USGS Report to CEOS WGCV 29

Dates: Sep 30-Oct 3, 2008 Avignon, France

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U.S. Department of the Interior

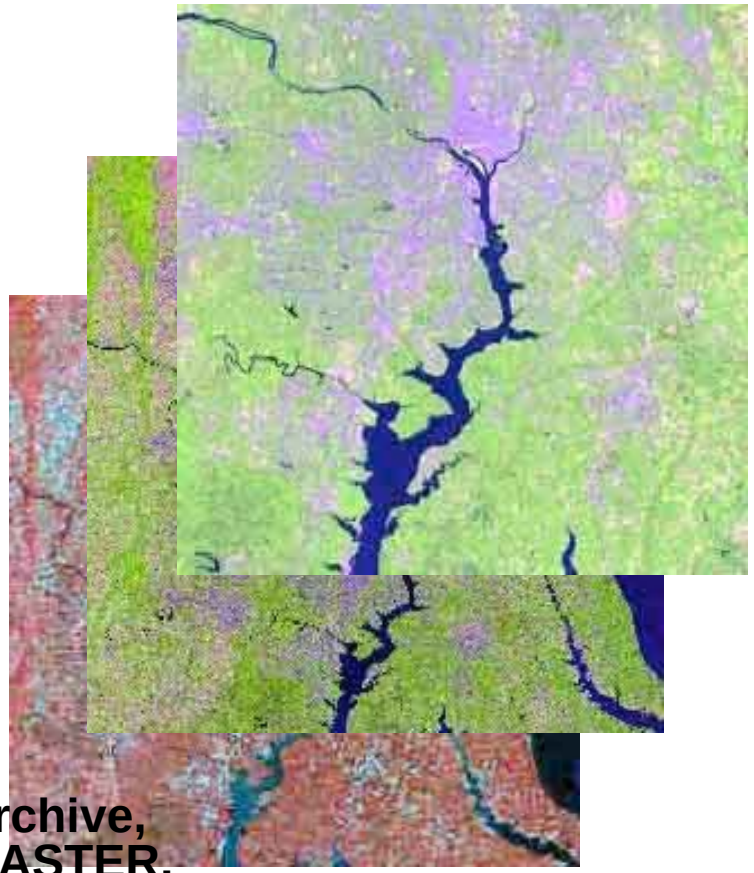
U.S. Geological Survey

USGS Archive Overview
(Marketable Scenes through May 31, 2008)

- **ETM+: Landsat 7**
  - 830,440 scenes
  - 771 TB RCC and L0Ra Data
  - Archive grows by 260 GB Daily

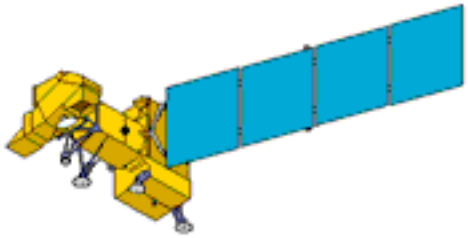
- **TM: Landsat 4 & Landsat 5**
  - 745,235 scenes
  - 373 TB of RCC and L0Ra Data
  - Archive Grows by 40 GB Daily

- **MSS: Landsat 1 through 5**
  - 652,174 scenes
  - 20 TB of Data



- **Also Land Processes DAAC, Long Term Archive, and commercial Remote Sensing archive (ASTER, MODIS, EO-1, ResourceSat, hi res satellites, aerial film, other satellite instruments, digital aerial datasets, LiDAR, …..)**

Landsat 7 Mission Status



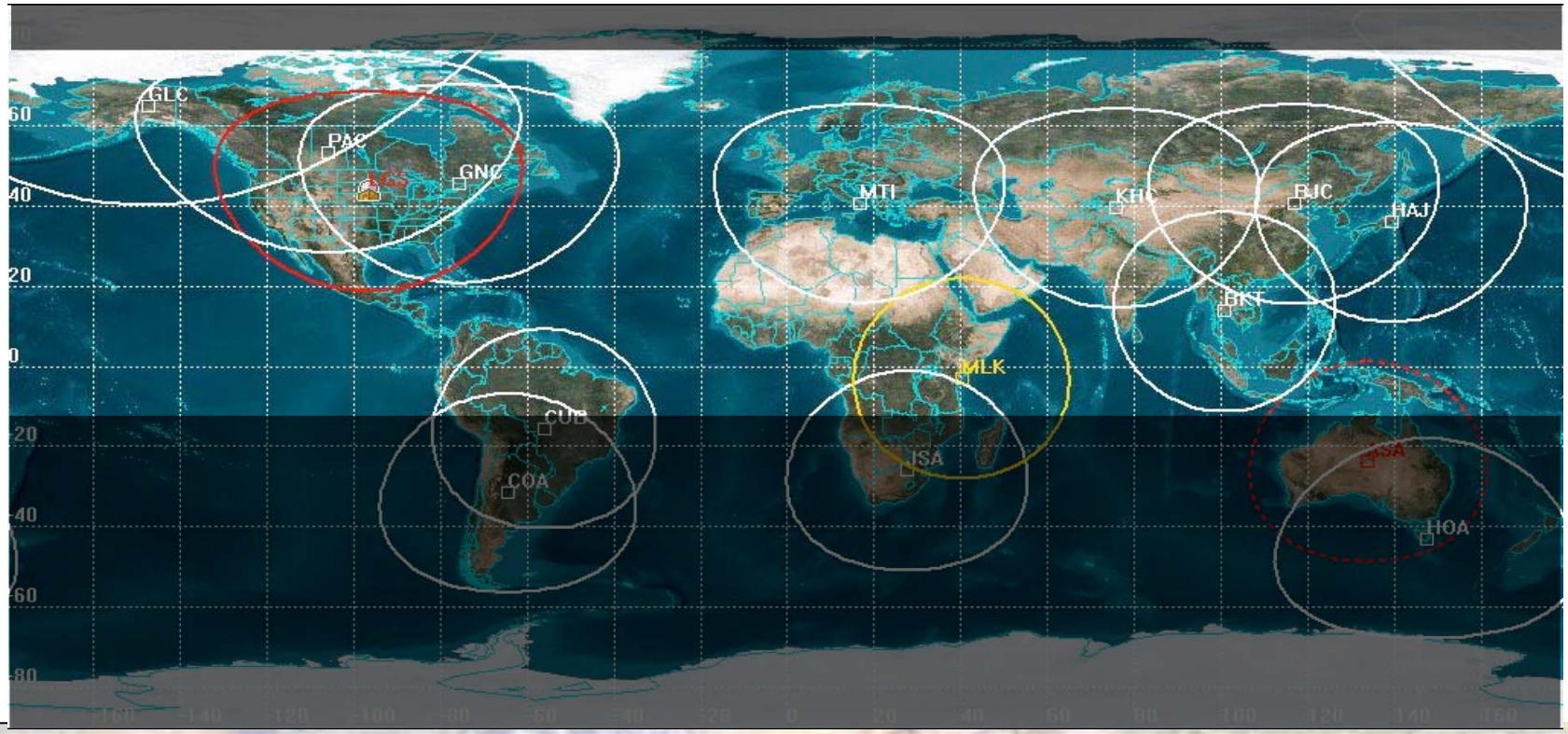
- **Landsat 7 - 15 April 1999 (~9 Years)**
  - Spacecraft
    - Gyro 3 Failure (Shut down May 5, 2004)
      - Working additional improvements for software gyro
    - Other Spacecraft Issues (non-critical)
      - Solid State Recorder – 4 memory boards
      - Electrical Power Subsystem – shunt #14 and shunt #6
      - Fuel Line Thermostat
  - ETM+
    - Scan Line Corrector Failure (May 31, 2003)
    - Bumper Mode Operations (April 1, 2007)

Landsat 5 Mission Status

- **Landsat 5 – 1 March 1984 (~25 years)**
  - Landsat-5 has exceeded 130,000 orbits!
  - Spacecraft
    - Battery 2 Anomaly – Oct 2007
    - Star Tracker Issue – June 2007
    - Solar Array Drive - Fixed array operations – Aug 2006
  - TM
    - Functioning normally in bumper-mode

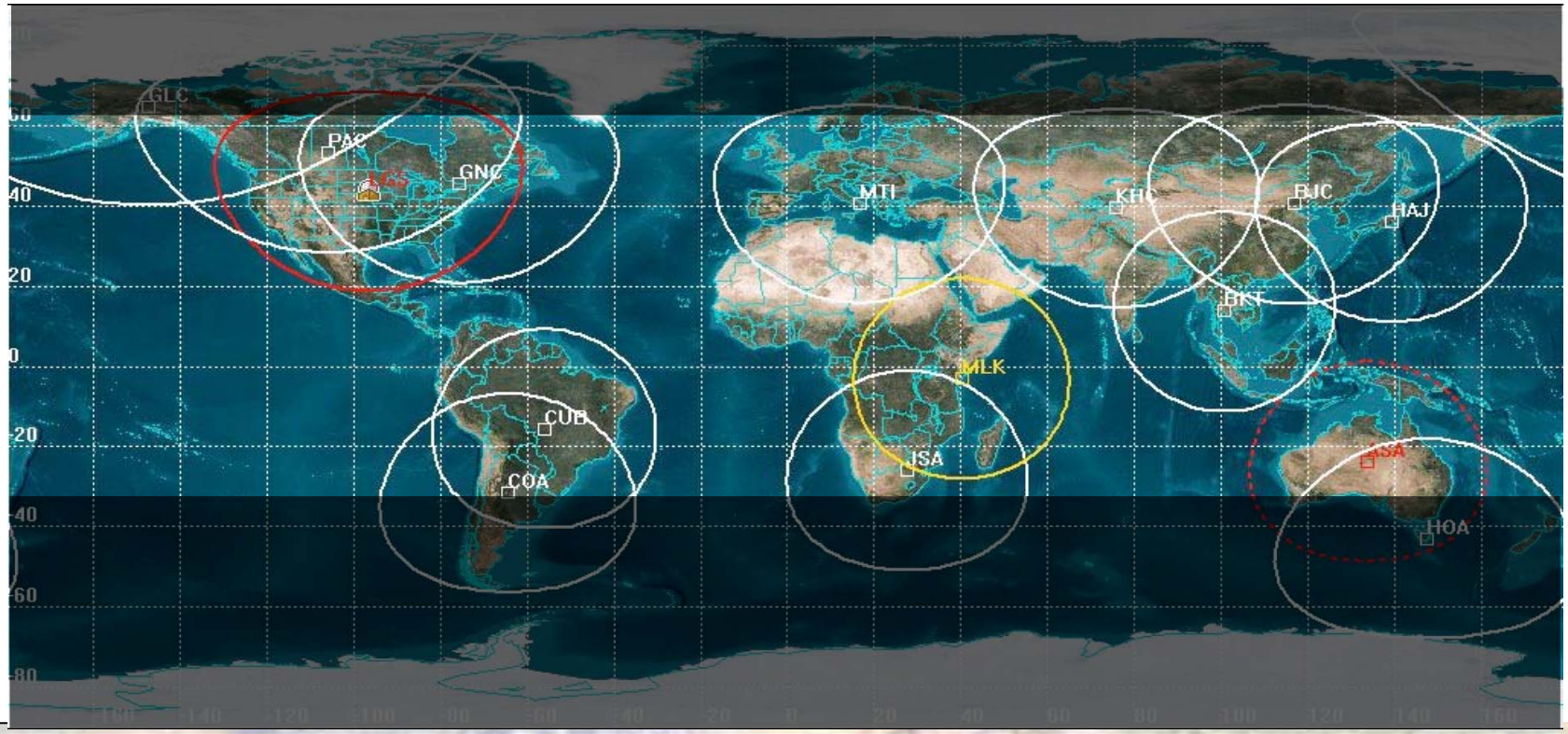
Landsat 5 Sun Angle Constraints

- **Nominal coverage at summer solstice**
  - June 21



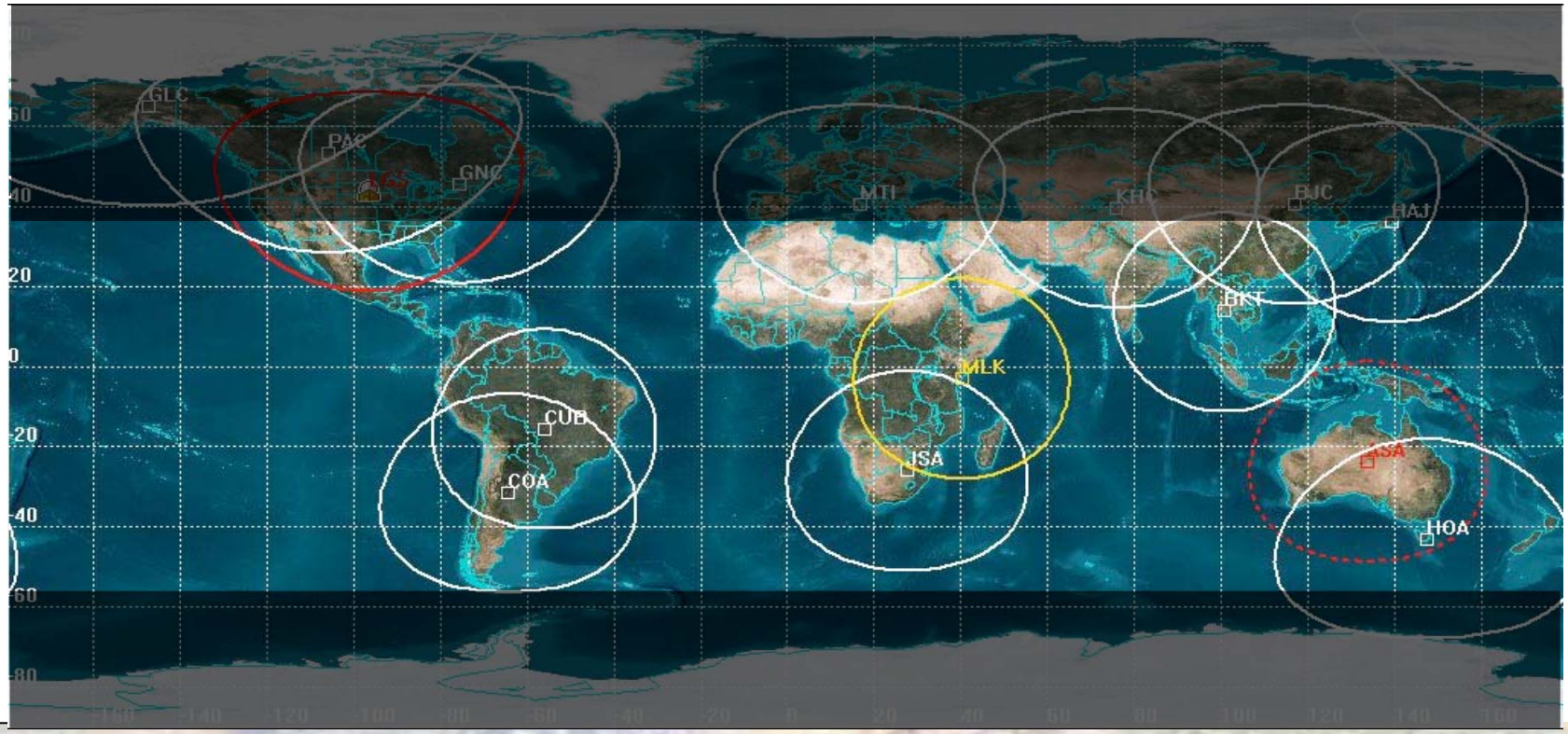
Landsat 5 Sun Angle Constraints

- **Nominal coverage at equinox**
  - March 21
  - September 21



Landsat 5 Sun Angle Constraints

- **Nominal coverage at winter solstice**
  - December 21



Landsat 7 ETM+ Calibration Update

- **Band-to-Band registration typically 0.05 pixels or better in line and scan direction (excluding band 6)**
- **Switch to bumper mode disrupted ETM+ sensor alignment calibration and degraded geodetic accuracy**
  - Pre-switch : 97% scenes better than 50 meters RMSE
  - Post-switch: 65% scenes better than 50 meters RMSE
- **Relative detector-to-detector normalization, i.e., striping less than ± 0.1%**
- **Absolute radiometric accuracy better than ± 5% (reflective) and 1 K (thermal)**
- **Noise stable over mission life**
- **SLC failure had no significant impact on L7 ETM+ reflective band radiometry- continues to be excellent**

Landsat 5 TM Calibration Update

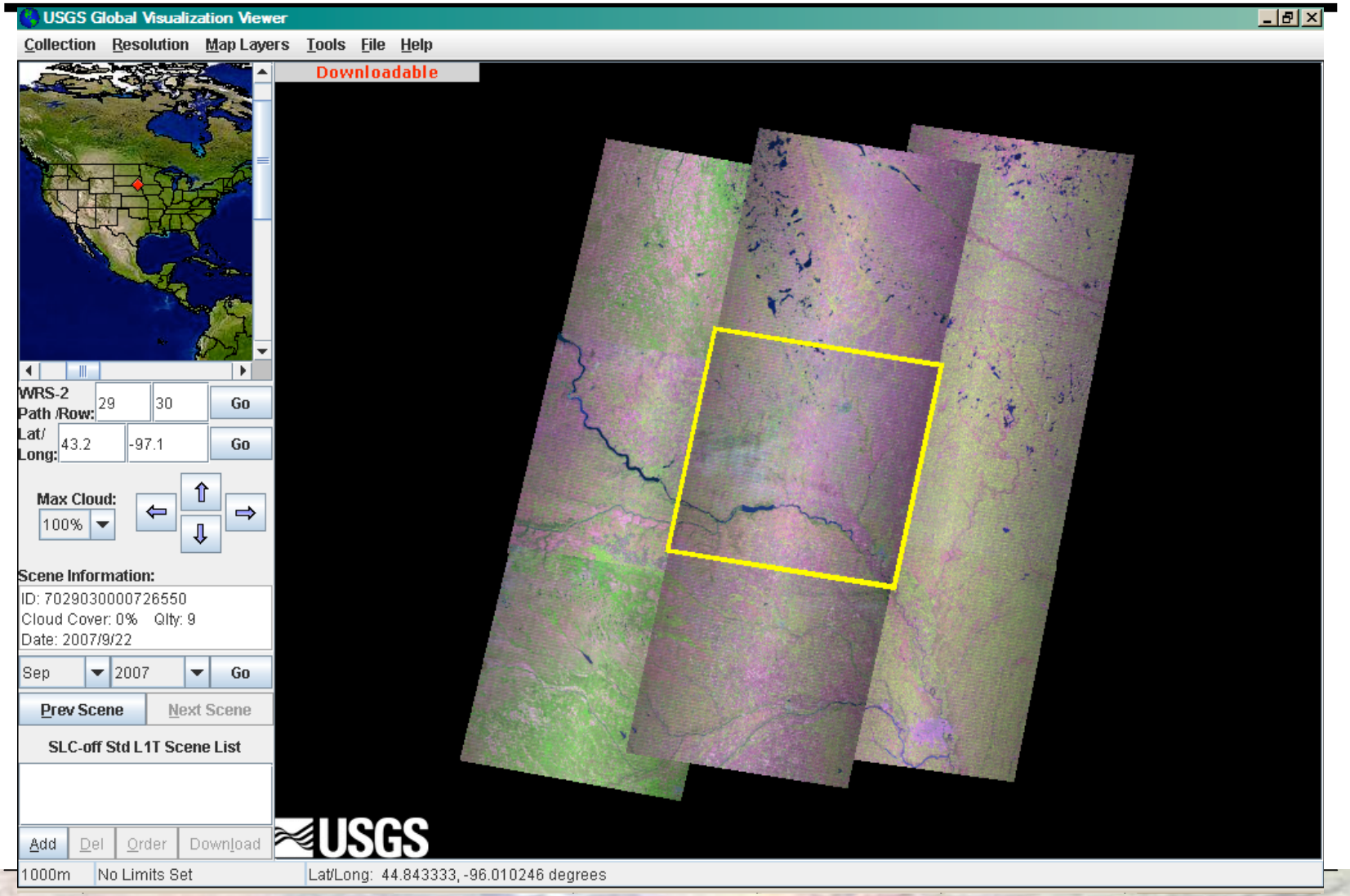
- **Within-band within-scene internal stability**
  - Scan-Correlated Shift (SCS) of up to 0.7 DN
    - Correctable with scan line-by-scan line background subtraction
  - Memory effect of up to 4 DN
    - Currently corrected in NLAPS processing
  - Some banding and striping issues remain to be resolved
- **Between-date stability**
  - Interference cycling from icing on B5 and B7
    - Correctable with IC processing or LUT that includes interference cycling
- **Radiometric calibration processing**
  - Uses Gain Calibration History stored in Look-Up Table
  - Extracts and applies biases on a scan line by scan line basis
  - Rescaled to Fixed Radiance Range (LMIN, LMAX)
  - Look-up Table revised April 2, 2007 to reflect revised trends from Sahara desert site data obtained from ESA

Landsat Web-enabled Data Pilot

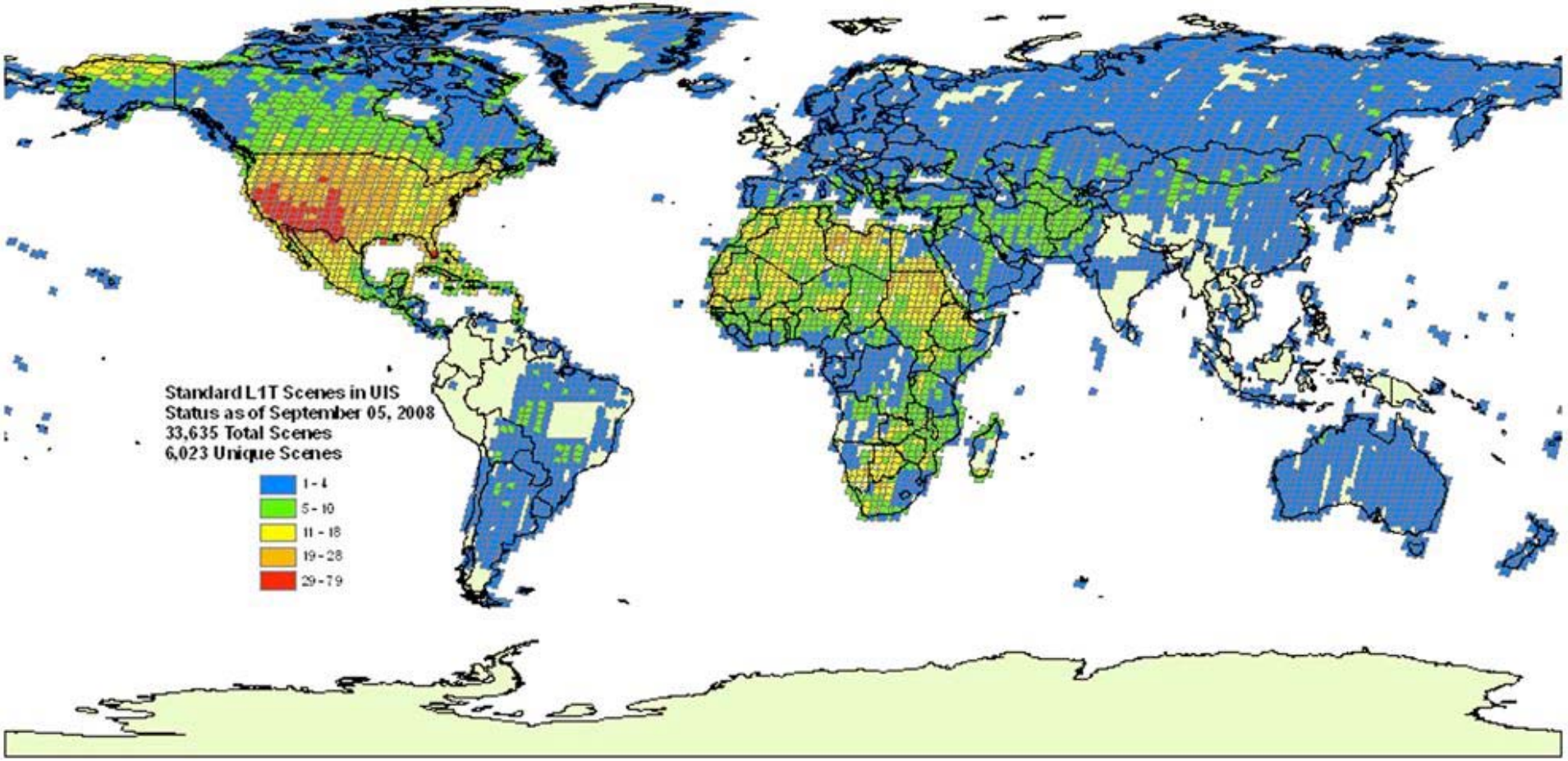
- **As of June 2007, the USGS web enabled release of Landsat 7 SLC-off image data of the United States through the Web**
  - US only – includes Alaska and Hawaii
  - L7 ETM+ SLC-off only – 2003 to present (and ongoing)
  - < 20% cloud cover
  - 9 quality
  - http://glovis.usgs.gov/ or http://earthexplorer.usgs.gov/
- **Recipe recommended by LST for this Web-enabled LDCM pilot project and for Global Land Survey dataset**

Pixel size:	15m/30m/60m
Media type:	Download (no cost), CD/DVD ($50)
Product type:	L1T (terrain-corrected)
Output format:	GeoTIFF
Map projection:	UTM
Orientation:	North up
Resampling:	Cubic convolution

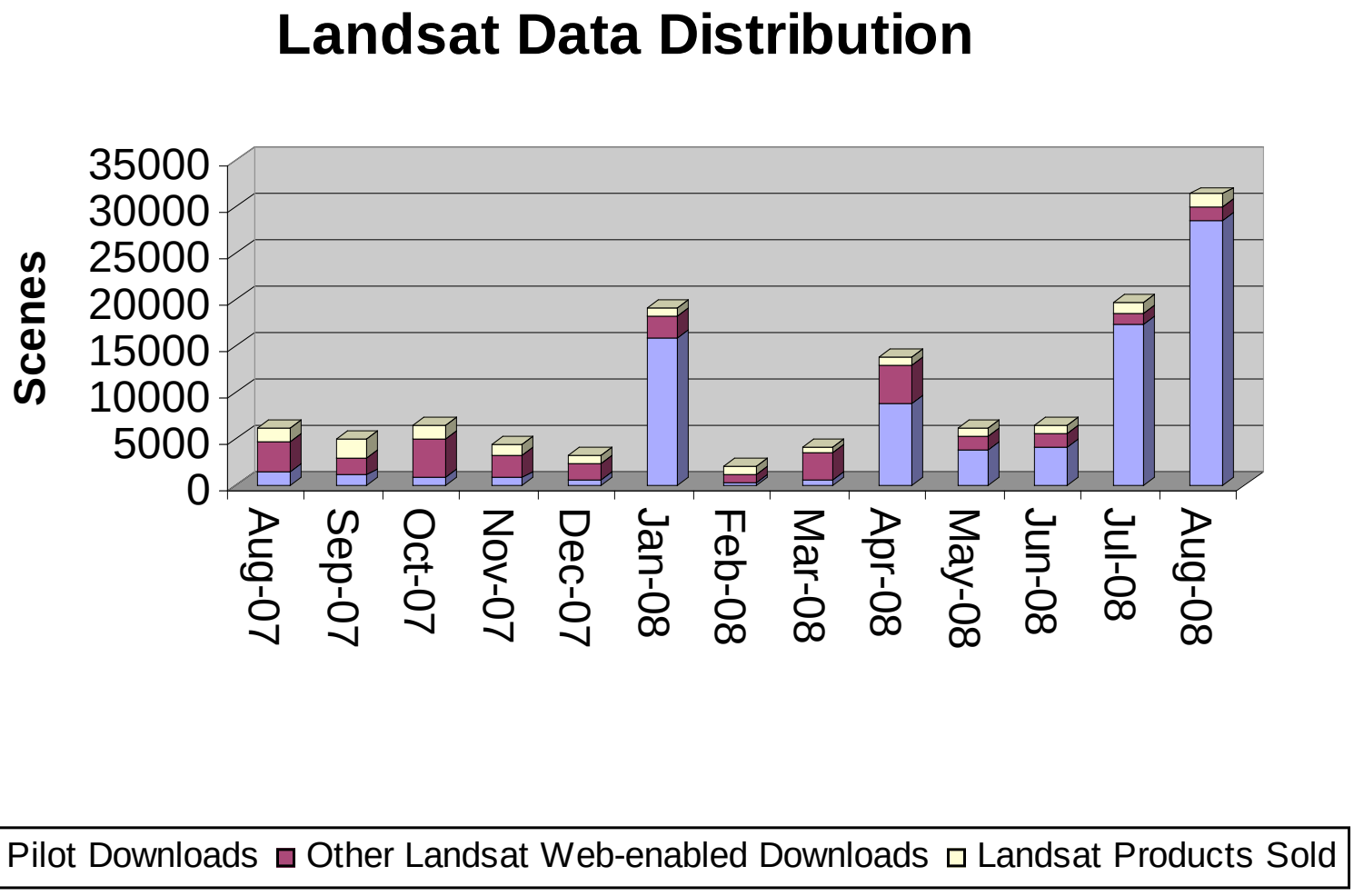
Changes to Systems



Web-enabled Scenes Available



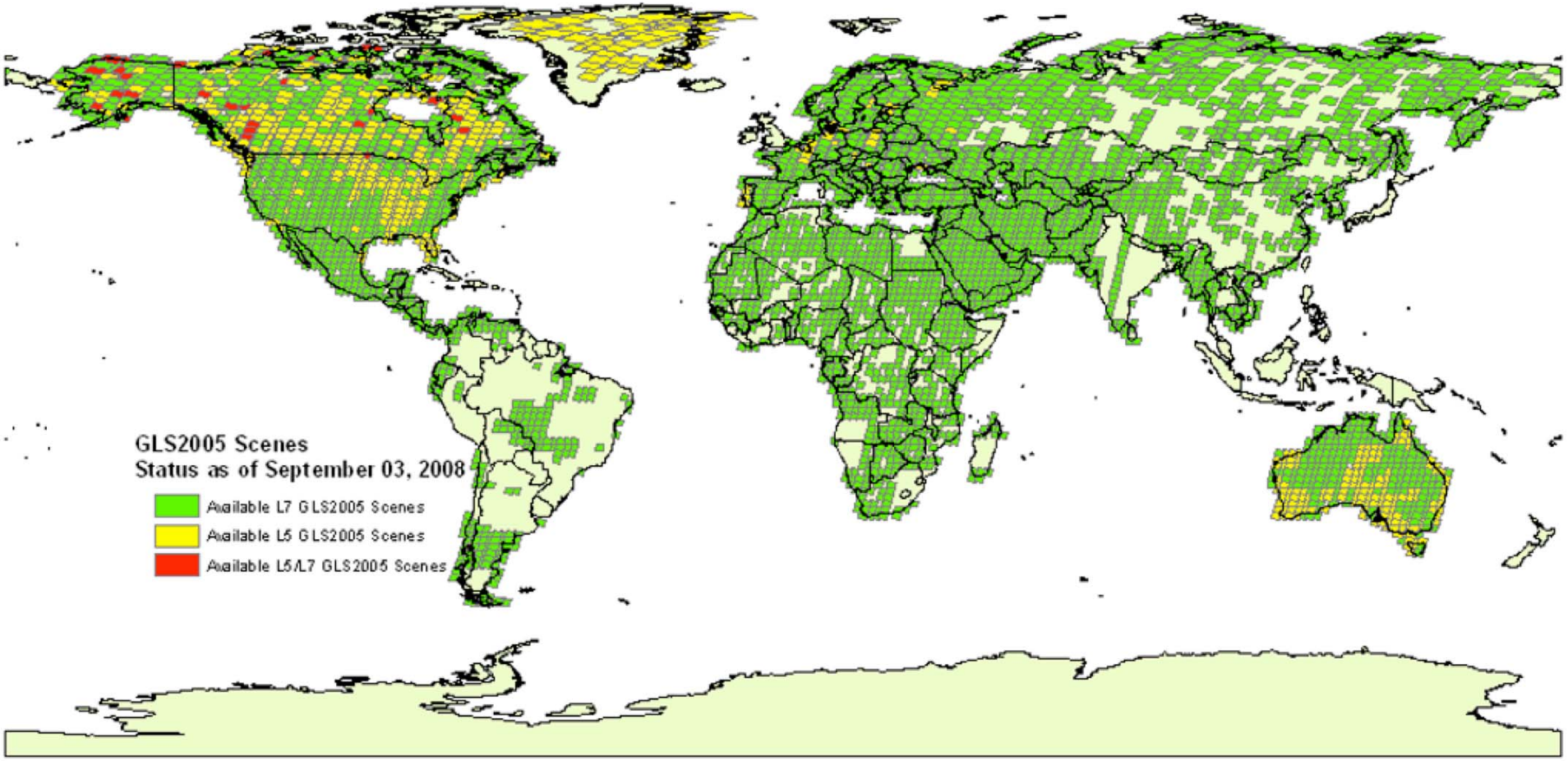
Landsat Data Distributed from EROS



Landsat L1T Data Released @ No Cost

- **ALL Landsat 7 L1T data released**
  - No cost to user
  - Pre-processed US coverage with <20% cloud cover during growing season
  - Remaining data available by request
    - Once requested, data is processed to L1T and made available on-line to all users
    - L1T “standard recipe” only as free download
  - Other products such as L0Rp are not available via on-demand processing
- **Release ALL Landsat data as L1T in December**
  - Pre-process some data prior to release
  - Process all new data with <20% cloud cover automatically
    - Same operations concept as Landsat 7
  - Other products such as L0Rp are not available via on-demand processing

GLS2005 Status

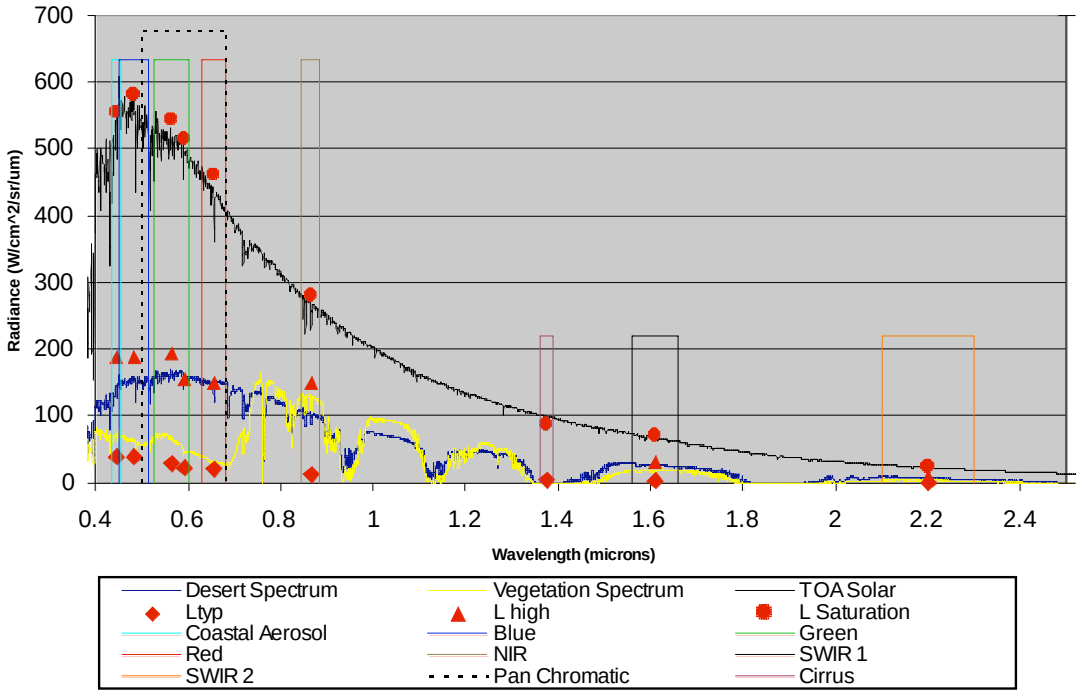


Implementation Strategy

- **Landsat data are desired where coverage exists**
- **International participation is strongly desired**
  - Augment gaps in Landsat coverage
  - Provide data coverage for participating agency ground station footprints
  - Intensify regional collection of multi-sensor data
- **Landsat is currently the primary data source and represent the U.S. contribution to the international effort**
- **Pursue international participation through the CEOS LSI Constellation Study Team**

OLI Maintains Landsat Legacy

- **Landsat Continuity Mission demands**
  - Accurate spectral and spatial information
  - Frequent synoptic earth views
  - NIST calibrated over time
  - Precise geo-referenced data



- Key instrument parameters
  - Cross-track FOV 185 km
  - S/C altitude 705 km
  - Geodetic accuracy*
    - Absolute 65 m
    - Relative 25 m
  - Geometric accuracy**
    - Absolute 12 m

Band Name	Band (nm)	Bandwidth (nm)	GSD (m)	SNR
Coastal/ Aerosol	443	20	30	130
Blue	482	65	30	130
Green	562	75	30	100
Red	655	50	30	90
NIR	865	40	30	90
SWIR 1	1610	100	30	100
SWIR 2	2200	200	30	100
PAN	590	180	15	80
Cirrus	1375	30	30	50

Visible/NIR SWIR

*No terrain compensation

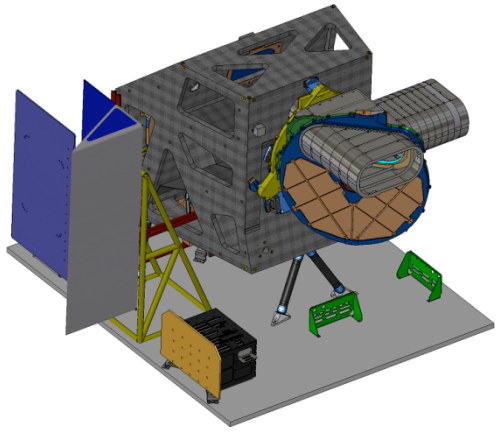
**w/ terrain compensation

Driving Performance Requirements

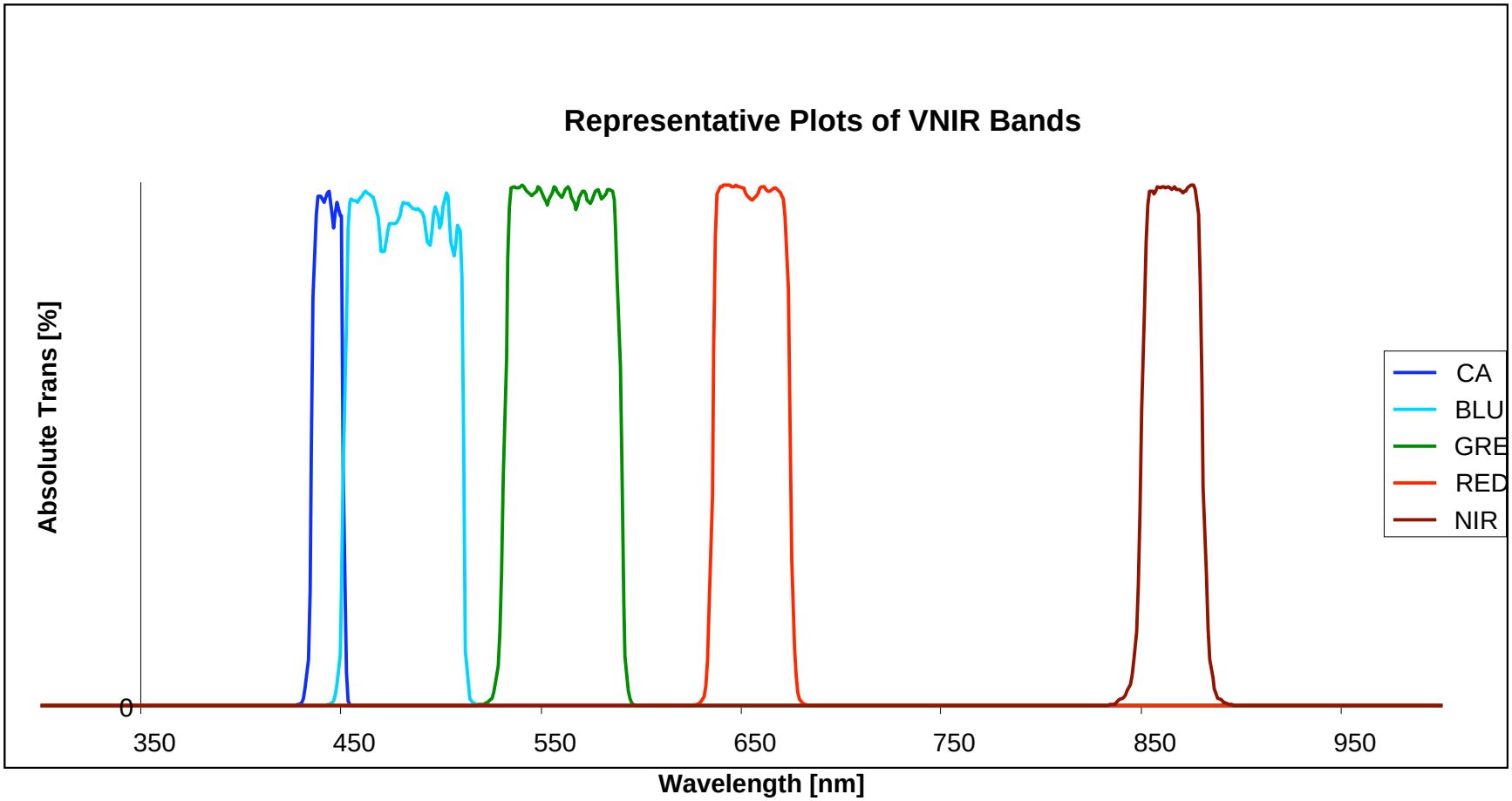
- Radiometric
  - Signal-to-noise radiometric stability (16-day, 60 sec, 5 year)
  - Pixel-to-pixel uniformity
  - Absolute radiometric accuracy
    - Absolute radiance – 5%, absolute reflectance – 3%
- Spectral
  - Spectral band edges and center wavelength tolerance
  - Integrated out-of-band (OOB) response (<2%)
  - Spectral uniformity (FWHM) (± 3%)
- Spatial
  - Edge response
  - Aliasing
  - Light rejection and internal scattering
  - Ghosting
- Geometric
  - Band-to-band co-registration (4.5 m)
  - Absolute geodetic accuracy (65 m)

OLI Band and SNR Specs

#	Minimum Lower Band Edge (nm)	Maximum Upper Band Edge (nm)	SNR at LTypical	SNR at LHigh
1	433	453	130	290
2	450	515	130	360
3	525	600	100	390
4	630	680	90	340
5	845	885	90	460
6	1560	1660	100	540
7	2100	2300	100	510
8	500	680	80	230
9	1360	1390	50	N/A

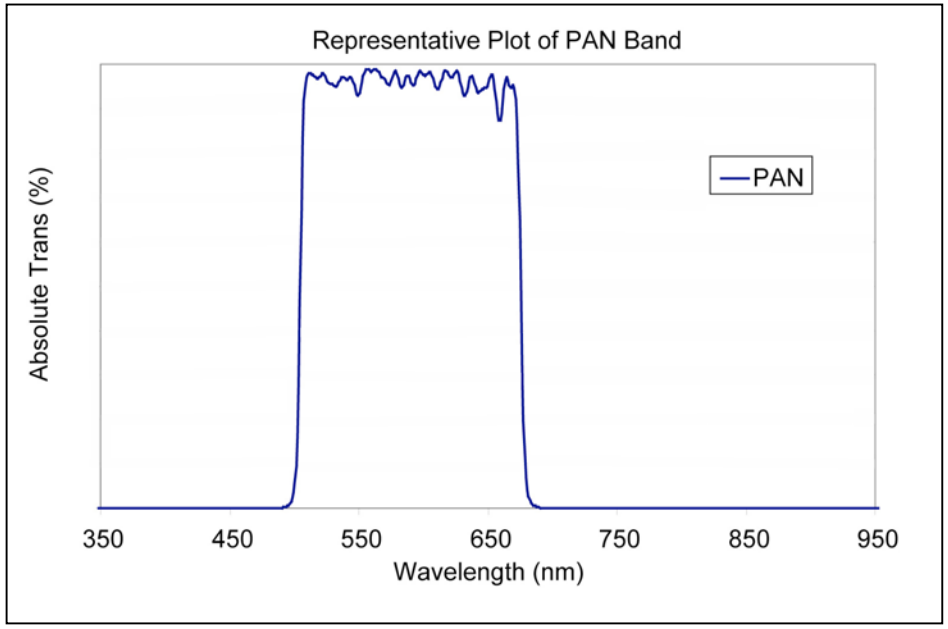


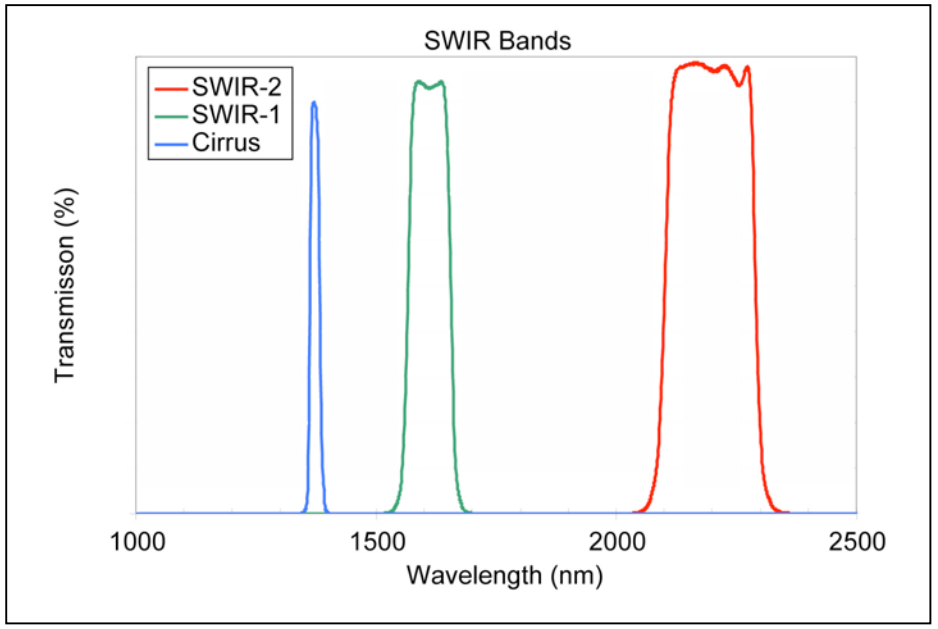
First Pass Spectral Filters Show VNIR In-Band Spectral Response Is Well Behaved



Data is from first of three lots that will be used to select flight filters

Pan and SWIR Spectral Response Is Excellent

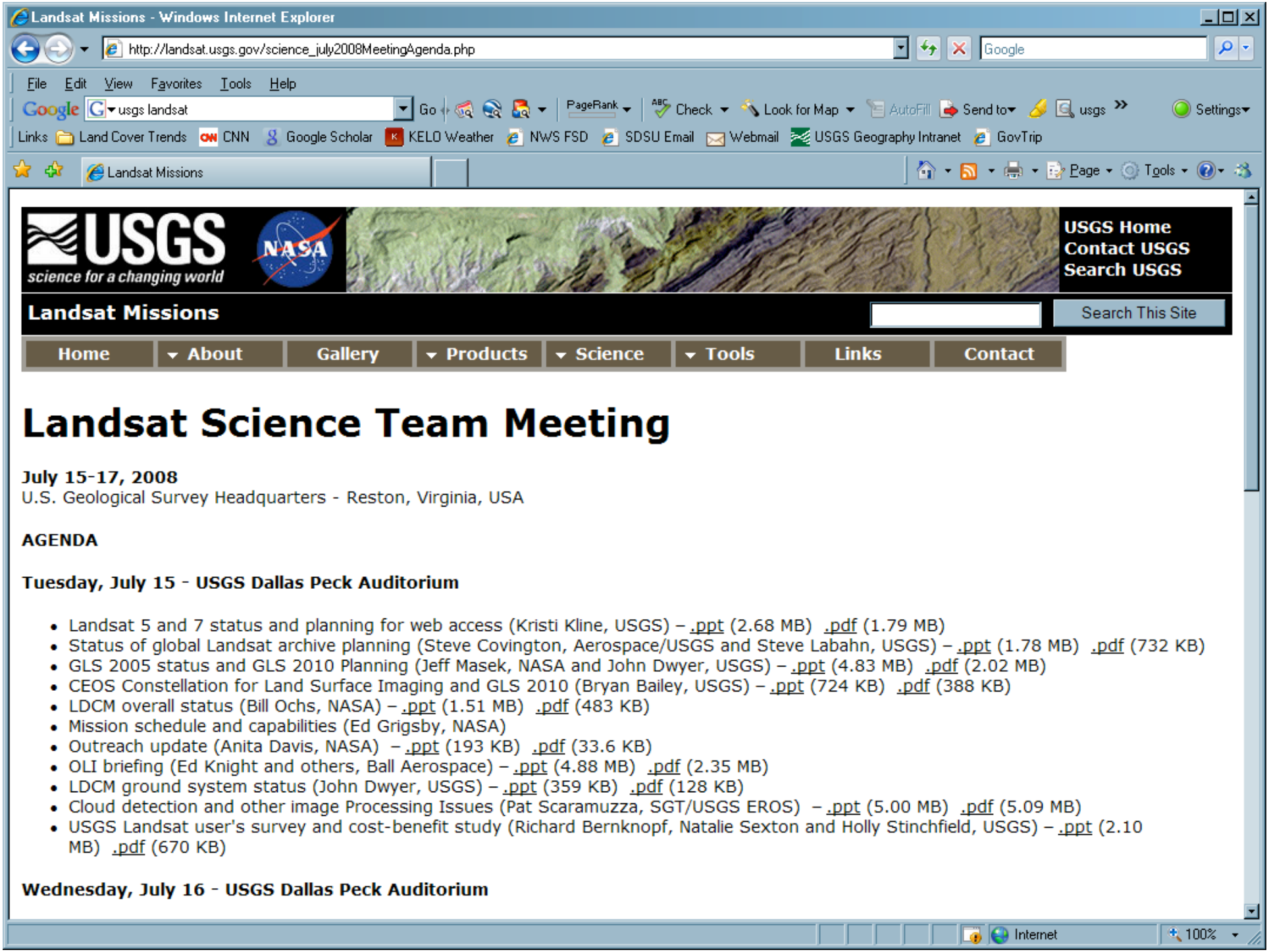




Data is from first of three lots that will be used to select flight filters

Landsat Science Team

- **USGS is co-chairing and funding the Landsat Science Team**
  - 1st Science Team meeting: January 9-11, 2007
  - 2nd Science Team meeting: June 12-14, 2007
  - 3rd Science Team meeting: January 8-10, 2008
  - 4th Science Team meeting: July 17-17, 2008
- **The Science Team is funded to conduct research and provide feedback to the LDCM in several areas**
  - Applied research in natural resource monitoring and algorithm development
  - Participation in ground system requirements reviews
  - Definition of product specifications
  - Development of LTAP-8
  - Instrument Engineering
  - Communications and Outreach
  - Policy recommendations


Landsat Missions - Windows Internet Explorer
http://landsat.usgs.gov/science_july2008MeetingAgenda.php
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KELO Weather
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Search USGS
Landsat Missions
Search This Site
Home
About
Gallery
Products
Science
Tools
Links
Contact
Landsat Science Team Meeting
July 15-17, 2008
U.S. Geological Survey Headquarters - Reston, Virginia, USA
AGENDA
Tuesday, July 15 - USGS Dallas Peck Auditorium
Landsat 5 and 7 status and planning for web access (Kristi Kline, USGS) – .ppt (2.68 MB) .pdf (1.79 MB)
Status of global Landsat archive planning (Steve Covington, Aerospace/USGS and Steve Labahn, USGS) – .ppt (1.78 MB) .pdf (732 KB)
GLS 2005 status and GLS 2010 Planning (Jeff Masek, NASA and John Dwyer, USGS) – .ppt (4.83 MB) .pdf (2.02 MB)
CEOS Constellation for Land Surface Imaging and GLS 2010 (Bryan Bailey, USGS) – .ppt (724 KB) .pdf (388 KB)
LDCM overall status (Bill Ochs, NASA) – .ppt (1.51 MB) .pdf (483 KB)
Mission schedule and capabilities (Ed Grigsby, NASA)
Outreach update (Anita Davis, NASA) – .ppt (193 KB) .pdf (33.6 KB)
OLI briefing (Ed Knight and others, Ball Aerospace) – .ppt (4.88 MB) .pdf (2.35 MB)
LDCM ground system status (John Dwyer, USGS) – .ppt (359 KB) .pdf (128 KB)
Cloud detection and other image Processing Issues (Pat Scaramuzza, SGT/USGS EROS) – .ppt (5.00 MB) .pdf (5.09 MB)
USGS Landsat user's survey and cost-benefit study (Richard Bernknopf, Natalie Sexton and Holly Stinchfield, USGS) – .ppt (2.10 MB) .pdf (670 KB)
Wednesday, July 16 - USGS Dallas Peck Auditorium
Internet
100%

Lessons from PI Presentations

- **Overall**
  - Clear value of a consistent time series, including access to the full Landsat archive (US and global)
  - Clear need for increased temporal frequency
- **Technical Configuration**
  - Strong evidence of the necessity for SWIR and growing evidence of TIR usefulness
  - Experimental results show potential value of aerosol blue band for water resources applications
  - Landsat offers high level of geometric and radiometric consistency
  - Consistent calibration of all bands aids science and applications
  - Improved signal to noise performance and > 8 bit quantization will improve analytical results

LDCM-Related LST Outcomes

- **LDCM development progress is encouraging**
  - USGS progress on LTAP-8 was recognized
  - Positive response to cloud assessment investigation. Suggested next steps include:
    - Consider cloud shadow masking
    - Assess the role of the cirrus band
- **LDCM development concerns**
  - Launch delays and the impact of TIRS
  - Absence of a surface reflectance product requirement

LDCM Standard L1T

- **Parameters based on:**
  - Consistency with heritage Landsat products
- **Standard Product Characteristics**
  - TOA reflectance
  - Precision and terrain corrected
  - 16-bits for each OLI band
  - 16-bit QC band (cloud, shadow, land, water, snow/ice, invalid data, etc.)
  - Generated for all globally acquired OLI data that can be processed to meet product specifications
  - To be generated routinely post-OIV
  - Reprocessing – driven by algorithm, software, and/or calibration parameter file (CPF) and bias parameter file (BPF) updates

LDCM Cloud Mask File

Bit	Description
0	Designated Fill
1	Water
2	Water Confidence
3	
4	Snow/Ice
5	Snow/Ice Confidence
6	
7	Cirrus
8	Cirrus Confidence
9	
10	Cloud
11	Cloud Confidence
12	
13	Artifact masks
14	
15	

The proposed format of the final CCA mask file is 16 bit, including 4 classes and an artifact mask.

Two-bit confidence levels:

- **`00`** = None or Unset.
- **`01`** = 0-33% confidence
- **`10`** = 34-66% confidence
- **`11`** = 67-100% confidence

The artifact mask may contain a similar 'contribution level', marking how much of a given pixel's radiance is from a resampled artifact.

This file format is preliminary and likely to change.

Intermediate CCA masks may use a different format, but will be standardized.

GS Roles & Responsibilities

- Operations
  - **NASA**
    - **Sensor procurement and launch**
    - **Performs Mission Operations Management through on-orbit acceptance**
  - **USGS**
    - **Ground Segement implementation**
    - **Provides Flight Operations Team (FOT)**
    - **Performs Mission Operations Management following on-orbit acceptance through the life of the mission**
  - **NASA & USGS jointly develop an inter-Agency Mission Management Transition Plan**

LDCM System Review Status

Review	Purpose	Date	Main Components
System Concept Review (SCR)	*Present the overall preliminary concepts, ops and development, behind the GS through a formal USGS peer review in order to resolve Ops Con policy issues.*	*Feb 2007*	●*GS Operations Concept*
System Requirements Review (SRR)	*Present the overall requirements of the ground system, along with the plan for managing and testing the system, schedules, etc.*	*Sep 2007*	● *Ground System Requirements Document*
Preliminary Design Review (PDR)	*Describes the preliminary design of the ground system as a whole, and at the element level. Describes current state of interface definitions.*	*Feb 2009*	●*Draft ICD's* ● **All Element PDRs complete prior to GS PDR**
Critical Design Review (CDR)	*Describes the detailed design of the ground system as a whole, and at the element level. Describes in detail the interface definitions.*	*Oct 2009*	●*Final ICD's* ● *Ops Agreement for Roles & Resp.* ● *GS I&T Plan* ● **All Element CDRs complete prior to GS CDR**
Test Readiness Reviews (TRR)	*Present overall Segment and GS readiness for test*	*Feb 2010 through Dec 2010*	●*GS Integration Plan* ●*Ground Readiness Test Plan* ●**Phased segment functional implementation and integration complete by Jun 2010** ●**Ground Readiness Test complete by Dec 2010**
Mission Operations Review (MOR)	*Gauges readiness of the Ground System for testing. Describes how the process, people, and products will be made operationally ready for launch.*	*TBD*	●**Performance specifications achieved Feb 2011** ●**Mission Readiness Testing complete June 2011** ●*Mission Readiness Test Plan* ●*Mission Operations Readiness Plan*
Flight Operations Review (FOR)	*Describes the state of operational readiness of the ground system, associated processes, people, and products.*	*TBD*	●*Flight Operations Plan*
Operations Readiness Review (ORR)	*Describes how the process, people, and products will be made operationally ready for launch.*	*TBD*	● *Final Versions of Operations Manuals and Flight Operations Plan* ●**"Go for Launch" as early as Dec 2011**

Landsat Cross-calibration Activities

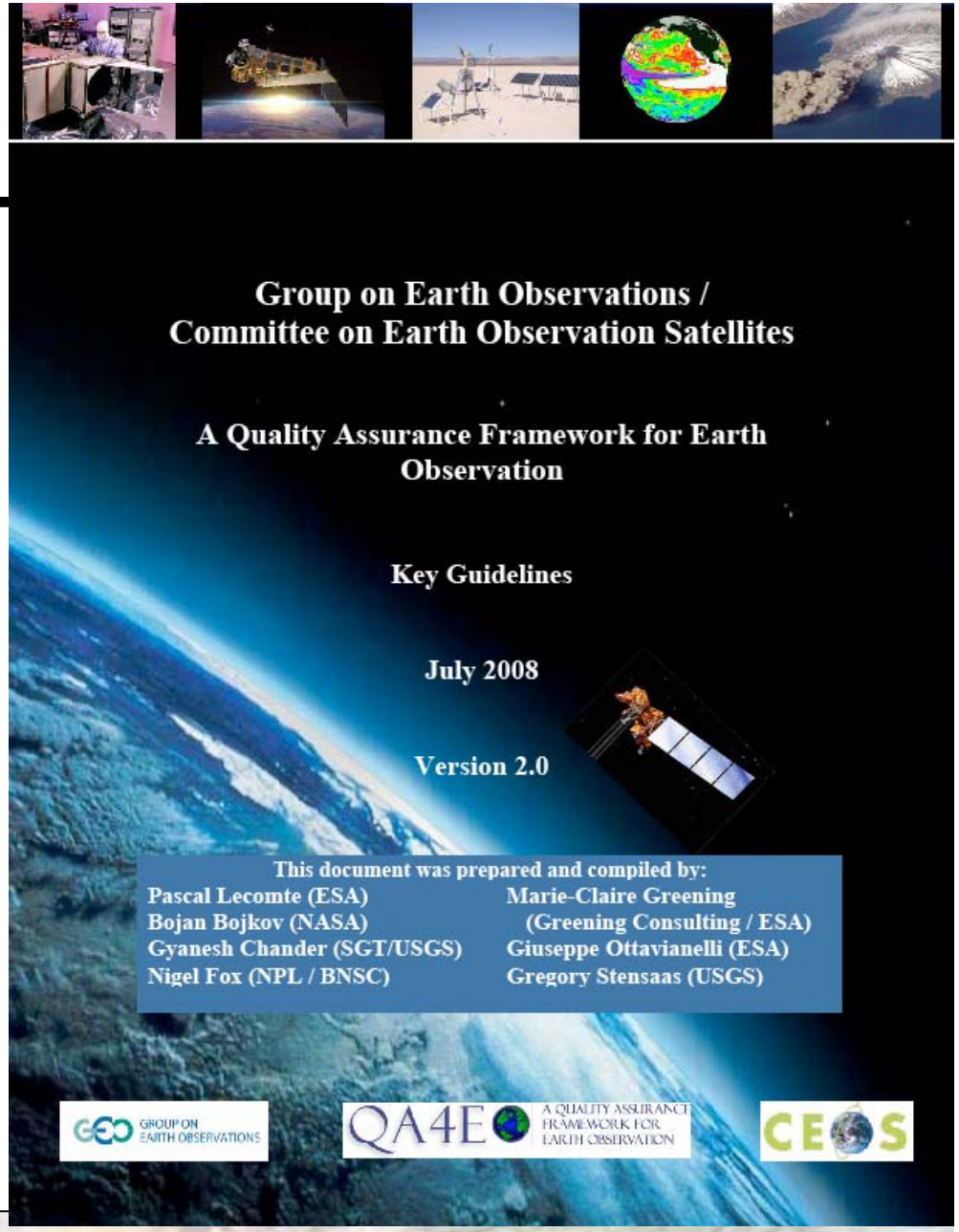
- **Planned Cross-calibration Activities**
  - L7 ETM+/L5 TM with: Cartosat-2, CBERS-2B, DMC, GEOEYE, MODIS, RapidEye, ResourceSat, SPOT, Worldview, digital aerial camera
- **Presentations at Joint Agency Commercial Imagery Evaluation (JACIE) Workshop, 31 March–April 2, 2009**
  - http://calval.cr.usgs.gov/

Work on CEOS WGCV QA4EO

- http://calvalportal.ceos.org/CalValPortal/welcome.do

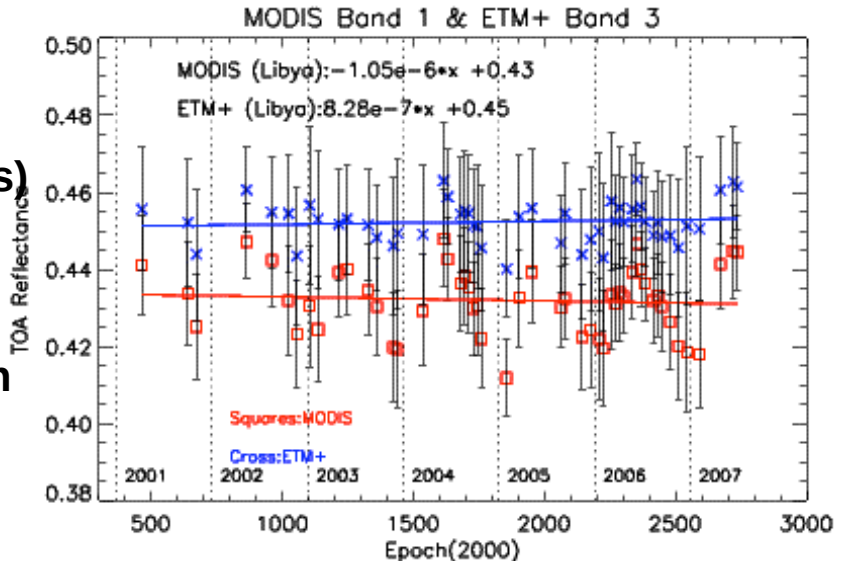
CEOS WGCV/GEO QA4EO WS1
GEO/WMO, Geneva, Switzerland
September 30 to October 3, 2007.

CEOS WGCV/GEO QA4EO WS2
NIST/NASA, Gaithersburg, Maryland May 3-5, 2008.



MODIS and ETM + B1 and B3

- **A long-term radiometric stability evaluation between Terra MODIS and L7 ETM+ was performed using near-simultaneous scene pairs over the uniform Libyan 4 (56 image pairs) desert target and RVPN (78 image pairs) covering the lifetime of the two sensors**
- **The accurate MODIS re-projection and pixel aggregation based on MODIS pixel geolocation information increased reliability**



- **The two sensors showed excellent long-term TOA reflectance stability generally within 2%**
  - Results are consistent between Libya 4 and RVPN sites
- **Hyperspectral data from ASD & EO-1 Hyperion provides a useful dataset to understand the RSR differences between the two sensors**
- **Additional work is underway to characterize the uncertainties due to spectral mismatches, spatial, BRDF, and atmospheric impacts**

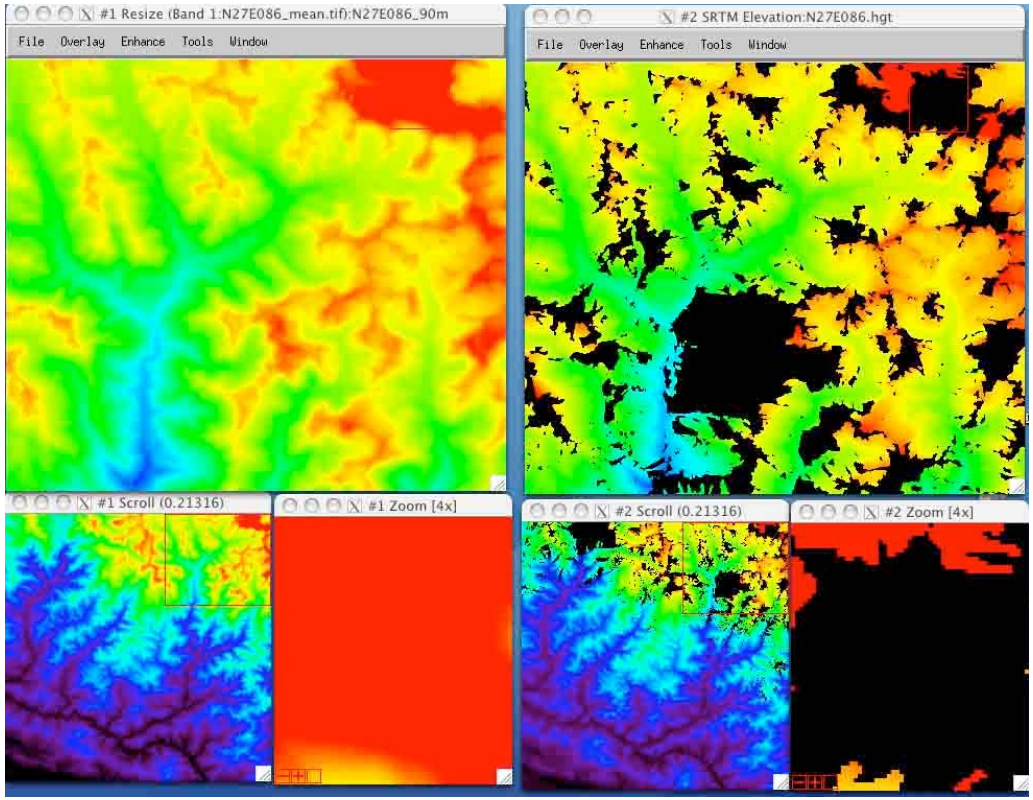
CEOS LSI Constellation

- **Agencies participating: CNES, CONAE, INPE, ISRO, NASA, JAXA, and USGS.**
- **WGISS website will provide information about and links to mid-resolution optical data**
- **Mid-resolution optical systems – acquire reflected and/or emitted electromagnetic radiation in the visible, short-wave infrared, and thermal infrared (VNIR, SWIR, and TIR) wavelengths with spatial resolutions between 10 meters and about 100 meters.**
- **Looking for cal val data collection over test sites**

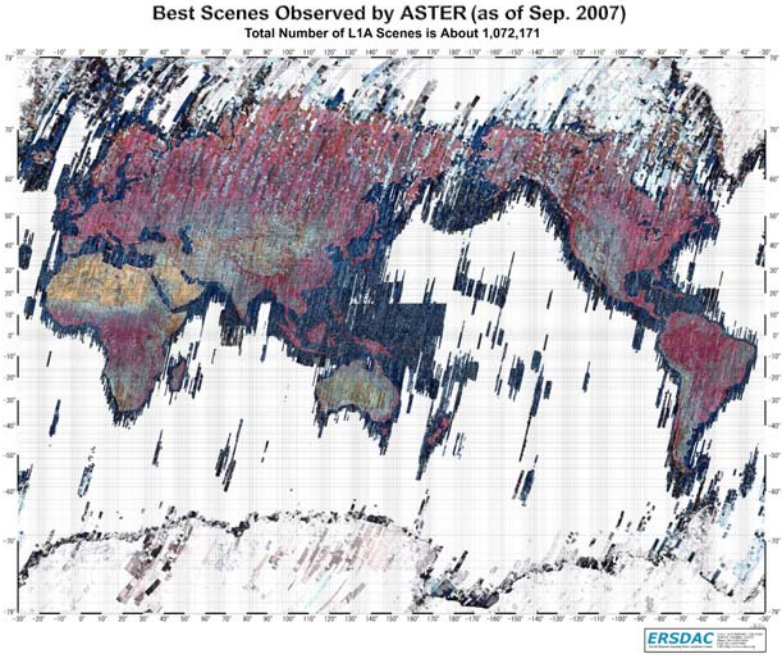
- Landsats 1-5 MSS (NASA/USGS)
- Landsats 4 & 5 TM (NASA/USGS)
- Landsat 7 ETM+ (NASA/USGS)
- SPOTs 1-3 HRV (CNES)
- SPOT 4 HRVIR (CNES)
- SPOT 5 HRG (CNES)
- IRS-1A & -1B LISS-I & LISS II (ISRO)
- IRS-P2 LISS II (ISRO)
- IRS-1C, 1D, & P6 LISS-III & AWiFS (ISRO)
- IMS-1 Mx (ISRO)
- JERS-1 OPS (JAXA)
- ADEOS-1 AVNIR (JAXA)
- ALOS AVNIR-2 (JAXA)
- TERRA ASTER (NASA/METI)
- CBERS-1 CCD (INPE)
- CBERS-2 HRCCD & IRMSS (INPE)
- CBERS-2B HRCCD (INPE)
- SAC-C HRTC (CONAE)
- EO-1 ALI & Hyperion (NASA)

ASTER Global DEM Project

Stacked ASTER SRTM

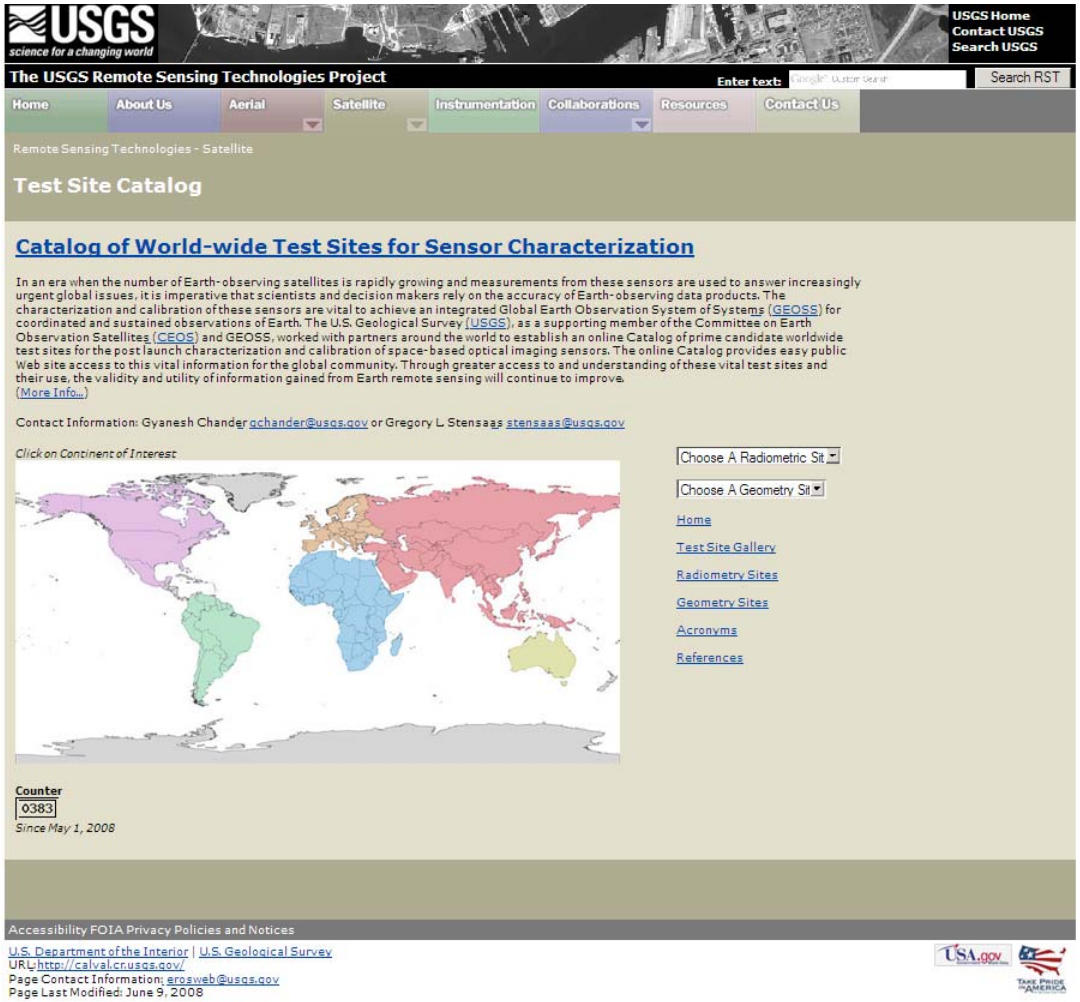


- **203 scenes used**
- **No holes for ASTER DEM**
- **Many large holes for SRTM**



- 22,895 1° x 1º tiles
- 83° N to 83° S
- 10 m Zrms
- May 2009 release

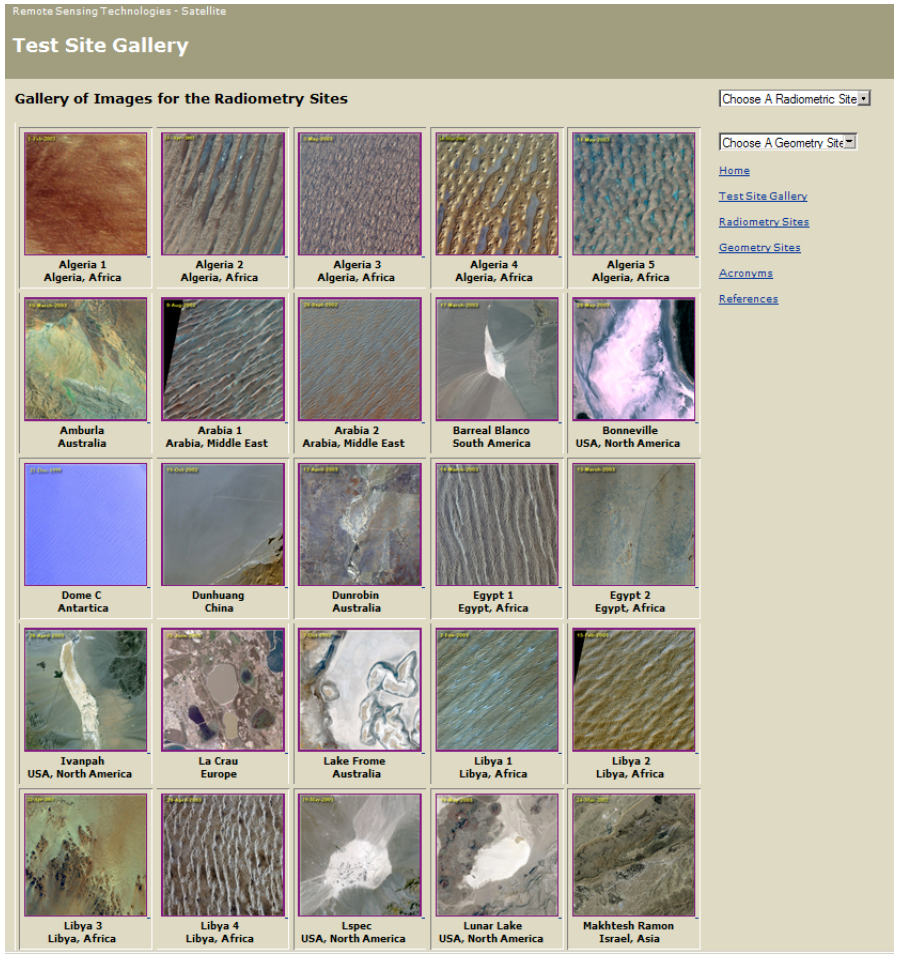
http://calval.cr.usgs.gov/sites_catalog_map.php

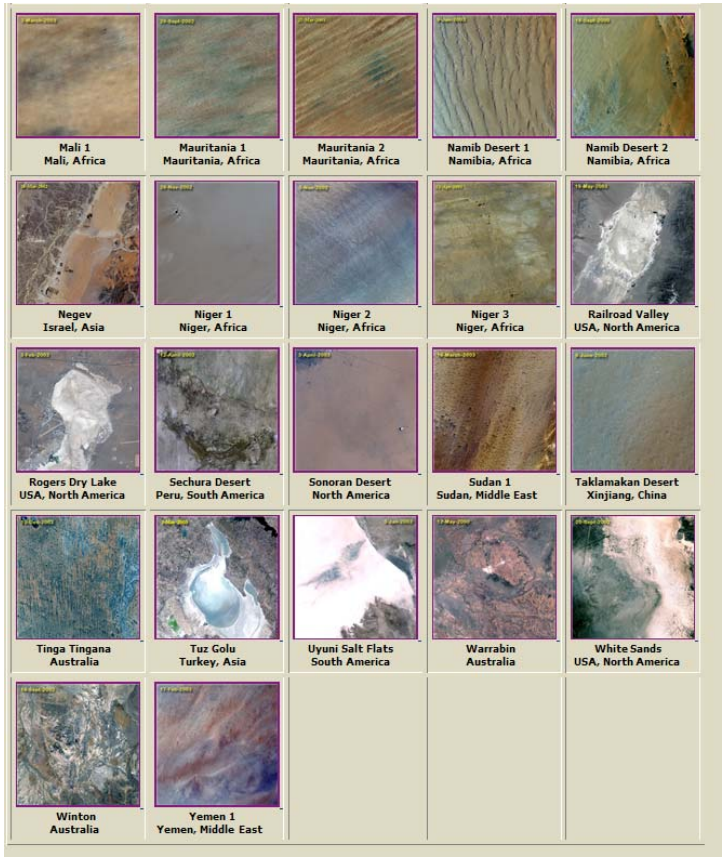


Online test site catalog

- **The layout is set up to help the user quickly locate the needed information available on the site**
  - Drop-down menus list locations so the user may go straight to a specific site
  - A map with clickable links provides another way to go to sites
  - The maps include a world map, where the user selects a continent, and a map of each major continent
- **Each of the calibration site pages contains the same fields for easy review**
  - These fields include location, terrain elevation, center latitude/longitude, WRS-2 path/row, size of usable area, owner, researcher, purpose, description, support data, suitability, and limitations
- **Other features include**
  - a small image of the globe depicting the position of the site
  - satellite images of the test site
  - previous/next button
  - sample Landsat images and Google KMZ files

Test Sites Gallery





Radiometry Sites

CEOS IVOS-19 Test sites Discussion Summary

Invariant Sites			
#	**Site Name**	**Center Latitude**	**Center Longitude**
1	Libya 4	28.55	23.39
2	Mauritania 1	19.40	-9.30
2	Mauritania 2	20.85	-8.78
3	Algeria 3	30.32	7.66
4	Libya 1	24.42	13.35
5	Algeria 5	31.02	2.23
Core Instrumented Sites			
1	Railroad Valley Playa	38.50	-115.69
2	Ivanpah Playa	35.57	-115.40
3	Lspec Frenchman Flat	36.81	-115.93
4	La Crau	43.47	4.97
5	Dunhuang	40.13	94.34
6	Negev, Southern Israel	30.11	35.01
7	Tuz Golu	38.83	33.33
8	Dome C	-74.50	123.00

Mauritania (consider as one site)

Core “Instrumented” IVOS Sites (Total=8)

“Invariant” IVOS Sites (Total=5)

- Libya 4
- Mauritania 1/2
- Algeria 3
- Libya 1
- Algeria 5

EROS Instruments

- **USGS instrumentation network site at EDC includes:**
  - 1) NOAA National Ocean Service National Geodetic Survey's Continuously Operating Reference Station (CORS) network,
  - 2) NOAA Forecast Systems Laboratory's GPS Surface Observation System (GSOS) network,
  - 3) USDA Natural Resources Conservation Service's Soil Climate Analysis Network (SCAN),
  - 4) NOAA Surface Radiation Research Branch's Surface Radiation Budget Network (SURFRAD), and
  - 5) NOAA National Climatic Data Center's Climate Reference Network (CRN).
  - 6) Two NASA AErosol RObotic NETwork (Aeronet) sites
  - 7) Two Carbon flux towers - FLUXNET
  - 8) USGS Seismologic Station - Global Seismographic Network
  - 9) Canada Environment Reference Climate Station (RCS) Network
    - Just added last week – only comparison site between 300+ Canada sites and approximately 110 NOAA CRN sites
    - First and only comparison site in US

USGS Recommendations

- **Coordinate and provide world-wide Cal/Val sites**
  - Coordinate and plan vicarious calibration field campaigns
- **Maintain a fully accessible Cal/Val portal to provide**
  - instrument characteristics of current & future systems,
  - seamless access of Cal/Val site data for users
  - database of in-situ data, documentation of best practices
  - Info regarding co-incident imagery
- **Work with others to enhance and implement QA4EO processes**
- **Work with other agencies to characterize and cross-calibrate sensors using QA4EO processes and document processes**
- **Encourage Cal/Val support for LSI activities**
- **Update CEOS WGCV web pages with membership information and technical links**
- **Make sure that operational instruments maintain a calibration characterization processing capability**

Thank You

29th WGCV Plenary , **INRA,** Avignon, France September 30 to October 3, 2008.

28th WGCV Plenary **NRSCC & CEODE,** Sanya, China 26-29 February, 2008.

27th WGCV Plenary **NPL,** Teddington, United Kingdom 12-15 June, 2007.

26th WGCV Plenary **GISTDA,** Chiang Mai, Thailand, 31 October - 3 November, 2006.

25th WGCV Plenary **HUNAGI ,** Budapest, Hungary 9-12 May 2006

24th WGCV Plenary **ESA,** Frascati, Italy 8-11 Nov 2005

Palais des Papes

Pont Saint-Bénézet

Pont Du Gard

Backup Slides

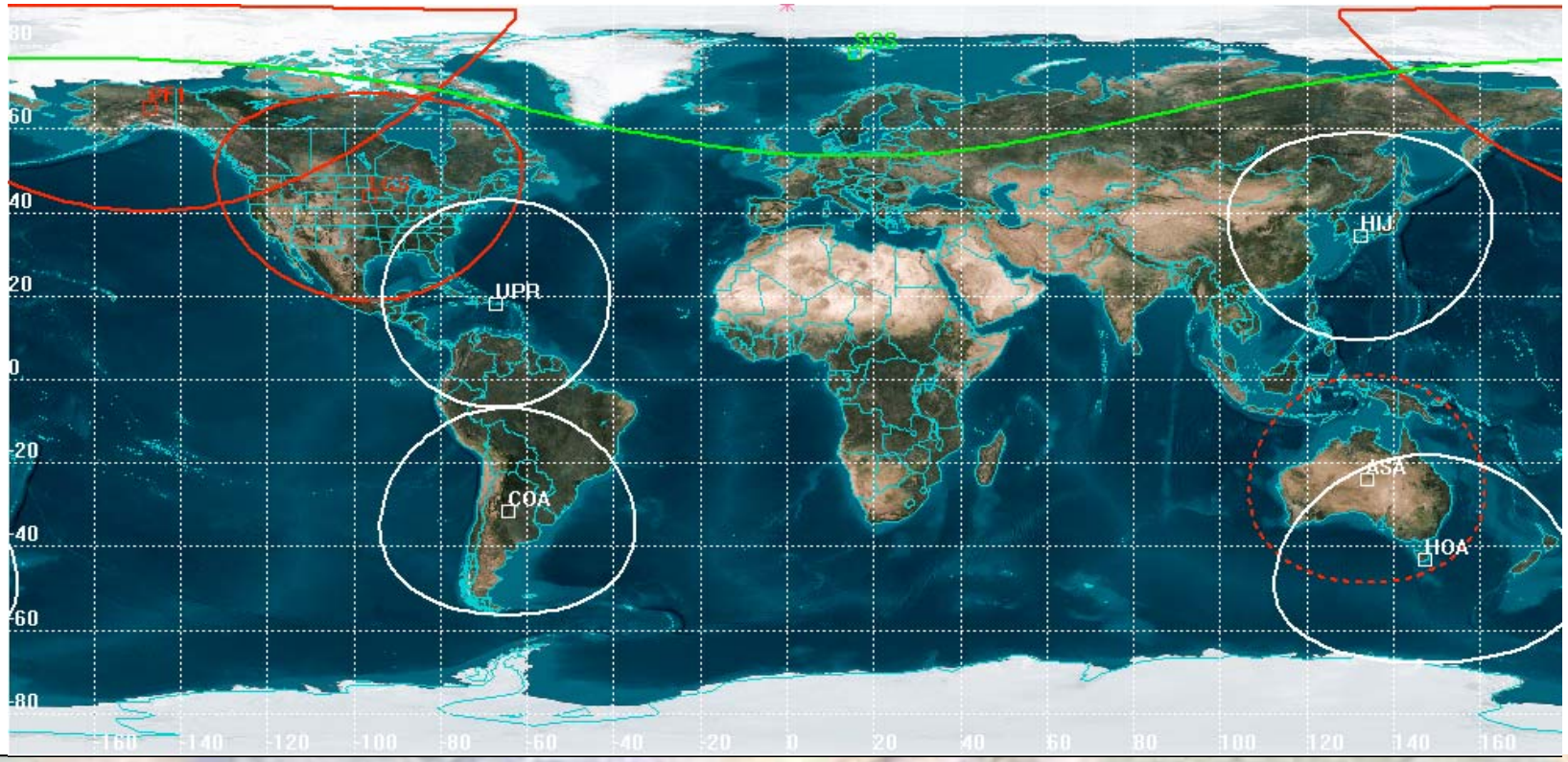
Define the content of the archives

USGS Archive Content (Sept 2007)

Satellite	Sensor	Date Range	Data Format	Scenes	Volume	Media
L1 - 3	MSS	Jul 23, 1972 – Sep 7, 1983	MSS-X, WBV	199,319	6.01 TB	DLT 7000
L2 - 3	MSS	Jan 22, 1975 – Sep 7, 1983	MSS-P, RCC	61,601	1.82 TB	9940B
L2 - 5	MSS	Jan 22, 1975 – Oct 15, 1992	MSS-A, RCC	261,046	7.88 TB	9940B
L4	TM	Aug 17, 1982 – Nov 18, 1993	TM-A, TM-R, RCC	58,457	29 TB	9940B
L5	TM	Mar 1, 1984 – Current	TM-A, TM-R, RCC	668,296	335 TB	9940B
L7	ETM+	Apr 15, 1999 – Current	L0Ra, RCC	755,401	701 TB	9940B
				2,004,120	1,081 TB	

Landsat 7 Reception Network

- L7 backup Network: SGS
- US Network: LGS, PF1
- L7 and US Network: ASA - - -
- L7 IGS Network: UPR, COA, HOA, HIJ

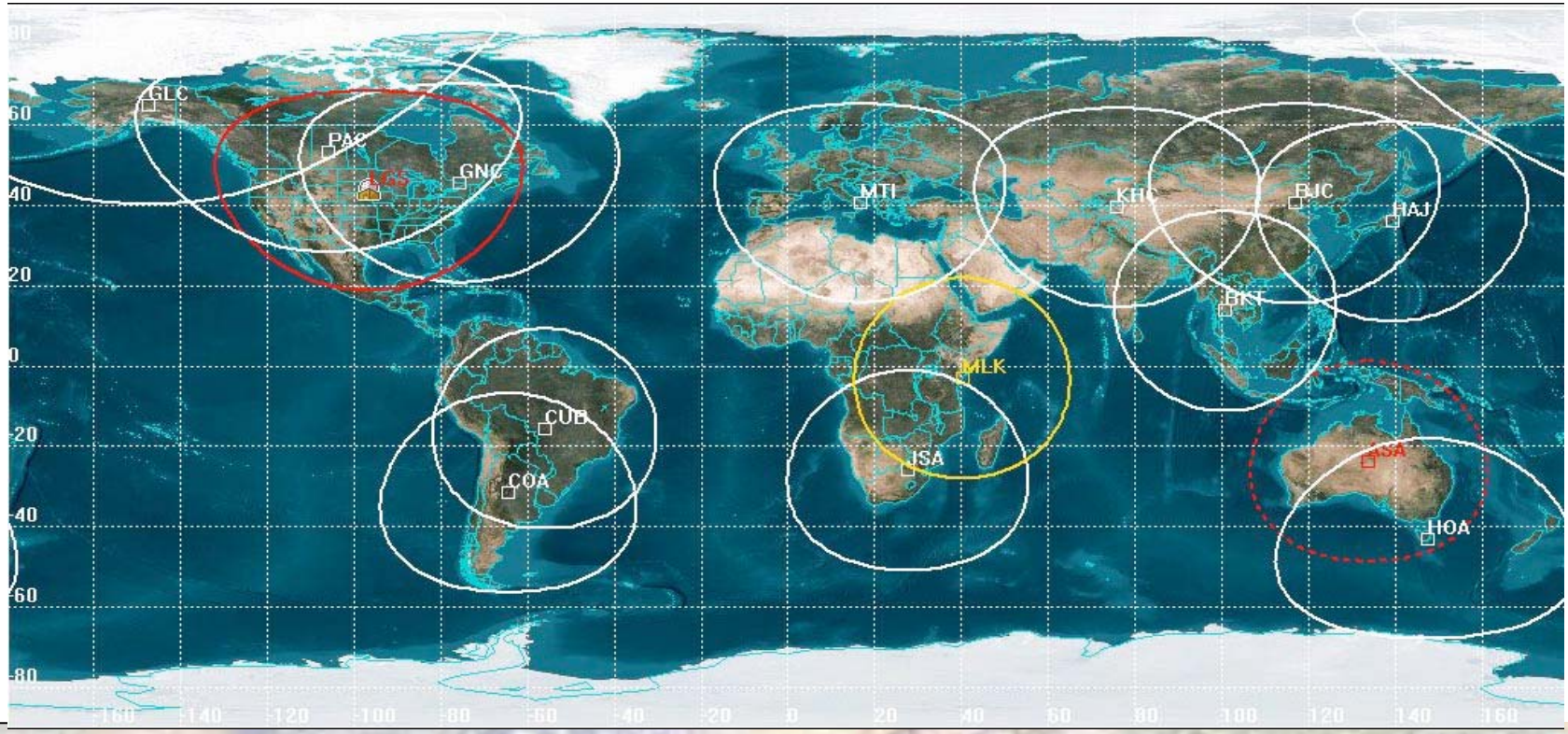


Landsat 7 Solid State Recorder (SSR) PWA Recovery

- **Over the past 9 years, 5 Printer Wire Assembly (PWA) boards have failed in the SSR**
  - PWA boards hold the solid state memory
  - The SSR has 24 PWAs; approximately 20% have failed
- **Analysis of the failures indicated a good chance for recovery**
  - Likely recover if the SSR is power cycled
    - SSR power has been cycled once (after first PWA failure)
  - Less-likely, but possible recovery if PWA power cycled
- **On September 3rd, the FOT attempted to repower two PWAs; the first and second failed PWAs**
  - This tested both recovery scenarios
- **One PWA recovered and one not.**
  - This confirms the need to power cycle SSR to recover PWAs
  - The SSR won't be power cycled unless from operational necessity
- **There are now 4 failed PWAs (16.7% failure rate)**

Landsat-5 Reception Network

- US Network: LGS
- L5 and US Network: ASA - - -
- L5 IGS Network: BJC, BKT, COA, CUB, GLC, GNC, HAJ, HOA, JSA, KHC, MTI, PAC
- L5 IGS Campaign: MLK



Activities Summary: General

- **Landsat-5 has exceeded 130,000 orbits!**
- **A series of special gyro calibration exercises were conducted to assess gyro misalignment (commenced 30 January 2008, and concluded on 18 June). Final results and recommendations are due by mid-September. 22 September is tentatively scheduled for the uplink of new bias values.**
- **Implemented new 4-day star catalogue process on 15 July (previously 8-day cats). Attitude knowledge and control has been improved as a result.**
- **On 8 September, the Flight Operations Team uplinked a flight S/W patch to L5 spacecraft to correct a Executive Request Error that could potentially halt the NASA Standard Spacecraft Computer (NSSC-1) used by L5, triggering a safe-hold condition.**
- **The L5 FOT and Mission Planning group provided special tone-ranging real-time events, as part of antenna certifications and check-outs for the NASA Lunar Reconnaissance Orbiter (LRO) project at their Hawaii, Germany, Sweden, and Australia antenna sites. Initial tests for this effort were conducted on 28 March, and were successfully concluded at the end of July.**

Activities Summary: Power

- **On 14 May, L5 commenced Battery-3 alone (1 + 1) operations. Battery-2 has been the contingency backup to Battery-3 since, and is brought back on-line for periodic short duration voltage boosts once every 4 – 6 weeks.**
  - Note: During 'Battery-2' re-boost activities, it is likely that some station support interruptions will be necessary. We apologize for any inconvenience.
- **On 5 August, in response to a rapidly falling Battery-2 Voltage, L5 engineers performed battery boost operations for Battery-3 and Battery-2. It had been 6 weeks since the last boost, the longest period ever with Battery-2 offline. Additionally, Battery-3 was showing low capacity indications so it first has to be boosted before Battery-2 was brought online.**
  - This event demonstrates the delicate state we are in regarding power. Our FOT learns more as we progress through each season.

More on power later…

Ground System Development Status

- **Participated in LDCM Mission Definition Review (MDR)**
- **Preliminary design work for elements (except MOE) in work**
  - Element PDR completed for the Collection Planning Activity Element (CAPE)
- **Ground System Preliminary Design Review targeted for early Dec 2008**
- **Significant progress made on LTAP-8 definition and algorithm development for Automated Cloud Cover Assessment (ACCA)**

GS Roles & Responsibilities

- Ground System Development
  - **NASA provides management oversight in support of Mission Integration role**
  - **USGS leads development of all functional elements, except the MOE**
- Flight Operations Segment Development
  - **NASA**
    - **Procures and manages MOE**
    - **Provides NASA Space Network (SN), Ground Network (GN), NASA Integrated Services Network (NISN), and Flight Dynamics (FD) services through on-orbit acceptance of the LDCM System**
    - **Provides a GSFC MOC for launch and early orbit verification**
  - **USGS**
    - **Leads, manages, and executes GNE and CAPE development**
    - **Provides an EROS MOC**
    - **Provides a backup MOC for long-term Operations and Maintenance**
- Data Processing and Archive Segment Development
  - **USGS leads, manages, and executes the development of all DPAS elements (SAE, IPE, UPE, IE)**

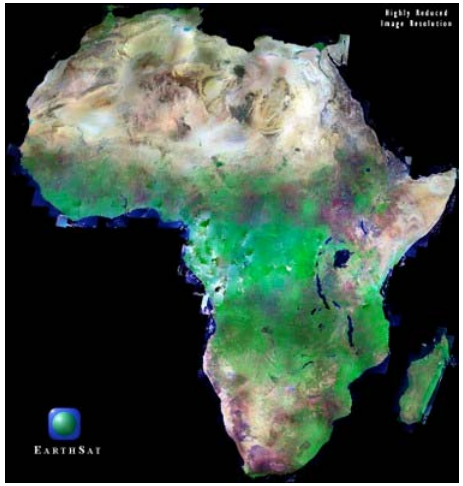
GS Roles & Responsibilities (cont.)

- GS Integration and Testing
  - **NASA**
    - **Provides oversight, guidance and expertise**
    - **Co-chairs the Ground Readiness Test Team**
    - **Facilitates integration of NASA SN, GN, FD services and NISN**
    - **Leads Mission Readiness Testing and Mission Simulations**
    - **Declares mission operational readiness**
  - **USGS**
    - **Leads GS Integration and Interface Connectivity Testing**
    - **Co-chairs the Ground Readiness Test Team**
    - **Performs the majority of ground I&T activities through FOT and DPAS operators**
  - **An initial GS I&T plan has been drafted by NASA and USGS to substantiate the GS element development schedules**

Global Land Survey Data Sets

Global cloud-free, orthorectified Landsat data sets centered on 1975, 1990, 2000, 2005, and 2010

- Partnership between USGS and NASA, in support of CCSP
- Support global assessments of land-cover, land-cover change, and ecosystem dynamics (disturbance, vegetation health, etc)
- Pilot project for routine global monitoring in LDCM era
- GLS 2005 primarily Landsat-7 ETM+ and Landsat-5 TM imagery, with ASTER and EO-1 ALI data as needed



GLS2010 - Background

- **Successful GLS2005 effort has stimulated interest in GLS2010 dataset development**
- **The Group on Earth Observations (GEO) has defined three tasks that are complementary to GLS2010:**
  - Task DA-07-02, which includes a subtask to "Coordinate 2010 Dataset with Contributions from Available International Assets"
  - Task AG-07-03 "Global Mapping of Agricultural Areas at 30m…Undertaken at 5 year intervals for 2005 and 2010"
  - Task DA-07-03 "Virtual Constellations," specifically the Land Surface Imaging (LSI) Constellation
    - Defining GEOSS contributions from Land Imagers

Global Land Survey

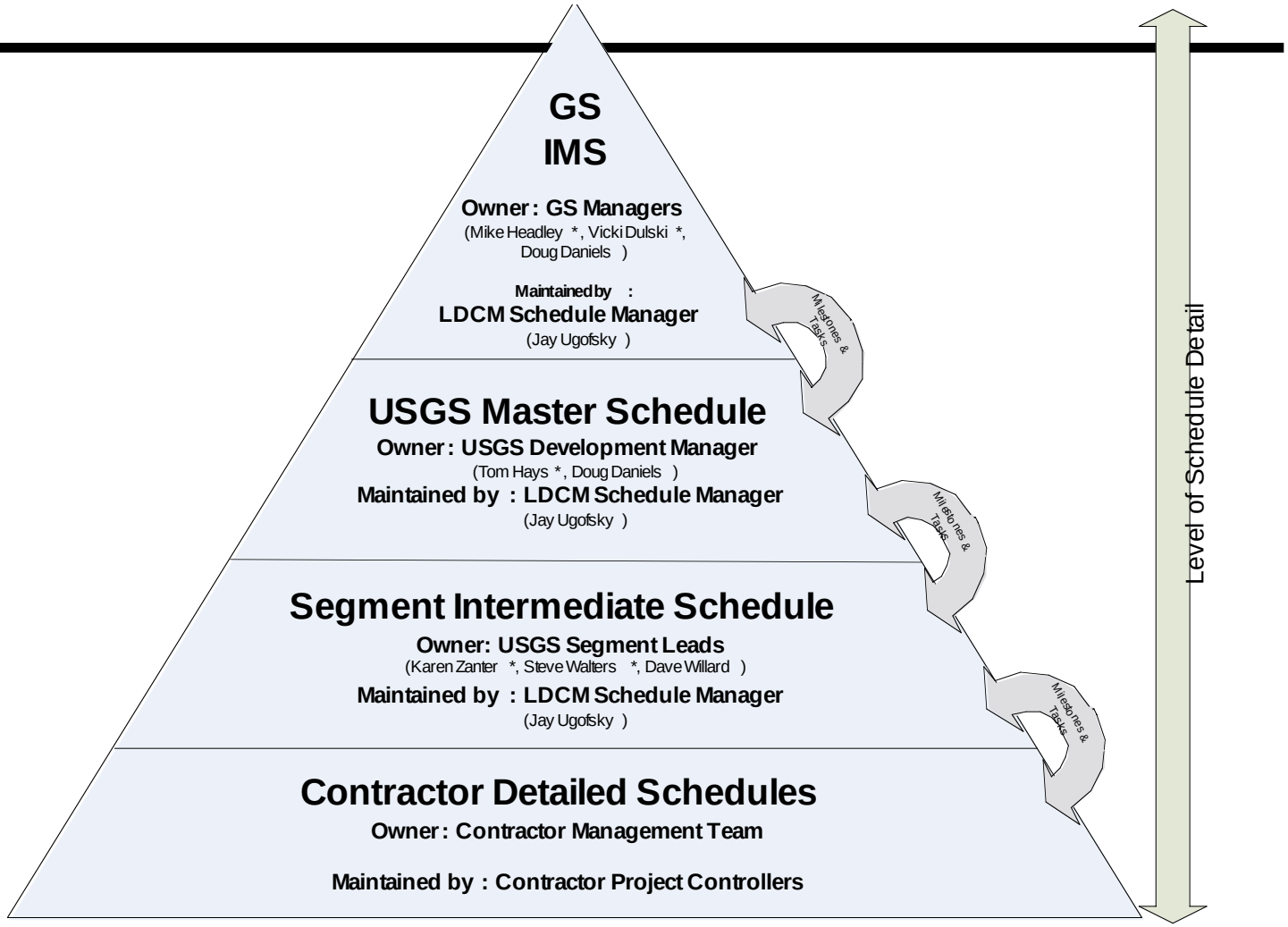
MDA Federal Task Order

- **GLS2000 processing**
  - Completed initial deliveries of all areas of the globe
  - 9 areas have been identified as not meeting 30m spec.
    - Rework in progress (6-700 scenes to be replaced)
    - Africa & India scenes resent and being analyzed
    - Expecting NZ and South America early next week
- **GLS1975, GLS1990**
  - Metadata issues in work
  - Should have delivery by end of 4th quarter
- **GLS2005**
  - L7 processing
    - North America, Africa, Eurasia, S. America complete
    - Waiting on scene lists for Rest of World
  - L5 processing
    - Start planned for late July

Coverage Summary

- **Landsat-7 can acquire global coverage (but with SLC gaps)**
- **Between CBERS and AWIFS, only west Africa, central America, southern South America, and Greenland cannot be acquired**
- **Adding Landsat-5 IGS and Campaign stations, only west Africa cannot be acquired**
  - Chetumal campaign station critical
  - Russian campaign stations critical in the absence of AWIFS
  - Malindi station critical in the absence of CBERS and/or failure of CBERS to implement Africa network

GS Schedule Management Process



Ground System IMS Links "Up" to the Mission IMS

Element Peer Reviews

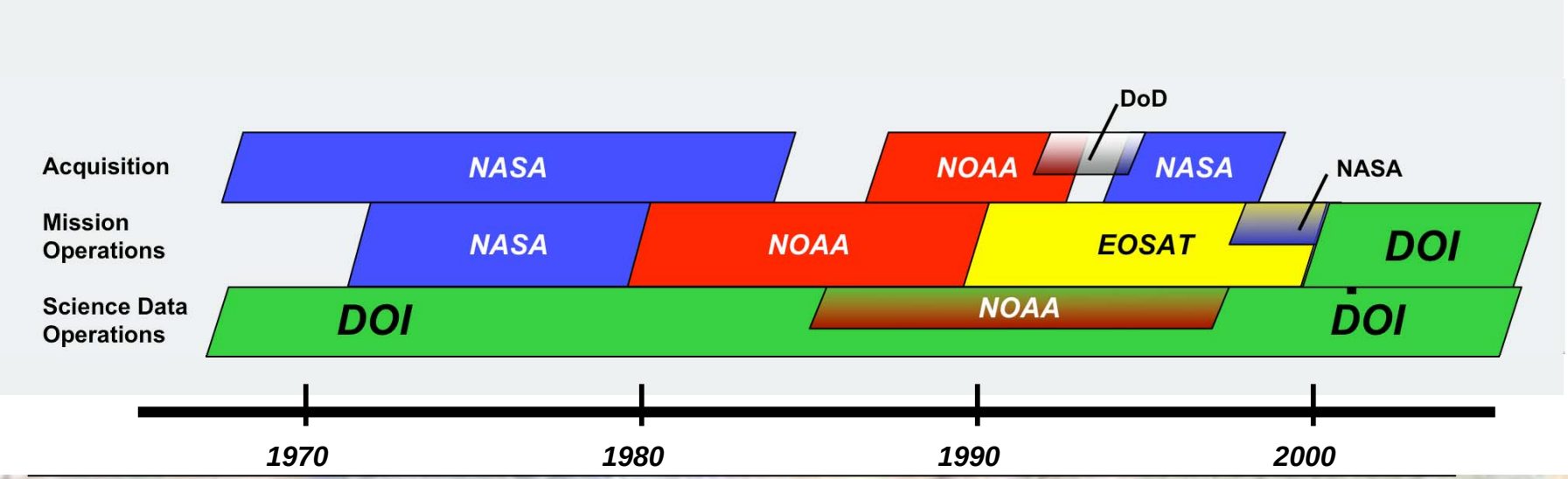
Flight Operations Segment (FOS)	Date
Collection Activity Planning Element (CAPE) PDR	✓**Apr 2008**
Mission Operations Element (MOE) SRR	**TBD**
Mission Operations Element (MOE) PDR	**TBD**
Ground Network Element (GNE) PDR	**Jan 2009**

Data Processing and Archive Segment	Date
Image Processing Element (IPE) PDR	**Oct 2008**
Infrastructure Element (IE) Spiral DR	✓**Jul 2008**
Storage and Archive Element (SAE) PDR	**Sep 2008**
User Portal Element (UPE) PDR	✓**Jul 2008**

Actual dates are subject change due to Mission activities and maturity of dependencies

The Issue

- No long-term U.S. commitment for providing Landsat-like data
- No U.S. commercial alternative
- No resources to sustain an operational land imaging program for the U.S



Core “Instrumented” IVOS Sites (Total=8) LANDNET

Railroad Valley Playa, NV, USA, North America

- Dr. Kurtis J. Thome (kthome@email.arizona.edu) – University of Arizona, USA

Ivanpah, NV/CA, USA, North America

- Dr. Kurtis J. Thome (kthome@email.arizona.edu) – University of Arizona, USA

Lspec Frenchman Flat, NV, USA, North America

- Mark C. Helmlinger (mark.helmlinger@ngc.com) – NGST, USA

La Crau, France, Europe

- Patrice Henry (patrice.henry@cnes.fr) – CNES, France

Dunhuang, Gobi Desert, Gansu Province, China, Asia

- Fu Qiaoyan (fqy@cresda.com) – CRESDA, China

Negev, Southern Israel, Asia

- Arnon Karnieli (karnieli@bgu.ac.il) – Ben Gurion University, Israël

Tuz Golu, Central Anatolia, Turkey, Asia

- Selime Gurol (selime.gurol@uzay.tubitak.gov.tr) – TUBITAK UZAY, Turkey

Dome C, Antartica

- Dr. Stephen Warren (sgw@atmos.washington.edu) – University of Washington, USA