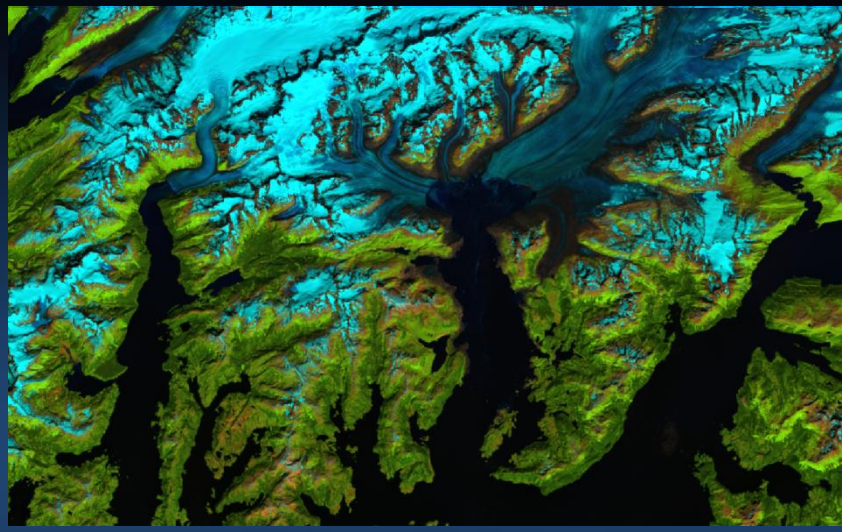
USGS
science for a changing world

Landsat – Monitoring our Earth's Condition for over 40 years

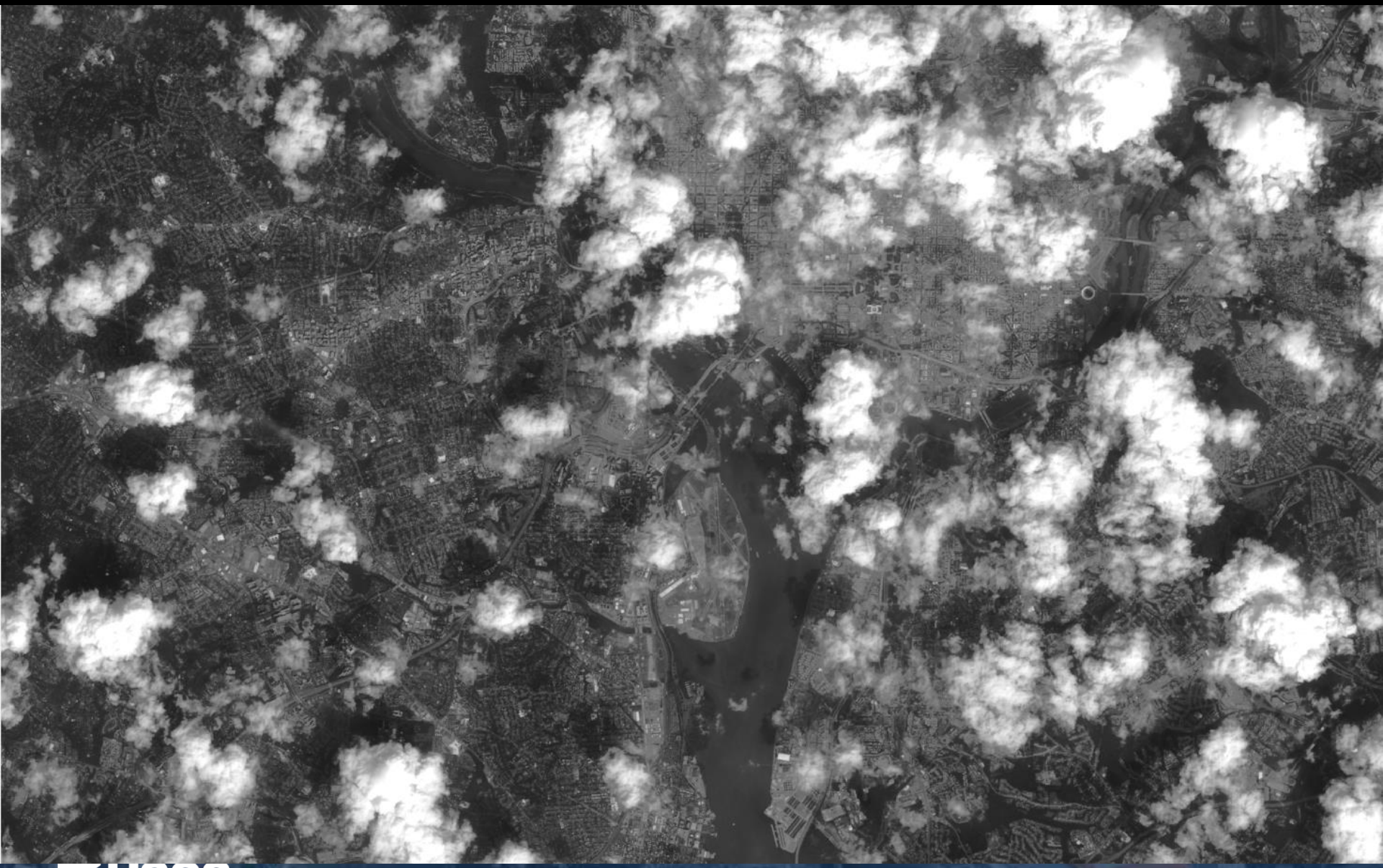


Thomas Cecere
Land Remote Sensing Program
USGS

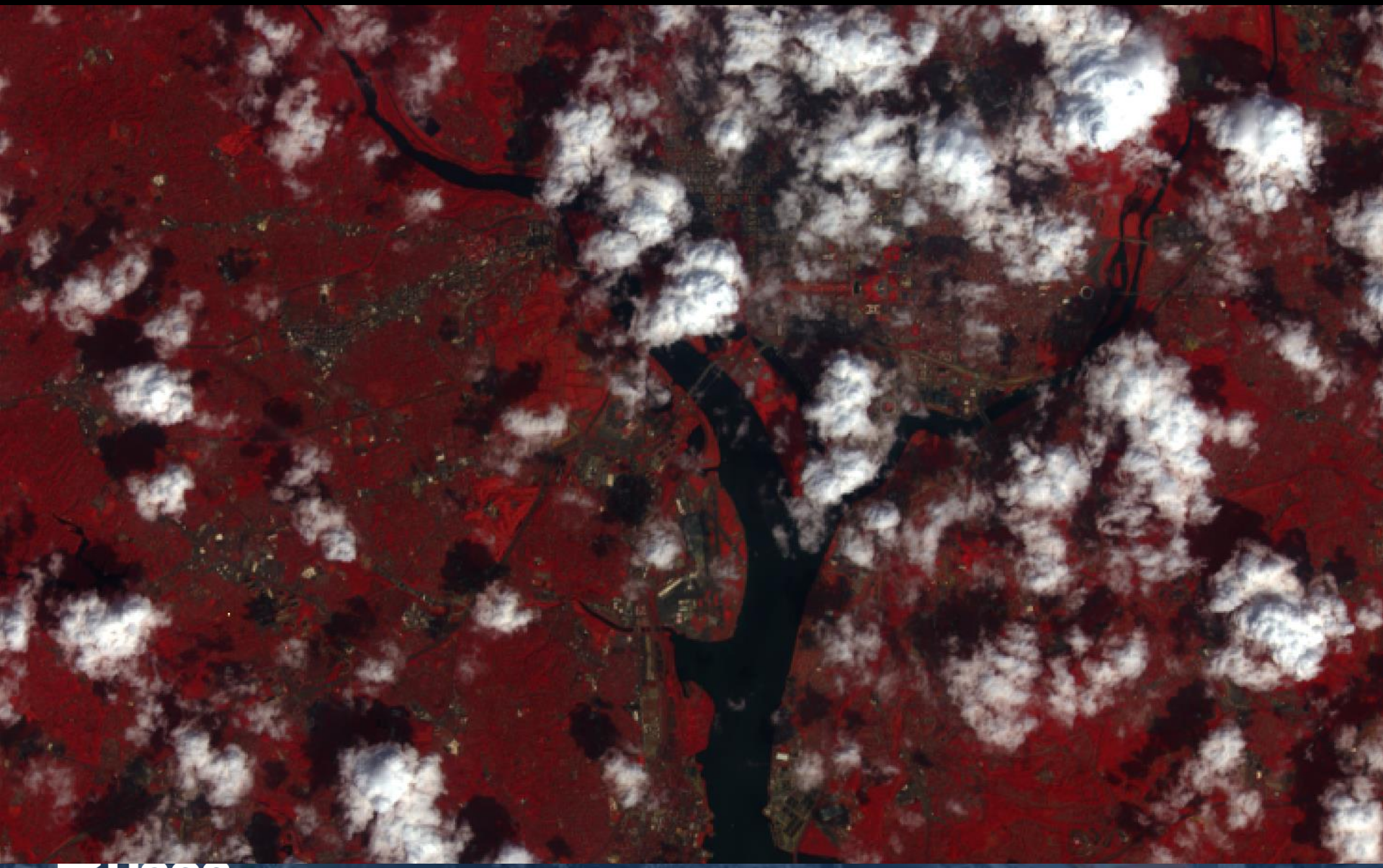
ISPRS:Earth Observing Data and Tools for Health Studies
Arlington, VA
August 28, 2013

U.S. Department of the Interior
U.S. Geological Survey

Vicinity Washington DC – August 27, 2013



Vicinity Washington DC – August 27, 2013

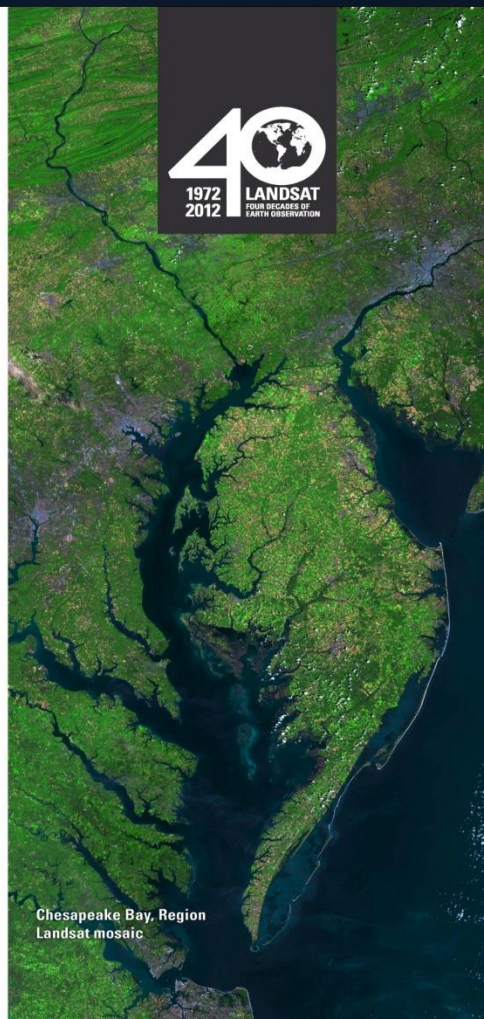


The Landsat Legacy:

Rooted in the USGS and the Department of the Interior

"… the time is now right and urgent to apply space technology towards the solution of many pressing natural resource problems being compounded by population and industrial growth."

Interior Secretary Steward L. Udall, 1966



Landsat Supports Science

- **Landsat provides a consistent, detailed, unbiased, unbroken record of the global land surface spanning 41 years**
- **The data are fundamental for:**
  - **mapping the pattern of cover across the landscape**
  - **monitoring land cover change over time**
  - **identifying the drivers of pattern and change**
  - **determining response and feedbacks to spatial and temporal variability, and**
  - **predicting response to an increasing population, growing economies, and changing climate**
- **Landsat-scale land-use research is essential to human adaptation to increasing pressure on our global resources**

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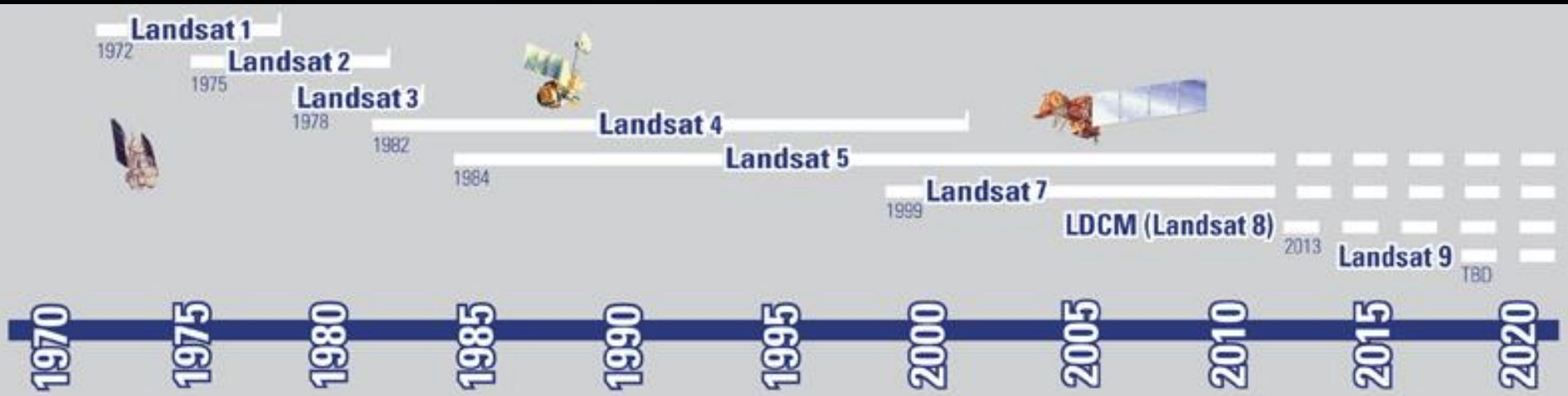
Landsat Mission History and Payloads



Mission	Launch	End of Imaging	Payload
Landsat 1	July 1972	January 1978	MSS
Landsat 2	January 1975	February 1982	MSS
Landsat 3	March 1978	March 1983	MSS
Landsat 4	July 1982	December 1993	MSS, TM
Landsat 5	March 1984	*November 2011*	MSS, TM
Landsat 6	October 1993	*[failed to achieve orbit]*	ETM
Landsat 7	April 1999	--	ETM+
Landsat 8	February 2013	--	OLI, TIRS

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Monitoring Urban Growth

•Urban Growth of Las Vegas, Nevada

May 1973
Population 358,400

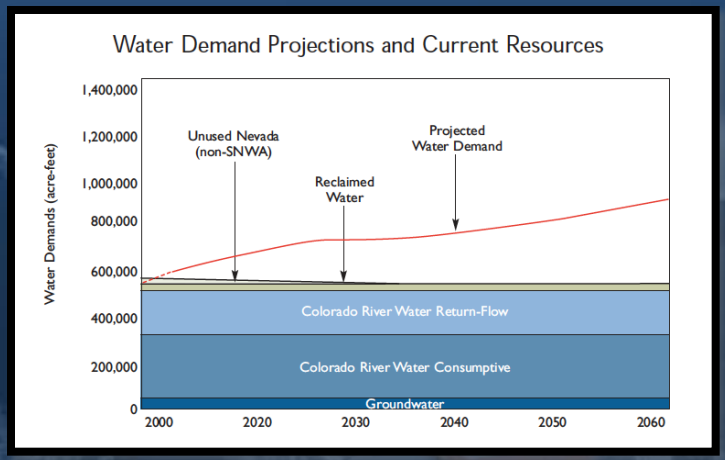
June 1991
Population 937,261

May 2000
Population 1,563,282

February 2006
Population 2,013,267

Critical Issues

- Water
- Economic Diversification
- Land Use
- Transportation
- Resource Conservation
- Public Health



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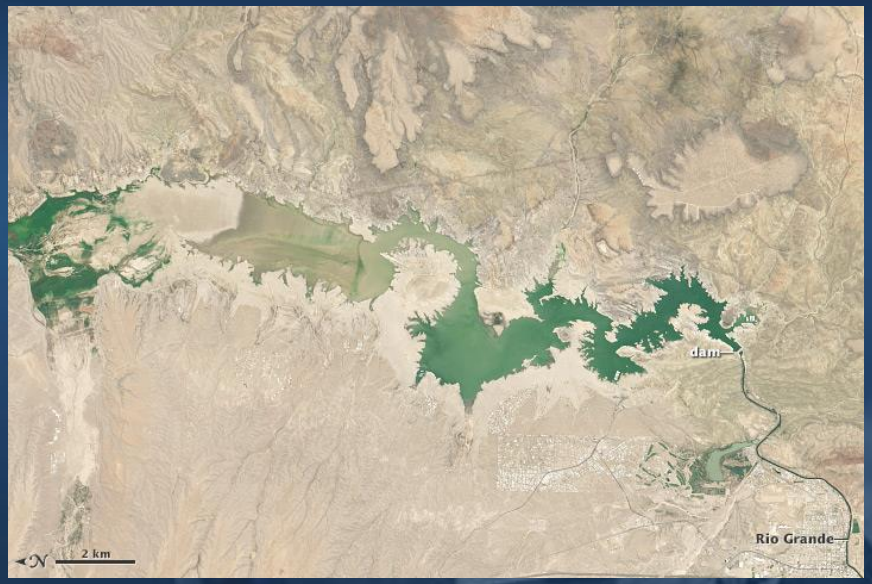
Drought in the American Southwest

Elephant Butte Reservoir

Southern New Mexico

June 2, 1994 (source: Landsat 5)

Reservoir filled to approximately 89% of capacity



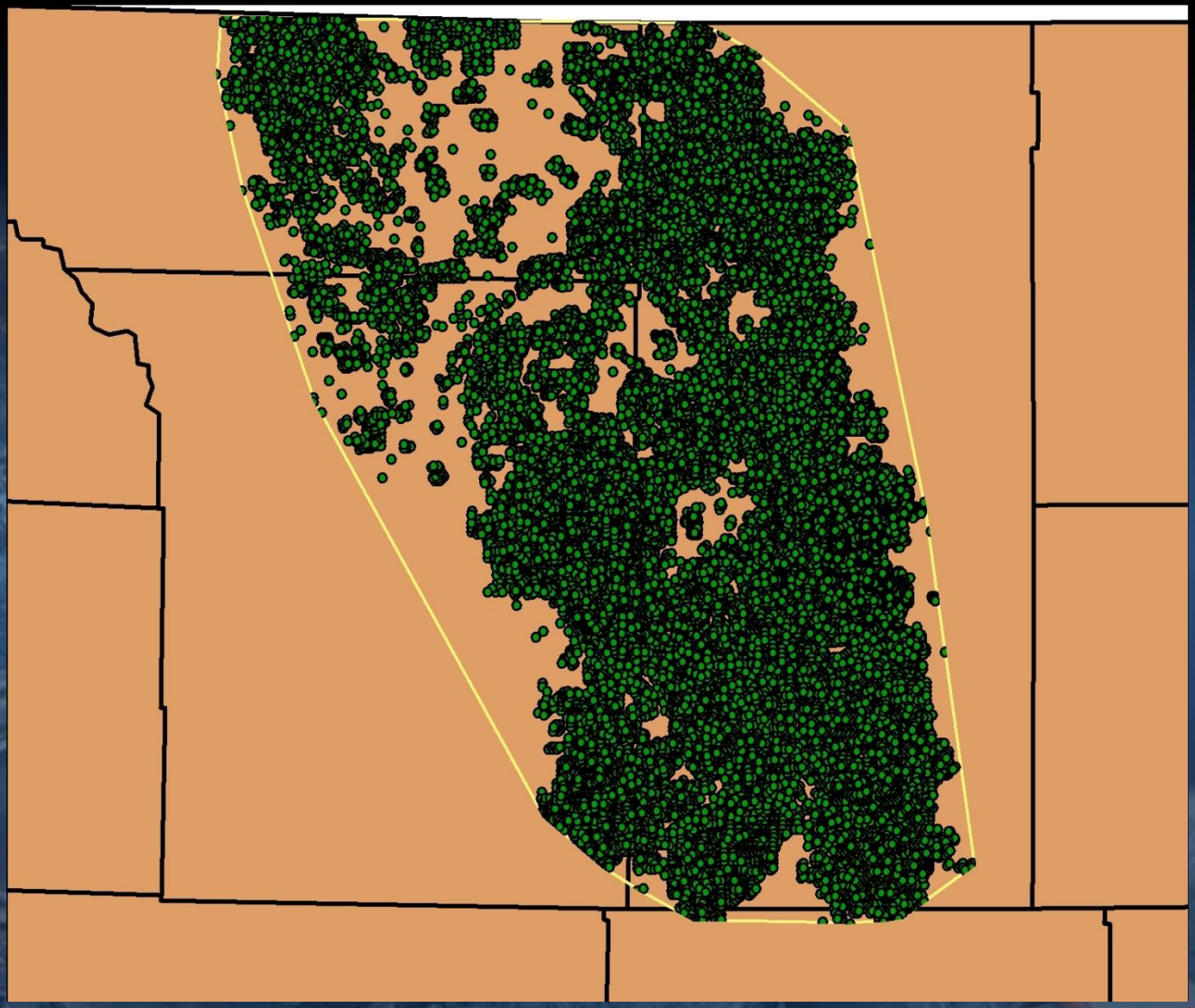
July 8, 2013 (source: Landsat 8)

Reservoir filled to approximately 3% of capacity

USGS

NASA

Powder River Basin - Wyoming



Green Dots represent locations of Coal Bed Natural Gas Wells

USGS

Courtesy of Dr. Ramesh Sivanpillai and Dr. Scott N. Miller (University of Wyoming)

Powder River Basin - Wyoming

False Natural Color

Bands 5,4,2

USGS

August 19, 2000 (source: Landsat 5)

Courtesy of Dr. Ramesh Sivanpillai and Dr. Scott N. Miller (University of Wyoming)

Powder River Basin - Wyoming

False Natural Color

Bands 5,4,2

USGS

August 21, 2009 (source: Landsat 5)

Courtesy of Dr. Ramesh Sivanpillai and Dr. Scott N. Miller (University of Wyoming)

Landsat 8 Improvements

- **More image data**
  - **41 year record will extend to 45-50 years or more**
  - **At least 400 scenes/day vs. at least 250 scenes/day from Landsat 7**
  - **100% of global data collected goes to the US archive each day**
  - **New images are available to users in less than 8 hours after acquisition**
  - **With Landsat 7, we have returned to an 8 day repeat cycle**
- **Better image data**
  - **8 - 10x improvement in signal to noise ratios**
  - **12 bit quantization permits improved measurement of subtle surface conditions and assessment of bright targets**
  - **Improved pixel geolocation (~ 12m)**
  - **Provides greater sensitivity to detect changes in surface properties**
- **New measurements – and new applications**
  - **Coastal blue band (0.433–0.453 µm) –detection of water column constituents (e.g., chlorophyll, suspended materials)**
  - **Cirrus band (1.360–1.390 µm) – improves overall image quality because of better cloud screening**
  - **Additional thermal band – more precise temperature measurements**

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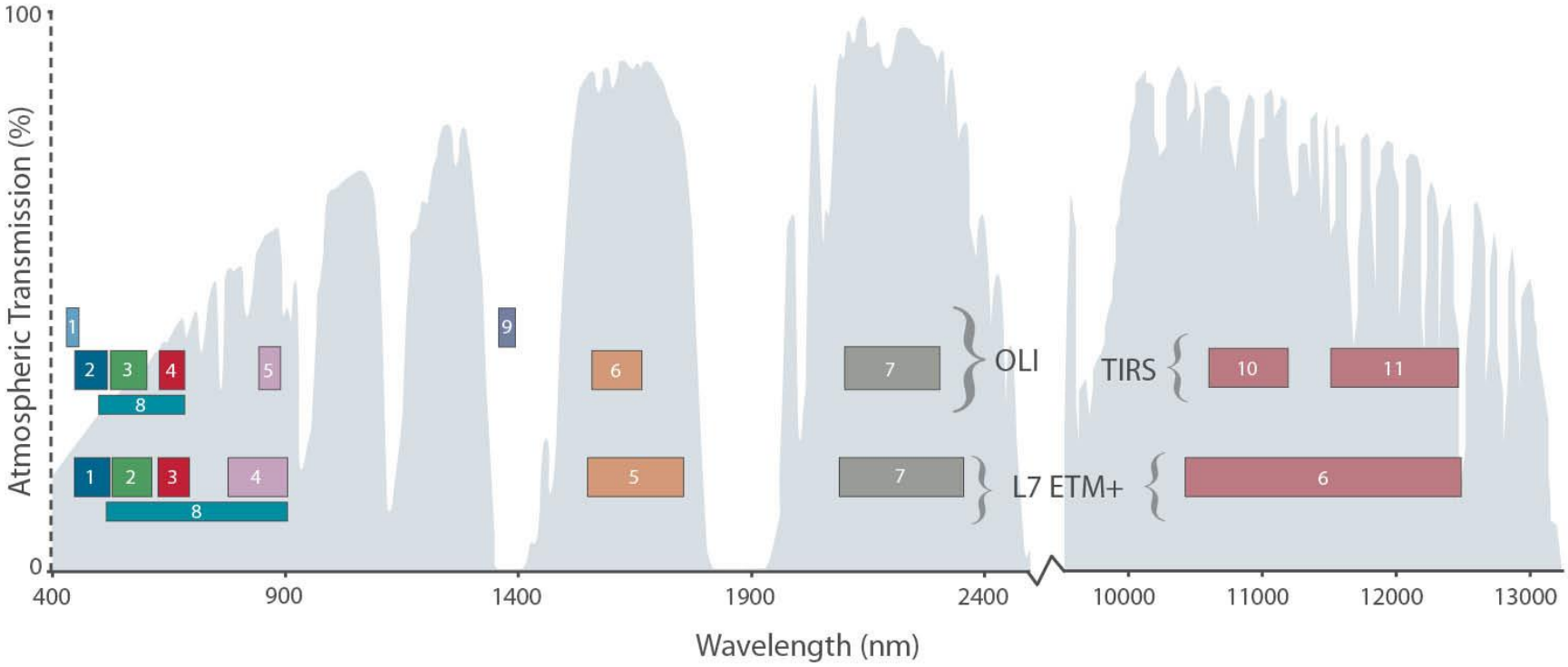
OLI & TIRS Spectral Bands



•This northern Australia tropical estuary was part of the first Landsat 8 image over Australia. The image combines the Red, Green and Deep Blue bands (RGB) for the water targets and SWIR, NIR and Green (RGB) for terrestrial areas.

•Courtesy of Leo Lymburner, Geoscience Australia

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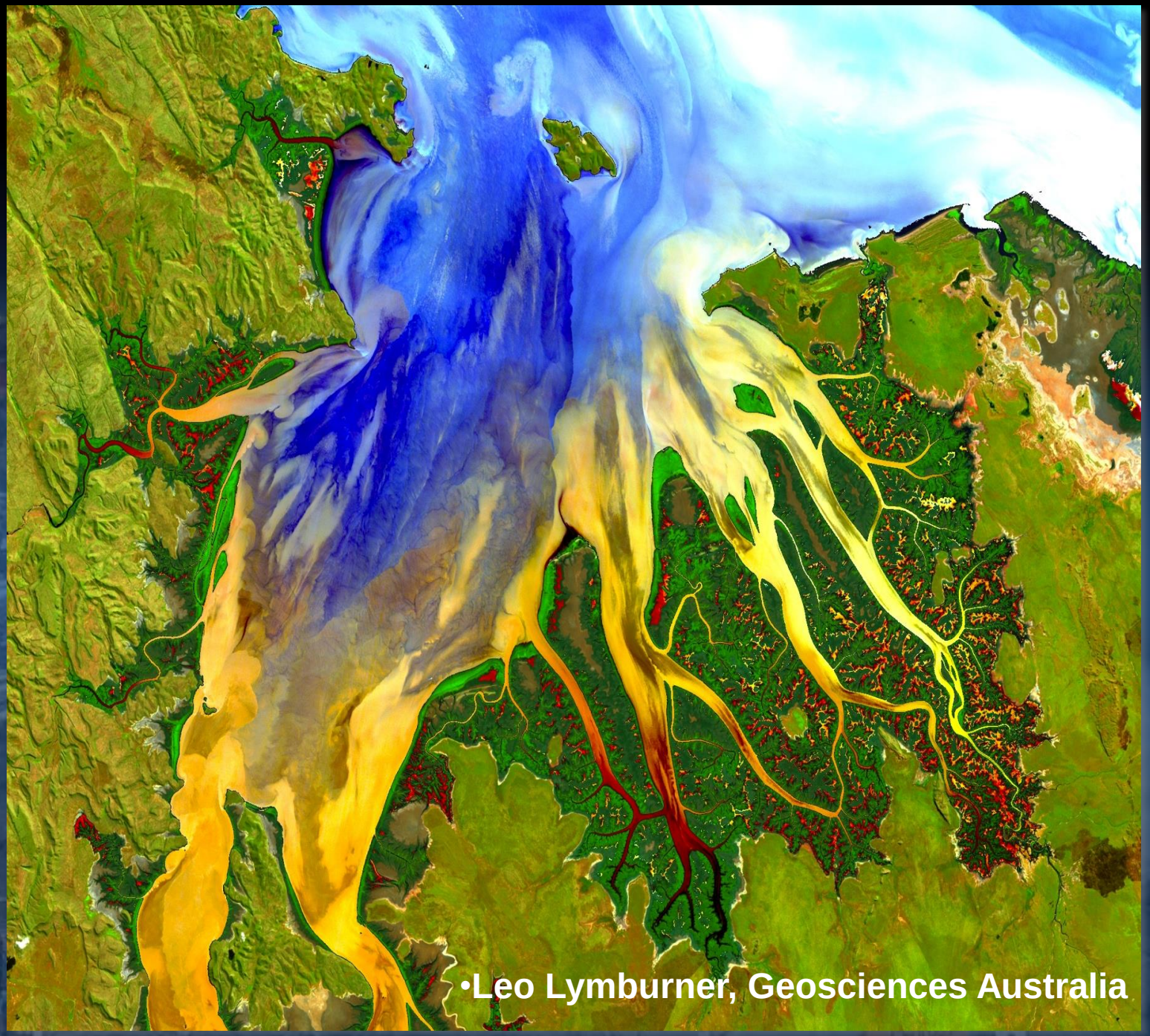
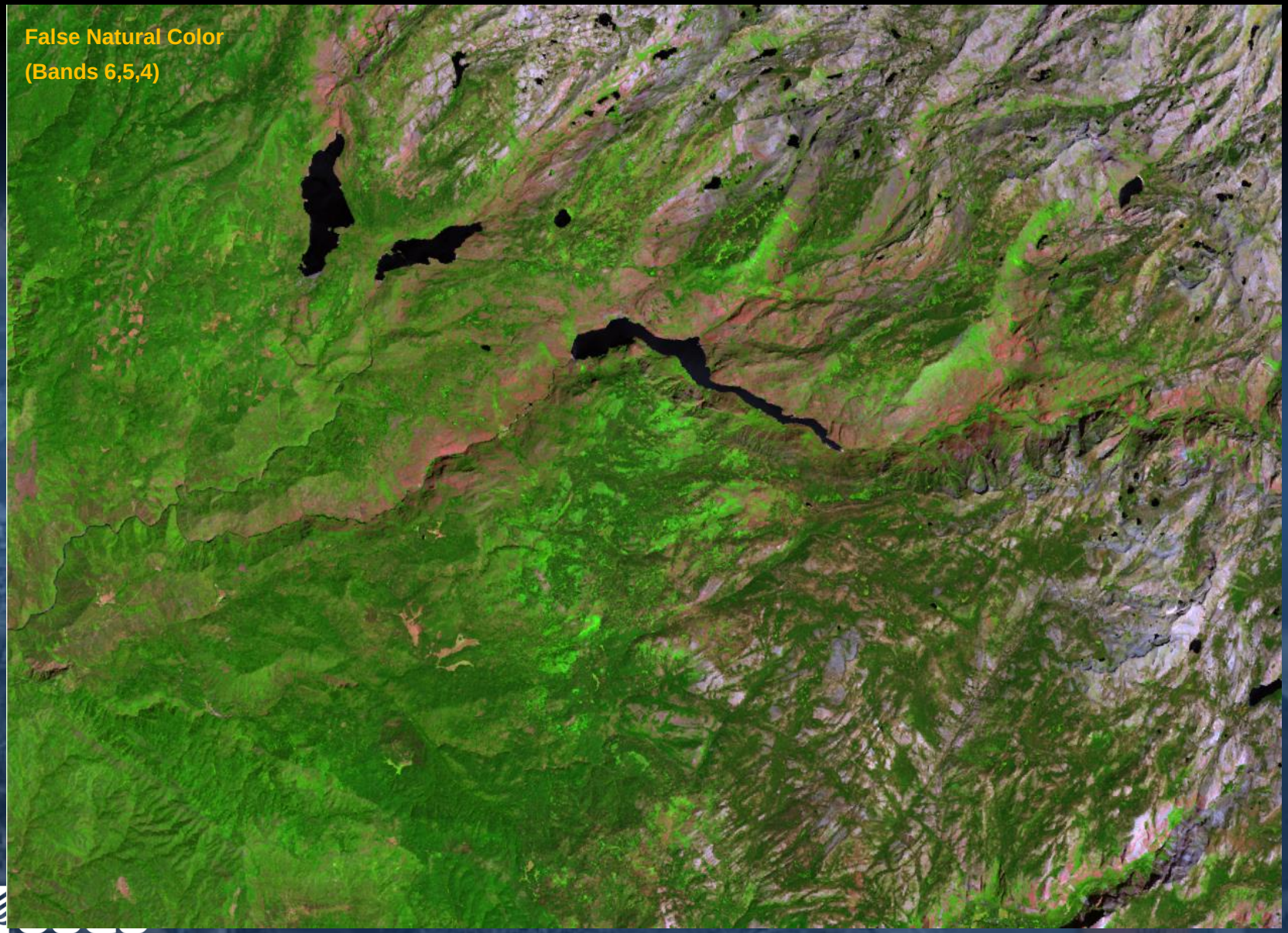


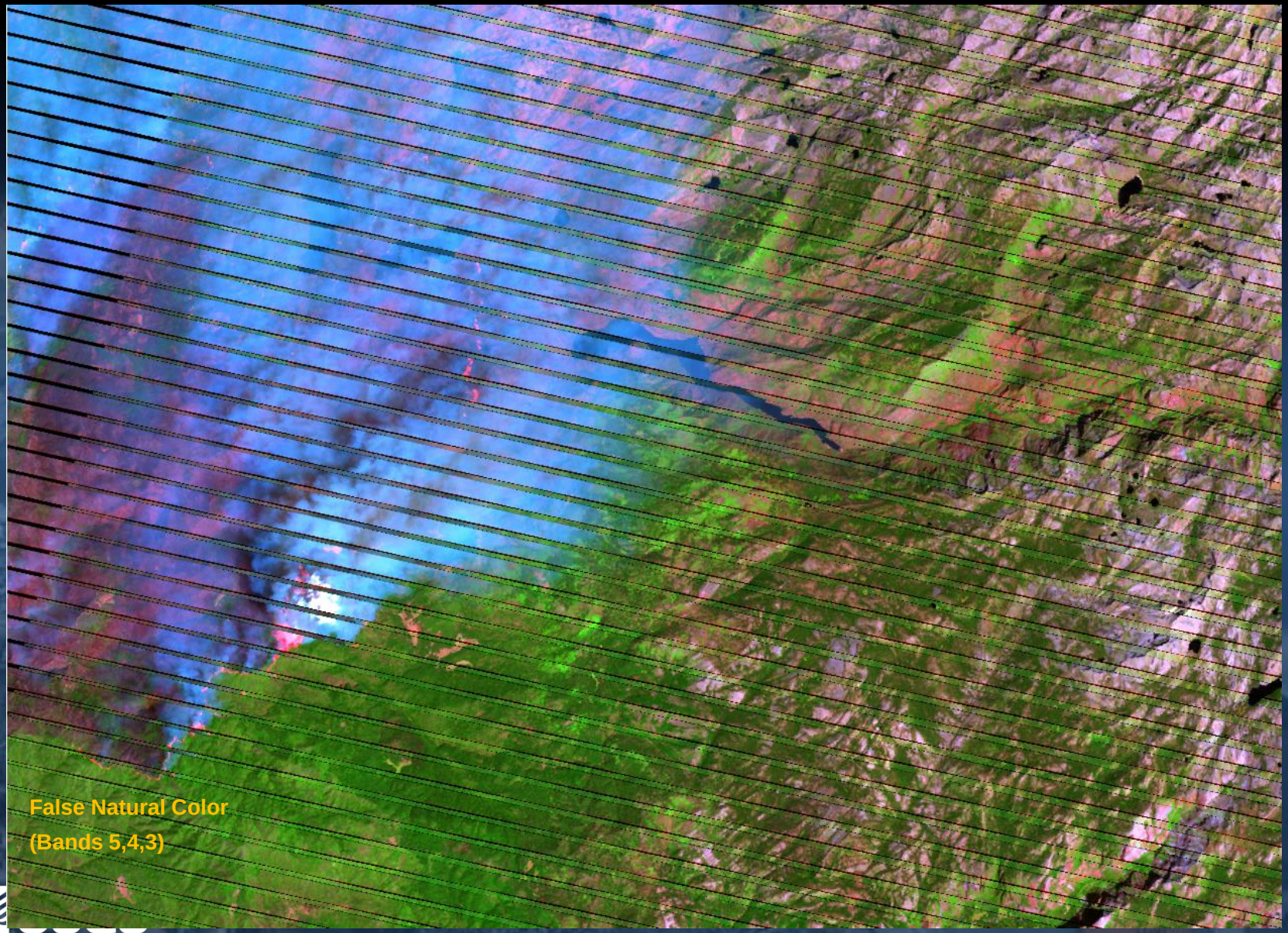
Yosemite Fire, CA – August 2013 (pre-fire)



August 15, 2013 (source: Landsat 8)

2km

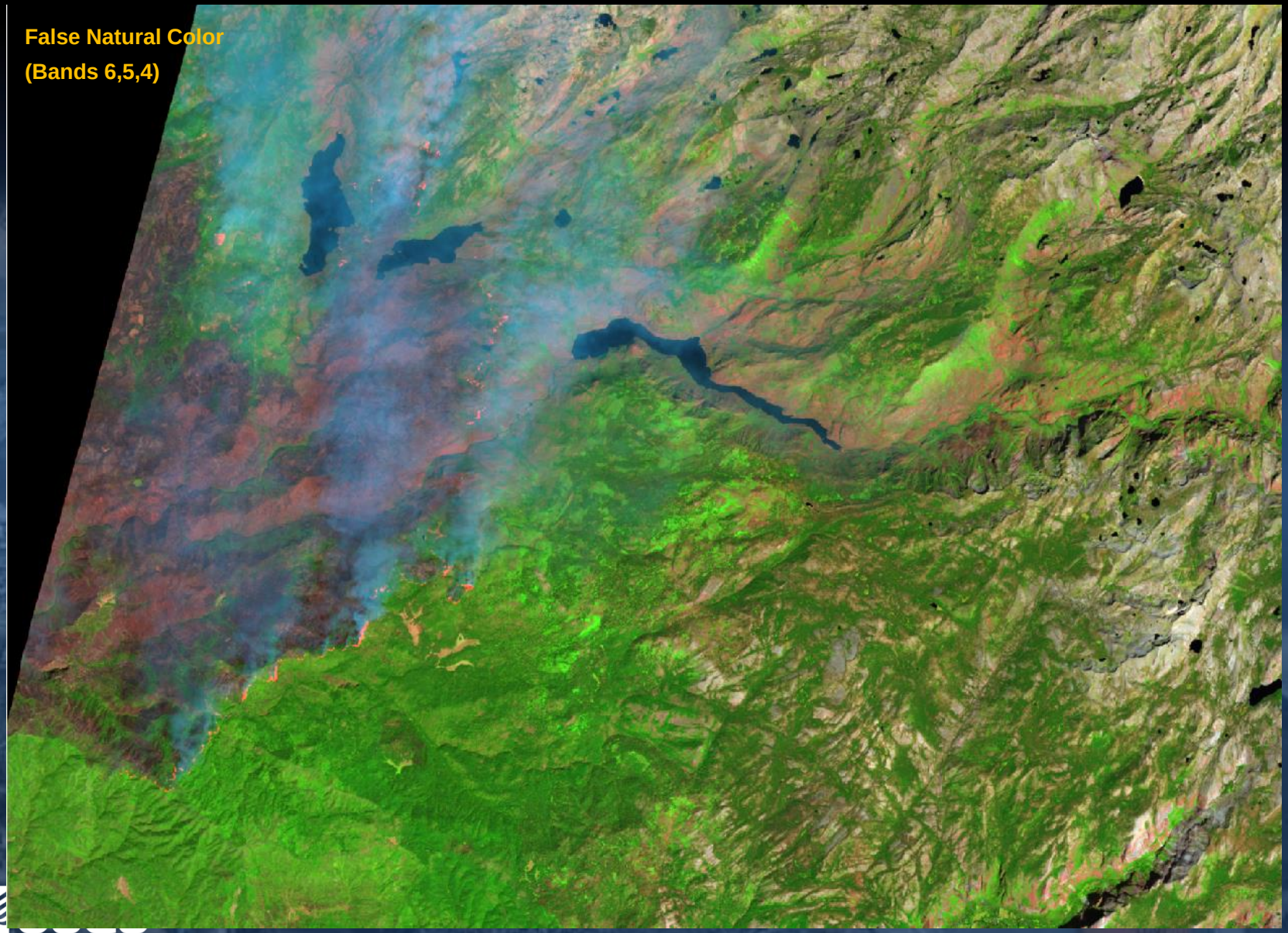
Yosemite Fire, CA – August 2013



August 23, 2013 (source: Landsat 7)

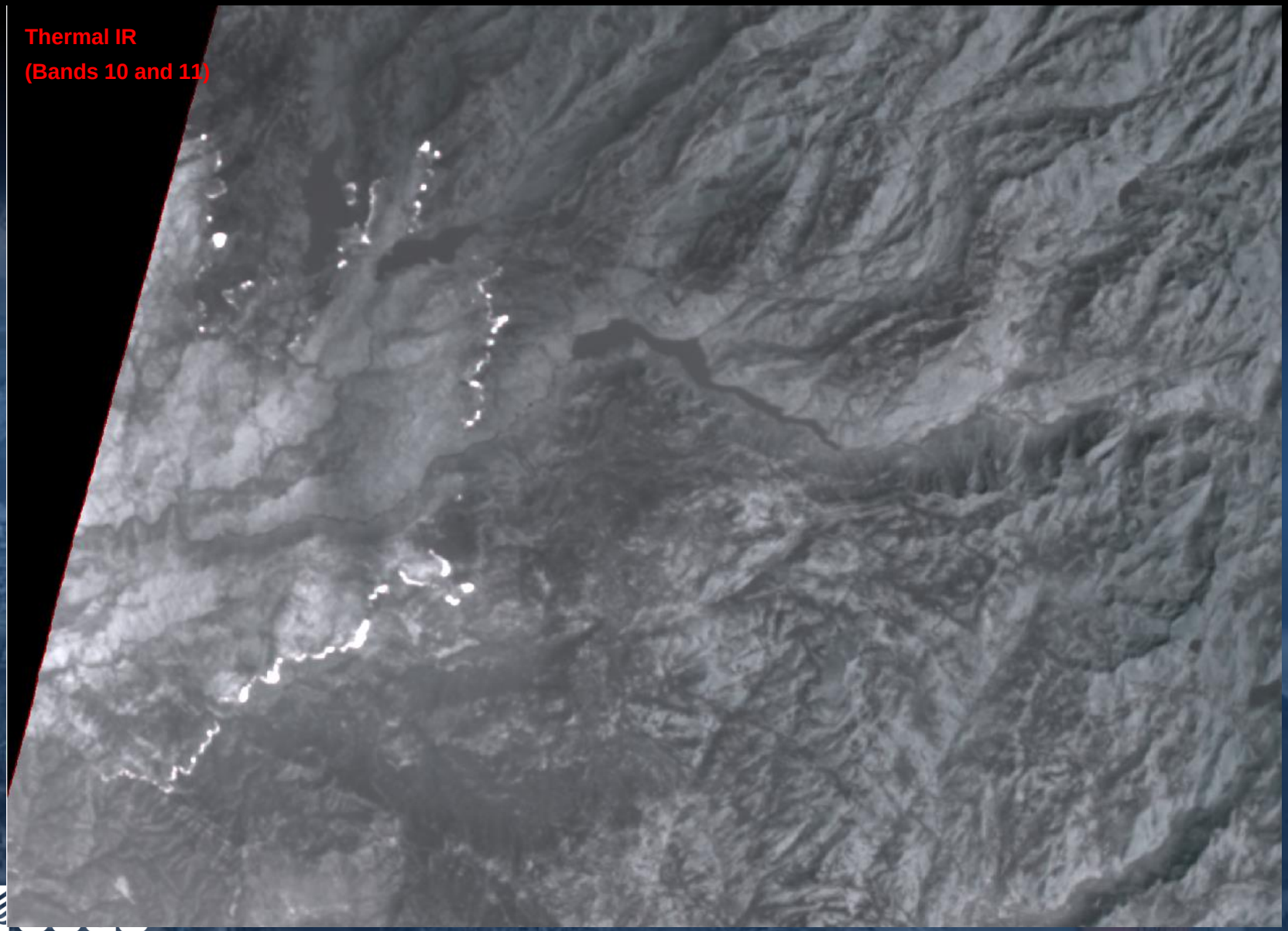
2km

Yosemite Fire, CA – August 2013



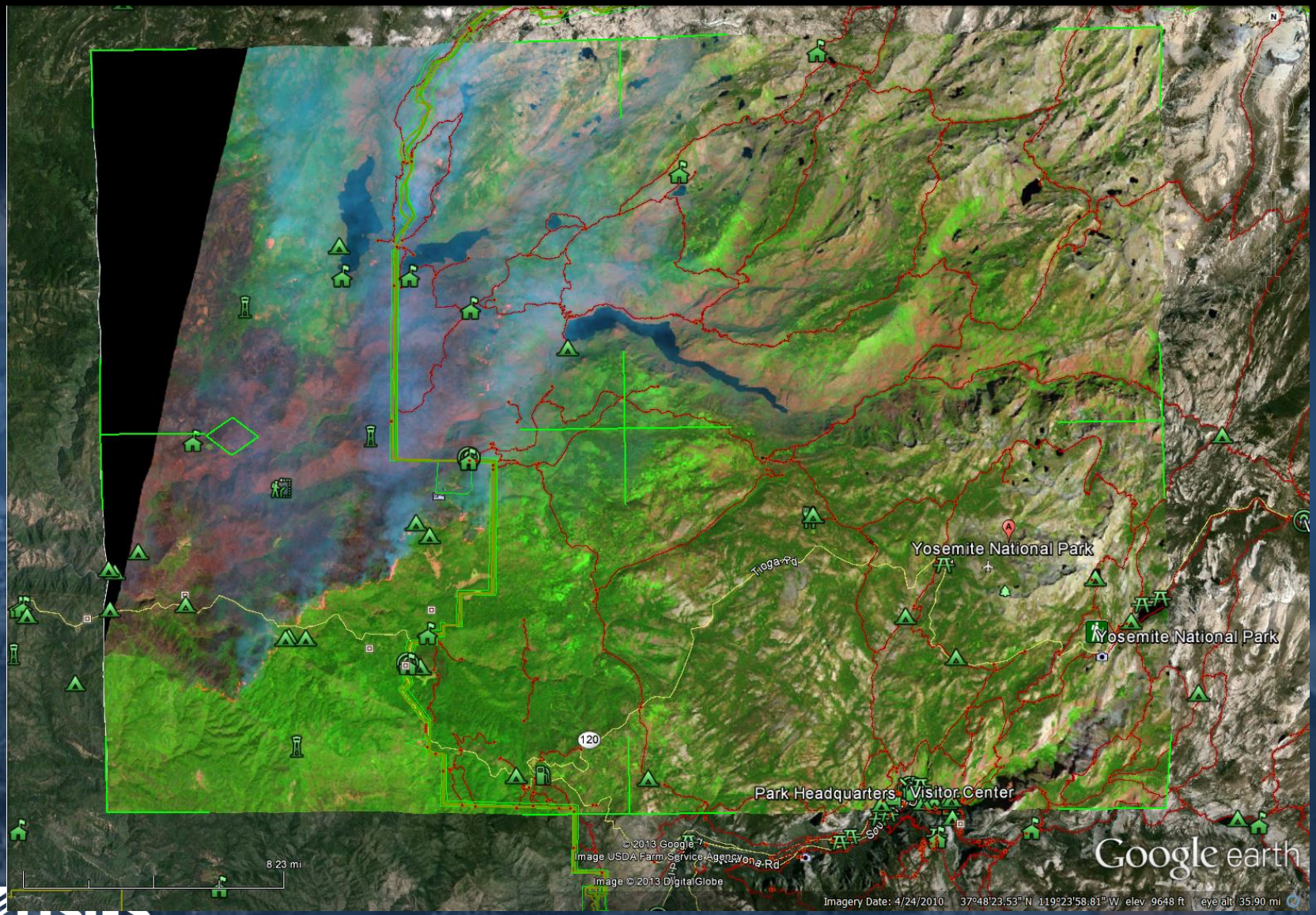
August 24, 2013 (source: Landsat 8)

Yosemite Fire, CA – August 2013



August 24, 2013 (source: Landsat 8)

Yosemite Fire, CA – August 2013



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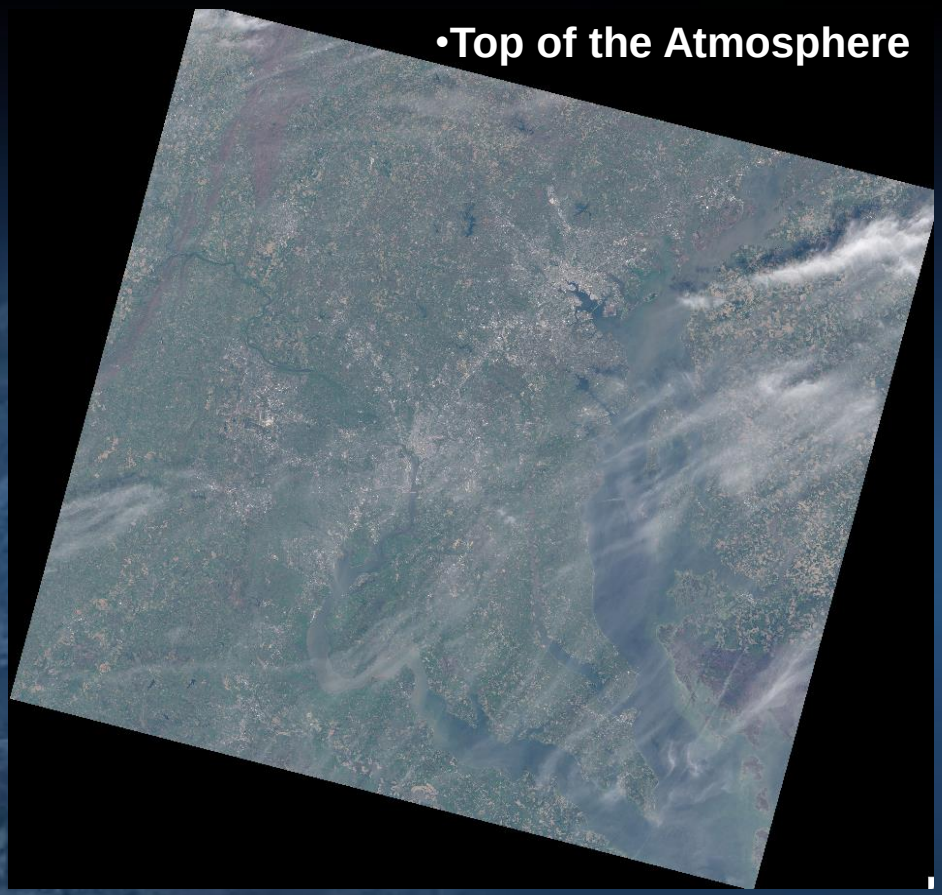
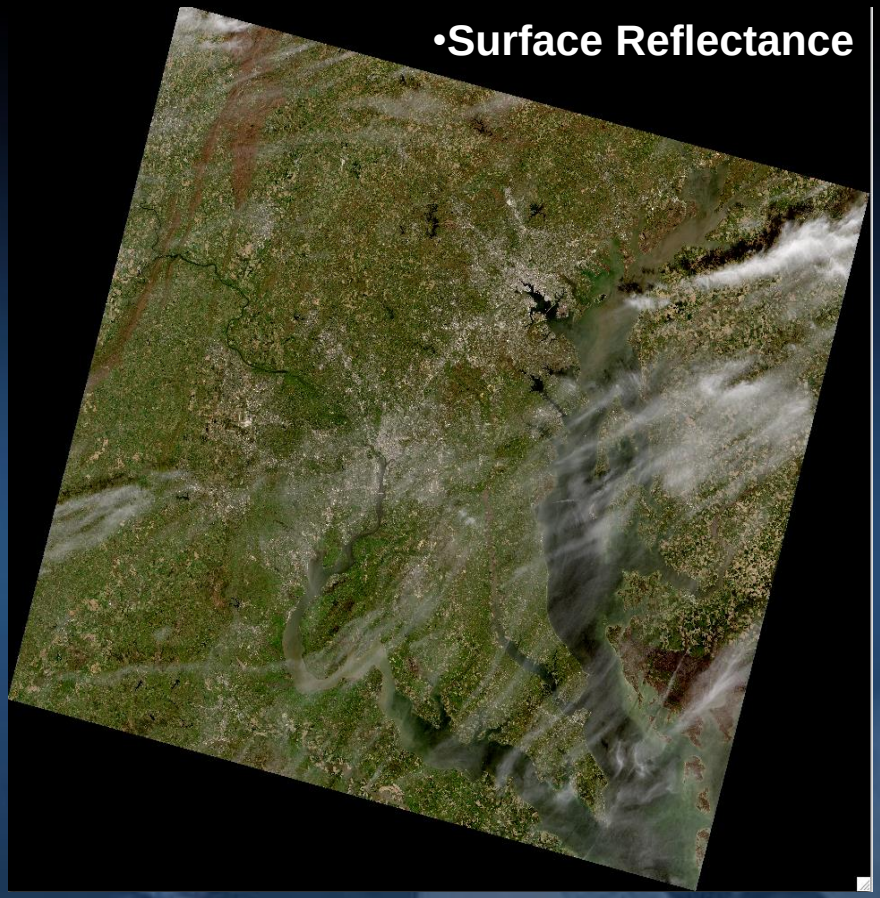
August 24, 2013 Landsat 8 image brought in to Google Earth (using Image Overlay tool)

•Applications Development – Landsat 8 Prototype Surface Reflectance

•Top of the Atmosphere



•Surface Reflectance



•From Eric Vermote, NASA GSFC - "…we we are going to be able to produce a great surface reflectance product given the radiometric performances (signal to noise) and the availability of extra and better band in the blue for aerosol retrieval over land."

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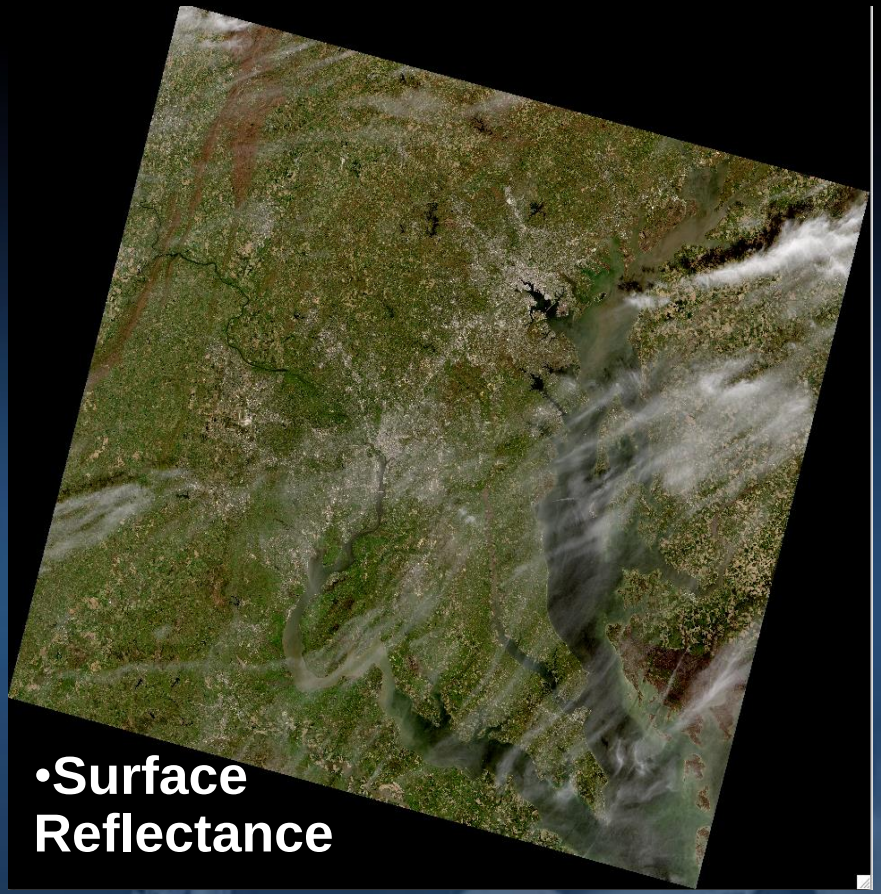
•Landsat 8 Improved Cloud Detection

•Band 9 - Cirrus



•Surface Reflectance

•Detection of cirrus clouds using band 9 improves atmospheric correction of Landsat 8 multispectral data.

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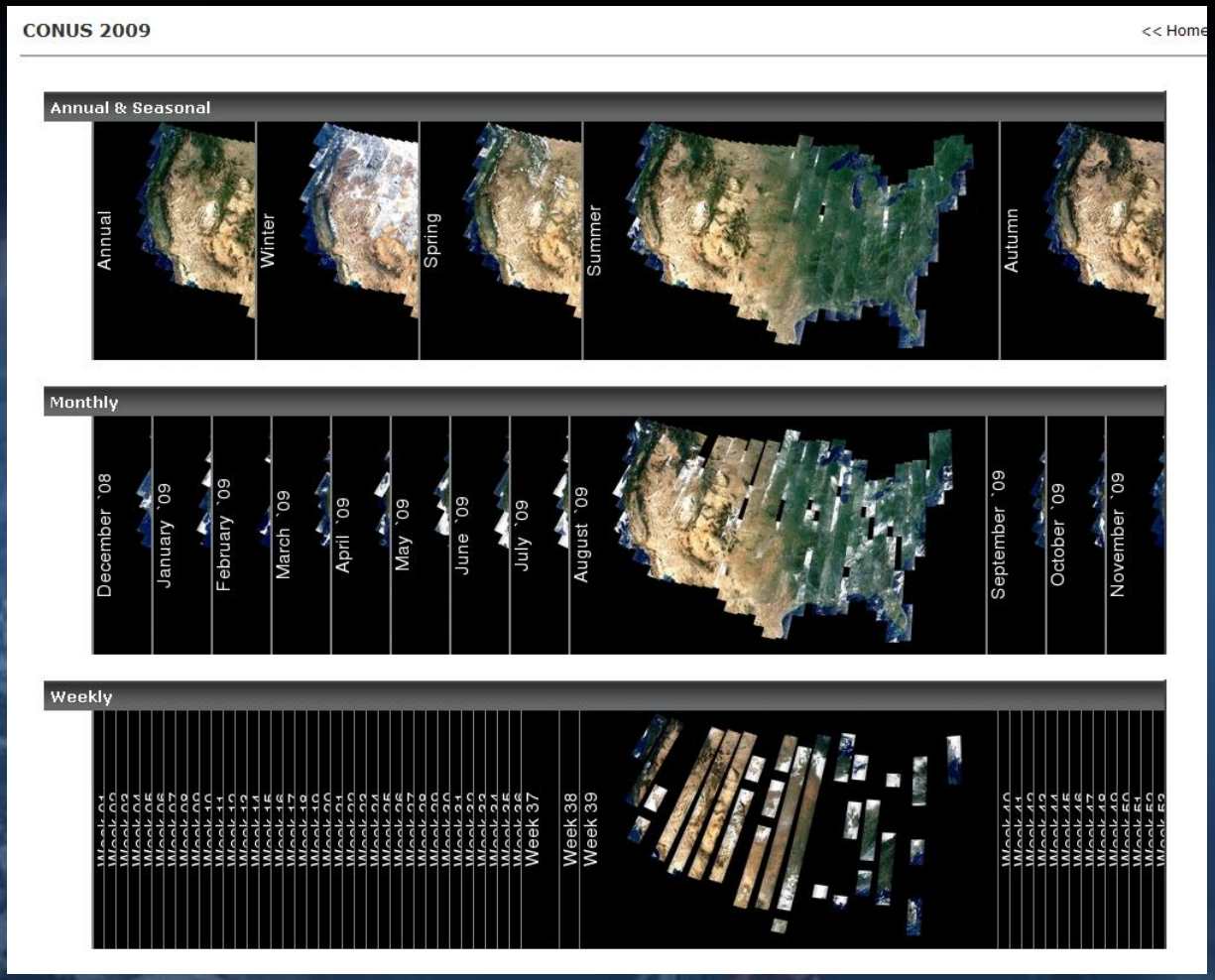
Web-Enabled Landsat 7 Data –2003 - 2012



- WELD provides seamless Landsat 7 ETM+ mosaics for Conterminous US and Alaska
- Developed by David Roy, South Dakota State University

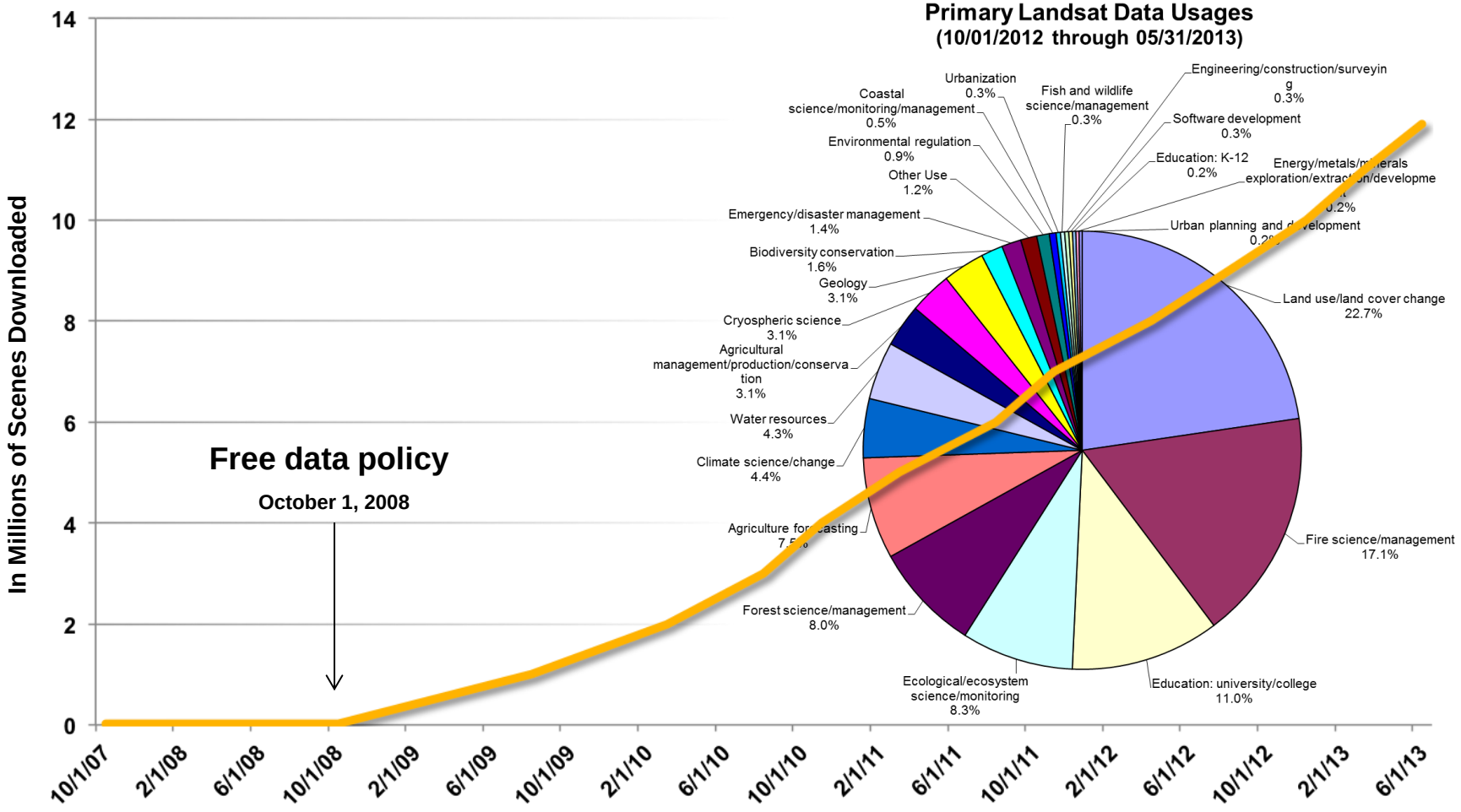
- http://landsat.usgs.gov/WELD.php

USGS

SDSU

Free, Web-Enabled Landsat Data

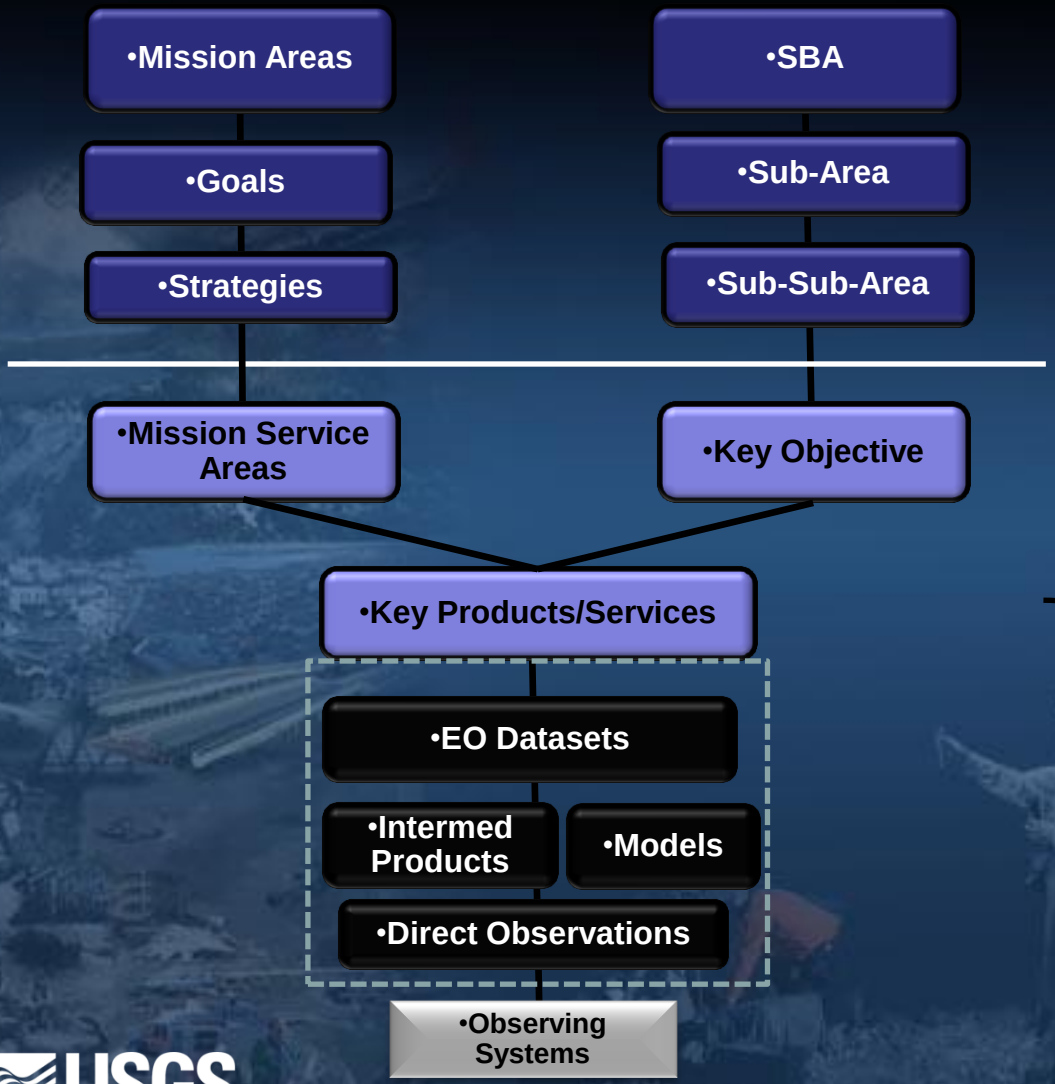
Each downloaded scene covers over 12K square miles



A New Era in Utilization of Land Satellite Imagery

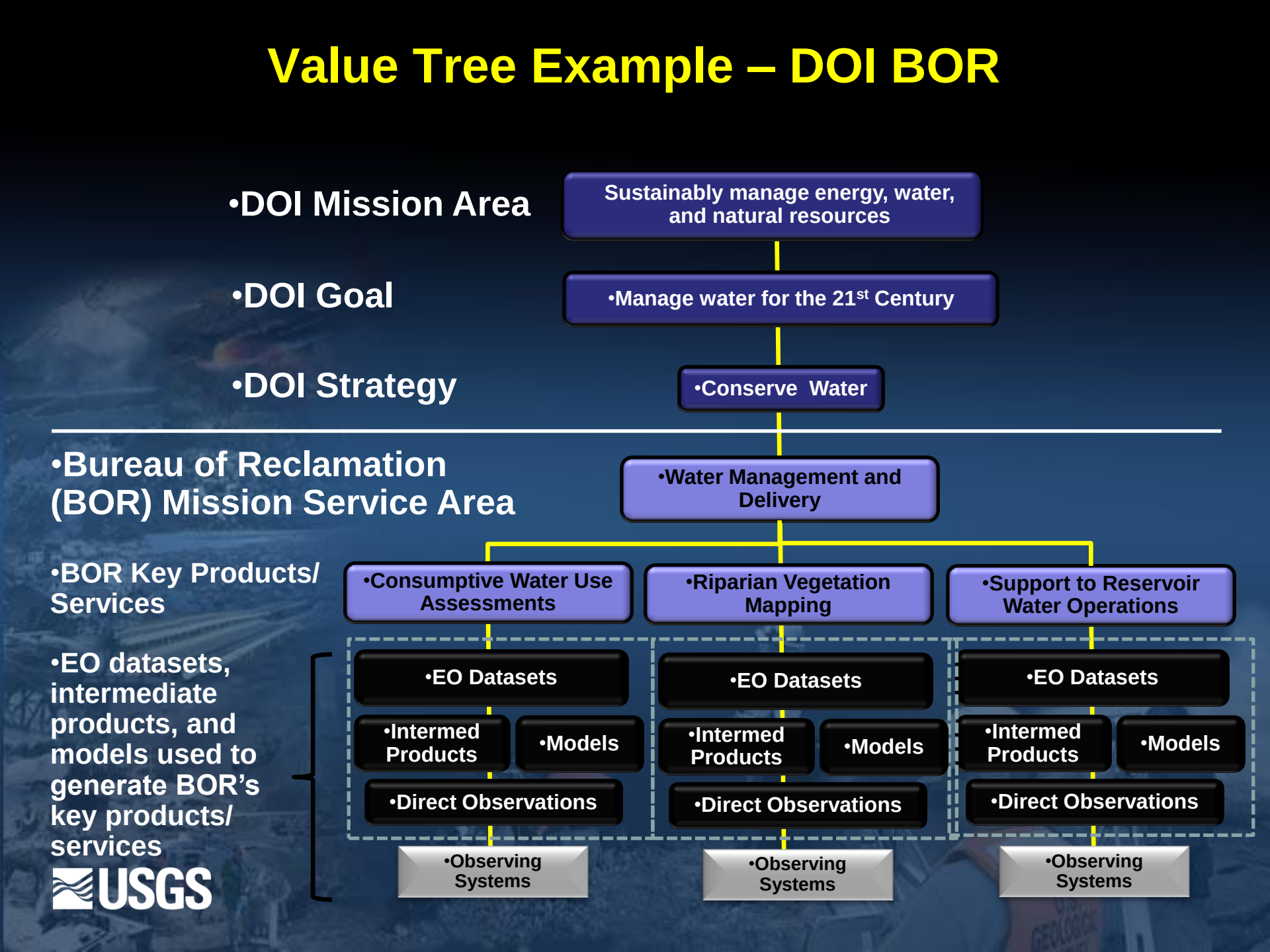
USGS

Understanding User Requirements



- Key Products/ Services provide a consistent and enduring component that can be mapped/ remapped to any value tree:
  - Organizational
  - SBA
  - Other

Value Tree Example – DOI BOR

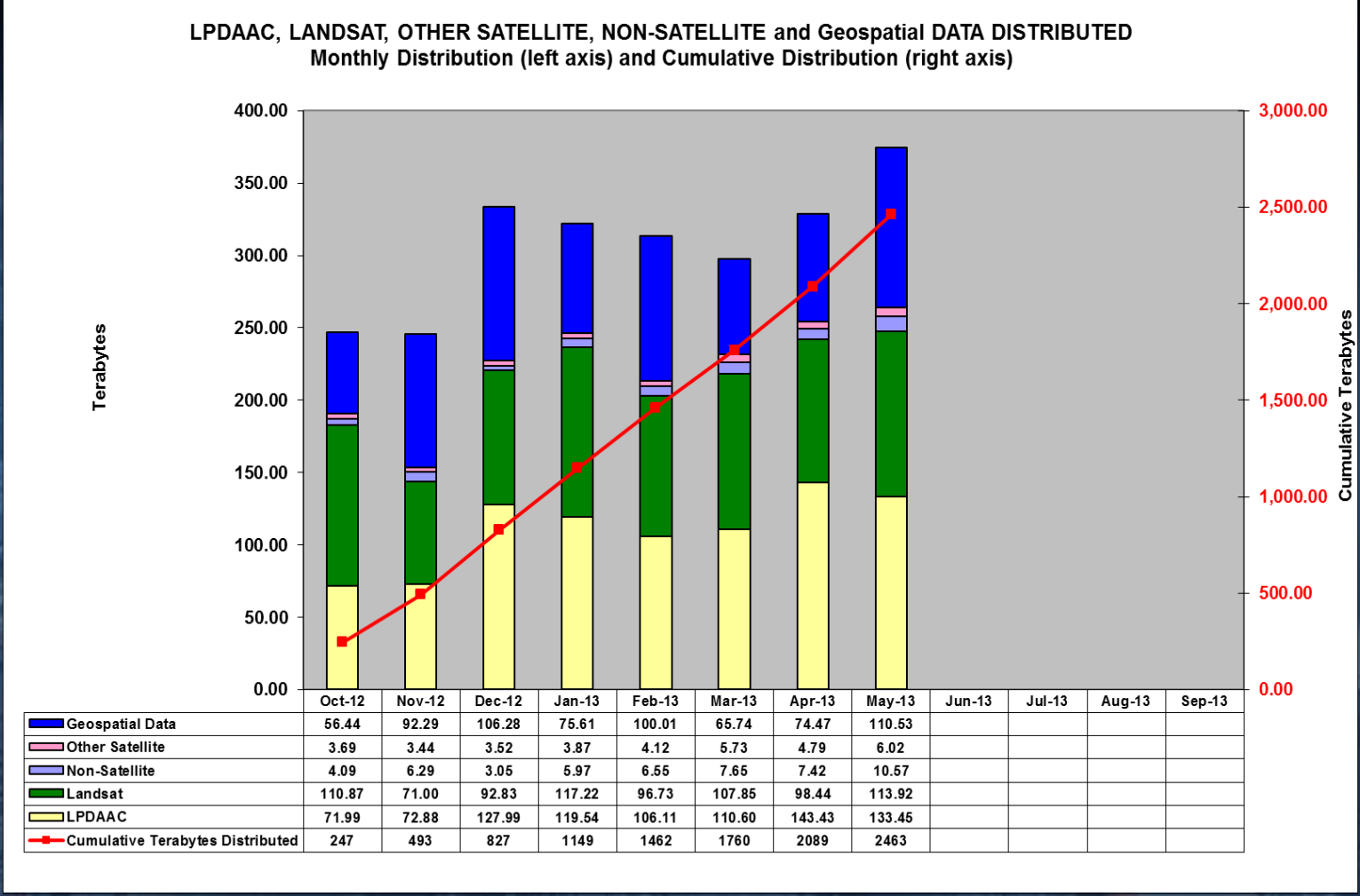


National Land Imaging Requirements Approach

- **Performance/ Satisfaction Scale**
  - **Basis for standardized product from each group elicited**

100	Ideal	Meets all requirements and exceeds some
90	Fully Satisfied	Meets all requirements
80	Good	Meets all major requirements with minor limitations
70		
60	Fair	Meets most major requirements, with significant limitations
50		
40	Poor	Fails to meet many major requirements, but provides some value
30		
20	Very Poor	Fails to meet most major requirements, but provides minor value
10		
1	No Capability	Provides no value

USGS Offers a Wide Range of Downloadable Datasets at http://earthexplorer.usgs.gov



	Oct-12	Nov-12	Dec-12	Jan-13	Feb-13	Mar-13	Apr-13	May-13	Jun-13	Jul-13	Aug-13	Sep-13
Geospatial Data	56.44	92.29	106.28	75.61	100.01	65.74	74.47	110.53				
Other Satellite	3.69	3.44	3.52	3.87	4.12	5.73	4.79	6.02				
Non-Satellite	4.09	6.29	3.05	5.97	6.55	7.65	7.42	10.57				
Landsat	110.87	71.00	92.83	117.22	96.73	107.85	98.44	113.92				
LPDAAC	71.99	72.88	127.99	119.54	106.11	110.60	143.43	133.45				
Cumulative Terabytes Distributed	247	493	827	1149	1462	1760	2089	2463				

USGS

Some Useful Links

- **USGS Landsat Web Site:** http://landsat.usgs.gov
- **Sources of USGS satellite data**
  - Earth Explorer: http://earthexplorer.usgs.gov
  - GloVis: http://glovis.usgs.gov
  - LandsatLook Viewer: http://landsatlook.usgs.gov
  - Web-enabled Landsat data (WELD): http://landsat.usgs.gov/WELD.php
- **Landsat 8 (LDCM) Orbit YouTube:**
  http://www.youtube.com/watch?v=iGoD5ZOPizc
- **My Contact Info:**
  - E-mail tcecere@usgs.gov
  - Phone 703-648-5551

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