



Cal/Val site characterisation & classification

***Chair: Gregory L Stensaas, USGS
CEOS/WGCV member***

***Session support: Gyanesh Chander, USGS SAIC
CEOS/WGCV member***

- With television, weather channels, Google Maps™ mapping service, and other day-to-day uses, satellite imagery has clearly become part of mainstream information society
- Nevertheless, for most operational remote sensing applications, critical issues remain with respect to the:
 - Reliability of supply
 - Consistent data quality
 - Plug-and-play capability
- Consistent data quality implies the adherence of data to appropriate standards of fidelity to the underlying physical quantities that they measure
- These well-calibrated data then assure the accuracy and enhance the intercomparability that enables the use of advanced Earth observation technologies to address societal benefits

- User communities increasingly rely on information products from multiple satellite sensors
- Better calibration can result from more post launch calibration, involving standardized measurement protocols, instrumentation, and processing
- Field measurements remain resource-intensive activities
- Less expensive complementary approaches can provide more frequent calibration updates and enable the monitoring of sensor performance trends, even without surface measurements
- Future global monitoring systems, using increasingly complex constellations of satellites with multiple sensors, such as the Global Earth Observation System of Systems (GEOSS), will amplify the need for this initiative to provide GEO societal benefits

- This session will focus on the establishment, definition & characterisation of calibration sites.
- Site characterisation requirements will vary between expert groups but the desire is to establish a global set of CEOS-endorsed sources of cal/val data, which span all required disciplines, including the right to access the data and the guarantee of maintenance.
- This session's primary focus will be on calibration requirements and associated sites.

- Session is broken into 2 sections
 - With discussion and then wrap up at the end
- Focus on answering questions via team process
 - If we have multiple suggestion and solutions, note them for further discussion after all questions are addressed
 - Do not get carried away on insolvable issue
 - Establish a “parking lot” of issues for discussion in wrap up
- Note taker and facilitator

- Establish pre-launch and post launch calibration baselines
 - General pre-launch requirement with traceability and uncertainty definitions
 - Define Post launch calibration and base requirements
 - Discuss recommended statements and standards
 - On-board calibration methods
 - Lunar Calibration method
 - Earth Surface calibration method
 - Use land imaging radiometric calibration as a starting process
 - Define best practices and methods
 - Establish a calibration site matrix that works for a majority of the discussed CEOS WCGV working group's systems

- Complete Land Imaging Radiometric Site Recommended Process
- Relate process to other calibration areas
 - Calibration requirements and methods
 - Standards and processes
 - Calibration Types and Site Uses
 - Selection and classification criteria
- Define Interoperability areas
- Final recommendations for other areas

- Pre-launch sensor and system calibration and testing
- On Orbit calibration
 - On Board Calibration process
 - Lunar Calibration – Documented seed material
 - Geometric and MTF Calibration (defined processes need to be documented and sites need to be defined similar radiometry)
 - Cross calibration and vicarious calibration
- In situ data and calibration

- WGCV has six subgroups, each with requirements
 - Atmospheric Composition
 - Infrared Visible Optical Sensors
 - Land Product Validation
 - Microwave
 - Synthetic Aperture Radar
 - Terrain Mapping
- Discuss different sites requirements per group
- Discuss and list currently used sites
- Discuss calibration requirements
- Discuss instrumentation requirements

- The use of cross calibration and vicarious calibration for post-launch calibration has continued to expand
- Increasingly, vicarious calibration addresses multiple satellite sensors and involves a multiplicity of test sites
 - Growing experience with more satellite sensors and more sites
- Improved understanding of relative importance of precision/accuracy in surface reflectance versus atmospheric knowledge

- Sensor/System data
- Calibration requirements
- Standards and processes
- Calibration types and site uses
- Selection and classification criteria
- Endorsement recommendation

Established Selection Criteria For Land Imaging

- High spatial uniformity over a large area (within 3 %)
 - Minimize misregistration and adjacency effects
- Surface reflectance greater than 0.3
 - To provide higher SNR and reduce uncertainty due to atmosphere
- Flat spectral reflectance
 - Reduce uncertainties due to different RSR
- Temporally invariant surface properties (within 2 %)
 - To reduce BRDF, spectral, surface reflectance effects
- Horizontal surface with nearly lambertian reflectance
 - Minimize uncertainty due different solar illumination and observation geometry
- At high altitude, far from ocean, urban, and industrial areas
 - Minimize aerosol loading and atmospheric water vapor
- In arid regions with low probability of cloud cover
 - Minimize precipitation that could change soil moisture

- Including only playa (dry lakebed), salt flat, and desert sand sites
- **Snow fields are excluded primarily because high surface reflectances are more sensitive to variations in atmospheric particle size distribution and because they are usually located at latitudes characterized by high solar zenith angles**
- **Vegetation targets are excluded because they are subject to phenological changes as well as strong reflectance anisotropy effects**
- **Water targets are excluded because low surface reflectances are more sensitive to atmospheric path radiance and because of sun glint**
- **Other target types (uniform cloud cover, atmospheric scattering, ocean glint) are excluded because more specialized analysis is required, not in keeping with operational use of benchmark test sites**

- Core Test Site (name, location, coordinates, size, shape, and orientation)
- Description of the Site
- Images (ground photos, digital topography, satellite screenshots, Google imagery)
- Current Status of the Site (instrumented, maintained, funding, visited, access)
- Surface Measurements (historical, meteorological, clear-sky data, seasonal variations)
- Surface Characteristics (sampling strategy, reflectance, BRDF, traceability, uniformity, topography, radar backscatter and thermal infrared signatures, surface and atmospheric stability, surveyed points)
- Site Instrumentation and calibration data
- Site Usage ((record of data and comparisons (ground, aircraft and satellite))
- Auxiliary Data (e.g., Landsat WRS2 Path/Row, satellite data, ...)

- 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
 - Sample Landsat images and Google KMZ files



[USGS Home](#)
[Contact USGS](#)
[Search USGS](#)

The USGS Remote Sensing Technologies Project

[Home](#) |
 [About Us](#) |
 [Aerial](#) |
 [Satellite](#) |
 [Instrumentation](#) |
 [Collaborations](#) |
 [Resources](#) |
 [Contact Us](#)

Remote Sensing Technologies - Satellite

Test Site Catalog

Catalog of World-wide Test Sites for Sensor Characterization

In an era when the number of Earth-observing satellites is rapidly growing and measurements from these sensors are used to answer increasingly urgent global issues, it is imperative that scientists and decision-makers rely on the accuracy of Earth-observing data products. The characterization and calibration of these sensors are vital to achieve an integrated Global Earth Observation System of Systems (GEOSS) for coordinated and sustained observations of Earth. The U.S. Geological Survey (USGS), as a supporting member of Committee on Earth Observation Satellites (CEOS) and GEOSS, worked with partners around the world to establish an online Catalog of prime candidate world-wide test sites for the post-launch characterization and calibration of space-based optical imaging sensors. The online Catalog provides easy public web site access to this vital information for the global community. Through greater access to and understanding of these vital test sites and their use, the validity and utility of information gained from Earth remote sensing will continue to improve.

Contact Information: Gyanesh Chander gchander@usgs.gov or Gregory L Stensaag stensaag@usgs.gov

|

[World Map](#)
[North America](#)
[Africa](#)
[Europe](#)
[Asia](#)
[Australia](#)
[South America](#)
[Geometry Sites](#)
[Acronyms](#)
[References](#)



[Accessibility](#) |
 [FOIA](#) |
 [Privacy Policies](#) and Notices

U.S. Department of the Interior | U.S. Geological Survey
 URL: <http://calval.cr.usgs.gov/>
 Page Contact Information: eresweb@usgs.gov
 Page Last Modified: August 21, 2007



36 initial sites

I: Among Best Sites with Routine Surface Measurements

II: Among Best Sites without Routine Surface Measurements

III: Other Potentially Good Sites

I

Dunhuang
Ivanpah Playa
La Crau
Railroad Valley Playa
White Sands

II

Algeria 3
Algeria 5
Arabia 2
Barreal Blanco
Dunrobin
Egypt 1
Lake Frome
Libya 1
Libya 2
Libya 4
Lunar Lake Playa
Mauritania 1
Niger I
Rogers Dry Lake
Sonoran Desert
Taklamakan Desert
Uyuni Salt Flats
Warrabin

III

Amburla
Arabia 1
Bonneville Salt Flats
Egypt 2
Mali 1
Namib Desert 1
Namib Desert 2
Niger 2
Sechura Desert
Sudan 1
Tinga Tingana
Winton
Yemen Desert 1

Site Location: Railroad Valley Playa

Choose A Radiometric Site

[Return to Railroad Valley Playa](#)

Choose A Radiometric Site

Radiometric

Choose A Geometry Site

Choose A Geometry Site

Location (City, State, Country):	Ely, Nevada, USA, North America
Altitude above sea level (meters):	1435
Center Latitude, Longitude (Degrees):	+38.5, -115.69
Landsat WRS-2 Path/Row:	40 / 33
Size of Usable Area (km):	10 x 10
Owner:	Bureau of Land Management (BLM)
Researcher:	Dr. Kurtis J. Thome Email Researcher

[World Map](#)

[North America](#)

[Africa](#)

[Europe](#)

[Asia](#)

[Australia](#)

[South America](#)

[Geometry Sites](#)

[Acronyms](#)

[References](#)

[World Map](#)

[North America](#)

[Africa](#)

[Europe](#)

[Asia](#)

[Australia](#)

[South America](#)

[Geometry Sites](#)

[Acronyms](#)

[References](#)



[Download 10 km x 10 km GeoTIFF Data](#)

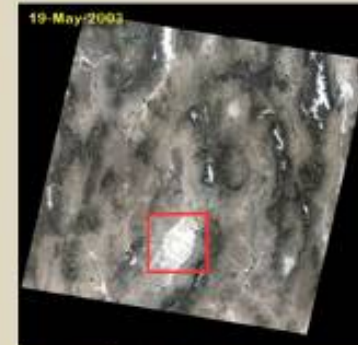
[Download Google Earth KML File](#)

[View Additional Photos](#)

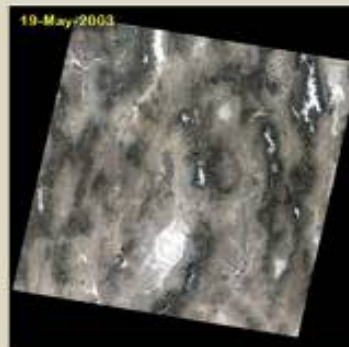
Purpose:	Radiometric, vicarious calibration test site, with large homogenous regions
Description:	Dry-lake playa, spatially homogeneous, consisting of compacted clay-rich lacustrine deposits forming a relatively smooth surface compared to most land covers, although it has a lower spatial uniformity compared to the Ivanpah and Lunar Lake sites. The surface composition is comparable to those of Ivanpah and Lunar Lake; however, all three sites suffer from the presence of iron absorption (Fe3+) in the visible part of the spectrum, characteristic of playas in this region of the US. Google Earth: Slightly patchy (in colour and intensity) across the playas.
Support Data:	Strong linear road features and oil drilling structures (no lat/long available)
Suitability:	Recommended for 15m GSD and larger. Visible/UV to SWIR. Solar reflective and emissive, sub-meter to 2km GSD
Limitations:	Soft surface composition, spatial and spectral variation, possible hot spot effects, periodic snow and water, cloud cover increases in winter, remote location for ground-based studies



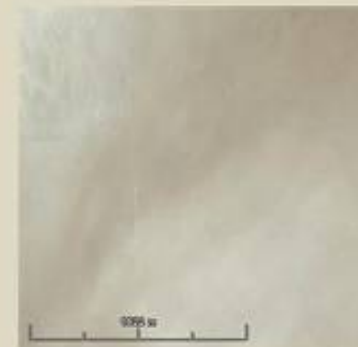
ETM+ Bands 321 Zoomed



ETM+ Bands 321 Site Parameters



ETM+ Bands 321



Google Earth Zoomed



Ground Picture 1



Ground Picture 2

Site Location: Libya 4

Radiometric

Location (City, State, Country):	Libya, Africa
Altitude above sea level (meters):	118
Center Latitude, Longitude (Degrees):	+28.55, +23.39
Landsat WRS-2 Path/Row:	181 / 40
Size of Usable Area (km):	75 x 75
Owner:	Unavailable
Researcher:	Unavailable

Choose A Radiometric Site ▾

Choose A Geometry Site ▾

[World Map](#)

[North America](#)

[Africa](#)

[Europe](#)

[Asia](#)

[Australia](#)

[South America](#)

[Geometry Sites](#)

[Acronyms](#)

[References](#)



[Return to Libya 4](#)

Choose A Radiometric Site ▾

Choose A Geometry Site ▾

[World Map](#)

[North America](#)

[Africa](#)

[Europe](#)

[Asia](#)

[Australia](#)

[South America](#)

[Geometry Sites](#)

[Acronyms](#)

[References](#)

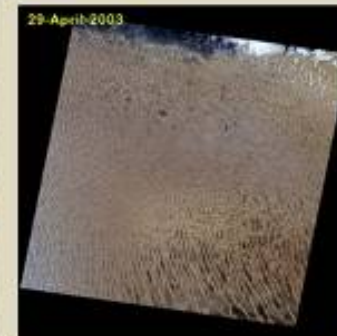


[Download LZ ETH+ GeoTiff Data](#)

[Download Google Earth KMZ File](#)



ETH+ Bands 321 Zoomed



ETM+ Bands 321



Google Earth Ground Picture

[Return to Libya 4](#)

[View Additional Photos](#)

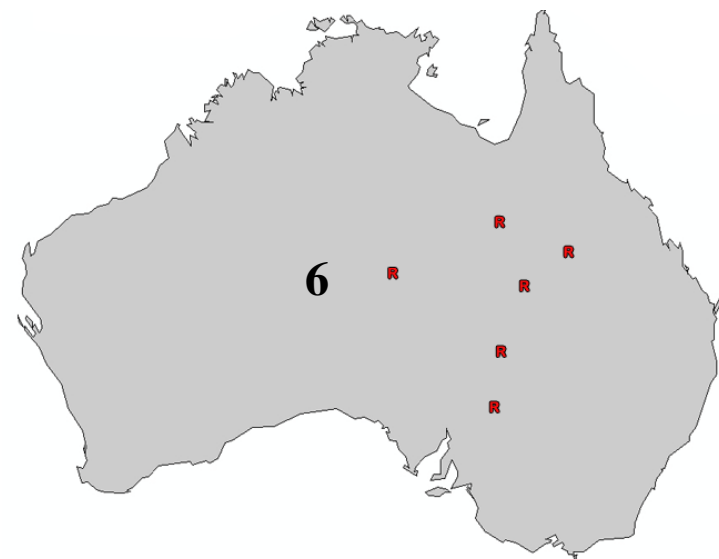
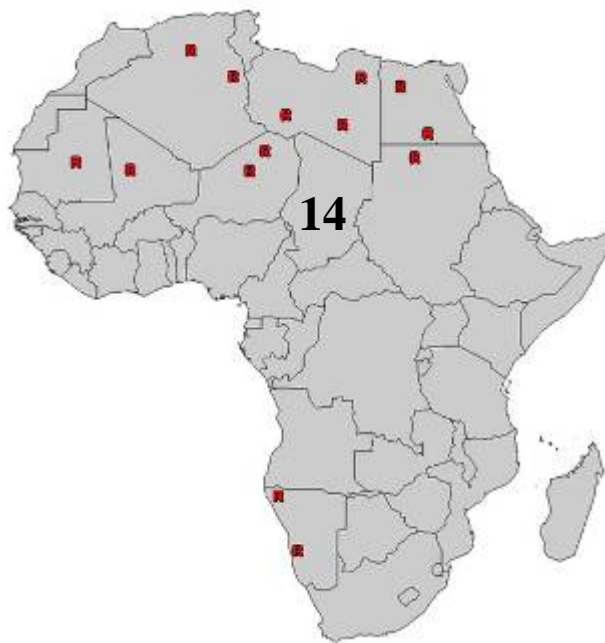
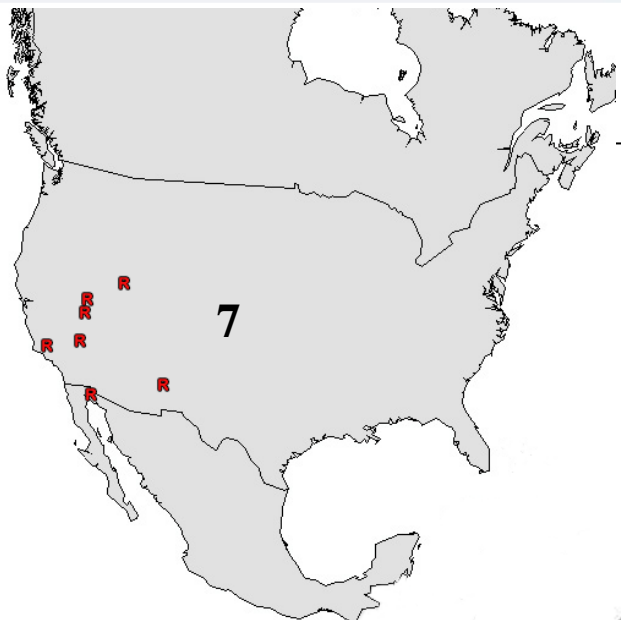
Purpose:	TBD
Description:	South-west quadrant of Landsat WRS-2 181/40. Used by CNES (100 x 100 km) - smaller area would be better. Google Earth: Dunes at multiple scales, but large usable areas of 75 km x 75 km or more, especially north-west of centre coordinates. The surface varies slightly in intensity and colour across the area.
Support Data:	TBD
Suitability:	TBD
Limitations:	TBD

- **Absolute Calibration (A)**
 - **An absolute calibration site is a location where in situ ground measurements of key physical parameters are acquired by calibrated ground instruments, allowing a detailed comparison of the ground instrument results to those of an orbiting sensor**
- **Pseudo-Invariant Calibration (I)**
 - **A pseudo-invariant site is a location on the Earth's surface that is very stable both temporally and spatially over long periods of time and over significant spatial extent. These sites are *typically* located in desert regions that receive little rainfall and have few surface features**
- **Cross-Calibration (X)**
 - **A cross-calibration site is a location on the Earth's surface that contains large homogeneous regions that are viewable by two or more satellite sensors within a relatively short time period**

Provisional Calibration Site Categorizations

A=Absolute I=Pseudo-Invariant X=Cross-Calibration

#	Site Name	WRS-2 Path	WRS-2 Row	Absolute Calibration (A)	Pseudo-Invariant Calibration (I)	Cross-Calibration (X)
1	Algeria 3	192	39		I	X
2	Algeria 5	195	39		I	X
3	Amburla	103	76	A		X
4	Arabia 1	164	47		I	X
5	Arabia 2	162	46		I	X
6	Barreal Blanco	232	82	A		X
7	Bonneville Salt Flats	39	32			X
8	Dunhuang	137	32	A		X
9	Dunrobin	94	76	A		X
10	Egypt 1	179	41		I	X
11	Egypt 2	177	44		I	X
12	Ivanpah Playa	39	35	A		X
13	La Crau	196	30	A		X
14	Lake Frome	97	81		I	X
15	Libya 1	187	43		I	X
16	Libya 2	182	43		I	X
17	Libya 4	181	40		I	X
18	Lunar Lake Playa	40	33	A		X
19	Mali 1	198	47			X
20	Mauritania 1	201	47		I	X
21	Namib Desert 1	179	77		I	X
22	Namib Desert 2	182	72		I	X
23	Niger I	189	46		I	X
24	Niger 2	188	45		I	X
25	Railroad Valley Playa	40	33	A		X
26	Rogers Dry Lake	41	36	A		X
27	Sechura Desert	10	64		I	X
28	Sonoran Desert	38	38		I	X
29	Sudan 1	177	45		I	X
30	Taklamakan Desert	146	32		I	X
31	Tinga Tingana	97	80	A		X
32	Uyuni Salt Flats	233	74		I	X
33	Warrabin	95	78	A		X
34	White Sands	33	37	A		X
35	Winton	96	76	A		X
36	Yemen Desert 1	164	48		I	X



- Calibration recommended practices
- What are the well established site selection criteria?
- Global distribution of test sites?
- Provisional calibration site categorizations- absolute, invariant, cross-cal?
- Key surface measurements and instruments needed?
- Ground truth data access?
- Do we need a CEOS certification/endorsement?
- What is the process for endorsement of test sites?

- Characterization of a given calibration test site can actually involve documenting several “nested” sites:
 - Specific measurement site
 - Area well represented by the measurement site
 - Larger pseudo-invariant and/or cross-calibration area suitable for vicarious calibration
- Stability requirements
- Site maintenance and support
- Who will do what, where, by when, and how?
- Funding

- Recommended calibration best practice to be endorsed by CEOS and used by GEO
 - Define recommended pre-launch requirements
 - Define recommended standard for Quantitative Definition of the System Response
 - Define process for cal/val site definition via instrument type of each WGCV sub-group
 - Currently used top sites; interim approval for baseline
 - Define process and requirements for site selection
 - Classes or categories
 - Define cal/val data requirements for each instrument group
 - Engineering/Housekeeping, Image data, Metadata, Auxiliary data

- Calibration site process and initial primary sites
 - Type of sites used per CEOS sub-group area
 - What makes them good or bad? What are the critical and non-critical criteria and parameters?
 - Establish a recommended process for each type
 - Defined implementation of this process for each type

- Refine selection process and criteria for CEOS endorsed sites and begin using currently available primary sites
- Gather and complete site characterization data and information
- Begin acquisition and archive data over initial sites and endorsed sites
- Establish on-line calibration data access infrastructure
- Develop guidelines and establish endorsement mechanisms for calibration standards
- Establish traceability and uncertainty information for all data collected over sites
- Endorse and advocate compliance with calibration standards

Template

- Variety of sites (e.g. area, product dependent, history, stability, representativity, global distribution, scale in terms of altitude and planimetry, ground composition)
- Characterised wrt parameter that seeking to measure (e.g. calibration, stability of the instrument, owner's interest, availability of the data, maintainability of site and instrumentation, commitment of owner)
- Number of sites (optimum number, not limited by funding but should be limited to the a number that achieves the best practices requirements)
- Reliability and frequency (operational, data accessibility)
- Key ancillary information (e.g. PTU, aerosol, species independent of variety, local geocoded imagery, geocoding of the instrument, climatology)
- Best practices defined by each area including demonstration of traceability (not limited by funding)
- Definition of parameter that seeking to identify
- Key endorsement criteria