Mapping Tornado Damage Tracks with NASA Satellite Data

Gary Jedlovec (NASA) and Brian Carcione (NWS)

with contributions from

Frank LaFontaine, Matt Smith, and Andrew Molthan

http://weather.msfc.nasa.gov/sport/tornadoes/20110427/

Outline

Introduction / background

Summary of wave of tornado /events producing the 61 tornadoes in Alabama on April 27, 2011

- survey information and statistics
- pictures

MODIS imagery

- natural color RGBs
- before / after and difference image

ASTER analysis of tornado damage regions

- single and multichannel imagery -Hackleburg, Harvest, Tuscaloosa
- before / after for Hackleburg

Integration of ASTER and radar data

Introduction / Background

NWS WFOs have been using MODIS natural color composite imagery to monitor surface features (land use, vegetation changes, etc.) for some time – both from data in AWIPS and from web sources

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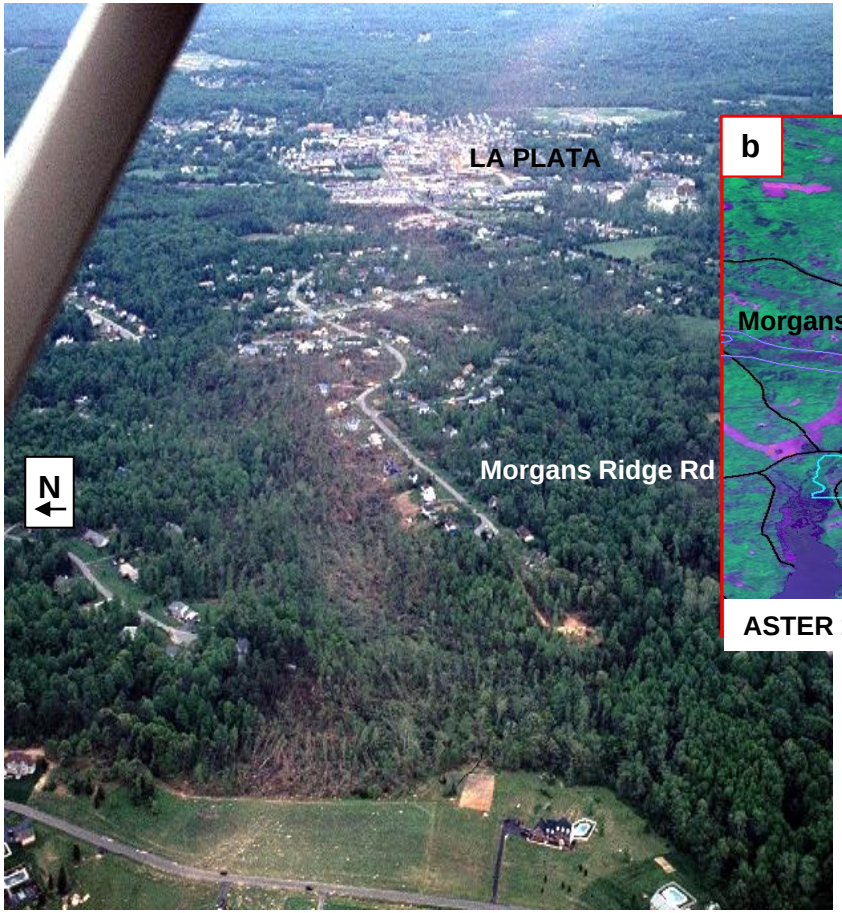
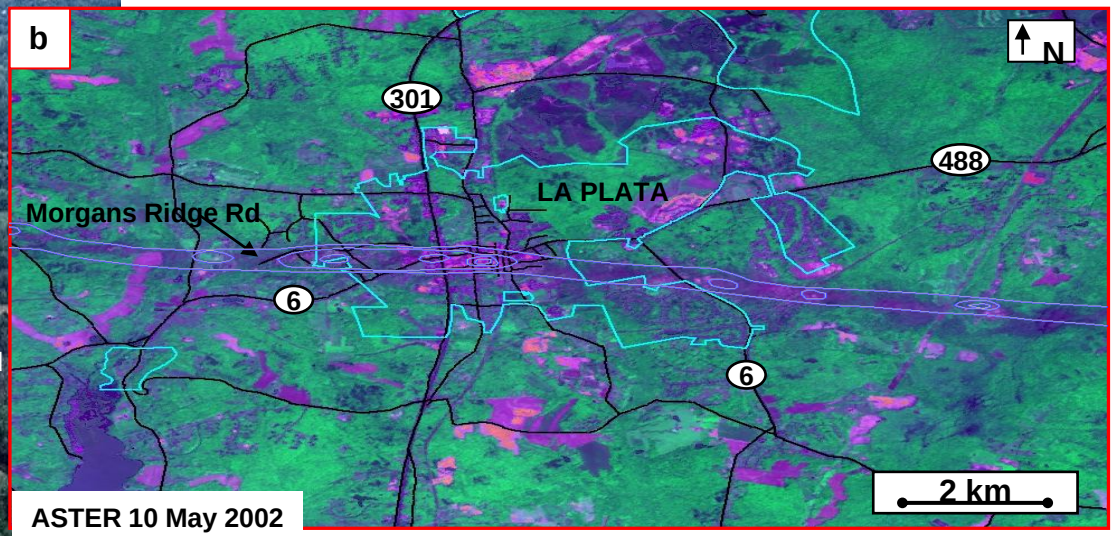
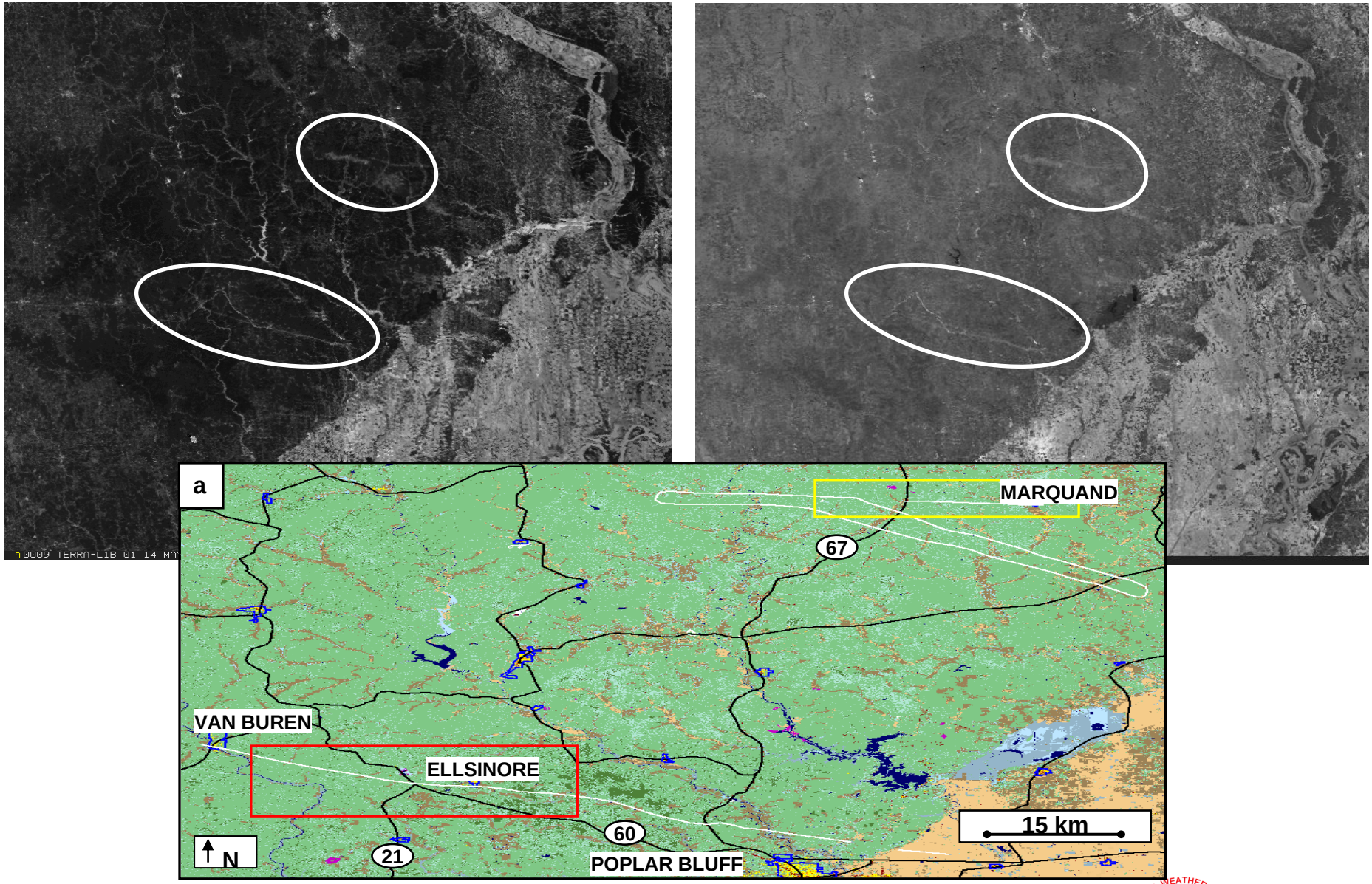
- NASA and private sector imagery
- tornado tracks and hail damage

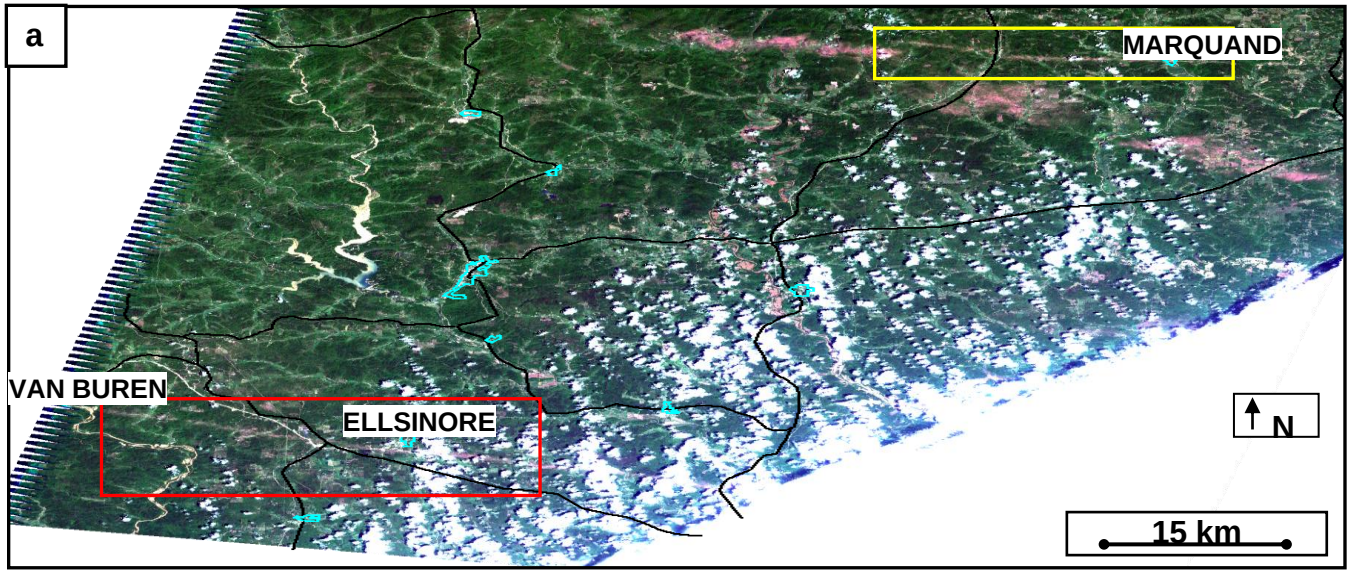


Aerial photograph taken on 30 April 2002 of the tornado damage path looking east towards La Plata. (Courtesy of Tim Marshall)



ASTER three-channel false color composite image of southwest Maryland, showing the tornado damage tracks centered over La Plata.


a
MARQUAND
67
VAN BUREN
ELLSINORE
60
21
POPLAR BLUFF
N
15 km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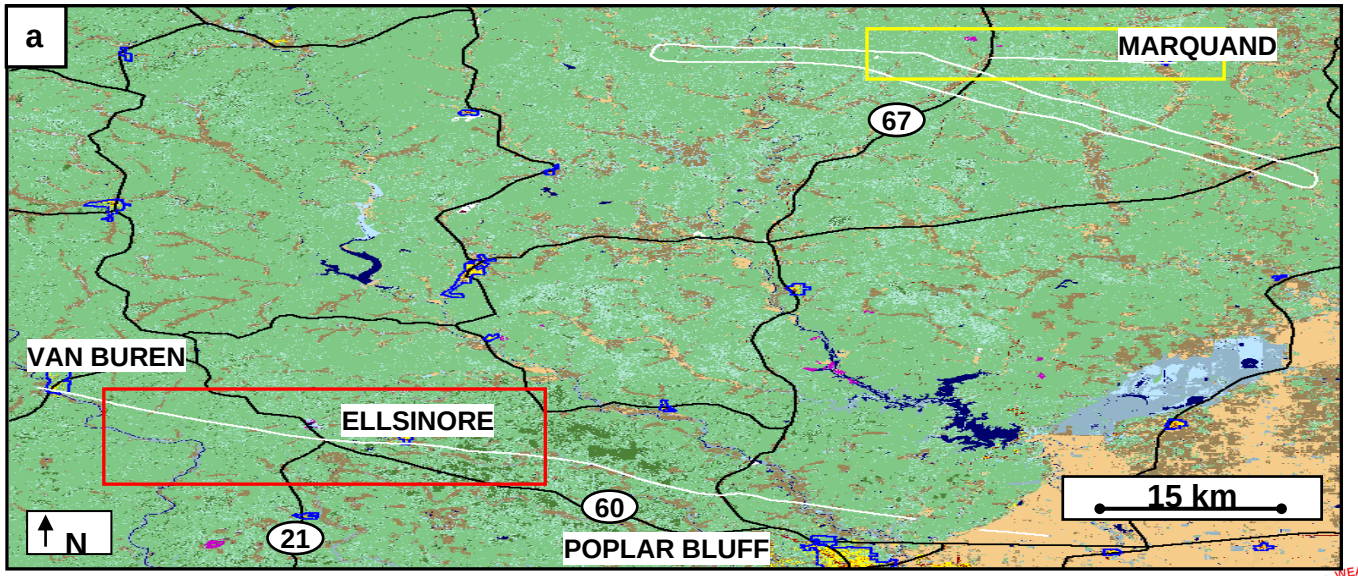
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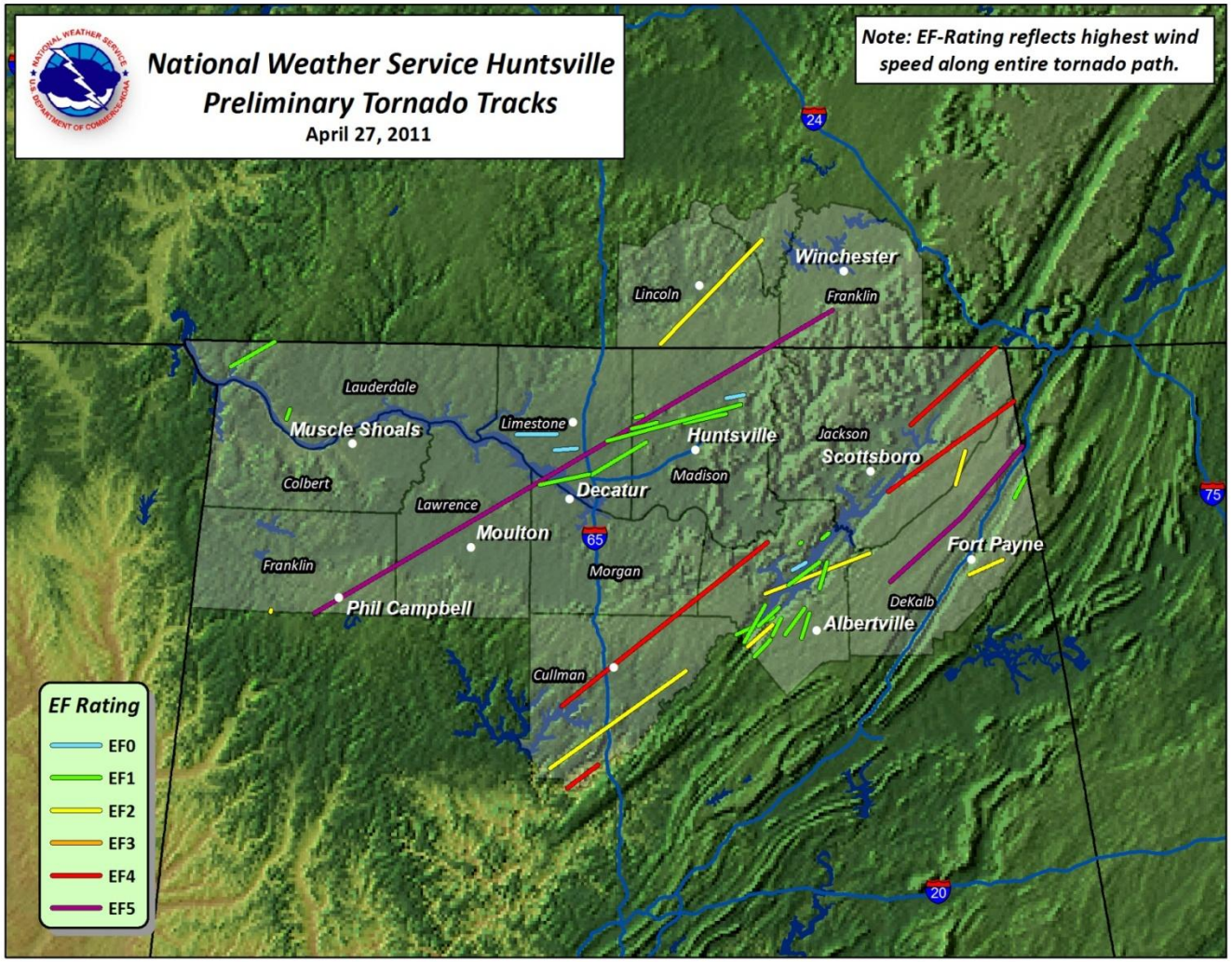
NWS and NASA utilized these capabilities after the April 27, 2011 SEUS Tornado Outbreak to assist in tornado damage track assessment

Tornado Summary of April 27, 2011



In Huntsville CWA:

38 tornado paths
- **2** EF-5s
- **4** EF-4s
- **7** EF-2s
- **21** EF-1s
- **4** EF-0s

19 tornadoes 4-8 AM

7 tornadoes 11 AM-12PM

12 tornadoes after 2 PM

101 fatalities

484.2 total path miles

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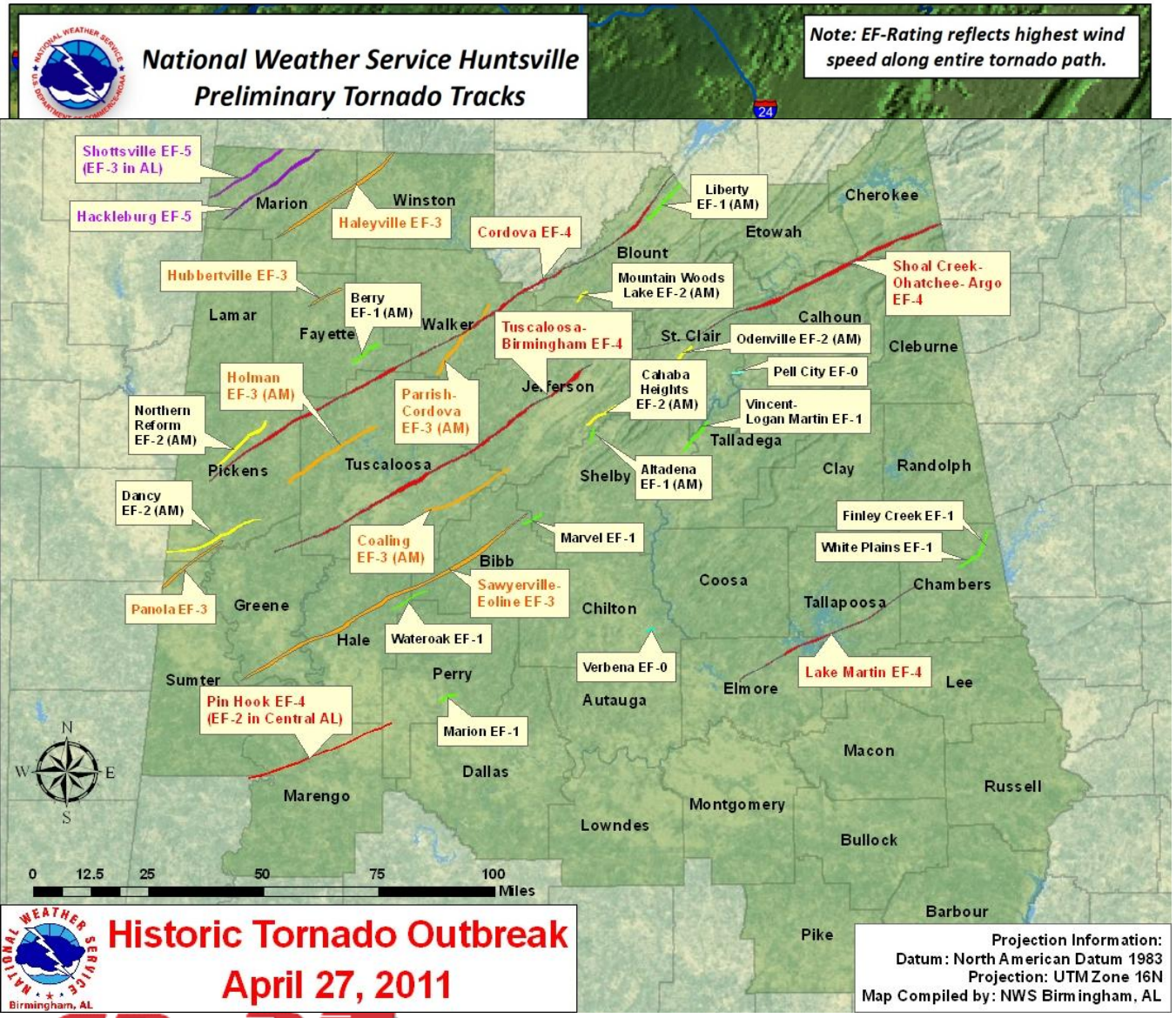


In Alabama:

62 tornadoes

238 fatalities

1,201.8 total path miles

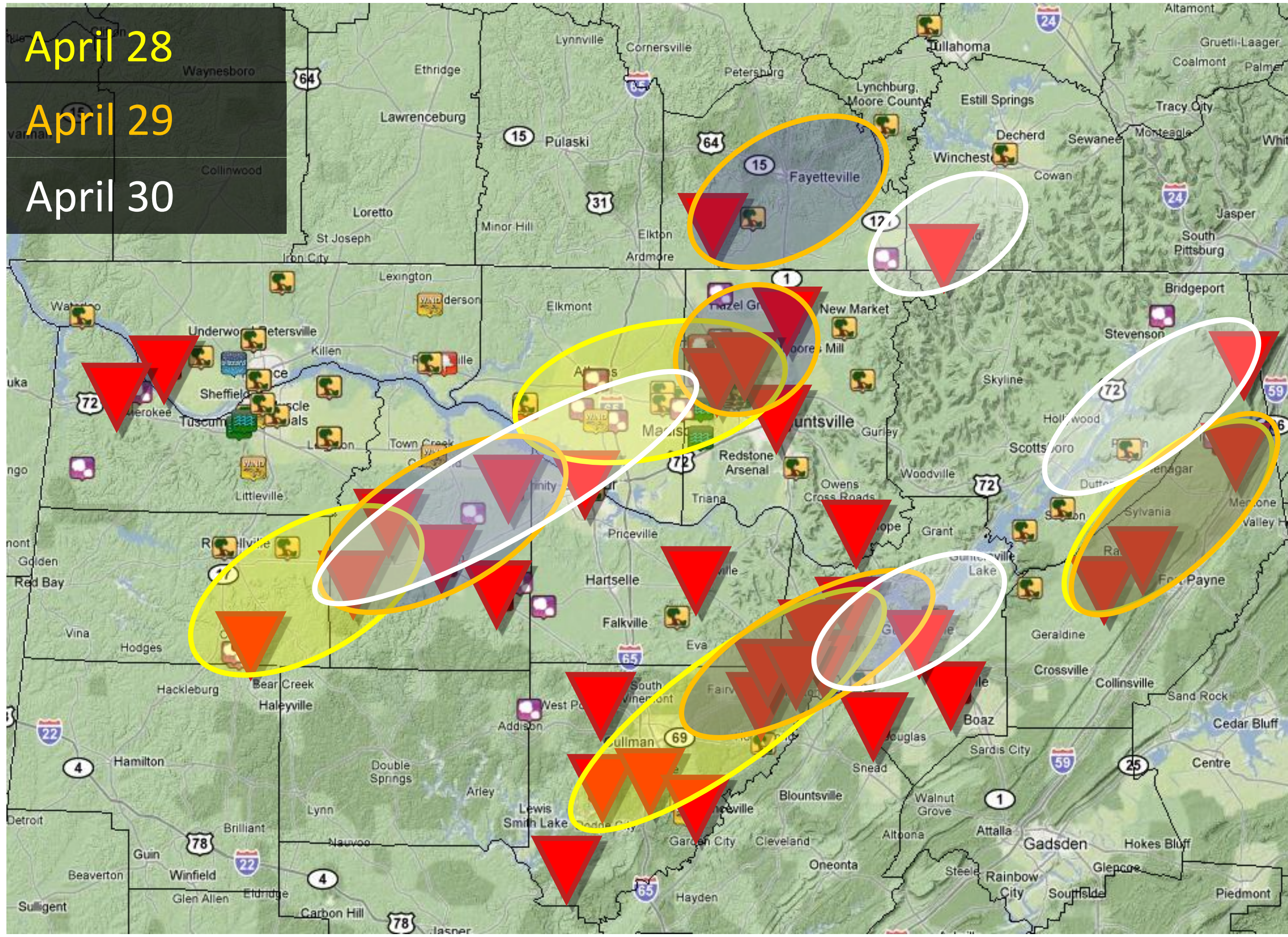
2 tornadoes with 120+ mile path length

Pre-Survey Planning

Teams are dispatched based on an incomplete picture of storm reports, calls to county officials, etc.

Case of “Triage”

3-5 teams each day for several days after the 4/27 event (typically no more than 2)



On the Ground

Phil Campbell, Mt. Hope, Tanner

On the Ground

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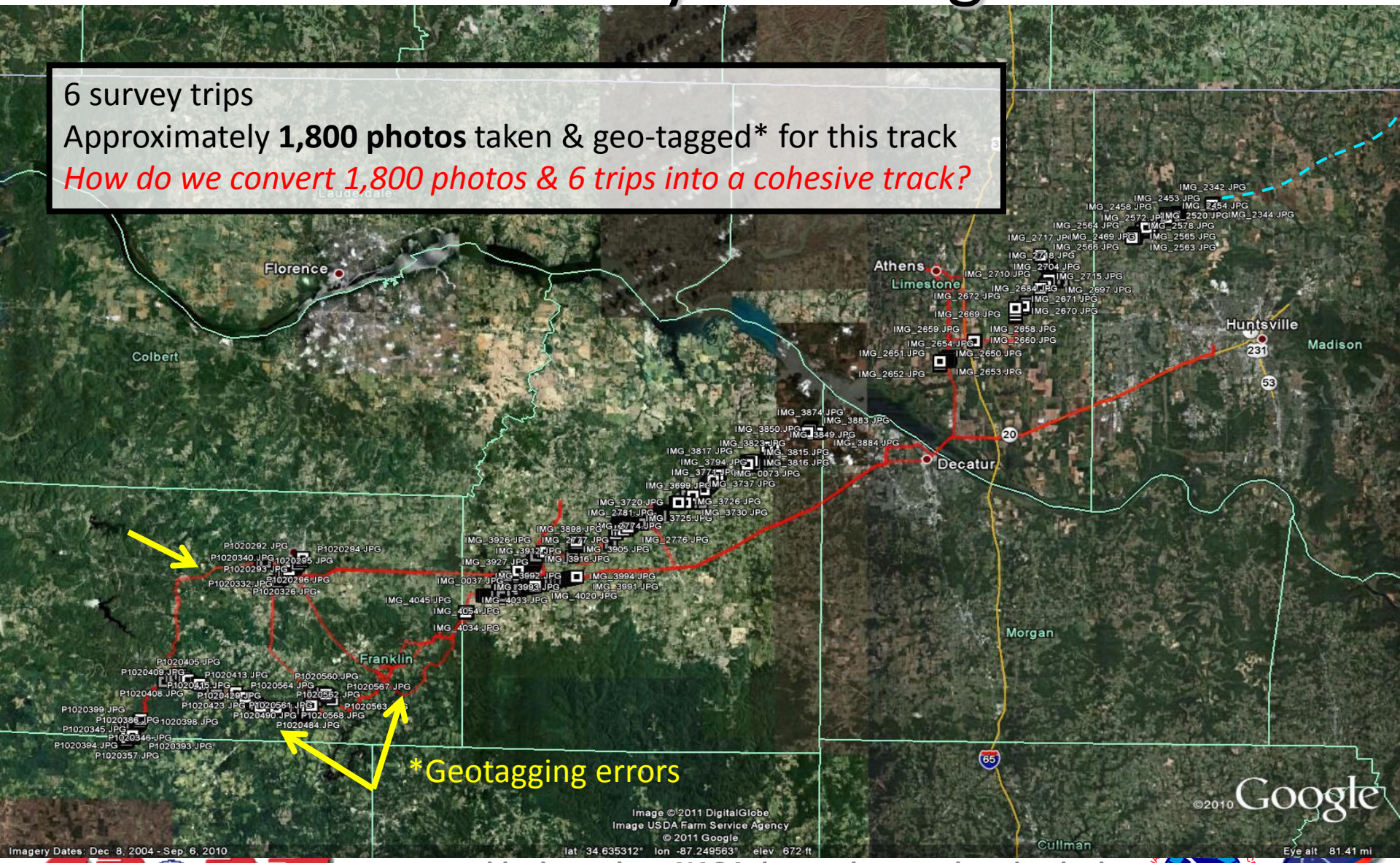
Post Survey Challenges



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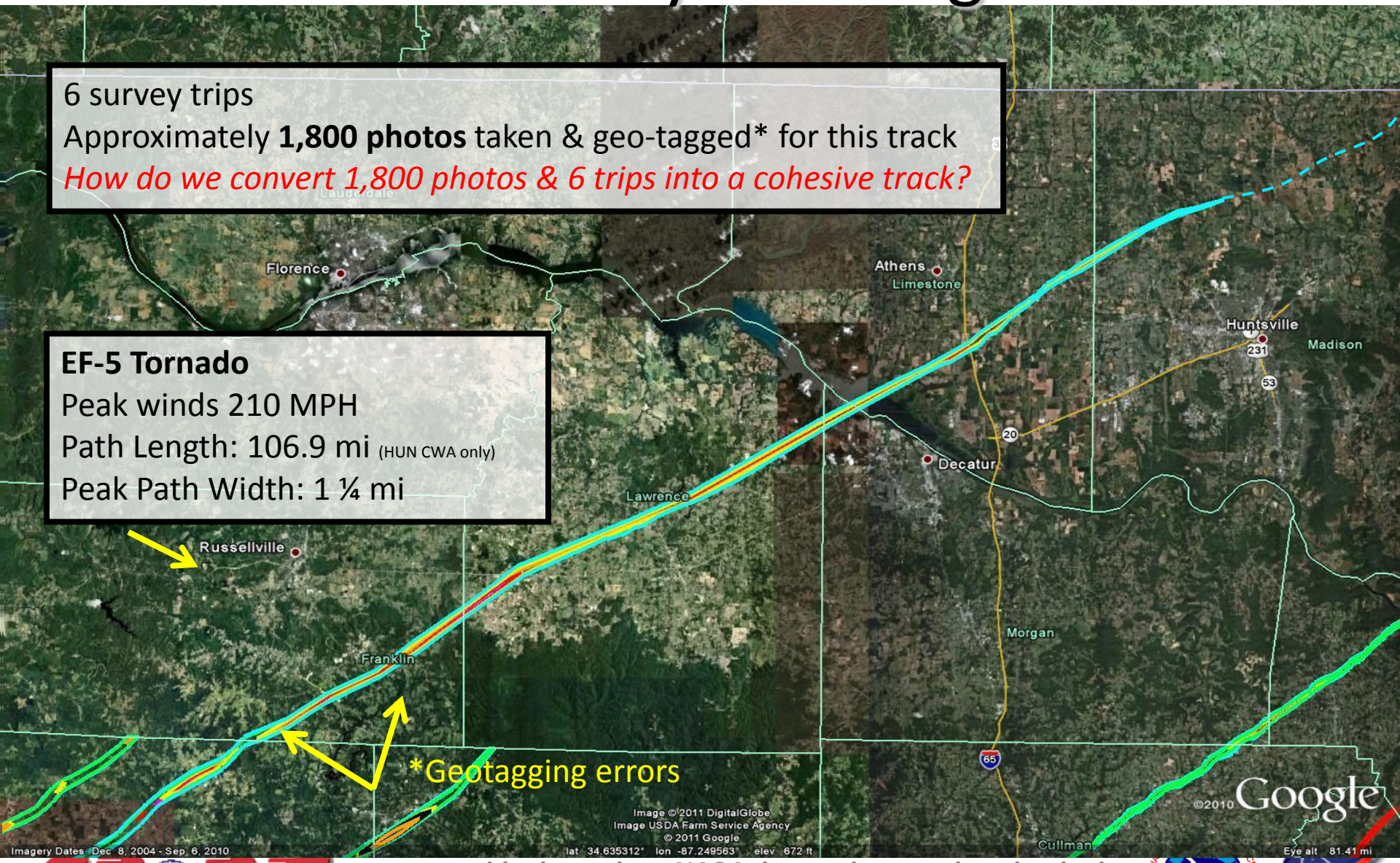
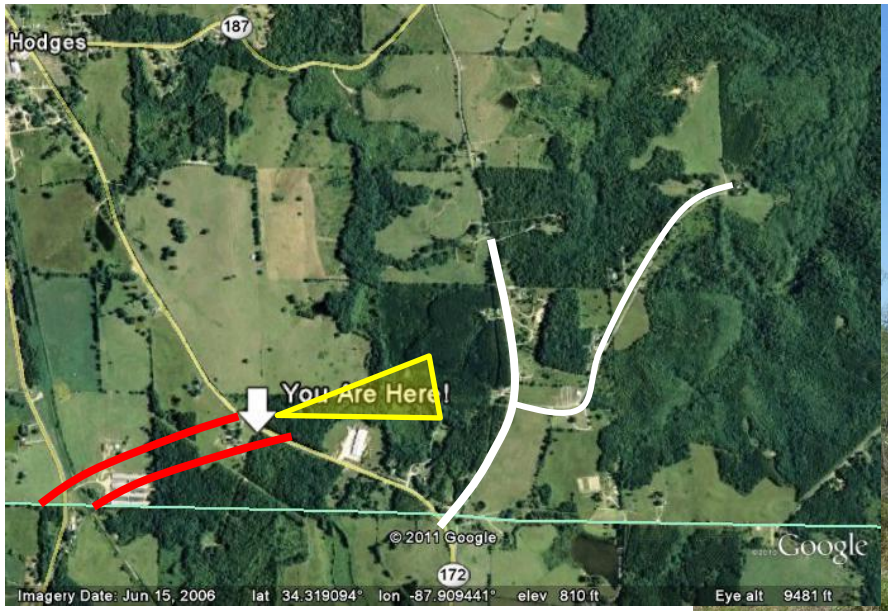


Additional Challenges

Incomplete tracks, bad roads, little time



There are two more crossing roads almost a mile away. The EM insists on moving on, and this spot is 2 hours from the NWS office.

How far east does the track go?

NWS Summary

- None of these challenges are insurmountable, but when the power is out at home, the office is down 3 staff members, and there are 30 more tracks to survey—each with their own additional challenges—any assistance can help.
- Aerial surveys can provide bigger picture insights, but generally provide context to the ground surveys.
- An even-bigger picture perspective would be helpful.

MODIS Imagery and Analysis

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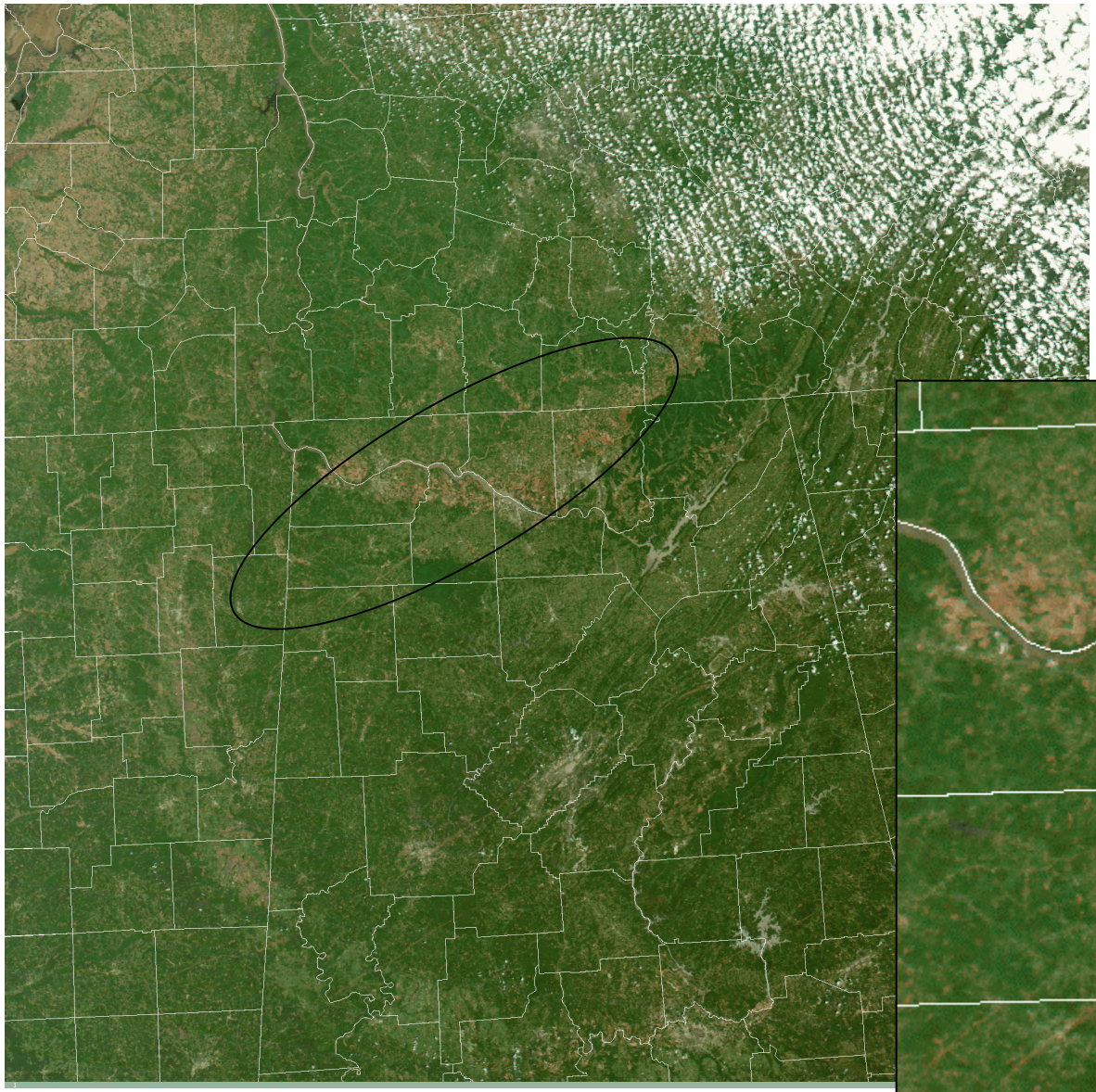
MODIS Natural Color Composite



Combines MODIS channels 1, 4, 3) into an RGB image

When viewed at 500m resolution, clearly shows damage tracks

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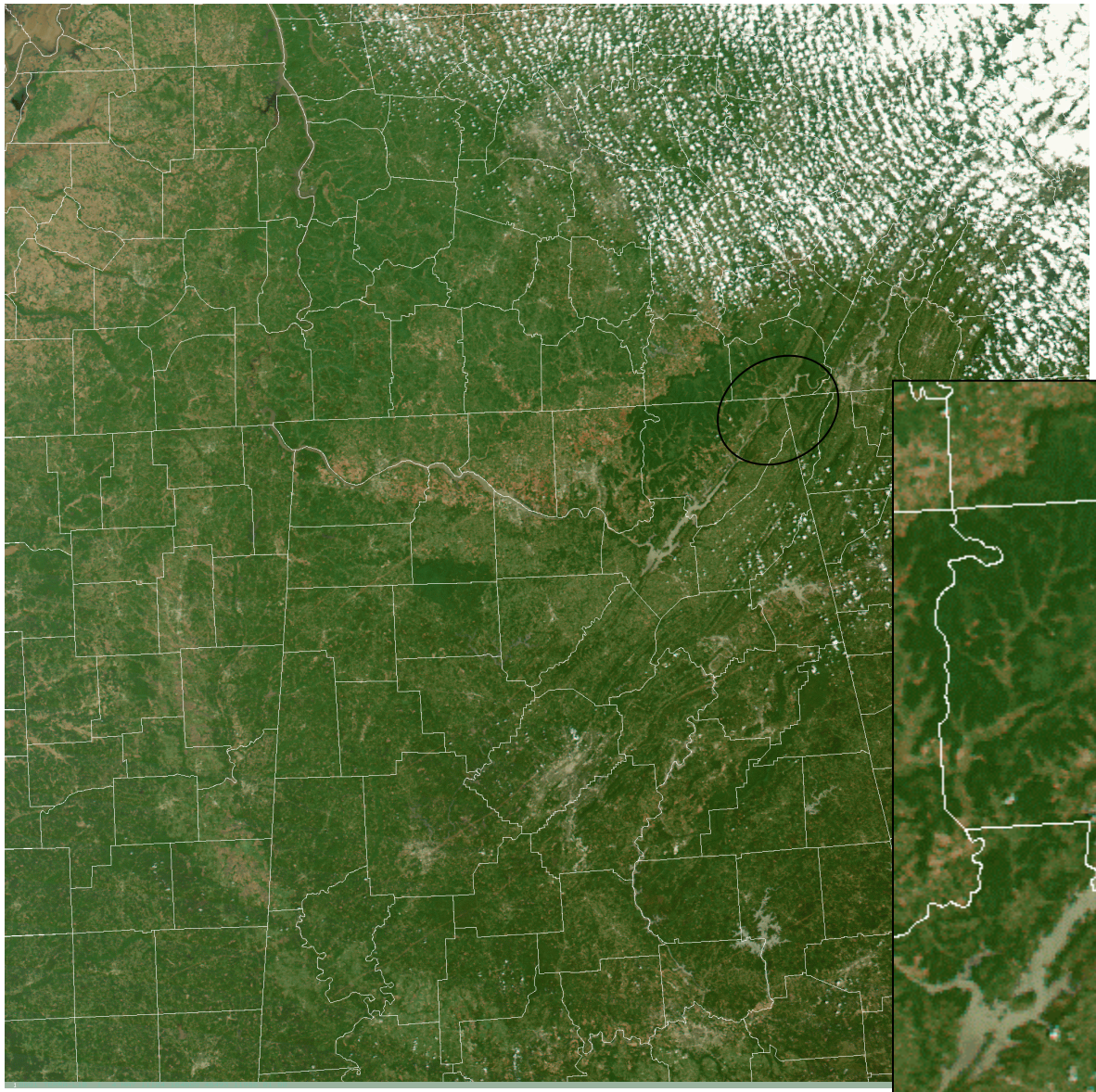

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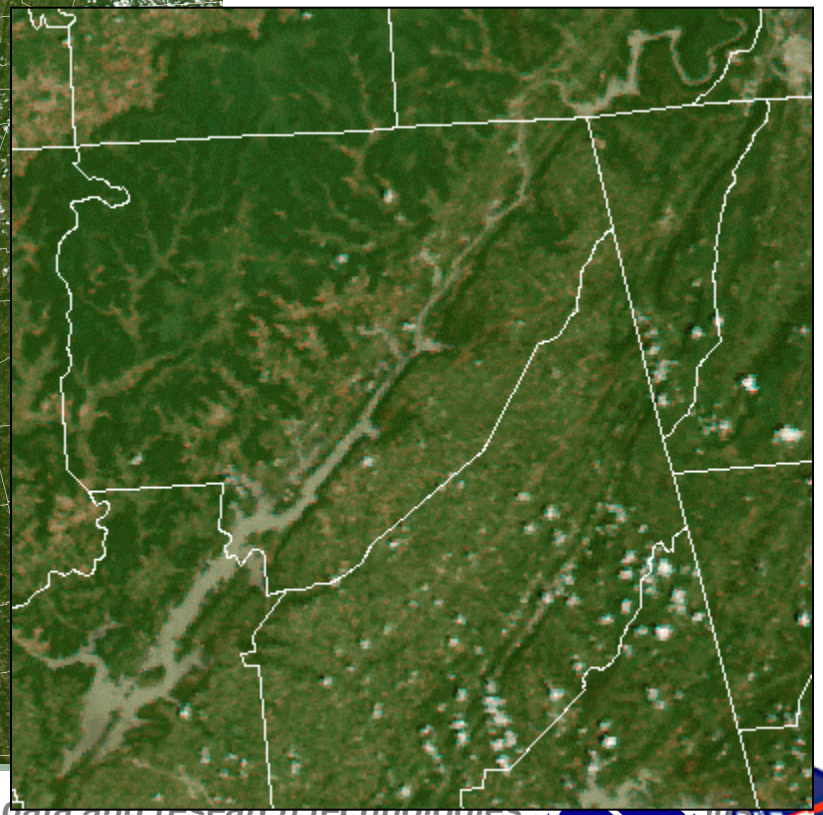

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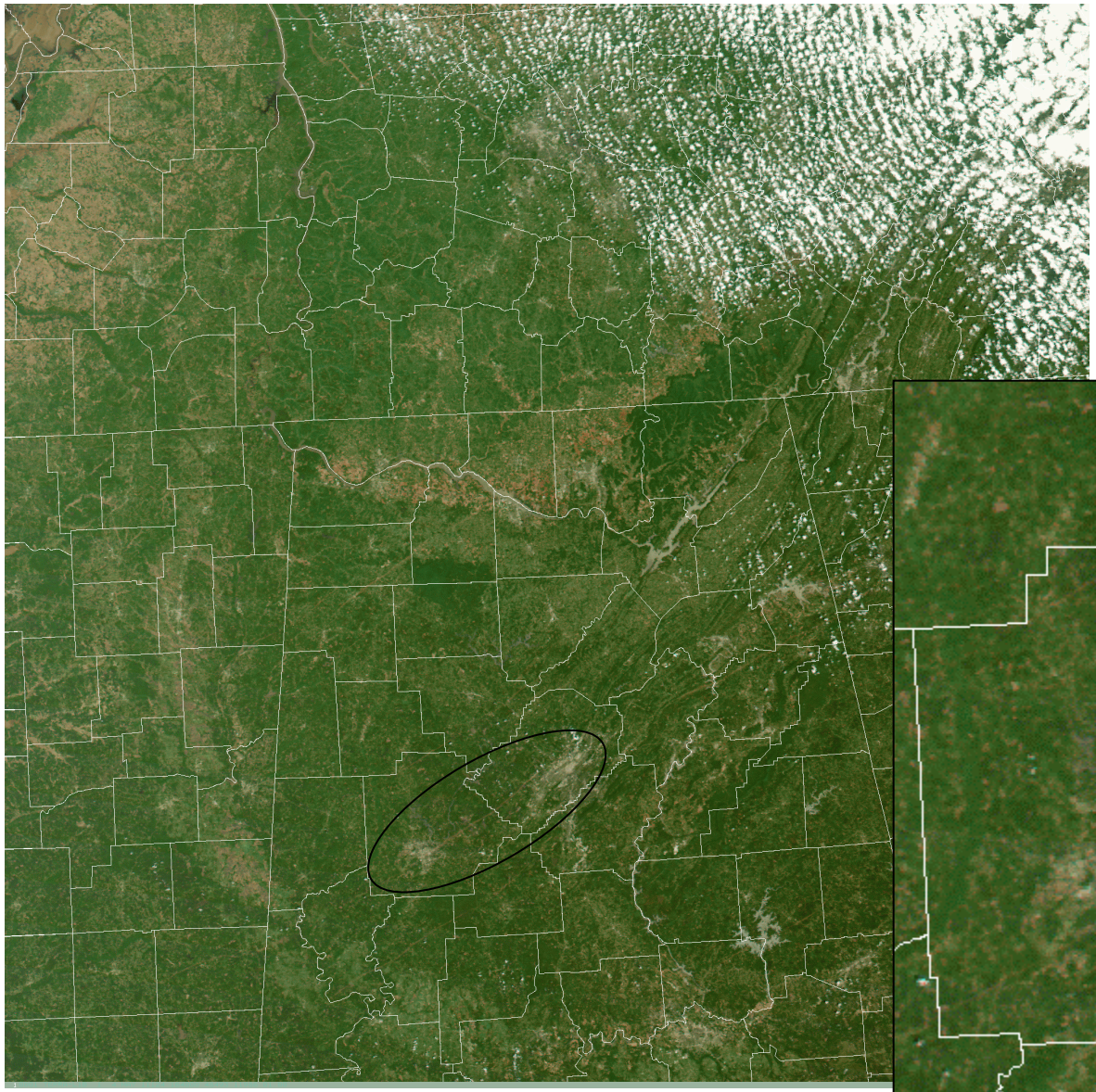

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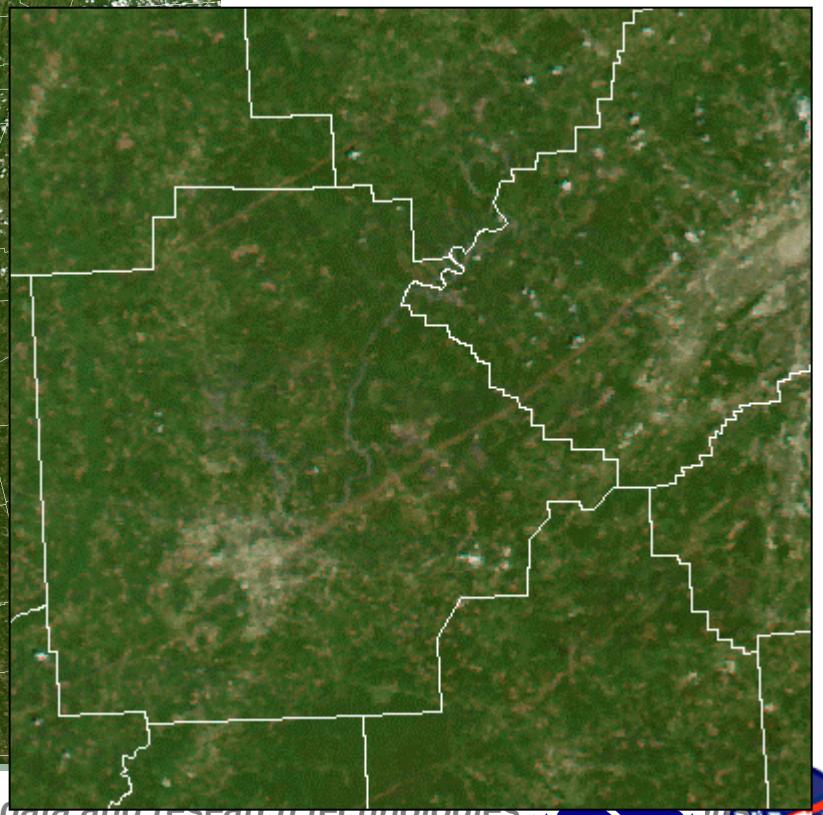
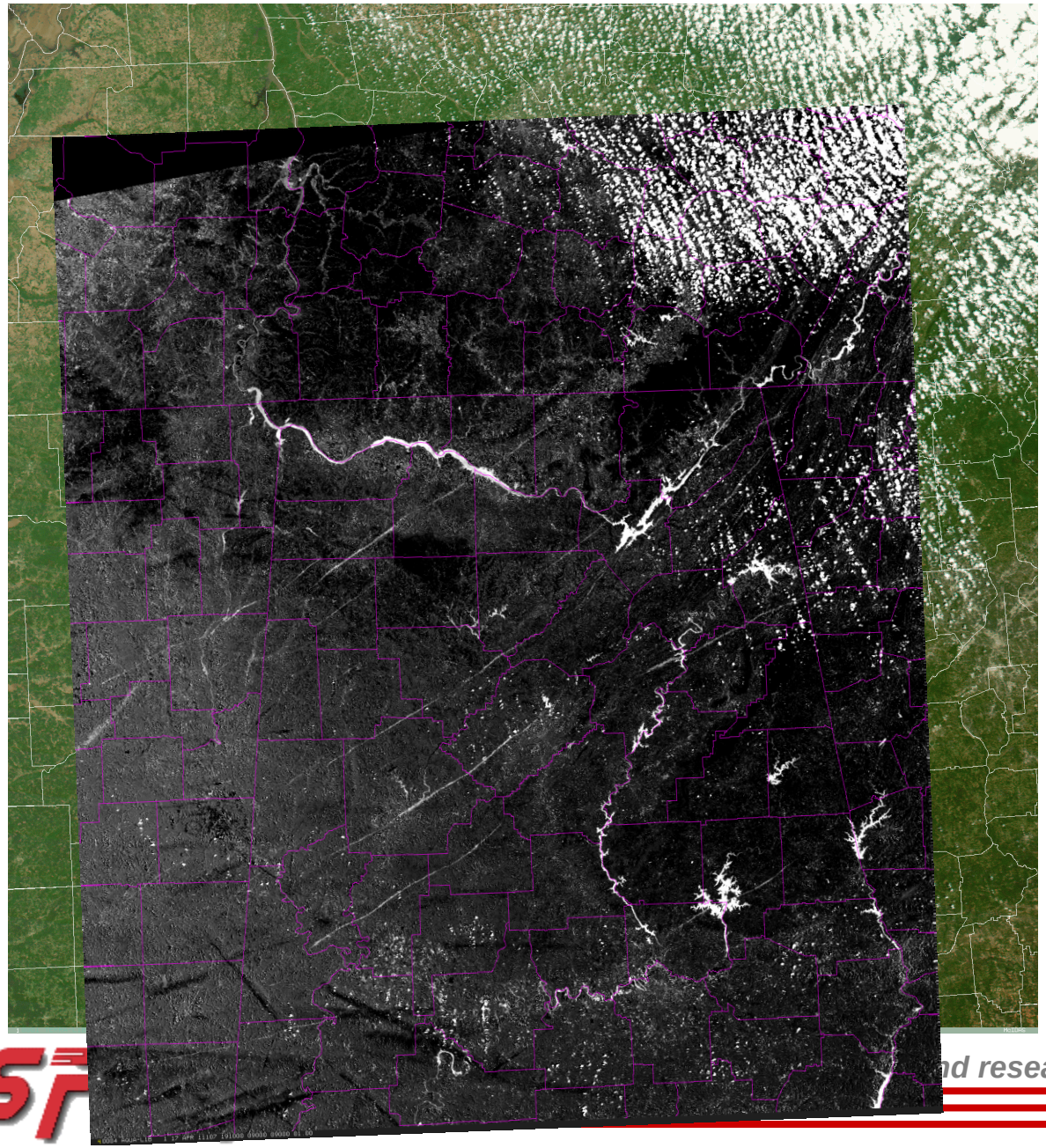


Before and After Difference Image



MODIS single channel (green) at 250m

MODIS image from April 17 (Aqua) and May 4 (Terra)

- geo-locate
- rectify to same coordinate system
- take temporal difference at each point in space

Tornado tracks become extremely easy to see

NWS forecasters used this image to help identify and assess track location for 21 out of 22 tornados that produced EF2 or greater damage

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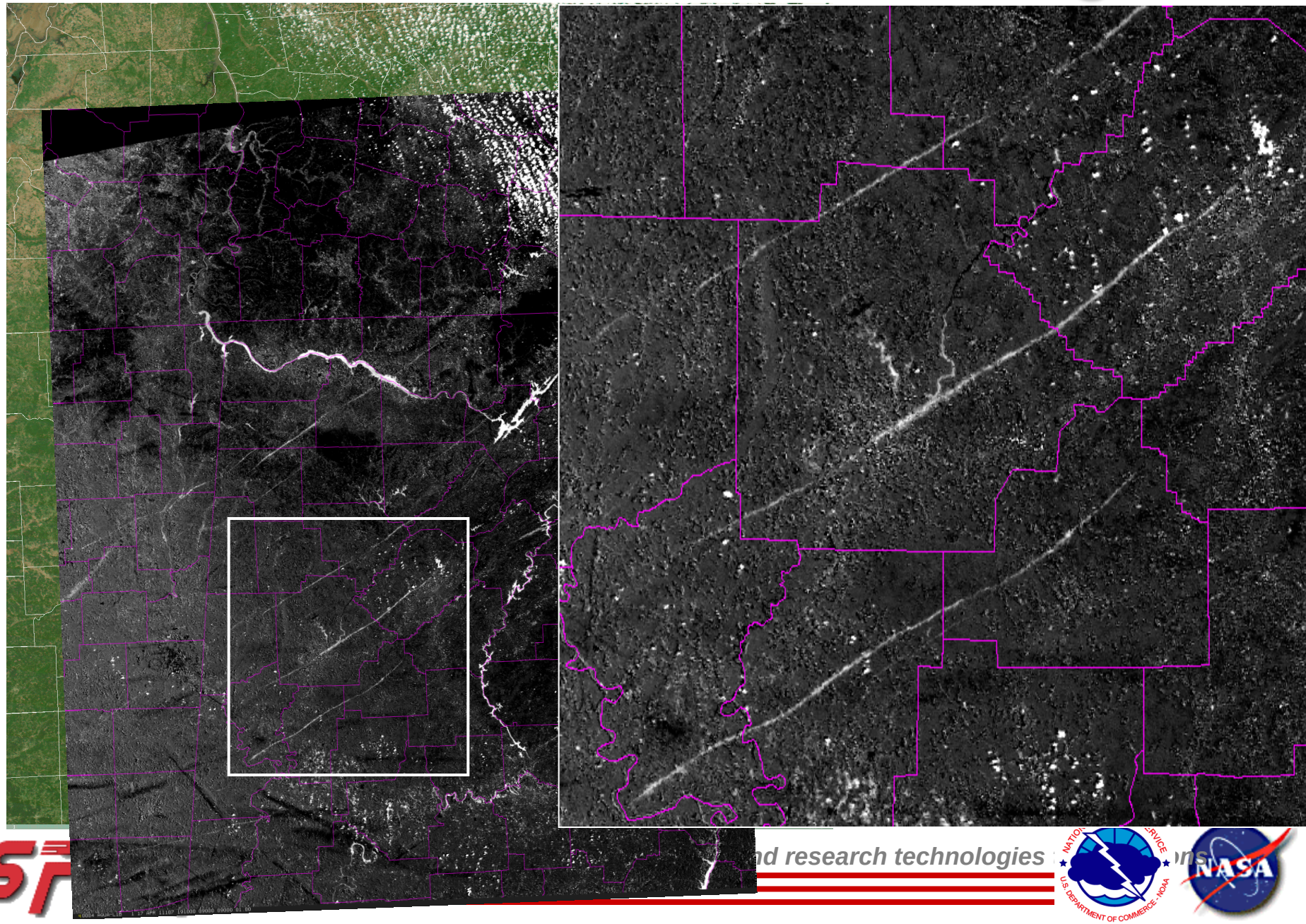

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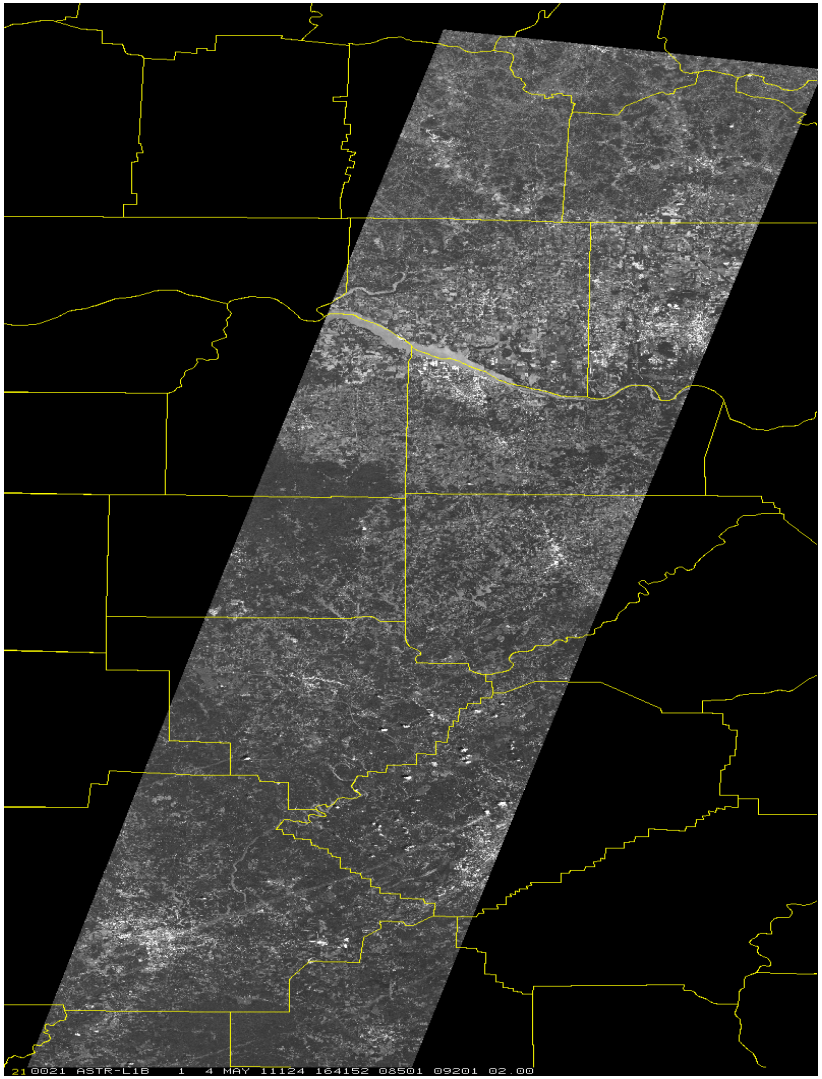

On Terra along with MODIS

- vis/nir, swir, thir subsystems
- 15, 30, and 90m spatial resolution
- 60km swath width
- pointable out to 300km
- 8 bits (limitation)

3 visible/ nir bands

- green, (.56), red (.66), nir (.81)

Land surface climatology (change), vegetation dynamics, mineral mapping, volcano analysis, hazard mapping

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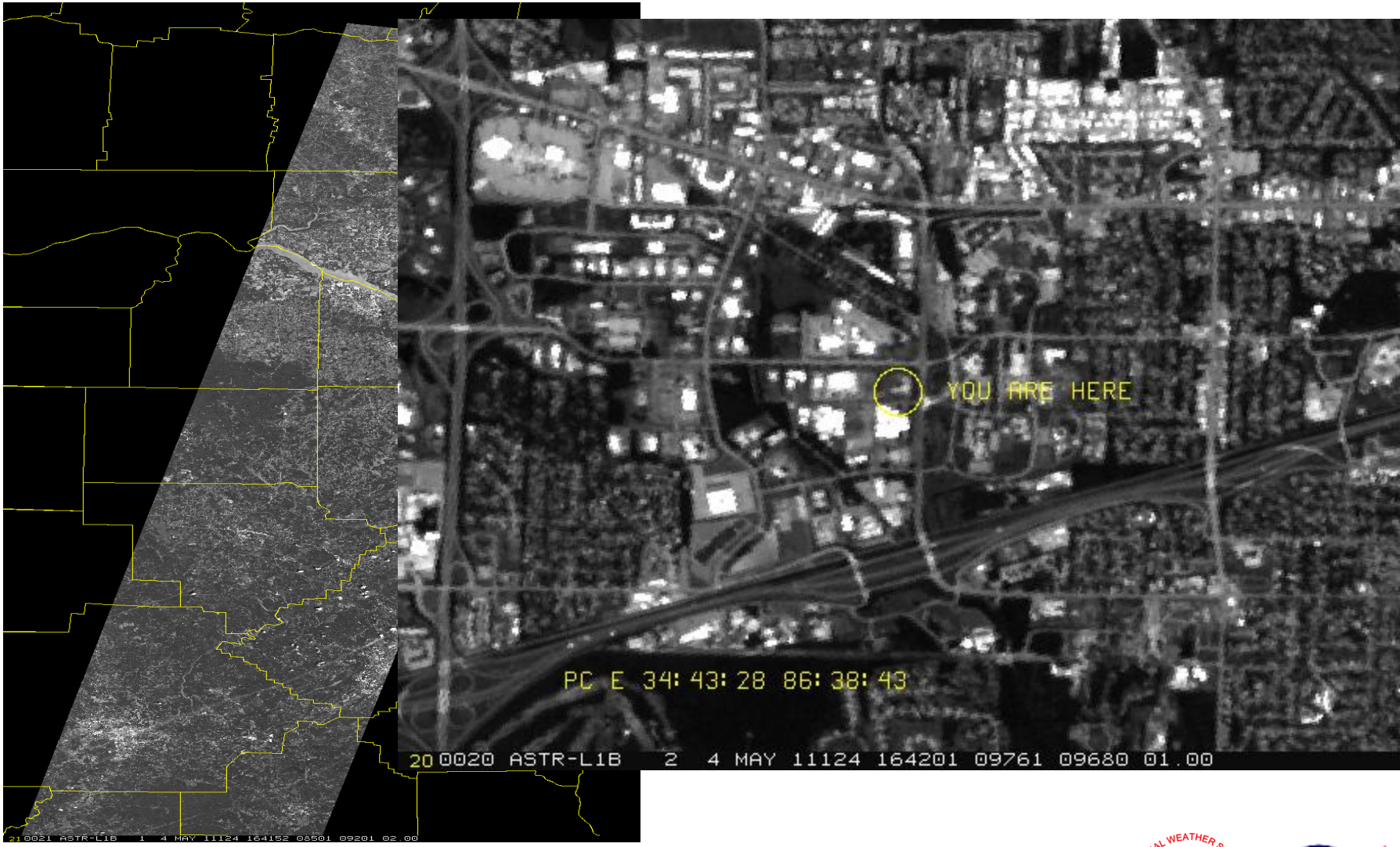
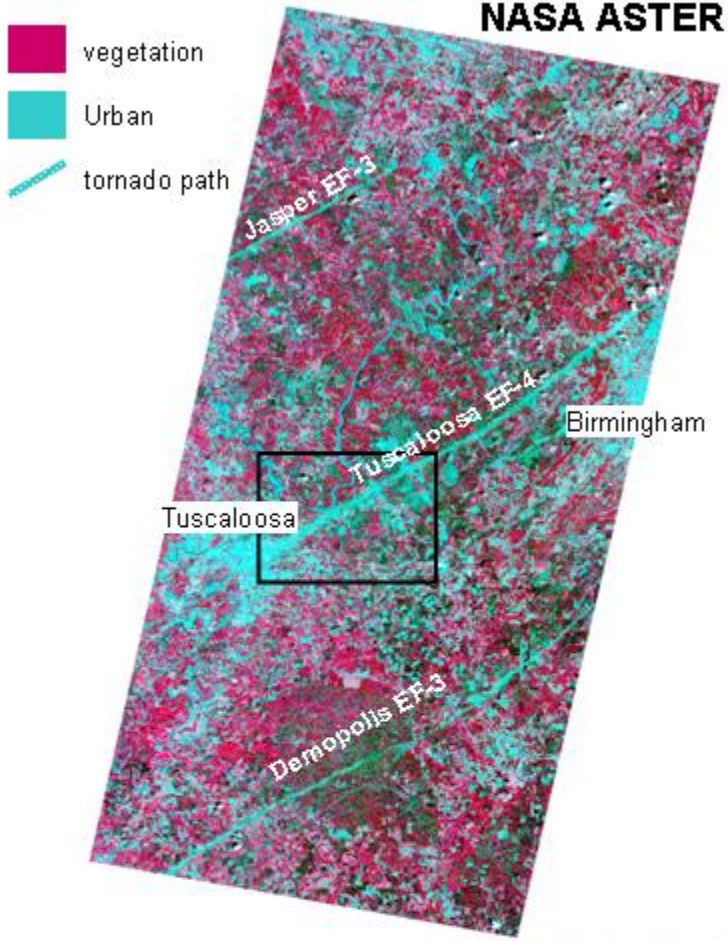
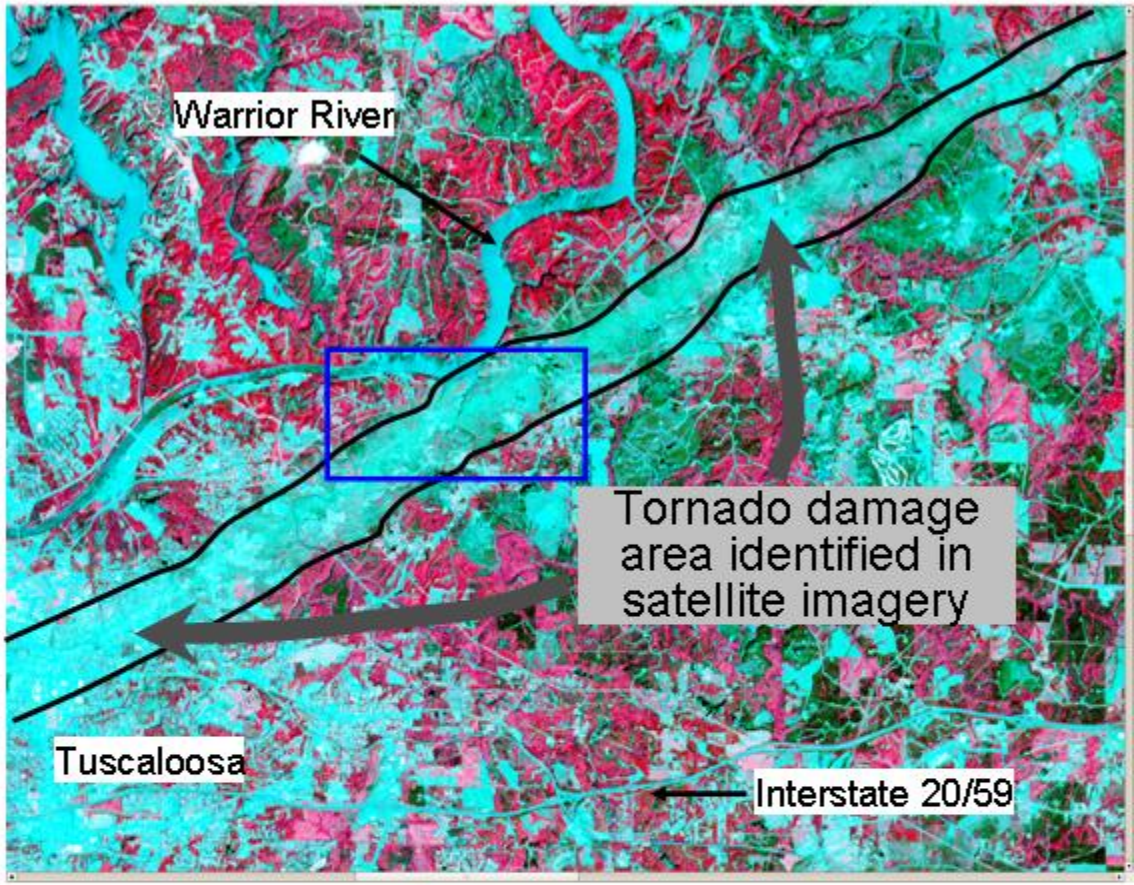
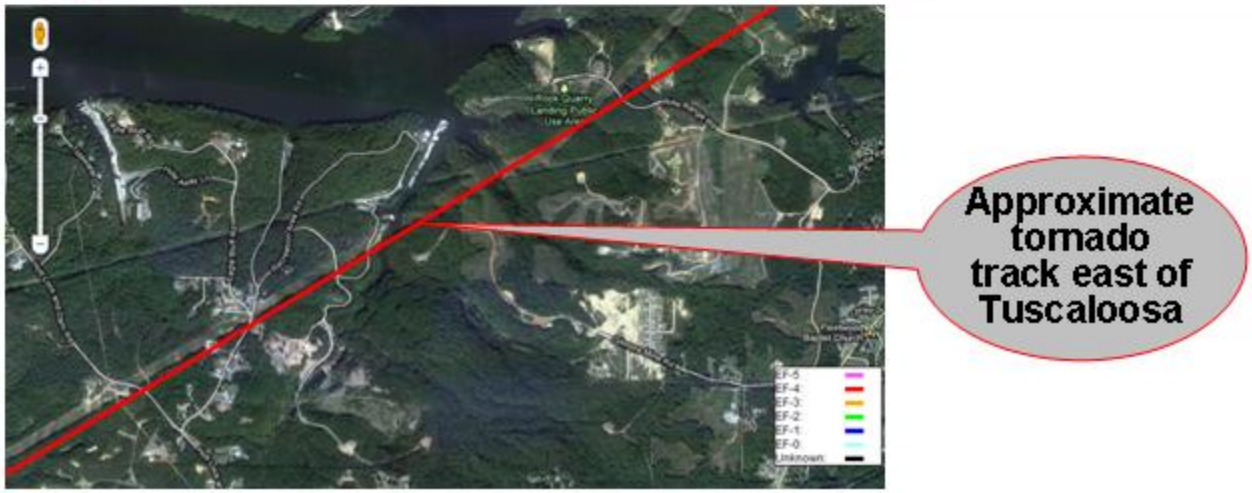


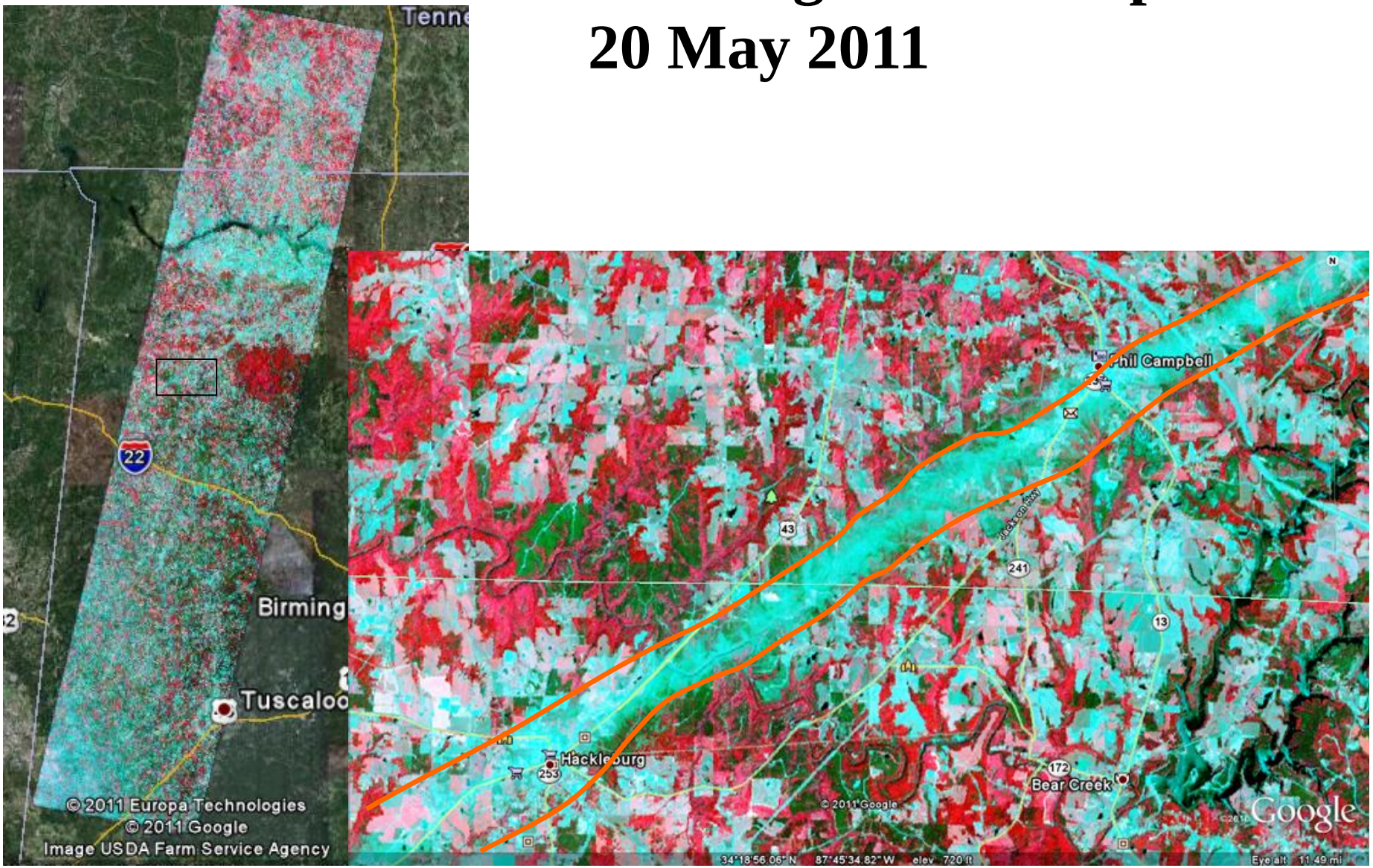
NASA ASTER Satellite Data - May 4, 2011 – 3 Channel Composite Imagery







ASTER: Hackleburg / Phil Campbell
20 May 2011



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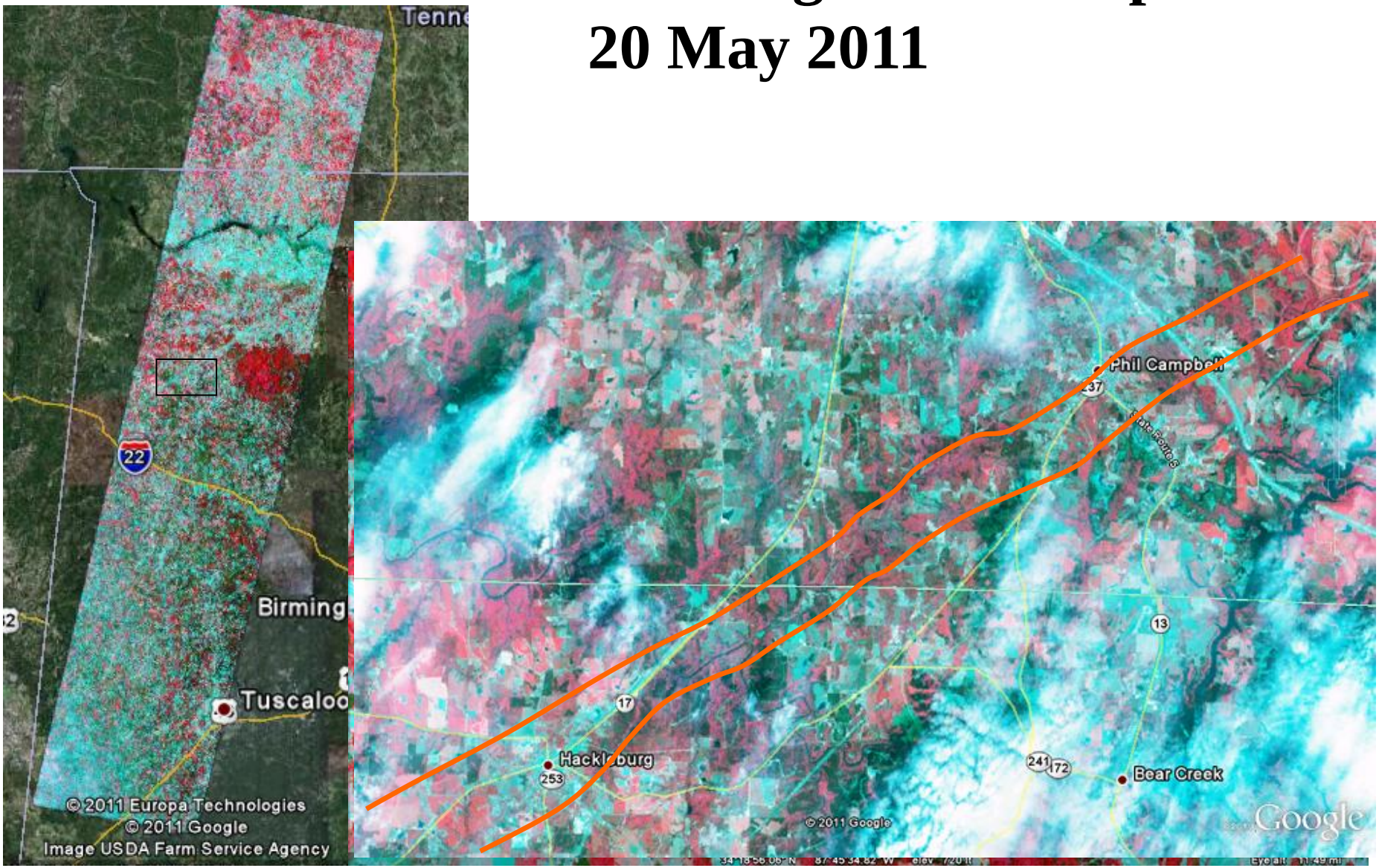

ASTER and Radar Data

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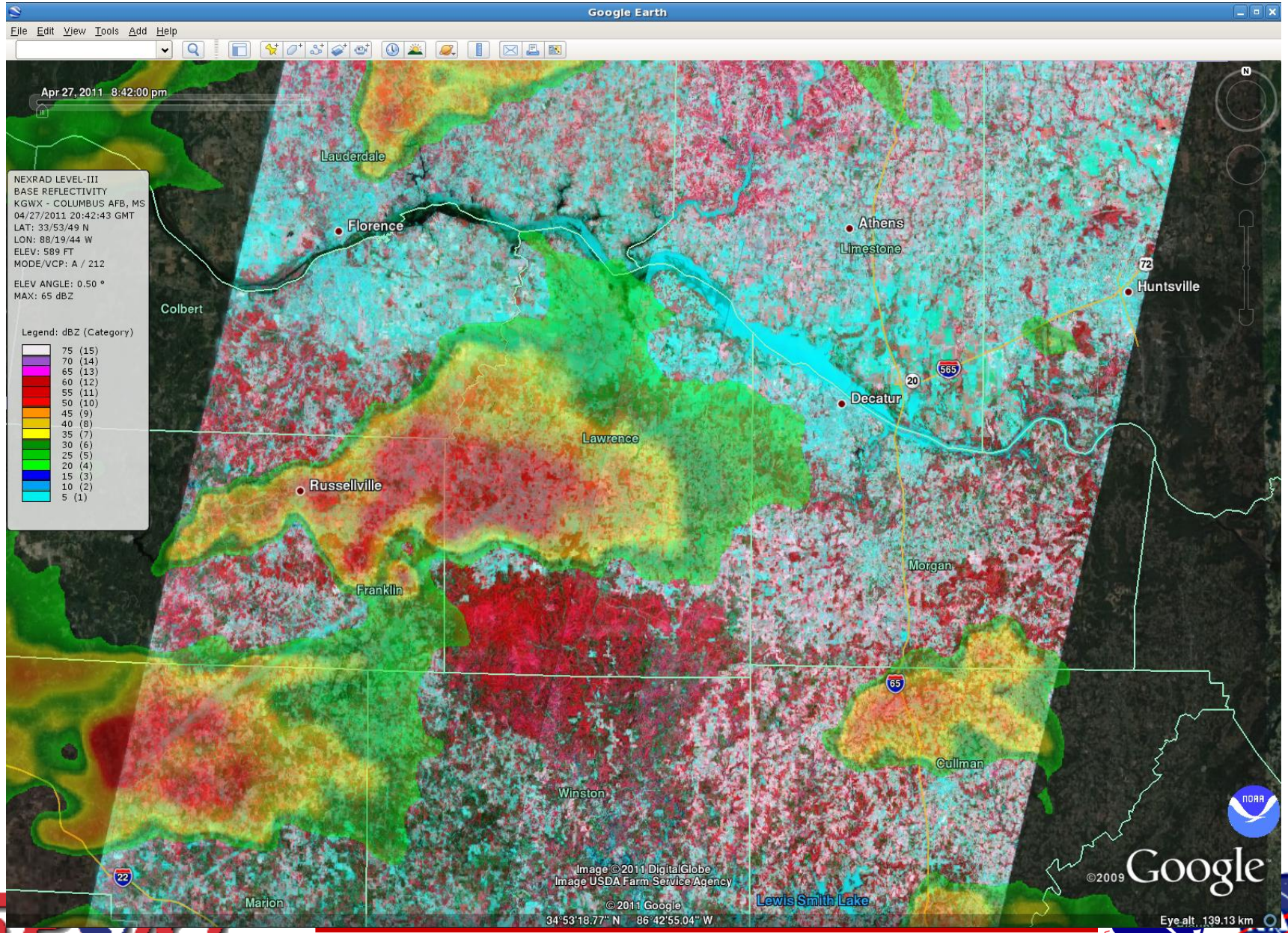
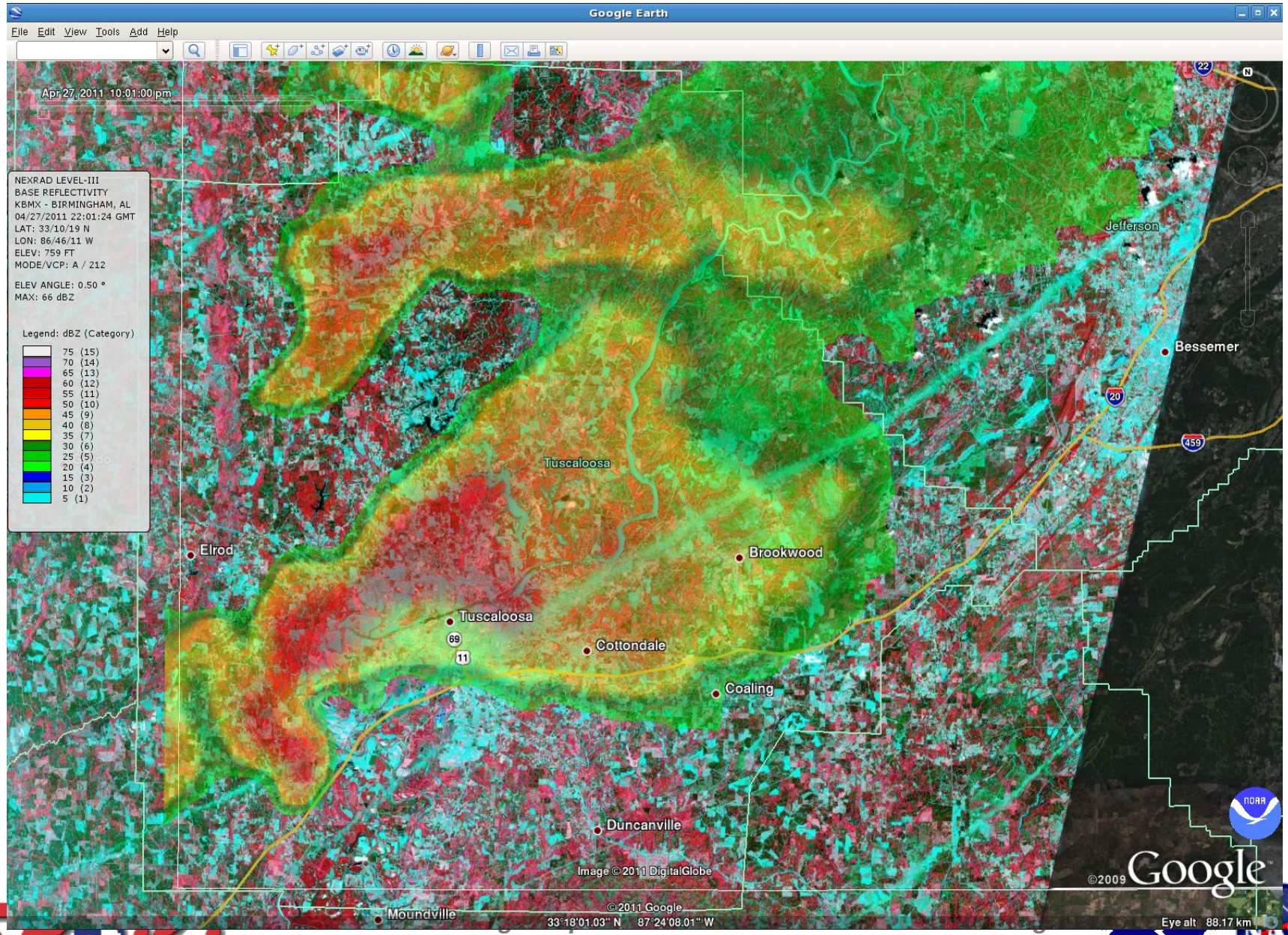
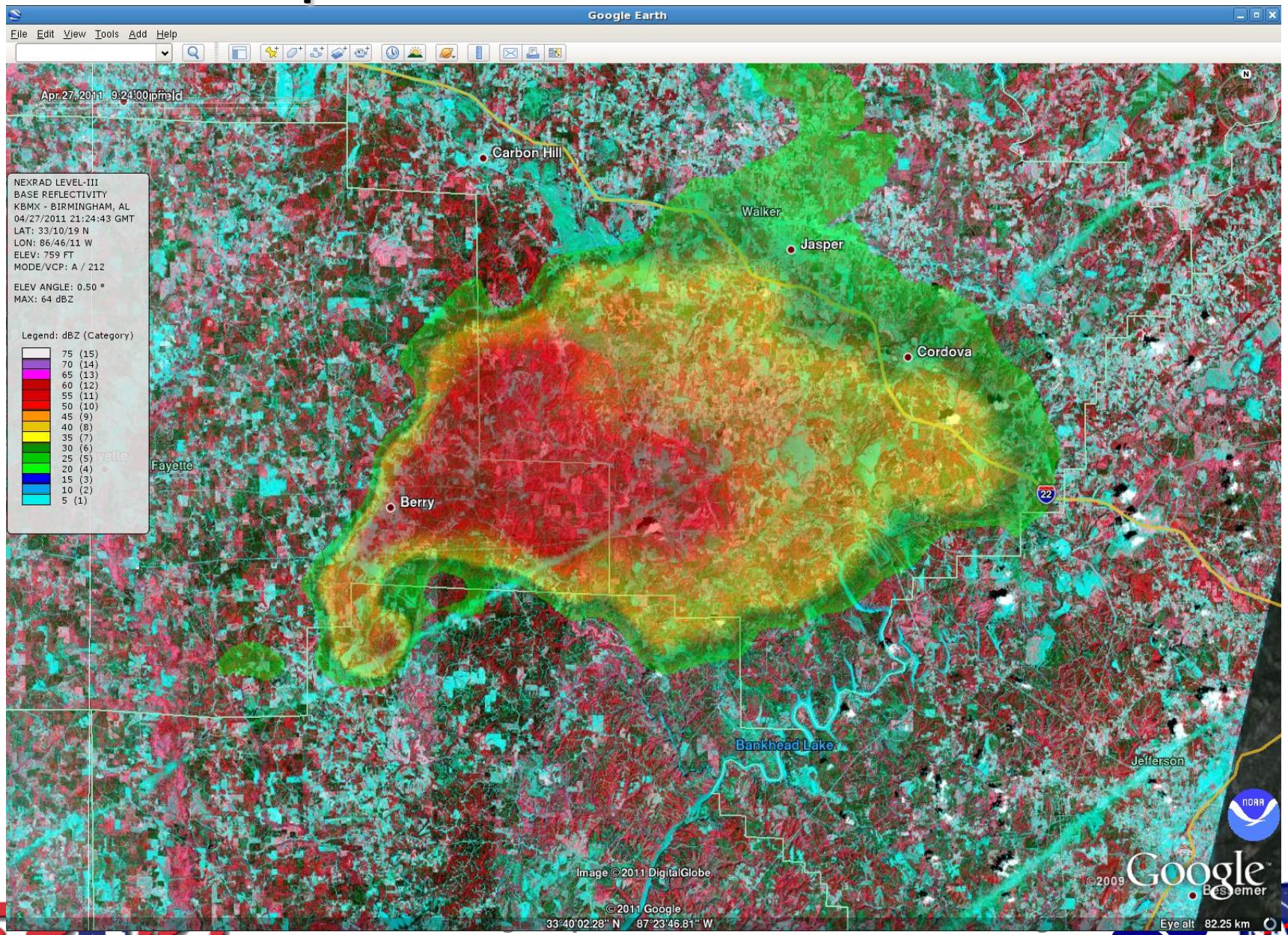
Hackleburg – Phil Campbell (20:43UTC)



Tuscaloosa (22:01UTC)



Jasper – Cordova (21:25UTC)



Summary

NASA satellite imagery provided a “bigger picture” view to put ground survey information in proper context

- determine additional areas to survey
- correct errors, make adjustments to track locations

Advanced processing enhances tornado track detection

- MODIS (before and after difference imagery)
- multi-spectral composites

High resolution ASTER data enhances understanding of storms

- variations in width associated with storm intensity
- enhance interpretation of radar signatures

Pursuing opportunities for more routine collection / processing of data to support NWS needs

http://weather.msfc.nasa.gov/sport/tornadoes/20110427/