



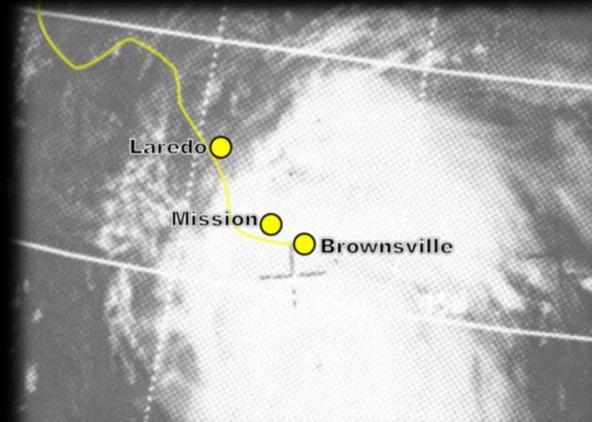
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Hurricane Beulah: Then and Now

Is the Rio Grande Valley Ready, 50 Years Later?

Barry Goldsmith
Warning Coordination Meteorologist
NWS Brownsville/Rio Grande Valley



At Landfall, September 20, 1967



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Beulah's Track

September 20:
Catastrophic Hurricane, 160 mph
67 miles south of Brownsville/Port
Isabel/SPI!

September 15:
Major Hurricane, 115 mph
Southwest of Cayman Islands

Tropical Storm, 60 mph
South of Jamaica

September 6:
Depression, 35 mph
Near Barbados

September 18:
Major Hurricane, 115 mph
East of Tampico

September 9:
Major Hurricane, 140 mph
South of Puerto Rico





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Beulah: Tale of the Tape

- Landfall: September 20, just after midnight. Wind SSHWS Rating most likely high Cat 3/Low Cat 4. Minimum central pressure ~945 mb.
- Inland inundation was the “Memory of Record”
 - Rainfall of 15-25” (or more) region wide
 - “Lake” South Texas
 - Floodways failed in at least two places
- Wind damage widespread in Lower Valley
 - 136 mph gust in ship channel entrance; eight hours of hurricane force winds at Brownsville
 - 100 mph gusts as far west as Weslaco and McAllen
- Peak storm tides 8 to 14 feet
 - Coastal inundation of South Padre Island, Port Mansfield, and parts of Port Isabel
- 115 (to 141) tornadoes in south and central Texas, a single-storm U.S. record that stood until Ivan (2004)



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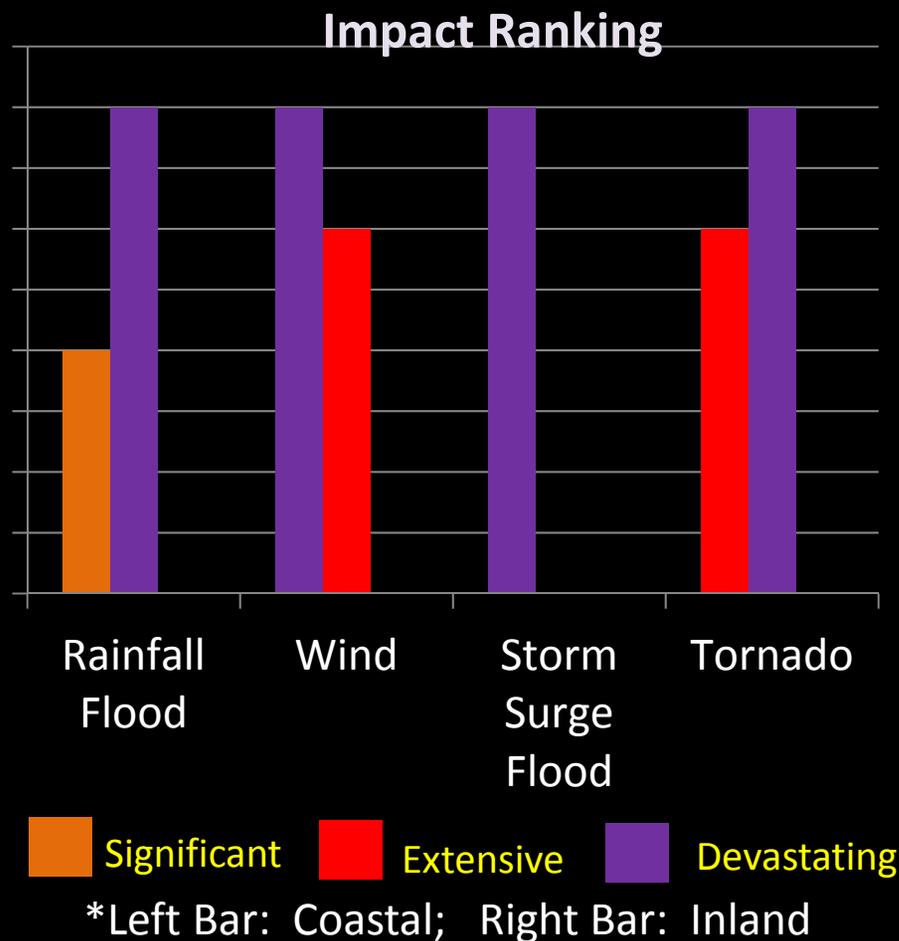


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Beulah: Tale of the Tape

- Damage Totals (1967 Dollars): \$170 million statewide; \$100 for the Rio Grande Valley. Total estimated damage was >\$1 billion, second on record at time
- Death toll still "fuzzy"; reports vary from 11 to as more than 15 persons. **Four were killed in tornadoes north of the impact zone**



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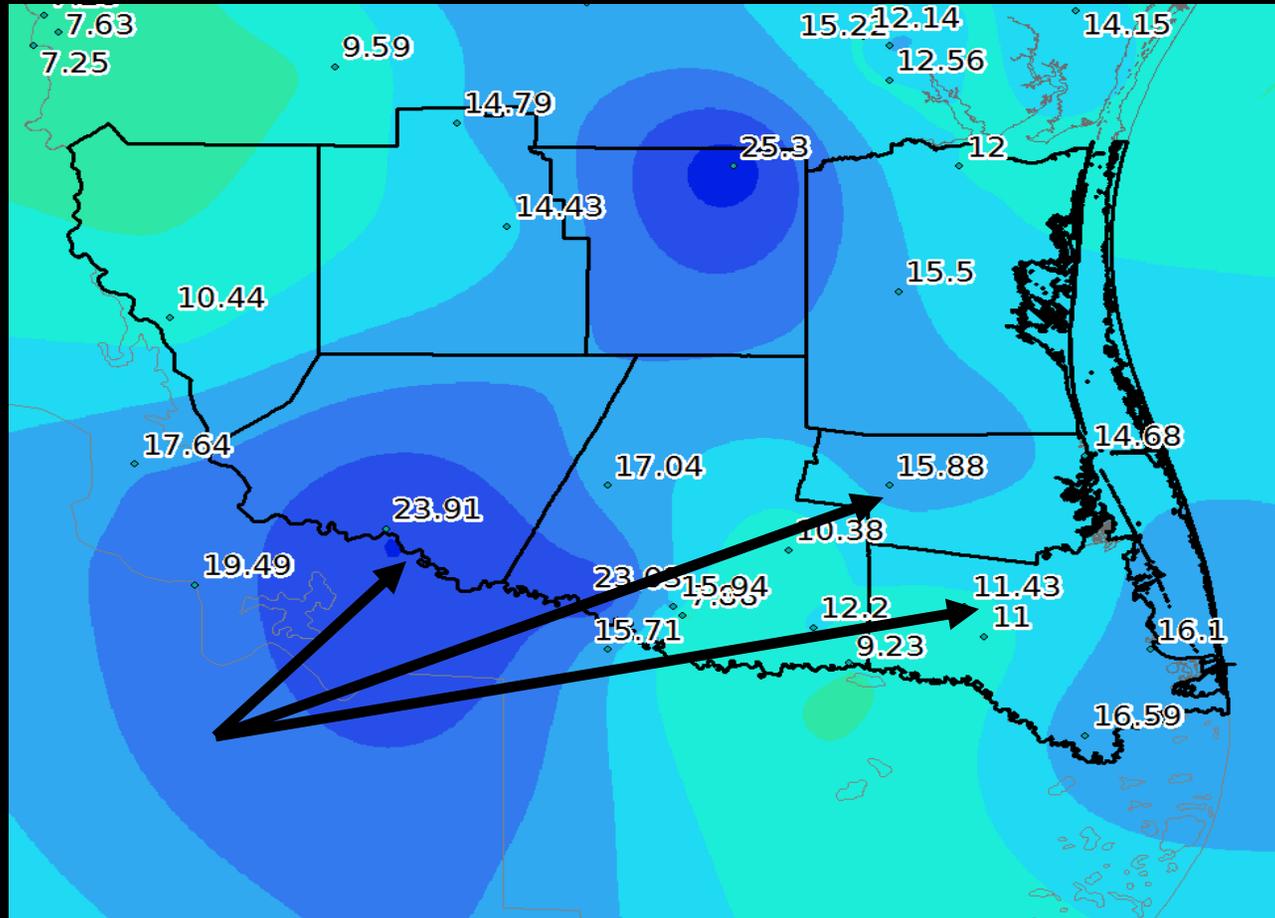
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Rainfall (Flooding)



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Rainfall/River Flooding



Harlingen



Aerial view of the Rio Grande @ Rio Grande City



Raymondville

- Heavy Rains Continued through September 22
- River Flooding Continued Much Longer (1 week+)



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Camargo Calamity



Hurricane Beulah Collection

Biography



Mario E. Ramirez

Photo Credits: Dr. Mario E. Ramirez
Hurricane Beulah Collection



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Camargo Calamity



- ◆ 14,000 “instant” Mexican refugees crossed into Starr Co. Texas
- ◆ Dr. Ramirez, assisted by state and federal medical services as well as U.S. Military forces, brought food and medicine to protect lives
- ◆ What if Beulah happened in 2017? Is Texas ready for all flood permutations?



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Wind Damage



Port Isabel



Port Isabel



Port Isabel



Citrus blown off trees



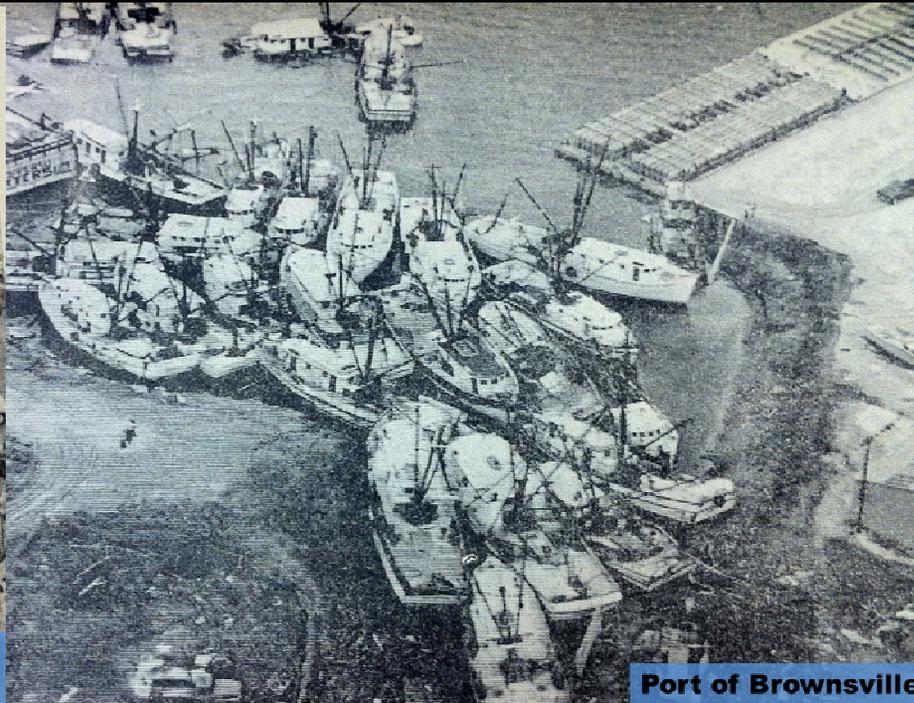
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Storm Surge Inundation



Port Isabel: Docks washed away



Port of Brownsville



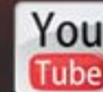
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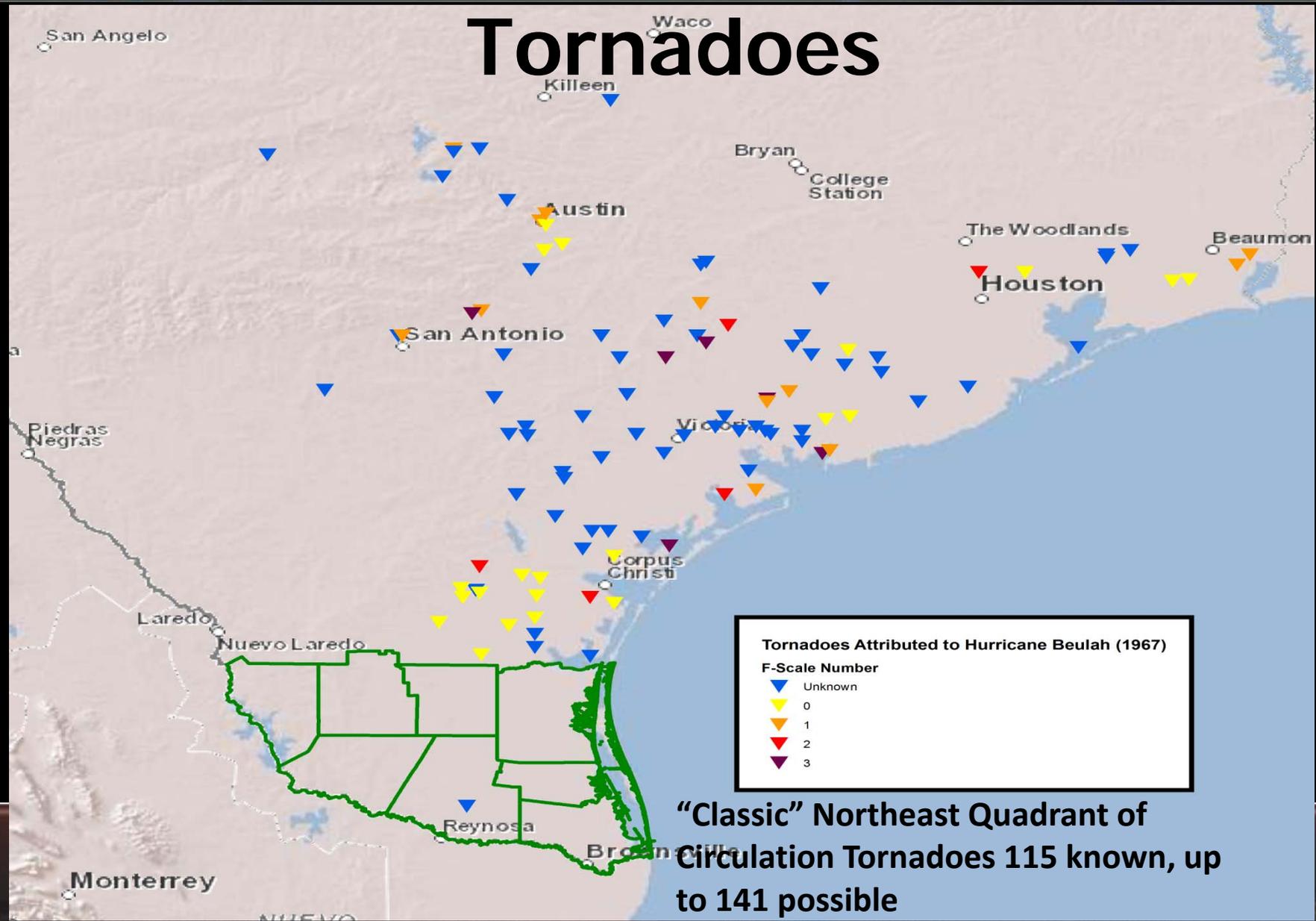
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Tornadoes



**“Classic” Northeast Quadrant of
Circulation Tornadoes 115 known, up
to 141 possible**



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Tornadoes



Near New Braunfels
(north of San Antonio)



Near Palacios



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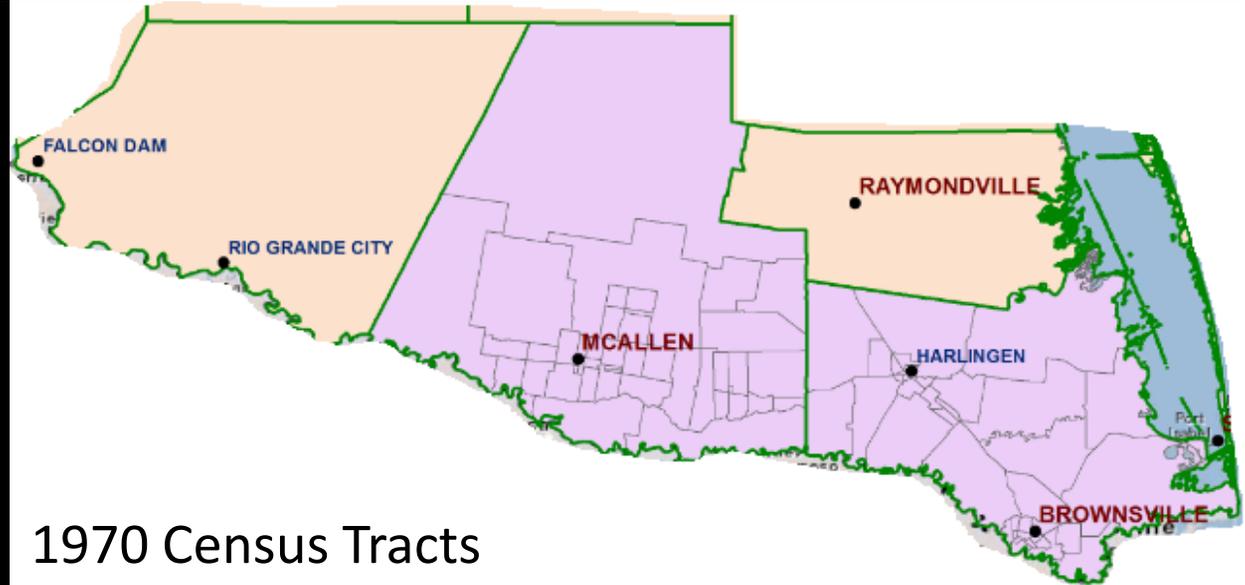
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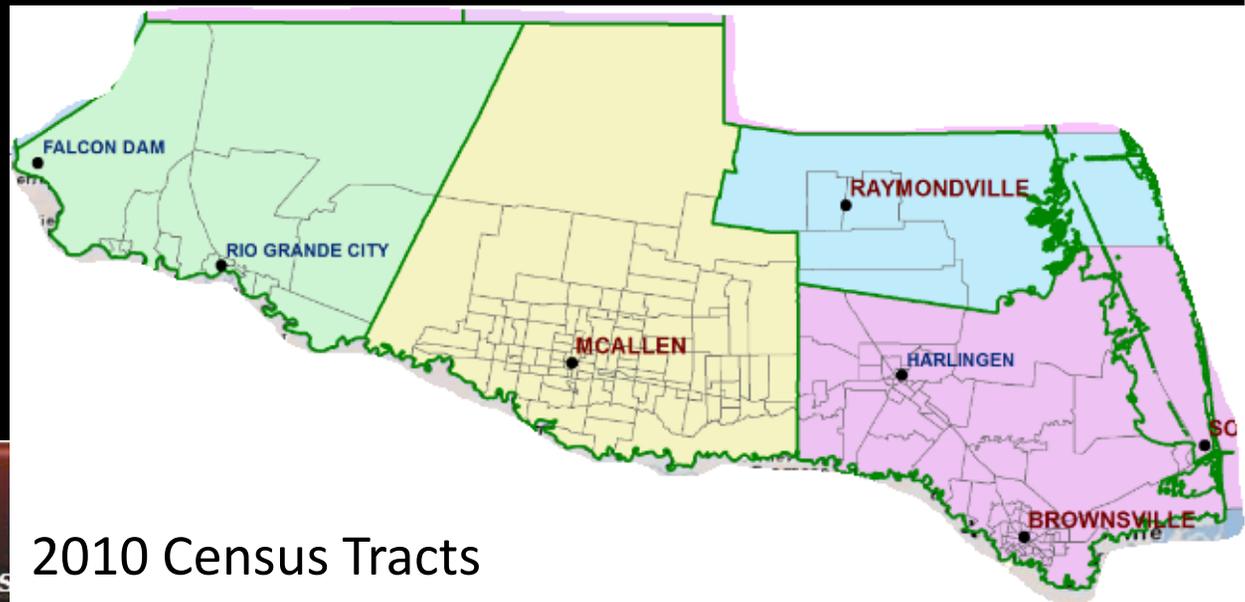


RGV: Then...



1970 Census Tracts

...and Now



2010 Census Tracts

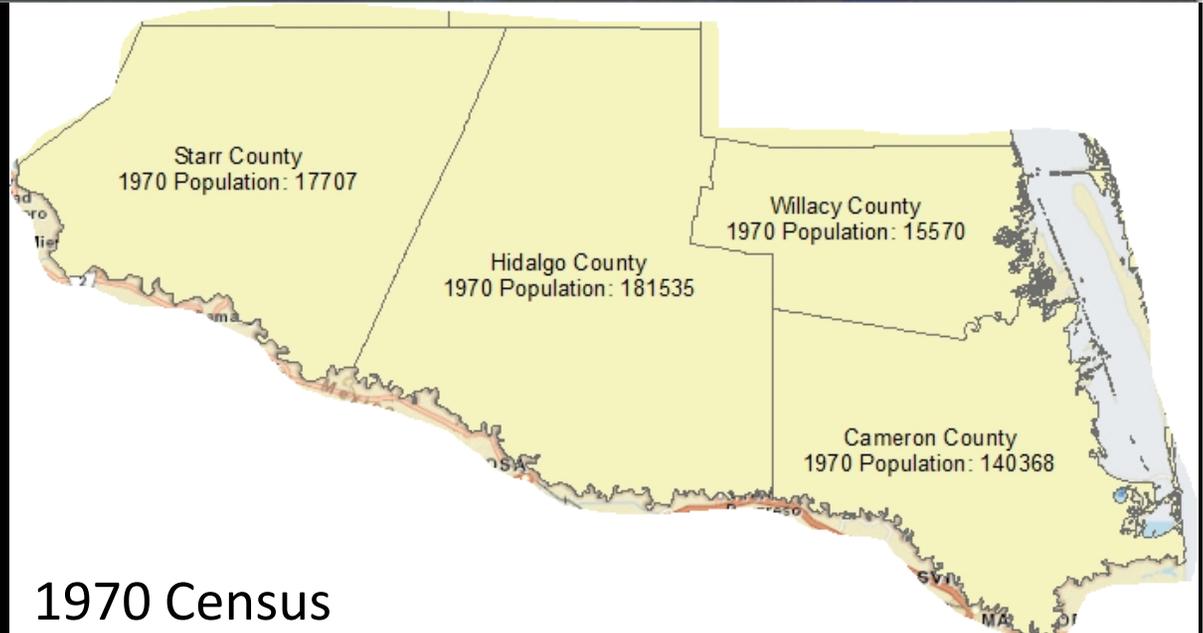




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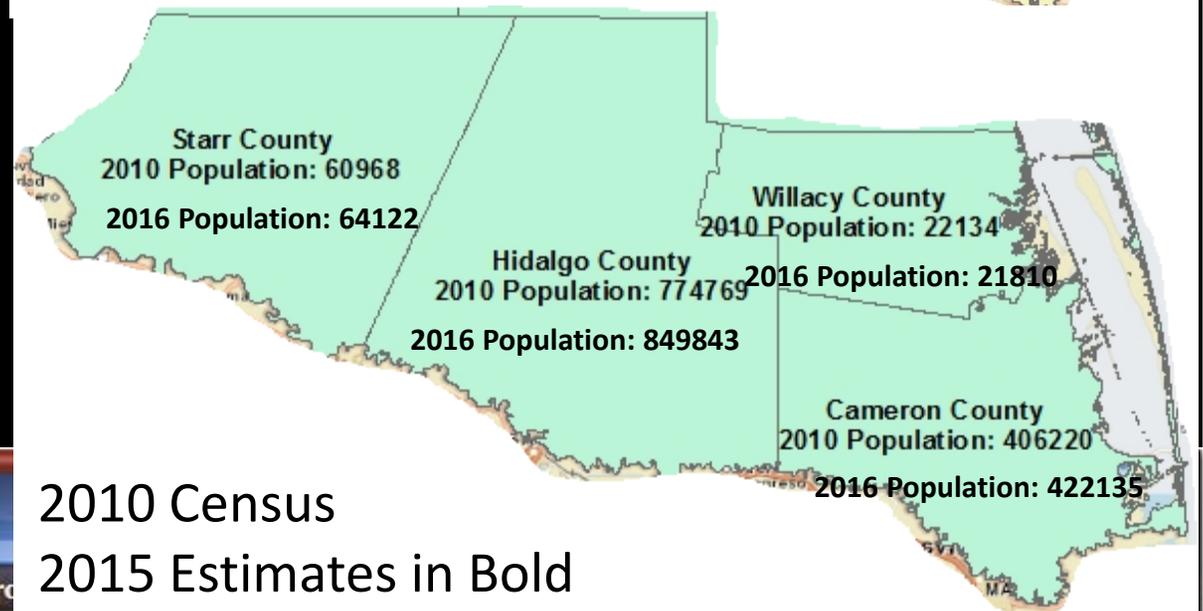


RGV: Then...
(Pop: 355,180)



1970 Census

...and Now
2010 Pop: 1,264,091
2016 Pop: 1,357,910



2010 Census

2015 Estimates in Bold





Rio Grande Valley: Tip of the Spear

**Building Resilience is a
Big Deal Here!**

Rio Grande Valley

| | |
|------------------|------------------|
| Cameron Co., TX | 420,392 |
| Hidalgo Co., TX | 831,073 |
| Starr Co., TX | 62,955 |
| Willacy, Co., TX | 21,903 |
| Total: | 1,336,323 |

- Median Income Per Capita: \$14,500
US Average: \$28,155
- Median Family Income: \$36,500
US Average: \$53,046

37% of all persons live in poverty

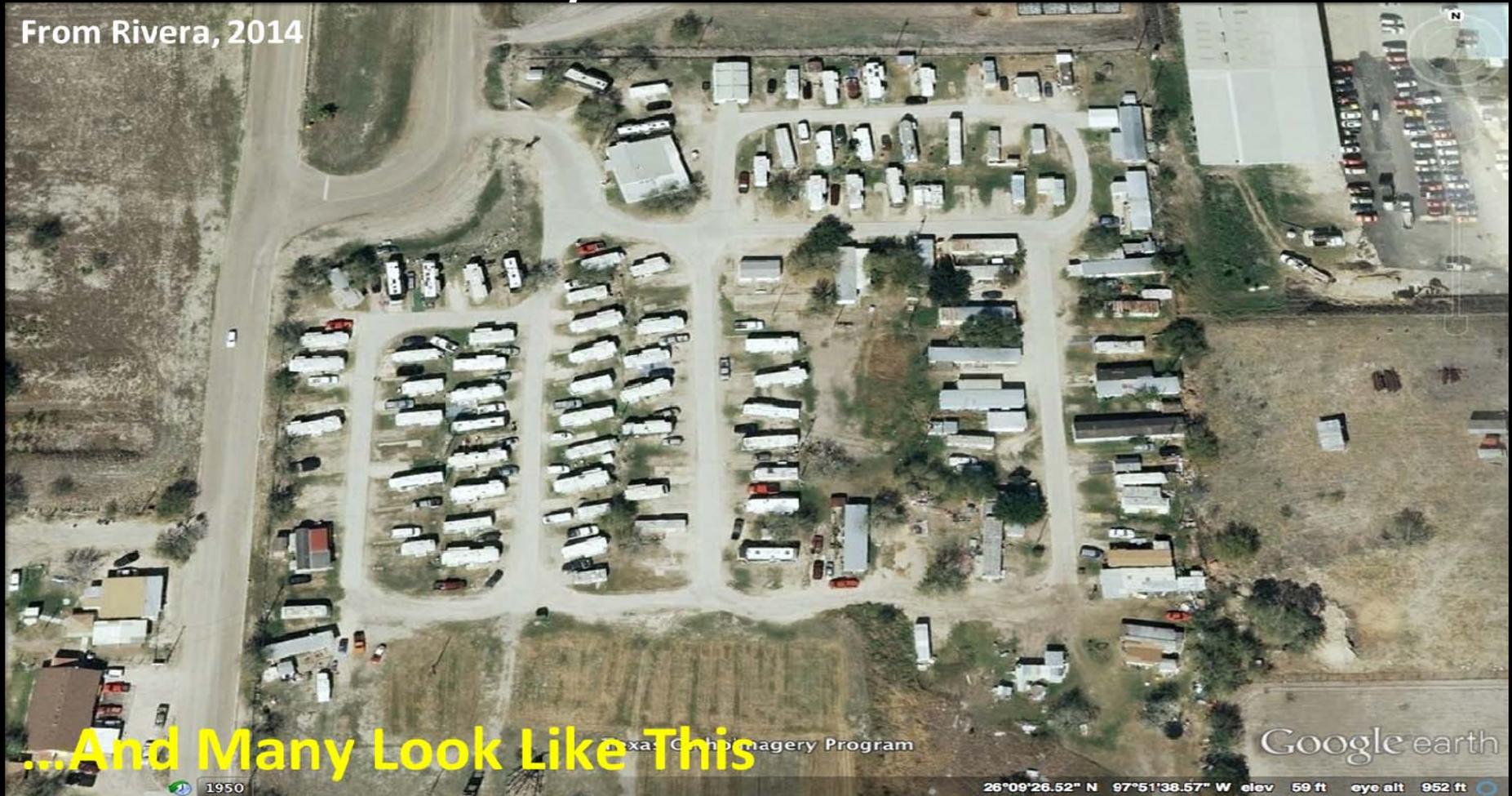


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At least 100,000 live in *Colonias*...

From Rivera, 2014



...And Many Look Like This



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La Joya, TX October 2015 – 65 mph winds did this!



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Building Wind Resistance

**Florida: Concrete
Block Systems**



**Rio Grande Valley (except coast):
Frame/Oriented Strand Board
(OSB). Tens of thousands of
homes built since Beulah/Allen
start this way. Does it matter?**



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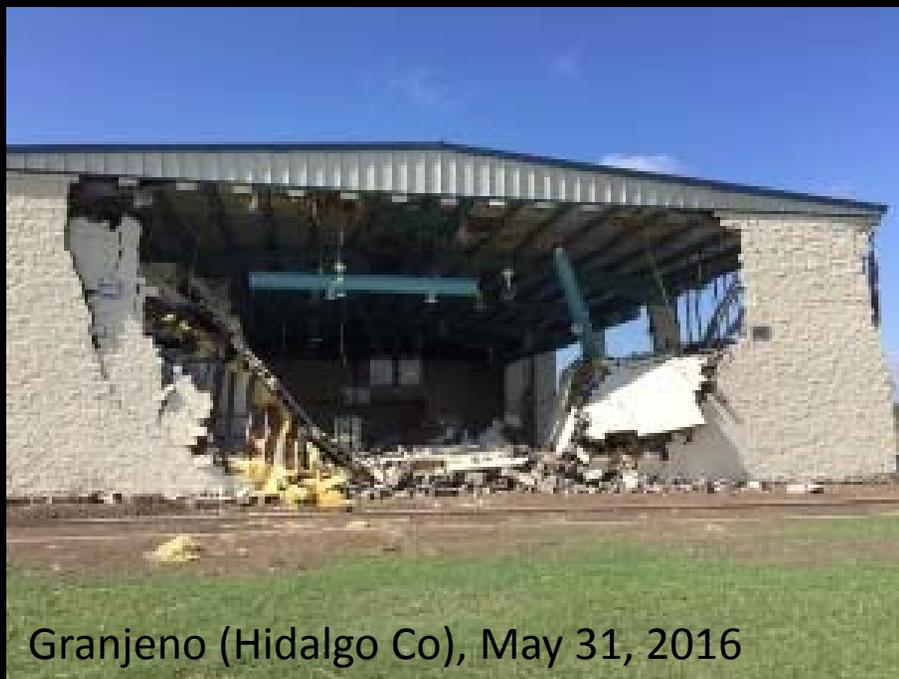
e



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Building Wind Resistance: Roofs/Connectors



Granjeno (Hidalgo Co), May 31, 2016

Rebar reinforced walls = Good

No viable connection to roof = Very, very BAD!

Estimated winds: 85 to 95 mph (thanks, Tim Marshall!)



Hurricane straps on every frame – Good
Nails vs. bolts on ground connection: ???



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From This... **...To This!**



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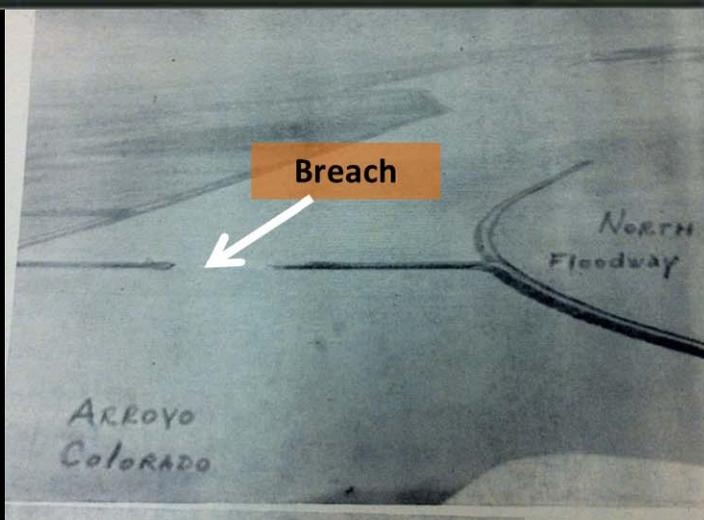
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In 1967...The Floodway did not adequately protect all of the Lower Rio Grande Valley

After Beulah, the Floodway was improved. In 2010, additional improvements helped protect the Valley despite equal or greater water flow in the Rio Grande Basin

Rainfall Flooding: River Response



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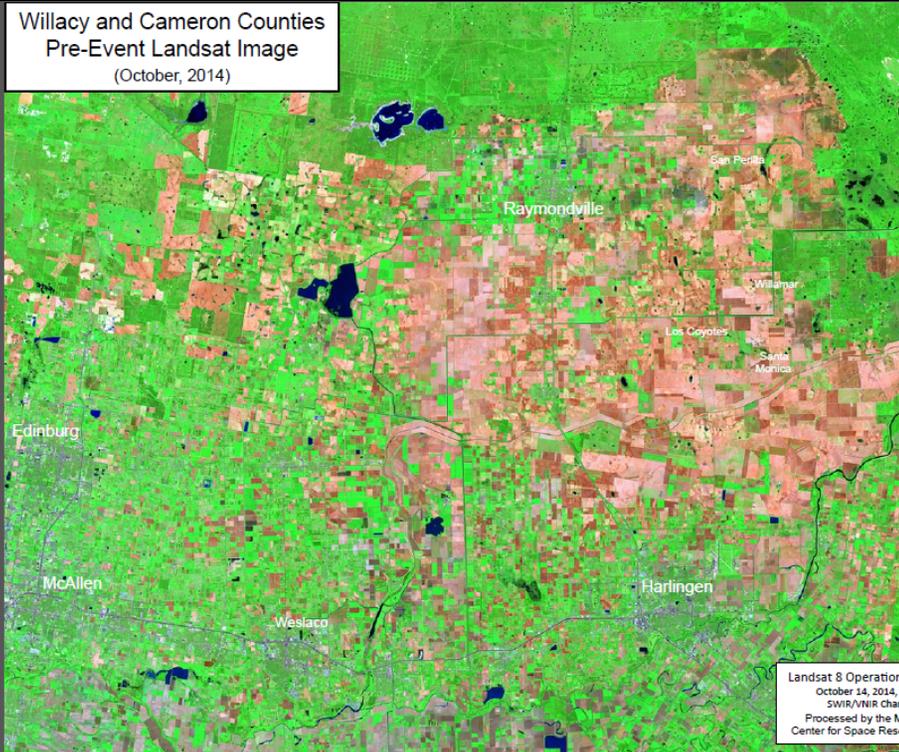


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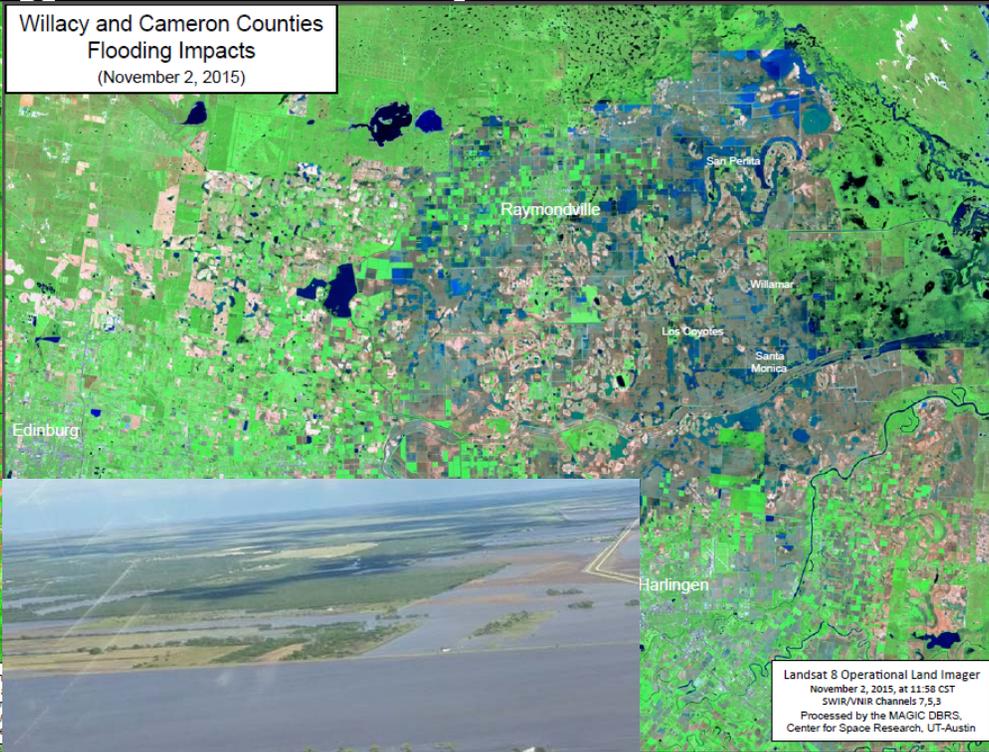


Rainfall Flooding: Land Response

Willacy and Cameron Counties
Pre-Event Landsat Image
(October, 2014)



Willacy and Cameron Counties
Flooding Impacts
(November 2, 2015)



Aerial view of rural Willacy County

Willacy County farmland, late
Oct. 2015 (14-18" rainfall)

Landsat 8 Operational
October 14, 2014,
SWIR/VNIR Chan
Processed by the M
Center for Space Res

Landsat 8 Operational Land Imager
November 2, 2015, at 11:58 CST
SWIR/VNIR Channels 7,5,3
Processed by the MAGIC DBRS,
Center for Space Research, UT-Austin



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Soil "101"

Rio Grande Plain soils formed on a broad coastal plain consisting of sediments of Tertiary and Quaternary age. The southern extent of this nearly level plain is within the ancestral valley cut by the Rio Grande. The coastal-plain landscape is dissected by generally southeastward flowing streams. Weesatche, Duval, Samosa, Hidalgo, Brennan, Pernitas, Uvalde, Pryor, Elindio, and McAllen soils are deep and very deep, well-developed, loamy soils that occur on nearly level to moderately sloping plains and broad ridges. Olmos, Delmita, and Randado soils, shallow to a root-restrictive layer of cemented caliche (CaCO₃), formed in gravelly Pleistocene sediments. Langtry soils are shallow, Montell and Catarina soils are clayey sodium-affected soils, and Maverick soils are clayey and moderately deep to weathered shale bedrock. Falfurrias, Sarita, and Nueces soils are very deep, sandy soils on the sand-sheet prairie that covers the southeast parts of the South Texas Coastal Plain.

McAllen/Hidalgo Soil



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Soil "101": Permeability

| Soil | Texture | Permeability |
|--------------|-------------------|------------------------------|
| Clayey soils | Fine | From very slow to very rapid |
| Loamy soils | Moderately fine | |
| | Moderately coarse | |
| Sandy soils | Coarse | |

Example

Average permeability for different soil textures in cm/hour

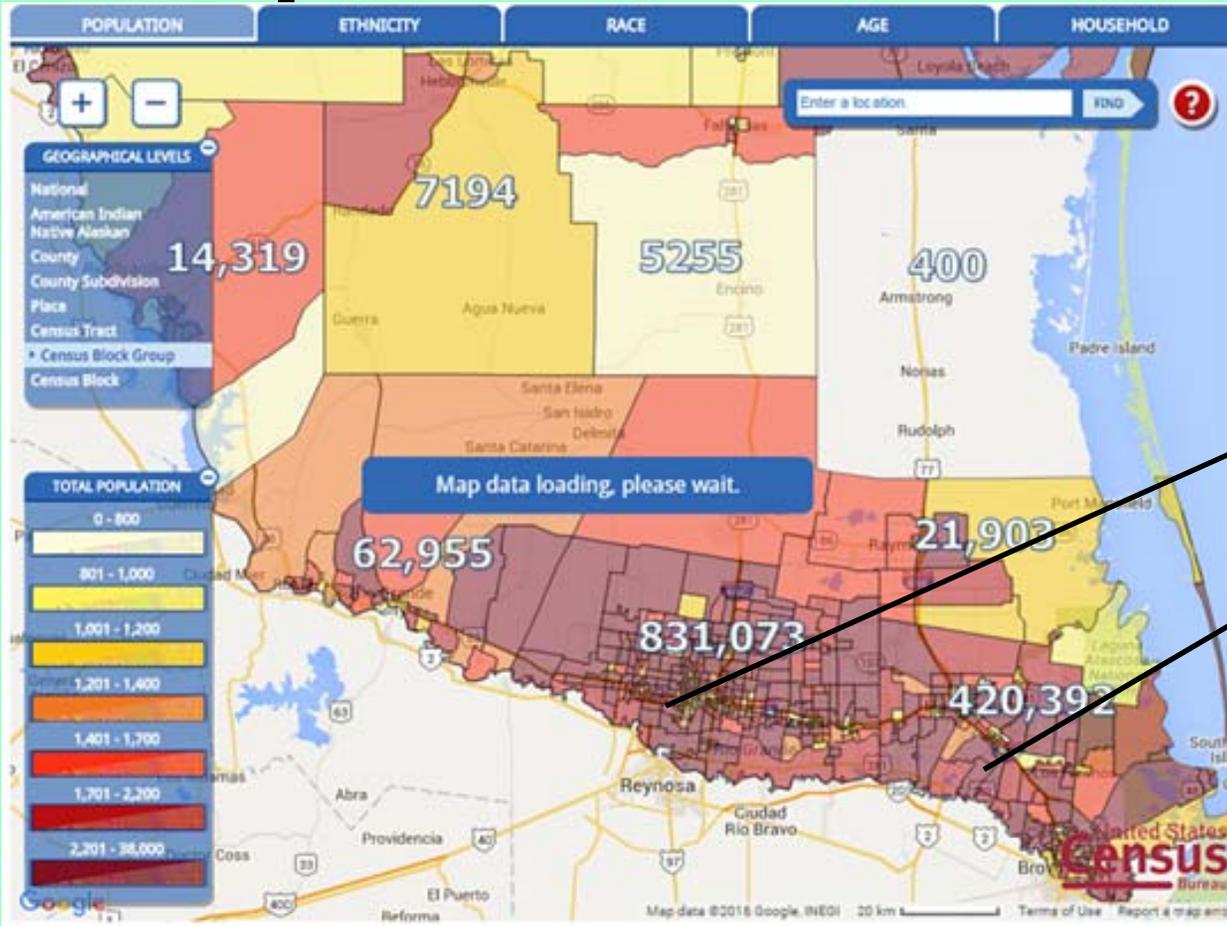
| | |
|------------|------|
| Sand | 5.0 |
| Sandy loam | 2.5 |
| Loam | 1.3 |
| Clay loam | 0.8 |
| Silty clay | 0.25 |
| Clay | 0.05 |



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Population and Permeability

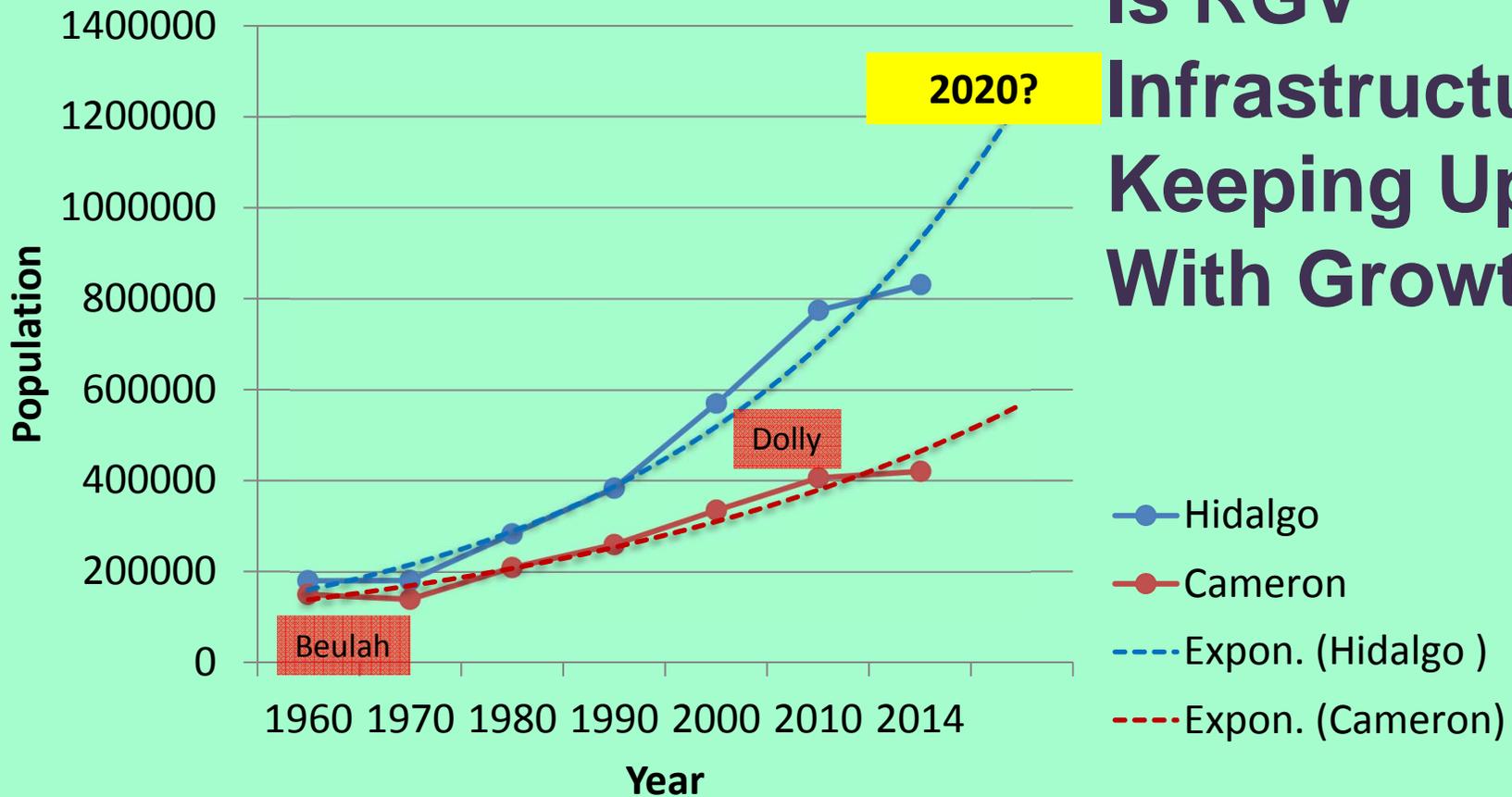


2014 Census Tract Estimates, U.S. Census Bureau



Population and Permeability

Is RGV Infrastructure Keeping Up With Growth?





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In 1967...South Padre Island was a sleepy beach town.

- Fewer Buildings and Roads, but...
- ...Many buildings were older and not able to withstand 120 mph winds and floodwaters



Today...South Padre Island is a full blown beach resort.

- More buildings and roads, but...
- ...Many built to withstand 120 mph winds
- Still, damage from Beulah today could exceed \$1 billion.



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Where We Are Today

- Favorable:
 - Coordinated Valley-wide Evacuation and Sheltering Plans; improved Hurricane Evacuation Study
 - ARRA and Potential Future Funds earmarked to further improve levee strength, height, etc. (River Flood Impact Reduction)
 - Stronger building codes through Texas Windstorm Insurance Association (Coastal -130 mph; Inland Wind 1 - 120 mph)



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Where We Are Today

- Unfavorable
 - Population and Farms replacing wetlands on loamy soil = More “Lake RGV” situations (rainfall flooding)
 - Oriented Strand Board vs. Concrete Block Systems just miles from the coast: Are roof/truss/beam clip/strap systems enough? (wind)
 - Over 1500 colonias with thousands of substandard housing and community mistrust of government information (wind/rainfall flood)
 - South Padre Island is several hundred million \$\$ more valuable in 2017 (storm surge/wind)



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The Bottom Line

Is it Too Late... to Mitigate?



Dr. Mario Ramirez Collection:

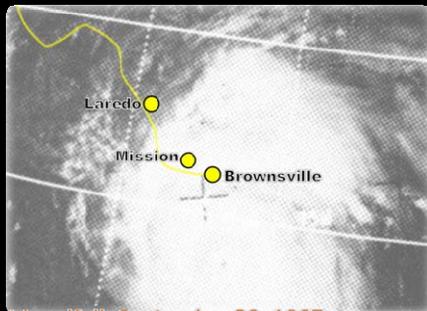
<http://library.uthscsa.edu/2011/09/hurricane-beulah-collection/>

“It Happened in Texas”:

http://www.texasarchive.org/library/index.php/It_Happened_in_Texas

USACE Beulah Flood Report:

<http://cees.tamui.edu/covertheborder/RISK/Exerpts.%20USACE%20REport.pdf>



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2017: What *Really* Matters?

#ItOnlyTakesOne

#HurricaneStrong



#HURRICANESTRONG™



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Brownsville/Rio Grande Valley**





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Atlantic Season So Far

- Six named cyclones, three ahead of schedule (for Aug. 10)...
- ...Five Tropical Storms, and Hurricane Franklin (today)
- Combination of "Energy" for the first five will be less than for Franklin (total: ~6.5 units; Franklin, est. 3.5 units)
- Meaning: It's been "quiet", despite the numbers.



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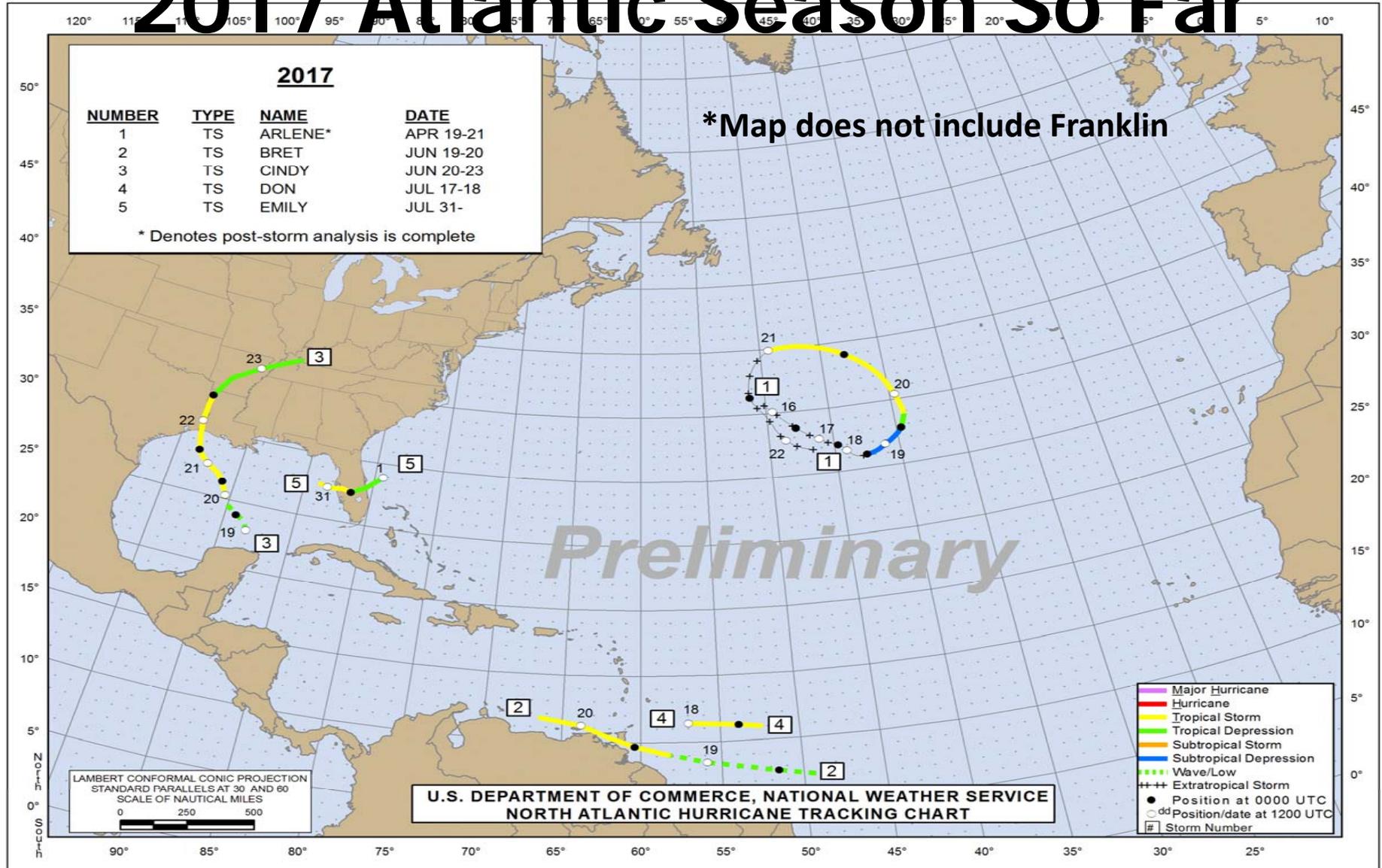
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2017 Atlantic Season So Far

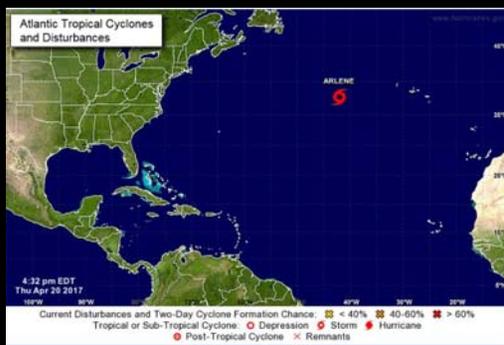




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Atlantic Season So Far: The A-B-Cs



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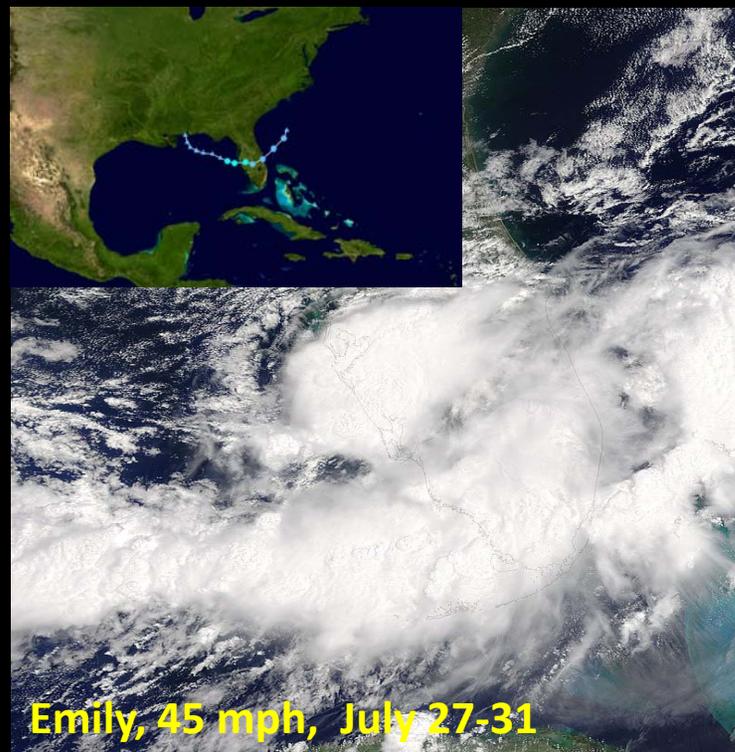
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Atlantic Season: And the D-E-Fs



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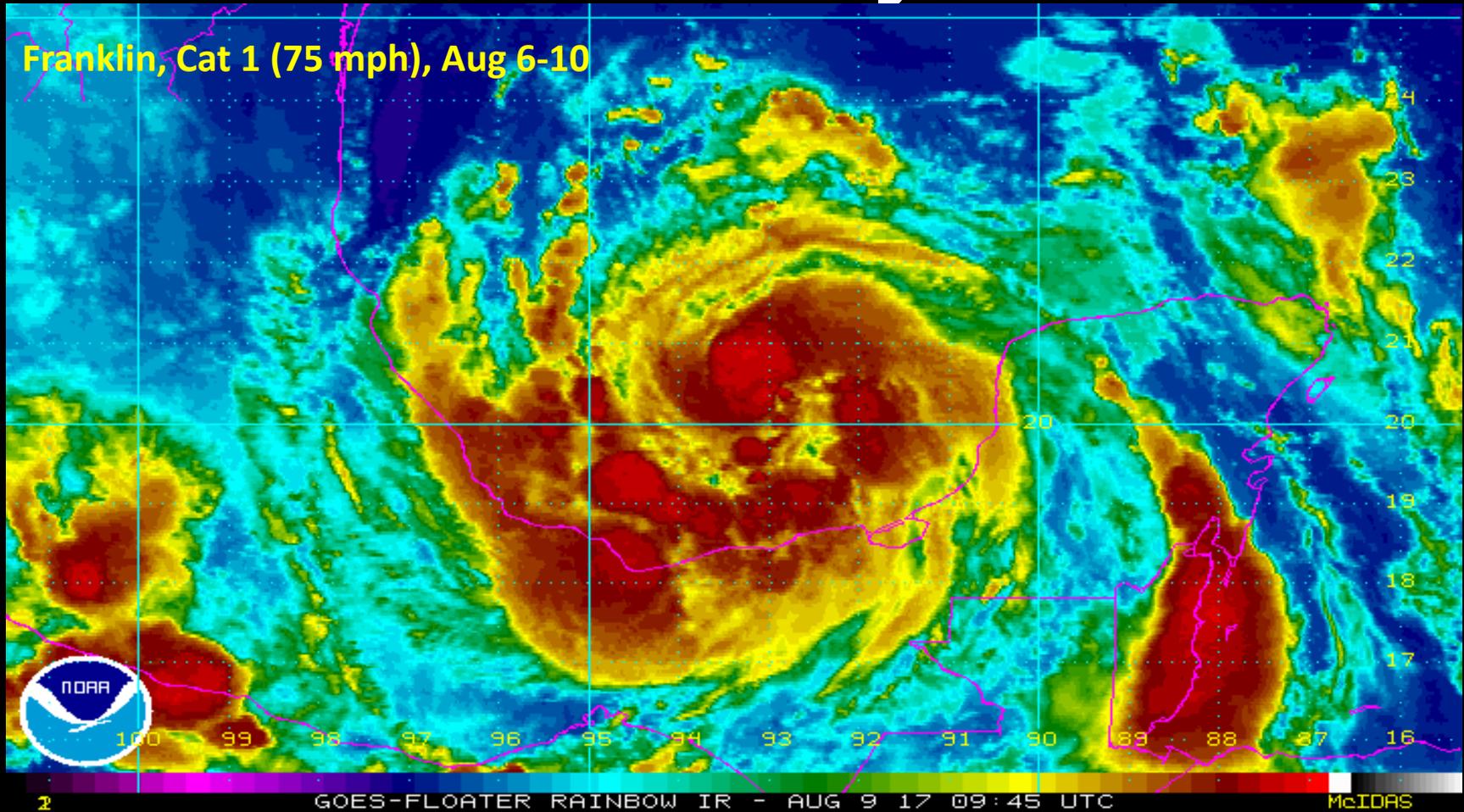


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Franklin: One Finally "Launches"

Franklin, Cat 1 (75 mph), Aug 6-10



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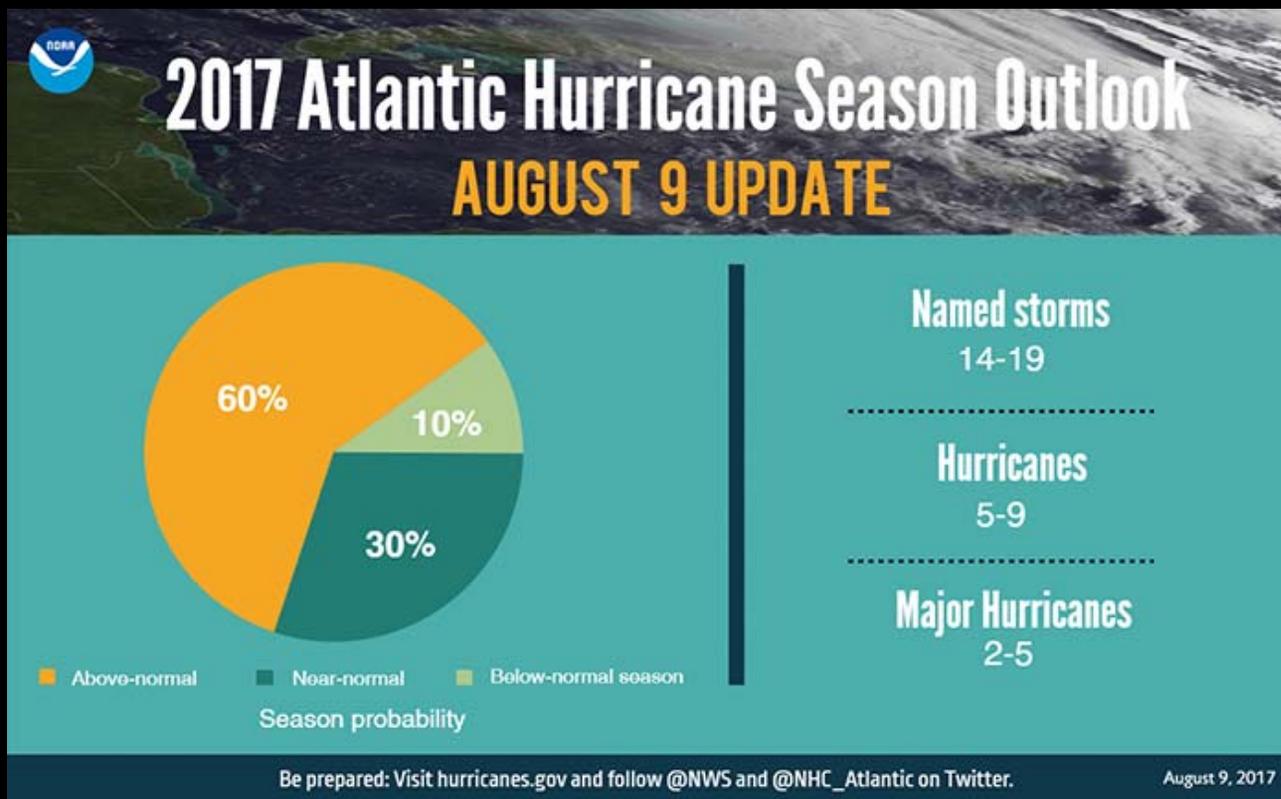


** Updated ** NOAA Atlantic Forecast

• Change is only in (Today, Aug. 9 2017)

the number of named cyclones. And only due to the "jackrabbit" start mentioned earlier.

• Conditions for the original forecast (Neutral ENSO, above average basin water temperatures remain on track as they were in May



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2017 Atlantic Tropical Cyclone Names^{*} AUGUST 9 UPDATE

~~Arlene~~
~~Dret~~
Cindy
~~Don~~
~~Emily~~
~~Franklin~~
Gert

Harvey
Irma
Jose
Katia
Lee
Maria
Nate

Ophelia
Philippe
Rina
Sean
Tammy
Vince
Whitney

^{*}Names provided by the World Meteorological Organization

Be prepared: Visit hurricanes.gov and follow @NWS and @NHC_Atlantic on Twitter.

August 9, 2017



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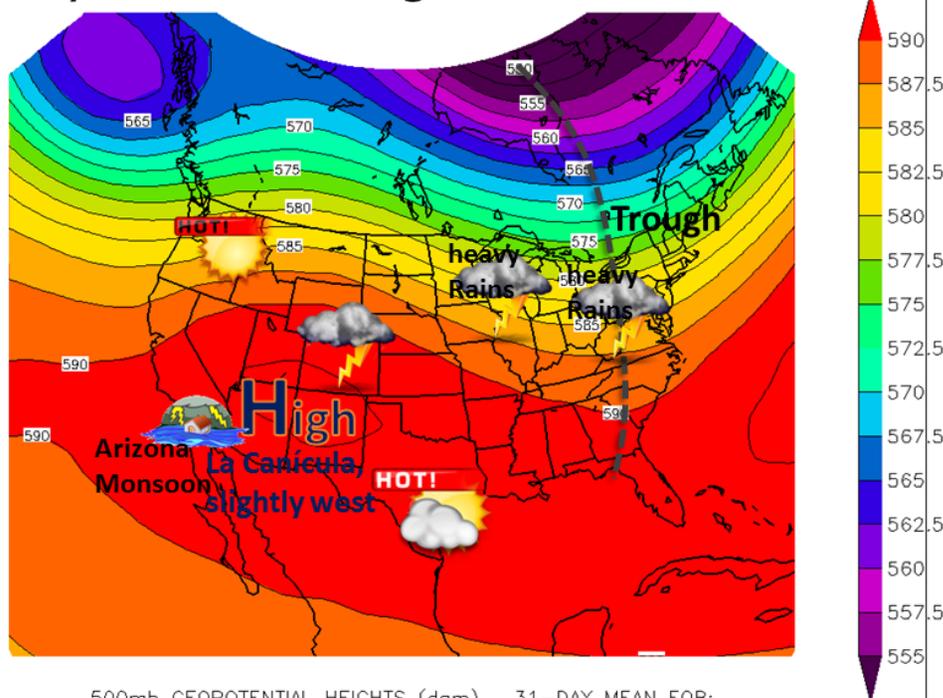


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But What About Us?

July 2017 Steering Pattern in Brief



500mb GEOPOTENTIAL HEIGHTS (dam) 31-DAY MEAN FOR:
Sat JUL 01 2017 - Mon JUL 31 2017
NCEP OPERATIONAL DATASET

- La Canícula (The Dog Days) Dominated June and July
- It Shows No Signs of Letting Up in August
- September is **still** a wildcard – Hence the attention on Beulah!



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La Canicula, Locked In

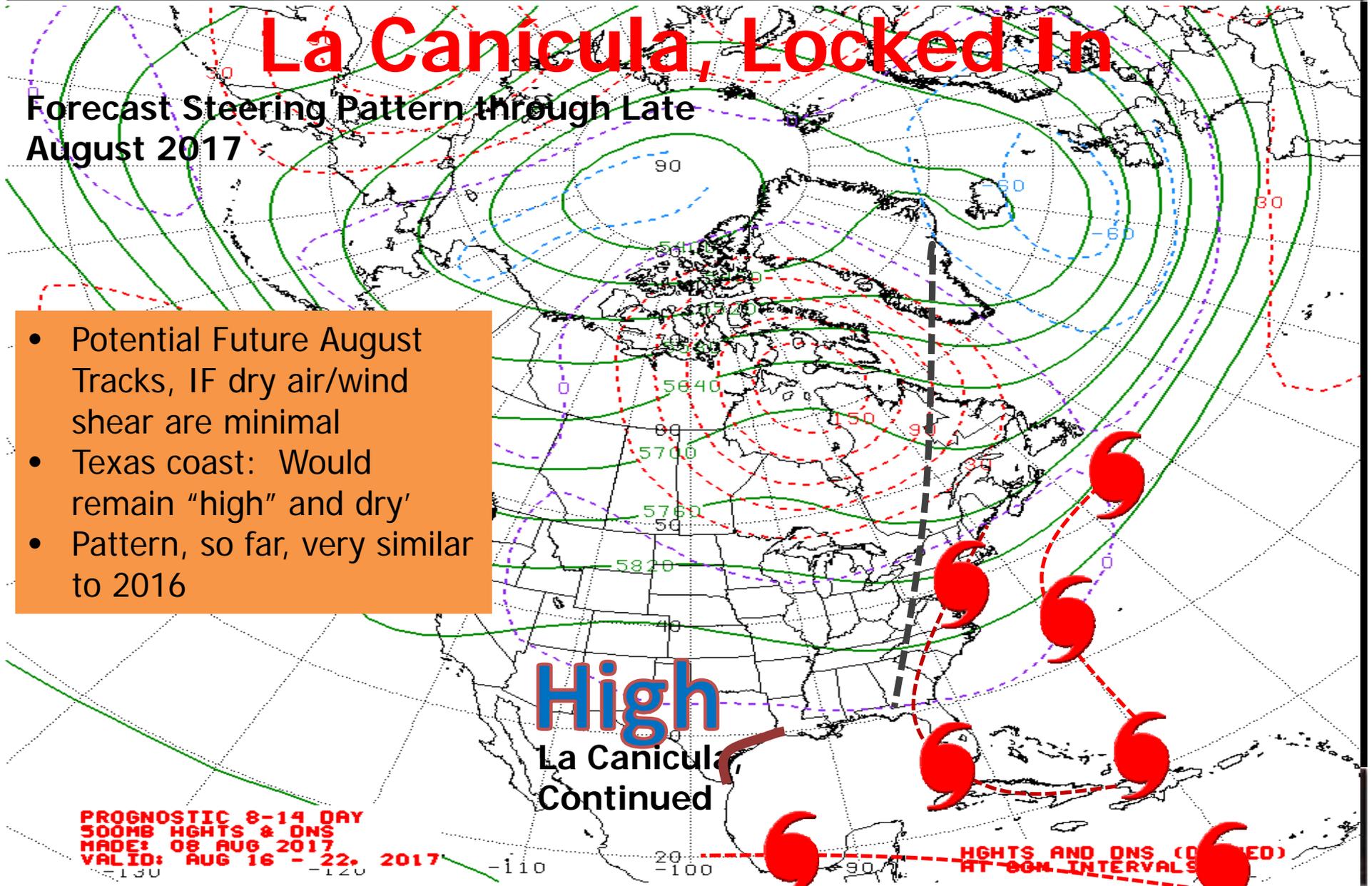
Forecast Steering Pattern through Late August 2017

- Potential Future August Tracks, IF dry air/wind shear are minimal
- Texas coast: Would remain "high" and dry'
- Pattern, so far, very similar to 2016

High
La Canicula
Continued

PROGNOSTIC 8-14 DAY
500MB HGHTS & DNS
MADE: 08 AUG 2017
VALID: AUG 16 - 22, 2017

HGHTS AND DNS (CONTINUED)
AT 60M INTERVALS

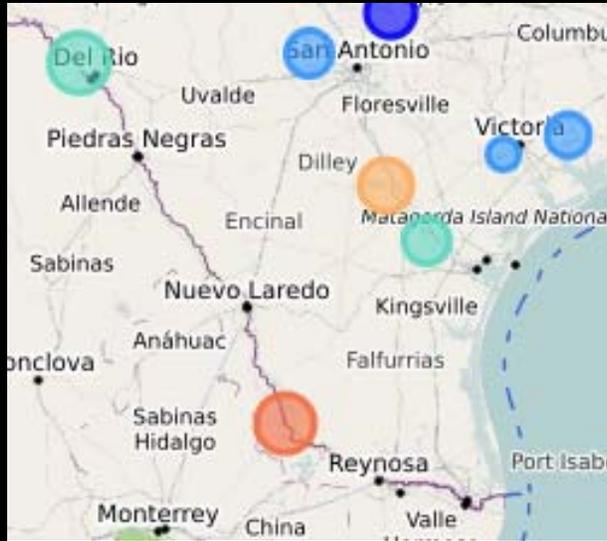




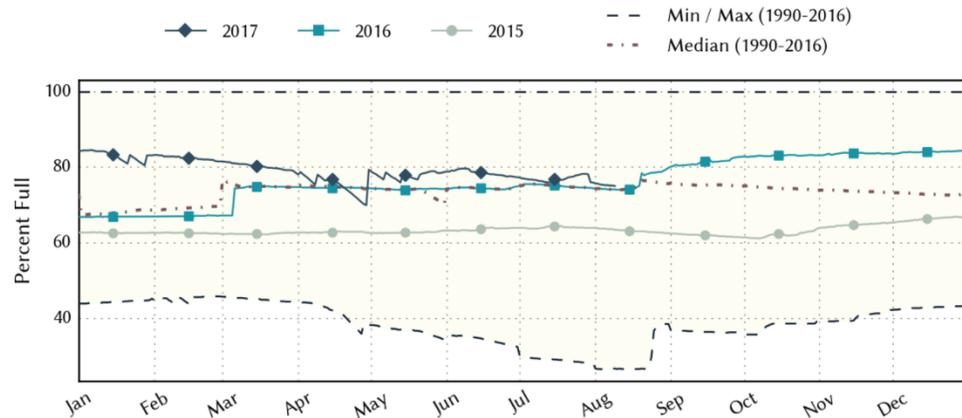
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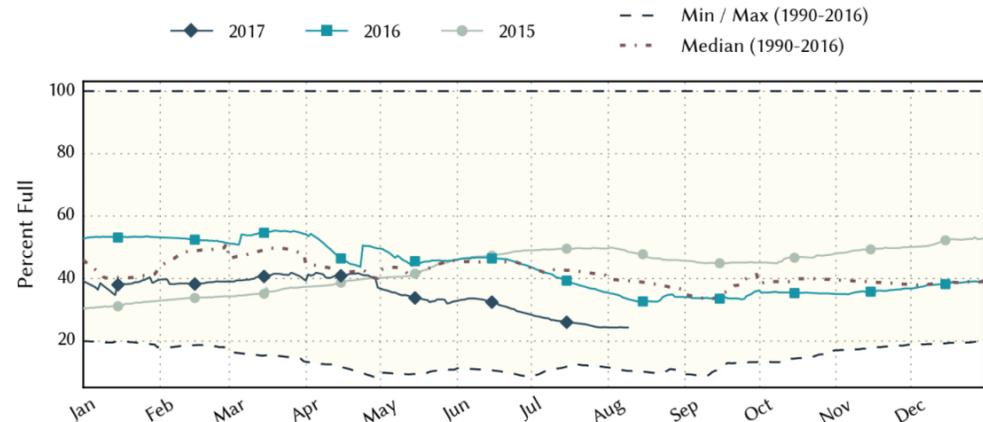
What If the Rains Don't Come?



Amistad Reservoir: 75.0% full as of 2017-08-09



Falcon Reservoir: 24.1% full as of 2017-08-09



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What if the Rains Don't Come?

| | | | | | | | |
|------------------------------|-------------|------|------|----------|----------|---------|------|
| SAN GABRIEL | | | | | | | |
| | 8/8/17 8:00 | 245 | 317 | 1774.620 | 183.112 | 0.000 | 75% |
| BOQUILLA | | | | | | | |
| | 8/8/17 8:00 | 2894 | 3278 | 1313.110 | 2269.584 | 15.200 | 78% |
| F.I. MADERO | | | | | | | |
| | 8/8/17 8:00 | 355 | 478 | 1239.900 | 376.305 | 244.460 | 106% |
| PICO DEL AGUILA | | | | | | | |
| | 8/8/17 8:00 | 51 | 87 | 1616.550 | 49.272 | 0.000 | 96% |
| CHIHUAHUA | | | | | | | |
| | 8/8/17 8:00 | 26 | 38 | 1538.910 | 18.092 | 0.090 | 70% |
| EL REJON | | | | | | | |
| | 8/8/17 8:00 | 7 | 8 | 1476.650 | 6.233 | 0.000 | 94% |
| LUIS L. LEON | | | | | | | |
| | 8/8/17 8:00 | 292 | 832 | 1038.840 | 394.856 | 116.797 | 135% |
| RIO SAN DIEGO BASIN | | | | | | | |
| CENTENARIO | | | | | | | |
| | 8/8/17 8:00 | 25 | 26 | 335.010 | 19.523 | 0.460 | 79% |
| SAN MIGUEL | | | | | | | |
| | 8/8/17 8:00 | 21 | 22 | 340.820 | 17.299 | 0.500 | 84% |
| RIO SAN RODRIGO BASIN | | | | | | | |
| LA FRAGUA | | | | | | | |
| | 8/8/17 8:00 | 47 | 85 | 297.620 | 28.346 | 0.000 | 60% |
| RIO SALADO BASIN | | | | | | | |
| VENUSTIANO CARRANZA | | | | | | | |
| | 8/8/17 8:00 | 1313 | 1322 | 257.260 | 598.573 | 0.000 | 46% |
| ----- | | | | | | | |
| RIO ALAMO BASIN | | | | | | | |
| LAS BLANCAS | | | | | | | |
| | 8/8/17 8:00 | 84 | 134 | 82.430 | 13.799 | 0.300 | 16% |
| RIO SAN JUAN BASIN | | | | | | | |
| EL CUCHILLO | | | | | | | |
| | 8/8/17 8:00 | 1123 | 1784 | 160.840 | 941.905 | 6.029 | 84% |
| MARTE GOMEZ | | | | | | | |
| | 8/8/17 8:00 | 782 | 2304 | 71.780 | 293.626 | 0.000 | 38% |

- At least there is some water in Mexican Reservoirs 😊
- Most at or above 75% conservation



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Bottom Lines

- Atlantic Season off to a “Jackrabbit” Start – but future impacts for Texas depend on the pattern “puzzle pieces”
- Other factors include deep moisture availability and wind shear. High wind shear and dry air are enemies to tropical cyclones, no matter how hot the water. The Caribbean has been “loaded” with shear this summer, so far
- September is a “wild card”, but if it follows June-August, the Texas coast may steer clear
- But Beulah reminds us that just a “crack” in the door can open the RGV up to potential danger



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Thank You!

Questions?

Contact Information:

barry.goldsmith@noaa.gov

956-572-1492 (cell)

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