Map Creation for Weather Information Using GIS

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U.S. Department of Commerce
National Oceanic and Atmospheric Administration
National Weather Service – Paducah, KY

NWS Paducah, KY

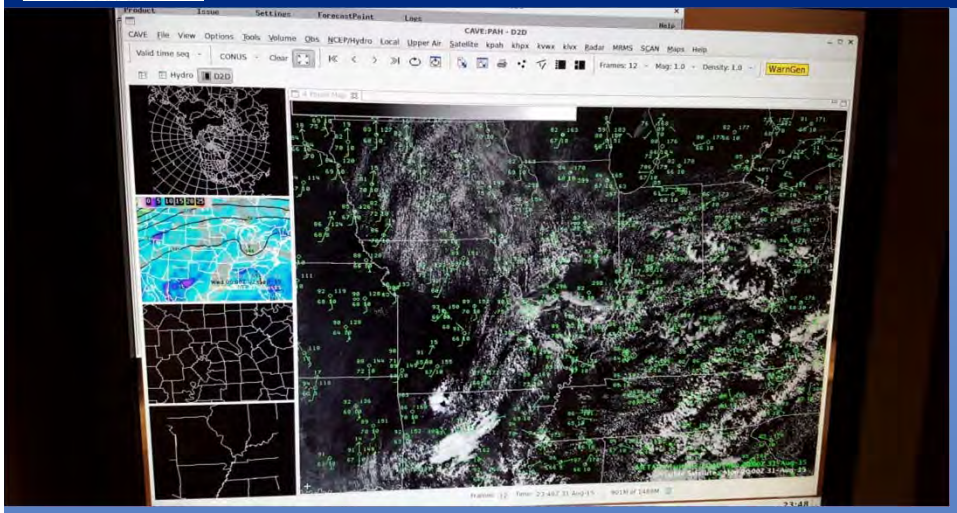
- Provides products and services such as:
  - 7 day weather forecasts
  - Warnings/Watches/Advisories
  - Aviation forecasts
  - Climate
  - River flooding and forecasts
  - Fire weather forecasts
- Forecast area consists of 58 counties divided between 4 states
  - Illinois, Indiana, Kentucky, and Missouri

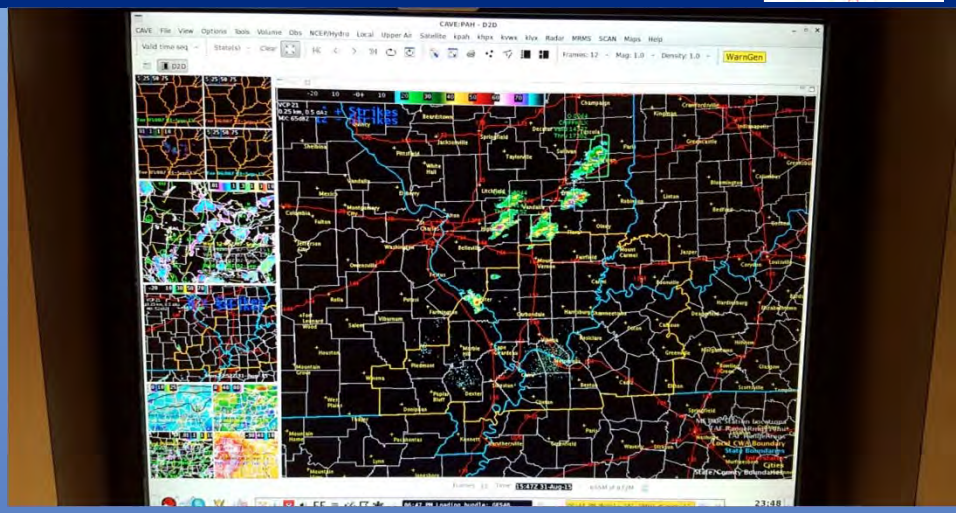
  http://www.weather.gov/pah/

NWS Paducah Office Layout

- 5 Work stations (consists of 4 AWIPS monitors and 1 PC)
  - No defined work station based on shift duties (except HMT/Intern station)
- AWIPS: Advanced Weather Interactive Processing System
  - Technologically advanced information processing, display, and telecommunications system
  - An interactive computer system that integrates all meteorological and hydrologic data to enable the forecaster to prepare and issue accurate and timely forecasts and warnings

NWS Paducah Office Layout



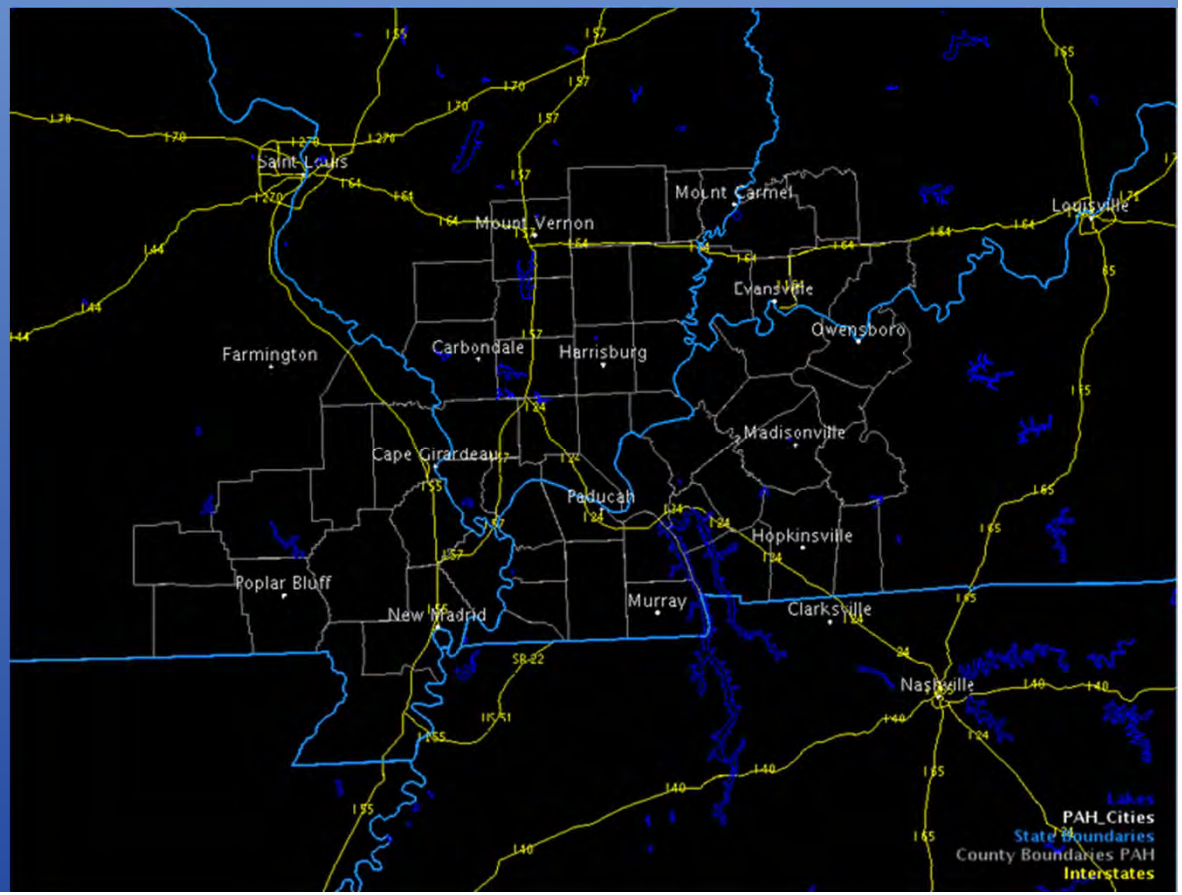


GIS within AWIPS

- Numerous background maps (shapefiles) available to be used in tandem with forecast models, radar, satellite, observations, etc.
- Examples of shapefiles used nationally in AWIPS:
  - Interstates
  - Cities
  - State boundaries
  - County boundaries
  - Rivers
  - Lakes
  - County Warning Areas(CWA)
  - Storm Spotter Info
  - Railroads
  - River Drainage Basins

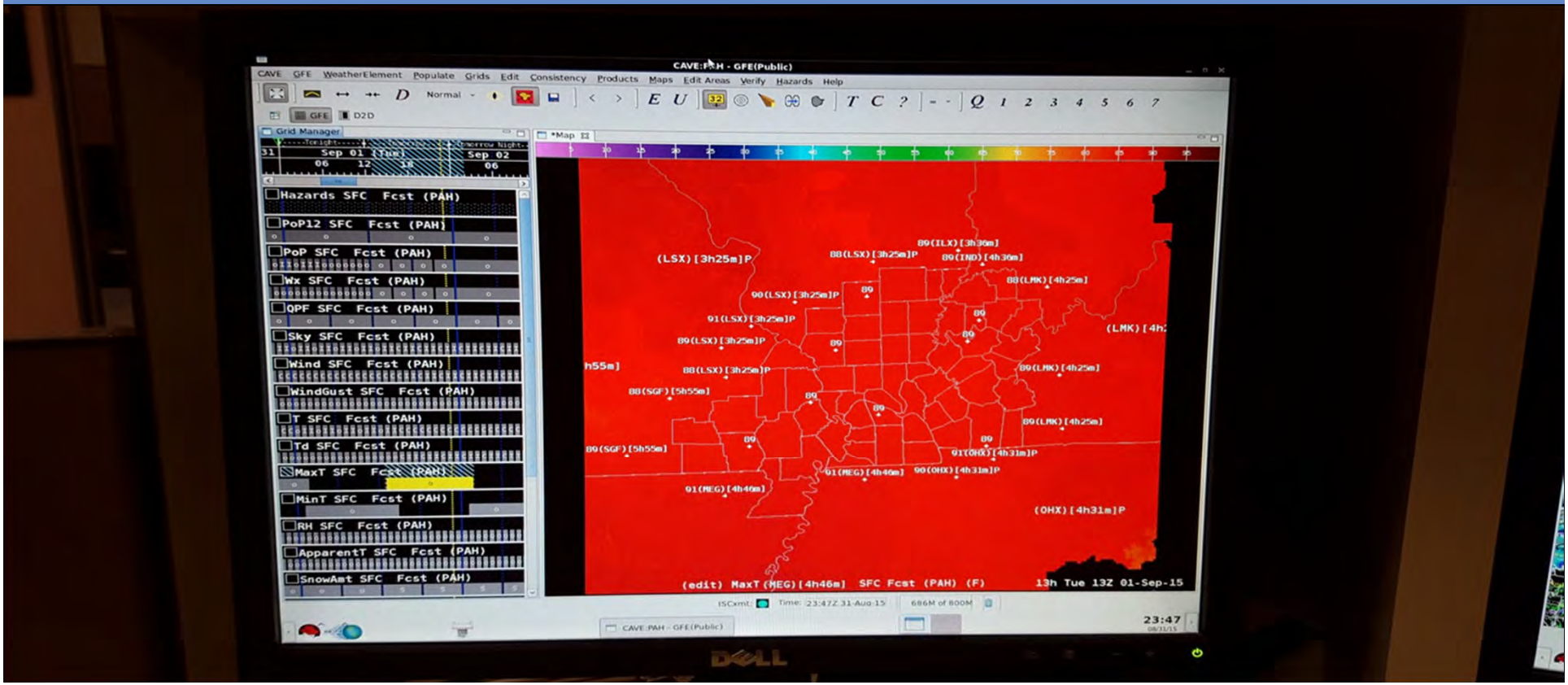
<u>Shapefiles I've created locally:</u>

- TAF Range Rings
  - Display a 5 and 10 mile ring around each of our 4 airports we issue aviation forecasts for
  - Good for when showers and thunderstorms are in vicinity of airport
- Paducah CWA Cities
  - Only shows more populated cities in our area
  - Nice for overlaying with radar and sending out as a graphicast
  - Default national cities layer has small towns pop up before larger ones and is more cluttered



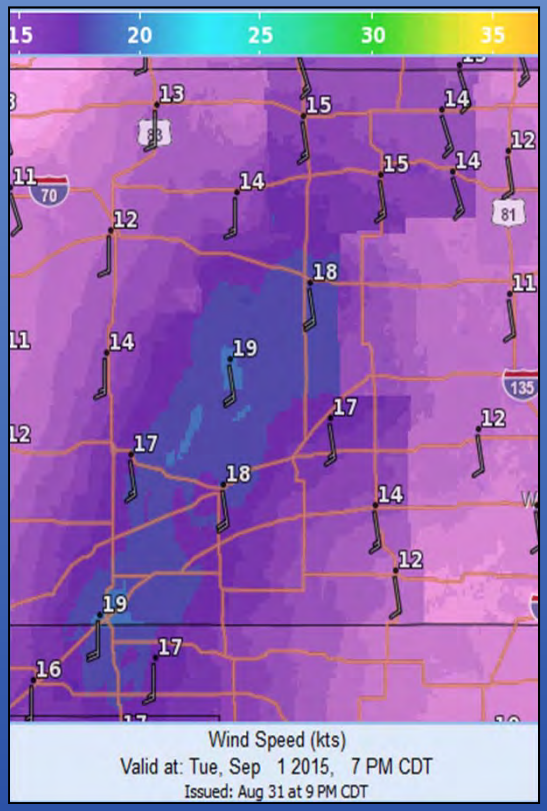
Creation of NWS Forecasts

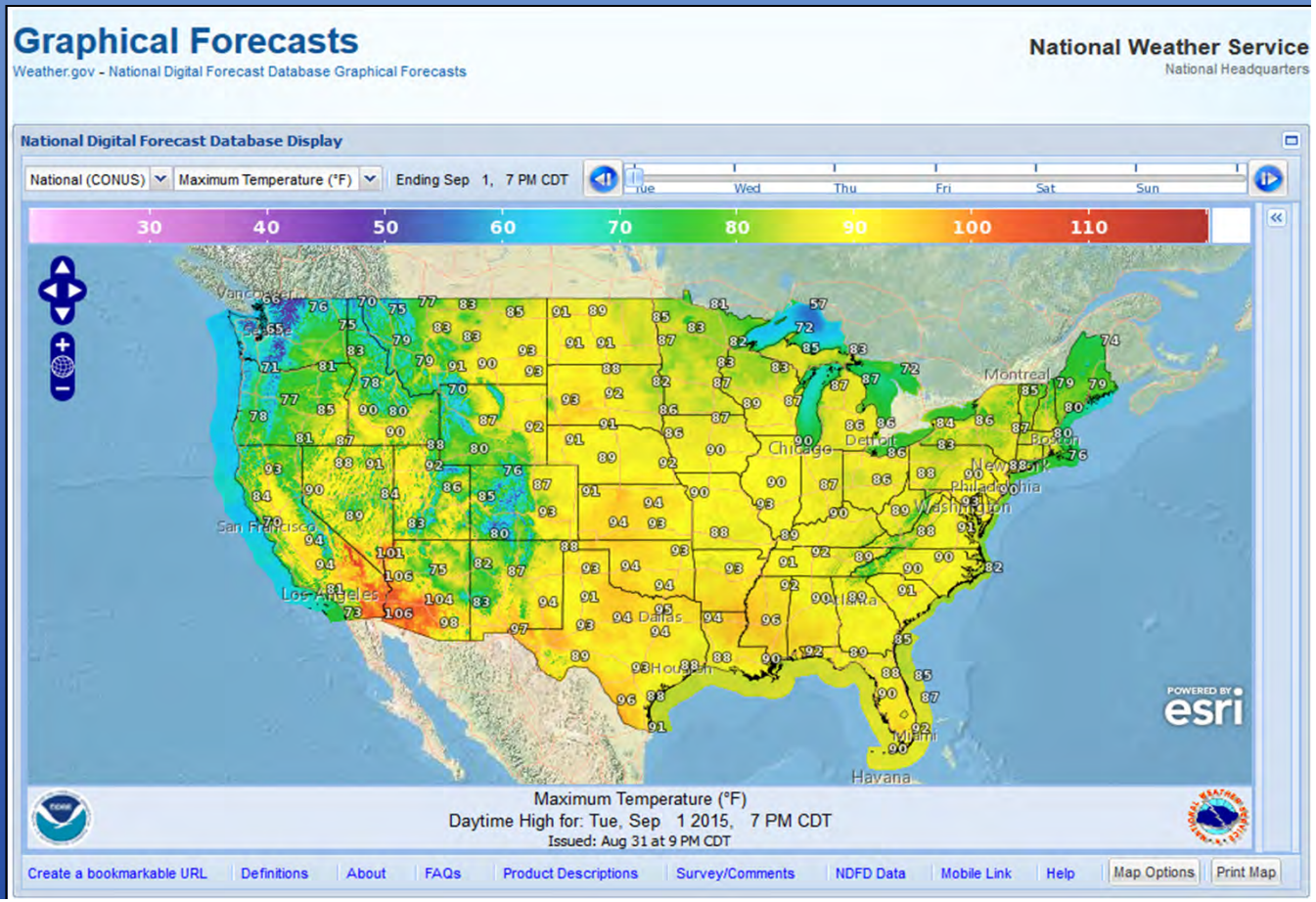
- We import computer models and interactively manipulate numerous forecasts grids
  - High/Low Temperatures
  - Probability of Precipitation
  - Precipitation/Snowfall Amounts
  - Dewpoints
  - Sky Cover
  - Wind
- Grids are merged together between all offices to form the National Digital Forecast Database (NDFD)



NDFD and GIS Examples

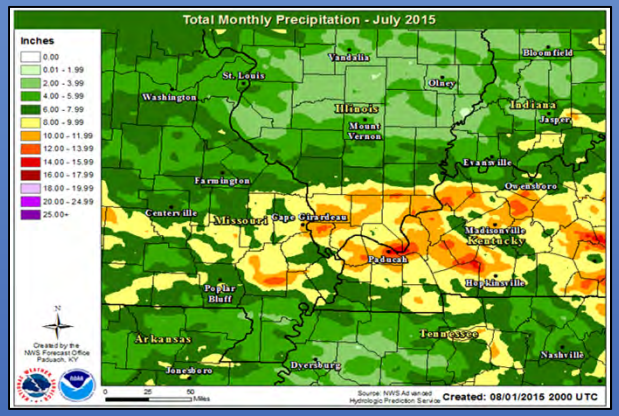
- http://digital.weather.gov/
- NDFD is an interactive display for our customers and partners to use
- Updates accordingly with new forecast data out to 7 days
- Map background contains cities, roads, etc. that can be toggled on or off.

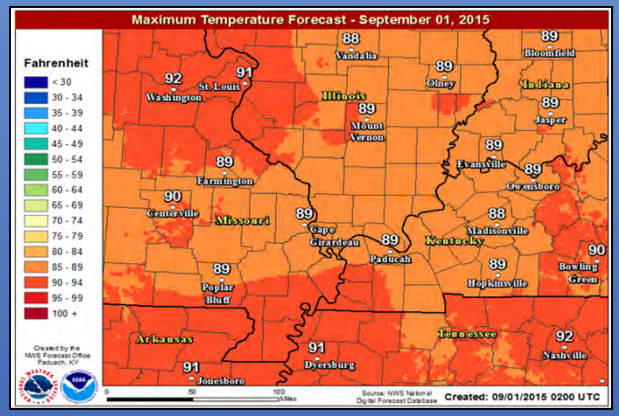


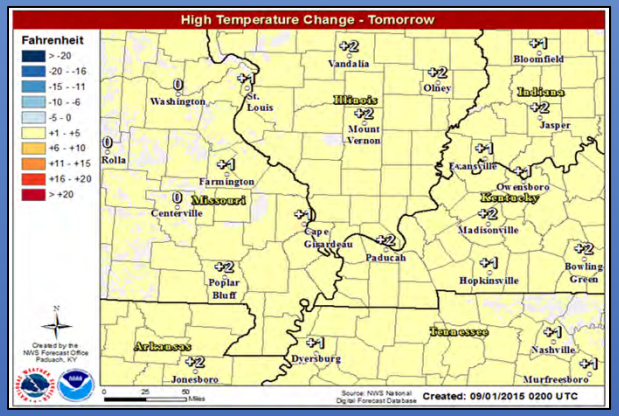


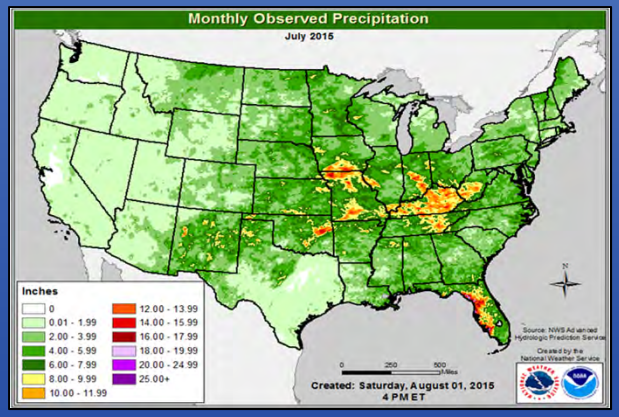
NDFD and GIS Examples

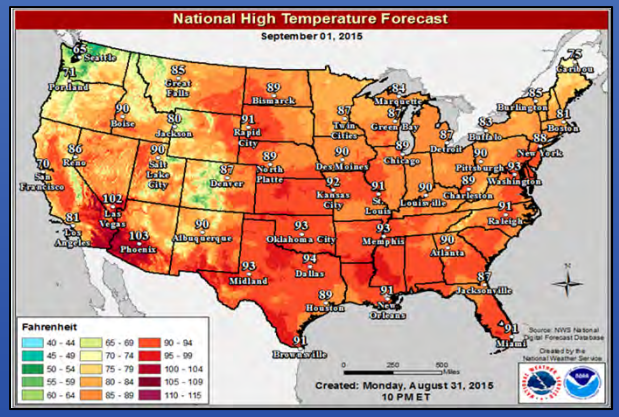
- http://www.erh.noaa.gov/gis/cr/pah/
- Static GIS maps are available for the CONUS and every individual NWS office county warning area (CWA)
- These are nice for easily posting on our Facebook or Twitter page
  - Maps include forecast temperatures in the 1 to 3 day timeframe
  - Rainfall maps of past 24hr, 48hr, and month to date precipitation accumulation

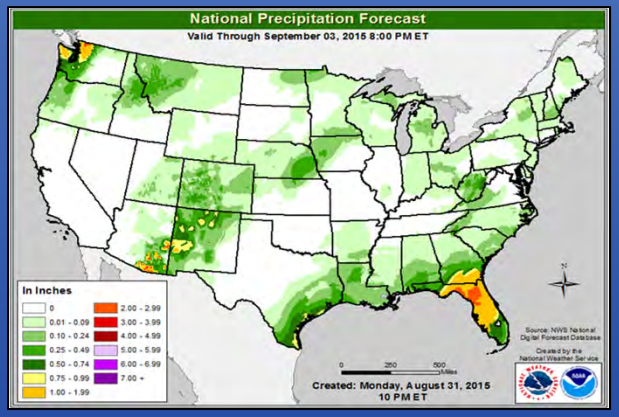






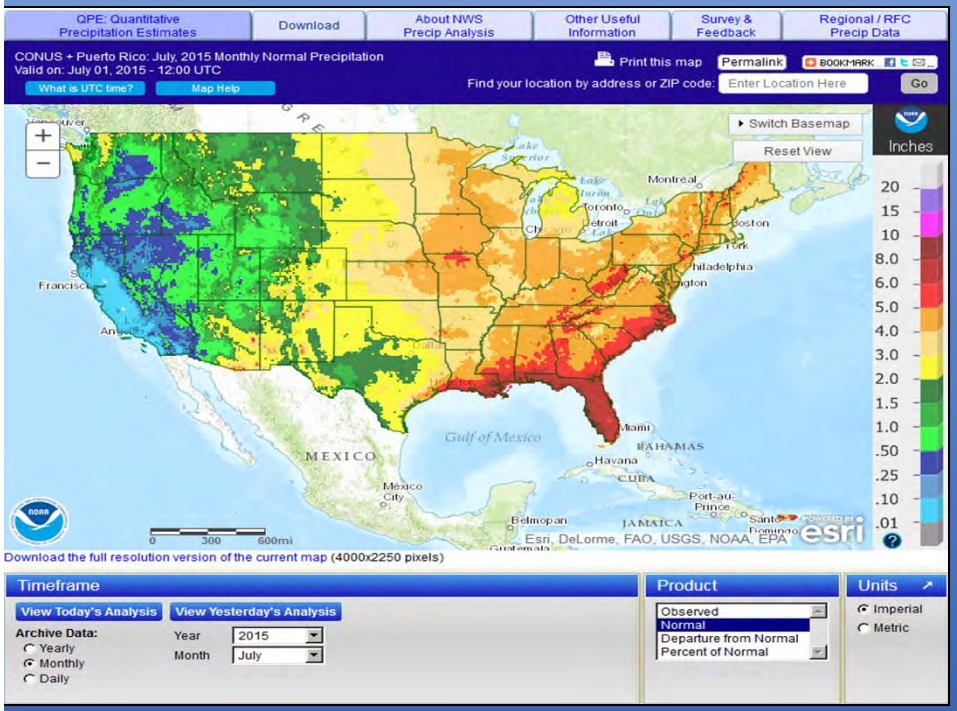


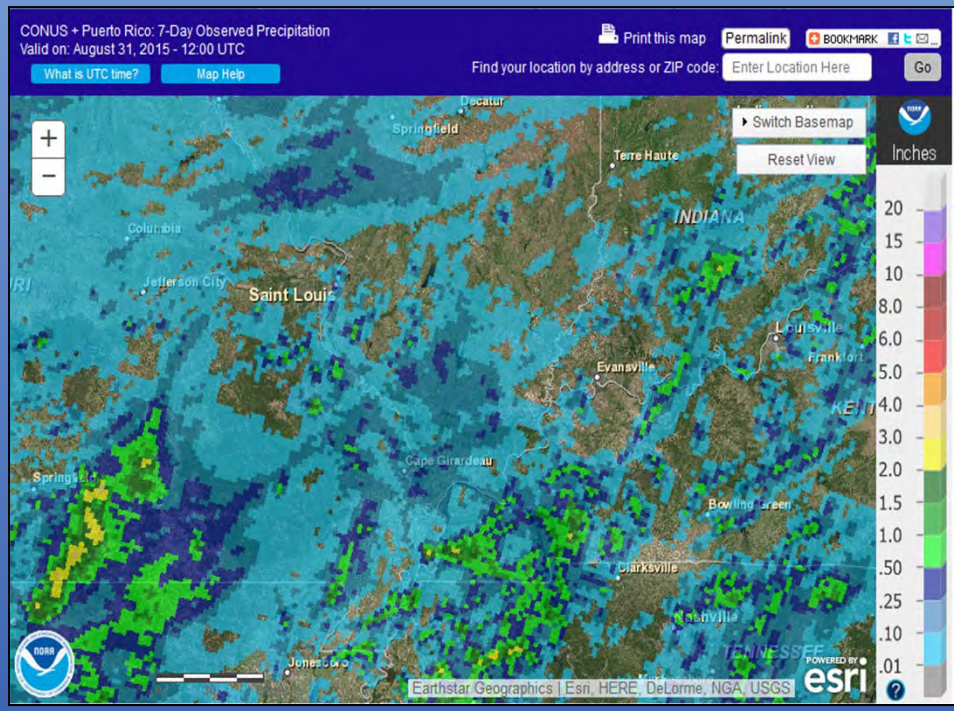




NWS Precipitation Analysis

- http://water.weather.gov/precip/
- Contains shapefiles of a variety of precipitation products covering past day to past year
  - Observed, Normal, & Departure/Percent of Normal





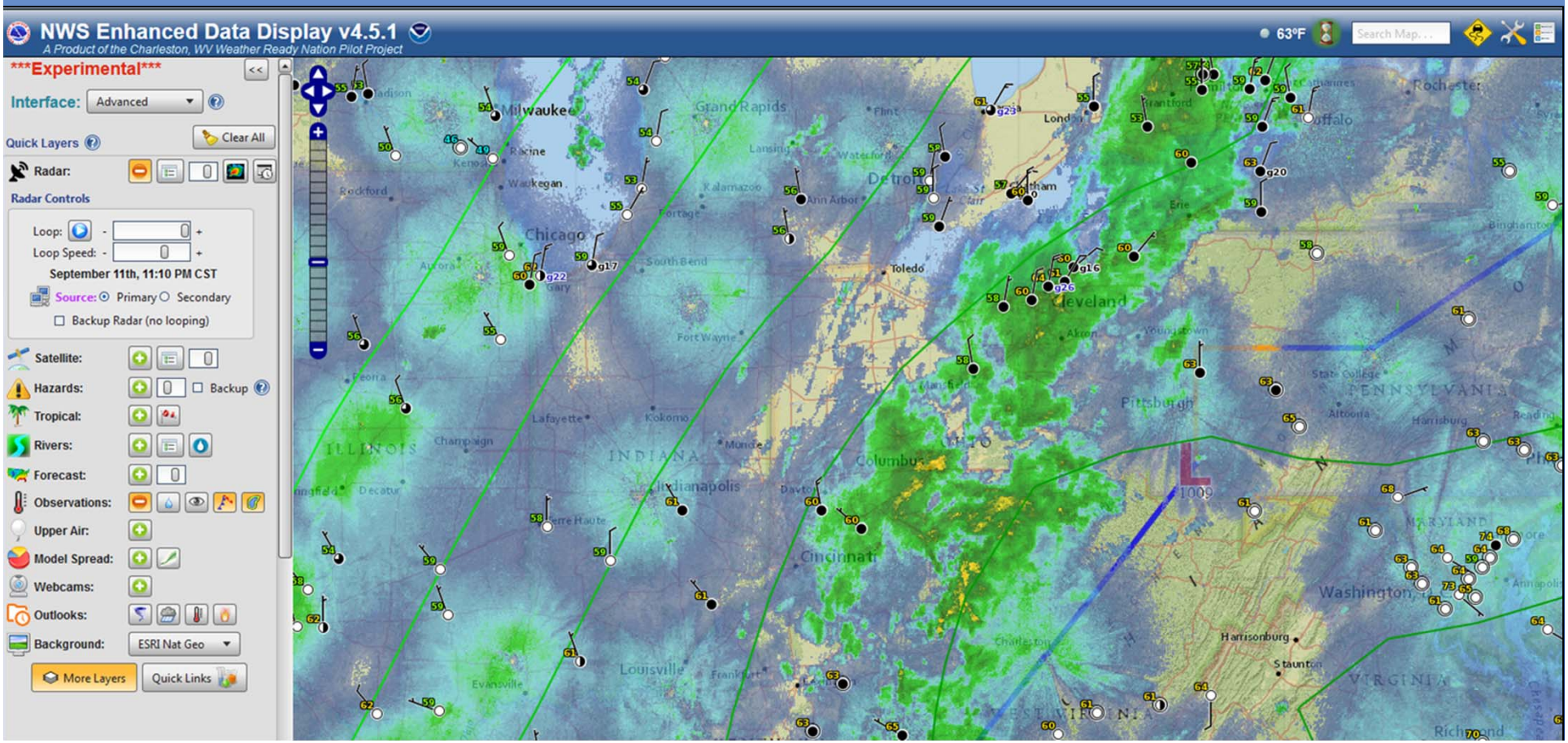
Last Update: 09/01/2015 0340 GMT

(1) Choose Format	(2) Select Time Range	(3) Select Date	(4) Outlook	(5) Select Download	(6) Select Product	(7) Press the "Download" Button
Shapefile Full resolution image NetCDF Archive	Year Month Day	Year 2015 Month September Day 1	QPE	1 Day Last 7 Days Last 14 Days Last 30 Days Last 60 Days	Observed Normal Departure from Normal Percent of Normal	Download

Shapefiles are not archived for dates older than 14 days

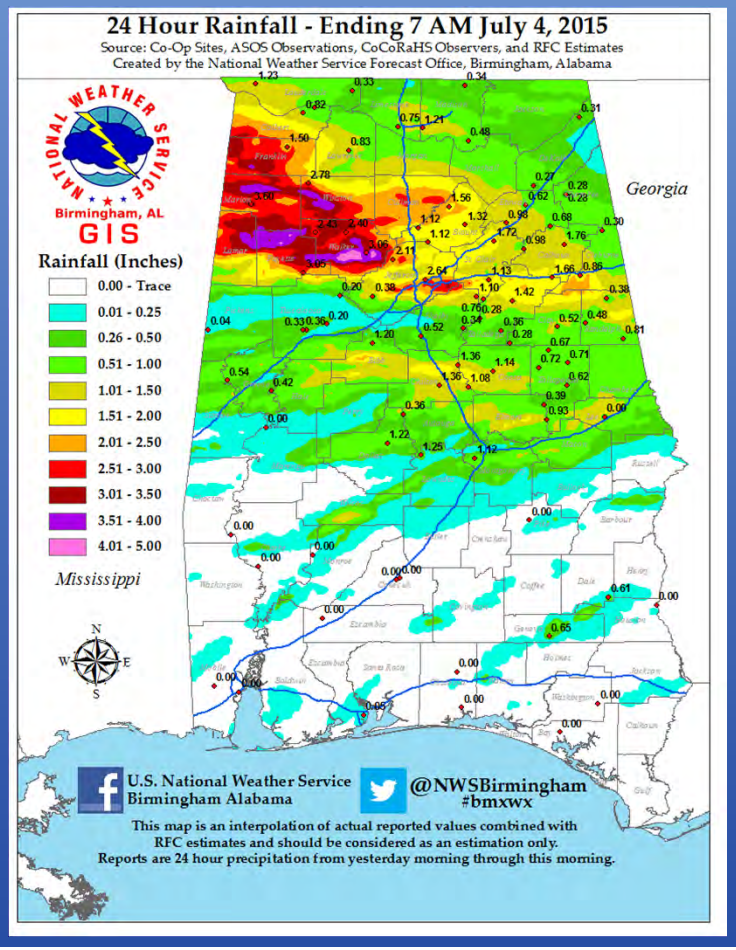
NWS Interactive GIS Websites

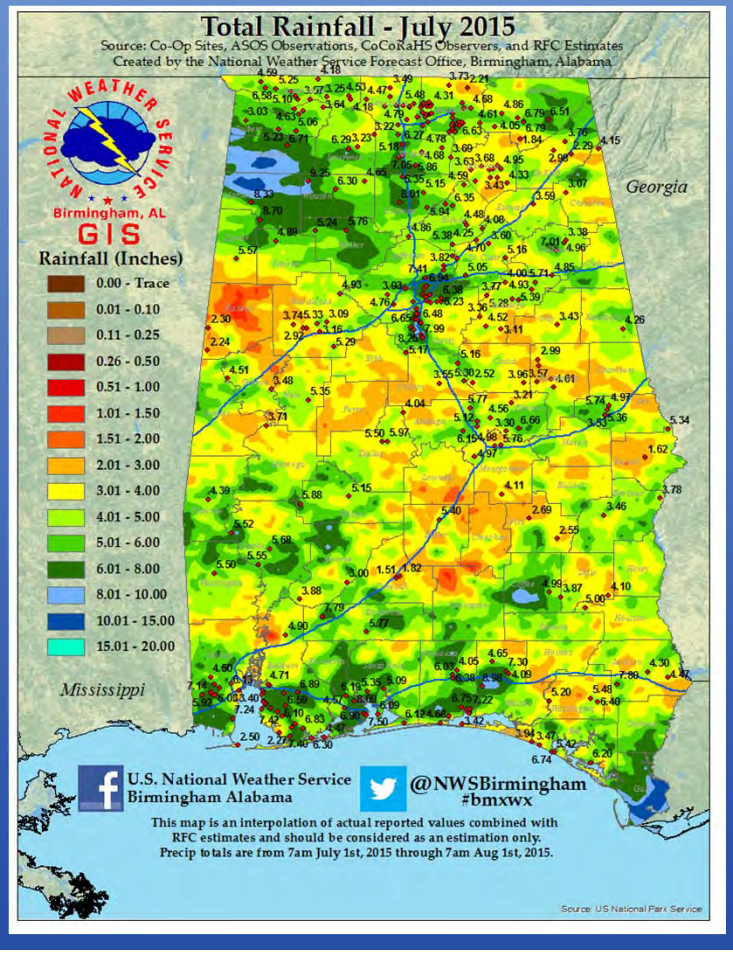
- Enhanced Data Display (http://preview.weather.gov/edd/)
  - Radar
  - Satellite
  - Hazards
  - Rivers
  - Forecasts
  - Observations
  - Upper Air
  - Tropical
  - Outlooks
  - Webcams
- Extremely powerful and flexible GIS application with access to an enormous amount of GIS data. Enormous amount of weather data is the downfall as can be slow loading.



Creation of GIS maps for Local use

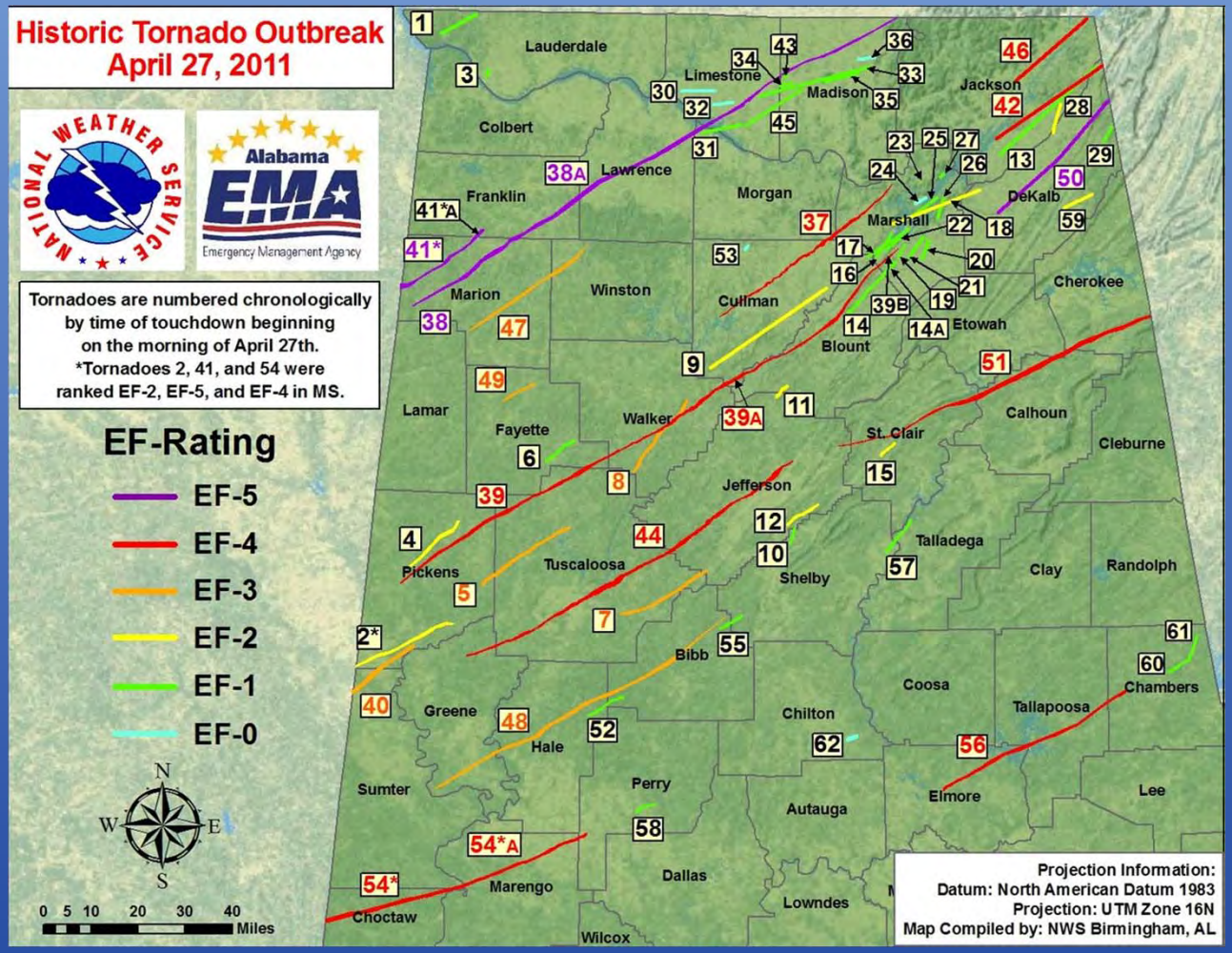
- http://www.srh.noaa.gov/bmx/rainfallPlots/index.php
- Example of Birmingham, AL office with page displaying 24 hr rainfall totals by day all the way back to 2006.
- Fairly challenging to setup the script to generate and archive these maps on a daily basis. This is what we are striving towards at the Paducah office though.





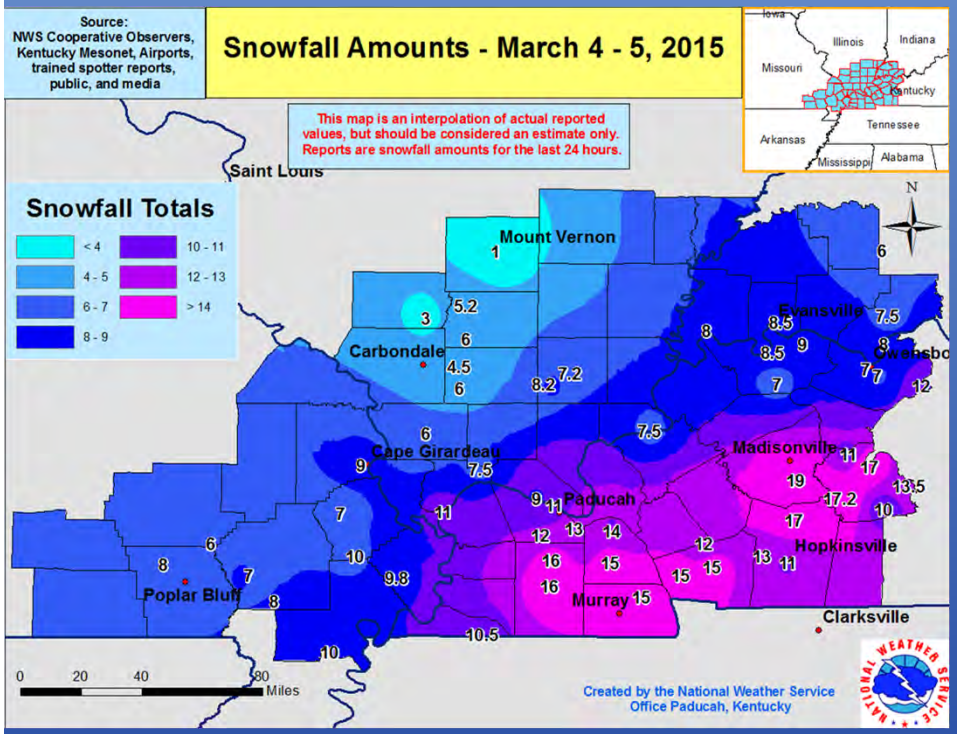
Creation of GIS maps for Local use

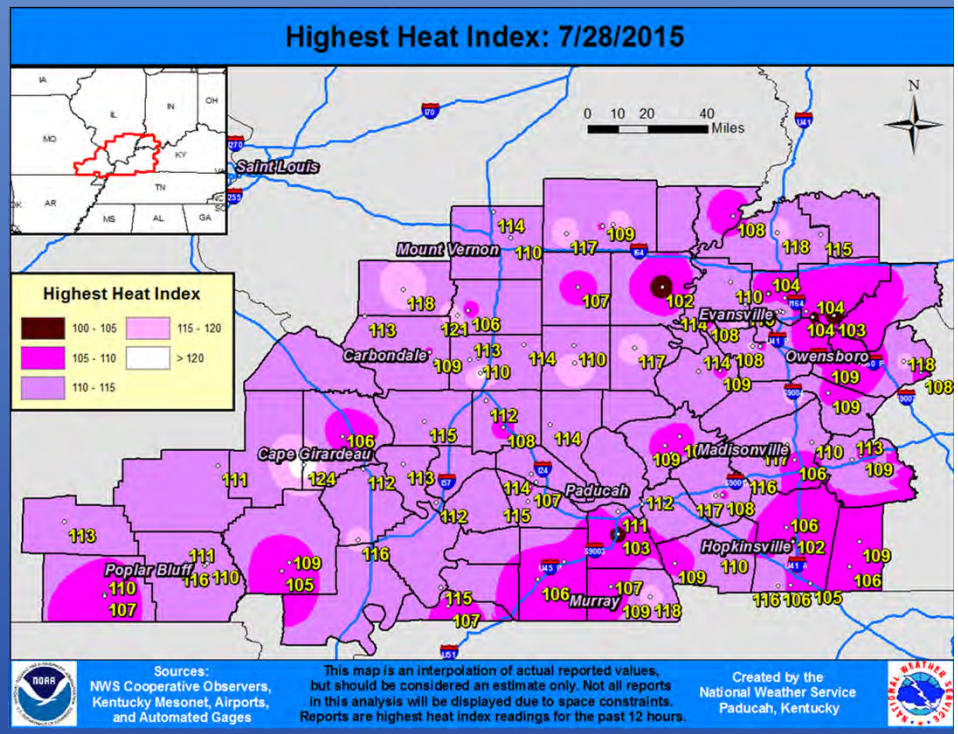
- http://www.srh.noaa.gov/bmx/?n=gis_archive#DAT
- NWS Birmingham GIS Maps for Tornadic Events
- Interactive Maps available along with SHP and KMZ files for download



GIS Maps at NWS Paducah

- We determine amount of use
  - Typically for event summaries and research
  - Created most often for extreme events such as record temperatures or excessive amounts of precipitation/snowfall





Process of creating maps at NWS PAH

- Fairly simple python script generated from ArcGIS ModelBuilder
  - 9 different scripts (High Temperatures, Low Temperatures, Current Temperatures, Heat Index, Current Heat Index, Precipitation, Snowfall, Wind chills, and Peak Winds)
  - Data is imported from a spreadsheet created by a website called IRIS
  - IRIS continuously updates with new data and is also a good source for high winds during severe weather and heavy precipitation events

Current Temps Script.py - P:\GIS maps\GIS Map Creation\Scripts\Current Temps Script.py

File Edit Format Run Options Windows Help

```
# Import arcpy module
import arcpy

# Check out any necessary licenses
arcpy.CheckOutExtension("spatial")
arcpy.env.overwriteOutput = True

# Local variables:
Temp_ = "P:\\GIS maps\\GIS Map Creation\\Model Input\\CurrentTemps.xlsx\\Temp$"
PAH_CWA_shp = "P:\\GIS maps\\GIS Map Creation\\Model Input\\PAH CWA\\PAH_CWA.shp"
Current_Temps = "Current Temps"
CurrentTemps_shp = "P:\\GIS maps\\Basic Maps\\Model Output\\CurrentTemps.shp"
Current_Temperatures = "P:\\GIS maps\\Basic Maps\\Paducah CWA.gdb\\Current_Temperatures"

# Process: Make XY Event Layer
arcpy.MakeXYEventLayer_management(Temp_, "lon", "lat", Current_Temps, "", "")

# Process: Copy Features
arcpy.CopyFeatures_management(Current_Temps, CurrentTemps_shp, "", "0", "0", "0")

# Process: IDW
tempEnvironment0 = arcpy.env.extent
arcpy.env.extent = "P:\\GIS maps\\GIS Map Creation\\Model Input\\PAH CWA\\PAH_CWA.shp"
tempEnvironment1 = arcpy.env.mask
arcpy.env.mask = "P:\\GIS maps\\GIS Map Creation\\Model Input\\PAH CWA\\PAH_CWA.shp"
arcpy.gp.Idw_sa(CurrentTemps_shp, "Temp", Current_Temperatures, "0.003", "2", "VARIABLE 24", "")
arcpy.env.extent = tempEnvironment0
arcpy.env.mask = tempEnvironment1

### End of automated script output
### This stuff added by SP
### set base map name
mapName = ("P:\\GIS maps\\Model Templates\\PAH CurrentTemps Map.mxd")
mxd = arcpy.mapping.MapDocument(mapName)
df = arcpy.mapping.ListDataFrames(mxd)[0]
### export basemap and shp to a png
arcpy.mapping.ExportToPNG(mxd,"P:\\GIS maps\\GIS Map Creation\\Social Media Map Products\\Current
print("Script is done")
```

IRIS | Iris 5.0.8 issues? | Reset Map | Mesonet Monitor | 00:11:24: Observations updated

Refresh Status: Next update: 4 mins.

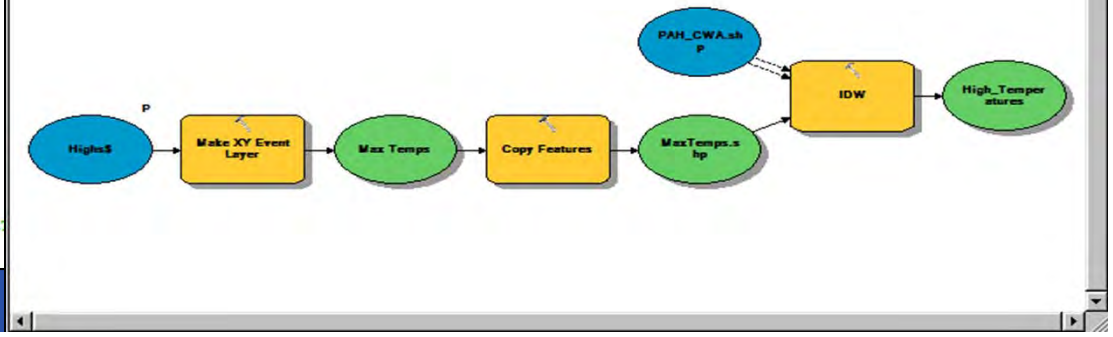
Data Selection: Show bordering obs; Include public networks; Observations; Past Hour; Get Data

Products: Spreadsheet

stationname	county, st	sid	elevati...	provider	reporttime	t	td	rh	hi	vis	dir	speed	gust
DIX	Jefferson, IL	E6608	577	CWOP	09/02 05:04	69	67	93	70		171	0	0
1 WNW SIKESTON	Scott, MO	D1593	326	CWOP	09/02 05:03	76	72	86	77		235	0	0
1 N GRAYVILLE	Edwards, IL	C3656	435	CWOP	09/02 05:02	76	72	87	77		196	0	0
3 SSE BARLOW	Ballard, KY	D9713	442	CWOP	09/02 05:02	71	69	93	72		255	0	0
6 N HICKMAN	Mississippi, ...	E4994	275	CWOP	09/02 05:02	76	74	94	78		134	0	4
SAN MARCOS	Hopkins, KY	D6351	426	CWOP	09/02 05:01	71	68	91	72		292	0	0
2 SE CAIRO	Mississippi, ...	BDPM7	274	USARMY-...	09/02 05:00								
1 WNW METROPOLIS	Massac, IL	C9283	383	CWOP	09/02 05:00	70	66	86	71		0	0	0
MISSISSIPPI RVR	Alexander, IL	COMM7	0	GOES	09/02 05:00								
MISSISSIPPI RIVER	Cape Girarde...	CPGM7	0	COOP	09/02 05:00								
4 SE ALLEGRE	Todd, KY	D3900	748	CWOP	09/02 05:00	69	68	97	70		40	0	0
1 ESE CALVERT CITY	Marshall, KY	D6002	363	CWOP	09/02 05:00	72	71	97	73		0	0	0
1 WSW EVANSVILLE	Vanderburg...	EVVI3	330	USARMY-...	09/02 05:00								
CLARKS RIVER AT M...	Calloway, KY	MURK2	0	GOES	09/02 05:00								
OLMSTED LOCK AN...	Ballard, KY	OLMI2	380	UCOOP	09/02 05:00								

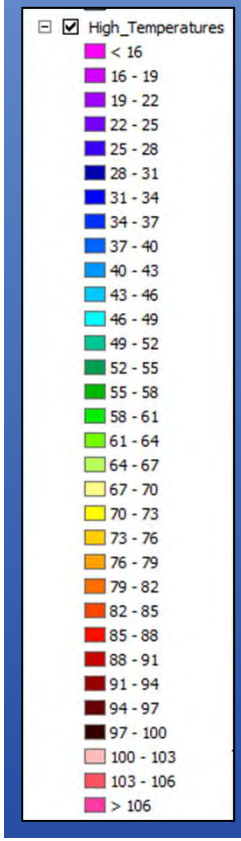
High Temps Model

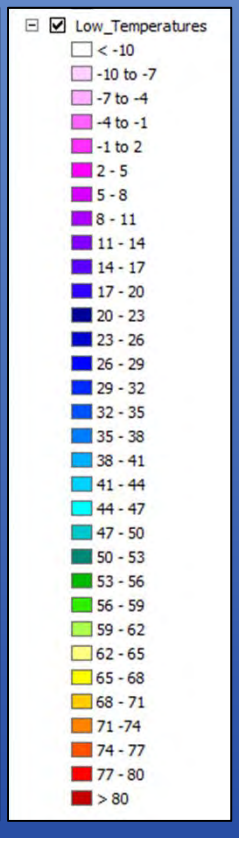
Model Edit Insert View Windows Help

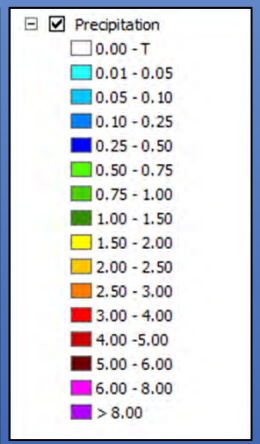


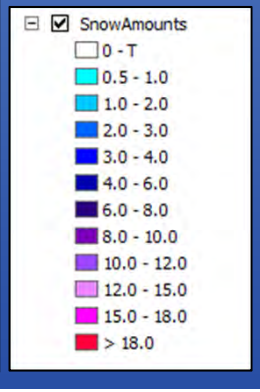
Process of creating maps at NWS PAH

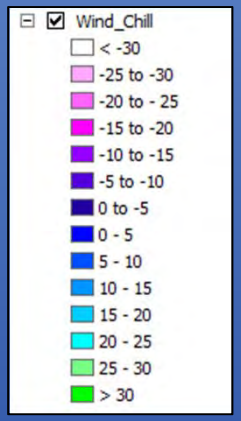
- IDW Spatial Analyst Tool used to interpolate the values into a raster surface
  - Works best when sampling is sufficiently dense
  - If sampling is sparse or uneven, the results may not represent the actual observations well
- Color tables are custom made to best suit the data variable
  - 3 degree increments used for temperatures
  - 5 degree increments for wind chill/heat index
  - Variable increments for rainfall and snowfall



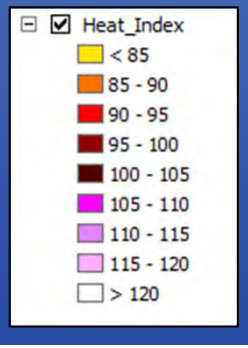


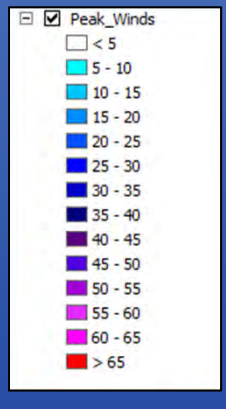




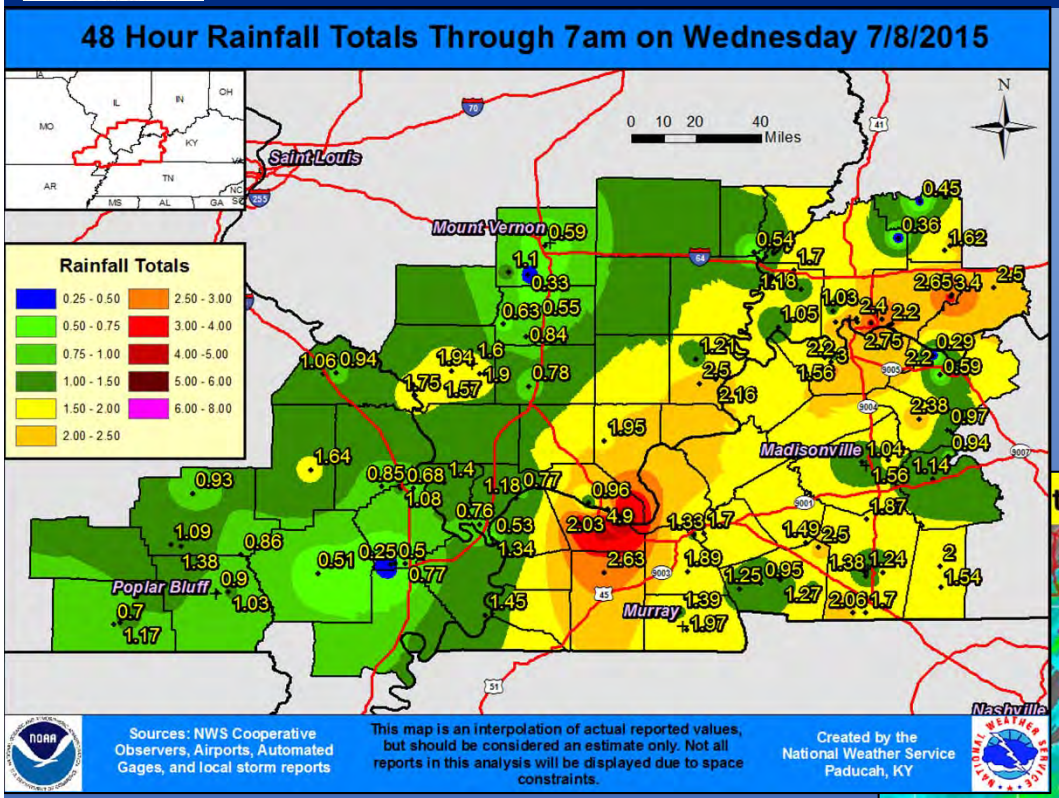


- Background layers created for general public to better depict where they live
  - Interstates
  - Cities with higher populations
  - County line boundaries
  - Each number is displayed with a corresponding dot to show exact location of report

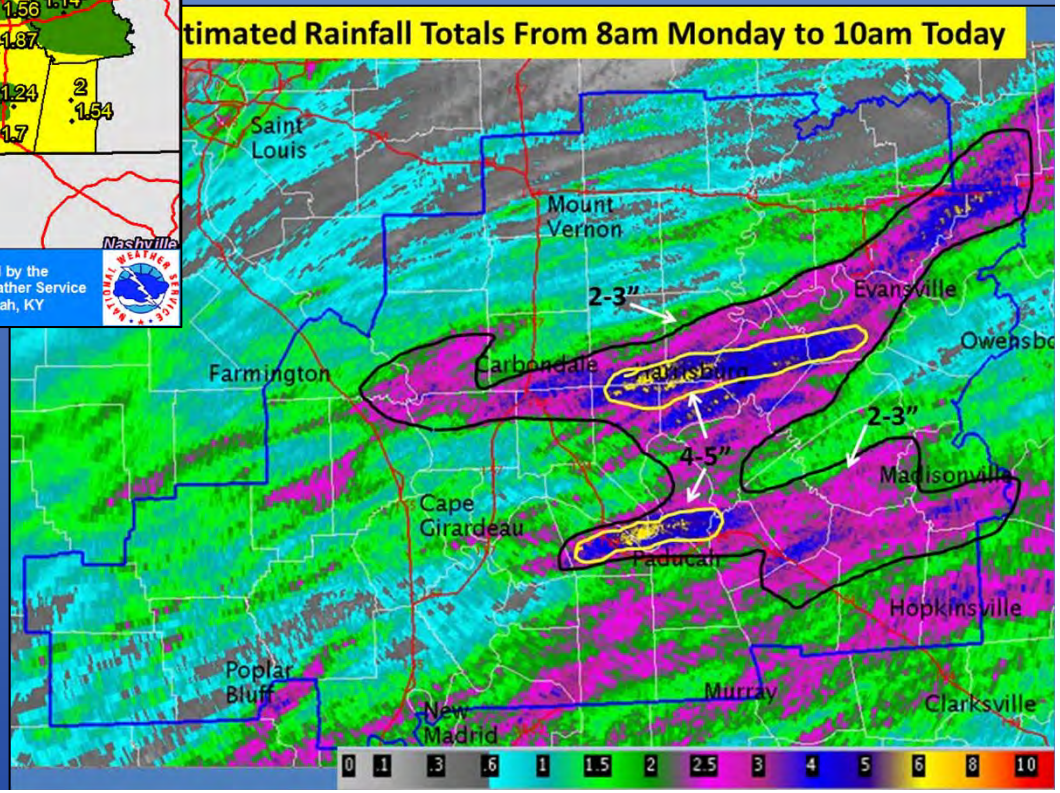




GIS Maps at NWS Paducah

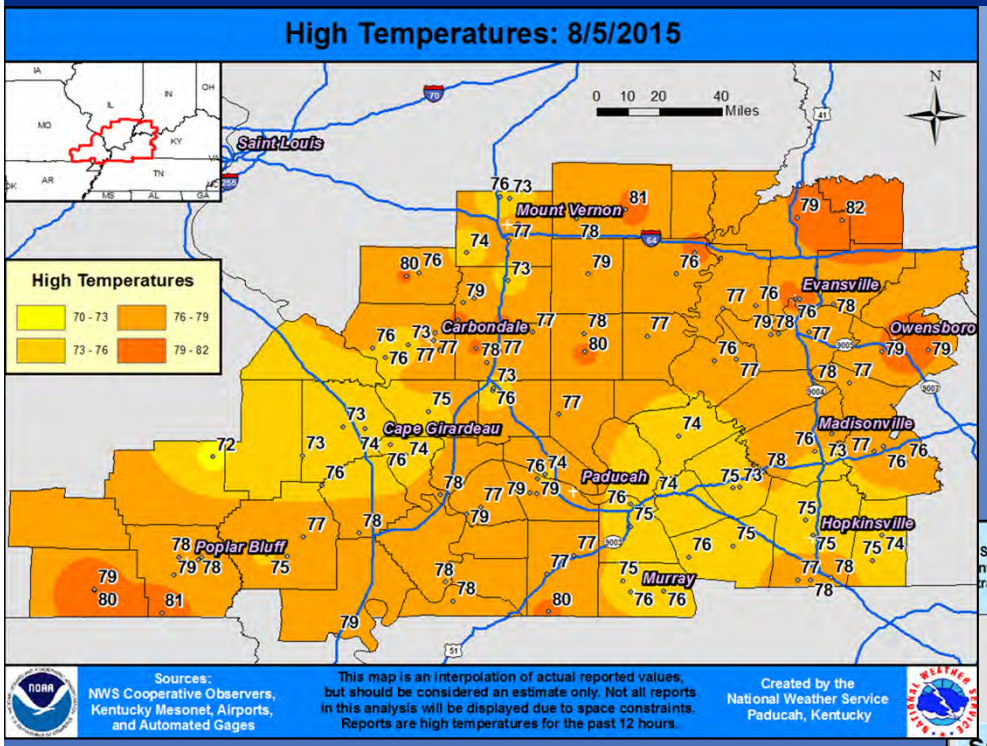


- Example of fairly poor depiction of observed rainfall due to poor sampling
  - Convective rain event with amounts varying greatly over small distances
  - Would work better if we had rain gauge reporting stations set up perfectly in like a 5x5 mile grid or less

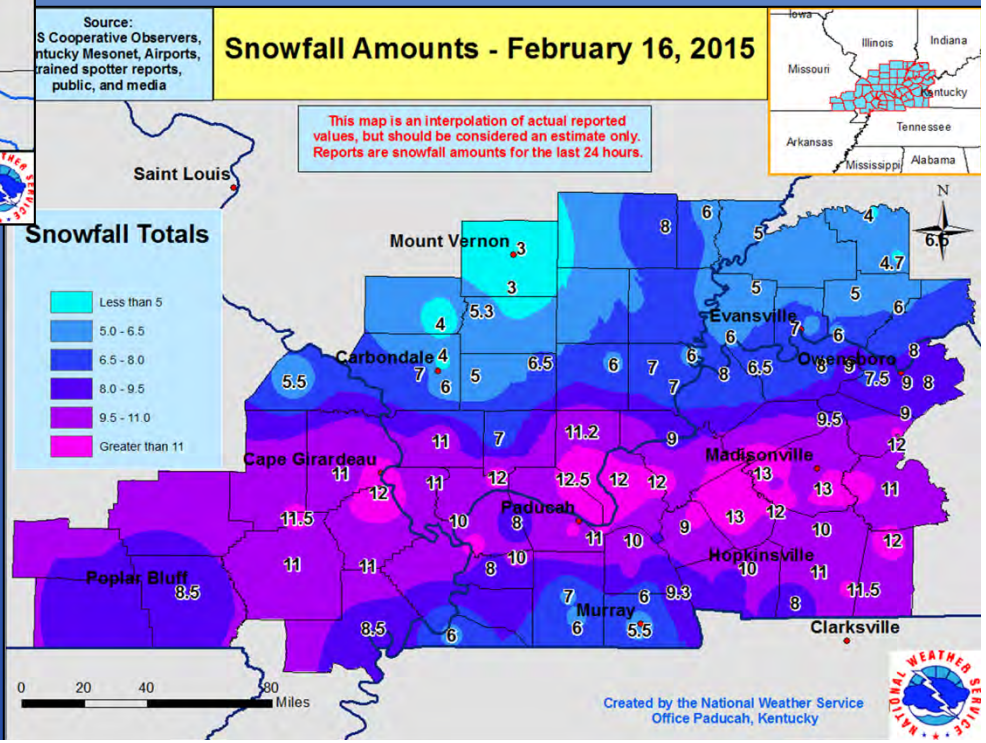


- Observations only done every 24 hrs at 7am in morning at certain sites
  - Creates issue with generating rainfall maps based on 24 hr timeframe since our official sites at Airports are based on Midnight to Midnight period

GIS Maps at NWS Paducah



- Example of good depiction of observed values
  - Temperature maps usually displayed nicely as long as quality controlling of data is done to take out a few erroneous observations
  - Precipitation events with widespread stratiform rainfall depicted well since amounts are more uniform and don't vary greatly over small distances



- Snowfall maps usually turn out fairly well
  - Reason is because we can combine the normal reporting stations like coop observers and airports with public and media local storm reports to get better data coverage
  - Snowfall maps are rather useful and informative to our customers and partners since snow usually causes some impact

GIS Maps at NWS Paducah

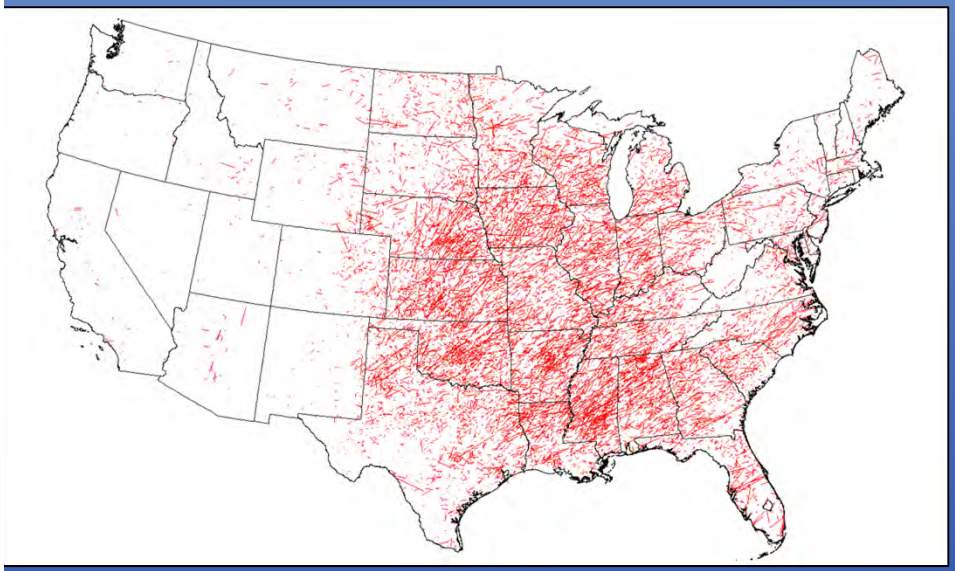
- When are these maps most beneficial?
  - During extreme events such as record heat or cold
  - Excessive rainfall events with amounts of 2 to 5+ inches
  - Large scale wind events from powerful low pressure systems (30 to 40+ mph)
  - Any snow event since it is less common especially south of the Ohio River. These typically are high impact events regardless of the magnitude

- Other reasons for generating these maps
  - Our customers have consistently shown us that they enjoy pretty graphics when we post content to our Facebook and Twitter pages. Creative posts with graphics to look at get more views, shares, tweets, likes, etc. (Simply put, an image catches a person's eye more than just plain text)
  - Even on nice normal weather days posting a depiction of the lovely current temperatures can catch the public's attention.
  - Research done on past events

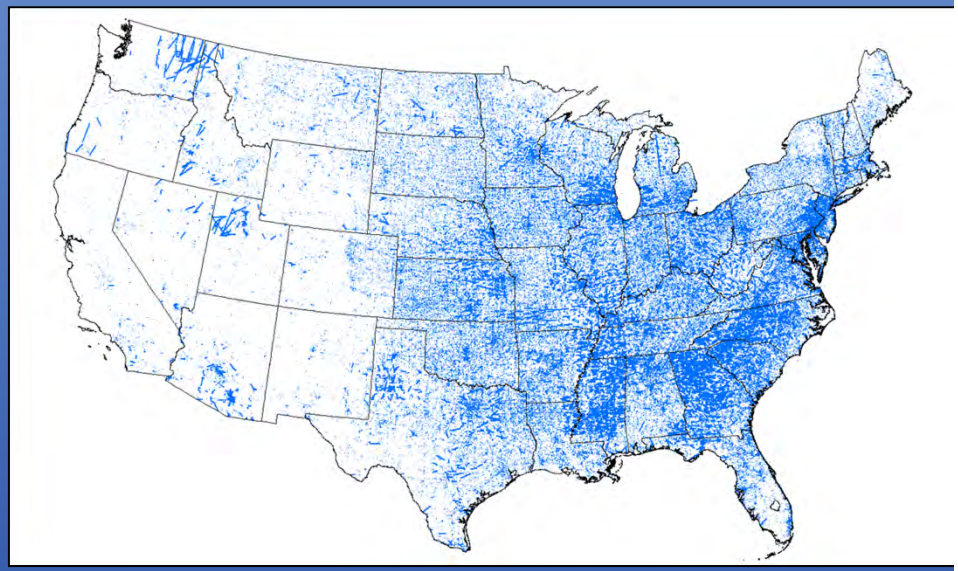
NWS Storm Reports Data

- http://www.spc.noaa.gov/gis/svrgis/
- Database of local severe storm reports converted into shapefile format
  - Storm reports from 1950 to 2014 included
  - Include tornado, wind, and hail reports
  - Additional shapefiles available to better view the data such as states, cities, counties, and NWS county warning areas

Tornado Tracks (1950 – 2014)

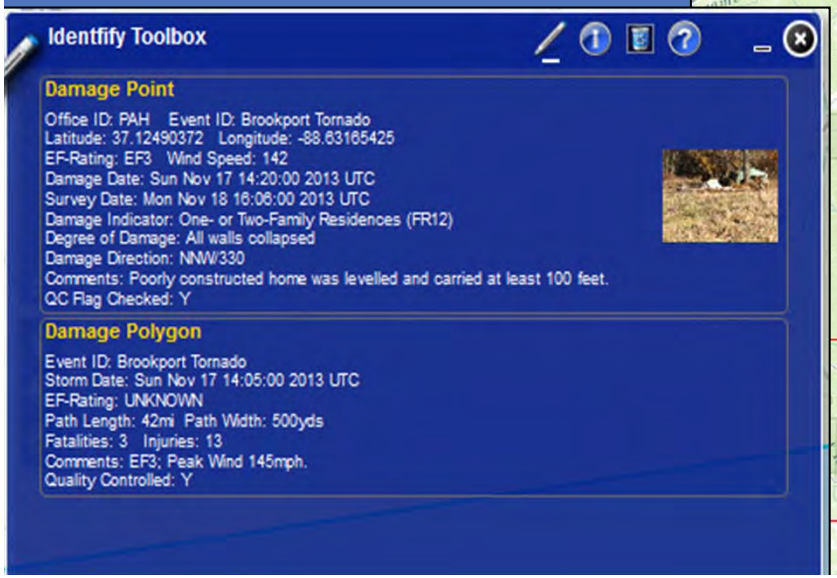


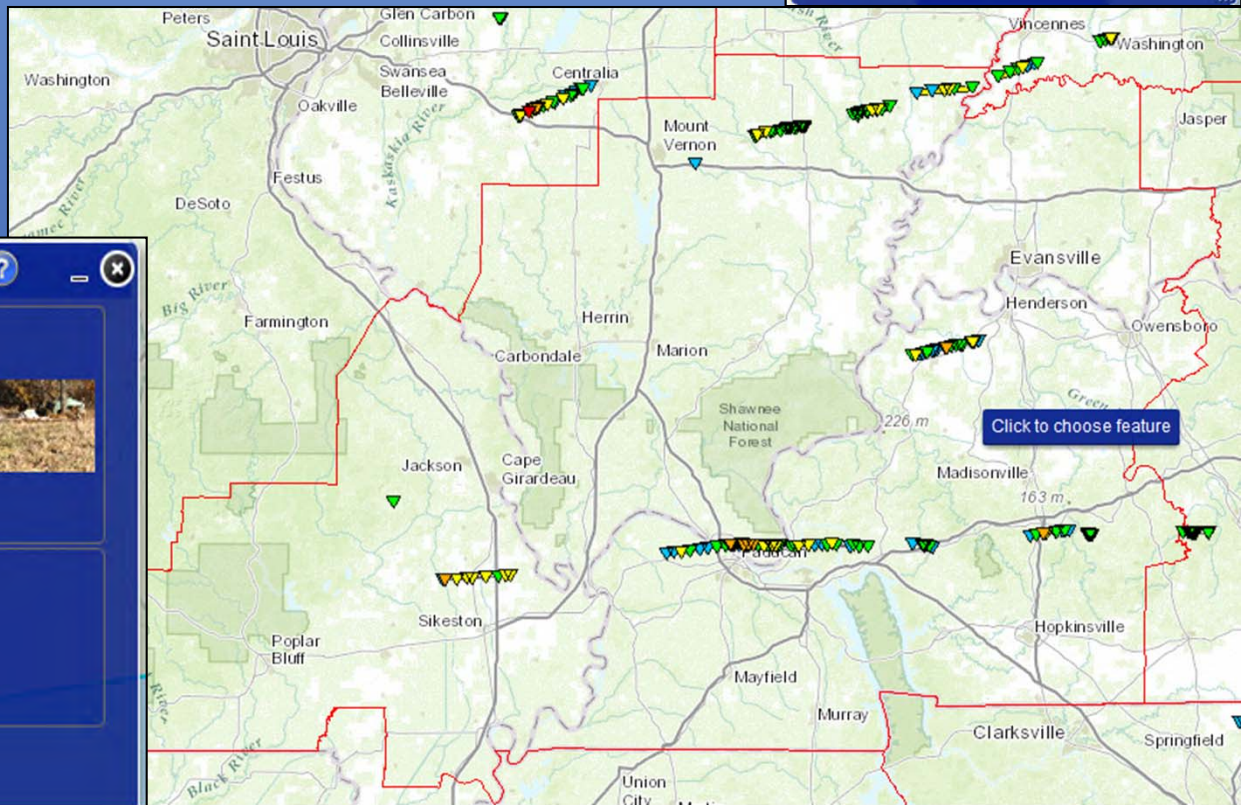
Wind Reports (1955 – 2014)



GIS and Storm Damage Surveys

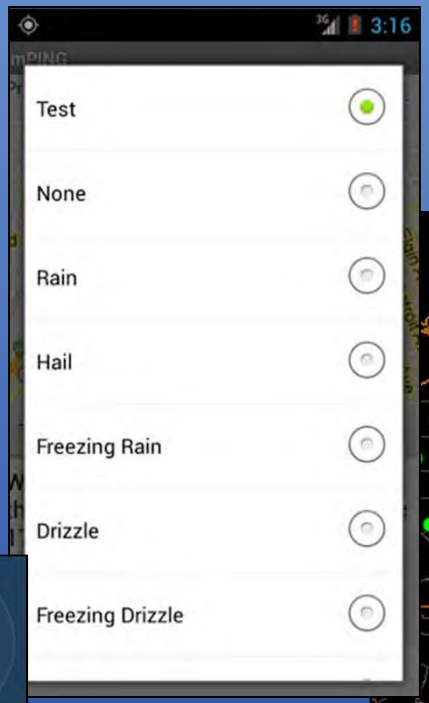
- https://apps.dat.noaa.gov/StormDamage/DamageViewer/
- DAT Software (Damage Assessment Toolkit)
  - iPads used to plot GPS coordinates and take pictures at each damage point
  - Transmits the data back to the local NWS office for editing
  - Damage swaths of tornadoes and severe thunderstorm winds
  - Color coordinated for magnitude of damage
  - Public can view final results and previous damage events

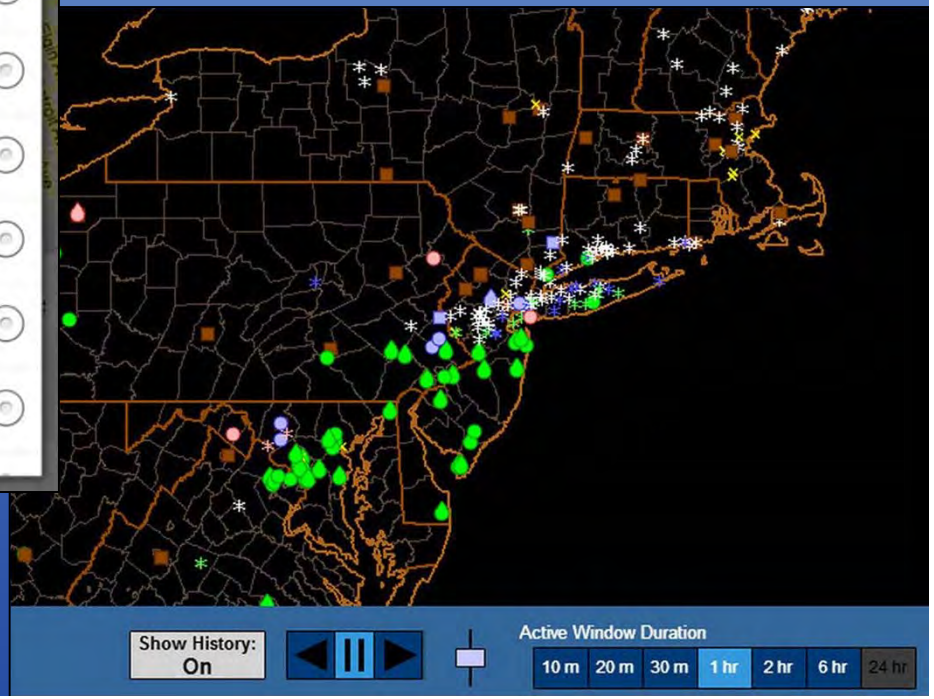




mPING Mobile App

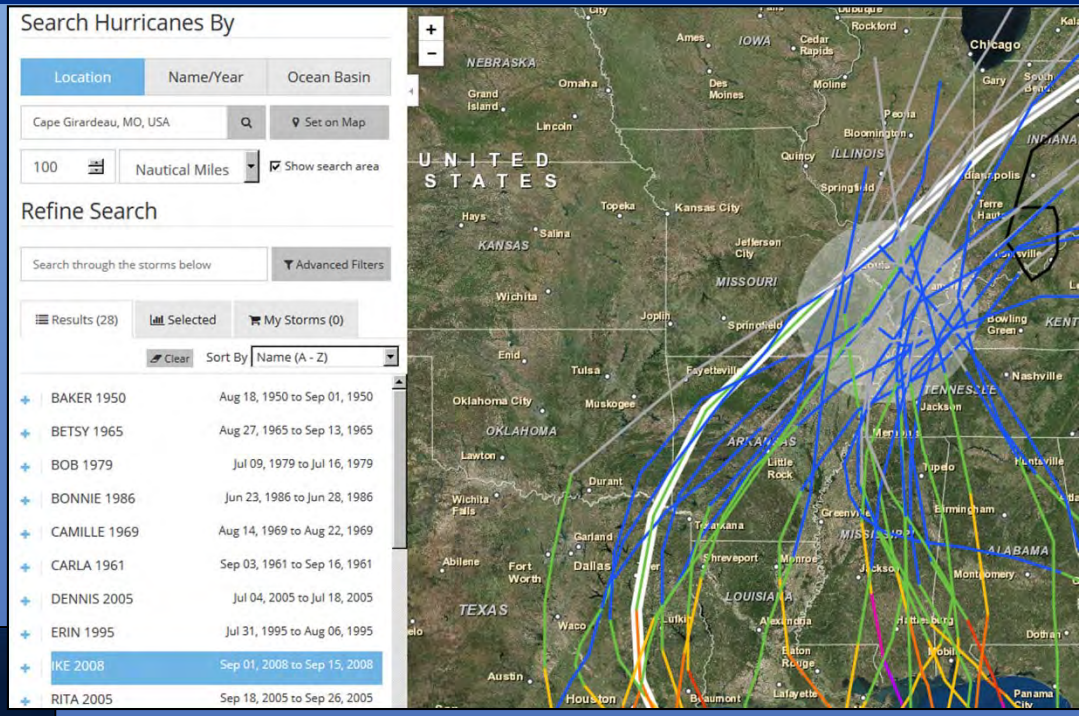
- http://www.nssl.noaa.gov/projects/ping/
- Meteorological Phenomena Identification Near the Ground
  - Developed by the NOAA National Severe Storms Laboratory (NSSL) to collect public weather reports through a free app available for smart phones and mobile devices
  - Anonymous reports submitted to display numerous types of weather based on GPS
- Types of weather you can report include:
  - Rain, Snow, Ice, Hail
  - Wind Damage and Severity
  - Flooding and Severity
  - Dense Fog
  - Tornadoes
  - Waterspouts
  - Mudslides
  - None (most useful shortly before precipitation begins and after it ends)





National Hurricane Center (NHC)

- http://coast.noaa.gov/hurricanes/
- Historical Hurricane/Tropical Storm tracks
  - Search by Location, Name/Year, or Ocean Basin
  - Can search for all tropical activity within a certain distance of a city
  - Cape Girardeau has seen the remnants of 28 tropical systems/hurricanes since the 1870s go within 100 miles of town.

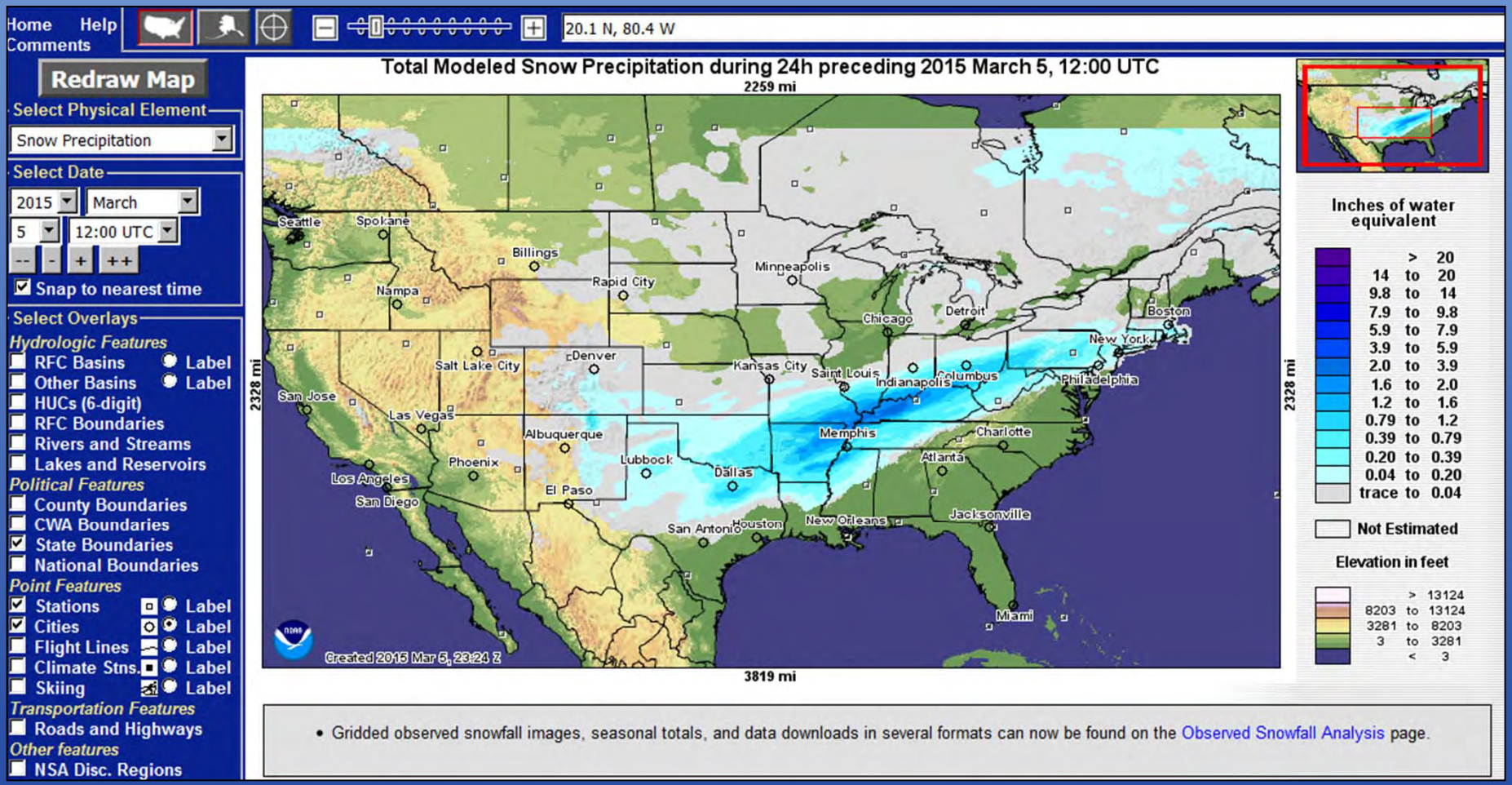


Hurricane Ike: September 1-15, 2008

- Interactive map that allows all or select hurricane tracks to be overlaid on a satellite or physical map
- Includes storm attributes for every 6 hours such as:
  - Wind magnitude
  - Location
  - Pressure
  - Intensity

NOHRSC (NOAA's Snow Information)

- National Operational Hydrologic Remote Sensing Center
  - http://www.nohrsc.noaa.gov/
  - Interactive maps with comprehensive snow information
  - Data includes Snow Depth, Snowfall, Snow Melt, Snow water equivalent, and much more!

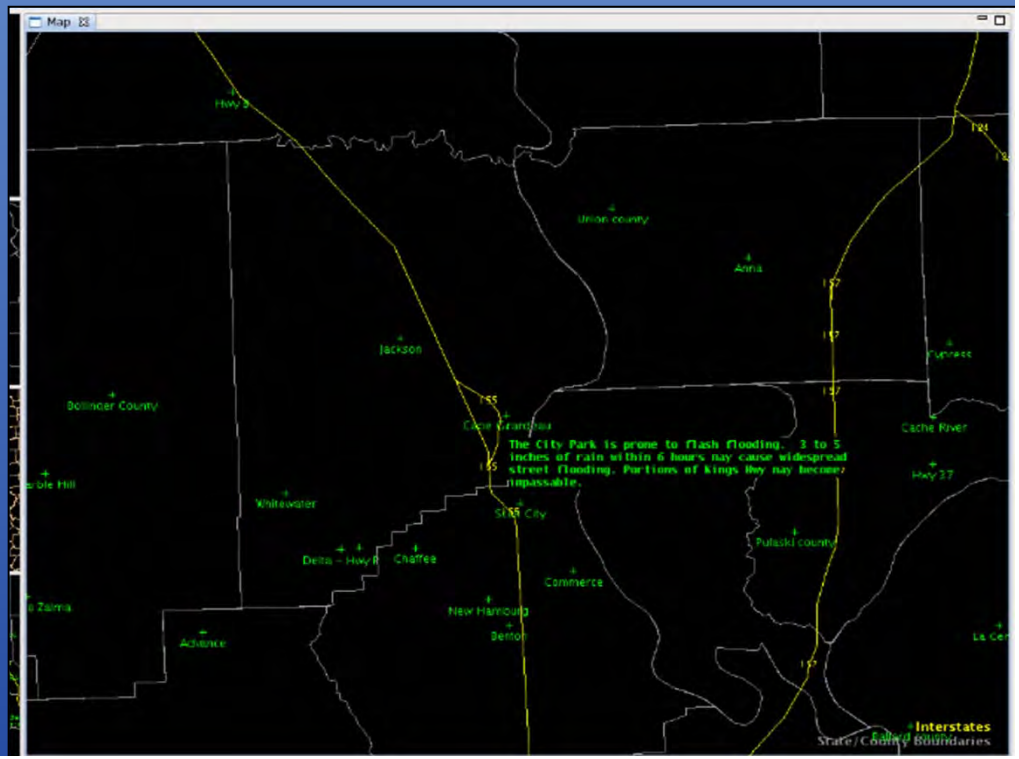


Future GIS Projects

- Flash Flooding Hot Spots:
  - Accessed data via calling Emergency Managers from every county to determine most prone areas for flooding
  - Input information into Google Earth as KMZ file
  - Converted to shapefile and working on getting formatting finalized for transfer into our AWIPS system
  - This will allow real-time monitoring of these vulnerable spots with radar overlayed. This will help in determining when to issue Flood warnings/advisories.
  - Descriptions can be added into warnings:

  Example: 2.5 inches of rain within 4 hours will produce major street flooding in Herrin

- Decision Support Services (DSS):
  - Our office is in process of calling Emergency Managers for each county
  - Goal is to obtain information on major outdoor events like Fairs, Concerts, Parades, Festivals, etc.
  - We will then input this information into a spreadsheet and convert into a shapefile to be used along with radar data to warn the event coordinator of impending bad weather



Questions/Comments?

Thank You!

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