

# The impact of sea-level rise on changing coastlines

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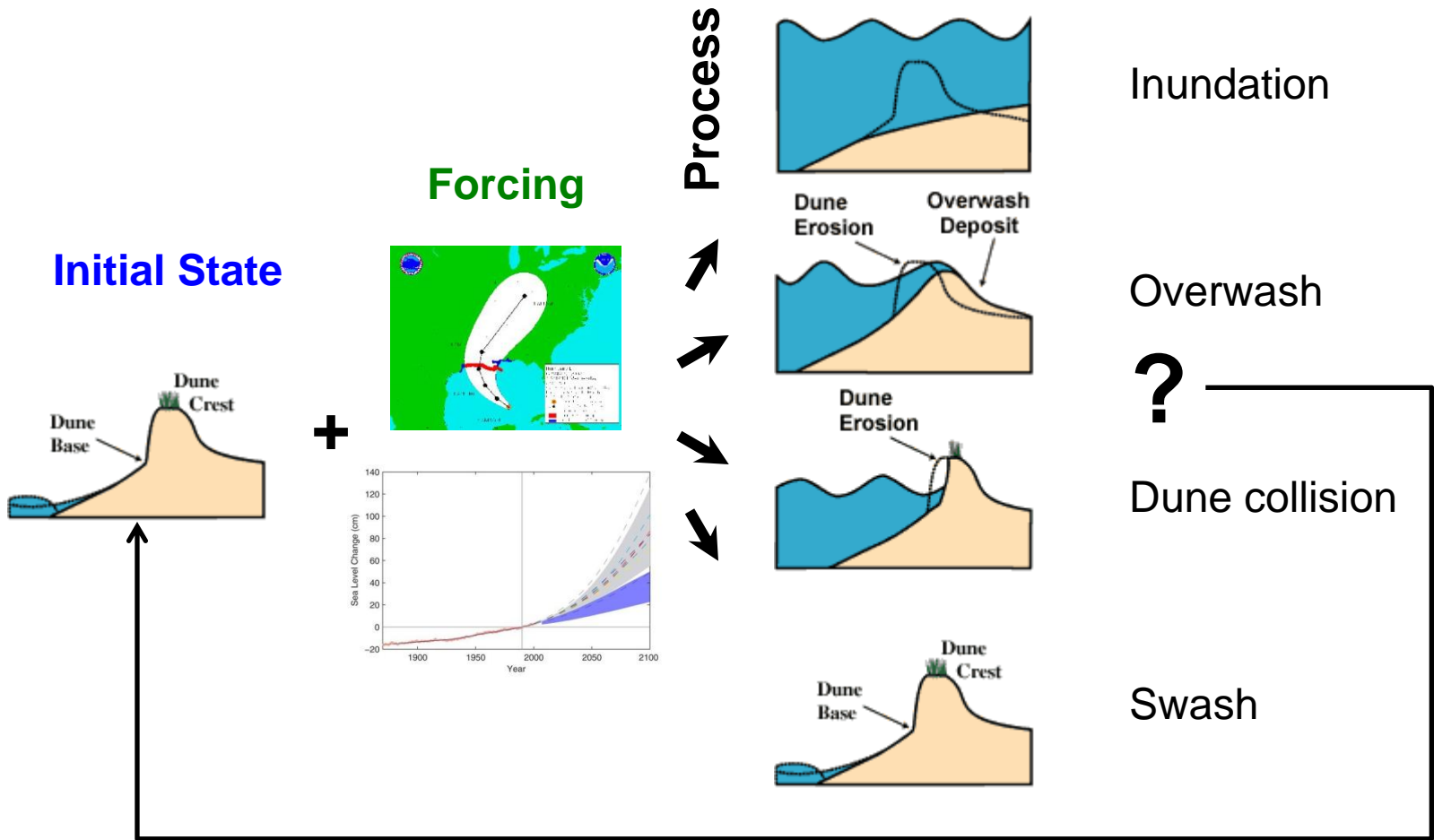
Acknowledgments:

USGS: Abby Sallenger, Hilary Stockdon, Rob Thieler, Mike Turco  
NOAA: Arthur Taylor

# Outline

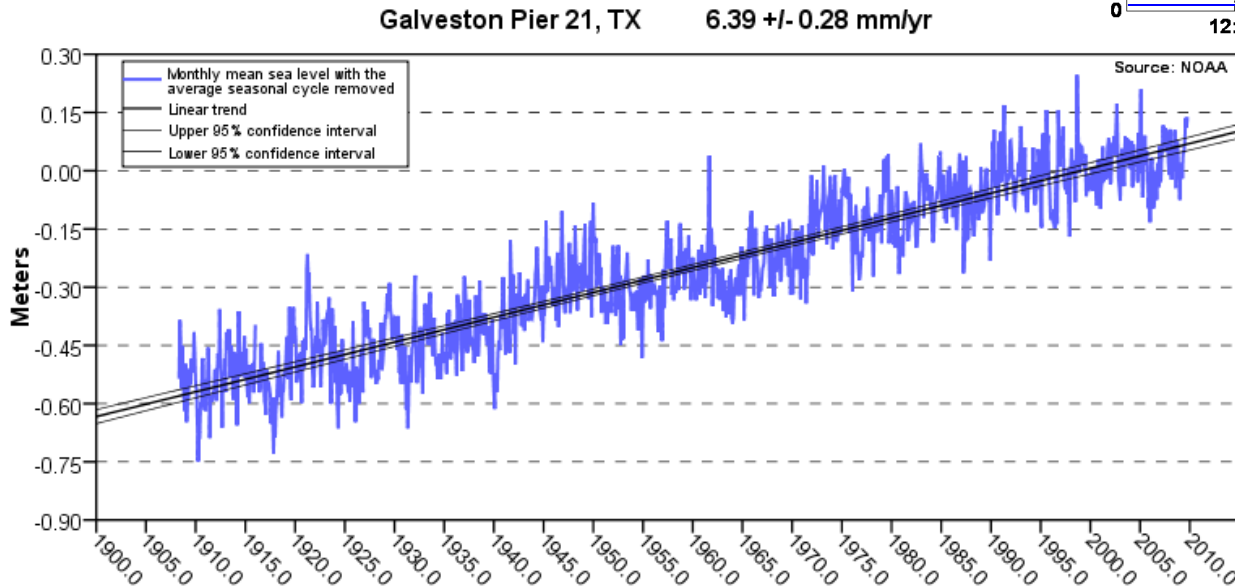
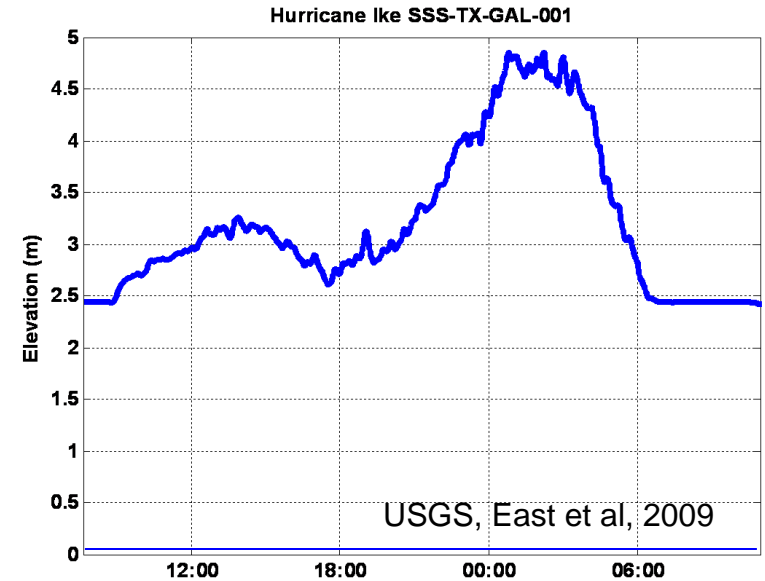
- Problem definition for coastal vulnerability to sea level rise
- Examples
  - Hurricane-induced coastal erosion
  - Sea-level rise & storm-driven erosion
- Conclusions
  - Predictive capability exists for erosion forecasting
  - Must describe uncertainty
  - Opportunity exists to guide management decisions

# Barrier island response to storms



# Sea level variations affecting coastal topography

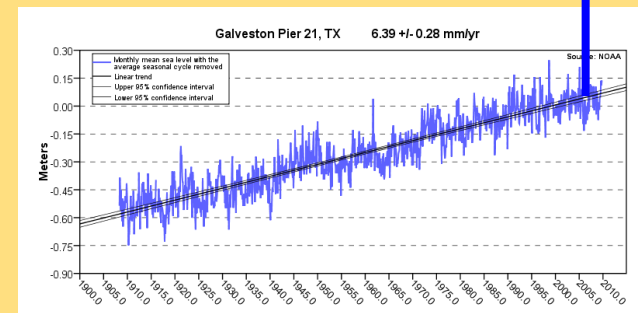
- Multiple scales
  - Storms (days)
  - Climate (decades)
  - other (waves, tides,...)



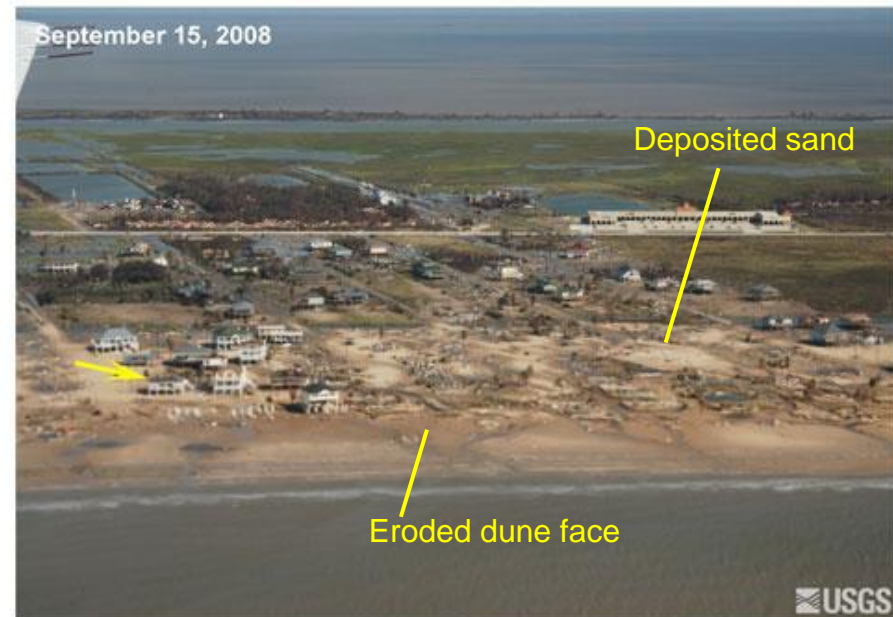
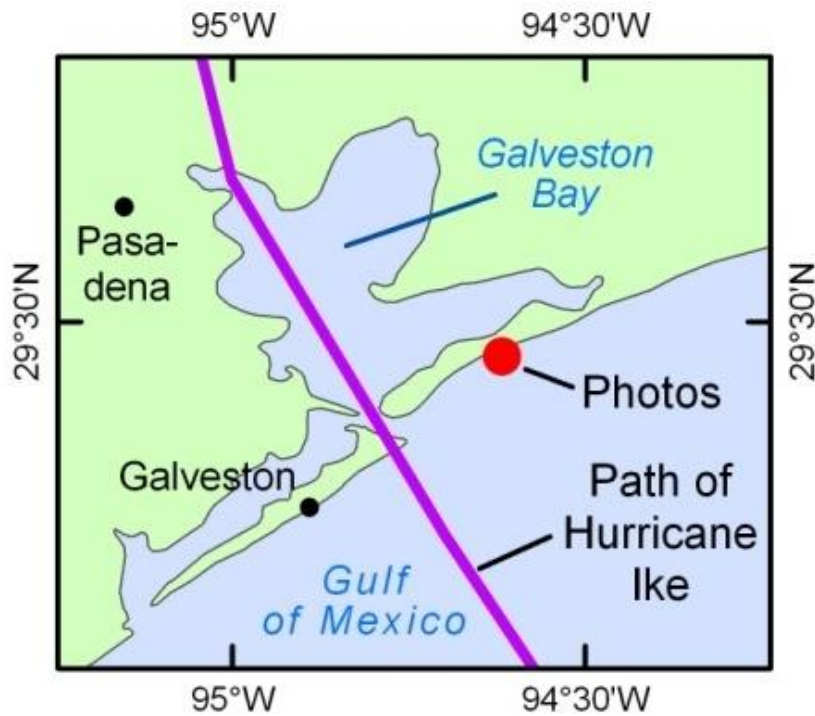
# Tortoise / Hare Problem

- With a twist:
  - Storms coupled to long term sea level rise
  - Topographic interactions
    - overwash, inundation
    - Sediment supply
    - Biology
    - ...

Hurricane Ike, 2008



# Hurricane Ike

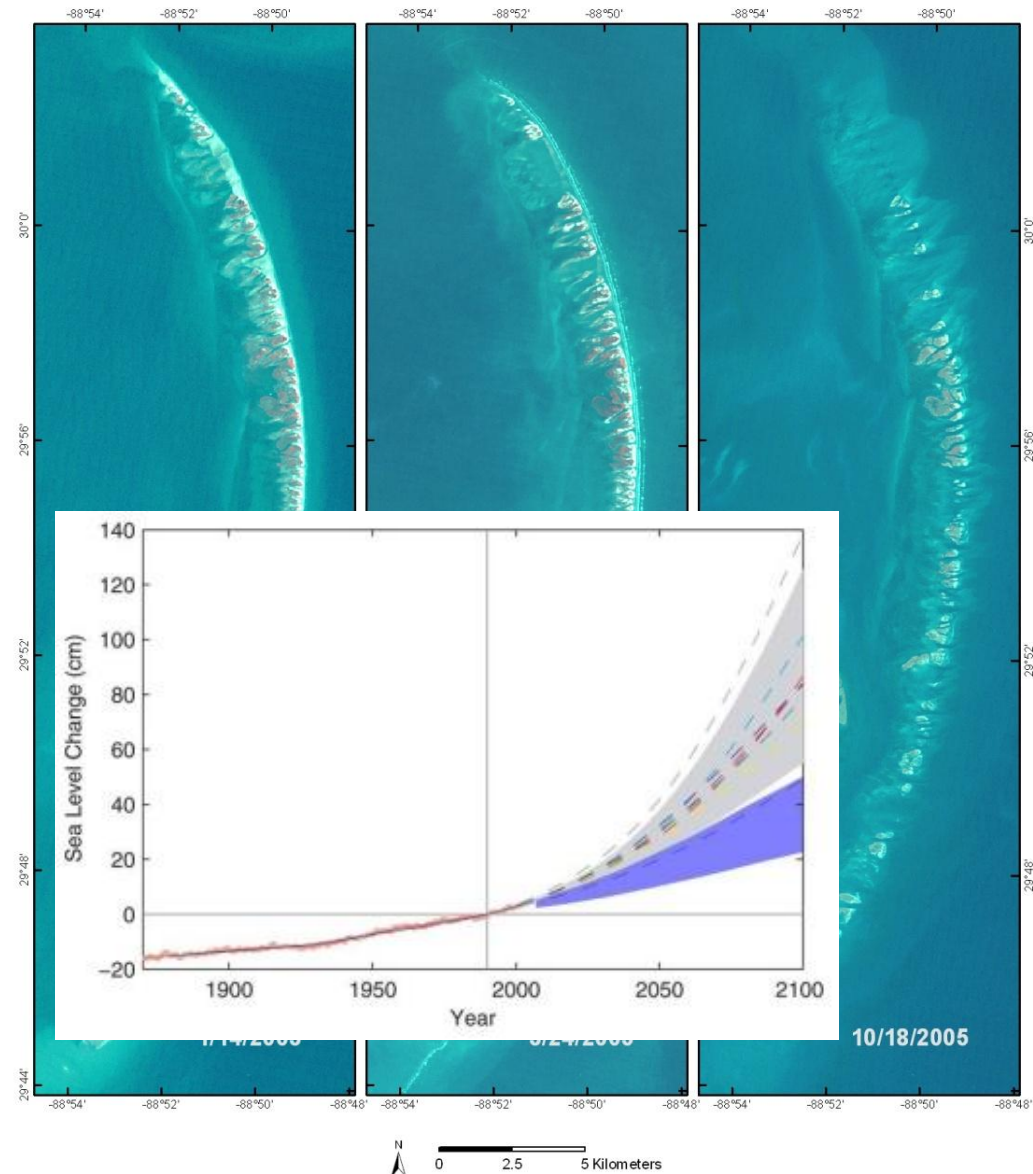




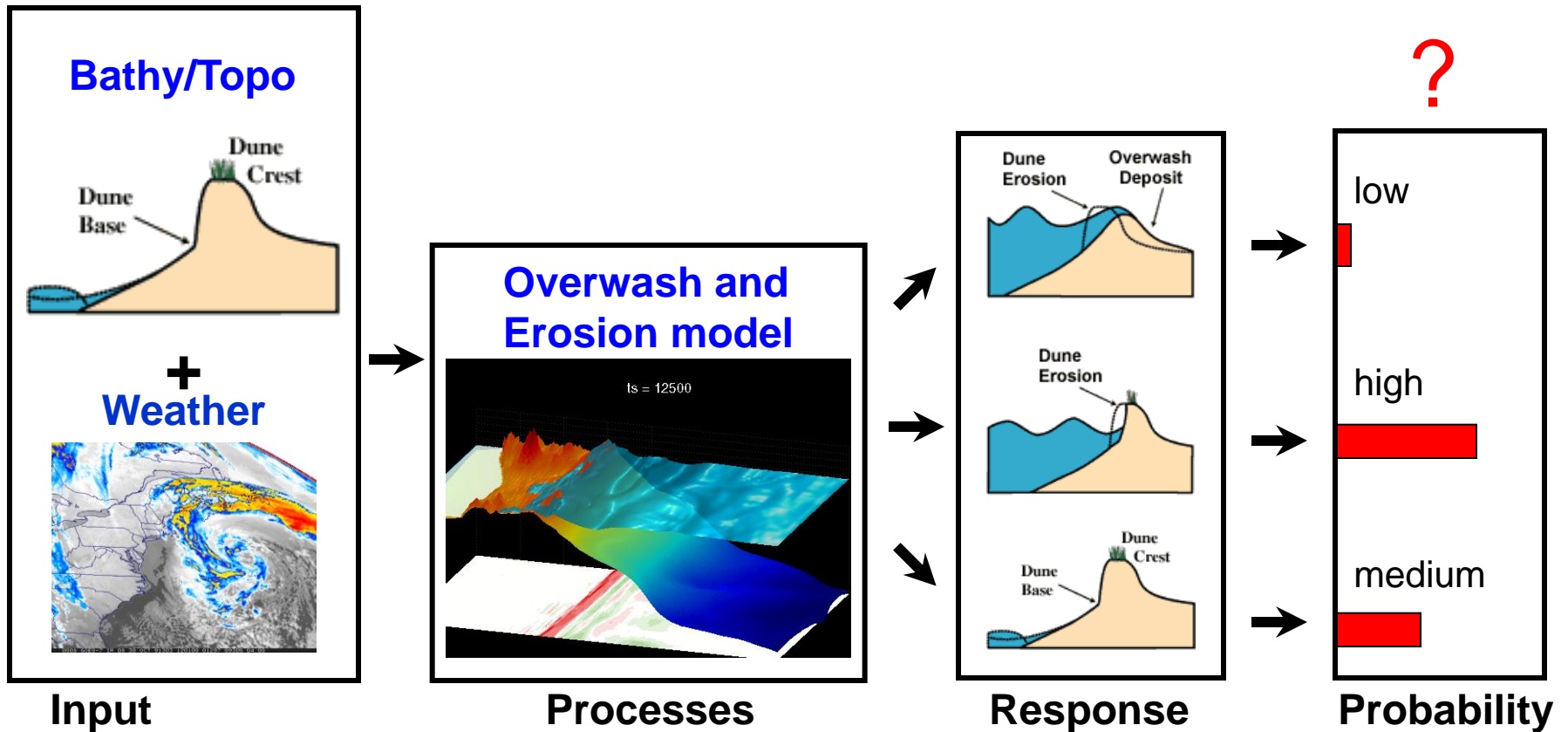
# Decadal vulnerability: Chandeleur Islands



- Processes
  - Relative sea-level rise
  - Sediment supply
  - Storm impacts
- Response
  - Overwash (landward migration)
  - Inundation (dissection)
  - New system dynamics



# Predicting Coastal Vulnerability

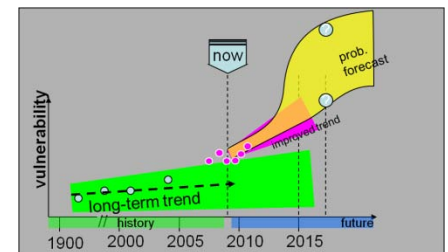
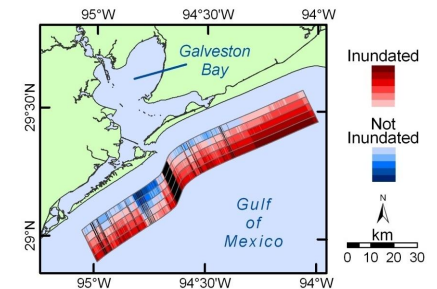
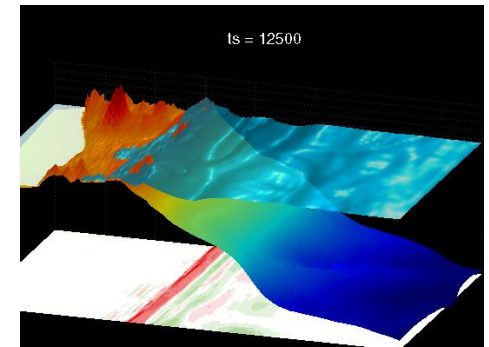


- Uncertainty is intrinsic part of this problem
- Must predict probability of multiple outcomes
- Must cope with variety of time scales

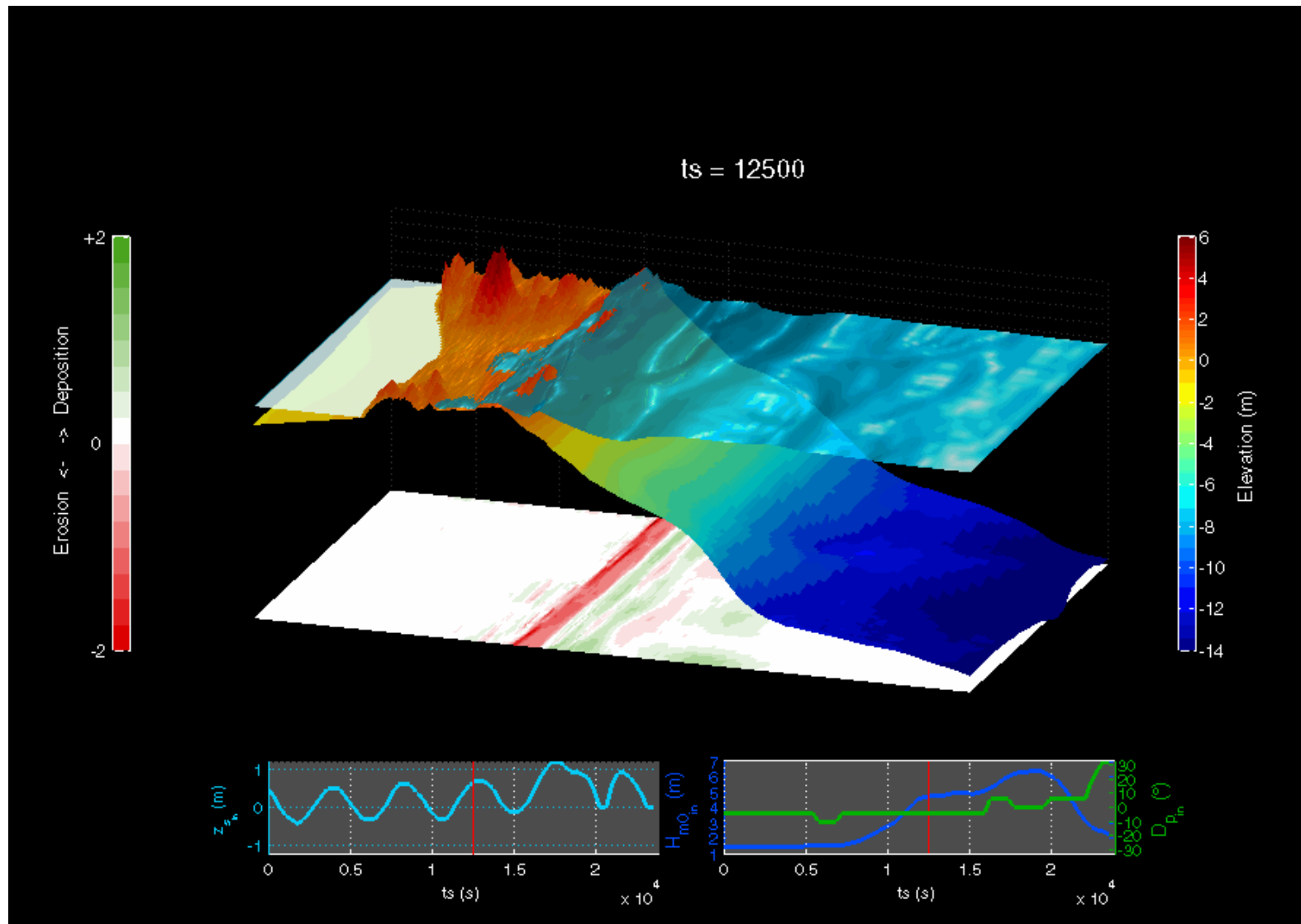


# Prediction approaches

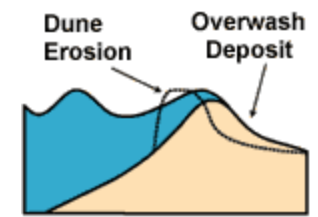
- Detailed numerical modeling
  - Resolves short-term physical processes
  - Difficult to resolve long-term scenarios
- Scenario modeling
  - Focus on distinct scenarios
  - May not correspond to reality
- Probabilistic forecast
  - Propagate uncertainties associated with each scenario



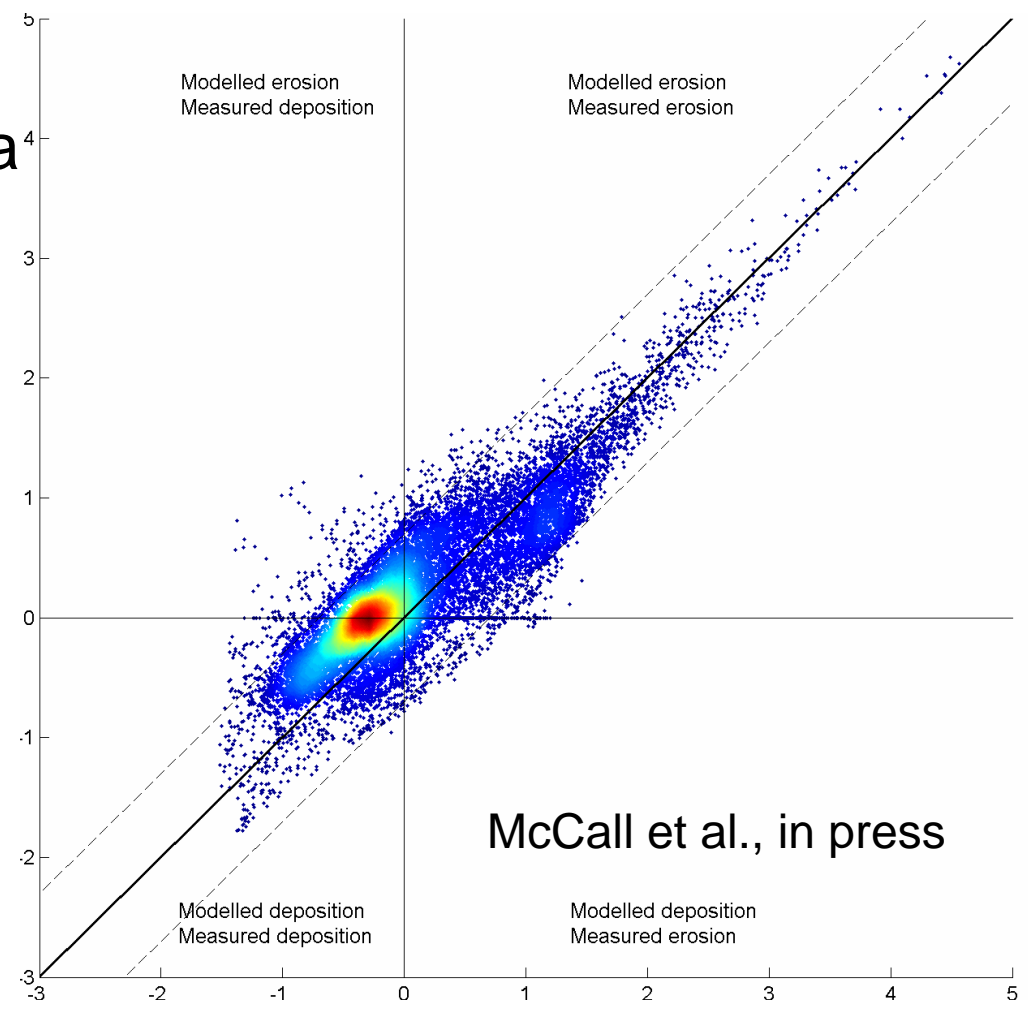
# Detailed Overwash Model



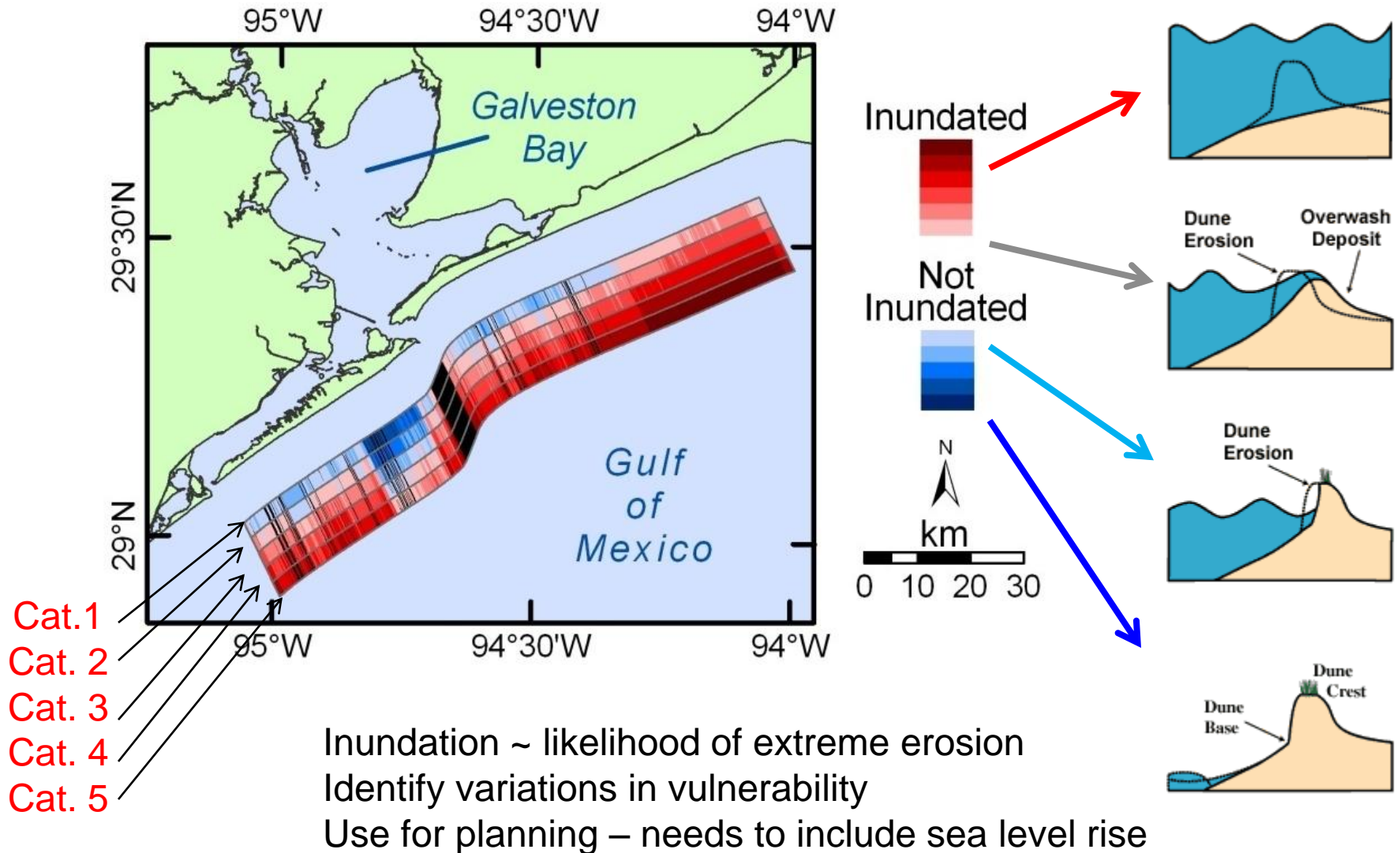
# Prediction skill



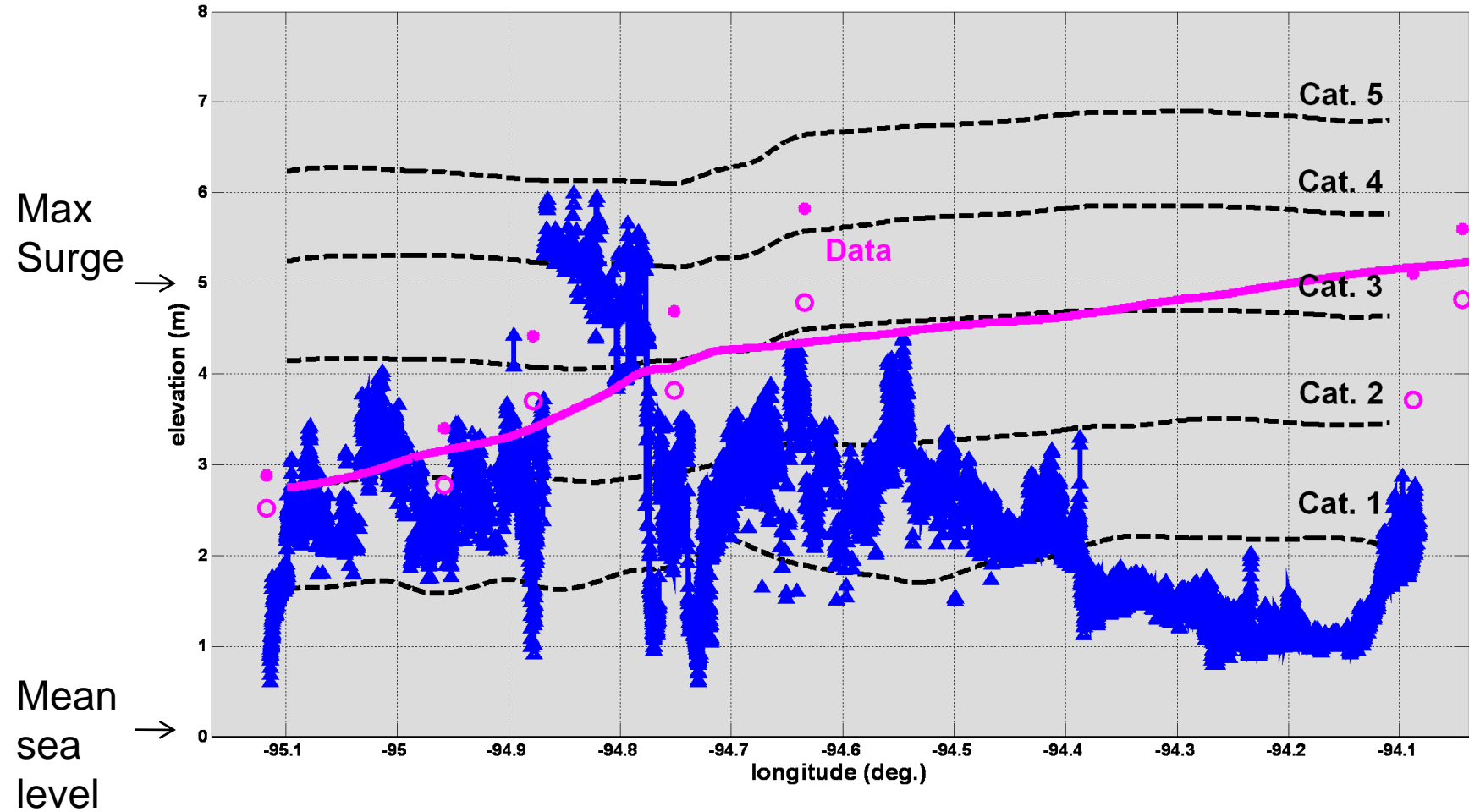
- Hurricane Ivan
  - Overwash at Santa Rosa Island, FL
- Resolve
  - Waves
  - overland flow
  - sediment transport
  - topography



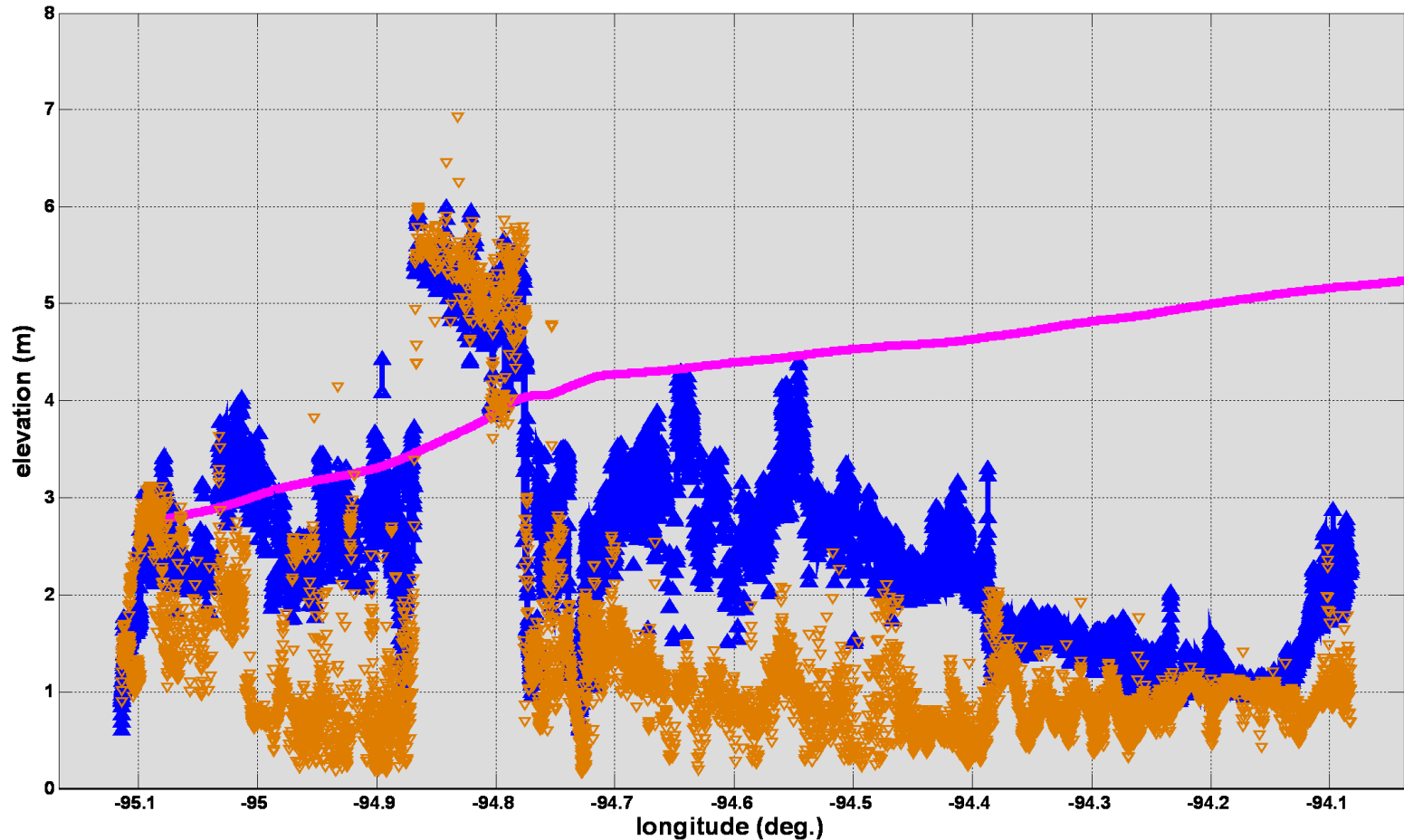
# Hurricane response scenarios



# Comparison to Hurricane Ike: Predicted and observed water levels

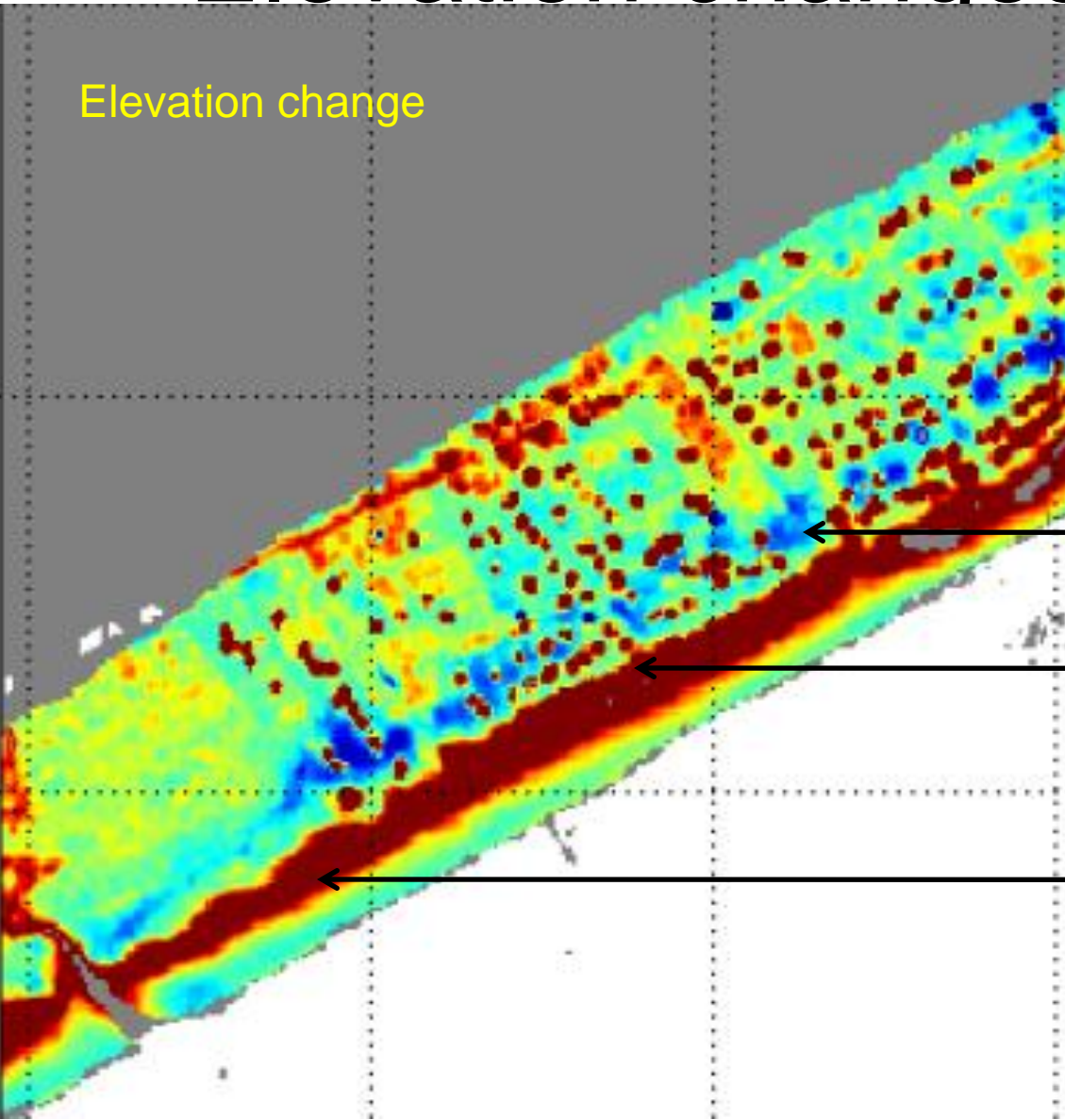


# Observed dune elevation change



# Elevation changes from Lidar

Elevation change



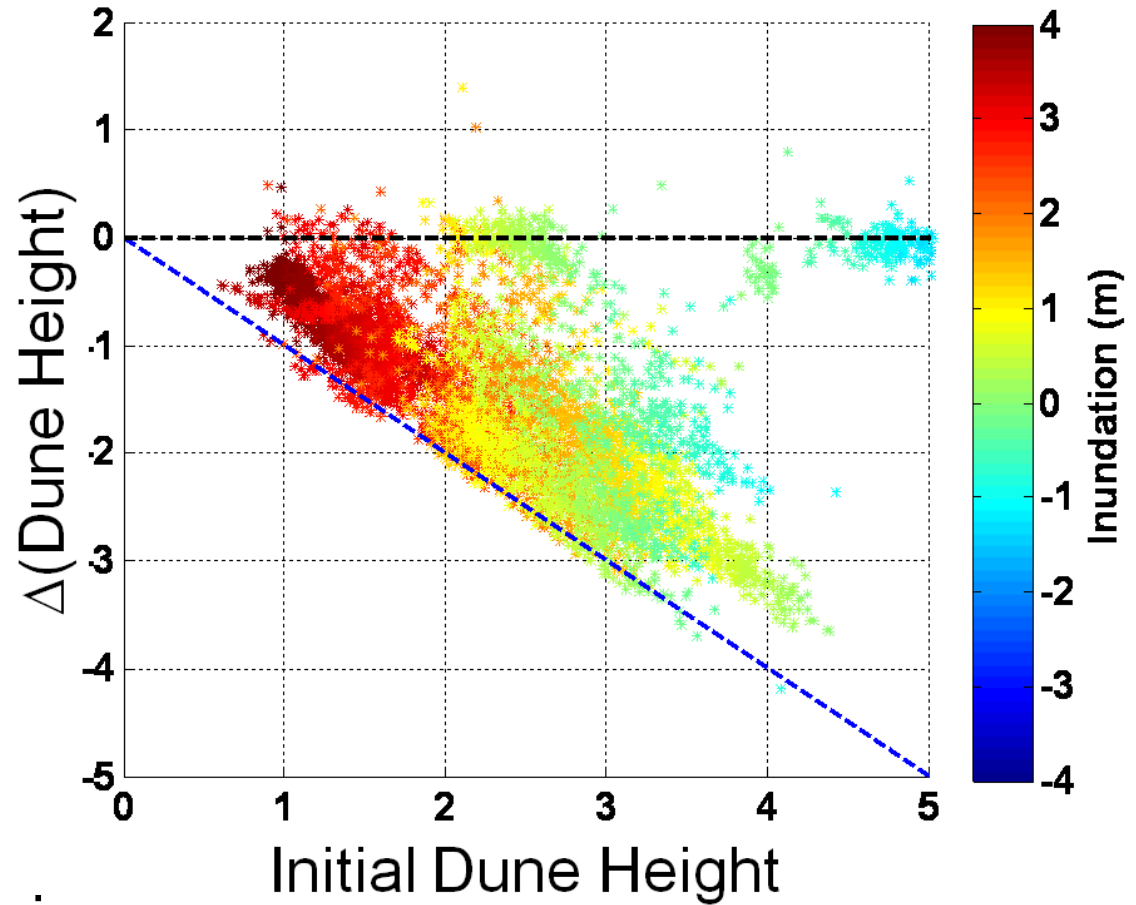
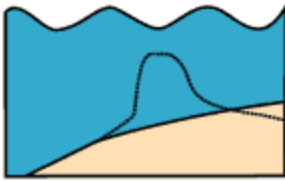
Sand deposits

MISSING houses

NO dune  
Shoreline MOVED



# Prediction skill



- Expected severe erosion
  - Dune erosion = 80% of initial dune height

# Probabilistic forecasting of coastal erosion

- Integration of

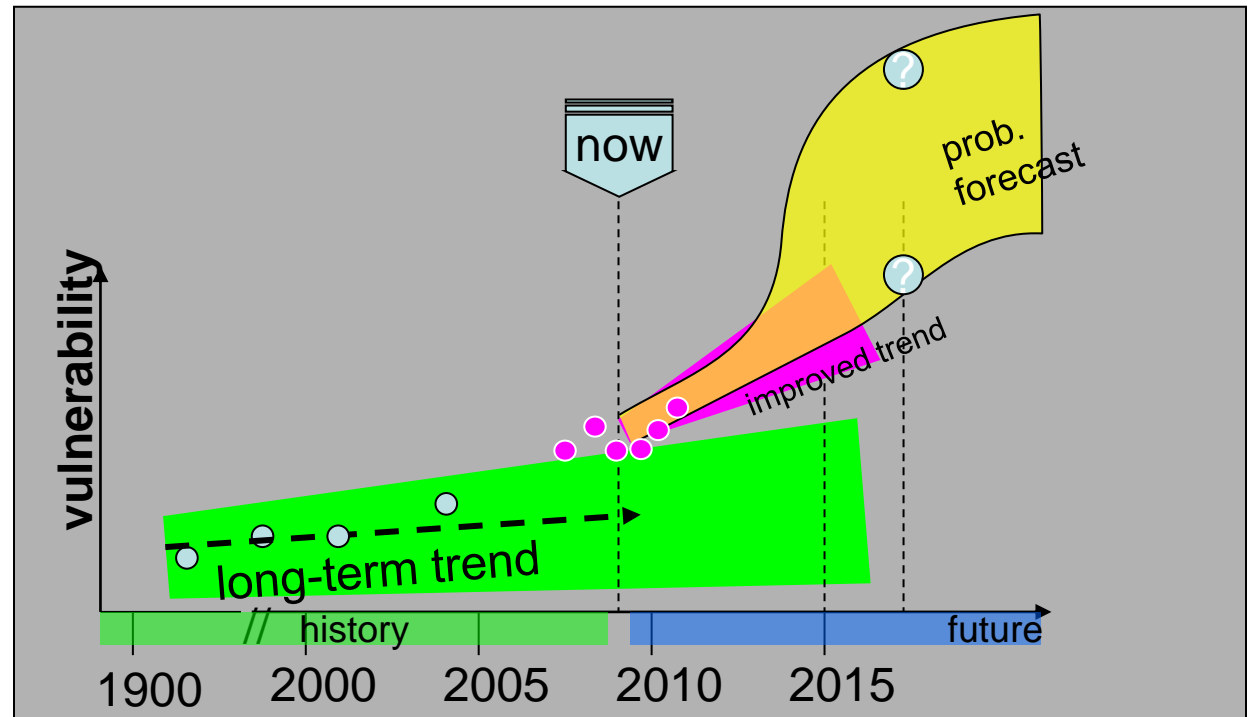
- Long-term observations

- Shoreline
- Sea level
- Storminess

- Recent observations

- Predictions

- Sea level + uncertainty
- Storminess + uncertainty
- Sediment transport + uncertainty



# The impact of sea-level rise on changing coastlines

- Problem

- Correlations in forcing (storms, sea-level rise)
- Uncertainty in forcing
- Complicated interactions with coastal topography (more uncertainty)

- Solutions

- Identify relevant scenarios (observations)
  - Hurricane interactions (hurricane Ike)
  - Long-term geomorphic system dynamics (Chandeleur Islands)
- Demonstrate fundamental understanding (numerical model)
- Demonstrate probabilistic prediction skill
  
- Forecast!

# Conclusions

- Future climate will take us to scenarios that we have not seen before
- Predictive capability exists for climate-driven topographic change forecasting
- Opportunity exists to guide management decisions

