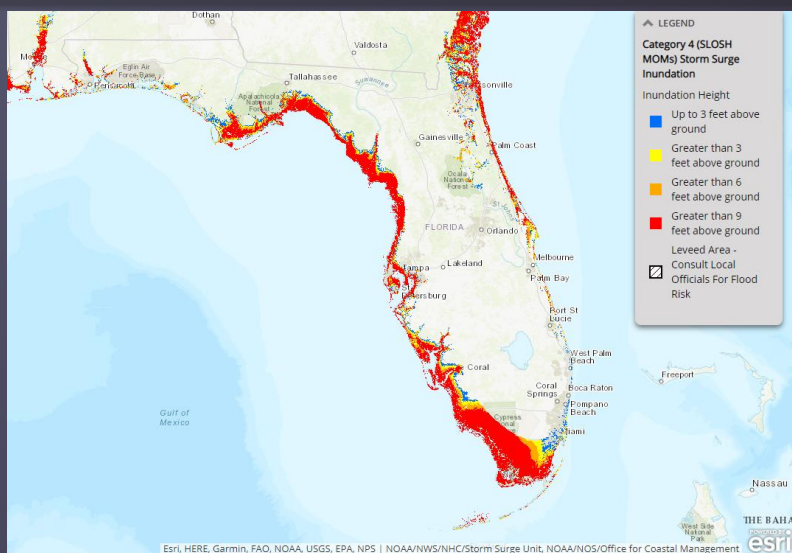


Florida's Storm Surge Issues The Local's Perspective

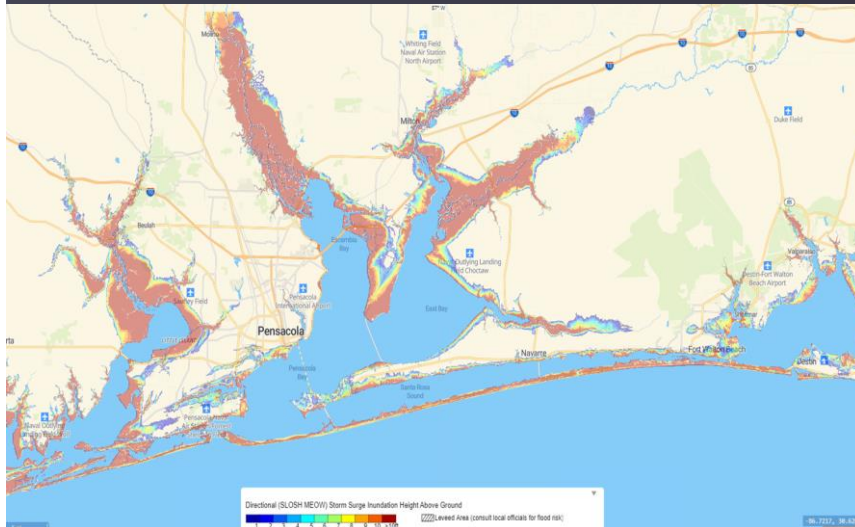


Florida's Storm Surge Issues The Local's Perspective



Maximum Potential Surge Inundation

Northwest Florida



- Quick elevation rise generally confines the greatest surge along immediate coastal areas.
- Barrier island locations most susceptible (Perdido Key, Pensacola Beach, Okaloosa Island, etc.)
- Northern portions of Perdido, Escambia, and East Bays very vulnerable to surge due to lower lying river valleys and the narrowing shape of the bays tends to funnel water advancing northward.

Highest Observed Water Levels

Pensacola, FL



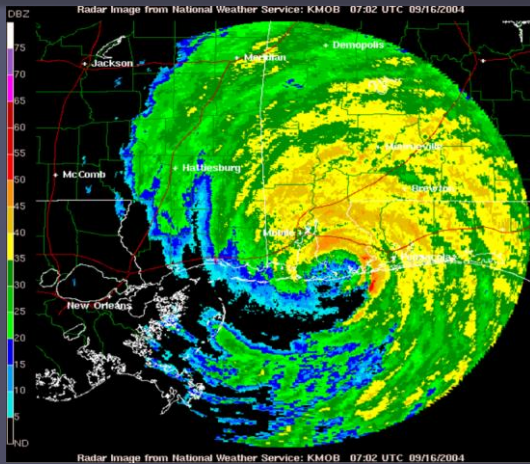
NOS/NOAA/CO-OPS
Top-10 Highest Water Levels
8729840, Pensacola FL

Date	Height (Feet above MHHW)	Event Category	Event	Source
September 16, 2004	9.54	Tropical	Hurricane Ivan	High Water Mark
September 20, 1926	7.42	Tropical	1926 Miami hurricane	High Water Mark
September 16, 2020	5.60	Tropical	Hurricane Sally	Observed Peak Water Level
August 29, 2005	5.43	Tropical	Hurricane Katrina	Observed Peak Water Level
October 4, 1995	4.71	Tropical	Hurricane Opal	Observed Peak Water Level
July 10, 2005	4.26	Tropical	Hurricane Dennis	Observed Peak Water Level
September 12, 1979	4.25	Tropical	Hurricane Frederic	Last Recorded Water Level
September 28, 1998	3.77	Tropical	Hurricane Georges	Observed Peak Water Level
August 31, 1950	3.31	Tropical	Hurricane Baker	Last Recorded Water Level
September 26, 2002	3.08	Tropical	Hurricane Isidore	Observed Peak Water Level

- These are the top 10 highest water levels observed at Pensacola, FL
- Currently, this tidal gauge at Pensacola (located the Port of Pensacola) is the only tide gauge located in northwest Florida. The next closest gauge is located in Panama City.

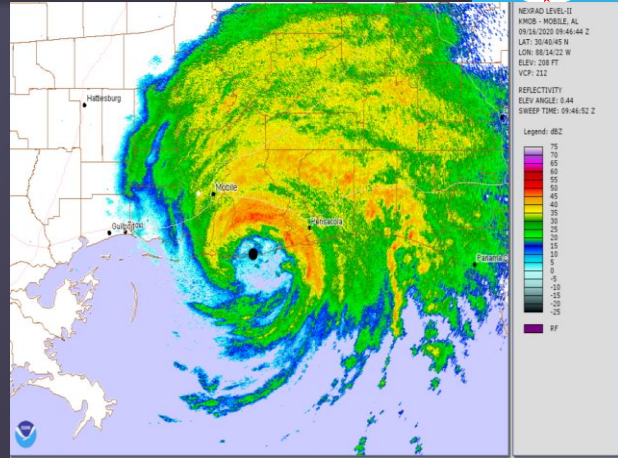
Ivan & Sally Outcomes

Same Location - Different Surge



Hurricane Ivan

- Landfall: September 16, 2004 in Gulf Shores, AL
- Landfall Intensity: 120mph, 943mb



Hurricane Sally

- Landfall: September 16, 2020 in Gulf Shores, AL
- Landfall Intensity: 110mph, 965mb

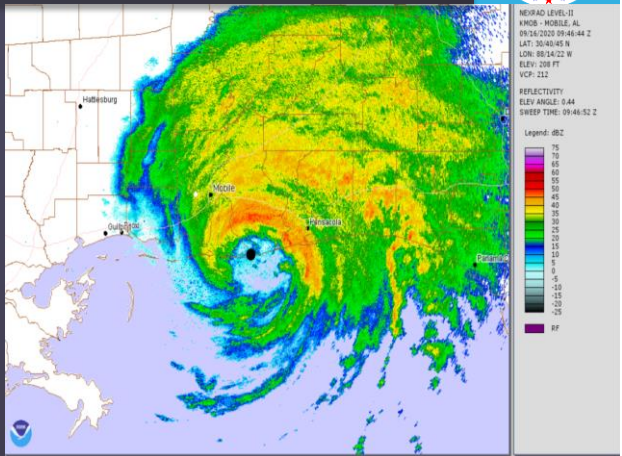
Ivan & Sally Outcomes

Same Location - Different Surge



Hurricane Ivan

- Peak Storm Surge: 10-15 ft from Pensacola to Destin
- Surge devastated both Gulf-facing shores and inland bay areas

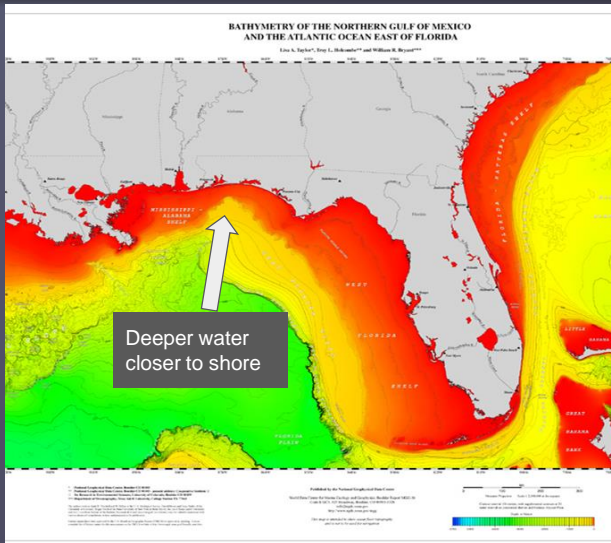


Hurricane Sally

- Peak Storm Surge Inundation: 5-7 ft
- Greatest surge and damage was in the inland bays and not along the Gulf. Total water levels were further compounded by excessive rainfall.

Large Battering Waves

Northwest Florida



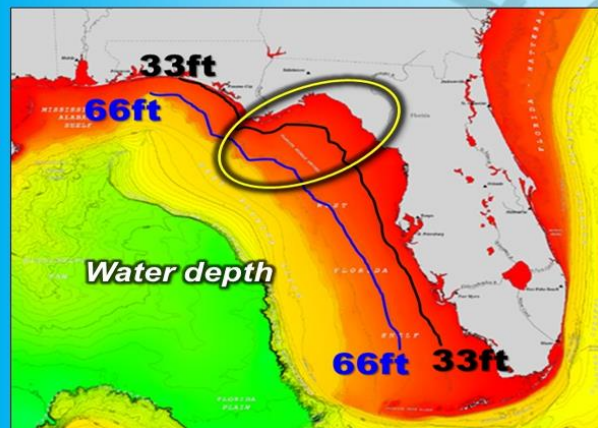
- Deeper water reaches closer to the coastline of northwest Florida.
- This results in larger waves making it closer to shore before breaking.
- Large, breaking waves result in wave run up/set up that results in enhanced flooding of barrier islands prior to the arrival of the main surge.
- These large waves also can produce damage to the barrier islands.

Surge Vulnerability

Florida Panhandle/Apalachee Bay



Apalachee Bay is one of the most surge-prone areas in the United States



Shape of the coast
(funneling in)

-AND-

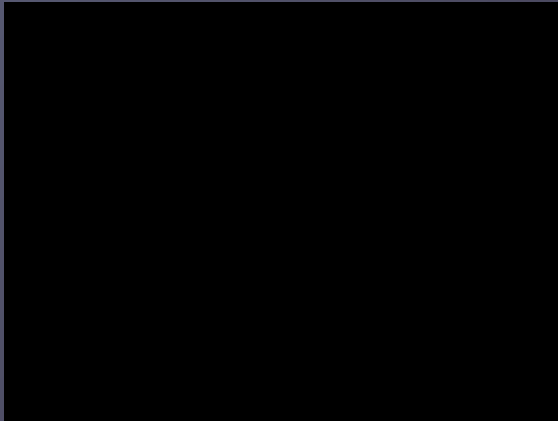
Shallow shelf waters

AMPLIFY
surge

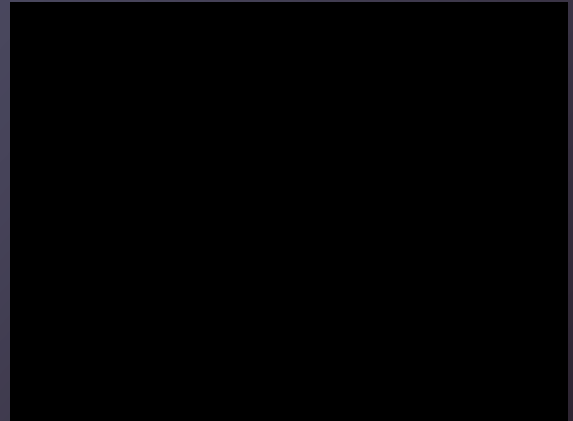
The shallow shelf waters extend many miles offshore. A shallower slope to the coast tends to make an area more prone to the effects of storm surge.

Surge Vulnerability

Florida Panhandle/Apalachee Bay



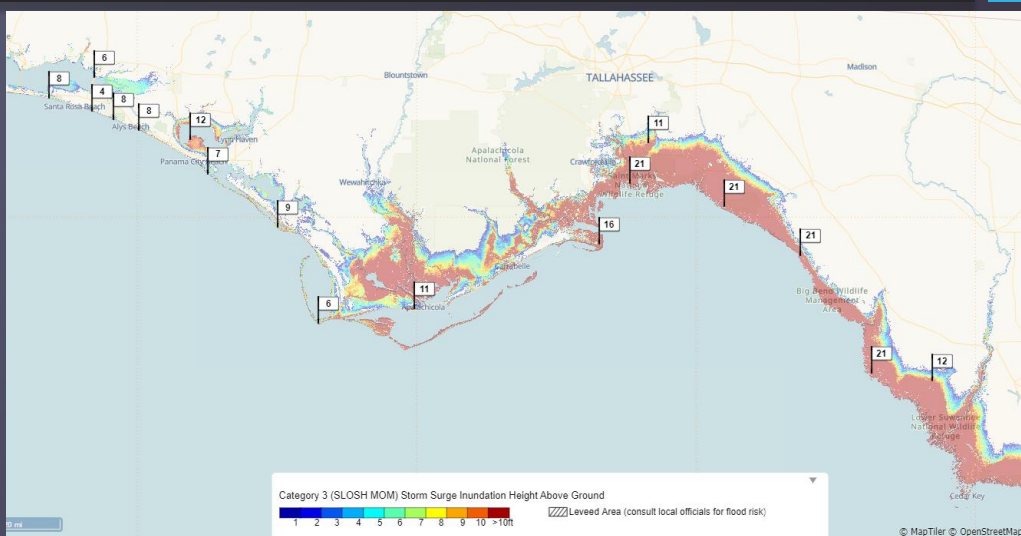
Narrow, sharp slope shelf -
More typical of the Florida Panhandle



Wide, gently sloping shelf -
Similar to Apalachee Bay

Surge Vulnerability

Florida Panhandle/Apalachee Bay



NWS Tampa Bay

Evacuation Difficulties



The 5 Most Difficult Hurricane Evacuation Areas in the US

1. Southwest Florida
2. Tampa Bay area, Florida
3. Delmarva Peninsula (DE, MD, VA)
4. New York City/New Jersey Coast
5. Southeast Florida

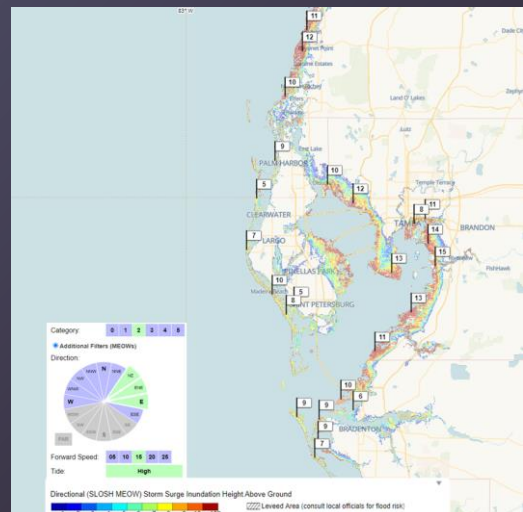
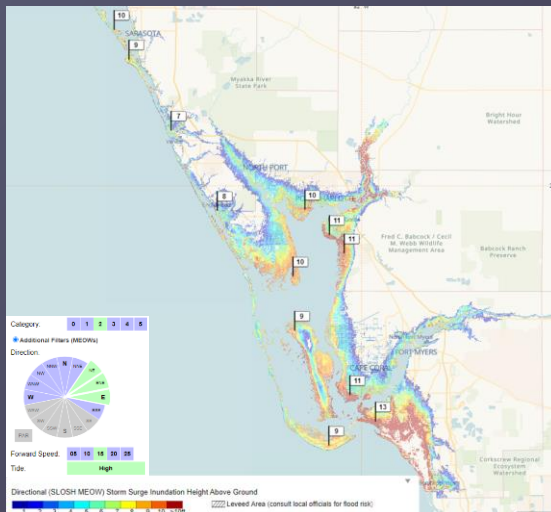
According to a study by Donald Lewis, VP of ATKINS at the 2012 National Hurricane Conference

NWS Tampa Bay

Southwest Florida and Tampa Bay



Landfalling Cat 2

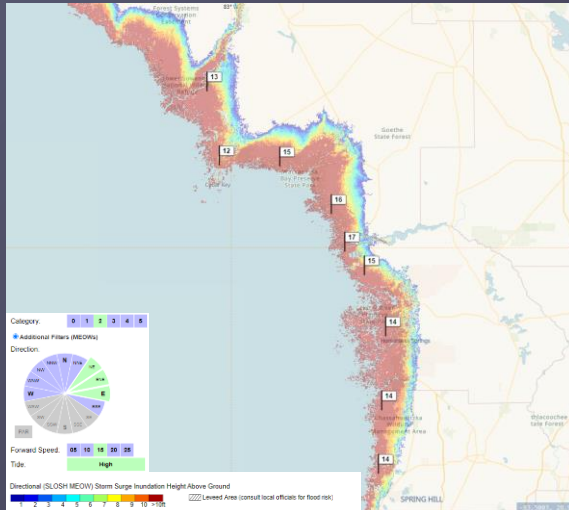


NWS Tampa Bay

Nature Coast



Landfalling Cat 2



Main Takeaways:

- Remember that every storm is unique; this is only meant to highlight vulnerable areas
- Barrier Islands take a huge brunt of the surge where they exist – realize that with strong storms, new passes may be carved into these islands
- Surge can push well inland along the Nature Coast, inside Tampa Bay and Charlotte Harbor, and along rivers
- Small changes in the storm can make for large differences in the outcome of where the highest surge occurs. Our probabilistic forecasts account for these variances.

NWS Tampa Bay

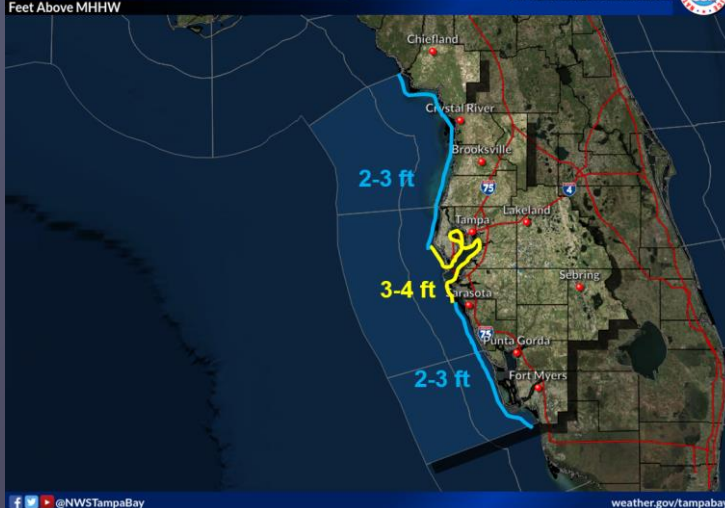
A Look Back at 2020 TS Eta



Tropical Storm Eta Storm Surge

Feet Above MHHW

Weather Forecast Office
Tampa Bay/Ruskin, FL



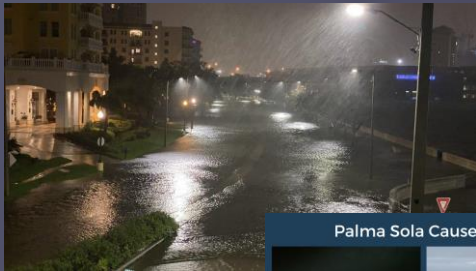
- Highest Surge values recorded were in Tampa Bay (3.87 ft at Old Tampa Bay)
- More of a NNE movement – landfall near Cedar Key, FL
- Over \$50 Million in damages mainly from surge

NWS Tampa Bay

A Look Back at 2020 TS Eta



"Just a Tropical Storm"



Tampa –
Bayshore



Bradenton

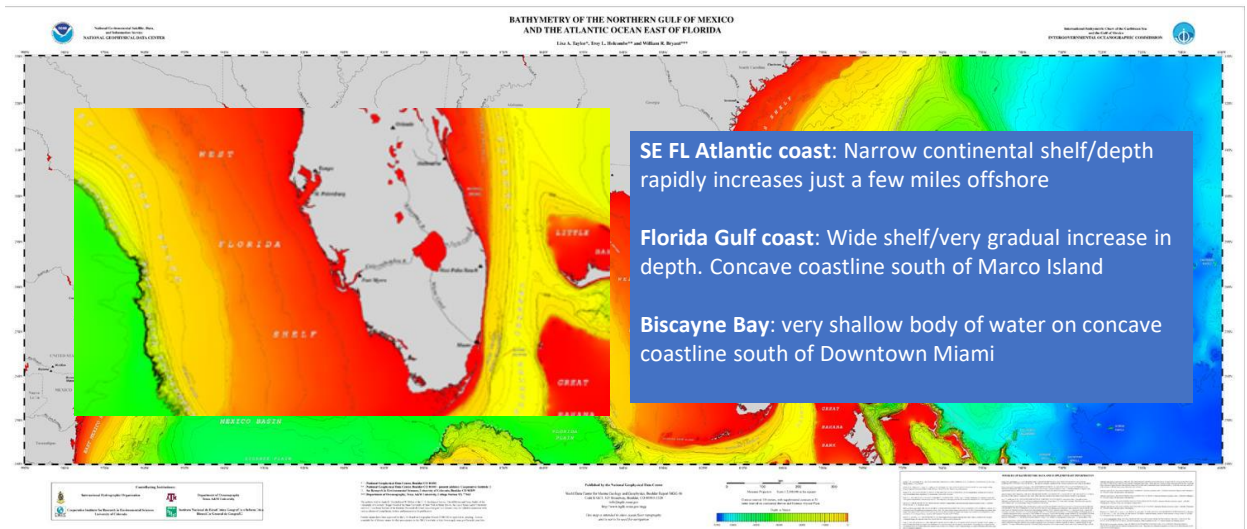


Sarasota – Lido
Key



St. Pete
Beach

Southern Florida Bathymetry

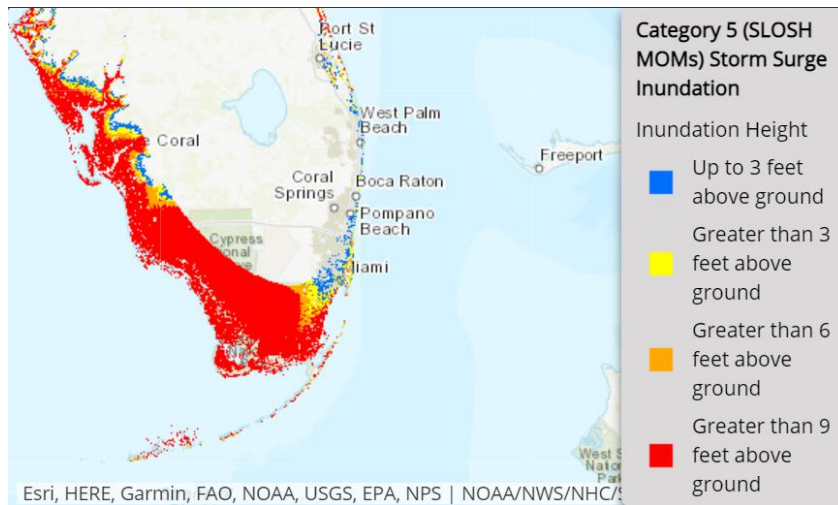


5/10/2021

weather.gov/miami

16

MOMs for Southern Florida Peninsula – Palm Beach to Collier

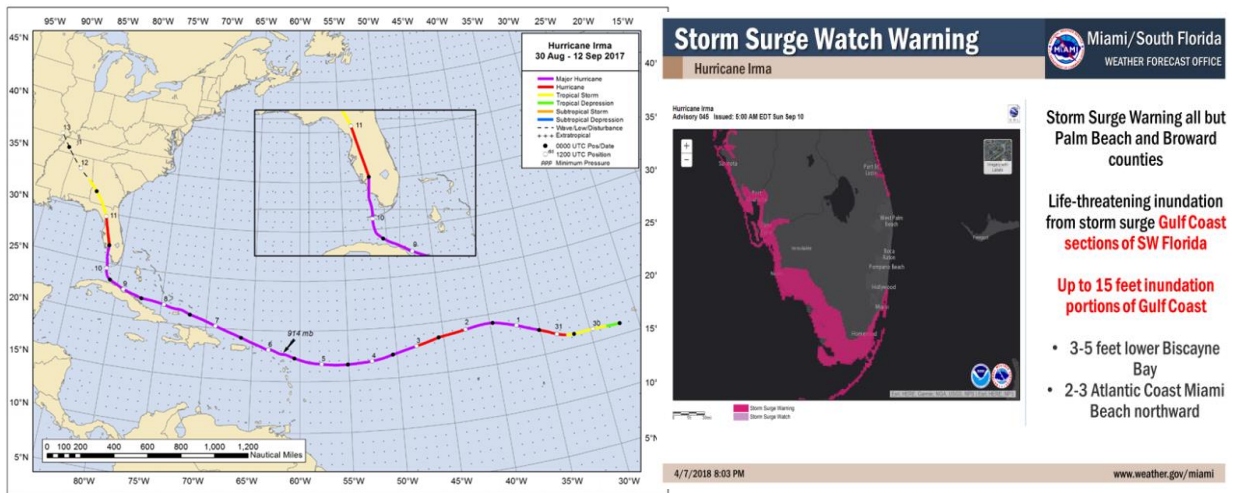


5/10/2021

weather.gov/miami

17

Hurricane Irma – Widely Varying Surge Impacts

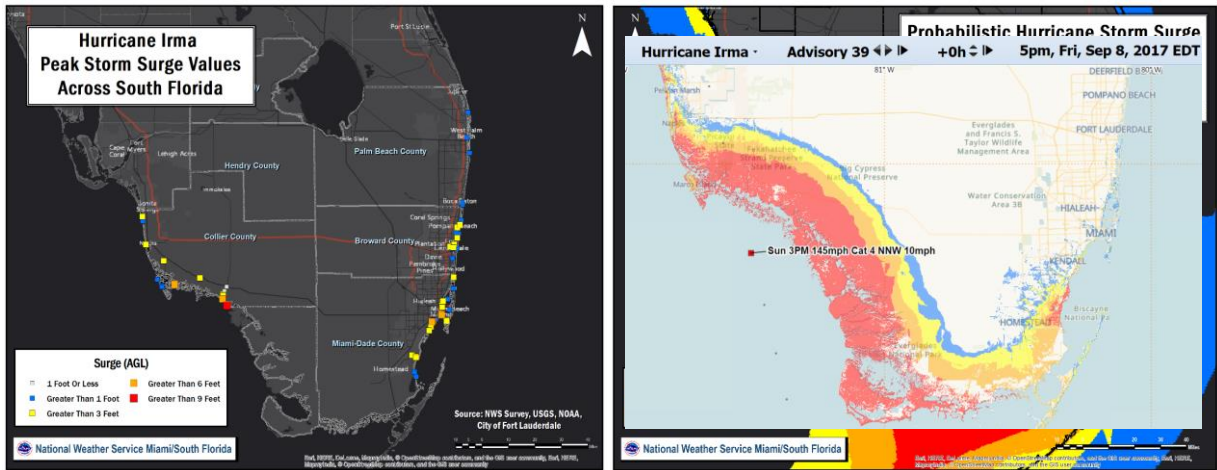


5/10/2021

weather.gov/miami

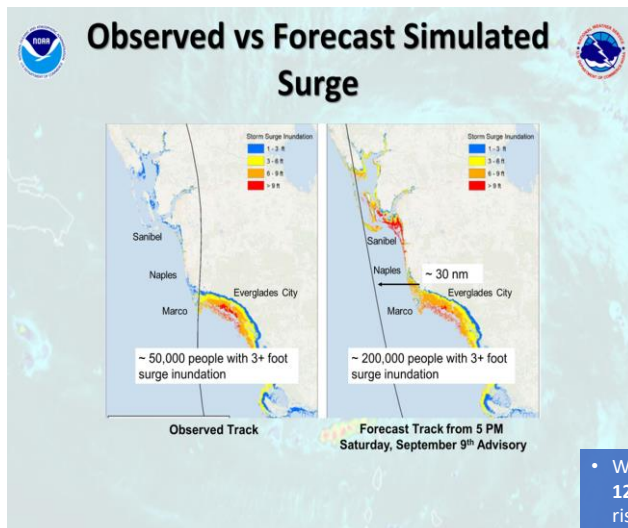
18

Irma Surge Verification



P-Surge forecast verified best in Everglades City area (max surge 8-10 feet). Probably verified well in Mainland Monroe County (no gauges/surveys to confirm)

Close Call



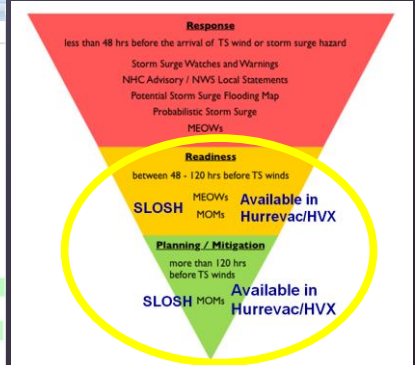
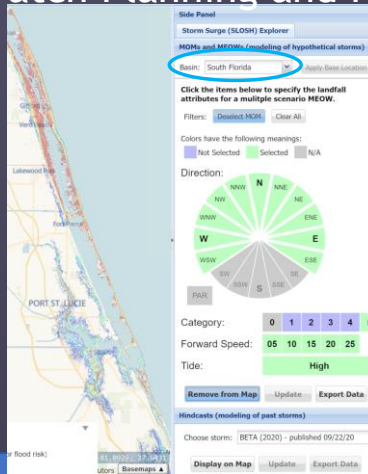
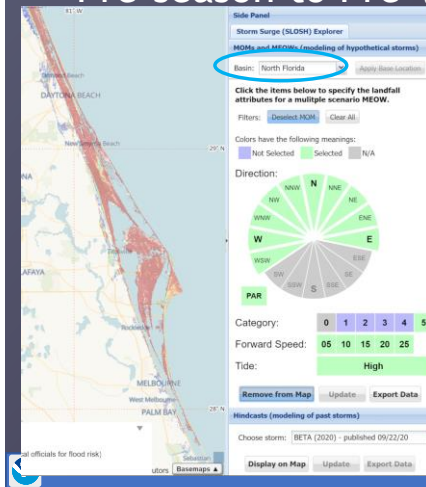
- Water rose 8 feet in just over 9 hours (**min. 3.9 ft below MHHW at 1200 EDT to max. 4.13 ft above MHHW at 2124 EDT**). Max rate of rise: ~ 3 ft/hr. Gauge location on bridge about 1/8 mile north of dock in picture at left

East Central Florida Storm Surge Planning & Readiness

SLOSH MOMs and MEOWs



- Hurrevac/HVX - SLOSH MOMs/MEOWs
- Pre-season to Pre-Watch Planning and Readiness



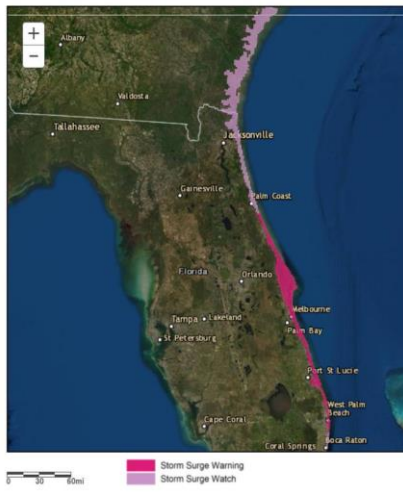
Storm Surge Watches & Warnings

Potential for Life-threatening Surge

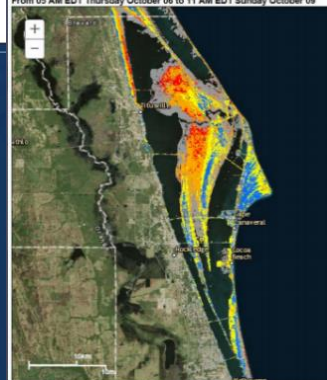


Storm Surge Watch/Warning Graphic*

Hurricane Dorian
Advisory 037 Issued: 11:00 AM EDT Mon Sep 2



NHC Potential Storm Surge Flooding Map Hurricane MATTHEW (2016) Advisory 33 From 05 AM EDT Thursday October 06 to 11 AM EDT Sunday October 09



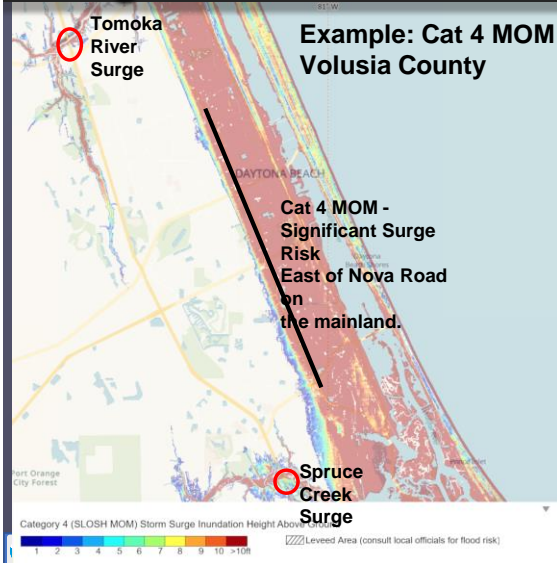
Potential Storm Surge Flooding*

- Inter tidal Zone/Estuarine Wetland
- Greater than 1 foot above ground
- Greater than 3 feet above ground
- Greater than 6 feet above ground
- Greater than 9 feet above ground

- **Storm Surge Watch:** The **possibility of life-threatening inundation** from rising water moving inland from the shoreline somewhere within the specified area, generally **within 48 hours**
- **Storm Surge Warning:** The **danger of life-threatening inundation** from rising water moving inland from the shoreline somewhere within the specified area, generally **within 36 hours**
- **Potential Storm Surge Flooding Map:** Provides a risk assessment for decision makers depicting the height above ground level the water **could** reach. Depicts the **reasonable worst case scenario** for storm surge flooding at any given location (10 percent chance of exceedance).

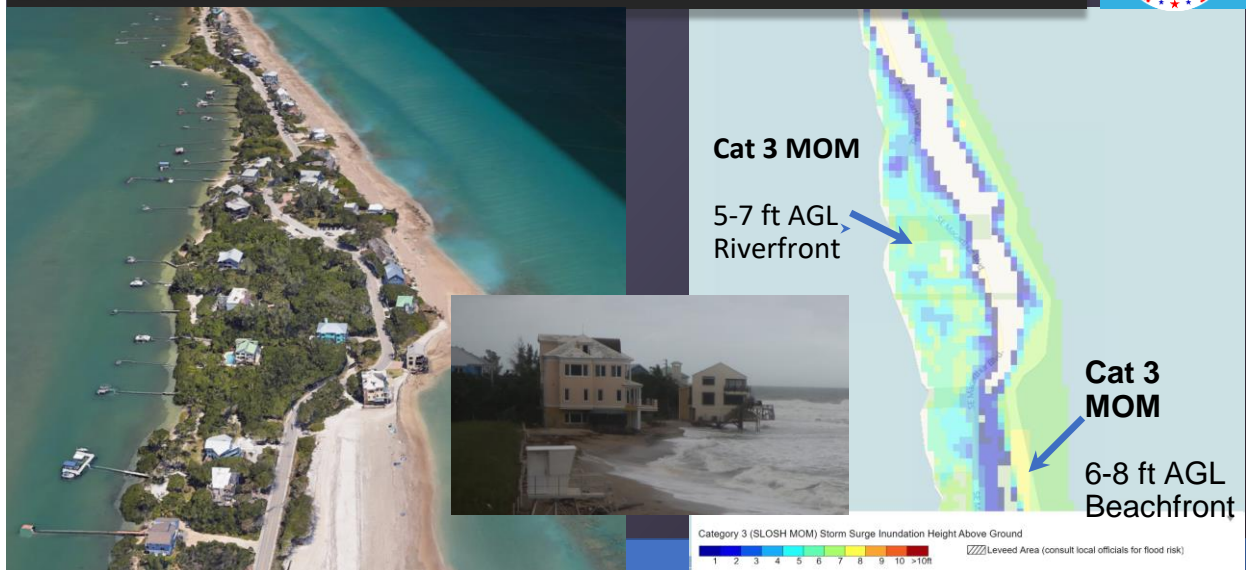
East Central Florida Surge Considerations

Beachfront, Intracoastal, Inlet Storm Surge



- Dunes generally well developed along east central Florida barrier islands and can provide a natural barrier to significant storm surge risk with low end Tropical Cyclones (TS to low end Cat1).
- With stronger tropical cyclones, storm surge risk extends along the intracoastal due to bathymetry and low elevation along intracoastal side of barrier islands and mainland including Merritt Island.
- Inlets, St Lucie Inlet/River, Ft Pierce Inlet, Sebastian Inlet and River, Ponce Inlet/Spruce Creek, Tomoka River allow for inland surge flooding vulnerability with major hurricanes.
- Cat 4-5 MOM - details inland extent with water level rises along inland rivers/creeks. Water potentially across I-95/FL Turnpike near St Lucie River in Martin county and potentially across I-95 near Tomoka River and Spruce Creek in Volusia county for Cat 4-5 MOM scenario.

Barrier Island Surge Vulnerability: Example: Martin County Beachfront & Intracoastal



East Central Florida Historical Surge Impacts

Satellite Beach
2004



Major Dune Erosion:
Undermines vulnerable
Coastal structures



Significant Dune Erosion/Loss



Bottom Line: **Storm Surge
Watches/Warnings** are
issued for the protection of
life and property.

Importance of getting people out of
harm's way.



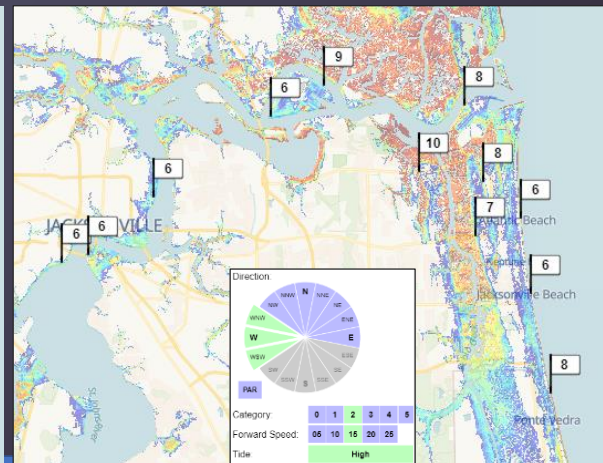
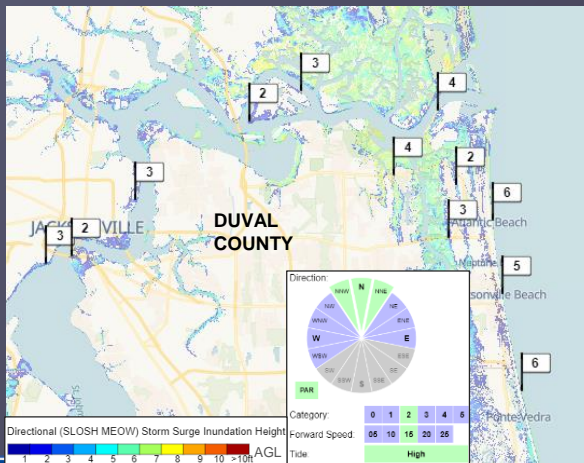
NWS Jacksonville

Parallel vs Direct Hit
Last Direct Hurricane Hit 1964 Cat 2 Dora



Northward Moving/Parallel

Landfalling CAT 2



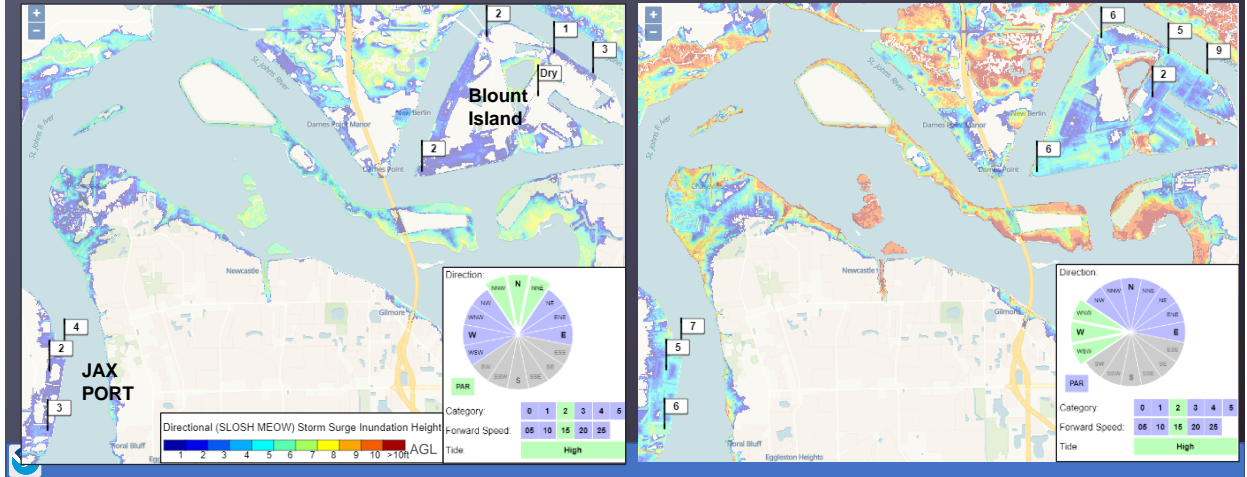
NWS Jacksonville

USMC Blount Island Command
& JAX Port



Northward Moving/Parallel

Landfalling CAT 2



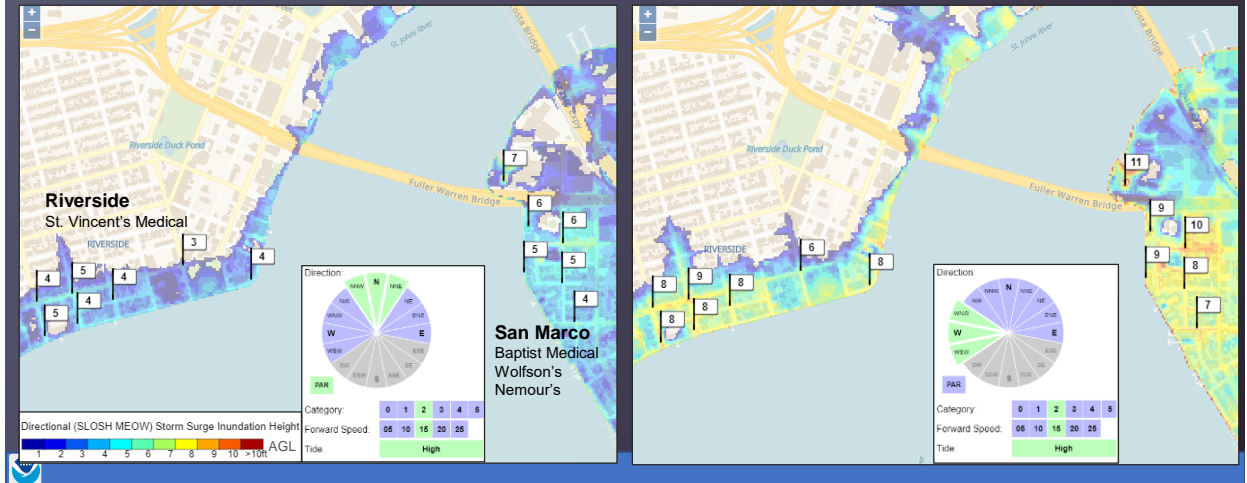
NWS Jacksonville

Regional Hospitals Downtown JAX
- St. Johns Riverfront



Northward Moving/Parallel

Landfalling CAT 2

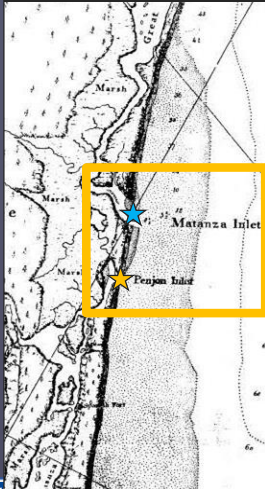


NWS Jacksonville

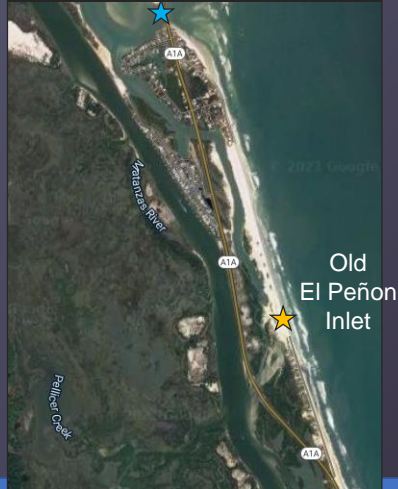
Evolving Coastline



1765 De Brahm Survey



Present Day



September 6, 2014



October 13, 2016

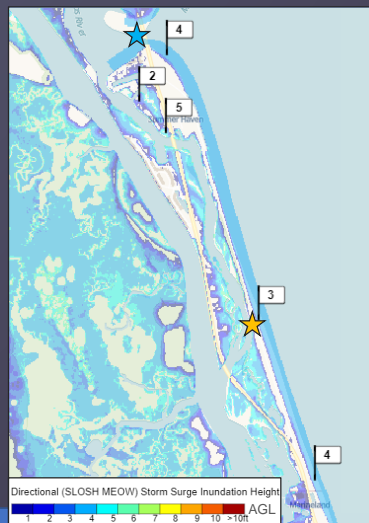
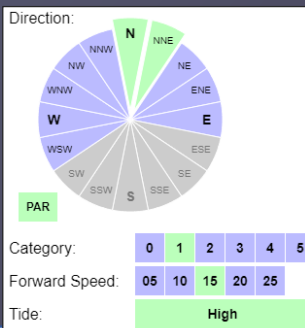


NWS Jacksonville

Vulnerable Coastline 2016 Matthew



Matanzas Inlet south
toward Marineland
(Summer Haven)

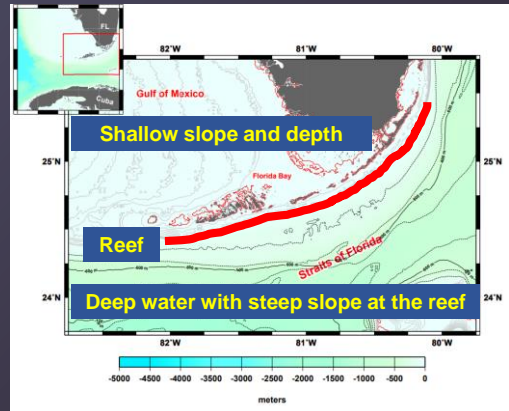


Florida Keys Storm Surge

Lessons from the Islands



- Labor Day Hurricane (1935)
- Hurricane Wilma (2005)
- Hurricane Irma (2017)
- Hurricane Eta (2020)



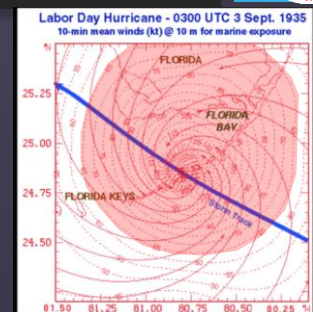
Jon Rizzo, Warning Coordination Meteorologist, NWS Florida Keys jonathan.rizzo@noaa.gov

Labor Day Hurricane

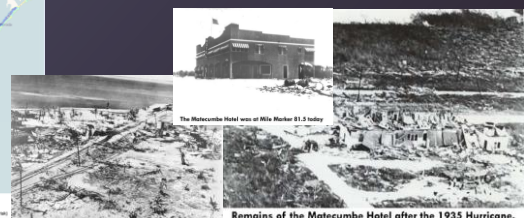
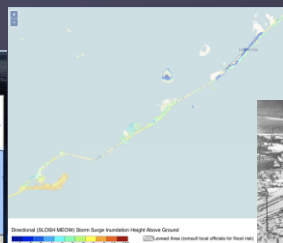
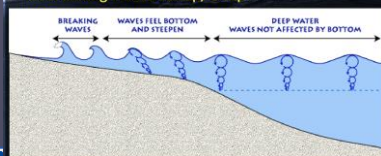
Wave Set and Wave Run-up



- Maximum inundation estimated by SLOSH MEOW just over 9 feet AGL.
- Measured up to 15 feet above ground level, with wave wash marks near 23 feet AGL.
- Wave setup (mostly) and run-up likely contributed to an additional increase of over 5 feet.



- Breaking waves also contribute to the total water level through wave runoff/setup

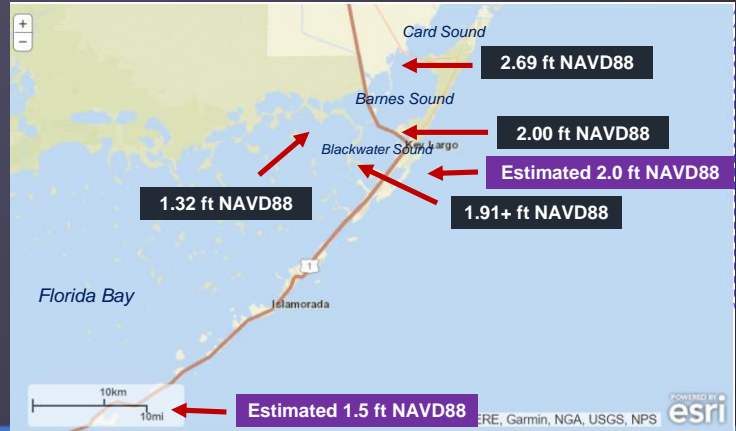


Hurricane Eta

Where There's a Bay, There's a Way



Eta (as a Tropical Storm) produced a minor surge oceanside in the Upper Keys, but more pronounced along Barnes Sound. Little things



Questions?

