



Perth, Australia · SkySat



SKYSAT IMAGERY PRODUCT SPECIFICATION

TABLE OF CONTENTS

| | |
|-------------------------|----------|
| COLLECTION TYPES | 4 |
| STANDARD IMAGE | 4 |
| STEREO PAIRS | 4 |
| VIDEO | 4 |
| PRODUCT TYPES | 5 |
| SCENES | 5 |
| Basic | 5 |
| Ortho | 6 |
| Scene Metadata | 11 |
| COLLECTS | 14 |
| Ortho | 14 |
| Basemap Mosaic Tiles | 15 |
| Video | 16 |

FIGURES

| | |
|--|---|
| Figure 1: A single “site,” or a standard SkySat image deliverable. | 4 |
|--|---|

TABLES

| | |
|---|----|
| Table 1: SkySat Basic Scene Product Attributes | 5 |
| Table 2: SkySat Ortho Scene Product Attributes | 7 |
| Table 3: SkySat Visual Ortho Scene Attributes | 8 |
| Table 4: SkySat Pansharpened Multispectral Scene Attributes | 8 |
| Table 5: SkySat Analytic Ortho Scene Attributes | 9 |
| Table 6: SkySat Analytic DN Ortho Scene Attributes | 10 |
| Table 7: SkySat Panchromatic Ortho Scene Attributes | 10 |
| Table 8: Skysat Basic Scene Geojson Metadata Schema | 11 |
| Table 9: Skysat Ortho Scene Geojson Metadata Schema | 12 |
| Table 10: Skysat Ortho Collect Attributes | 14 |
| Table 11: Individual Quad Specifications | 15 |
| Table 12: Video Product Metadata | 16 |
| Table 13: Frame Index (csv) | 17 |

© Planet 2018. All rights reserved.

This document is designed as a general guideline for customers interested in acquiring Planet imagery products and services. Planet takes an agile and iterative approach to its technology, and therefore may make changes to the product(s) described in this document.

+ COLLECTION TYPES

STANDARD IMAGE

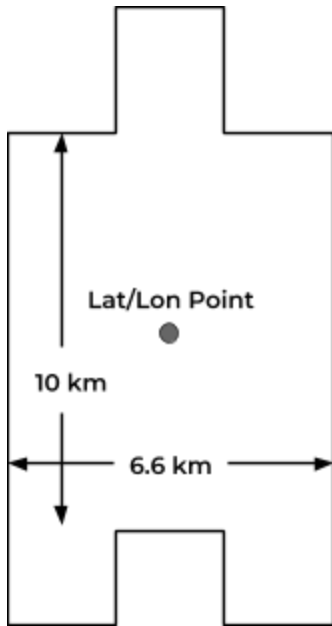


Figure 1: A single “site,” or a standard SkySat image deliverable. Image width varies with satellite and collection angle; 6.6 km represents the minimum width.

STEREO PAIRS

Stereo pairs are currently collected as two standard images, one from the north, the other from the south, with 20 to 40 degrees convergence angle between the two. Stereo products are delivered as two separate images through the Planet platform.

VIDEO

Full motion videos are collected between 30 and 120 seconds by a single camera from any of the active SkySats. Videos are collected using only the Panchromatic half of the camera, hence all videos are PAN only.

Videos are packaged and delivered with a video mpeg-4 file, plus all image frames with accompanying video metadata and a frame index file (reference Product Types below).

+

PRODUCT TYPES

SCENES

Basic

The SkySat Basic Scene product includes Analytic DN and Panchromatic imagery that is uncalibrated and in a raw digital number format. The Basic Scene Product is not radiometrically corrected for atmosphere or for any geometric distortions inherent in the imaging process.

Imagery data is accompanied by Rational Polynomial Coefficients (RPCs) to enable orthorectification by the user. This product is designed for users with advanced image processing capabilities and a desire to geometrically correct the product themselves.

The SkySat Basic Scene Product has a sensor-based framing, and is not mapped to a cartographic projection.

Table 1: SkySat Basic Scene Product Attributes

| SKYSAT BASIC SCENE PRODUCT ATTRIBUTES | |
|---------------------------------------|--|
| Product Attribute | Description |
| Product Components and Format | Image File – GeoTIFF format Metadata File – JSON format Rational Polynomial Coefficients – Text File UDM File – GeoTIFF format |
| Information Content | |
| Image Configurations | 4-band Analytic DN Image (Blue, Green, Red, NIR) 1-band Panchromatic DN Image (Pan) |
| Product Orientation | Spacecraft/Sensor Orientation |
| Product Framing | <div style="display: flex; align-items: center;"> <div style="flex: 1;"> <p>SkySat Satellites have three cameras per satellite, which capture overlapping strips. Each of these strips contain overlapping scenes.</p> </div> <div style="flex: 2;"> </div> </div> |

| | |
|-------------------------|--|
| | One scene is approximately 2560px x 1080px. |
| Sensor Type | CMOS Frame Camera with Panchromatic and Multispectral halves |
| Spectral Bands | Blue: 450 - 515 nm Green: 515 - 595 nm Red: 605 - 695 nm NIR: 740 - 900 nm Pan: 450 - 900 nm |
| Processing | Basic Scene |
| Product Bit Depth | 16-bit Unsigned Integer Multispectral and Panchromatic Imagery |
| Radiometric Corrections | Cross-Sensor Non Uniformity Correction (1%) Color Balancing across cameras |
| Geometric Corrections | Idealized sensor model and Rational Polynomial Coefficients (RPC) Bands are co-registered |
| Horizontal Datum | WGS84 |
| Map Projection | N/A |
| Resampling Kernel | Resampling of Analytic Multispectral Data to > 1.0m GSD |
| Ground Sample Distance | [SkySat-1, SkySat-2] Panchromatic: 0.86m Multispectral: 1.0m |
| | [SkySat-3 - SkySat-13] Panchromatic: 0.72m Multispectral: 1.0m |
| Geometric Accuracy | <50m RMSE |

Ortho

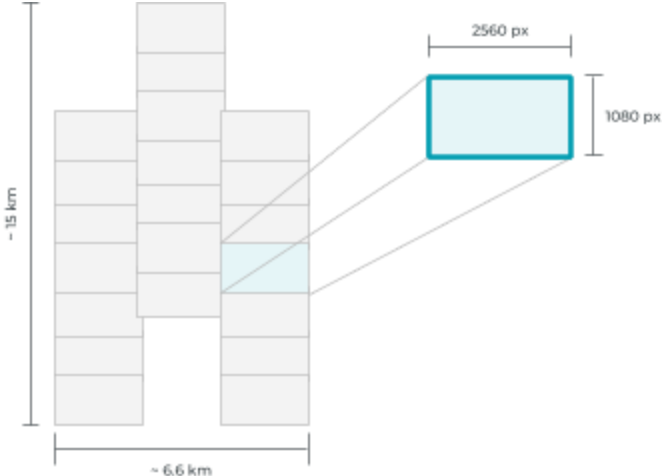
The SkySat Ortho Scene product includes Visual, Analytic DN, Analytic, Panchromatic, and Pansharpened Multispectral imagery. The Ortho Scene product is sensor- and geometrically-corrected, and is projected to a cartographic map projection. The geometric correction uses fine Digital Elevation Models (DEMs) with a post spacing of between 30 and 90 meters.

Ground Control Points (GCPs) are used in the creation of every image and the accuracy of the product will vary from region to region based on available GCPs.

- Visual - pansharpened, orthorectified, color corrected RGB
- Pansharpened Multispectral - pansharpened, orthorectified, color corrected BGRN
- Analytic - orthorectified, radiometrically corrected, multispectral BGRN
- Analytic DN - orthorectified, multispectral BGRN
- Panchromatic DN - orthorectified, panchromatic (PAN)

Table 2: SkySat Ortho Scene Product Attributes

SKYSAT ORTHO SCENE PRODUCT ATTRIBUTES

| Product Attribute | Description |
|-------------------------------|---|
| Product Components and Format | Image File – GeoTIFF format Metadata File – JSON format Rational Polynomial Coefficients – Text File UDM File – GeoTIFF format |
| Information Content | |
| Product Framing | <p>Scene Based:</p> <p>SkySat Satellites have three cameras per satellite, which capture overlapping strips. Each of these strips contain overlapping scenes. One scene is approximately 2560px x 1080px.</p>  |
| Sensor Type | CMOS Frame Camera with Panchromatic and Multispectral halves |
| Spectral Bands | Blue: 450 - 515 nm Green: 515 - 595 nm Red: 605 - 695 nm NIR: 740 - 900 nm Pan: 450 - 900 nm |
| Processing | |
| Radiometric Corrections | Digital Number and TOA Radiance |
| Geometric Corrections | Sensor-related effects are corrected using sensor telemetry and a sensor model. Orthorectification uses GCPs and fine DEMs (30 m to 90 m posting). |
| Horizontal Datum | WGS84 |
| Map Projection | UTM |
| Resampling Kernel | Cubic Convolution |
| Geometric Accuracy | <10 m RMSE |

Skysat Visual Ortho Scene

The SkySat Visual Ortho Scene product is orthorectified, pansharpended, and color-corrected (using a color curve) 3-band RGB Imagery.

Table 3: SkySat Visual Ortho Scene Attributes

| SKYSAT VISUAL ORTHO SCENE ATTRIBUTES | |
|--------------------------------------|--|
| Product Attribute | Description |
| Visual Bands | Visual: 3-band Pansharpended Image (PS Red, PS Green, PS Blue) |
| Ground Sample Distance | Multispectral: 1.0 m |
| | Panchromatic: 0.72 m |
| Processing | |
| Pixel Size (Orthorectified) | 0.8 m ¹ |
| Bit Depth | 8-bit Unsigned Integer |
| Geometric Corrections | Sensor-related effects are corrected using sensor telemetry and a sensor model. Orthorectification uses GCPs and fine DEMs (30m to 90m posting). |
| Positional Accuracy | Less than 10 m RMSE |
| Color Enhancements | Enhanced for visual use |

SKYSAT PANSHARPENED MULTISPECTRAL ORTHO SCENE

The SkySat Pansharpended Multispectral Scene product is orthorectified, pansharpended, and color-corrected (using a color curve) 4-band BGRN Imagery.

Table 4: SkySat Pansharpended Multispectral Scene Attributes

| SKYSAT PANSHARPENED MULTISPECTRAL SCENE ATTRIBUTES | |
|--|---|
| Product Attribute | Description |
| Visual Bands | Multispectral: 4-band Pansharpended Image (PS Blue, PS Green, PS Red, PS NIR) |
| Ground Sample Distance | Multispectral: 1.0 m |
| | Panchromatic: 0.72 m |

¹ Subject to change

Processing

| | |
|-----------------------------|--|
| Pixel Size (Orthorectified) | 0.8 m ² |
| Bit Depth | 16-bit Unsigned Integer |
| Geometric Corrections | Sensor-related effects are corrected using sensor telemetry and a sensor model. Orthorectification uses GCPs and fine DEMs (30m to 90m posting). |
| Positional Accuracy | Less than 10 m RMSE |
| Color Enhancements | Enhanced for visual use |

Skysat Analytic Ortho Scene - Top Of Atmosphere Radiance

Analytic products are calibrated multispectral imagery products that have been processed to allow analysts to derive information products for data science and analytics. The imagery has radiometric corrections applied to correct for any sensor artifacts and transformation to top-of-atmosphere radiance.

Table 5: SkySat Analytic Ortho Scene Attributes

SKYSAT ANALYTIC ORTHO SCENE ATTRIBUTES

| Product Attribute | Description |
|-------------------------|---|
| Analytic Bands | 4-band Analytic Image (B, G, R, N) |
| Pixel Size | 1.0 m |
| Image Bit Depth | 16-bit Unsigned Integer |
| Projection | UTM WGS84 |
| Resampling Kernel | Cubic Convolution |
| Size | Approximately 2560x1080 px |
| Radiometric Corrections | <ul style="list-style-type: none"> Absolute Radiance derived using vicarious calibration methods Product is radiometrically calibrated to radiance units $[W/(\mu m * m^2 * str)]$, and scaled by 100 to reduce quantization errors Calibration regularly monitored and updated with on-orbit calibration techniques. |

² Subject to change

Skysat Analytic Dn Ortho Scene

The SkySat Analytic DN Ortho Scene product is orthorectified, multispectral data from the SkySat constellation. The Analytic DN product is an uncalibrated, digital number imagery product. This product is designed for a wide variety of applications that require imagery with an accurate geolocation and cartographic projection. The product has been processed to remove distortions caused by terrain. It eliminates the perspective effect on the ground (not on buildings), restoring the geometry of a vertical shot. In addition to orthorectification, the imagery has radiometric corrections applied to correct for any sensor artifacts. The initial availability does not include transformation to at-sensor radiance.

Table 6: SkySat Analytic DN Ortho Scene Attributes

| SKYSAT ANALYTIC DN ORTHO SCENE ATTRIBUTES | |
|---|--|
| Product Attribute | Description |
| Analytic Bands | 4-band Analytic DN Image (B, G, R, N) |
| Ground Sample Distance | 1.0 m |
| Processing | |
| Pixel Size (Orthorectified) | 1.0 m |
| Bit Depth | 16-bit Unsigned Integer |
| Geometric Corrections | Sensor-related effects are corrected using sensor telemetry and a sensor model. Orthorectification uses GCPs and fine DEMs (30m to 90m posting). |
| Positional Accuracy | Less than 10 m RMSE |
| Radiometric Calibration Accuracy | Initial availability: No correction applied; pixel values are digital numbers |

Skysat Panchromatic Dn Ortho Scene

The SkySat Panchromatic Ortho Scene product is orthorectified, panchromatic data from the SkySat constellation. The Panchromatic DN product is an uncalibrated, digital number imagery product. The Panchromatic product has a finer GSD than the Analytic Product due to NOAA license restrictions, and is useful for visual interpretation as well as pan-sharpening of coarser resolution Multispectral data. The initial availability does not include transformation to at-sensor radiance.

Table 7: SkySat Panchromatic Ortho Scene Attributes

| SKYSAT PANCHROMATIC ORTHO SCENE ATTRIBUTES | |
|--|---------------------------|
| Product Attribute | Description |
| Analytic Bands | 1-band Panchromatic Image |
| Ground Sample Distance | 0.72 m |

Processing

| | |
|----------------------------------|--|
| Pixel Size (Orthorectified) | 0.8 m |
| Bit Depth | 16-bit Unsigned Integer |
| Geometric Corrections | Sensor-related effects are corrected using sensor telemetry and a sensor model. Orthorectification uses GCPs and fine DEMs (30m to 90m posting). |
| Positional Accuracy | Less than 10 m RMSE |
| Radiometric Calibration Accuracy | Initial availability: No correction applied: pixel values are digital numbers |

Scene Metadata

Basic Scene GeoJSON metadata

Table 8: Skysat Basic Scene Geojson Metadata Schema

SKYSAT BASIC SCENE GEOJSON METADATA SCHEMA

| Parameter | Description | Type |
|------------------|--|--|
| acquired | The RFC 3339 acquisition time of the image. | string |
| camera_id | The specific detector used to capture the scene. | String (e.g. "d1", "d2") |
| cloud_cover | The estimated percentage of the image covered by clouds. | number (0-100) |
| ground_control | If the image meets the positional accuracy specifications this value will be true. If the image has uncertain positional accuracy, this value will be false. | boolean |
| gsd | The ground sampling distance of the image acquisition. | number |
| item_type | The name of the item type that models shared imagery data schema. | string (e.g. "PSScene3Band", "SkySatScene") |
| provider | Name of the imagery provider. | string ("planetscope", "rapideye", "skysat") |
| published | The RFC 3339 timestamp at which this item was added to the API. | string |
| quality_category | Metric for image quality. To qualify for "standard" image quality an image must meet the following criteria: sun altitude greater than or equal to 10 degrees, off nadir | string ("standard", "test") |

| | | |
|-------------------|--|--------------------|
| | view angle less than 20 degrees, and saturated pixels fewer than 20%. If the image does not meet these criteria it is considered "test" quality. | |
| satellite_azimuth | Angle from true north to the satellite vector at the time of imaging, projected on the horizontal plane in degrees. | number (0 - 360) |
| satellite_id | Globally unique identifier of the satellite that acquired the underlying imagery. | string |
| strip_id | Globally unique identifier of the image strip this scene was collected against | string |
| sun_azimuth | Angle from true north to the sun vector projected on the horizontal plane in degrees. | number (0 - 360) |
| sun_elevation | Elevation angle of the sun in degrees. | number (0 - 90) |
| updated | The RFC 3339 timestamp at which this item was updated in the API. | string |
| view_angle | Spacecraft across-track off-nadir viewing angle used for imaging, in degrees with + being east and - being west. | number (-25 - +25) |

Ortho Scene GeoJSON metadata

Table 9: Skysat Ortho Scene Geojson Metadata Schema

SKYSAT ORTHO SCENE GEOJSON METADATA SCHEMA

| Parameter | Description | Type |
|----------------|--|--------------------------|
| acquired | The RFC 3339 acquisition time of the image. | string |
| camera_id | The specific detector used to capture the scene. | String (e.g. "d1", "d2") |
| cloud_cover | The estimated percentage of the image covered by clouds. | number (0-100) |
| ground_control | If the image meets the positional accuracy specifications this value will be true. If the image has uncertain positional accuracy, this value will be false. | boolean |
| gsd | The ground sampling distance of the image acquisition. | number |

| | | |
|-------------------|---|--|
| item_type | The name of the item type that models shared imagery data schema. | string (e.g. "PSScene3Band", "SkySatScene") |
| provider | Name of the imagery provider. | string ("planetscope", "rapideye", "skysat") |
| published | The RFC 3339 timestamp at which this item was added to the API. | string |
| quality_category | Metric for image quality. To qualify for "standard" image quality an image must meet the following criteria: sun altitude greater than or equal to 10 degrees, off nadir view angle less than 20 degrees, and saturated pixels fewer than 20%. If the image does not meet these criteria it is considered "test" quality. | string ("standard", "test") |
| satellite_azimuth | Angle from true north to the satellite vector at the time of imaging, projected on the horizontal plane in degrees. | number (0 - 360) |
| satellite_id | Globally unique identifier of the satellite that acquired the underlying imagery. | string |
| strip_id | Globally unique identifier of the image strip this scene was collected against | string |
| sun_azimuth | Angle from true north to the sun vector projected on the horizontal plane in degrees. | number (0 - 360) |
| sun_elevation | Elevation angle of the sun in degrees. | number (0 - 90) |
| updated | The RFC 3339 timestamp at which this item was updated in the API. | string |
| view_angle | Spacecraft across-track off-nadir viewing angle used for imaging, in degrees with + being east and - being west. | number (-25 - +25) |

COLLECTS

Ortho

The SkySat Basic Scene product includes Analytic DN and Panchromatic imagery that is uncalibrated and in a raw digital number format. The Basic Scene Product is not radiometrically corrected for atmosphere or for any geometric distortions inherent in the imaging process.

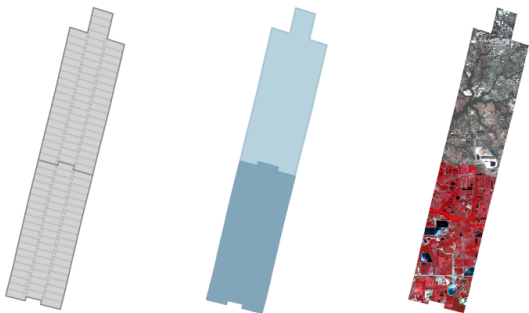
Imagery data is accompanied by Rational Polynomial Coefficients (RPCs) to enable orthorectification by the user. This product is designed for users with advanced image processing capabilities and a desire to geometrically correct the product themselves.

The Ortho Collect product is created by composing SkySat Ortho Scenes along an imaging strip into segments typically unifying ~60 SkySat Ortho Scenes. The product may contain artifacts resulting from the composing process, particular offsets in areas of stitched source scenes. In a next version artifacts caused by scene misalignment will be hidden by cutlines. This is particularly important for the appearance of objects in built-up areas and their accurate extraction.

- Visual - pansharpened, orthorectified, color corrected RGB
- Pansharpened Multispectral - pansharpened, orthorectified, color corrected BGRN
- Analytic DN - orthorectified, multispectral BGRN
- Panchromatic DN - orthorectified, panchromatic (PAN)

*Attributes match those of the Scene counterparts listed above

Table 10: Skysat Ortho Collect Attributes

| SKYSAT ORTHO COLLECT ATTRIBUTES | |
|---------------------------------|--|
| Attribute | Description |
| Product Framing | Strip Based |
| |  <p>SkySat Satellites have three cameras per satellite, which capture overlapping strips. Each of these strips contain overlapping scenes. One Collect product composes up to 60 scenes (up to 20 per camera) and is approximately 20km x 6.6km.</p> |
| Assets | Visual: 3-band Pansharpened Image (8-bit Unsigned Integer) Multispectral: 4-band Pansharpened Image (16-bit Unsigned Integer) 4-band Analytic DN Image (B, G, R, N) (16-bit Unsigned Integer) 1-band Panchromatic Image (16-bit Unsigned Integer) |

| | |
|-------------------------|--|
| Projection | UTM WGS84 |
| Geometric Corrections | Sensor-related effects are corrected using sensor telemetry and a sensor model. Orthorectification uses GCPs and fine DEMs (30m to 90m posting). |
| Positional Accuracy | Less than 10 m RMSE |
| Radiometric Corrections | No correction applied; pixel values are digital numbers |

Basemap Mosaic Tiles

Table 11: Individual Quad Specifications

| INDIVIDUAL QUAD SPECIFICATIONS | |
|--------------------------------|--|
| Attribute | Description |
| Sensors | SkySat |
| Pixel Size (resolution) | .597m |
| Image Bit Depth | 8 bits per pixel |
| Bands | Red, Green, Blue, Alpha |
| Projection | WGS84 Web Mercator (EPSG:3857) |
| Size | 4096 x 4096 pixels |
| Processing | Pansharpened. Geometrically aligned. Seam lines are minimized with tonal balancing. Cutlines to minimize visual breaks |

The projection used in Planet basemaps has been selected to match what is typically used in web mapping applications. All basemaps can be viewed at full resolution within the Planet graphical user interface (up to Zoom Level 18 in the Web Mercator Projection), giving a resolution of 0.597 m at the Equator. The resolution improves at higher and lower latitudes. The Alpha Mask indicates areas of the quad where there is no imagery data available.

Video

Table 12: Video Product Metadata

| VIDEO PRODUCT METADATA | | |
|------------------------|--|---------------------|
| Field | Value | Sample |
| Satellite | Satellite ID | 00110 |
| Camera | Camera used for imaging | 2 |
| Time | | |
| Start | Start time of video capture | 2018-04-10T21:43:07 |
| End | End time of video capture | 2018-04-10T21:44:07 |
| Duration (s) | Duration of video in seconds | 59.976592063903809 |
| Angle | | |
| Start | Satellite collection elevation of first frame in video | 55.476973516035933 |
| End | Satellite collection elevation of last frame in video | 61.410026752389307 |
| Convergence | Convergence angle between first and last frames | 5.9330532363533734 |
| Azimuth | | |
| Start | Satellite azimuth angle of first frame in video | 48.316762122631033 |
| End | Satellite azimuth angle of last frame in video | 143.12580513942621 |
| Delta | Difference between start and end satellite azimuth angle | 94.809043016795172 |

Table 13: Frame Index (csv)

| FRAME INDEX (CSV) | | |
|-------------------|--|---|
| Field | Value | Sample |
| name | Frame image filename(w/o file extension) | 1207431805.69566202_sc00110_c2_PAN |
| datetime | Time of frame capture | 2018-04-10T21:43:07Z |
| gsd | Ground Sample Distance | 0.964506 |
| sat_az | Avg satellite azimuth for frame | 48.3168 |
| sat_elev | Avg satellite elevation for frame | 55.477 |
| x_sat_eci | X-axis aligned ECI coordinate | 3074.73 |
| y_sat_eci | Y-axis aligned ECI coordinate | 3057.87 |
| z_sat_eci | Z-axis aligned ECI coordinate | 5338.56 |
| q0 | First quaternion coefficient | -0.246954 |
| q1 | Second quaternion coefficient | -0.887421 |
| q2 | Third quaternion coefficient | -0.385464 |
| q3 | Fourth quaternion coefficient | 0.0539912 |
| bit_depth | Pixel bit depth of frame | 16 |
| geom | Frame dimensions | POLYGON((-123.132 49.2933,-123.089 49.294,-123.092 49.2825,-123.135 49.2818)) |