Applica'ons of Earth Remote Sensing for Severe Weather and Damage Assessment

Andrew Molthan[1], Jason Burks[1], Lori Schultz[2], Kelsey Angle[3], Parks Camp[4], Kevin McGrath[1], and Jordan Bell[2]

[1]NASA Short---term Predic'on Research and Transi'on (SPoRT) Center, Huntsville, Alabama
[2]University of Alabama in Huntsville / SPoRT, Huntsville, Alabama
[3]Na'onal Weather Service, Des Moines, Iowa
[4]Na'onal Weather Service, Tallahassee, Florida

andrew.molthan@nasa.gov

27th Conference on Weather Analysis and Forecas'ng – Chicago, IL

SPoRT

NASA Missions and *SPoRT* Applications

Satellite Products

Pla$orm	Sensor	Product	Resolu2on	Repeat Cycle	Source
Terra / Aqua	MODIS	NDVI True Color	250 m 500 m	Daily	Direct Broadcast (CIMSS) NASA LANCE
Suomi NPP	VIIRS	NDVI True Color Day---Night Band	375 m 375 m 750 m	Daily	Direct Broadcast (CIMSS) NASA SIPS / LANCE (TBD)
Landsat 7 Landsat 8	ETM+ OLI	Natural Color NDVI	30 m	16 Days	USGS Earth Explorer
Terra	ASTER	False Color NDVI	15 m	On Demand	ASTER Expedited USGS Earth Explorer
Interna'onal Space Sta'on	ISERV	True Color	5 m	On Demand	SERVIR Project at MSFC
Commercial / Interna'onal	Varies	Panchroma'c True Color	< 1 m 1 m	On Demand	USGS Hazards Data Distribu'on System

Latency of products vary by type of imagery and source. Through partners, we provide a broad range of sensors for post---storm analysis. Data can be used by surveyors up to 60 days afer the event.

Satellite Products
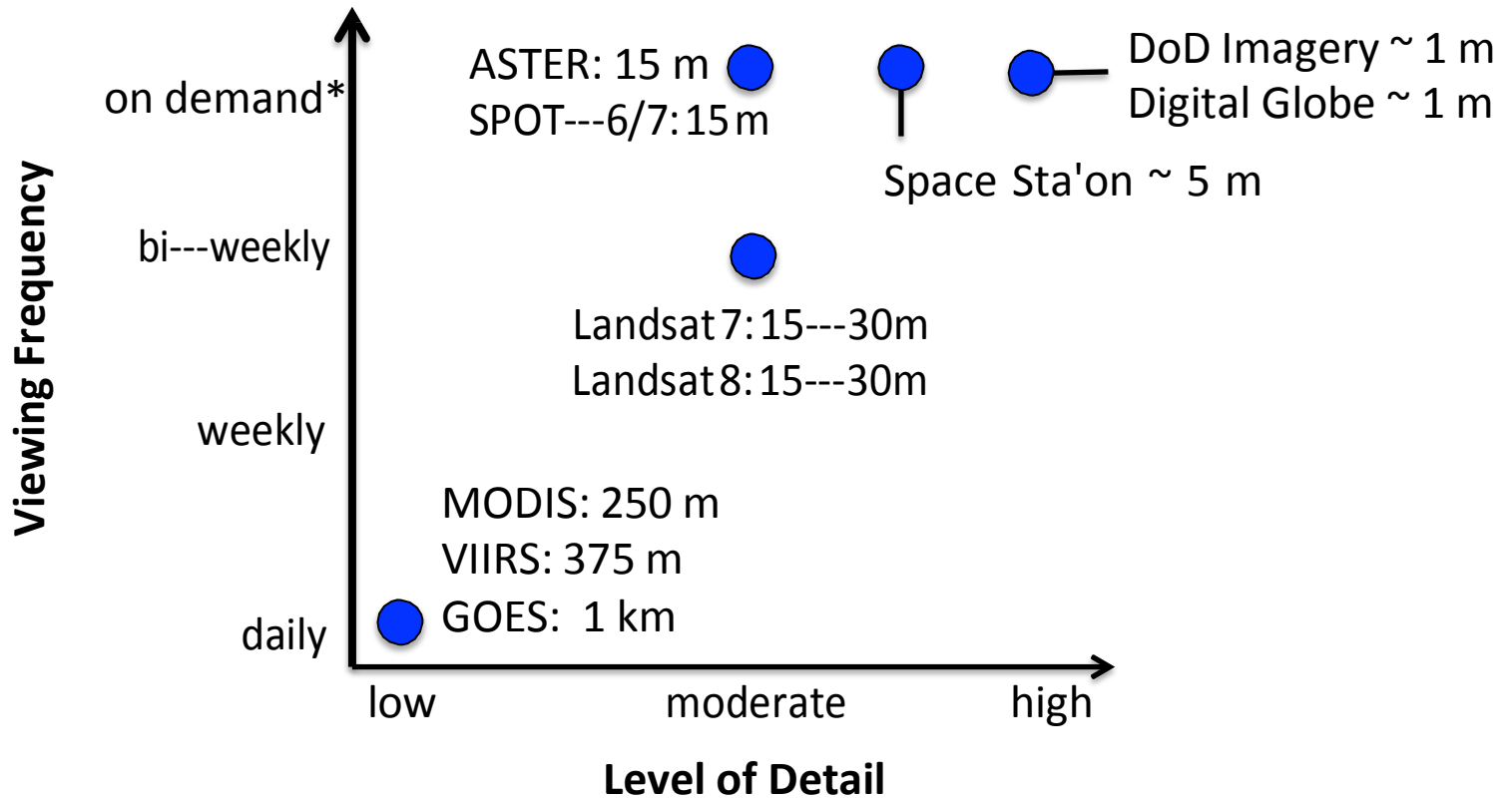
*on demand products are managed by request through USGS Hazards Data Distribu;on System

NASA Applied Sciences Project

- Following the April 27, 2011 severe weather outbreak across the southeastern U.S., the SPoRT team provided MODIS and ASTER imagery to NWS forecast offices in Alabama

  – Imagery was used to refine and adjust some tornado tracks, par'cularly those that crossed CWA boundaries or were in areas with limited road access

- SPoRT was awarded a NASA Applied Science: Disasters "Feasibility" award to pursue inclusion of Earth remote sensing imagery and derived products within the NOAA/NWS Damage Assessment Toolkit
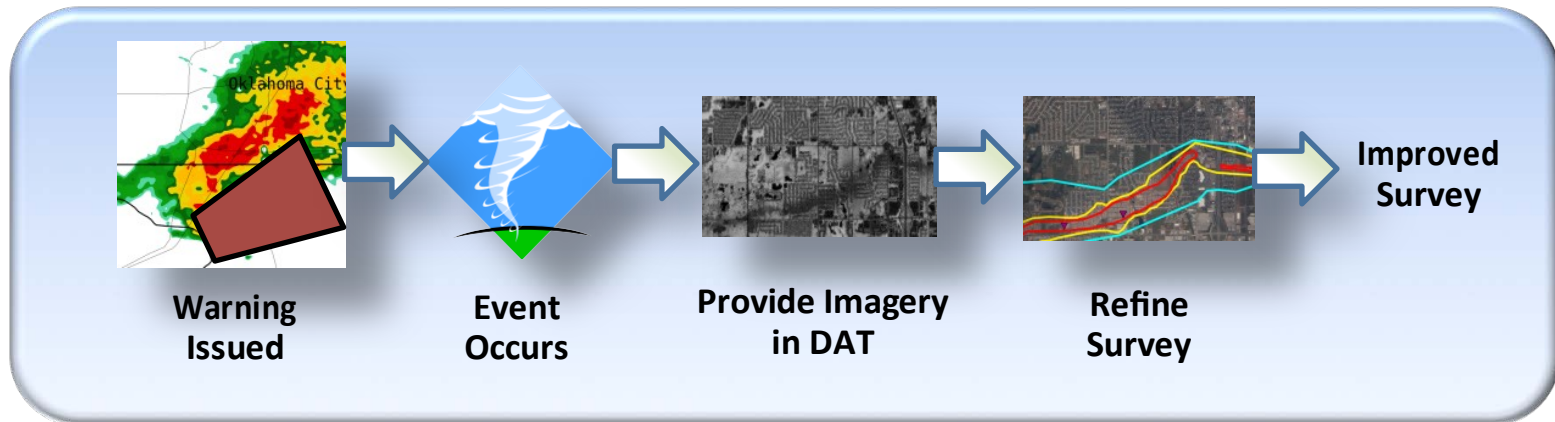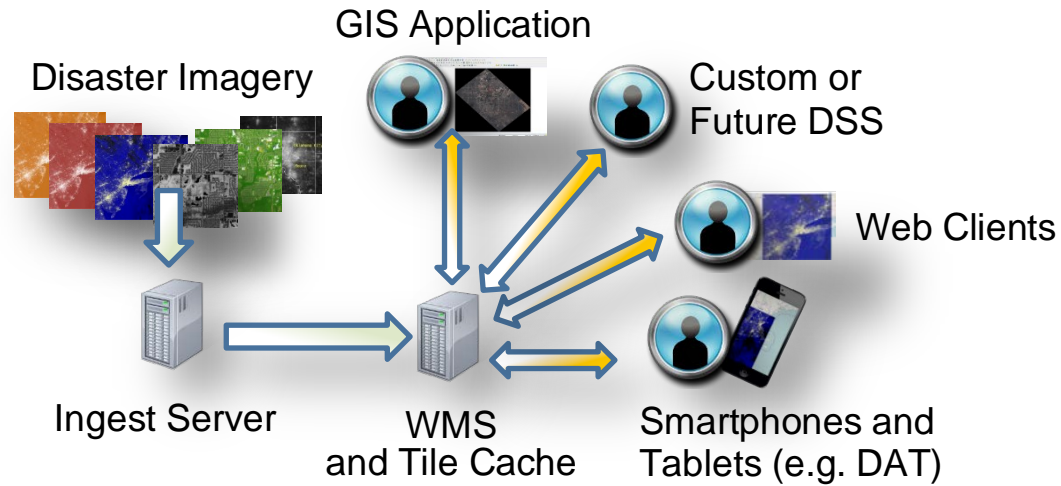
Data Integra'on

- NOAA/NWS Damage Assessment Toolkit (DAT)
  - The SPoRT team has partnered with NOAA/NWS DAT developers, imagery providers, and end users to integrate imagery into the DAT to complement other tools in the survey process.
  - Parks Camp, Paul Kirkwood, Keith Stellman, Ira Graffman, Jay Laseman, Kelsey Angle, Brioney Coleman, Rynn Lamb (USGS), Brian Walawender
- Imagery are provided by NASA, NOAA, and USGS for integra'on and DAT display.

Data Dissemina'on and Use Case

GIS Application

Disaster Imagery

Custom or Future DSS

Web Clients

Ingest Server

WMS and Tile Cache

Smartphones and Tablets (e.g. DAT)

Warning Issued

Event Occurs

Provide Imagery in DAT

Refine Survey

Improved Survey

Damage Assessment Toolkit
(Mobile Client)

As part of the Feasibility Study, the team worked with Parks Camp (NWS WFO Tallahassee, FL) to integrate full resolu;on imagery within the mobile and web versions of the DAT.

Shown here, the mobile DAT interface now includes addi;onal buNons and other features to search and display imagery that SPoRT provides via WMS.
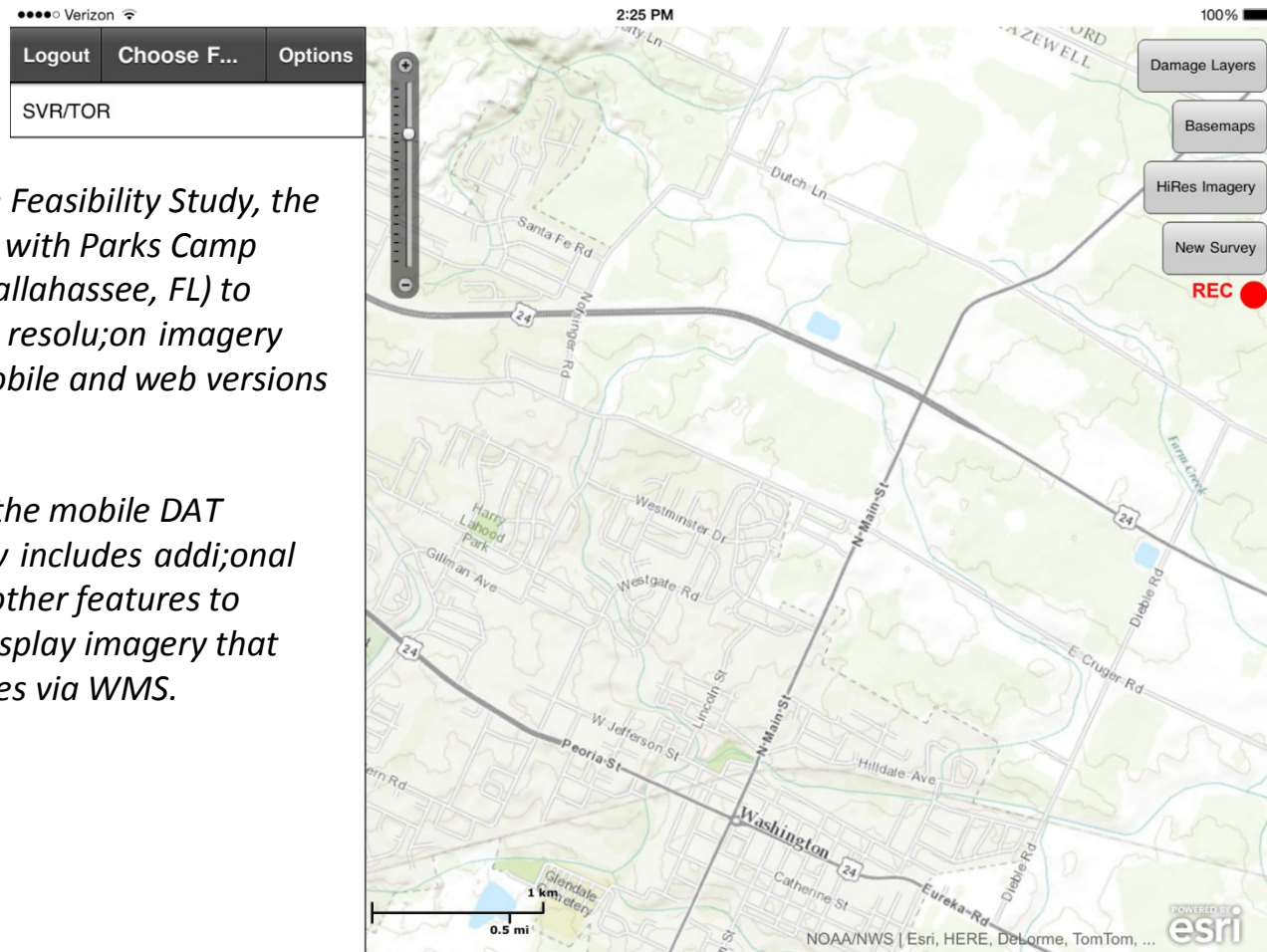
Damage Assessment Toolkit

(Mobile Client)

An addi;onal toggle buNon creates a menu to search for available imagery based upon the viewing loca;on and ;me of year.

Caching of imagery allows users to download data before they go out to the field, ensuring availability despite a loss of cellular data.
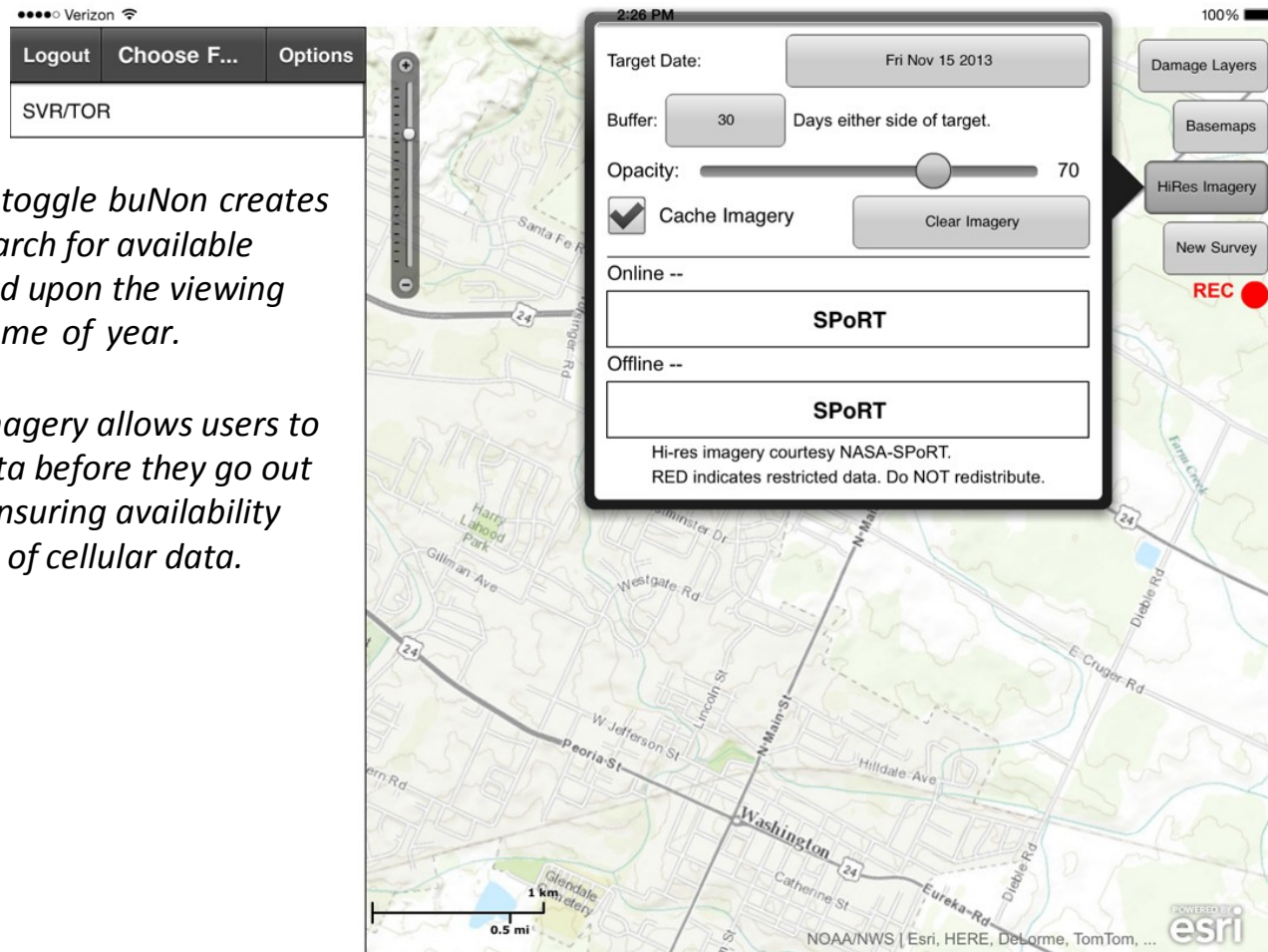
Damage Assessment Toolkit
(Mobile Client)

In this example, the WMS has two types of imagery available for Washington, IL in the period of interest:

MODIS true color imagery provided via SPoRT, and higher resolu;on Worldview (commercial) imagery provided via the USGS.

Damage Assessment Toolkit

(Mobile Client)

By drilling down through the data menus, an image can be loaded for this specific event and then displayed within the DAT applica;on.

Damage Assessment Toolkit
(Mobile Client)
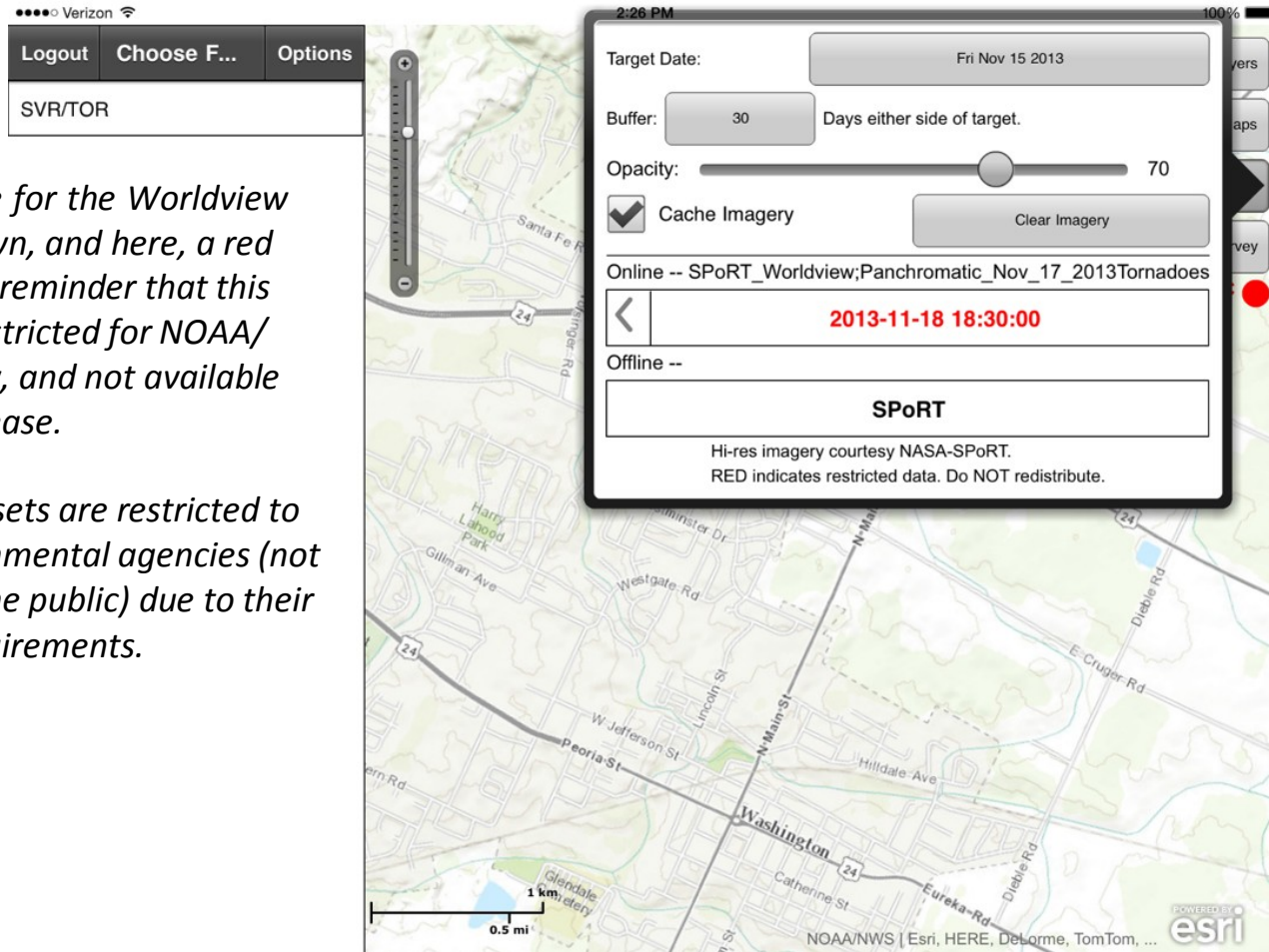
Date and ;me for the Worldview image is shown, and here, a red text view is a reminder that this imagery is restricted for NOAA/ NWS use only, and not available for public release.

Certain data sets are restricted to use by governmental agencies (not released to the public) due to their licensing requirements.

# Damage Assessment Toolkit
(Mobile Client)
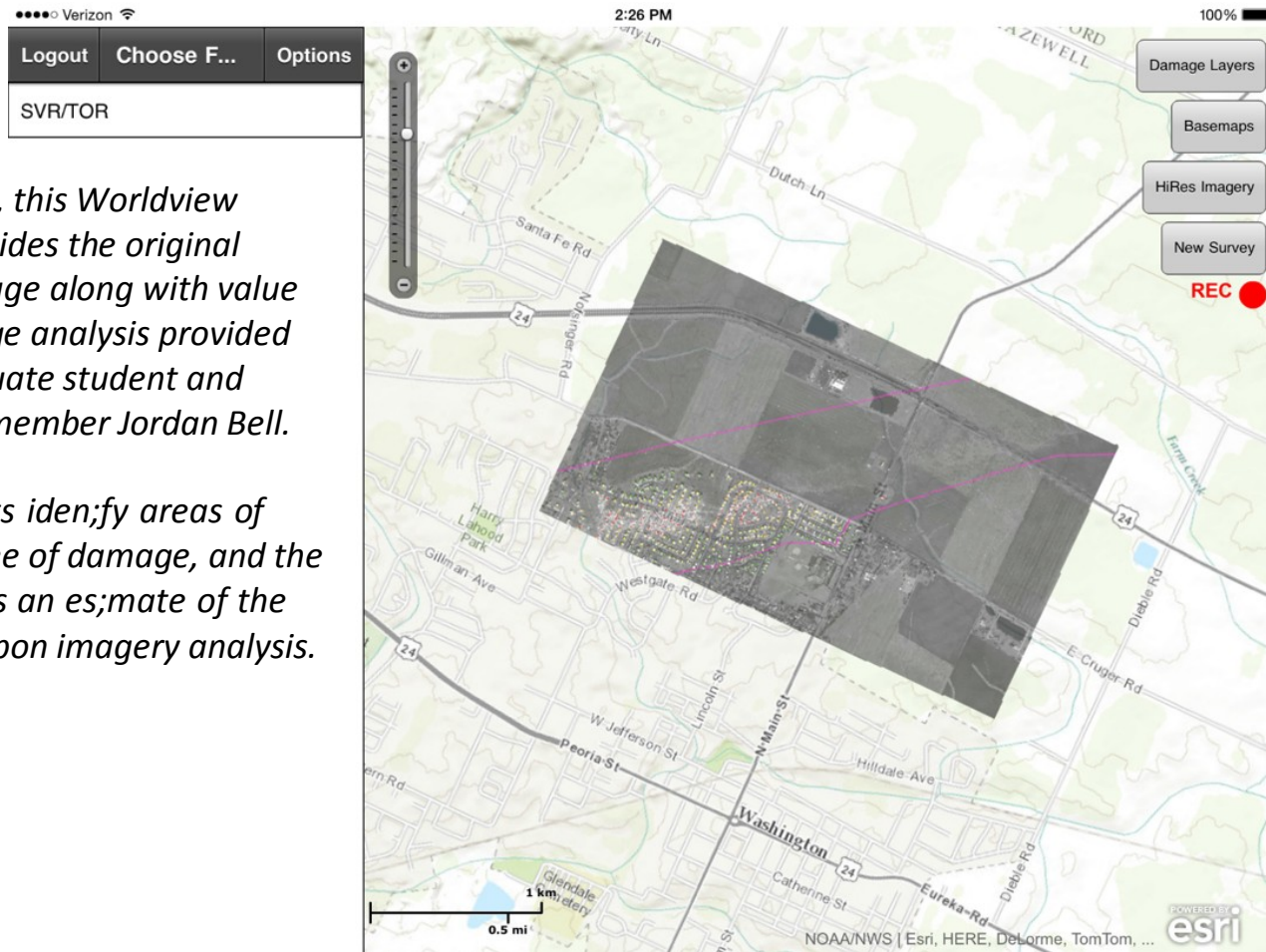
When loaded, this Worldview example provides the original grayscale image along with value added damage analysis provided by UAH graduate student and SPoRT team member Jordan Bell.

Colored points iden;fy areas of varying degree of damage, and the pink outline is an es;mate of the path based upon imagery analysis.

Damage Assessment Toolkit
(Mobile Client)
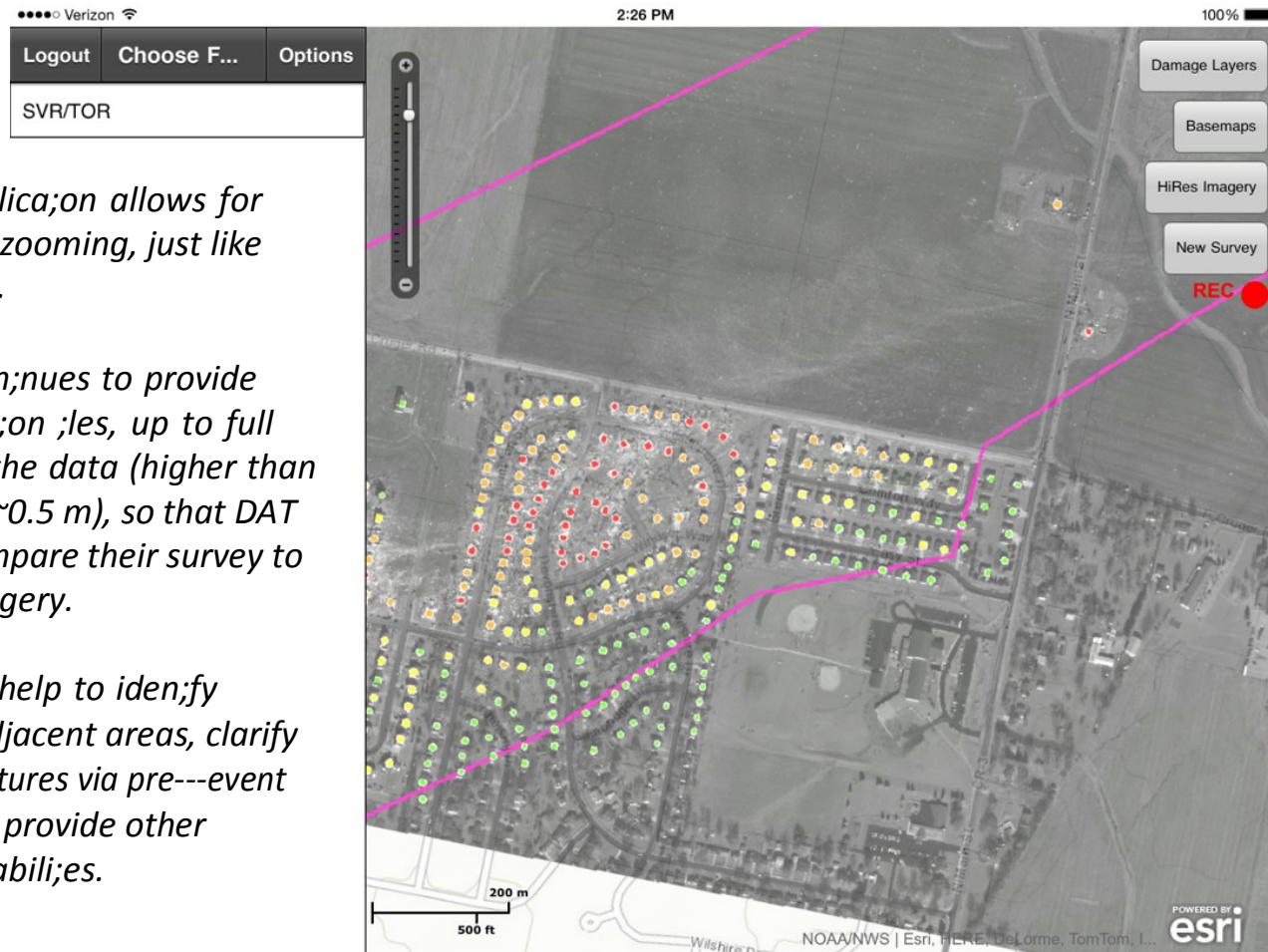
*The DAT applica;on allows for pinching and zooming, just like Google Maps.*

The WMS con;nues to provide higher resolu;on ;les, up to full resolu;on of the data (higher than shown here, ~0.5 m), so that DAT users can compare their survey to available imagery.

Imagery can help to iden;fy damage in adjacent areas, clarify previous structures via pre-‐-‐-event imagery, and provide other analysis capabili;es.
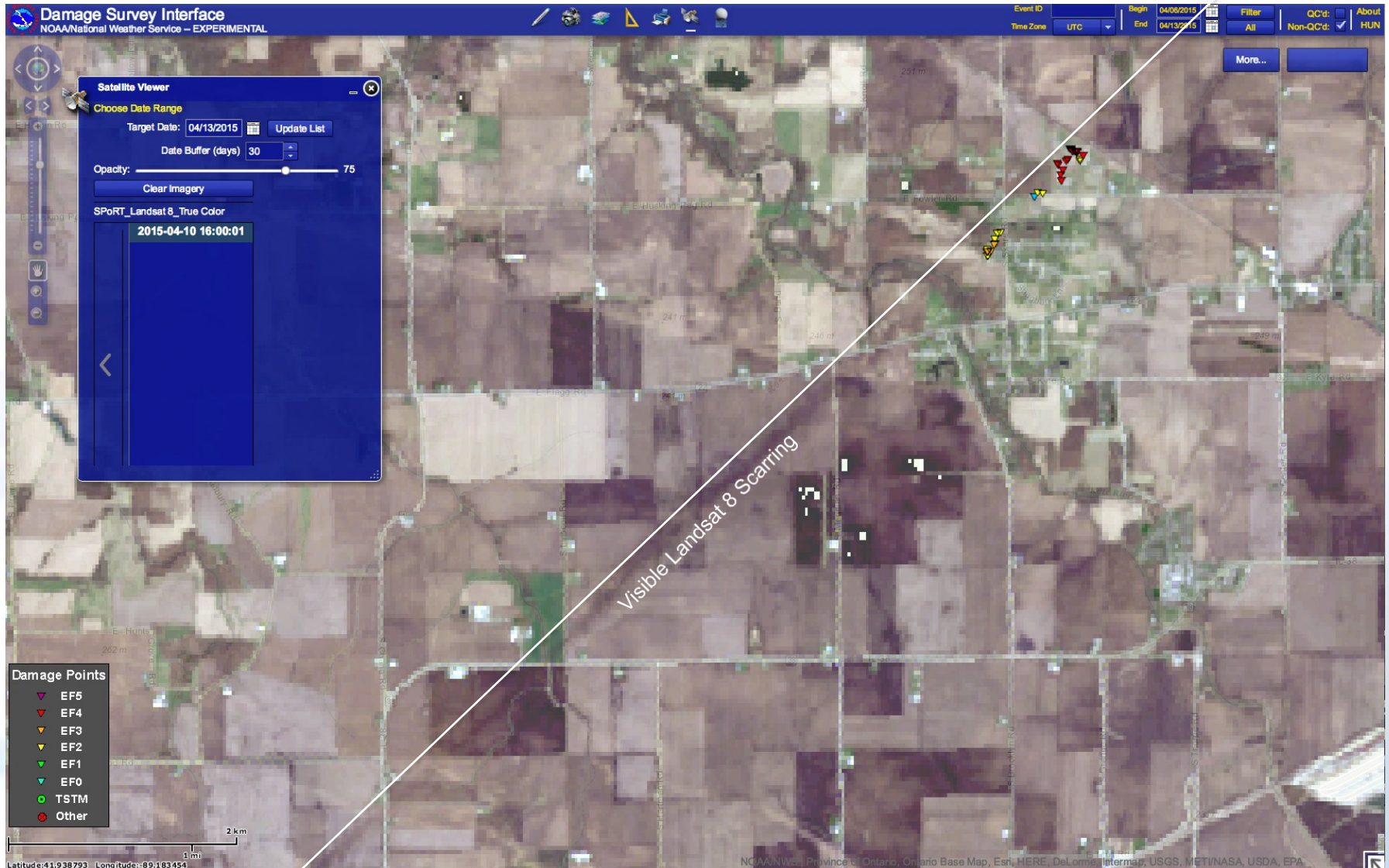
Highlights

Meteorologists at NWS WFO in Chicago, IL analyze Landsat 8 imagery within the NOAA/NWS Damage Assessment Toolkit, and are "very excited and impressed" by this capability.

Highlights

The SPoRT/MSFC Disasters Team provided examples of imagery via social media, and The Weather Channel shared Landsat 8 imagery with follows, attributed to MSFC: NASA/SPoRT and USGS.

Landsat 8 imagery was viewed at @NASA_SPoRT and @weatherchannel over 65,000 times.

```
PUBLIC INFORMATION STATEMENT•..UPDATED
NATIONAL WEATHER SERVICE CHICAGO IL
1247 AM CDT WED APR 15 2015

.•.NWS DAMAGE SURVEY RESULTS FOR 04/09/15 TORNADO EVENT.•.

NWS METEOROLOGISTS HAVE NOW CONFIRMED SEVEN TORNADOES ACROSS
NORTH CENTRAL ILLINOIS FROM THE EVENING OF APRIL 9. NWS CHICAGO
 OULD LIKE TO EXPRESS APPRECIATION TO NASA SPORT FOR THE SATELLIT
IMAGERY••.NOAA REMOTE SENSING DIVISION FOR THE HIGH RESOLUTION
AREAL PHOTOGRAPHY•..THE CIVIL AIR PATROL FOR AREAL
PHOTOGRAPHY••.AS WELL AS THE ILLINOIS STATE POLICE AND THE MCHENRY
COUNTY EMERGENCY MANAGEMENT AGENCY FOR THEIR AREAL DAMAGE PHOTOS
AS WELL.ALL OF THIS REMOTE SENSING DATA ALONG WITH THE GROUND
SURVEYS WERE INSTRUMENTAL IN IDENTIFYING THE TORNADO PATHS LISTED
BELOW AS WELL AS THE DAMAGE INTENSITY.

THE FIRST TORNADO WAS SPAWNED OVER FAR SOUTHEAST WINNEBAGO COUNTY
INTO BOONE COUNTY BY THE FIRST SUPERCELL THUNDERSTORM••.WHILE THE
NEXT SIX TORNADOES FORMED FROM ONE POWERFUL AND LONG DURATION
SUPERCELL STORM.••INCLUDING THE VIOLENT LONG TRACK EF-4 FROM
NORTHERN LEE COUNTY..•THROUGH OGLE AND DEKALB COUNTIES•.•AND
ENDING IN FAR SOUTHERN BOONE COUNTY.
```

Staff at the Chicago forecast office expressed appreciation to the NASA MSFC/SPoRT team for
their assistance in providing satellite imagery supporting the survey efforts.
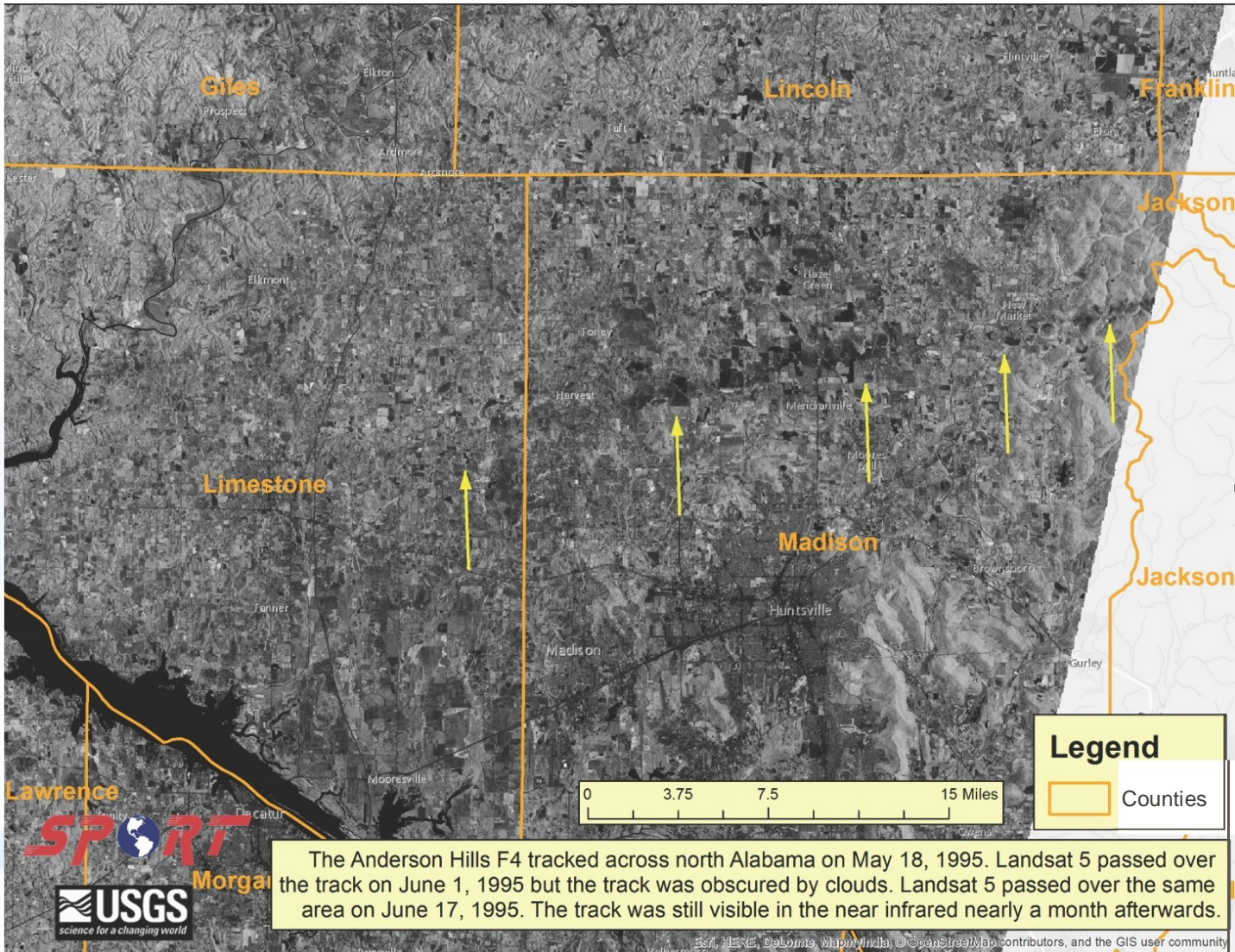
The Anderson Hills F4 tracked across north Alabama on May 18, 1995. Landsat 5 passed over the track on June 1, 1995 but the track was obscured by clouds. Landsat 5 passed over the same area on June 17, 1995. The track was still visible in the near infrared nearly a month afterwards.

SPoRT provided NWS Huntsville, Alabama with a revisit to the Anderson Hills F4 damage track from 1995, where Landsat scarring differs in some areas from the previously established track.

1118

Highlights

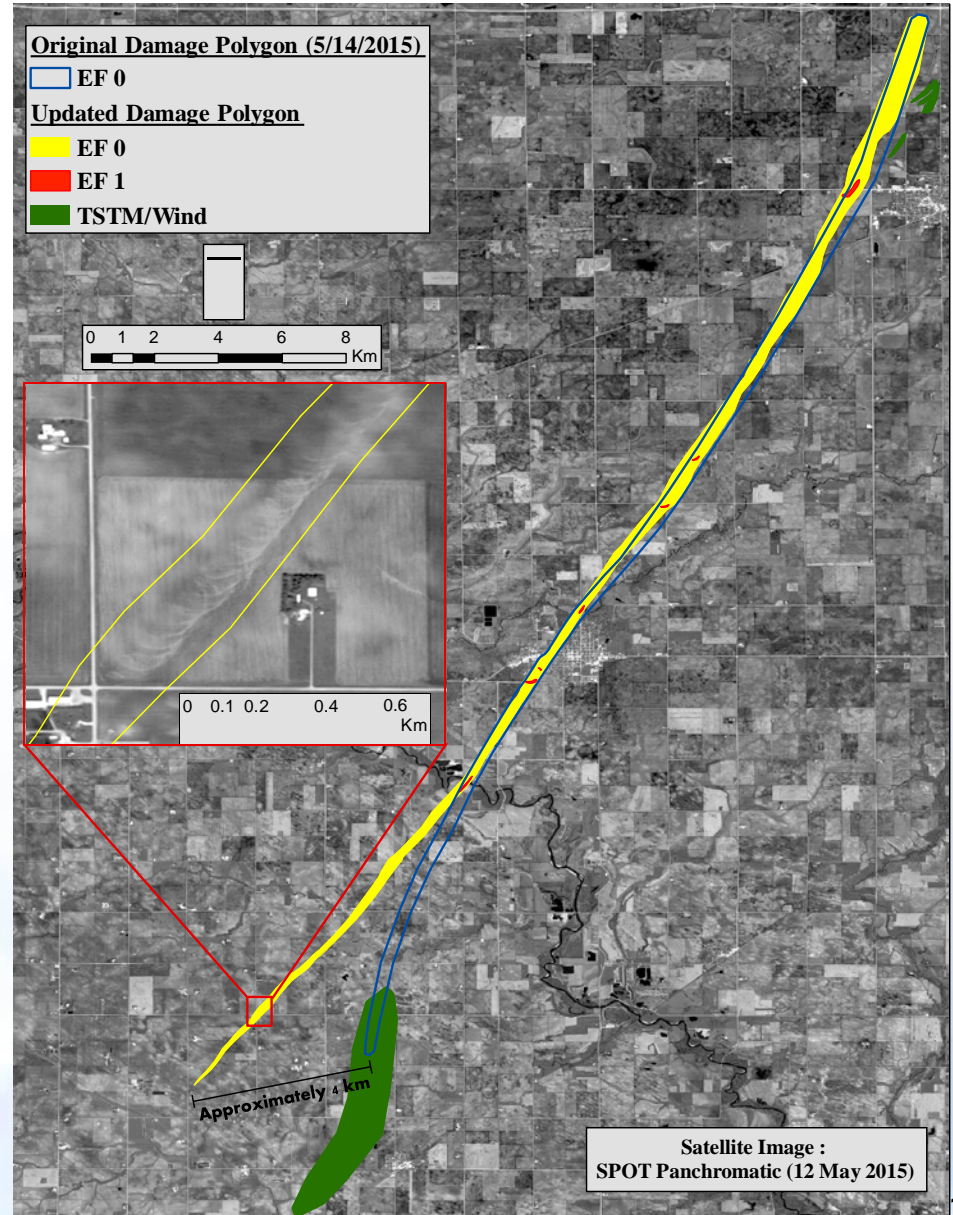**SPOT Imagery Used to Revise Damage Survey Track**

Imagery provided by the USGS and to the NOAA/NWS Damage Assessment Toolkit (via SPoRT) was used to refine an initial damage survey performed by the NWS forecast office in Des Moines, Iowa.

In the image to the right, the original damage survey (blue outline) was revised further to the southwest due to the appearance of field scarring by the tornado, evident in the inset zoomed image (red box). The initial track connected EF1 damage to thunderstorm wind damage due south, whereas the inclusion of SPOT imagery allowed for the track to be reassessed and modified to the correct location.

User Feedback (emphasis ours):

"The modifications you are seeing in the DAT are a *direct result of what we found in the satellite data*. A second storm produced wind damage within a few miles of the actual tornado path that same night. The ground survey team thought that this damage might be from the tornado. However, the satellite data showed that the path was further to the NW. The satellite data also helped us fine tune the path north of Lake City. *The satellite data has proven once again to be a great asset for our storm surveying operations.*"

Figure created by the SPoRT Disaster Response Team.

Original Damage Polygon (5/14/2015)
EF 0
Updated Damage Polygon
EF 0
EF 1
TSTM/Wind

0 1 2   4   6   8
Km

0   0.1 0.2   0.4   0.6
Km

Approximately 4 km

Satellite Image :
SPOT Panchromatic (12 May 2015)

Ques'ons?

- andrew.molthan@nasa.gov