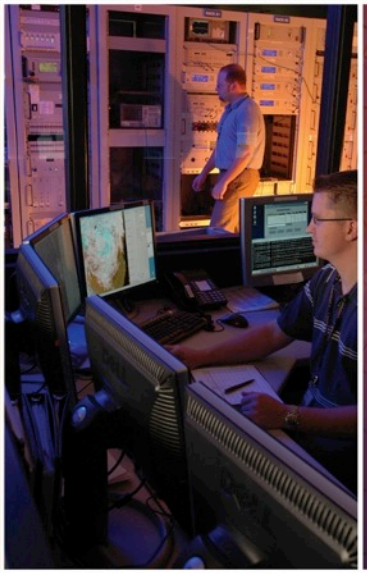
USGS
science for a changing world

# USGS EROS Center

## Observing Systems …

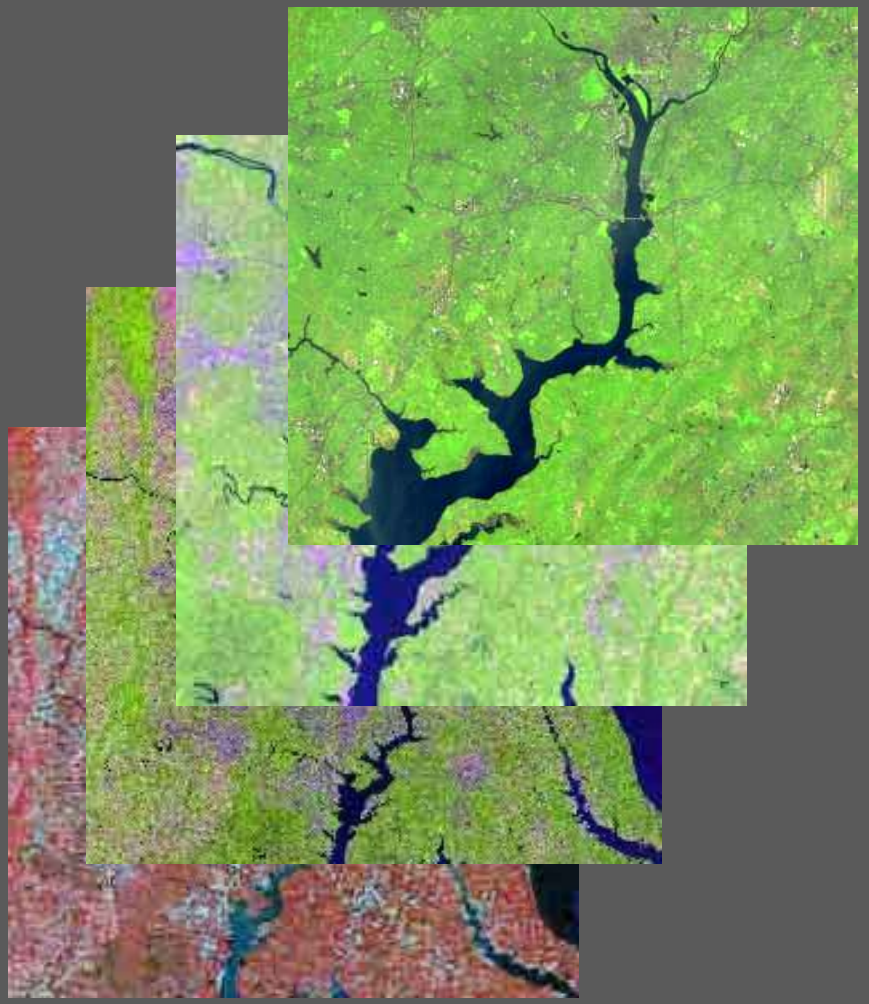


U.S. Department of the Interior
U.S. Geological Survey

# U.S. Landsat Archive Overview

(August 1, 2013)

- OLI-TIRS: Landsat 8
  - 63,548 scenes
    - ~ 219 TB Raw and L0Ra Data
      average scene size 1813 MB
- ETM+: Landsat 7
  - 1,615,620 scenes
    - ~ 1,500 TB Raw and L0Ra Data
      average scene size 487 MB
- TM: Landsat 4 & Landsat 5
  - 1,776,755 scenes
    - ~ 891 TB Raw and L0Ra Data
      average scene size 263 MB
- MSS: Landsat 1 through 5
  - 866,762 scenes
    - ~ 52 TB Raw and L0Ra Data
      average scene size 32 MB
- Total:
  - 4,322,685 scenes
    - ~ 2662 TB Raw and L0Ra Data



USGS

# Landsat-5 Decommission

- **Plan development started April of 2012**
- **Plan peer reviewed at 17 October, 2012 MOWG with broad support**
- **Decommission key dates**
  - Apogee Lowering: Jan 15 – 23, 2013
  - Perigee and Fuel Depletion: April 17 – May 24, 2013
  - Passivation: Performed May 28 – June 5, 2013
- **Control Center Disassembly: Began June 6**

USGS

# Landsat 7 Spacecraft Status

≈ 14 years of on-orbit operations

## Enhanced Thematic Mapper +

- 5/31/2003 SLC Failure
- 4/01/2007 SAM -> Bumper mode

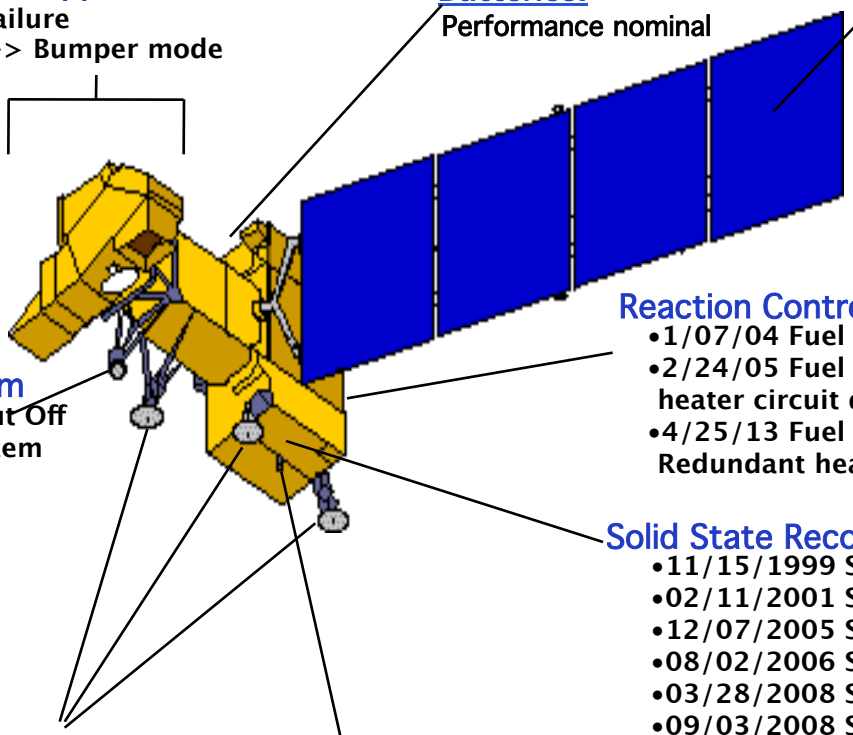
## Electrical Power System

### Batteries:

Performance nominal

### Solar array:

- 5/14/2002 Circuit #14 Failure
- 5/16/2005 Circuit # 6 Failure
- 8/13/2008 Circuit #14 partial recovery
- 14 circuits remain operating
- No impact to ops



## Reaction Control System

- 1/07/04 Fuel line #4 thermostat #1a failure
- 2/24/05 Fuel line #4 thermostat failure; Primary heater circuit disabled
- 4/25/13 Fuel line #2 thermostat failure; Redundant heater circuit disabled

## Attitude Control System

- 05/05/2004 Gyro 3 Shut Off
- Single gyro control system in development

## Solid State Recorder

- 11/15/1999 SSR PWA #23 Loss
- 02/11/2001 SSR PWA #12 Loss
- 12/07/2005 SSR PWA #02 Loss
- 08/02/2006 SSR PWA #13 Loss
- 03/28/2008 SSR PWA #22 Loss
- 09/03/2008 SSR PWA #23 Recovered
- Each PWA is 4% loss of launch capacity
- Boards are likely recoverable

## X-band System

Performance nominal

## S-band System

Performance nominal

USGS

# Launch – Landsat 8

## LDCM launched February 11, 2013

- **Atlas V 401 launch vehicle selected by NASA Kennedy Space Center**
  - Contract with United Launch Alliance (ULA)
- **Launched from Vandenberg Air Force Base (VAFB), California**

USGS

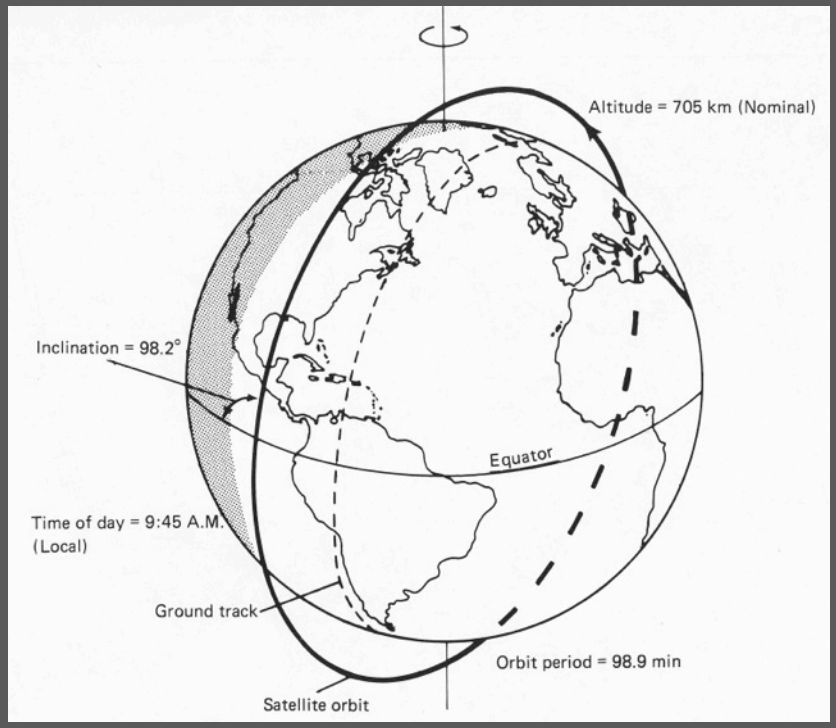
# 100-Day LDCM In-Orbit Check-Out

- **March 18 – first release of OLI & TIRS images**
- **March 29 – 31 – Landsat 7 underfly for cross-calibratioin**
- **April 12 – ascent to nominal 705-km operational orbit**
- **April 27 – May 12 – 16-day Design Reference Case**
- **May 30 – Mission Transition Review at USGS EROS Center**
  - Lead for satellite operations formally transitioned from NASA to USGS
  - USGS immediately renamed the satellite Landsat 8
  - The Landsat 8 data archive opened to the public at 1:00 p.m. CDT with over 22,000 Landsat 8 images, going back to April 12, available for distribution

USGS

# Landsat 8 Operations Concept

- Fly Landsat 8 in legacy orbit (705 km, near-polar, sun-synchronous)
- Ground tracks maintained along heritage WRS-2 paths with 10:00 a.m. equatorial crossing time & 16 day repeat period
- Collect image data for multiple spectral bands (Vis/NIR/SWIR/TIR) across 185 km swath along each path
- Provide coverage of global land mass each season by scheduling 400 WRS-2 scenes per day
- Maintain rigorous calibration




- Archive data and distribute data products
- Provide nondiscriminatory access to general public, generate Level 1 data products, distribute data products at no cost upon request
- Direct broadcast of data to network of international ground stations having memoranda-of-understanding with USGS

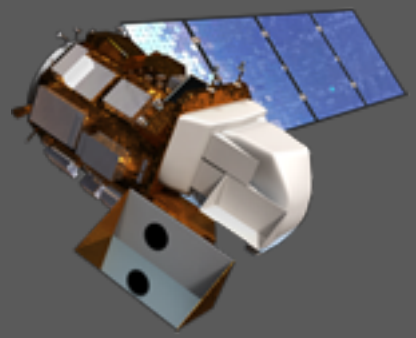
USGS

# Summary of New Landsat 8 Capabilities

- **We are receiving significantly more image data**
  - Averaging 550 images a 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

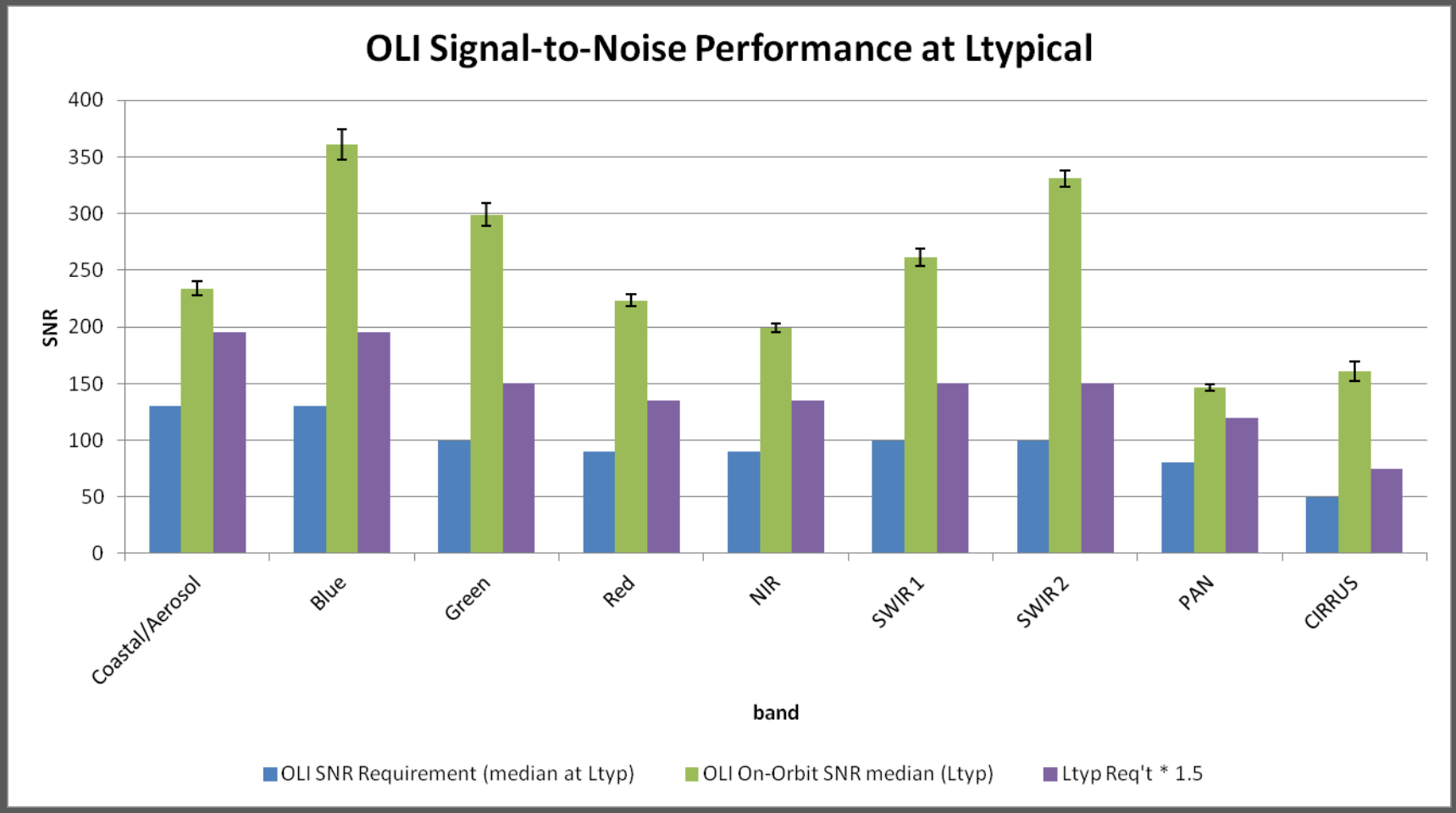
- **Better image data – improves surface characterization**
  - 8–10x improvement in signal to noise ratios
  - 12 bit quantization permits improved measurement of subtle surface conditions and assessment of bright targets
  - Improved pixel geo-location ~ 12m

- **New measurements – enabling new applications**
  - Coastal blue band (0.433–0.453 μm)
  - Cirrus band (1.360–1.390 μm)
  - Additional thermal band



USGS

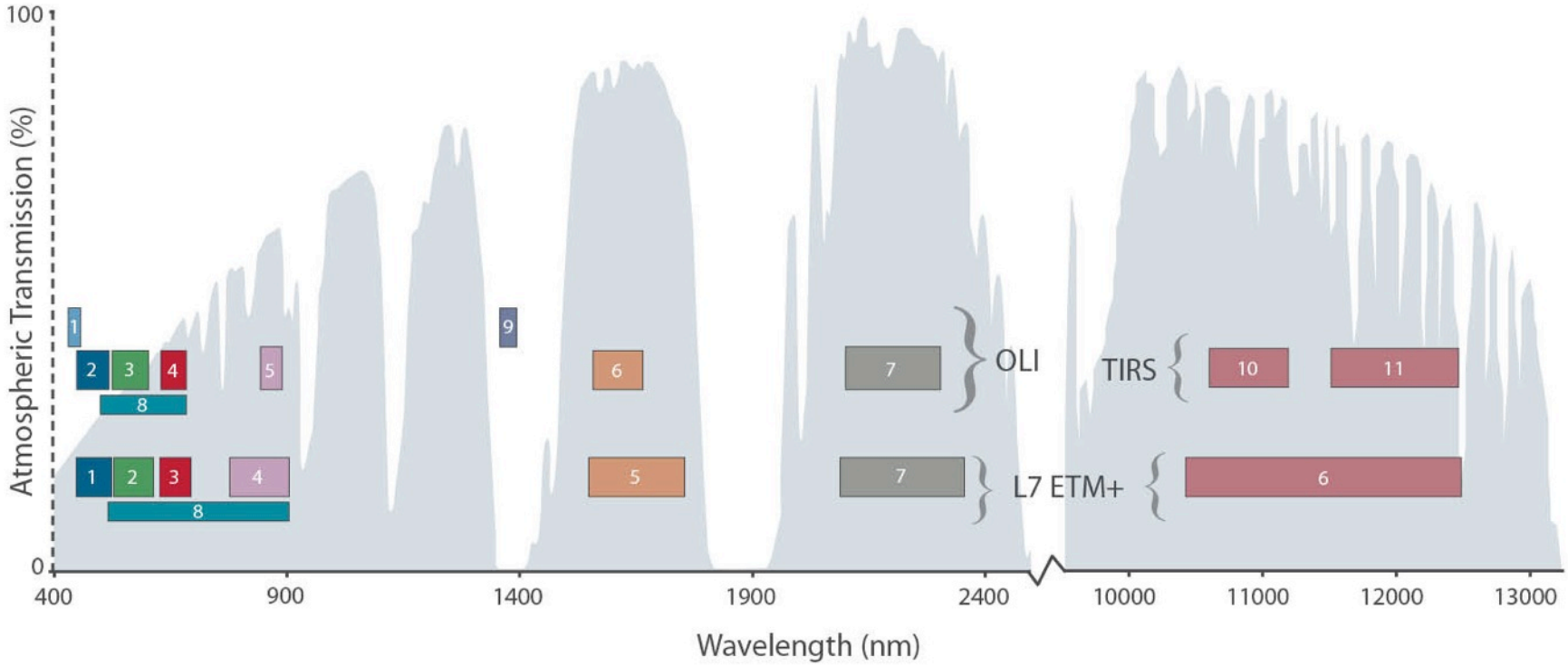
# Landsat 8 Single-to-Noise



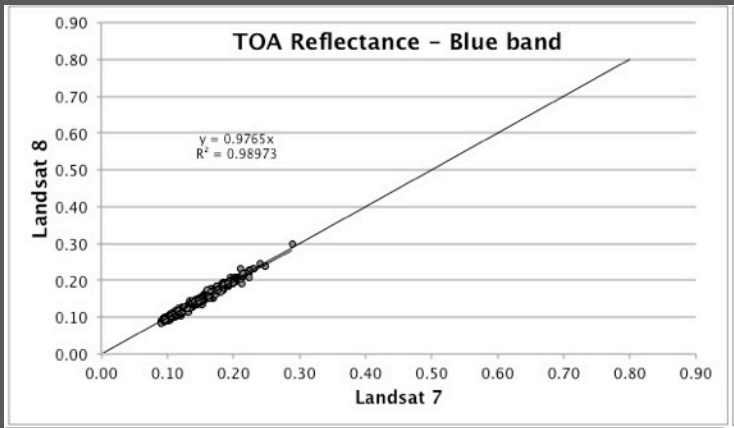

Improved SNR allows the more accurate detection and characterization of subtle land and water conditions.

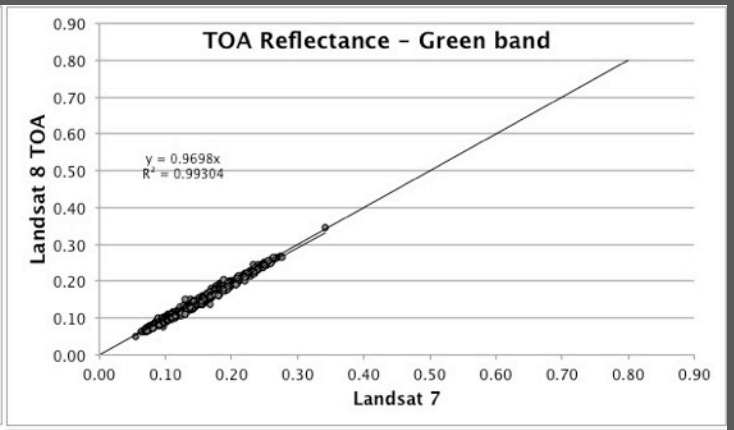
USGS

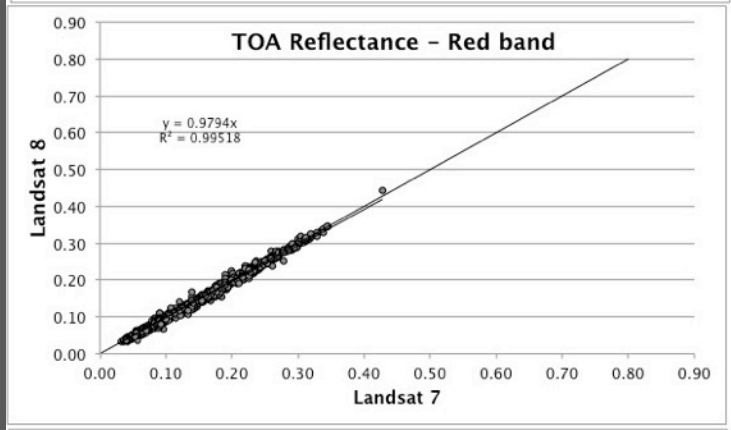
# OLI & TIRS Spectral Bands

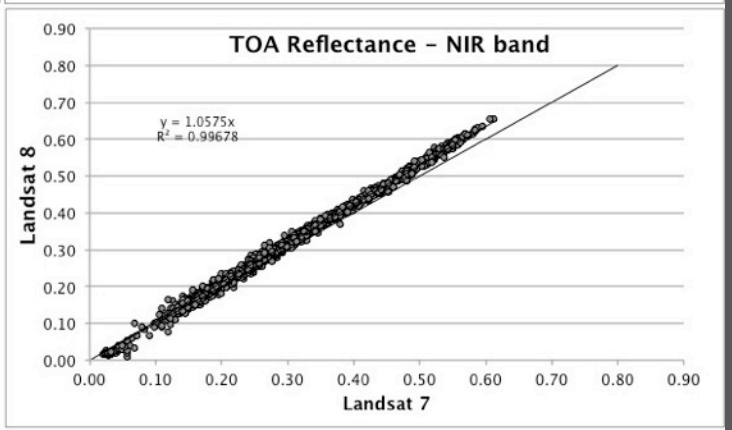


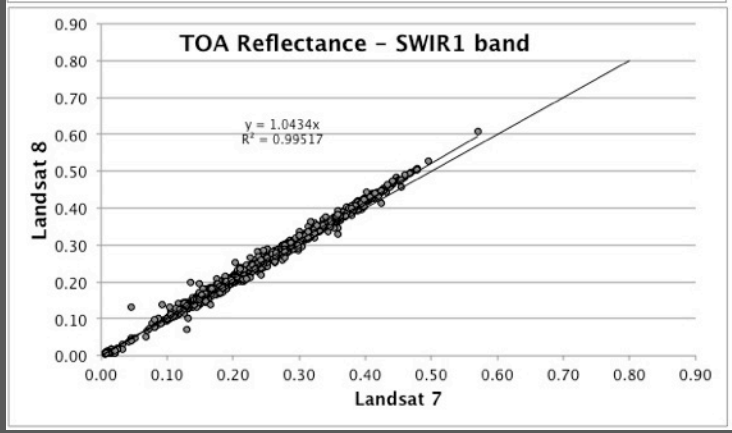

USGS

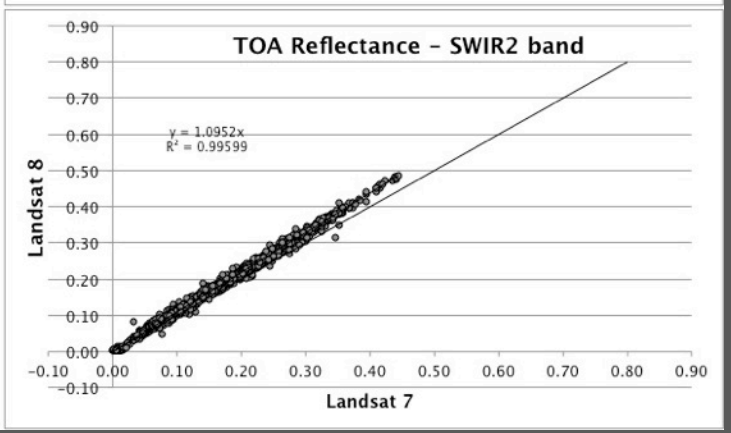


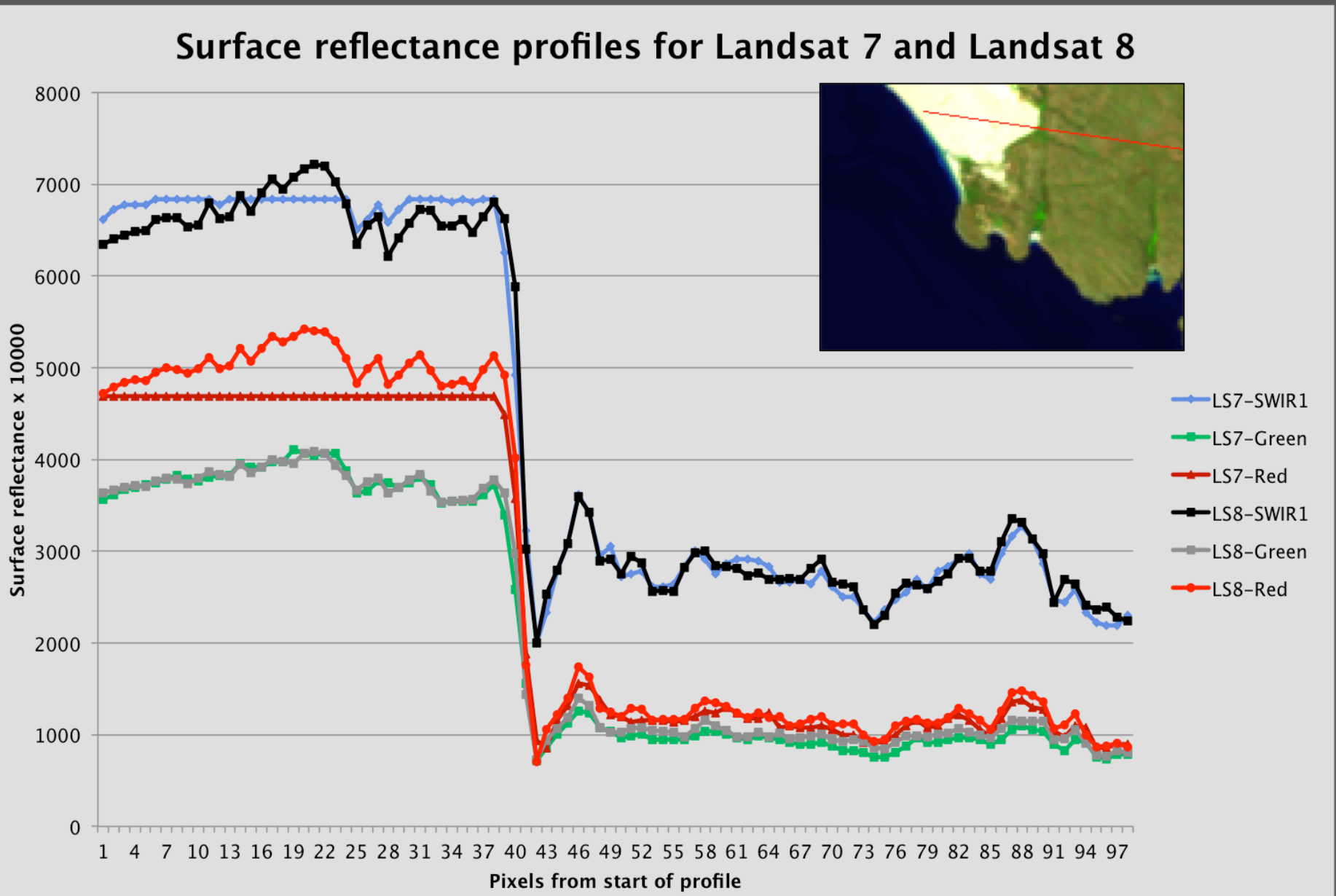




# Comparison of Landsat 7 and 8 Top-of-Atmosphere Reflectance

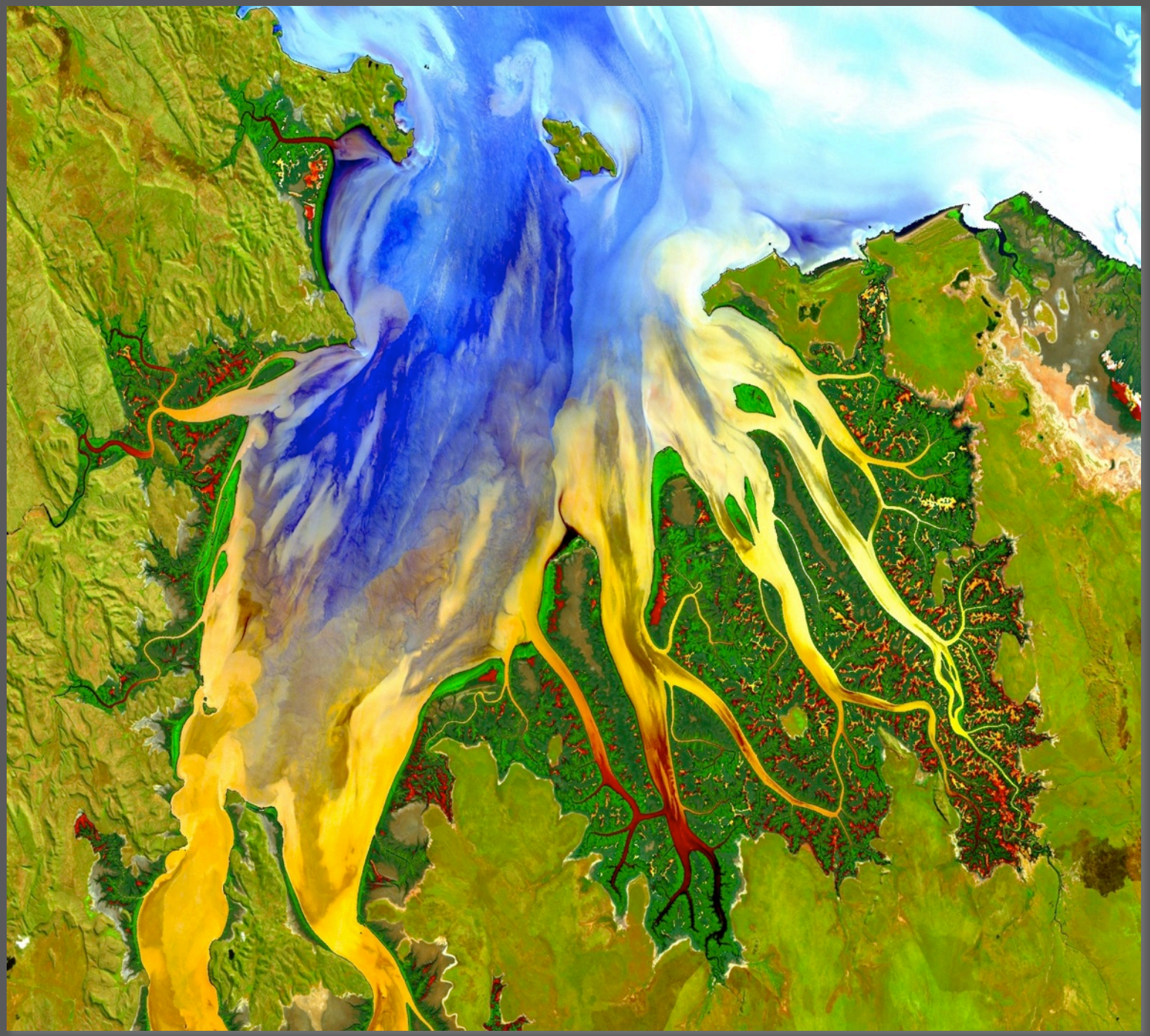
Rick Allen, U of Idaho

# 12-bit Quantization Eliminates Bright Target Saturation




Leo Lymburner, Geosciences Australia

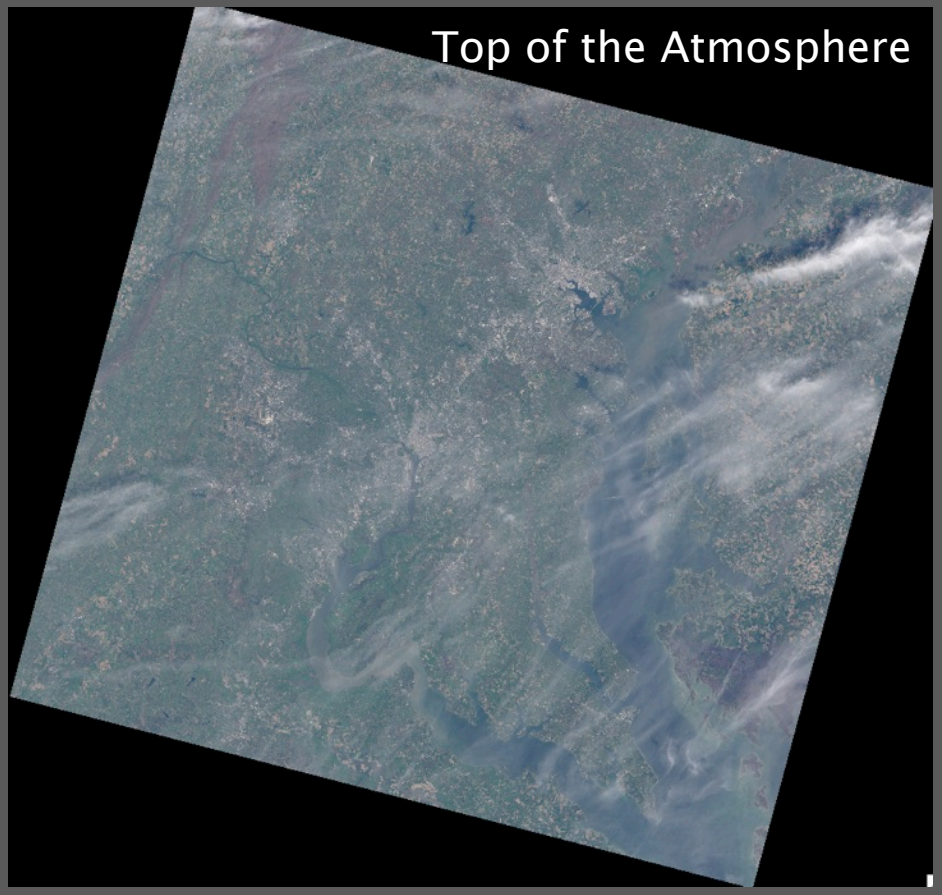
This northern Australia tropical estuary was part of the first Landsat 8 image over Australia. The image combines the Red, Green and Deep Blue bands (RGB) for the water targets and SWIR, NIR and Green (RGB) for terrestrial areas.

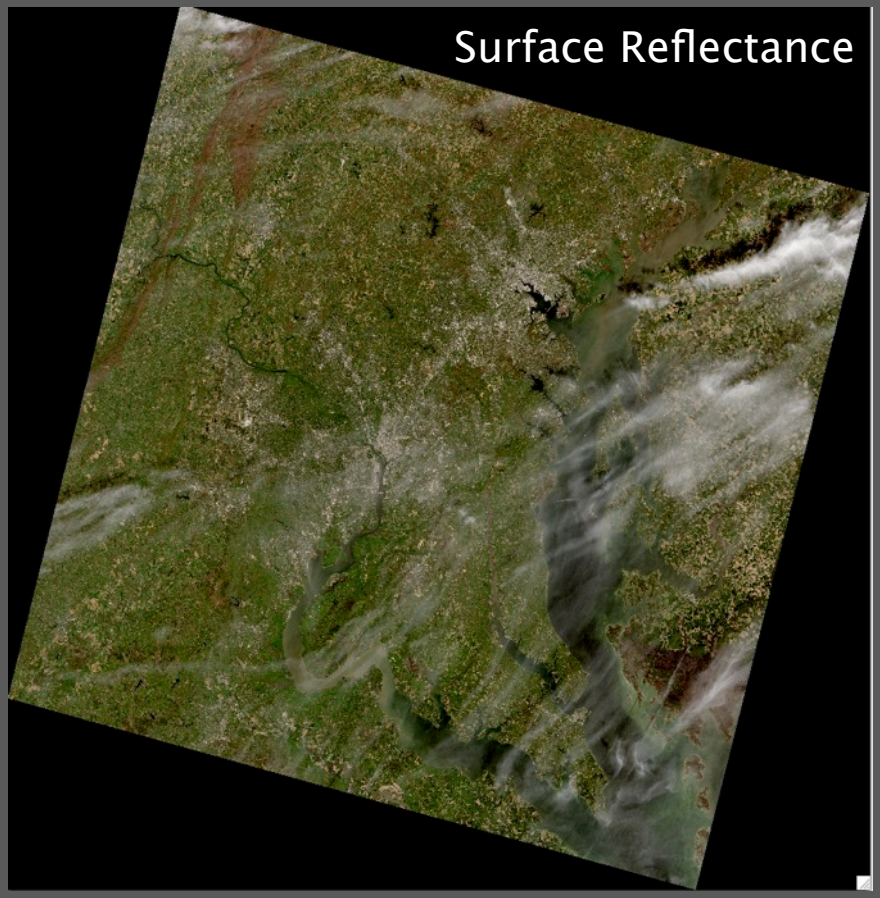


Courtesy of Leo Lymburner, Geoscience Australia

USGS

# Applications Development – Landsat 8 Prototype Surface Reflectance

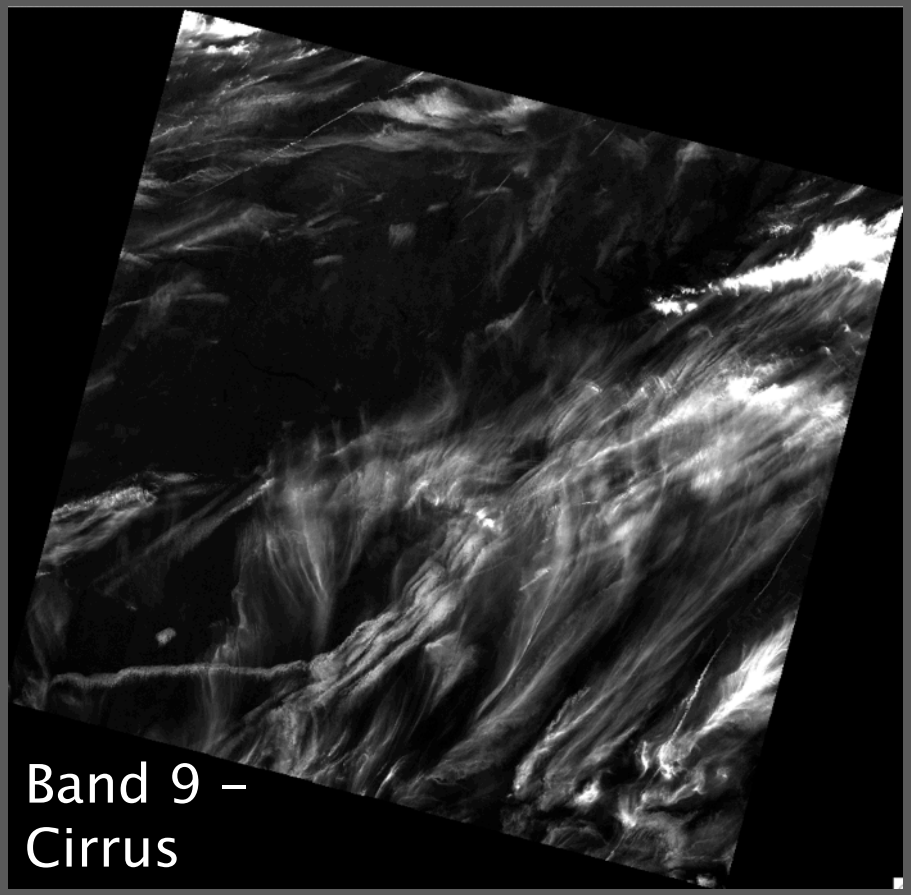


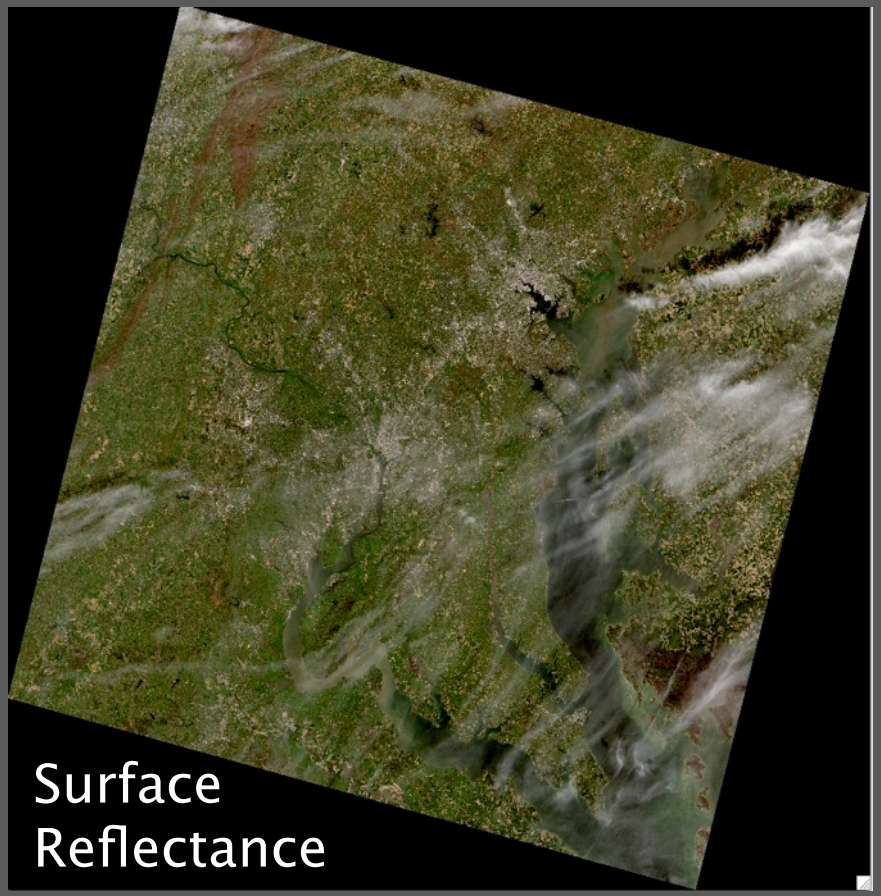




From Eric Vermote, NASA GSFC – "…we we are going to be able to produce a great surface reflectance product given the radiometric performances (signal to noise) and the availability of extra and better band in the blue for aerosol retrieval over land."

USGS

# Landsat 8 Improved Cloud Detection




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

USGS

# Evolution of NLI Requirements

- **President's FY 2012 budget request included funding for Landsat 9**
  - Request included language for "understanding Federal land imaging requirements"
- **USGS issued a Landsat Request for Information**
  - Notional requirements against which to assess alternative for future mission profiles
- **OSTP initiated national Earth Observation Assessment (EOA) – completed in Fall 2012**
  - Collected value tree information to access impact of observing systems across the societal benefit areas (SBAs)
  - Served as an aid to the Administration in formulating a National Plan for Earth Observations

USGS

# NLIR Plans

- **Collaborative effort with NOAA to develop and operate a capability to obtain, characterize, manage, maintain and prioritize project requirements**
  - Goal: Better understanding of the community needs that can be supported with observation capability resources
- **Conducting a requirements gathering pilot**
  - Developing, exercising, and documenting processes for capturing value tree information
  - Focus on requirements for moderate resolution imagery, suitable for:
    - Sensor trade studies, and
    - Landsat mission formulation
  - **Creating a value tree for moderate resolution imagery that provides traceability of requirements to users and missions**
    - Building off of the EOA work
    - Lessons learned to apply to future requirements gathering

USGS

# US President's FY14 Budget

- **The Administration has committed to continue the Landsat program and its invaluable data stream**
- **Language calls on NASA and DOI-USGS to jointly develop a follow-on mission to Landsat 8**
- **Work with NASA and use the information from NLIR process to determine best items to study**

*"Near-term activities led by NASA, in cooperation with USGS, will focus on studies to define the scope, measurement approaches, cost, and risk of a viable long-term land imaging system that will achieve national objectives. Evaluations and design activities will include consideration of stand-alone new instruments and satellites, as well as potential international partnerships."*

USGS

# Landsat 9 and Beyond

- Department of the Interior is working closely with OSTP, OMB, and NASA to consider affordable alternatives for long-term continuity

- NASA and USGS study team to define a sustainable multi-decadal Landsat program

*"We will be examining and doing system design for this sustained land-imaging system"*

Mike Freilich, Director
NASA Earth Science Division

USGS