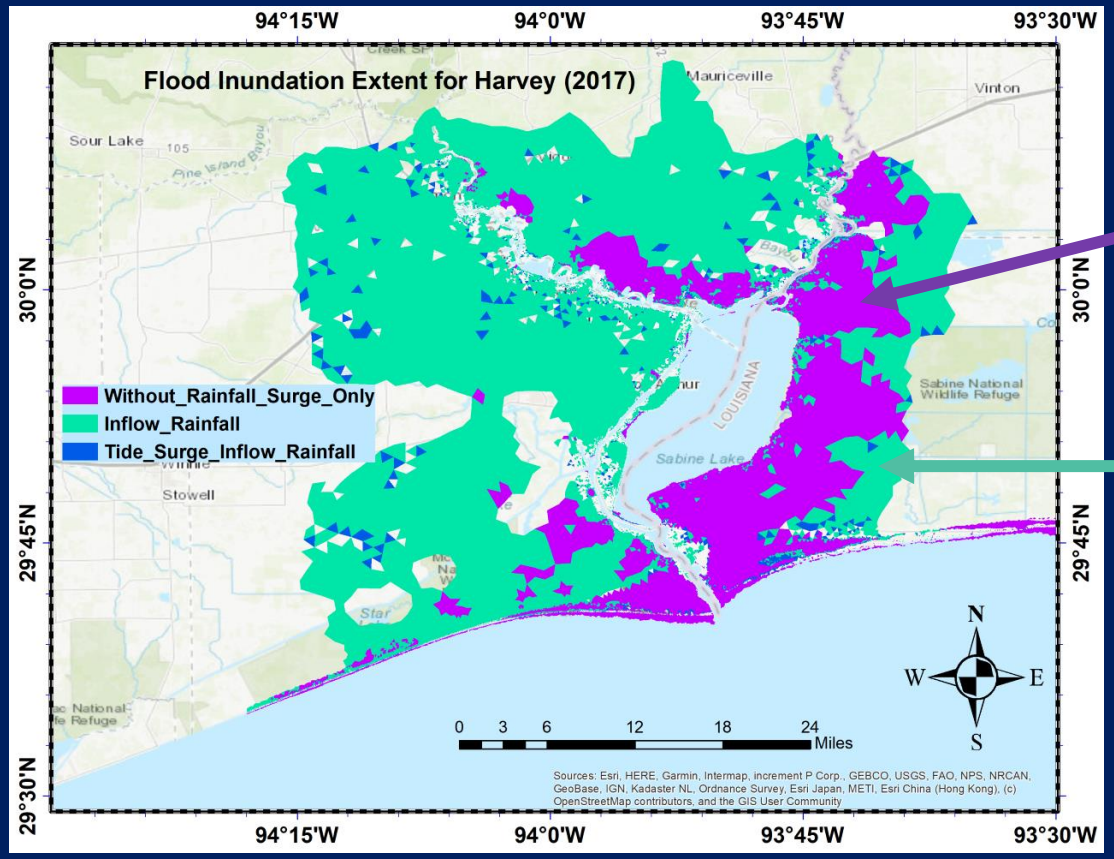
- High water level along the Sabine Pass – partly rainfall-driven



HARVEY – COMPOUNDING EFFECTS



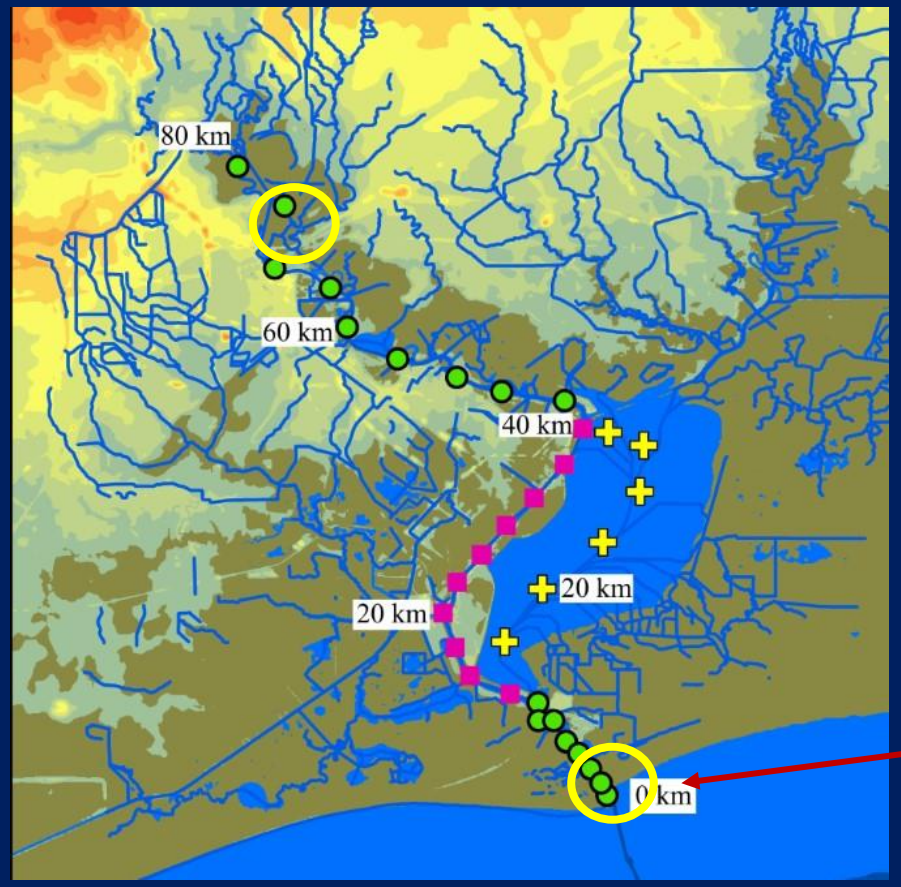
Initial surge minor but manages to penetrate upstream due to low elevation gradient

Inundation extent dictated by rainfall and upstream inflow

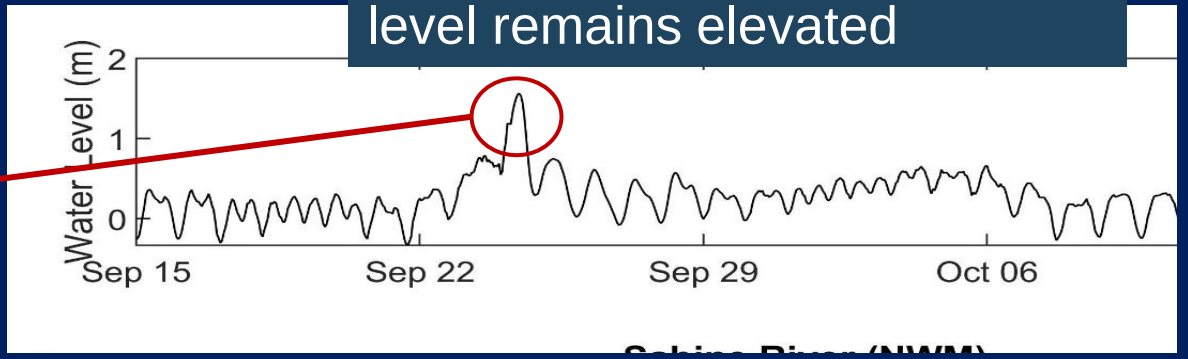
Conclusion: Initial surge has miniscule impact on the maximum extent of flood

SIMULATION RESULTS FOR RITA

- Moderate surge, moderate discharge



Surge on 24 but offshore water level remains elevated



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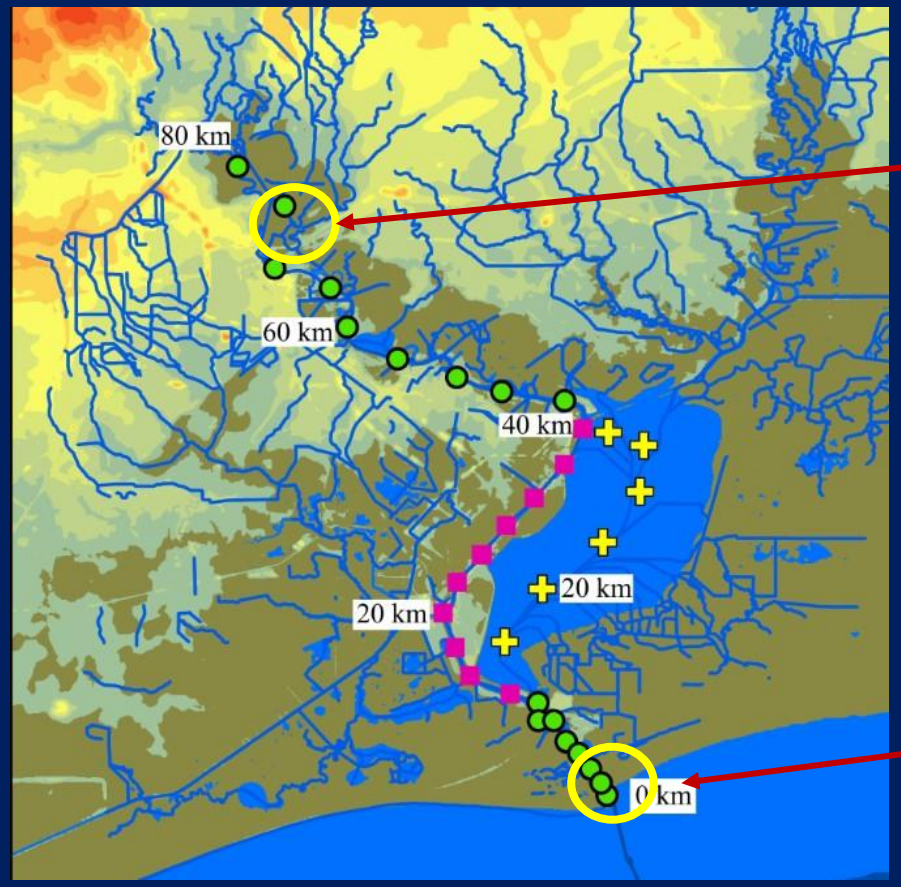
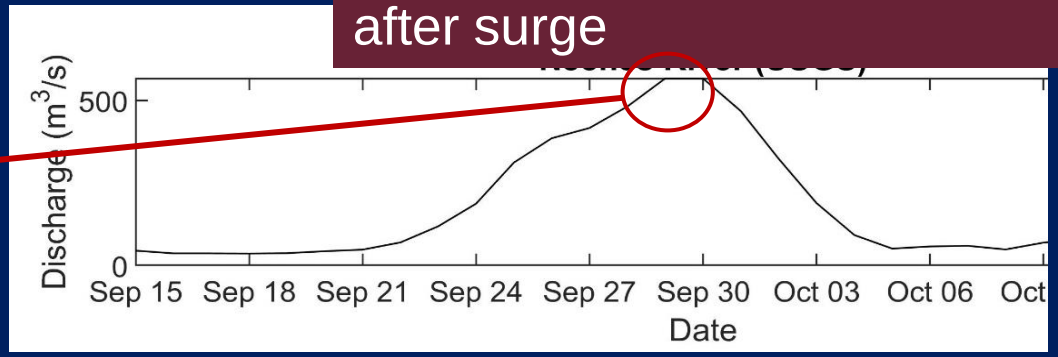


Riverine flow crests ~6 days after surge



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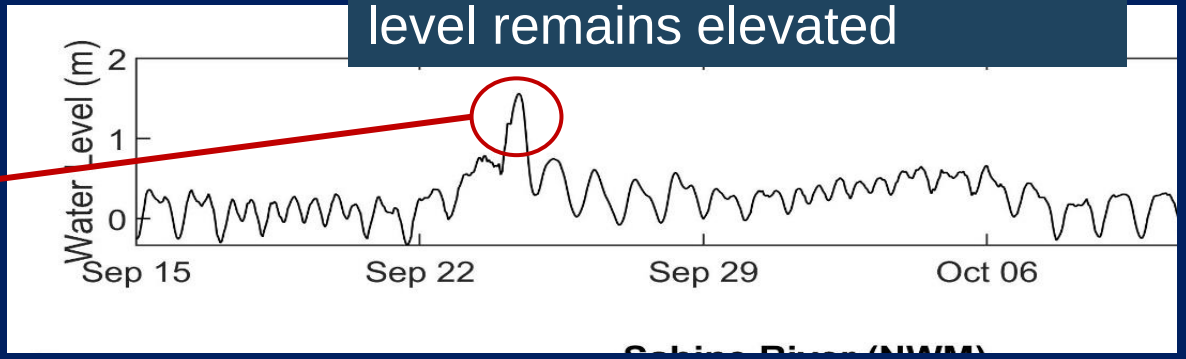

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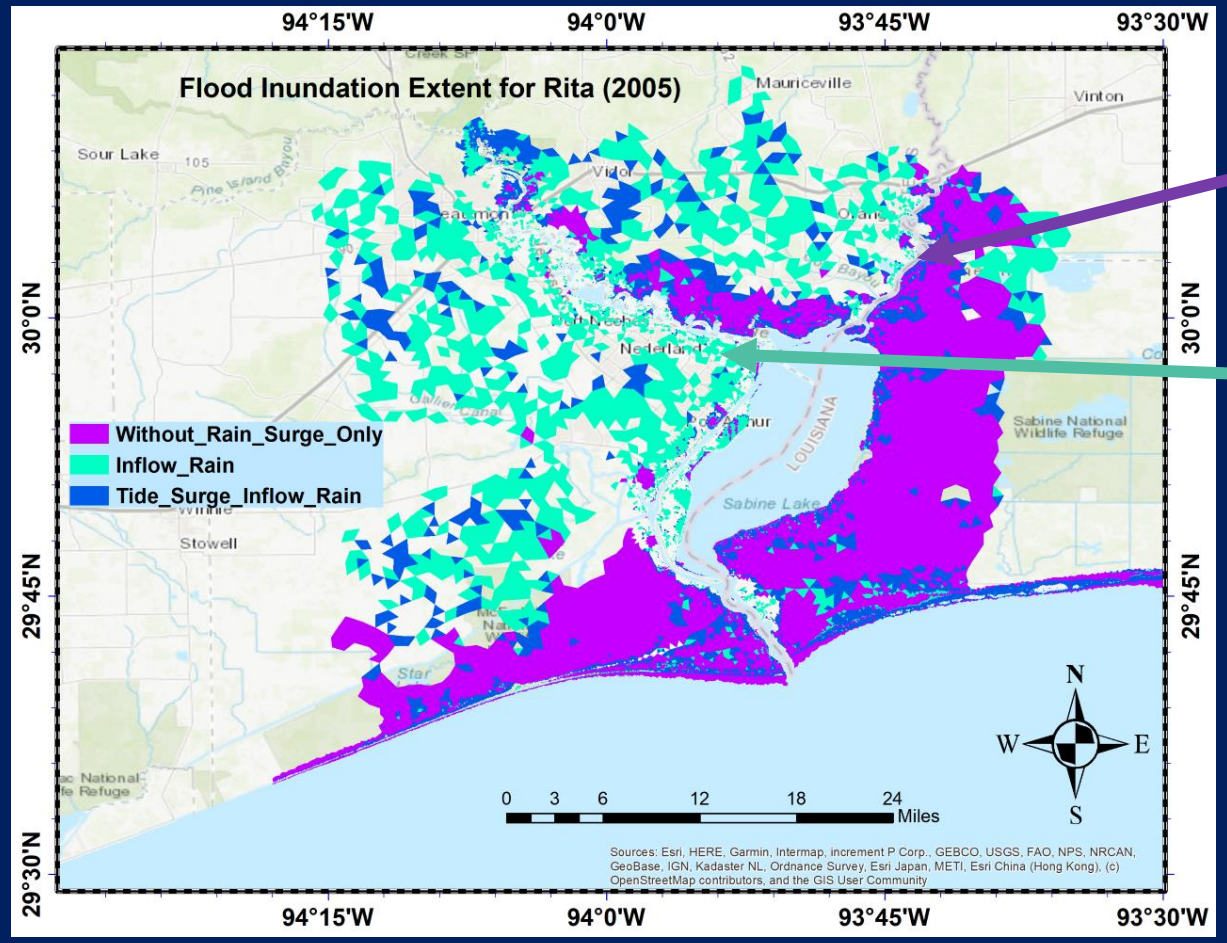


Initial surge more intense and further reaching

Rainfall causes localized flooding across the region

Conclusion: Limited compounding effects by rainfall, confined to the regions impacted by surge. Riverine flow lagged way behind

SUMMARY AND KEY TAKEAWAYS

- Climate-informed flood risk assessment framework
  - Focus on water infrastructures in southeast Texas
  - Coupled NWM-Delft-3D modeling system
    - Accounts for coastal
    - Able to perform future scenario analysis
- Reconstruction of flooding processes for Harvey, Ike and Rita
  - Cases with large impacts on regional partners
  - Contrasting genesis and “compounding” factors

SUMMARY AND KEY TAKEAWAYS

- Harvey
  - Initial surge (~ 1m) penetrated ~35 miles upstream
  - This impact largely diminished when flood crest arrives at Beaumont
  - Accounting for local rainfall crucial in resolving inundation near Sabine Lake
- Rita
  - Intense rainfall during landfall
    - amplification of flooding due to surge along Sabine Lake
  - Riverine flow contributes little due to a long lag time

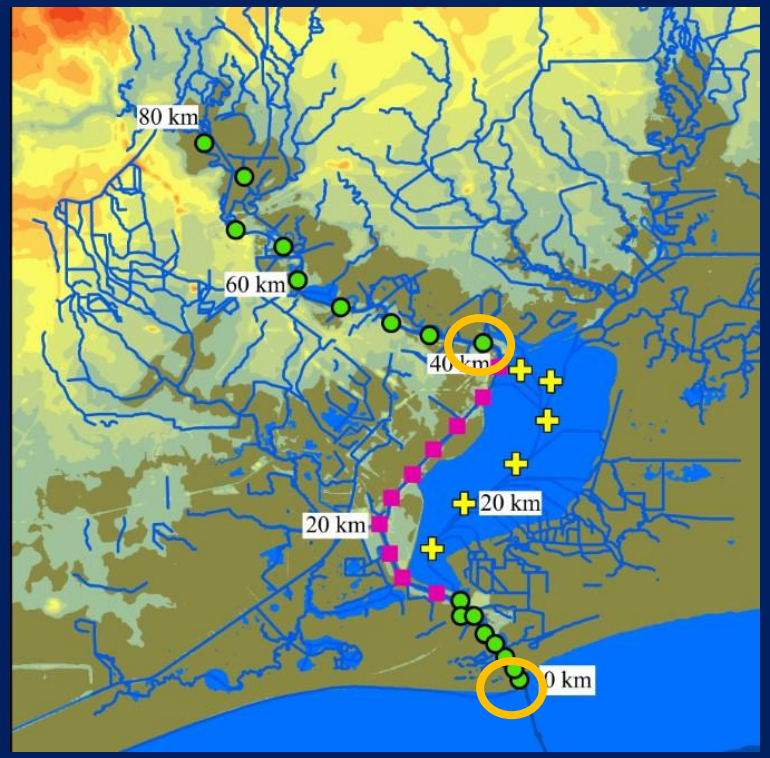
ONGOING WORK

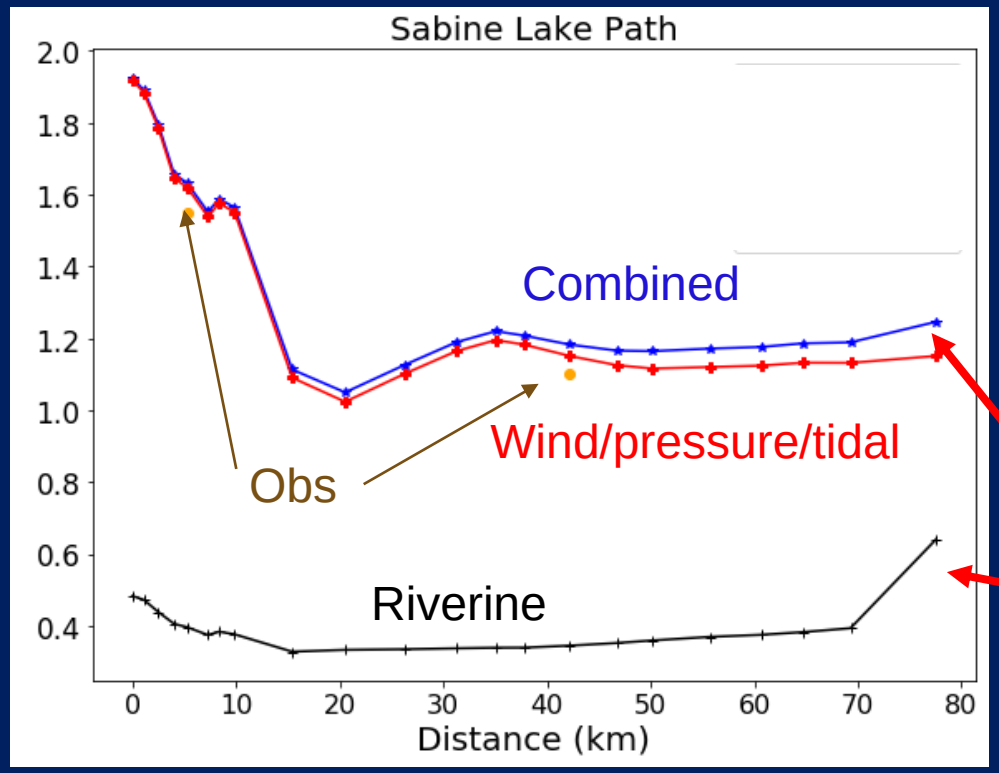
- Creation of storm scenarios for future climates
- Understanding how compound effects evolve in future climate
  - Changes in occurrence/amplitude of tropical vs non-tropical storms
    - Non-tropical storms may produce high tide/surge but are quite rare along the Gulf
  - More slower moving, heavy-rainfall producing tropical storms?
    - Shorter/longer lag time in runoff conducive to
    - Elevated/diminished interactions with surge/wave

THANK YOU!

FOR QUESTIONS, CONTACT YU.ZHANG@UTA.EDU

MAXIMUM WATER ELEVATION AND COMPOUNDING EFFECTS





Combined effects less than sum of the two

- High water level felt upstream due to low elevation gradient
- Impacts of rainfall more pronounced upstream (rainfall centered upstream)