



# Ohio River Temperature Survey Utilizing Satellite Imagery

Agenda Item 20  
207<sup>th</sup> Technical Committee Meeting  
February 11-12, 2015

Informational Item

Steve Braun

# Objectives

1. Understand the impacts of thermal discharges during the summer to the Ohio River
2. Determine if ORSANCO can access and interpret the data without the use of a contractor



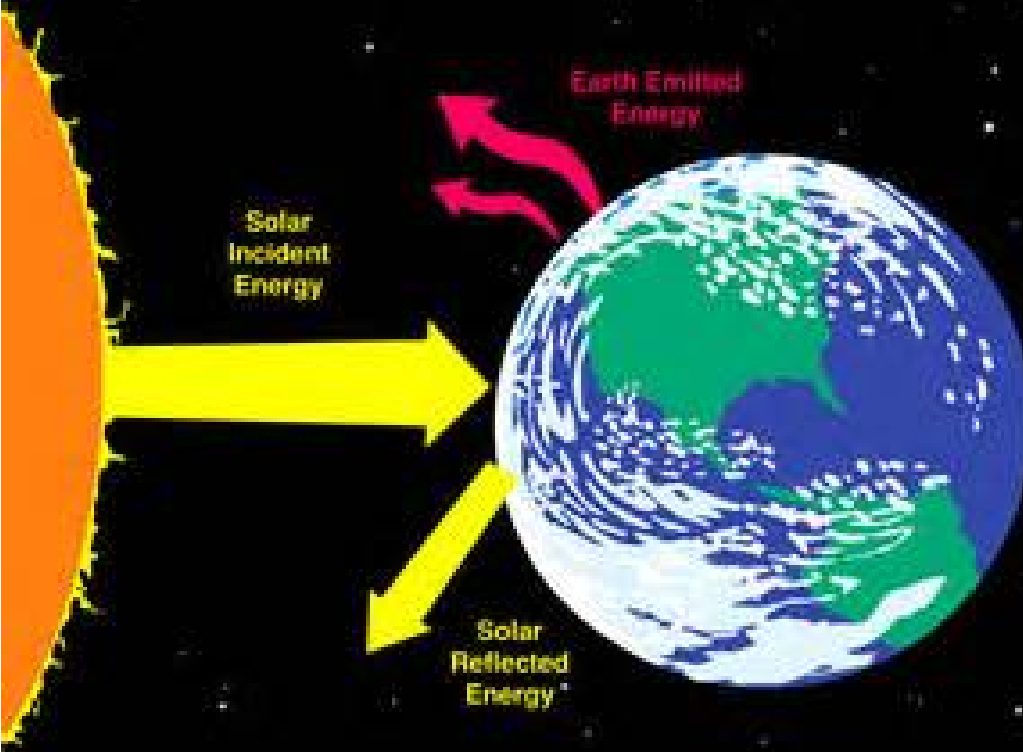
# Remote Sensing

Measurement of a quantity associated with an object by a device not in direct contact with the object

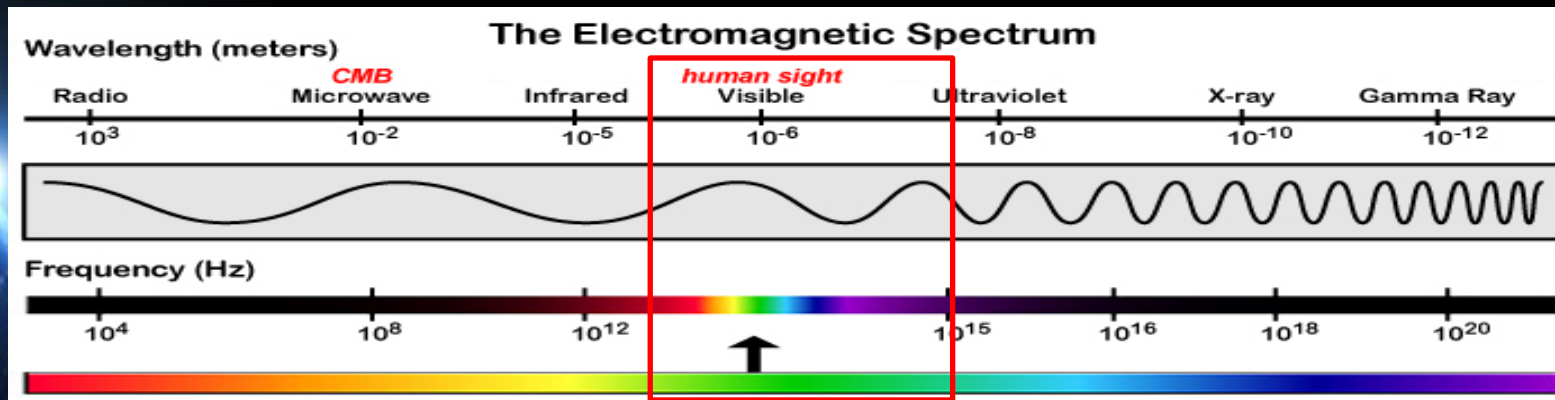


# Remote Sensing of Water Quality

## Earth Radiation Components



Reflected solar radiation back to space and emitted infrared radiation are used



# Remote Sensing of Water Quality Parameters

- Color
- Temperature
- Suspended Sediments
- Salinity
- Algal Bloom/Chlorophyll-a
- Cyanobacteria
- Total Phosphorous
- Dissolved Organic Carbon
- Aquatic Vascular Plants
- Oils
- Some Metals (in development)

# Remote Sensing of Water Quality Parameters continued

- All change the energy spectra of the reflected/emitting thermal radiation from surface waters so they can be derived from RS measurements
- Most Chemicals and pathogens do not directly affect the spectral properties of surface waters

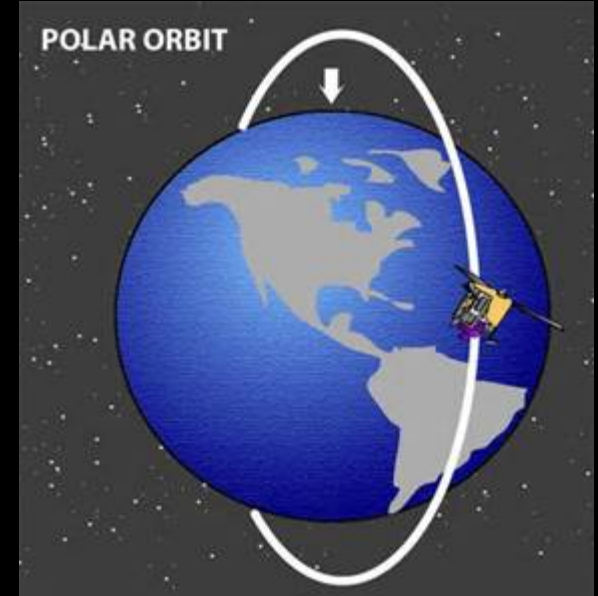


# **Objective 1. Understand the impacts of thermal discharges during the summer to the Ohio River**

- **Contract with Blue Water Satellite**
  - **Provided Satellite imagery and temperature data for entire Ohio River for the Aug. and Sept. of 2010 (avg hottest months and year from 2009-2013)**
    - **Data had a 30m x 30m resolution (Ohio River in Louisville is 500 m wide)**
    - **Accuracy is  $\pm 2.74$  deg. F.**
    - **Temperature at surface of water**

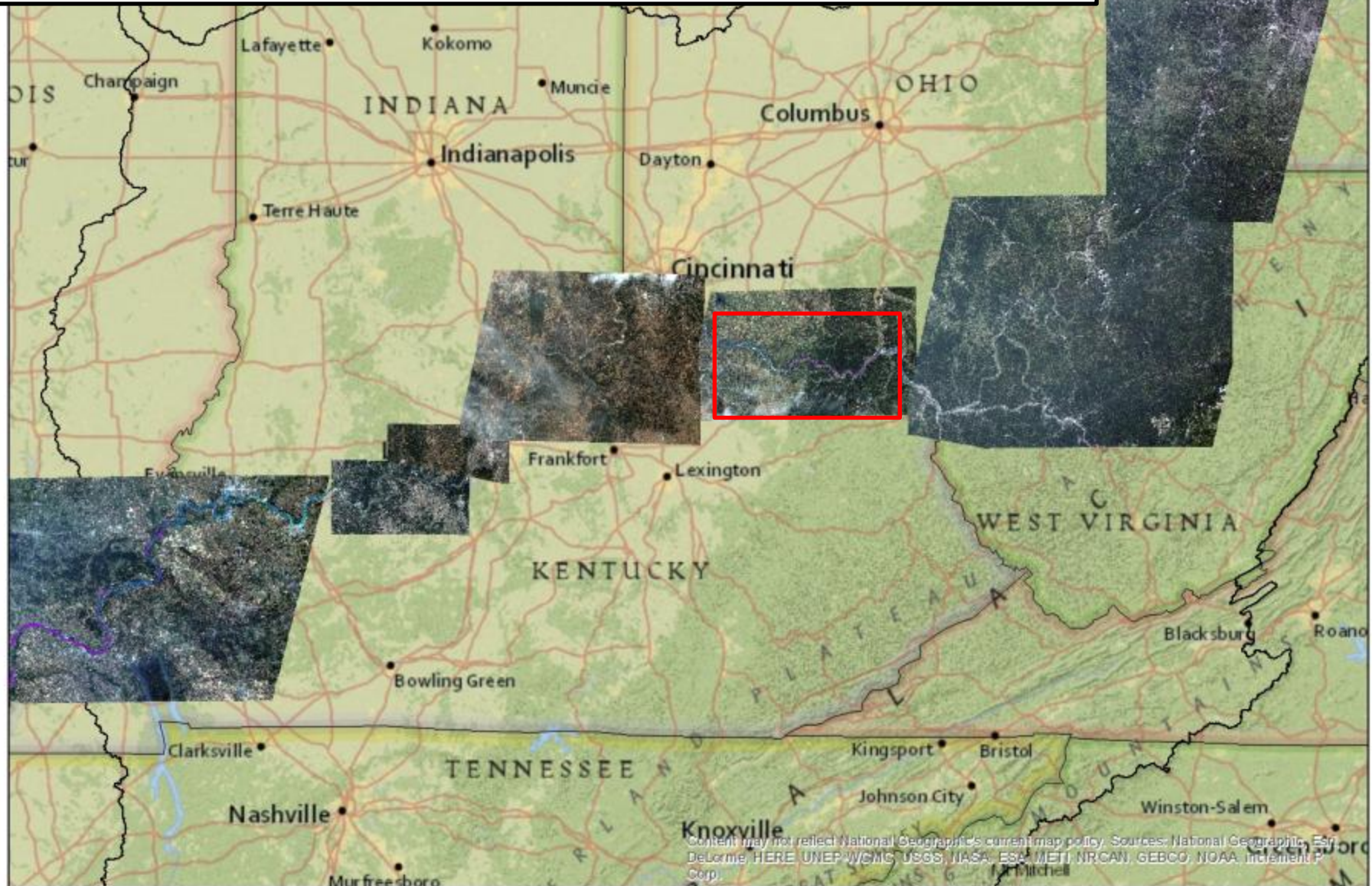
# Satellites Used

- Landsat 7 and 8
- 438 miles above earth
- 4.7 miles/second
- Launched Feb 11, 2013
- Orbits earth 15 times per day
- 8 day cycle
- 5-10 year life expectancy
- All data is free from USGS



# Blue Water Satellite Project Output Overview

## Summer 2010



# Area of Interest 3 example (River Miles 330.6 – 445.6)

9-8-2010 (Julian Day 251)

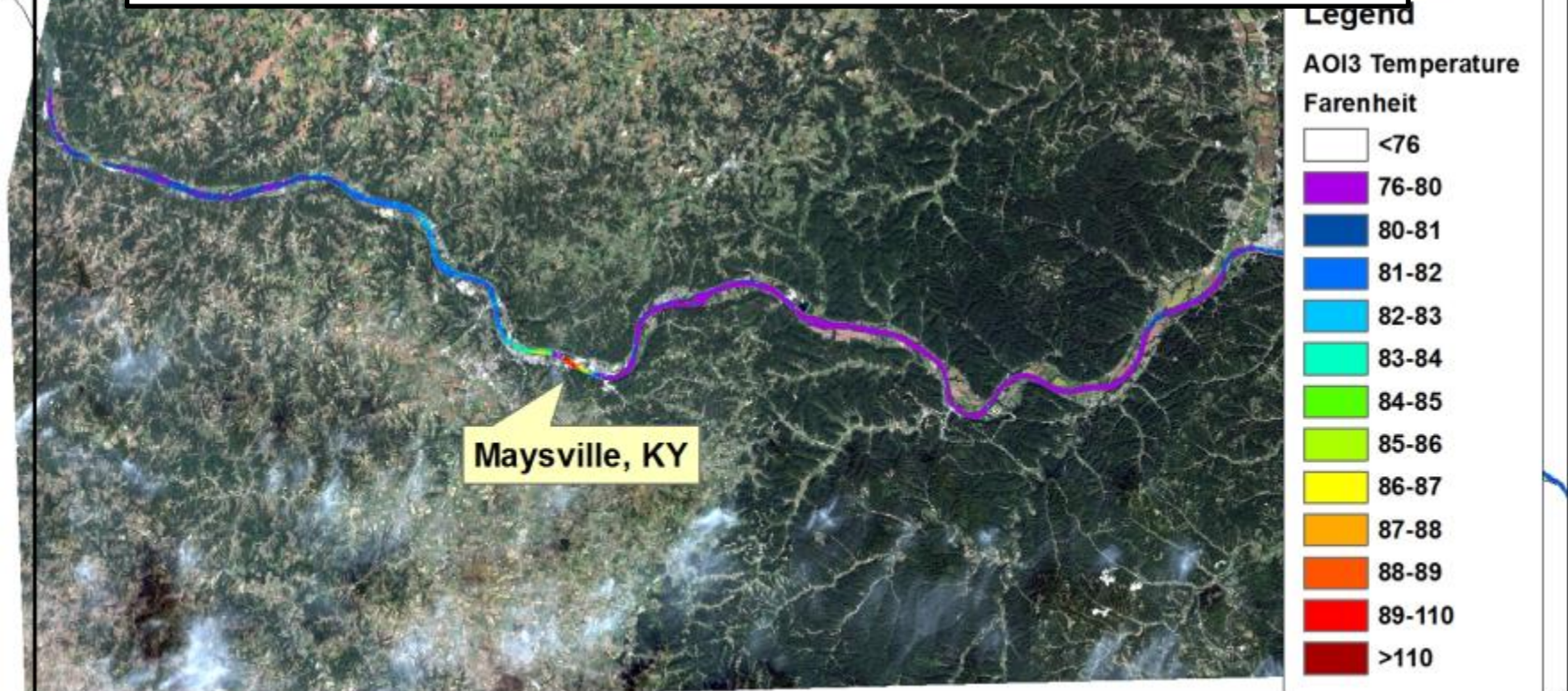
Air Temp = 63 min – 93 max

In-situ temp @ Greenup = 83 deg. F

Satellite temp range = 76.7 – 108.7

Aquatic Life Protection Criterion = 87 deg. F

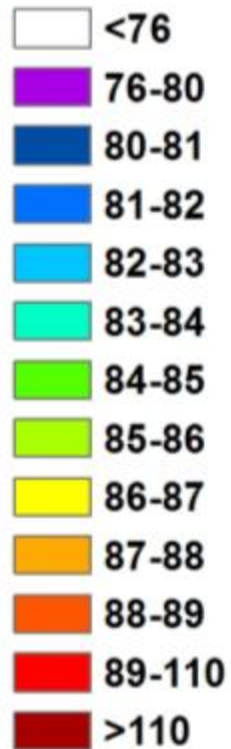
Human Health Protection Criterion = 110 deg. F



# AOI 3 Example 9-8-2010

76-80 deg. F  
RM 423.8

## AOI3 Temperature Farenheit

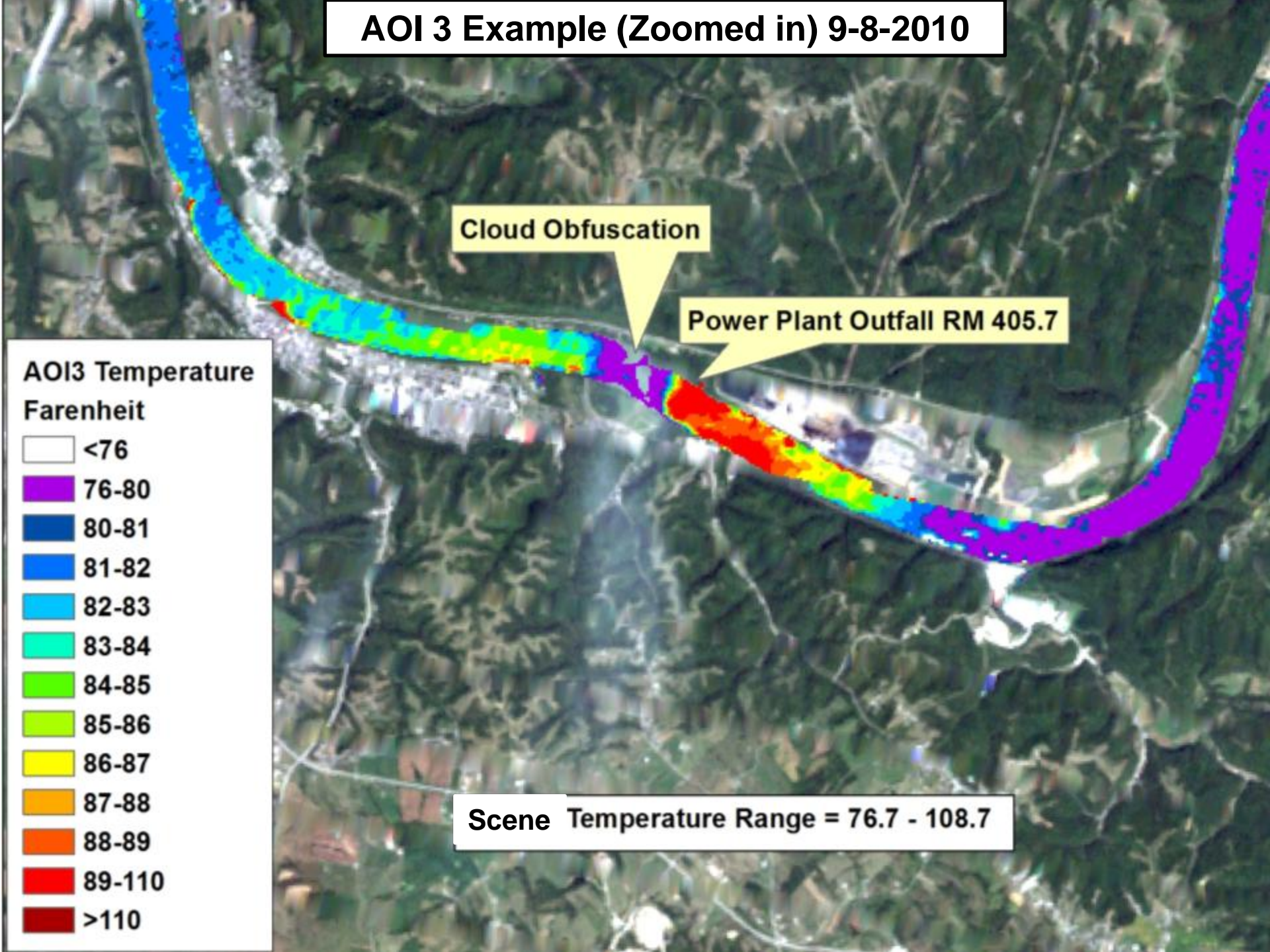


76-80 deg. F

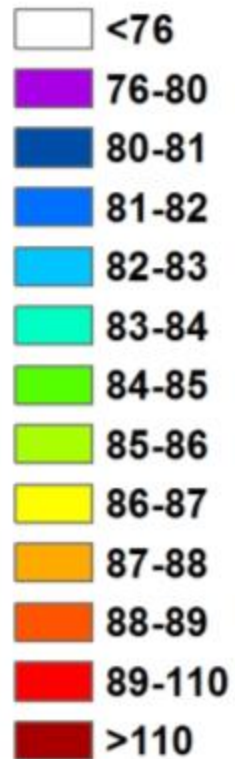
Cloud Obfuscation

Power Plant Outfall RM 405.7

# AOI 3 Example (Zoomed in) 9-8-2010



## AOI3 Temperature Farenheit



# Temperature Violation Example

## 9-8-2010

Cloud Obfuscation

Power Plant Outfall RM 405.7

### AOI3 Temp Violations

Farenheit

 <87

 87-110 Aquatic Life

 >110 Human Health

Current View

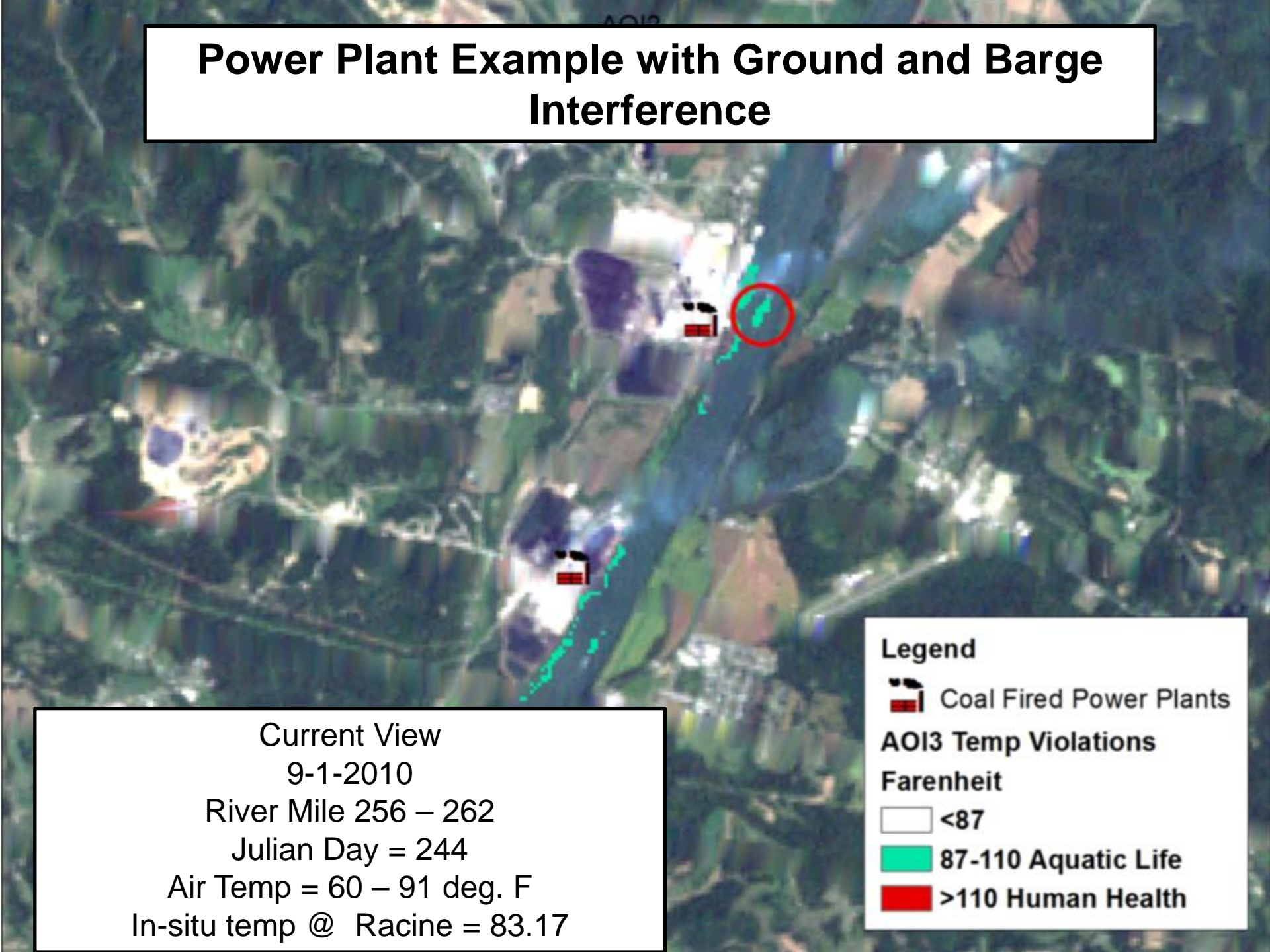
Julian Day = 251

River Mlle = 399.0 - 411.1

Air Temp = 63 - 93 deg. F

In-situ Temp @ Greenup (RM 341) = 83 deg. F

# Power Plant Example with Ground and Barge Interference



Current View

9-1-2010

River Mile 256 – 262

Julian Day = 244

Air Temp = 60 – 91 deg. F

In-situ temp @ Racine = 83.17

## Legend



Coal Fired Power Plants

AOI3 Temp Violations

Farenheit



<87

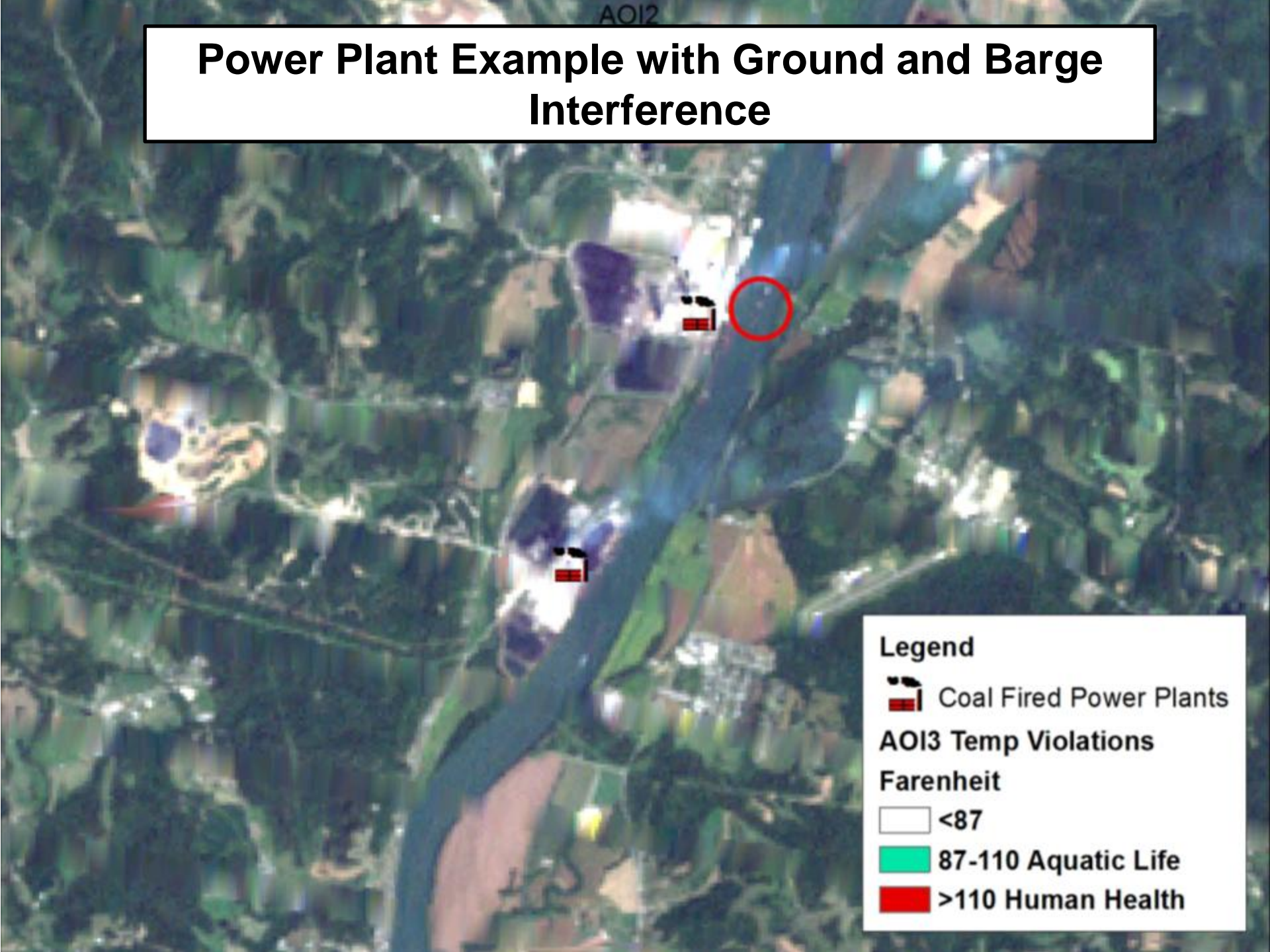


87-110 Aquatic Life



>110 Human Health

# Power Plant Example with Ground and Barge Interference



## **Objective 1.**

**Understand the impacts of thermal discharges during the summer to the Ohio River**

## **Conclusion**

**Using Remote sensing, on specific days in August and September of 2010, no human health violations were observed. The only significant section of the river with aquatic life violations occurred at river mile 405.3 to 407.4 for both years**

# Ohio River Temperature Survey Utilizing Satellite Imagery

Objective 2 – Determine if ORSANCO can  
access and interpret the data without the use of  
a contractor



# All data is available online for free

The screenshot displays the USGS EarthExplorer web application. The browser's address bar shows the URL <http://earthexplorer.usgs.gov/>. The page features a navigation menu with links for Home, New System Message, Login, Register, Feedback, and Help. The main content area is divided into two sections: 'Search Criteria' and 'Search Criteria Summary (Show)'. The 'Search Criteria' section includes a '1. Enter Search Criteria' heading, instructions on how to narrow the search area, and input fields for Address/Place, Path/Row, Feature, Circle, Coordinates, and Date Range. The 'Search Criteria Summary' section shows a map of North America with a search area highlighted. The map includes a coordinate display of (52° 33' 15" N, 068° 05' 07" W) and a scale bar. The bottom of the screen shows a Windows taskbar with various application icons and a system clock indicating 3:53 PM on 2/3/2015.

USGS  
science for a changing world

EarthExplorer

Page Expires In 1:59:53

Search Criteria Data Sets Additional Criteria Results

1. Enter Search Criteria  
To narrow your search area: type in an address or place name, enter coordinates or click the map to define your search area (for advanced map tools, view the [help documentation](#)), and/or choose a date range.

Address/Place Path/Row Feature Circle

Show Clear

Coordinates Predefined Area Shapefile KML

Degree/Minute/Second Decimal

No coordinates selected.

Use Map Add Coordinate Clear Coordinates

Date Range Result Options

Search from: 01/01/1920 to: 02/03/2015

Search months: (all)

Data Sets Additional Criteria Results

Search Criteria Summary (Show)

Clear Criteria

(52° 33' 15" N, 068° 05' 07" W) Options Overlays Map Satellite

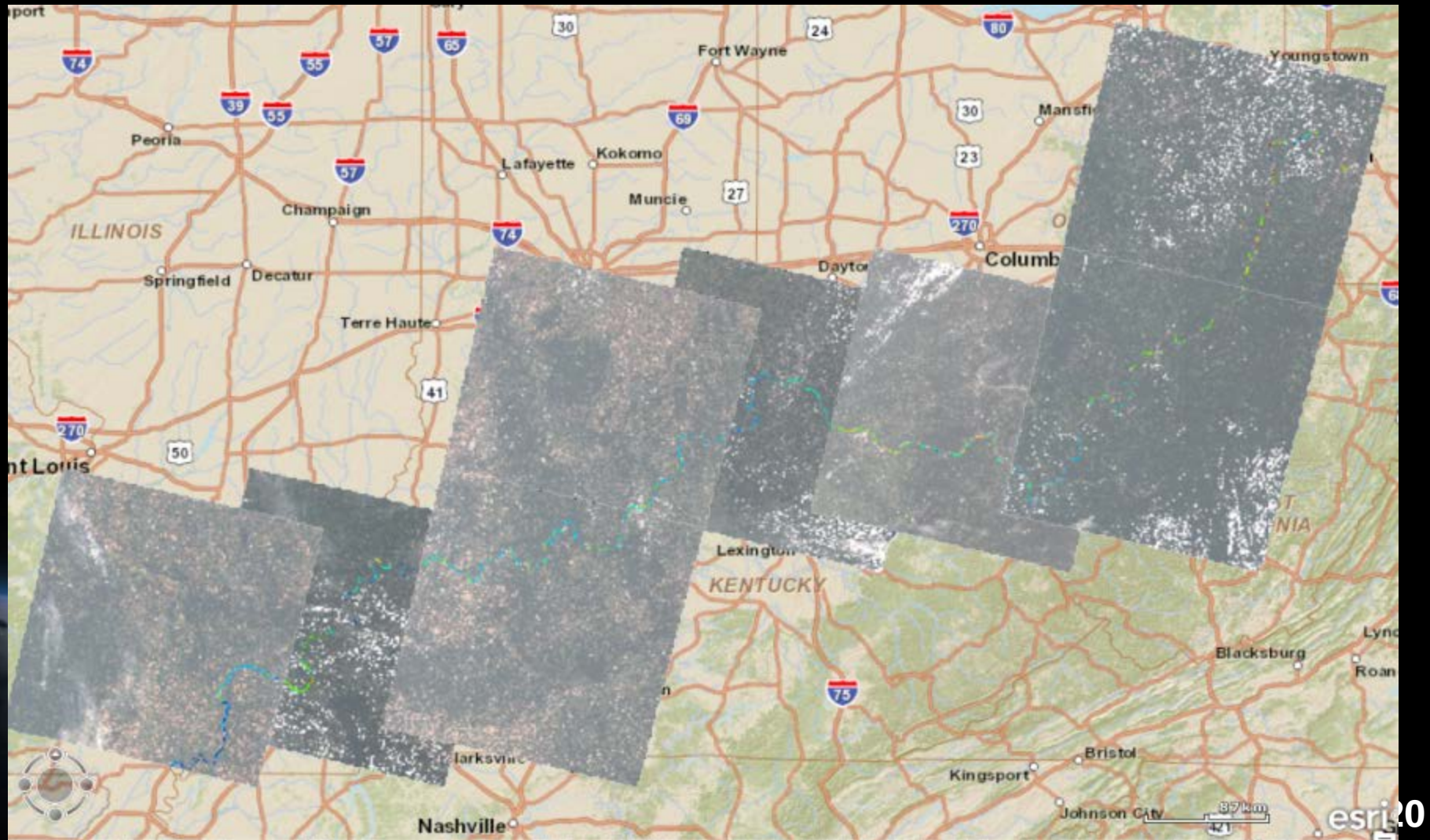
90%

3:53 PM  
2/3/2015

# Ohio River Temperature Survey



# 8 Scenes needed for spatial coverage of the Ohio River



# How ORSANCO Compared

Blue Water Satellite Comparison to ORSANCO Method [BWS accuracy +/-2.74 (f)]							
L&D	Scene Date	In-situ date	Avg. In-situ Temp	Avg. BWS temp	Diff. between BWS & In-situ	Avg. ORSANCO Temp	Diff. between ORSANCO & In-situ
Racine	9/1/2010	9/1/2010	83.17	83.295	0.13	84.15	0.98
Greenup	9/8/2010	9/9/2010	83	81.45	-1.55	84.2	1.20
Markland	9/15/2010	9/15/2010	78.8	71.4	-7.40	74.75	-4.05
Cannelton	9/6/2010	9/7/2010	82.09	82.95	0.87	83	0.92
Newburgh	8/28/2010	8/27/2010	85.67	83.85	-1.82	88.65	2.98
Newburgh	9/6/2010	9/7/2010	81.96	81.05	-0.91	83.6	1.64
J.T. Myers	8/28/2010	8/27/2010	84.975	80.6	-4.38	87.4	2.43
Smithland	8/28/2010	8/27/2010	85.665	80.1	-5.57	86.5	0.84
Average Difference between RS and in-situ					-2.58		0.87
Average Abs. Percent Difference between RS and in-situ					3.52		2.27

## Objective 2.

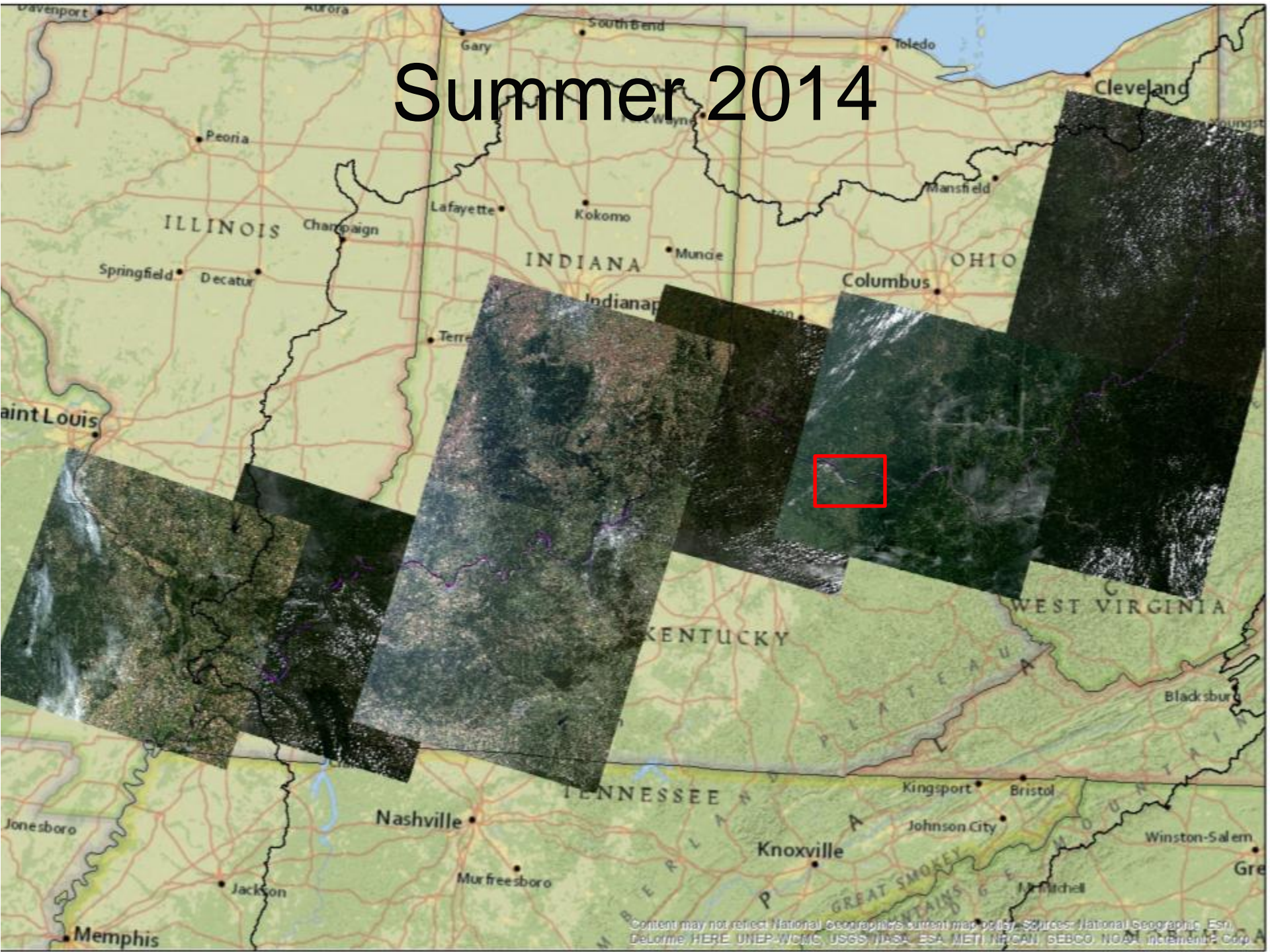
Determine if ORSANCO can access and interpret the data without the use of a contractor

## Conclusion

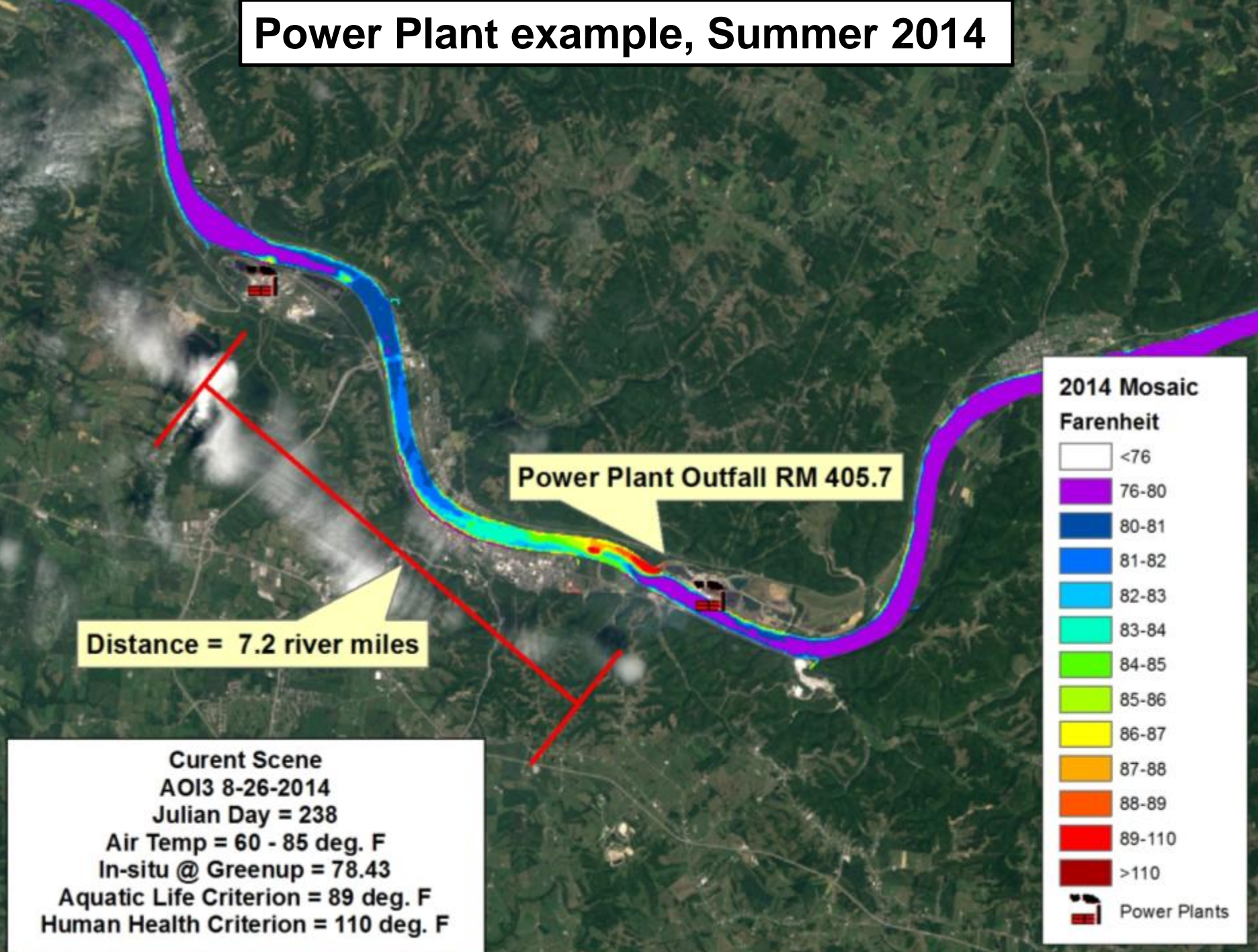
Yes, the data can be accessed for free and interpreted using ArcGIS. ORSANCO's data showed a closer result to the in-situ samples

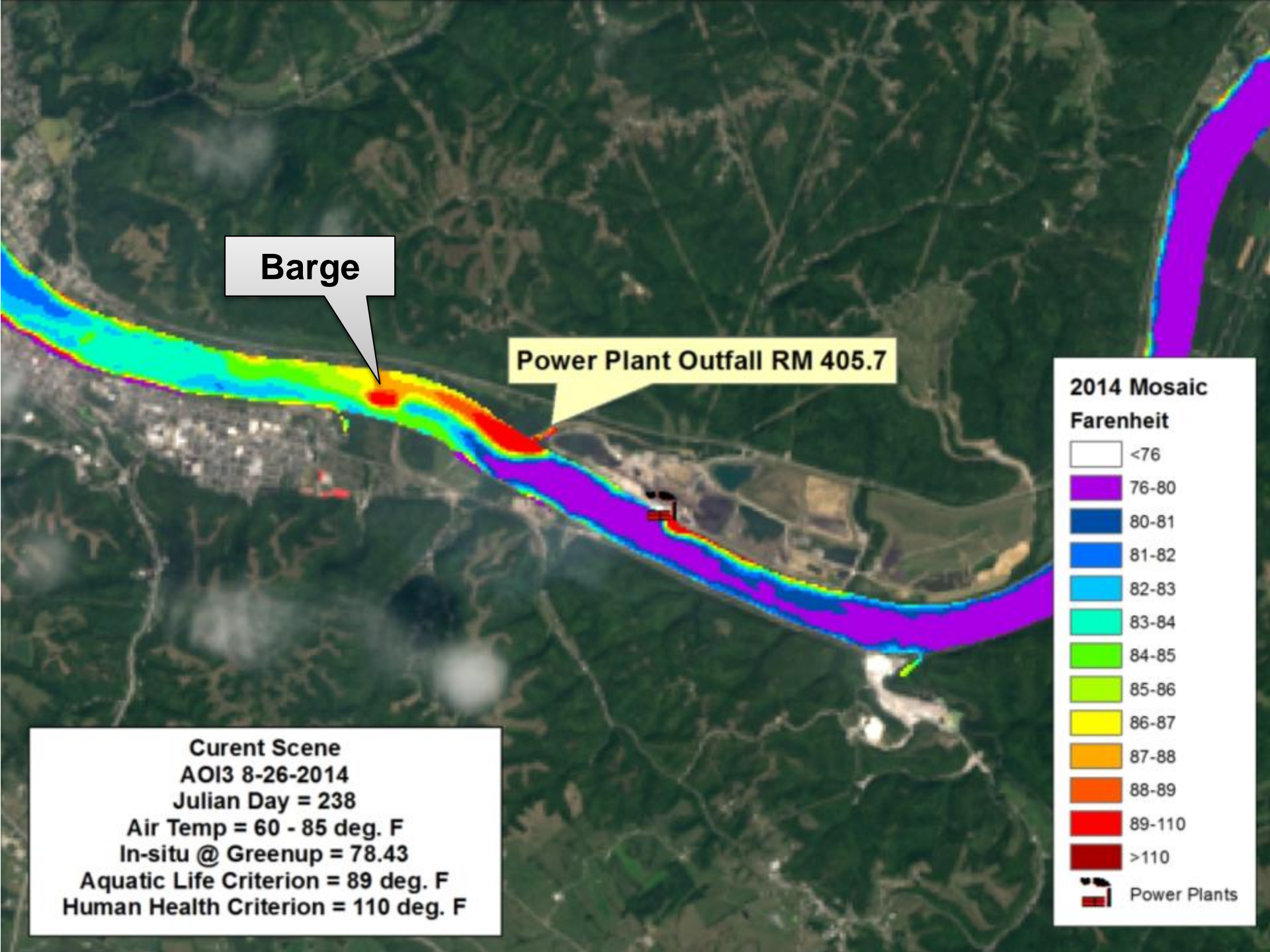


# Summer 2014



# Power Plant example, Summer 2014





Barge

Power Plant Outfall RM 405.7

2014 Mosaic  
Farenheit

- <76
- 76-80
- 80-81
- 81-82
- 82-83
- 83-84
- 84-85
- 85-86
- 86-87
- 87-88
- 88-89
- 89-110
- >110



Power Plants

Curent Scene  
AOI3 8-26-2014  
Julian Day = 238  
Air Temp = 60 - 85 deg. F  
In-situ @ Greenup = 78.43  
Aquatic Life Criterion = 89 deg. F  
Human Health Criterion = 110 deg. F

# Summer 2014 Example, Temp Violations

Barge

Power Plant Outfall RM 405.7

Curent Scene  
AOI3 8-26-2014  
Julian Day = 238  
Air Temp = 60 - 85 deg. F  
In-situ @ Greenup = 78.43  
Maz Temp = 103.7  
Aquatic Life Criterion = 89 deg. F  
Human Health Criterion = 110 deg. F

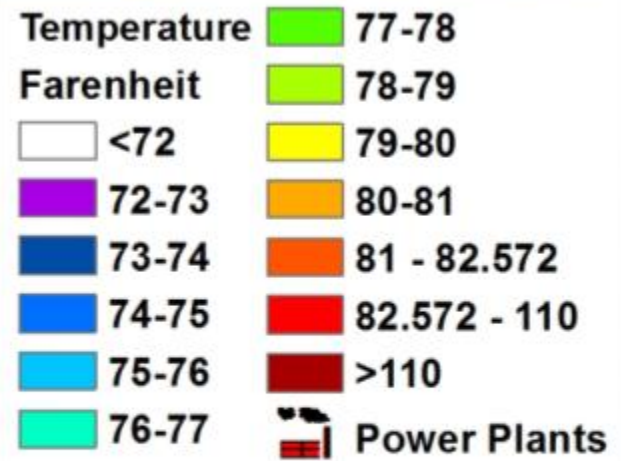
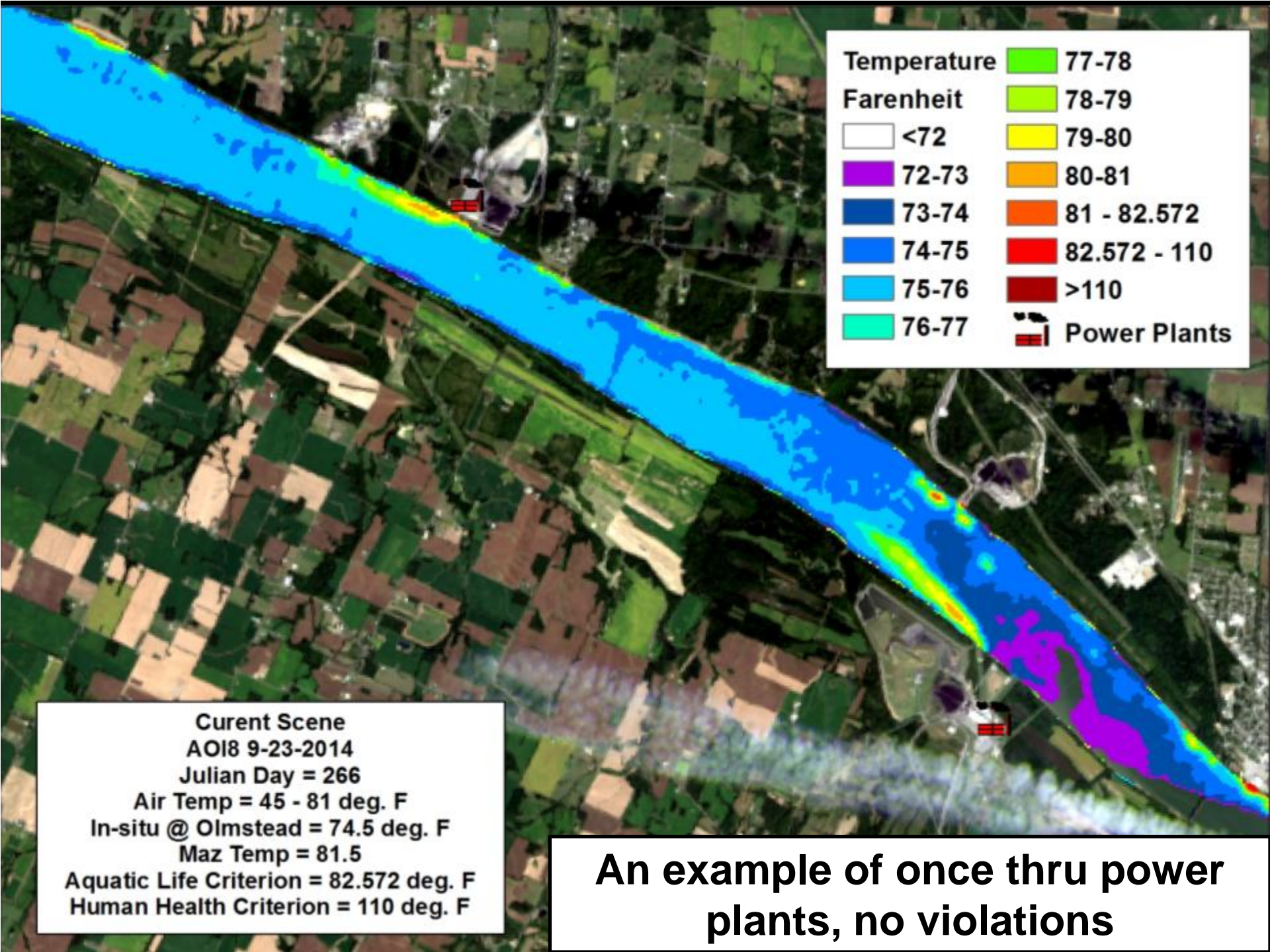
AOI3 Temp Violations.img  
Farenheit

 <89

 89 - 110 Aquatic Life

 >110 Human Health

 Power Plants



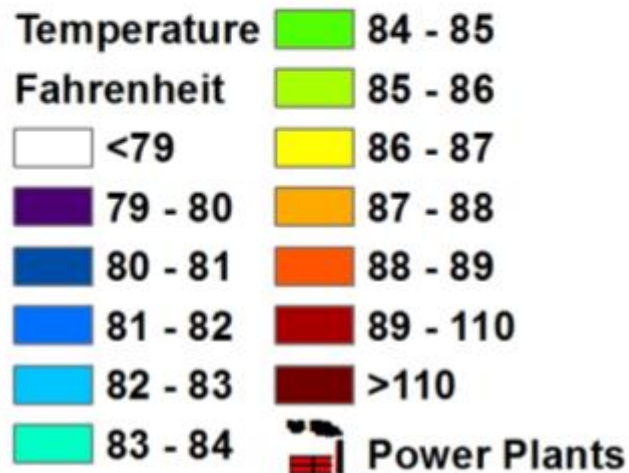
Curent Scene  
AOI8 9-23-2014  
Julian Day = 266  
Air Temp = 45 - 81 deg. F  
In-situ @ Olmstead = 74.5 deg. F  
Maz Temp = 81.5  
Aquatic Life Criterion = 82.572 deg. F  
Human Health Criterion = 110 deg. F

An example of once thru power plants, no violations

# Another Example of Thermal Discharge

- On Aug 9, 2007 ORSANCO conducted a temperature profile characterization study
- Results showed:
  - Upstream reference site was 84.56°F
  - Surface temp at Little Three Mile Creek confluence was 119.48°F
  - elevated temps were observed 4.5 miles downstream of LTMC
- Air temp = 73-100 °F

Temperature Satellite Image on 7-30-2007, 10 days  
prior to ORSANCO's Temperature Profile Study  
where temps of 119 deg. F were recorded



Current Scene  
AOI 3 7-30-2007  
Julian Day = 211  
Air temp = 66-89 deg. F  
In-situ @ Greenup = 81.39 deg. F  
Maz satellite temp = 100.6 deg. F  
Aquatic Life Criterion = 89 deg. F

Temperature Satellite Image on 7-30-2007, 10 days  
prior to ORSANCO's Temperature Profile Study  
where temps of 119 deg. F were recorded

**Temperature Violations  
Fahrenheit**

-  <89
-  89-110
-  >110



**Power Plants**

**Current Scene**

**AOI 3 7-30-2007**

**Julian Day = 211**

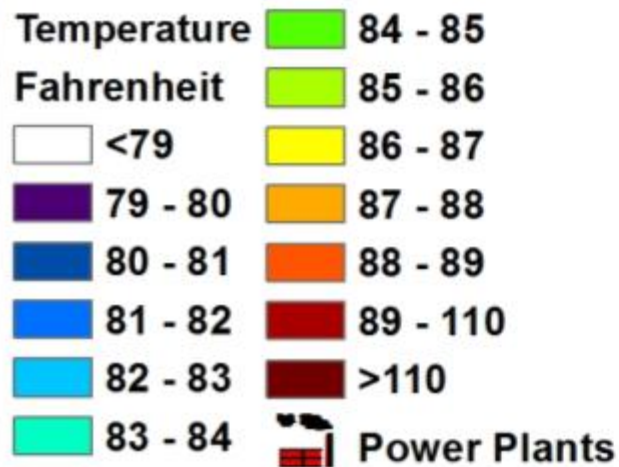
**Air temp = 66-89 deg. F**

**In-situ @ Greenup = 81.39 deg. F**

**Maz satellite temp = 100.6 deg. F**

**Aquatic Life Criterion = 89 deg. F**

Temperature Satellite Image on 8-15-2007, 6 days  
after ORSANCO's Temperature Profile Study where  
temps of 119 deg. F were recorded



Current Scene  
AOI 3 8-15-2007  
Julian Day = 227  
Air temp = 64-97 deg. F  
In-situ @ Greenup = 84.93 deg. F  
Maz satellite temp = 103.4 deg. F  
Aquatic Life Criterion = 89 deg. F

Temperature Satellite Image on 8-15-2007, 6 days  
after ORSANCO's Temperature Profile Study where  
temps of 119 deg. F were recorded

**Temp. Violations  
Fahrenheit**

 <89

 89-110

 >110

 Power Plants

**Current Scene**

**AOI 3 8-15-2007**

**Julian Day = 227**

**Air temp = 64-97 deg. F**

**In-situ @ Greenup = 84.93 deg. F**

**Maz satellite temp = 103.4 deg. F**

**Aquatic Life Criterion = 89 deg. F**

# What's Next?

- GPM – Global Precipitation Measurement
  - Data available now
  - Precip amount every 3 hours
- SMAP – Soil Moisture Active Passive
  - Launched Jan 29<sup>th</sup>.
  - Will Provide Soil moisture content



# Conclusion

- Remote Sensing data is accurate to within a couple of degrees
- ORSANCO can interpret the data ourselves with closer results to the in-situ measurements
- The impacts of thermal discharges can be observed
  - No human health violations occurred on specific summer days in 2010 and 2014
  - Aquatic life criterion violations occurred in both 2010 and 2014 at only one location, approximately river mile 405.7



# Acknowledgements

- Special Thanks to Garrett Stillings of KY DEP