

The impact of sea-level rise on changing coastlines

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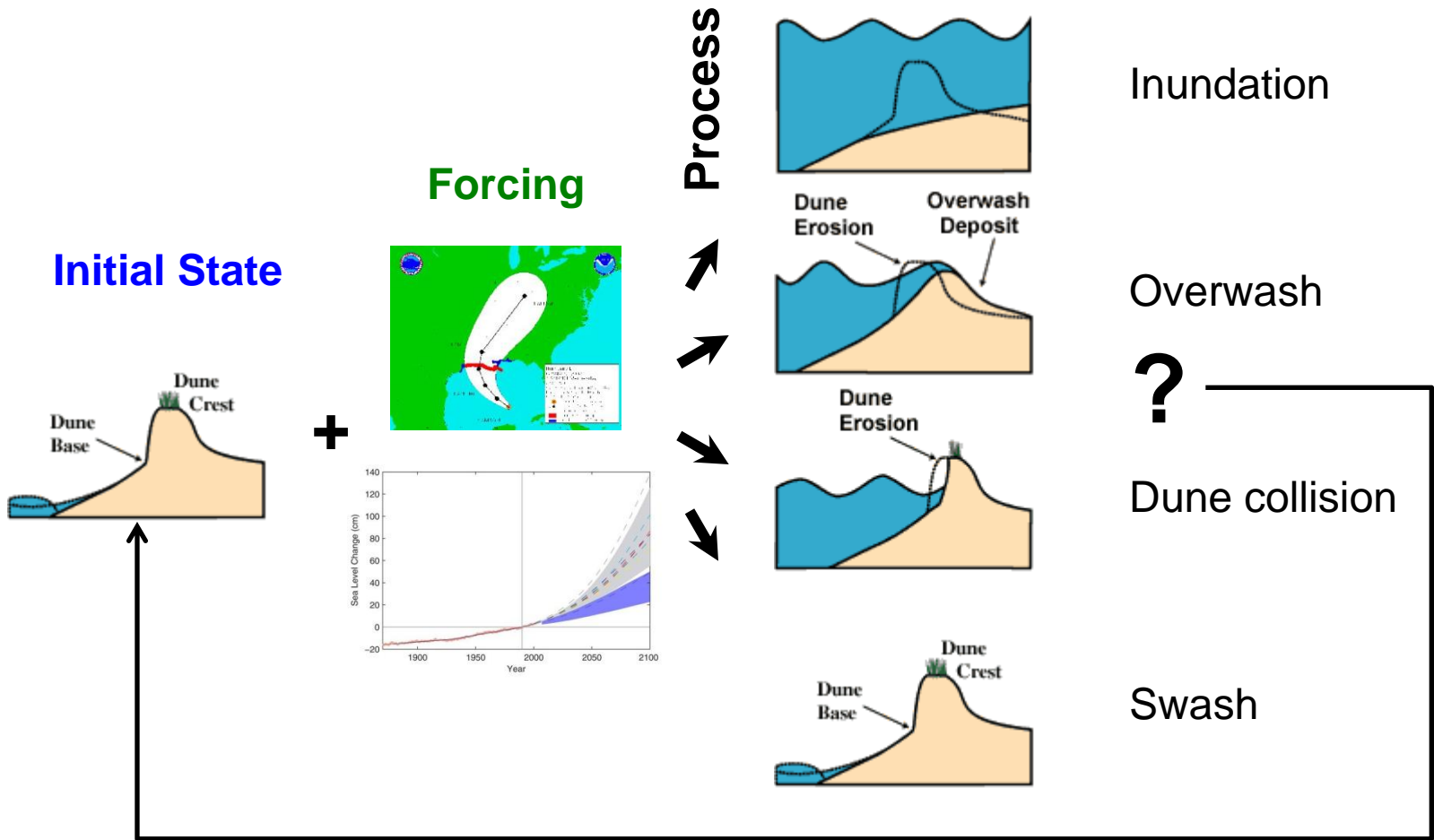
Acknowledgments:

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

Outline

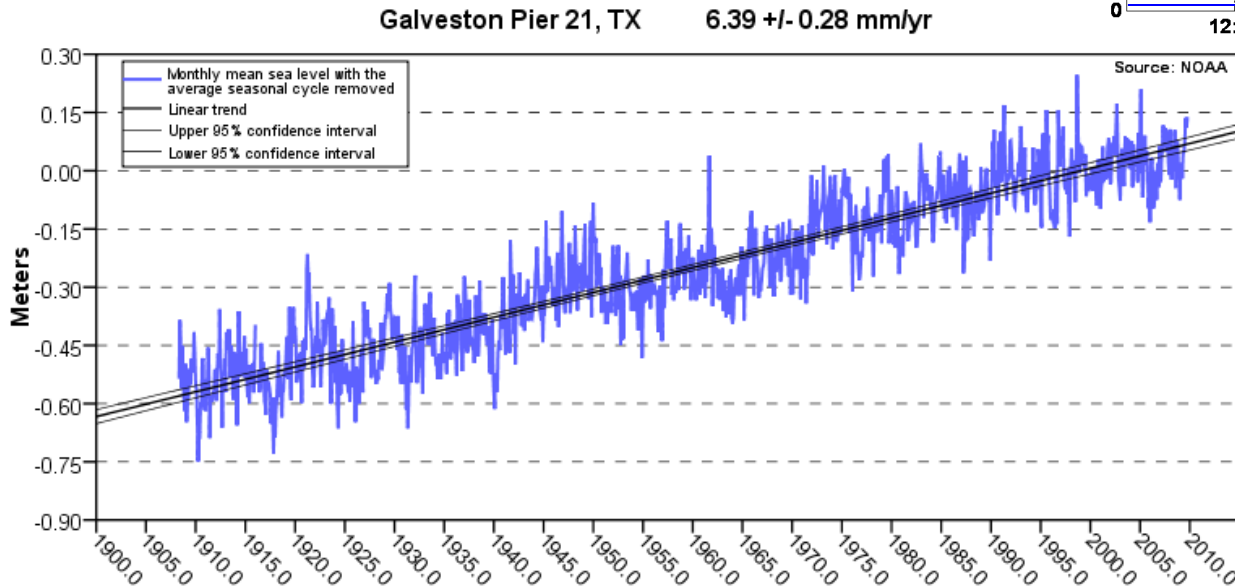
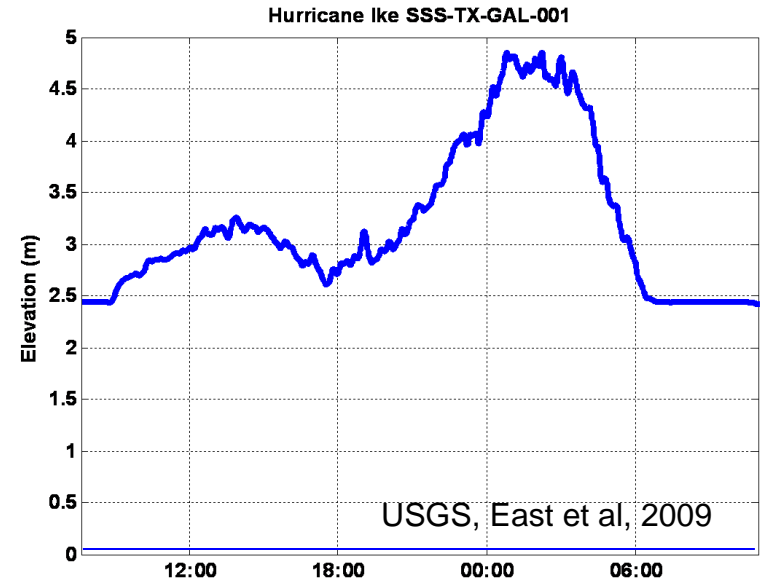
- Problem definition for coastal vulnerability to sea level rise
- Examples
 - Hurricane-induced coastal erosion
 - Sea-level rise & storm-driven erosion
- Conclusions
 - Predictive capability exists for erosion forecasting
 - Must describe uncertainty
 - Opportunity exists to guide management decisions

Barrier island response to storms



Sea level variations affecting coastal topography

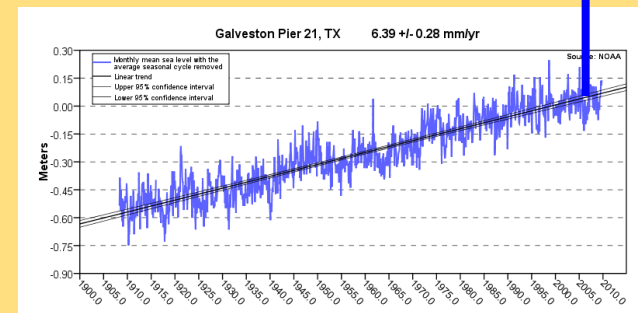
- Multiple scales
 - Storms (days)
 - Climate (decades)
 - other (waves, tides,...)



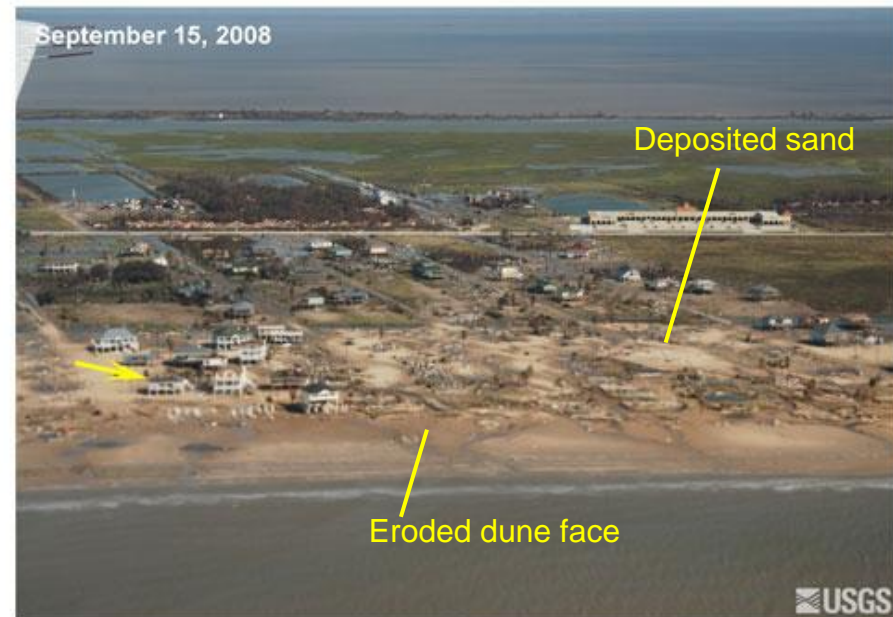
Tortoise / Hare Problem

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

Hurricane Ike, 2008



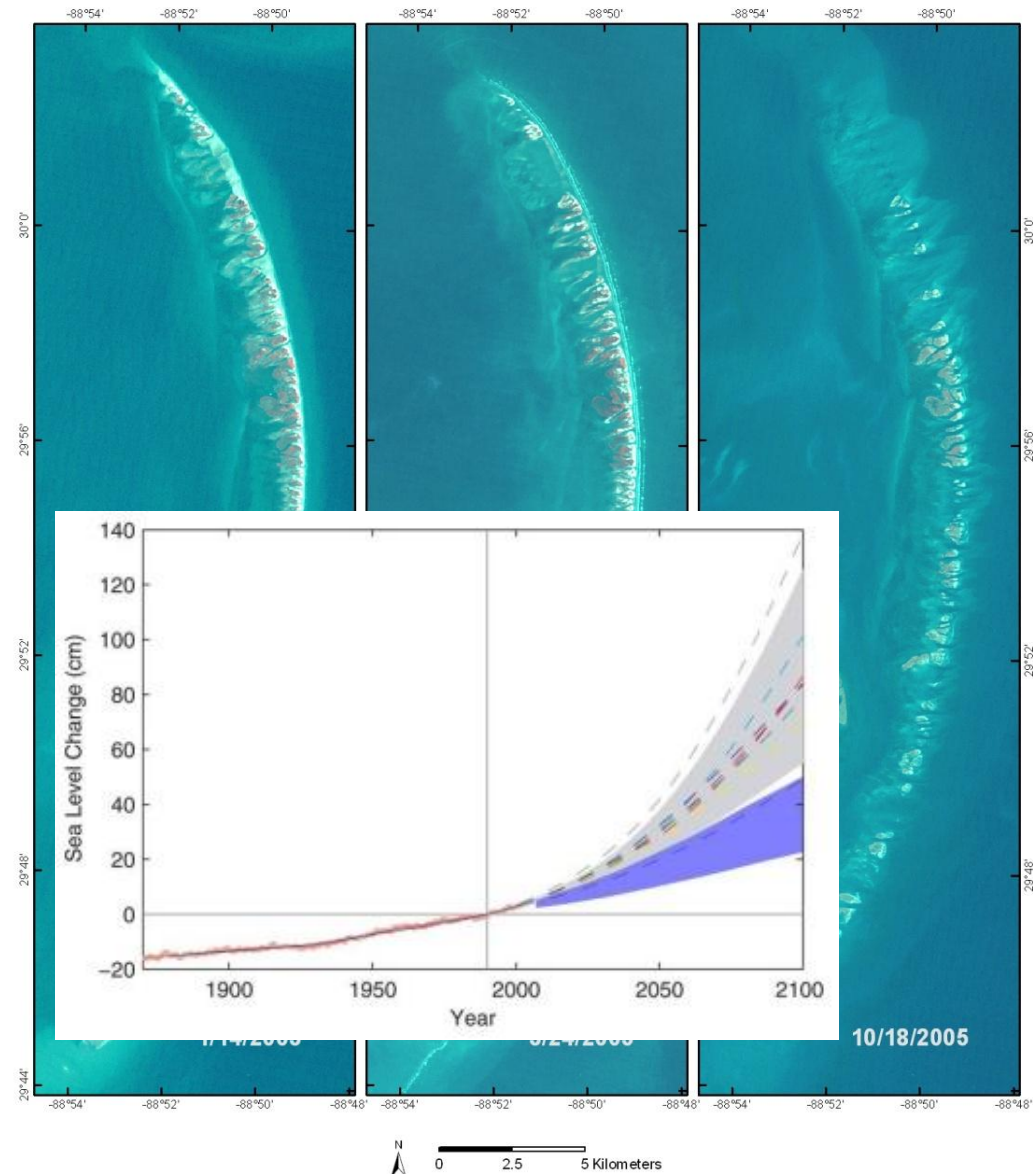
Hurricane Ike



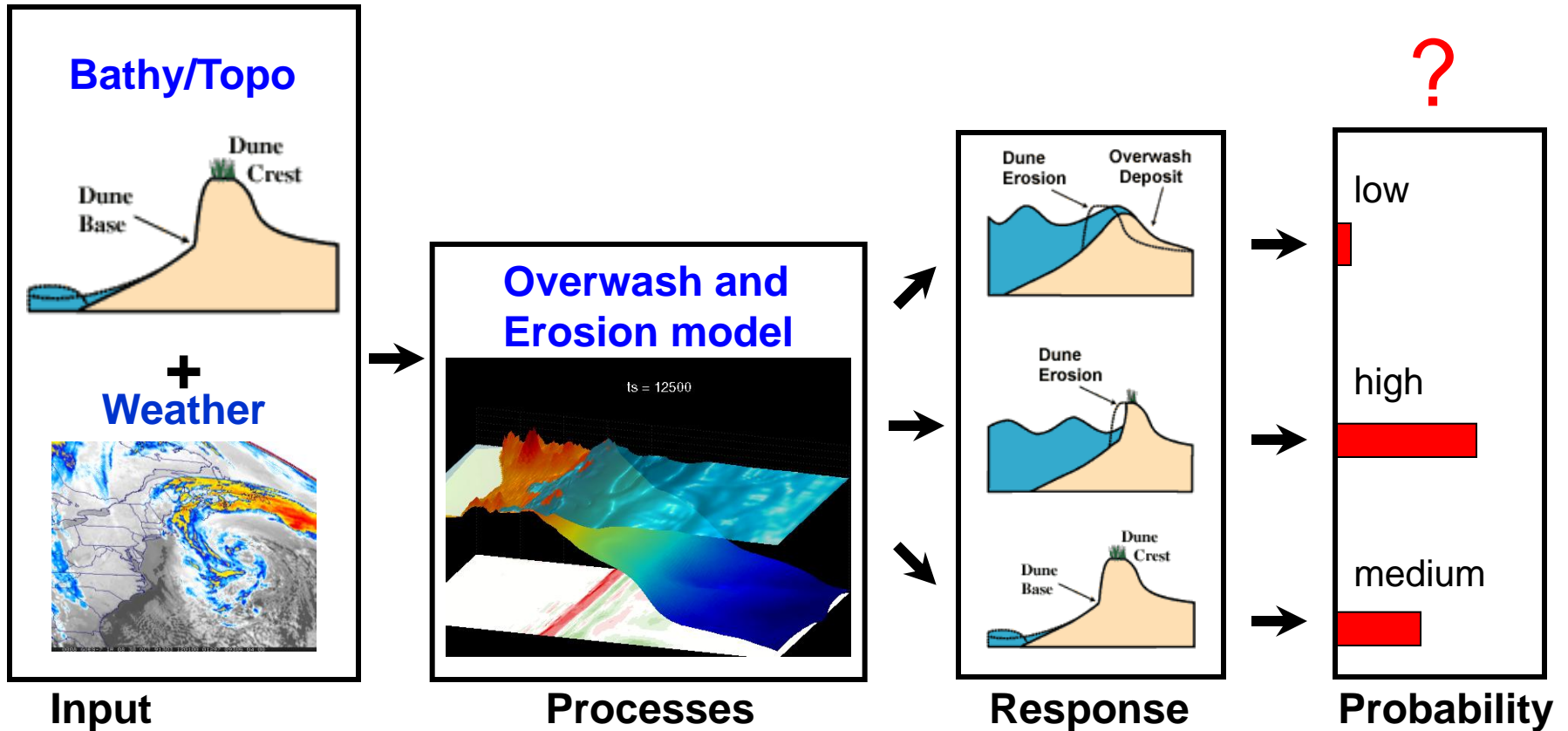
Decadal vulnerability: Chandeleur Islands



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



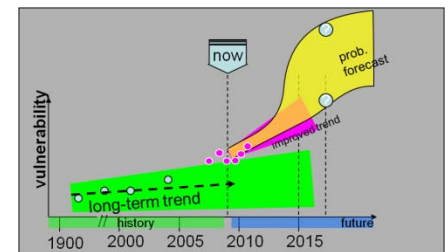
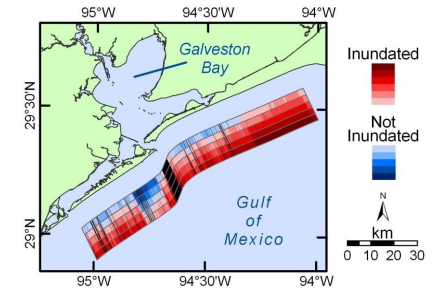
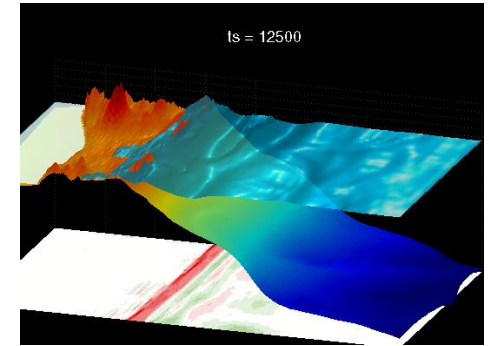
Predicting Coastal Vulnerability



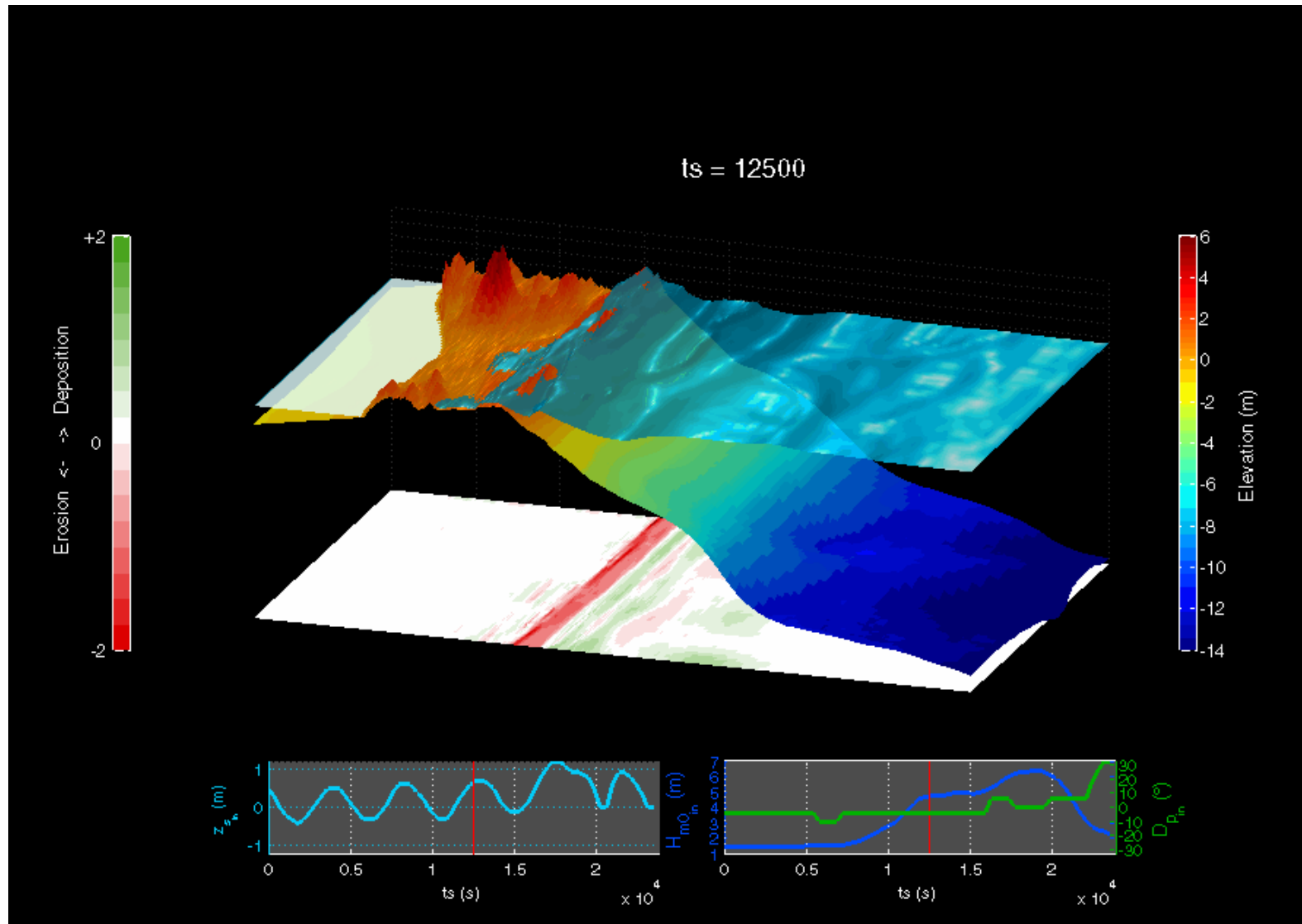
- Uncertainty is intrinsic part of this problem
- Must predict probability of multiple outcomes
- Must cope with variety of time scales

Prediction approaches

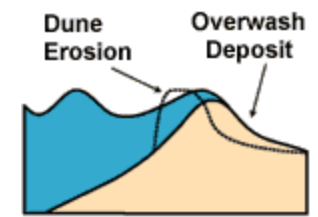
- Detailed numerical modeling
 - Resolves short-term physical processes
 - Difficult to resolve long-term scenarios
- Scenario modeling
 - Focus on distinct scenarios
 - May not correspond to reality
- Probabilistic forecast
 - Propagate uncertainties associated with each scenario



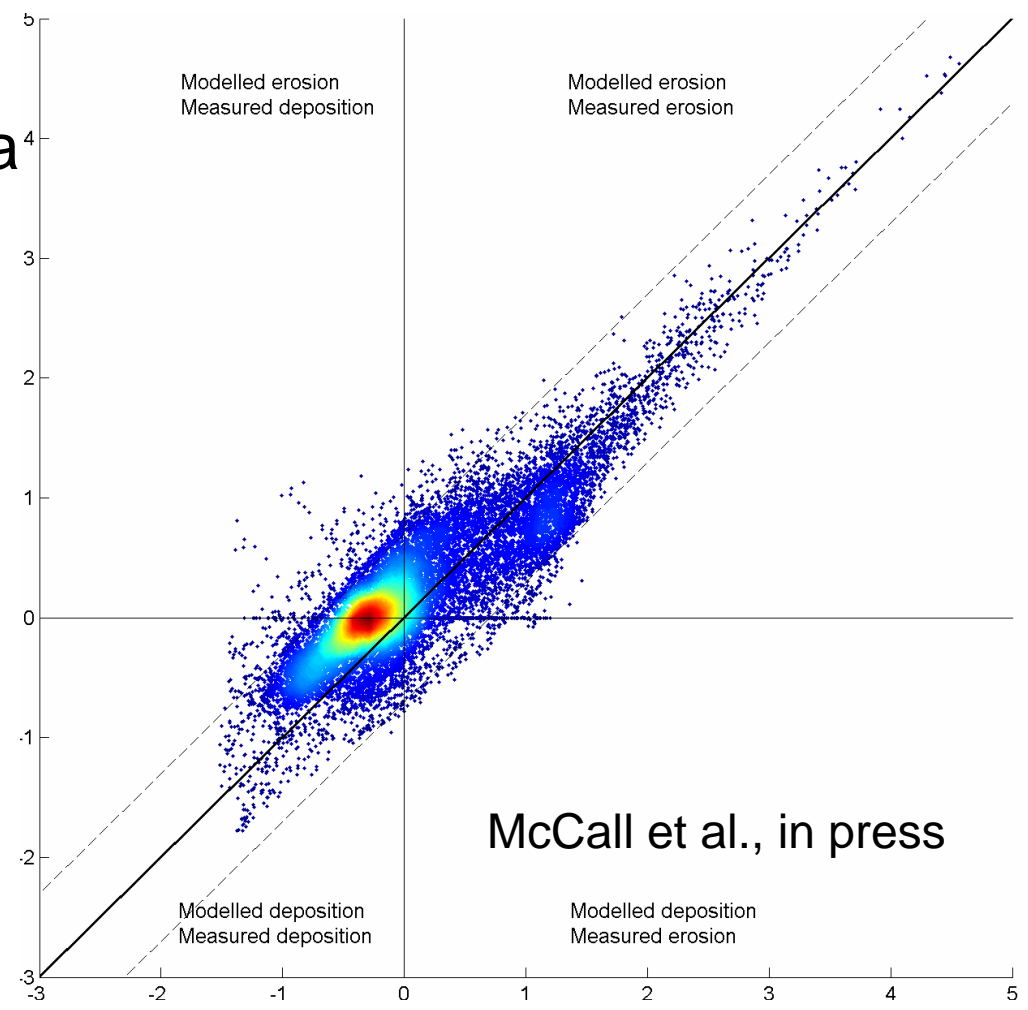
Detailed Overwash Model



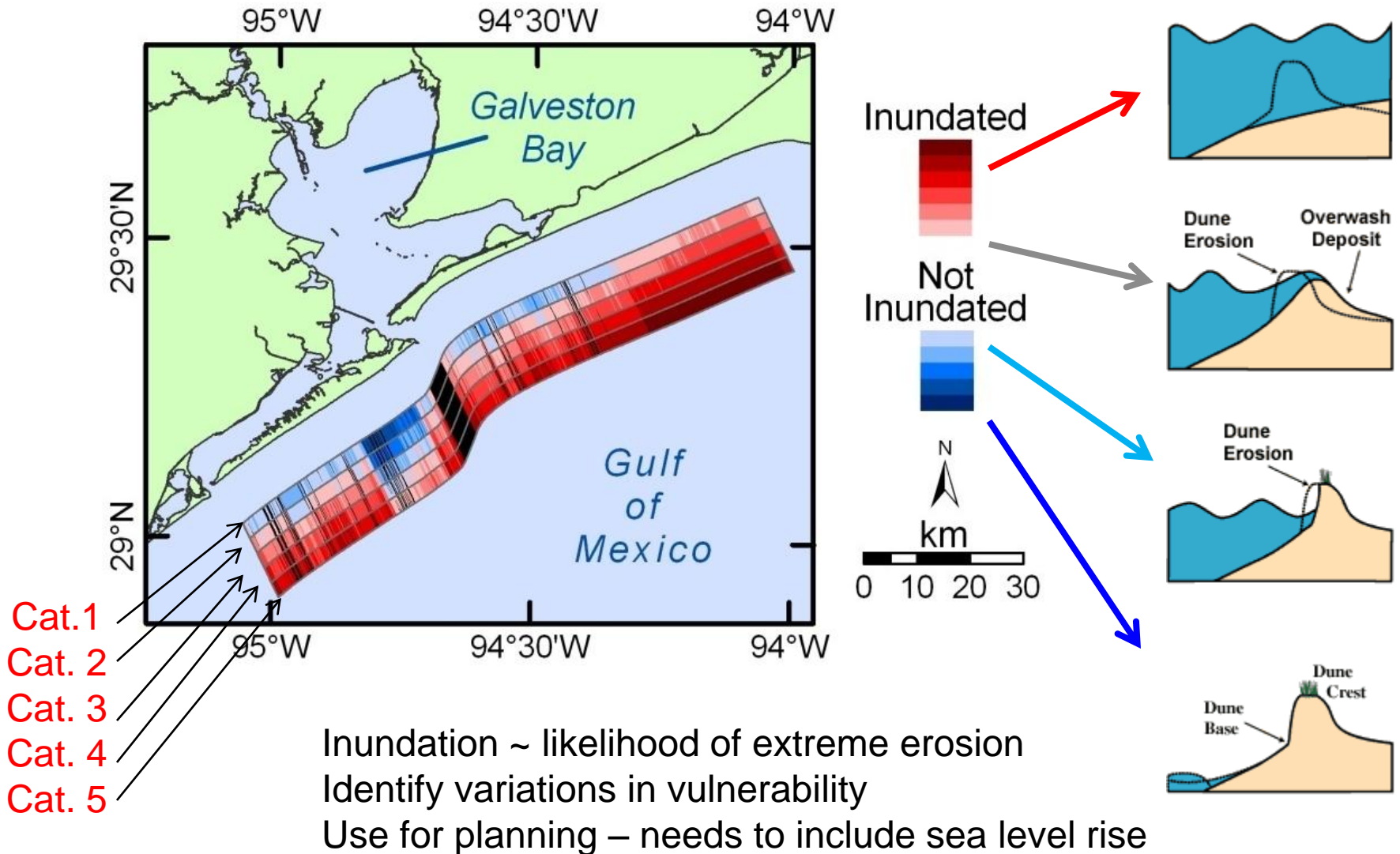
Prediction skill



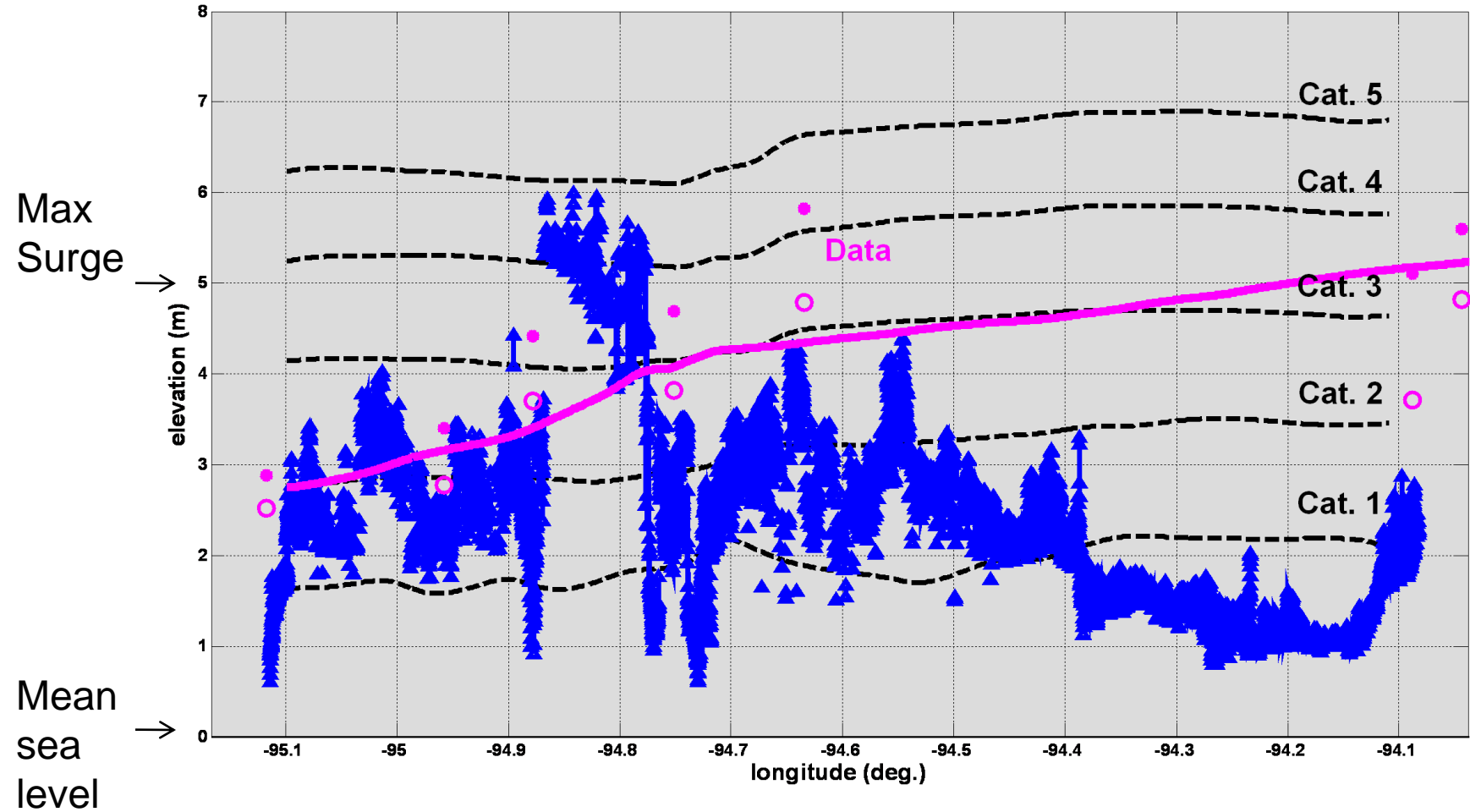
- Hurricane Ivan
 - Overwash at Santa Rosa Island, FL
- Resolve
 - Waves
 - overland flow
 - sediment transport
 - topography



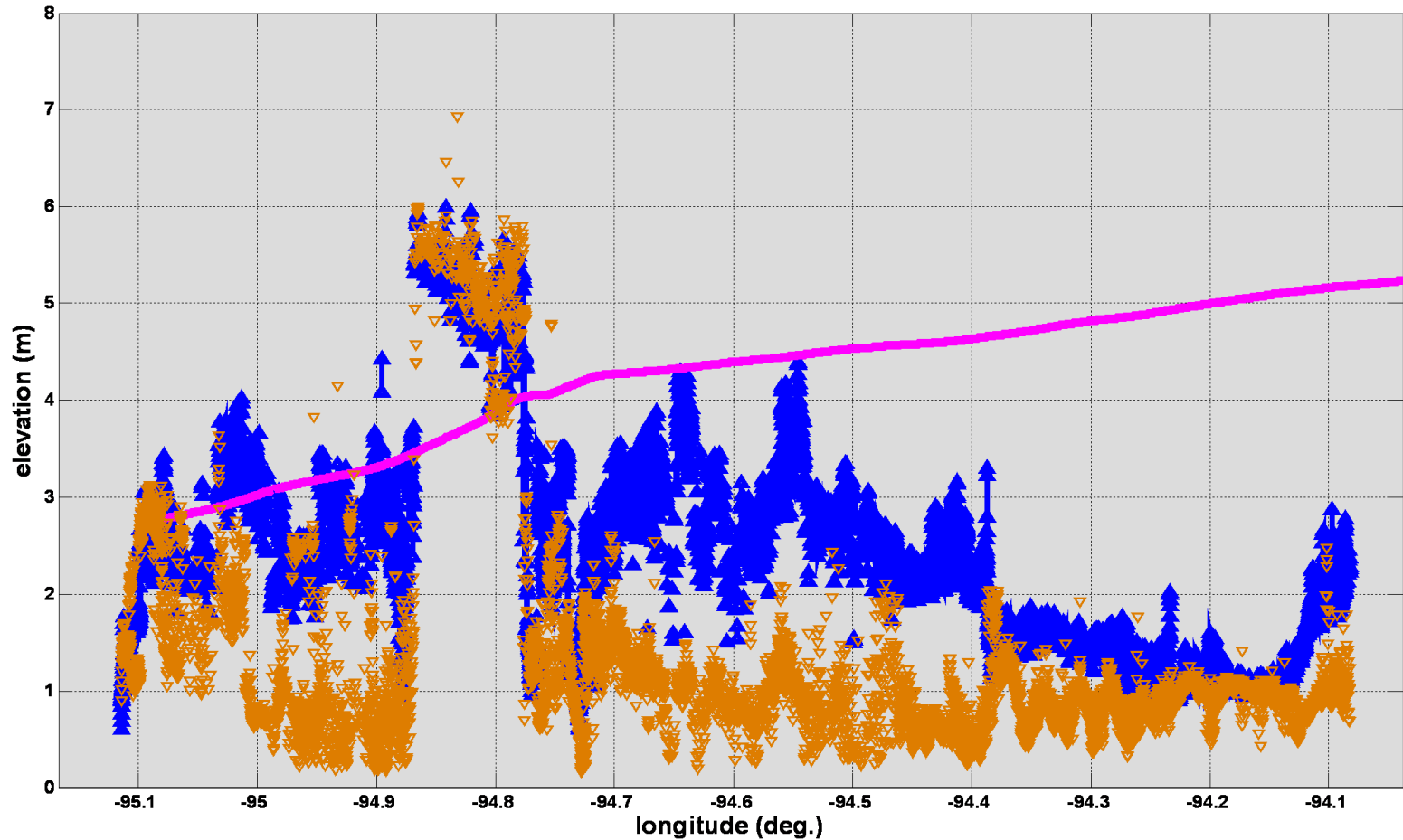
Hurricane response scenarios



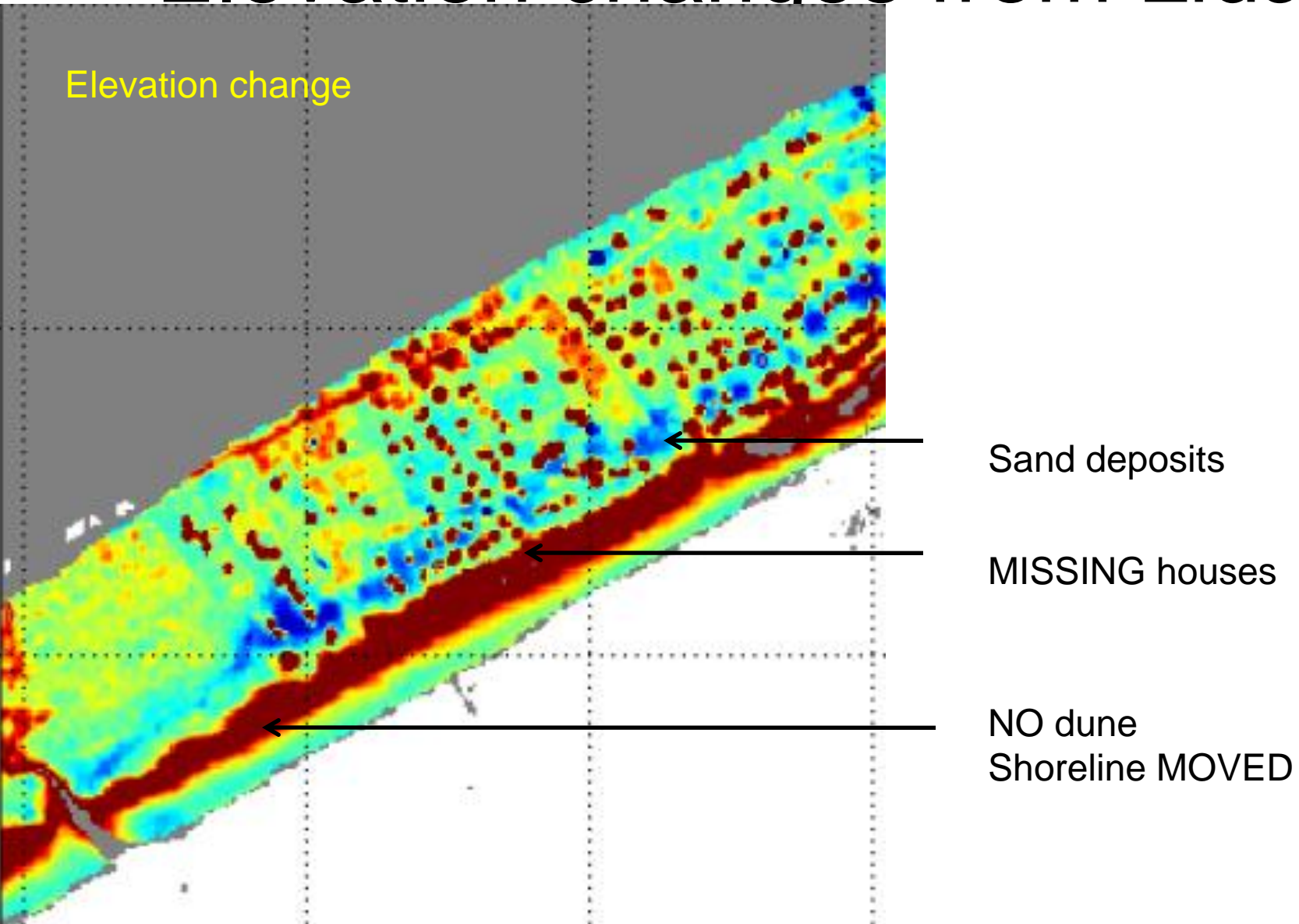
Comparison to Hurricane Ike: Predicted and observed water levels



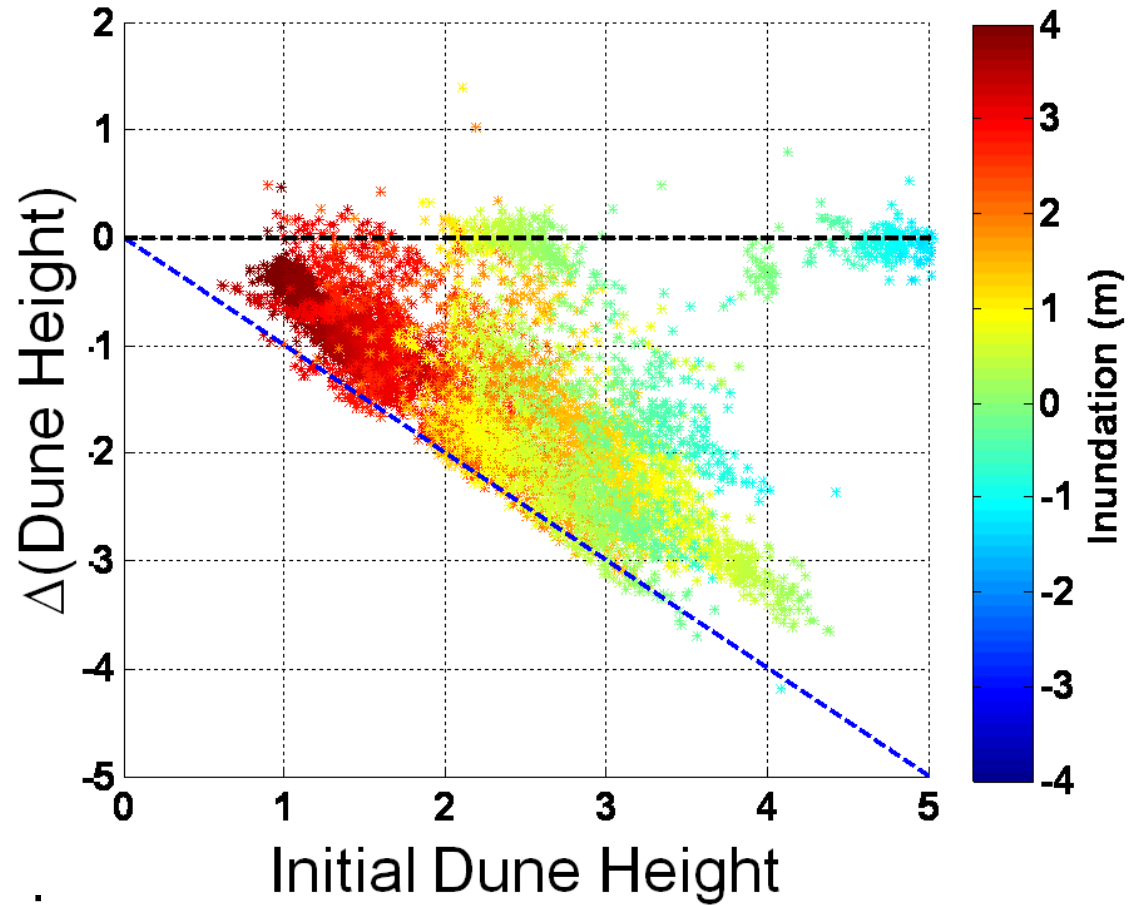
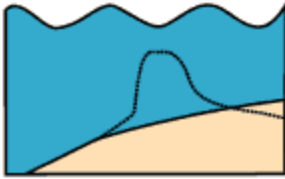
Observed dune elevation change



Elevation changes from Lidar



Prediction skill



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

Probabilistic forecasting of coastal erosion

- Integration of

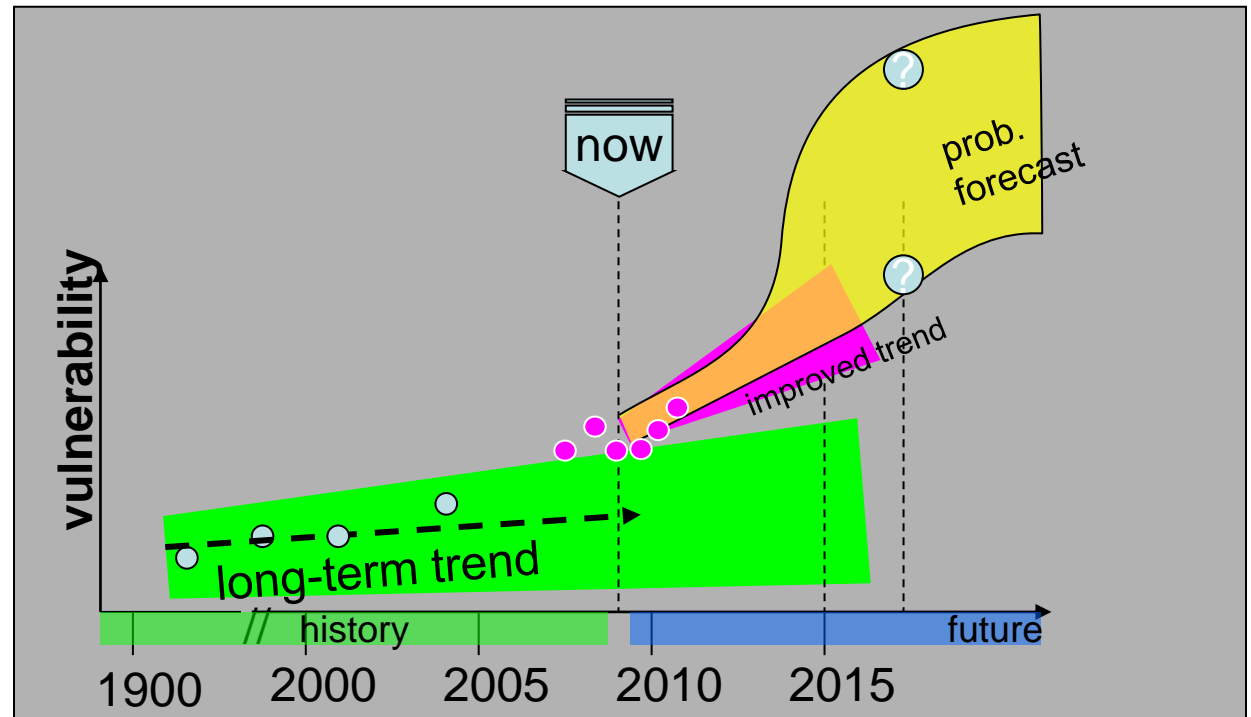
- Long-term observations

- 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

