

BioSCape: PRISM L1B Calibrated Radiance

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Summary

This dataset holds Level 1B (L1B) calibrated radiance data collected by the Portable Remote Imaging SpectroMeter (PRISM) instrument. The data were acquired in October-November 2023 for the Biodiversity Survey of the Cape (BioSCape), an international collaboration between the National Aeronautics and Space Administration (NASA) and the South African National Space Agency (SANSA) to study biodiversity in South Africa's Greater Cape Floristic Region (GCFR). PRISM is a compact image spectrometer that acquires data in the near ultraviolet (UV) to near infrared (IR) spectral bands between 350 and 1050 nanometers with 3.5 nm spectral resolution. PRISM also has a two-channel spot radiometer at short-wave infrared (SWIR) band (1240 nm and 1640 nm) in order to provide accurate atmospheric correction of the ocean color measurements. PRISM's capabilities make it well suited for studies of aquatic and coastal ecosystems. This dataset includes calibrated radiance and observational parameters in netCDF format, quicklook images as TIFF images, and processing information in text-based YAML format.

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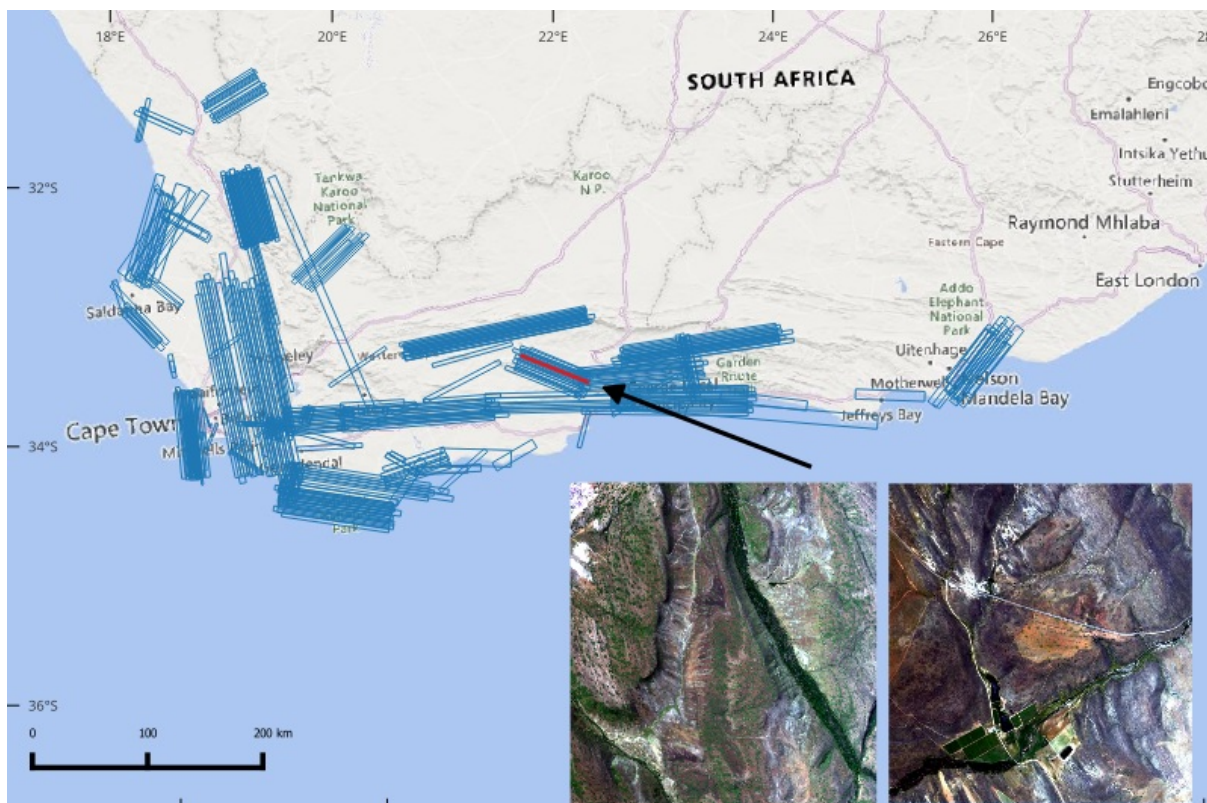


Figure 1. Imagery footprints for PRISM data collected in South Africa for the BioSCape project in October-November 2023 shown as blue rectangles. Insets display quicklooks for two scenes (4 and 20) along the flight line prm20231114t083700 (highlighted as red rectangle) acquired on 14 November 2023 northwest of the city of George, Western Cape Province. Background map: Bing Maps, copyright Microsoft and its suppliers.

Citation

Thompson, D.R., R. Eckert, M. Bernas, P.G. Brodrick, A.M. Chlus, J.W. Chapman, M. Eastwood, H. Bender, S. Geier, E. Greenberg, D. Keymeulen, E. Liggett, W. Olson-Duvall, L.M. Rios, E.D. Brunner, D.J. Jensen, S. Zandbergen, Z. Small, L.A. Shaw, P. Sullivan, Q.P. Vinckier, W. Turner, J.Y. Wang, and R.O. Green. 2026. BioSCape: PRISM L1B Calibrated Radiance. ORNL DAAC, Oak Ridge, Tennessee, USA. <https://doi.org/10.3334/ORNLDAAC/2493>

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1. Dataset Overview

This dataset holds Level 1 (L1) calibrated radiance data collected by the Portable Remote Imaging SpectroMeter (PRISM) instrument. The data were acquired in October-November 2023 for the Biodiversity Survey of the Cape (BioSCape), an international collaboration between National Aeronautics and Space Administration (NASA) and the South African National Space Agency (SANSA) to study biodiversity in South Africa's Greater Cape Floristic Region (GCFR). This dataset includes calibrated radiance and observational parameters in NetCDF format, quicklook images as TIFF images, and processing information in text-based YAML format.

PRISM is a compact image spectrometer that acquires data in the near ultraviolet (UV) to near infrared (IR) spectral bands between 350 and 1050 nanometers with 3.5-nm spectral resolution. PRISM's capabilities make it well suited for studies of aquatic and coastal ecosystems. It was deployed on a NASA Gulfstream III aircraft.

Project: Biodiversity Survey of the Cape ([BioSCape](#))

The Biodiversity Survey of the Cape (BioSCape) is an international collaboration between National Aeronautics and Space Administration (NASA) and the South African National Space Agency (SANSA) to study biodiversity in South Africa's Greater Cape Floristic Region (GCFR). The GCFR was selected due to two exceptional hotspots of both terrestrial and aquatic biodiversity. The GCFR is listed among the World's 200 Significant Ecoregions. The BioSCape is an integrated field and airborne campaign occurring in 2023. The campaign collected UV/visible to short wavelength infrared (UVSWIR) and thermal imaging spectroscopy and laser altimetry LiDAR data over terrestrial and aquatic targets using four airborne instruments: Airborne Visible InfraRed Imaging Spectrometer - Next Generation (AVIRIS-NG), Portable Remote Imaging SpectroMeter (PRISM), Land, Vegetation, and Ice Sensor (LVIS), and Hyperspectral Thermal Emission Spectrometer (HyTES). The airborne data set is unique in its size and scope and unprecedented in its instrument combination and level of detail. These airborne data was accompanied by a range of biodiversity-related field observations. BioSCape's primary objective is to understand the structure, function, and composition of the region's ecosystems, and to learn about how and why they are changing in time and space.

Related Publications

Cardoso, A.W. and The BioSCape Consortium. 2025. BioSCape combines local knowledge and remote-sensing technology for inclusive biodiversity science. *Nature Reviews Biodiversity* 1:2-4. <https://doi.org/10.1038/s44358-024-00007-8>

Cardoso, A., E. Hestir, J. Slingsby, C. Forbes, G. Moncrieff, W. Turner, A. Skowno, J. Nesslage, P. Brodrick, K. Gaddis, and A. Wilson. 2025. The biodiversity survey of the Cape (BioSCape), integrating remote sensing with biodiversity science. *npj Biodiversity* 4:2. <https://doi.org/10.1038/s44185-024-00071-5>

Related Datasets

Greenberg, E., P.G. Brodrick, D.R. Thompson, A.M. Chlus, N. Bohn, J. Montgomery, J.W. Chapman, B.A. Wilder, M. Eastwood, S.R. Lundeen, R. Eckert, W. Olson-Duvall, R.F. Kokaly, and R.O. Green. 2026. BioSCape: PRISM L2A Orthorectified Surface Reflectance. ORNL DAAC, Oak Ridge, Tennessee, USA. <https://doi.org/10.3334/ORNLDAAC/2494>

Other field and airborne datasets for BioSCape are available through the [BioSCape project page](#).

Acknowledgement

The BioSCape Project is a multi-agency, NASA-led research project that integrates airborne imaging spectroscopy (AVIRIS NG, PRISM) and lidar (LVIS) with a suite of surface measures of biodiversity. BioSCape was supported by NASA grant 80NSSC21K0086, the South African government (NRF/SAEON), and the United Nations Educational, Scientific and Cultural Organization (UNESCO). The PRISM instrument is maintained, operated, and the data processing is conducted by the Jet Propulsion Laboratory, California Institute of Technology, in Pasadena, California.

2. Data Characteristics

Spatial Coverage: Greater Cape Floristic Region of South Africa

Spatial Resolution: approximately 5 m

Temporal Coverage: 2023-10-17 to 2023-11-26

Temporal Resolution: Daily, weather permitting, during deployment

Study Areas: All latitudes and longitudes given in decimal degrees.

Site	Westernmost Longitude	Easternmost Longitude	Northernmost Latitude	Southernmost Latitude
Southern Cape of South Africa	17.7865	26.1522	-31.2404	-34.9001

Data File Information

This dataset includes calibrated radiance and observational parameters in NetCDF format, quicklook images as TIFF images, and processing information in text-based YAML format.

The naming convention for the files is `<flight prefix>_<id>_<level>_<ver>_<product>.<ext>`, where

- `<flight prefix>` = flight line identifier, `prmYYYYMMDDthhmmss`, encoding the date and time by year (YYYY), month (MM), day (DD), hour (hh), minute (mm), and second (ss) of the flight (e.g., `prm20231114t083700`).
- `<id>` = scene-id from within a flight line
- `<level>` = data level: "L1B" for Level 1B. "ORT" for orthorectified. "RDN" for radiance.

- <ver> = unique eight-character identifier of full heritage versioning (e.g., "ab7dce31").
- <product> = Level 1B data product: "RDN" for radiance, "OBS" for orthorectified observational parameters, "RDN_QL" for quicklook image, "BANDMASK" for denoting interpolated wavelengths.
- <ext> = file extension indicating file type: "nc" for NetCDF, "tif" for TIFF image, "yaml" for YAML text file.

Example file names for one flight line are:

- prm20231114t083700_022_L1B_ORT_ab7dce31_OBS.nc
- prm20231114t083700_022_L1B_ORT_ab7dce31.yaml
- prm20231114t083700_022_L1B_RDN_a3b26c21_BANDMASK.nc
- prm20231114t083700_022_L1B_RDN_a3b26c21_RDN.nc
- prm20231114t083700_022_L1B_RDN_a3b26c21_RDN_QL.tif
- prm20231114t083700_022_L1B_RDN_a3b26c21.yaml

The radiance (RDN) files hold calibrated radiance in raw spatial format (not orthorectified) (Tables 1 and 2). However, both the RDN and OBS files include the geometric lookup table (GLT), which provides a georeferenced location for each pixel in the raw image (Table 3). The GLT is an orthorectified product with a fixed pixel size projected into a UTM coordinate system that contains the information about which original pixel occupies which output pixel in the final product. Orthorectified pixels are referenced back to the raw image by the *line* and *sample* variables. The *line* and *sample* values are sign coded to indicate if it is a real measurement (indicated by a positive value) or a nearest-neighbor infill (indicated by negative values).

The band mask (BANDMASK) files indicate for each pixel whether a given wavelength was interpolated. Interpolation occurred due to a bad pixel in the focal plane array or from saturation. The per pixel data is provided as a bit-packed unsigned integer array with dimensions of lines x samples, organized across 31 layers. There is one value per pixel for each of 246 wavelengths, ordered from shortest to longest wavelength. Each layer holds the mask values for eight wavelengths; however, the last layer (31) holds mask values for the six longest wavelengths. For each pixel in a given layer, the bit-packed value is an unsigned integer, ranging 0 to 255, that indicates which of eight wavelengths were interpolated. The integer value represents a Boolean vector of eight bits (Table 4); each bit corresponds to a wavelength. An integer value of 0 (also the nodata value) indicates that no wavelengths were interpolated. The value of 1 indicates that the first wavelength was interpolated and the remaining seven were not. A 3 indicates that the first and second wavelengths were interpolated. See Table 4 for more examples.

The two YAML files contain processing details for radiance calibration (*_RDN_*.yaml) and georeferencing and orthorectification (*_ORT_*.yaml).

Table 1. Variables in Level 1B calibrated radiance (RDN) netCDF files.

Variable	Description	Units
radiance	Calibrated radiances in 246 bands covering wavelengths between 350 nm to 1050 nm in approximately 3.5-nm intervals. Image cube dimensions = lines x 606 samples x 246 bands. The number of lines varies per scene.	$\mu\text{W nm}^{-1} \text{cm}^{-2} \text{sr}^{-1}$
wavelength	Center wavelength for each spectral band (n = 246)	nm
fwhm	Full width at half maximum for band (n = 246)	nm

Table 2. Variables in Level 1B observational parameters (ORT_*_OBS) netCDF files. These parameters are in the raw spatial format matching the corresponding unorthorectified radiance image. Pixels are referenced by the *line* and *sample* variables. Use the geometric lookup table to find the georeferenced location for each pixel.

Variable	Description	Units
path_length	Sensor-to-ground distance	m
to_sensor_azimuth	Sensor azimuth angle; 0 to 360 degrees clockwise from north	degrees
to_sensor_zenith	Sensor zenith angle; 0 to 90 degrees from zenith	degrees
to_sun_azimuth	Solar azimuth angle; 0 to 360 degrees clockwise from north	degrees
to_sun_zenith	Solar zenith angle; 0 to 360 degrees clockwise from north	degrees
solar_phase	Solar phase; degrees between to-sensor and to-sun vectors in principal plane	degrees
slope	Local surface slope as derived from DEM in degrees	degrees
aspect	Local surface aspect 0 to 360 degrees clockwise from N	degrees
cosine_i	Apparent local illumination factor based on DEM slope and aspect and to sun vector; range -1.0 to 1.0	1
utc_time	Decimal hours since 2025-08-05 00:00:00Z for mid-line pixels	h
earth_sun_distance	Earth-to-sun distance in astronomical units	au

Table 3. Geolocation variables in both radiance (RDN) and observational parameters (ORT_*_OBS) NetCDF files. Coordinates use the WGS 84 ellipsoid.

Variable	Description	Units
easting	UTM easting coordinate for center of grid cell for orthorectified pixel location	m
northing	UTM northing coordinate for center of grid cell for orthorectified pixel location	m
transverse_mercator	Details about the projected UTM coordinate system in well-known text (WKT) format.	-
lon	Longitude for center of grid cell; EPSG 4326	degrees east
lat	Latitude for center of grid cell; EPSG 4326	degrees north
elev	Elevation for center of grid cell in height above mean sea level (surface elevation)	m

line	Pixel identifier in the along-track (flight path) direction, indicating the row location of a pixel from the uncorrected sensor image within the orthorectified grid.	1
sample	Pixel identifier in the across-track direction, indicating the column location of a pixel from the uncorrected sensor image within the orthorectified grid.	1

Table 4. Bit-packing scheme employed in band mask (BANDMASK) files that uses integer values to indicate which of eight wavelengths were interpolated. Potential values range from 0 to 255. This table provides selected examples and does not illustrate all possible values. "-" = not interpolated.

Value	Wavelength interpolated							
	1	2	3	4	5	6	7	8
0	-	-	-	-	-	-	-	-
1	yes	-	-	-	-	-	-	-
2	-	yes	-	-	-	-	-	-
3	yes	yes	-	-	-	-	-	-
4	-	-	yes	-	-	-	-	-
9	yes	-	-	yes	-	-	-	-
16	-	-	-	-	yes	-	-	-
25	yes	-	-	yes	yes	-	-	-
36	-	-	yes	-	-	yes	-	-
64	-	-	-	-	-	-	yes	-
128	-	-	-	-	-	-	-	yes
239	yes	yes	yes	yes	-	yes	yes	yes
255	yes	yes	yes	yes	yes	yes	yes	yes

3. Application and Derivation

NASA's BioSCape project is an integrated field and airborne campaign occurring in the hyperdiverse Cape Floristic Region of South Africa in October and November of 2023. The campaign collected UV/visible to short wavelength infrared (UVSWIR) and thermal imaging spectroscopy and laser altimetry LiDAR data over terrestrial and aquatic targets using four airborne instruments: AVIRIS-NG, PRISM, LVIS, and HyTES. The airborne data set is unique in its size and scope and unprecedented in its instrument combination and level of detail. These airborne data are accompanied by a range of biodiversity-related field observations. BioSCape's primary objective is to understand the structure, function, and composition of the region's ecosystems, and to learn about how and why they are changing in time and space.

4. Quality Assessment

The PRISM calibration procedure addresses electronic effects involving radiometric responses of each detector, optical effects involving the spatial and spectral view of each detector, and radiometric calibration. Instrument artifacts in the spectrometer data, such as striping, are removed statistically by minimizing a Markov Random Field model. Likewise, bad pixels are identified and corrected using statistical methods followed by laboratory and field protocols to evaluate effectiveness. Details of calibration methods are available in Chapman et al. (2019).

5. Data Acquisition, Materials, and Methods

South Africa's Greater Cape Floristic Region (GCFR) is a globally important region for biodiversity with the richest temperate flora and the third highest marine endemism in the world. It contains two Global Biodiversity Hotspots and is experiencing climate-driven changes in biodiversity, which are predicted to continue. GCFR's vulnerability is compounded by ecological feedbacks between water scarcity, fire, and pressures from human populations.

The BioSCape campaign's focus was on biological diversity. It spanned both terrestrial and aquatic realms and included research on both plant and animal life. The primary objective for this campaign was to understand the structure, function, and composition of the region's ecosystems, and to learn about how and why they are changing in time and space. The campaign was organized around three major themes, aimed at understanding:

1. the distribution and abundance of biodiversity,
2. the role of biodiversity in ecosystem function, and
3. the impacts of biodiversity change on ecosystem services.

The experimental design for BioSCape was based on combining in-situ field data with airborne remote sensing data to answer questions about Earth's natural systems. In October-November 2023, the BioSCape project collected hyperspectral, thermal infrared, and laser altimeter data over the terrestrial and aquatic realms of the GCFR. The airborne instruments deployed include Airborne Visible InfraRed Imaging Spectrometer - Next Generation (AVIRIS-NG), Portable Remote Imaging Spectrometer (PRISM), Land, Vegetation, and Ice Sensor (LVIS), and Hyperspectral Thermal Emission Spectrometer (HyTES).

PRISM comprises a pushbroom imaging spectrometer covering the near UV to near IR range (350-1050 nm) and a separate spot radiometer covering two short wave infrared (SWIR) bands at 1240 and 1610 nm respectively (Mouroulis et al., 2014). The two-channel radiometer permits accurate atmospheric corrections for ocean color measurements. PRISM offers high temporal resolution and below cloud flight altitudes to resolve spatial features as small as 30 cm. These characteristics make PRISM well suited for studies of aquatic and coastal environments (Thompson et al., 2015). Additional details about the PRISM instrument are available at <https://science.nasa.gov/mission/portable-remote-imaging-spectrometer-prism/>.

This Level 1B dataset contains two separate NetCDF files: radiance (RDN) and observation parameters (OBS). The radiance file contains calibrated at-sensor radiance measurements in $\mu\text{W nm}^{-1} \text{cm}^{-2} \text{sr}^{-1}$, while the observational parameters NetCDF file contains viewing and solar geometries, timing, topographic, and other information about the observation. Both radiance and observational parameters files contain a geometric lookup table (GLT), a dataset that links relative row and column reference locations (via *line* and *sample* variables) with the orthorectified latitude, longitude and elevation for each pixel. Pixel locations are also provided in projected UTM coordinates. Each image line of the Level 1B data product is also UTC time-tagged. Nodata values are set to -9999.



Figure 2. BioSCape study domain (red polygon) over Southern Cape of South Africa. White rectangles show the general locations of planned flight lines. Background image from Google Earth.

6. Data Access

These data are available through the Oak Ridge National Laboratory (ORNL) Distributed Active Archive Center (DAAC).

BioSCape: PRISM L1B Calibrated Radiance

Contact for Data Center Access Information:

- E-mail: uso@daac.ornl.gov
- Telephone: +1 (865) 241-3952

7. References

- Cardoso, A.W. and The BioSCape Consortium. 2025. BioSCape combines local knowledge and remote-sensing technology for inclusive biodiversity science. *Nature Reviews Biodiversity* 1:2-4. <https://doi.org/10.1038/s44358-024-00007-8>
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