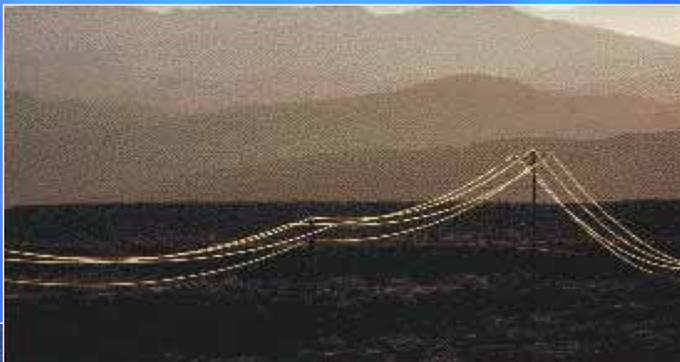


# Lessons Learned from Hurricanes Dennis, Katrina, Rita and Wilma

## Maintenance of Daily Functioning of U.S. Society in the Face of Threats to our Infrastructure



**During the 2005 season key information was available 36 hours to 96 hours before landfall. Whether information was used depended upon meeting the critical criteria for decision support information**

# Three Criteria for Actionable Information

- **Is the information credible?** Decision makers must have a frame of reference created through validation exercises, simulations, or the past.
- **Is the information salient?** The information must answer the critical questions and be presented to the decision maker at the moment needed. Overload may result in non-use of credible information.
- **Is the information legitimate?** Credible and salient information presented from unofficial sources may be discounted. The information needs to survive the decision maker's belief filter

# Actionable Predictions

Many models and predictions can provide the decision makers the support they require

Independently, will they be there in a credible, salient and legitimate form when decision makers need them?

Or do we need to weave the models together to provide decision makers with their Common Operating Picture?

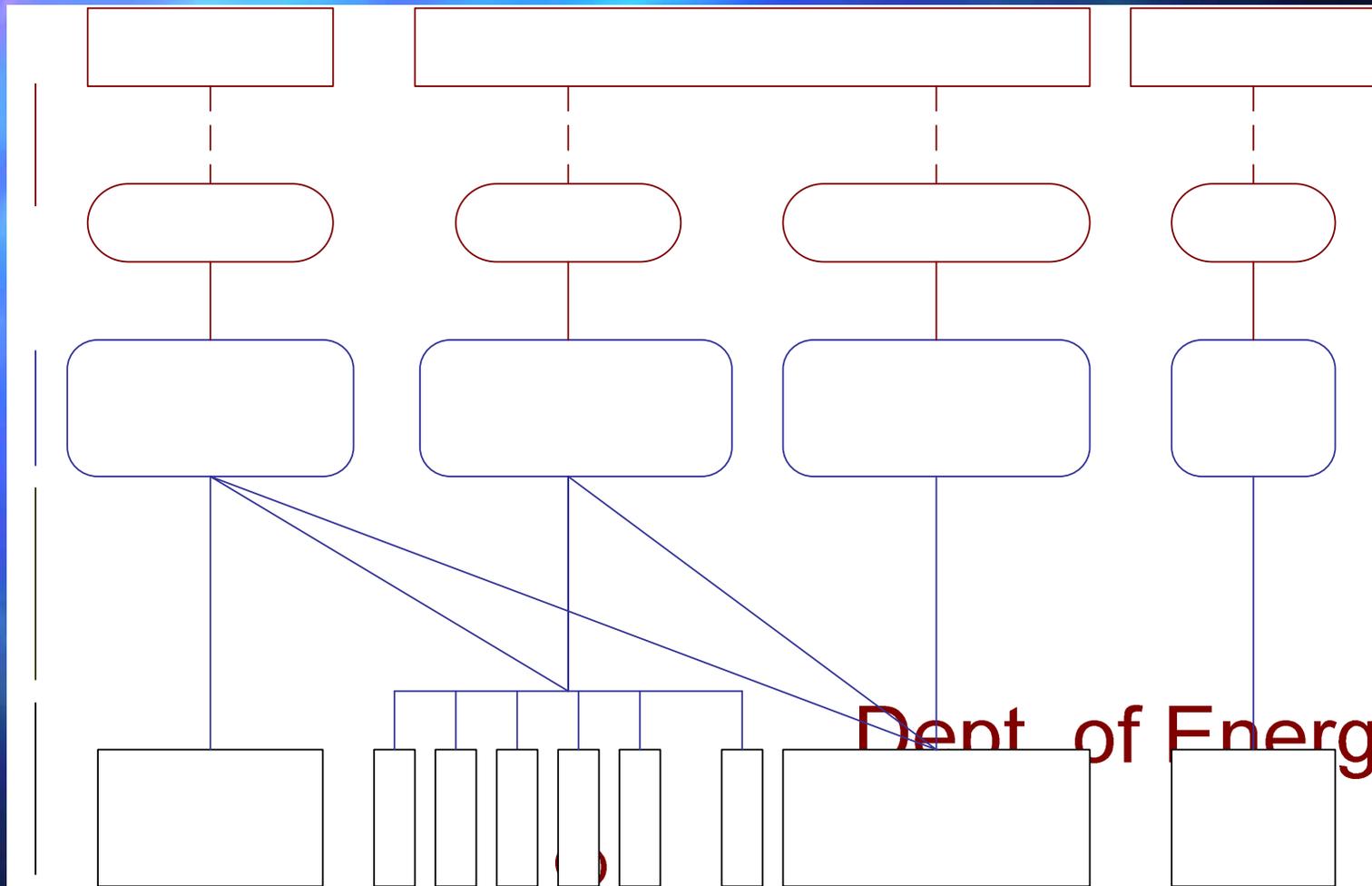
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# How a National Integrated Fast Response Modeling Capability might meet this need

- A series of model relationships can begin to be woven into a roadmap of inputs/outputs for:
  - extreme weather modeling,
  - the infrastructure impact and cascading modeling
  - the debris, waterways and flooding modeling
  - the transportation and response models

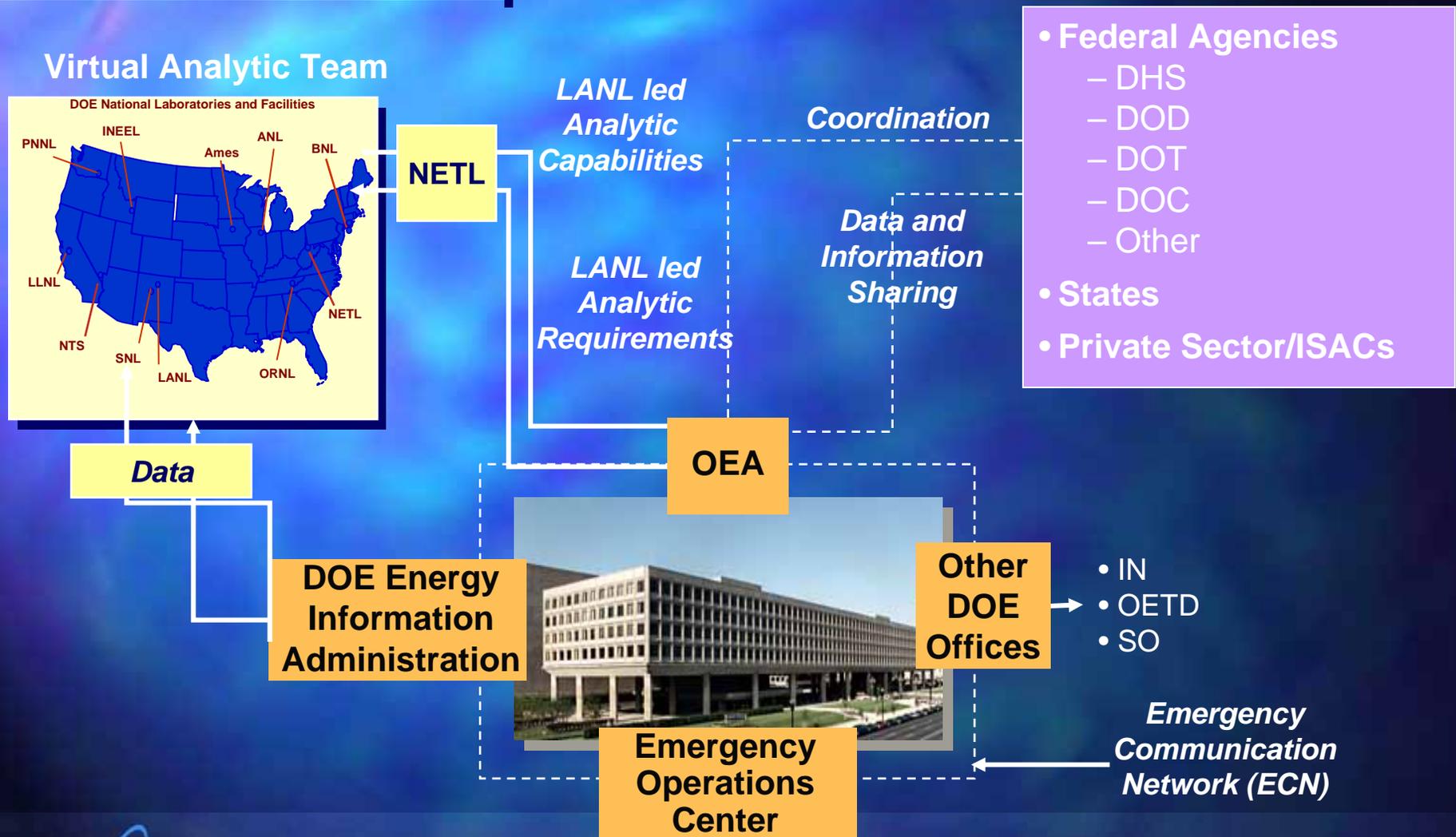
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# One attempt at an integrated system



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# Virtual Team Concept

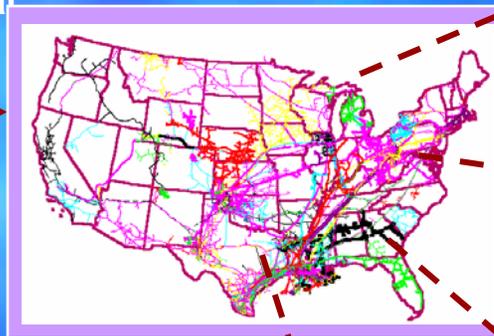


# Visualization Analysis Process

## 1 Hour Response (Informational Phase)

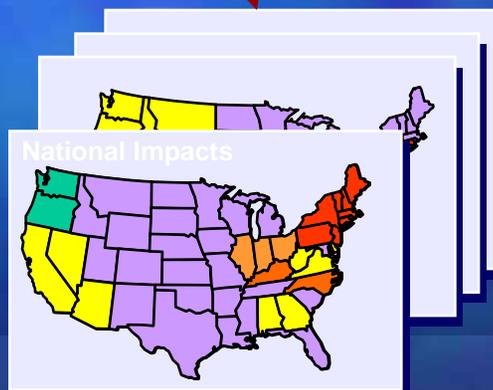
- Maps of energy infrastructure impacted
- Identification of potential assets and companies affected

## GIS (Baseline Analysis)

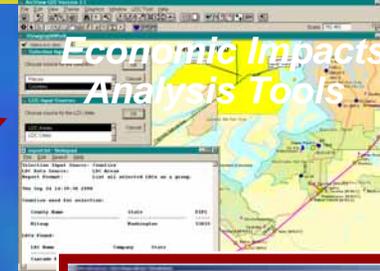


## 4 Hour Response (Assessment Phase)

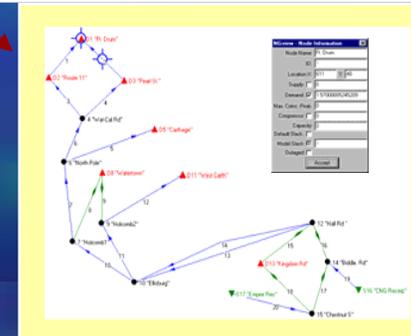
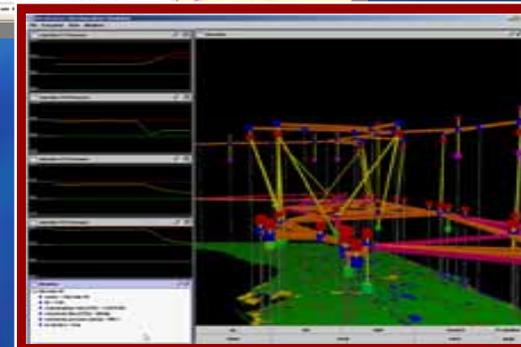
- Annotated maps
- Initial impact assessments
  - Area impacted
  - Population
- Consequences
  - Energy infrastructure
  - Restoration times



## 8+ Hour Response (Analysis Phase)

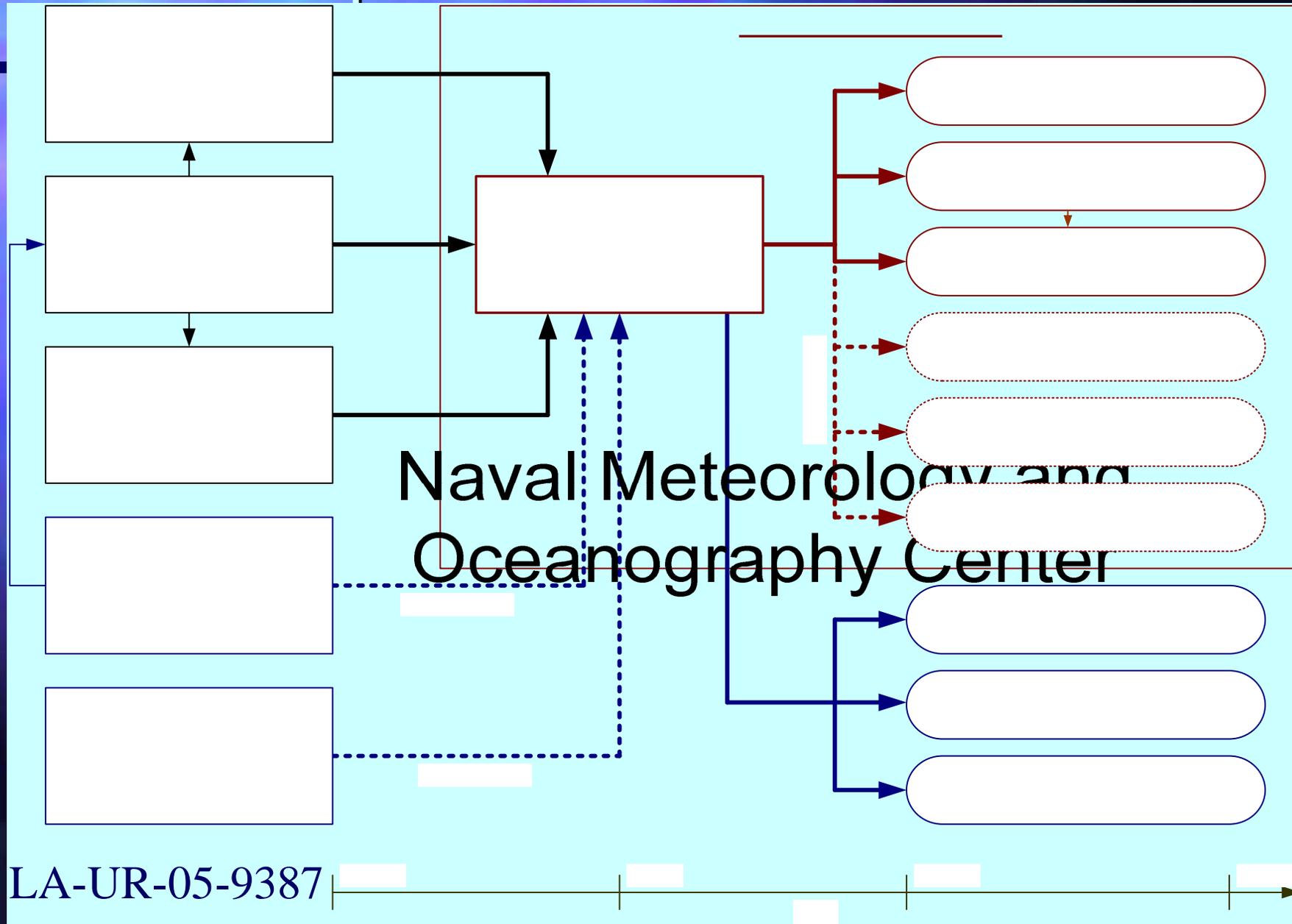


Interdependence  
Simulation Tools



Network  
Analysis  
Tools

# Quick-Response Process



Official NHC Products

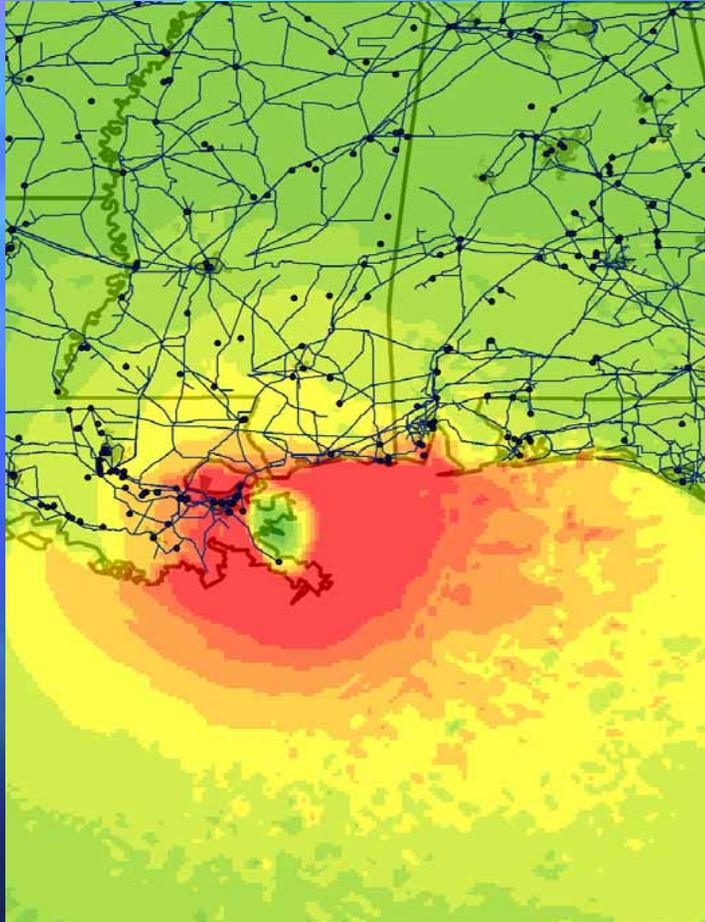
How might a roadmap answer the new decision maker questions?

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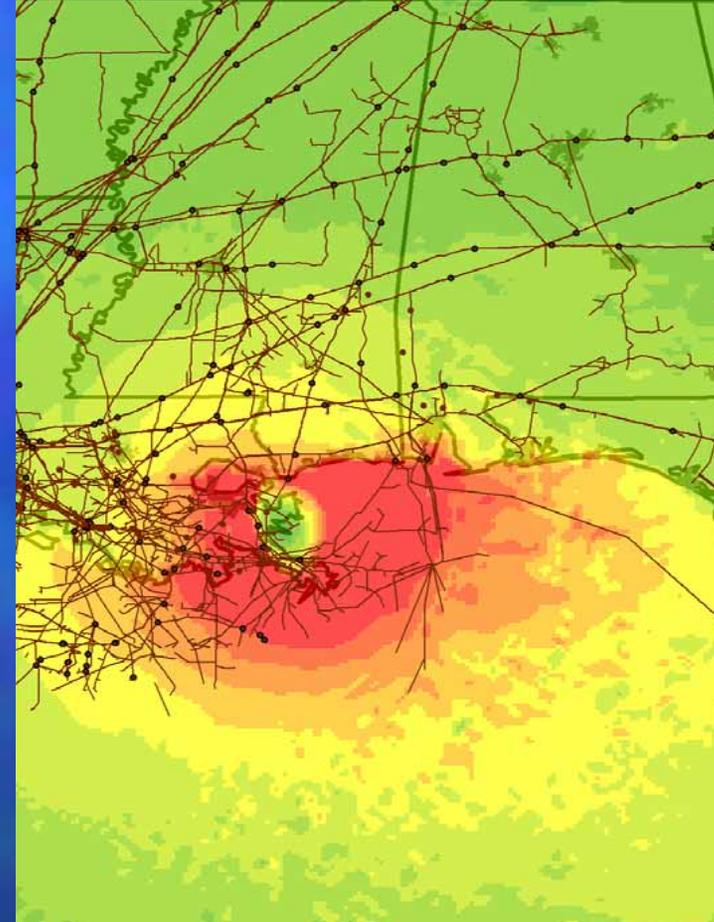
One possible roadmap that integrates the extreme weather models, infrastructure failure and restoration models, the USACE emergency response models, and economic models is described as an example.

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# Landfall and wind calculations

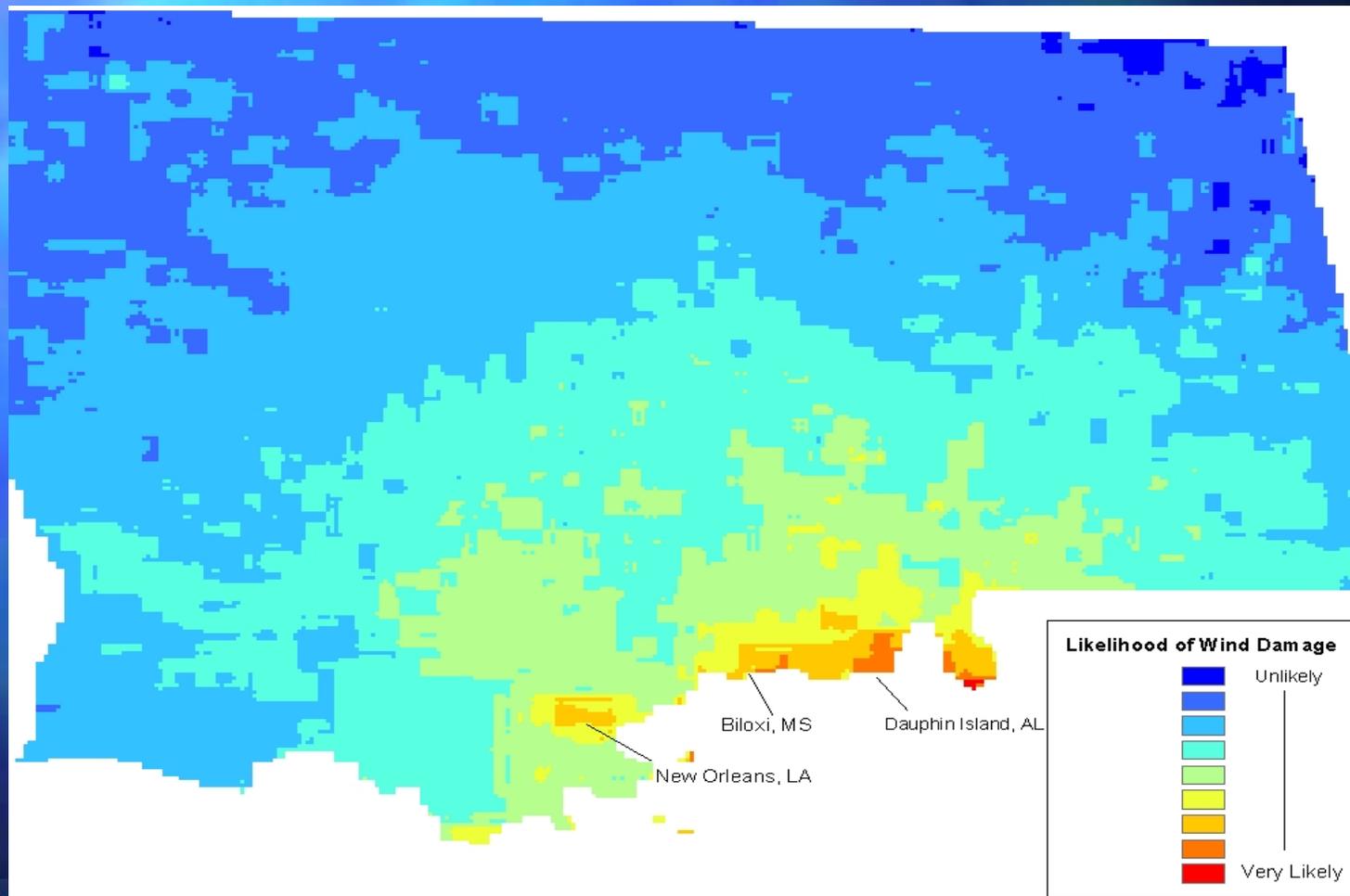


Electric Transmission Lines  
& Power Plants

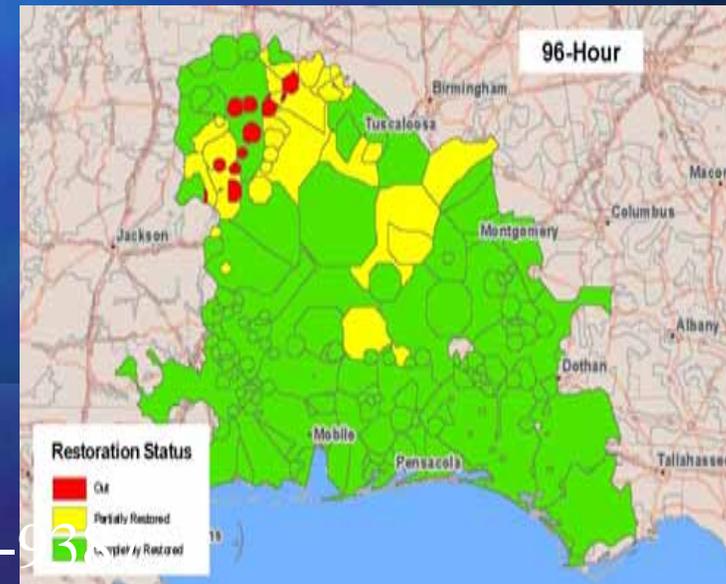
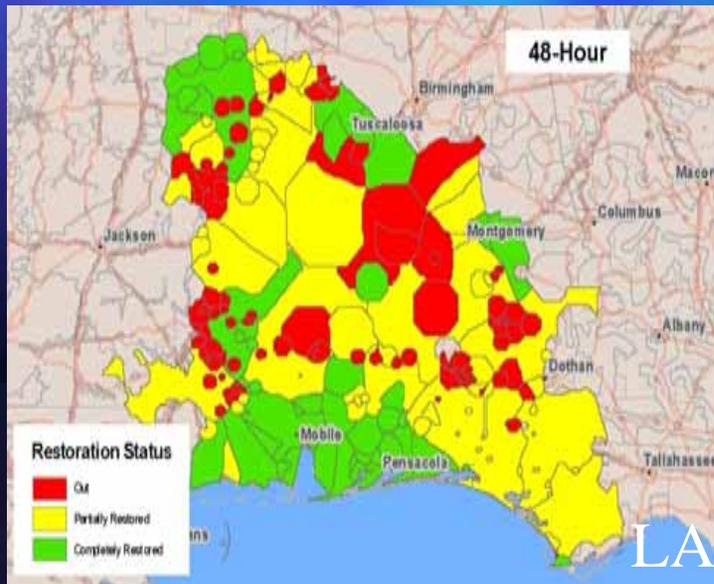
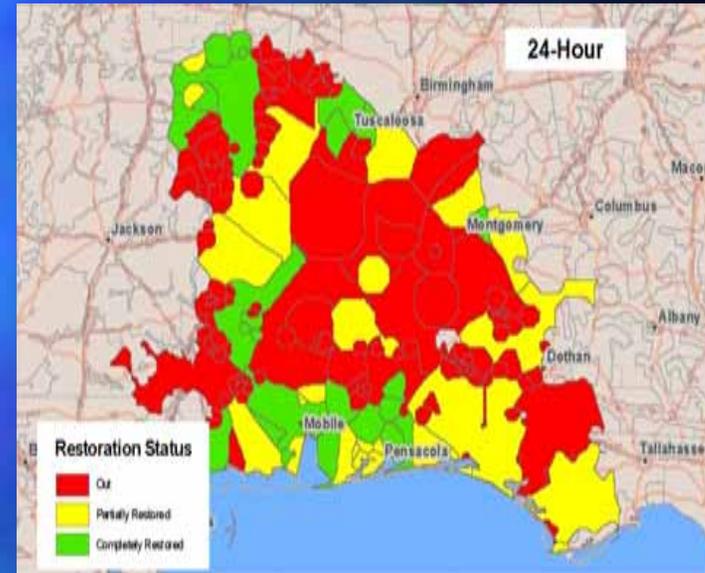
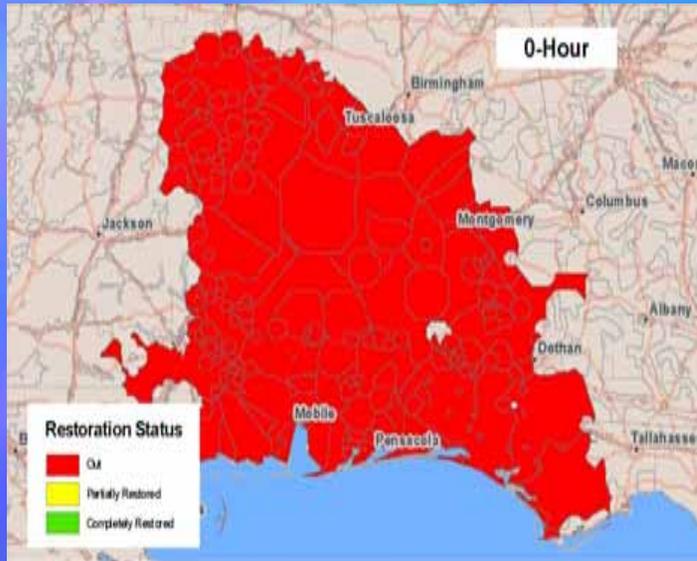


Natural Gas Pipelines, Processing  
Plants & Compressors

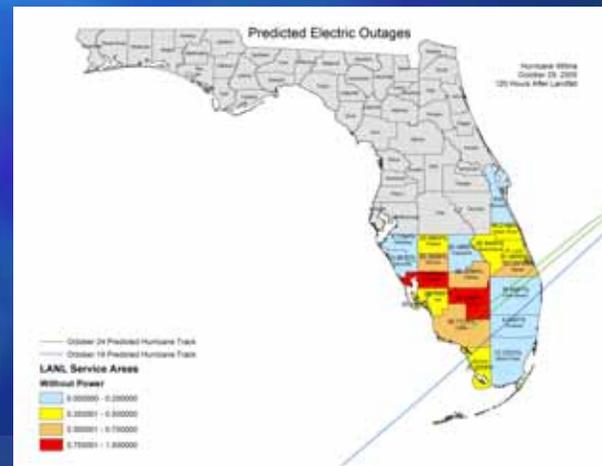
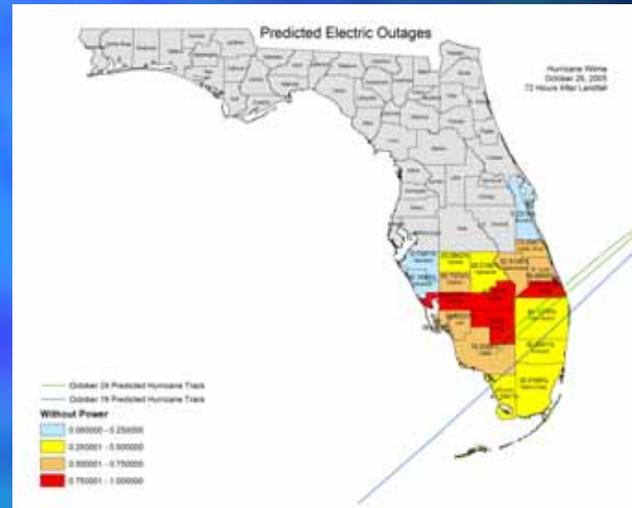
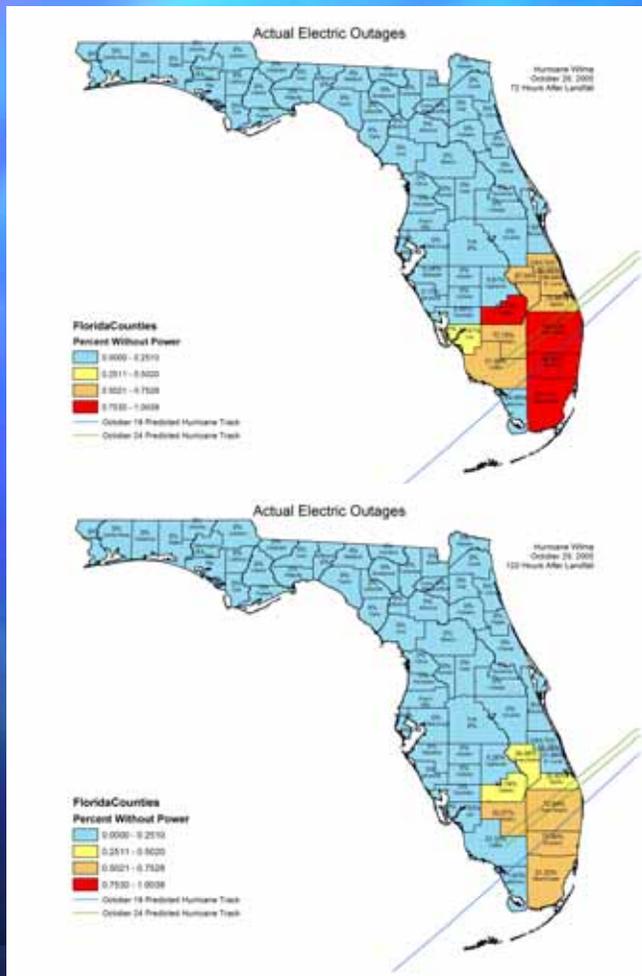
# Wind Damage Likelihood



# Hurricane Dennis Outage Restoration



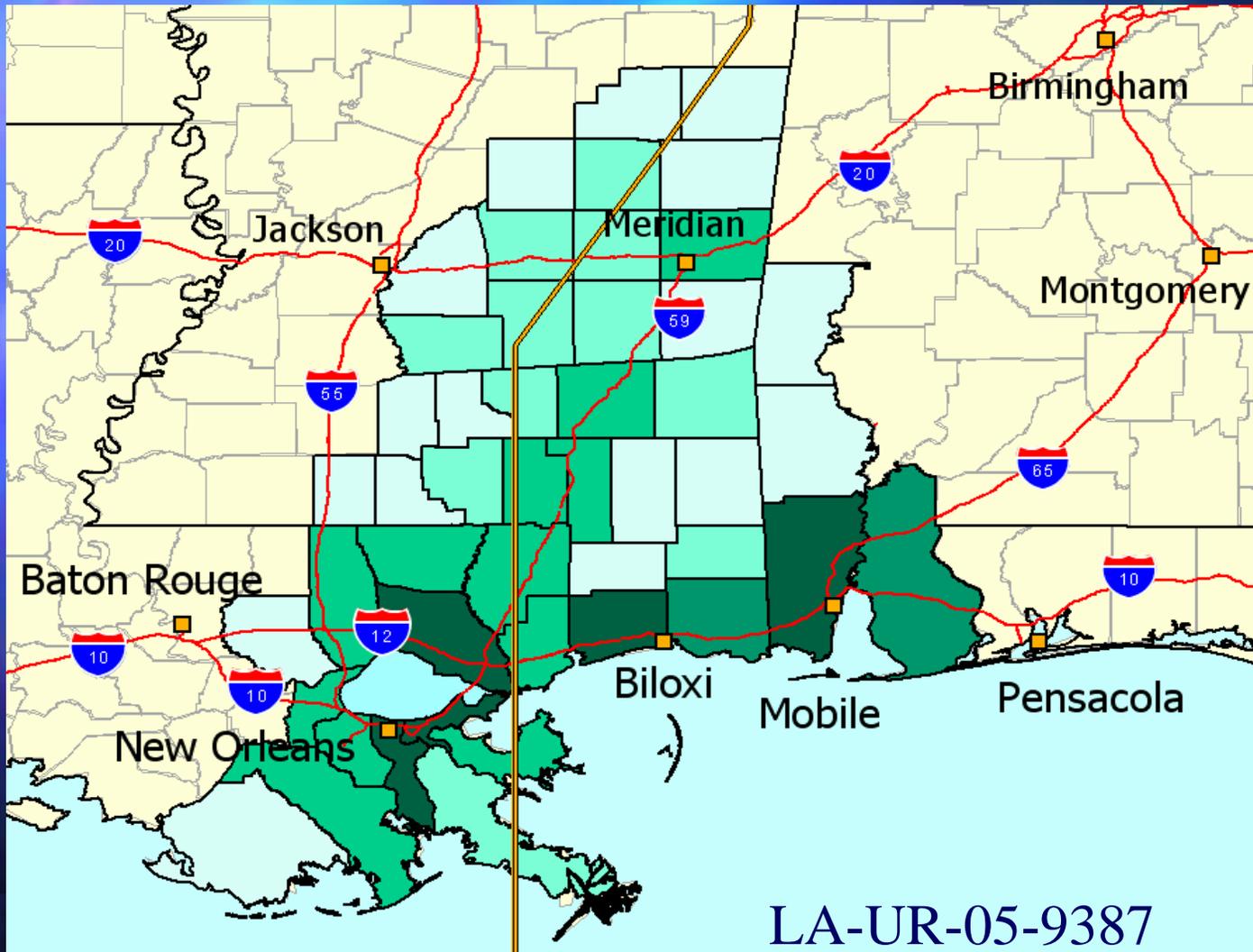
# Time History – Actual vs. Predicted



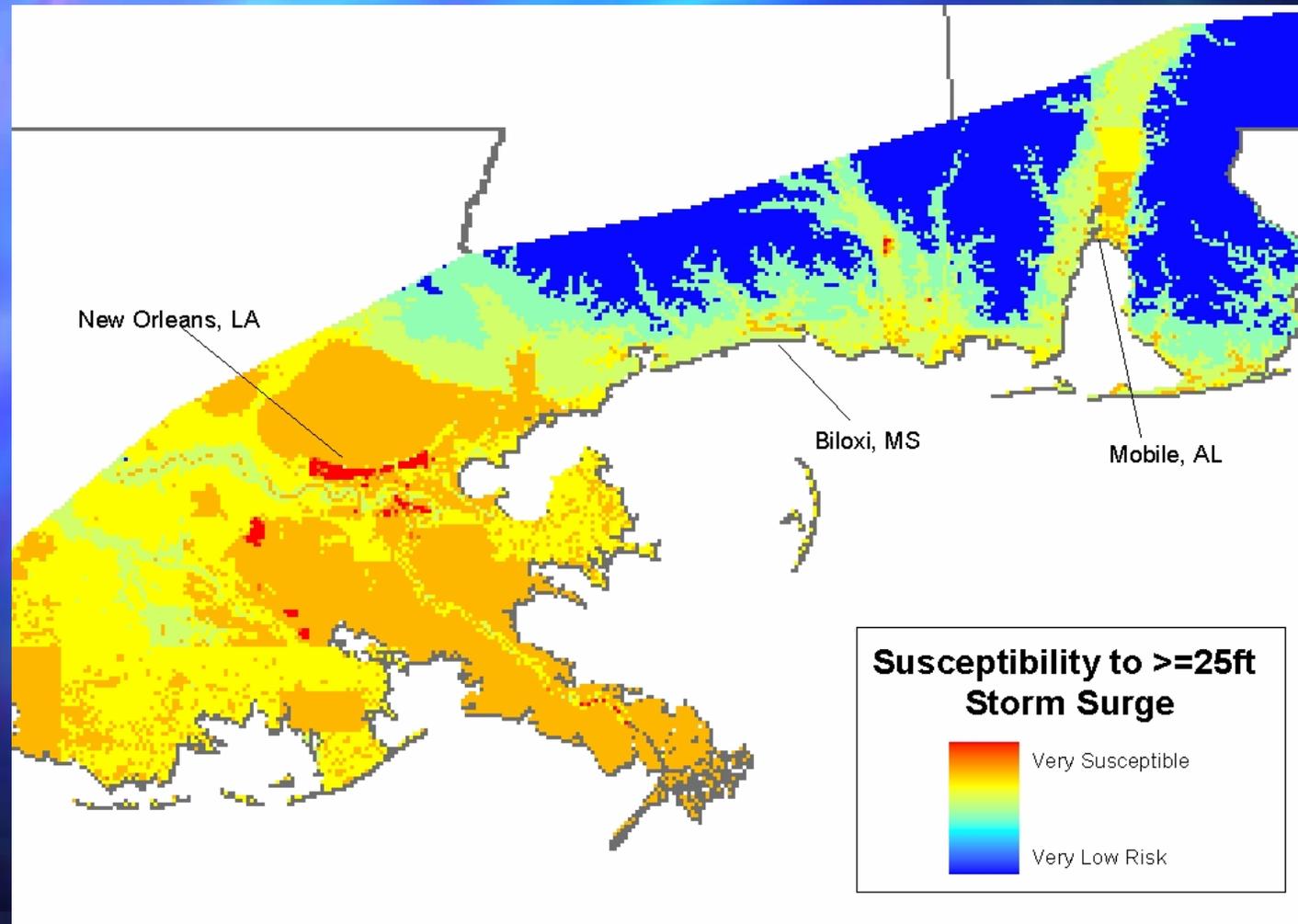


# Hurricane Katrina Ice Model

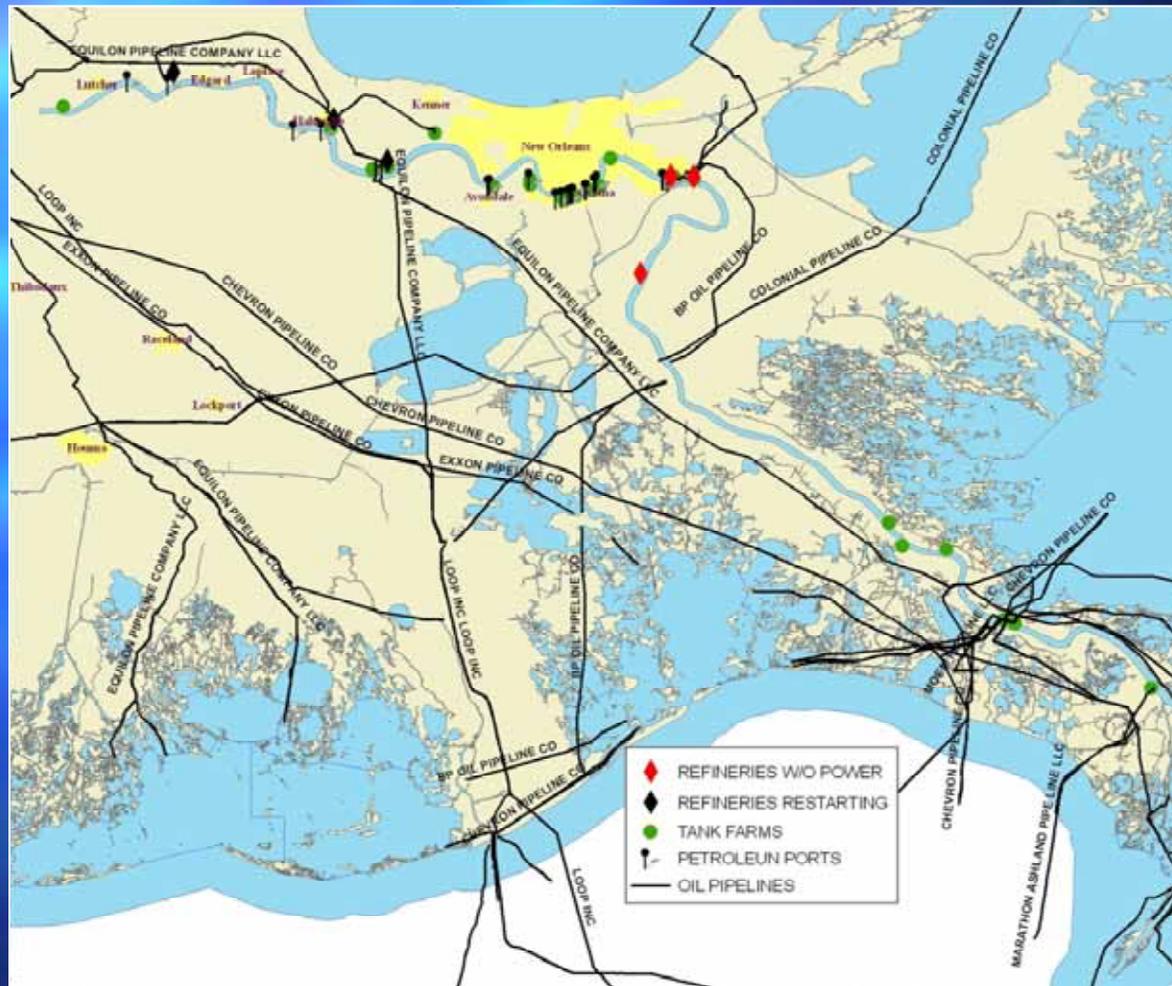
Landfall Plus About 24 Hours



# Storm Surge Potential



# Actionable Maps on the effect of flooding on Energy Commerce Assets



# Summary

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- The time is right to discuss a series of model relationships that we can now weave into a roadmap of inputs/outputs for:
  - extreme weather modeling,
  - the infrastructure impact and cascading modeling
  - the debris, waterways and flooding modeling
  - the transportation and response models

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