BioSCape: L3 Fractional Cover and Uncertainty from AVIRIS-NG imagery, V1

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Summary

This dataset holds fractional cover estimates and uncertainties for the Biodiversity Survey of the Cape (BioSCape) project. Three component (non photosynthetic, photosynthetic, and bare rock/soil) fractional cover estimates and uncertainties were derived from surface reflectance mosaics using a Monte Carlo Spectral Unmixing. These data are useful for separating surface components for downstream analyses, as well as understanding land cover distributions. Imagery from the Airborne Visible / Infrared Imaging Spectrometer-Next Generation (AVIRIS-NG) instrument was acquired in October - November 2023 over the Greater Cape Floristic Region (GCFR), South Africa. Level 2B (L2B) surface reflectance from these AVIRIS-NG data were resampled to 5-m spatial resolution into a regular tile system of 807 tiles to create Level 3 (L3) resampled reflectance mosaics. The L3 mosaics were used to generate this fractional cover product. Each tile includes fractional cover estimates from multiple flight lines at 5-m resolution spanning multiple days. The dataset includes fraction cover estimates and uncertainty for 870 tiles in cloud-optimized GeoTIFF (COG) format.

This dataset holds 6090 cloud-optimized GeoTIFFs covering 870 tiles.

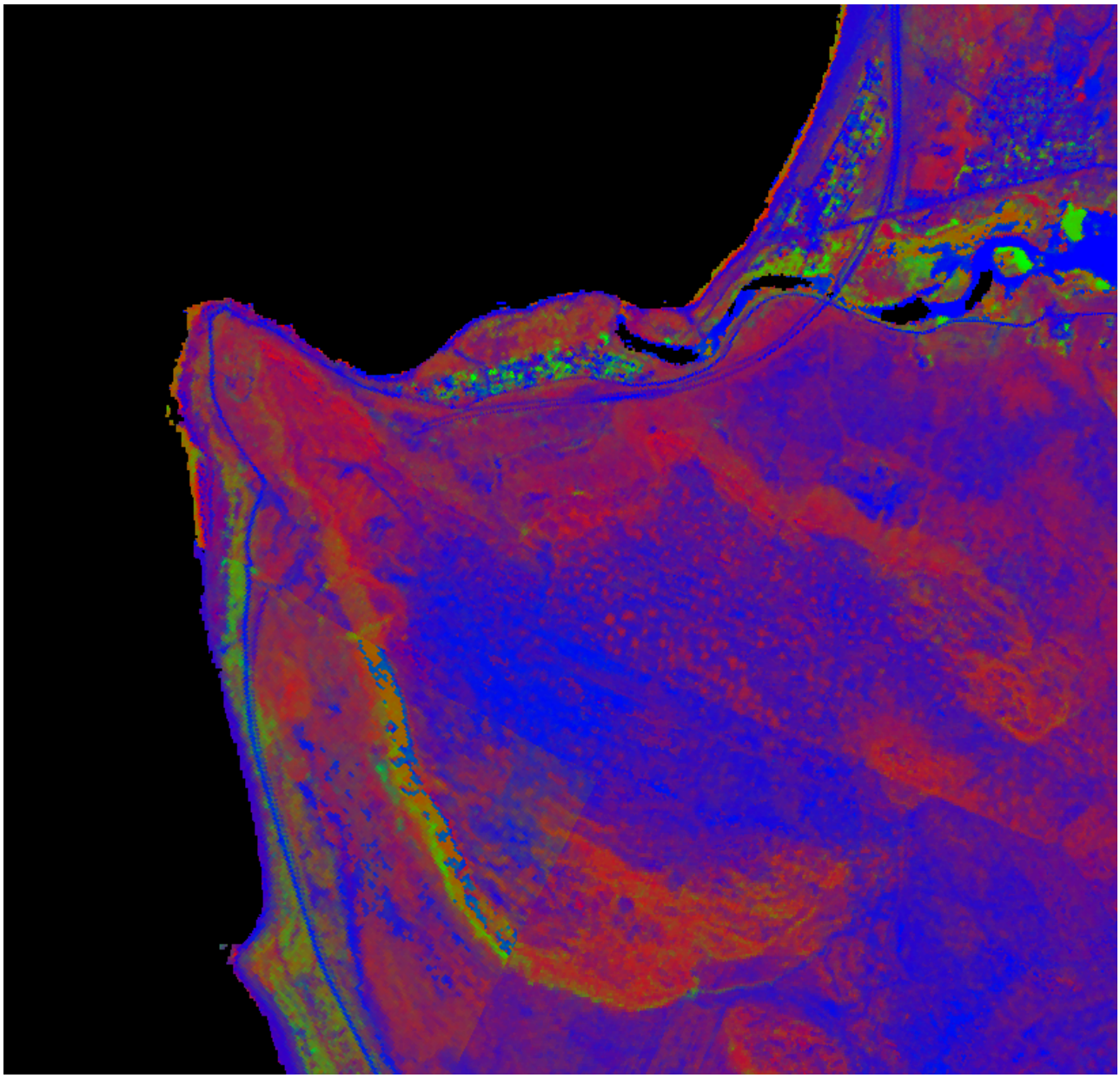


Figure 1. Falsecolor RGB composite image for southeast portion of tile 16_9 over the Elands Bay region in Western Cape, South Africa (approximately -32.325 lat,18.335 lon). R: non-photosynthetic vegetation fraction, G: photosynthetic vegetation fraction, B: bare rock/soil fraction. Black areas are ocean or other surface water. Source: AVIRIS-NG_BIOSCAPE_V01_L3_16_9_QL.tif

Citation

Grant, K., P.G. Brodrick, F. Ochoa, and K. Cawse-Nicholson. 2026. BioSCape: L3 Fractional Cover and Uncertainty from AVIRIS-NG imagery, V1. ORNL DAAC, Oak Ridge, Tennessee, USA. https://doi.org/10.3334/ORNLDAAC/2538

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1. Dataset Overview

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The NASA AVIRIS-NG is a pushbroom spectral mapping system with high signal-to-noise ratio (SNR), designed and toleranced for high performance spectroscopy. AVIRIS-NG measures reflected radiance at 5-nm intervals in the Visible to Shortwave Infrared (VSWIR) spectral range from 380-2510 nm. The AVIRIS-NG sensor has a 1 milliradian instantaneous field of view, providing altitude dependent ground sampling distances from 20 m to sub meter range. The AVIRIS-NG was flown on a NASA Gulfstream III aircraft for the BioSCape project.

Project: Biodiversity Survey of the Cape (BioSCape)

The Biodiversity Survey of the Cape (BioSCape) is a research project that uses remote sensing and field data to understand the distribution, function, and importance of biodiversity on land and in the water around the Greater Cape Floristic Region (GCFR). Located in southwestern South Africa along the Atlantic coast, the GCFR is one of the world's 36 biodiversity hotspots. BioSCape is a collaboration between the US and South Africa. The team conducted an integrated field and airborne campaign in the hyperdiverse region in 2023. Researchers collected laser altimetry LiDAR data and UV/visible to short wavelength infrared (UVSWIR) and thermal imaging spectroscopy data over terrestrial and aquatic targets using four airborne instruments: AVIRIS-NG, PRISM, LVIS, and HyTES. This airborne dataset 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.

Related Publications:

Cardoso, A.W., E.L. Hestir, J.A. Slingsby, C.J. Forbes, G.R. Moncrieff, W. Turner, A.L. Skowno, J. Nesslage, P.G. Brodrick, K.D. Gaddis, and A.M. Wilson. 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.W., E.L. Hestir, J.A. Slingsby, C.J. Forbes, G.R. Moncrieff, W. Turner, A.L. Skowno, J. Nesslage, P.G. Brodrick, K.D. Gaddis, and A.M. 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:

Brodrick, P.G., A.M. Chlus, R. Eckert, J.W. Chapman, M. Eastwood, S. Geier, M. Helmlinger, S.R. Lundeen, W. Olson-Duvall, R. Pavlick, L.M. Rios, D.R. Thompson, and R.O. Green. 2025. BioSCape: AVIRIS-NG L3 Resampled Reflectance Mosaics, V2. ORNL Distributed Active Archive Center. https://doi.org/10.3334/ORNLDAAC/2427

Green, R.O., P.G. Brodrick, J.W. Chapman, M. Eastwood, S. Geier, M. Helmlinger, S.R. Lundeen, W. Olson-Duvall, R. Pavlick, L.M. Rios, D.R. Thompson, and A.K. Thorpe. 2023. AVIRIS-NG L2 Surface Reflectance, Facility Instrument Collection, V1. ORNL Distributed Active Archive Center. https://doi.org/10.3334/ORNLDAAC/2110

Green, R.O., P.G. Brodrick, J.W. Chapman, M. Eastwood, S. Geier, M. Helmlinger, S.R. Lundeen, W. Olson-Duvall, R. Pavlick, L.M. Rios, D.R. Thompson, and A.K. Thorpe. 2023. AVIRIS-NG L1B Calibrated Radiance, Facility Instrument Collection, V1. ORNL Distributed Active Archive Center. https://doi.org/10.3334/ORNLDAAC/2095

Green, R.O., P.G. Brodrick, J.W. Chapman, M. Eastwood, S. Geier, M. Helmlinger, S.R. Lundeen, W. Olson-Duvall, R. Pavlick, L.M. Rios, D.R. Thompson, and A.K. Thorpe. 2023. AVIRIS Facility Instruments: Flight Line Geospatial and Contextual Data. ORNL Distributed Active Archive Center. https://doi.org/10.3334/ORNLDAAC/2140

Acknowledgements:

The BioSCape Project is a multi-agency, NASA-led research project that integrates airborne imaging spectroscopy (AVIRIS NG) 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).

2. Data Characteristics

Spatial Coverage: Greater Cape Floristic Region (GCFR), South Africa

Spatial Resolution: 5 m

Temporal Coverage: 2023-10-22 to 2023-11-26

Temporal Resolution: Daily, weather permitting, during deployment

Site Boundaries: Latitude and longitude are given in decimal degrees.

Site	Westernmost Longitude	Easternmost Longitude	Northernmost Latitude	Southernmost Latitude
Greater Cape Floristic Region, South Africa	17.6241	26.3228	-31.1562	-35.0059

Data File Information

This dataset holds 6090 cloud-optimized GeoTIFFs (COGs) with fraction cover estimates and uncertainty for 870 tiles. The COGs hold orthorectified fractional cover estimates and uncertainty mapped in the Hartebeesthoek94 projected coordinate system (WGS-84 datum, EPSG 9221). The spatial resolution is 5 m.

The file naming convention is *AVIRIS-NG_BIOSCAPE_V01_L3_<tile>_<var>.tif*, where

- <*tile*> = grid cell of the tiling system (e.g., “10_12”)
- <*var*> = mapped variable listed in Table 1.

Example file names for one tile:

- *AVIRIS-NG_BIOSCAPE_V01_L3_10_12_NPV.tif*
- *AVIRIS-NG_BIOSCAPE_V01_L3_10_12_NPV_UNC.tif*
- *AVIRIS-NG_BIOSCAPE_V01_L3_10_12_PV.tif*
- *AVIRIS-NG_BIOSCAPE_V01_L3_10_12_PV_UNC.tif*
- *AVIRIS-NG_BIOSCAPE_V01_L3_10_12_BARE.tif*
- *AVIRIS-NG_BIOSCAPE_V01_L3_10_12_BARE_UNC.tif*

For each tile, there is a quicklook image in GeoTIFF format named *AVIRIS-NG_BIOSCAPE_V01_L3_<tile>_QL.tif* (e.g., *AVIRIS-NG_BIOSCAPE_V01_L3_10_12_QL.tif*)

In NASA Earthdata, these files are packaged as multi-file granules. Each granule contains all files for the tile and are named *AVIRIS-NG_BIOSCAPE_V01_L3_<tile>*

Table 1. Fractional cover variables in GeoTIFFs.

Estimate	Uncertainty	Description
NPV	NPV_UNC	Fractional cover of non-photosynthetic vegetation
PV	PV_UNC	Fractional cover of photosynthetic vegetation
BARE	BARE_UNC	Fractional cover of bare rock and bare soil

3. Application and Derivation

The terrestrial surface of the Earth is composed of a diverse array of materials with distinct spectral properties. Using imaging spectroscopy data, surface components can be classified into functional groups to support interpretation of spectral signals and downstream algorithms. The fractional cover product described here is a three component model categorizing surface materials into broad classes including non-photosynthetic vegetation, photosynthetic vegetation, and bare substrate. The fractional cover product is derived using a Monte Carlo Spectral Unmixing approach, which is described in detail in the EMIT L2B Fractional Cover ATBD (Brodrick et al., 2026). Areas affected by cloud cover or other image artifacts were identified and excluded using the procedures outlined in Section 4.

4. Quality Assessment

The AVIRIS-NG 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. Detector responsiveness is measured at the beginning of each deployment and mid-flight for particularly long deployments. 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).

Water: Water masking was performed using the ESA WorldCover landcover classification dataset. The WorldCover raster was reprojected to match the spatial alignment of the fractional cover product. Pixels corresponding to the ESA WorldCover permanent water bodies class (class 80) were masked by assigning a no-data value of -9999.

Clouds: All pixels were assessed for the presence of clouds. Cloud-covered pixels were manually identified and removed by visually referencing the fractional cover product and mosaic v02 RGB tiles (Brodrick et al., 2025a). Pixels initially identified as containing cloud cover were further evaluated

based on their acquisition dates to support accurate cloud identification and exclusion from the fractional cover product.

Cloud Shadows: All pixels were assessed for the presence of cloud shadows. Pixels affected by cloud shadows were manually identified and removed only when there was clear evidence that the shadow was associated with a visible cloud feature. Potential cloud shadow pixels were retained when the source cloud responsible for the shadow was not present within the mosaic, such as in areas where adjacent flightlines were stitched together and a shadow was visible without the corresponding cloud feature in the contributing imagery. This approach ensured that only confidently identified cloud shadow artifacts were excluded from the fractional cover product.

See additional information in the Known Issues portion of Section 5.

5. Data Acquisition, Materials, and Methods

South Africa's Greater Cape Floristic Region (GCFR) is a globally significant biodiversity hotspot facing climate-driven change, with strong links between water scarcity, fire, and human pressure. The BioSCape campaign studied biodiversity across land and water to understand its distribution, function, and change over time, combining field measurements with airborne remote sensing. In late 2023, it collected hyperspectral, thermal, and lidar data using instruments like AVIRIS-NG, PRISM, LVIS, and HyTES. AVIRIS-NG was deployed on a Gulfstream III aircraft and acquired imagery across the Northern, Western, and Eastern Cape provinces of South Africa (Figure 2).

AVIRIS-NG imagery was processed into calibrated reflectance products, and the data were subsequently mosaicked as detailed in Brodrick et al. (2025a). The resulting mosaics were used as inputs to an unmixing strategy implemented in Brodrick et al. (2025b) and described in Ochoa et al. (2025) to generate the 5-m fractional cover product presented here.

Known Issues

The fractional cover estimates are accompanied by model uncertainty metrics; however, comprehensive ground-based validation of the final product across the full range of environmental conditions represented in the study area is not available. In particular, separation of non-photosynthetic vegetation (NPV) and bare soil remains a well-known challenge in optical remote sensing due to the similarity of their spectral signatures, and some degree of confusion between these classes should be expected.

Water masking was performed using the ESA WorldCover land cover product. Because the spatial resolution and acquisition period of WorldCover differs from that of the fractional cover product, some water features may not be fully captured by the mask, particularly along shorelines, in narrow channels, and non-permanent water bodies. Additionally, cloud-contaminated areas were manually removed from the fractional cover mosaics; however, residual atmospheric effects, cloud shadows, haze, and other artifacts may still influence fractional cover estimates in localized areas.

Finally, fractional cover predictions are dependent on the spectral library and modeling framework used to relate surface reflectance to vegetation and soil fractions. While the spectral library is expected to be representative of conditions within the study area, model performance can vary across ecosystems, soil backgrounds, phenological states, and illumination conditions. As a result, uncertainty may increase in areas or conditions that are underrepresented within the source library.

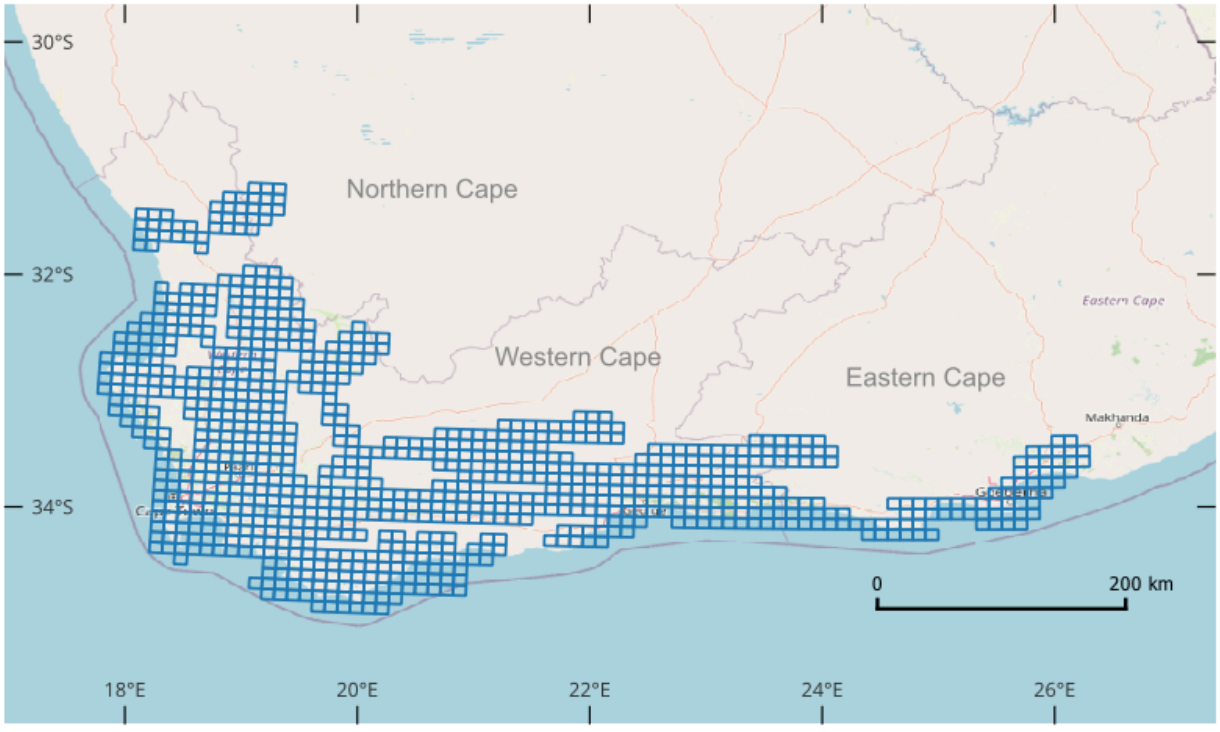


Figure 2. Location of fractional cover tiles (blue rectangles) across the Northern, Western, and Eastern Cape Provinces of South Africa.

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