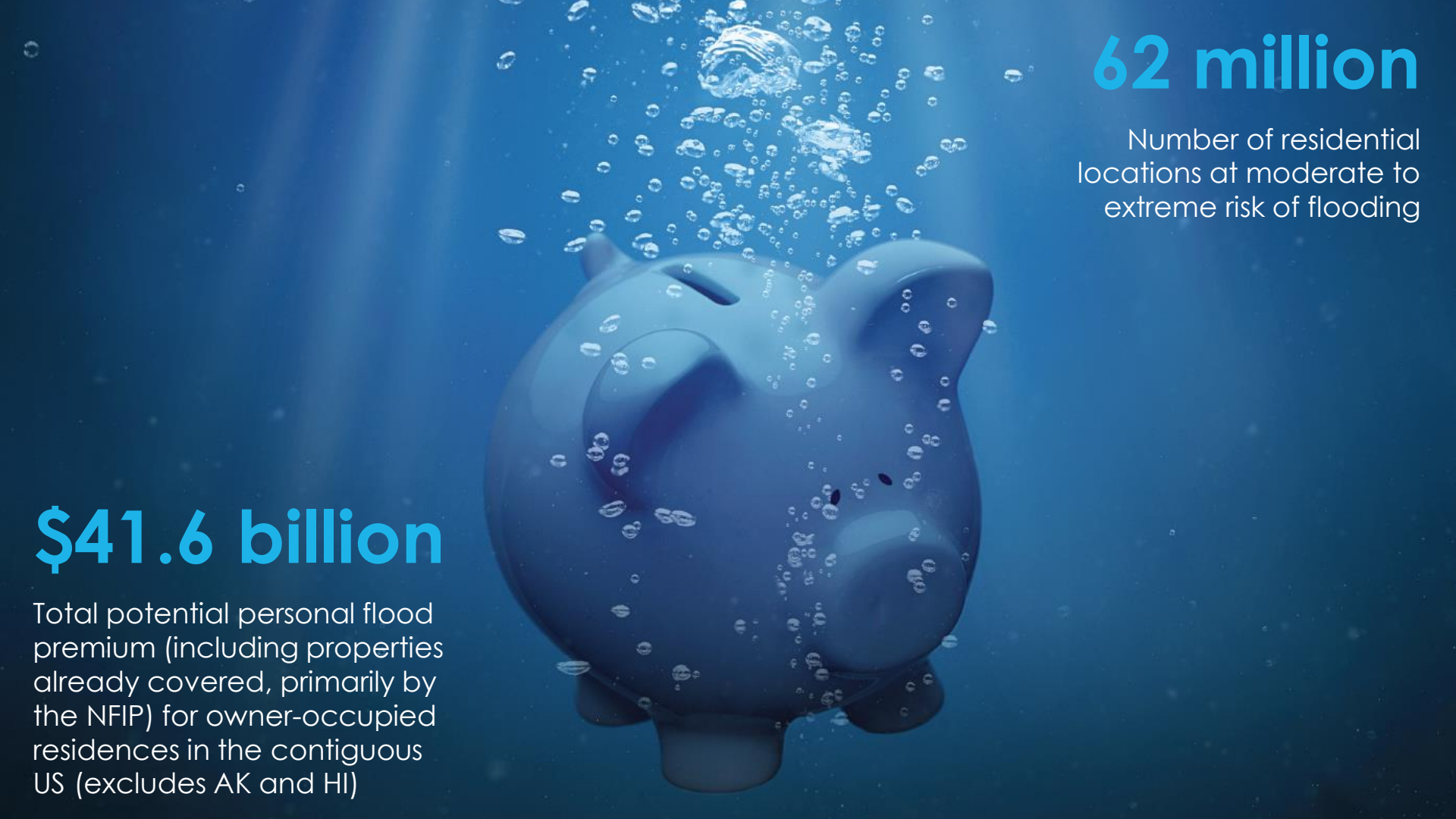

2019
AIR European
Seminars
London

US Hurricane and US Flood Model Enhancements

Cagdas Kafali, PhD

AIR



62 million

Number of residential locations at moderate to extreme risk of flooding

$41.6 billion

Total potential personal flood premium (including properties already covered, primarily by the NFIP) for owner-occupied residences in the contiguous US (excludes AK and HI)

Agenda

I. The Evolution of AIR's Flood-Based Solutions for the US

II. Upcoming Enhancements to Precipitation-Induced Flood Modelling

- Hazard
- Vulnerability

The Evolution of AIR's Flood-Based Solutions for the US

2014

Inland Flood Model

Non-hurricane precipitation

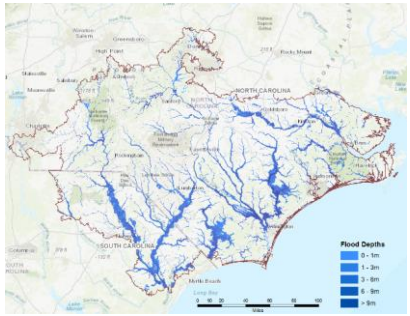
2015

Hurricane Model

Storm surge update

2016-2018

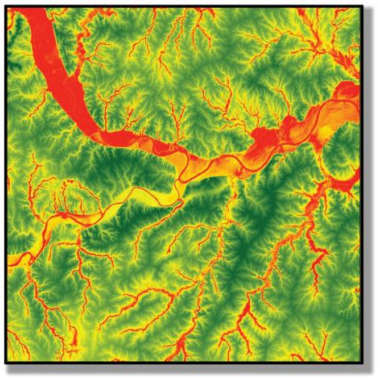
2016 Louisiana floods
2017 Hurricane Harvey
2018 Hurricane Florence



AIR's Hurricane Florence Flood Footprint

2019

WaterLine™



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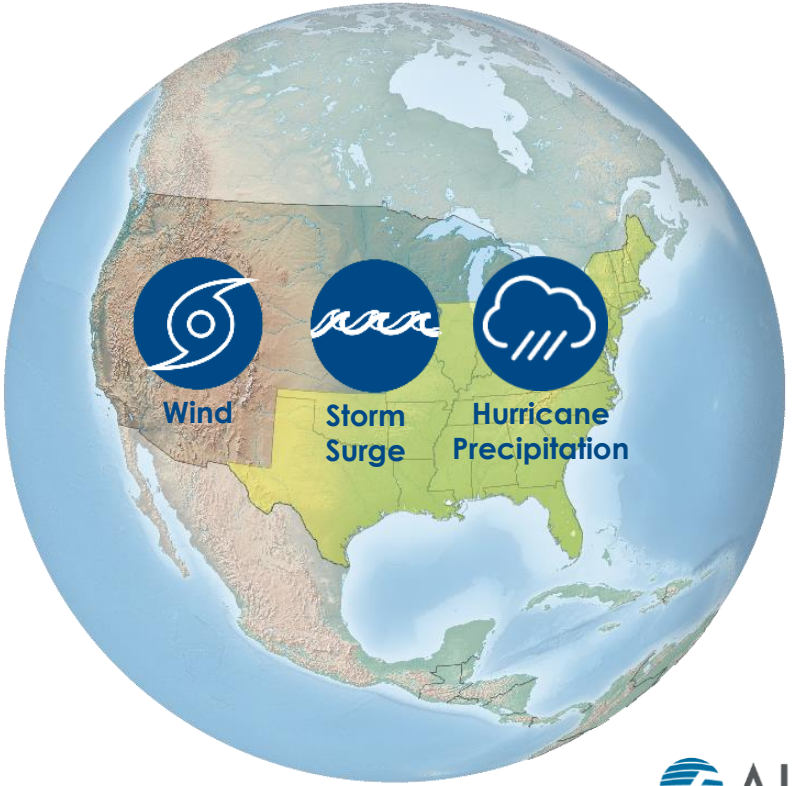
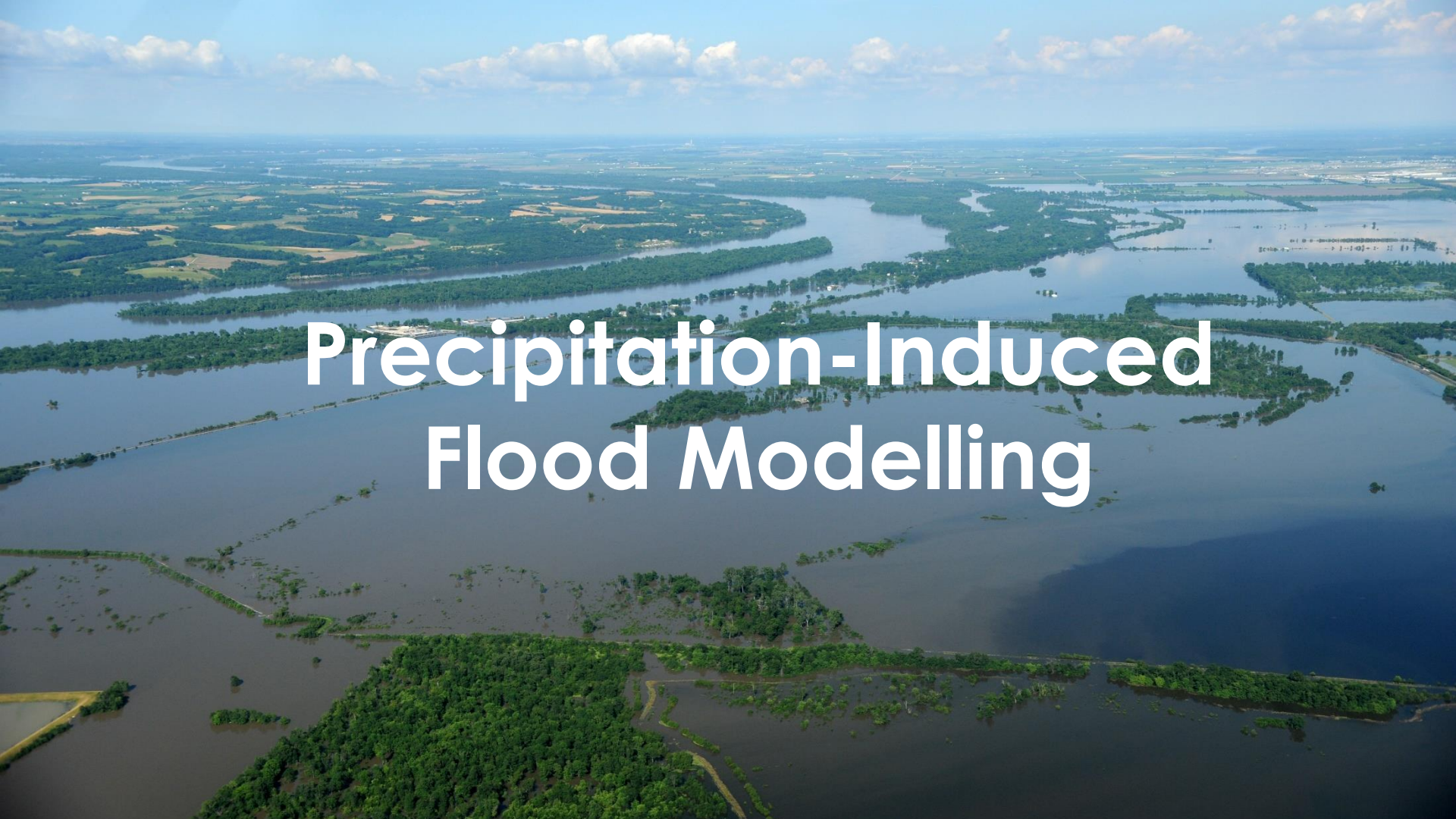
AIR's US Hurricane and US Flood Models in Touchstone 2020

Inland Flood Model

Hurricane Model

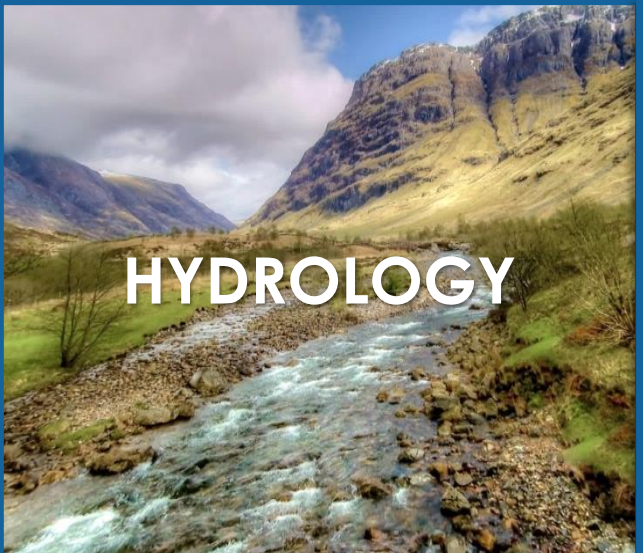




Precipitation-Induced Flood Modelling


GEOPROCESSING


PRECIPITATION


HYDROLOGY


HYDRAULICS

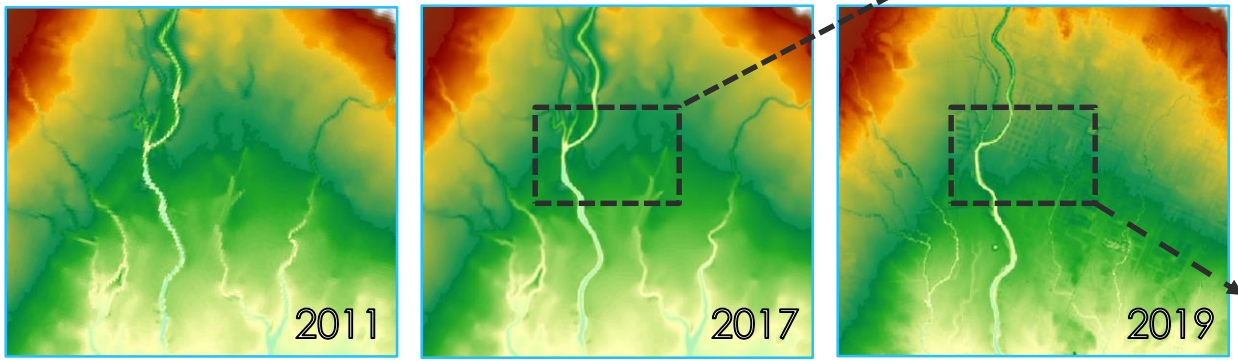

VULNERABILITY

GEOPROCESSING

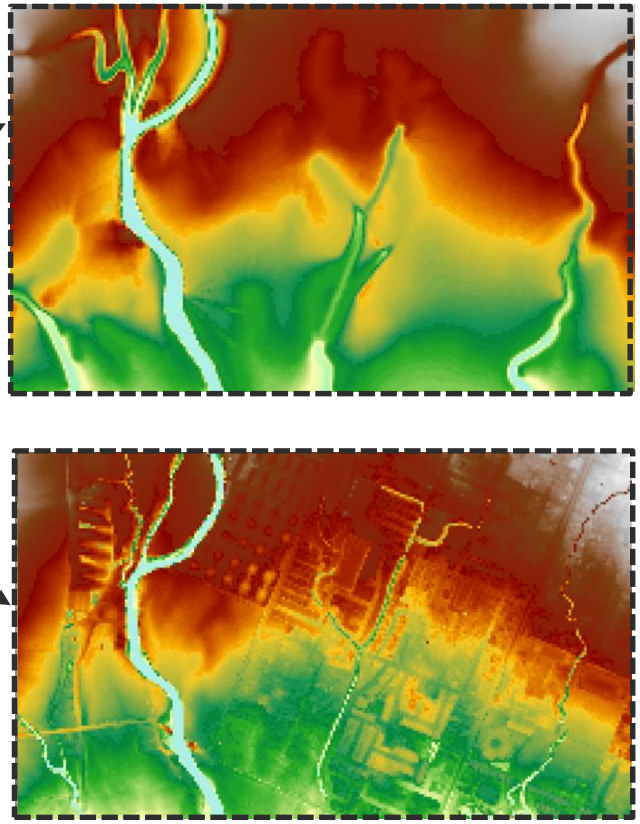
An Enhanced Digital Terrain Model (DTM) Facilitates Better Flood Modelling

Increased usage of LiDAR data coverage to leverage technological advancements

Sonoma, California



Existing (30m) New (10m) Enhanced (10m)



Low **High**

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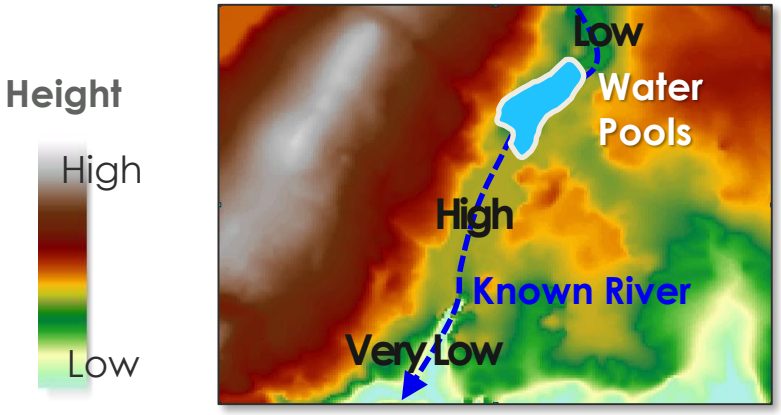
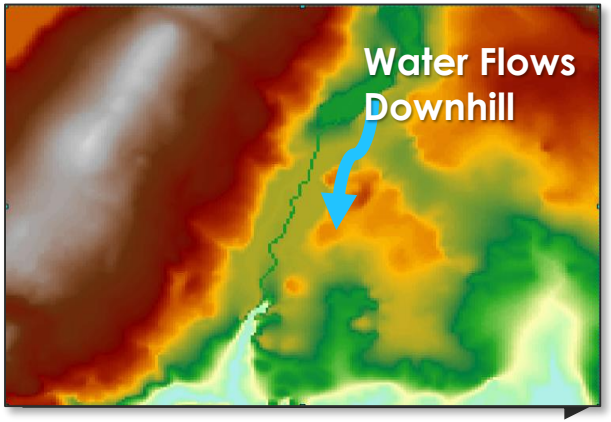
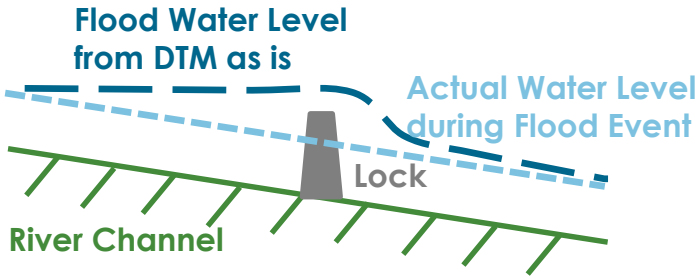
Geoprocessing Corrections Help Ensure Realistic Flood Outcomes

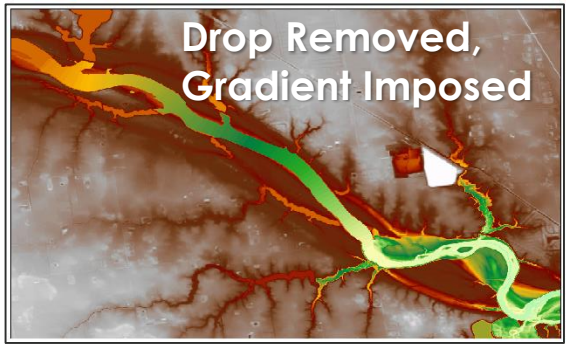
Enforce downhill slopes ("hydroburning"):





Remove sudden steep drops (new gradient):

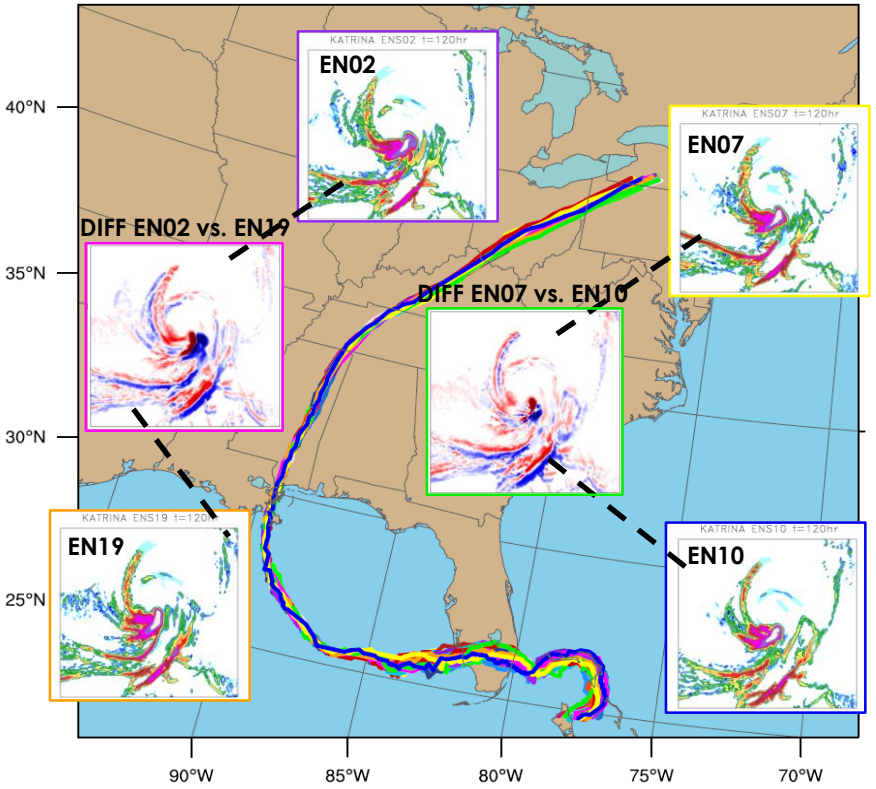




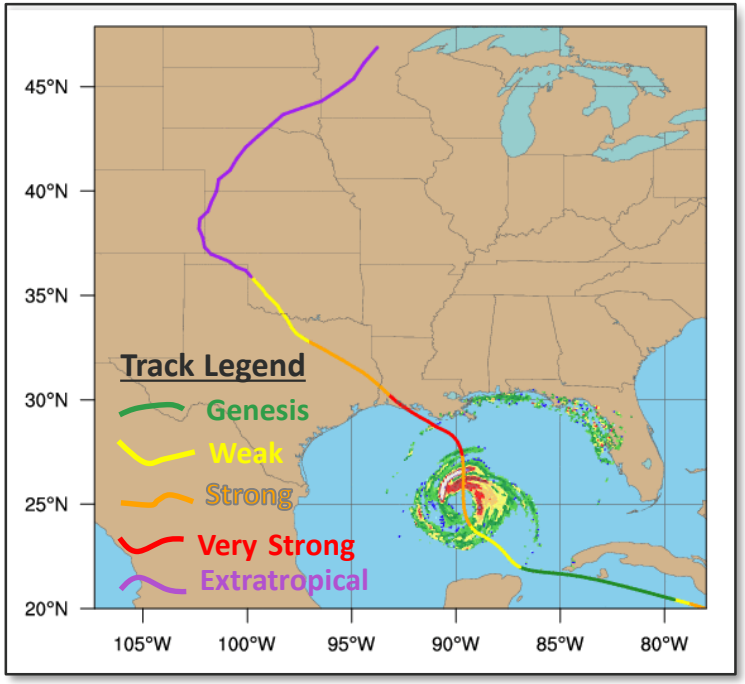
PRECIPITATION

Ensemble Modelling Meets Machine Learning

Simulated Katrina Rainfall

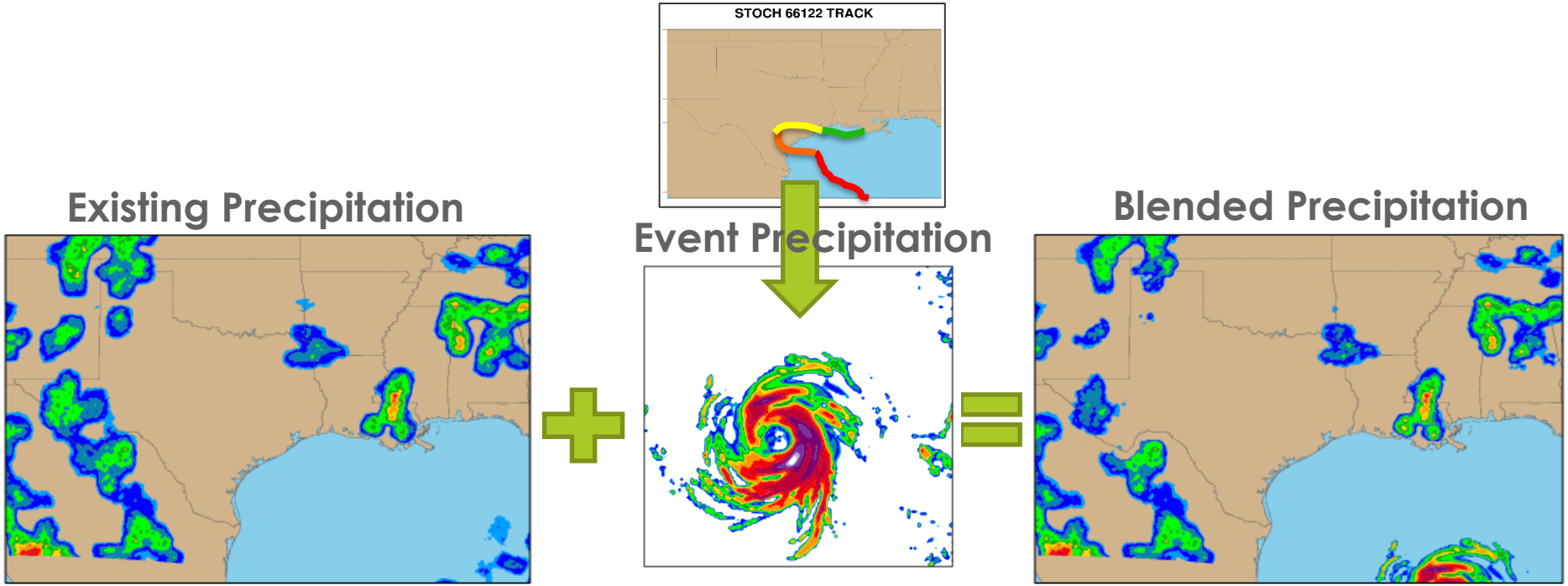


Stochastic Event



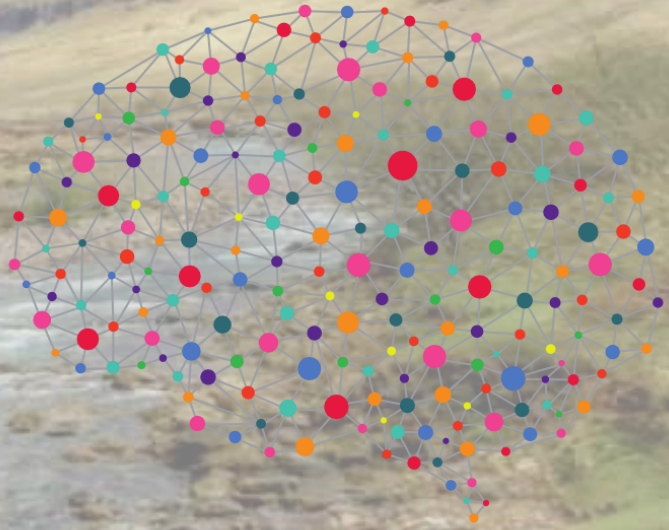
Blending Precipitation from All Sources

- Stochastically simulated events are blended with existing non-hurricane precipitation based on track location and time



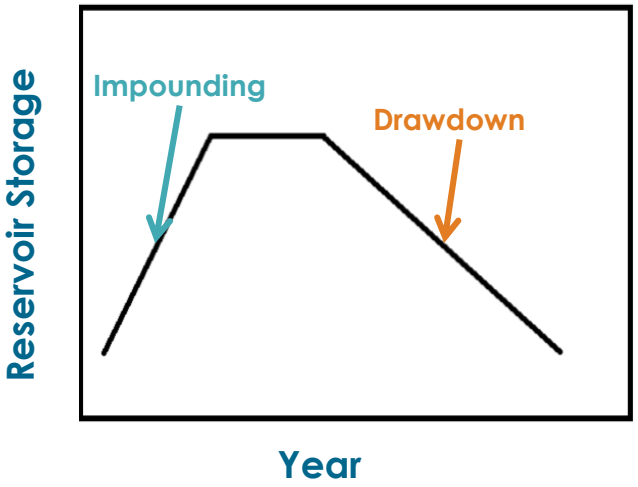
HYDROLOGY

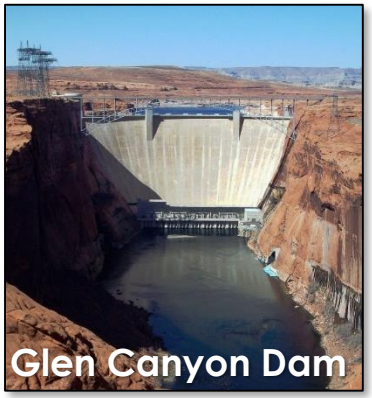
+

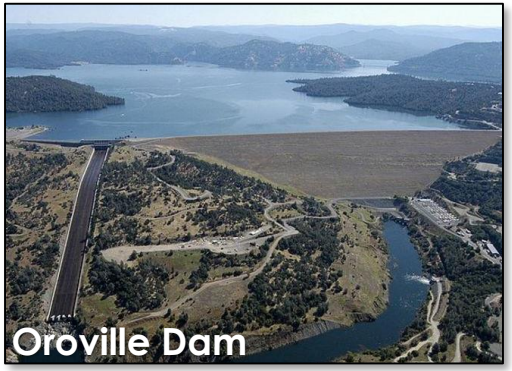


Reservoirs and Dams Significantly Attenuate Downstream Flow

Typical Reservoir Rule Curve

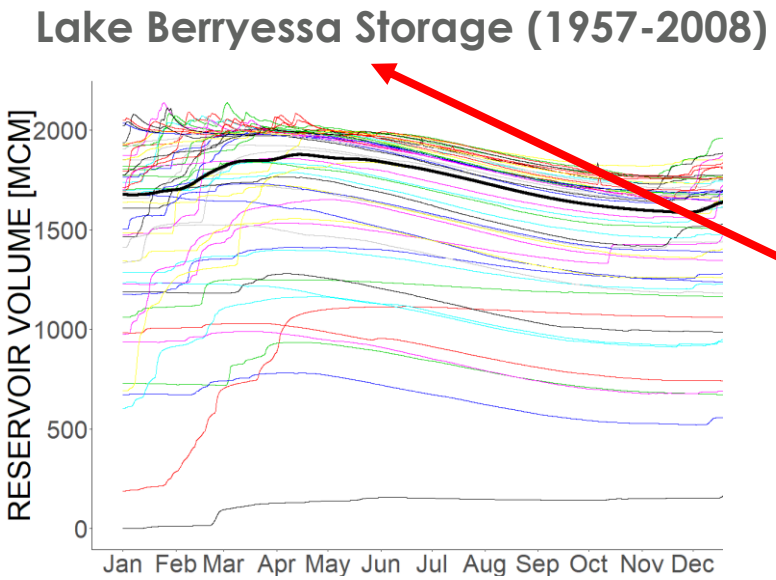


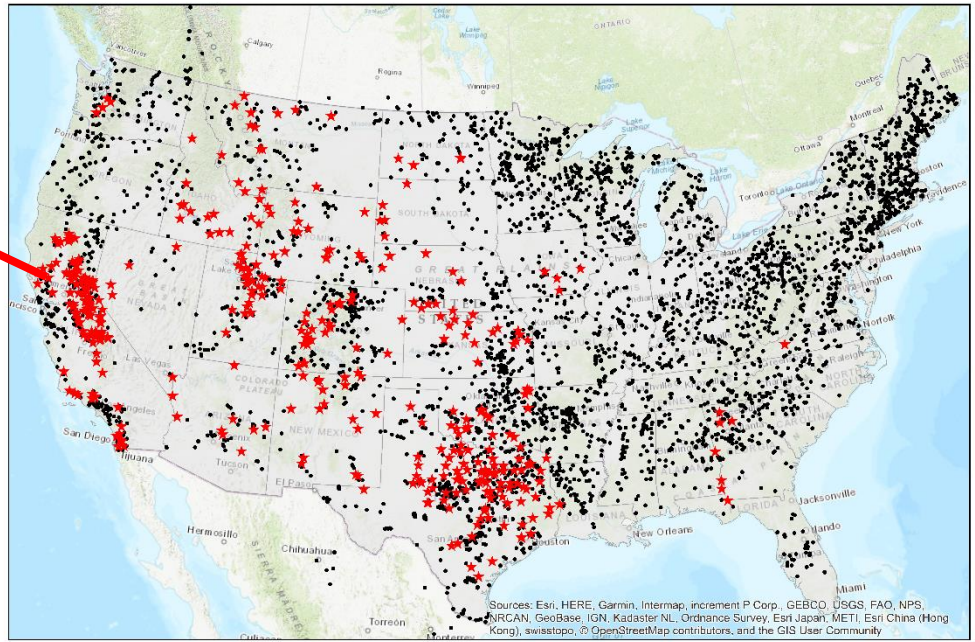




The operation rules (i.e., reservoir rule curves) determine the desired reservoir stage at any given time

Reservoir Storage Can Be Highly Variable

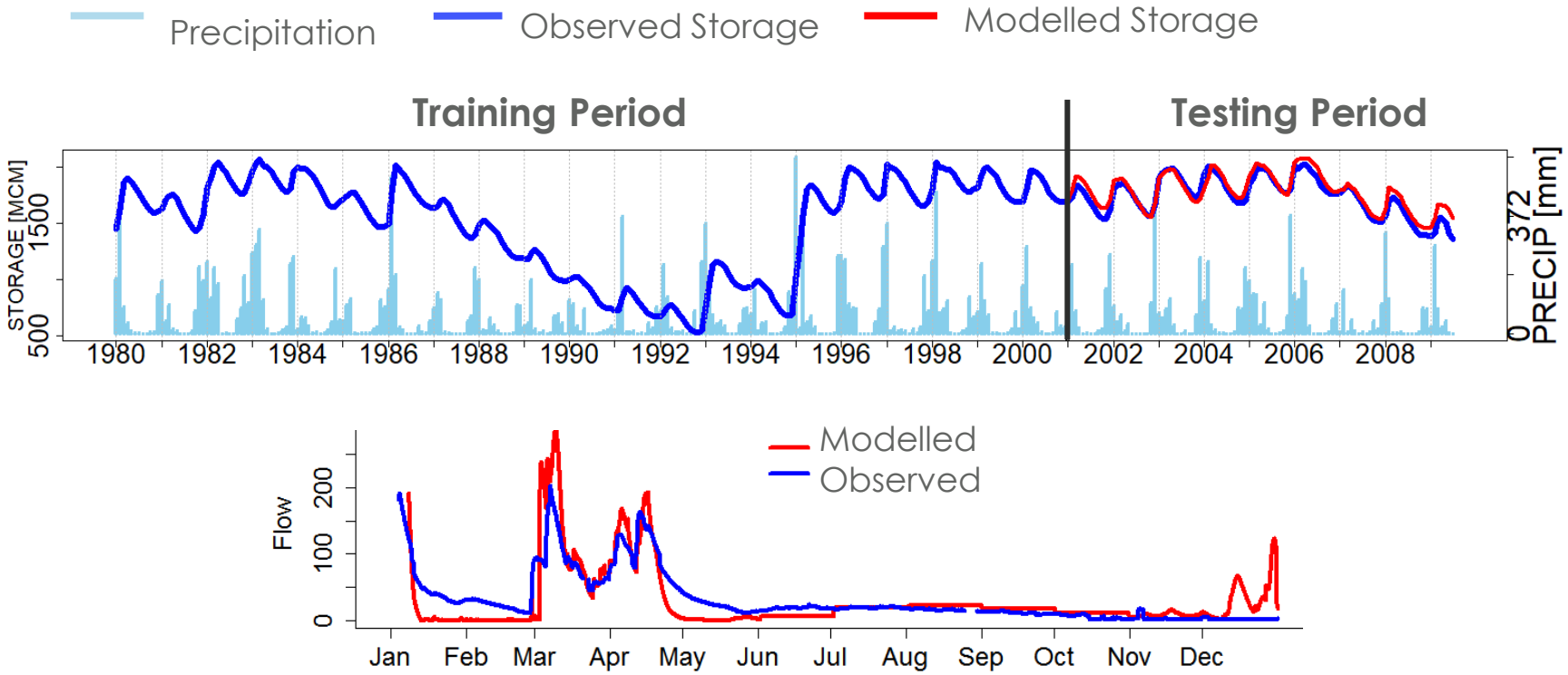




★ Dams with storage data

● All dams/reservoirs in the model

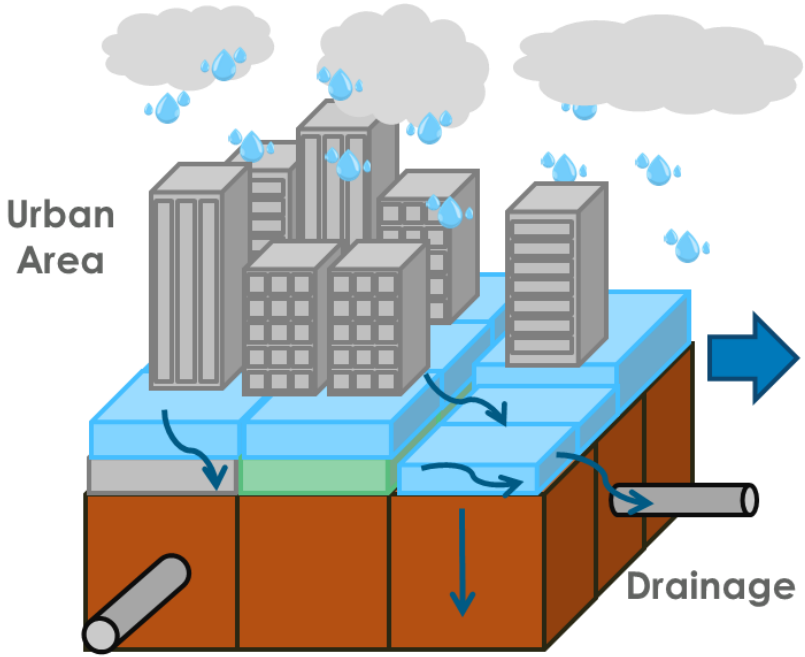
Artificial Neural Networks Learn Storage State from Precipitation



HYDRAULICS

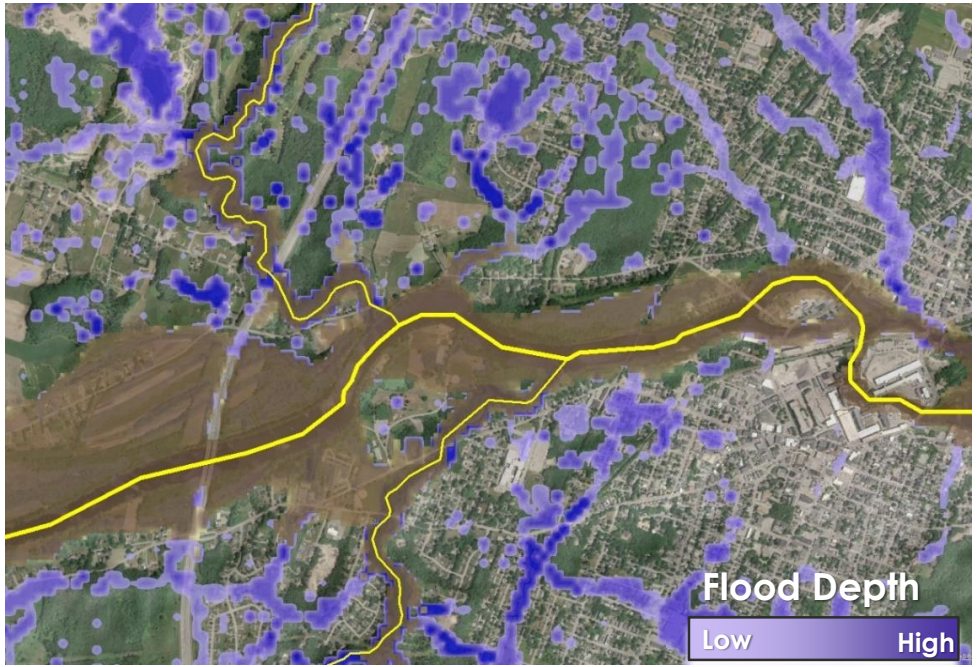
Introducing Physically Based Pluvial Flood Modelling at Very High Resolution

Precipitation Intensity

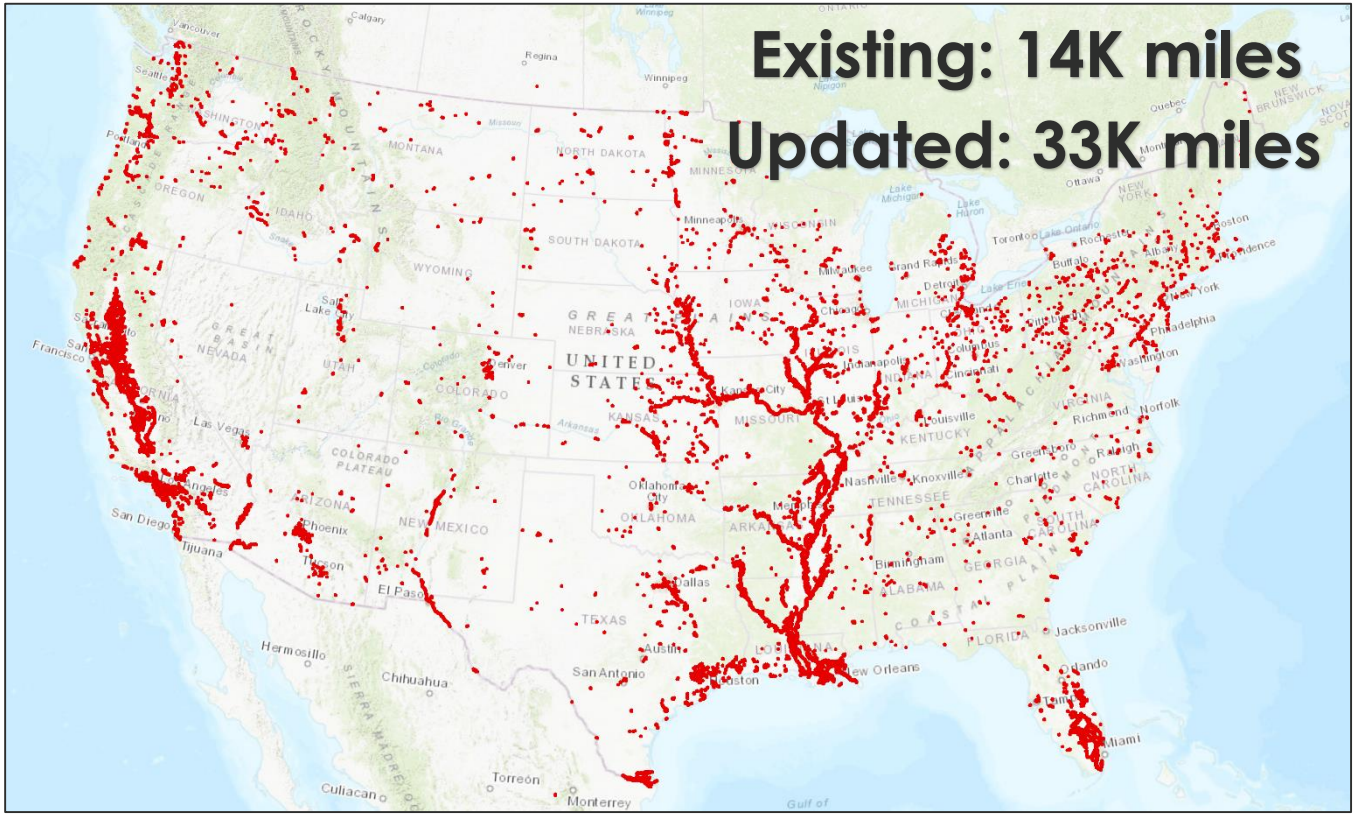


2D Pluvial Model Schematic

Example of Pluvial Event



Significant Expansion to Levee Information



Data Source	Levee Length (Miles)
National Levee Database* (USACE + FEMA + Others)	~28,000
DTM Derived (AIR)	~5,000
TOTAL	**~33,000**

*Released 5 June 2018

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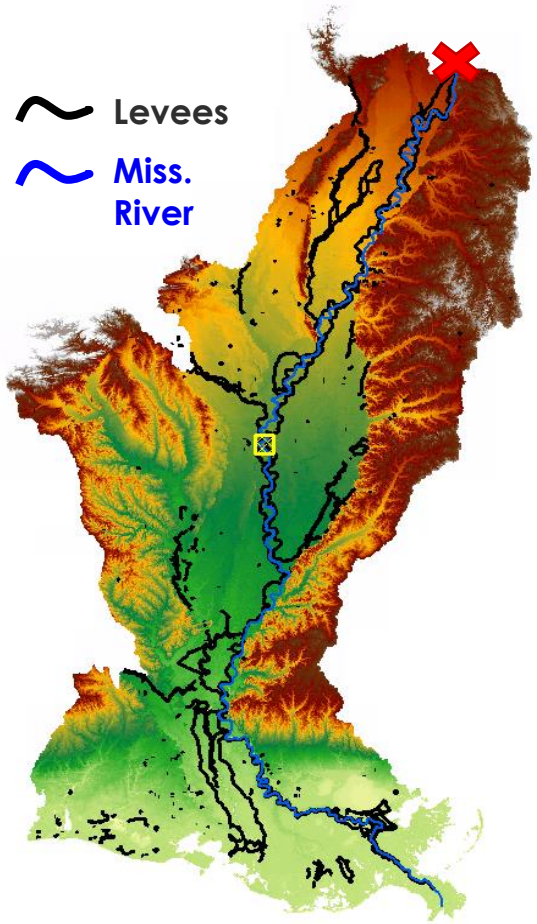
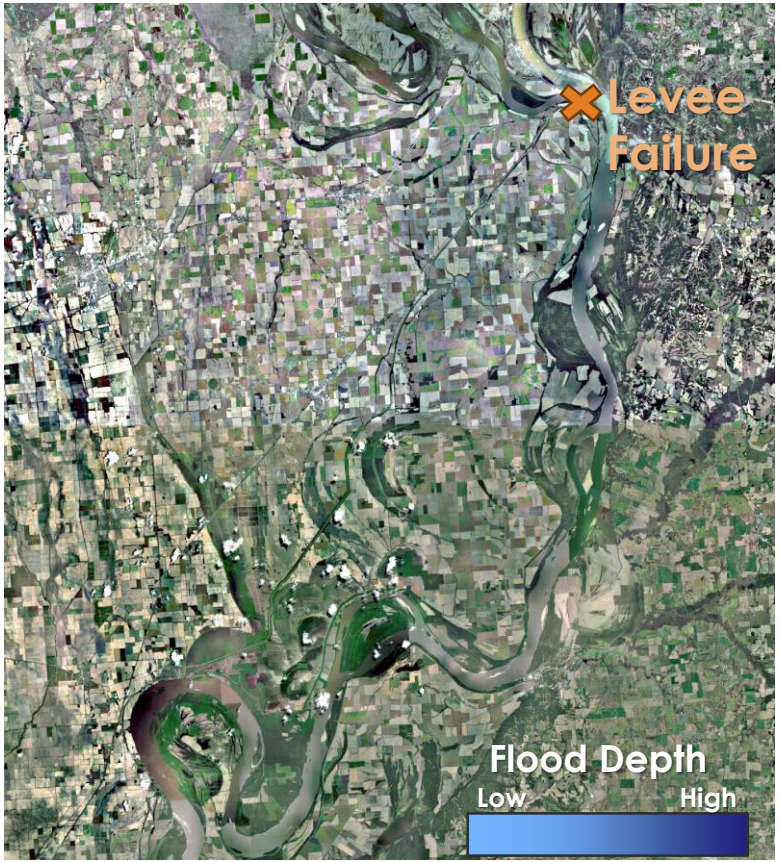
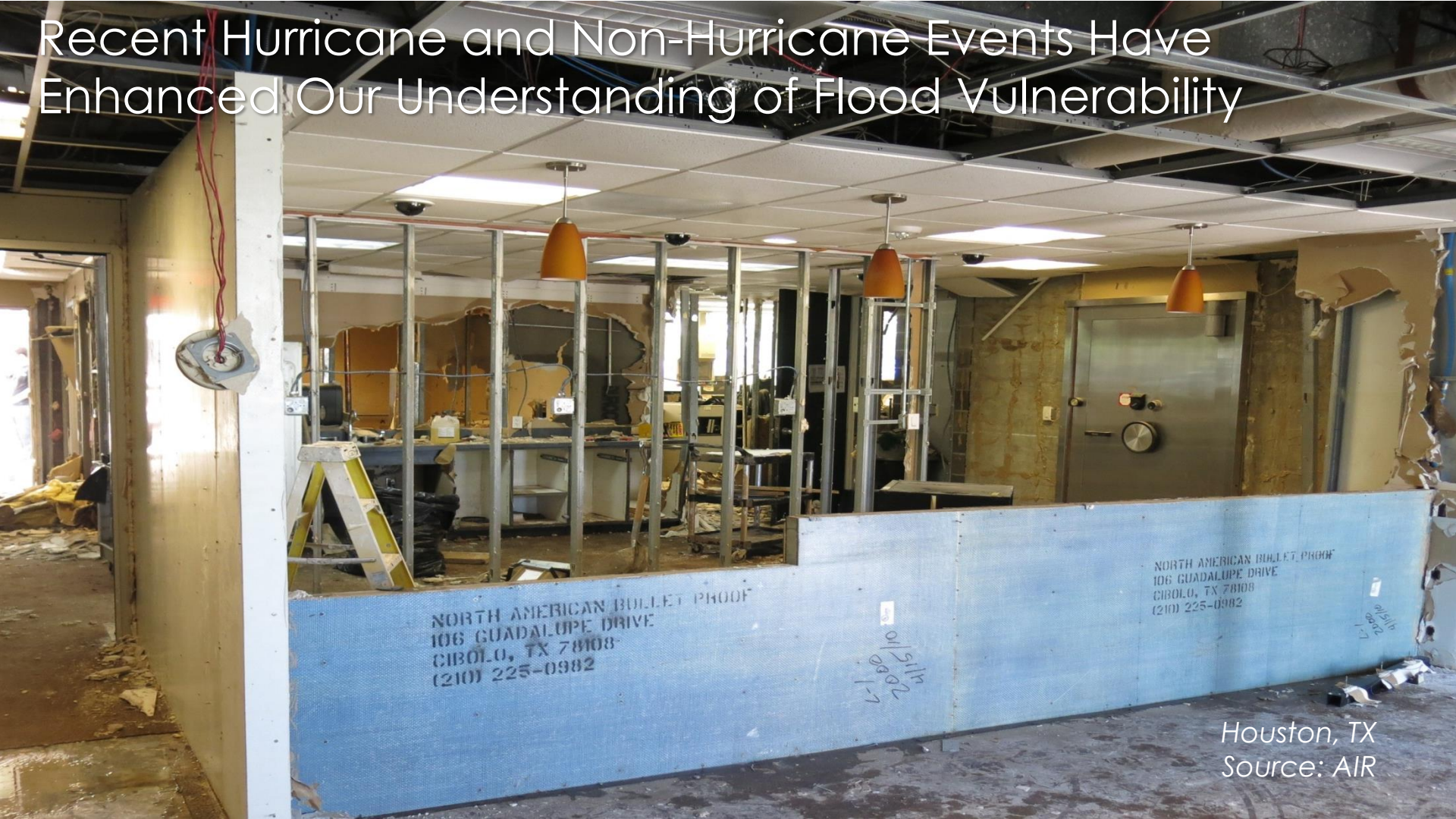
Capturing the Unique Physical Attributes of the Lower Mississippi



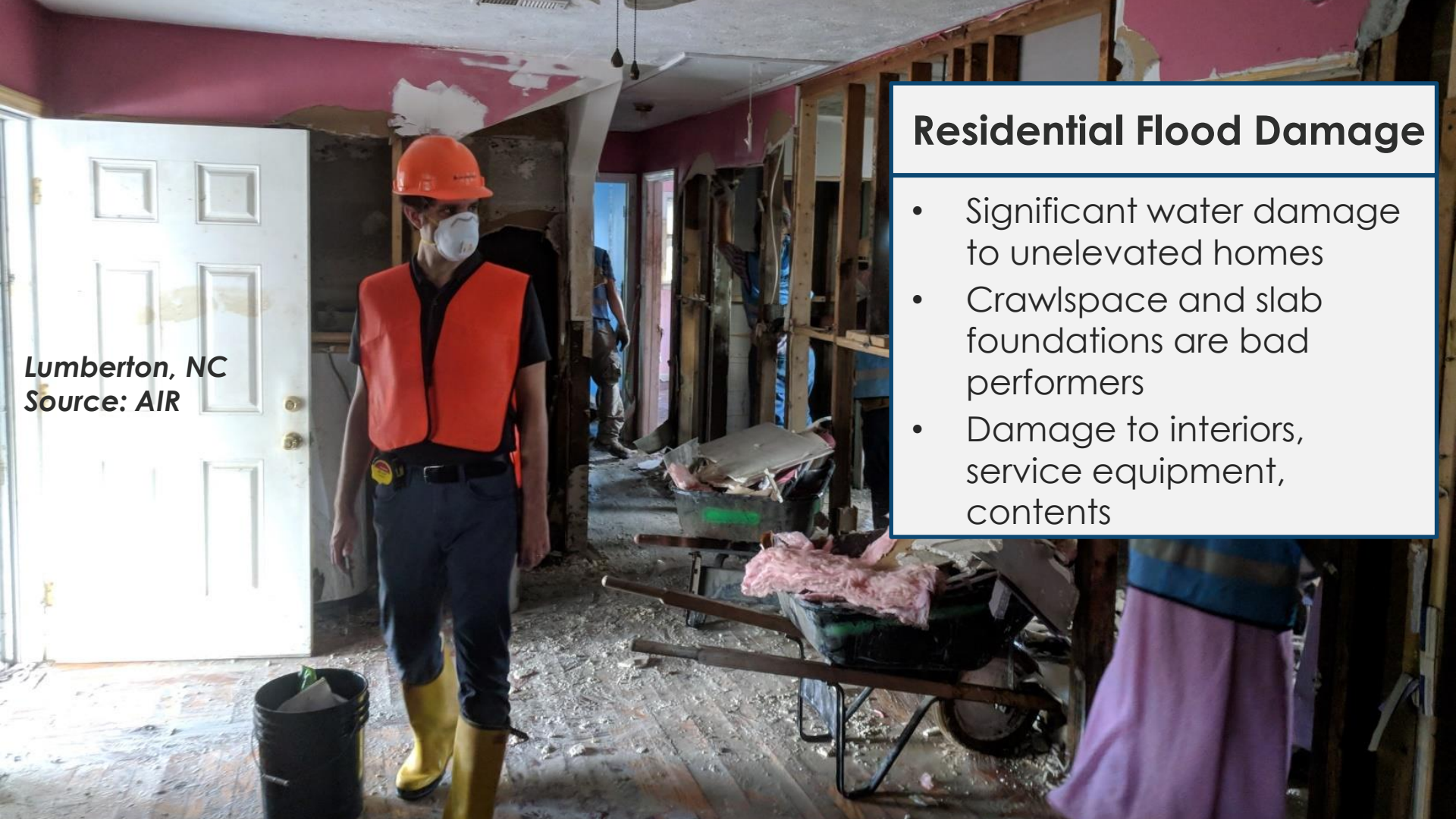


VULNERABILITY

Recent Hurricane and Non-Hurricane Events Have Enhanced Our Understanding of Flood Vulnerability



Houston, TX
Source: AIR



Lumberton, NC
Source: AIR

Residential Flood Damage

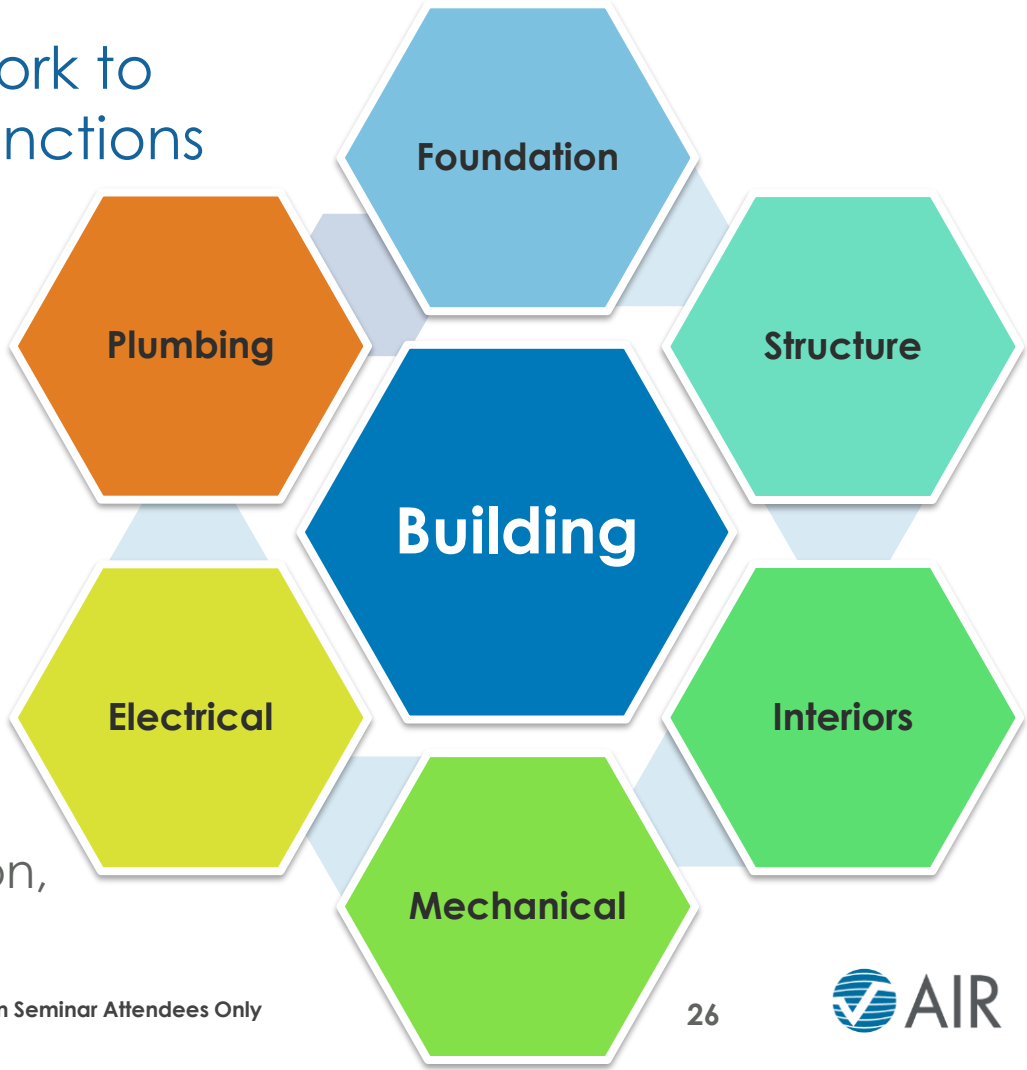
- Significant water damage to unelevated homes
- Crawlspace and slab foundations are bad performers
- Damage to interiors, service equipment, contents

Component-Level Framework to Develop Flood Damage Functions

$$DF_{building} = \sum_{\text{Floors}} \left(\sum_{\text{Comp}} \alpha_i \beta_j DF_{Comp,i} \right)$$

Component Cost Estimates

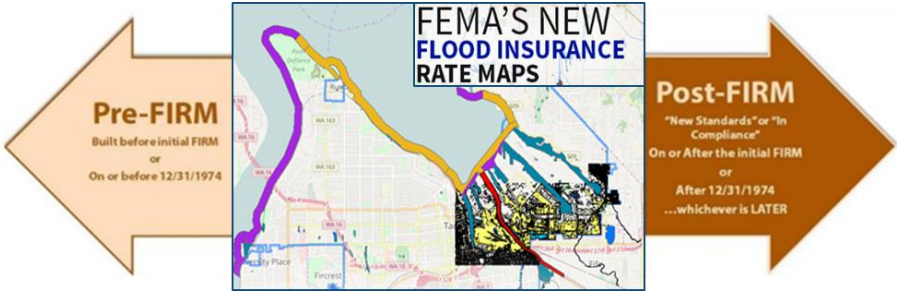
Component Damage Functions

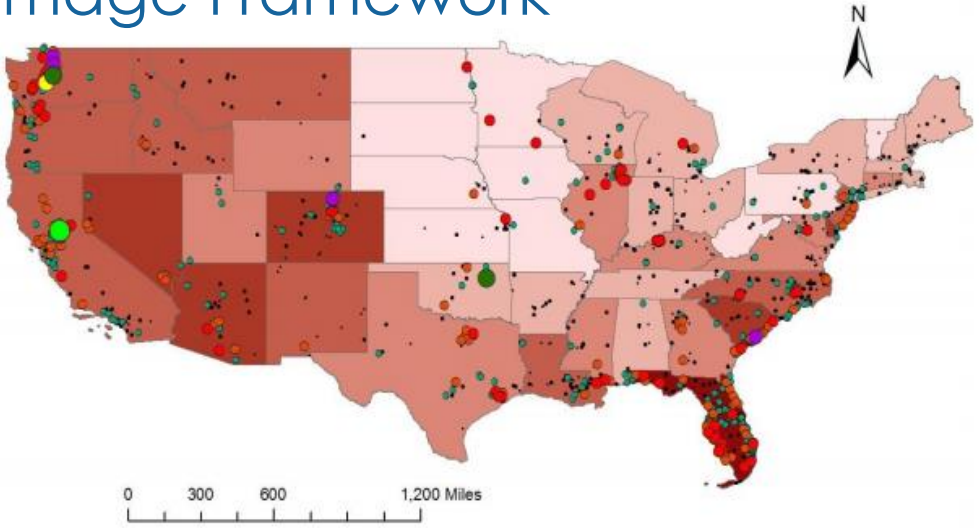


Varies by occupancy, construction, height, and foundation type

Several Verisk Data Sets Are Used as Inputs to the Component-Level Damage Framework

Commercial Foundation Distributions





FIRM Compliance

CRS Communities (as % of total NFIP communites)

- 0 - 2 %
- 2.1 - 4%
- 4.1 - 8%
- 8.1 - 14%
- 14.1 - 27%
- 27.1 - 46%

ISO®
A Verisk Analytics Business

CRS Class

- 1
- 2
- 3
- 4
- 5
- 6
- 7
- 8
- 9

- Personally owned versus commercial automobiles
- Regionality in automobile damage

Baytown, TX
Source: YouTube

Damage to Industrial Facilities

Beaumont, Texas
Source: Google Earth and NOAA Hurricane Harvey Imagery

Enhancements to Industrial Facilities Module

Designed to withstand certain flood levels depending on their location (FEMA flood zone) and importance (risk category)

Support for New Lines of Business

- Addition of several new lines of business in the US Flood Model
  - Infrastructure
  - Marine, including inland transit, marine cargo, marine hull
- Consistency in supported lines with US hurricane and US earthquake models

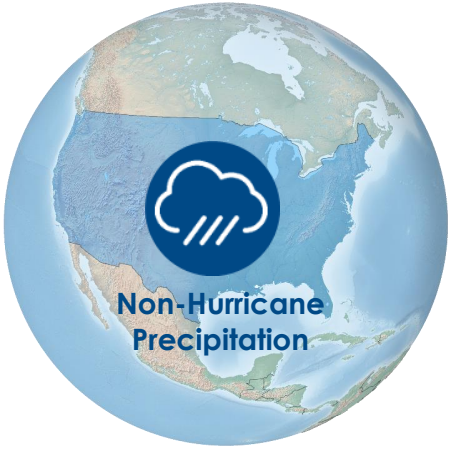
AIR

Leveraging Several Loss Data Sets for Model Validation

Leverage Touchstone's Flexibility to Capture Several Views of Risk

Hurricane Model

Inland Flood Model



Flood Risk

- Storm Surge
- Hurricane Precipitation-Induced Flooding
- Non-Hurricane Precipitation-Induced Flooding

Summary

Recent events such as Hurricanes Harvey (2017) and Florence (2018) have emphasised the need for a comprehensive and flexible view of flood risk

Verisk and AIR provide a suite of flood-based solutions that can be used across policy and portfolio lifecycles

Enhancements to AIR's Inland Flood Model span hazard and vulnerability modules, improving granularity while more effectively incorporating the physical environment and historical event characteristics

Questions?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