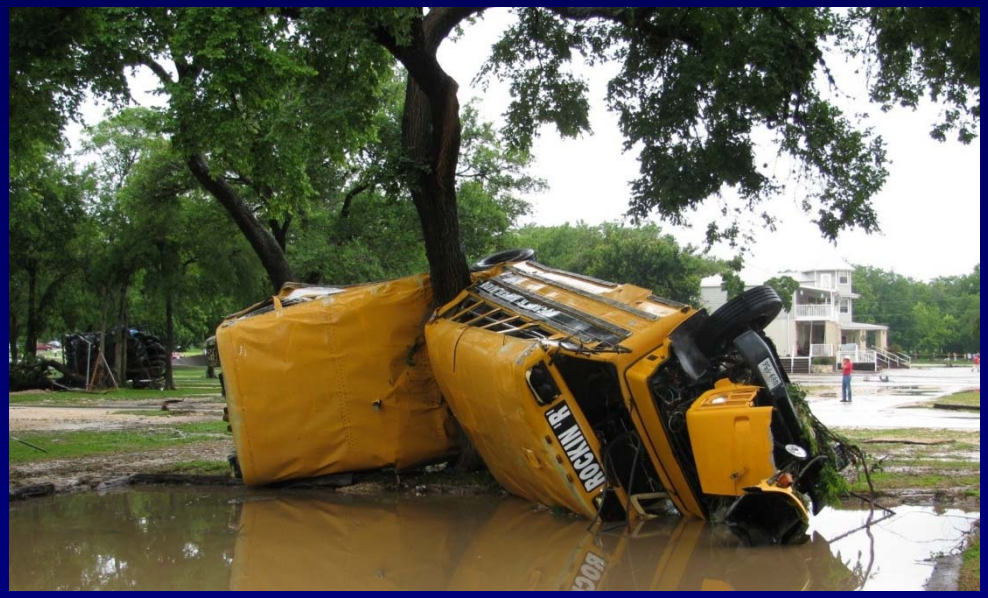
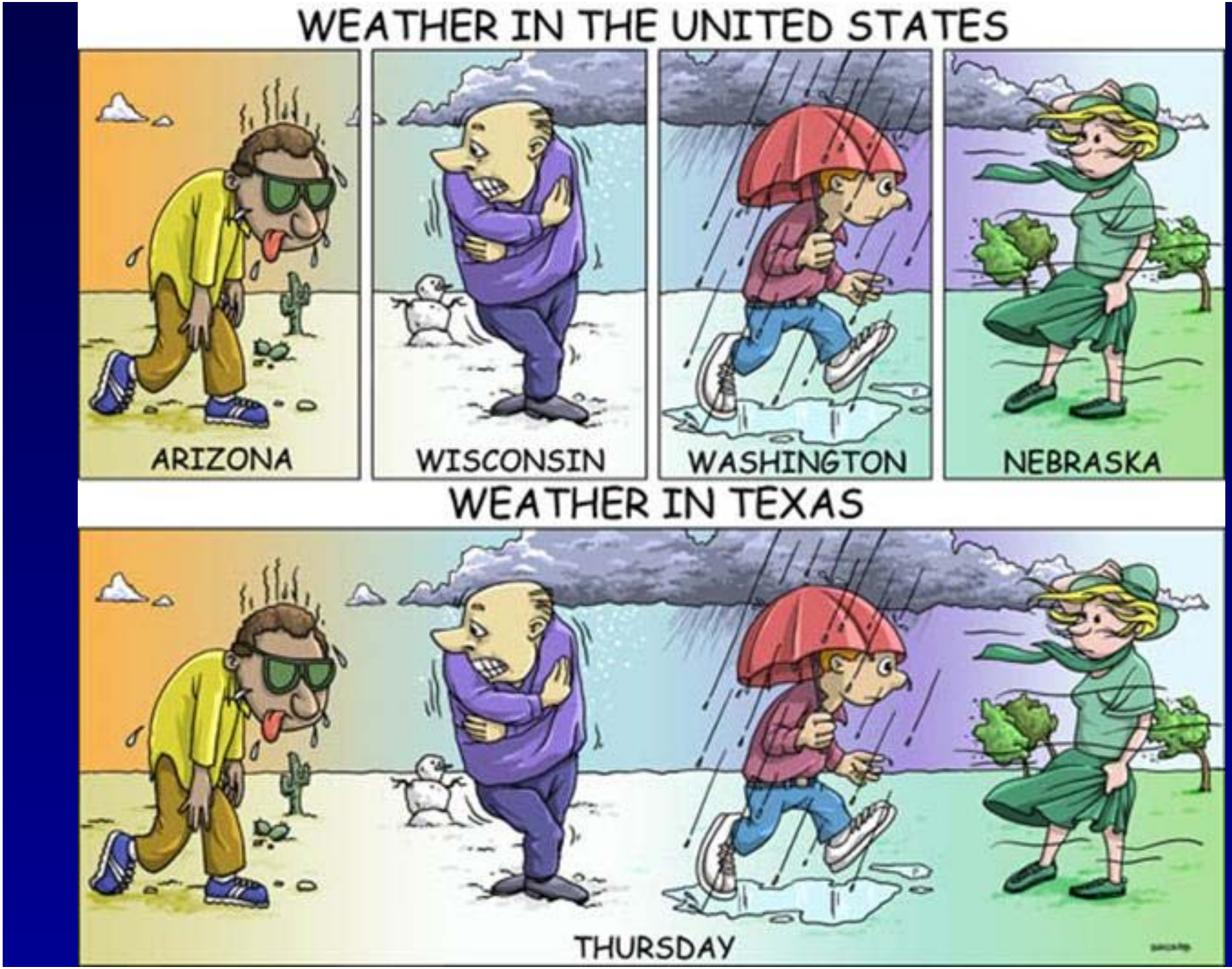
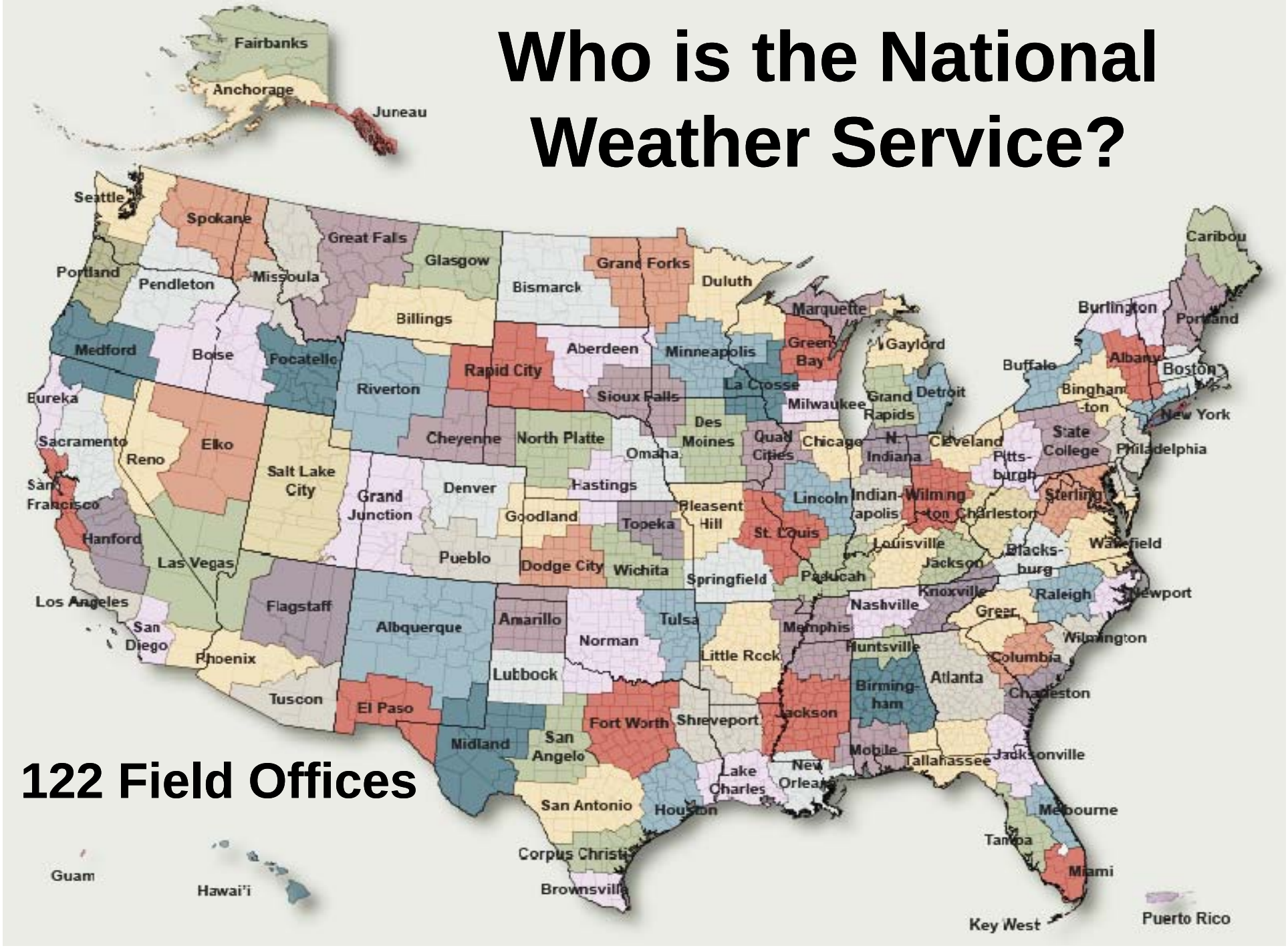
Weather…Expect the Unexpected



December 9, 2016
Paul Yura
National Weather Service
Austin-San Antonio TX

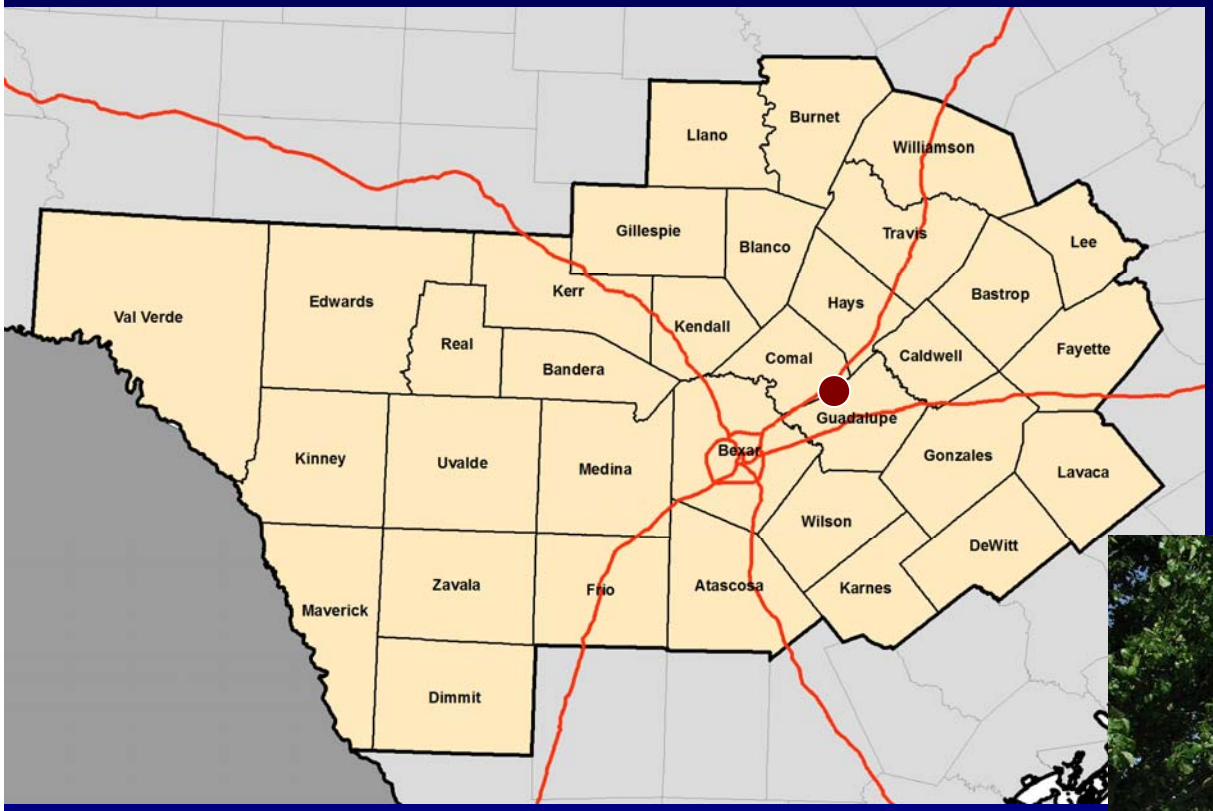

WEATHER IN THE UNITED STATES
ARIZONA
WISCONSIN
WASHINGTON
NEBRASKA
WEATHER IN TEXAS
THURSDAY

Who is the National Weather Service?

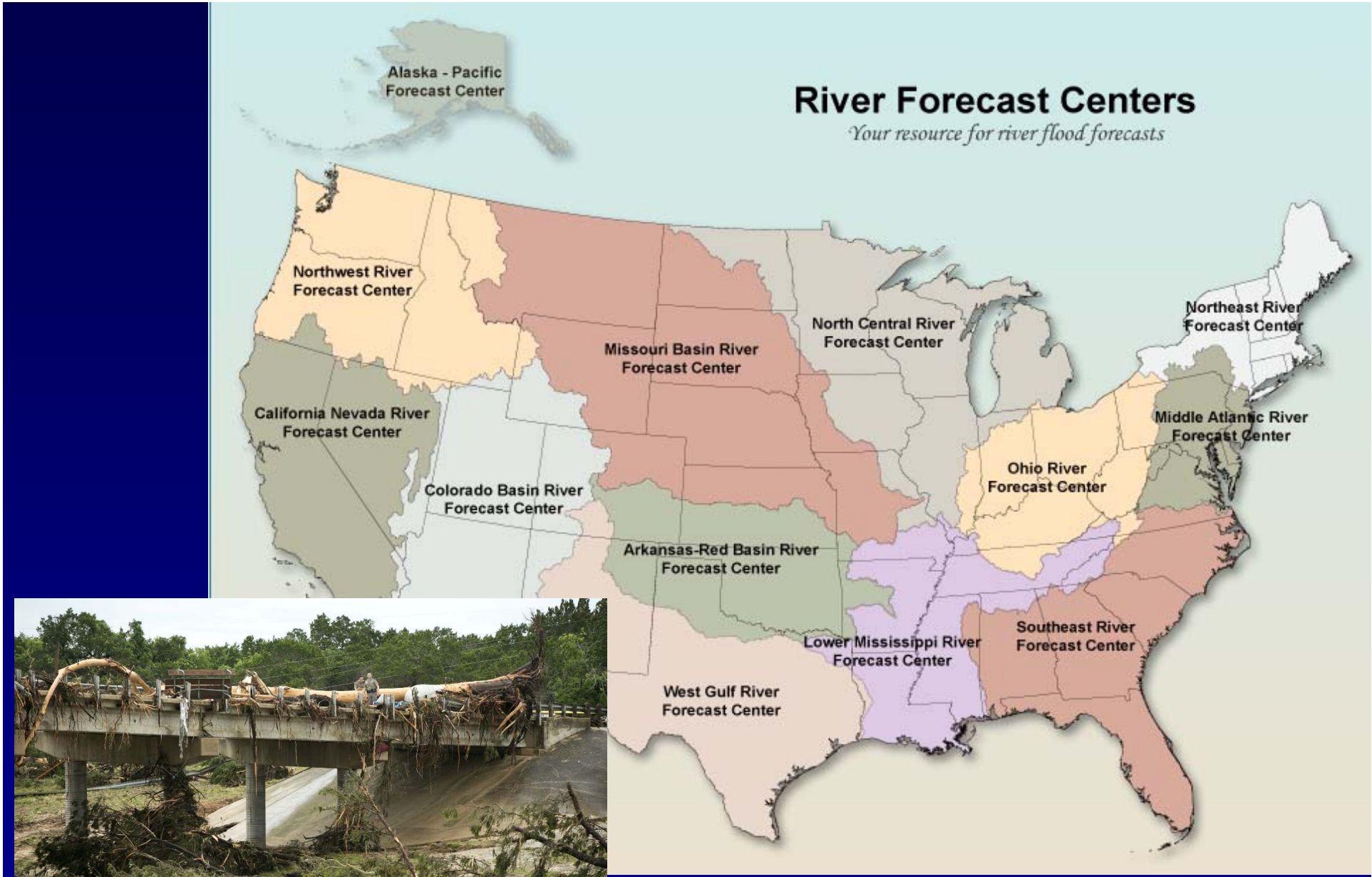


122 Field Offices

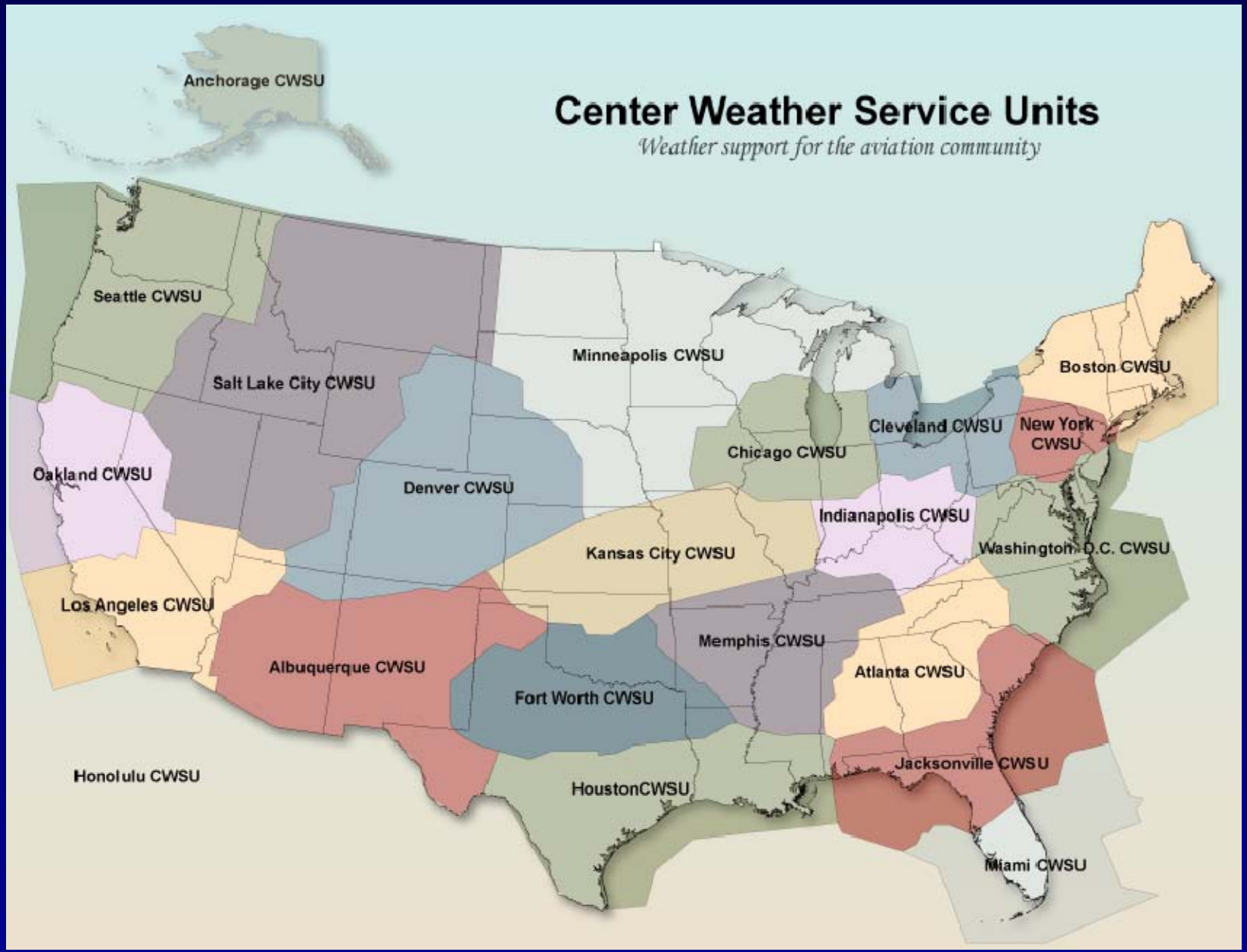
NWS Austin/San Antonio "County Warning Area"



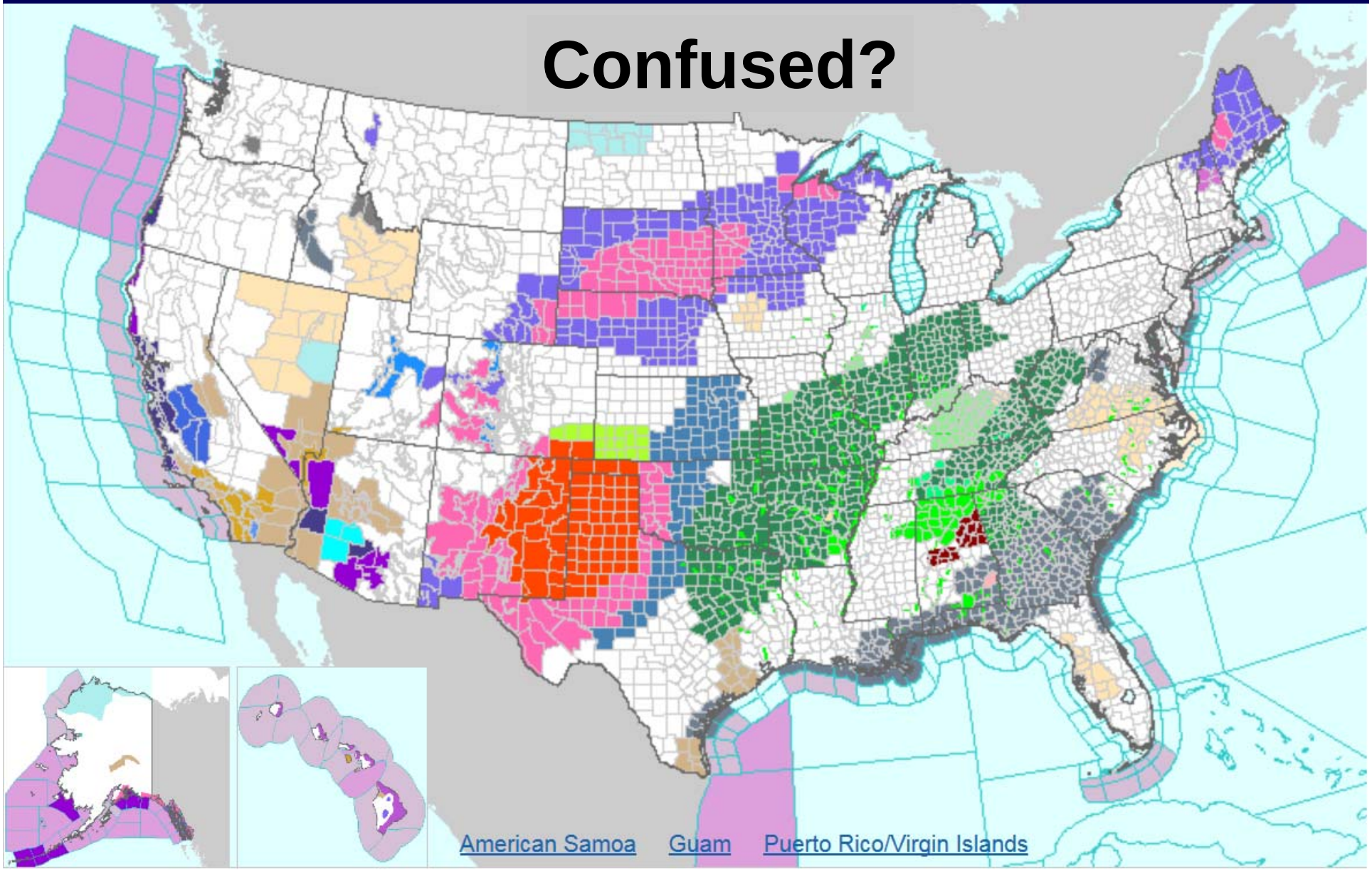
- Forecasts
- Watches/Warnings
- Decision Support
- Local Research
- Outreach


River Forecast Centers
Your resource for river flood forecasts
Alaska - Pacific Forecast Center
Northwest River Forecast Center
Missouri Basin River Forecast Center
North Central River Forecast Center
Northeast River Forecast Center
California Nevada River Forecast Center
Middle Atlantic River Forecast Center
Ohio River Forecast Center
Colorado Basin River Forecast Center
Arkansas-Red Basin River Forecast Center
Southeast River Forecast Center
Lower Mississippi River Forecast Center
West Gulf River Forecast Center

Aviation Forecasts



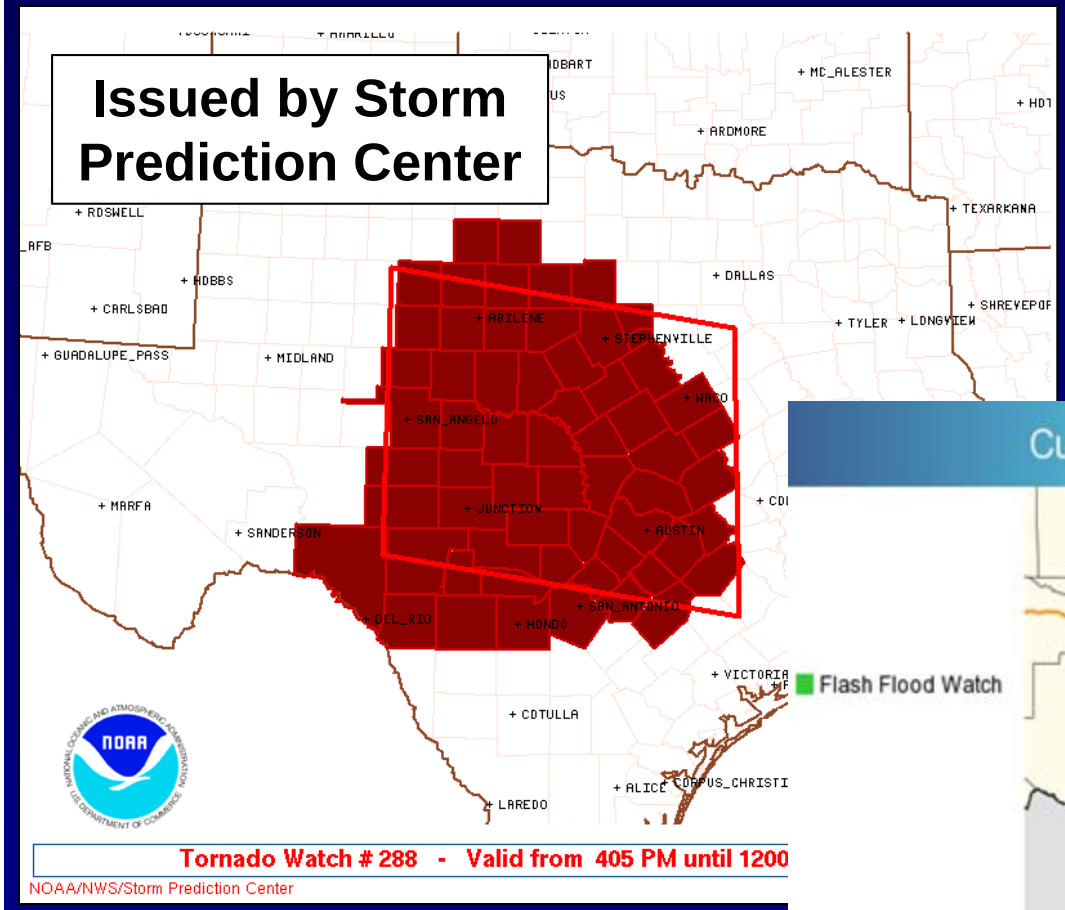
Advisory / Watch / Warnings



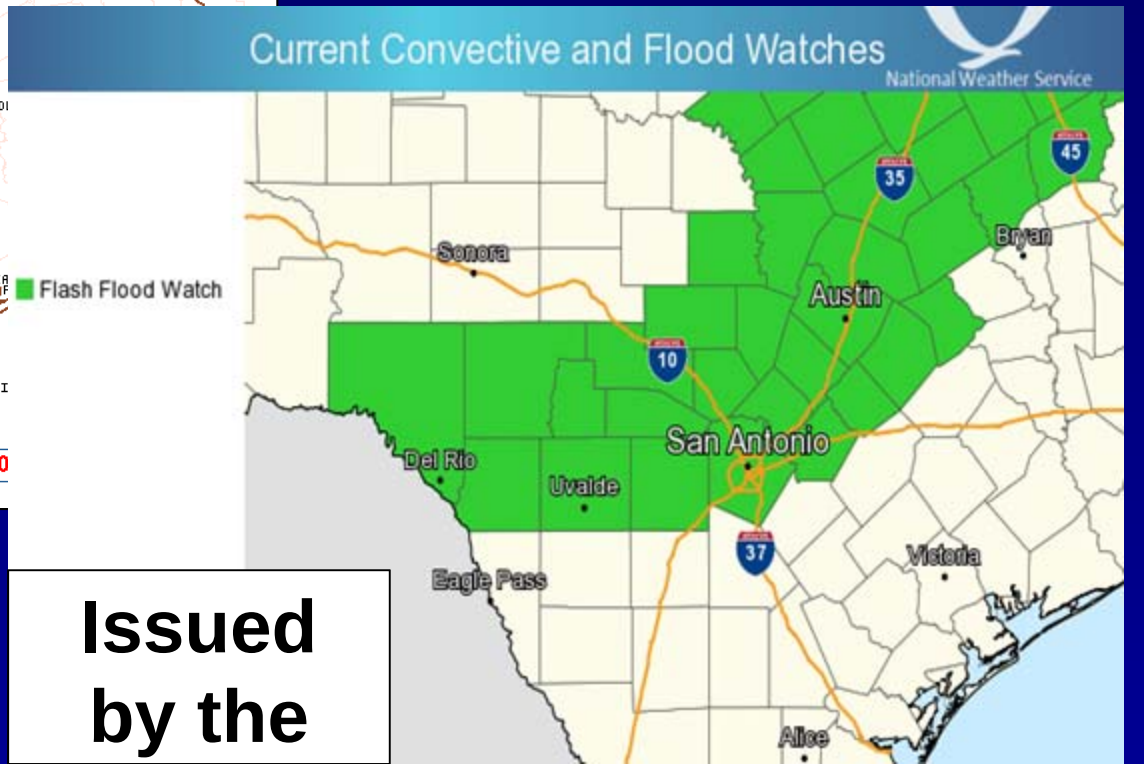
Weather Advisory

Is occurring….travel hazard/delay, inconveniences

Weather Watch



SVR/TOR Watches are usually in effect for 4-8 hr

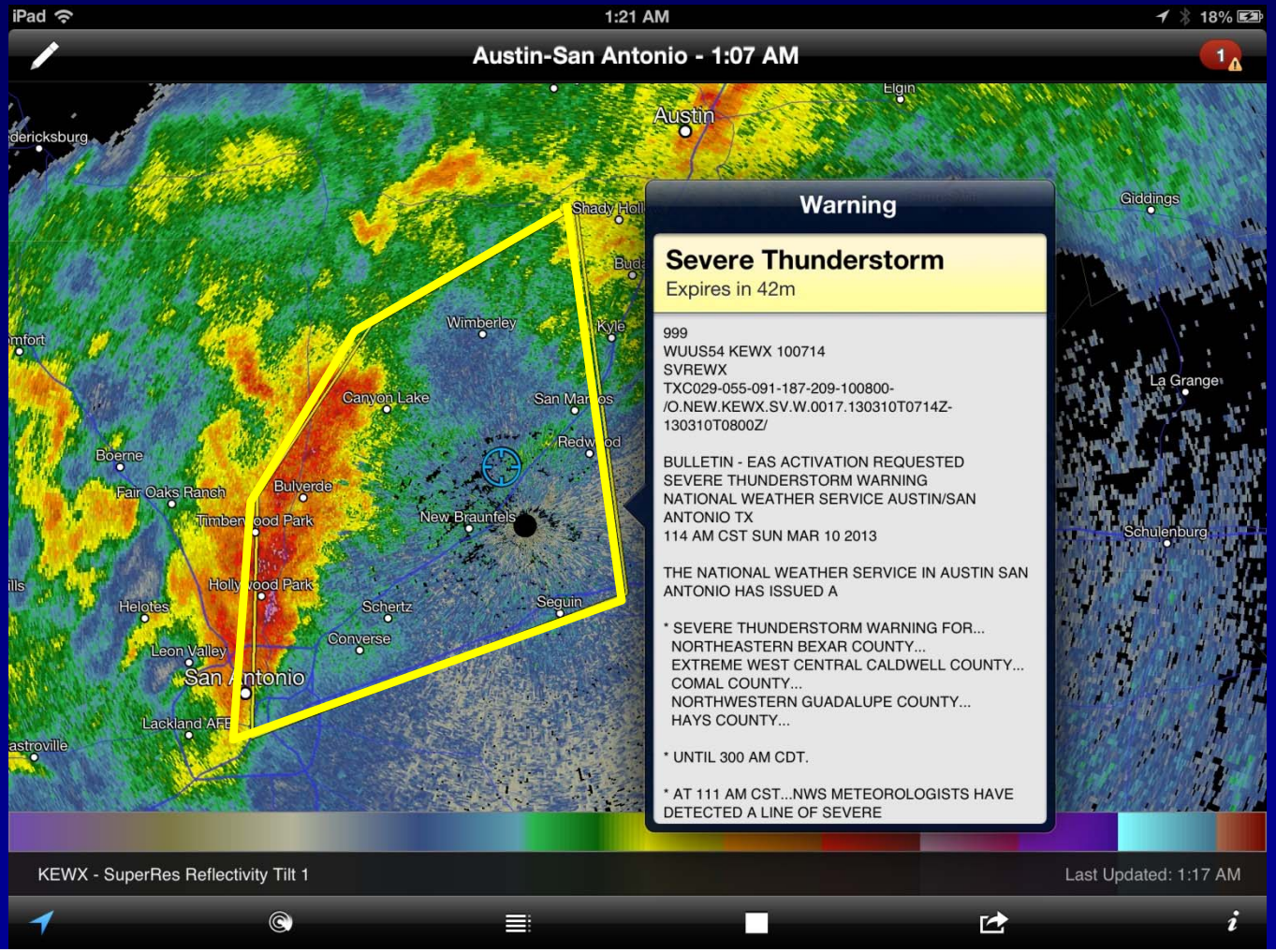


Watch for the threat

Issued by the

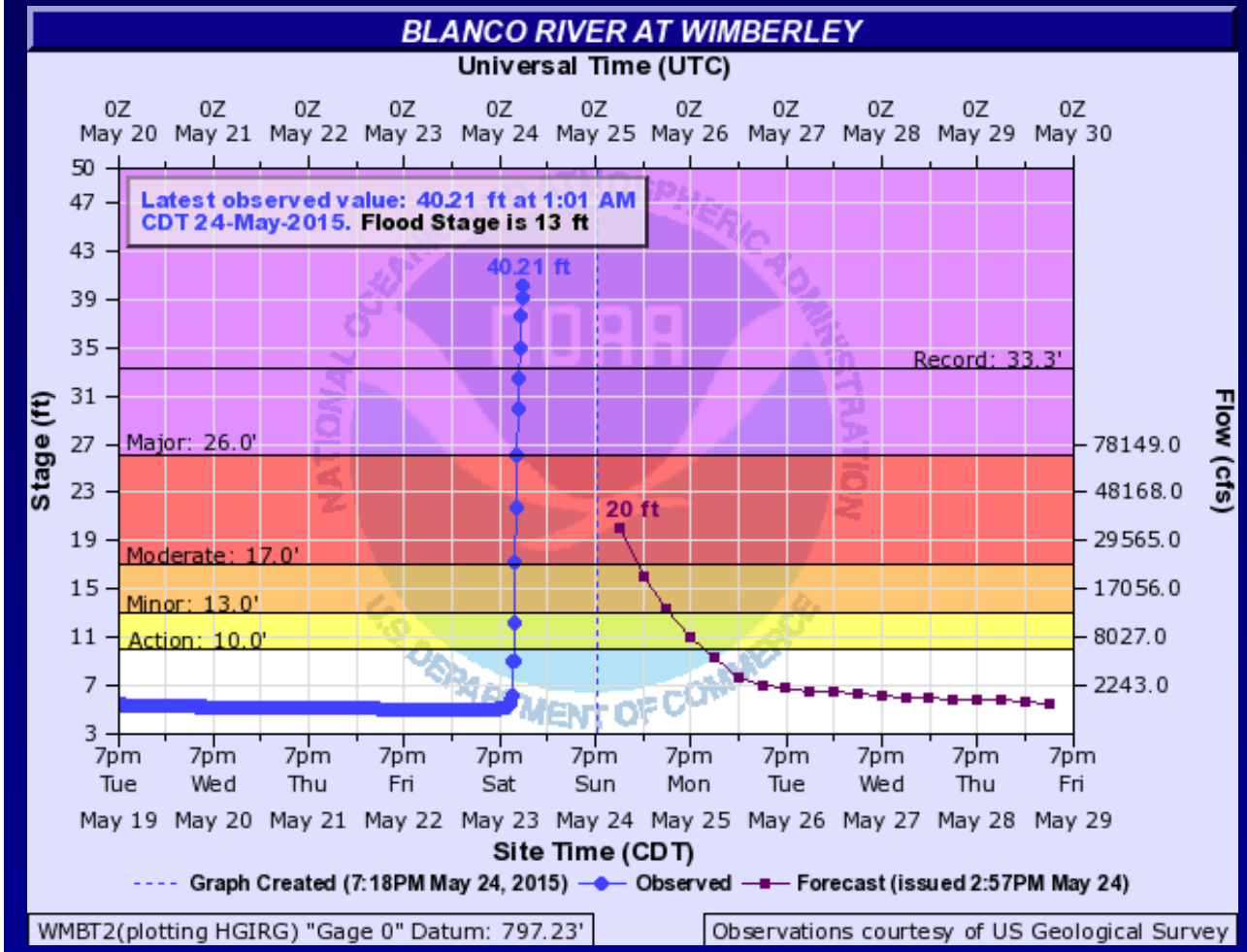
Weather Warning

Severe weather is imminent or is occurring in the warned area… Seek shelter now!



“Emergency” Warnings

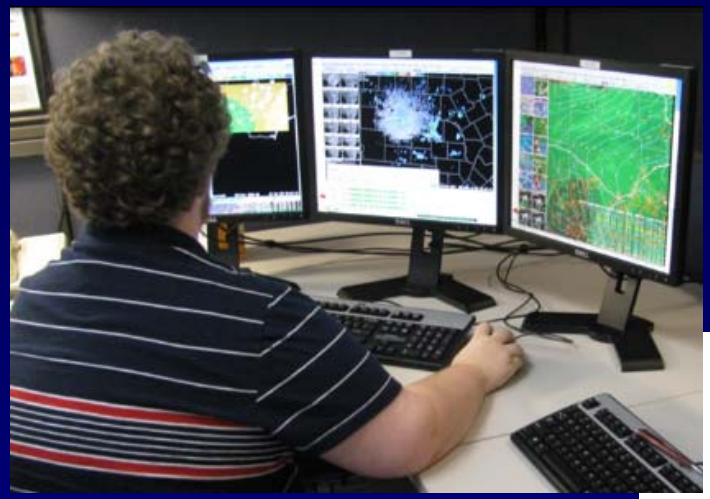
Loss of life is imminent… Seek Higher Ground!



Have 3 Ways to Receive Weather Warnings

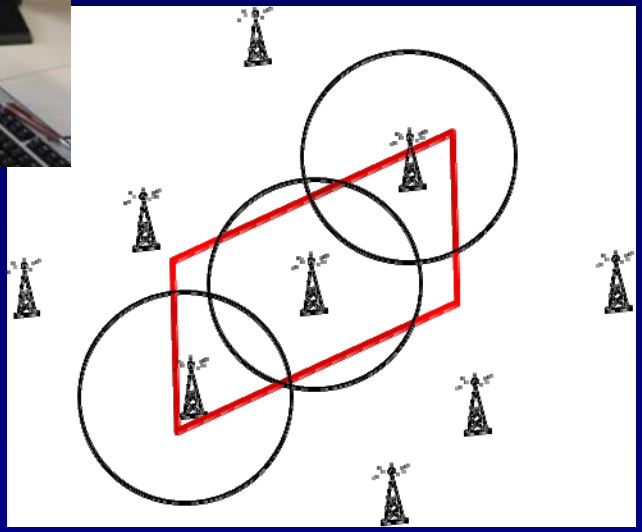
Weather Apps
Television
Weather Radio
Commercial Radio

Wireless Emergency Alerts (WEA)



Warnings issued

WIRELESS EMERGENCY ALERTS CAPABLE



Warnings sent to cell phone towers

Warning arrives within seconds

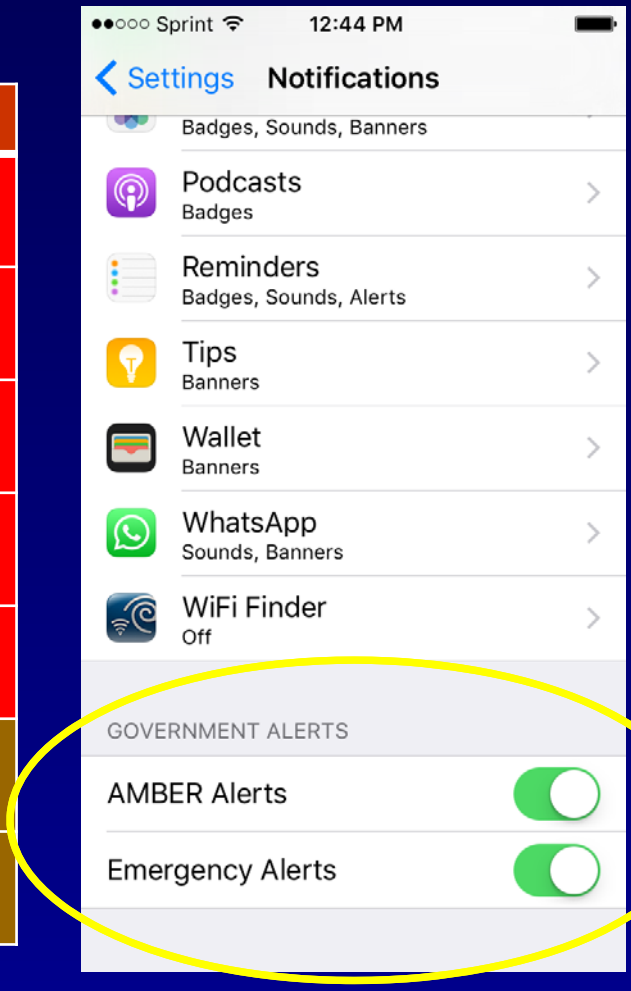
Message limited to 90 characters

WEA Messages Originated by NWS

Extreme

Warning Type
Tsunami Warning
Tornado Warning
Extreme Wind Warning
Hurricane Warning
Typhoon Warning
Flash Flood Warning
Dust Storm Warning

Severe

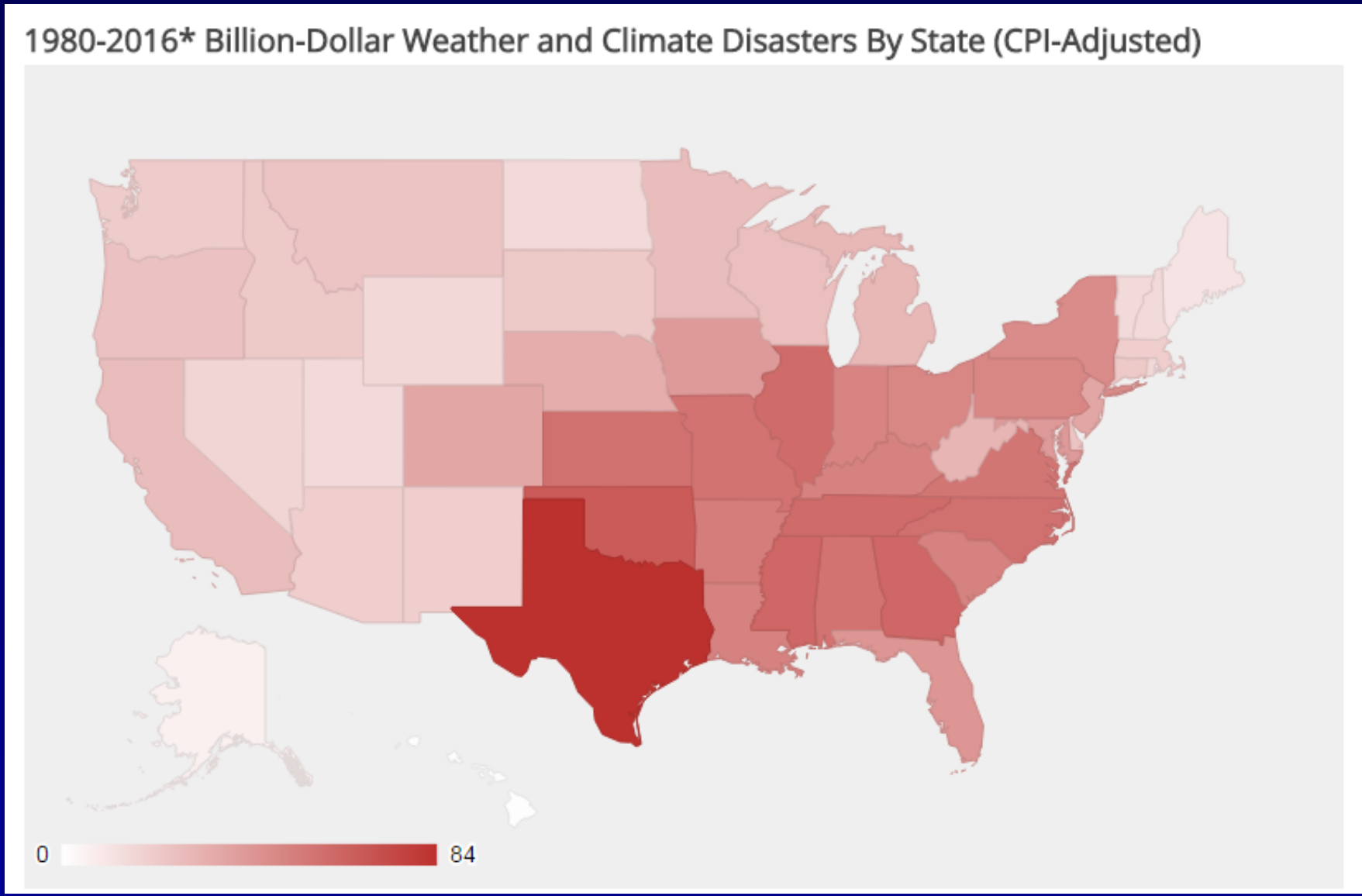


Controls are in "Notifications" settings page

Sign Up for Local Jurisdiction Alerts

Check city/county website for signup instructions

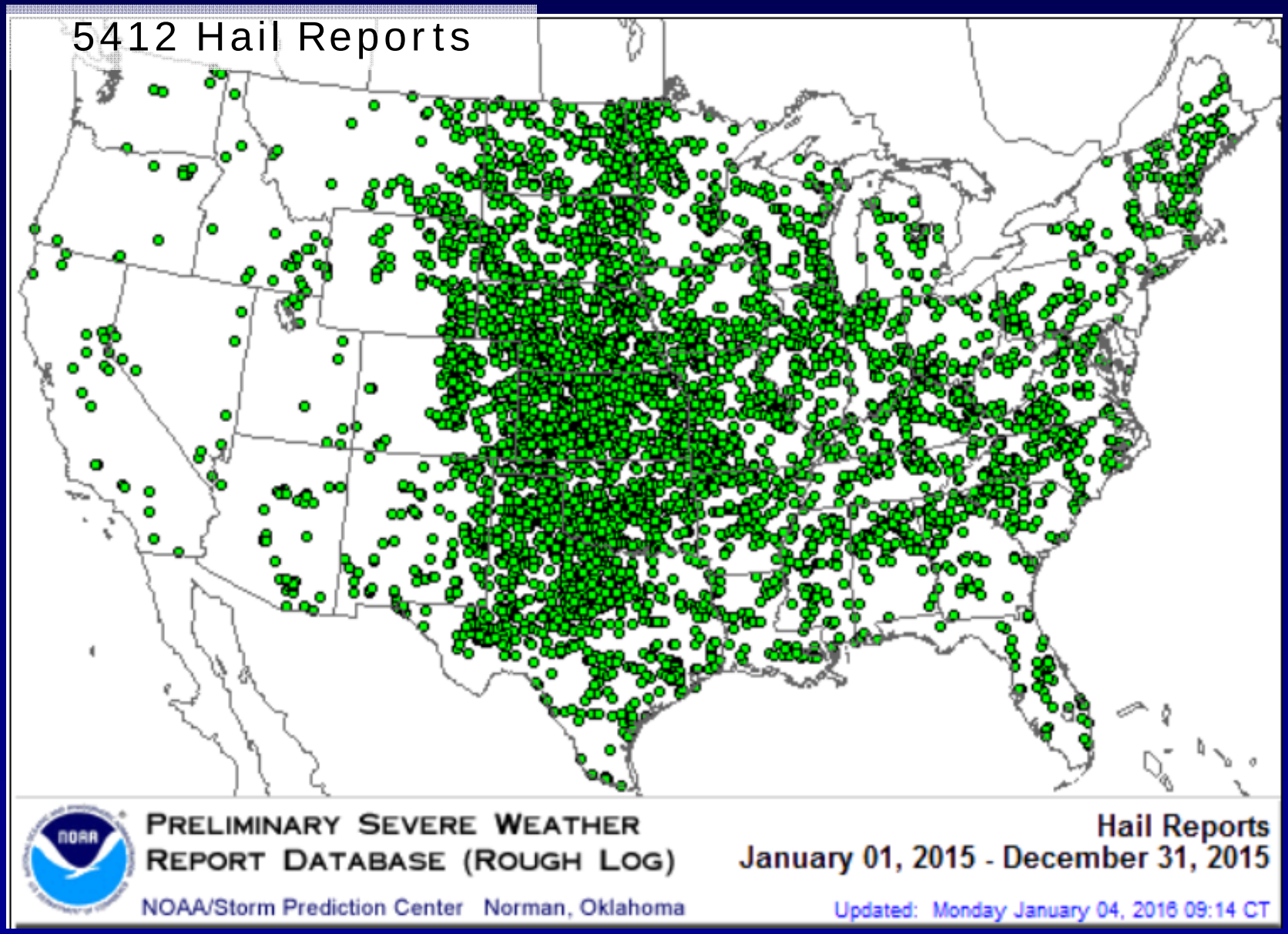
Billion Dollar Weather Events



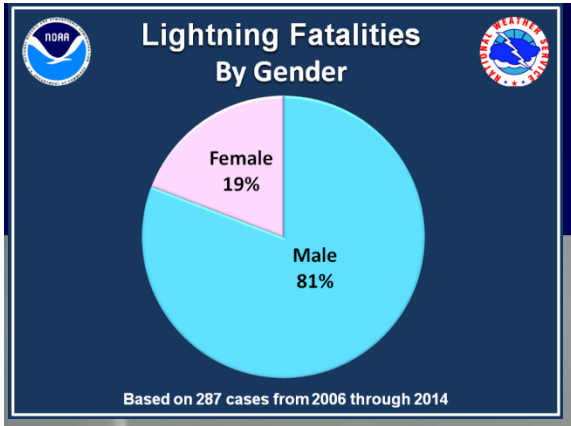
Thunderstorm Hazards

- Lightning
- Flash Flooding
- **Hail**
- Damaging Winds
- Tornadoes

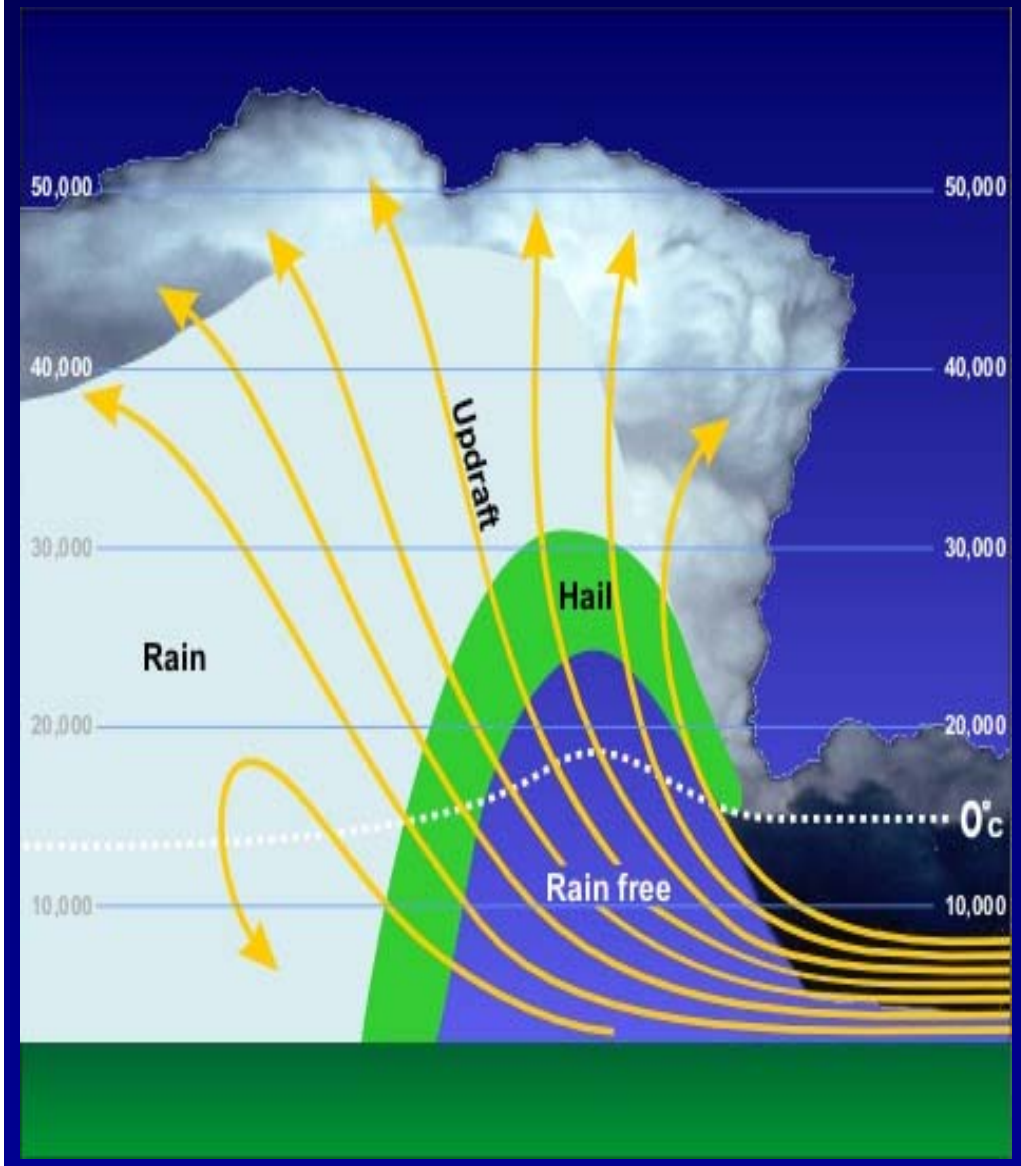
Large Hail reports in 2015



A Shirt is Not Adequate Hail Protection

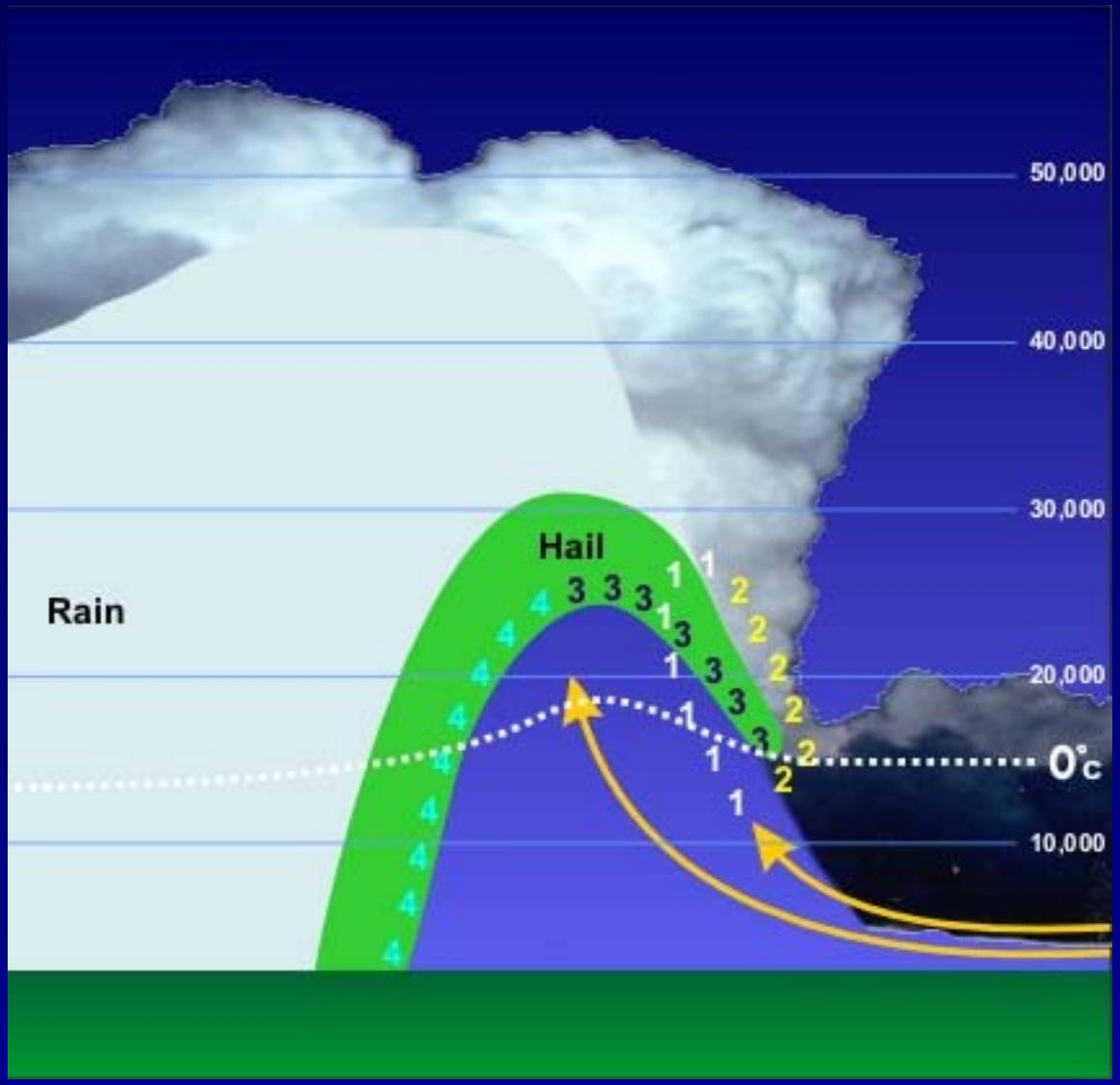


Hail Formation



- Falls at 100+ mph
- Fatalities?
- Pull Over
- Greenish Sky

Hail Growth



1. Hail nucleus carried aloft
2. Blown out of main updraft
3. Collides with more water, gets bigger
4. Hail falls to the ground

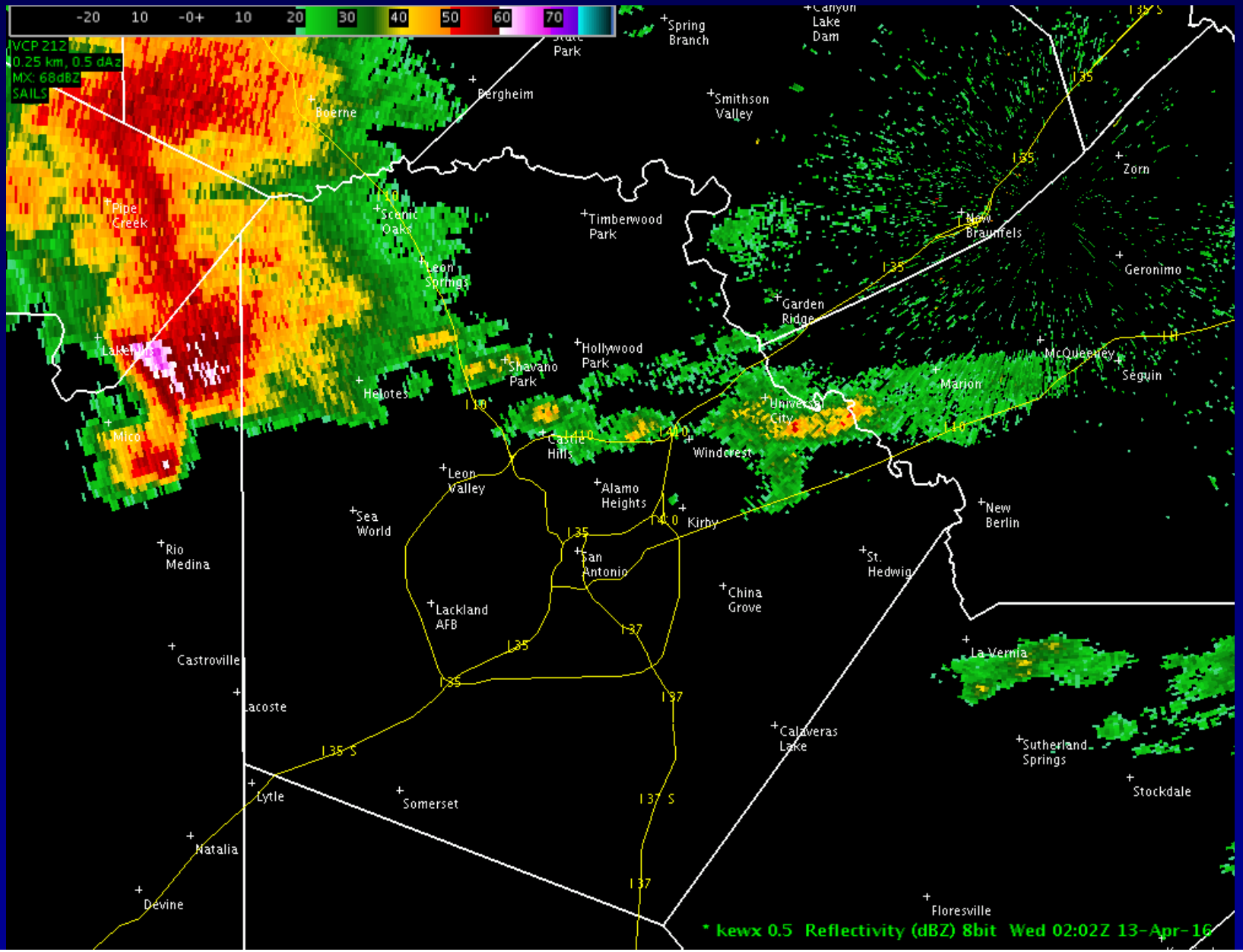
Hailstone size	Measurement		Updraft Speed	
	in.	cm.	mph	km/h
bb	< 1/4	< 0.64	< 24	< 39
pea	1/4	0.64	24	39
marble	1/2	1.3	35	56
dime	7/10	1.8	38	61
penny	3/4	1.9	40	64
nickel	7/8	2.2	46	74
quarter	1	2.5	49	79
half dollar	1 1/4	3.2	54	87
walnut	1 1/2	3.8	60	97
golf ball	1 3/4	4.4	64	103
hen egg	2	5.1	69	111
tennis ball	2 1/2	6.4	77	124
baseball	2 3/4	7.0	81	130
tea cup	3	7.6	84	135
grapefruit	4	10.1	98	158
softball	4 1/2	11.4	103	166

Reporting Hail…Use a Reference

Do You Want to Be Outside?

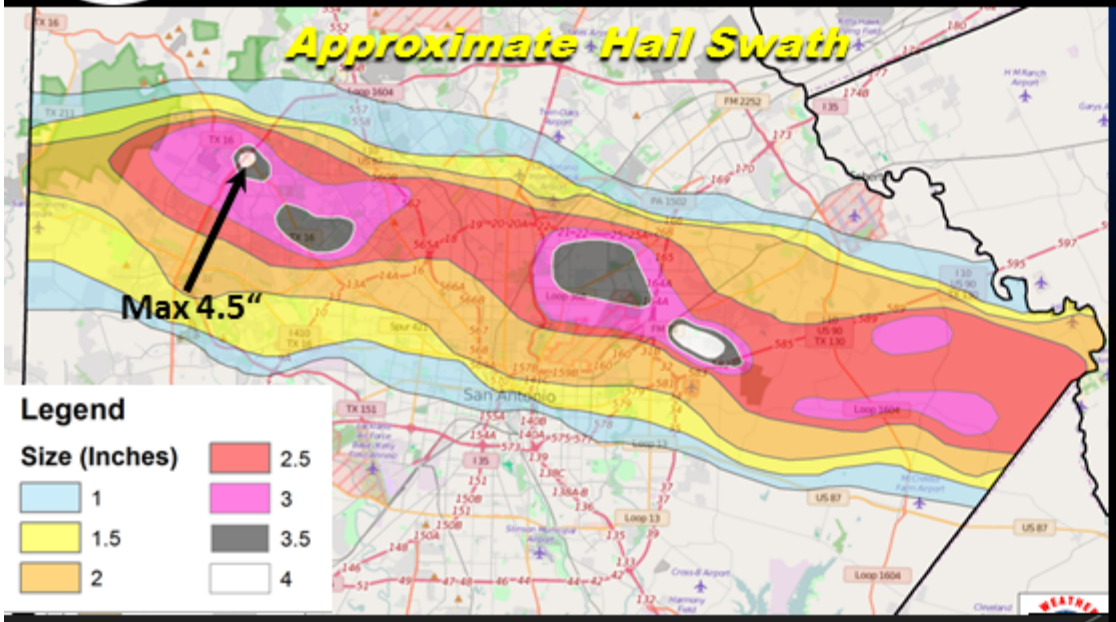
Texas Hail Storms

San Antonio Billion $ Storm…4/12/16



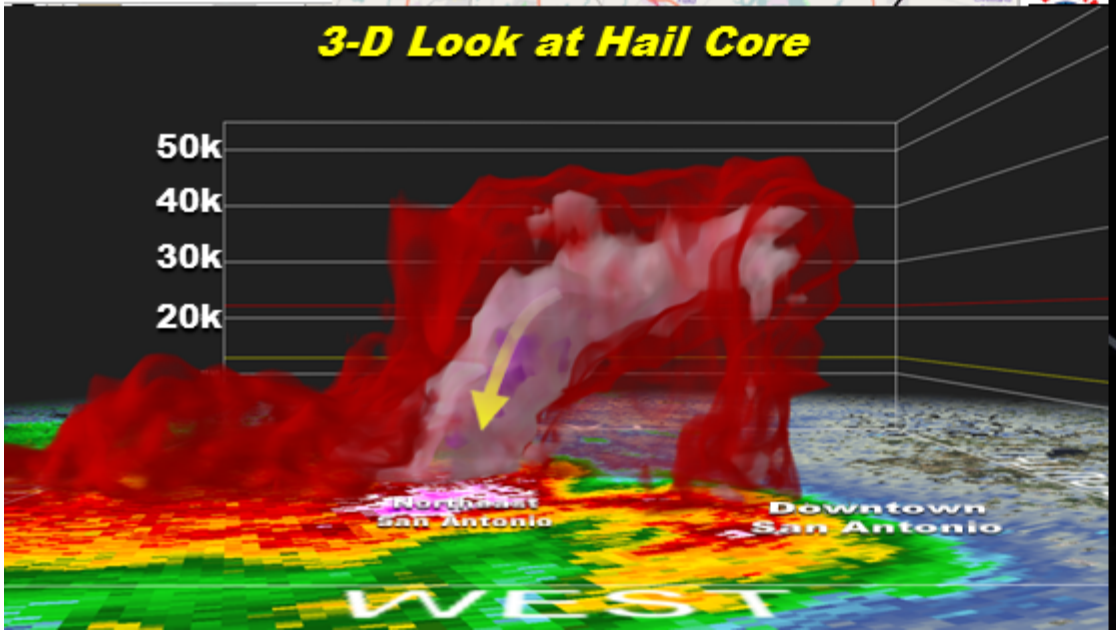
San Antonio Area Hail Storm – April 12, 2016
One of the Costliest in Texas History

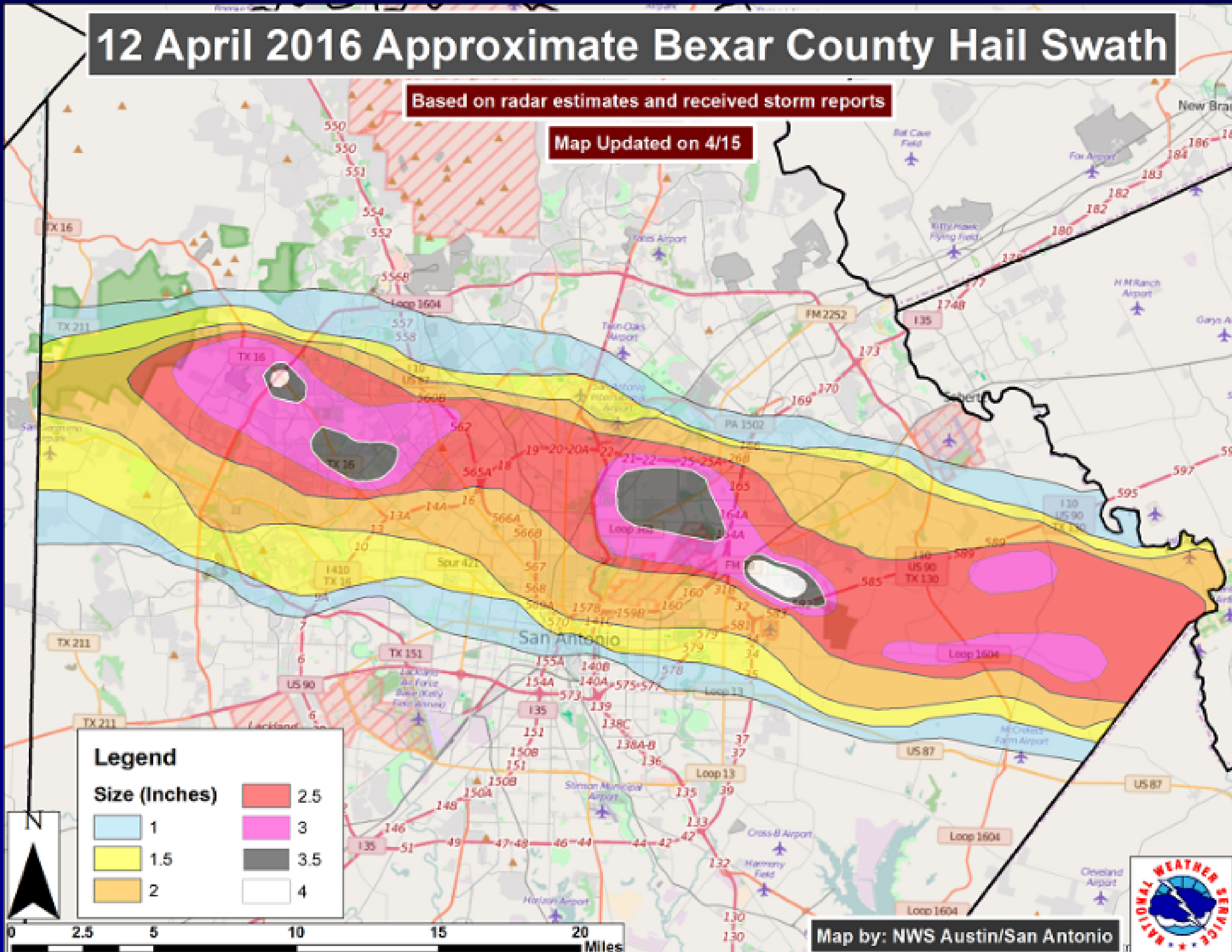
National Weather Service Austin / San Antonio



Facts

- Largest Hail Observed in San Antonio/Bexar County:
  4.5" in diameter – Softball Sized
- Estimated Insured Losses:
  $1.36 Billion
- Costliest Texas Hail Storms:
  1995 – Fort Worth ($1.6 Billion - 2016 dollars)
  2016 – San Antonio ($1.36 Billion)

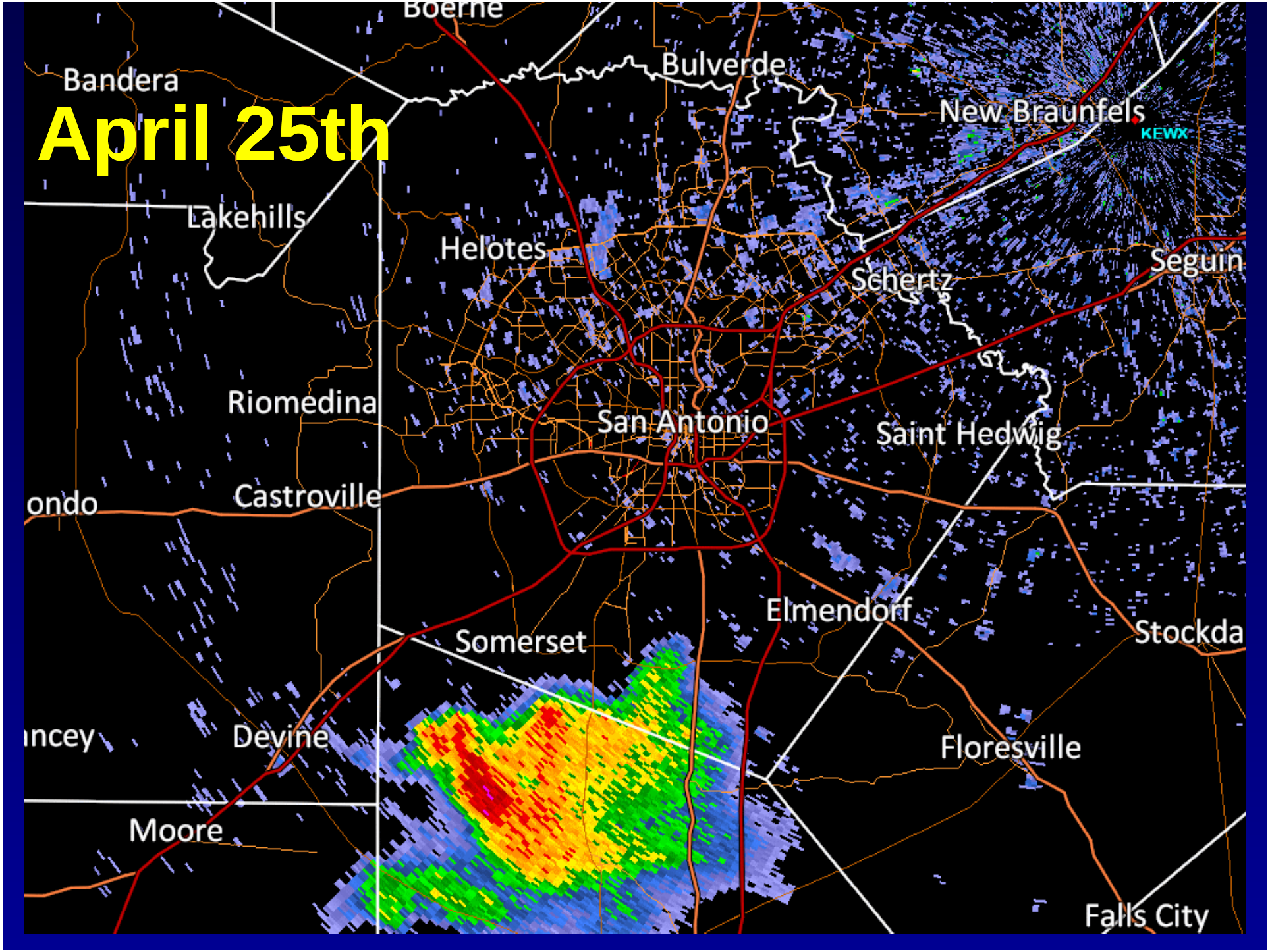




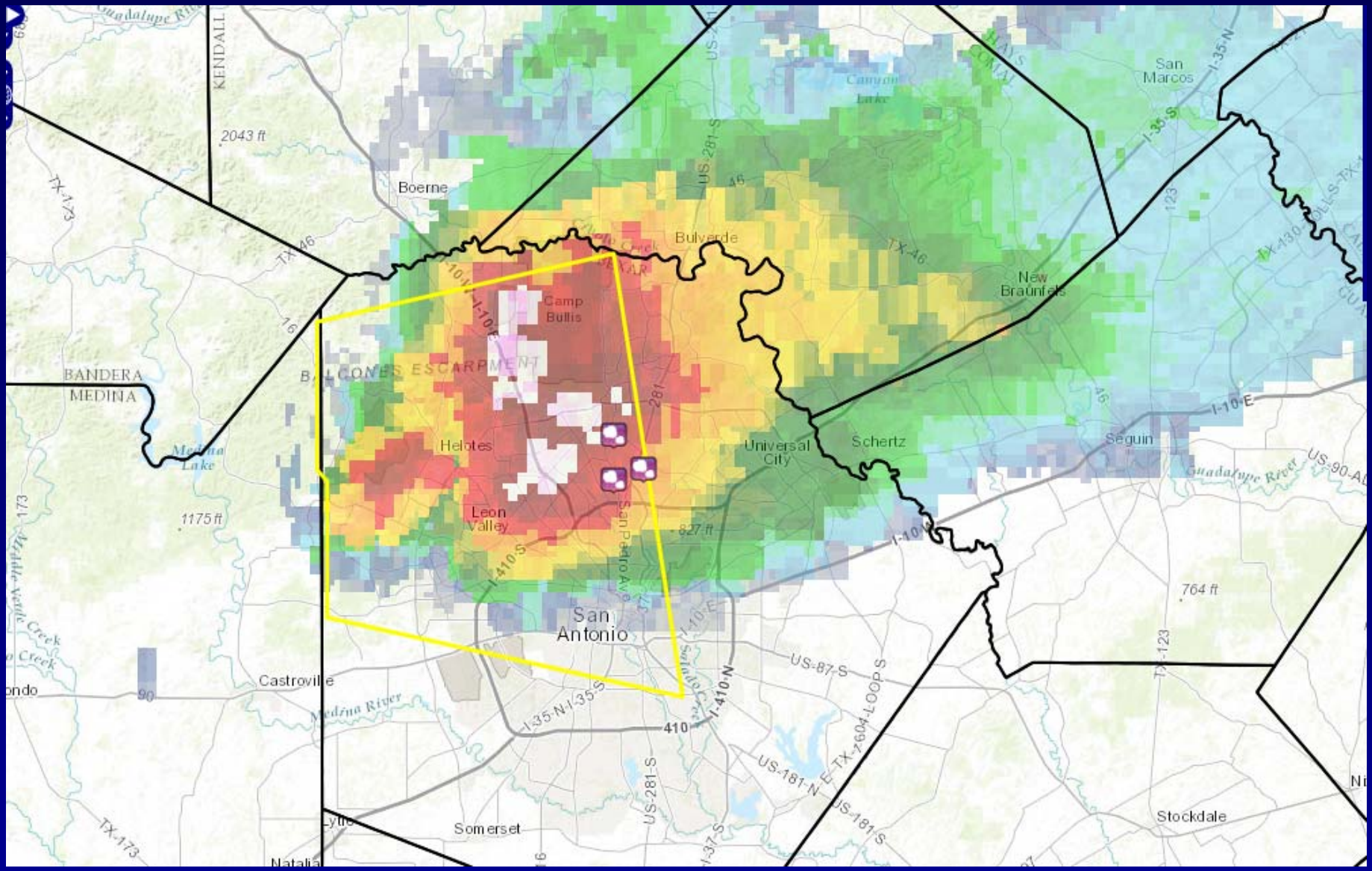
12 April 2016 Approximate Bexar County Hail Swath
Based on radar estimates and received storm reports
Map Updated on 4/15
Legend
Size (Inches)
1
1.5
2
2.5
3
3.5
4
N
0
2.5
5
10
15
20
Miles
San Antonio
New Braunfels
Map by: NWS Austin/San Antonio


221 Park Ave.
East Hartford, CT. 06108
DUR-A-FLEX® Inc.
Pioneers in Epoxy Technology


YETI
TEXAS
DN3 V396


April 25th
Boerne
Bandera
Bulverde
New Braunfels
KEWX
Lakehills
Helotes
Schertz
Seguin
Riomedina
San Antonio
Saint Hedwig
ondo
Castroville
Elmendorf
Somerset
Stockda
ncey
Devine
Floresville
Moore
Falls City

April 30th…same area…again!



3 April Storms…2+ Billion$

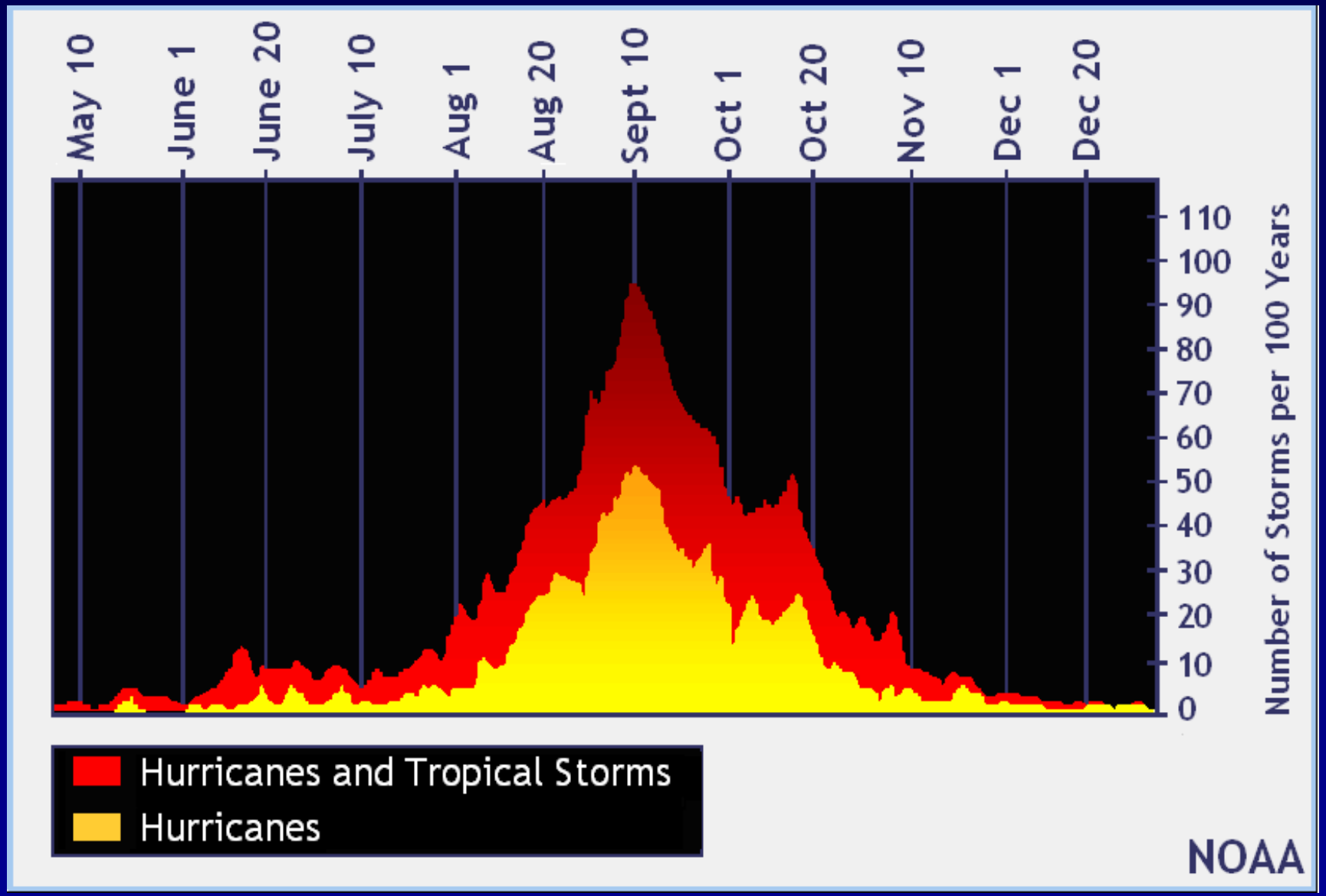
COSTLIEST TEXAS STORMS

2016 Dollars

1950 – Present

RANK	COST	STORM	DATE	LOCATION
1	$13.04 billion	Hurricane Ike	Sept. 13, 2008	Galveston Island
2	$ 4.69 billion	Tropical Storm Allison	June 8, 2001	Houston
3	$ 3.39 billion	Hurricane Rita	Sept. 24, 2005	Sabine Pass
4	$ 2.50 billion	Hurricane Carla *	Sept. 11, 1961	Port O'Connor
5	$ 1.88 billion	Hurricane Celia *	Aug. 3, 1970	Corpus Christi
6	$ 1.87 billion	Hurricane Alicia	Aug. 18, 1983	Galveston
7	$ 1.63 billion	Hail Storm	May 5, 1995	North Texas
8	$ 1.36 billion	Hail Storm	April 12, 2016	San Antonio
9	$ 1.21 billion	Hail Storm	April 28, 1992	Ft. Worth - Waco
10	$ 1.2 billion	Tornadoes	Dec 26, 2015	Garland - Rowlett

Peak of Tropical Season



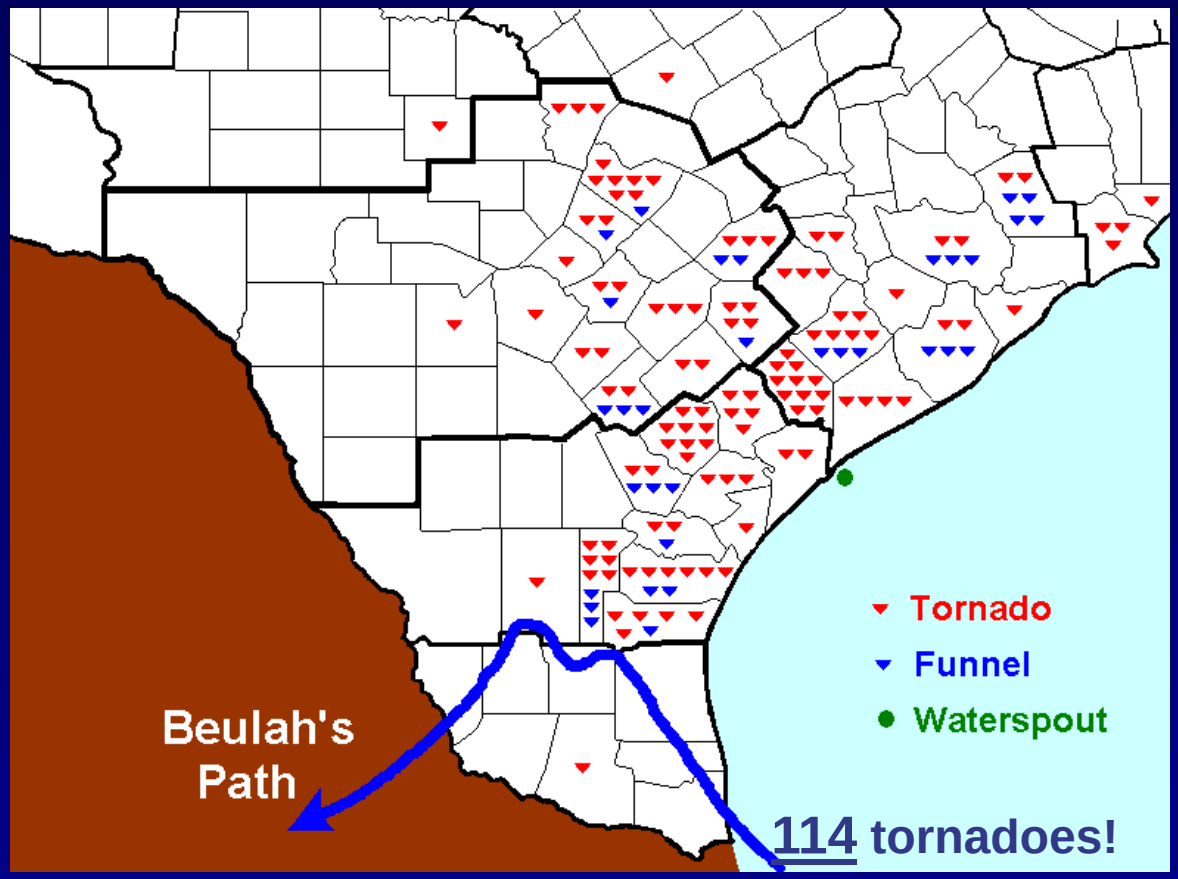

Storm Surge
45 SOUTH
Galveston
146
6
Texas City


Damaging
Winds


Tornadoes


Inland
Flooding

Tropical Tornadoes

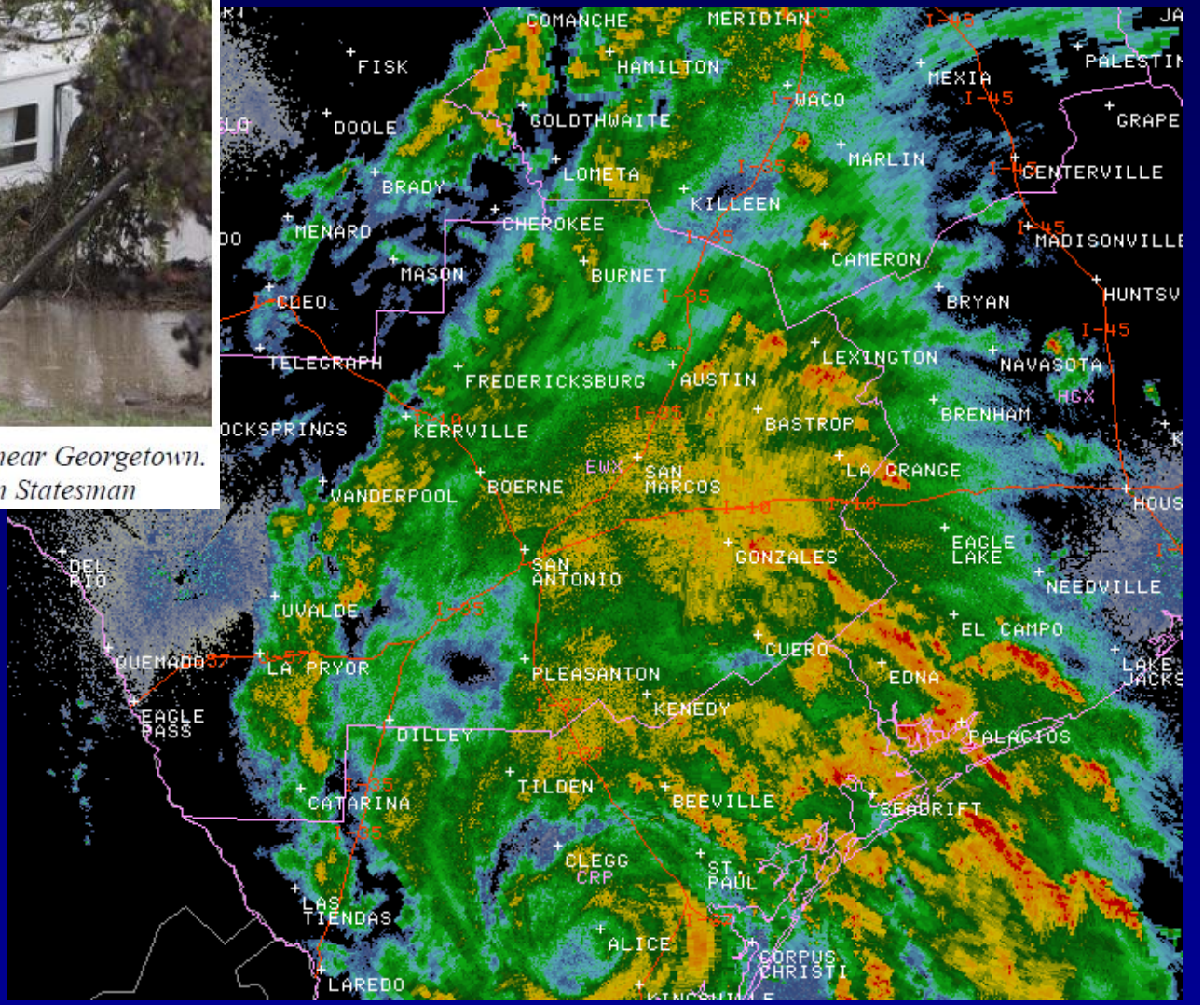


- Right-front quad
- On rainbands
- EF0, EF1
- Day or night

Hurricane Beulah - 1967

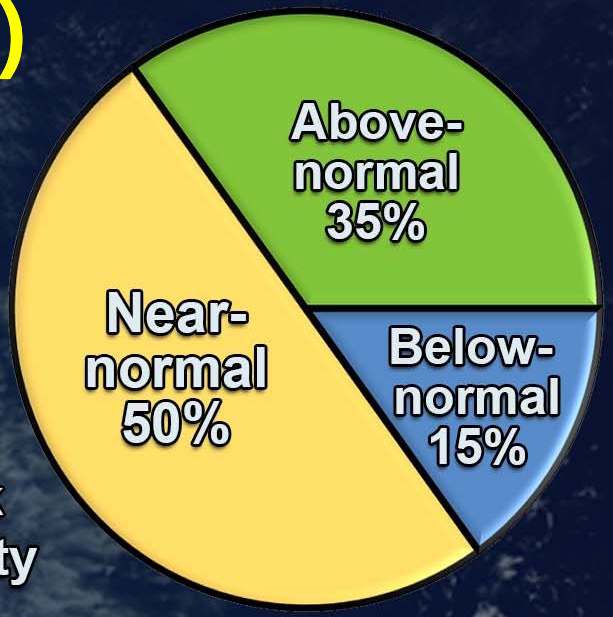
Tropical Storm Hermine…Inland

Flood damage in the Shady River RV Park near Georgetown. Photo courtesy of the Austin American Statesman



2016 Atlantic Hurricane Season Outlook Update

Named storms:	12–17 **(15)**
Hurricanes:	5–8 **(7)**
Major hurricanes:	2–4 **(3)**

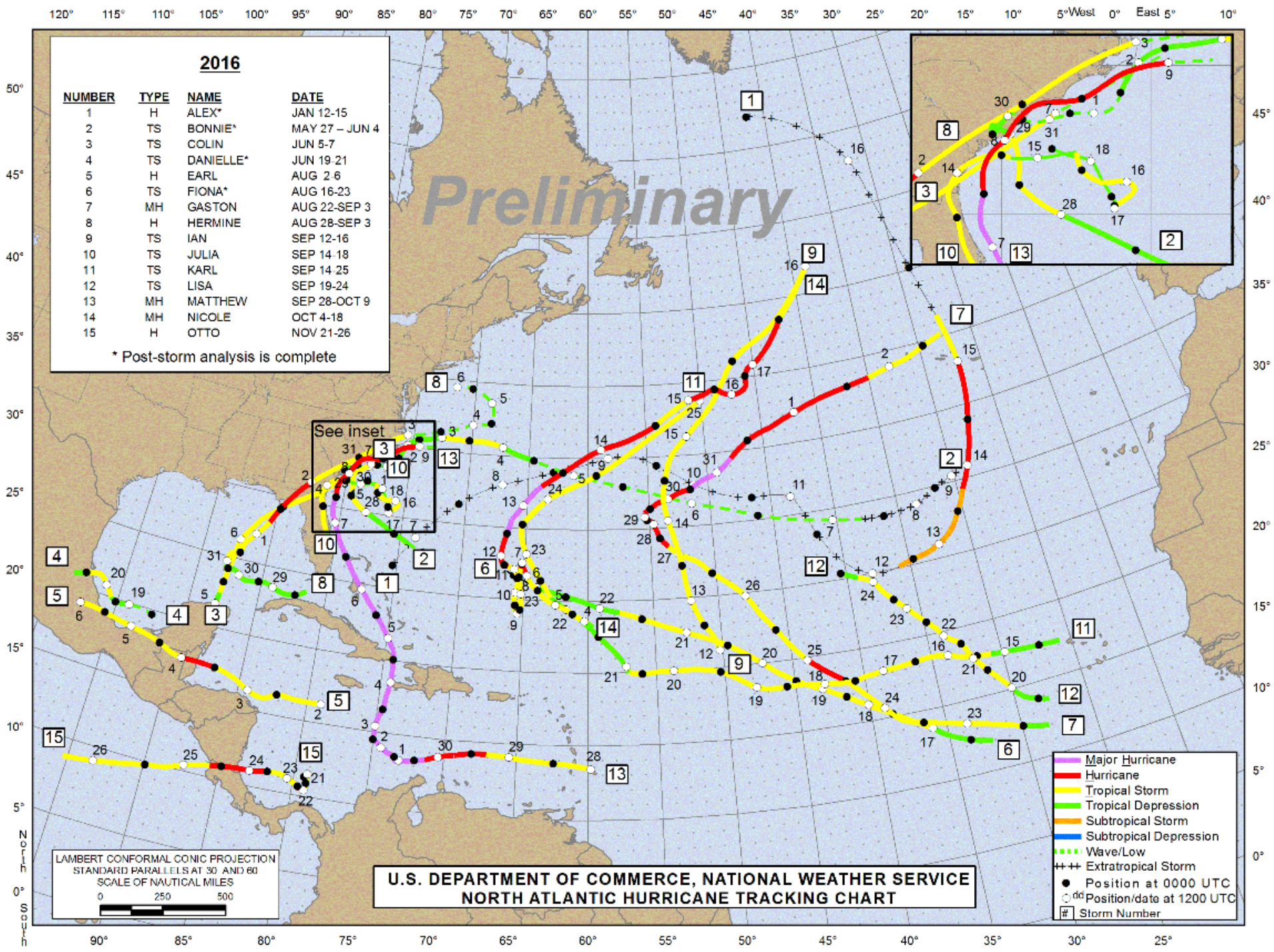


Outlook probability

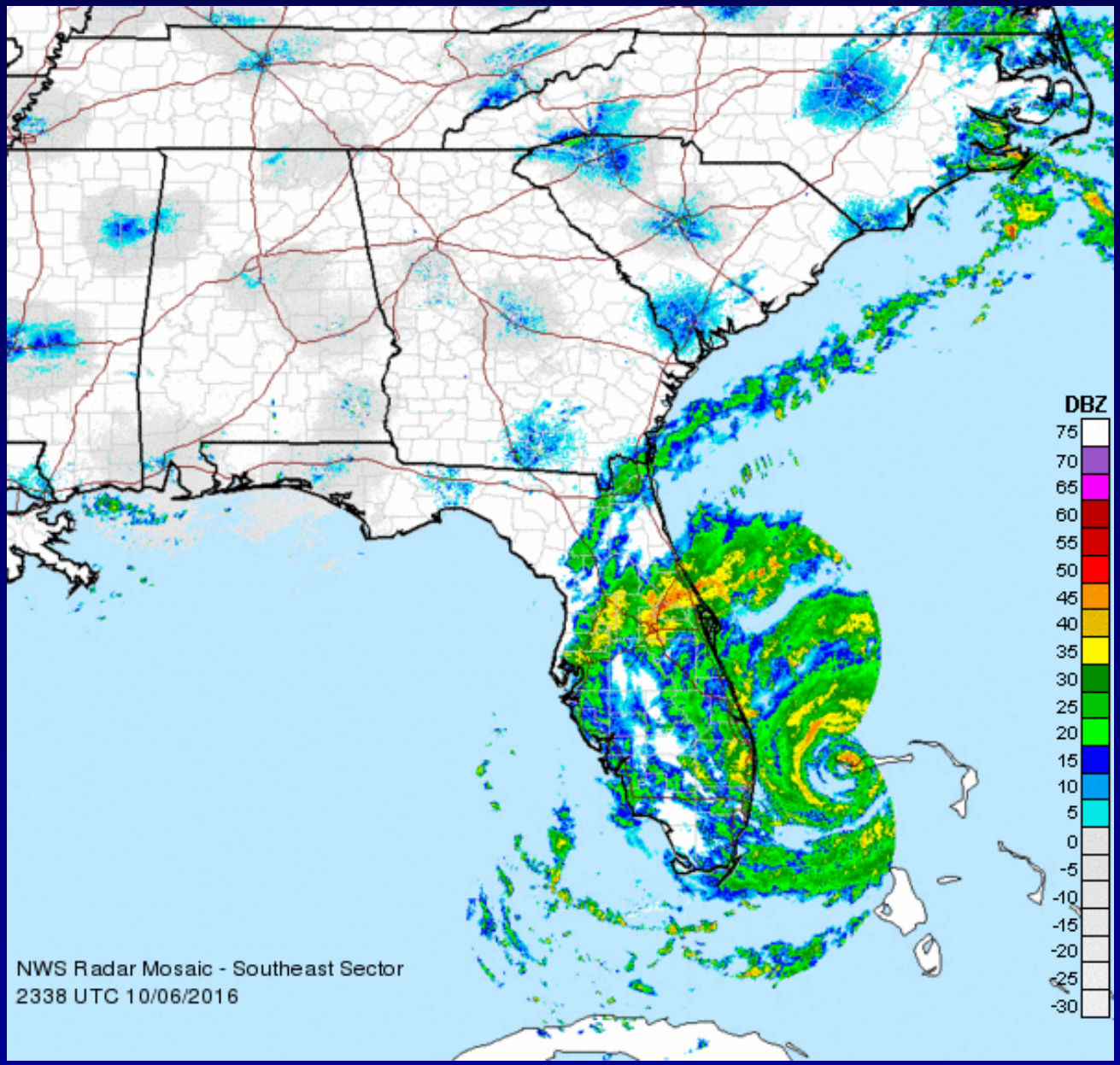
Be prepared: Visit hurricanes.gov
and follow @NWS and @NHC_Atlantic on Twitter

NOAA

08/11/2016


2016
NUMBER TYPE NAME DATE
1 H ALEX* JAN 12-15
2 TS BONNIE* MAY 27 – JUN 4
3 TS COLIN JUN 5-7
4 TS DANIELLE* JUN 19-21
5 H EARL AUG 2-6
6 TS FIONA* AUG 16-23
7 MH GASTON AUG 22-SEP 3
8 H HERMINE AUG 28-SEP 3
9 TS IAN SEP 12-16
10 TS JULIA SEP 14-18
11 TS KARL SEP 14-25
12 TS LISA SEP 19-24
13 MH MATTHEW SEP 28-OCT 9
14 MH NICOLE OCT 4-18
15 H OTTO NOV 21-26
* Post-storm analysis is complete
Preliminary
See inset
Major Hurricane
Hurricane
Tropical Storm
Tropical Depression
Subtropical Storm
Subtropical Depression
Wave/Low
Extratropical Storm
Position at 0000 UTC
Position/date at 1200 UTC
Storm Number
LAMBERT CONFORMAL CONIC PROJECTION
STANDARD PARALLELS AT 30 AND 60
SCALE OF NAUTICAL MILES
0 250 500
U.S. DEPARTMENT OF COMMERCE, NATIONAL WEATHER SERVICE
NORTH ATLANTIC HURRICANE TRACKING CHART

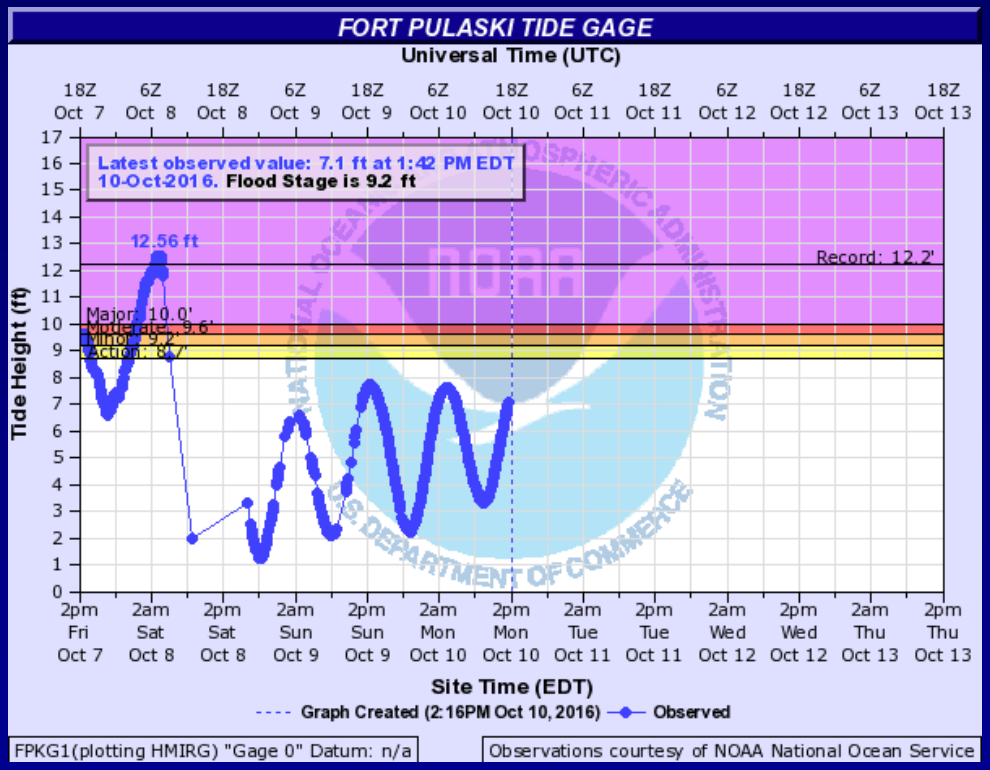
Hurricane Matthew…Sept 28-Oct 9

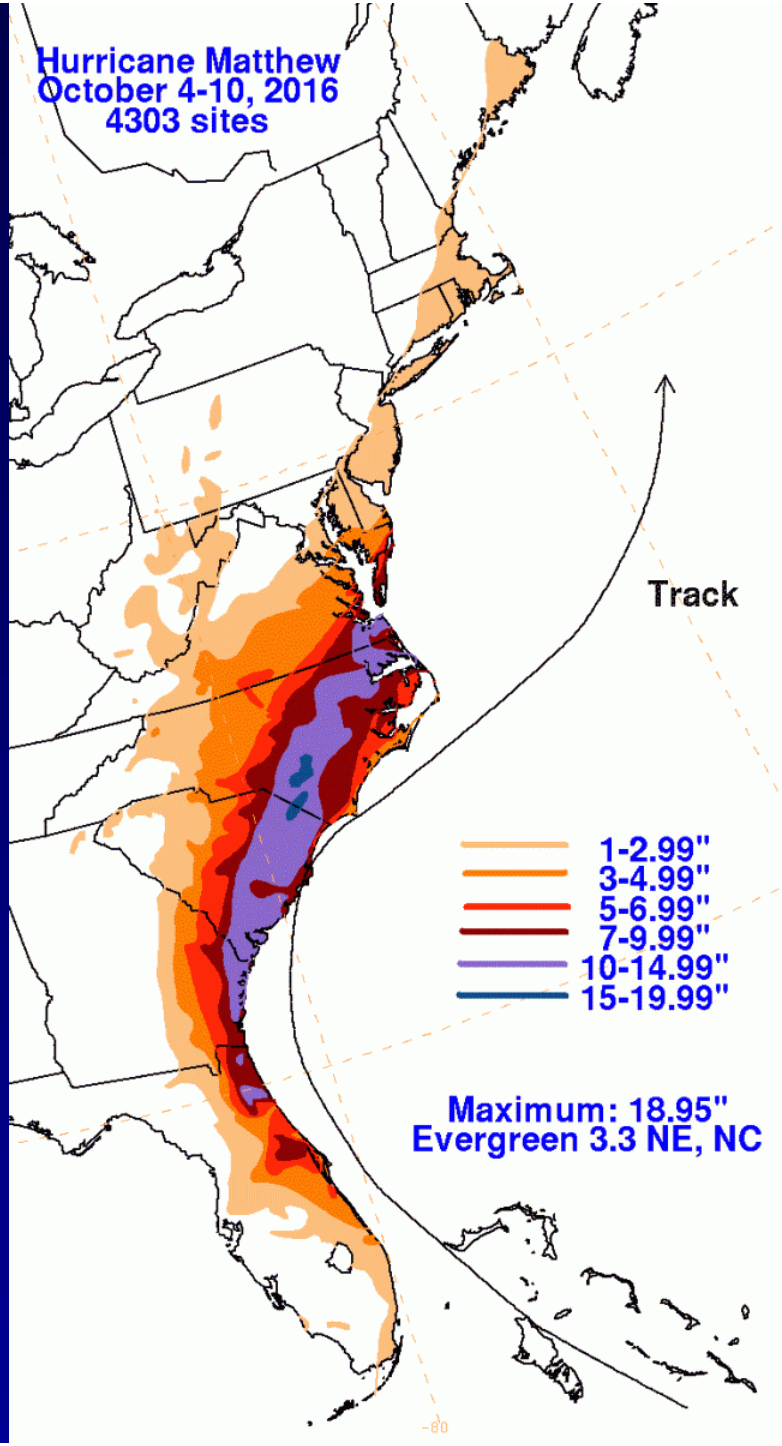


Hurricane Matthew… Hugging the Cost

Record Rainfall in NC

Record Surge in GA

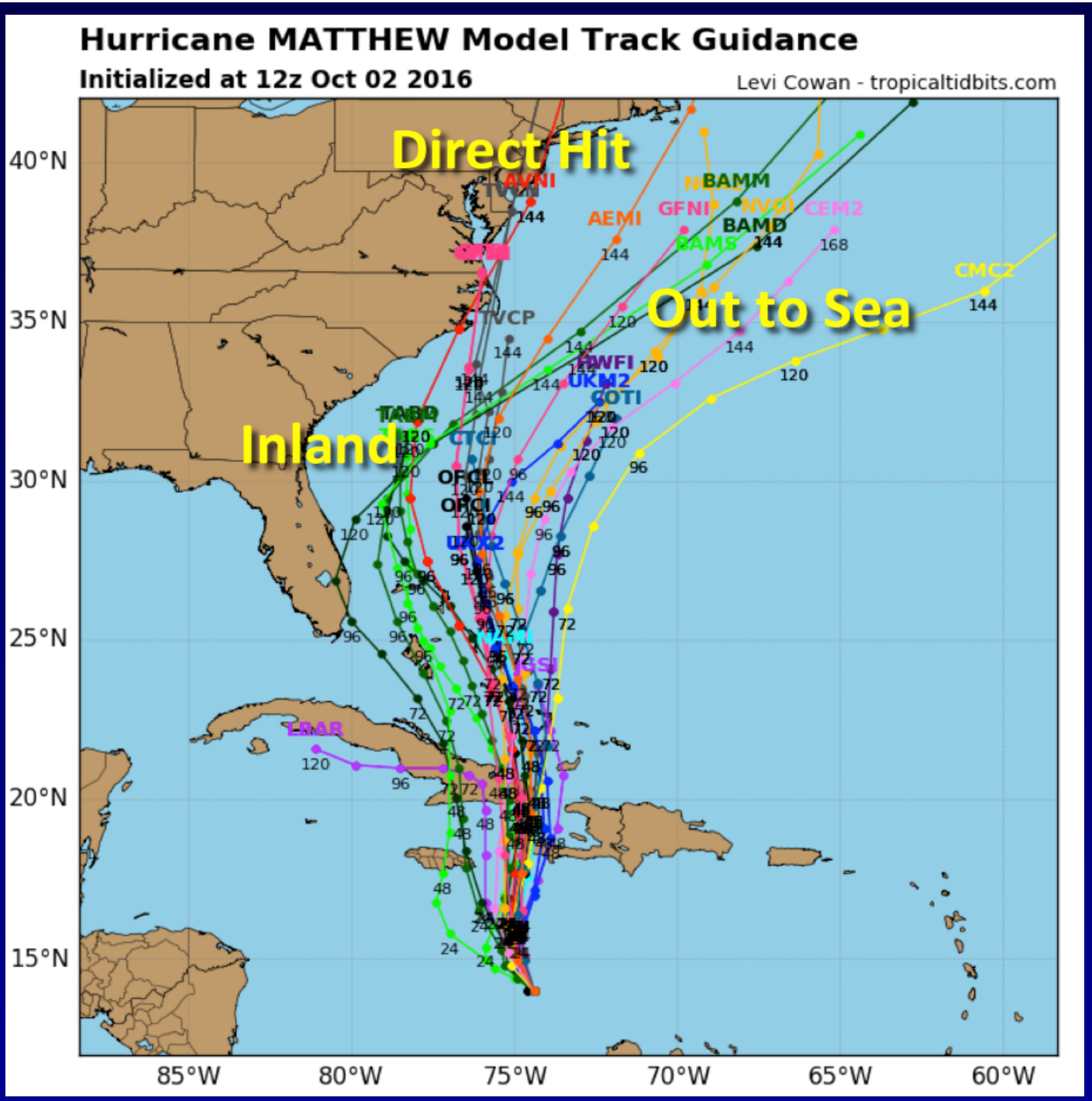




The Problem with Models…

This is now available to the public…

That's not necessarily a good thing.



For All You Math Types….

We calculate…

Primitive Equations

$$\frac{\partial u}{\partial t}+\dot{\sigma}\frac{\partial u}{\partial \sigma}+u\frac{\partial u}{\partial x}+v\frac{\partial u}{\partial y}-fv-\frac{uv}{r}\tan\phi+g\frac{\partial z}{\partial x}+c_p\theta\frac{\partial \pi}{\partial x}+F_x=0$$

$$\frac{\partial v}{\partial t}+\dot{\sigma}\frac{\partial v}{\partial \sigma}+u\frac{\partial v}{\partial x}+v\frac{\partial v}{\partial y}+fu+\frac{u^2}{r}\tan\phi+g\frac{\partial z}{\partial x}+c_p\theta\frac{\partial \pi}{\partial y}+F_y=0$$

$$\frac{\partial (gz)}{\partial \sigma}+c_p\theta\frac{\partial \pi}{\partial \sigma}=0,$$

$$\frac{\partial \theta}{\partial t}+\dot{\sigma}\frac{\partial \theta}{\partial \sigma}+u\frac{\partial \theta}{\partial x}+v\frac{\partial \theta}{\partial y}+H=0,$$

$$\frac{\partial p_\sigma}{\partial t}+\frac{\partial}{\partial \sigma}(\dot{\sigma}p_\sigma)+\frac{\partial}{\partial x}(up_\sigma)+\frac{\partial}{\partial y}(vp_\sigma)-\frac{vp_\sigma}{r}\tan\phi=0, \qquad \pi=\left(\frac{p}{P}\right)^\kappa.$$

Primitive Equations (2)

Horizontal Equations of Motion
- Newton's 2nd law of motion

The Hydrostatic Equation
- Vertical stratification

Thermodynamic Equation
- The 1st law of thermodynamics

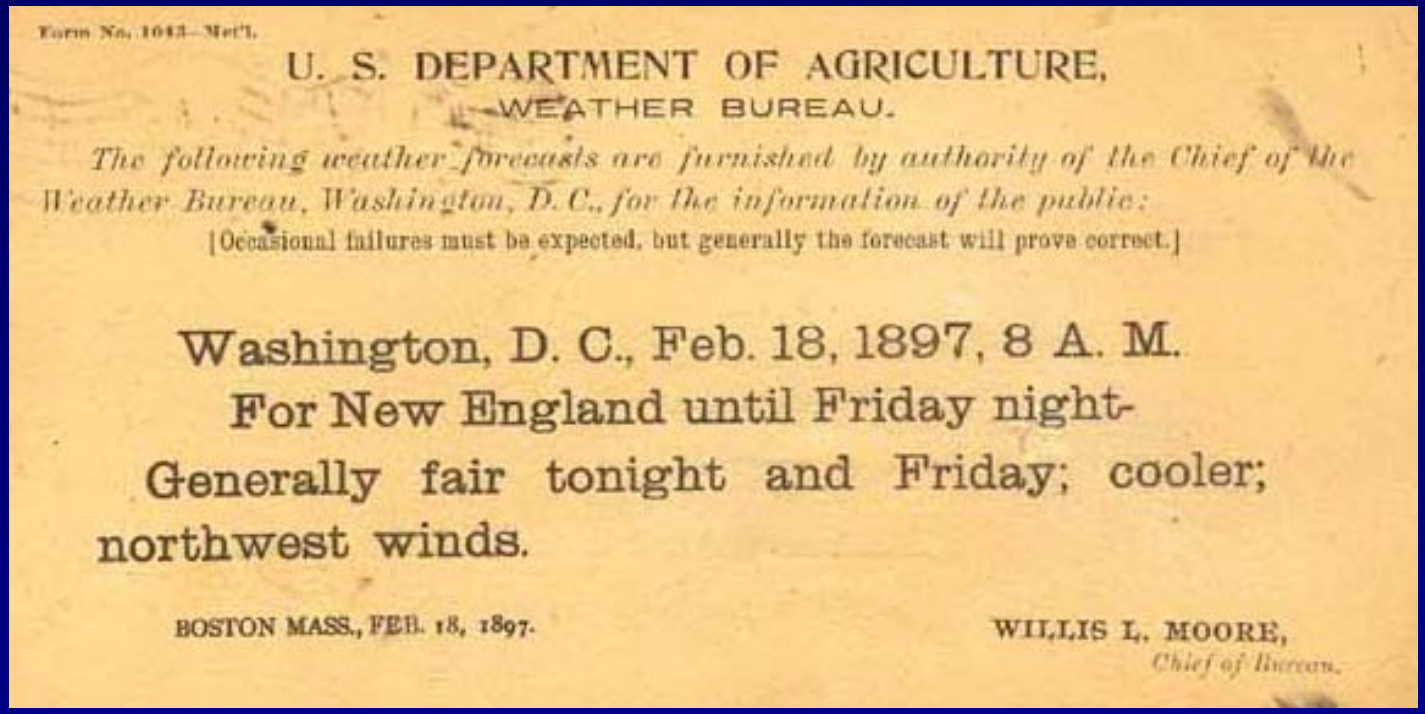
Continuity Equation
- Conservation of Mass

Equation of State
- Property of the ideal gas

Water Vapor Equation

For All You Math Types….

We Get…



Form No. 1043—Met'l.

U. S. DEPARTMENT OF AGRICULTURE,
WEATHER BUREAU.

The following weather forecasts are furnished by authority of the Chief of the Weather Bureau, Washington, D. C., for the information of the public:

[Occasional failures must be expected, but generally the forecast will prove correct.]

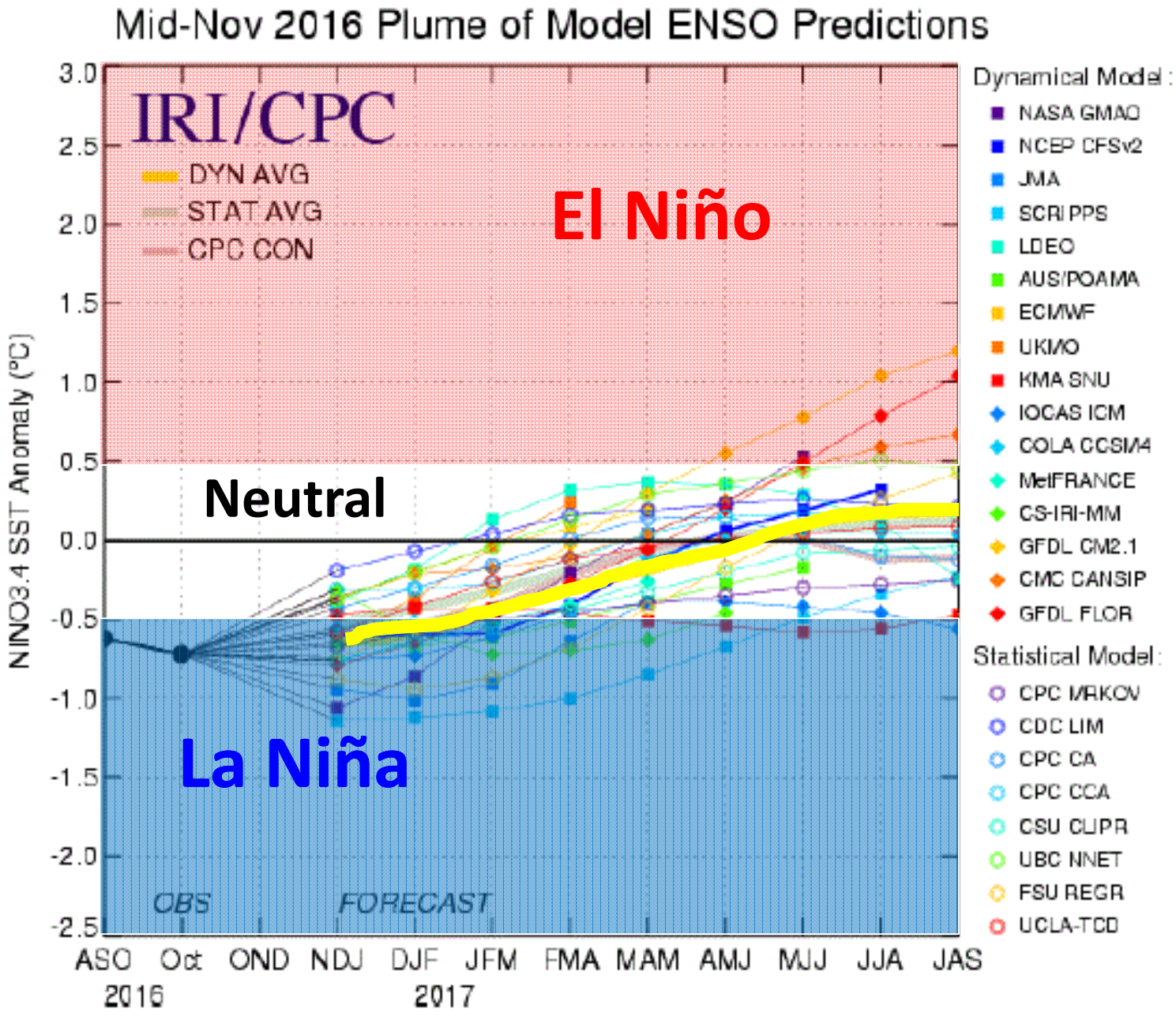
Washington, D. C., Feb. 18, 1897, 8 A. M.

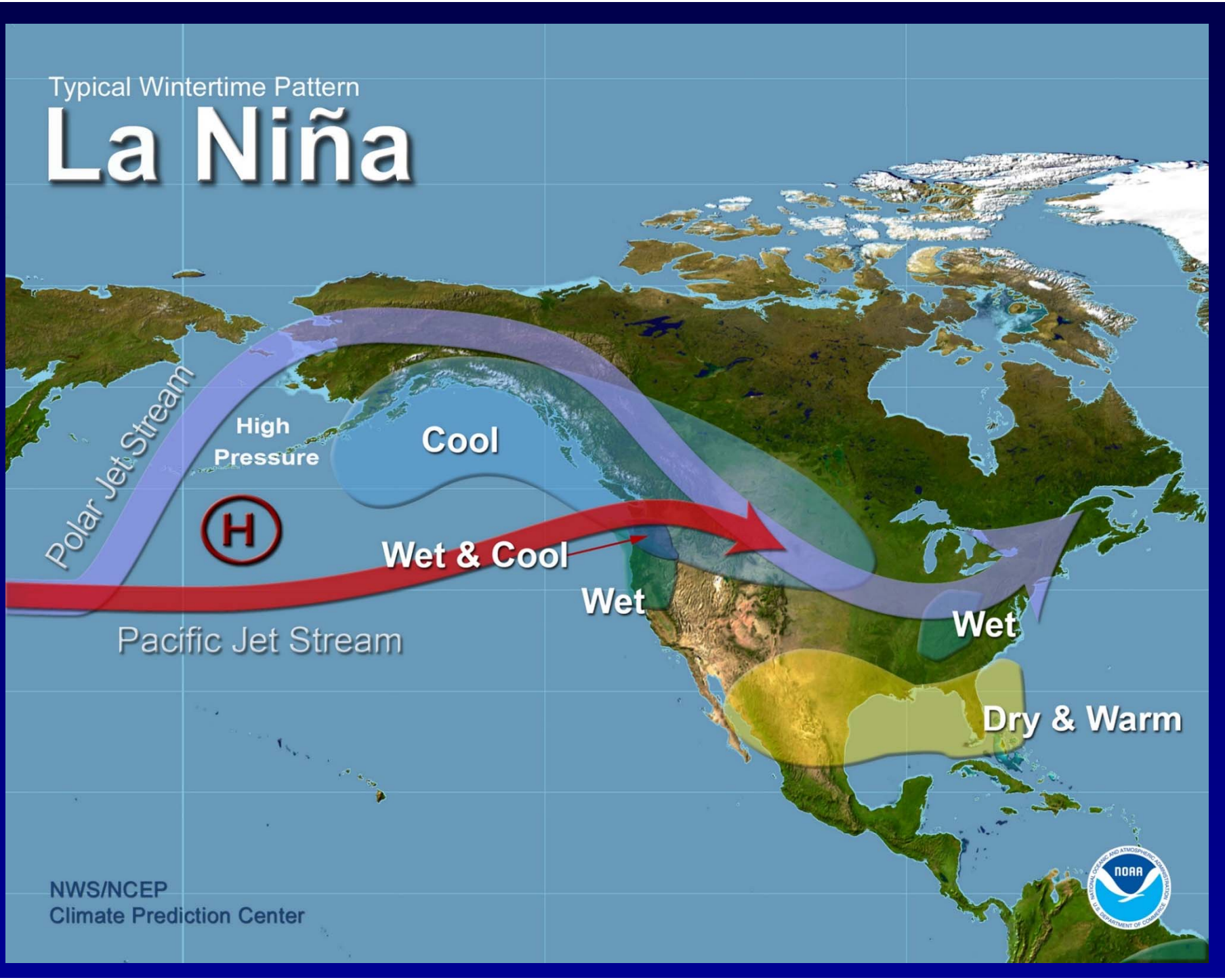
For New England until Friday night-

Generally fair tonight and Friday; cooler; northwest winds.

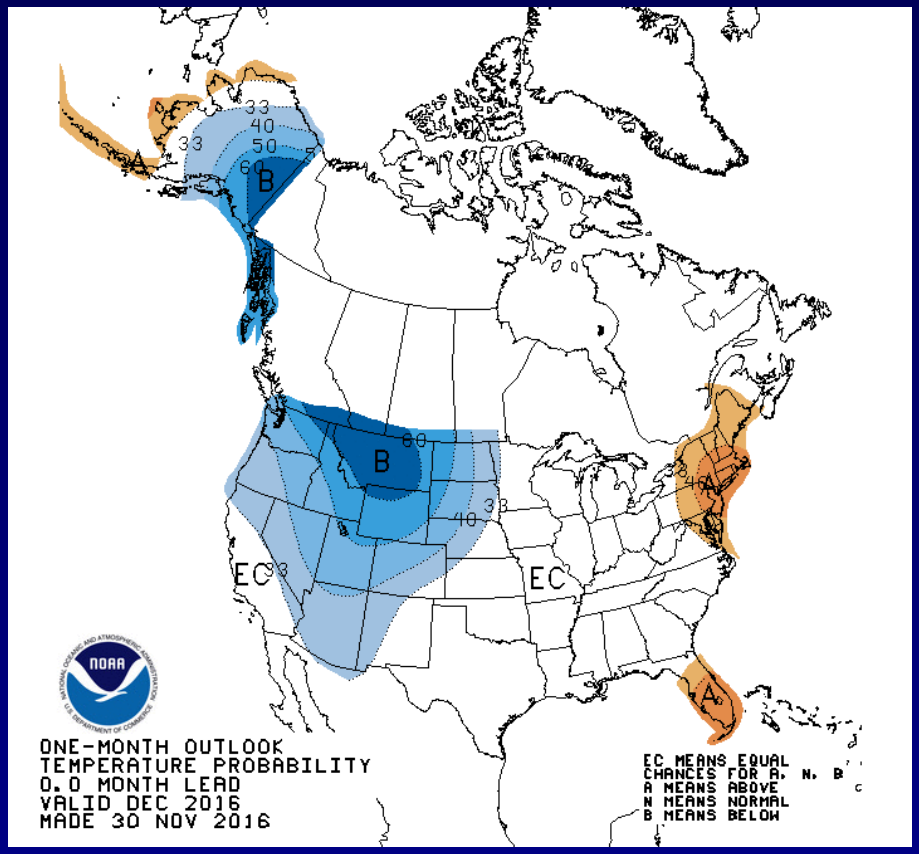
BOSTON MASS., FEB. 18, 1897.

WILLIS L. MOORE,
Chief of Bureau.

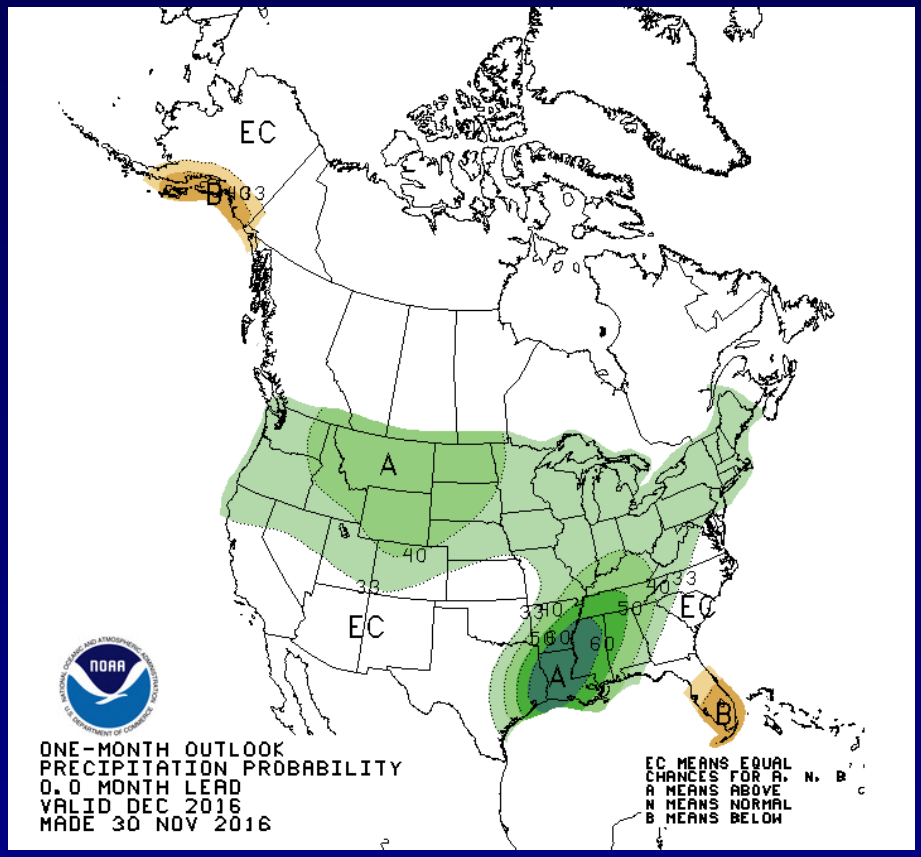

Mid-Nov 2016 Plume of Model ENSO Predictions
IRI/CPC
DYN AVG
STAT AVG
CPC CON
El Niño
Neutral
La Niña
OBS
FORECAST
NINO3.4 SST Anomaly (°C)
3.0
2.5
2.0
1.5
1.0
0.5
0.0
-0.5
-1.0
-1.5
-2.0
-2.5
ASO
Oct
OND
NDJ
DJF
JFM
FMA
MAM
AMJ
MJJ
JJA
JAS
2016
2017
Dynamical Model:
NASA GMAO
NCEP CFSv2
JMA
SCRIPPS
LDEO
AUS/POAMA
ECMWF
UKMO
KMA SNU
IOCAS ICM
COLA CCSM4
MetFRANCE
CS-IRI-MM
GFDL CM2.1
CMC CANSIP
GFDL FLOR
Statistical Model:
CPC MRKOV
CDC LIM
CPC CA
CPC CCA
CSU CLIPR
UBC NNET
FSU REGR
UCLA-TCD


Typical Wintertime Pattern
La Niña
Polar Jet Stream
High Pressure
H
Cool
Wet & Cool
Wet
Wet
Dry & Warm
Pacific Jet Stream
NWS/NCEP
Climate Prediction Center
NOAA

One Month Outlook...December

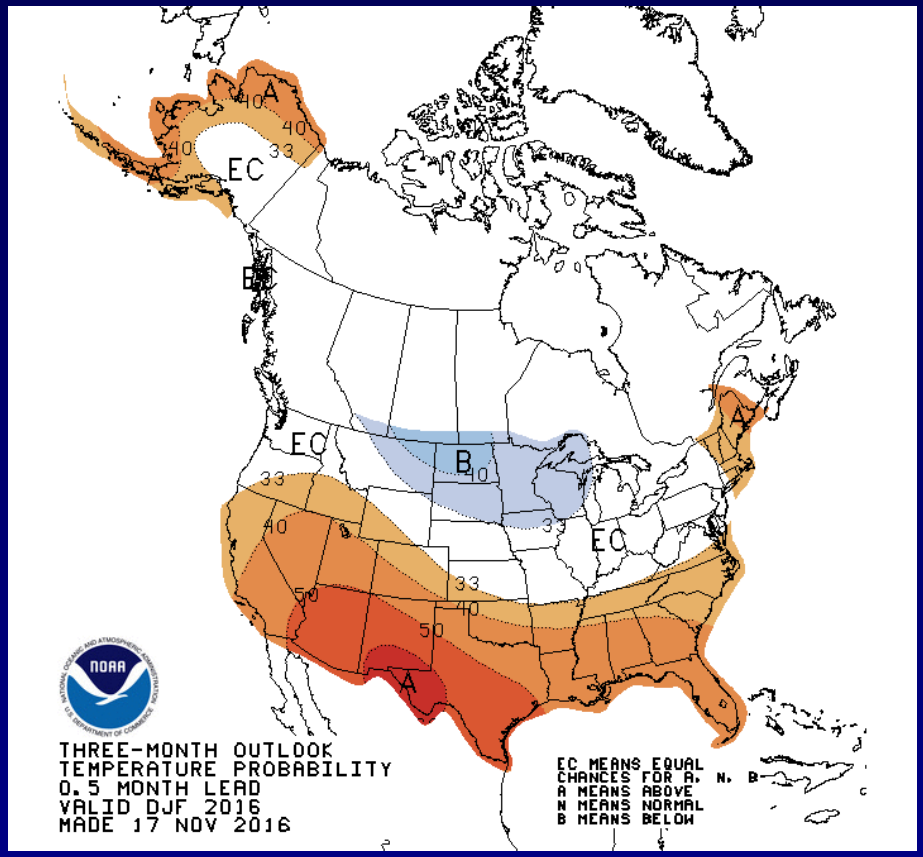


Temperature

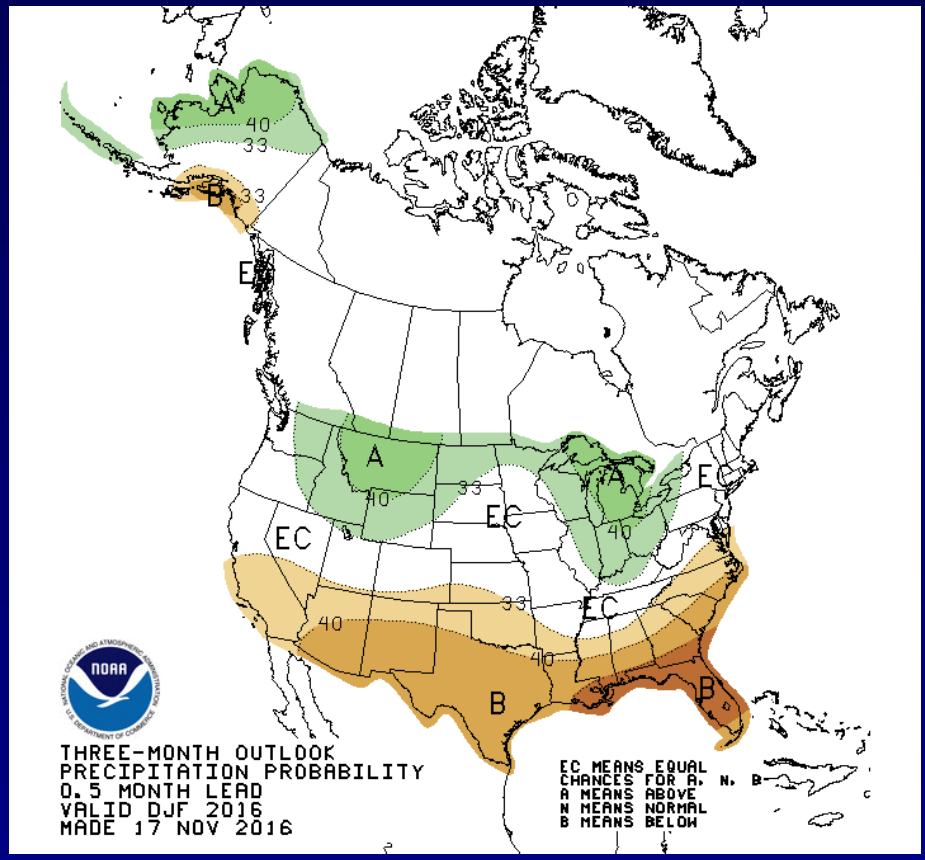


Precipitation

3 Month Outlook…Dec-Feb



Temperature



Precipitation

Questions?

Paul.Yura@noaa.gov

NWS Austin/San Antonio
2090 Airport Road
New Braunfels, TX 78130

- **# 830-629-0130 ext 223**

@NWSSanAntonio
weather.gov/ewx