



The Online Hurricane Decision Simulator

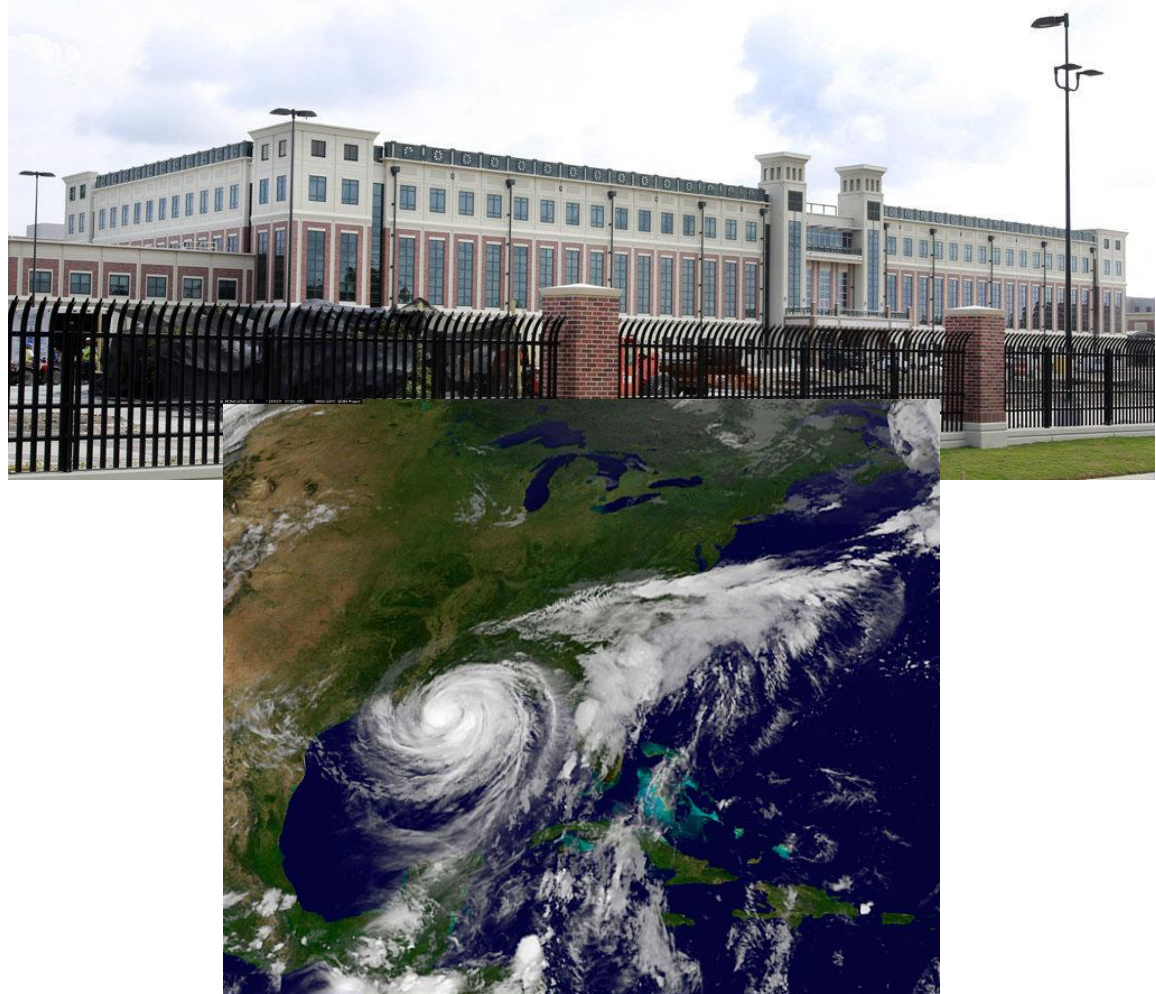
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Iowa State University

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Naval Postgraduate

U.S. Marine Forces Reserve (MFR)



Lt. Gen.
Rex McMillian

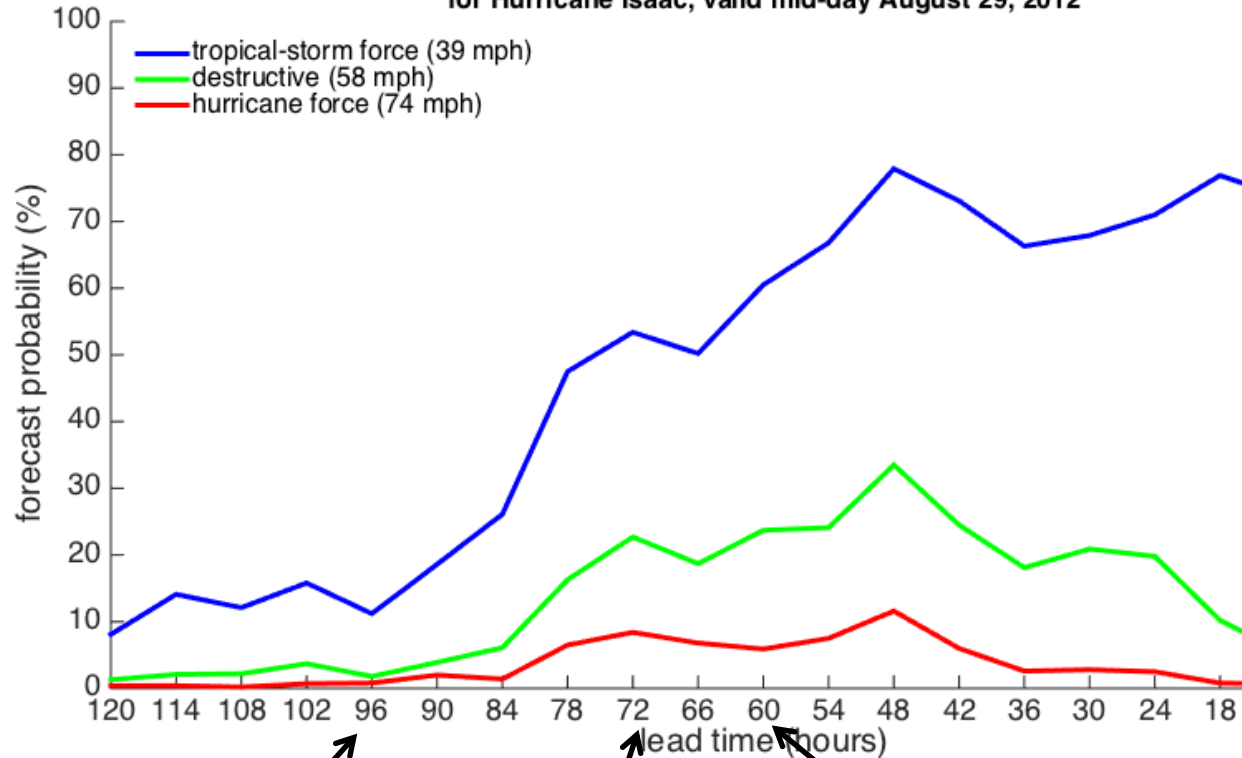


MFR Decision Support Matrix

Hours before arrival of 36-mph winds

1. 96 hours: Send advance emergency relocation staff (ERS) to alternate headquarters
2. 96 hours: Send liaison officers to local municipal emergency operations centers
3. 72 hours: Send rest of ERS to alternate headquarters
4. 72 hours: Activate remain behind element to stay if evacuation ordered
5. 60 hours: Evacuate or shelter in place
6. 48 hours: Transfer command and control to alternate headquarters

National Hurricane Center wind-speed probability forecasts
for Hurricane Isaac, valid mid-day August 29, 2012



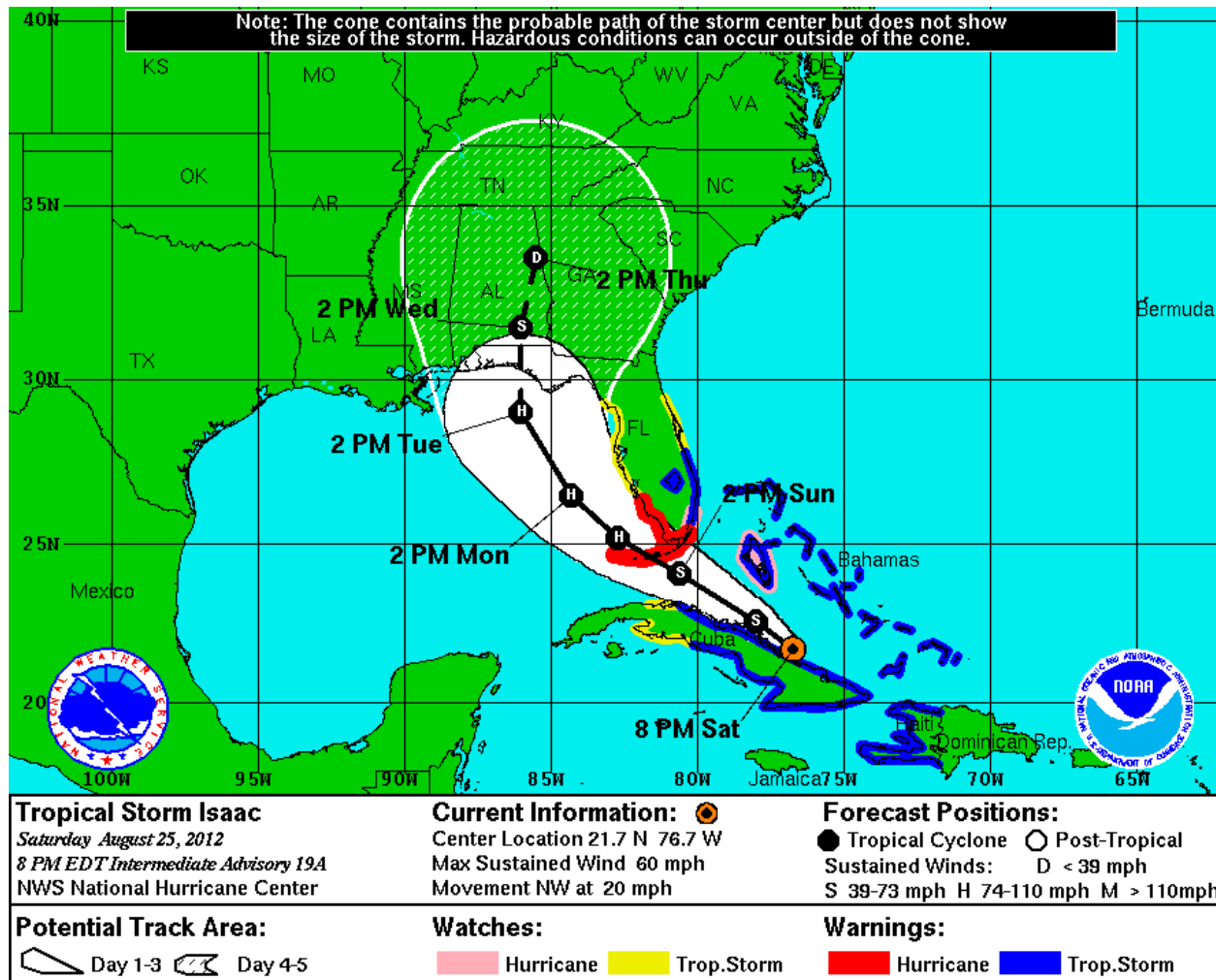
Deploy
advance team

Deploy
away team

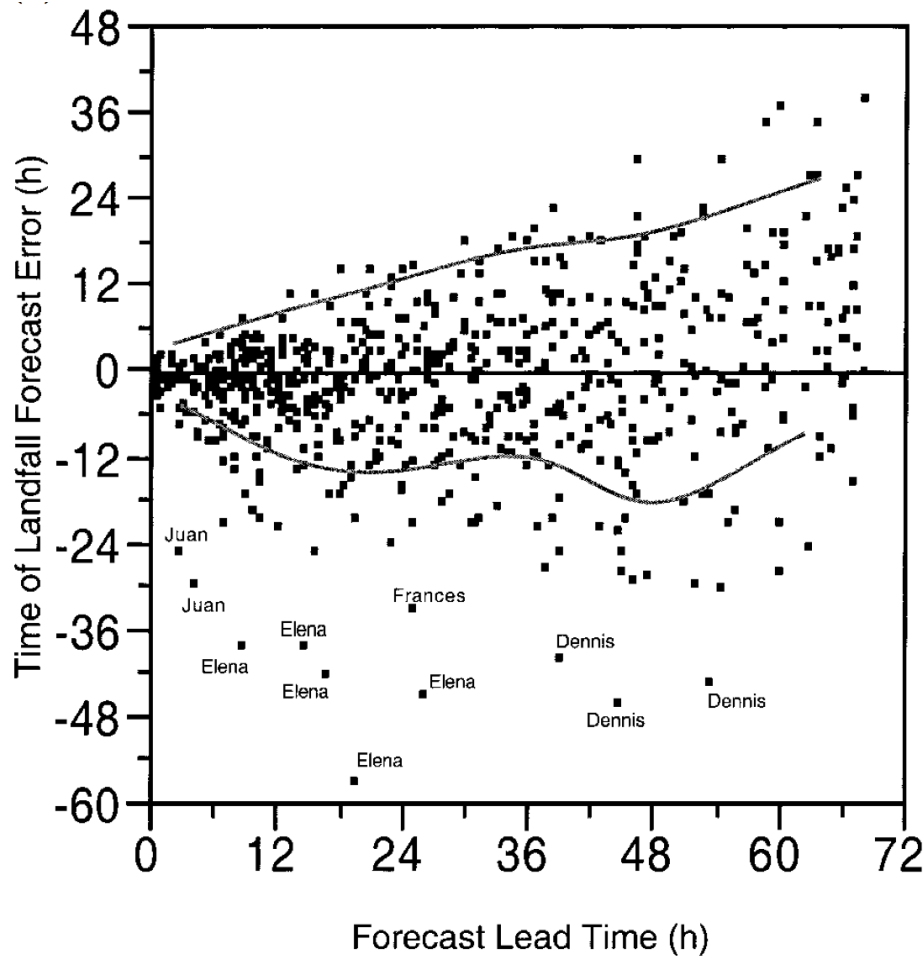
Order evacuation or
shelter-in-place

Marine Forces Reserve hurricane decision timeline

Isaac 72 hours before landfall

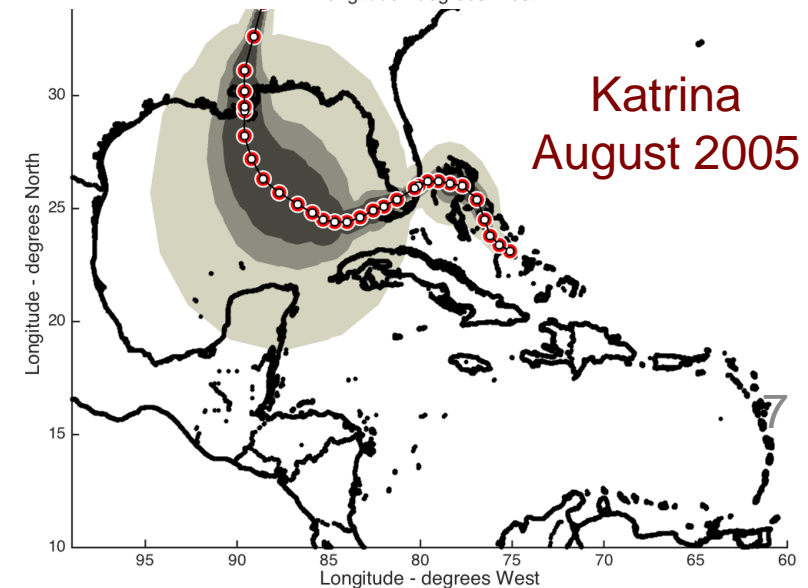
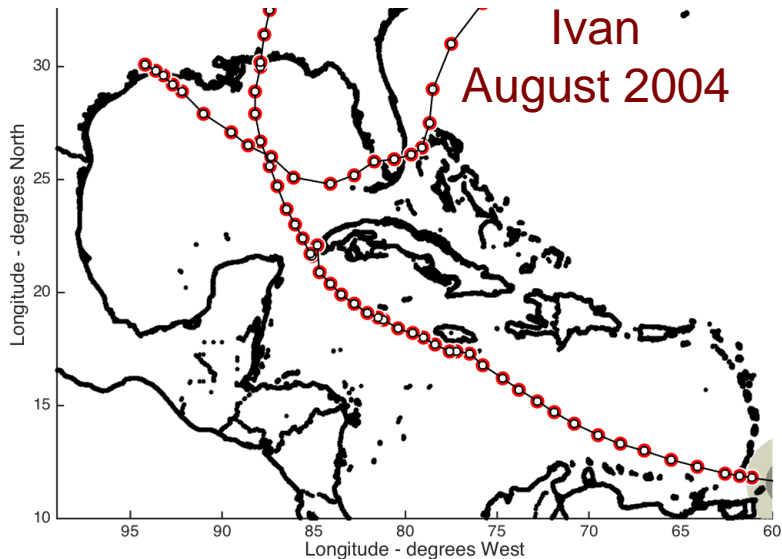
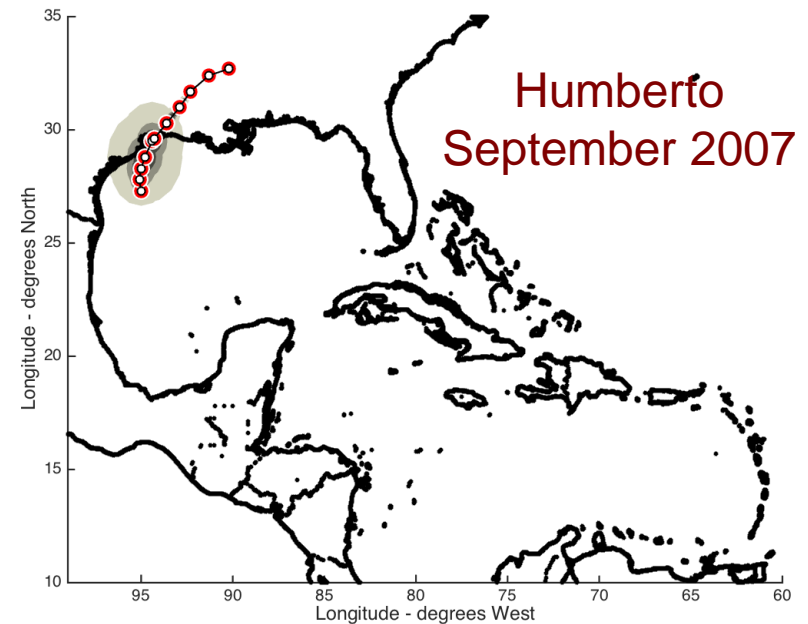
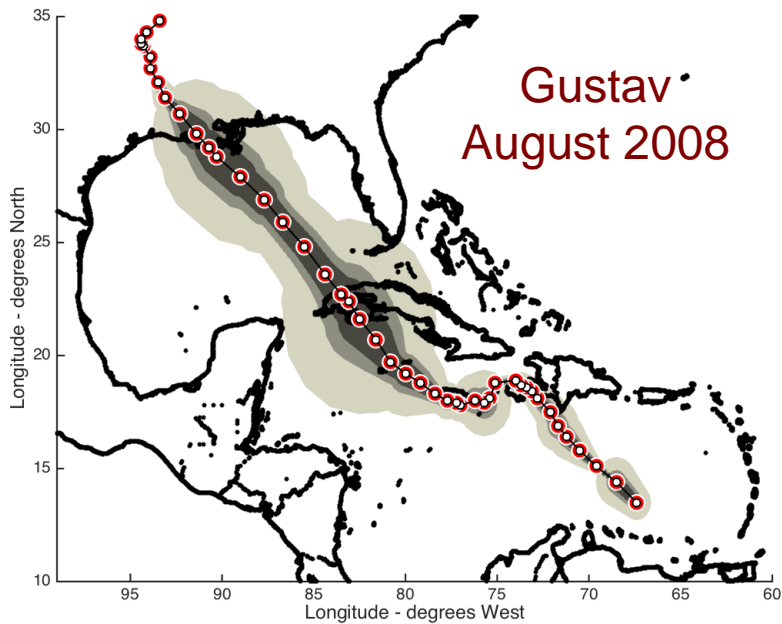


Error in forecast lead time



Powell, M.D. & Aberson, S.D.
(2001) Accuracy of United States
tropical cyclone landfall forecasts in
the Atlantic Basin. *Bulletin of the
American Meteorological Society*
82(12): 2749-2767.

Every storm is different



Challenges in hurricane preparation

Task environment

- Too much information
- Uncertainty
- Dynamic information sources (frequent updates)

Formation of expertise

- Highly variable context
- Dynamic information sources
- Few learning opportunities
- Ambiguous feedback

Training tool for hurricane preparations

Key characteristics

- Storm model (storm and forecasts)
- User decisions
- Actions of other entities
- Consequences of storm plus decisions
- Quickly experience many storms

Storm model

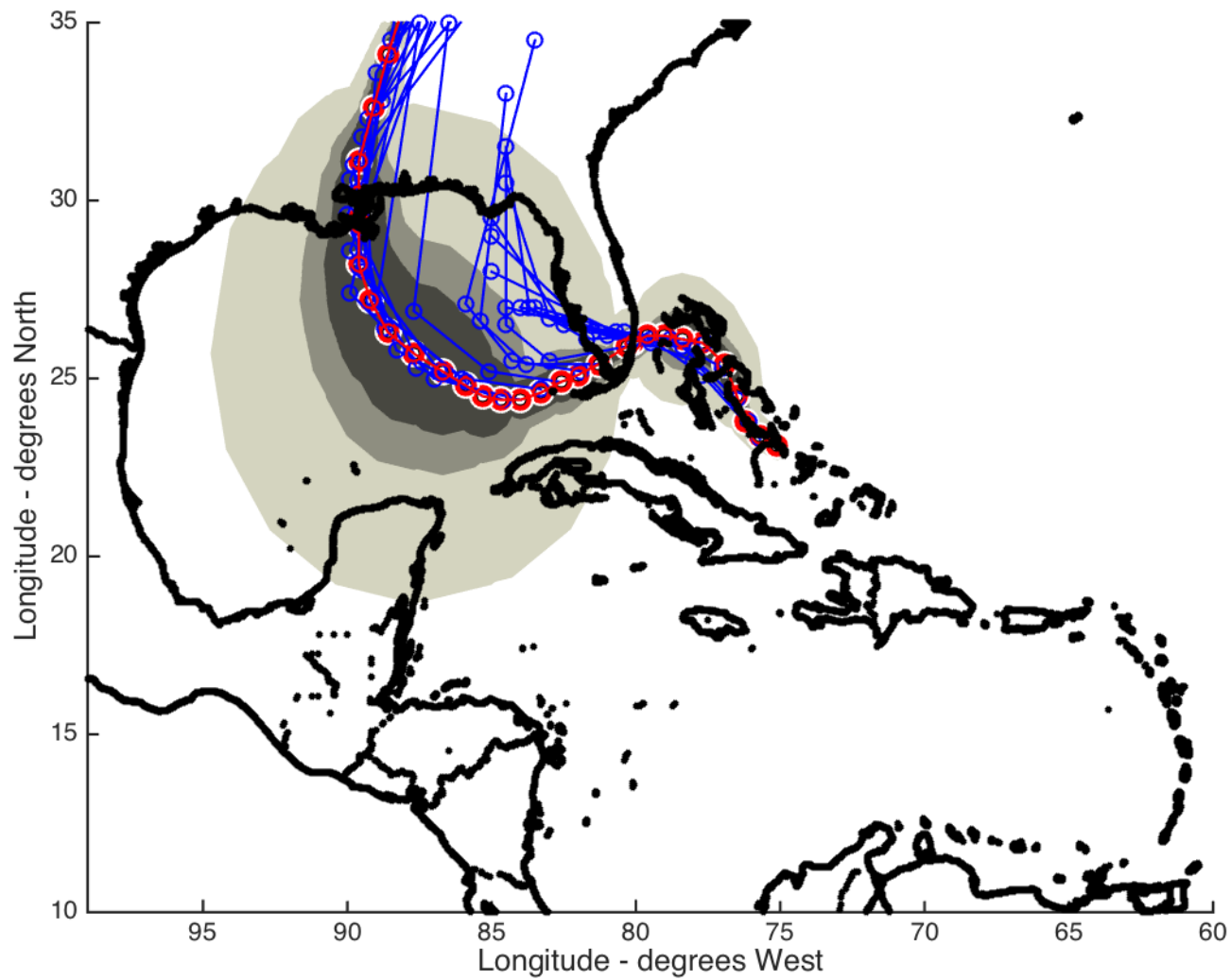
- Synthetic storms
 - Realism – storms should feel believable
 - Features should span realistic ranges
 - Unusual events should occur in synthetic storms
- Storm forecasts in 6-hour increments
 - Most likely path (forecast track)
 - Probability forecasts for next 120 hours
 - 38-mph winds (tropical winds)
 - 58-mph winds (destructive force winds)
 - 74-mph winds (hurricane-force winds)
- Realistic forecasts: forecast errors consistent with recent NHC forecasts

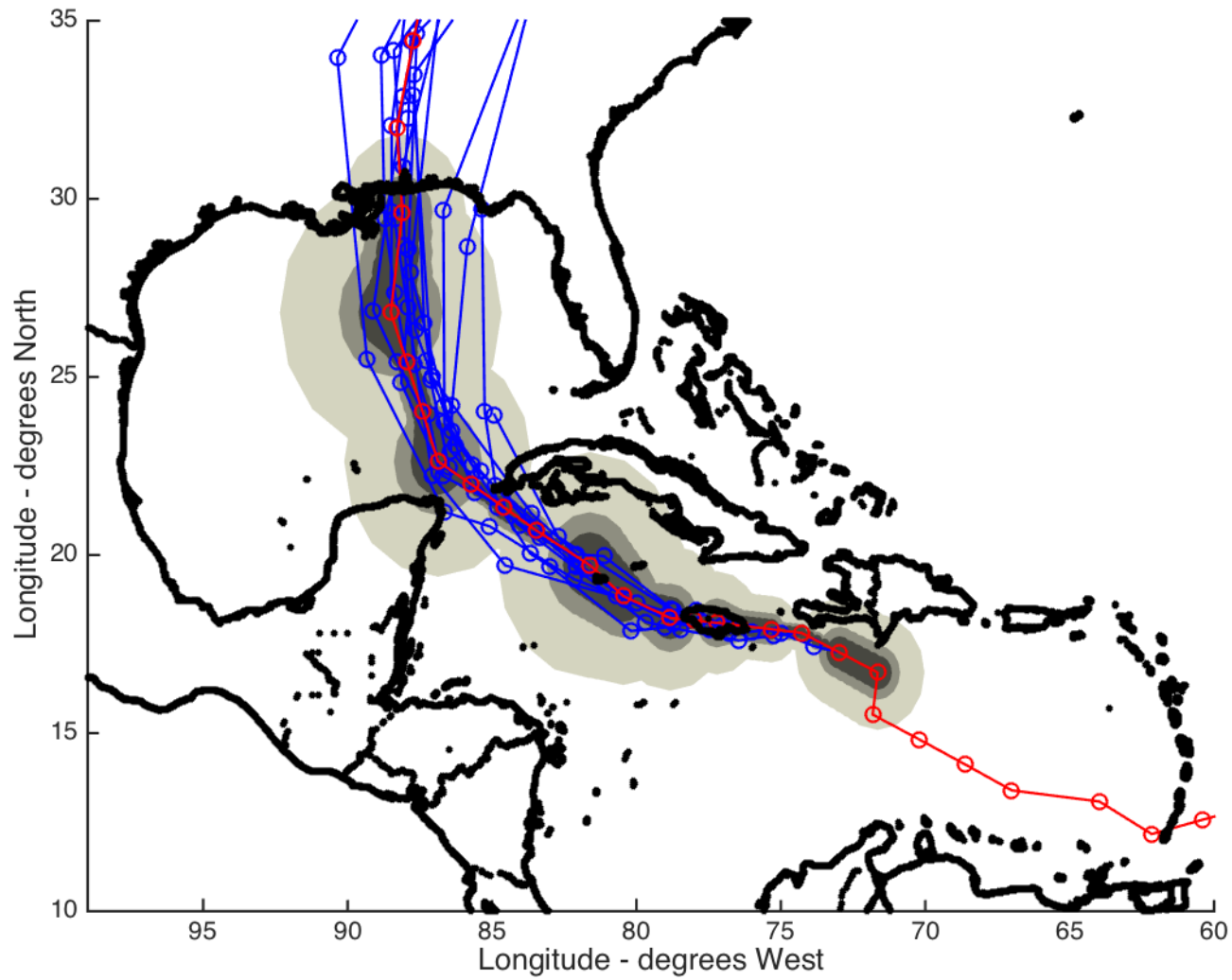
Storm model

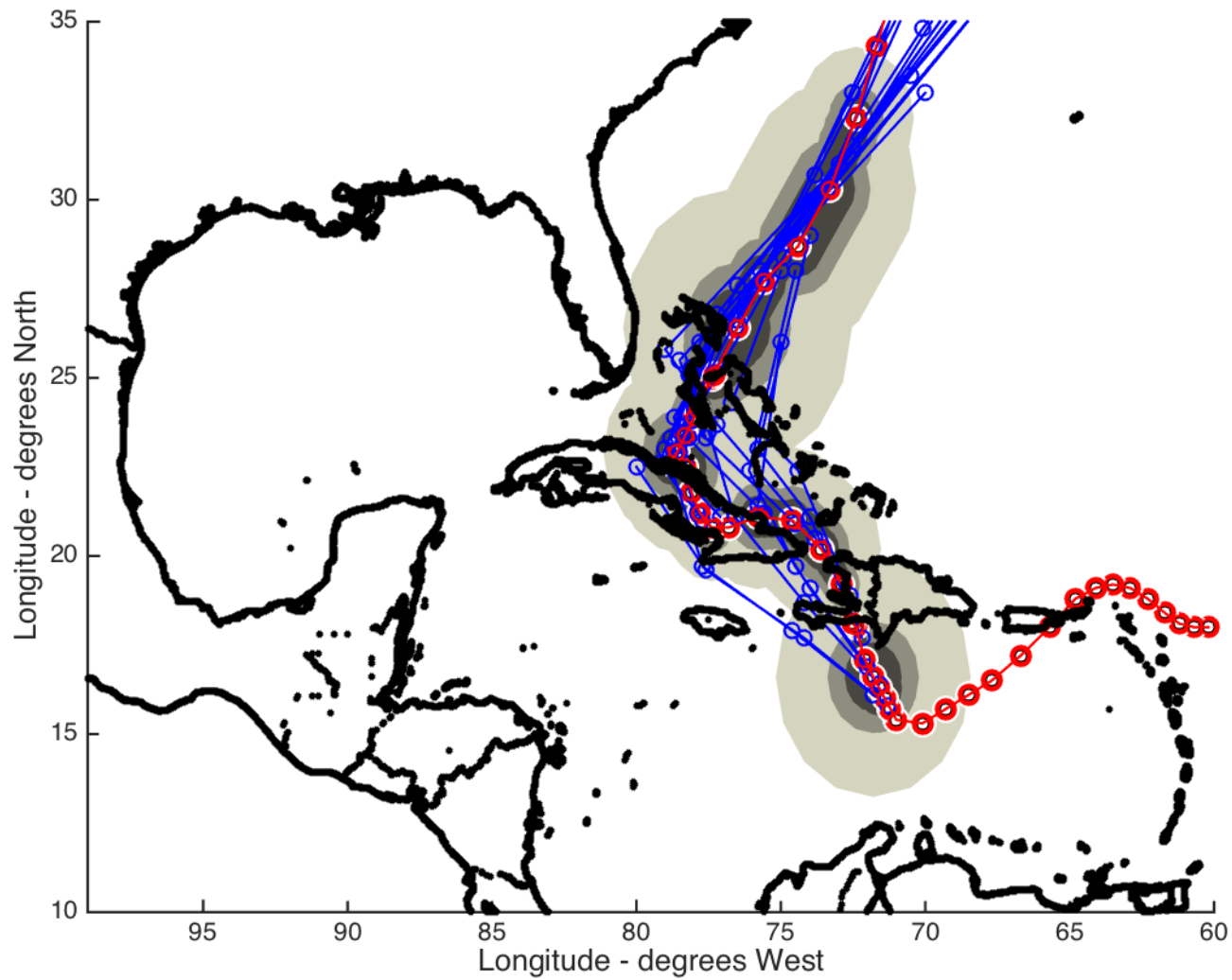
- Features
 - Tracks – center position over time
 - Intensities – maximum sustained winds
 - Size – radius of maximum winds
- Forecasts
 - Forecasts of track, intensity, and size
 - Wind-speed probability plumes
 - Storm surge at New Orleans

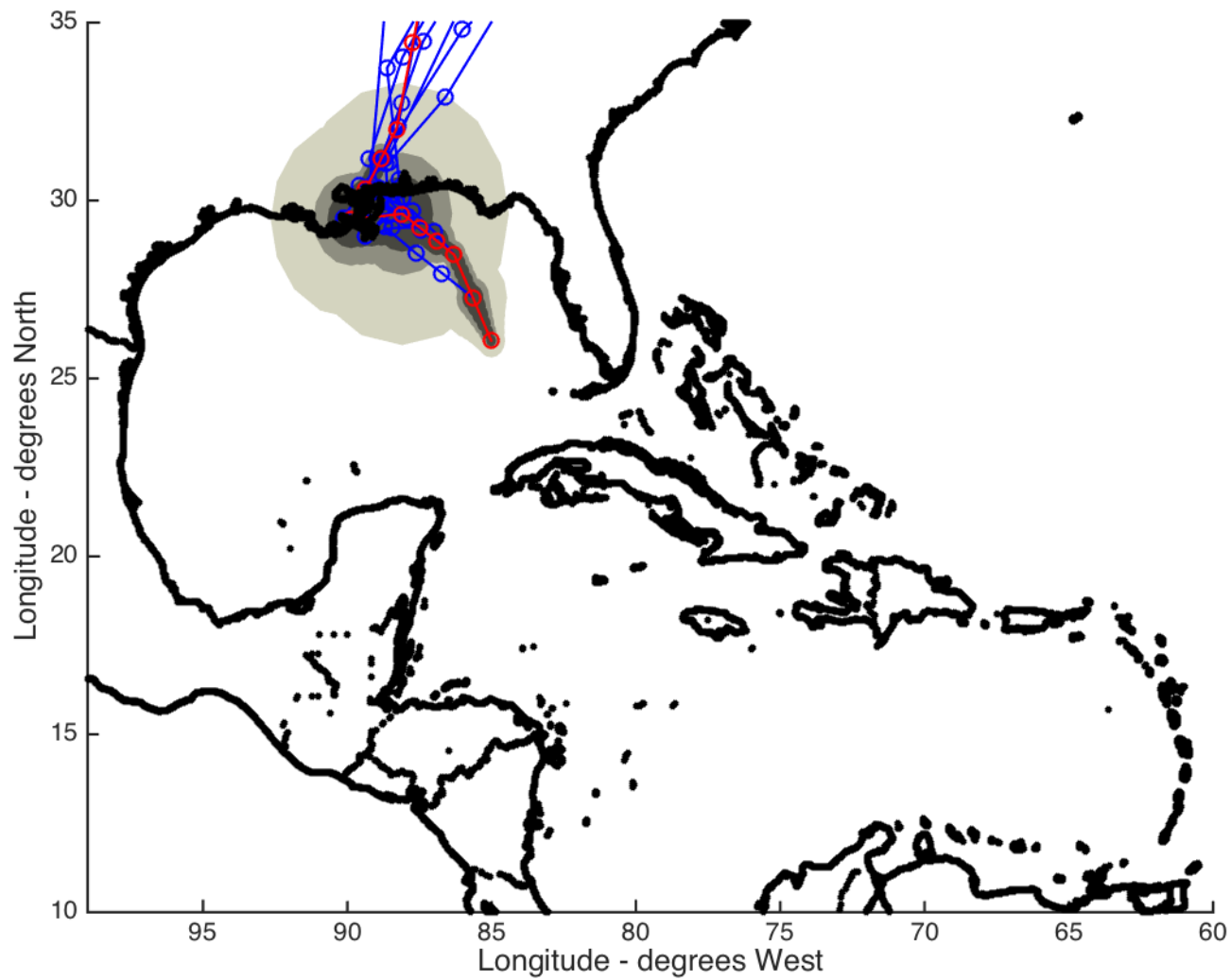
Storm model

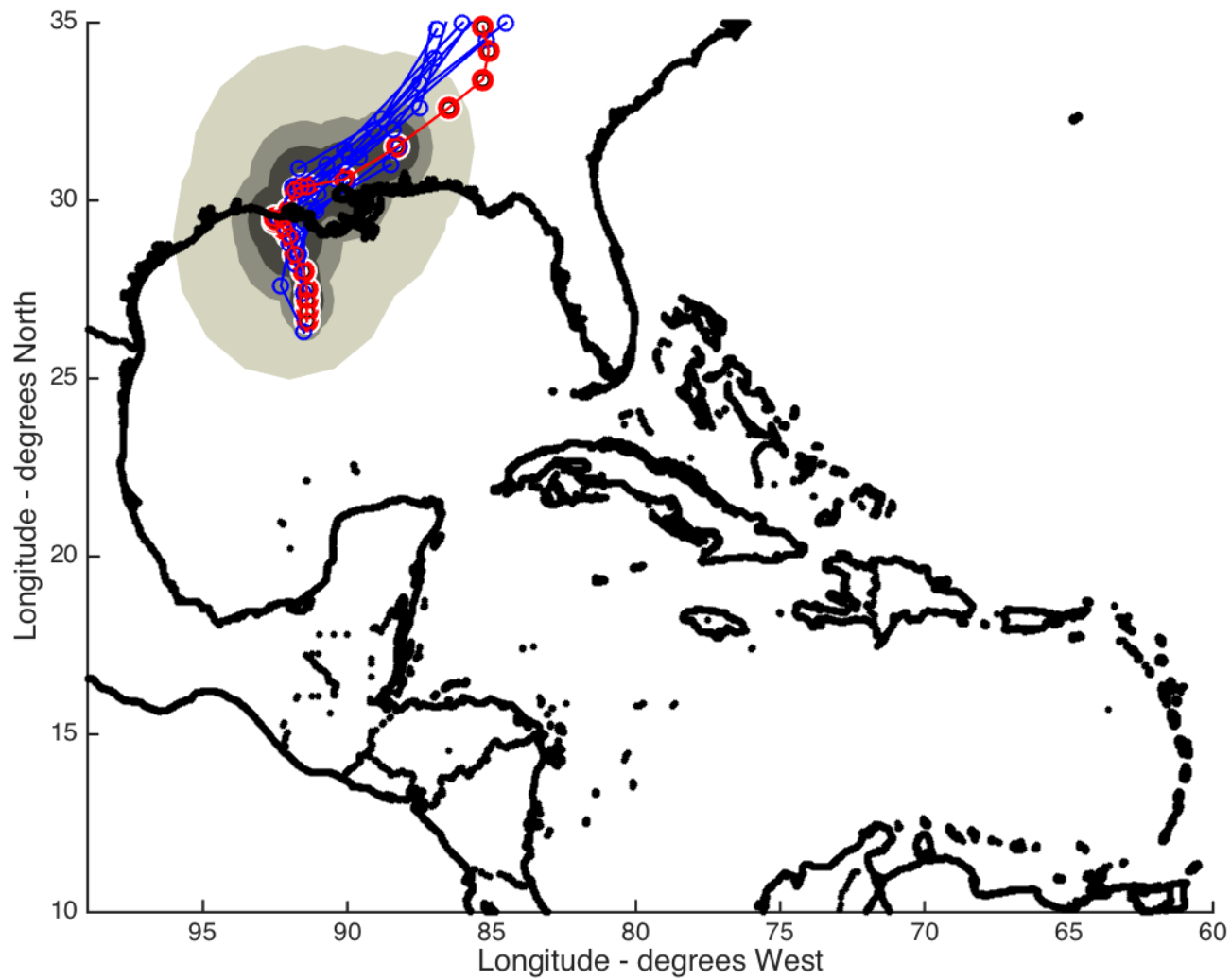
- Data set
 - National Hurricane Center best tracks 1980-2014
 - 542 storms → 14,882 observations
- Markov chain model for center of storm
 - 1500 states defined by k-means clustering algorithm
 - Transition probabilities = observed relative frequency
- Predictors for forecast
 - Current storm center position
 - Prior speed and bearing
 - Overland or on water











Hurricane Decision Simulator for Marine Commands in New Orleans

The screenshot displays the Hurricane Decision Simulator interface. On the left, a 'Record of Events' sidebar lists updates from 'BPT' at various time intervals (70 hrs, 75 hrs, 79 hrs, 83 hrs, 88 hrs) with associated probabilities (77%, 72%, 75%, 81%, 60%). The main area is titled 'HURRICANE DECISION SIMULATOR' and 'PROBABILITIES (of Winds Exceeding Threshold)'. It features a map of the Gulf of Mexico with concentric colored rings representing wind speed probabilities. A 'Decision' modal window is open, asking: 'Do you want to deploy the ADVON (19 personnel) for about \$25,000?'. Below the question, it states: 'The HURREVAC timeline recommends deploying the ADVON 96 hours prior to the arrival of tropical storm force winds if hurricane force winds are expected to follow.' The modal has 'YES' and 'NO, CONTINUE' buttons. At the bottom, a 'CURRENT UPDATE' section for '5 Jul 1200' shows a '120-hour probability of 39 mph winds affecting NOLA: 77%'. It also includes a table with storm details: Expected Landfall (70 hrs at 30.1°N x 85.5°W), Storm Center (26.7°N x 88.3°W), Radius of Max Winds (69 mi), and Max Sus. Winds (50 mph). A 'SHOW MAP' button is visible.

Simulated storms...with forecasts

Six key decisions

and follow-on actions

Expected Landfall	Storm Center	Radius of Max Winds	Max Sus. Winds
70 hrs (at 30.1°N x 85.5°W)	26.7°N x 88.3°W	69 mi	50 mph

Hurricane Decision Simulator for Marine Commands in New Orleans

eddy.nps.edu/hurricaneSim/simulation#

Most Visited Getting Started

HURRICANE DECISION SIMULATOR

About Help

Record of Events

Current 70 hrs 77%

6 hrs ago 75 hrs 72%
BPT provide staff updates to Commander


12 hrs ago 79 hrs 75%
BPT provide staff updates to Commander

18 hrs ago 83 hrs 81%
BPT provide staff updates

24 hrs ago 88 hrs 60%
[Initial Storm Update](#)
RBE, ERS, and CAT rosters are validated

PROBABILITIES (of Winds Exceeding Threshold)

39 mph 58 mph 74 mph Cone 5 Jul 1200



Decision

Do you want to deploy the ADVON (19 personnel) for about \$25,000?

The HURREVAC timeline recommends deploying the ADVON 96 hours prior to the arrival of tropical storm force winds if hurricane force winds are expected to follow.

YES **NO, CONTINUE**

CURRENT UPDATE 5 Jul 1200 No Actions Details

120-hour probability of 39 mph winds affecting NOLA: **77%**

Expected Landfall	Storm Center	Radius of Max Winds	Max Sus. Winds
70 hrs (at 30.1°N x 85.5°W)	26.7°N x 88.3°W	69 mi	50 mph

SHOW MAP

CONTINUE

19

Results so far

- Fall 2015, used in crisis action team group exercise
- Shared with continuity of operations planning team
- In review by Deputy Director
- In use for individual training by crisis action team and emergency relocation team (almost 200 people)
- Used in developing annual (team) specialized hurricane exercises
- Interest from additional sites/agencies
 - II Marine Expeditionary Force (North Carolina)
 - City of New Orleans
 - Federal Executive Board in New Orleans

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