SPoRT/MSFC Applied Science: Disaster Activities

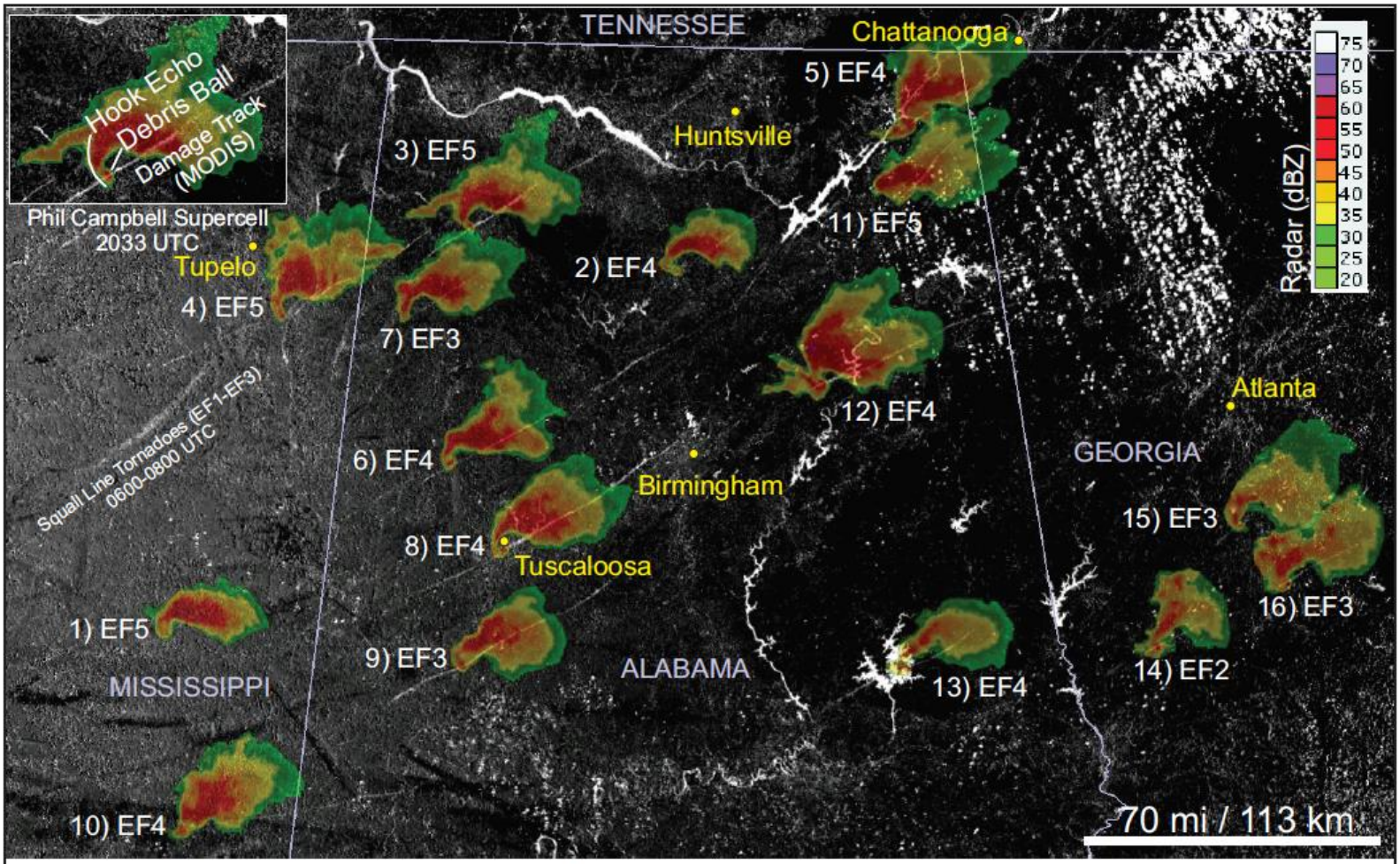
GHRC Users Working Group Meeting

25-26 September, 2014

National Space Science and Technology Center, Huntsville, AL

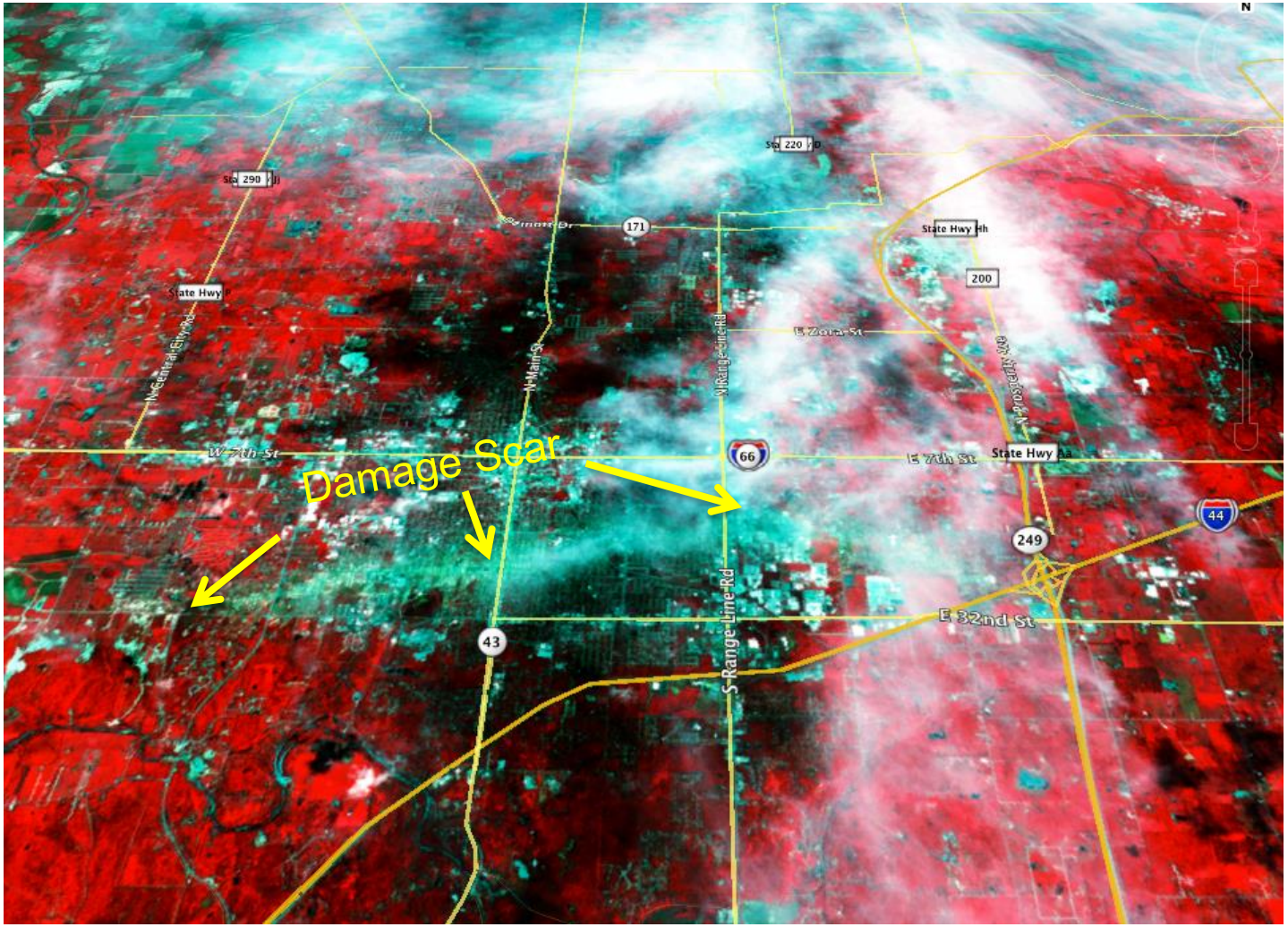
Disaster Response Activities

- SPoRT has increased involvement in disaster response:
  - Support for imagery to WFOs or the broader community following April 27, 2011 and other significant weather events
    - Extended previous work by Jedlovec et al. (2006) by providing MODIS short-term land surface change (scars) and higher-resolution ASTER to aid with April 27 track refinements and post-storm surveys
    - Developed false color composites and other products for other tornadoes in 2011 and the years that followed
  - Use of VIIRS DNB for power outage detection
    - Developed techniques for identifying power outages that result from severe storms and tropical cyclones by using the VIIRS day-night band
  - Use of commercial, higher-resolution imagery
    - Examined higher-resolution commercial imagery via USGS to develop preliminary damage identification and classification techniques



1) Philadelphia, MS, 1938
2) Cullman, AL, 1956
3) Phil Campbell, AL, 2033
4) Smithville, MS, 2038
5) Section, AL, 2115
6) Cordova, AL, 2210
7) Haleyville, AL, 2210
8) Tuscaloosa, AL, 2210
9) Sawyerville, AL, 2255
10) Raleigh, MS, 2331
11) Rainsville, AL, 2338
12) Shoal Creek, AL, 2335
13) Lake Martin, AL, 0142
14) Pine Mtn. Valley, GA, 0403
15) Birdie, GA, 0417
16) Meansville, GA, 0449

Reproduced from Molthan et al. (2012), this difference image from Terra and Aqua MODIS identifies tornado damage scars (white to gray) along the path of various supercells observed by radar during the afternoon and evening of April 27, 2011.



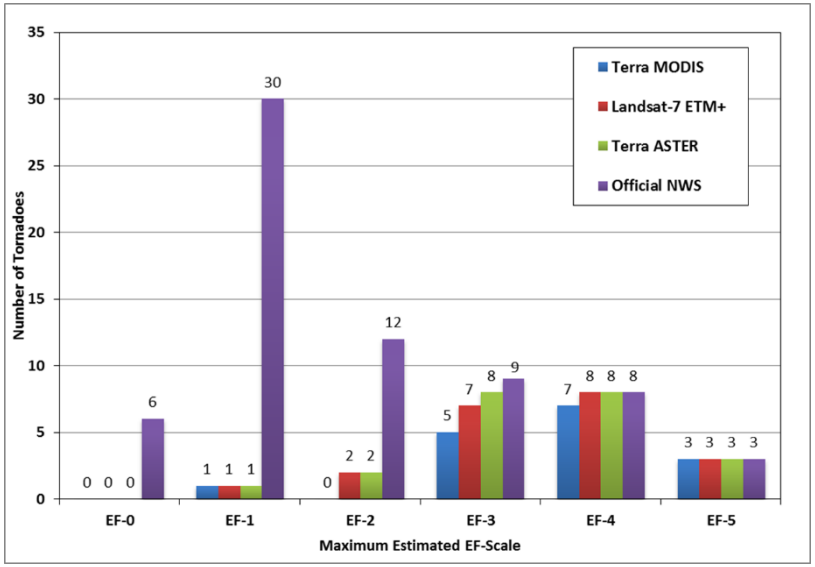
False color image combination from Terra ASTER, acquired on May 30, 2011, identifying the tornado damage scar across the community of Joplin, Missouri. Imagery viewed through Google Earth on a tilted plane at reduced resolution. Full resolution ASTER imagery is available at 15 m.

Applied Science Feasibility Study

- Efforts to support tornado damage detection techniques were continued through a ROSES Applied Sciences: Disasters proposal as a *feasibility study* in partnership with NOAA/NWS.
  - Feasibility study ran through 2012-2013
  - In the “feasibility study” phase, our goal was to demonstrate the ability to integrate Earth remote sensing within the DAT, and show potential value in a longer-term collaboration.

Applied Science Feasibility Study

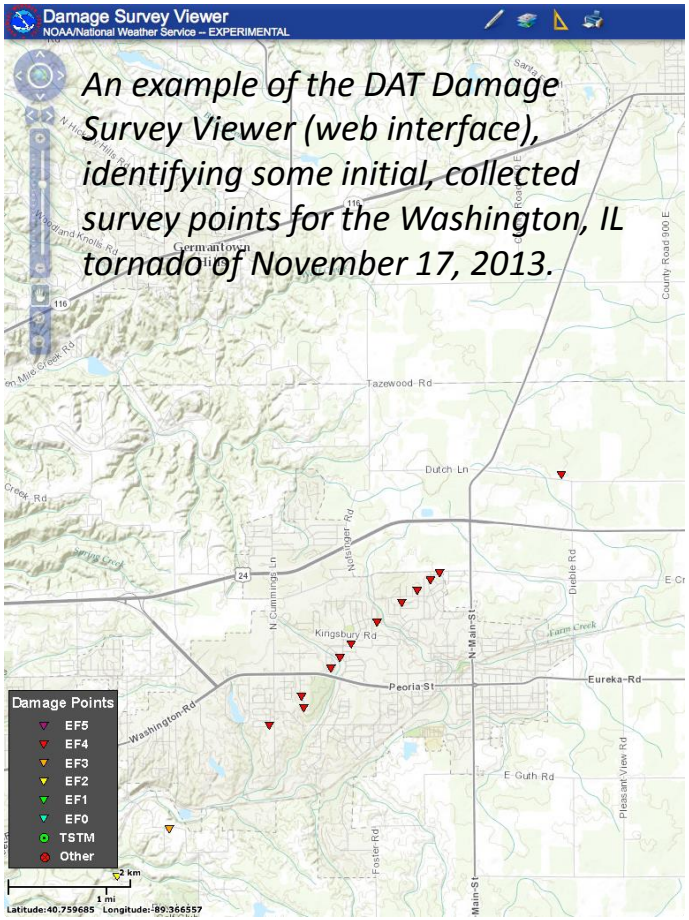
- As part of the feasibility study phase, the team evaluated tornado track detections across Alabama following the April 27, 2011 events.
- General conclusions:
  - Analysts could frequently identify damage tracks from single-day NDVI imagery using sensors such as ASTER (15 m), Landsat-7 (30 m), and MODIS (250 m).
  - Tracks were most frequently identified for tornadoes with maximum intensity of EF-3 and greater.
  - Less intense tornadoes were harder to identify due to limited path width and vegetation damage, though in some cases, higher resolution imagery was valuable for filling in track details.



Reproduced from Molthan et al. (2014), counts of identified NDVI scars (damage tracks) identified by various satellite sensors, based upon observations of tracks resulting from the April 27, 2011 event.

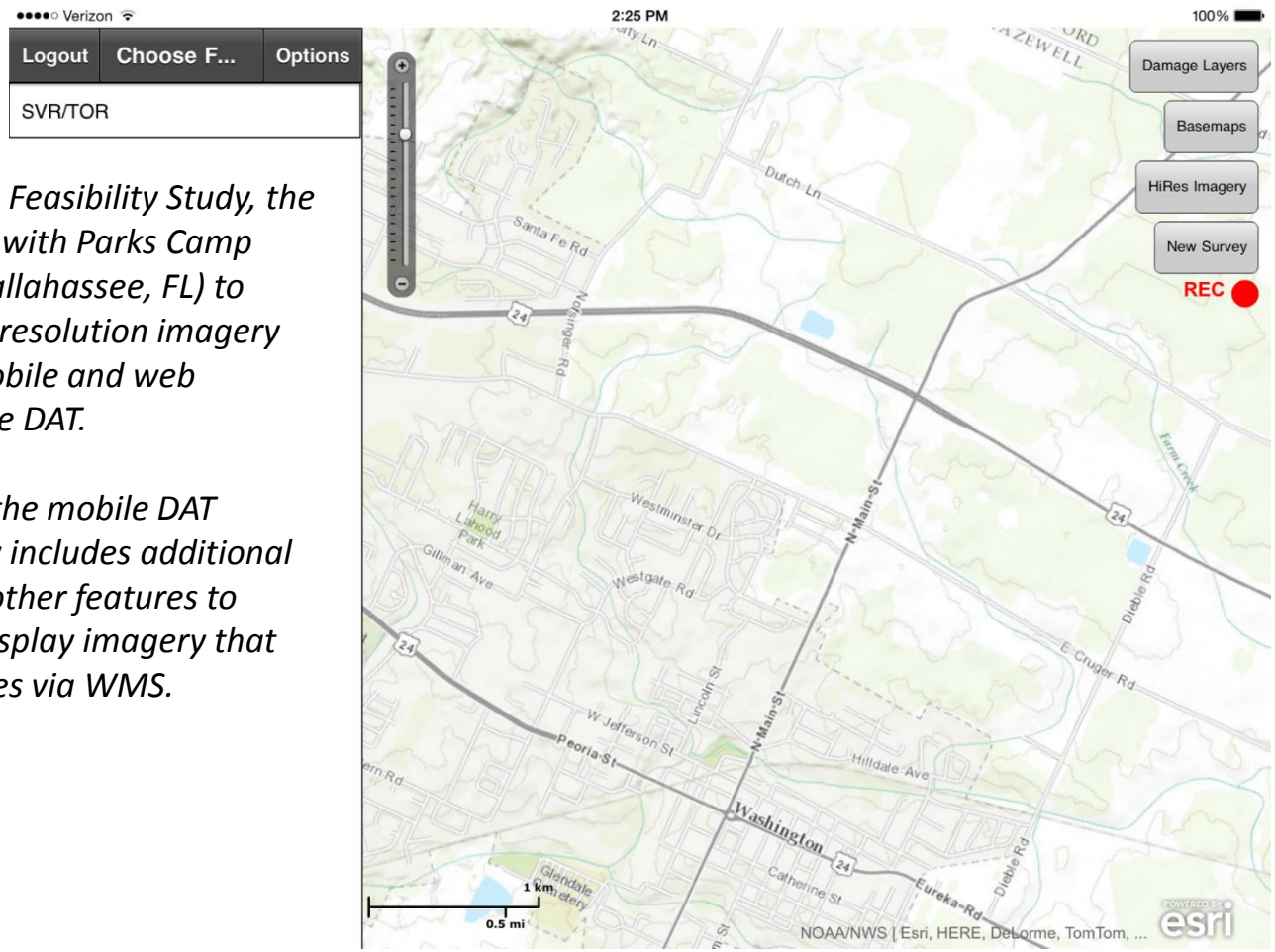
Applied Science Feasibility Study

- The feasibility study focused on inclusion of Earth remote sensing within the NOAA/NWS Damage Assessment Toolkit, or DAT.
- The DAT is a smartphone, tablet, and web-based framework for acquiring tornado damage locations and assigning estimated intensity.
- Once acquired, the various data points are then used to characterize the damage path and assign overall intensity or intensity at various points along the path.



An example of the DAT Damage Survey Viewer (web interface), identifying some initial, collected survey points for the Washington, IL tornado of November 17, 2013.

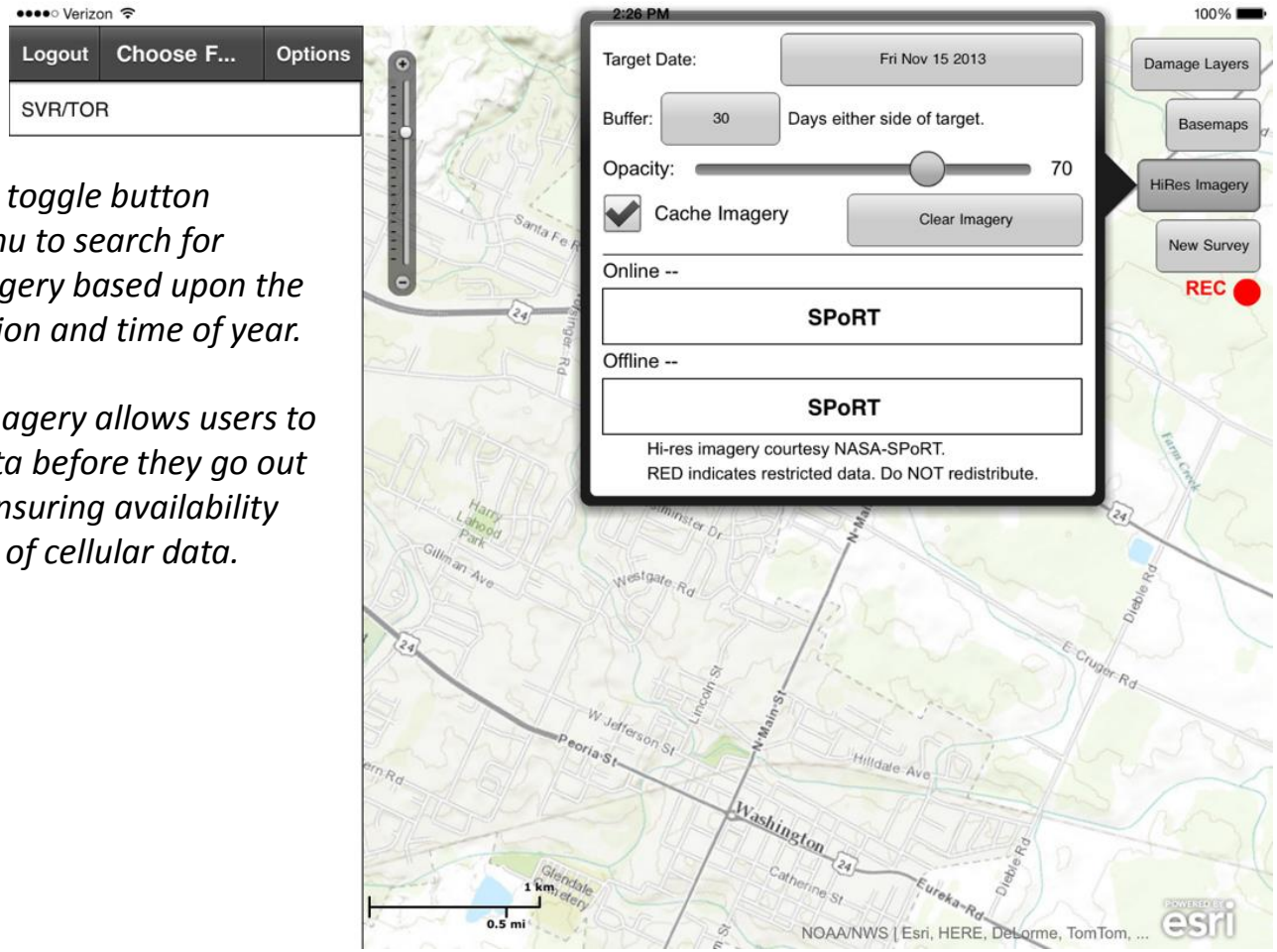
Applied Science Feasibility Study



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

Shown here, the mobile DAT interface now includes additional buttons and other features to search and display imagery that SPoRT provides via WMS.

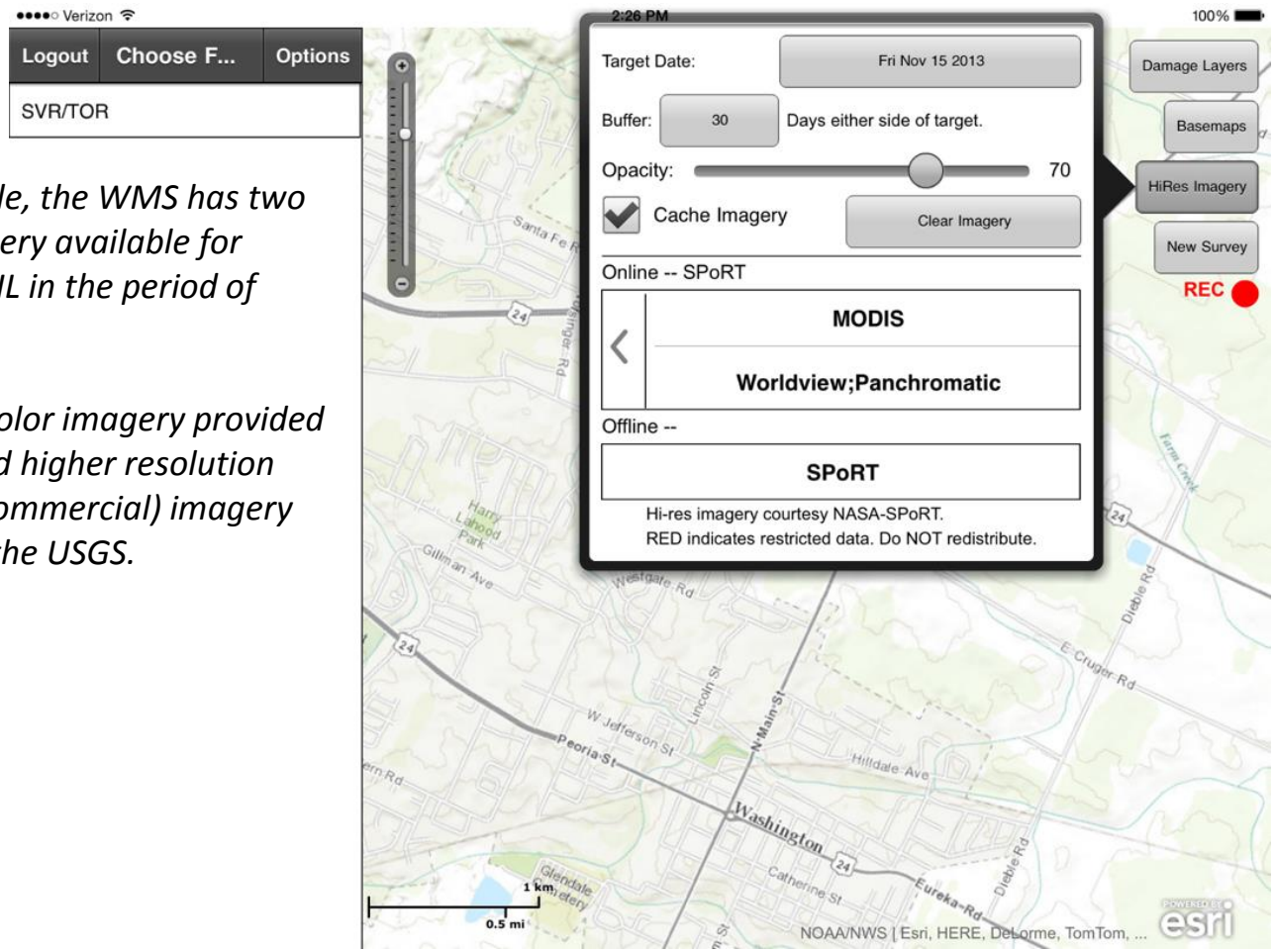
Applied Science Feasibility Study



An additional toggle button creates a menu to search for available imagery based upon the viewing location and time 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.

Applied Science Feasibility Study

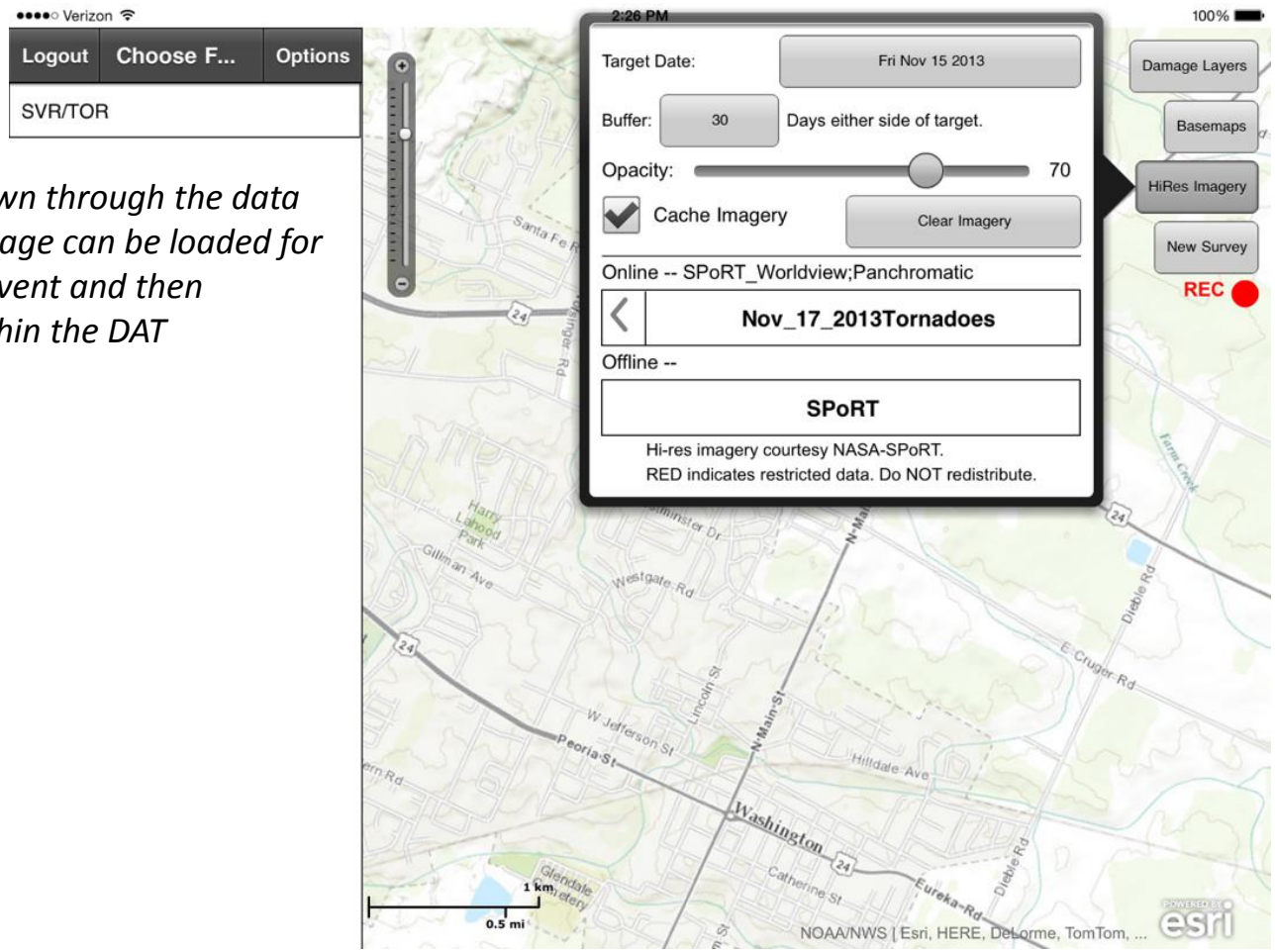


In this example, the WMS has two types of imagery available for Washington, IL in the period of interest:

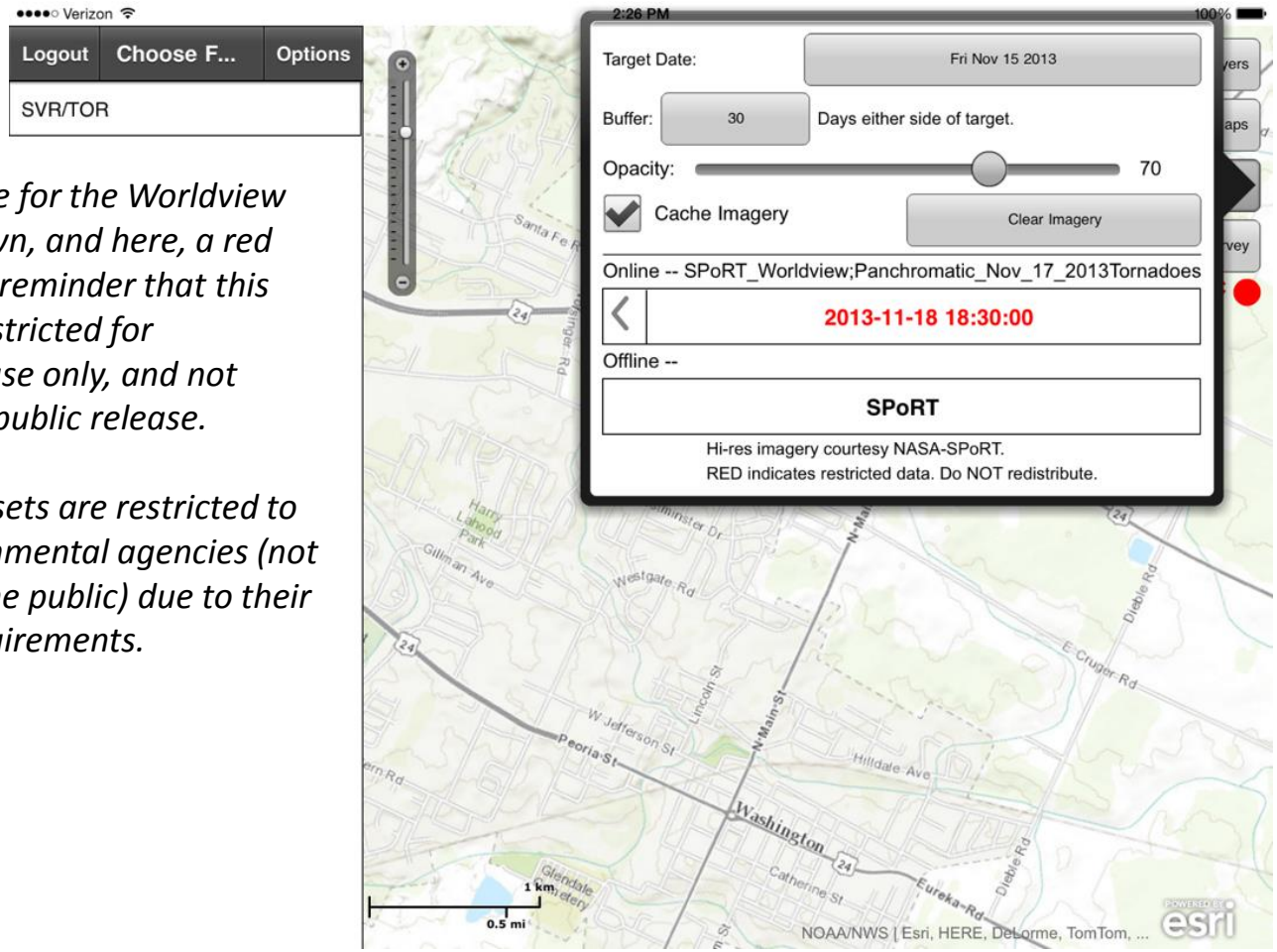
MODIS true color imagery provided via SPoRT, and higher resolution Worldview (commercial) imagery provided via the USGS.

Applied Science Feasibility Study

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



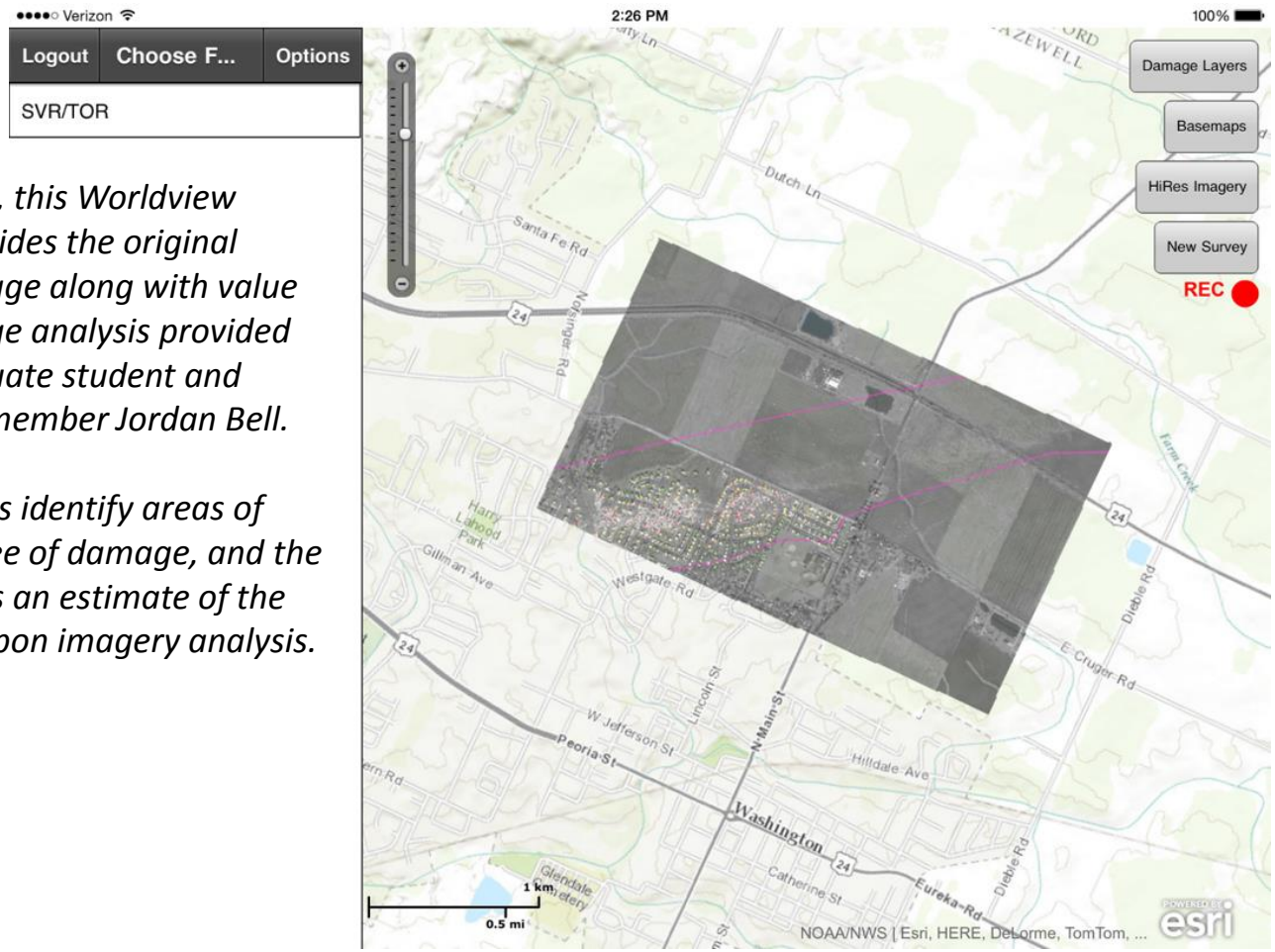
Applied Science Feasibility Study



Date and time 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.

Applied Science Feasibility Study



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 identify areas of varying degree of damage, and the pink outline is an estimate of the path based upon imagery analysis.

Applied Science Feasibility Study

The DAT application allows for pinching and zooming, just like Google Maps.

The WMS continues to provide higher resolution tiles, up to full resolution 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 identify damage in adjacent areas, clarify previous structures via pre-event imagery, and provide other analysis capabilities.

Applied Science Decisions Award

- Following our successful "feasibility study" award, the team was awarded a three-year follow-on "Decisions" award
  - Goals of the Decisions phase require a transition of track detection capabilities to NOAA/NWS operations
  - During this transition phase, the proposal team will provide support and guidance to NOAA/NWS on the use and integration of satellite products for the DAT

Applied Science Decisions Award

- Goals of the Decisions award include:
  - Near real-time products to the DAT, derived from MODIS and VIIRS. Likely products include vegetation index (NDVI) and short-term change detection.
  - The team will develop additional tools to aid NOAA/NWS in the integration and processing of imagery from ASTER, Landsat-7, and Landsat-8
  - New tools and capabilities for the processing and display of highest resolution commercial imagery
  - Support to end users with relevant training, end-user surveys and improvements via end user feedback
- Recently, the team met in July 2014 to carve out an initial, but comprehensive plan to transition capabilities to NOAA/NWS implementation

Future Work

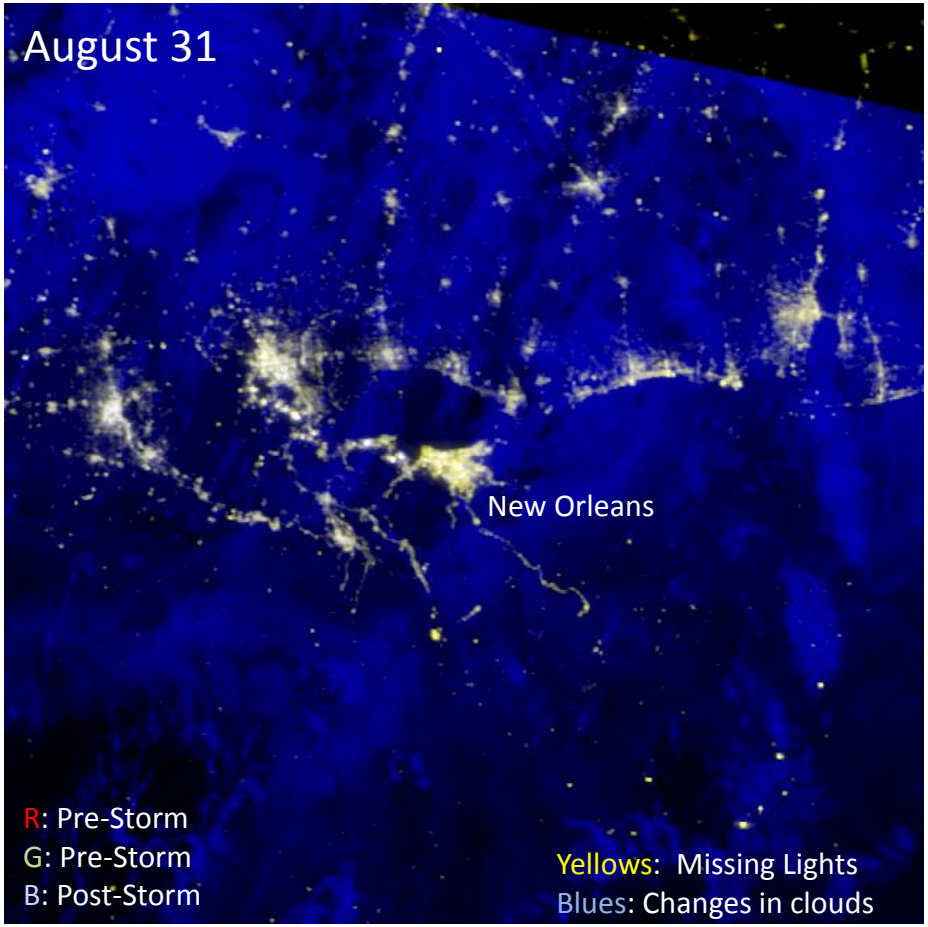
- SPoRT will further develop web mapping service capabilities to expand the reach and applicability of disaster-related imagery.
- Over the past several months, WMS knowledge and capabilities have grown, along with partnerships in USGS to aid in acquiring post-disaster imagery.

Backup

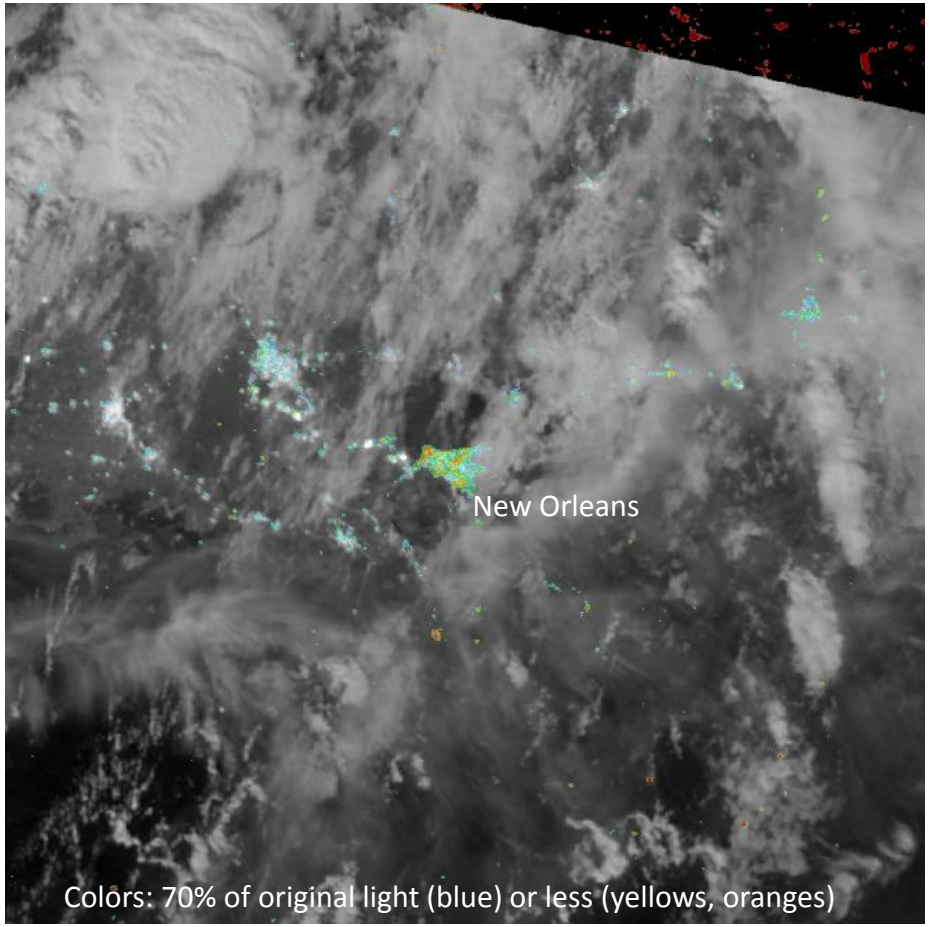
Use of the VIIRS DNB

- Since the VIIRS DNB observes light emitted from human activities, we focus on the loss or change in pre-event light in order to identify affected areas and recovery
- Two concepts have been explored to date:
  - False color RGB compositing to highlight changes in light
    - Using a composite where R and G are pre-event, and B as post-event, missing lights are highlighted in shades of yellow.
  - Differencing pre- and post-event to produce a “percent of normal light”
    - In a more quantitative approach, dividing current emissions by a reasonable pre-event baseline allows for monitoring current light conditions and trends toward normal during recovery efforts
- Disaster response can be further supported by identifying populations and infrastructure located within outage areas.

Concepts Applied to Hurricane Isaac

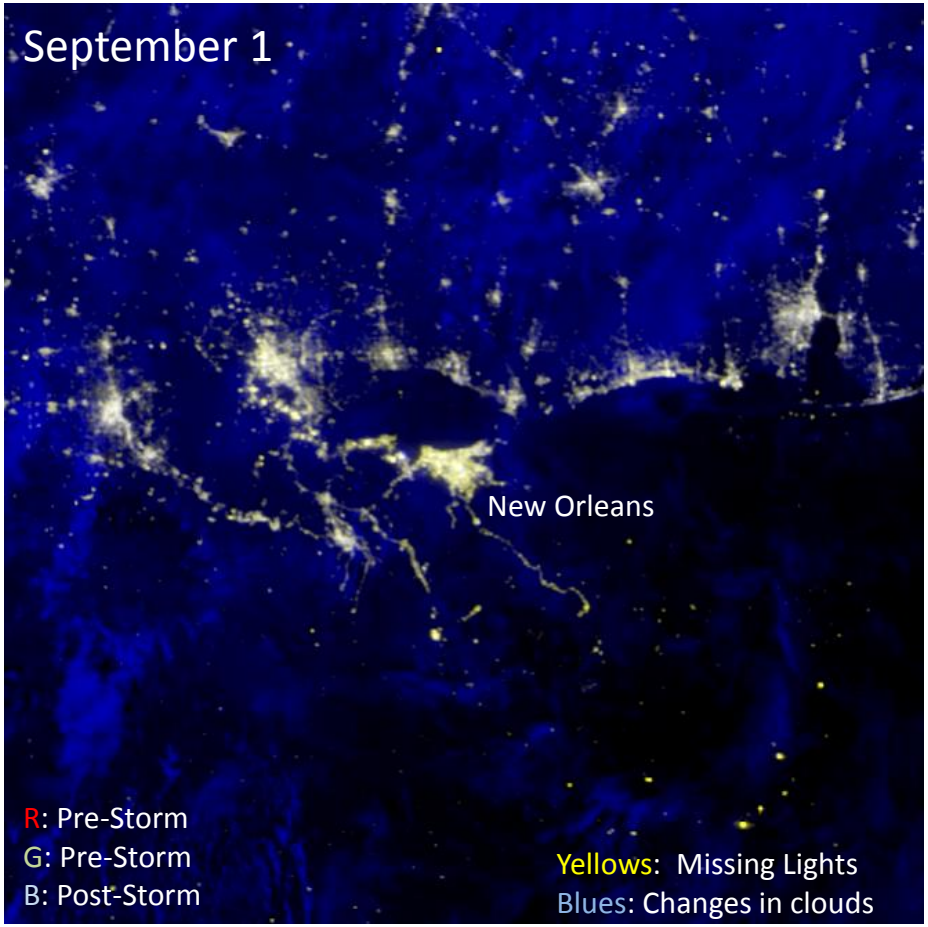


False color composite of pre- and post-storm VIIRS DNB imagery over New Orleans, immediately following Issac.

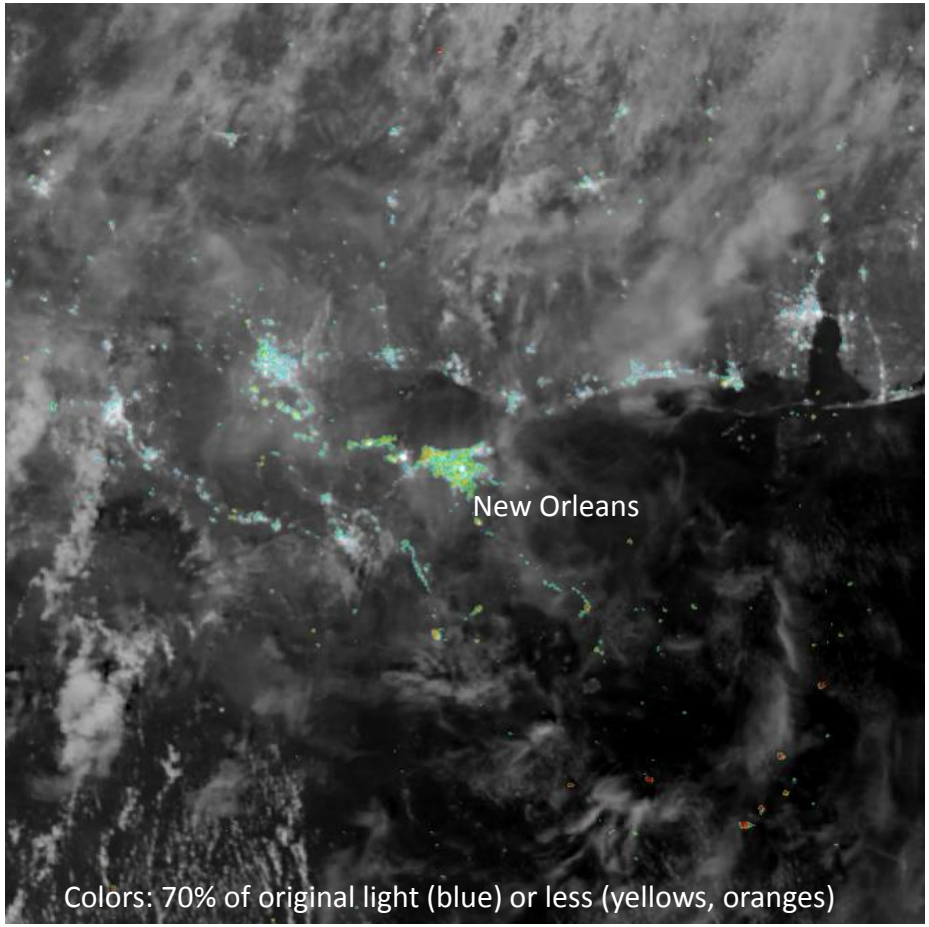


VIIRS DNB imagery (moonlit clouds, emitted light) following Isaac, superimposed with "percent of normal" light, based upon differencing of clear pre-storm imagery.

Concepts Applied to Hurricane Isaac

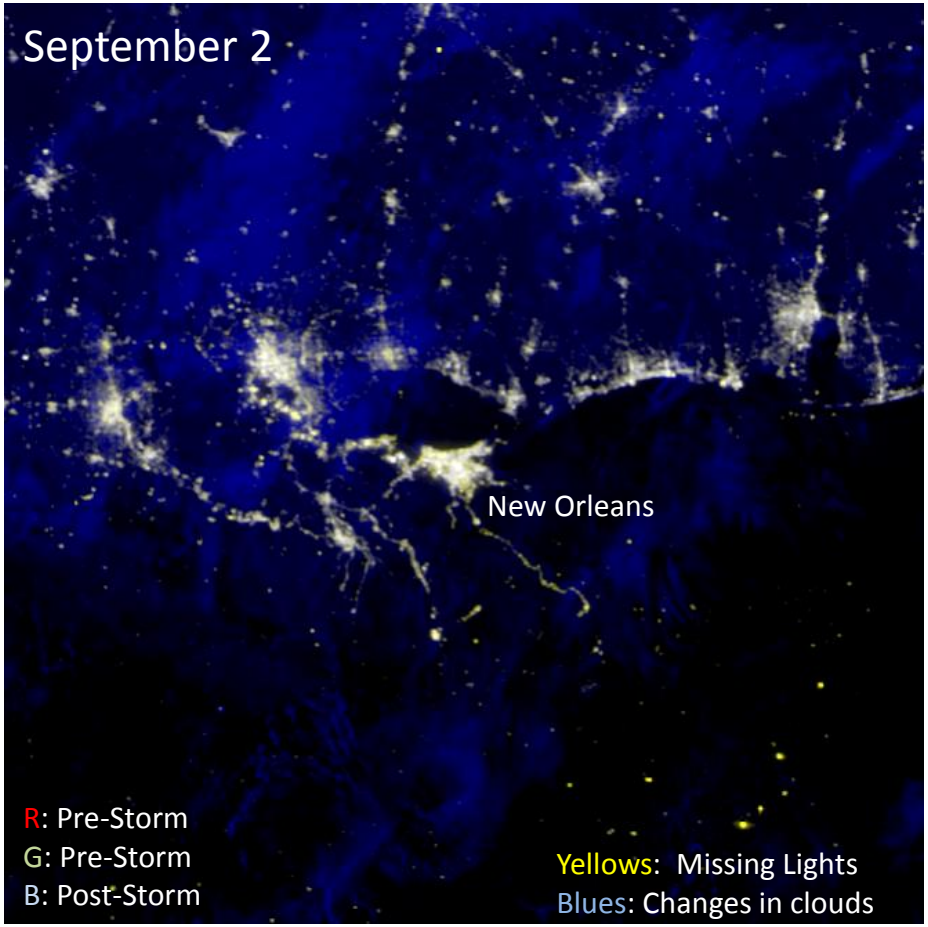


False color composite of pre- and post-storm VIIRS DNB imagery over New Orleans, as power recovery continued.

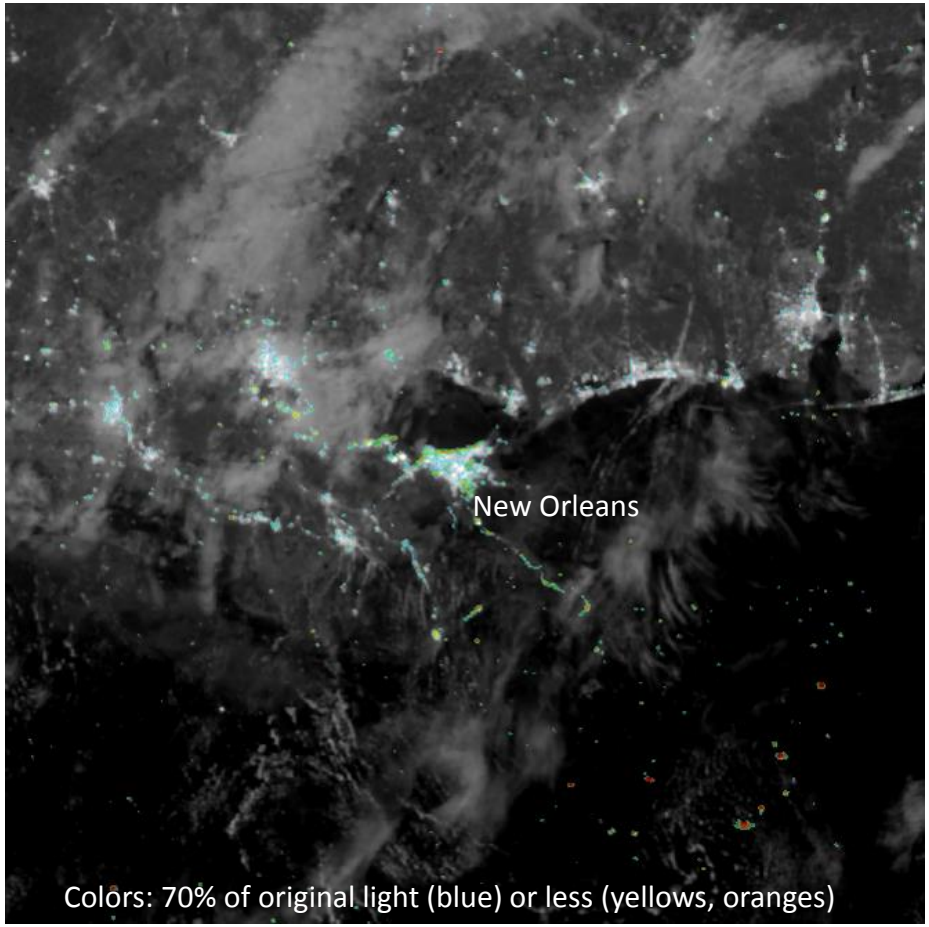


VIIRS DNB imagery (moonlit clouds, emitted light) following Isaac, superimposed with "percent of normal" light, based upon differencing of clear pre-storm imagery.

Concepts Applied to Hurricane Isaac

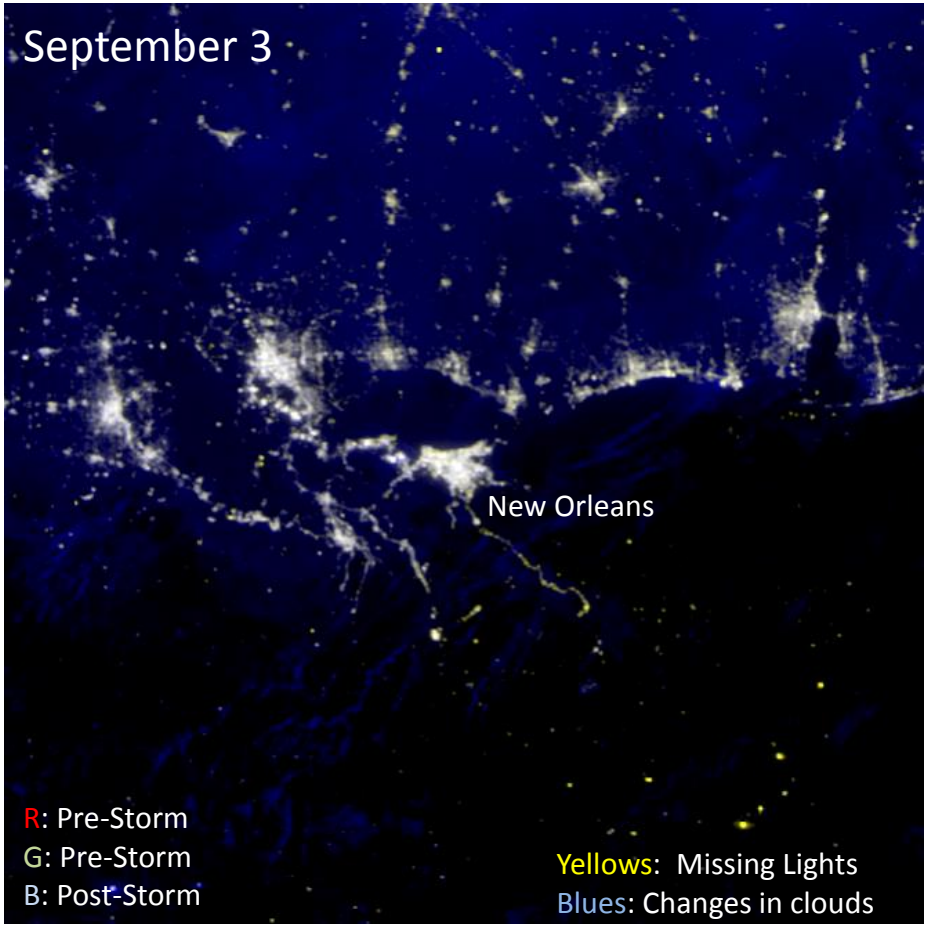


False color composite of pre- and post-storm VIIRS DNB imagery over New Orleans, as power recovery continued.

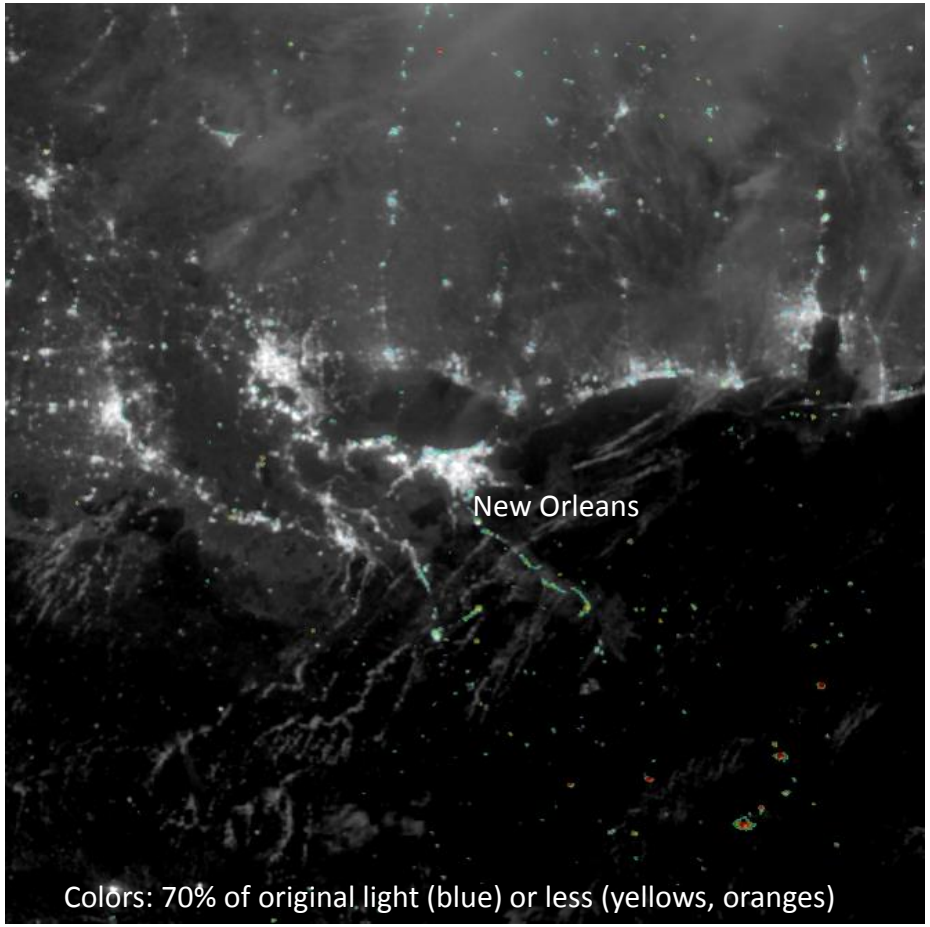


VIIRS DNB imagery (moonlit clouds, emitted light) following Isaac, superimposed with "percent of normal" light, based upon differencing of clear pre-storm imagery.

Concepts Applied to Hurricane Isaac

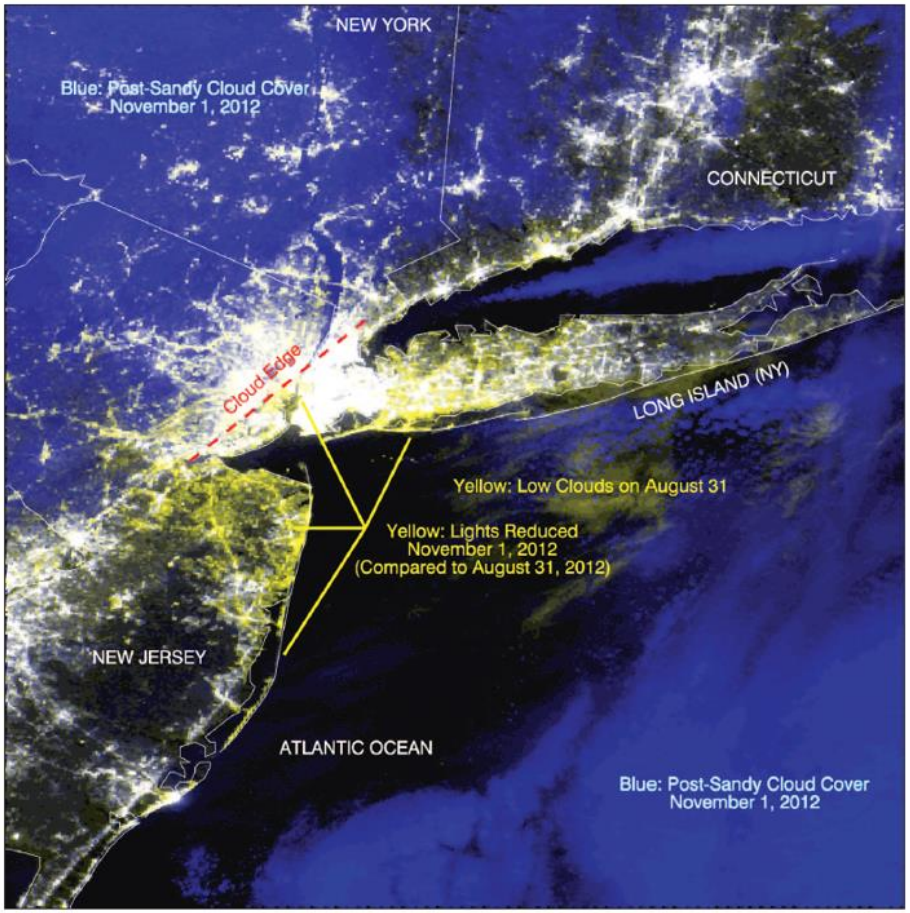


False color composite of pre- and post-storm VIIRS DNB imagery over New Orleans, as power recovery continued.

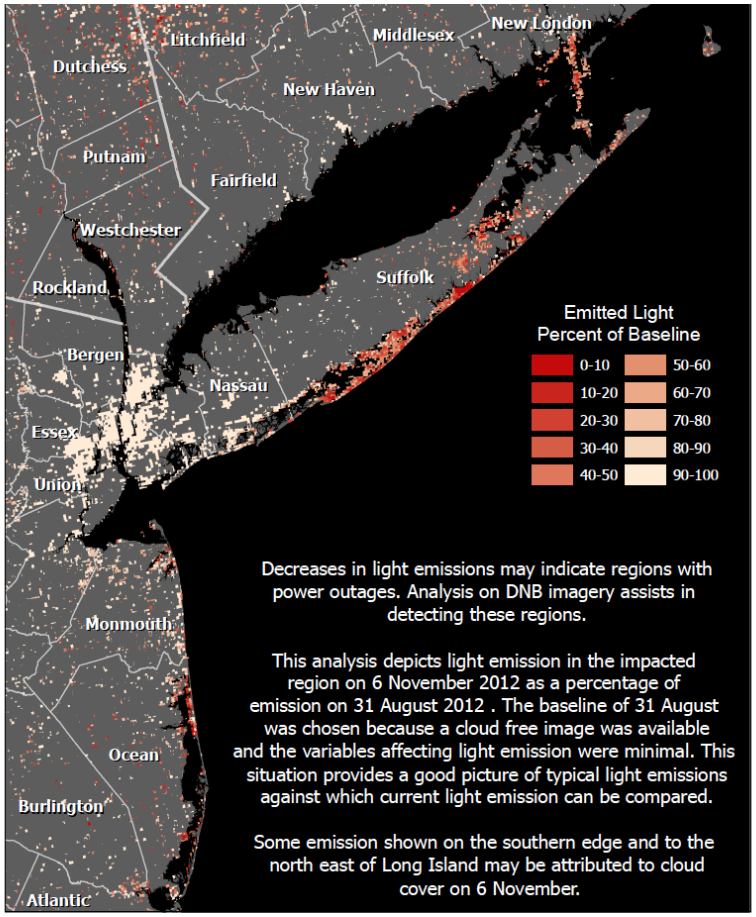


VIIRS DNB imagery (moonlit clouds, emitted light) following Isaac, superimposed with "percent of normal" light, based upon differencing of clear pre-storm imagery.

Concepts Applied to Superstorm Sandy



False color composite of pre- and post-storm VIIRS DNB imagery over New York and New Jersey following Superstorm Sandy (reproduced from Molthan et al. 2013)



SPoRT provided U.S. Northern Command with daily VIIRS DNB and guidance on deriving "percent of baseline" light emissions used by DoD in recovery efforts.