Scenario-based Language for Hurricane Decision Support

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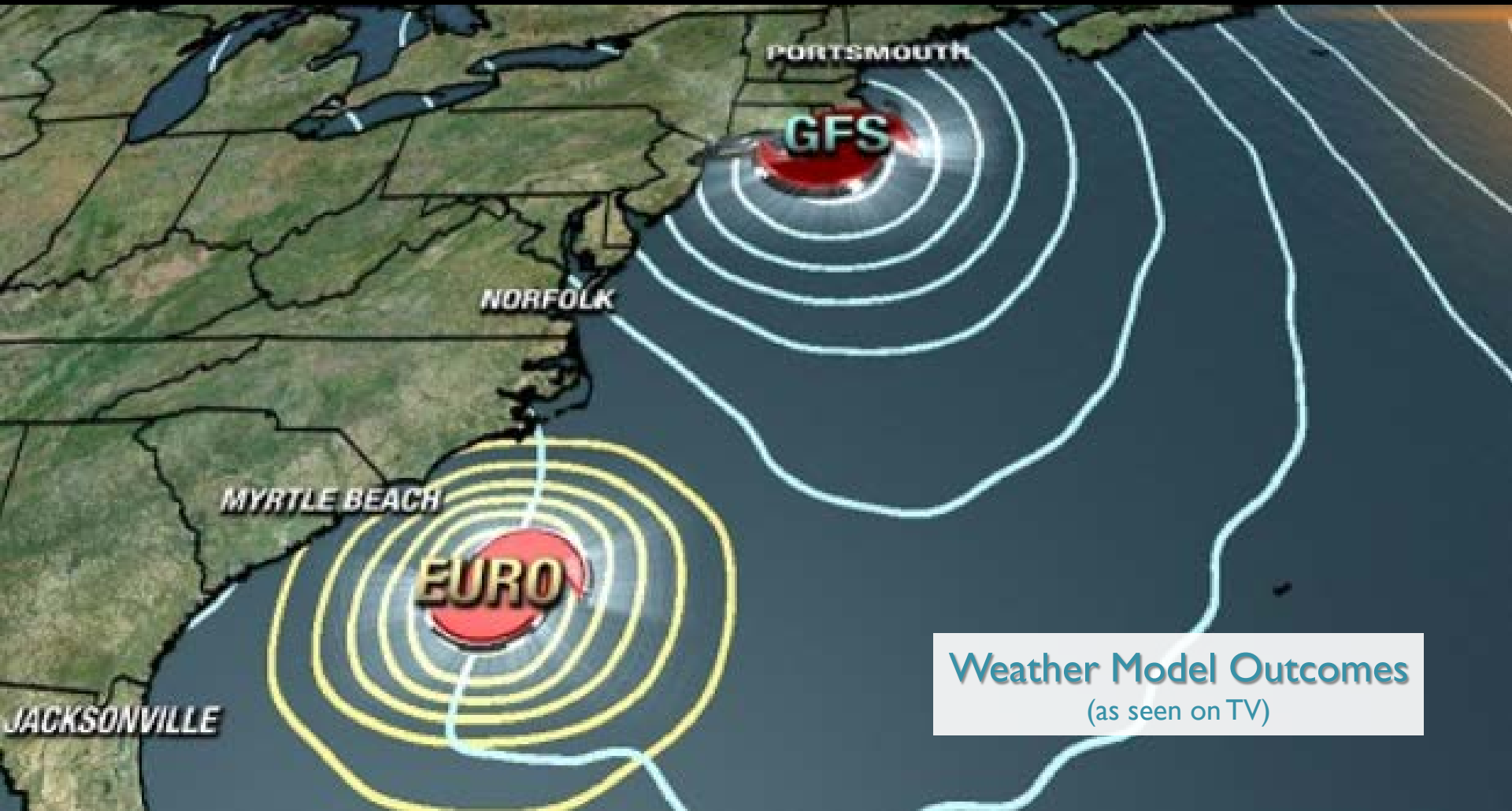
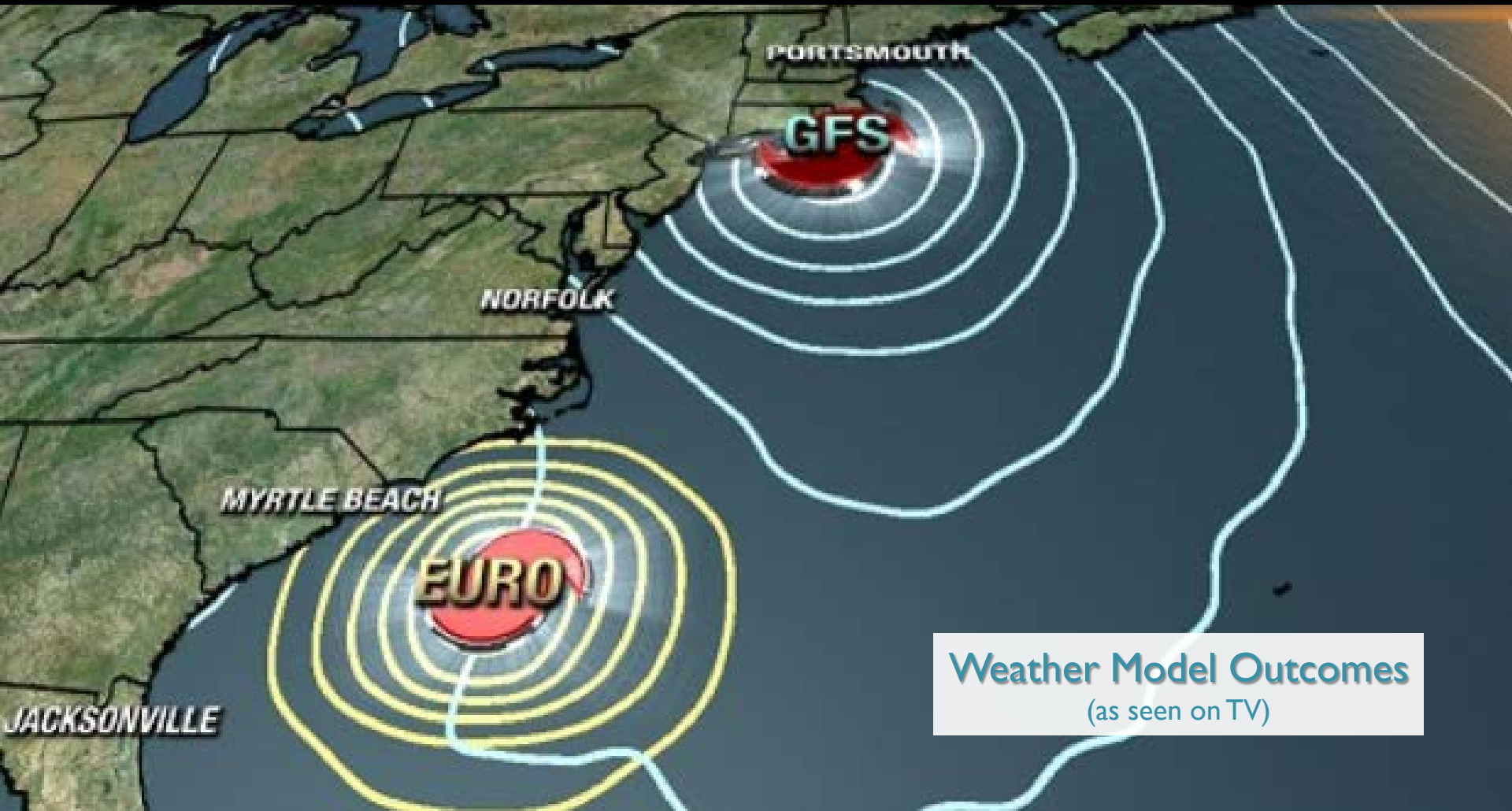
Miami, FL



OR …

The Relationship Between the Latest Forecast, the Most Likely Scenario, and the Reasonable Worst Case Scenario



Old Weather Briefer's Adage:

"If you must apologize for a forecast, you didn't communicate the uncertainty well enough."

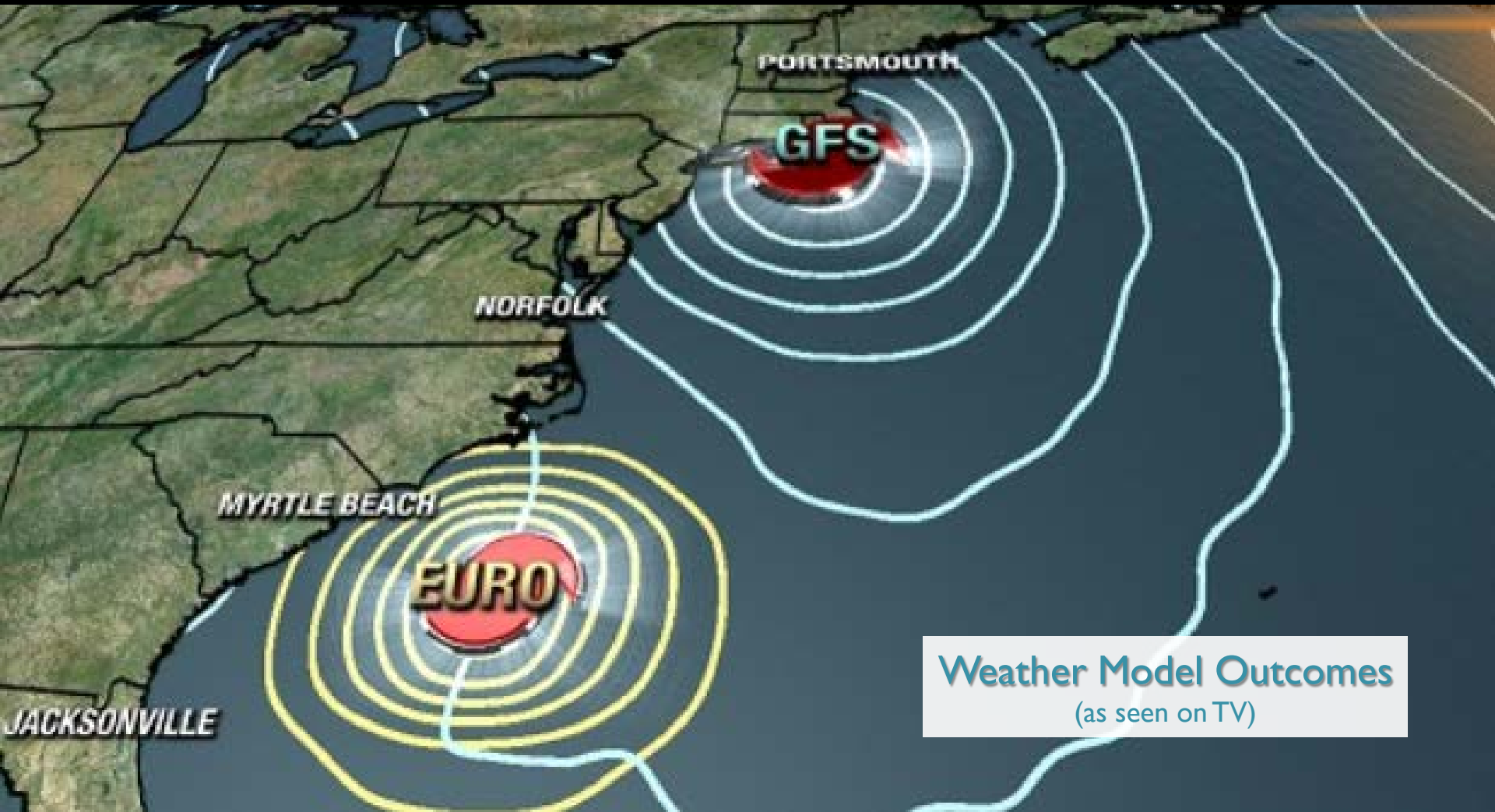
Three Main Interest Areas

for each hurricane hazard

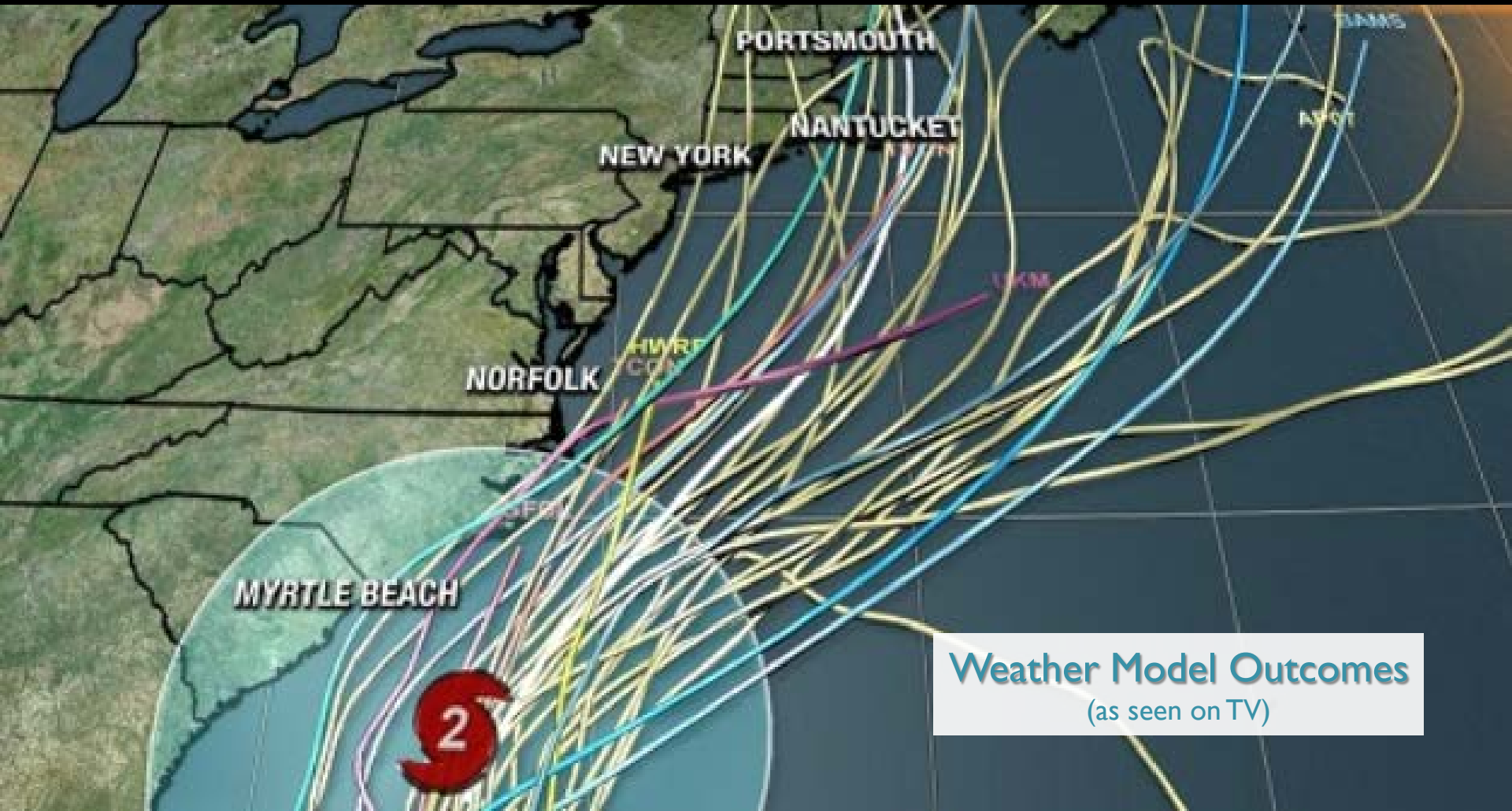
For a given community…

1. **Magnitude** + *Uncertainty*
2. **Timing** + *Uncertainty*
3. **Impacts** + *Uncertainty*

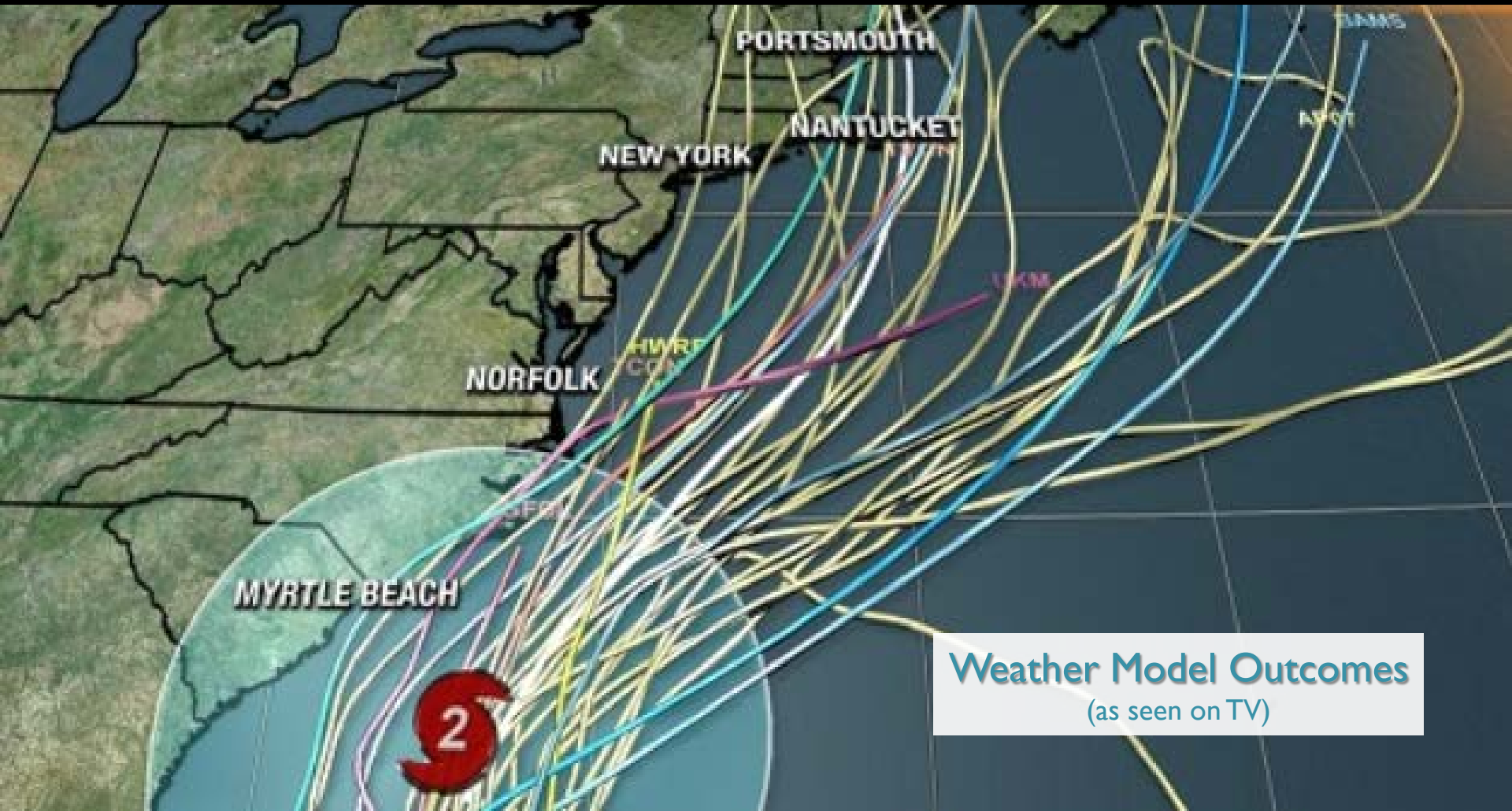
What actionable information does this image convey?



And, what actionable information does this image convey?



Perhaps it represents an attempt to use more than one single solution (i.e. deterministic outcome) to address forecast uncertainty and confidence issues.



Old Weather Briefer's Adage:

"Confusion and doubt are not the same as uncertainty. It is possible to clearly and confidently talk about uncertainty."

The Value of Probability Data

But, many people have an aversion to using probability data.

study.com

Axioms: Deterministic *vs.* Probabilistic

- For well-behaved systems, forecast uncertainty is typically larger at extended time periods.
  - Especially for organized, well-forecast systems
- For ill-behaved systems, forecast uncertainty can be large at any time period.
  - Especially for disorganized systems offering considerable forecast challenges

Axioms: Deterministic *vs.* Probabilistic

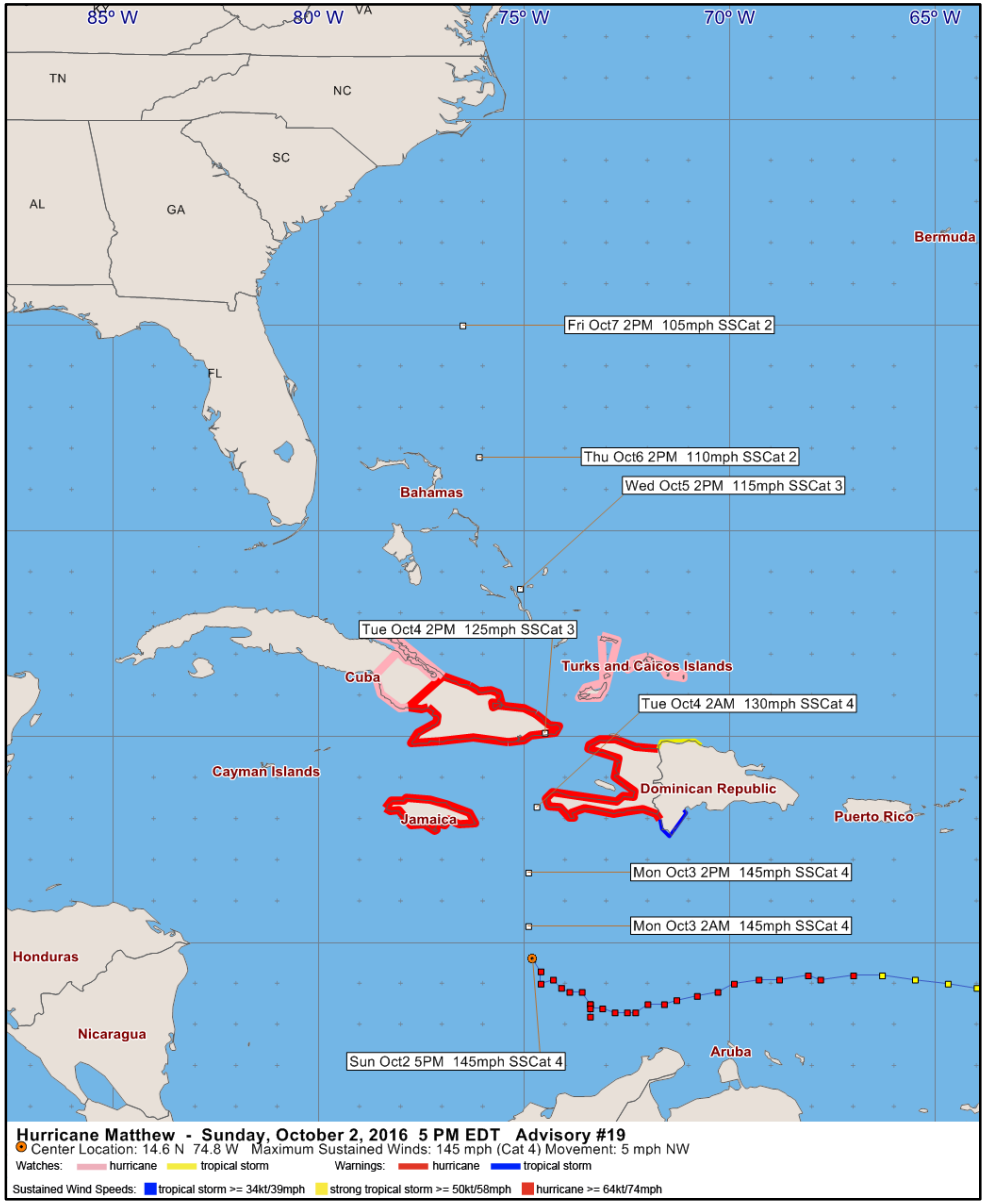
- Probabilistic-only wind information typically has its greatest value well before and leading into the local event.
- Deterministic-only wind information typically has its greatest value at the imminent onset and during the local event.

Axioms: Deterministic *vs.* Probabilistic

- Ideally, as a local hurricane wind event unfolds and draws closer in time … probabilistic depictions should trend toward deterministic depictions.

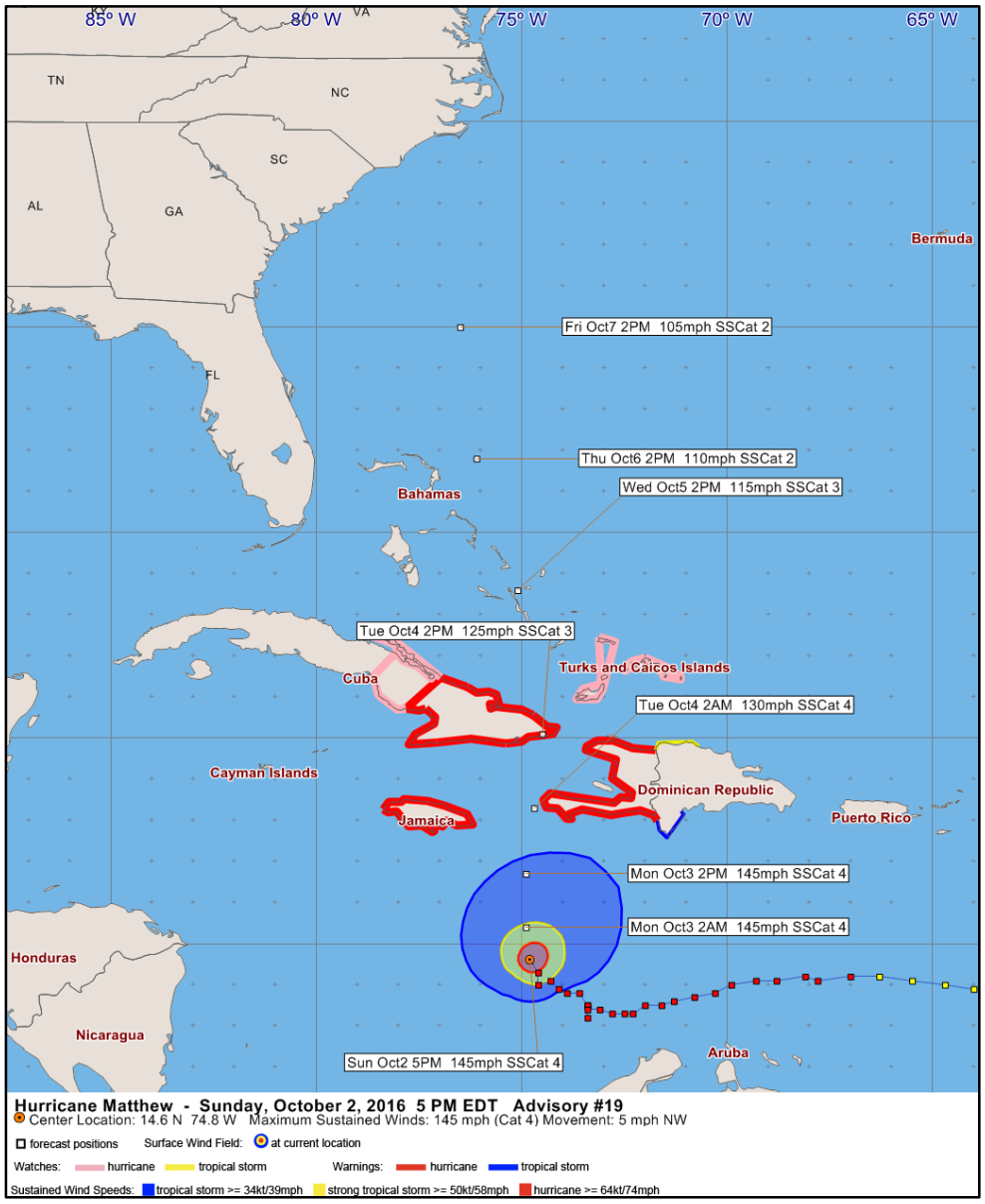
The Latest Forecast

- Analyzed location, size, and intensity
- Forecast points, size, and intensity
  - 5-day forecasts
  - 12 & 24 hr points
  - Motion



The Latest Forecast

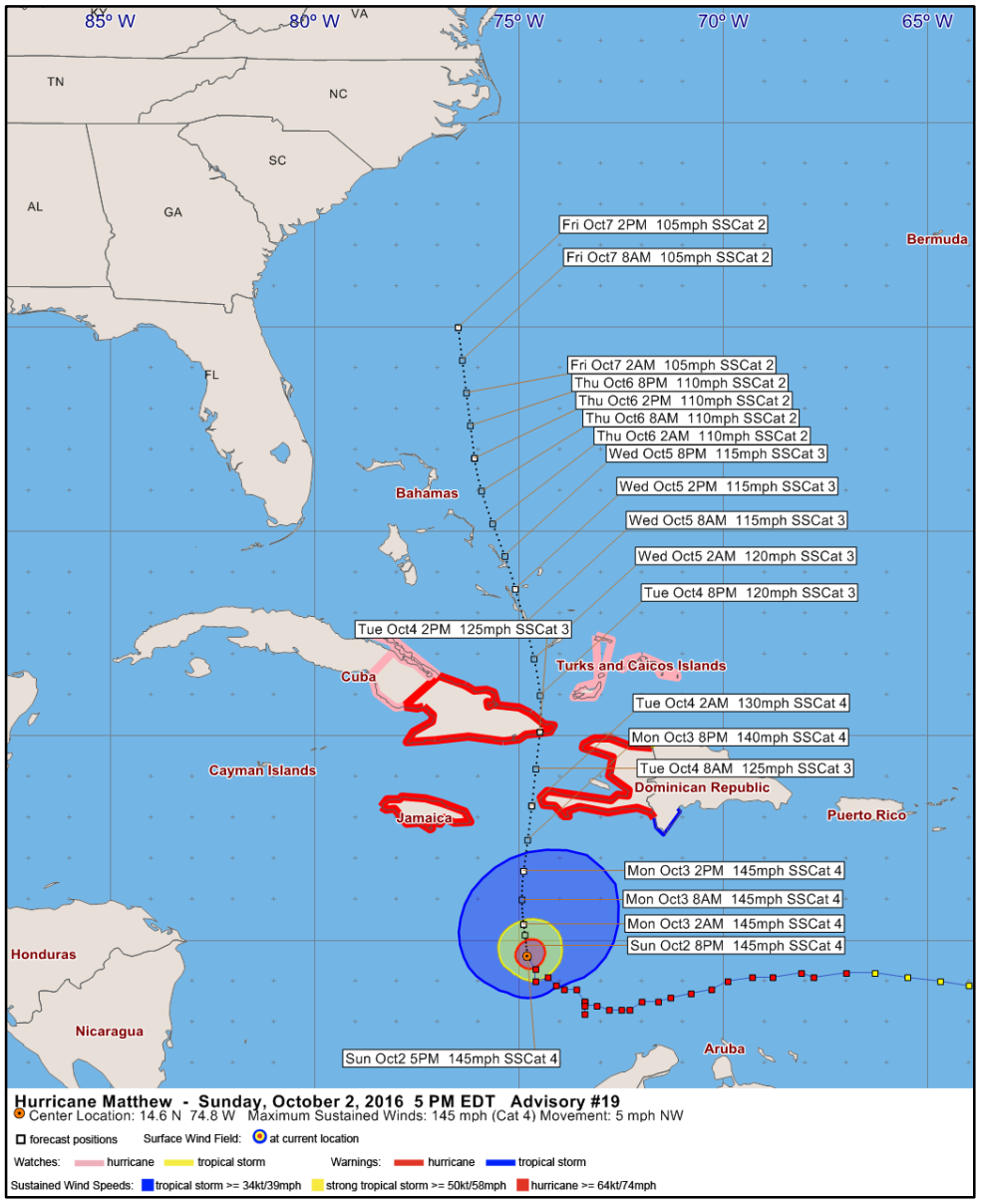
- Analyzed location, size, and intensity
- Forecast points, size, and intensity
  - 5-day forecasts
  - 12 & 24 hr points
  - Motion
- *"NWS Official Forecast"*
  - Synoptic



The Latest Forecast

- Quadrant winds
  - Somewhere vs. Everywhere
- Intermediate points
  - 1-hr resolution (interpolated)
- CAT2-5 winds
- Days 6-7

- NHC … Storm-relative forecast
- WFO … Geo-relative forecast (downscaled & refined)



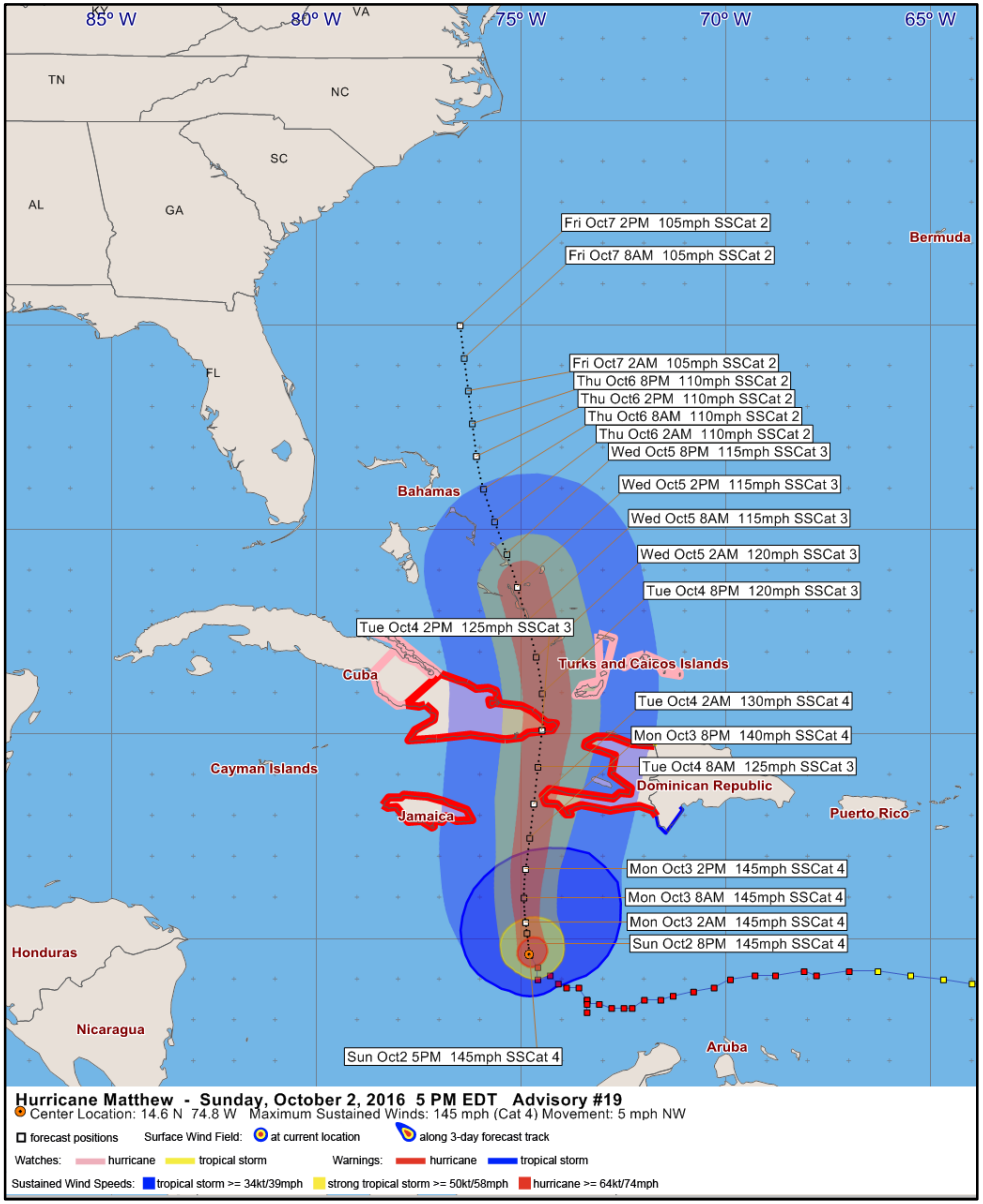
The Latest Forecast

- Forecast Track
  - *Skinny Black Line*
- Peak Wind Swath

deterministic; zero error

"Alright, now I can make some really good decisions."

"Well, hang on a minute!"



What is the one thing every decision-maker wants but we <u>cannot</u> provide?

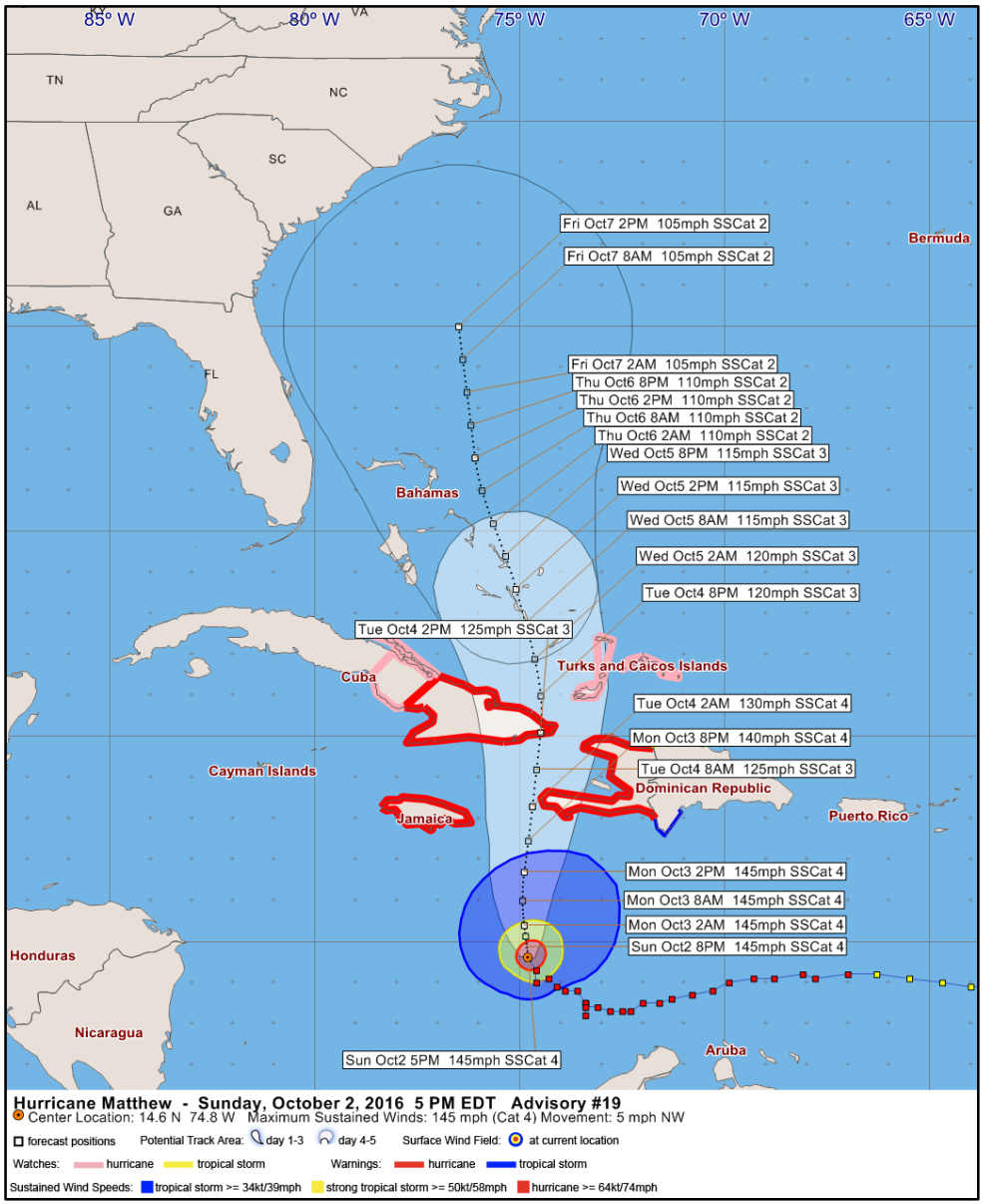
… a perfect forecast !!!

The Most Likely Scenario

- Error Cone
  - Cross Track Errors
  - Along Track Errors

"Hurricanes are not points; they have size and dimension."

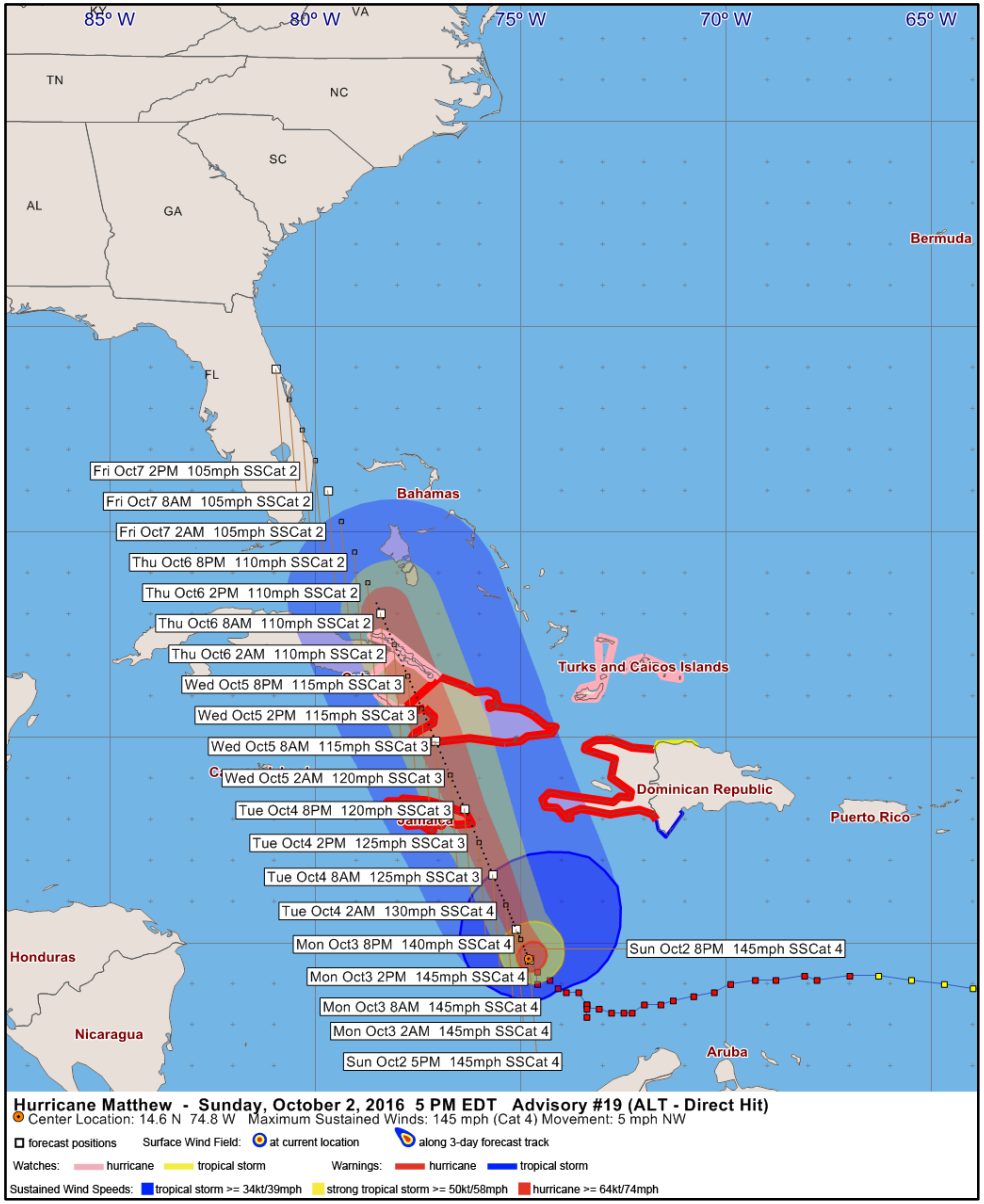
As overlay to ***qualitatively*** consider outcome variations; center tracks within the cone two-thirds of the time.



The Most Likely Alternate Scenario

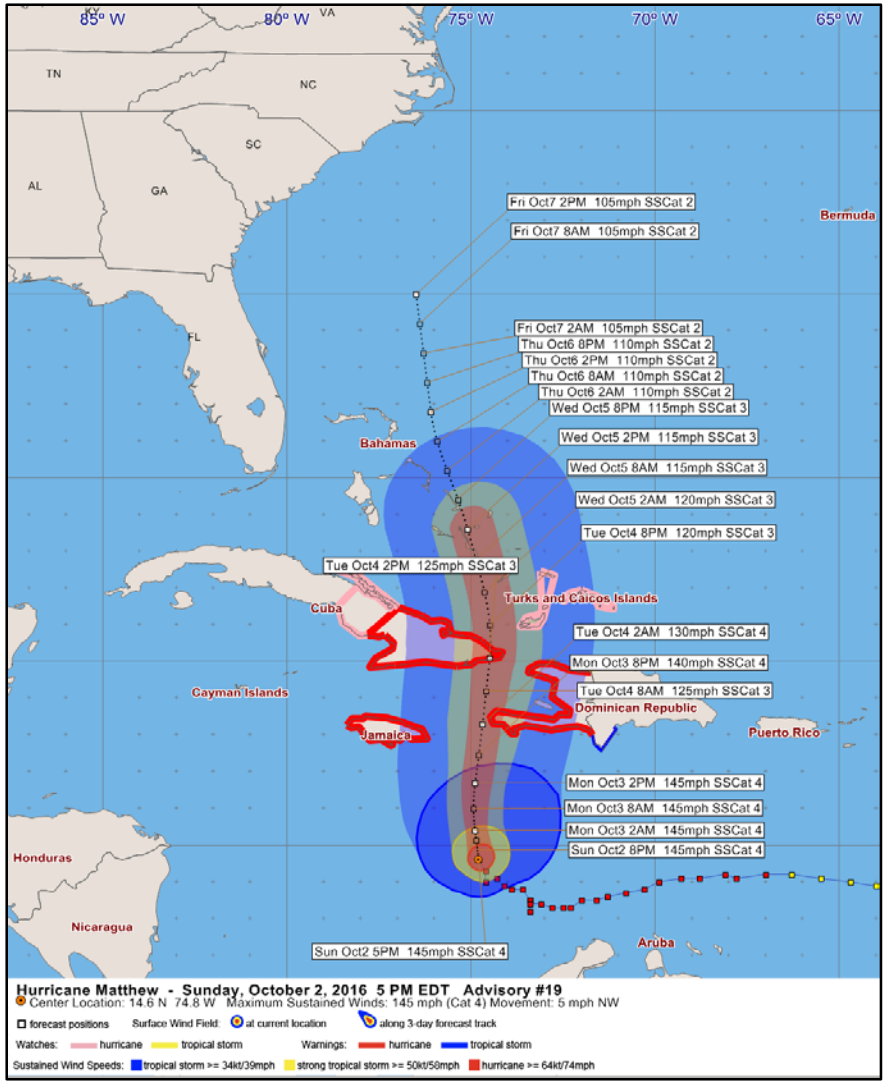
"For contingency planning, is there a next most likely solution (qualitative-sense)?"

- Yes, but there are many alternate scenarios
- Determining which is the next *"most likely"* also takes expertise (and to assess whether there is actual meteorological bearing)



Single-Solution Depictions Used Qualitatively

Most Likely Scenario



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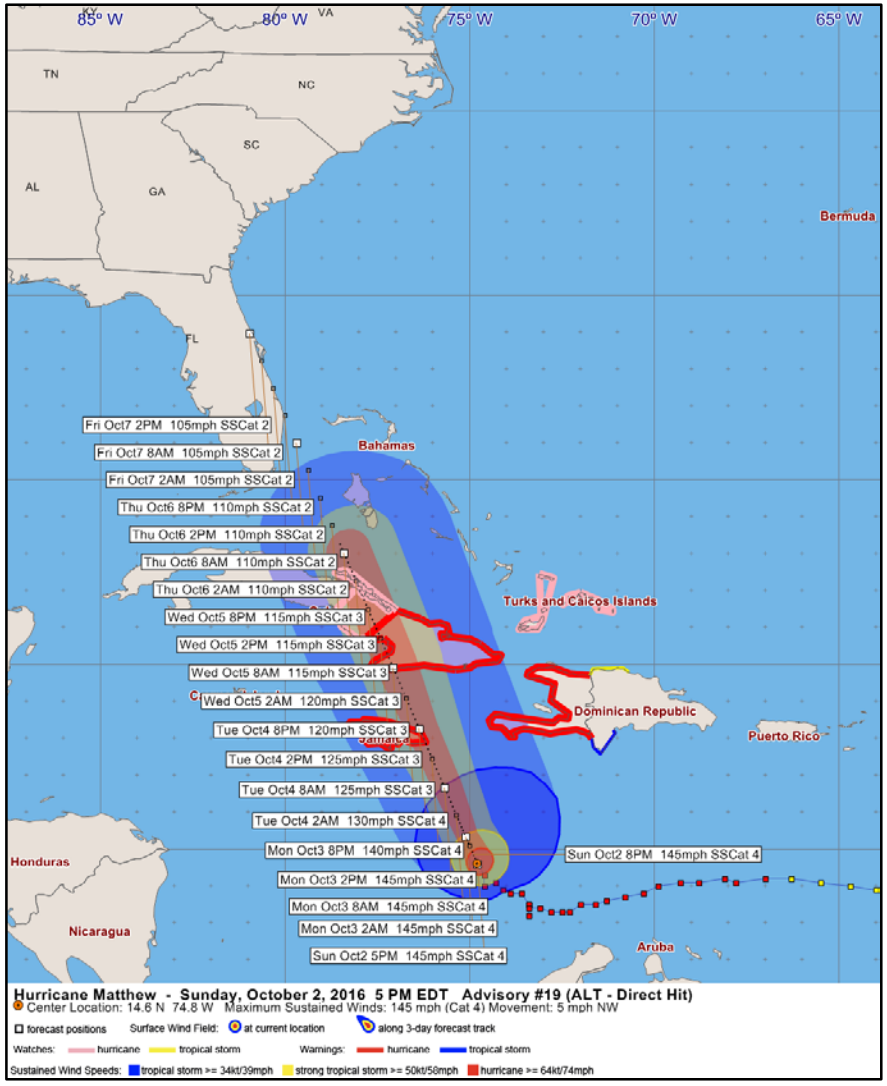
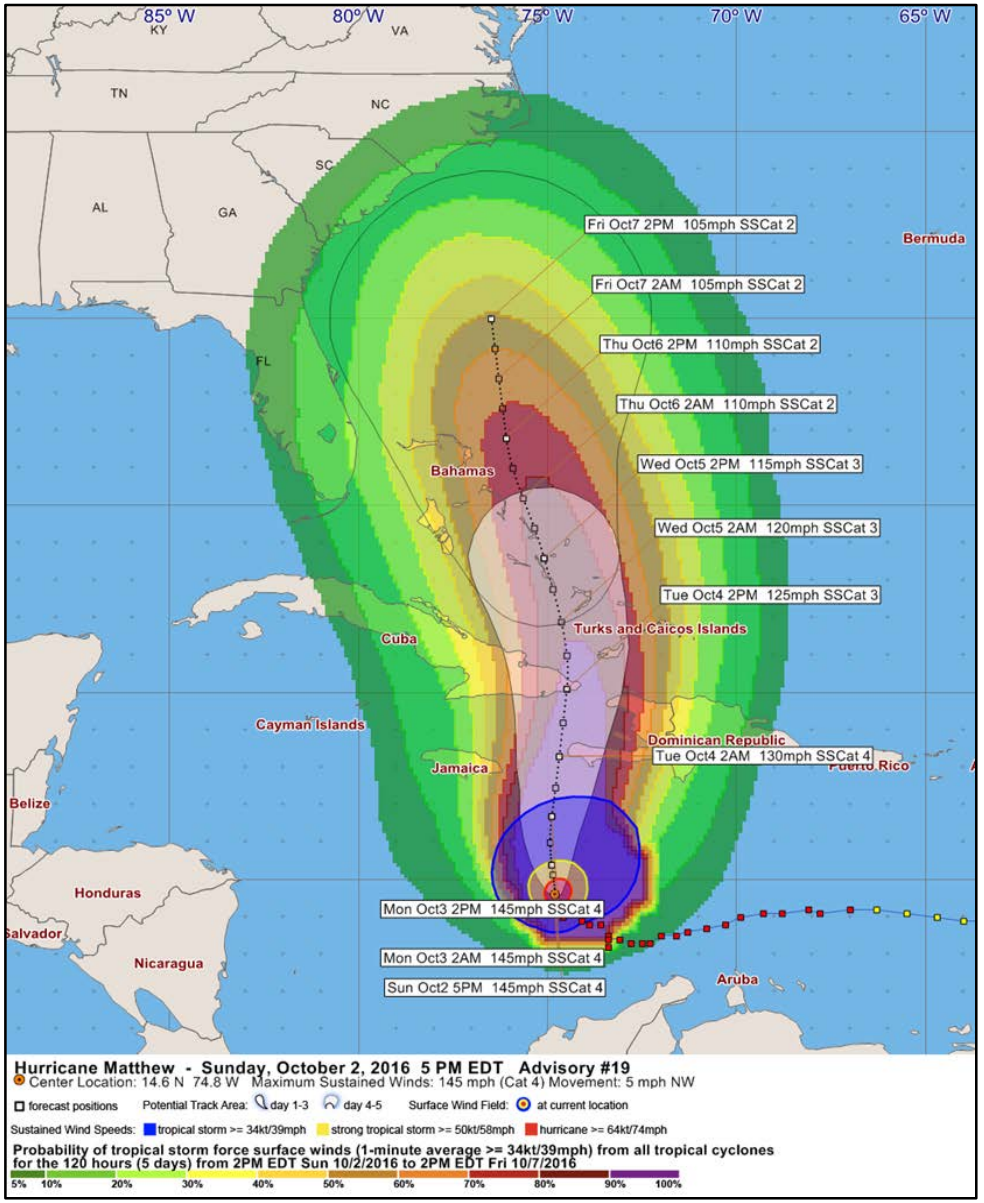


Incorporating Probability Data

Cumulative Wind Speed Probabilities: Tropical Storm

- Chance of a *"tropical storm"* wind event at a particular location
- ***Quantitative***; centered about latest forecast; point location values
- Accounts for potential variations in track, intensity, and size of the cyclone



Incorporating Probability Data

Cumulative Wind Speed Probabilities: Hurricane

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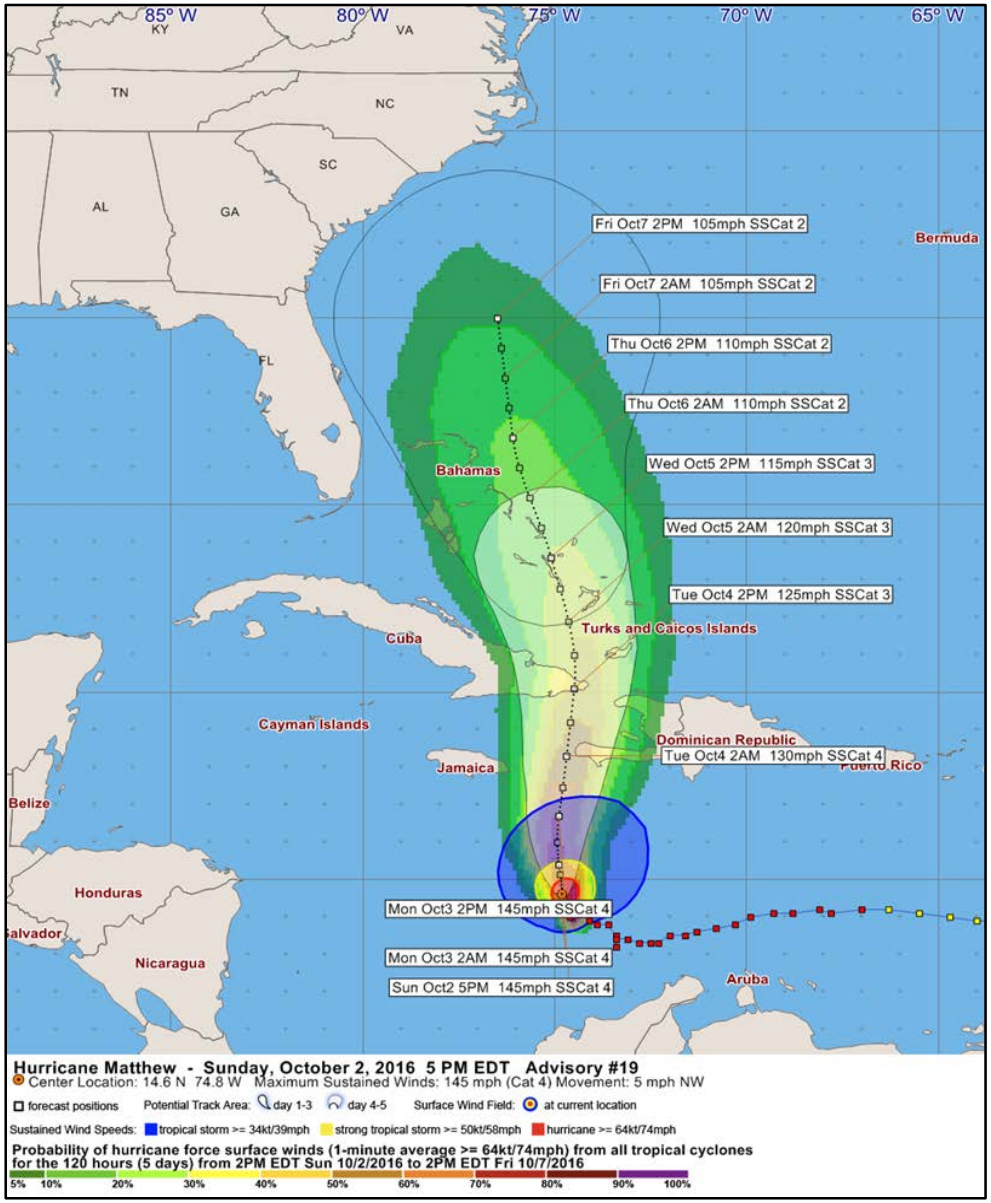


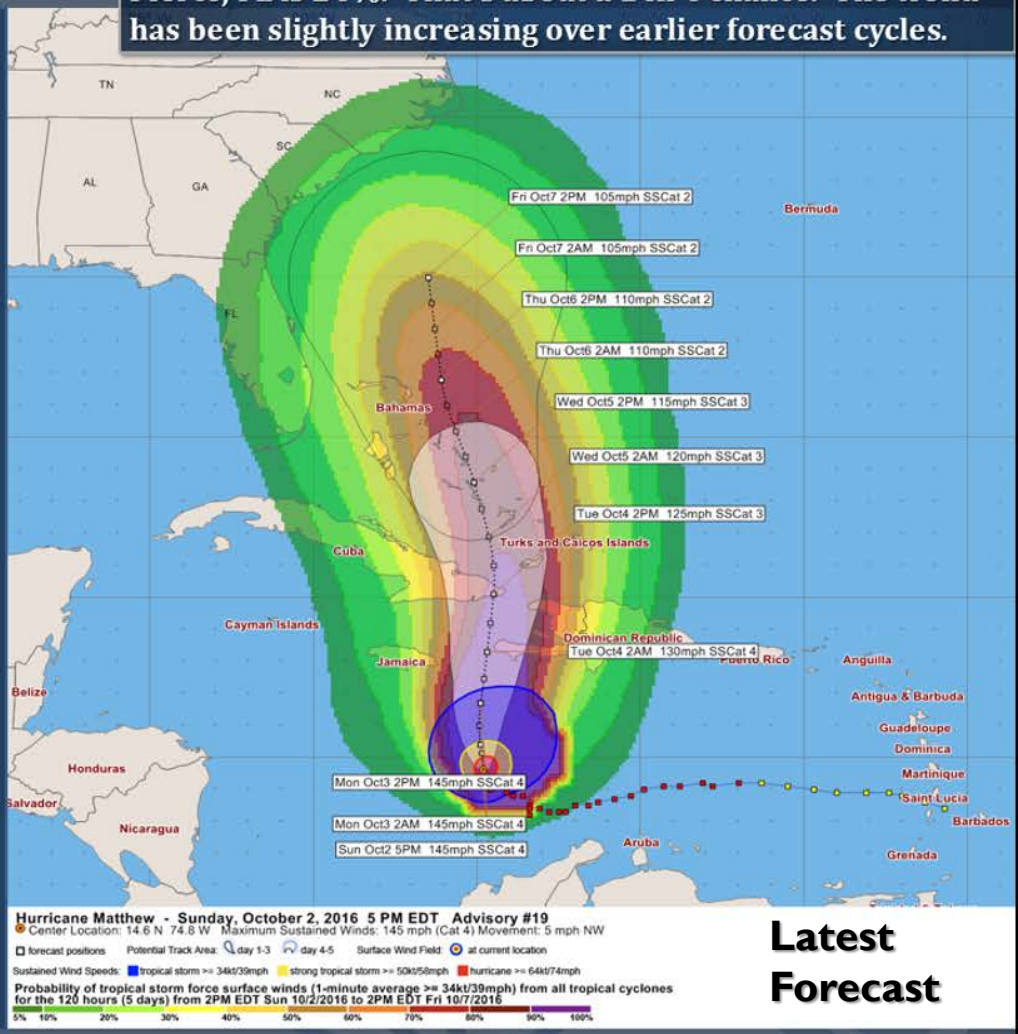
Situation Overview

East Central Florida & Adjacent Coastal Waters

The probability for tropical storm force winds at Fort Pierce, FL is 24%. That's about a 1 in 4 chance. The trend has been slightly increasing over earlier forecast cycles.

According to the latest forecast...

- A most likely scenario still keeps Matthew to the east of the Florida Peninsula.
  - Offering significant marine and coastal/beach concerns to ECFL



Latest Forecast

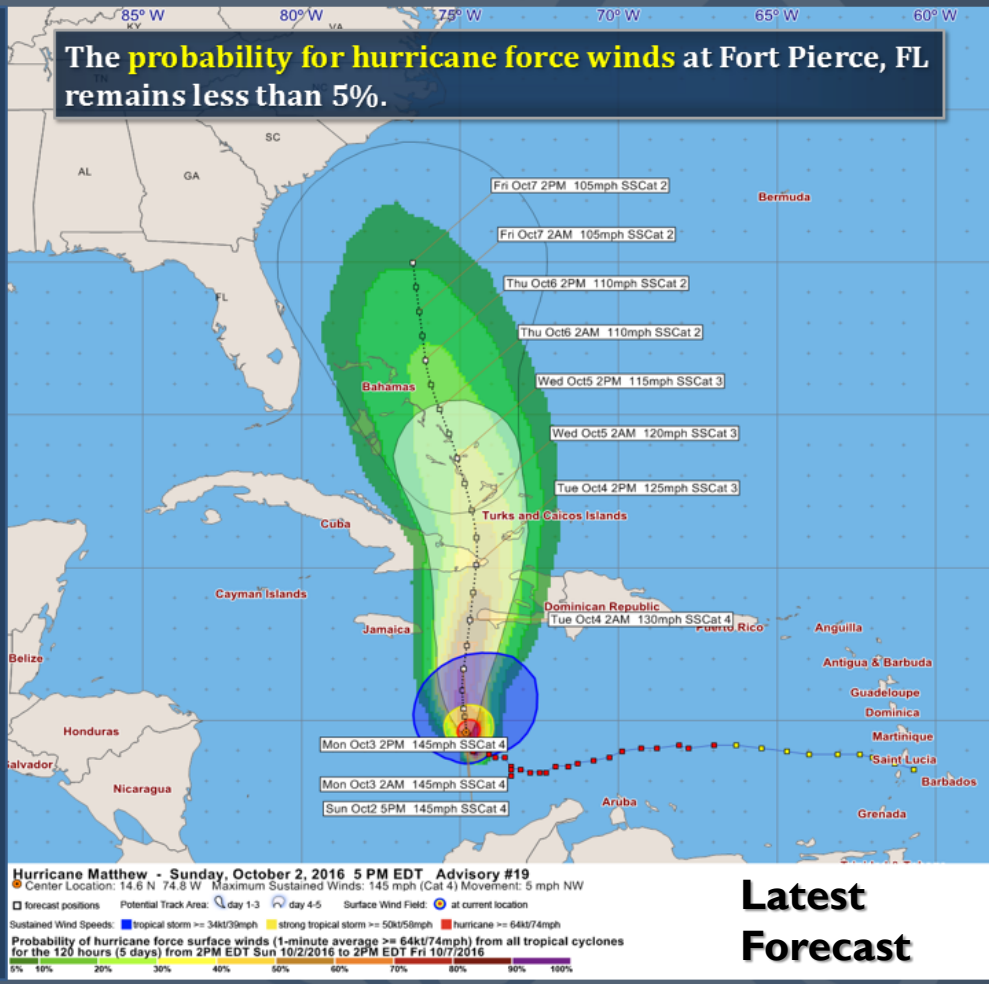
Situation Overview

East Central Florida & Adjacent Coastal Waters

According to the latest forecast...

- A most likely scenario still keeps Matthew to the east of the Florida Peninsula.
  - Offering significant marine and coastal/beach concerns to ECFL
- An alternate scenario could bring Matthew closer to ECFL.
  - Increasing the concern for potential wind impacts for land locations

<u>Key Point</u>: It is possible for a major hurricane to be in our vicinity by mid-late week.



Latest Forecast

Melbourne
WEATHER FORECAST OFFICE
http://www.weather.gov/melbourne
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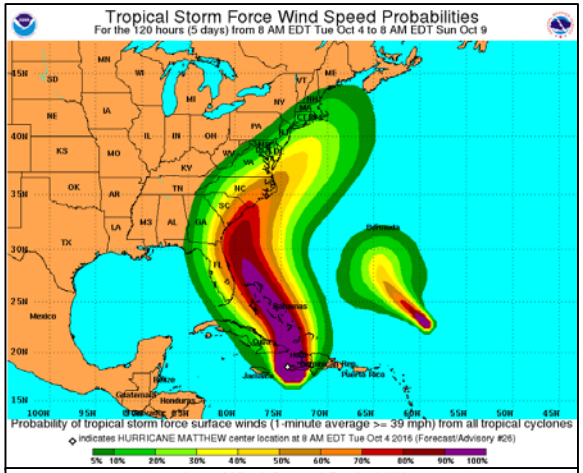
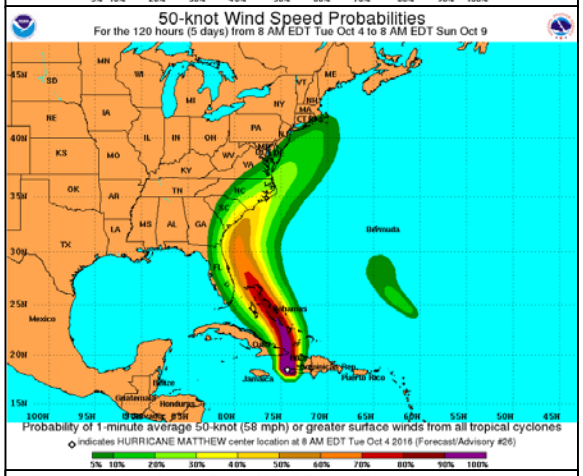
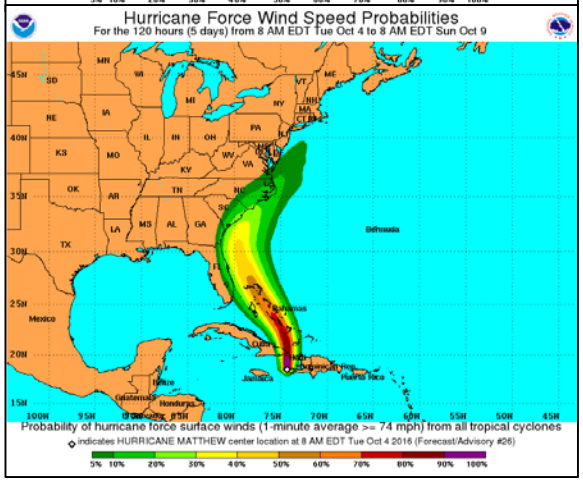
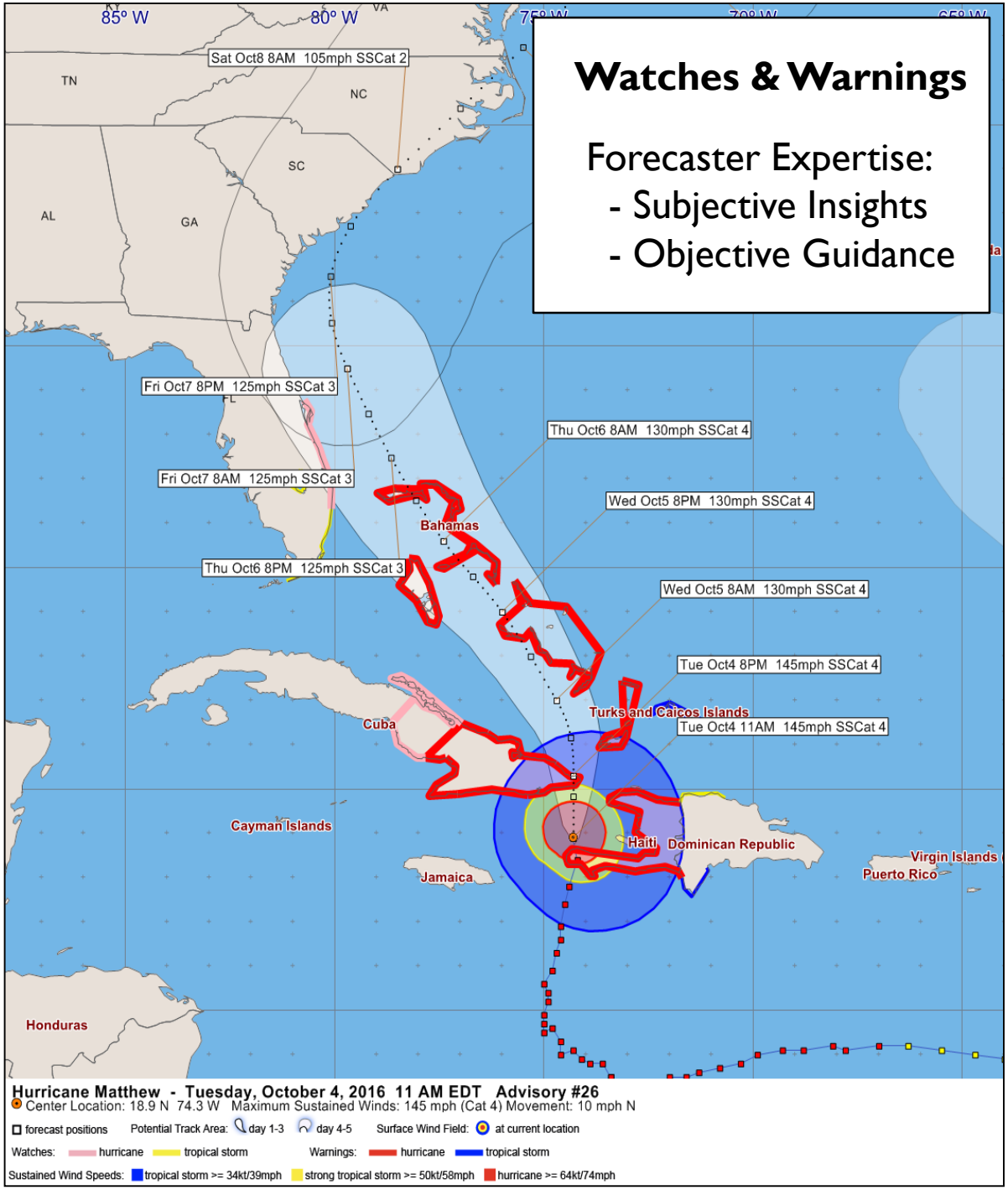
@NWSMelbourne

October 2, 2016

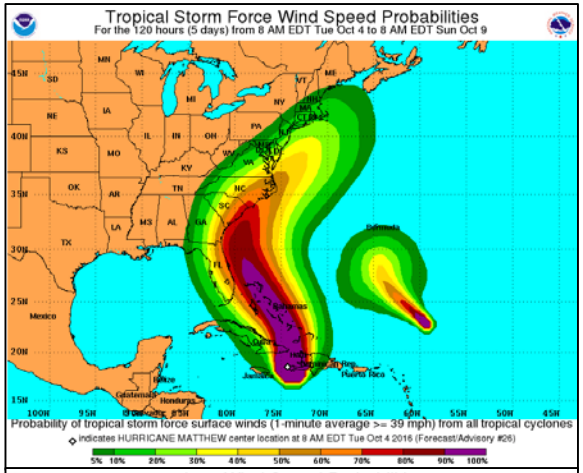

Tropical Storm Force Wind Speed Probabilities
For the 120 hours (5 days) from 8 AM EDT Tue Oct 4 to 8 AM EDT Sun Oct 9
Probability of tropical storm force surface winds (1-minute average >= 39 mph) from all tropical cyclones
indicates HURRICANE MATTHEW center location at 8 AM EDT Tue Oct 4 2016 (Forecast/Advisory #26)

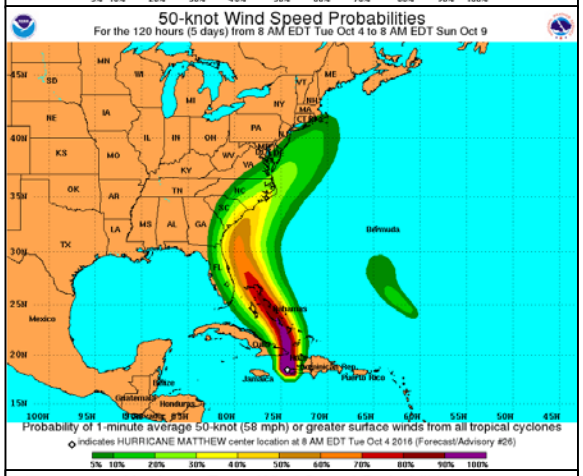

50-knot Wind Speed Probabilities
For the 120 hours (5 days) from 8 AM EDT Tue Oct 4 to 8 AM EDT Sun Oct 9
Probability of 1-minute average 50-knot (58 mph) or greater surface winds from all tropical cyclones
indicates HURRICANE MATTHEW center location at 8 AM EDT Tue Oct 4 2016 (Forecast/Advisory #26)

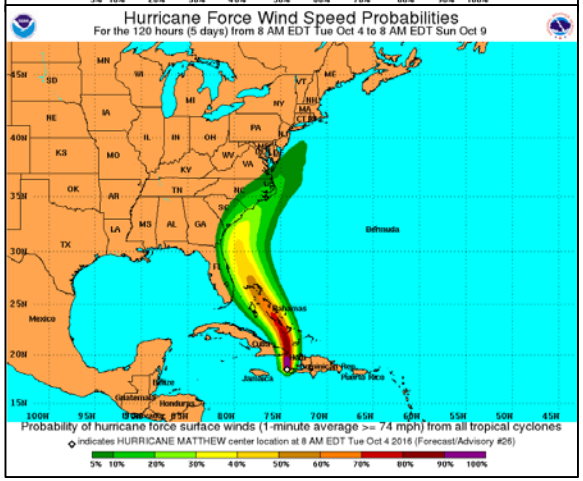

Hurricane Force Wind Speed Probabilities
For the 120 hours (5 days) from 8 AM EDT Tue Oct 4 to 8 AM EDT Sun Oct 9
Probability of hurricane force surface winds (1-minute average >= 74 mph) from all tropical cyclones
indicates HURRICANE MATTHEW center location at 8 AM EDT Tue Oct 4 2016 (Forecast/Advisory #26)

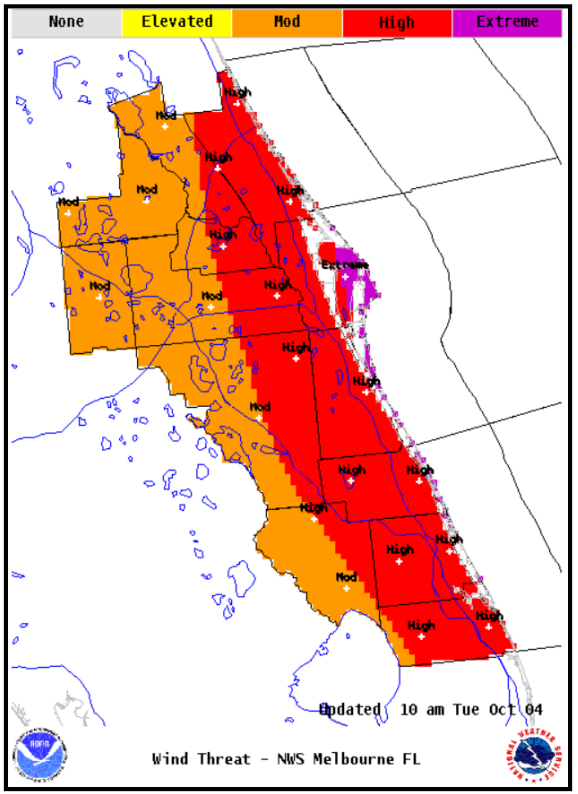

Watches & Warnings
Forecaster Expertise:
- Subjective Insights
- Objective Guidance
Sat Oct8 8AM 105mph SSCat 2
Fri Oct7 8PM 125mph SSCat 3
Fri Oct7 8AM 125mph SSCat 3
Thu Oct6 8PM 125mph SSCat 3
Thu Oct6 8AM 130mph SSCat 4
Wed Oct5 8PM 130mph SSCat 4
Wed Oct5 8AM 130mph SSCat 4
Tue Oct4 8PM 145mph SSCat 4
Tue Oct4 11AM 145mph SSCat 4
Bahamas
Cuba
Turks and Caicos Islands
Cayman Islands
Haiti
Dominican Republic
Jamaica
Virgin Islands
Puerto Rico
Honduras
Hurricane Matthew - Tuesday, October 4, 2016 11 AM EDT Advisory #26
Center Location: 18.9 N 74.3 W Maximum Sustained Winds: 145 mph (Cat 4) Movement: 10 mph N
forecast positions
Potential Track Area: day 1-3 day 4-5
Surface Wind Field: at current location
Watches: hurricane tropical storm
Warnings: hurricane tropical storm
Sustained Wind Speeds: tropical storm >= 34kt/39mph strong tropical storm >= 50kt/58mph hurricane >= 64kt/74mph

Reasonable Worst Case Scenario









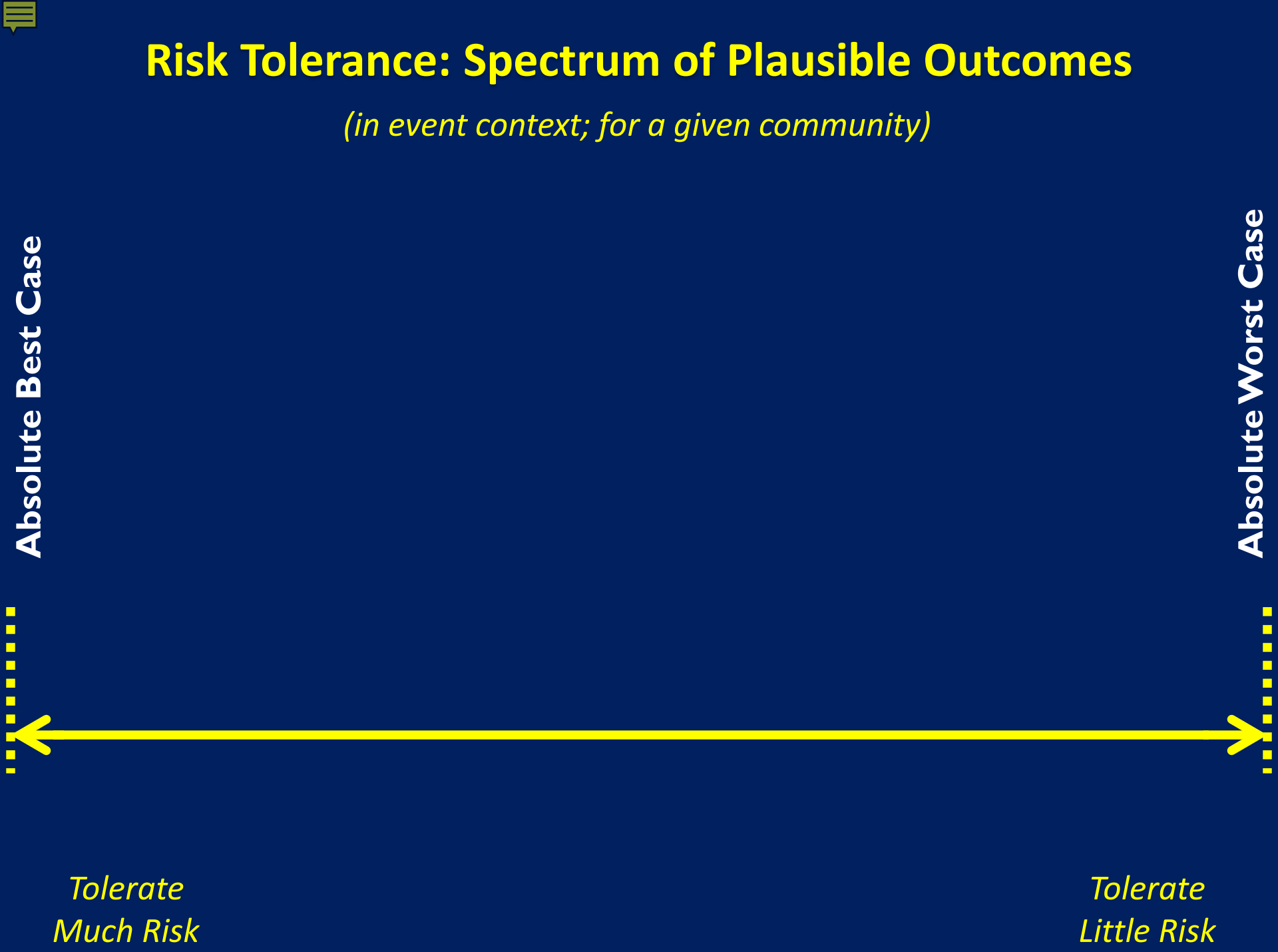
Forecast with Safety Margin

WIND THREAT
Potential for wind > 110 mph
Potential for wind 74-110 mph
Potential for wind 58-73 mph
Potential for wind 39-57 mph
Wind < 39 mph

10% exceedance

Risk Tolerance: Spectrum of Plausible Outcomes

(in event context; for a given community)



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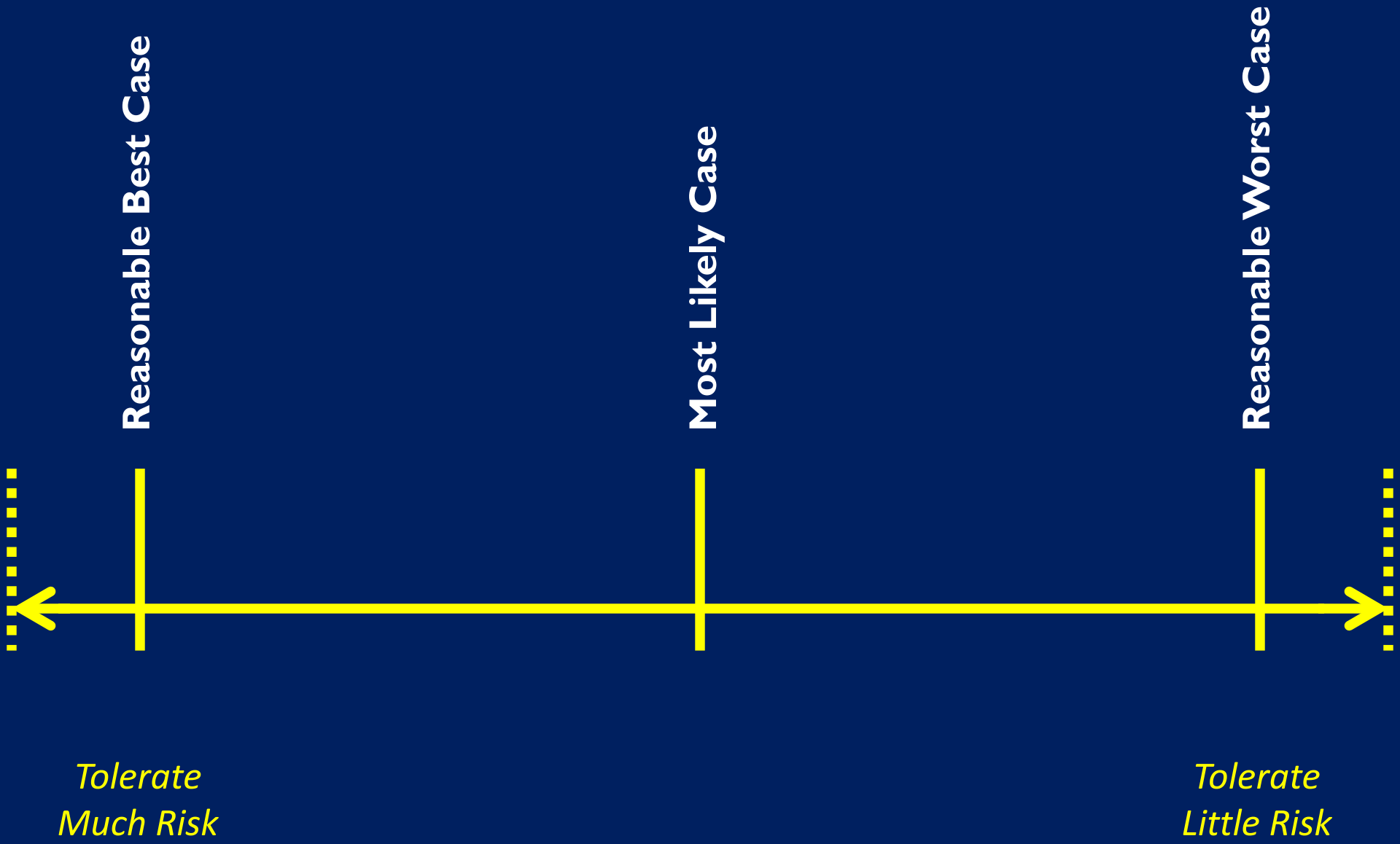

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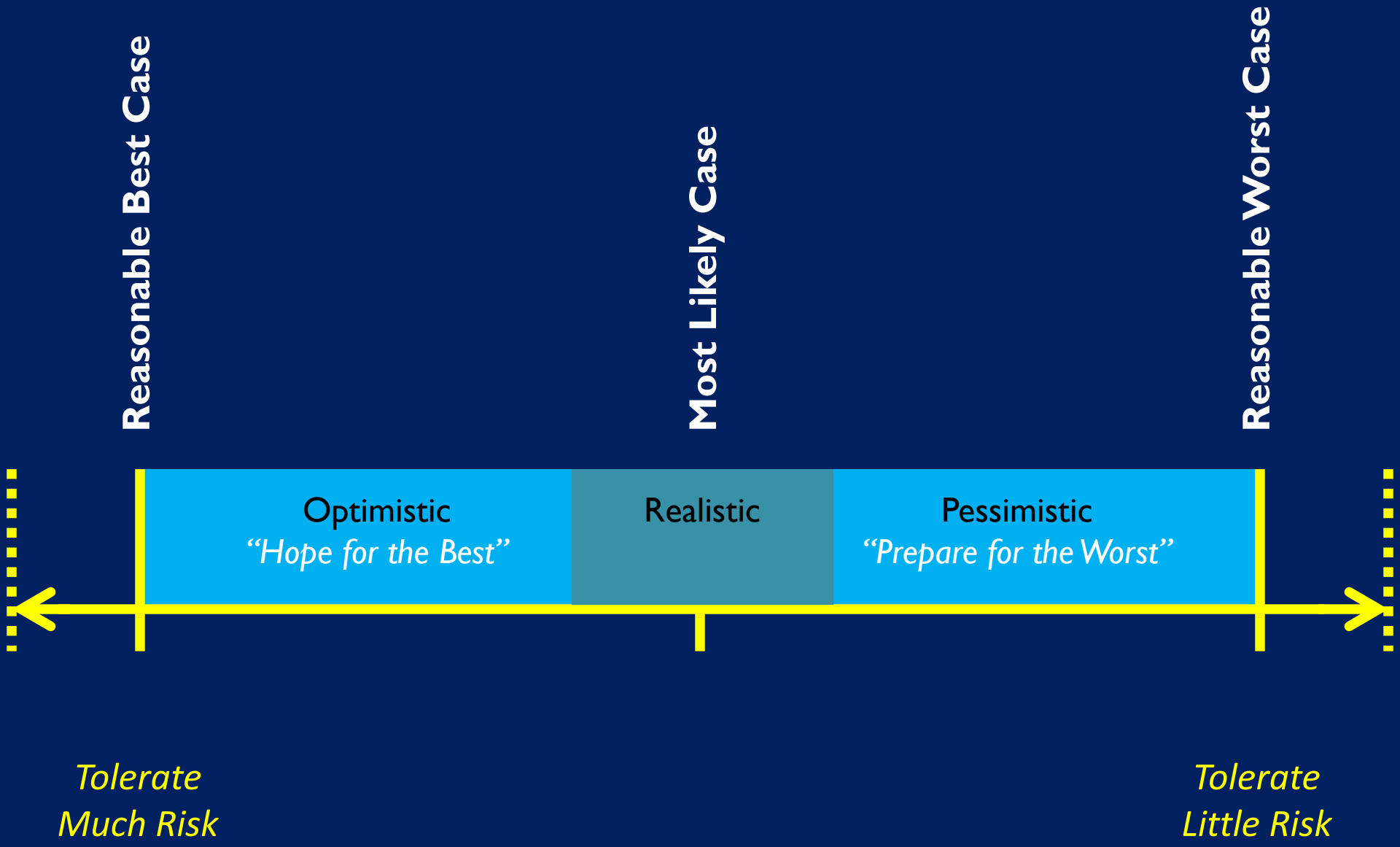

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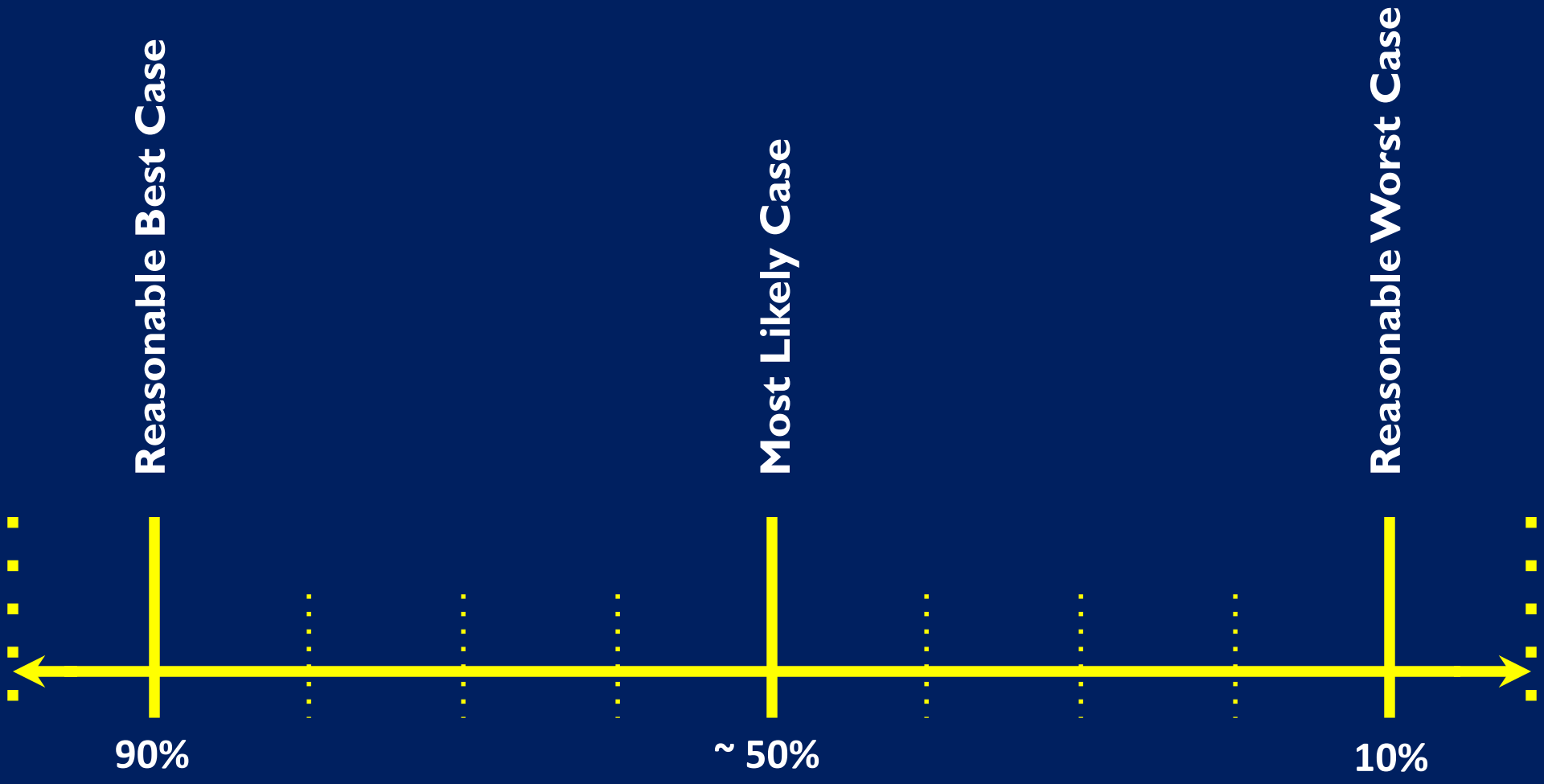

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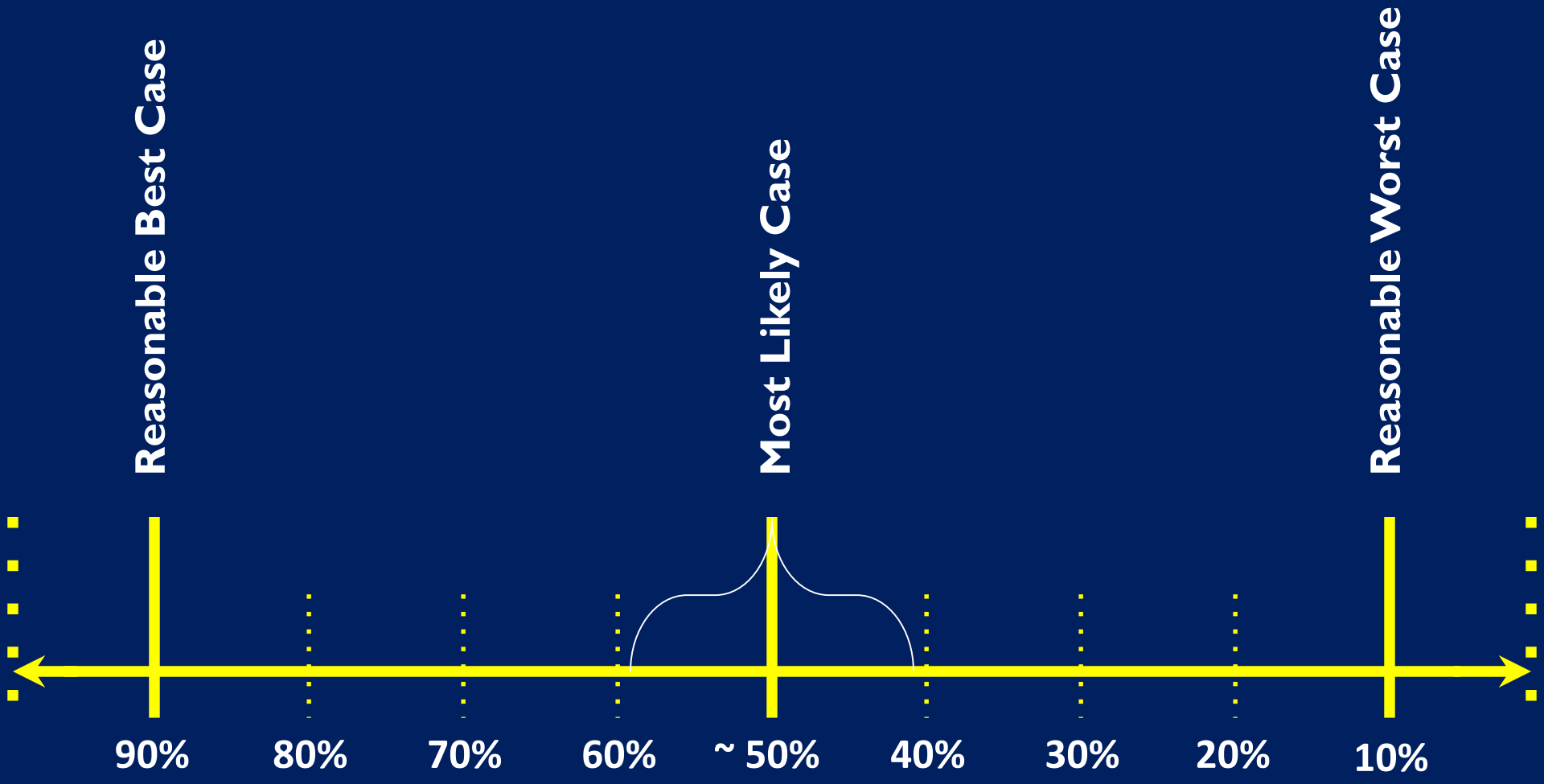

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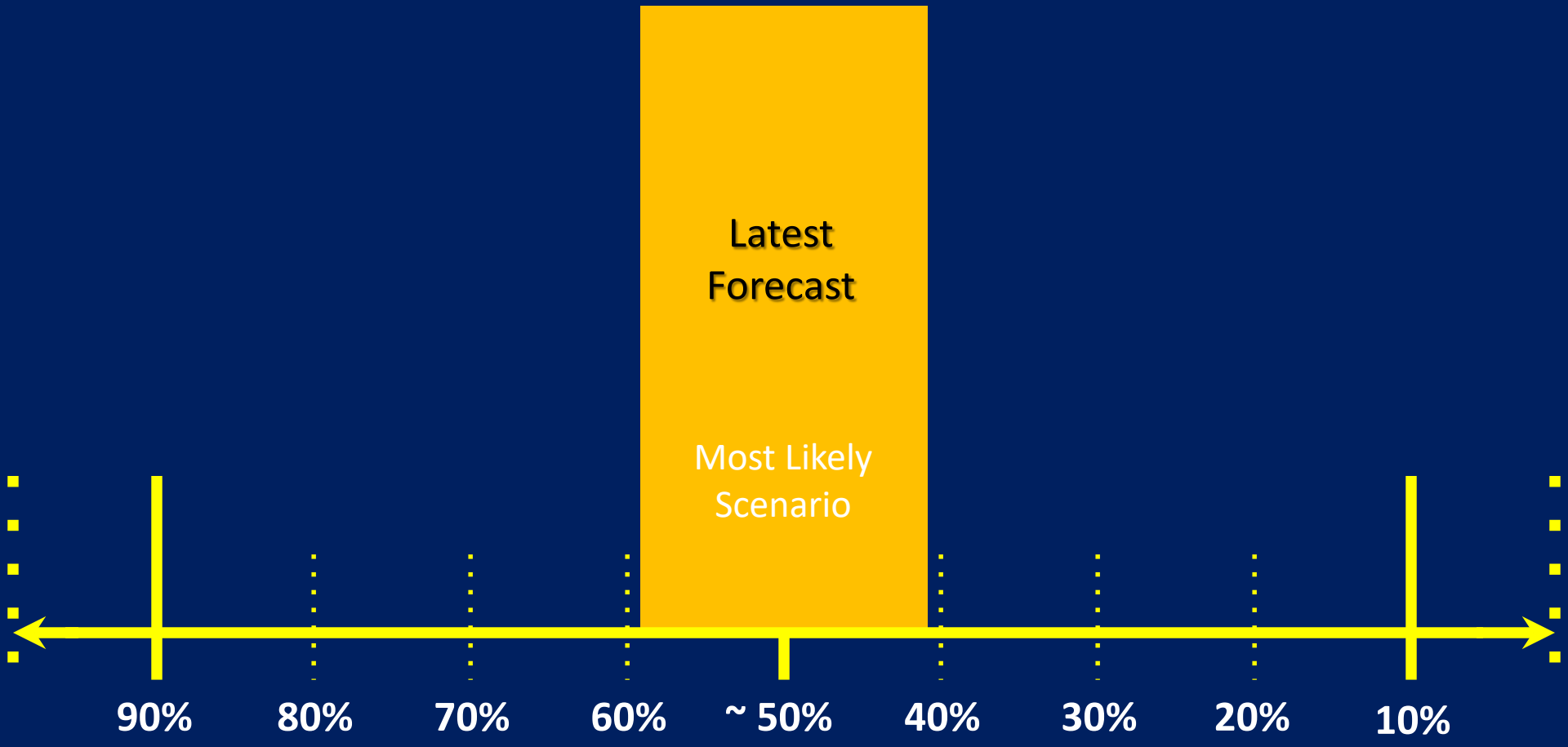

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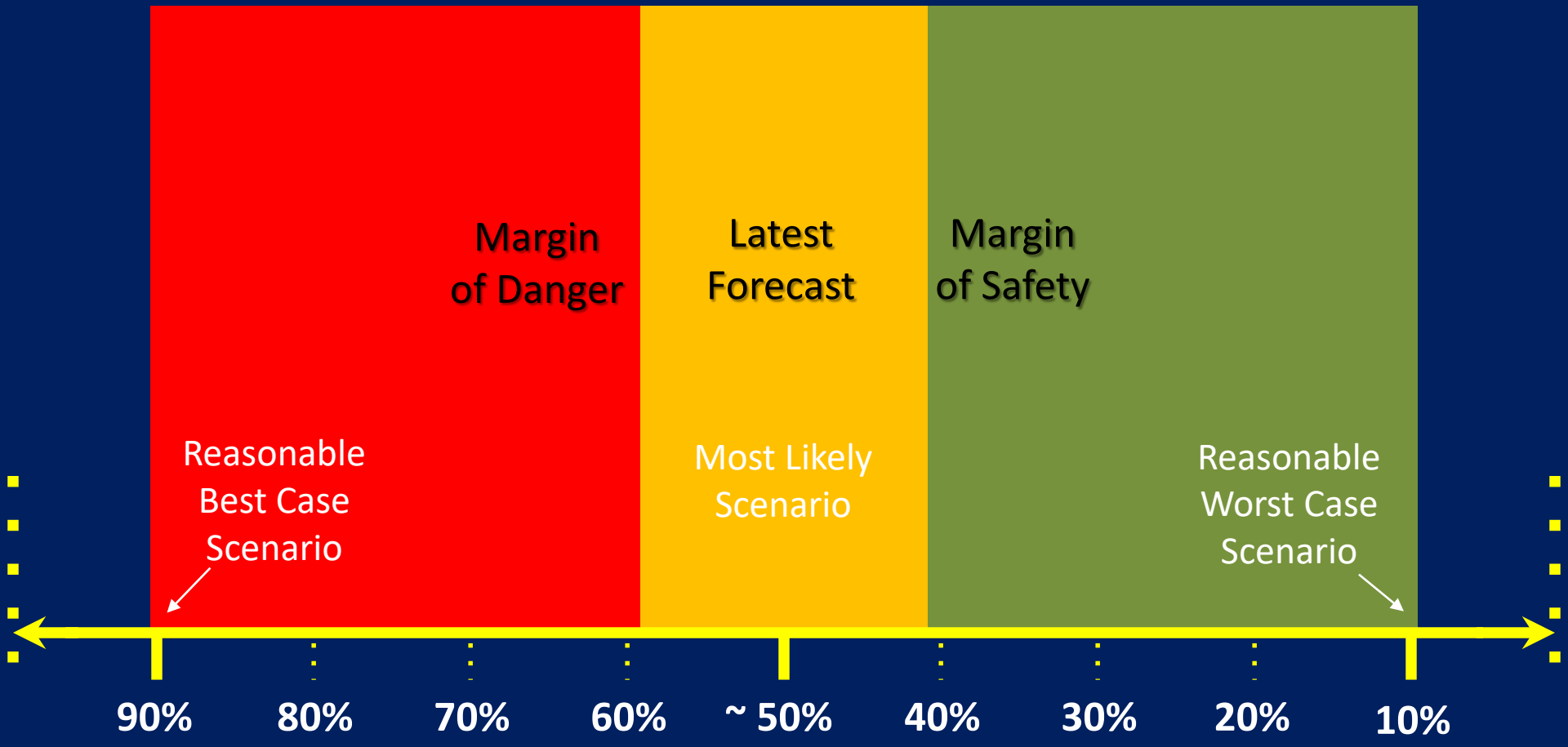

Tolerate Much Risk

% exceedance

Tolerate Little Risk

Risk Tolerance: Spectrum of Plausible Outcomes

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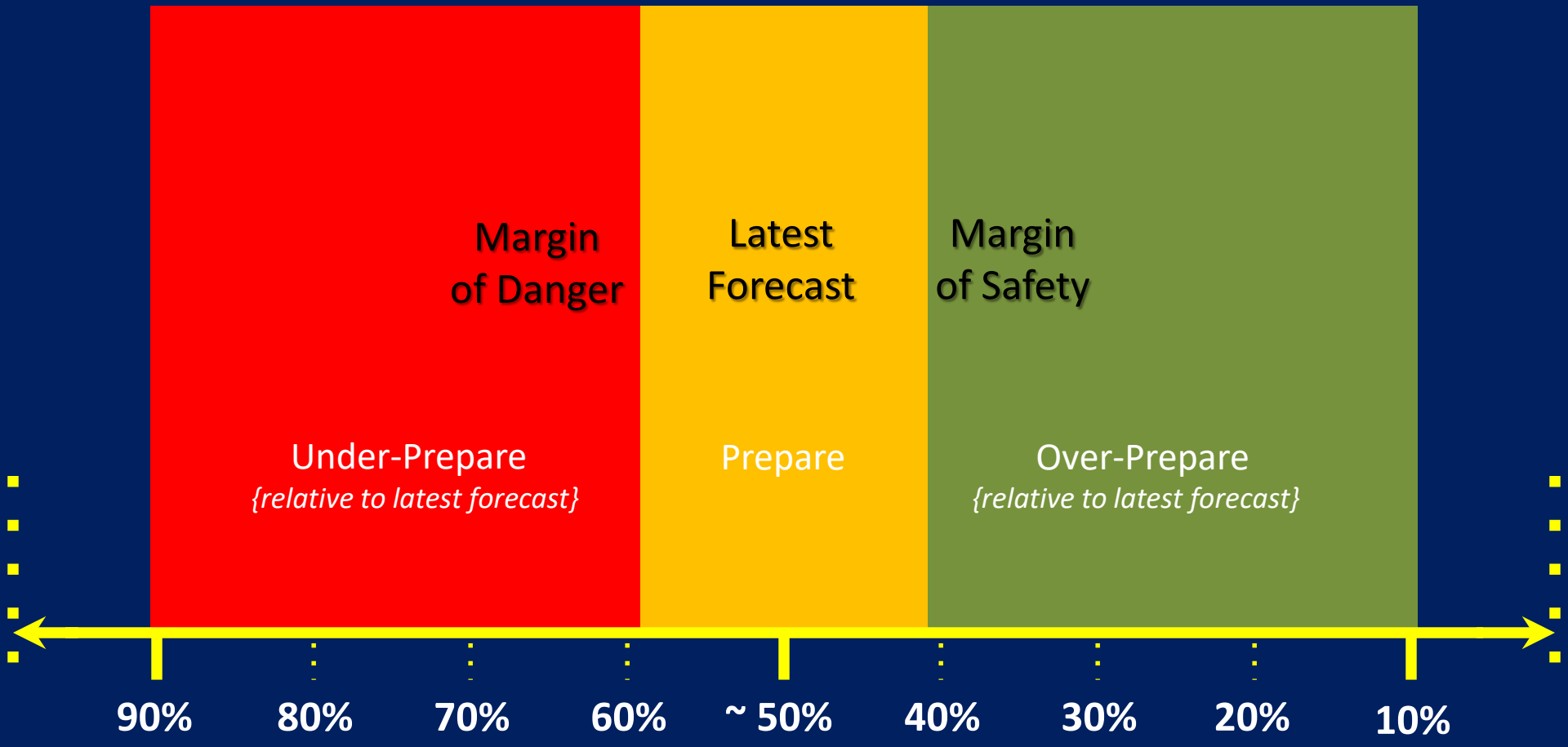

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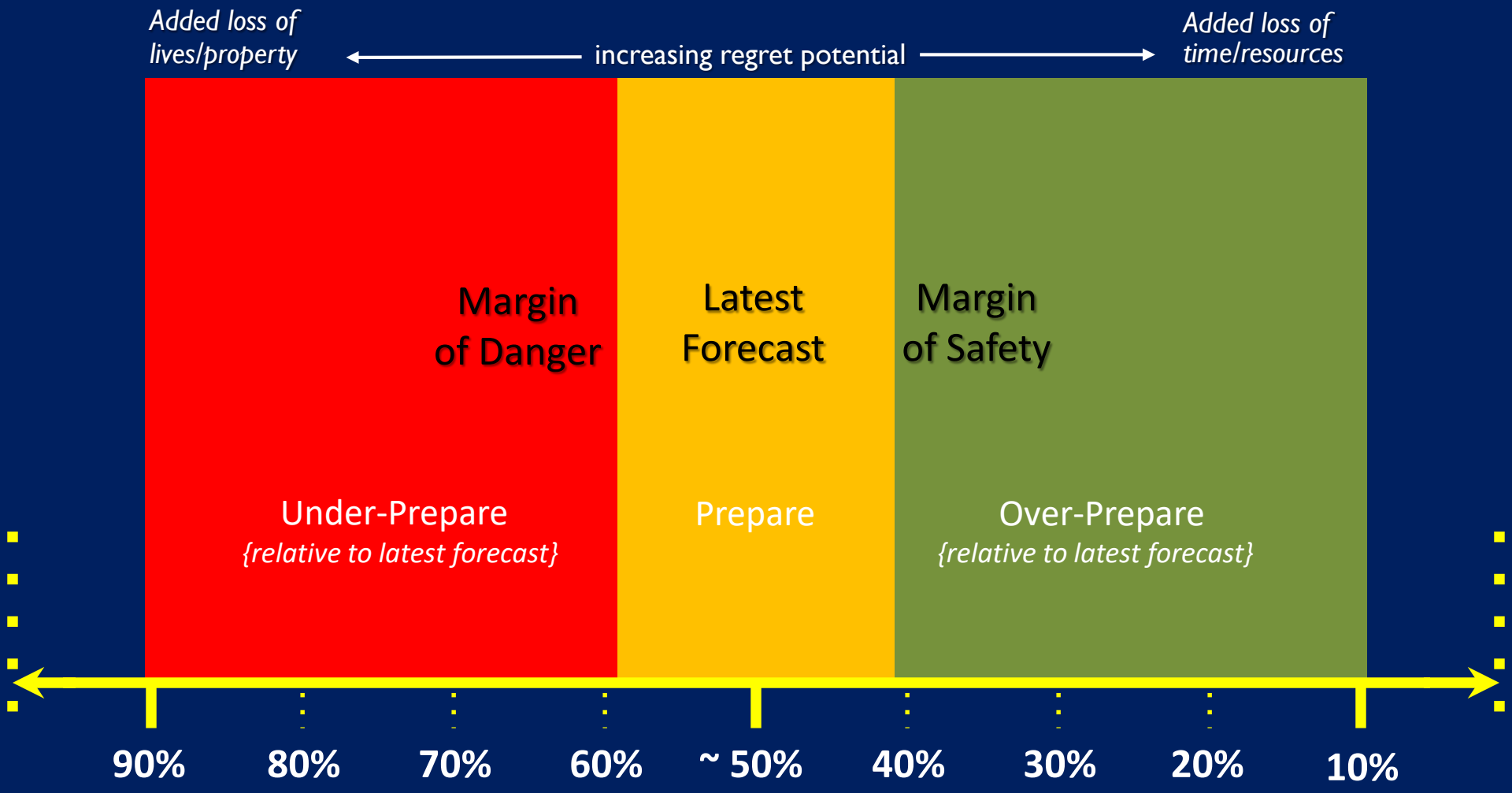

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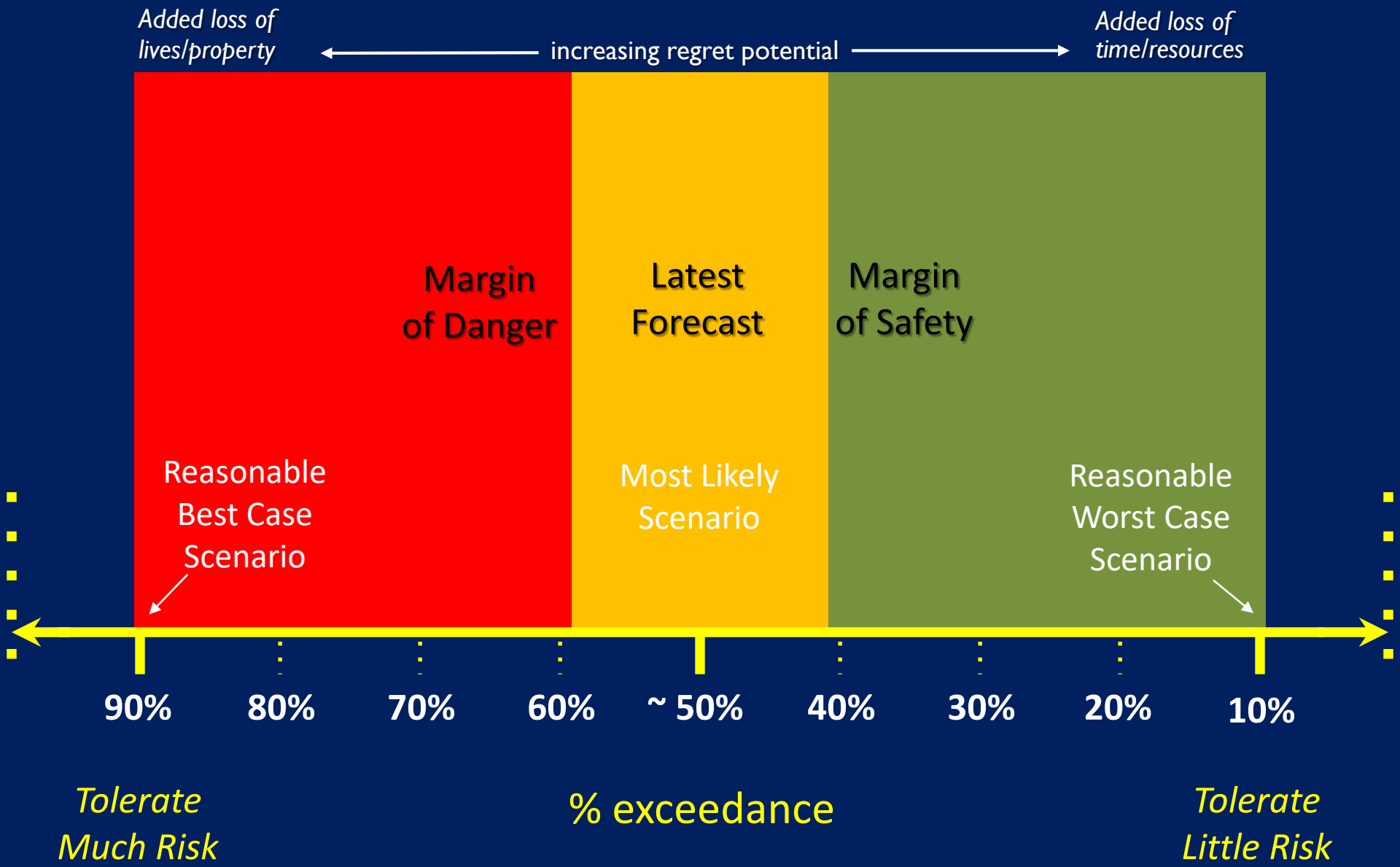

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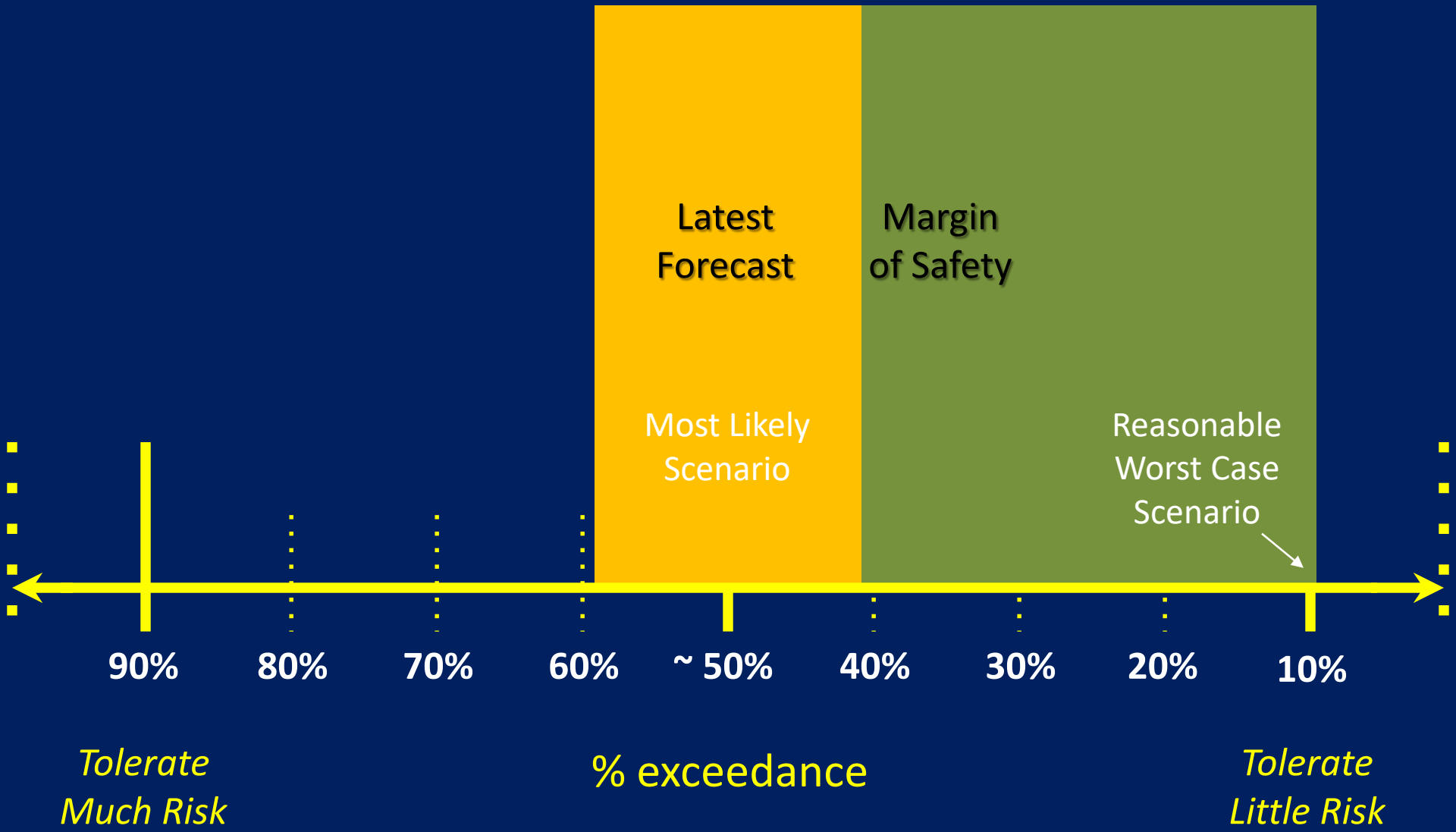
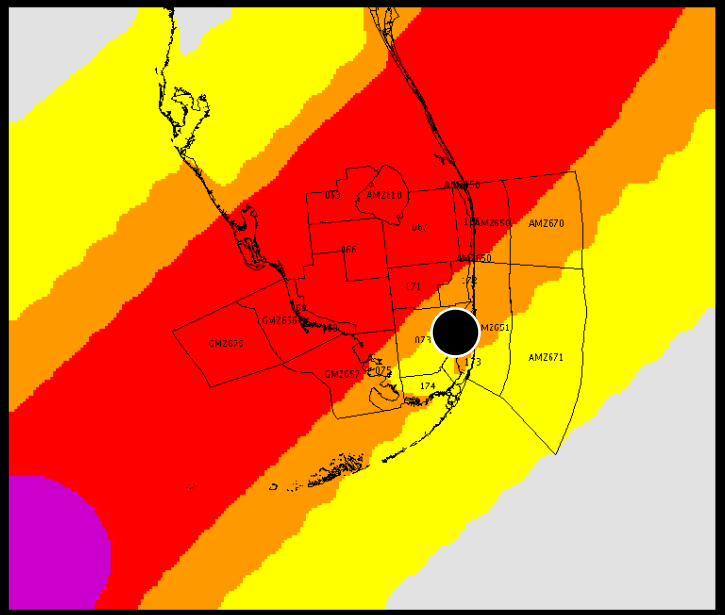
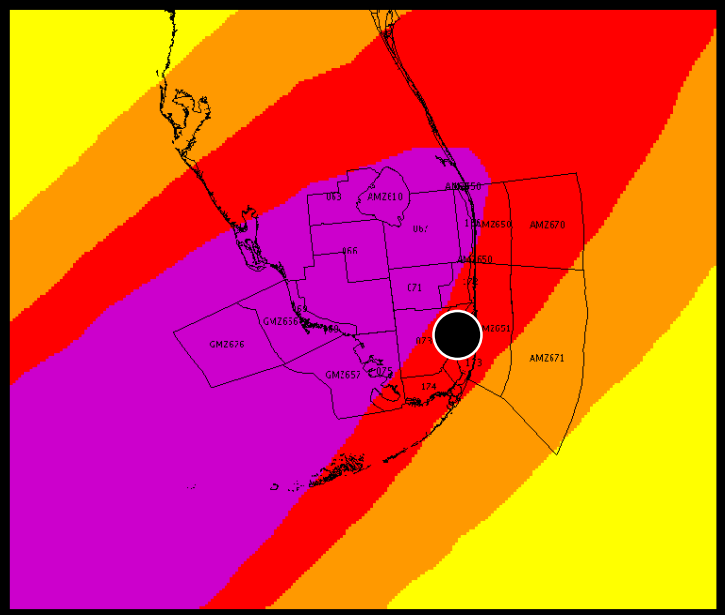


Latest Forecast



Most Likely Scenario

Forecast with Safety Margin



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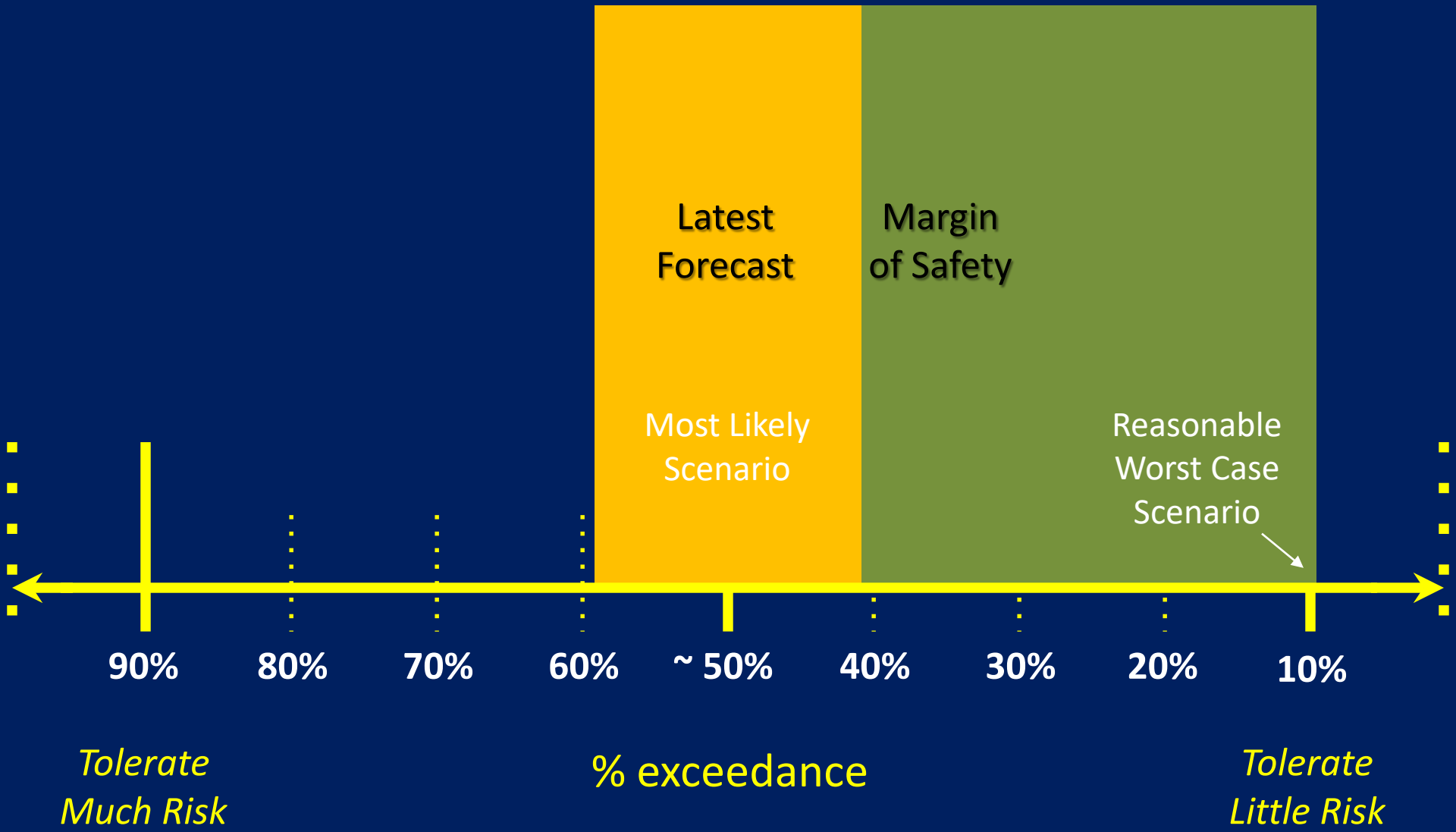

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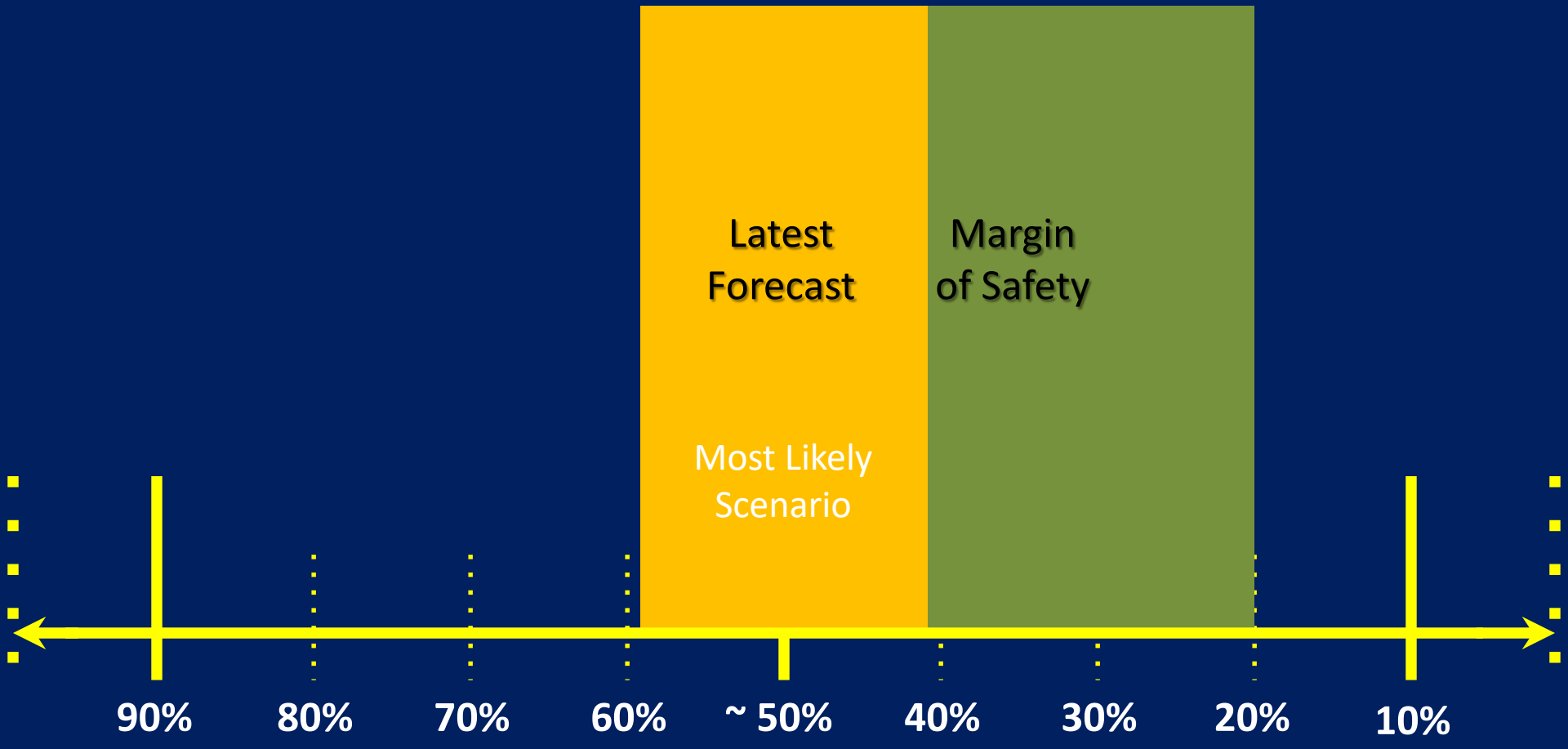
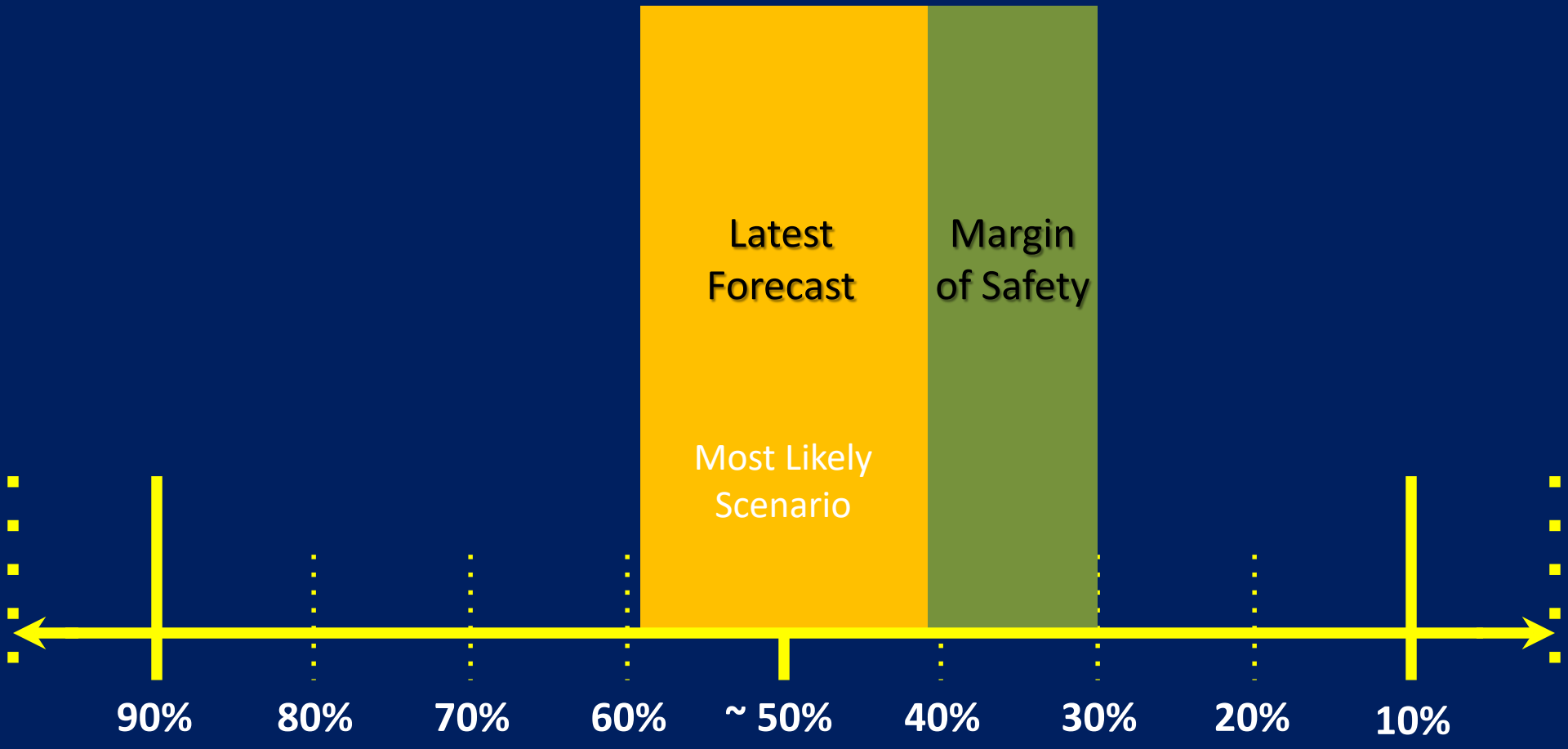
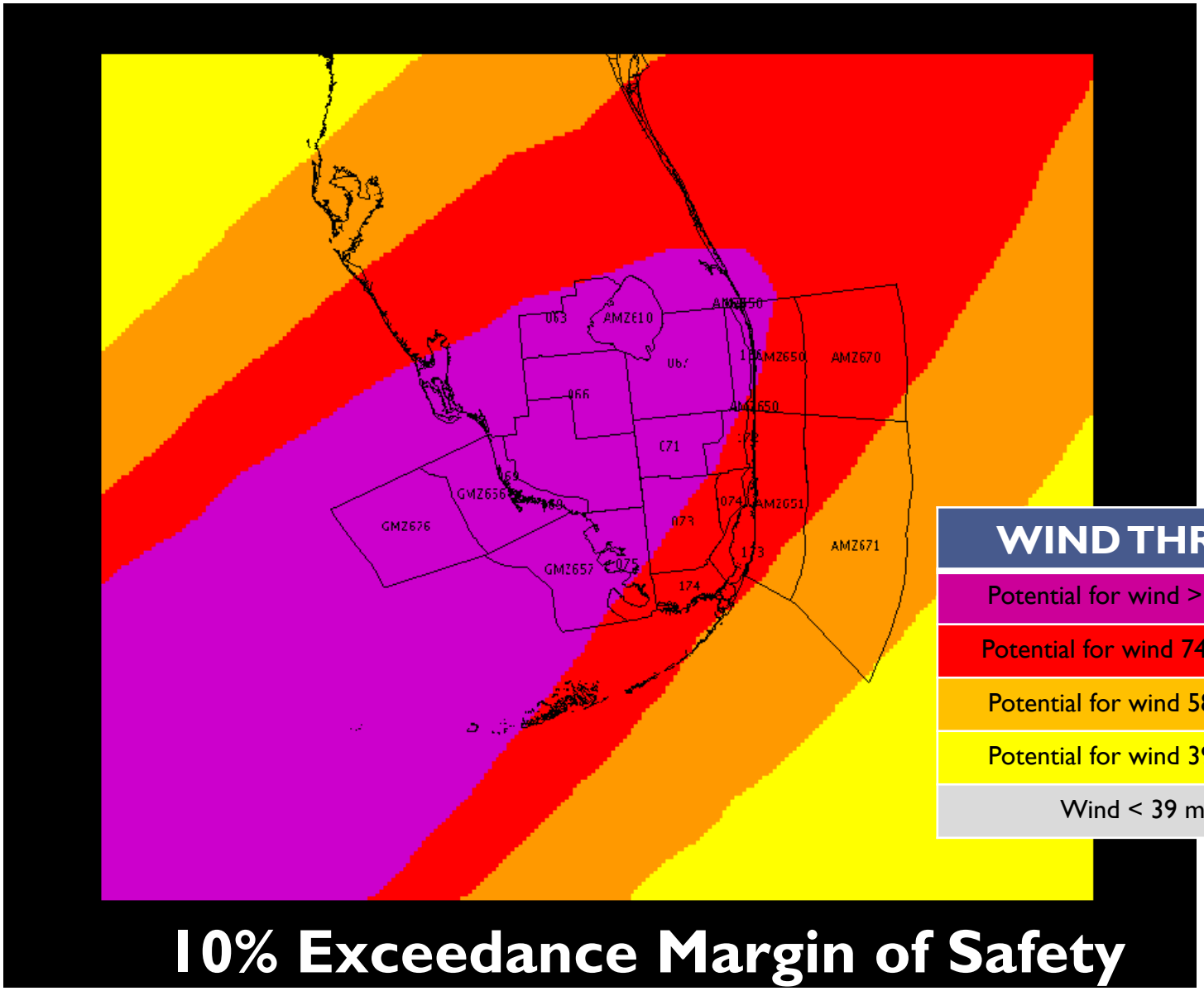


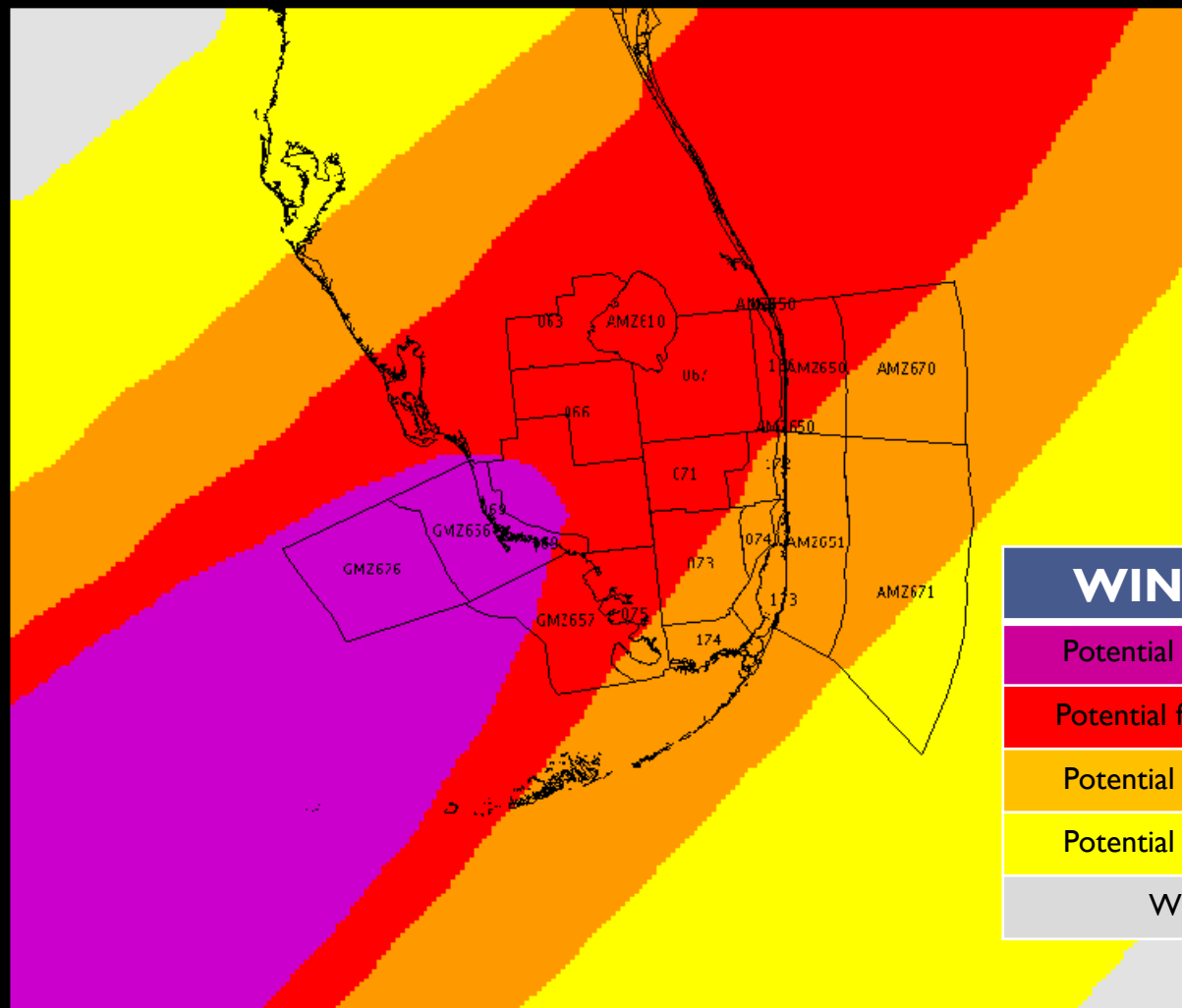
Risk Tolerance: Spectrum of Plausible Outcomes

(in event context; for a given community)



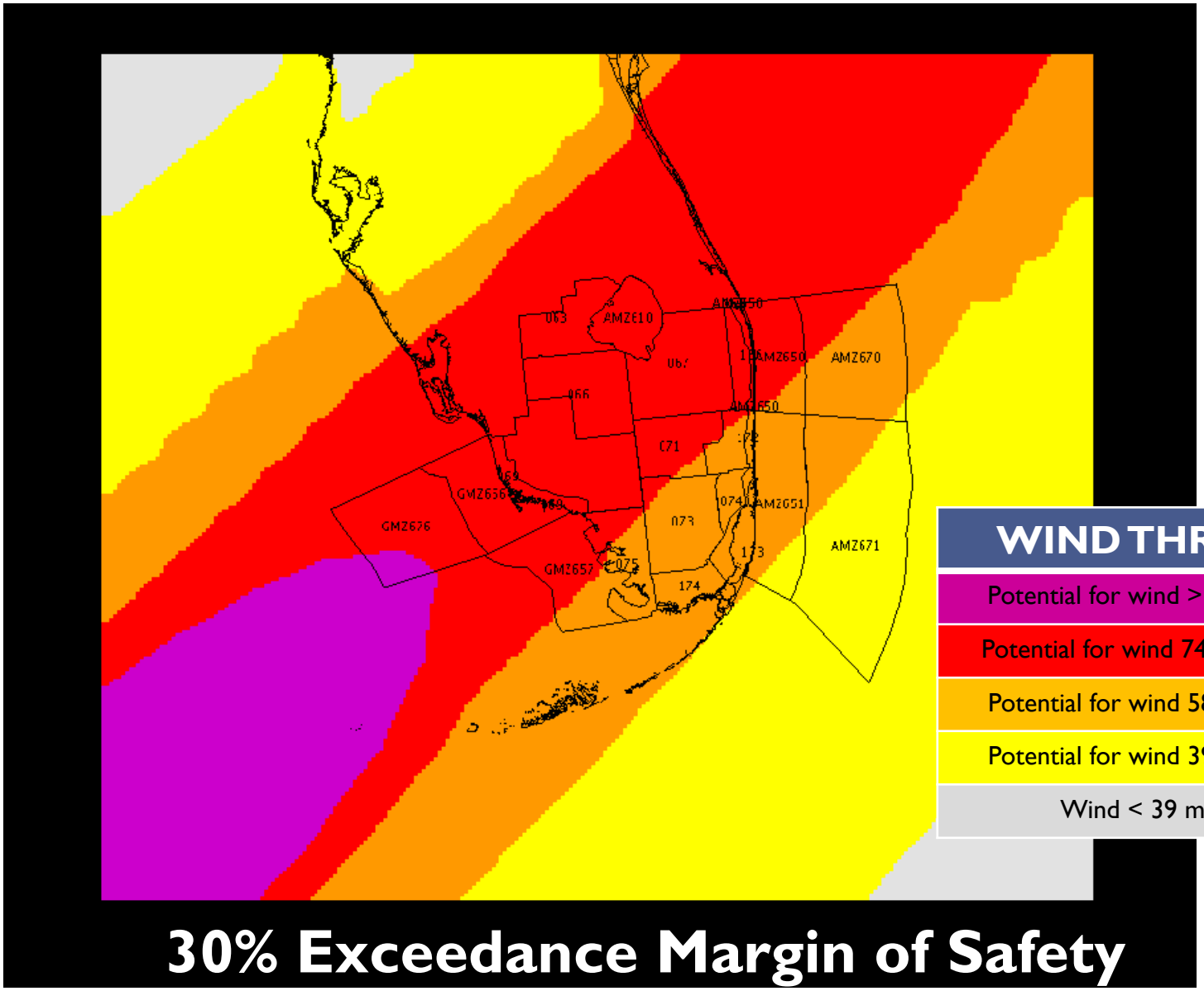
Reasonable Worst Case Scenario



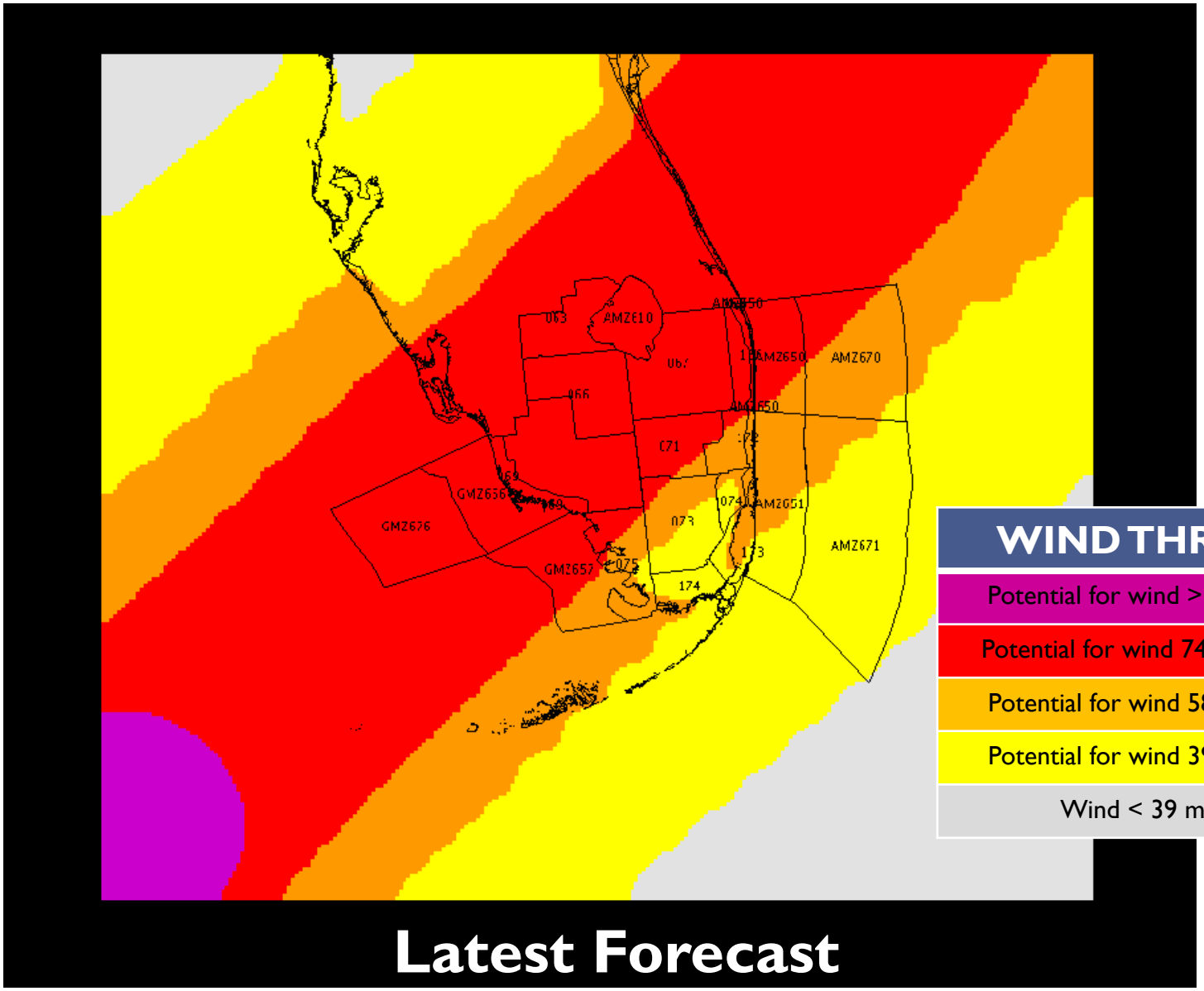


WIND THREAT
Potential for wind > 110 mph
Potential for wind 74-110 mph
Potential for wind 58-73 mph
Potential for wind 39-57 mph
Wind < 39 mph

20% Exceedance Margin of Safety

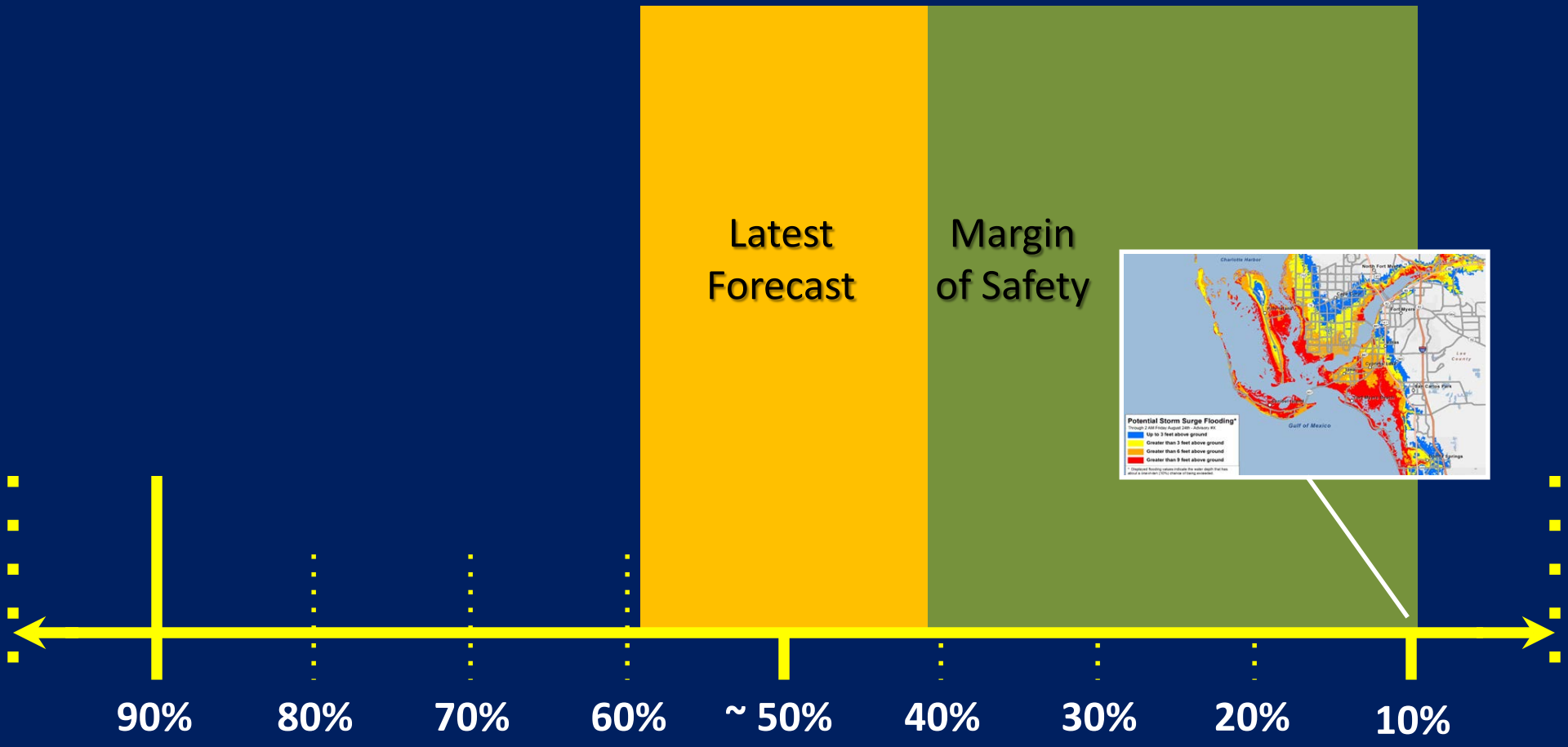

AMZ650
063
AMZE10
067
AMZ650
AMZ670
066
AMZ650
071
069
GMZ656
068
074
AMZ651
GMZ676
073
AMZ671
173
GMZ657
075
174
WIND THREAT
Potential for wind > 110 mph
Potential for wind 74-110 mph
Potential for wind 58-73 mph
Potential for wind 39-57 mph
Wind < 39 mph
30% Exceedance Margin of Safety

Most Likely Scenario



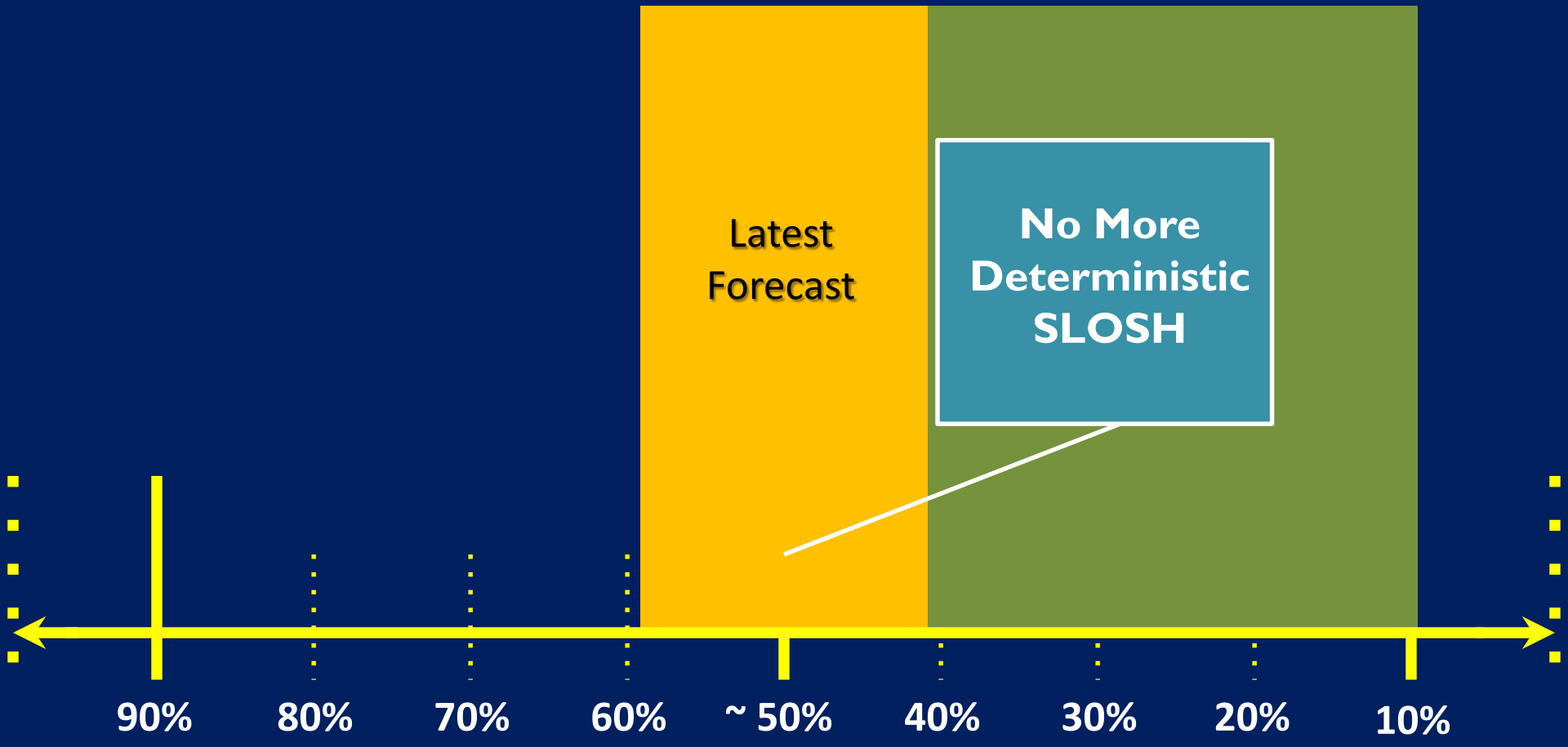
Risk Tolerance: Spectrum of Plausible Outcomes

(in event context; for a given community)



Risk Tolerance: Spectrum of Plausible Outcomes

(in event context; for a given community)



To Summarize:

"Hurricane forecasts are not perfect. Uncertainty must be accounted for when the risk to life and property is great."

To Summarize:

"Forecast uncertainty may be addressed both qualitatively and quantitatively."

To Summarize:

"Briefers can use scenario-based language to effectively convey decision support information."

To Summarize:

- *Centered on the Latest Forecast*
  - *Most Likely Scenario*
  - *Most Likely Alternate Scenario*
  - *Reasonable Worst Case Scenario*

To Summarize:

"Exceedance probabilities may be used to accommodate risk according to a customer's risk tolerance (i.e. to smartly narrow the safety margin if appropriate)."

To Summarize:

"Remember, regardless of form, both wind speed and storm surge probabilities are location specific."

Thank You