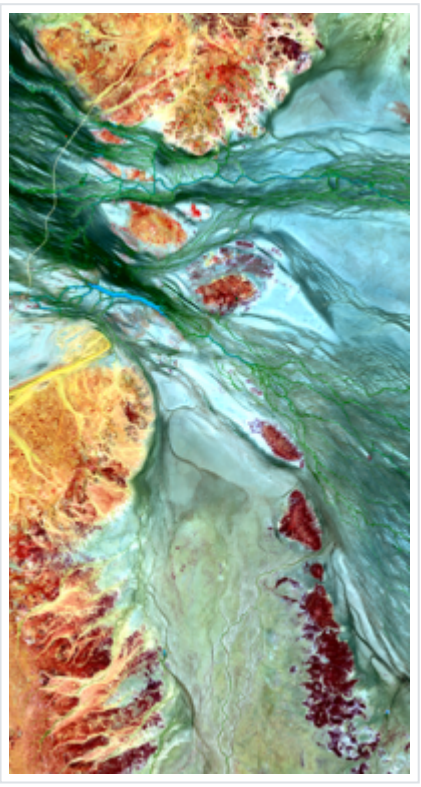
# DEA Surface Reflectance (Landsat 8 OLI-TIRS)



## Geoscience Australia Landsat 8 OLI-TIRS Analysis Ready Data Collection 3

**Version**
3.0.0

**Product ID**
ga_ls8c_ard_3

**Program**
Digital Earth Australia

**Collection**
Geoscience Australia Landsat Collection 3

**Resource type**
Baseline

**Date modified**
26/03/2021

View the original metadata page for the most up-to-date information on this product.

# Basics

## Background

The United States Geological Survey's (USGS) Landsat satellite program has been capturing images of the Australian continent for more than 30 years. This data is highly useful for land and coastal mapping studies.

In particular, the light reflected from the Earth's surface (surface reflectance) is important for monitoring environmental resources – such as agricultural production and mining activities – over time.

We need to make accurate comparisons of imagery acquired at different times, seasons and geographic locations. However, inconsistencies can arise due to variations in atmospheric conditions, sun position, sensor view angle, surface slope and surface aspect. These need to be reduced or removed to ensure the data is consistent and can be compared over time.

## What this product offers

This product  takes Landsat 8 imagery captured over the Australian continent and corrects for inconsistencies across land and coastal fringes. The result is accurate and standardised surface reflectance data, which is instrumental in identifying and quantifying environmental change.

The imagery is captured using the Operational Land Imager (OLI) and Thermal Infra-Red Scanner (TIRS) sensors aboard Landsat 8.

This product is a single, cohesive Analysis Ready Data (ARD) package, which allows you to analyse surface reflectance data as is, without the need to apply additional corrections.

It contains three sub-products that provide corrections or attribution information:

- DEA Surface Reflectance NBAR (Landsat 8 OLI-TIRS)
- DEA Surface Reflectance NBART (Landsat 8 OLI-TIRS)
- DEA Surface Reflectance OA (Landsat 8 OLI-TIRS)

The resolution is a 30 m grid based on the USGS Landsat Collection 1 archive.

## Applications

- The development of derivative products to monitor land, inland waterways and coastal features, such as:
  - urban growth
  - coastal habitats
  - mining activities
  - agricultural activity (e.g. pastoral, irrigated cropping, rain-fed cropping)
  - water extent
- The development of refined information products, such as:
  - areal units of detected surface water
  - areal units of deforestation
  - yield predictions of agricultural parcels
- Compliance surveys
- Emergency management

## Related products

- DEA Surface Reflectance NBAR (Landsat 8 OLI-TIRS)
- DEA Surface Reflectance NBART (Landsat 8 OLI-TIRS)
- DEA Surface Reflectance OA (Landsat 8 OLI-TIRS)

## Publications


- Li, F., Jupp, D. L. B., Reddy, S., Lymburner, L., Mueller, N., Tan, P., & Islam, A. (2010). An evaluation of the use of atmospheric and BRDF correction to standardize Landsat data. IEEE Journal of Selected Topics in Applied Earth Observations and Remote Sensing, 3(3), 257–270.

https://doi.org/10.1109/JSTARS.2010.2042281

- Li, F., Jupp, D. L. B., Thankappan, M., Lymburner, L., Mueller, N., Lewis, A., & Held, A. (2012). A physics-based atmospheric and BRDF correction for Landsat data over mountainous terrain. Remote Sensing of Environment, 124, 756–770. https://doi.org/10.1016/j.rse.2012.06.018

# Access

## Data access

| | |
|---|---|
| **Link to data** | THREDDS |
| **eCat record** | 132317 |
| **Product ID** | ga_ls8c_ard_3 |
| **CMI RESTful node ID** | 365 |
| **NCI project code** | xu18 |
| **Security classification** | Unclassified |
| **Update frequency** | asNeeded |

## Access notes

**Open Data Cube**

This product is contained in the Open Data Cube instance managed by Digital Earth Australia (DEA). This simplified process allows you to query data from its sub-products as part of a single query submitted to the database.

See Analysis Ready Data: example queries

# Details

## Technical information

**Operational Land Imager (OLI) and Thermal Infrared Sensor (TIRS)**

OLI is a push-broom sensor with a four-mirror telescope and 12-bit quantisation. OLI collects data for visible, near infrared, and short wave infrared spectral bands as well as a panchromatic band.

TIRS measures land surface temperature in two thermal bands with new technology that applies quantum physics to detect heat.

**The Analysis Ready Data concept**

The Analysis Ready Data (ARD) package allows you to get up and running with your analysis as quickly as possible with minimal data preparation and additional input. This makes it simpler for you to develop applications and for the database to execute queries.

The satellite data has been processed to a minimum set of requirements and organised into a form that allows immediate analysis and interoperability through time and with other datasets. It has been adapted from CEOS Analysis Ready Data ( CARD4L).

The technical report containing the data summary for the Phase 1 DEA Surface Reflectance Validation is available.

**ARD sub-products**

*1) DEA Surface Reflectance NBAR (Landsat 8 OLI-TIRS)*

This sub-product produces standardised optical surface reflectance data using robust physical models which correct for variations and inconsistencies in image radiance values. Corrections are performed using Nadir corrected Bi-directional reflectance distribution function Adjusted Reflectance (NBAR).

*2) DEA Surface Reflectance NBART (Landsat 8 OLI-TIRS)*

This sub-product performs the same function as Surface Reflectance (Landsat 8 OLI-TIRS NBAR), but also applies terrain illumination correction.

*3) DEA Surface Reflectance OA (Landsat 8 OLI-TIRS)*

The NBAR and NBART sibling products depend upon the OA product to provide accurate and reliable contextual information about the Landsat data. This ‘data provenance’ provides a chain of information which allows the data to be replicated or utilised by derivative applications. It takes a number of different forms, including satellite, solar and surface geometry and classification attribution labels.

## Accuracy and limitations

For detailed information on accuracy and limitations, refer to the sub-products' pages:

- DEA Surface Reflectance NBAR (Landsat 8 OLI-TIRS)
- DEA Surface Reflectance NBART (Landsat 8 OLI-TIRS)
- DEA Surface Reflectance OA (Landsat 8 OLI-TIRS)

## Quality assurance

For detailed information on quality assurance, refer to the sub-products' pages:

- DEA Surface Reflectance NBAR (Landsat 8 OLI-TIRS)
- DEA Surface Reflectance NBART (Landsat 8 OLI-TIRS)
- DEA Surface Reflectance OA (Landsat 8 OLI-TIRS)

## Software

- MODTRAN
- wagl
- eugl
- tesp
- eodatasets
- pythonfmask

## Relevant websites

- Landsat OLI-TIRS
- MODIS BRDF
- Land Processes Distributed Active Archive Center (LP DAAC)
- Global ozone maps
- National Geospatial-Intelligence Agency
- NASA Shuttle Radar Topography Mission
- Earth Resources Observation and Science (EROS) Center
- USGS Landsat Collection 1

## References

Berk, A., Conforti, P., Kennett, R., Perkins, T., Hawes, F., & van den Bosch, J. (2014, June 13). *MODTRAN6: A major upgrade of the MODTRAN radiative transfer code* (M. Velez-Reyes & F. A. Kruse, Eds.). https://doi.org/10.1117/12.2050433

Dymond, J. R., & Shepherd, J. D. (1999). Correction of the topographic effect in remote sensing. IEEE Transactions on Geoscience and Remote Sensing, 37(5), 2618–2619. https://doi.org/10.1109/36.789656

Hudson, S. R., Warren, S. G., Brandt, R. E., Grenfell, T. C., & Six, D. (2006). Spectral bidirectional reflectance of Antarctic snow: Measurements and parameterization. Journal of Geophysical Research, 111(D18), D18106.

https://doi.org/10.1029/2006JD007290

Kalnay, E., Kanamitsu, M., Kistler, R., Collins, W., Deaven, D., & Gandin, L. et al. (1996). The NCEP/NCAR 40-Year Reanalysis Project. Bulletin Of The American Meteorological Society, 77(3), 437-471. https://doi.org/10.1175/1520-0477(1996)077<0437:tnyrp>2.0.co;2

Li, F., Jupp, D. L. B., Reddy, S., Lymburner, L., Mueller, N., Tan, P., & Islam, A. (2010). An evaluation of the use of atmospheric and brdf correction to standardize landsat data. *IEEE Journal of Selected Topics in Applied Earth Observations and Remote Sensing*, *3*(3), 257–270. https://doi.org/10.1109/JSTARS.2010.2042281

Li, F., Jupp, D. L. B., Thankappan, M., Lymburner, L., Mueller, N., Lewis, A., & Held, A. (2012). A physics-based atmospheric and BRDF correction for Landsat data over mountainous terrain. Remote Sensing of Environment, 124, 756–770. https://doi.org/10.1016/j.rse.2012.06.018

Qin, Y., Mitchell, R., & Forgan, B. W. (2015). Characterizing the aerosol and surface reflectance over Australia using AATSR. IEEE Transactions on Geoscience and Remote Sensing, 53(11), 6163–6182. https://doi.org/10.1109/TGRS.2015.2433911

Schaaf, C., Gao, F., Strahler, A., Lucht, W., Li, X., & Tsang, T. et al. (2002). First operational BRDF, albedo nadir reflectance products from MODIS. Remote Sensing Of Environment, 83(1-2), 135-148. https://www.doi.org/10.1016/s0034-4257(02)00091-3

SZA. (2011). Retrieved May 2019, from http://sacs.aeronomie.be/info/sza.php

Zhu, Z., Wang, S., & Woodcock, C. (2015). Improvement and expansion of the Fmask algorithm: cloud, cloud shadow, and snow detection for Landsats 4–7, 8, and Sentinel 2 images. Remote Sensing Of Environment, 159, 269-277. https://doi.org/10.1016/j.rse.2014.12.014

Zhu, Z., & Woodcock, C. E. (2012). Object-based cloud and cloud shadow detection in Landsat imagery. Remote Sensing of Environment, 118, 83–94. https://doi.org/10.1016/j.rse.2011.10.028

# Processing

## Lineage

This product is derived from the USGS Landsat Collection 1 archive.

- The Moderate Resolution Imaging Spectroradiometer (MODIS) MCD43A1 Version 6 Bidirectional Reflectance Distribution Function and Albedo (BRDF/Albedo) Model Parameters dataset was provided by the National Aeronautics and Space Administration (NASA). It was produced daily using 16 days of Terra and Aqua MODIS data at 500 m resolution.
  See USGS: MCD43A1, NASA: MODIS BRDF / Albedo Parameter, Schaaf et al. (2002)
- The ozone data was provided by Environment Canada.
  See Environment Canada: Global Ozone Maps
- The Aerosol Optical Thickness data was provided by the Commonwealth Scientific and Industrial Research Organisation (CSIRO).
  See Qin et al. (2015)
- The Precipitable Water for Entire Atmosphere data was provided by the National Oceanic and Atmospheric Administration (NOAA) / Earth System Research Laboratory (ESRL) / Physical Sciences Division (PSD).
  See Kalnay et al. (1996)
- The baseline Digital Surface Model (DSM) data produced from the Shuttle Radar Topography Mission (SRTM) was provided by the National Geospatial-Intelligence Agency (NGA).
  See NGA: SRTM, NASA: SRTM
- Level 1 Collection 1 data was provided by the United States Geological Survey (USGS)'s Earth Resources Observation and Science (EROS) Center.
  See USGS: EROS, USGS: Landsat Collection 1

## Data sources

- DEA Surface Reflectance NBAR (Landsat 8 OLI-TIRS)
- DEA Surface Reflectance NBART (Landsat 8 OLI-TIRS)
- DEA Surface Reflectance OA (Landsat 8 OLI-TIRS)

## Processing steps

- Longitude and Latitude Calculation
- Satellite and Solar Geometry Calculation
- Aerosol Optical Thickness Retrieval
- BRDF Shape Function Retrieval
- Ozone Retrieval
- Elevation Retrieval and Smoothing
- Slope and Aspect Calculation
- Incidence and Azimuthal Incident Angles Calculation
- Exiting and Azimuthal Exiting Angles Calculation
- Relative Slope Calculation
- Terrain Occlusion Mask
- MODTRAN

- Atmospheric Correction Coefficients Calculation
- Bilinear Interpolation of Atmospheric Correction Coefficients
- Surface Reflectance Calculation (NBAR)
- Surface Reflectance Calculation (NBAR + Terrain Illumination Correction)
- Function of Mask (Fmask)
- Contiguous Spectral Data Mask Calculation

## Schema / spatial extent

**Geoscience Australia Landsat Collection 3**

| | |
|---|---|
| **Update frequency** | asNeeded |
| **Temporal extent** | 2019-04-09 21:27:33 |
| **Coordinate reference system** | Universal Transverse Mercator (variable) |
| **Cell size X** | 30.00 |
| **Cell size Y** | 30.00 |

# Media

# Credits

## Owner

Commonwealth of Australia (Geoscience Australia)

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## License



## Rights statement



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