



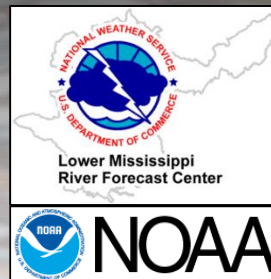
NWS River Forecasting, GIS, and the 2016 Amite/Comite River Flood

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*National Weather Service
Lower Mississippi River Forecast Center*

Overview

1. LMRFC river forecast process
2. GIS at the LMRFC
3. The 2016 Amite/Comite River Flood



LMRFC river forecast process

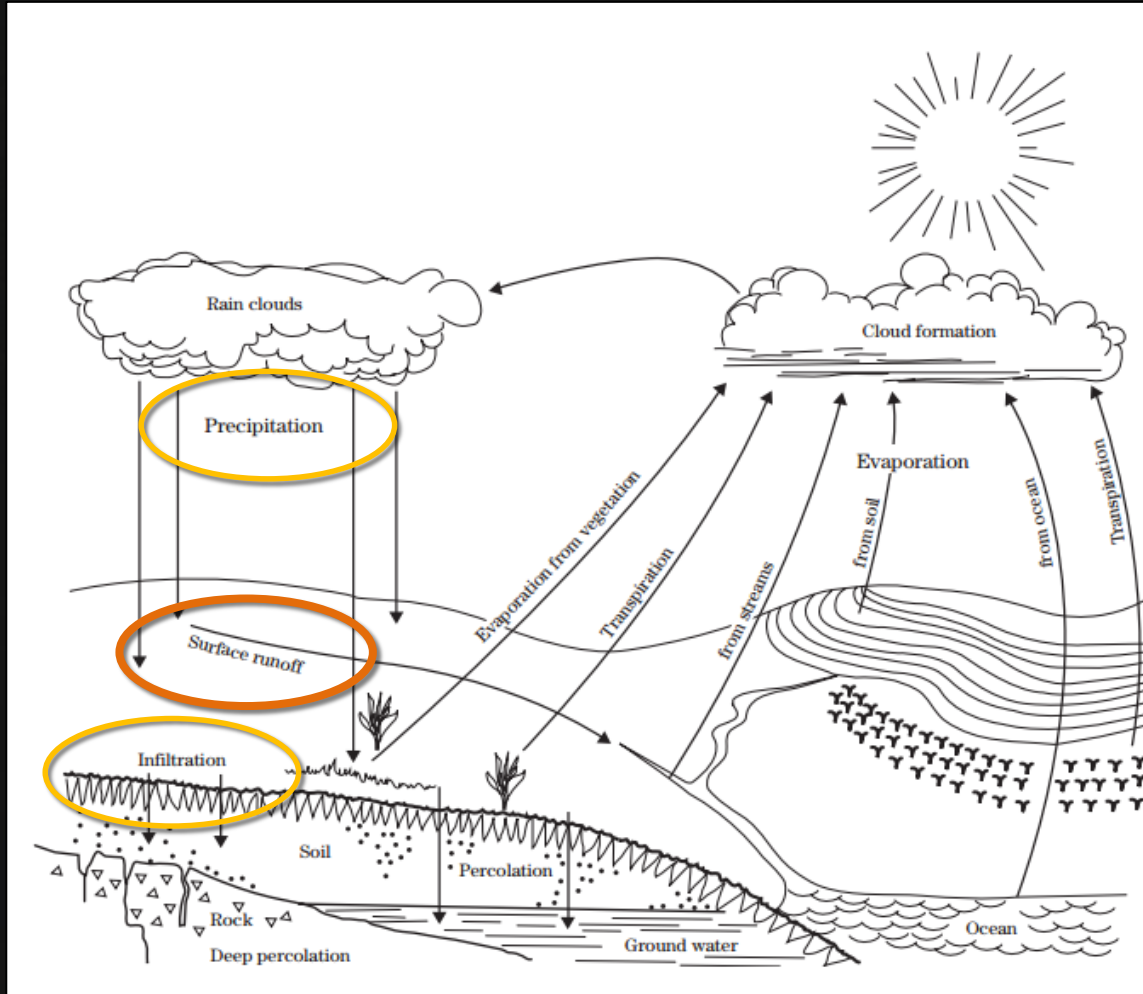
1

River Forecast Process

What do we do at the LMRFC?

- Forecast river stages for ~220,000 mi² area
 - River Gauge Data
 - Rainfall Data
 - Amount/Location and Fallen/Forecasted
 - Soil Moisture Data
- Assist with Flash Flooding

River Forecast Process



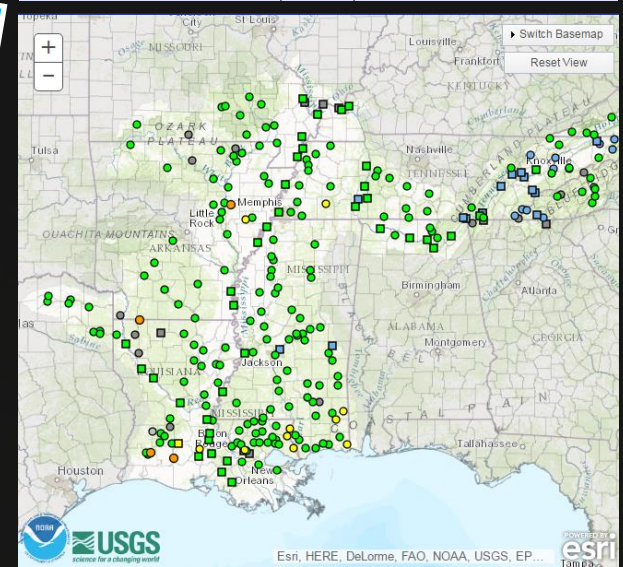
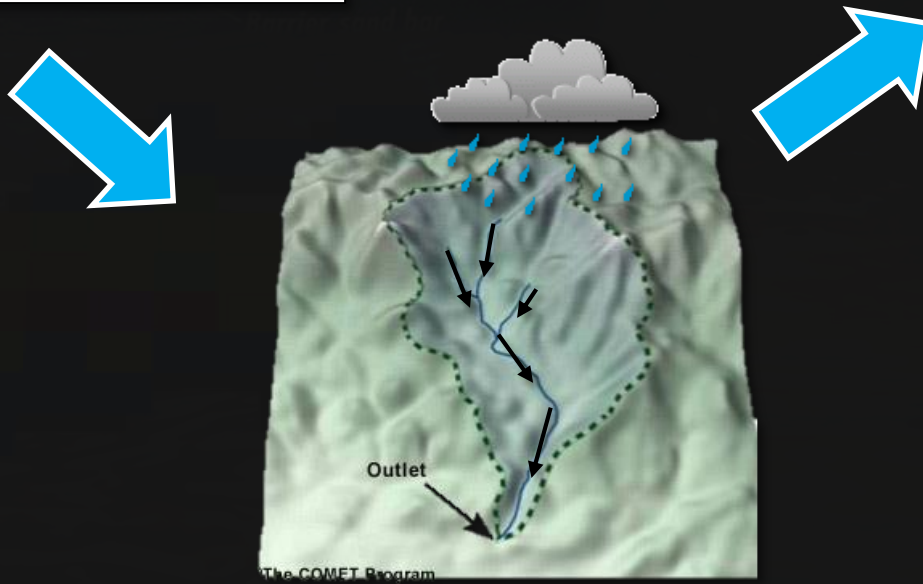
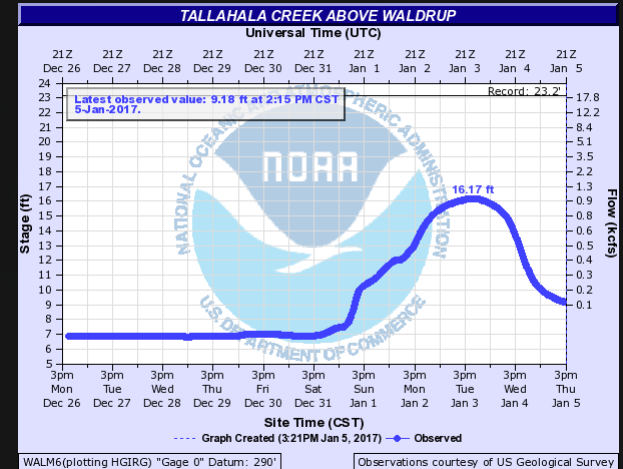
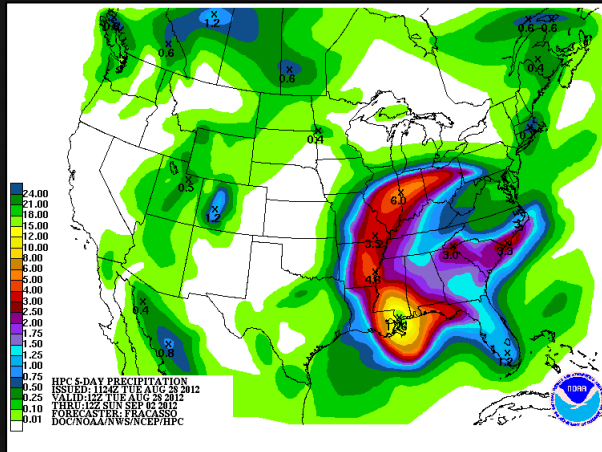
The Water Cycle

Hydrologists focus mostly on water at the Earth's surface.

Hydro forecasters for the National Weather Service focus primarily on "Surface Runoff"

USDA Natural Resources Conservation Service

River Forecast Process



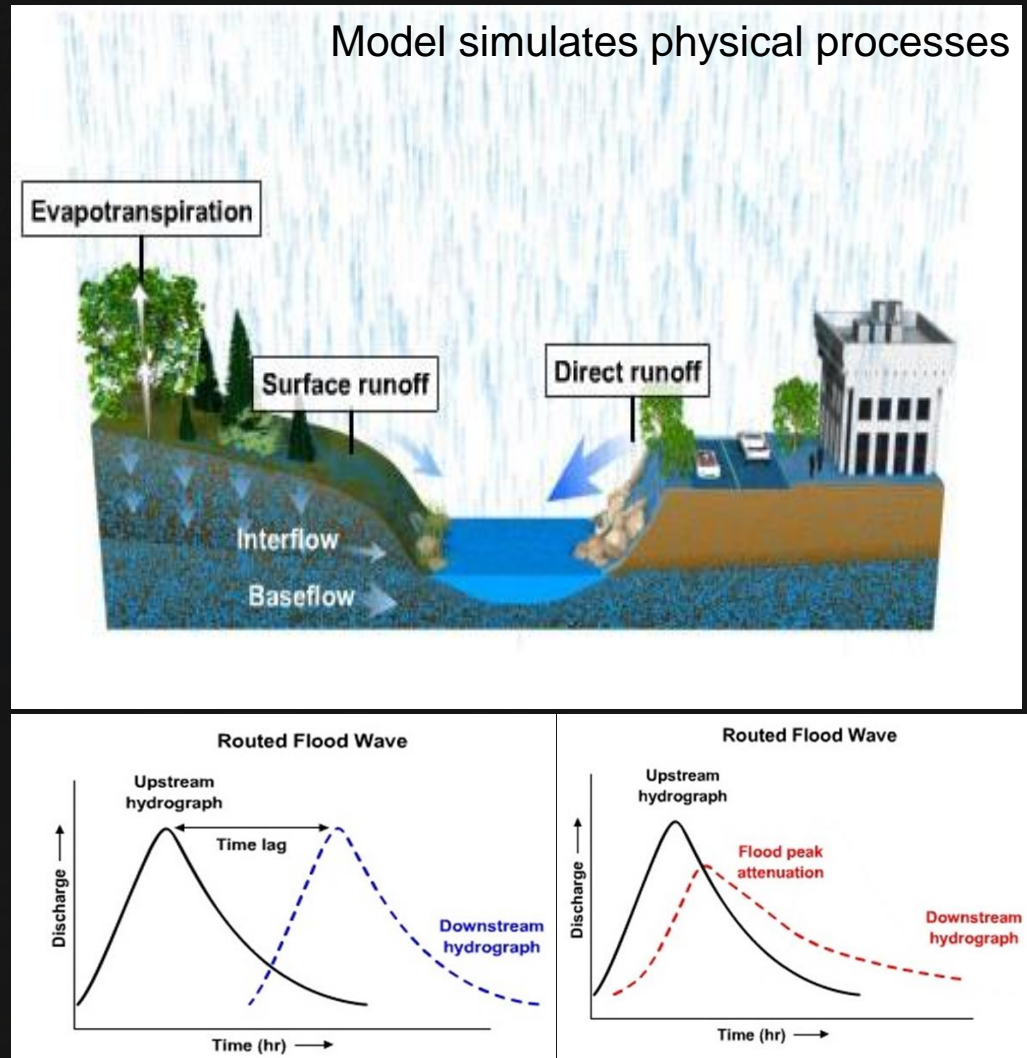
River Forecast Process

Sacramento Soil Moisture Accounting (SAC SMA) Model

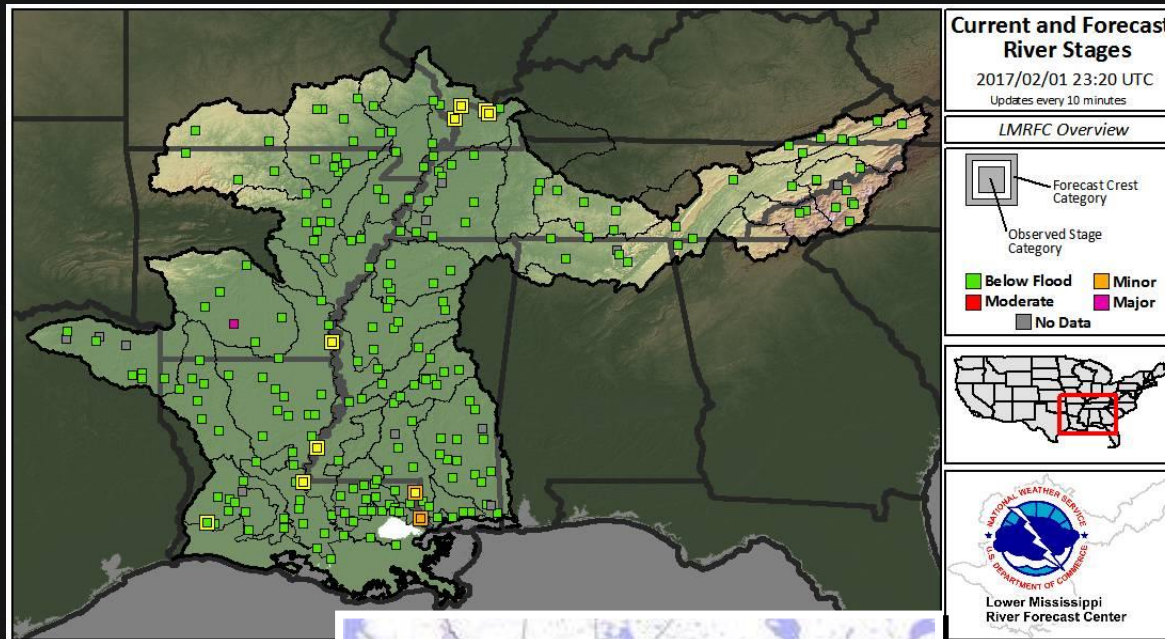
- Conceptual model
- Total runoff based on interaction of 2 soil zones
- Variable parameters used to simulate movement of water into and out of zones

Routing

- Movement of water from one river location to next
- Parameters simulate time delay and also attenuation



River Forecast Process



- River Forecast Centers issue precipitation, river, and flash flood guidance based on hydrologic/hydraulic models
- Provide river forecast guidance to Weather Forecast Offices (WFOs)
- Develop and calibrate models

River Forecast Process

Flood Outlook and Warning Products (2016 08 Example)

- **Outlooks** – Issued for long lead time, days in advance.
(mentioned on Sat Aug 6 and issued special product on Mon Aug 8)
- **Flood/Flash Flood Watch** – Issued 36 to 48 hours in advance.
(Initial Watch issued Tue 9 – continued thru event)
- **River Flood Warnings** – Lead time up several days in advance, if possible, depending on rainfall forecasts and river watershed size
 - Utilize RFC guidance to generate River Forecasts and Warnings.
(Wed, Aug 10 – initial river flood warning based strictly on forecasted rainfall)
- **Flash Flood Warnings** – issued for flooding small streams/bayous/local drainages.
 - Tools – real time precip estimates from radar/gages/satellite, radar trends, reports, and flash flood guidance. Software tools.
(Initial Warnings Thu – Aug 11)
 - Can elevate Warnings to “Emergency” level when there is a particular threat to life.
(Fri early morning – Aug 12)

River Forecast Process

- **Provide Advice to State and Local Emergency Management**
 - Blast e-mails , webinars, conference calls, direct briefings.
(started Mon Aug 8 and continued thru event)
- **Direct to Media and Public**
 - Media - Conference calls *(Wed Aug 10)*
 - Public- thru media as partner/conduit
 - Public – direct thru Web Page, Social Media, NOAA Weather Radio, phone calls *(utilized throughout the event)*



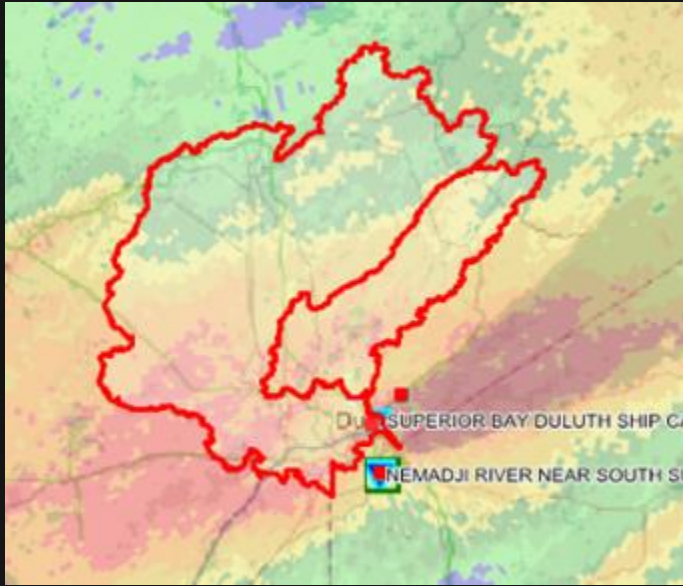
GIS at LMRFC

2

GIS at LMRFC

- Most data used by LMRFC (or any NWS office) inherently geospatial
- Tools/Techniques for Situational Awareness
- Research

GIS at LMRFC



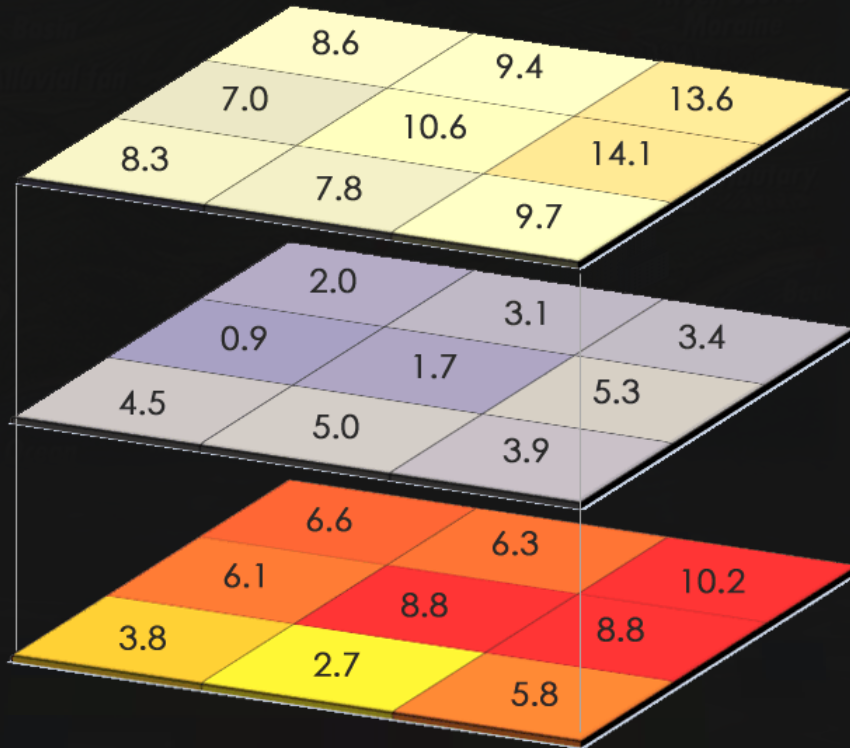
NOAA Sea Grant

Spatial Averaging

At RFCs, virtually all modeling is done on the watershed/basin-scale.

Gridded data is averaged by forecast basin before being used by models.

GIS at LMRFC



gisgeography.com

Other “Map Algebra”

Comparison of values
(rainfall, soil moisture)
to climatology

Calculation of potential
evapotranspiration

Comparison of rainfall
to flash flood guidance

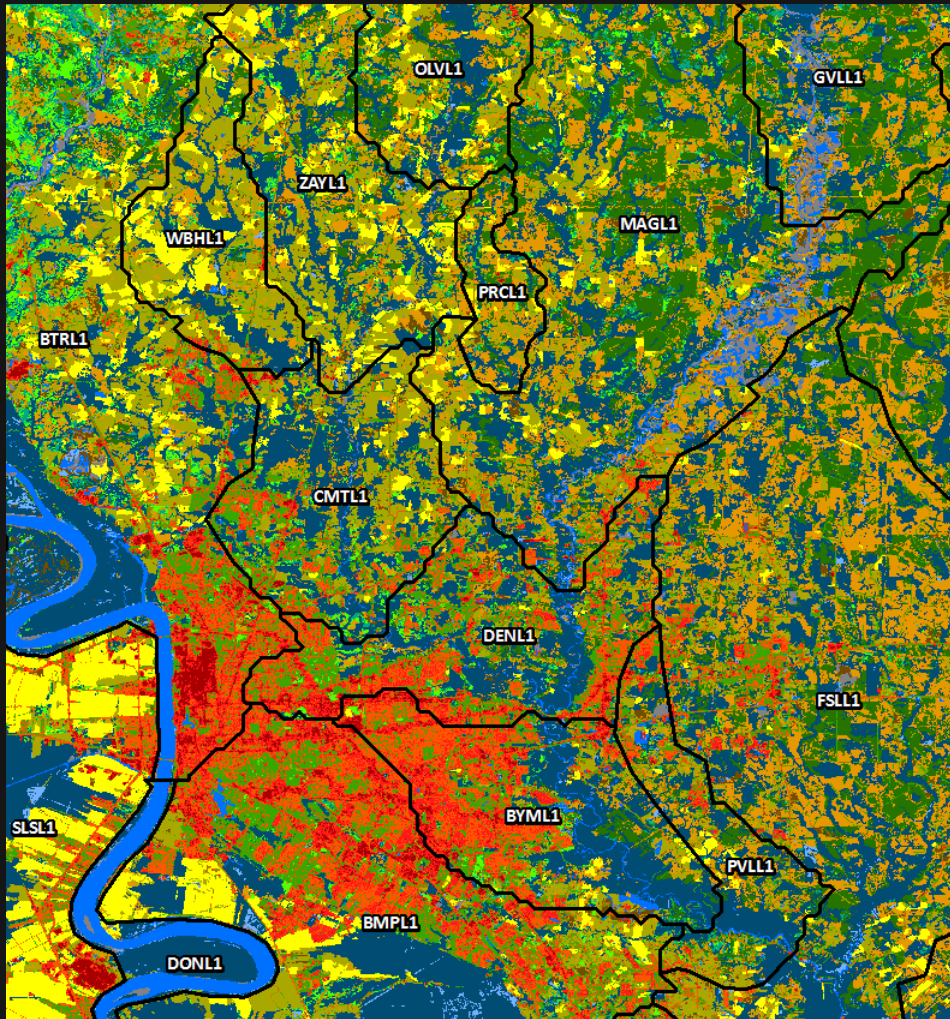
GIS at LMRFC



Other Analyses

Estimating gauge crest elevation for Hurricane Isaac flooding

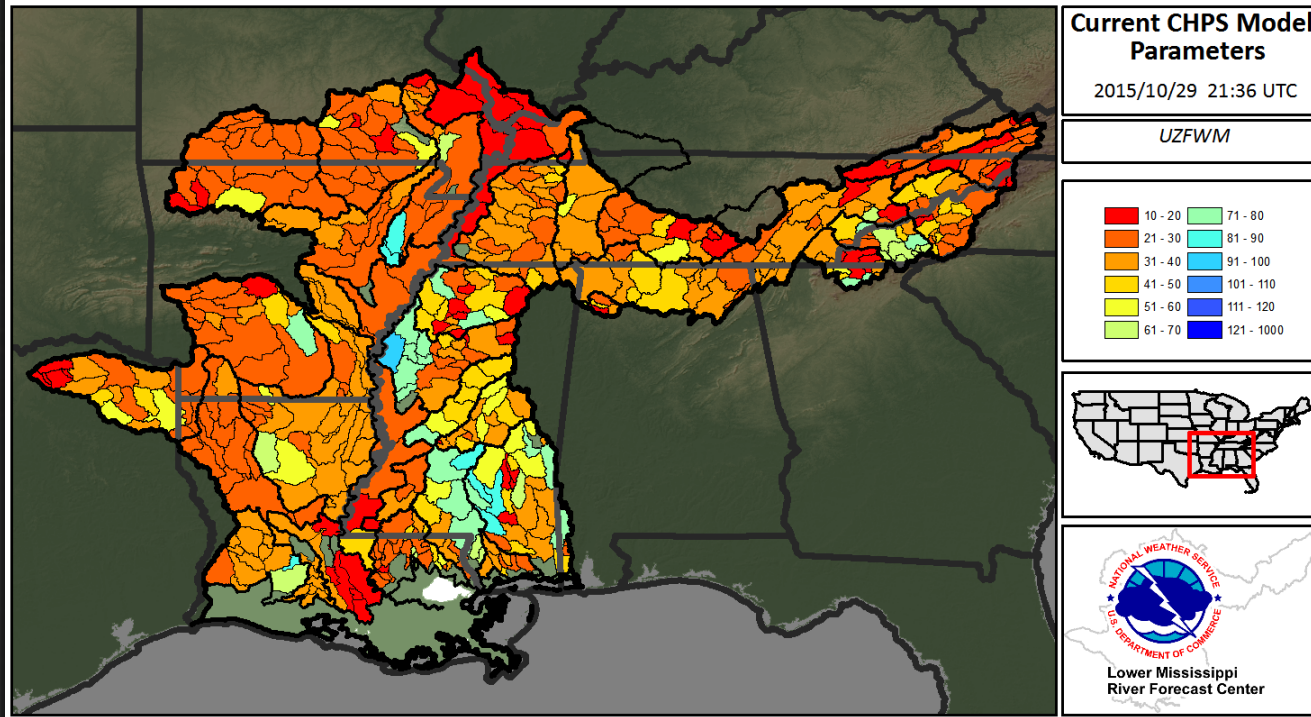
GIS at LMRFC



Other Analyses

Monitoring development patterns for possible model parameter changes

GIS at LMRFC

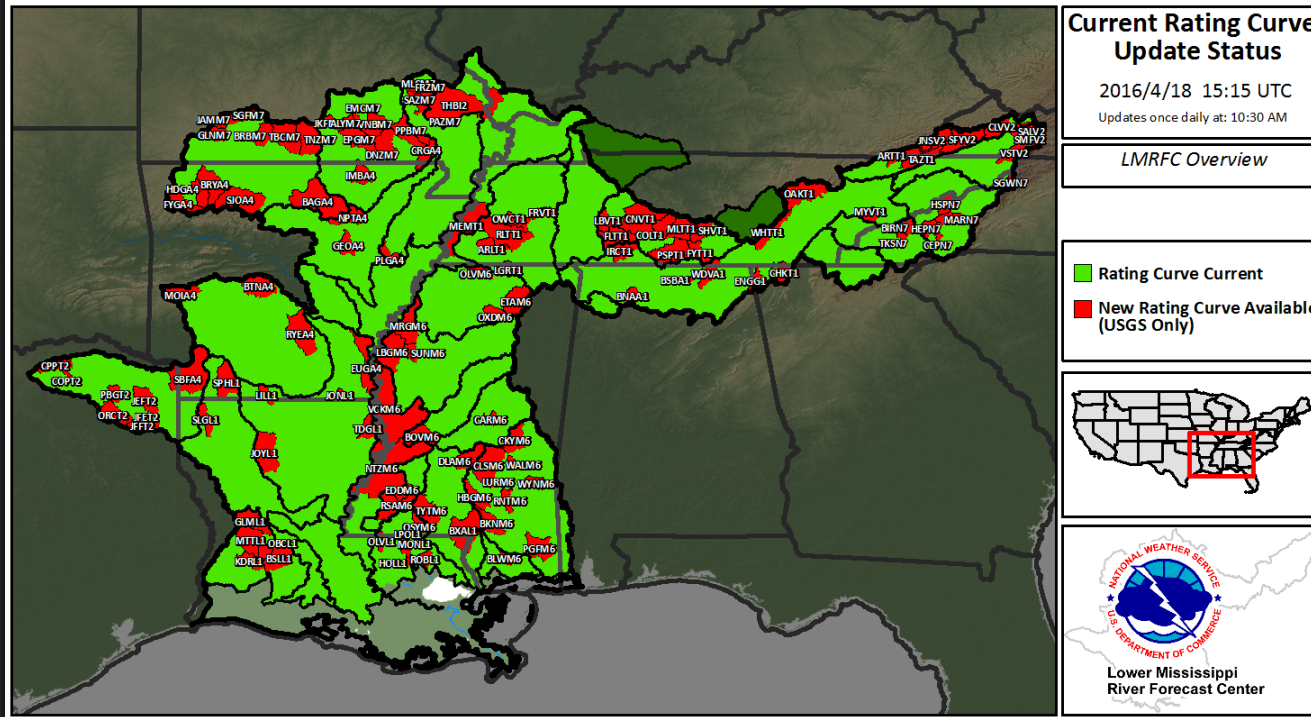


Situational Awareness

Joins of watersheds to numeric data

Comparison of parameters between neighboring watersheds

GIS at LMRFC



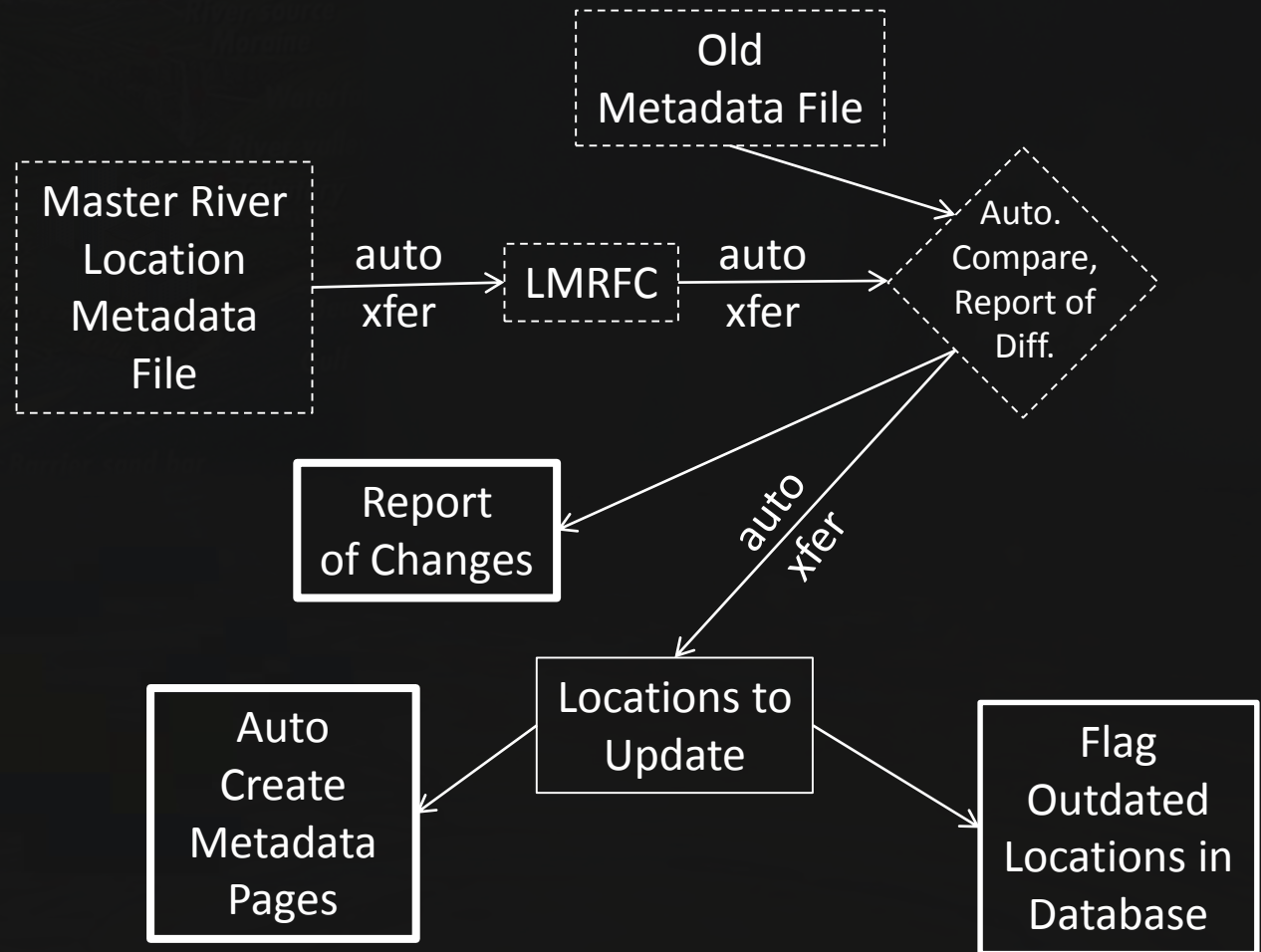
Situational Awareness

Simple joins of watersheds to text file of “yes” or “no”

Tells forecasters if updates available

GIS at LMRFC

From simple to complex...



GIS at LMRFC

Vermilion River

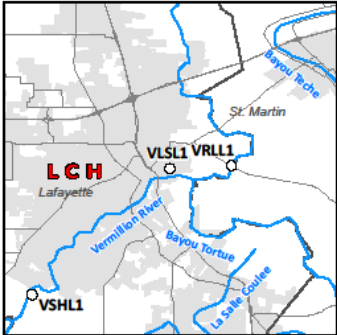
At Lafayette, Surrey Street Gage

VLSL1

<http://water.weather.gov/ahps2/hydrograph.php?wfo=LCH&gage=VLSL1>

State:	LA	Lat:	30.2172
County:	Lafayette	Lon:	-91.9925
HSA:	LCH	Owner:	N/A
USGS ID:	07386880	USACE ID:	

Low Water:	--.- FT	Vertical Datum:	-2.7 FT NAVD88
Action Stage:	10.0 FT		
Minor Flood:	10.0 FT		
Moderate Stage:	14.0 FT		
Major Stage:	16.0 FT		



CRESTS

24.9 FT	1940-08-09
16.8 FT	1947-03-13
16.4 FT	1942-04-08
15.8 FT	1993-01-20
15.6 FT	1980-05-17
15.3 FT	2001-06-10
15.0 FT	1993-01-21
14.8 FT	1977-04-22
14.6 FT	1971-12-06
14.3 FT	1966-02-16

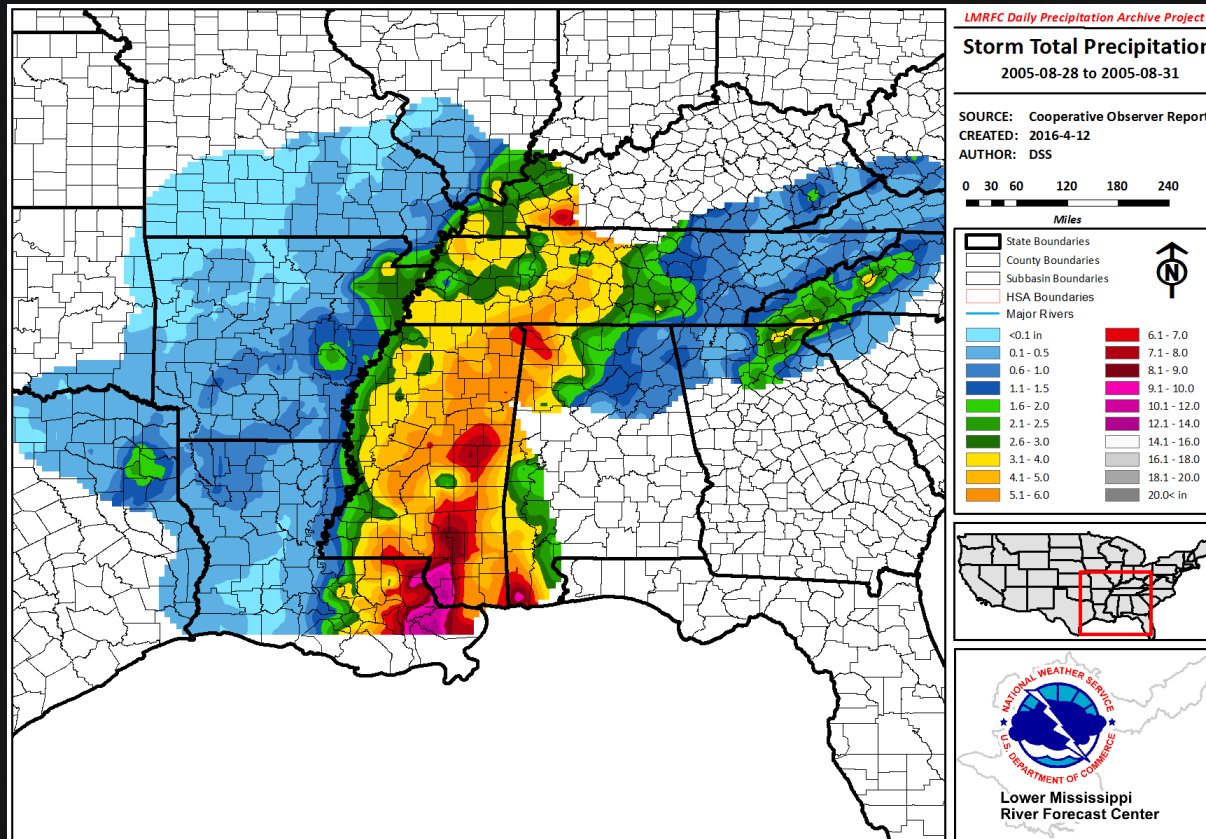
Created: 2016/3/31

Consistent Metadata

Built from an ArcMap layout

Python edits text boxes based upon metadata, python moves map window

GIS at LMRFC

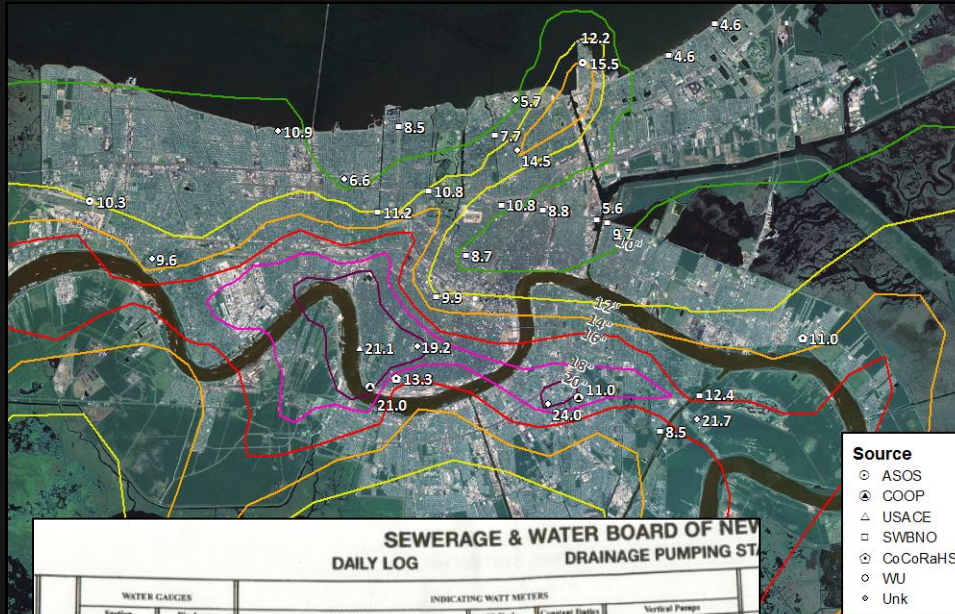


Past Event Archive

Over 60 years of daily point precipitation data converted to shapefiles, then interpolated (kriging) to grids

Tool created to access database and auto create maps

GIS at LMRFC



Analyzing Major Events

Acquisition of rainfall data from numerous networks to verify extreme rainfall totals.

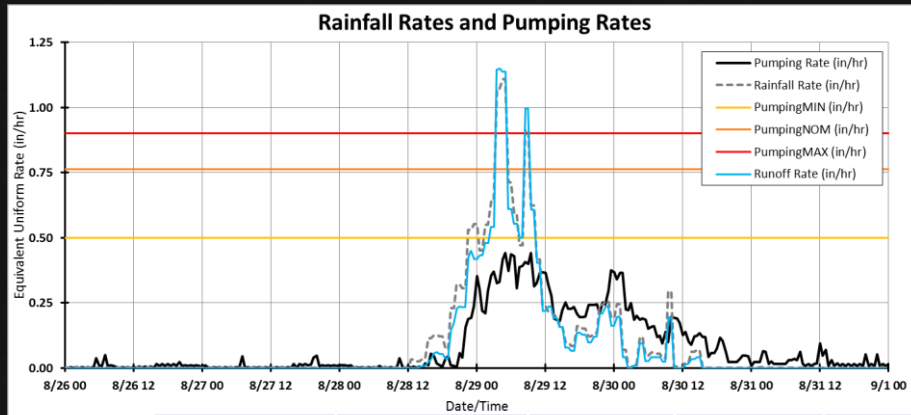
SEWERAGE & WATER BOARD OF NEW ORLEANS
DAILY LOG
DRAINAGE PUMPING STATION

Time	WATER GAUGES				INDICATING WATT METERS													
	In Back of Screen	In Front of Screen	Discharge	5144	6600 V Units					60 Cycle			Constant Dials		Vertical Pumps			
					A	B	C	D	E	F	G	H	I	#1	#2	No.3	No.4	By
12:30	105	105	232	232														
1:00	105	111	233	233														
1:30	105	106	232	232														
2:00	113	119	231	231														
2:30	108	124	233	233														
3:00	113	121	233	233														
3:30	124	121	234	234														
4:00	124	129	232	232														
4:30	126	132	234	234														
5:00	143	15	215	235														
5:30	143	143	215	235														
6:00	143	143	217	237														
6:30	143	148	218	238														
7:00	143	148	218	243														
7:30	179	147	214	242														
8:00	134	137	215	245														
8:30	133	139	214	244														
9:00	133	129	214	244														

Using pumping records to confirm rainfall amounts

New Orleans Sewerage and Water Board

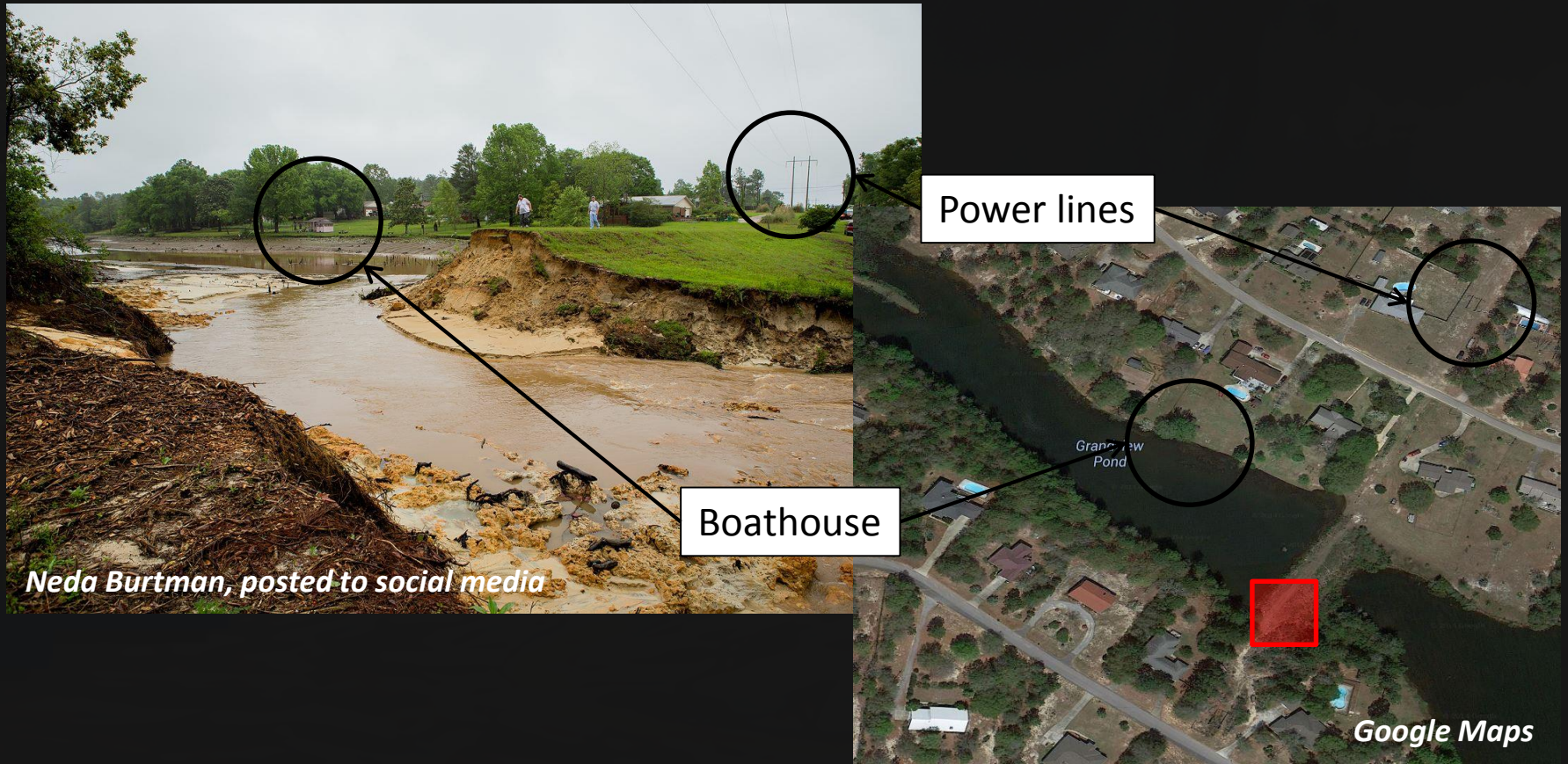
GIS at LMRFC



Subbasin	Rainfall (in)	Loss (%)	Loss (in)	Modeled Runoff (in)	Equivalent Depth Pumped (in)
1	16.97	13.5%	2.29	14.77	
2	11.29	1.5%	0.17	11.02	
3	10.42	2.2%	0.22	10.11	
4	12.02	4.3%	0.51	11.43	
6	17.35	20.4%	3.54	13.88	
7	12.28	3.3%	0.40	11.76	
19	9.11	2.7%	0.24	8.77	
PolderAVG	13.54	10.2%	1.39	12.13	11.94

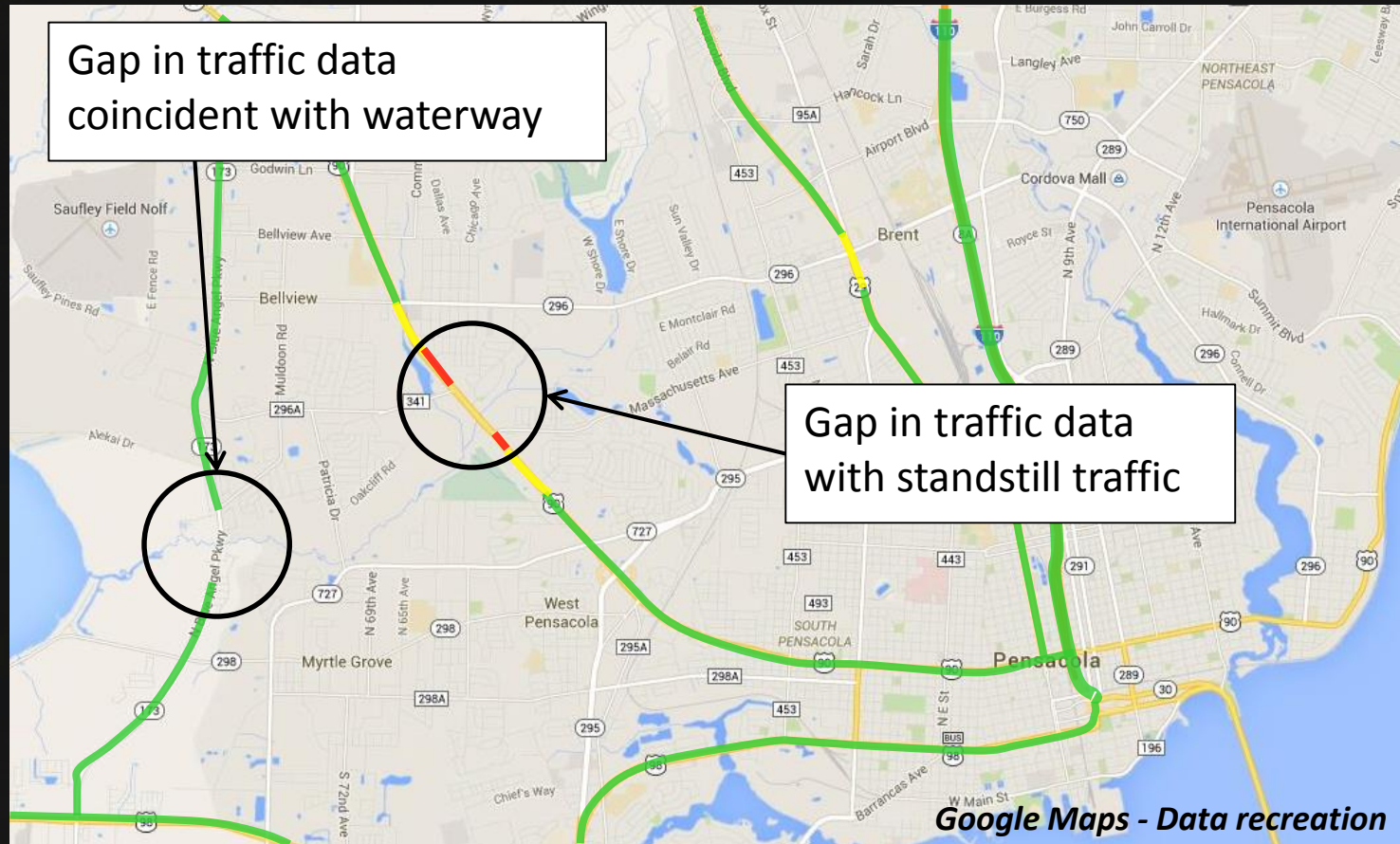
GIS at LMRFC

Analyzing Past Events – “Geo-intelligence”

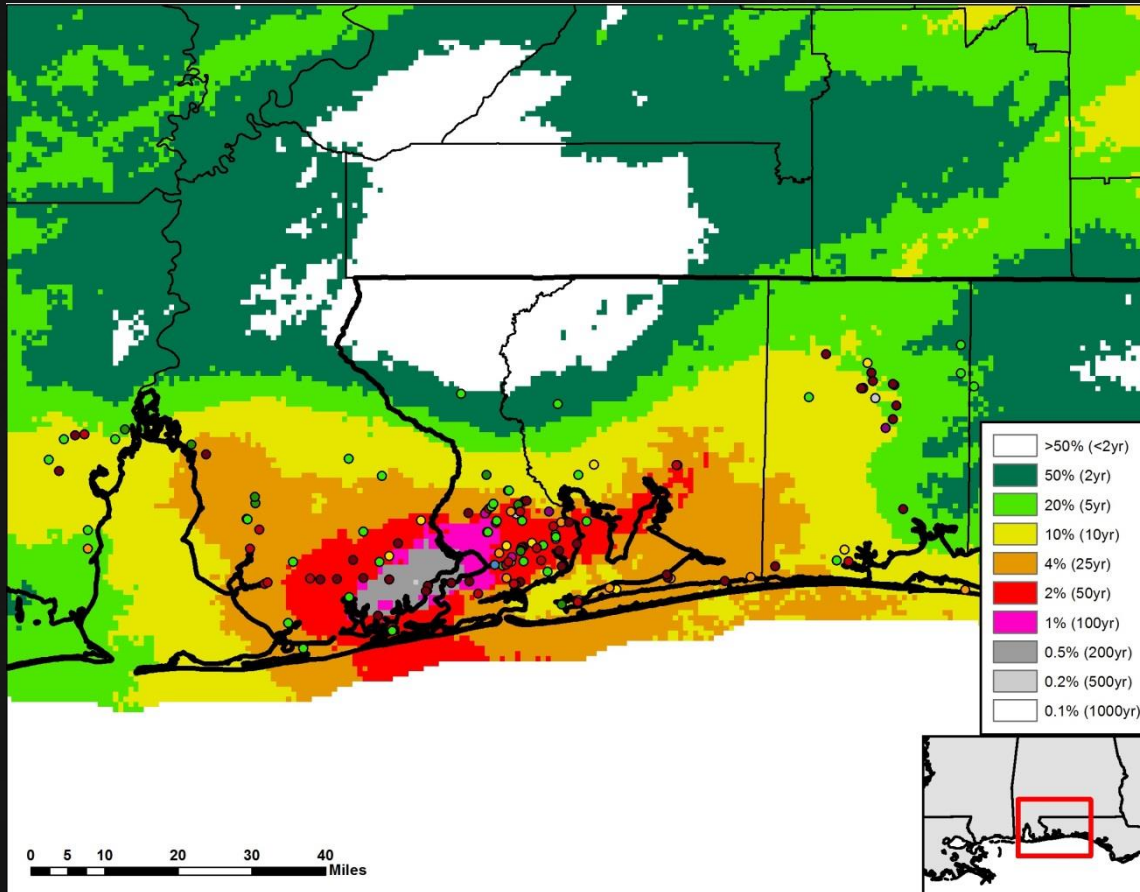


GIS at LMRFC

Analyzing Past Events – “Geo-intelligence”



GIS at LMRFC



Analyzing Major Events

Comparing rainfall to climatology to determine annual exceedance probability (AEP) / average recurrence interval (ARI)

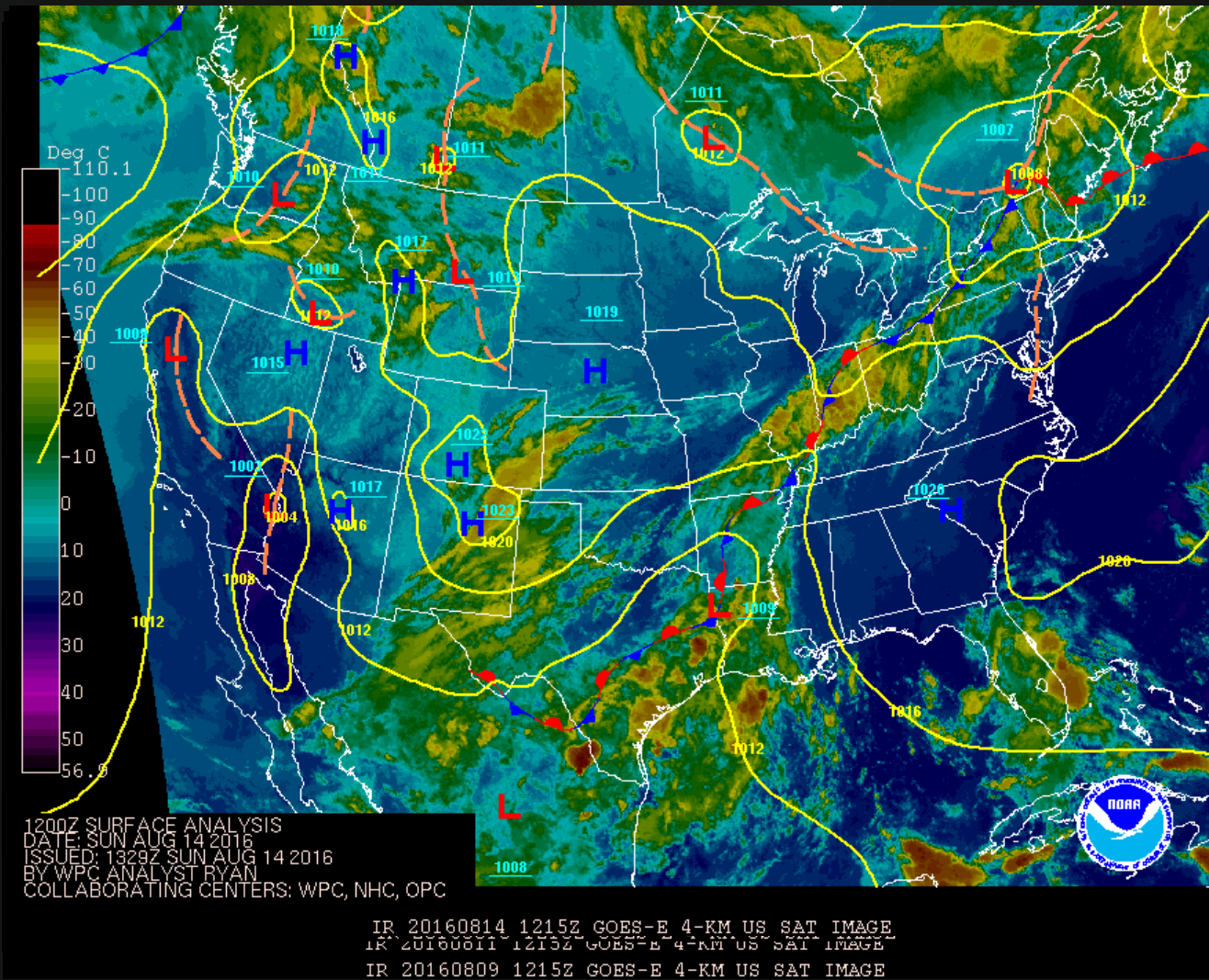
Comparison to flood reports



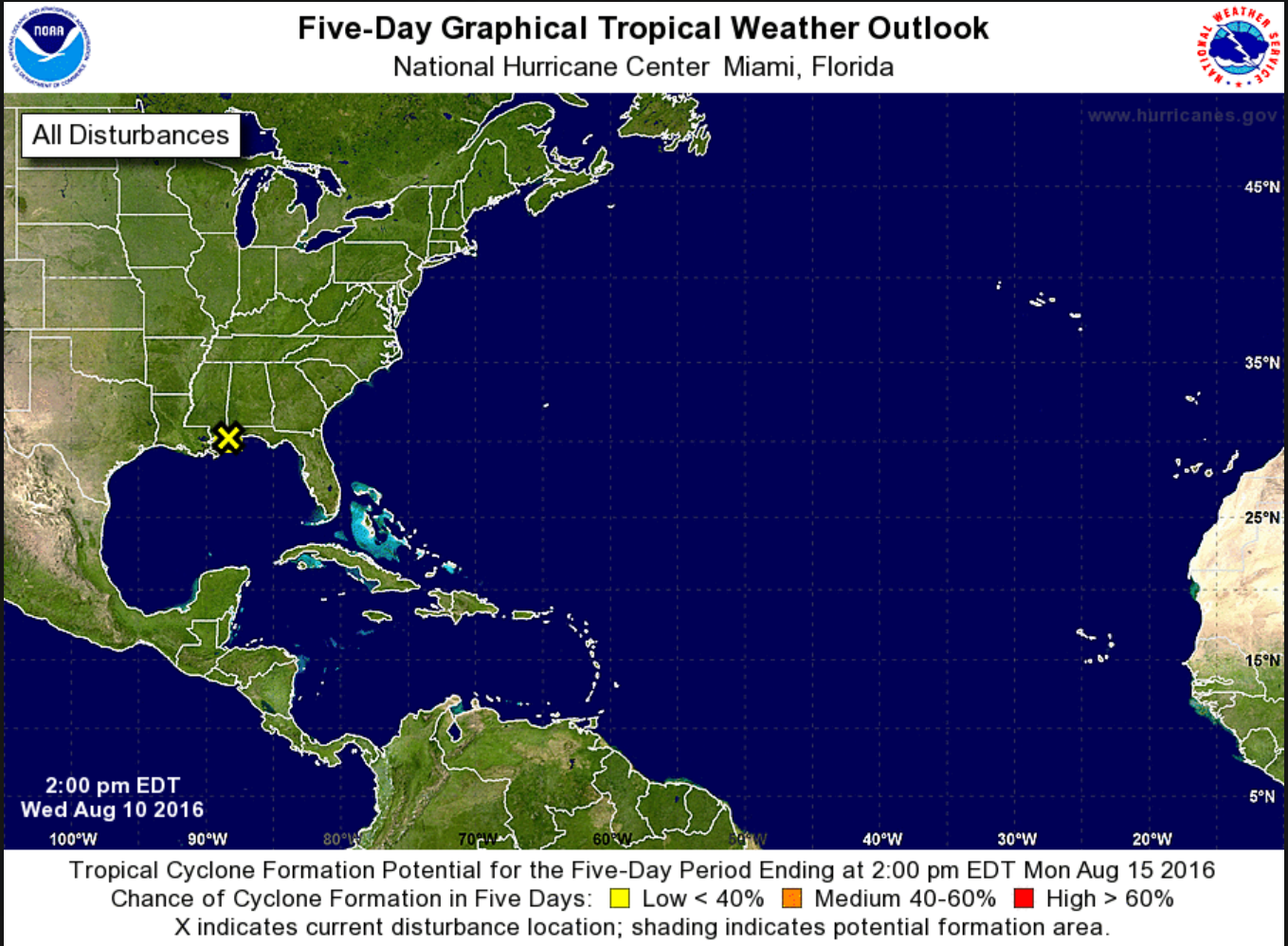
2016 Amite/Comite River Flood

3

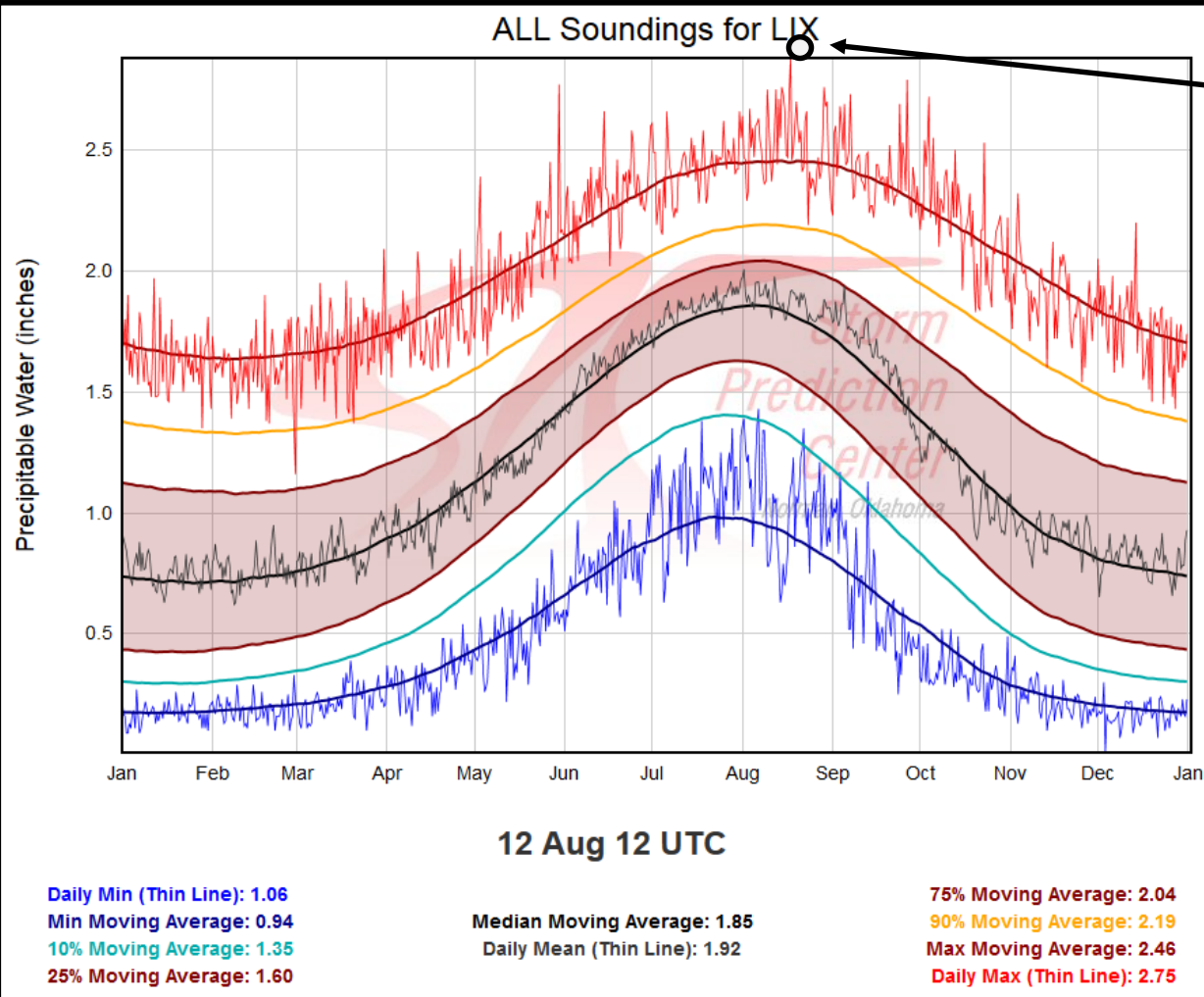
2016 Amite/Comite River Flood



2016 Amite/Comite River Flood



2016 Amite/Comite River Flood

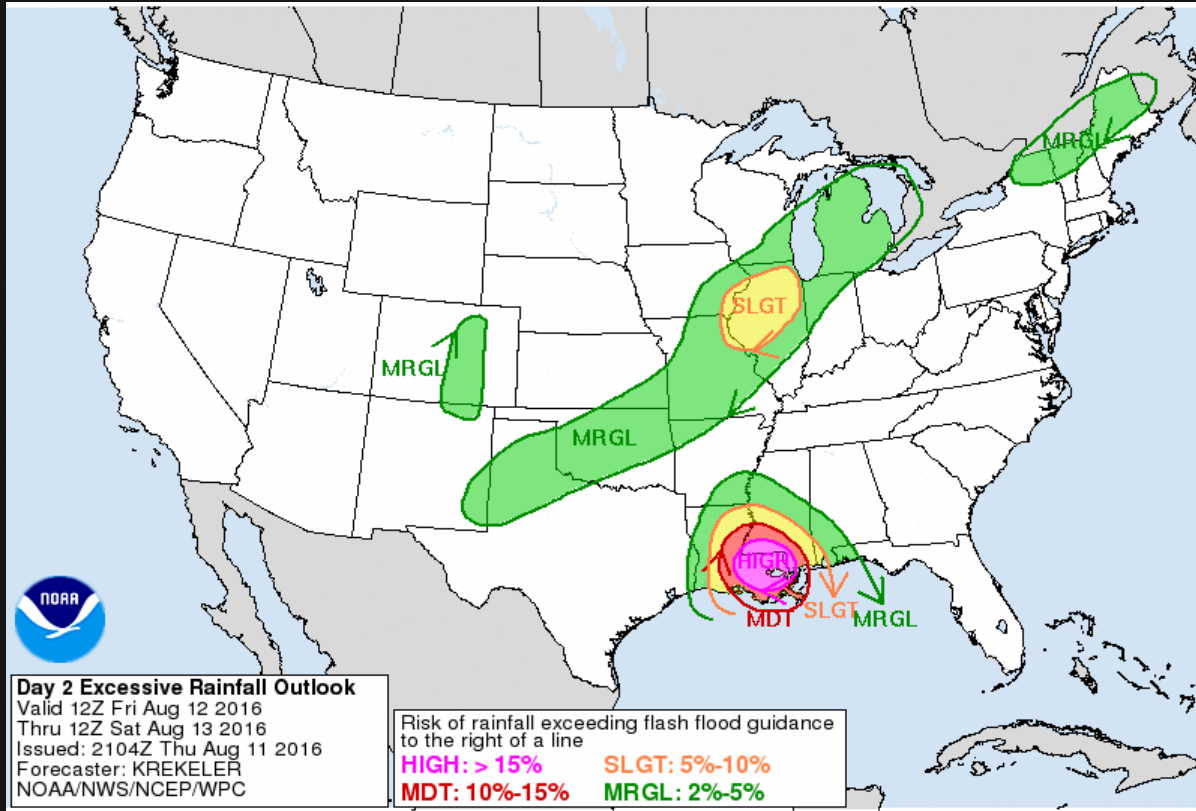


Near record atmospheric moisture

Climatology of moisture content 1948-2014

3rd highest value on record, above daily maximum

2016 Amite/Comite River Flood



Excessive Rainfall Outlook

Issued 1200 UTC
(7am CDT) Friday
Aug 12

Language included

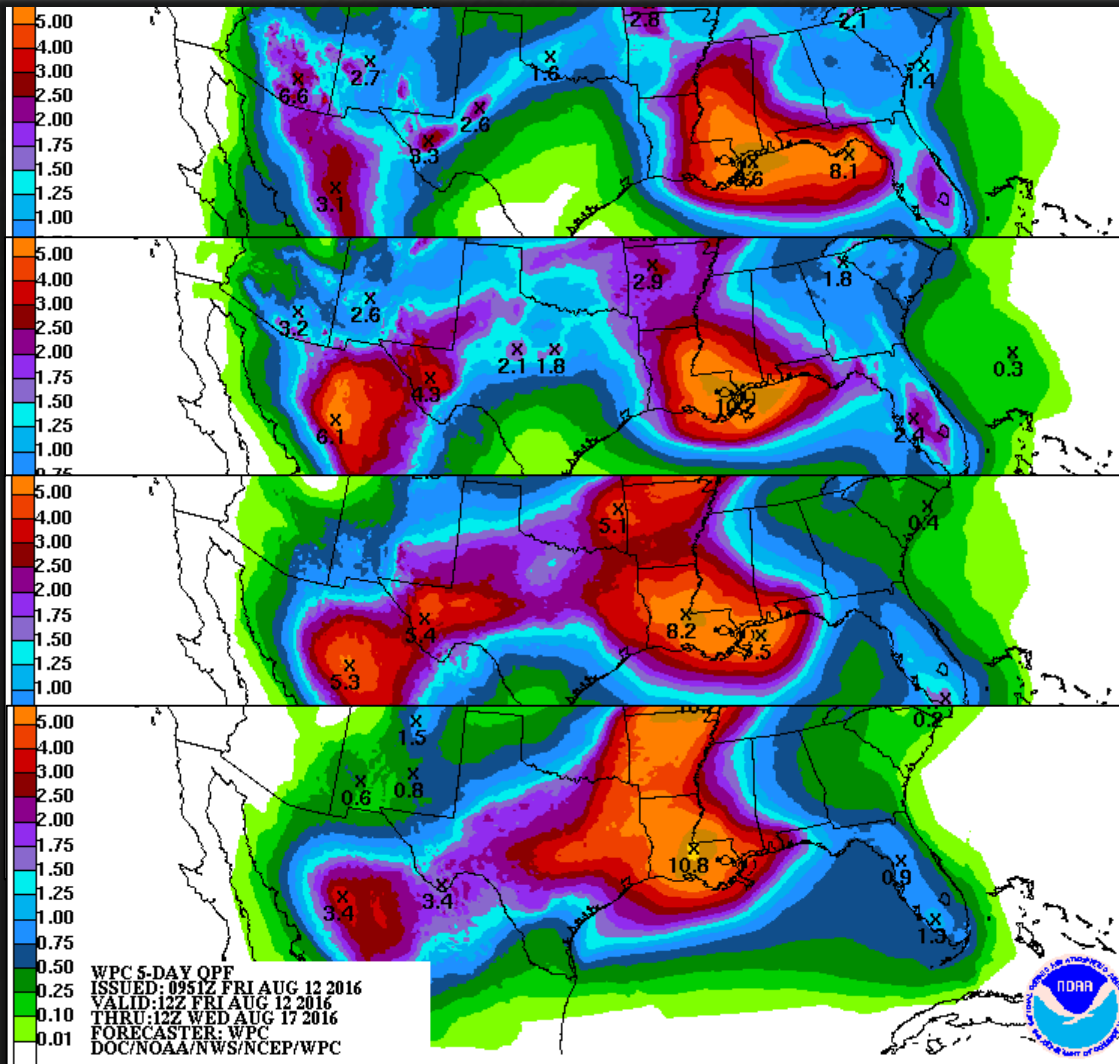
“life threatening flash flooding”

“Model rainfall truly prolific”

“High Risk” used in

Day 2 – very unusual

2016 Amite/Comite River Flood



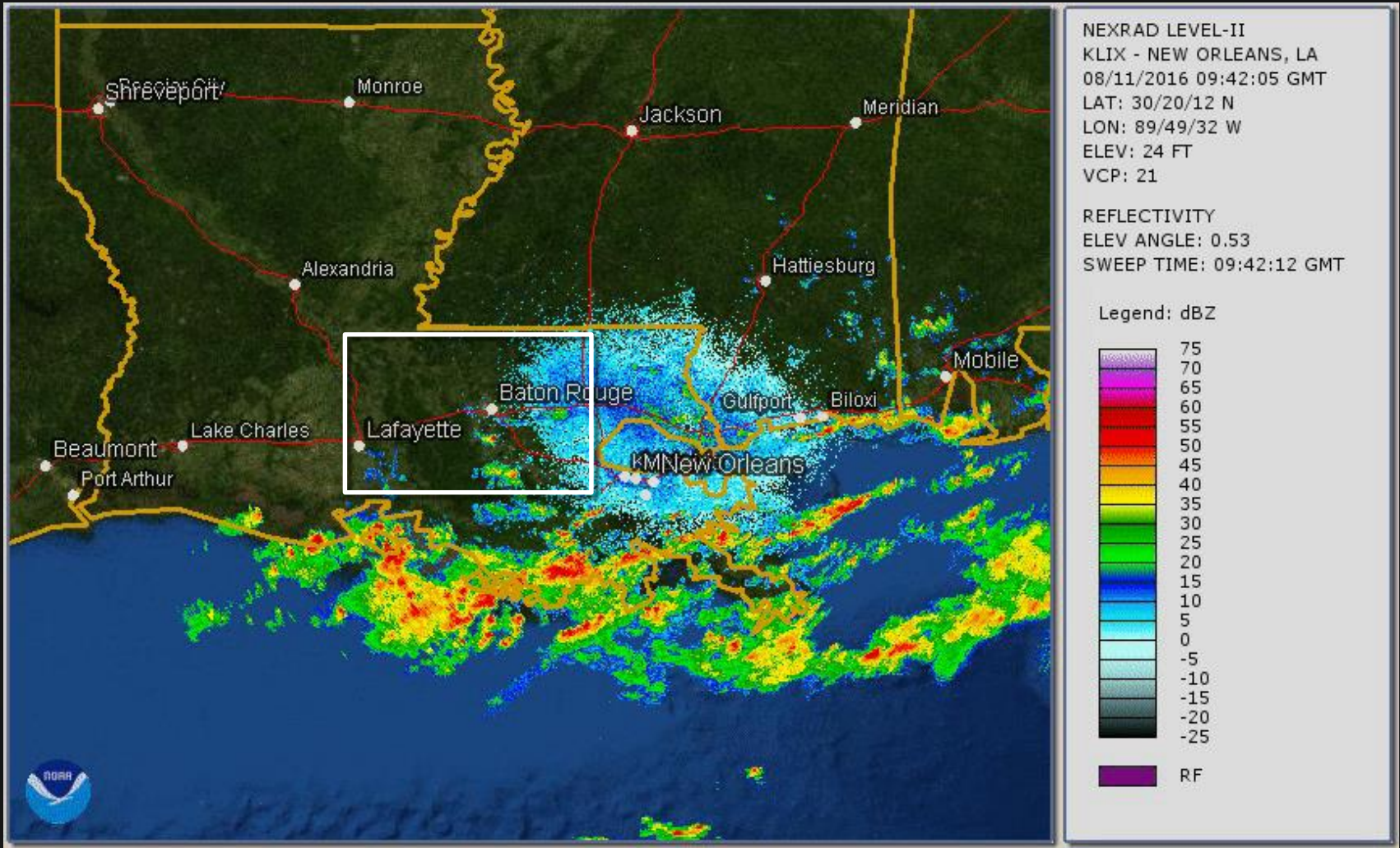
Tuesday
Aug 9

Wednesday
Aug 10

Thursday
Aug 11

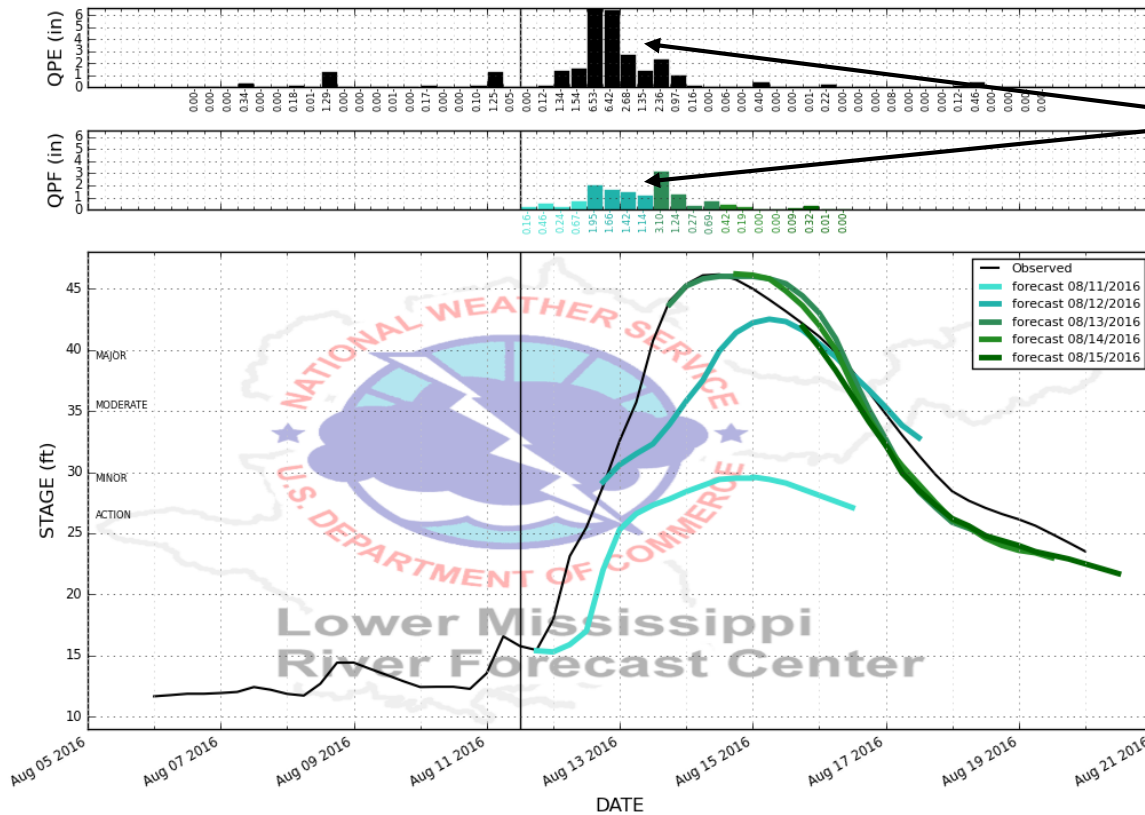
Friday
Aug 12

Event Radar Loop



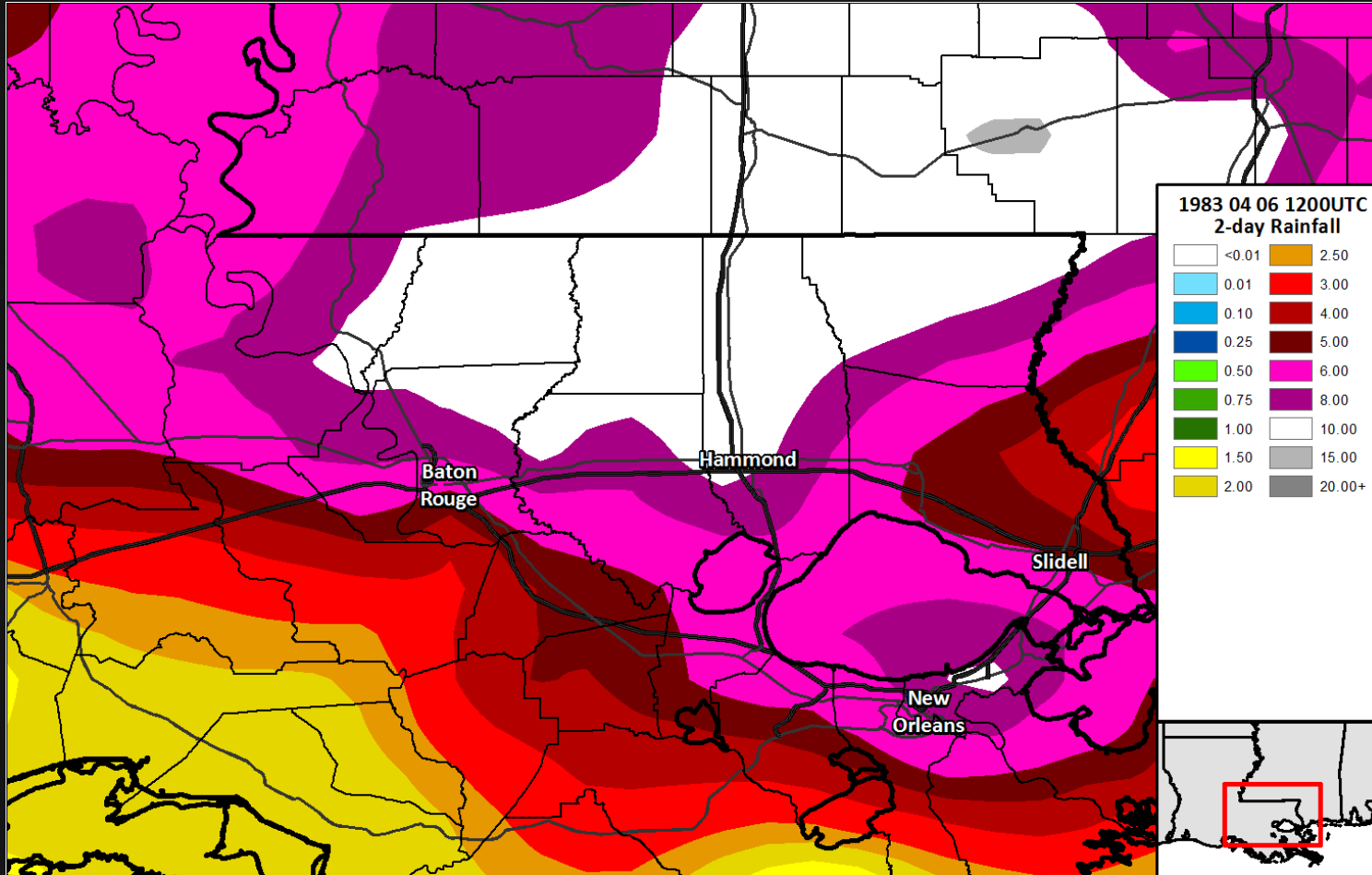
2016 Amite/Comite River Flood

DENL1 HISTORICAL FORECAST DATA
08/11/2016 12Z

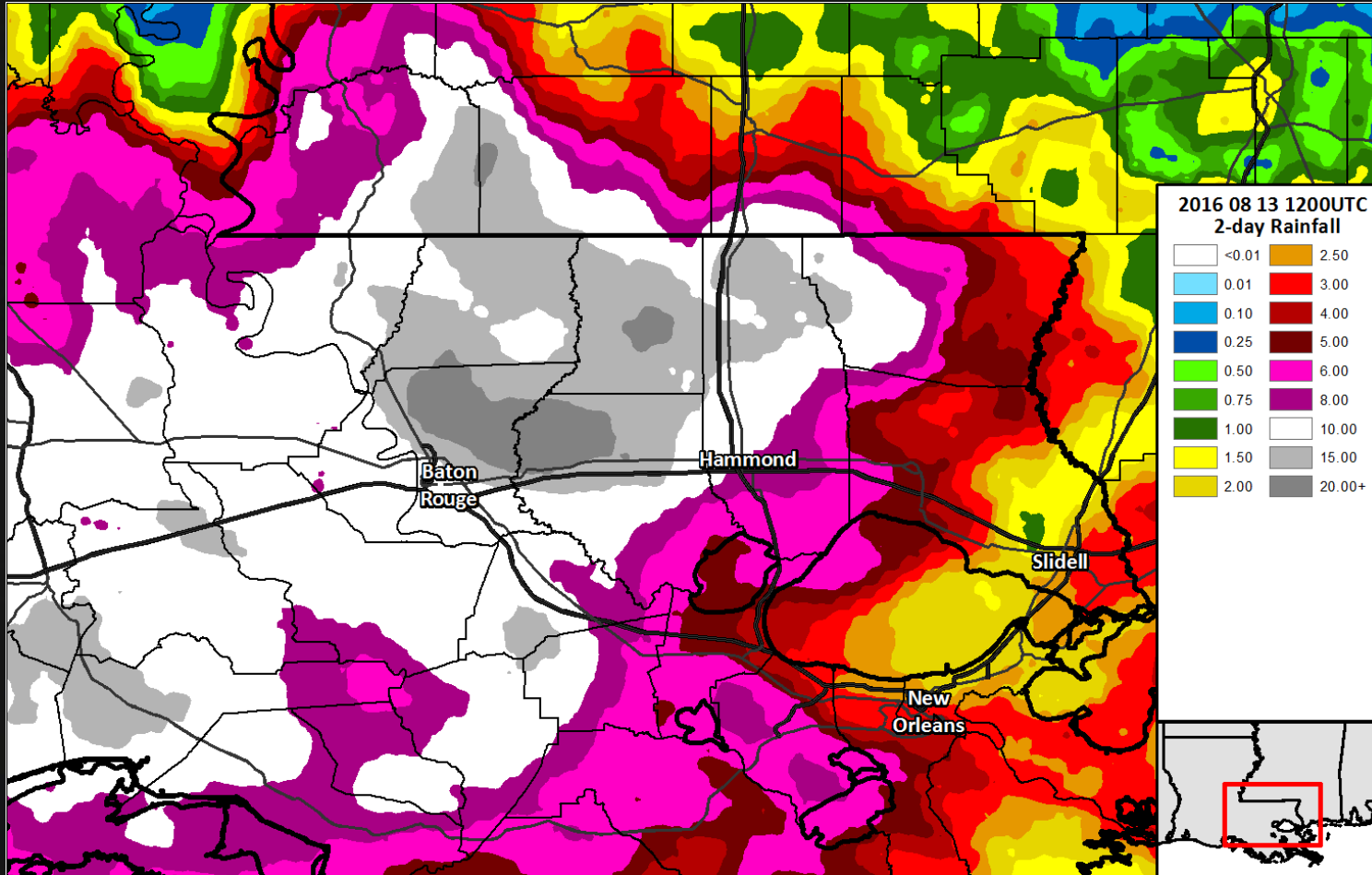


Already forecasting a record flood event with much less rainfall than what actually occurred

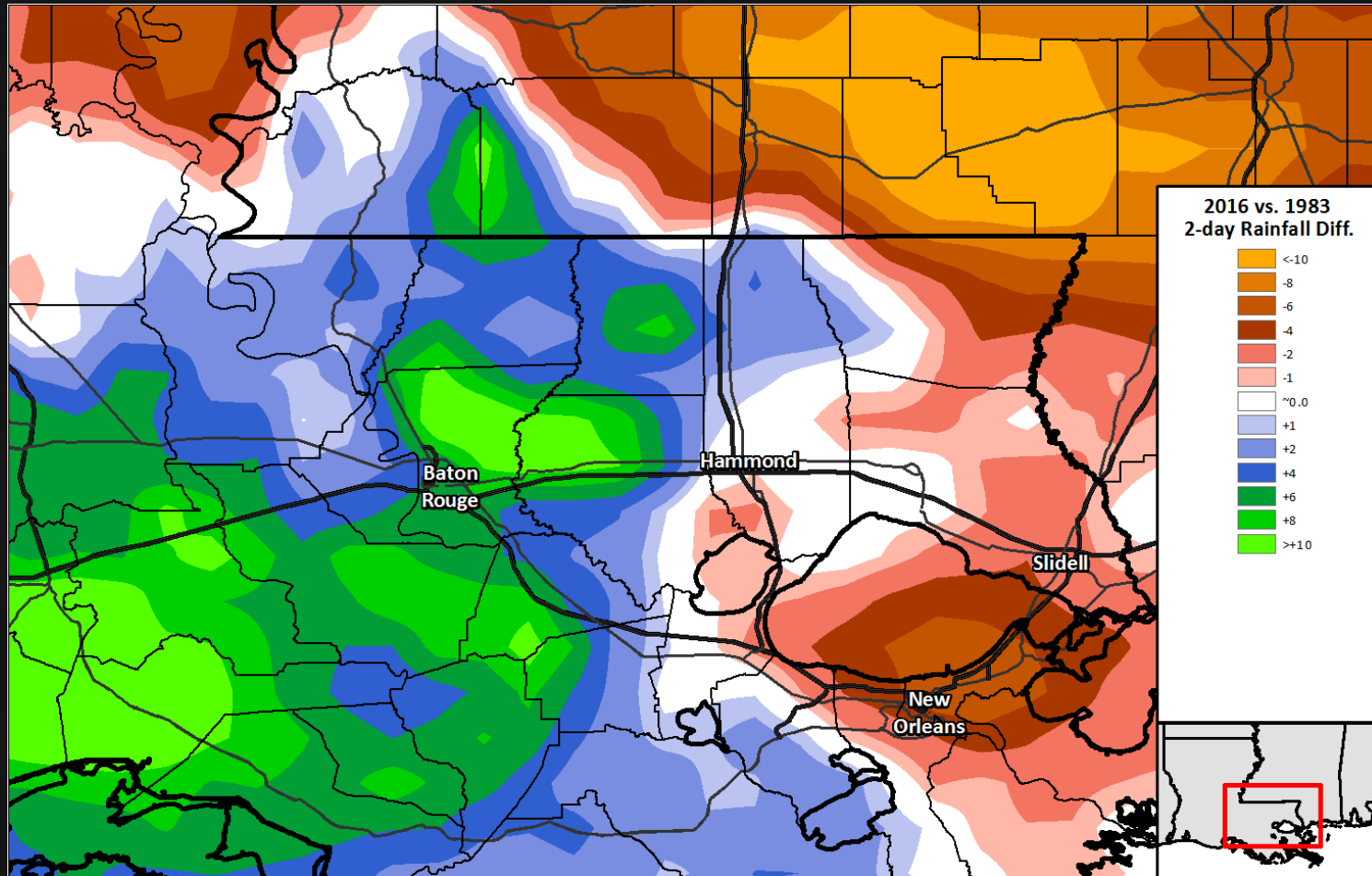
1983 04 Rainfall



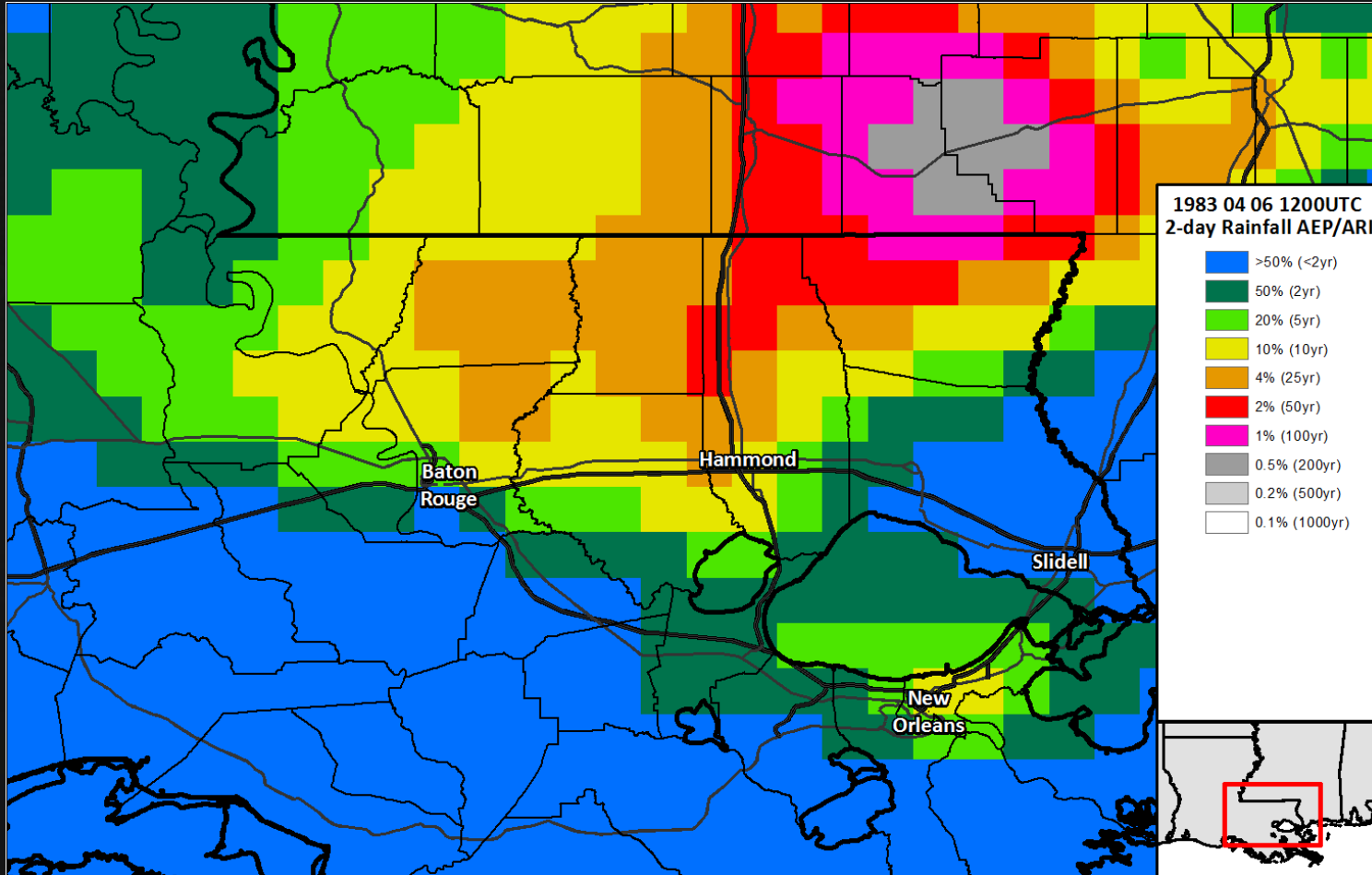
2016 08 Rainfall



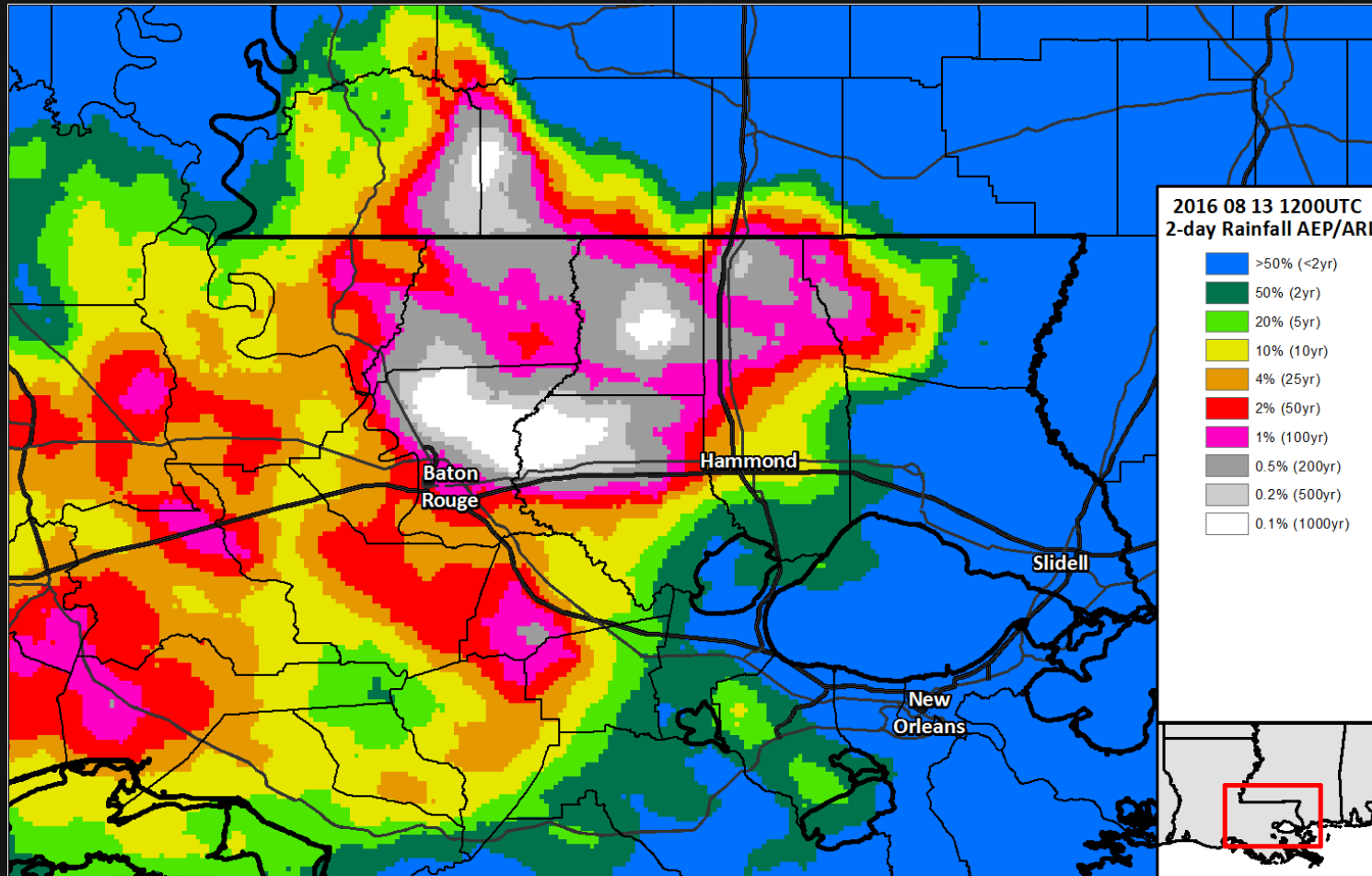
2016 / 1983 Rainfall Difference



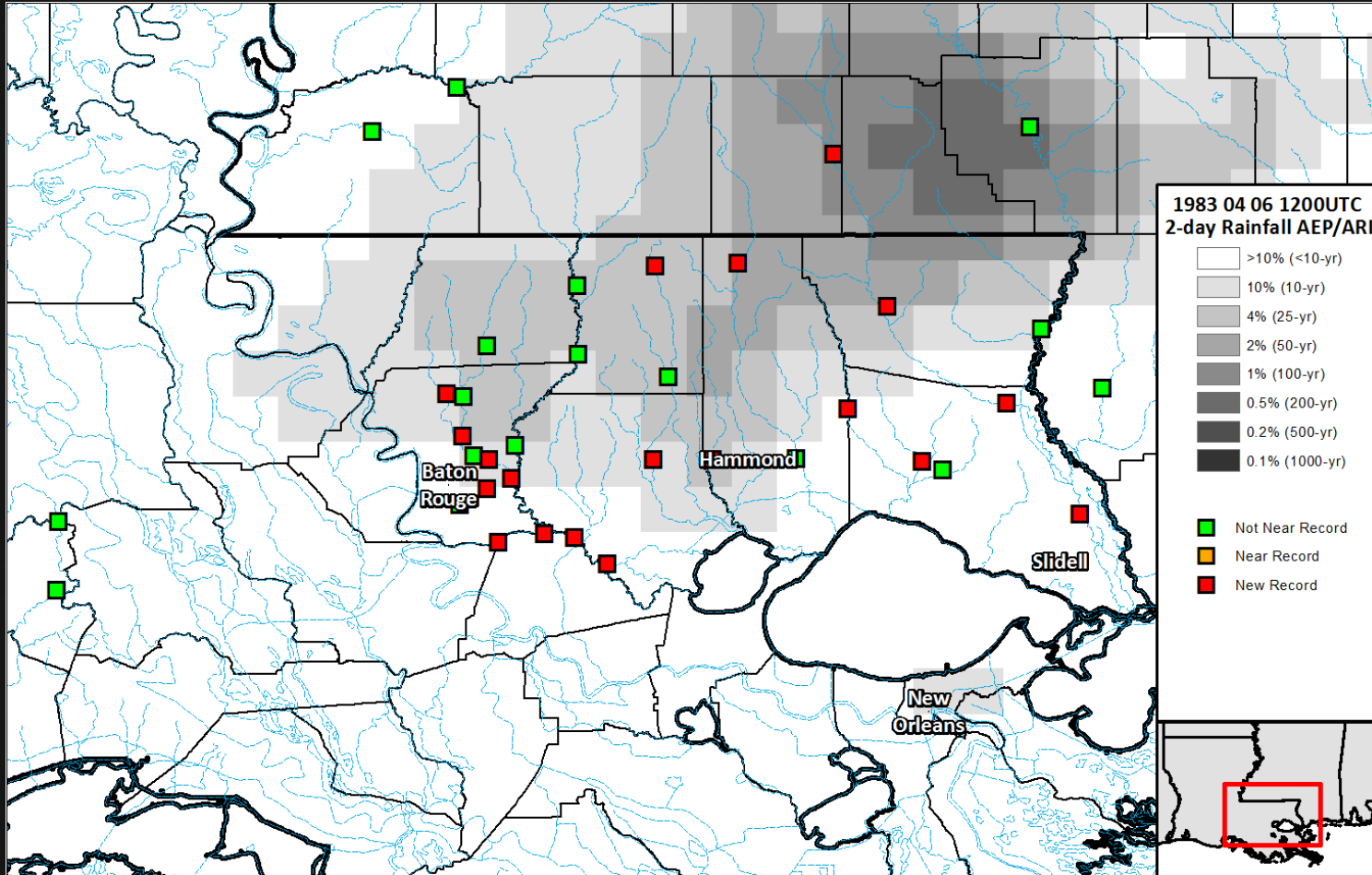
1983 04 Rainfall AEP/ARI



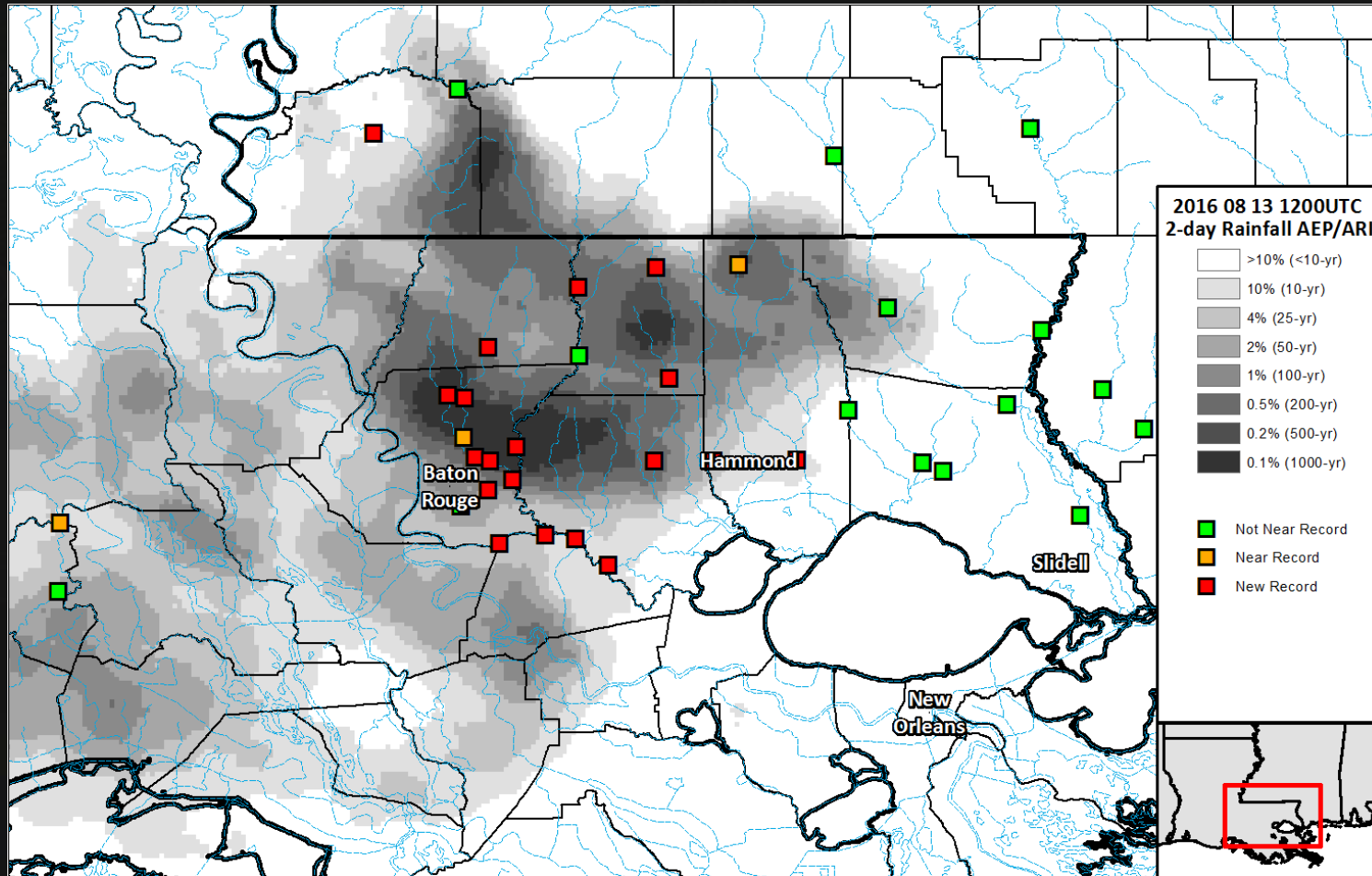
2016 08 Rainfall AEP/ARI



1983 04 River Crests



2016 08 River Crests



2016 08 Rain Event in Context

- Can we really expect only a 0.1% chance of this event occurring again in any year?

Yes and no.

- What does this mean for 2017?... Beyond?

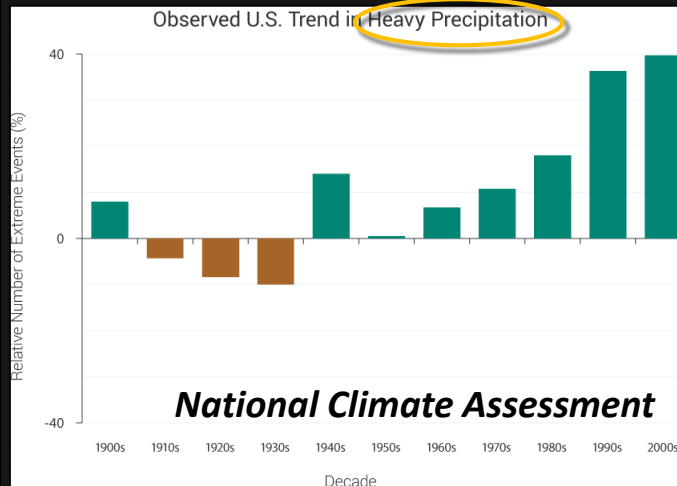
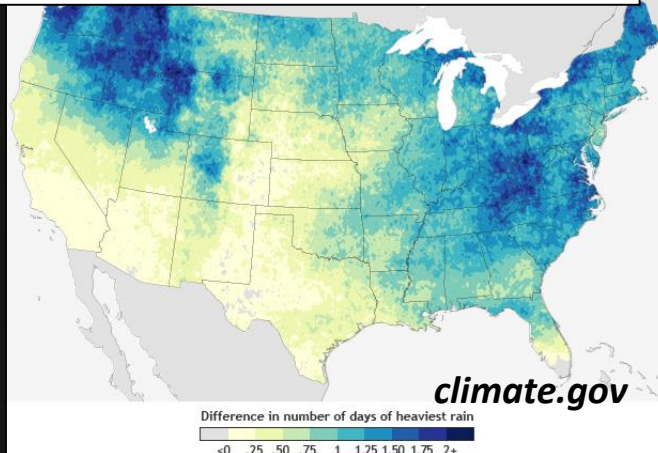
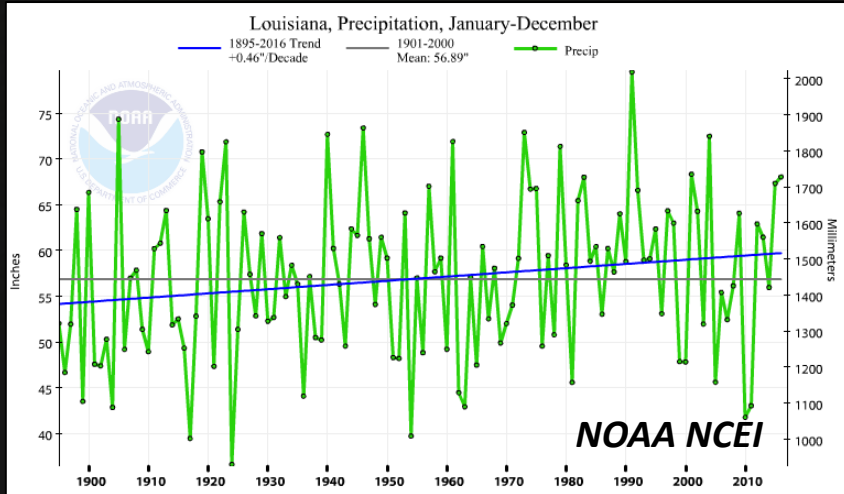
Also hard to say, but we have some educated guesses.

2016 08 Rain Event in Context

- ARI/AEP analyses are based upon statistics of observed data, and valid only for *point locations*
- Creation of ARI/AEP rainfall frequency data assumes *stationary climate* over reference period
- Usage of ARI/AEP analyses assumes *no future changes to climate*

2016 08 Rain Event in Context

Something to keep in mind as regional/urban planners...

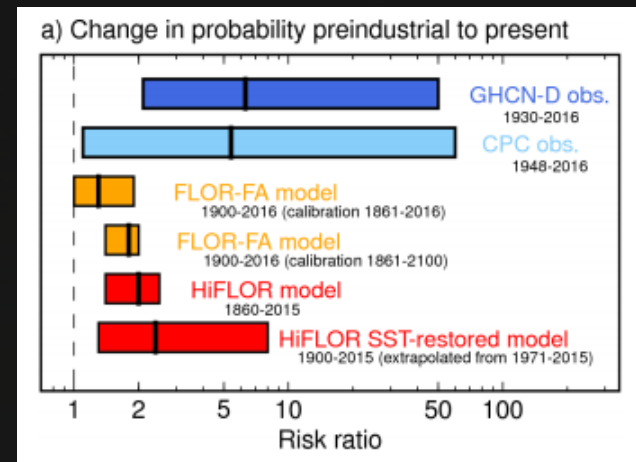


2016 08 Rain Event in Context

2016 08 Rain Event was...

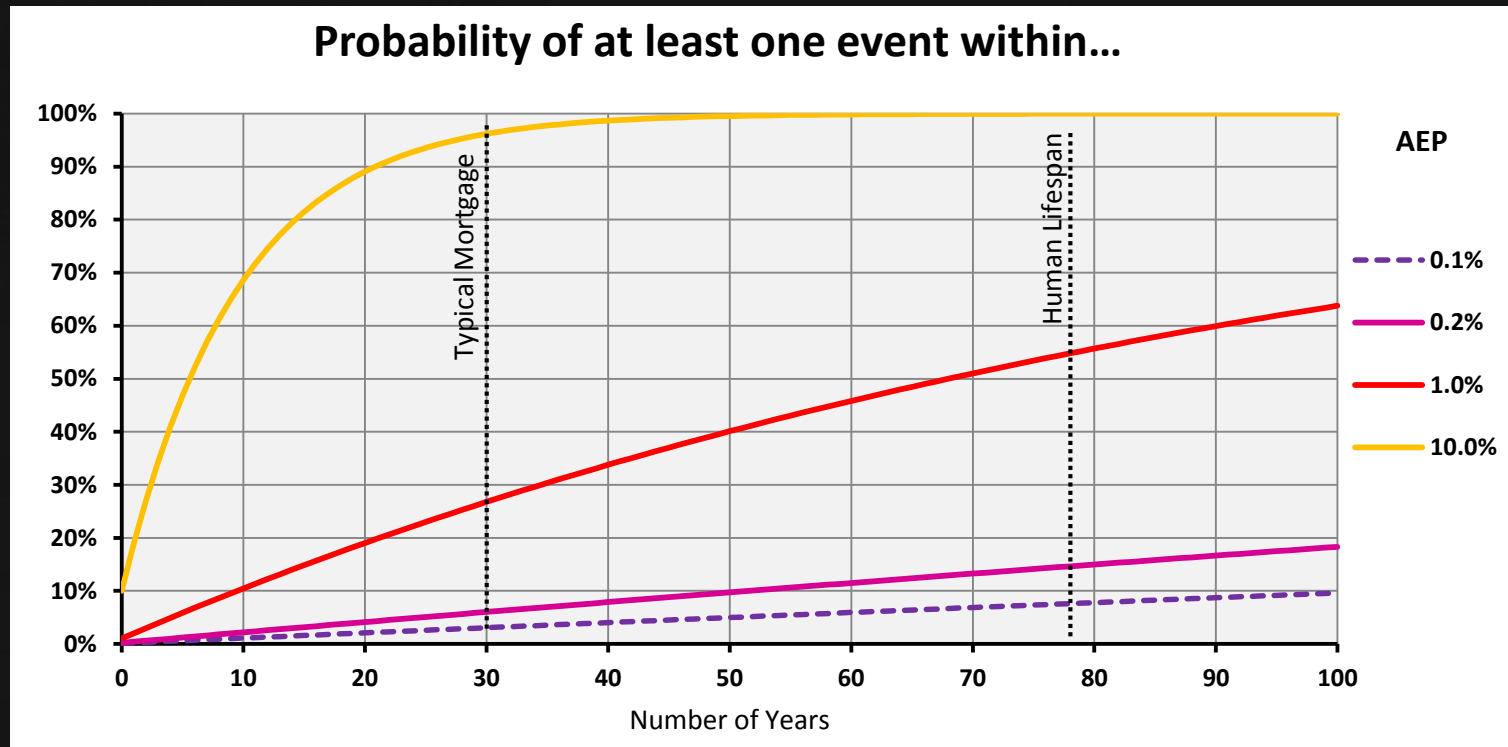
- 1/1000 event for specific point locations, but
- Estimated as only a 1/30 event for the central Gulf Coast (roughly Houston to Tallahassee) as a whole
- At least 40% more likely to occur because of increased sea surface temperatures and atmospheric moisture, compared to early 1900s, according to recent study

Wiel, K. and coauthors, 2016: Rapid attribution of the August 2016 flood-inducing extreme precipitation in south Louisiana to climate change. *Hydrol. Earth. Syst. Discuss.* In peer review.



2016 08 Rain Event in Context

- What do these probabilities really mean?



2016 08 Rain Event Summary

- Caused by extreme, low-probability rainfall event
- Rarity of causative rainfall does not necessarily correlate to magnitude of river levels!
 - NO: “This was a 1000-yr flood event”
 - YES: “For isolated areas NE of Baton Rouge the *rainfall* event was estimated to have only 0.1% chance of occurring in a given year”

2016 08 Rain Event Summary

- What does this mean for 2017?... Beyond?
 - NO: “We just had our 1000-yr flood last year, so we wont flood this year.”
 - YES: “There was a 0.1% chance of that extreme rainfall last year and there is also a 0.1% chance of it occurring this year.”*
- **...although these statistics are likely changing, in hard to quantify ways, due to climate change and development.*

2016 08 Rain Event Summary

- Numerous independent, scientific studies have shown that heavier rainfall events are already *observed* as increasing in frequency, and this trend is expected to continue
- Low probability, high impact events are often difficult to forecast

Questions/Comments?

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Slidell, Louisiana
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Credits & Citations

Graphics and references:

- NOAA Sea Grant
- NOAA NCEI
- NOAA Climate.gov
- NOAA SPC
- NOAA WPC
- NASA
- USDA
- New Orleans Sewerage and Water Board
- maps.google.com
- gisgeography.com
- Wiel, K. and coauthors, 2016: Rapid attribution of the August 2016 flood-inducing extreme precipitation in south Louisiana to climate change. Hydrol. Earth. Syst. Discuss.