A Proposal to Clearly Define Threat and Risk for Weather Events

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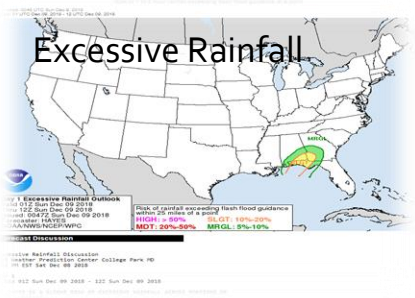
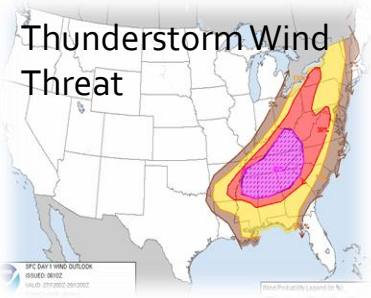
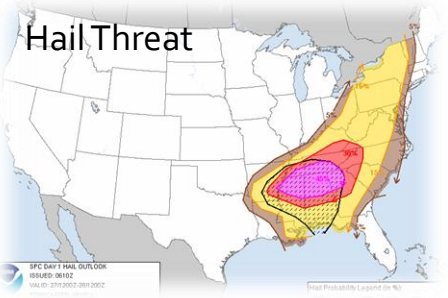






Weather-Ready Nation's Key Premise

Impact-Based Decision Support Services (IDSS) Requires Effective Communication of ***Risk***

NWS Strategic Plan, Section 1.1.1 – From Product-Focused to Interpretation

from its limited ability to convey complete information, often encompasses too wide a threat window, and is subject to widely varied interpretation. To enhance the completeness of information, NWS will develop future products from foundational datasets, with a focus on social science inputs and testing and evaluation both at test beds and the NWS Operations and Services Proving Ground. Examples are a combination of text, graphics, and imagery. To support improved decision support, services need to evolve to real-time, interactive communication of information, forecast, and risks that aids community decision-makers.

Weather-Ready Nation's Key Premise

Impact-Based Decision Support Services (IDSS) Requires Effective Communication of ***Risk***

NWS Strategic Plan, Section 1.1.1.1: Impact vs. Cause

Demand-driven IDSS will require a significant change in how NWS personnel communicate environmental information to core partners and users. Weather forecasts, watches, advisories, and warnings will need to evolve into impact-based environmental information related to NWS analysis, forecasts, and warnings through user-defined thresholds. This change represents a significant cultural shift and requires in-depth training to ensure that critical weather information is communicated in terms of societal impacts to those most at risk.

Weather-Ready Nation's Key Premise

Impact-Based Decision Support Services (IDSS) Requires Effective Communication of ***Risk***

NWS Strategic Plan, Section 1.1.2: Communicate On-Demand, Confidence Info

either it was going to rain, or it was not going to rain. Decision-makers want more information about the probability or likelihood of a high impact event to make more informed risk-based decisions. As weather-sensitive industries place greater reliance on increasingly skillful weather prediction, they are seeking a better understanding of probabilities to make optimal, objective decisions, factoring in risk, impacts, costs, and benefits. Quantifying communicating forecast certainty especially as it relates to key thresholds affected decisions during extreme events is fundamental to the success of IDSS.

What Defines Risk? A Few Examples

- FEMA: “A combination of the probability that an event will occur, and the consequences of its occurrence.” (FEMA, Unit V, Building Design for Homeland Security) In simple equation form:

  Risk = Asset Value x Threat Rating x Vulnerability Rating

- DHS/FEMA: **Risk (R)** = Threat (T) x Vulnerability (V) x Consequence (C) (Cong. Research Service, 2007)
- IPCC (2018, literature review references): “{Disaster} **Risk** is determined by a combination of physical hazards and the vulnerabilities of exposed elements.”

  Risk = Hazards (H) + Vulnerability (V) + Exposure (E) – Resiliency (R)

But…IT’S much more COMPLICATED!

Risk is a Moving Target!

- Consider:
- **Hazard** = the *possible* future occurrence of natural or man-made events that *may* have adverse effects on vulnerable and exposed elements. The "event" and associated probability of occurrence (the "threat")
- **Exposure** occurs when the hazard is *encountered* by people and the inventory of elements in the area of occurrence.
- **Vulnerability** is the *propensity* of exposed "elements" (people, livelihoods, assets) to suffer adverse effects when impacted by a hazard(s)
- **Resiliency** is the *capacity* to anticipate, cope with, and adapt to extremes and changes caused by a hazard – and reduce vulnerability

So…a Variation on the Risk Equation

$$\text{RISK}^{1} = \frac{\text{Hazards} + \text{Vulnerability} + \text{Exposure}}{\text{Resilience}}$$

Equation Notes:

Increasing the numerator results in enhancing the risk.

Increasing resilience, while holding the factors in the numerator stable (or in concert with decreasing them) will lower the overall risk.

With regard to weather and water scenarios, increased resilience can improve your capability to mitigate the effects of vulnerability and exposure.

[1] National Weather Service Impact-Based Decision Support Services Professional Development Series, Professional Competency Unit 3, Section 2: Risk Communication

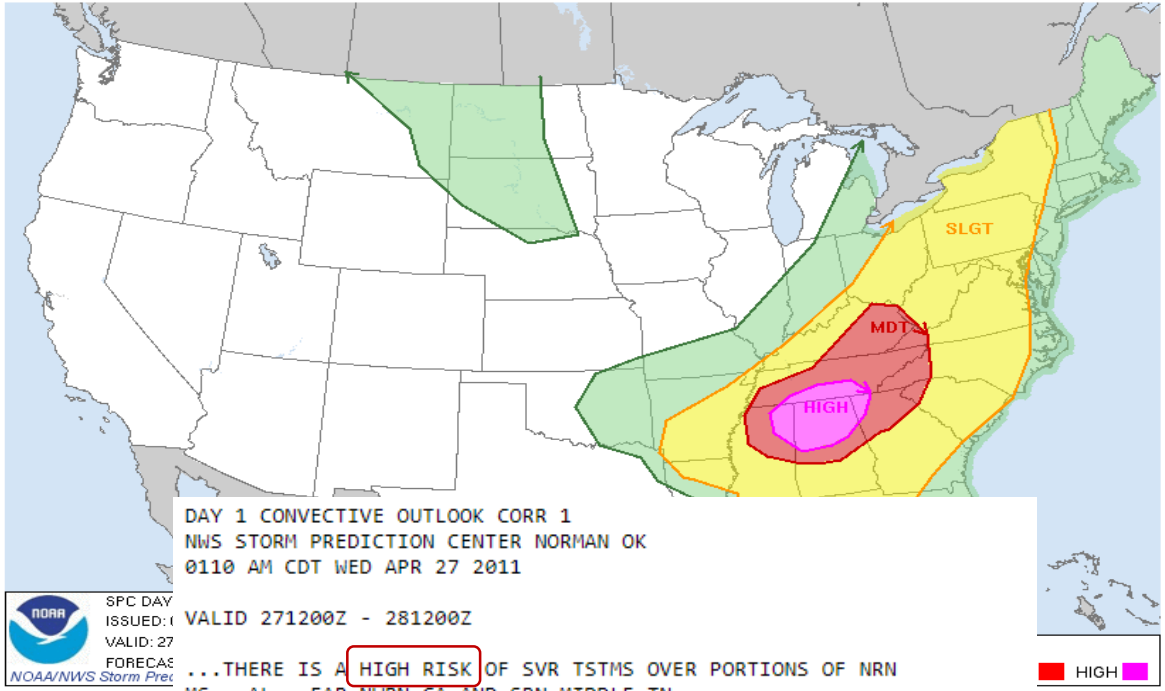
If defining Risk is so complicated…
…Why are we (Weather Enterprise) exchanging "Risk" for "Threat"?

Three Possible Reasons:

- Unintended exchange of terms ('what we really mean is…')
- No deep insight into the meaning of threat vs. risk
- "It's always been done this way"

Consider: Risk Communication is the heart of IDSS – and building WRN with core partners. We MUST get the definition correct – no matter how complicated – in order to proceed.

Incorrect Usage: NWS Storm Prediction Center



DAY 1 CONVECTIVE OUTLOOK CORR 1
NWS STORM PREDICTION CENTER NORMAN OK
0110 AM CDT WED APR 27 2011

VALID 271200Z - 281200Z

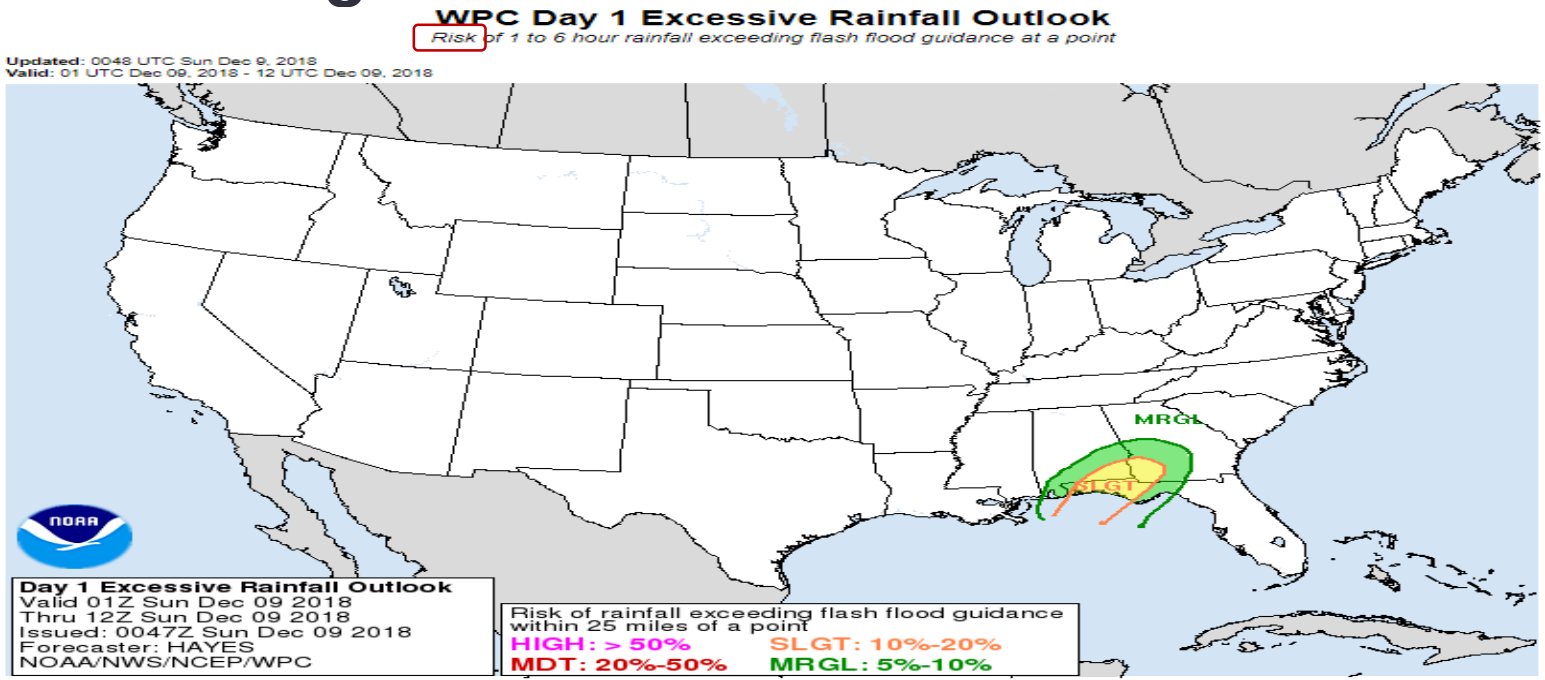
...THERE IS A HIGH RISK OF SVR TSTMS OVER PORTIONS OF NRN MS...AL...FAR NWRN GA AND SRN MIDDLE TN...

...THERE IS A MDT RISK OF SVR TSTMS OVER MUCH OF CNTRL AND NRN MS AND AL...NWRN GA...MUCH OF TN AND KY...WRN CAROLINAS...

...THERE IS A SLGT RISK OF SVR TSTMS FROM THE LOWER MS VALLEY/GULF COAST STATES NWD TO THE CANADIAN BORDER...

Incorrect Usage: Media Using Storm Prediction Center Graphic

Incorrect Usage: NWS Weather Prediction Center



Forecast Discussion

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Excessive Rainfall Discussion
NWS Weather Prediction Center College Park MD
752 PM EST Sat Dec 08 2018

Day 1
Valid 01Z Sun Dec 09 2018 - 12Z Sun Dec 09 2018

...THERE IS A SLIGHT RISK OF EXCESSIVE RAINFALL ACROSS PORTIONS OF
THE SOUTHEAST...
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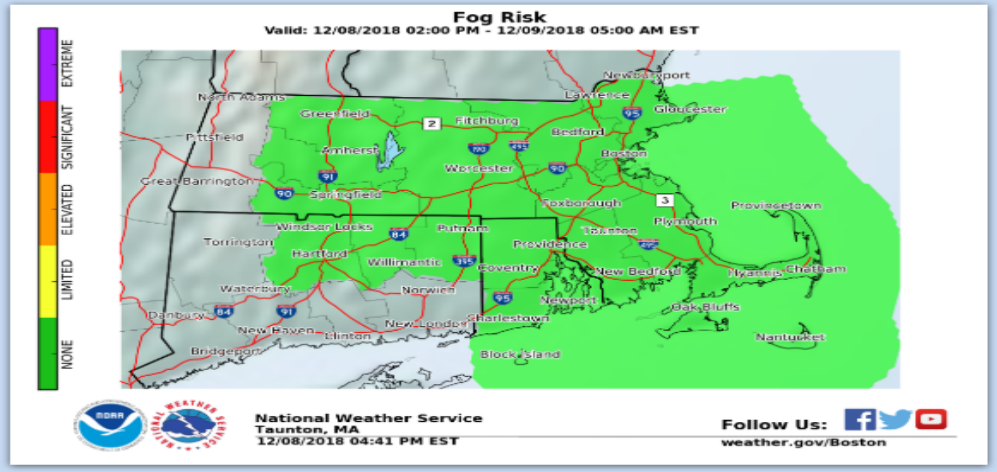
Incorrect Usage: NWS Forecast Office Graphical Weather Outlook

Fog Risk
This Afternoon/Tonight
Current Time - 6 am

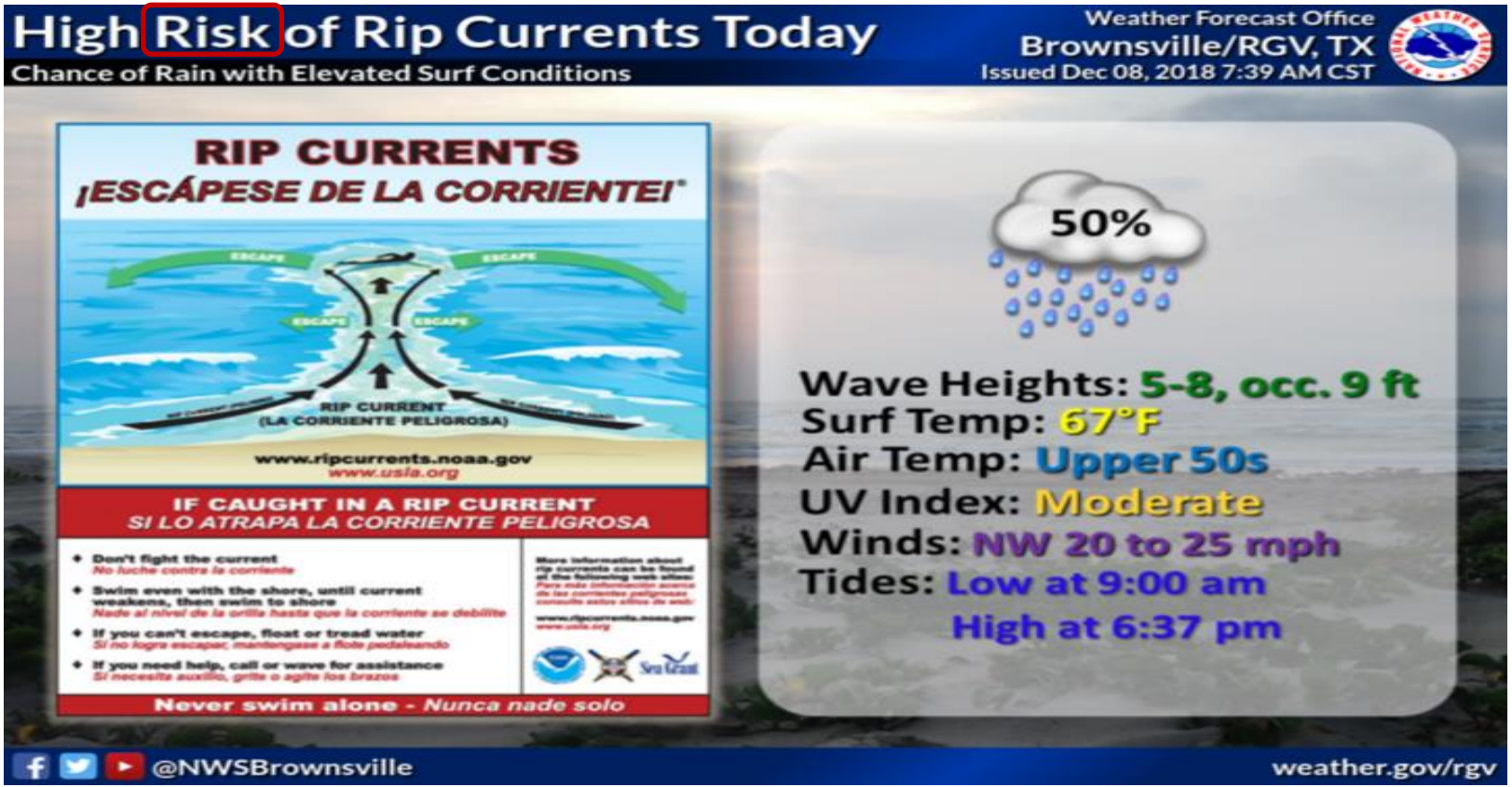


24 Hr. Hazards	Day 1	Sun	Mon	Tue	Wed	Thu	Fri
Tornado							
Hail							
Thunderstorm Wind Gust							
Severe Thunderstorms							
Lightning							
Flooding							
Fire Weather							
Fog							
Non Thunderstorm Winds							
Excessive Heat							
Coastal Flood							
High Surf							
Marine Hazard							
Freezing Spray							

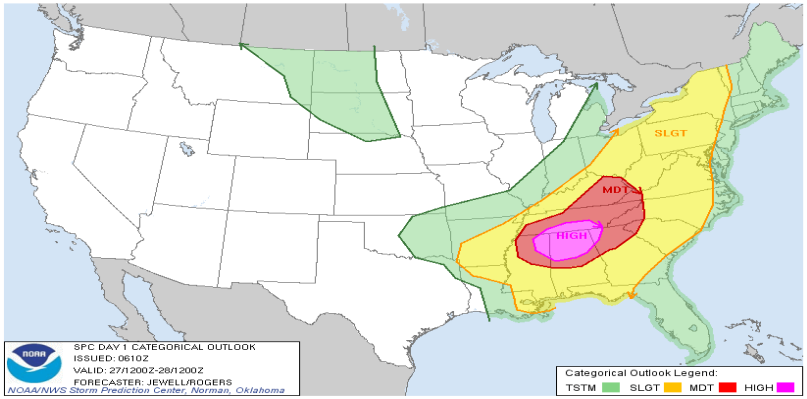
Fog Legend Fog Safety Tips

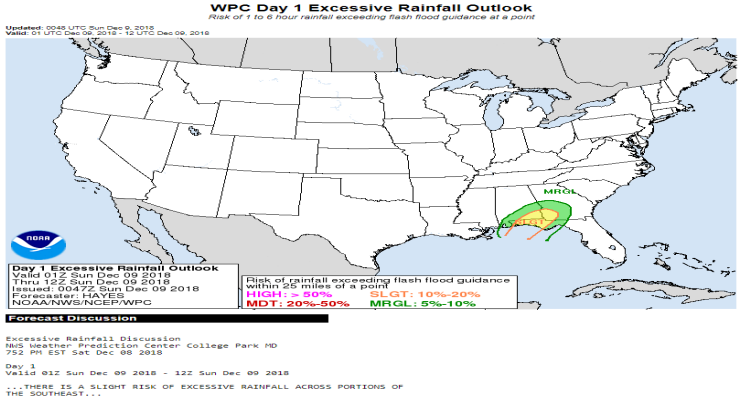
Risk Level	Definition
None	No risk of fog.
Limited	Fog with visibilities less than or equal to 1 mile.
Elevated	Fog with visibilities less than or equal to 1/2 mile.
Significant	Fog with visibilities less than or equal to 1/4 mile.
Extreme	Fog with near zero visibilities.

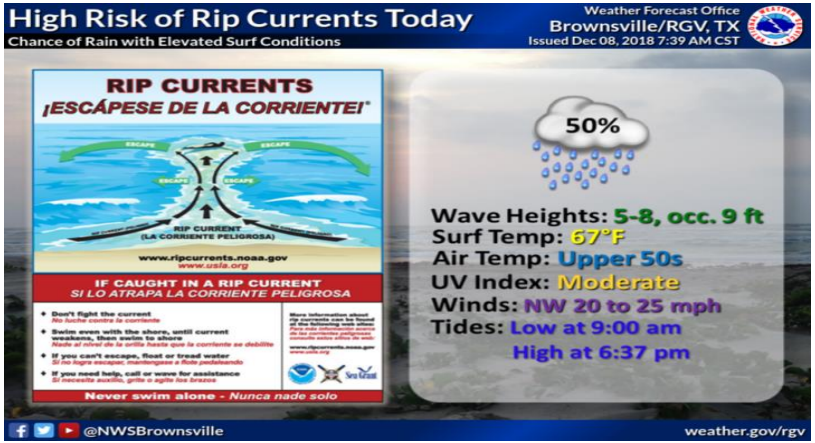
Incorrect Usage: NWS Forecast Office

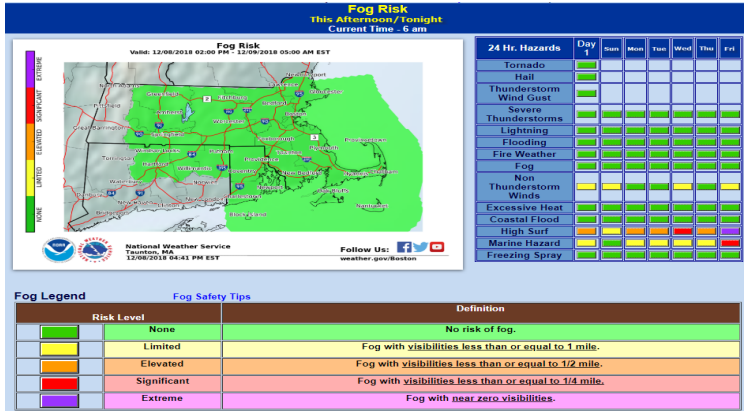


Let's Take a Look At Each Case…



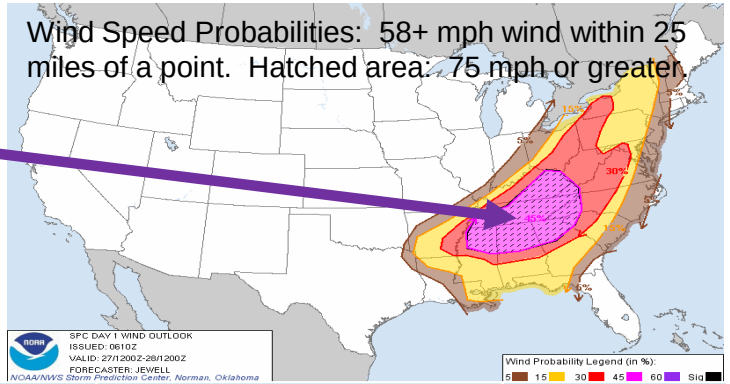






Storm Prediction Center

In "High" Threat Area (and "hatched"):



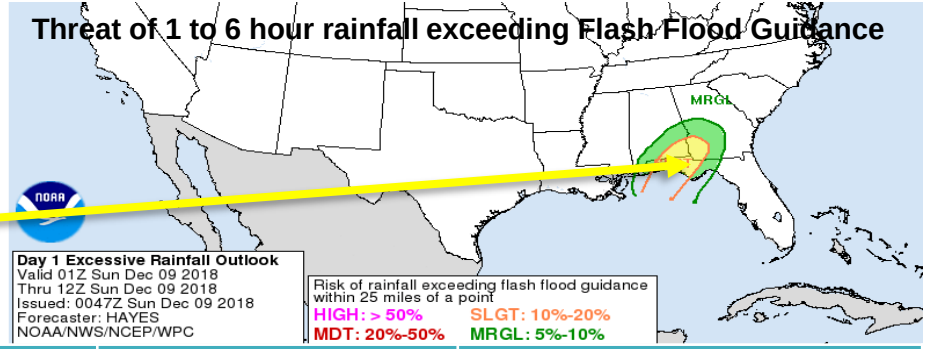
Consider Building Construction:

Construction Quality	Implicit Vulnerability	Threat Condition	Risk Level	Pre-Event Resiliency	Evidence
Poor	Substantial+	(unusually) High	Extreme	Little to None (no means to harden home prior to event	 Donna, TX, 2015
Well-Built	Marginal	(unusually) High	Moderate to High	Strength of walls and roof; internal windowless rooms, double-pane windows	 Sunnyvale, TX, 2015
Hurricane-Resilient	Near Zero	(unusually) High	Low to none	Miami-Dade rated "steel" home; 130+ mph rated windows and doors or similar shutter systems that can be activated in moments	 Punta Gorda, Florida, 2004

Weather Prediction Center

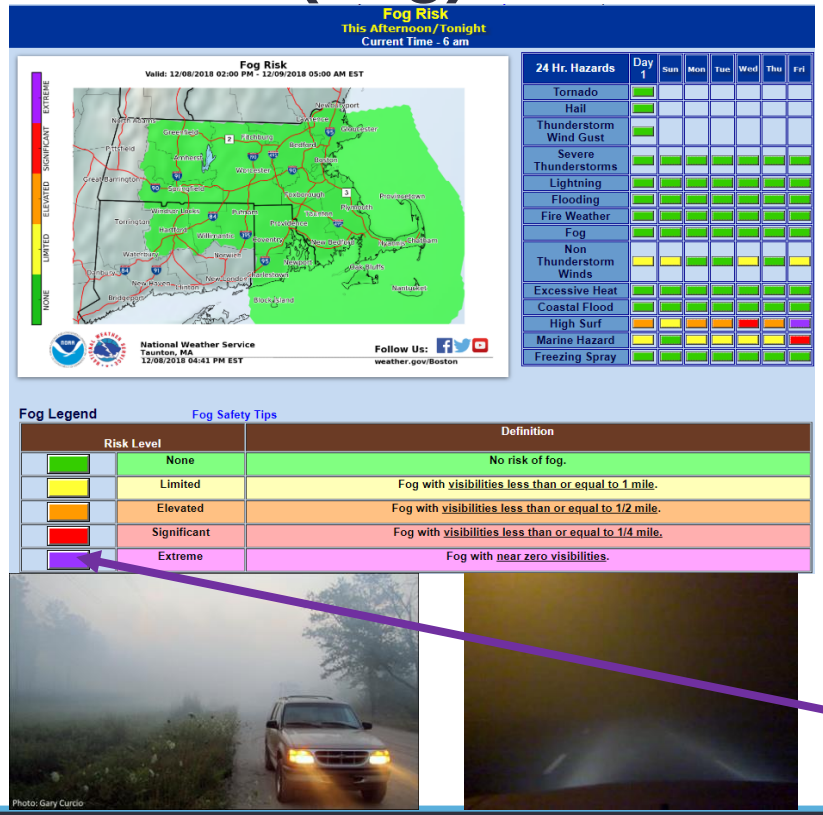
In "Slight" (Low Probability) Threat Area.

Note: Rainfall rate is not explicitly factored into calculation



Geographic Location	Drainage Situation	Threat Condition	Risk Level	Pre-Event Resiliency (Prepare For)
Low Lying	**Good**	**Low**	**Low**	• Roads: Know which are perilous • Home: Minimum preparedness (seals/sandbags)
Low Lying	**Poor**	**Low**	**Moderate to High**	• Roads: Perilous on all drives • Home: Seals, sandbags, first floor items moved higher
Higher Ground	**Poor**	**Low**	**Low to Moderate**	• Roads: Keep track of roads. Some will be perilous. • Home: Minimum preparedness (seals/sandbags)

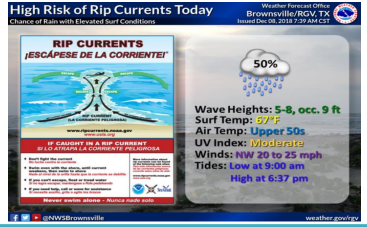
Weather Forecast Office: Enhanced Hazardous Weather Outlook (Fog)



- Vulnerability from fog differs from rainfall, wind, and ocean currents as it does not create a ***direct*** impact
- At limited, elevated, and significant levels, ***risk*** can be related to the following:
  - Day vs. Night
  - Urban vs. Rural
  - Vehicle lights (fog lights vs. “downroad” HD vs. incandescent)
  - Other vehicle safety features (tire tread/inflation, brakes, wipers)
- At “extreme”, risk and threat are equal here (zero visibility is…zero!!)

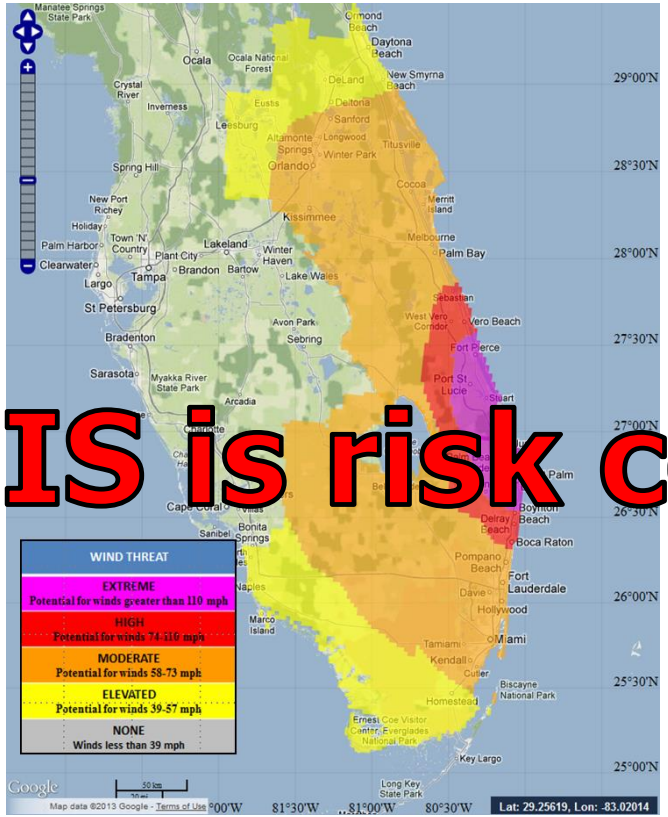
Weather Forecast Office – Rip Currents

All rip currents are dangerous by definition. We're actually talking about a ***threat*** of rip current ***intensity***



Swim Skill Level	Rip Current Intensity	Risk	Resiliency Actions
Poor (little to no swim training, up to American Red Cross (ARC, Level 2)	**Low**	**Moderate to High**	Waist deep water with flotation device
	Moderate	**High**	Knee deep water with flotation device
	High	**Extreme**	Toes in water only
Average (Equivalent swim training of ARC Level 5)	**Low**	**Low to Moderate**	Swim but be aware and ready to swim out of the current
	Moderate	**Moderate to High**	Swim with flotation device and be ready to swim out of the current. If any doubt in abilities, remain in waist deep water
	High	**High to Extreme**	Knee deep with flotation device
Excellent (Equivalent of swim training of ARC Level 6+; "seasoned" surfer for multiple wave regimes)	**Low**	**None to Low**	Safe swimming
	Moderate	**Low to Moderate**	Swim but be aware and ready to swim out of the current
	High	**Moderate to High**	Swim with flotation device and ready to swim out of current. **High** risk a challenge to the most expert swimmers

Getting it Right: Hurricane Threats and Impacts (HTI)

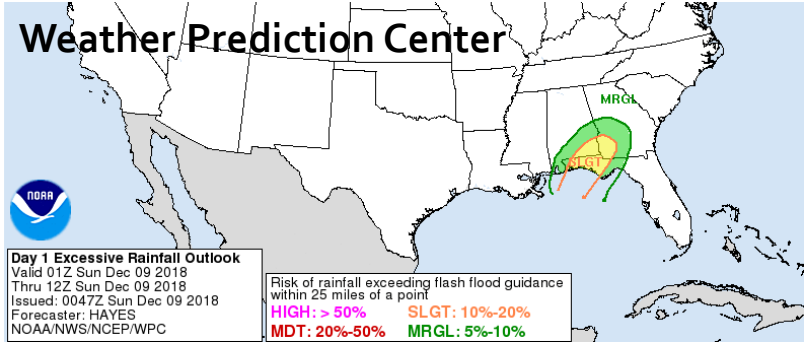


Wind Threat	Potential Wind Impacts
Wind greater than 110 mph	**DEVASTATING TO CATASTROPHIC** Prepare for structural damage to sturdy buildings, some with complete roof failure, and complete destruction of poorly built structures. Numerous large trees snapped and uprooted. Widespread power and communications outages. Locations may be uninhabitable for weeks.
Threat for wind 74-110 mph	**EXTENSIVE** Prepare for considerable roof damage to sturdy buildings, with some window, door, garage failure leading to structural damage. Mobile homes severely damaged, with some destroyed. Large areas with power and communications outages.
[illegible]	**SIGNIFICANT** [illegible] large trees snapped and uprooted, more numerous for shallow-rooted varieties. Scattered power outages, more prevalent in areas with above-ground lines.
Threat for wind 39-57 mph	**LIMITED** Prepare for damage to porches, awnings, carports, sheds, and unanchored mobile homes. A few trees snapped or uprooted. Scattered power and communications outages.
Wind less than 39 mph	**LITTLE TO NONE** Prepare for little to no damage, mainly from falling palm fronds and movement of lightweight unfastened objects such as lawn furniture.

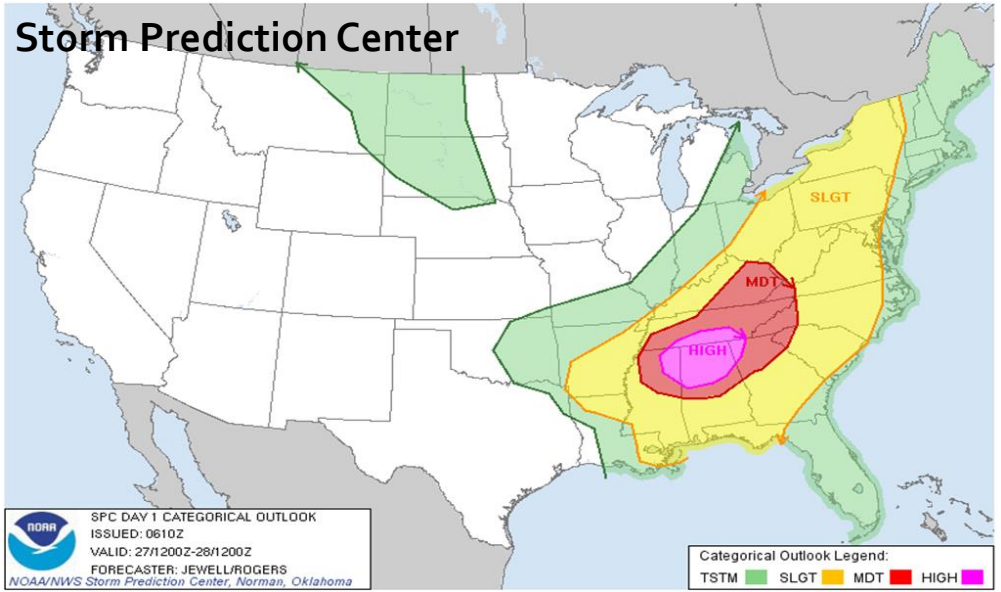
THIS is risk communication!

The Proposal: Replace Usage of “Risk” with “Threat”!

Good starting points, as these examples include true threat based on *probability* forecasts



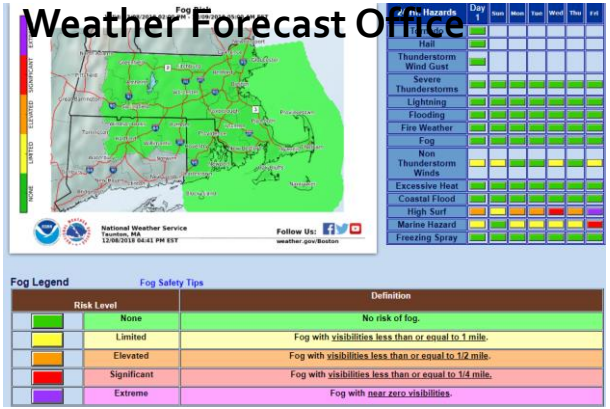
Threat of exceeding flash flood guidance (10-20 percent in “slight” area) within 25 miles of a point



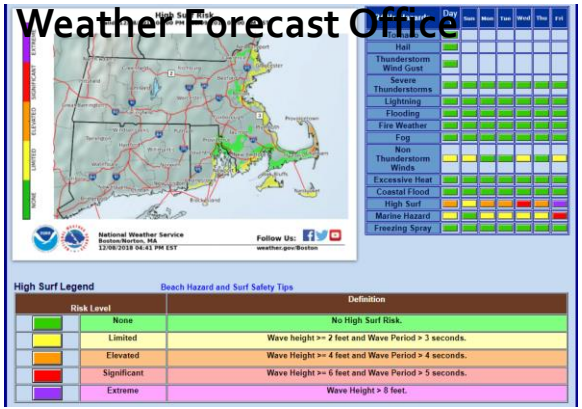
Threat of 58+ and 75+ mph wind within 25 miles of a point

The Proposal: Replace Usage of “Risk” with “Threat”!

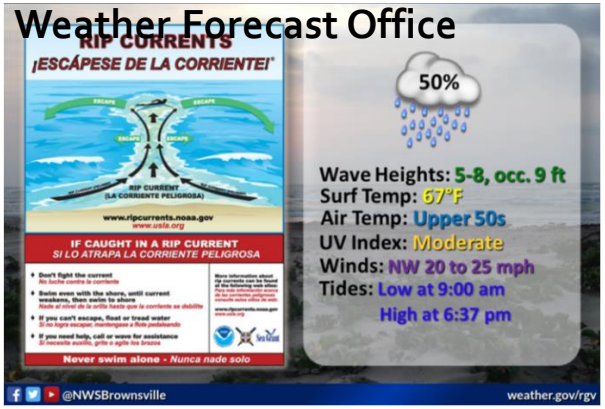
Work to do! These are deterministic forecasts of elements related to potential hazards; even “threat” is not strictly correct



Threat of visibility levels as assigned. Most likely based on a deterministic forecast of visibility and fog occurrence



Threat of High Surf based on deterministic wave height and onshore swell period



Threat of intense rip currents, based on deterministic heuristics of offshore seas and swell.

Getting There

- Starting point: Replace the term risk with the term threat for probabilistic forecasts of hazards (events)
- Next steps/ongoing:
  - Develop probabilistic forecasts for all potential hazards (events) to create new threat matrices
  - Continue developing multi-level impact provision, at least for “most likely” and “reasonable worse case” outcomes for all potential hazards (non-tropical cyclone flooding, winter weather, wildfire growth/spread, non-convective wind, etc.)
- Through the 2020s:
  - Continue to develop potential impacts targeted to neighborhood – or even home/business – level by leveraging dynamic GIS data – based on “most likely” and “reasonable worse case” outcomes. Community partners are key to providing resiliency/vulnerability specifics.

NOW we’re talking risk communication. Let’s do this!

Thank You!

Questions?

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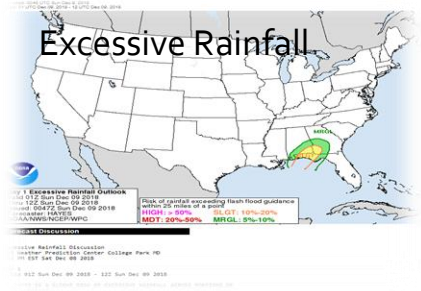
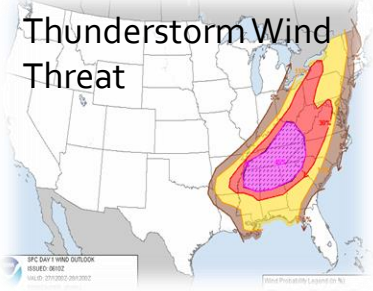
Excessive Rainfall



Lightning Threat

Thunderstorm Wind Threat



Hail Threat