



# Emerging Technology, Remote Sensing Applications, and Investments by Federal and State Agencies

## Remote Sensing Workshop

*San Diego, CA*

*September 27, 2012*

## Anne Castle

*Assistant Secretary*

*for Water and Science*

*U.S. Department of the Interior*





# An expanding global society pressures global resources



# Satellite Remote Sensing at DOI



## 1966 - Initiated Earth Resources Observation Systems Program

*"...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."*

Secretary of the Interior Stewart L. Udall, 1966



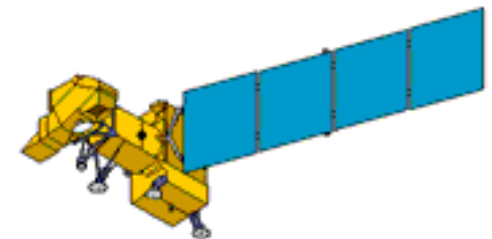
**Landsat 1-3**

Multi-Spectral Scanner (MSS) 79 meter  
Return Beam Vidicon (RBV) 80/40 meter



**Landsat 4-5**

Multi-Spectral Scanner (MSS) 79 meter  
Thematic Mapper (TM) 30 meter



**Landsat 7**

Enhanced Thematic Mapper Plus  
(ETM+) 30/15 meter

**2012 – USGS owns and operates Landsats 5 & 7;  
archives Earth observation data from other satellite systems**

# LANDSAT

Four Decades of Earth Observation  
1972–2012



*"Because Landsat enables us to see Earth's surface so clearly, so broadly, so objectively, we gain invaluable insights about the complexity of Earth systems and the condition of our natural resources."*

— USGS Director Marcia McNitt

**40**  
1972  
2012  
**LANDSAT**  
FOUR DECADES OF  
EARTH OBSERVATION

Mexico Irrigation  
Landsat 5  
August 3, 2010

# Four Decades of Earth Imaging: Current Status

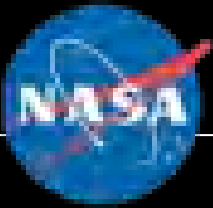


## Landsat 5

- Launched in 1984 (3-year design life)
- November 2011: USGS suspended imaging temporarily to investigate electronic problem

## Landsat 7

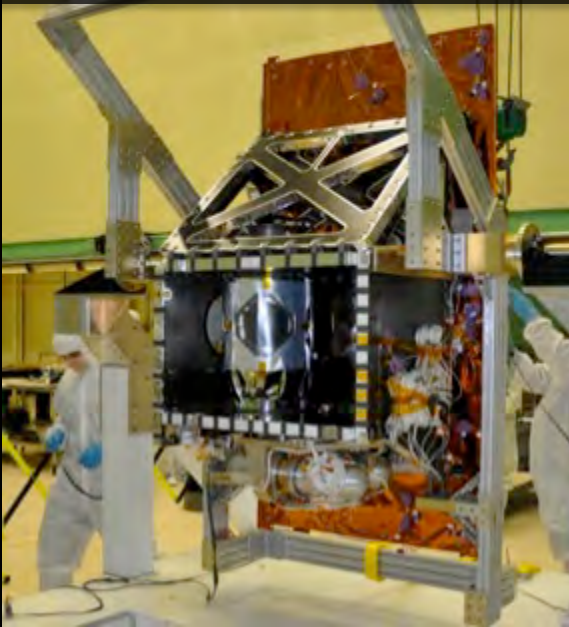
- Launched in 1999 (5-year design life)
- Acquiring over 350 images/day worldwide
- Estimated end of mission, based on fuel supply only: January 2017



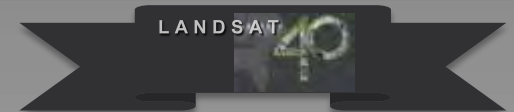
Operational Land Imager, Ball Aerospace & Technologies Corp.n



Thermal Infrared Sensor, NASA GSFC



Landsat 8 Spacecraft, Orbital Sciences Corp.



# DOI Applications of Landsat Imagery



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## Agriculture & Forestry

Crop and Timber Inventories and Forecasting  
Crop, Irrigation, & Forest Management

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## Wildlife & Public Lands

Vegetation, Species, Habitat & Wetlands Inventories  
& Management

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## Commerce & Industry

Natural Resource, Mineral Wealth, Rangeland  
Management  
Mines, Mineral Resources, & Energy Exploration &  
Management

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## Regional, State, and Local Government

Navigation  
Land Surveys, Soils & Geologic Mapping  
Water Resource Administration, Consumptive Use  
Flooding Prediction & Analysis, Flood Plain  
Assessment  
Erosion Control

# DOI Applications of Landsat Imagery



## Disaster Management

- Hazard Analysis
- Mitigation & Planning
- Damage Assessment
- Recovery & Relief

Hurricanes & Severe Storms  
Floods & Landslides  
Wildfires & Forest Fires  
Earthquakes & Volcanoes

Intl. Economic Development  
National Security  
Homeland Security

Global Coastal Mapping & Monitoring,  
Emergency Response, Theater Mapping,  
Illicit Crop Detection

Global Change Policy &  
Research

Deforestation, Desertification, Sea Water  
Intrusion  
Snow cover & Glaciation  
Ecosystem Analysis, Urban and Rural  
Geography



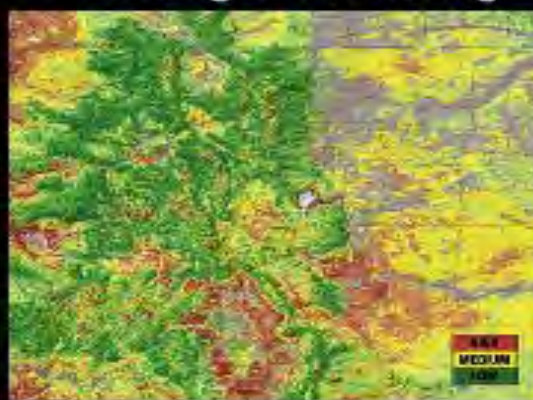
# Remote Sensing for Wildland Fire



**Fire Fuel Mapping**



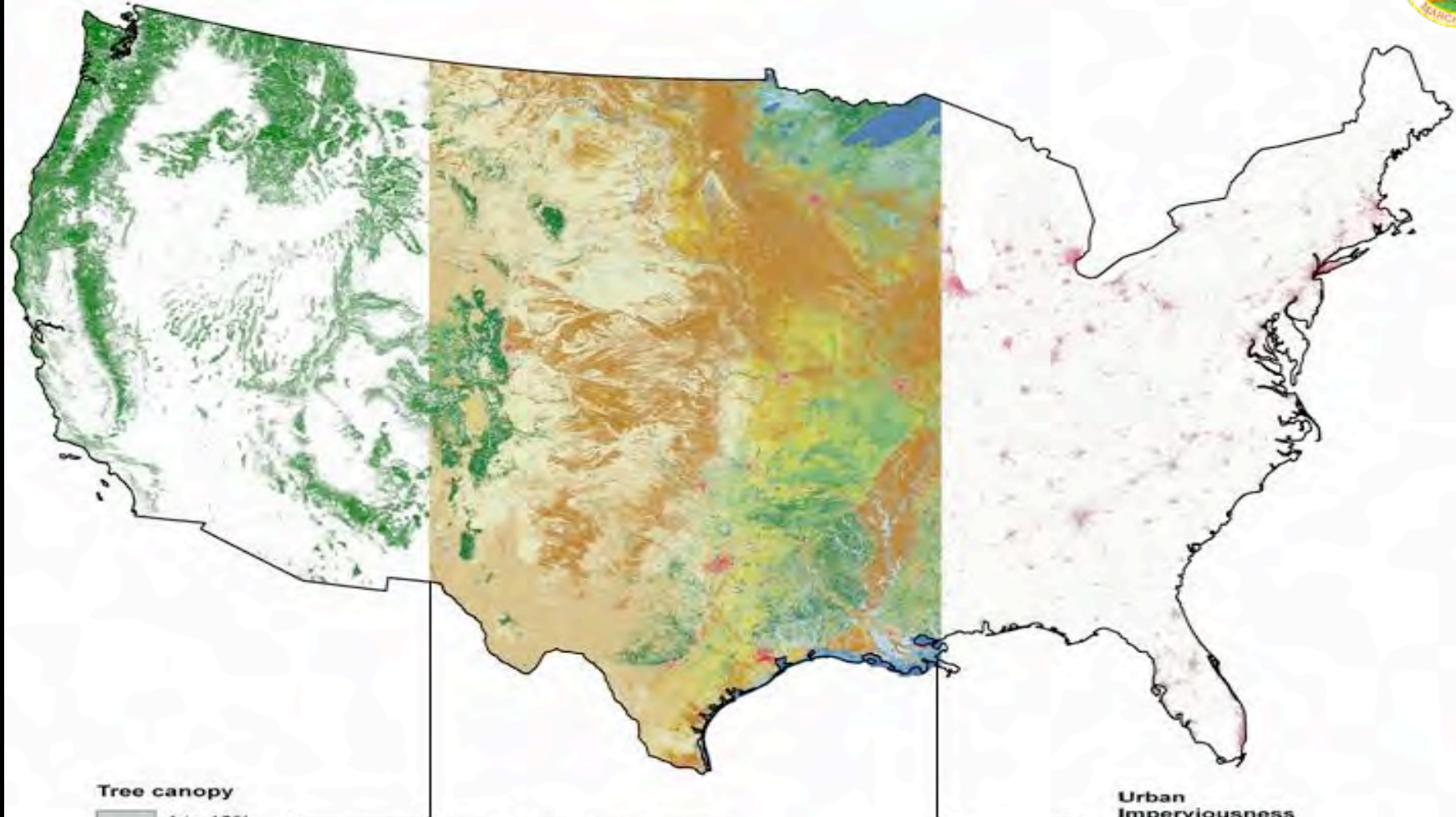
**Fire Danger Monitoring**



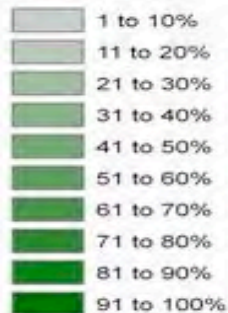
**Burn Severity Assessment**



# National Land Cover Database (NLCD 2006)



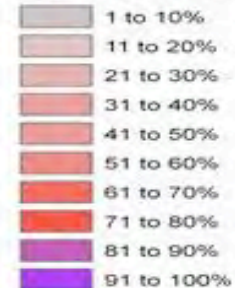
## Tree canopy



## Land Cover Class Value and Description



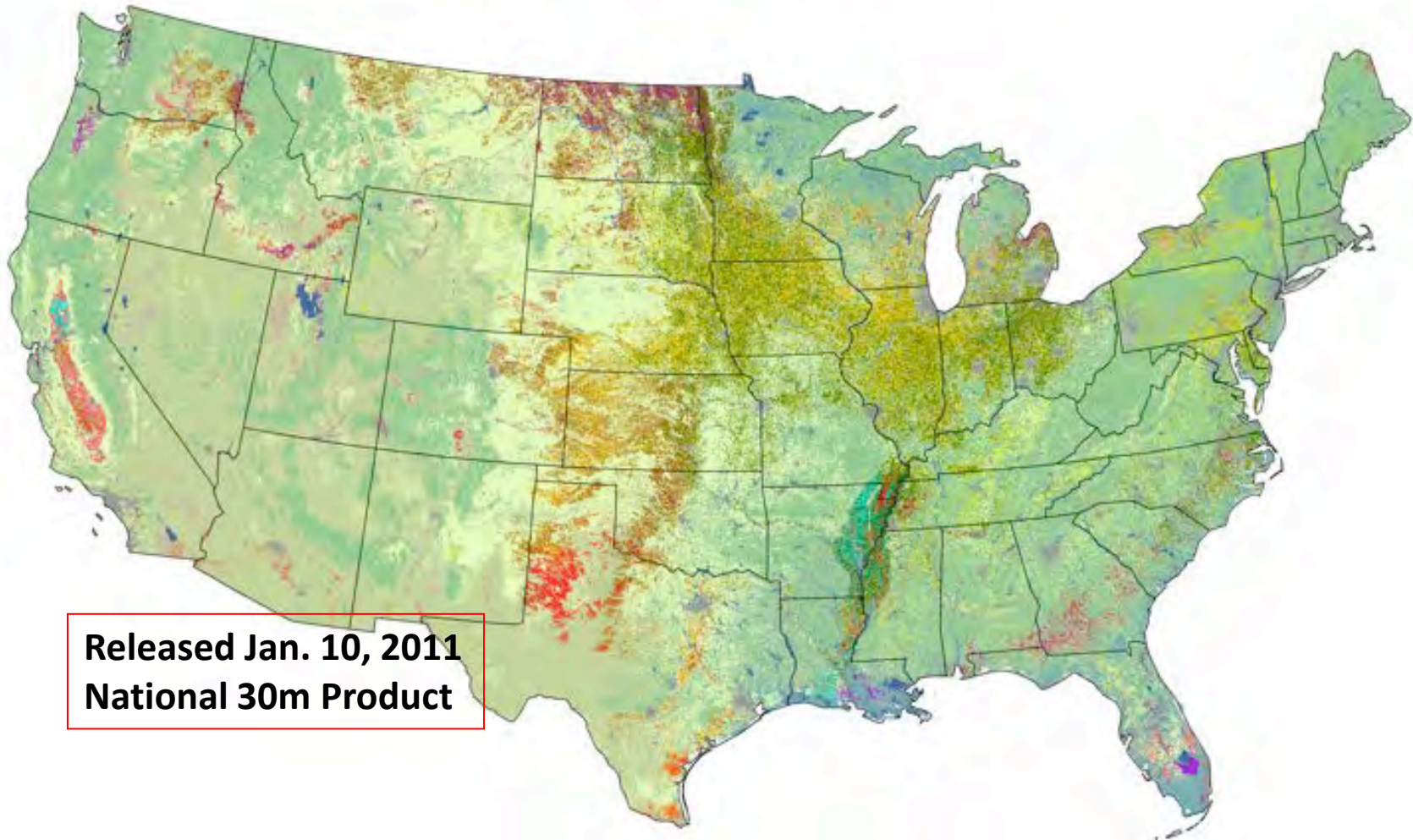
## Urban Imperviousness



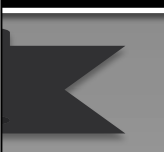
# Landsat comprehensively portrays crop status



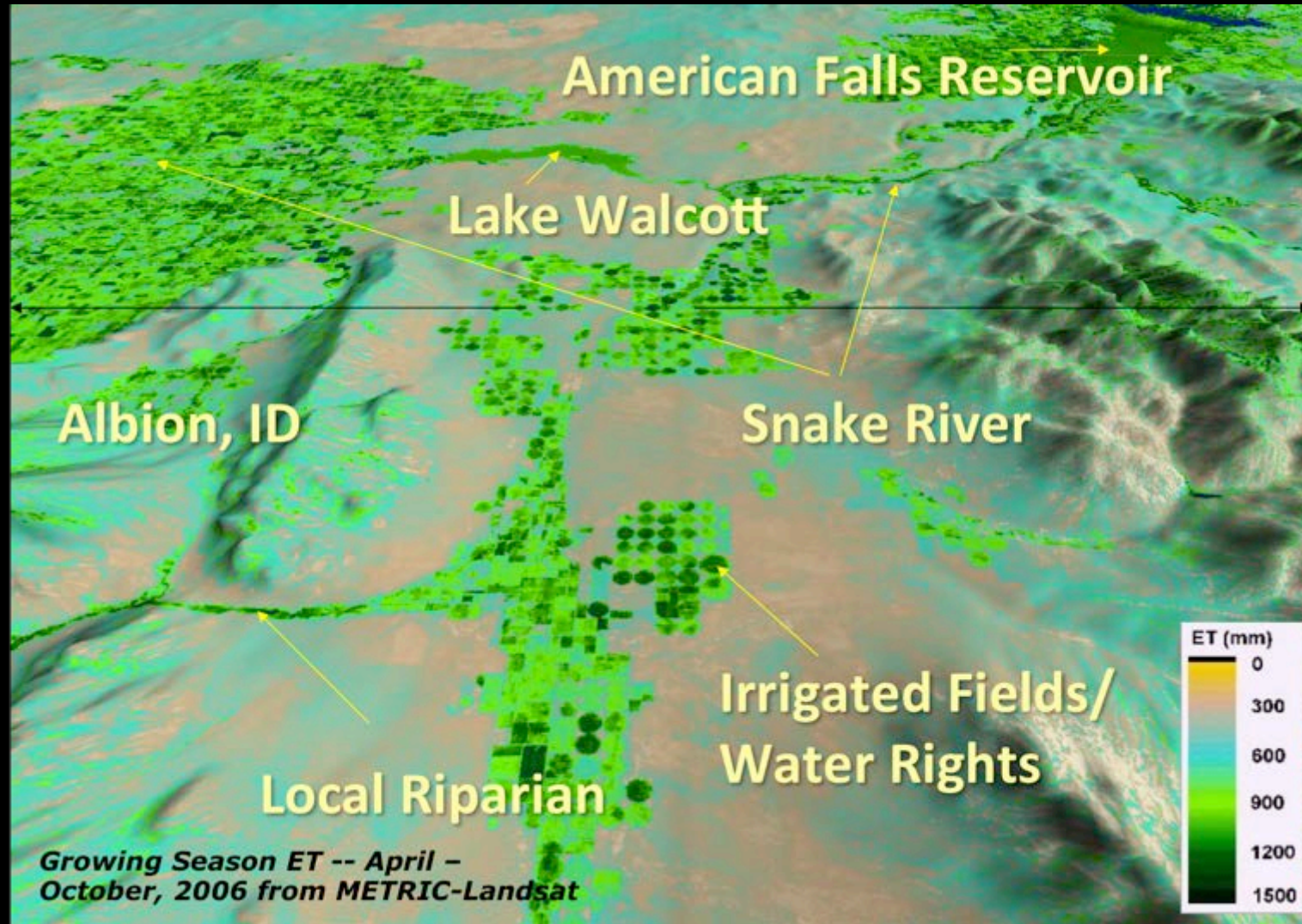
## 2010 Cropland Data Layers



Released Jan. 10, 2011  
National 30m Product



# Evapotranspiration (ET) monitoring with Landsat



# Harvard's Ash Institute's Innovations in American Government Award - 2009



Idaho Department of Water Resources and University of Idaho  
"Mapping Evapotranspiration from Satellites"



"METRIC....is measurably more accurate, fast, and cost-effective than the traditional, cumbersome, slow and expensive methods that were commonly used in the last century."

"...it would be practically *impossible* to adjudicate water rights disputes in the future without [TIRS]."

"It is measurably effective in that it has distinctive capacities to monitor evapotranspiration and consumptive water use across both space...and time (..with the help of historic Landsat thermal band."

# Other states using or gearing up to use METRIC

- **Nevada**
  - Water transfers to Reno and Las Vegas
- **Nebraska**
  - Over pumping of the Ogallala Aquifer
- **Colorado**
  - Arkansas River in Kansas vs. Colorado
  - South Platte River in Nebraska vs. Colorado
- **Wyoming**
  - North Platte River in Nebraska vs. Wyoming
- **Oregon**
  - Klamath Basin water shortages
- **California**
  - Imperial Irrigation District: water consumption by irrigation
- **New Mexico**
  - Middle Rio Grande: water consumption by agriculture and riparian systems
- **Montana**
  - Flathead Indian Reservation and ground water areas east of Helena: for improved irrigation water management and management of total depletion

# The Landsat Revolution

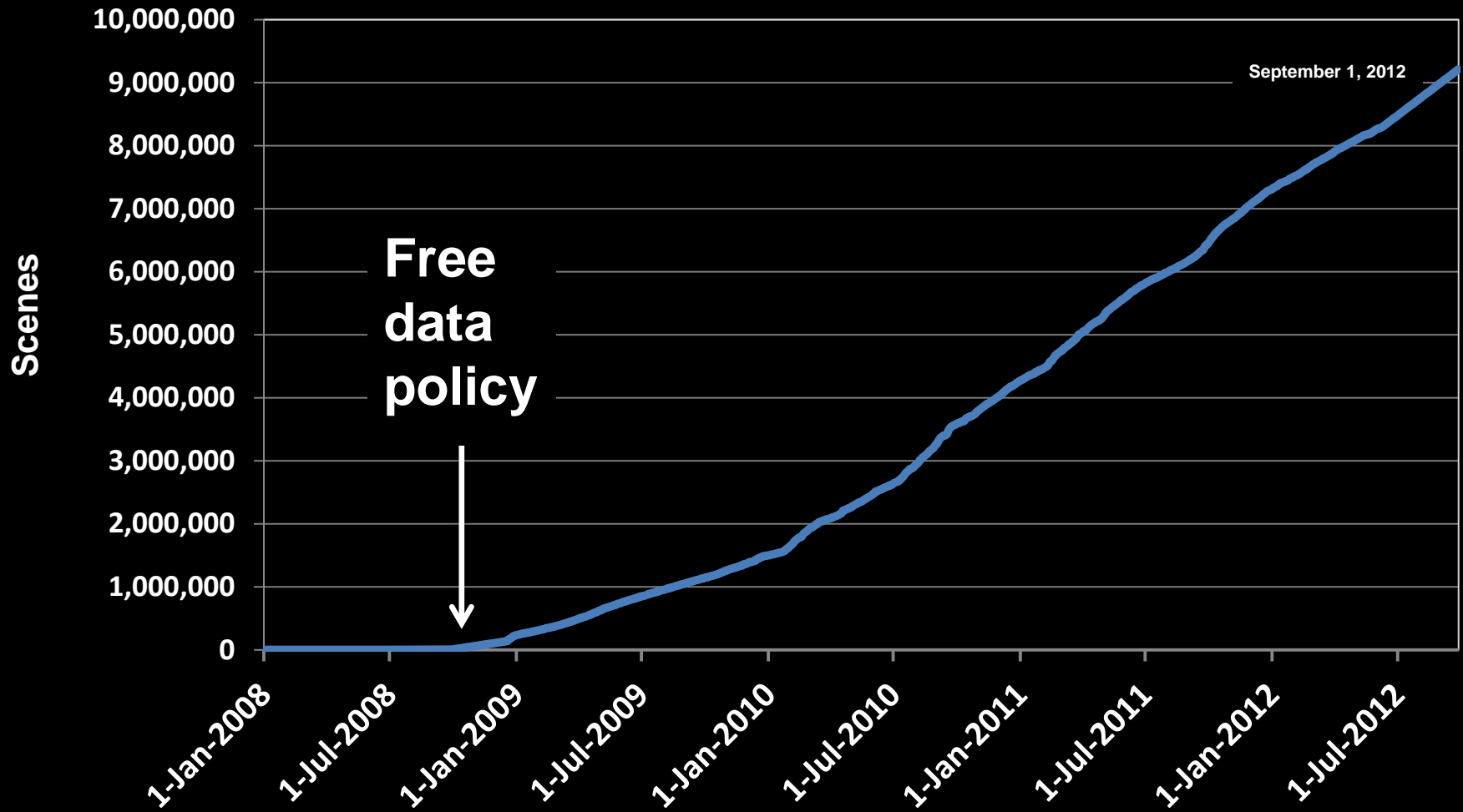
In October 2008, the USGS made the entire Landsat archive, over 3 million images, available via the Internet at no cost.

*The opening of the Landsat archive reshaped the future of moderate resolution Earth observations.*



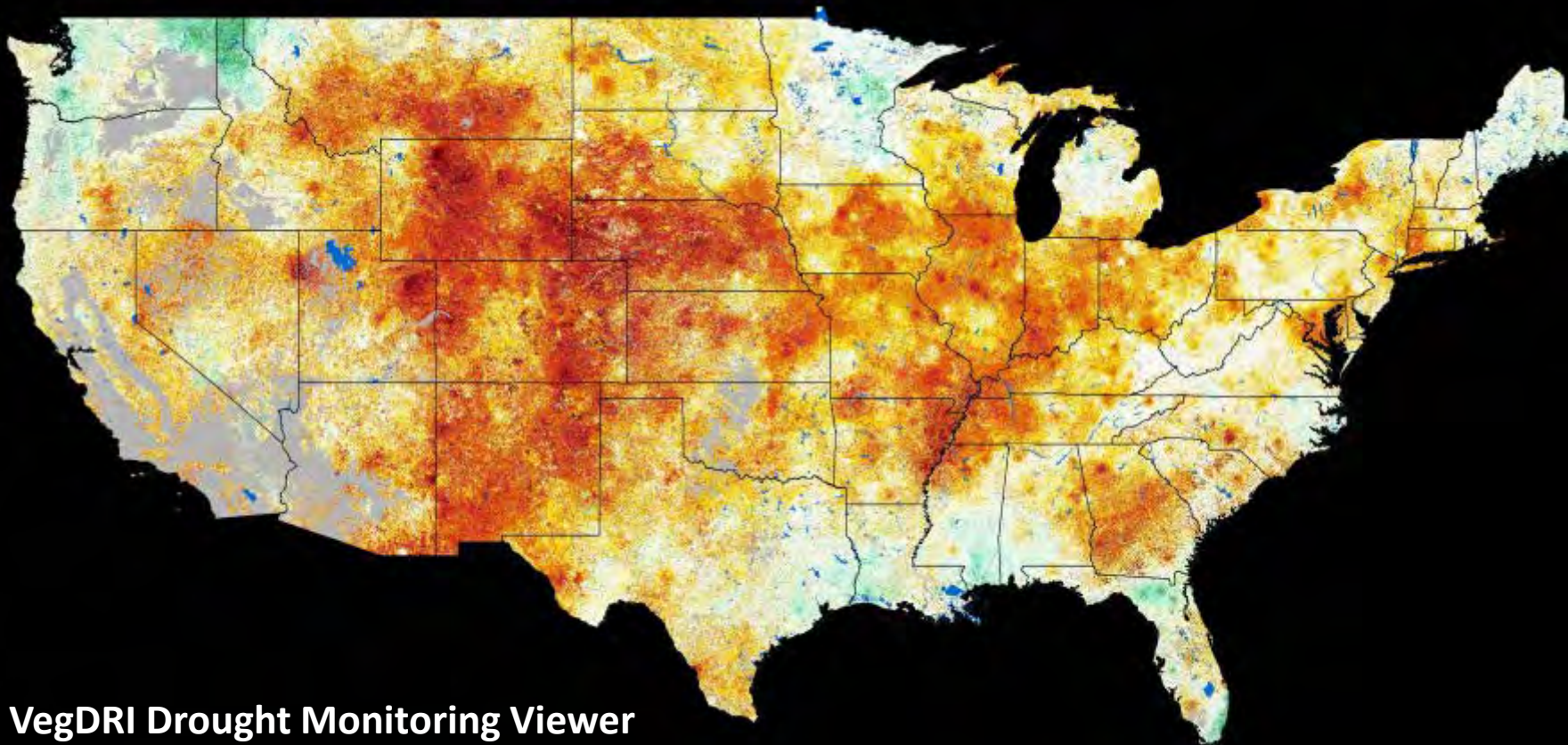
# Landsat Data: 40 Years of Global Data Free Online

Total Landsat Scenes Provided to Users Since January 1, 2008





# Monitoring drought with remote sensing



**VegDRI Drought Monitoring Viewer**  
<http://vegdrri.cr.usgs.gov/viewer/viewer.htm>  
**VegDRI = Vegetation Drought Response Index**

# Synthetic Aperture RADAR (SAR) to monitor invasive species



*Phragmites*



*Typha*

- SAR can differentiate native and invasive wetland species based on:
  - Inundation/water level patterns
  - Vertical Structure
  - Soil moisture
  - Biomass
  - Seasonal (spring, summer, fall data)

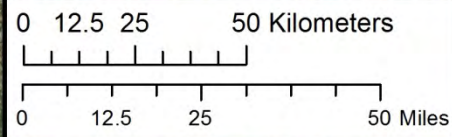


# Lake Erie Potential Invasive Phragmites



**Legend**

 Potential invasive Phragmites



# Saginaw Bay Coastal Wetlands Classification



Classification based on  
CASI Hyperspectral Imagery and LiDAR data

## Classification -- Area (ha)

Yellow	SAV -- 3600.6
Light Green	Bullrush -- 2147.8
Orange	Cattail -- 2934.0
Brown	Phragmites -- 1590.3
Magenta	Other Emergent -- 811.1
Purple	Wet Meadow -- 977.8
Dark Green	Forest -- 6930.6
Red	Urban -- 814.3
Tan	Agriculture -- 7414.1
Light Gray	Other Upland -- 2855.6
Green	Upland Meadow -- 557.7

# Unmanned Aerial Systems (UAS)



# Department of the Interior – UAS Technology

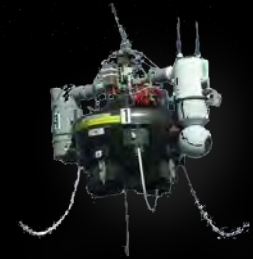
## Raven A

- 4.2lb, 36 in. long battery powered single engine fixed wing
- 19 systems, 3 aircraft per system, 57 total Raven A



## T-Hawk

- 20lb, 21 inch wide gas powered single engine rotary wing.
- 22 systems, 2 aircraft per system, 44 total T-Hawk



## Predator (DHS-CBP)

Data collected on a noninterference basis or as requested for emergency operations.

- Wing Span: 66 ft., Length: 36 ft., Max Takeoff Weight: 10,500 lb., Range: Up to 3200 nm, Max Demonstrated Endurance: 21 hrs, Air Speed Max/Transit/Loiter: 240+/180/110 kts
- Payloads: EO/IR, Lynx Synthetic Aperture Radar (SAR)



# USGS UAS Project Office Mission



*Enhanced Earth Observations + New Science = More Informed Decisions*

USGS/DOI works closely with partners from:

- NOAA
- DoD
- DHS
- NASA
- Academia
- FAA
- FWS, BLM, OSM, NPS, BoR





# Thermal images of sandhill cranes

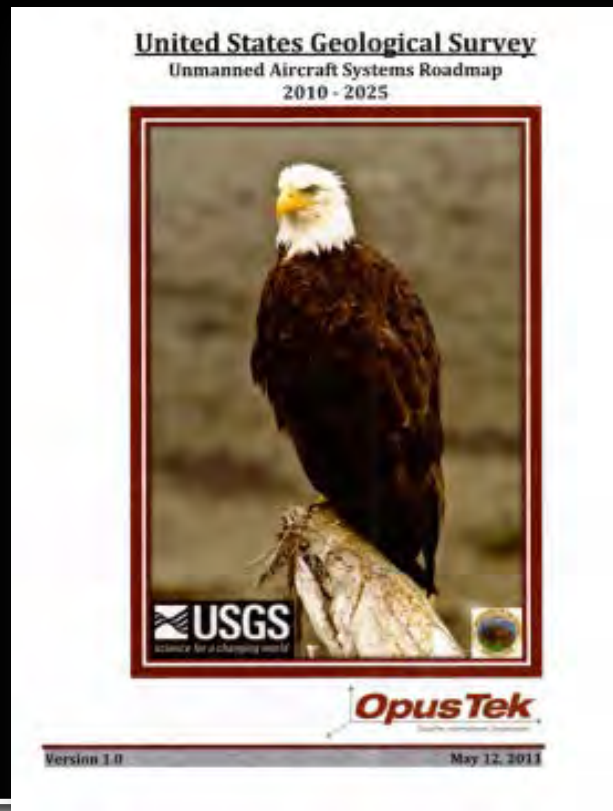


Raven A Infra-Red Thermal Imagery of roost  
Taken 6:39 am 3/24/11.



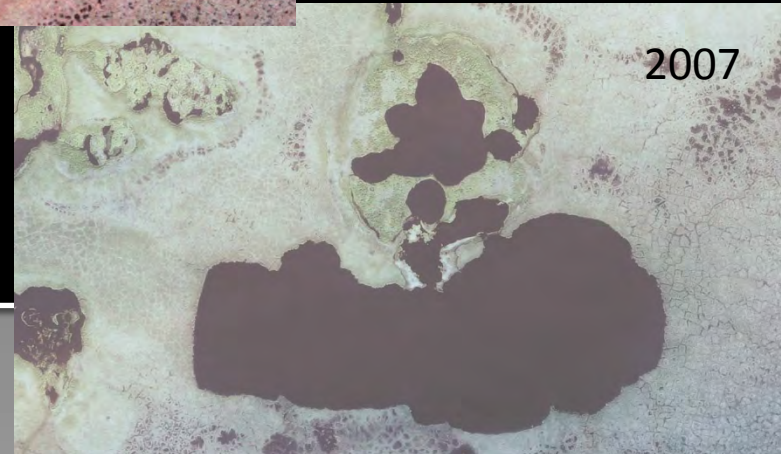
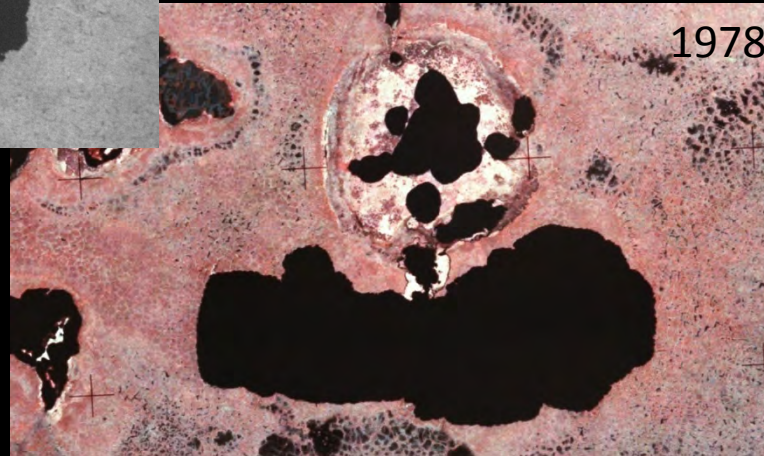
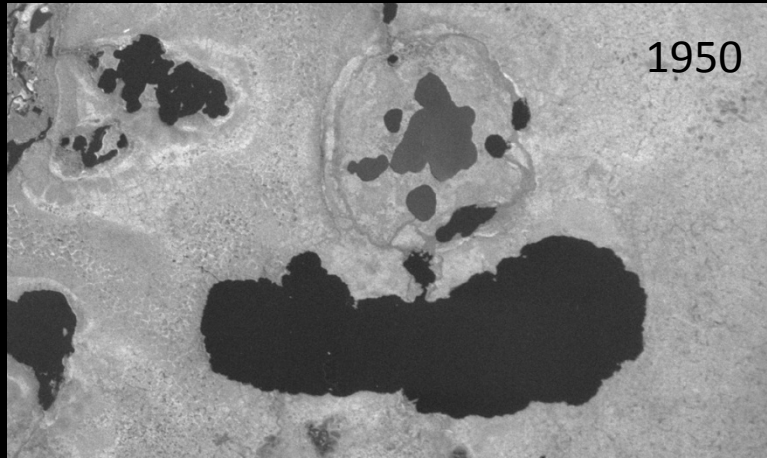
# UAS Roadmap

USGS has worked with many partners to develop a report that will serve as a roadmap for the development of UAS applications.



# Lake Expansion Due to Surface Permafrost Degradation

## Aerial Photography, Alaska



# Why are Earth observations important for civil society?

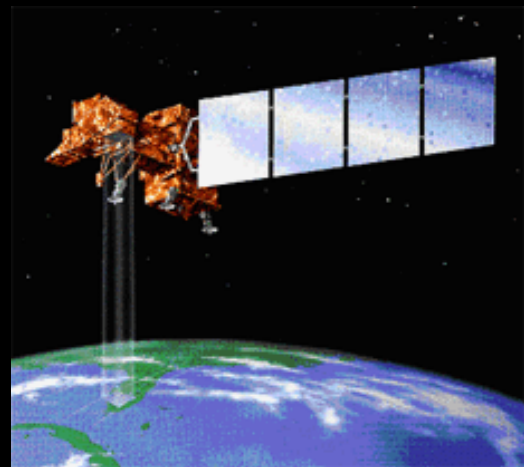
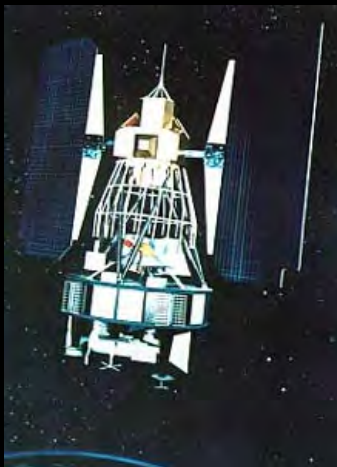
Continuous Earth imaging from space ensures that events are registered and cannot be concealed, even if the traces of the event have been removed on-site (for example, oil spills).

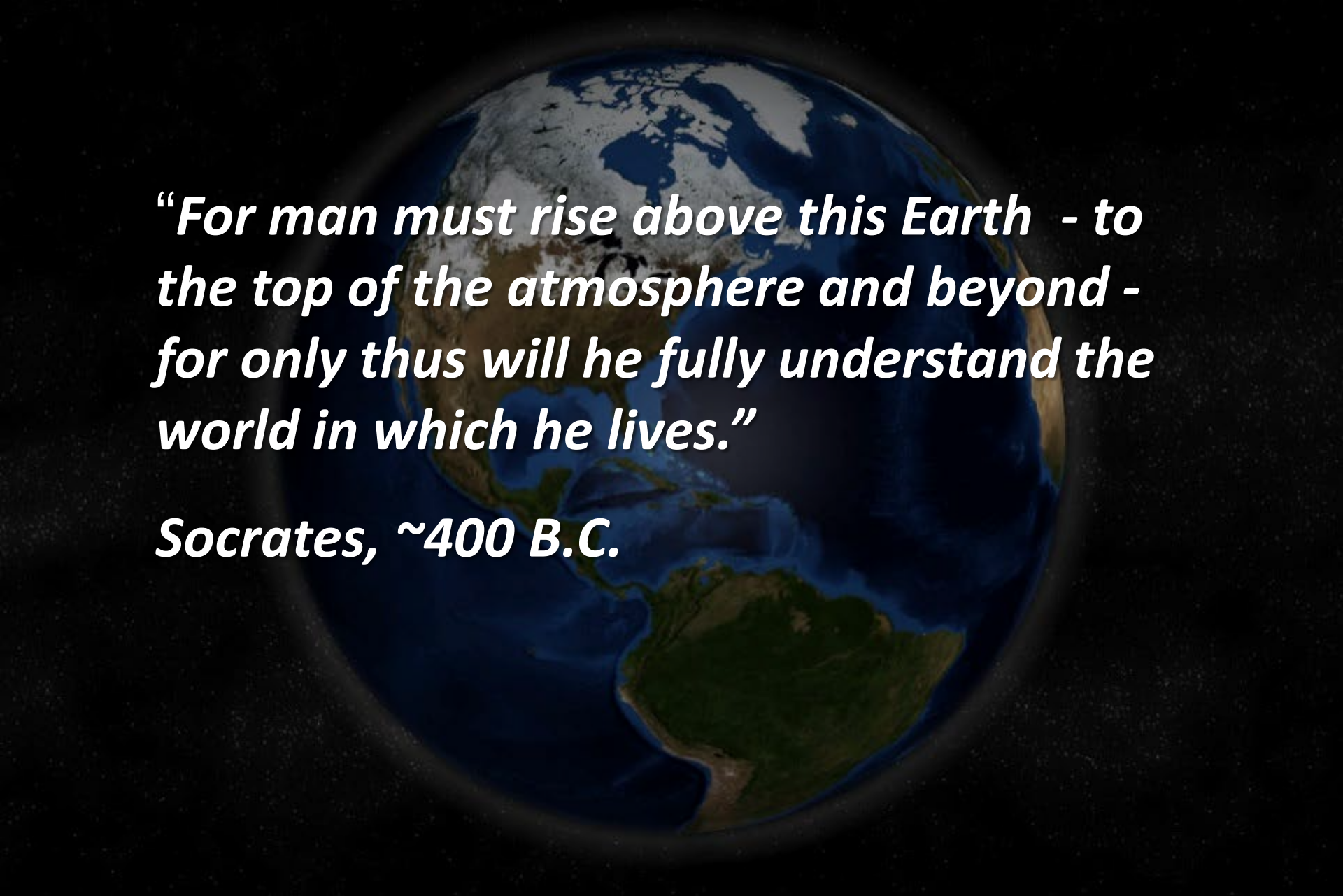
*O. Gershenzon, RussiaTransparent World Partnership, 2011.*

Landsat is akin to the Earth's free press. With its global perspective, we have objective and indisputable evidence of the condition of the planet.

*Curtis Woodcock, Boston University, 2011.*

# Observing Earth from afar – a continuing quest





***“For man must rise above this Earth - to the top of the atmosphere and beyond - for only thus will he fully understand the world in which he lives.”***

***Socrates, ~400 B.C.***