LSU College of the Coast & Environment

LSU CENTER FOR COMPUTATION & TECHNOLOGY

Coupled Ocean Modeling @ LSU

# Develop Supercomputer Models to Increase Louisiana's Resilience to Compound Flood


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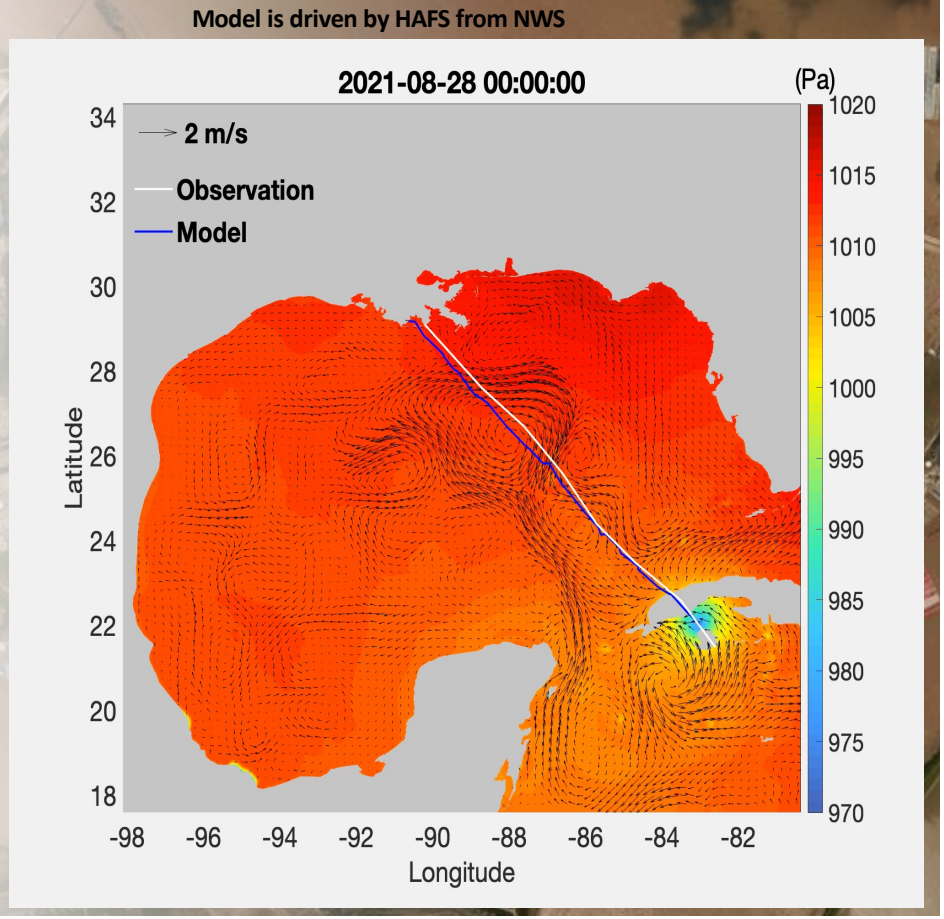
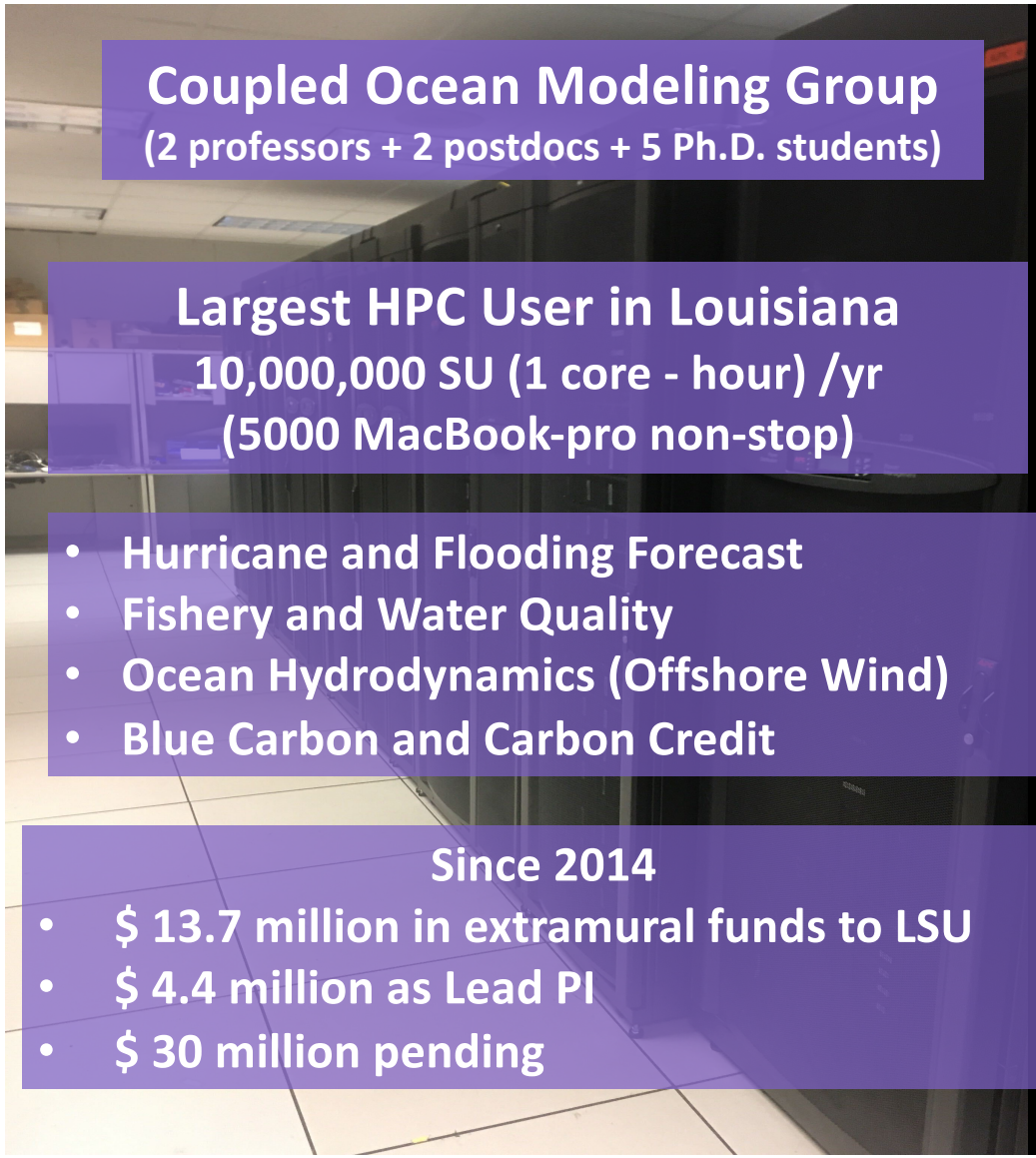
Center for Computation and Technology
Louisiana State University



## Coupled Ocean Modeling Group

(2 professors + 2 postdocs + 5 Ph.D. students)

## Largest HPC User in Louisiana

10,000,000 SU (1 core - hour) /yr

(5000 MacBook-pro non-stop)

- Hurricane and Flooding Forecast
- Fishery and Water Quality
- Ocean Hydrodynamics (Offshore Wind)
- Blue Carbon and Carbon Credit

## Since 2014

- $ 13.7 million in extramural funds to LSU
- $ 4.4 million as Lead PI
- $ 30 million pending

## Funding agencies

NSF

NASA

Office of Naval Research — ONR — Science & Technology

NOAA — National Oceanic and Atmospheric Administration — U.S. Department of Commerce

USGS

The National Academies of Sciences Engineering Medicine — Gulf Research Program

BOEM — Bureau of Ocean Energy Management

Vietnam Education Foundation — VIETNAM EDUCATION FOUNDATION

NCAR — National Center for Atmospheric Research

Coastal Protection and Restoration Authority — CPRA

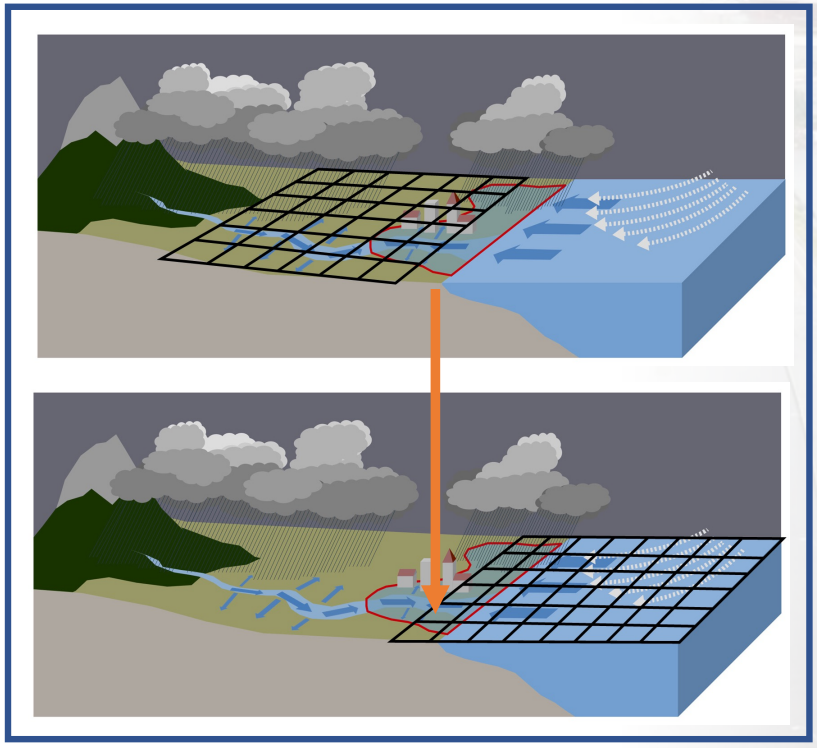
The Water Institute of the Gulf — RESTORE Act Center of Excellence — Louisiana

CUAHSI — allied for water science

Sea Grant — Louisiana

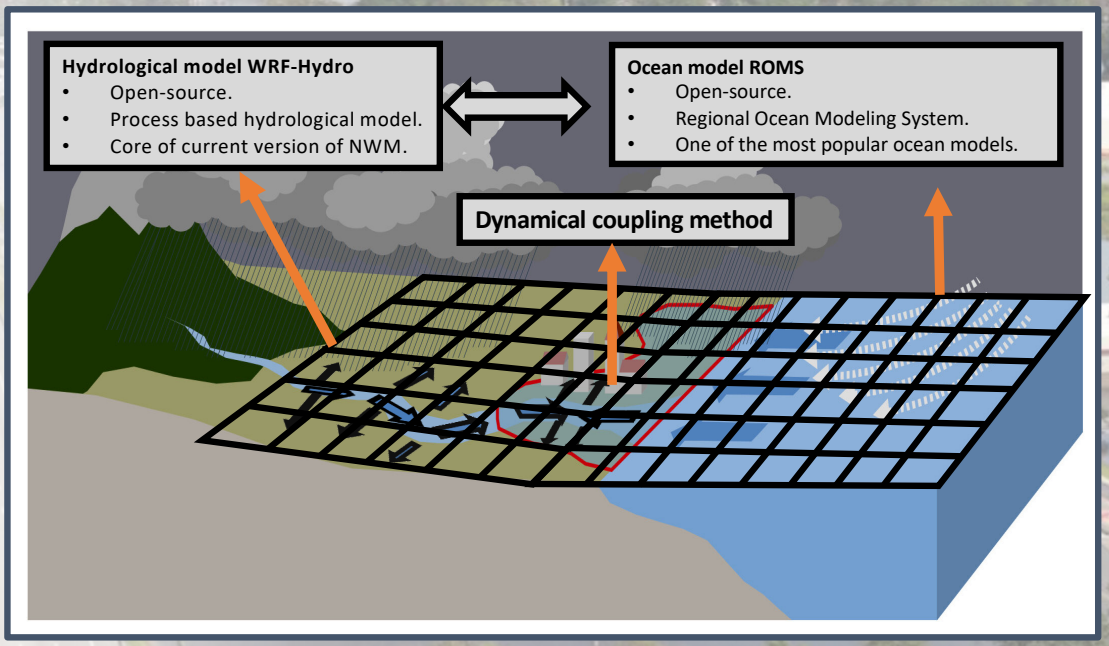
REGENTS

# Dynamically coupled hydrological-ocean modeling system

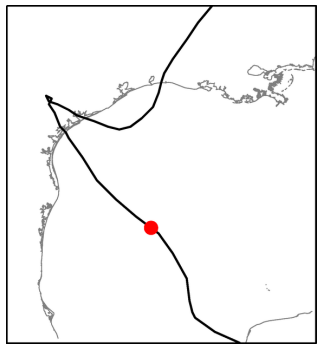


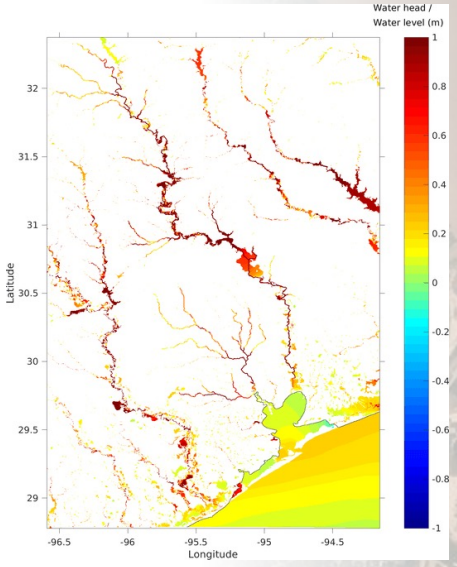
One-way coupling

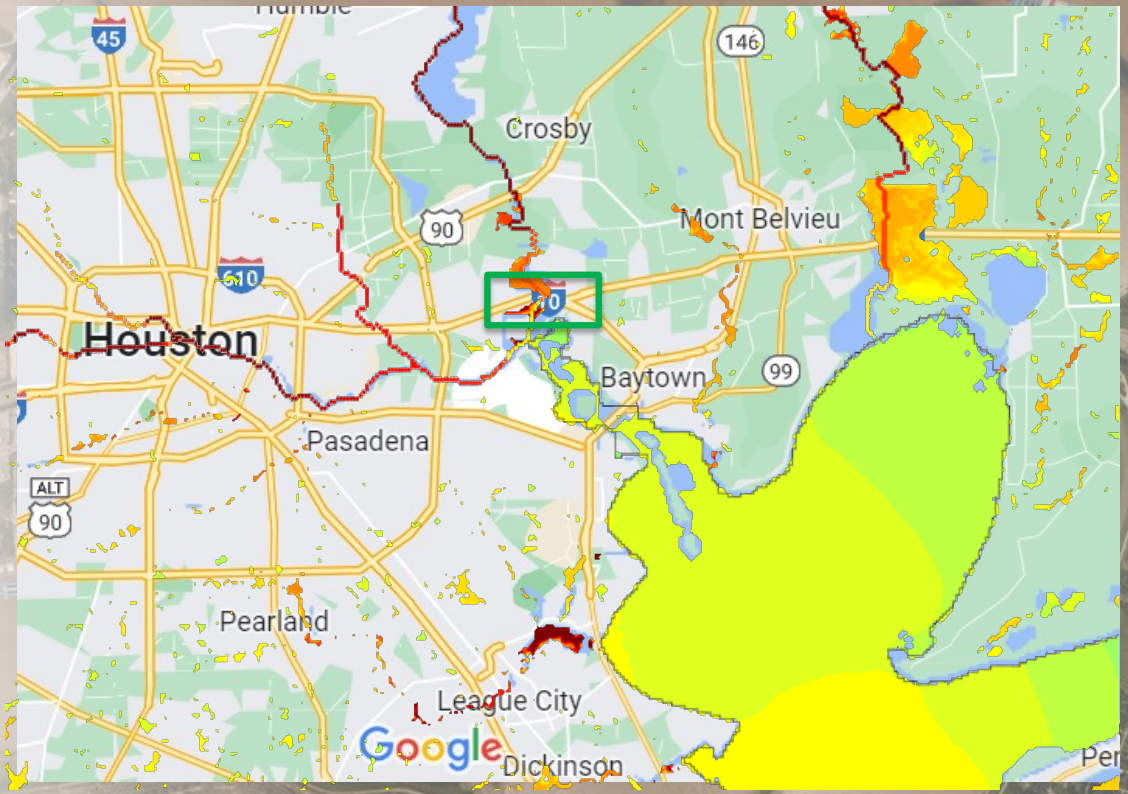
VS.



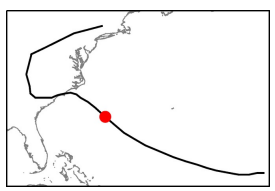
# Hurricane Harvey

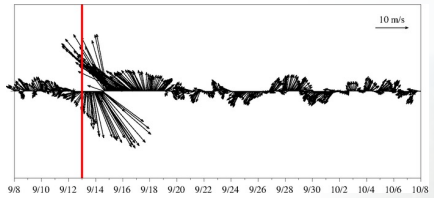


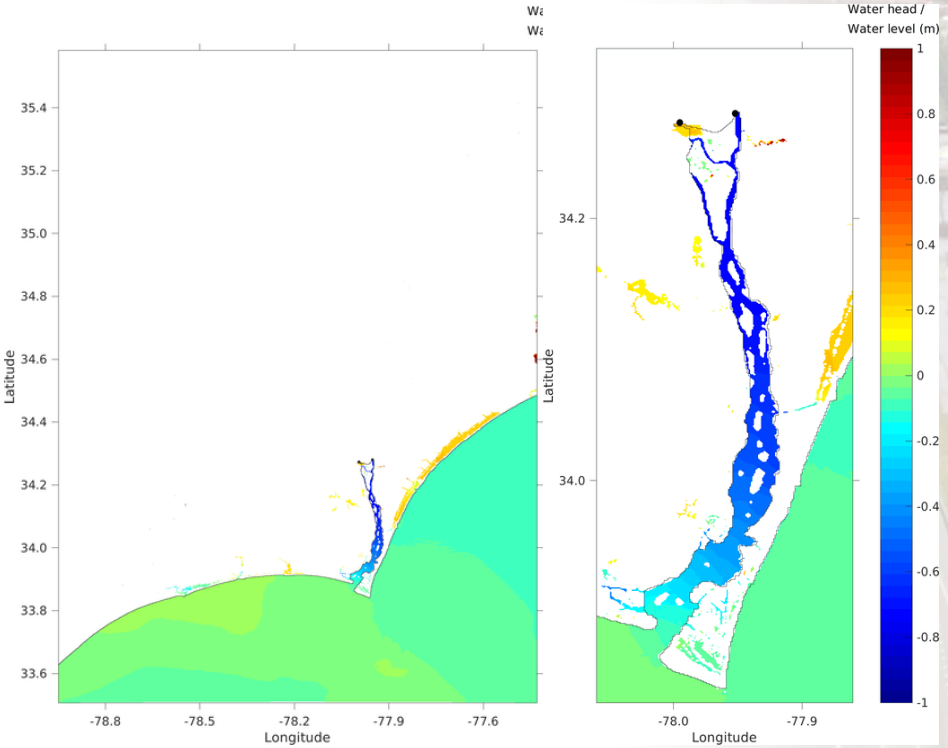


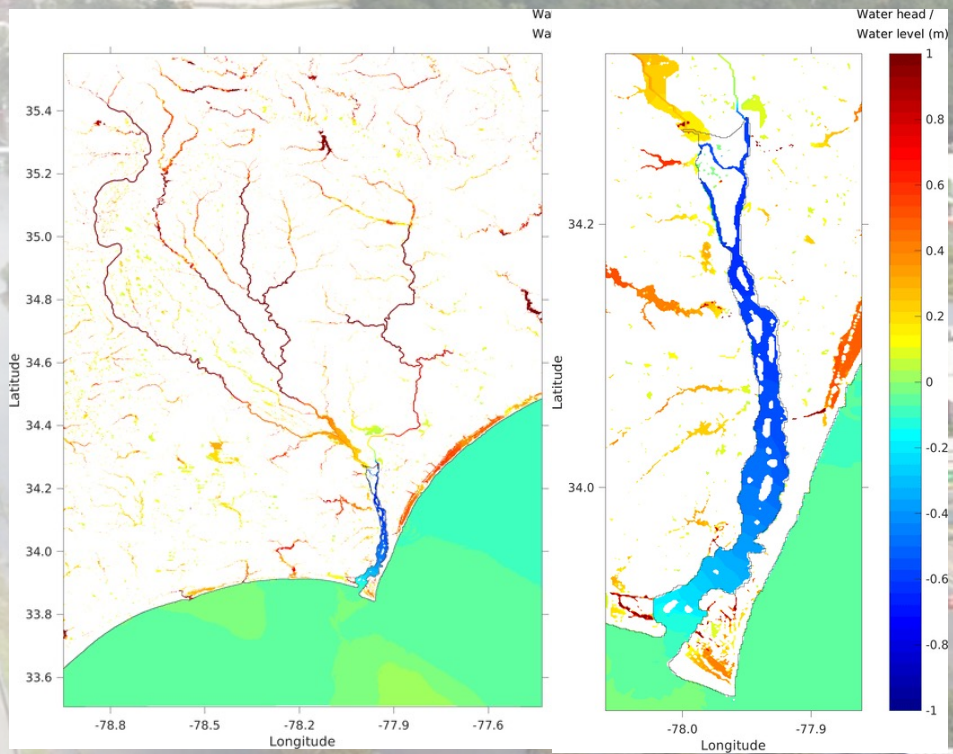



# One-way Coupling vs. Dynamical (two-way)



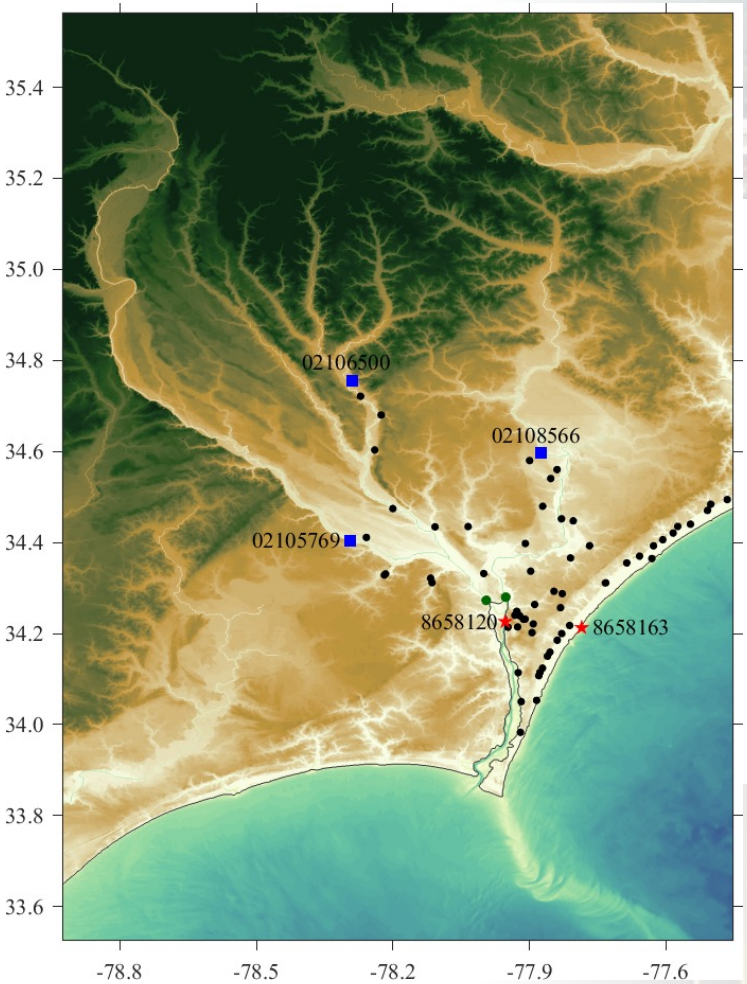


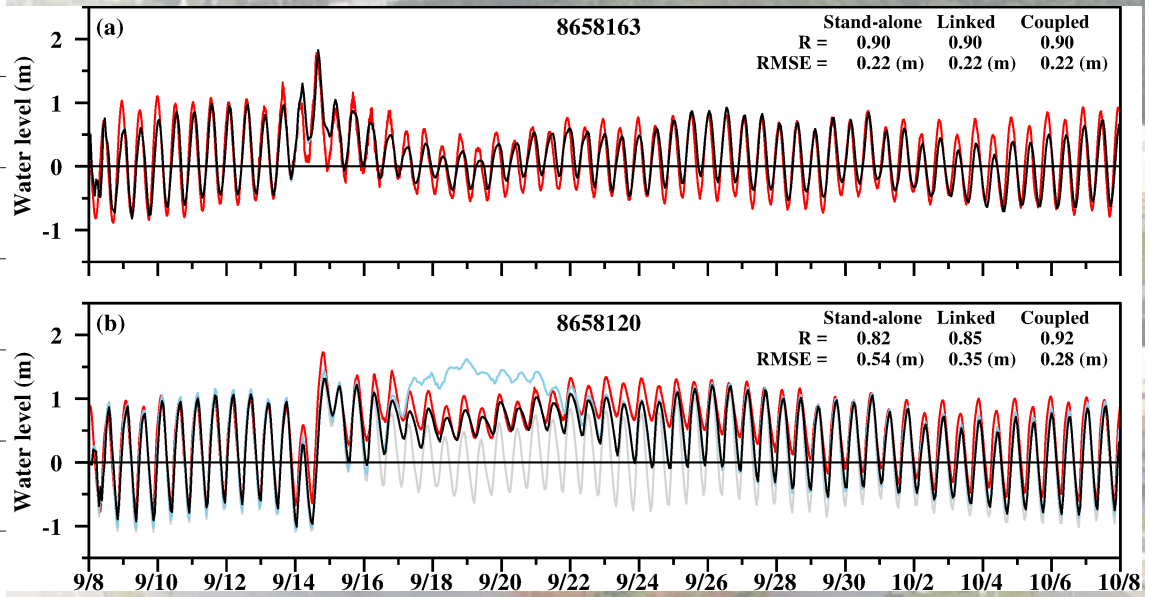



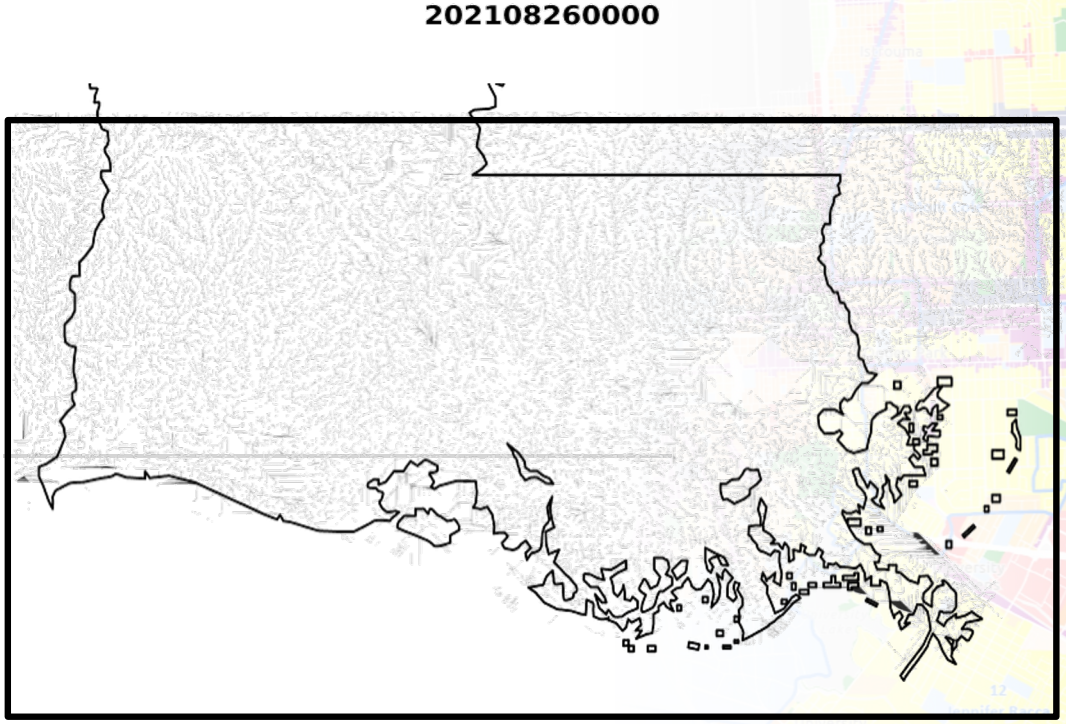
# Model Setup and Validation

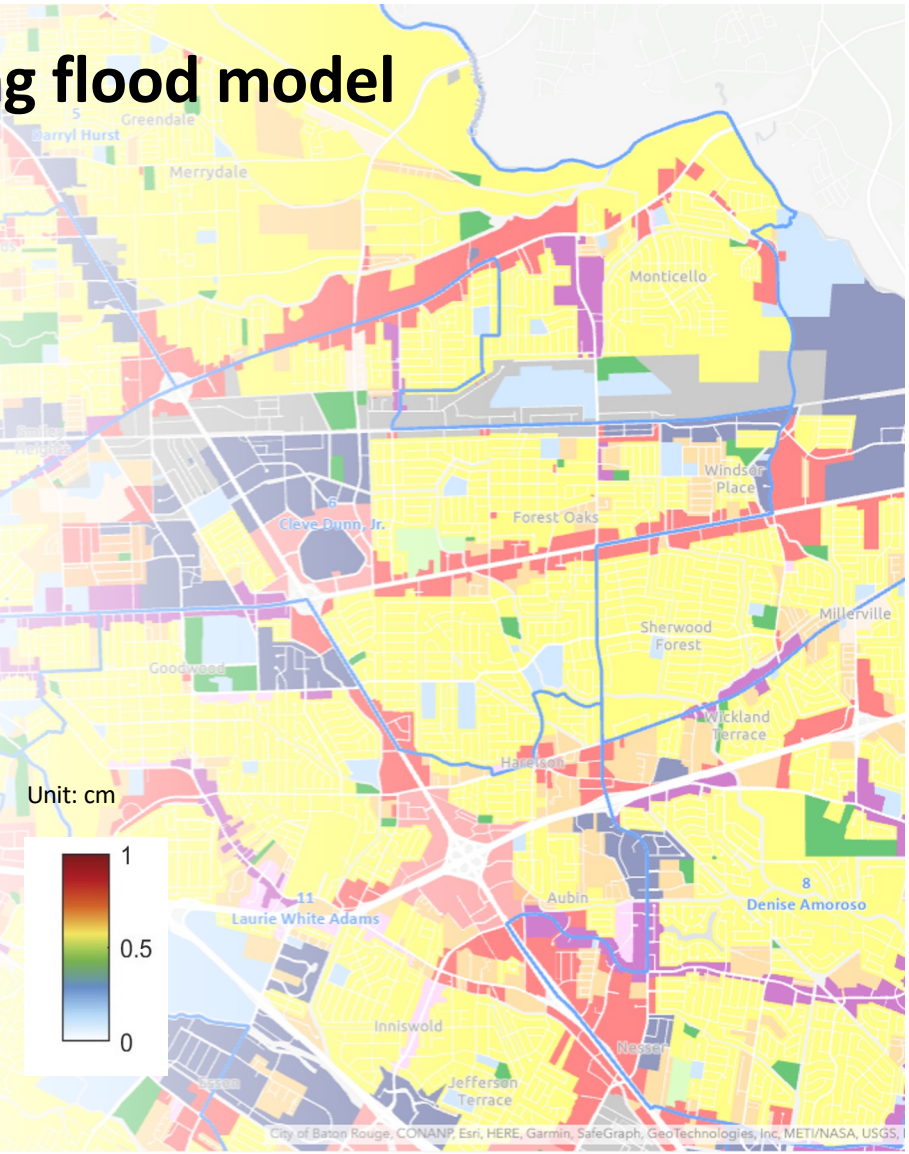
| Name | Coupling Method |
|---|---|
| OBS | |
| Exp1 | Stand-alone ROMS |
| Exp2 | Linked ROMS |
| Exp3 | Dynamic Coupling |



# A higher-resolution compounding flood model for Baton Rouge / Louisiana?



# How much can we trust Flood Zone?

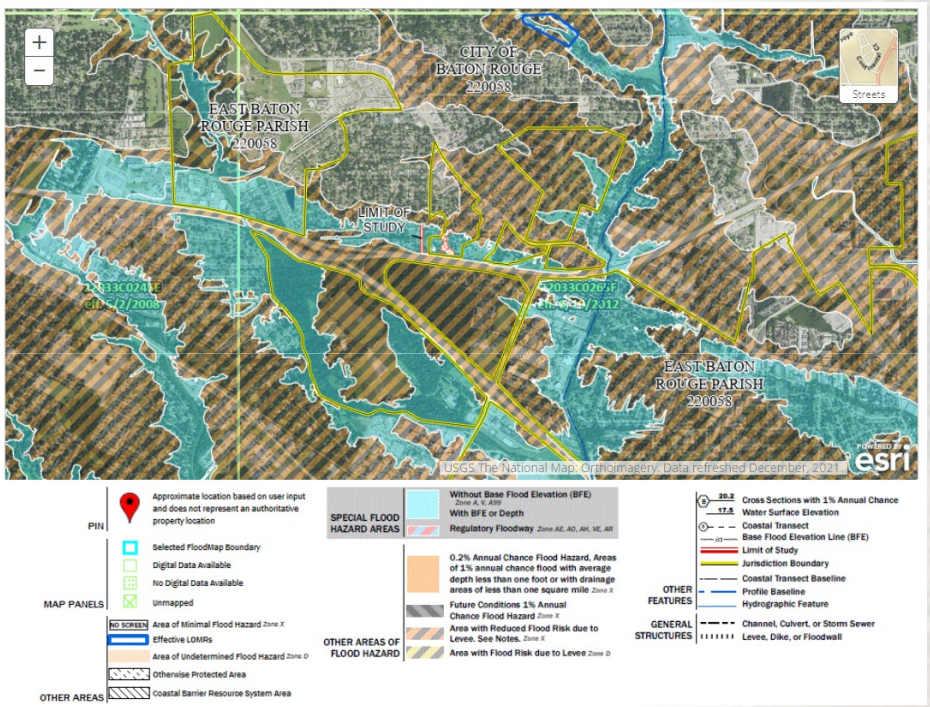


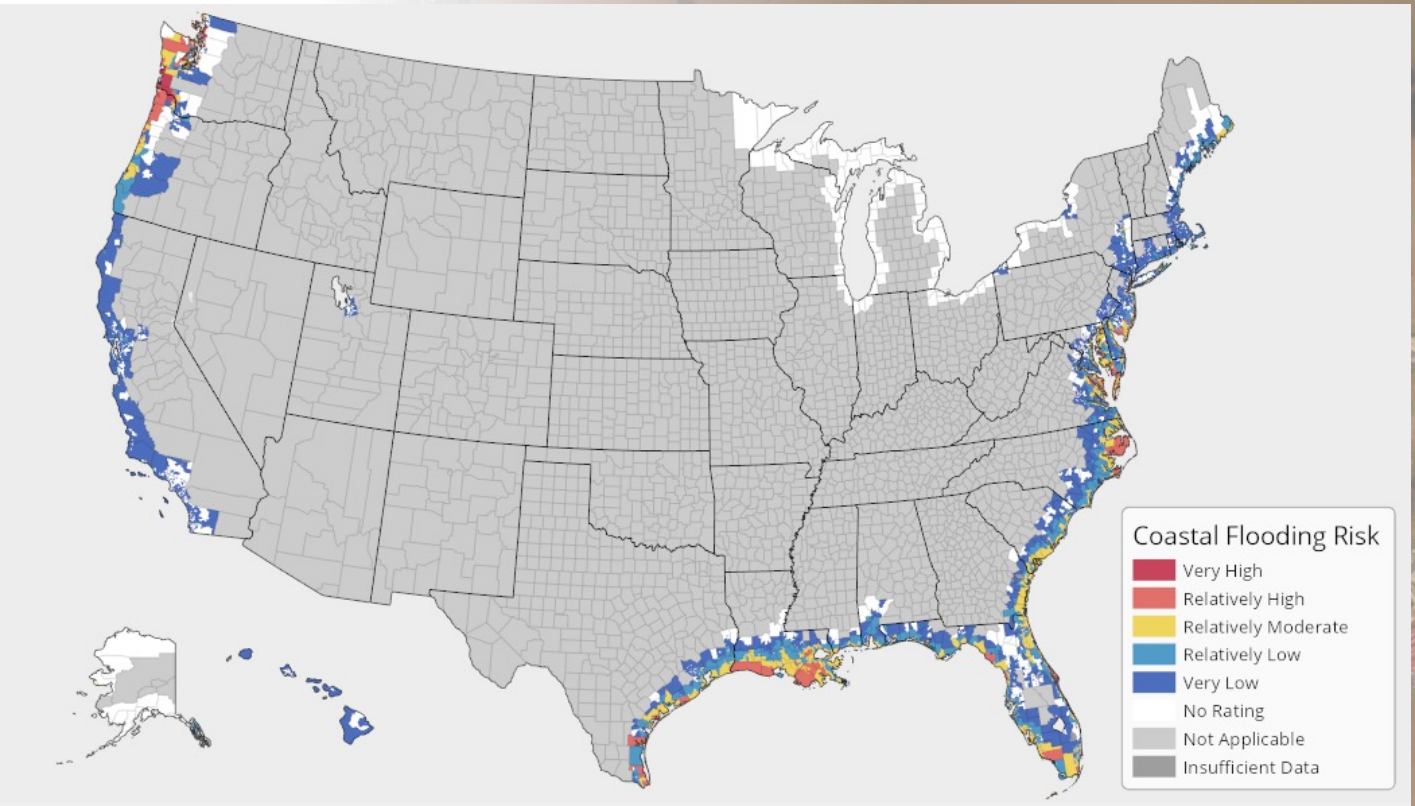

**Table 1: Flooding in mapped flood zones**

| FEMA Flood Zone | Flooded Area (square miles) in analyzed images | Percent of Flooded Area (totals > 100%) |
|---|---|---|
| Floodway | 26.37 $mi^2$ | 12.45% |
| Special Flood Hazard Area ("100 year" floodplain; zones A, AE, AH, AO) | 89.40 $mi^2$ | 32.26% |
| VE (Coastal) | 2.48 $mi^2$ | 0.89% |
| Shaded X zone ("500 year" floodplain) | 37.23 $mi^2$ | 13.44% |
| "Minimal flood hazard" | 147.94 $mi^2$ | 53.39% |

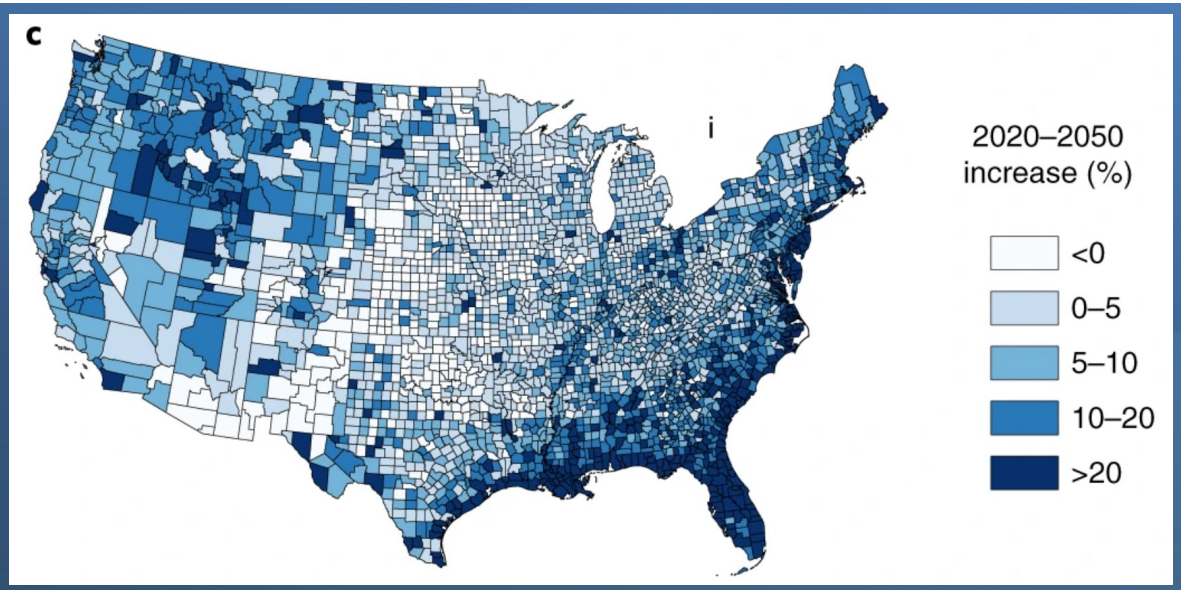
**The return period of Harvey's three-day precipitation exceeds 1000 years**

over 50% of estimated inundation occurred outside of any mapped flood zone.

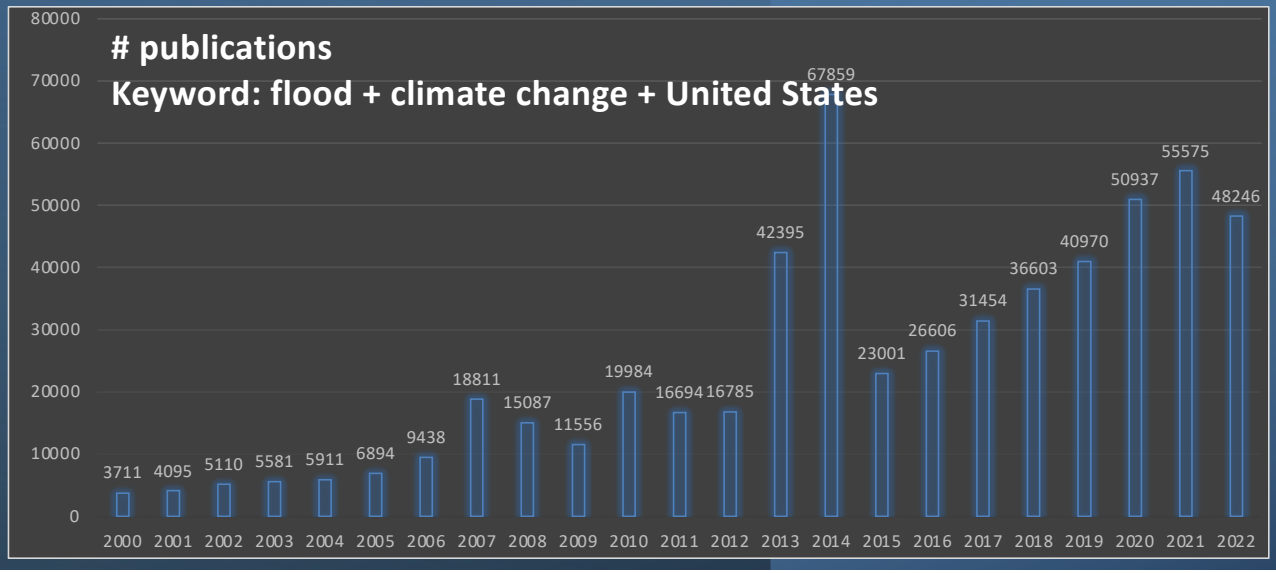
# Market Size & Potential (Flood Insurance)

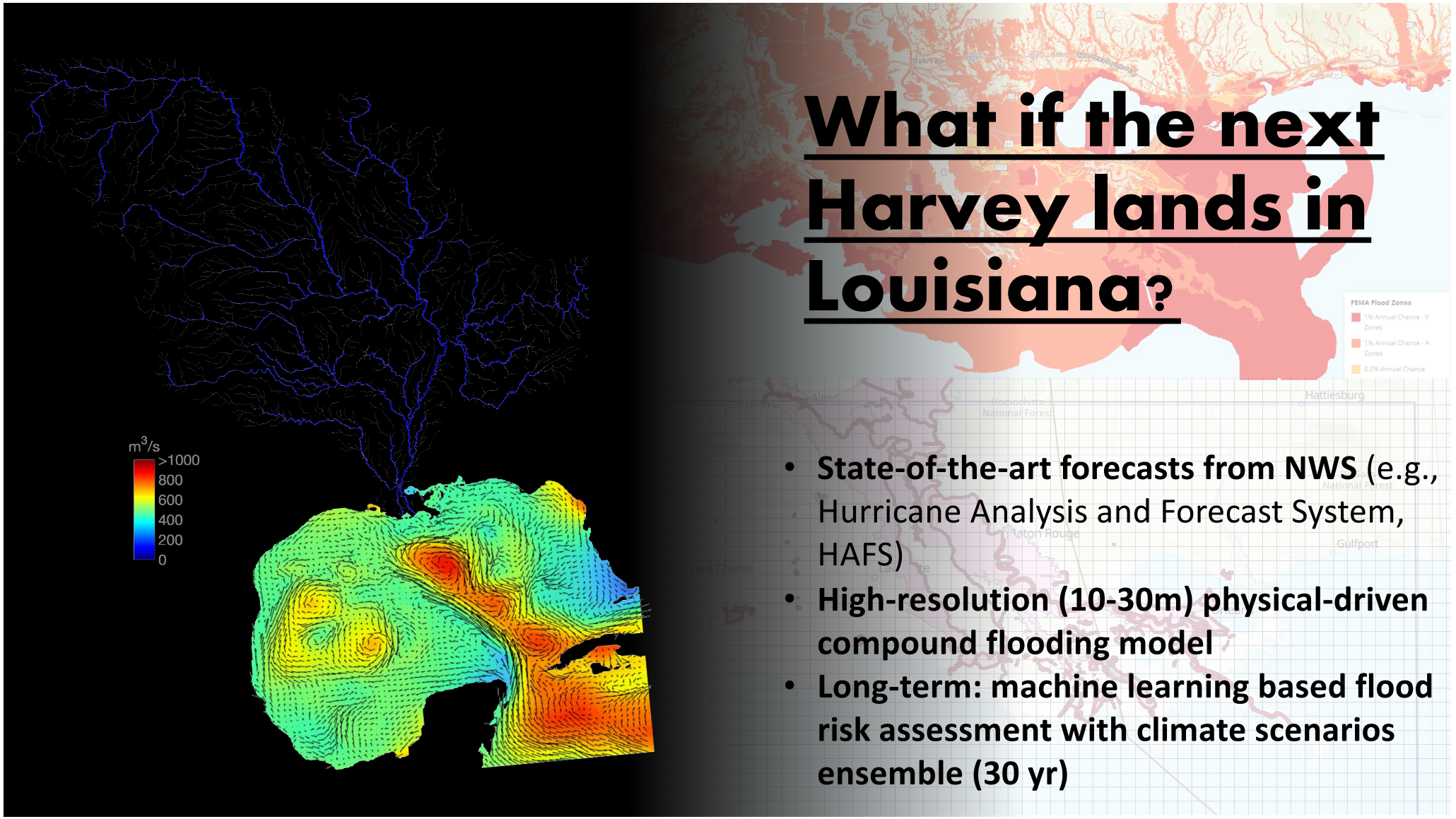



The Flood Insurance Market size was valued at USD 9.03 Billion in 2019 and is projected to reach **USD 27.31 Billion by 2027**, growing at a **CAGR of 14.84 % from 2020 to 2027**.




**a 26.4% increase across a typical 30-year mortgage because of flooding loss under RCP4.5 scenario**
**(Wing et al., 2022 Nature climate change)**


m3/s
>1000
800
600
400
200
0
What if the next Harvey lands in Louisiana?
FEMA Flood Zones
1% Annual Chance - V Zones
1% Annual Chance - A Zones
0.2% Annual Chance
Hattiesburg
Baton Rouge
Gulfport
Lake Charles
• State-of-the-art forecasts from NWS (e.g., Hurricane Analysis and Forecast System, HAFS)
• High-resolution (10-30m) physical-driven compound flooding model
• Long-term: machine learning based flood risk assessment with climate scenarios ensemble (30 yr)