



Santa Marta



PLANET IMAGERY PRODUCT SPECIFICATIONS

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GLOSSARY

The following list defines terms used to describe Planet's satellite imagery products.

Alpha Mask

An alpha mask is an image channel with binary values that can be used to render areas of the image product transparent where no data is available.

Application Programming Interface (API)

A set of routines, protocols, and tools for building software applications.

Atmospheric Correction

The process of correcting at-sensor radiance imagery to account for effects related to the intervening atmosphere between the earth's surface and the satellite. Atmospheric correction has been shown to significantly improve the accuracy of image classification.

Blackfill

Non-imaged pixels or pixels outside of the buffered area of interest that are set to black. They may appear as pixels with a value of "0" or as "noData" depending on the viewing software.

Digital Elevation Model (DEM)

The representation of continuous elevation values over a topographic surface by a regular array of z-values, referenced to a common datum. DEMs are typically used to represent terrain relief.

GeoJSON

A standard for encoding geospatial data using JSON (see JSON below).

GeoTIFF

An image format with geospatial metadata suitable for use in a GIS or other remote sensing software.

Ground Sample Distance (GSD)

The distance between pixel centers, as measured on the ground. It is mathematically calculated based on optical characteristics of the telescope, the altitude of the satellite, and the size and shape of the CCD sensor.

Graphical User Interface (GUI)

The web-based graphical user interfaces allows users to browse, preview and download Planet's imagery products.

International Space Station (ISS) Orbit

International Space Station (ISS) orbits at a 51.6° inclination at approximately 400 km altitude. Planet deploys satellites from the ISS, each having a similar orbit.

JavaScript Object Notation (JSON)

Text-based data interchange format used by the Planet API.

Landsat 8

Freely available dataset offered through NASA and the United States Geological Survey.

Metadata

Data delivered with Planet's imagery products that describes the products content and context and can be used to conduct analysis or further processing.

Nadir

The point on the ground directly below the satellite.

Near-Infrared (NIR)

Near Infrared is a region of the electromagnetic spectrum.

Orthorectification

The process of removing and correcting geometric image distortions introduced by satellite collection geometry, pointing error, and terrain variability.

Ortho Tile

Ortho Tiles are Planet's core product lines of high-resolution satellite images. Ortho tiles are available in two different product formats: Visual and Analytic, each offered in GeoTIFF format.

PlanetScope

The first three generations of Planet's optical systems are referred to as PlanetScope 0, PlanetScope 1, and PlanetScope 2.

Radiometric Correction

The correction of variations in data that are not caused by the object or image being scanned. These include correction for relative radiometric response between detectors, filling non-responsive detectors and scanner inconsistencies.

Reflectance Coefficient

The reflectance coefficient provided in the metadata is used as a multiplicative to convert Analytic TOA Radiance values to TOA Reflectance.

RapidEye

RapidEye refers to the five-satellite constellation in operation since 2009.

Scene

A single image captured by a PlanetScope satellite.

Sensor Correction

The correction of variations in the data that are caused by sensor geometry, attitude and ephemeris.

Sentinel-2

Copernicus Sentinel-2 is a multispectral imaging satellite constellation operated by the European Space Agency.

SkySat

SkySat refers to the 15-satellite constellation in operation since 2014.

Sun Azimuth

The angle of the sun as seen by an observer located at the target point, as measured in a clockwise direction from the North.

Sun Elevation

The angle of the sun above the horizon.

Sun Synchronous Orbit (SSO)

A geocentric orbit that combines altitude and inclination in such a way that the satellite passes over any given point of the planet's surface at the same local solar time.

Surface Reflectance (SR)

Surface reflectance is the amount of light reflected by the surface of the earth. It is a ratio of surface radiance to surface irradiance, and as such is unitless, and typically has values between 0 and 1. The Surface Reflectance (SR) Product is derived from the standard Planet Analytic (Radiance) Product and is processed to top of atmosphere reflectance and then atmospherically corrected to (bottom of atmosphere or) surface reflectance. Planet uses the 6S radiative transfer model with ancillary data from MODIS to account for atmospheric effects on the observed signal at the sensor for the PlanetScope constellation.

Tile Grid System

Ortho tiles are based on a worldwide, fixed UTM grid system. The grid is defined in 24 km by 24 km tile centers, with 1 km of overlap (each tile has an additional 500 m overlap with adjacent tiles), resulting in 25 km by 25 km tiles.

Unusable Data Mask

The unusable data mask is a raster image having the same dimensions as the image product, indicating on a pixel-by-pixel basis, which pixels are unusable because they are cloud filled, outside of the observed area and therefore blackfilled, or the pixel value is missing or suspect (due to saturation, blooming, hot pixels, dust, sensor damage, etc). The unusable data mask is an 8-bit image, where each pixel contains a bit pattern indicating conditions applying to the imagery pixel. A value of zero indicates a "good" imagery pixel.

- Bit 0: Black fill - Identifies whether the area contains blackfill in all bands (this area was not imaged by the spacecraft). A value of "1" indicates blackfill.
- Bit 1: Cloud - This pixel is assessed to likely be an opaque cloud.
- Bit 2: Blue is missing or suspect.
- Bit 3: Green is missing or suspect.
- Bit 4: Red is missing or suspect.
- Bit 5: Red Edge is missing or suspect (RapidEye only).
- Bit 6: NIR is missing or suspect
- Bit 7: Unused

Usable Data Mask

The usable data mask is a raster image having the same dimensions as the image product, comprised of 8 bands, where each band represents a specific usability class mask. The usability masks are mutually exclusive, and a value of one indicates that the pixel is assigned to that usability class.

- Band 1: clear mask (a value of “1” indicates the pixel is clear, a value of “0” indicates that the pixel is not clear and is one of the 5 remaining classes below)
- Band 2: snow mask
- Band 3: shadow mask
- Band 4: light haze mask
- Band 5: heavy haze mask
- Band 6: cloud mask
- Band 7: confidence map (a value of “0” indicates a low confidence in the assigned classification, a value of “100” indicates a high confidence in the assigned classification)
- Band 8: unusable data mask (see [Unusable Data Mask](#) above)



1. OVERVIEW OF DOCUMENT

This document describes Planet satellite imagery products. It is intended for users of satellite imagery interested in working with Planet's product offerings.

1.1. COMPANY OVERVIEW

Planet uses an agile aerospace approach for the design of its satellites, mission control and operations systems; and the development of its web-based platform for imagery processing and delivery. Planet employs an "always on" image-capturing method as opposed to the traditional tasking model used by most satellite companies today.

1.2 DATA PRODUCT OVERVIEW

Planet operates the PlanetScope (PS), RapidEye (RE) and SkySat (SS) Earth-imaging constellations. Imagery is collected and processed in a variety of formats to serve different use cases, be it mapping, deep learning, disaster response, precision agriculture, or simple temporal image analytics to create rich information products.

PlanetScope satellite imagery is captured as a continuous strip of single frame images known as "scenes." Scenes may be acquired as a single RGB (red, green, blue) frame or a split-frame with a RGB half and a NIR (near-infrared) half depending on the capability of the satellite.

Planet offers three product lines for PlanetScope imagery: a Basic Scene product, an Ortho Scene product, and an Ortho Tile product. The Basic Scene product is a scaled Top of Atmosphere Radiance (at sensor) and sensor-corrected product. The Basic Scene product is designed for users with advanced image processing and geometric correction capabilities. The product is not orthorectified or corrected for terrain distortions. Ortho Scenes represent the single-frame image captures as acquired by a PlanetScope satellite with additional post processing applied. Ortho Tiles are multiple orthorectified scenes in a single strip that have been merged and then divided according to a defined grid.

SkySat imagery is captured similar to PlanetScope in a continuous strip of single frame images known as "scenes", which are all acquired in the blue, green, red, nir-infrared, and panchromatic bands. SkySat data is available in four product lines: the Basic Scene, Ortho Scene, Basemap, and SkySat Collect products.



2. SATELLITE CONSTELLATION AND SENSOR OVERVIEW

2.1 PLANETSCOPE SATELLITE CONSTELLATION AND SENSOR CHARACTERISTICS

The PlanetScope satellite constellation consists of multiple launches of groups of individual satellites. Therefore, on-orbit capacity is constantly improving in capability or quantity, with technology improvements deployed at a rapid pace.

Each PlanetScope satellite is a CubeSat 3U form factor (10 cm by 10 cm by 30 cm). The complete PlanetScope constellation of approximately 130 satellites is able to image the entire land surface of the Earth every day (equating to a daily collection capacity of 200 million km²/day).

All PlanetScope satellites launched starting in November 2018 have new sensor characteristics that enable improved spectral resolution. The new PlanetScope sensor plane consists of four separate stripes organized vertically along the track of the flight path.

Composite images with the new PlanetScope sensor plane, both 3-band and 4-band, are produced by an image registration process involving up to four frames ahead and four frames behind an anchor frame. The band alignment is dependent on ground-lock in the anchor frame and will vary with scene content. For example, publication yield is expected to be lower in scenes over open water, mountainous terrain, or cloudy areas.

The band alignment threshold is based on across-track registration residual, currently set to 0.4 pixels for "standard" PlanetScope products (PS2.SD), 0.66 to qualify for "test."

Table 1-A: PlanetScope Constellation and Sensor Specifications

| CONSTELLATION OVERVIEW: PLANETSCOPE | | |
|-------------------------------------|----------------------------------------------------------|---------------------------------------------------------------------------------------------|
| Mission Characteristics | Sun-synchronous Orbit | |
| Instrument | PS2 | PS2.SD |
| Orbit Altitude (reference) | 475 km (~98° inclination) | |
| Max/Min Latitude Coverage | ±81.5° (depending on season) | |
| Equator Crossing Time | 9:30 - 11:30 am (local solar time) | |
| Sensor Type | Four-band frame Imager with a split-frame VIS+NIR filter | Four-band frame imager with butcher-block filter providing blue, red, NIR and green stripes |
| Spectral Bands | Blue: 455 - 515 nm | Blue: 464 - 517 nm |

| | | |
|--------------------------------|---------------------------------------------------------------|---------------------------------------------------------------|
| | Green: 500 - 590 nm Red: 590 - 670 nm NIR: 780 - 860 nm | Green: 547 - 585 nm Red: 650 - 682 nm NIR: 846 - 888 nm |
| Ground Sample Distance (nadir) | 3.7 m (approximate) | |
| Frame Size | 24 km x 8 km (approximate) | 24 km x 16km (approximate) |
| Maximum Image Strip per orbit | 20,000 km ² | |
| Revisit Time | Daily at nadir | |
| Image Capture Capacity | 200 million km ² /day | |
| Camera Dynamic Range | 12-bit | |

2.2 RAPIDEYE SATELLITE CONSTELLATION AND SENSOR CHARACTERISTICS

The RapidEye satellite constellation consists of five satellites collectively able to collect over 6 million square kilometers of data per day at 6.5 meter GSD (at nadir). Each satellite measures less than one cubic meter and weighs 150 kg (bus + payload). All five satellites are equipped with identical sensors and are located in the same orbital plane.

Table 1-B: RapidEye Constellation and Sensor Specifications

| CONSTELLATION OVERVIEW: RAPIDEYE | |
|----------------------------------|---------------------------------------------------------------------------------------------------------------|
| Mission Characteristics | Information |
| Number of Satellites | 5 |
| Orbit Altitude | 630 km in Sun-Synchronous Orbit |
| Equator Crossing Time | 11:00 am local time (approximately) |
| Sensor Type | Multispectral push broom |
| Spectral Bands | Blue: 440 - 510 nm Green: 520 - 590 nm Red: 630 - 685 nm Red Edge: 690 - 730 nm NIR: 760 - 850 nm |
| Ground Sampling Distance (nadir) | 6.5 m |
| Swath Width | 77 km |

| | |
|-------------------------------|-----------------------------------------|
| Maximum Image Strip per orbit | Up to 1500 km of image data per orbit |
| Revisit Time | Daily (off-nadir) / 5.5 days (at nadir) |
| Image Capture Capacity | > 6 million km ² /day |
| Camera Dynamic Range | 12-bit |

2.3 SKYSAT SATELLITE CONSTELLATION AND SENSOR CHARACTERISTICS

The SkySat-C generation satellite is a high-resolution Earth imaging satellite, first launched in 2016. Fourteen are currently in orbit, all collecting thousands of sq km of imagery. Each satellite is 3-axis stabilized and agile enough to slew between different targets of interest. Each satellite has four thrusters for orbital control, along with four reaction wheels and three magnetic torquers for attitude control.

All SkySats contain Cassegrain telescopes with a focal length of 3.6m, with three 5.5 megapixel CMOS imaging detectors making up the focal plane.

Table 1-C: SkySat Constellation Overview

| CONSTELLATION OVERVIEW: SKYSAT | |
|--------------------------------|---------------------------------------------------------------------------------------------------------------------------------------|
| Attribute | Value |
| Mass | 110 kg |
| Dimensions | 60 x 60 x 95 cm |
| Total DeltaV | 180 m/s |
| Onboard Storage | 360 GB + 360 GB cold spare storage |
| RF Communication | X-band downlink (payload): variable, up to 580 Mbit/s X-band downlink (telemetry): 64 Kbit/s S-band uplink (command): 32 Kbit/s |
| Design Life | ~6 years |

Table 1-D: SkySat Pointing

| SKYSAT POINTING | |
|---------------------------|--------------------------------------------------------------------------------------------------------------|
| Attribute | Value |
| Geolocation Knowledge | 30 m CE90 in a 500 km altitude orbit |
| Ground Sample Distance | [SkySat-1, SkySat-2] Panchromatic: 0.86m Multispectral: 1.0m |
| | [SkySat-3 - SkySat-14] Panchromatic: 0.72m Multispectral: 1.0m 2.3 targets (6.6 x 10 km) per minute |
| Revisit (per satellite) | 4 - 5 days *Reference altitude 500 km |
| Equatorial Crossing (UTC) | 10:30 - SkySat-3 - 6, 14 - 16 13:00 - SkySat-1 and SkySat-2 13:00 - SkySat-8 - 13 |

Table 1-E: SkySat Sensor Specifications

| SKYSAT SENSOR SPECIFICATIONS | |
|------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Product Attribute | Description |
| Image Configurations | Multispectral Sensor (Blue, Green, Red, NIR) |
| | Panchromatic Sensor |
| Product Framing | SkySat Satellites have three cameras per satellite, which capture overlapping strips. Each of these strips contain overlapping scenes. One scene is approximately 2560 x 1080 pixels |
| 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 |



3. PLANETSCOPE IMAGERY PRODUCTS

PlanetScope imagery products are available as either individual Basic Scenes, Ortho Scenes, or Ortho Tile products.

Table 2-A: PlanetScope Satellite Image Product Processing Levels

| PLANETSCOPE SATELLITE IMAGE PRODUCT PROCESSING LEVELS | | |
|-------------------------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------------|
| Name | Description | Product Level |
| PlanetScope Basic Scene Product | Scaled Top of Atmosphere Radiance (at sensor) and sensor corrected product. The Basic Scene product is designed for users with advanced image processing and geometric correction capabilities. This product has scene based framing and is not projected to a cartographic projection. Radiometric and sensor corrections applied to the data. | Level 1B |
| PlanetScope Ortho Scene Product | Orthorectified, scaled Top of Atmosphere Radiance (at sensor) or Surface Reflectance image product suitable for analytic and visual applications. This product has scene based framing and projected to a cartographic projection. | Level 3B |
| PlanetScope Ortho Tile Product | Radiometric and sensor corrections applied to the data. Imagery is orthorectified and projected to a UTM projection. | Level 3A |

The name of each acquired PlanetScope image is designed to be unique and allow for easier recognition and sorting of the imagery. It includes the date and time of capture, as well as the id of the satellite that captured it. The name of each downloaded image product is composed of the following elements:

`<acquisition date>_<acquisition time>_<satellite_id>_<productLevel><bandProduct>.<extension>`

3.1 RADIOMETRIC INTERPRETATION

Analytic products are scaled to Top of Atmosphere Radiance. Validation of radiometric accuracy of the on-orbit calibration has been measured at 5% using vicarious collects in the Railroad Valley calibration site.

All PlanetScope satellite images are collected at a bit depth of 12 bits and stored on-board the satellites with a bit depth of up to 12 bits. Radiometric corrections are applied during ground processing and all images are scaled to a 16-bit dynamic range. This scaling converts the (relative) pixel DNs coming directly from the sensor into values directly related to absolute at-sensor radiances. The scaling factor is applied to minimize quantization error and the resultant single DN values correspond to 1/100th of a $W/(m^2 \cdot sr \cdot \mu m)$. The DNs of the PlanetScope image pixels represent the absolute calibrated radiance values for the image.

Converting to Radiance and Top of Atmosphere Reflectance

To convert the pixel values of the Analytic products to radiance, it is necessary to multiply the DN value by the radiometric scale factor, as follows:

$RAD(i) = DN(i) * radiometricScaleFactor(i)$, where $radiometricScaleFactor(i) = 0.01$

The resulting value is the at sensor radiance of that pixel in watts per steradian per square meter ($W/m^2 \cdot sr \cdot \mu m$).

To convert the pixel values of the Analytic products to Top of Atmosphere Reflectance, it is necessary to multiply the DN value by the reflectance coefficient found in the XML file. This makes the complete conversion from DN to Top of Atmosphere Reflectance to be as follows:

$REF(i) = DN(i) * reflectanceCoefficient(i)$

Atmospheric Correction

Surface reflectance is determined from top of atmosphere (TOA) reflectance, calculated using coefficients supplied with the Planet Radiance product.

The Planet Surface Reflectance product corrects for the effects of the Earth's atmosphere, accounting for the molecular composition and variation with altitude along with aerosol content. Combining the use of standard atmospheric models with the use of MODIS water vapor, ozone and aerosol data, this provides reliable and consistent surface reflectance scenes over Planet's varied constellation of satellites as part of our normal, on-demand data pipeline. However, there are some limitations to the corrections performed:

- In some instances there is no MODIS data overlapping a Planet scene or the area nearby. In those cases, AOD is set to a value of 0.226 which corresponds to a "clear sky" visibility of 23km, the `aot_quality` is set to the MODIS "no data" value of 127, and `aot_status` is set to 'Missing Data - Using Default AOT'. If there is no overlapping water vapor or ozone data, the correction falls back to a predefined 6SV internal model.
- The effects of haze and thin cirrus clouds are not corrected for.
- Aerosol type is limited to a single, global model.
- All scenes are assumed to be at sea level and the surfaces are assumed to exhibit Lambertian scattering - no BRDF effects are accounted for.
- Stray light and adjacency effects are not corrected for.

3.1.1 PLANETSCOPE HARMONIZATION

An xml file will accompany PlanetScope image products (instrument = PS2.SD), with coefficients to transform the Next-Generation PlanetScope sensor radiance values to match those of the previous PlanetScope satellites (instrument = PS2).

Convert the new PlanetScope DN values to Top of Atmosphere Radiance using the reflectanceCoefficients in the xml metadata. All bands may then be harmonized to the previous PlanetScope band values using the harmonizationTransform parameters. This requires multiplying each band by its associated bandCoefficient given in the xml metadata file, under bandSpecificMetadata.

3.2 PLANETSCOPE BASIC SCENE PRODUCT SPECIFICATION

The PlanetScope Basic Scene product is a Scaled Top of Atmosphere Radiance (at sensor) and sensor corrected product, providing imagery as seen from the spacecraft without correction for any geometric distortions inherent in the imaging process. It has a scene based framing, and is not mapped to a cartographic projection. This product line is available in GeoTIFF and NITF 2.1 formats.

The PlanetScope Basic Scene product is a multispectral analytic data product from the satellite constellation. This product has not been processed to remove distortions caused by terrain and allows analysts to derive information products for data science and analytics.

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

The geometric sensor corrections applied to this product correct for:

- Optical distortions caused by sensor optics
- Co-registration of bands

The table below describes the attributes for the PlanetScope Basic Scene product:

Table 2-B: PlanetScope Analytic Basic Scene Product Attributes

| PLANETSCOPE BASIC SCENE PRODUCT ATTRIBUTES | |
|--------------------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Product Attribute | Description |
| Product Components and Format | The PlanetScope Basic Scene product consists of the following file components: <ul style="list-style-type: none">• Image File – GeoTIFF format• Metadata File – XML format• Rational Polynomial Coefficients - XML format• Thumbnail File – GeoTIFF format• Unusable Data Mask (UDM) File – GeoTIFF format• Usable Data Mask (UDM2) File - GeoTIFF format |
| Information Content | |

| | |
|-------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Analytic Bands | 3-band natural color (red, green, blue) or 4-band multispectral image (blue, green, red, near-infrared) |
| Ground Sample Distance | 3.7 m (average at reference altitude 475 km) |
| Processing | |
| Pixel Size | 3.7 - 4.1 m (altitude dependent GSD) |
| Bit Depth | Analytic (DN): 12-bit Analytic (Radiance - $W\ m^{-2}\ sr^{-1}\ \mu m^{-1}$): 16-bit |
| Product Size | Nominal scene size is approximately (at 475 km altitude): PS2 : 24 km by 8 km PS2.SD : 24 km by 16 km with some variability by satellite altitude. |
| Geometric Corrections | Spacecraft-related effects are corrected using attitude telemetry and best available ephemeris data, and refined using GCPs. |
| Positional Accuracy | Less than 10 m RMSE |
| Radiometric Corrections | <ul style="list-style-type: none"> • Conversion to absolute radiometric values based on calibration coefficients • Radiometric values scaled by 100 to reduce quantization error • Calibration coefficients regularly monitored and updated with on-orbit calibration techniques. |
| Map Projection | N/A |

3.3 PLANETSCOPE ORTHO SCENES PRODUCT SPECIFICATION

PlanetScope satellites collect imagery as a series of overlapping framed scenes, and these Scene products are not organized to any particular tiling grid system. The Ortho Scene products enable users to create seamless imagery by stitching together PlanetScope Ortho Scenes of their choice and clipping it to a tiling grid structure as required.

The PlanetScope Ortho Scene product is orthorectified and the product was designed for a wide variety of applications that require imagery with an accurate geolocation and cartographic projection. It has been processed to remove distortions caused by terrain and can be used for cartographic purposes. The Ortho Scenes are delivered as visual (RGB) and analytic products. Ortho Scenes are radiometrically-, sensor-, and geometrically-corrected (optional atmospherically corrected) products that are 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. Computer vision algorithms are used for extracting feature points such as OpenCV's STAR keypoint detector and FREAK keypoint extractor. The GCP and tiepoint matching is done using a combination of RANSAC, phase correlation and mutual information.

The table below describes the attributes for the PlanetScope Ortho Scene product:

Table 2-C: PlanetScope Ortho Scene Product Attributes

| PLANETSCOPE ORTHO SCENE PRODUCT ATTRIBUTES | |
|--------------------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Product Attribute | Description |
| Product Components and Format | PlanetScope Ortho Scene product consists of the following file components: <ul style="list-style-type: none"> • Image File – GeoTIFF format • Metadata File – XML format • Thumbnail File – GeoTIFF format • Unusable Data Mask (UDM) file – GeoTIFF format • Usable Data Mask (UDM2) file - GeoTIFF format |
| Product Orientation | Map North up |
| Product Framing | Scene Based |
| Pixel Size (orthorectified) | 3 m |
| Bit Depth | Visual: 8-bit Analytic (DN): 12-bit Analytic (Radiance - W m ⁻² sr ⁻¹ μm ⁻¹): 16-bit Analytic SR (Surface Reflectance): 16-bit |
| Product Size | Nominal scene size is approximately (at 475km altitude): PS2: 25 km by 11.5 km PS2.SD: 25 km by 23.0 km with some variability by satellite altitude. |
| 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). |
| Atmospheric Corrections | Atmospheric effects are corrected using 6SV2.1 radiative transfer code. AOD, water vapor and ozone inputs are retrieved from MODIS near-real-time data (MOD09CMA, MOD09CMG and MOD08-D3). |
| Horizontal Datum | WGS84 |
| Map Projection | UTM |
| Resampling Kernel | Cubic Convolution |

3.3.1 PlanetScope Visual Ortho Scene Product Specification

The PlanetScope Visual Ortho Scene product is orthorectified and color-corrected (using a color curve). This correction attempts to optimize colors as seen by the human eye providing images as they would look if viewed from the perspective of the satellite. This product has been processed to remove distortions caused by terrain and can be used for cartographic mapping and visualization purposes. This correction also eliminates the perspective effect on the ground (not on buildings), restoring the geometry of a vertical shot. Additionally, a correction is made to the sun angle in each image to account for differences in latitude and time of acquisition.

The Visual Ortho Scene product is optimal for simple and direct use of an image. It is designed and made visually appealing for a wide variety of applications that require imagery with an accurate geolocation and cartographic projection. The product can be used and ingested directly into a Geographic Information System.

Table 2-D: PlanetScope Visual Ortho Scene Product Attributes

| PLANETSCOPE VISUAL ORTHO SCENE PRODUCT ATTRIBUTES | |
|---------------------------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Product Attribute | Description |
| Information Content | |
| Visual Bands | 3-band natural color (red, green, blue) |
| Ground Sample Distance | 3.7 m (average at reference altitude 475 km) |
| Processing | |
| Pixel Size (orthorectified) | 3.0 m |
| Bit Depth | 8-bit |
| Geometric Corrections | Sensor-related effects are corrected using sensor telemetry and a sensor model. Spacecraft-related effects are corrected using attitude telemetry and best available ephemeris data. Orthorectified using GCPs and fine DEMs (30 m to 90 m posting) to <10 m RMSE positional accuracy. |
| Positional Accuracy | Less than 10 m RMSE |
| Color Enhancements | Enhanced for visual use and corrected for sun angle |

3.3.2 PlanetScope Analytic Ortho Scene Product Specification

The PlanetScope Analytic Ortho Scene product is orthorectified, multispectral data from the satellite constellation. Analytic products are calibrated multispectral imagery products that have been processed to allow analysts to derive information products for data science and analytics. 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 and can be used for many data science and analytic applications. It eliminates the perspective effect on the ground (not on buildings), restoring the geometry of a vertical shot. The PlanetScope Analytic Ortho Scene is optimal for value-added image processing such as land cover classifications. The imagery has radiometric corrections applied to correct for any sensor artifacts and transformation to at-sensor radiance.

Table 2-E: PlanetScope Analytic Ortho Scene Product Attributes

| PLANETSCOPE ANALYTIC ORTHO SCENE PRODUCT ATTRIBUTES | |
|-----------------------------------------------------|---------------------------------------------------------------------------------------------------------------|
| Product Attribute | Description |
| Information Content | |
| Analytic Bands | 3-band multispectral image (red, green, blue) 4-band multispectral image (blue, green, red, near-infrared) |

| | |
|-----------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Ground Sample Distance | 3.7 m (average at reference altitude 475 km) |
| Processing | |
| Pixel Size (orthorectified) | 3.0 m |
| Bit Depth | Analytic (DN): 12-bit Analytic (Radiance - $W\ m^{-2}\ sr^{-1}\ \mu m^{-1}$): 16-bit Analytic SR (Surface Reflectance): 16-bit |
| Geometric Corrections | Sensor-related effects are corrected using sensor telemetry and a sensor model. Spacecraft-related effects are corrected using attitude telemetry and best available ephemeris data. Orthorectified using GCPs and fine DEMs (30 m to 90 m posting) to <10 m RMSE positional accuracy. |
| Positional Accuracy | Less than 10 m RMSE |
| Radiometric Corrections | <ul style="list-style-type: none"> • Conversion to absolute radiometric values based on calibration coefficients • Radiometric values scaled by 100 to reduce quantization error • Calibration coefficients regularly monitored and updated with on-orbit calibration techniques. |
| Atmospheric Corrections | <ul style="list-style-type: none"> • Conversion to top of atmosphere (TOA) reflectance values using at-sensor radiance and supplied coefficients • Conversion to surface reflectance values using the 6SV2.1 radiative transfer code and MODIS NRT data • Reflectance values scaled by 10,000 to reduce quantization error |

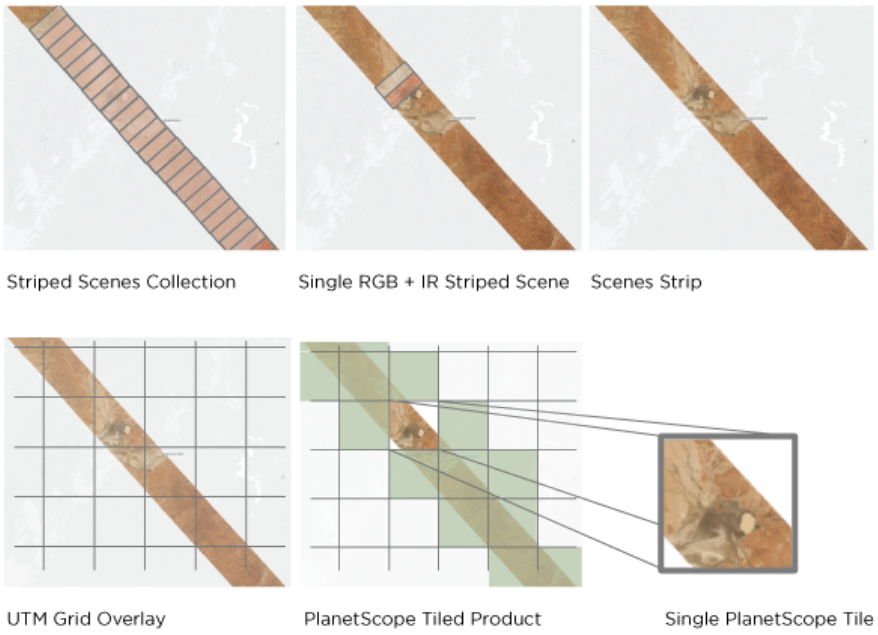
3.4 PLANETSCOPE ORTHO TILE PRODUCT SPECIFICATION

The PlanetScope Ortho Tile products offer PlanetScope Satellite imagery orthorectified as individual 25 km by 25 km tiles referenced to a fixed, standard image tile grid system. This product was designed for a wide variety of applications that require imagery with an accurate geolocation and cartographic projection. It has been processed to remove distortions caused by terrain and can be used for cartographic purposes.

For PlanetScope split-frame satellites, imagery is collected as a series of overlapping framed scenes from a single satellite in a single pass. These scenes are subsequently orthorectified and an ortho tile is then generated from a collection of consecutive scenes, typically 4 to 5. The process of conversion of framed scene to ortho tile is outlined in the figure below.

The PlanetScope Ortho Tile products are radiometrically-, sensor-, and geometrically-corrected and aligned to a cartographic map projection. The geometric correction uses fine DEMs with a post spacing of between 30 and 90 meters. 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.

Figure 2: PlanetScope Scene to Ortho Tile Conversion.



The table below describes the attributes for the PlanetScope Ortho Tile product:

Table 2-F: PlanetScope Ortho Tile Product Attributes

| PLANETSCOPE ORTHO TILE PRODUCT ATTRIBUTES | |
|-------------------------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Product Attribute | Description |
| Product Components and Format | PlanetScope Ortho Tile product consists of the following file components: <ul style="list-style-type: none"> • Image File – GeoTIFF format • Metadata File – XML format • Thumbnail File – GeoTIFF format • Unusable Data Mask (UDM) File – GeoTIFF format • Usable Data Mask (UDM2) File - GeoTIFF format |
| Product Orientation | Map North Up |
| Product Framing | PlanetScope Ortho Tiles are based on a worldwide, fixed UTM grid system. The grid is defined in 24 km by 24 km tile centers, with 1 km of overlap (each tile has an additional 500 m overlap with adjacent tiles), resulting in 25 km by 25 km tiles. |
| Pixel Size (orthorectified) | 3.125 m |
| Bit Depth | 16-bit |
| Product Size | Tile size is 25 km (8000 lines) by 25 km (8000 columns). 5 to 500 Mbytes per Tile for 4 bands at 3.125 m pixel size after orthorectification. |
| Geometric Corrections | Sensor-related effects are corrected using sensor telemetry and a sensor model. Orthorectified using GCPs and fine DEMs (30 m to 90 m posting). |
| Horizontal Datum | WGS84: UTM |
| Resampling Kernel | Cubic Convolution |

3.4.1 PlanetScope Visual Ortho Tile Product Specification

The PlanetScope Visual Ortho Tile product is orthorectified and color-corrected (using a color curve). This correction attempts to optimize colors as seen by the human eye providing images as they would look if viewed from the perspective of the satellite. It has been processed to remove distortions caused by terrain and can be used for cartographic mapping and visualization purposes. It eliminates the perspective effect on the ground (not on buildings), restoring the geometry of a vertical shot. Additionally, a correction is made to the sun angle in each image to account for differences in latitude and time of acquisition.

The Visual product is optimal for simple and direct use of the image. It is designed and made visually appealing for a wide variety of applications that require imagery with an accurate geolocation and cartographic projection. The product can be used and ingested directly into a Geographic Information System.

Table 2-G: PlanetScope Visual Ortho Tile Product Attributes

| PLANETSCOPE VISUAL ORTHO TILE PRODUCT ATTRIBUTES | |
|--------------------------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Product Attribute | Description |
| Information Content | |
| Visual Bands | 3-band natural color (red, green, blue) |
| Ground Sample Distance | 3.7 m (average at reference altitude 475 km) |
| Processing | |
| Pixel Size (orthorectified) | 3.125 m |
| Bit Depth | 8-bit |
| Geometric Corrections | Sensor-related effects are corrected using sensor telemetry and a sensor model, bands are co-registered, and spacecraft-related effects are corrected using attitude telemetry and best available ephemeris data. Orthorectified using GCPs and fine DEMs (30 m to 90 m posting) to < 10 m RMSE positional accuracy. |
| Positional Accuracy | Less than 10 m RMSE |
| Color Enhancements | Enhanced for visual use and corrected for sun angle |

3.4.2 PlanetScope Analytic Ortho Tile Product Specification

The PlanetScope Analytic Ortho Tile product is orthorectified, multispectral data from the satellite constellation. Analytic products are calibrated multispectral imagery products that have been processed to allow analysts to derive information products for data science and analytics. This product is designed for a wide variety of applications that require imagery with an accurate geolocation and cartographic projection. It has been processed to remove distortions caused by terrain and can be used for many data science and analytic applications. It eliminates the perspective effect on the ground (not on buildings), restoring the geometry of a vertical shot. The orthorectified visual imagery is optimal for value-added image processing including vegetation indices, land cover classifications, etc. In addition to orthorectification, the imagery has radiometric corrections applied to correct for any sensor artifacts and transformation to scaled at-sensor radiance.

Figure 3: PlanetScope Analytic Ortho Tiles with RGB (left) and NIR False-Color Composite (right)

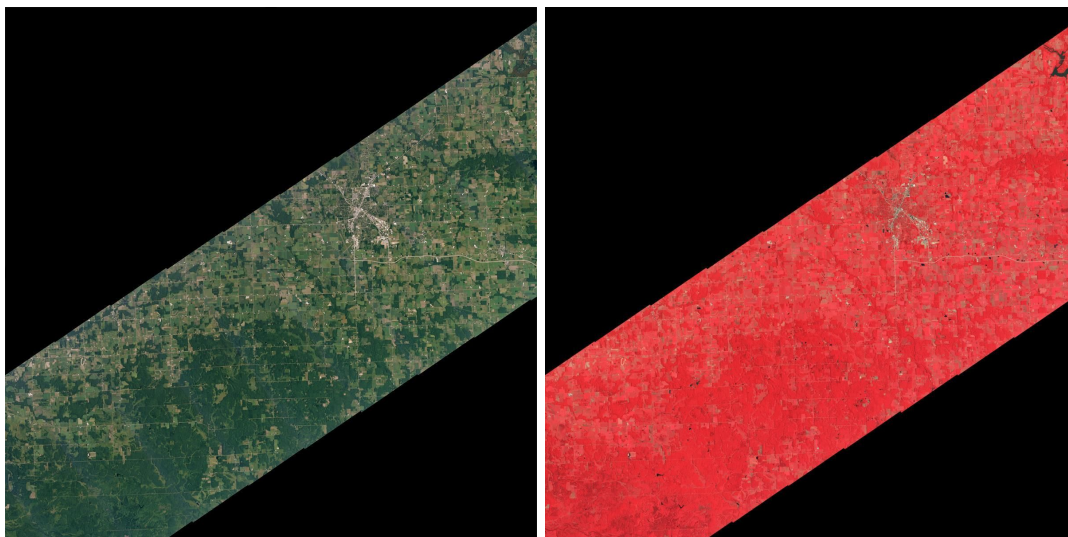
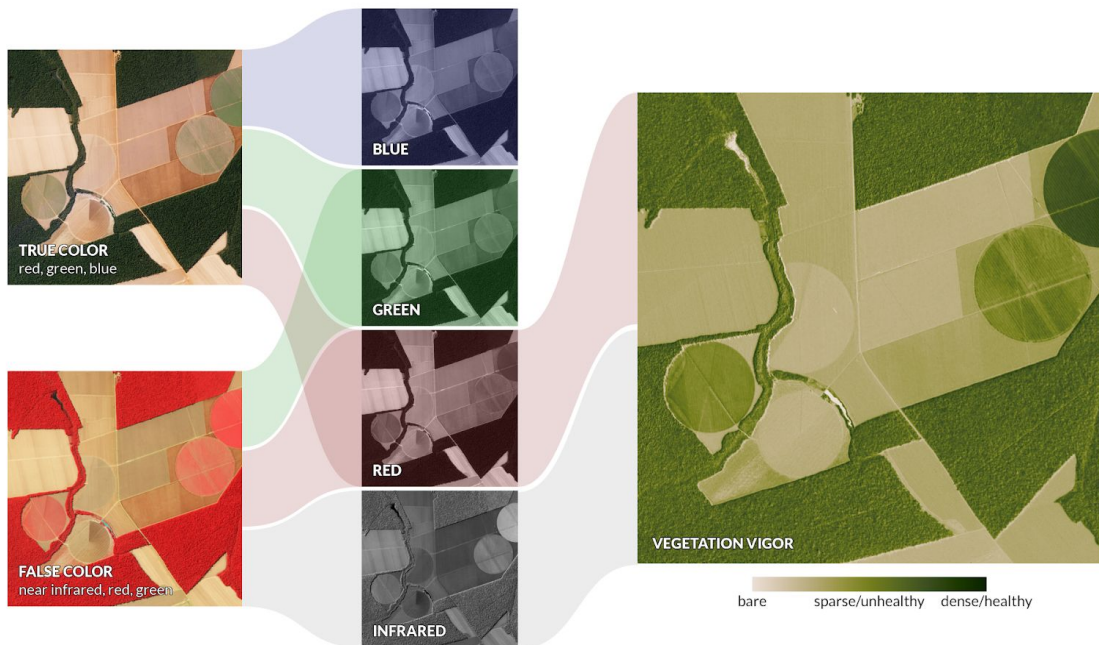


Table 2-H: PlanetScope Analytic Ortho Tile Product Attributes

| PLANETSCOPE ANALYTIC ORTHO TILE PRODUCT ATTRIBUTES | |
|----------------------------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Product Attribute | Description |
| Information Content | |
| Analytic Bands | 4-band multispectral image (blue, green, red, near-infrared) |
| Ground Sample Distance | 3.7 m (average at reference altitude 475 km) |
| Processing | |
| Pixel Size (orthorectified) | 3.125 m |
| Bit Depth | Analytic (DN): 12-bit Analytic (Radiance - $W\ m^{-2}\ sr^{-1}\ \mu m^{-1}$): 16-bit |
| Geometric Corrections | Sensor-related effects are corrected using sensor telemetry and a sensor model, bands are co-registered, and spacecraft-related effects are corrected using attitude |

| | |
|-------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| | telemetry and best available ephemeris data. Orthorectified using GCPs and fine DEMs (30 m to 90 m posting) to <10 m RMSE positional accuracy. |
| Positional Accuracy | Less than 10 m RMSE |
| Radiometric Corrections | <ul style="list-style-type: none"> • Conversion to absolute radiometric values based on calibration coefficients • Radiometric values scaled by 100 to reduce quantization error • Calibration coefficients regularly monitored and updated with on-orbit calibration techniques. |

Figure 4: PlanetScope Analytic Bands



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4. RAPIDEYE IMAGERY PRODUCTS

RapidEye imagery products are available in two different processing levels to be directly applicable to customer needs.

Table 3-A: RapidEye Satellite Image Product Processing Levels

| Name | Description | Product Level |
|------------------------------|--------------------------------------------------------------------------------------------------------------------------|---------------|
| RapidEye Basic Scene Product | Radiometric and sensor corrections applied to the data. On-board spacecraft attitude and ephemeris applied to the data. | Level 1B |
| RapidEye Ortho Tile Product | Radiometric and sensor corrections applied to the data. Imagery is orthorectified using the RPCs and an elevation model. | Level 3A |

The name of each acquired RapidEye image is designed to be unique and allow for easier recognition and sorting of the imagery. It includes the date and time of capture, as well as the id of the satellite that captured it. The name of each downloaded image product is composed of the following elements:

RapidEye Ortho Tiles:

`<tileid>_<acquisition_date>_<satellite_id>_<productLevel>_<productType>.<extension>`

RapidEye Basic Scenes:

`<acquisition_date>T<acquisition_time>_<satellite_id>_<productLevel>_<productType>.<extension>`

4.1 RADIOMETRIC INTERPRETATION

Analytic products are scaled to Top of Atmosphere Radiance. Validation of radiometric accuracy of the on-orbit calibration has been measured at 5% using vicarious collects in the Railroad Valley calibration site. Furthermore, each band is maintained within a range of +/- 2.5% from the band mean value across the constellation and over the satellite's lifetime.

All RapidEye satellite images are collected at a bit depth of 12 bits and on-board the satellites, the least significant bit is removed, and thus 11 bits are stored and downloaded. On the ground, the bit shift is reversed by a multiplication factor of 2. The bit depth of the original raw imagery can be determined from the "shifting" field in the XML metadata file. During on-ground processing, radiometric corrections are applied and all images are scaled to a 16-bit dynamic range. This scaling converts the (relative) pixel DN's coming directly from the sensor into values directly related to absolute at sensor radiances. The scaling factor is applied so that the

resultant single DN values correspond to 1/100th of a $W/(m^2 \cdot sr \cdot \mu m)$. The DNs of the RapidEye image pixels represent the absolute calibrated radiance values for the image.

Absolute calibration is validated continuously and updated in the processing chain when necessary.

Converting to Radiance and Top of Atmosphere Reflectance

To convert the pixel values of the Analytic products to radiance, it is necessary to multiply the DN value by the radiometric scale factor, as follows:

$RAD(i) = DN(i) * radiometricScaleFactor(i)$, where $radiometricScaleFactor(i) = 0.01$

The resulting value is the at-sensor radiance of that pixel in watts per steradian per square meter ($W/m^2 \cdot sr \cdot \mu m$).

Reflectance is generally the ratio of the reflected radiance divided by the incoming radiance. Note, that this ratio has a directional aspect. To turn radiance into reflectance it is necessary to relate the radiance values (e.g. the pixel DNs multiplied with the radiometric scale factor) to the radiance the object is illuminated with. This is often done by applying an atmospheric correction software to the image, because this way the impact of the atmosphere to the radiance values is eliminated at the same time. But it would also be possible to neglect the influence of the atmosphere by calculating the Top Of Atmosphere (TOA) reflectance taking into consideration only the sun distance and the geometry of the incoming solar radiation. The formula to calculate the TOA reflectance not taking into account any atmospheric influence is as follows:

$$REF(i) = RAD(i) \frac{\pi * SunDist^2}{EAI(i) * \cos(SolarZenith)}$$

with:

- i = Number of the spectral band
- REF = reflectance value
- RAD = Radiance value
- SunDist = Earth-Sun Distance at the day of acquisition in Astronomical Units. Note: This value is not fixed, it varies between 0.9832898912 AU and 1.0167103335 AU and has to be calculated for the image acquisition point in time.
- EAI = Exo-Atmospheric Irradiance
- SolarZenith = Solar Zenith angle in degrees (= $90^\circ - \text{sun elevation}$)

For RapidEye, the EAI values for the 5 bands are (based on the "New Kurucz 2005" model):

- Blue: 1997.8 $W/m^2 \cdot \mu m$
- Green: 1863.5 $W/m^2 \cdot \mu m$
- Red: 1560.4 $W/m^2 \cdot \mu m$
- RE: 1395.0 $W/m^2 \cdot \mu m$
- NIR: 1124.4 $W/m^2 \cdot \mu m$

4.2 RAPIDEYE BASIC SCENE PRODUCT SPECIFICATION

The RapidEye Basic product is the least processed of the available RapidEye imagery products. This product is designed for customers with advanced image processing capabilities and a desire to geometrically correct the product themselves. This product line will be available in GeoTIFF and NITF formats.

The RapidEye Basic Scene product is radiometrically- and sensor-corrected, providing imagery as seen from the spacecraft without correction for any geometric distortions inherent in the imaging process, and is not mapped to a cartographic projection. The imagery data is accompanied by all spacecraft telemetry necessary for the processing of the data into a geo-corrected form, or when matched with a stereo pair, for the generation of digital elevation data. Resolution of the images is 6.5 meters GSD at nadir. The images are resampled to a coordinate system defined by an idealized basic camera model for band alignment.

The radiometric corrections applied to this product are:

- Correction of relative differences of the radiometric response between detectors
- Non-responsive detector filling which fills null values from detectors that are no longer responding (This isn't currently done because there are no non-responsive detectors)
- Conversion to absolute radiometric values based on calibration coefficients

The geometric sensor corrections applied to this product correct for:

- Internal detector geometry which combines the two sensor chipsets into a virtual array
- Optical distortions caused by sensor optics
- Registration of all bands together to ensure all bands line up with each other correctly

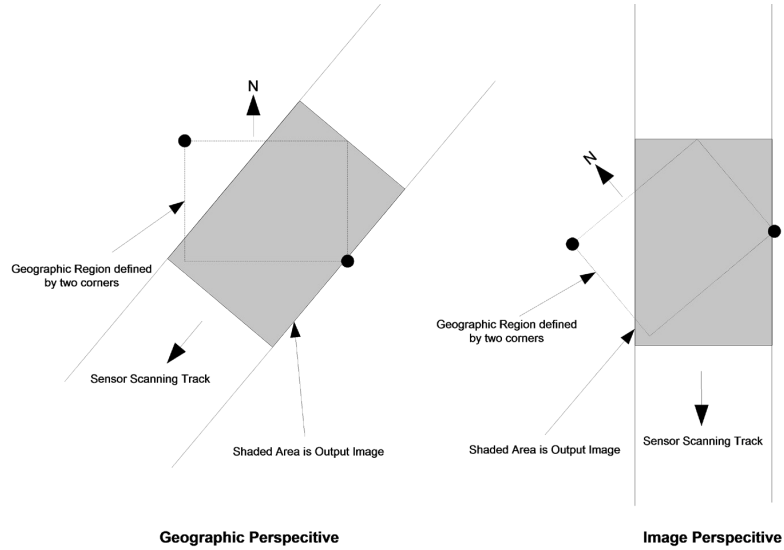
The table below lists the product attributes for the RapidEye Basic Scene product.

Table 3-B: RapidEye Basic Scene Product Attributes

| RAPIDEYE BASIC SCENE PRODUCT ATTRIBUTES | |
|-----------------------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Product Attribute | Description |
| Product Components and Format | RapidEye Basic Scene product consists of the following file components: <ul style="list-style-type: none">• Image File – Image product delivered as a group of single-band NITF or GeoTIFF files with associated RPC values. Bands are co-registered.• Metadata File – XML format metadata file and GeoJSON metadata available• Unusable Data Mask (UDM) File – GeoTIFF format• Spacecraft information (SCI) file - XML format and contains additional information related to spacecraft attitude, spacecraft ephemeris, spacecraft temperature measurements, line imaging times, camera geometry, and radiometric calibration data.• Browse Image - GeoTIFF format (also referred to as "Quicklook") |
| Product Orientation | Spacecraft/Sensor Orientation |

Product Framing

Geographic based framing – a geographic region is defined by two corners. The product width is close to the full image swath as observed by all bands (77 km at nadir, subject to minor trimming of up to 3 km during processing) with a product length that does not exceed 300 km with a minimum length of 50 km and around a 10km overlap.



| | |
|--------------------------------------------------|-------------------------------------------------------------------------------------------------------------------------------|
| Ground Sample Distance (nadir) | 6.5 m |
| Bit Depth | 16-bit unsigned integers |
| Pixel Size (orthorectified) | 6.5m at Nadir |
| Radiometric Accuracy | Absolute accuracy less than +/- 5.0% Inter-satellite Accuracy less than +/- 2.5% of the band mean across the constellation |
| Geometric Corrections | Idealized sensor, orbit and attitude models. Bands are co-registered. |
| Positional Accuracy Band-to-Band Registration | Less than 10 m RMSE Less than 0.2 pixels (1-sigma) for terrain with slope below 10° |
| Horizontal Datum | WGS84 |
| Map Projection | N/A |
| Resampling Kernel | Cubic Convolution |

4.3 RAPIDEYE VISUAL ORTHO TILE PRODUCT SPECIFICATION

The RapidEye Ortho Tile products offer RapidEye Satellite imagery orthorectified as individual 25 km by 25 km tiles. This product was designed for a wide variety of applications that require imagery with an accurate geolocation and cartographic projection. It has been processed to remove distortions caused by terrain and can be used for many cartographic purposes.

The RapidEye Ortho Tile products are radiometrically-, sensor- and geometrically-corrected and aligned to a cartographic map projection. The geometric correction uses fine DEMs with a post spacing of between 30 and 90 meters. 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. RapidEye Ortho Tile products are output as 25 km by 25 km tiles referenced to a fixed, standard RapidEye image tile grid system.

The table below lists the product attributes for the RapidEye Ortho Tile product.

Table 3-C: RapidEye Ortho Tile Product Attributes

| RAPIDEYE ORTHO TILE PRODUCT ATTRIBUTES | |
|----------------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Product Attribute | Description |
| Product Components and Format | RapidEye Ortho Tile product consists of the following file components: <ul style="list-style-type: none">• Image File – GeoTIFF file that contains image data and geolocation information• Metadata File – XML format metadata file and GeoJSON metadata available• Unusable Data Mask (UDM) File – GeoTIFF format |
| Product Orientation | Map North Up |
| Product Framing | RapidEye Ortho Tiles are based on a worldwide, fixed UTM grid system. The grid is defined in 24 km by 24 km tile centers, with 1 km of overlap (each tile has an additional 500 m overlap with adjacent tiles), resulting in 25 km by 25 km tiles. |
| Pixel Size (orthorectified) | 5 m |
| Bit Depth | Visual: 8-bit Analytic (Radiance - $W\ m^{-2}\ sr^{-1}\ \mu m^{-1}$): 16-bit |
| Product Size | Tile size is 25 km (5000 lines) by 25 km (5000 columns). 250 Mbytes per Tile for 5 bands at 5 m pixel size after orthorectification. |
| Geometric Corrections | Sensor-related effects are corrected using sensor telemetry and a sensor model, bands are co-registered, and spacecraft-related effects are corrected using attitude telemetry and best available ephemeris data. Orthorectified using GCPs and fine DEMs (30 m to 90 m posting). |
| Horizontal Datum | WGS84 |
| Map Projection | UTM |
| Resampling Kernel | Cubic Convolution |

4.3.1 RapidEye Visual Ortho Tile Product Specification

The RapidEye Visual Ortho Tile product is orthorectified and color-corrected (using a color curve). This correction attempts to optimize colors as seen by the human eye providing images as they would look if viewed from the perspective of the satellite. It has been processed to remove distortions caused by terrain and can be used for cartographic mapping and visualization purposes. It eliminates the perspective effect on the ground (not on buildings), restoring the geometry of a vertical shot. Additionally, a correction is made to the sun angle in each image to account for differences in latitude and time of acquisition.

The Visual product is optimal for simple and direct use of the image. It is designed and made visually appealing for a wide variety of applications that require imagery with an accurate geolocation and cartographic projection. The product can be used and ingested directly into a Geographic Information System.

Below is a sample of a RapidEye Visual Ortho Tile:

Figure 5: RapidEye Visual Ortho Tile



Table 3-D: RapidEye Visual Ortho Tile Product Attributes

| RAPIDEYE VISUAL ORTHO TILE PRODUCT ATTRIBUTES | |
|-----------------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Product Attribute | Description |
| Information Content | |
| Visual Bands | 3-band natural color (red, green, blue) |
| Ground Sample Distance | 6.5 m (at reference altitude 630 km) |
| Processing | |
| Pixel Size (orthorectified) | 5 m |
| Bit Depth | 8-bit |
| Geometric Corrections | Sensor-related effects are corrected using sensor telemetry and a sensor model, bands are co-registered, and spacecraft-related effects are corrected using attitude telemetry and best available ephemeris data. Orthorectified using GCPs and fine DEMs (30 m to 90 m posting) to < 10 m RMSE positional accuracy. |
| Positional Accuracy | Less than 10 m RMSE |
| Band-to-Band Registration | Less than 0.2 pixels (1-sigma) for terrain with slope below 10° |
| Radiometric Corrections | <ul style="list-style-type: none"> • Correction of relative differences of the radiometric response between detectors. • Non-responsive detector filling which fills nulls values from detectors that are no longer responding. • Conversion to absolute radiometric values based on calibration coefficients. |
| Color Enhancements | Enhanced for visual use and corrected for sun angle |

4.3.2 RapidEye Analytic Ortho Tile Product Specification

The RapidEye Analytic Ortho Tile product is orthorectified, multispectral data from the RapidEye satellite constellation. This product is designed for a wide variety of applications that require imagery with an accurate geolocation and cartographic projection. It has been processed to remove distortions caused by terrain and can be used for many data science and analytic applications. It eliminates the perspective effect on the ground (not on buildings), restoring the geometry of a vertical shot. The orthorectified imagery is optimal for value-added image processing including vegetation indices, land cover classifications, etc. In addition to orthorectification, the imagery has radiometric corrections applied to correct for any sensor artifacts and transformation to at-sensor radiance.

Table 3-E: RapidEye Analytic Ortho Tile Product Attributes

| RAPIDEYE ANALYTIC ORTHO TILE PRODUCT ATTRIBUTES | |
|-------------------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Product Attribute | Description |
| Information Content | |
| Analytic Bands | 5-band multispectral image (blue, green, red, red edge, near-infrared) |
| Ground Sample Distance | 6.5 m (at reference altitude 630 km) |
| Processing | |
| Pixel Size (orthorectified) | 5 m |
| Bit Depth | 16-bit |
| Radiometric Accuracy | Absolute accuracy less than +/- 5.0% Inter-satellite Accuracy less than +/- 2.5% of the band mean across the constellation |
| Geometric Corrections | Sensor-related effects are corrected using sensor telemetry and a sensor model, bands are co-registered, and spacecraft-related effects are corrected using attitude telemetry and best available ephemeris data. Orthorectified using GCPs and fine DEMs (30 m to 90 m posting) to < 10 m RMSE positional accuracy. |
| Positional Accuracy | Less than 10 m RMSE |
| Band-to-Band Registration | Less than 0.2 pixels (1-sigma) for terrain with slope below 10° |
| Radiometric Corrections | <ul style="list-style-type: none"> • Correction of relative differences of the radiometric response between detectors. • Non-responsive detector filling which fills nulls values from detectors that are no longer responding. • Conversion to absolute radiometric values based on calibration coefficients. |

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5. SKYSAT IMAGERY PRODUCTS

5.1 SKYSAT BASIC SCENE PRODUCT SPECIFICATION

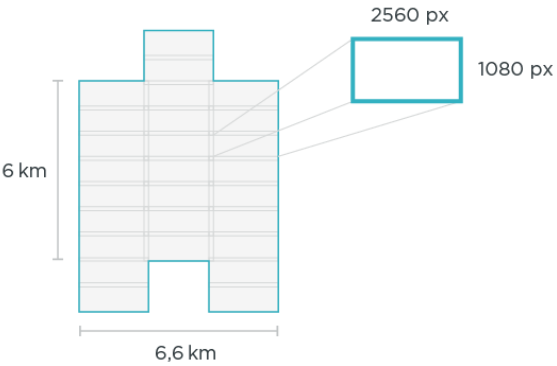
The SkySat Basic Scene product includes Analytic, Analytic DN, and Panchromatic imagery that is uncalibrated and in a raw digital number format. The Basic Scene Product is not corrected for any geometric distortions inherent in the imaging process.

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.

- Analytic - unorthorectified, radiometrically corrected, multispectral BGRN
- Analytic DN - unorthorectified, multispectral BGRN
- Panchromatic DN - unorthorectified, panchromatic (PAN)

Table 4-A: 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 | Scene based:  |

| | |
|-------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| | 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. |
| 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%) Conversion to absolute radiometric values based on calibration coefficients Calibration coefficients regularly monitored and updated with on-orbit calibration techniques |
| 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-14] Panchromatic: 0.72m Multispectral: 1.0m |
| Geometric Accuracy | <50m RMSE |

5.5 RADIOMETRIC INTERPRETATION

To convert the pixel values of the Analytic products to radiance, it is necessary to multiply the DN value by the radiometric scale factor, as follows:

$$\text{RAD}(i) = \text{DN}(i) * \text{radiometric_scale_factor}(i), \text{ where radiometric_scale_factor}(i) = 0.01$$

The resulting value is the Top of Atmosphere Radiance of that pixel in watts per steradian per square meter ($\text{W}/\text{m}^2 * \text{sr} * \mu\text{m}$).

To convert the pixel values of the Analytic products to Top of Atmosphere Reflectance, it is necessary to multiply the DN value by the reflectance coefficient found in the GeoTiff header. This makes the complete conversion from DN to Top of Atmosphere Reflectance to be as follows:

$$REF(i) = DN(i) * reflectance_coefficient(i)$$

Alternatively, the customer may perform the TOA Reflectance conversion on their own using the following equation, with the ESUN values given below in Table 3.

$$TOAR = \frac{(\pi \times Radiance \times d^2)}{ESUN \times \cos(90 - sun\ elevation)}$$

d = Earth to sun distance in astronomical units

Table 11: Skysat Analytic Ortho Scene ESUN values, resampled from Thuillier irradiance spectra

| | PAN | BLUE | GREEN | RED | NIR |
|------------------|---------|---------|---------|---------|---------|
| SkySat-1 | 1587.94 | 1984.85 | 1812.88 | 1565.83 | 1127 |
| SkySat-2 | 1587.94 | 1984.85 | 1812.88 | 1565.83 | 1127 |
| SkySat-3 | 1585.89 | 2000.7 | 1821.8 | 1584.13 | 1120.33 |
| SkySat-4 | 1585.89 | 2000.7 | 1821.8 | 1584.13 | 1120.33 |
| SkySat-5 | 1573.42 | 2009.23 | 1820.33 | 1584.84 | 1104.96 |
| SkySat-6 | 1573.42 | 2009.23 | 1820.33 | 1584.84 | 1104.96 |
| SkySat-7 | 1573.42 | 2009.23 | 1820.33 | 1584.84 | 1104.96 |
| SkySat-8 | 1582.79 | 2009.28 | 1820.25 | 1583.3 | 1114.22 |
| SkySat-9 | 1583.61 | 2009.29 | 1821.04 | 1583.83 | 1109.44 |
| SkySat-10 | 1583.88 | 2008.61 | 1820.87 | 1583.5 | 1112.3 |
| SkySat-11 | 1586.89 | 2009.26 | 1821.14 | 1583.66 | 1113.77 |
| SkySat-12 | 1581.65 | 2009.5 | 1821.24 | 1584.91 | 1109.01 |
| SkySat-13 | 1580.89 | 2009.43 | 1821.7 | 1583.77 | 1108.74 |
| SkySat-14 | 1581.65 | 2009.5 | 1821.24 | 1584.91 | 1109.01 |
| SkySat-15 | 1580.89 | 2009.43 | 1821.7 | 1583.77 | 1108.74 |

5.2 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 scene 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 a variety of quality standards, for example: PAN motion blur less than 1.15 pixels, compression bits per pixel less than 3. 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 (-90 - +90) |

5.3 BASIC SCENE RPC METADATA

Table 9: Skysat Basic Scene Text file Metadata Schema

| Parameter | Description | Sample |
|-----------------|-------------------------------------------------------|------------------|
| LINE_OFF | Row offset of center point | 534.896219421794 |
| SAMP_OFF | Column offset of center point | 1267.3960612691 |
| LAT_OFF | Latitude coordinate of center point | -18.1132 |
| LONG_OFF | Longitude coordinate of center point | 178.4441 |
| HEIGHT_OFF | Altitude of center point | 123 |
| LINE_SCALE | Scaling factor for row coordinate | 534.896219421794 |
| SAMP_SCALE | Scaling factor for column coordinate | 1267.39606126914 |
| LAT_SCALE | Scaling factor for latitude coordinates | -0.0264 |
| LONG_SCALE | Scaling factor for longitude coordinates | 0.0331 |
| HEIGHT_SCALE | Scaling factor for altitude coordinates | 77 |
| LINE_NUM_COEFF_ | Numerator coefficient in row RPC equation (1-20) | 4.27902854674 |
| LINE_DEN_COEFF_ | Denominator Coefficient in row RPC equation(1-20) | 0.00174493132019 |
| SAMP_NUM_COEFF_ | Numerator coefficient in column RPC equation(1-20) | 0.0110620153979 |
| SAMP_DEN_COEFF_ | Denominator coefficient in column RPC equation (1-20) | 0.00174477677906 |

5.4 SKYSAT ORTHO SCENE PRODUCT SPECIFICATION

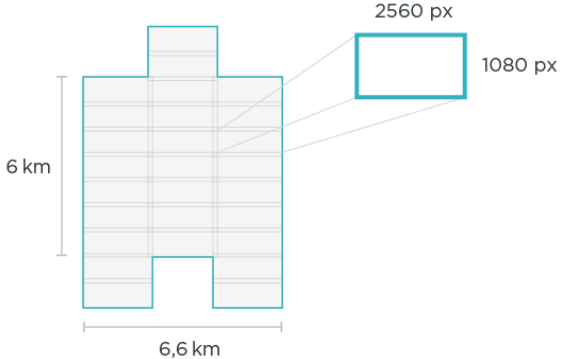
The SkySat Ortho Scene product includes Visual, Analytic DN, Analytic, Panchromatic, and Pan-sharpened Multispectral imagery. The Ortho Scene product is sensor- and geometrically-corrected, and is projected to a cartographic map projection. The geometric correction uses fine Digital Elevation Models (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. Note that ortho accuracy is not guaranteed for collections with view angle greater than 30 degrees.

- 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 4-B: SkySat Ortho Scene 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 | Scene Based:  <p>The diagram illustrates the scene framing for a SkySat Ortho Scene. It shows a large rectangular area with a grid of overlapping strips. The overall dimensions are 6 km in height and 6.6 km in width. A callout box highlights a single scene within the grid, which is approximately 2560 pixels wide and 1080 pixels high.</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. |
| 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 | Cross-Sensor Non Uniformity Correction (1%) Conversion to absolute radiometric values based on calibration coefficients Calibration coefficients regularly monitored and updated with on-orbit calibration techniques |
| 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 |

5.4.1 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 4-C: SkySat Visual Ortho Scene Attribute

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 |
| 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 |

5.4.2 SkySat Pansharpened Multispectral Ortho Scene

The SkySat Pansharpened Multispectral Scene product is orthorectified, pansharpened 4-band BGRN Imagery.

Table 4-D: SkySat Pansharpened Multispectral Ortho Scene Attribute

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

5.4.3 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 4-E: 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 |

5.4.4 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 4-F: 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 |

5.4.5 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 4-G: 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 |
| 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. |
| Radiometric Accuracy | +/- 5% Relative accuracy at < 10 degrees off-nadir angle |

5.6 SKYSAT ANALYTIC SCENE GEOTIFF PROPERTIES

Table 12: Properties included in the GeoTIFF Header, under 'TIFFTAG_IMAGEDESCRIPTION'

| Field | Value | Sample |
|--------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------------------------------------------------------------------------------------|
| radiometric_scale_factor | Provides the parameter to convert the scaled radiance pixel value to radiance. Multiplying the scaled radiance pixel values by the scale factor, derives the Top of Atmosphere Radiance product. This value is a constant, set to 0.01 | 0.01 |
| reflectance_coefficients | The value is a multiplicative, when multiplied with the DN values, provides the Top of Atmosphere Reflectance values, in watts per steradian per square meter ($W/m^2 * sr * \mu m$) | [0.0019093447035360626, 0.0021074819723268657, 0.002420630889355243, 0.003471901841411239] |
| satellite_azimuth | Angle from true north to the satellite vector at the time of imaging, projected on the horizontal plane in degrees. | 103.22169693 |

| | | |
|---------------------|-------------------------------------------------------------------------------------------|-------------|
| satellite_elevation | Angle between the satellite pointing direction and the local horizontal plane in degrees. | 61.32334041 |
| sun_azimuth | Angle from true north to the sun vector projected on the horizontal plane in degrees. | 136.7200917 |
| sun_elevation | Elevation angle of the sun in degrees. | 56.98039498 |

5.7 SKYSAT ORTHO SCENE GEOJSON METADATA

Table 10: 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 scene 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 a variety of quality standards, for example: PAN motion blur less than 1.15 pixels, compression bits per pixel less than 3. 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 (-90 - +90) |

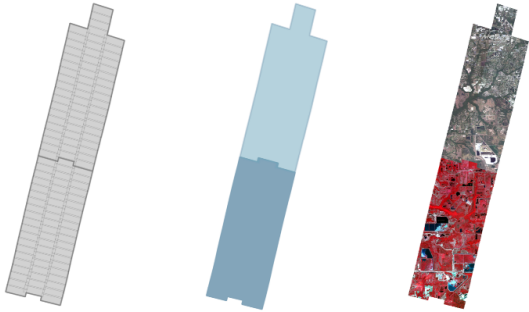
5.8 SKYSAT ORTHO COLLECT PRODUCT SPECIFICATION

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)

*Asset attributes match those of the Scene counterparts listed above

Table 4-H: 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 |

5.9 SKYSAT COLLECT METADATA

Ortho Collect GeoJSON metadata

Table 14: Skysat Ortho Collect Geojson Metadata Schema

| SKYSAT ORTHO COLLECT 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 scene 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", "SkySatCollect") |
| 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 a variety of quality standards, for example: PAN motion blur less than 1.15 pixels, compression bits per pixel less than 3. 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 (-90 - +90) |

5.10 SKYSAT BASEMAP MOSAIC TILES PRODUCT SPECIFICATION

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 projection used in Planet basemaps has been selected to match what is typically used in web mapping applications. The resolution improves at higher and lower latitudes. The Alpha Mask indicates areas of the quad where there is no imagery data available.

Table 4-1: 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 |



6. OTHER PROVIDER IMAGERY PRODUCTS

Planet provides access to two other freely available datasets: Landsat 8, operated by the NASA and the United States Geological Survey, and Sentinel-2, operated by the European Space Agency. The goal is to make these products easily available to Planet users to augment their analyses.

6.1 LANDSAT 8 PRODUCT SPECIFICATION

For detailed characteristics of the Landsat 8 sensor and mission please refer to the official Landsat 8 documentation which can be found here: <https://landsat.usgs.gov/landsat-8>

Table 5-A: Landsat 8 data properties

| LANDSAT 8 L1G PRODUCT ATTRIBUTE | |
|---------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Product Attribute | Description |
| Information Content | |
| Analytic Bands | |
| Pan | Band 8 |
| Visible, NIR, SWIR | Band 1-7 and Band 9 (Coastal/Aerosol, Blue, Green, Red, NIR, SWIR 1, SWIR 2, Cirrus) |
| Processing | |
| Pixel Size | 4-band Analytic DN Image (Blue, Green, Red, NIR) |
| | 1-band Panchromatic DN Image (Pan) |
| Pan | 15 m |
| Visible, NIR, SWIR | 30 m |
| TIR | 100 m |
| Bit Depth | 12-bit data depth, distributed as 16-bit data for easier processing |
| Geometric Corrections | The Geometric Processing Subsystem (GPS) creates L1 geometrically corrected imagery (L1G) from L1R products. The geometrically corrected products can be systematic terrain corrected (L1Gt) or precision terrain-corrected products (L1T). The GPS generates a satellite model, prepares a resampling grid, and resamples the data to create an L1Gt or L1T product. The GPS performs sophisticated satellite geometric correction to create the image according to the map projection and orientation specified for the L1 standard product. |
| Positional Accuracy | 12 m CE90 |
| Radiometric Corrections | <ul style="list-style-type: none">Converts the brightness of the L1R image pixels to absolute radiance in preparation for geometric correction. |

| | |
|----------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| | <ul style="list-style-type: none"> • Performs radiometric characterization of LOR images by locating radiometric artifacts in images. • Corrects radiometric artifacts and converts the image to radiance. |
| Metadata | Landsat 8 MTL text file |

6.2 SENTINEL-2 PRODUCT SPECIFICATION

For detailed characteristics of the Sentinel-2 sensor and mission please refer to the official Sentinel-2 documentation which can be found here:

<https://earth.esa.int/web/sentinel/user-guides/sentinel-2-msi/product-types/level-1c>

Table 5-B: Sentinel-2 Data Properties

| SENTINEL-2 LEVEL 1C PRODUCT ATTRIBUTE | |
|----------------------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Product Attribute | Description |
| Information Content | |
| Analytic Bands | |
| Visible, NIR | 4 bands at 10 m: blue (490 nm), green (560 nm), red (665 nm) and near infrared (842 nm). |
| RedEdge and NIR | 4 narrow bands for vegetation characterisation (705 nm, 740 nm, 783 nm and 865 nm) |
| SWIR | 2 larger SWIR bands (1610 nm and 2190 nm) |
| Aerosol, Water Vapor, Cirrus | 443 nm for aerosols, 945 for water vapour and 1375 nm for cirrus detection |
| Processing | |
| Pixel Size | |
| Visible, NIR (4 bands) | 10 m |
| RedEdge, NIR (6 bands) | 20 m |
| SWIR (2 bands) | 20 m |
| Cirrus, Aerosol, Water Vapor (3 bands) | 60 m |
| Bit Depth | 12 |
| Geometric Corrections | <ul style="list-style-type: none"> • Resampling on the common geometry grid for registration between the Global Reference Image (GRI) and the reference band. • Collection of the tie-points from the two images for registration between the GRI and the reference band. |

| | |
|-------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| | <ul style="list-style-type: none"> • Tie-points filtering for image-GRI registration: filtering of the tie-points over several areas. A minimum number of tie-points is required. • Refinement of the viewing model using the initialised viewing model and GCPs. The output refined model ensures registration between the GRI and the reference band. • Resampling grid computation: enabling linking of the native geometry image to the target geometry image (ortho-rectified). • Resampling of each spectral band in the geometry of the ortho-image using the resampling grids and an interpolation filter. |
| Positional Accuracy | 20 m 2σ without GCPs; 12.5 m 2σ with GCPs |
| Radiometric Corrections | <ul style="list-style-type: none"> • Dark Signal Correction • Pixel Response non-uniformity correction • Crosstalk correction • Defective pixels identification • High Spatial resolution bands restoration (deconvolution and de-noising) • Binning of the 60m spectral bands • TOA reflectance calculation |
| MetaData/Data Structure | <ul style="list-style-type: none"> • Level-1C_Tile_Metadata_File (Tile Metadata): XML main metadata file (DIMAP mandatory file) containing the requested level of information and referring all the product elements describing the tile. • IMG_DATA: folder containing image data files compressed using the JPEG2000 algorithm, one file per band. • QL_DATA: folder containing QLQC XML reports of quality checks, mask files and PVI files. • Inventory_Metadata.xml: inventory metadata file (mandatory). • manifest.safe: XML SAFE manifest file (Mandatory) • rep-info: folder containing the XSD schema provided inside a SAFE Level-0 granule |

+ 7. PRODUCT PROCESSING

7.1 PLANETSCOPE PROCESSING

Several processing steps are applied to PlanetScope imagery products, listed in the table below.

Table 6-A: PlanetScope Processing Steps

| PLANETSCOPE PROCESSING STEPS | |
|-----------------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Step | Description |
| Darkfield/Offset Correction | Corrects for sensor bias and dark noise. Master offset tables are created by averaging on-orbit darkfield collects across 5-10 degree temperature bins and applied to scenes during processing based on the CCD temperature at acquisition time. |
| Flat Field Correction | Flat fields are collected for each optical instrument prior to launch. These fields are used to correct image lighting and CCD element effects to match the optimal response area of the sensor. Flat fields are routinely updated on-orbit during the satellite lifetime. |
| Camera Acquisition Parameter Correction | Determines a common radiometric response for each image (regardless of exposure time, number of TDI stages, gain, camera temperature and other camera parameters). |
| Absolute Calibration | As a last step, the spatially and temporally adjusted datasets are transformed from digital number values into physical based radiance values (scaled to $W/(m^2 \cdot \mu m) \cdot 100$). |
| Visual Product Processing | <p>Presents the imagery as natural color, optimize colors as seen by the human eye. This process is broken down into 4 steps:</p> <ul style="list-style-type: none"> • Flat fielding applied to correct for vignetting. • Nominalization - Sun angle correction, to account for differences in latitude and time of acquisition. This makes the imagery appear to look like it was acquired at the same sun angle by converting the exposure time to the nominal time (noon). • Two filters applied: an unsharp mask for improving local dynamic range, and a sharpening filter for accentuating spatial features. • Custom color curve applied post warping. |
| Orthorectification | <p>This process is broken down into 2 steps:</p> <ul style="list-style-type: none"> • The rectification tiedown process wherein tie points are identified across the source images and a collection of reference images (ALOS, NAIP, OSM, Landsat) and RPCs are generated. • The actual orthorectification of the scenes using the RPCs, to remove terrain distortions. The terrain model used for the orthorectification process is derived from multiple sources (SRTM, Intermap, and other local elevation datasets) which are periodically updated. Snapshots of the elevation datasets used are archived (helps in identifying the DEM that was used for any given scene at any given point). |

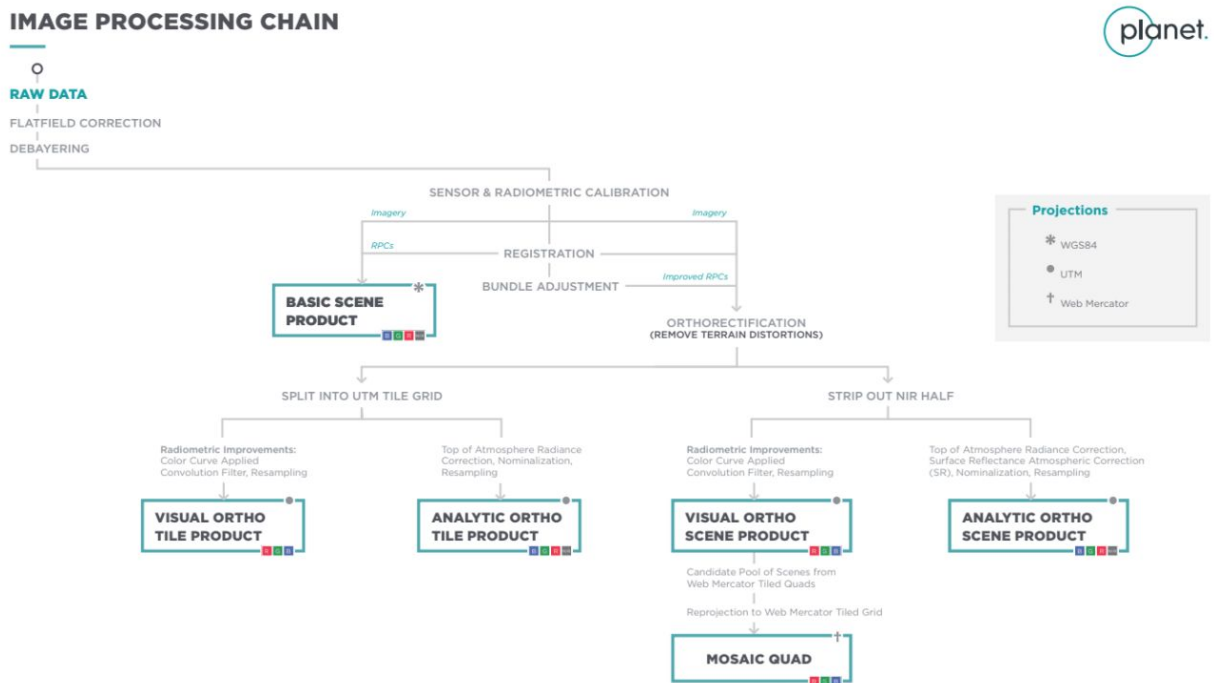
Atmospheric Correction

Removes atmospheric effects. This process consists of 3 steps:

- Top of Atmosphere (TOA) reflectance calculation using coefficients supplied with the at-sensor radiance product.
- Lookup table (LUT) generation using the 6SV2.1 radiative transfer code and MODIS near-real-time data inputs.
- Conversion of TOA reflectance to surface reflectance for all combinations of selected ranges of physical conditions and for each satellite sensor type using its individual spectral response as well as estimates of the state of the atmosphere.

The figure below illustrates the processing chain and steps involved to generate each of PlanetScope’s imagery products.

Figure 6: PlanetScope Image Processing Chain



7.2 RAPIDEYE PROCESSING

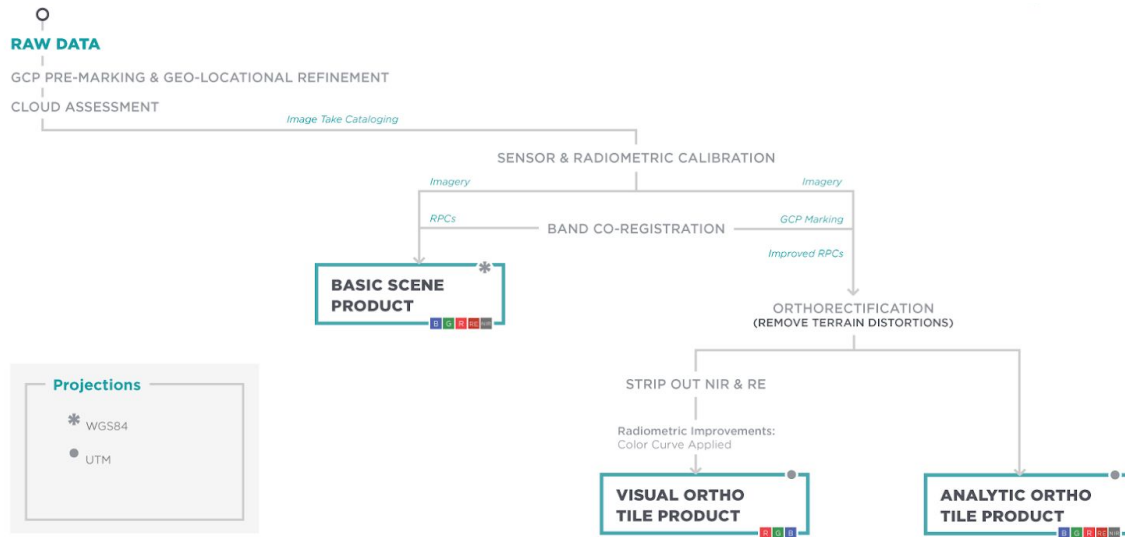
For RapidEye imagery products, the processing steps are listed in the table below.

Table 6-B: RapidEye Processing Steps

| RAPIDEYE PROCESSING STEPS | |
|-----------------------------------------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Step | Description |
| Flat Field Correction (also referred to as spatial calibration) | Correction parameters to achieve the common response of all CCD elements when exposed to the same amount of light have been collected for each optical instrument prior to launch. During operations, these corrections are adjusted every quarter or more frequently on an as-needed basis when effects become visible or measurable. The corrections are derived using side slither or statistical methods. This step additionally involves statistical adjustments of the read-out channel gains and offsets on a per image basis. |
| Temporal Calibration | Corrections are applied so that all RapidEye cameras read the same DN (digital number) regardless of when the image has been taken in the mission lifetime. Additionally with this step a cross calibration between all spacecraft is achieved. |
| Absolute Calibration | As a last step the spatially and temporally adjusted datasets are transformed from digital number values into physical based radiance values (scaled to $W/(m^2 \cdot \mu m) \cdot 100$). |
| Visual Product Processing | <p>Presents the imagery as natural color, optimize colors as seen by the human eye. This process is broken down into 3 steps:</p> <ul style="list-style-type: none"> • Nominalization - Sun angle correction, to account for differences in latitude and time of acquisition. This makes the imagery appear to look like it was acquired at the same sun angle by converting the exposure time to the nominal time (noon). • Unsharp mask (sharpening filter) applied before the warp process. • Custom color curve applied post warping. |
| Orthorectification | <p>Removes terrain distortions. This process is broken down into 2 steps:</p> <ul style="list-style-type: none"> • The rectification tiedown process wherein tie points are identified across the source images and a collection of reference images (ALOS, NAIP, Landsat) and RPCs are generated. • The actual orthorectification of the scenes using the RPCs, to remove terrain distortions. The terrain model used for the orthorectification process is derived from multiple sources (Intermap, NED, SRTM and other local elevation datasets) which are periodically updated. Snapshots of the elevation datasets used are archived (helps in identifying the DEM that was used for any given scene at any given point). |

The figure below illustrates the processing chain and steps involved to generate each of RapidEye's imagery products.

Figure 7: RapidEye Image Processing Chain



7.3 SKYSAT PROCESSING

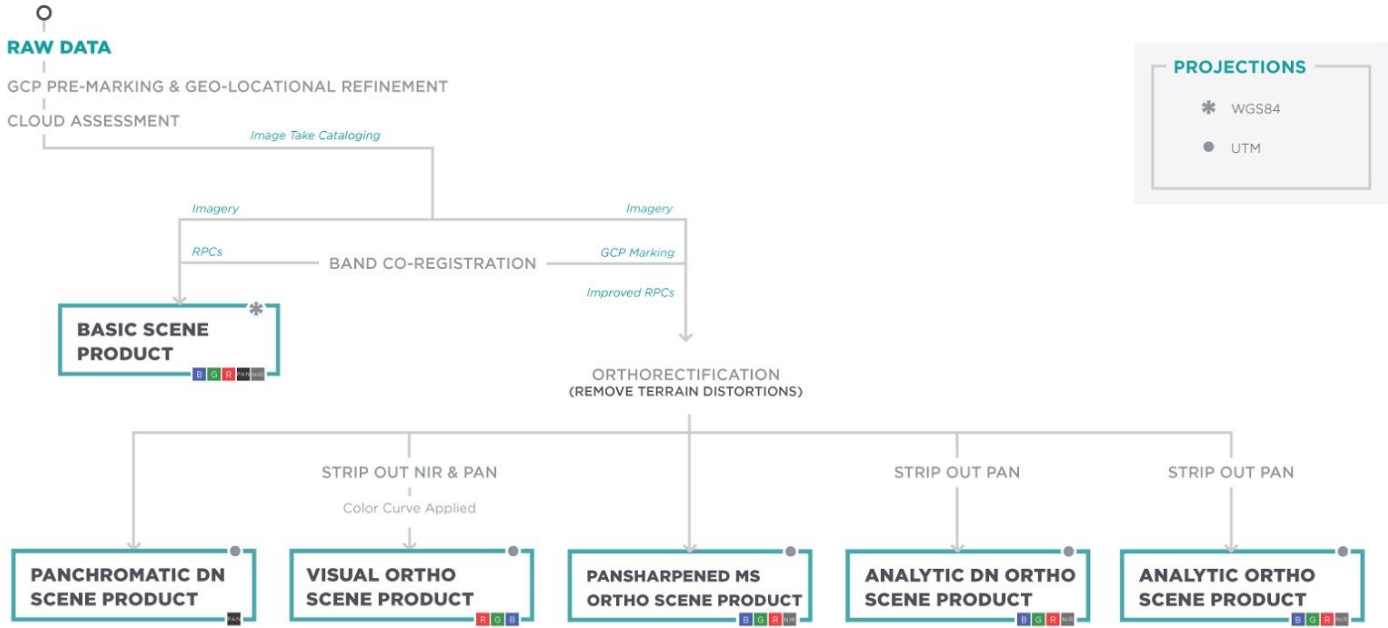
For SkySat imagery products, the processing steps are listed in the table below.

Table 6-C: SkySat Processing Steps

| SKYSAT PROCESSING STEPS | |
|--------------------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Step | Description |
| Darkfield/Offset Correction | Corrects for sensor bias and dark noise. Master offset tables are created by averaging ground calibration data collected across 5-10 degree temperature bins and applied to scenes during processing based on the CCD temperature at acquisition time. |
| Flat Field Correction | Flat fields are created using cloud flats collected on-orbit post-launch. These fields are used to correct image lighting and CCD element effects to match the optimal response area of the sensor. |
| Camera Acquisition Parameter Correction | Determines a common radiometric response for each image (regardless of exposure time, TDI, gain, camera temperature and other camera parameters). |
| Inter Sensor Radiometric Response (Intra Camera) | Cross calibrates the 3 sensors in each camera to a common relative radiometric response. The offsets between each sensor is derived using on-orbit cloud flats and the overlap regions between sensors on SkySat spacecraft. |
| Super Resolution (Level 1B Processing) | A super resolved image, SR, is the process of creating an improved resolution image fusing information from low resolution images, with the created higher resolution image being a better description of the scene. |
| Visual Product Processing | Presents the imagery as natural color, optimizing colors as seen by the human eye. Custom color curves applied post warping to deliver a visually appealing image. |
| Orthorectification | Removes terrain distortions. This process is broken down into 2 steps: The rectification tiedown process wherein tie points are identified across the source images and a collection of reference images (NAIP, ALOS, Landsat, and high resolution image chips) and RPCs are generated. The actual orthorectification of the scenes using the RPCs, to remove terrain distortions. The terrain model used for the orthorectification process is derived from multiple sources (SRTM, Intermap, and other local elevation datasets) which are periodically updated. Snapshots of the elevation datasets used are archived (helps in identifying the DEM that was used for any given scene at any given point. |

The figure below illustrates the processing chain and steps involved to generate SkySat's Basic and Ortho Scene products.

Figure 8: SkySat Image Processing Chain



Scenes also available mosaicked as a SkySatCollect

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8. PRODUCT METADATA

8.1 ORTHO TILES

8.1.1 PlanetScope

As mentioned in earlier sections, the Ortho Tile data in the Planet API will contain metadata in machine-readable GeoJSON and supported by standards-compliant GIS tools (e.g. GDAL and derivatives, JavaScript libraries). See APPENDIX A for info on general product XML metadata.

The table below describes the GeoJSON metadata schema for PlanetScope Ortho Tile products:

Table 7-A: PlanetScope Ortho Tile GeoJSON Metadata Schema

PLANETSCOPE ORTHO TILE GEOJSON METADATA SCHEMA

| Parameter | Description | Type |
|-----------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------------|
| acquired | The RFC 3339 acquisition time of the image. | string |
| anomalous_pixel | Percentage of anomalous pixels. Pixels that have image quality issues documented in the quality taxonomy (e.g. hot columns). This is represented spatially within the UDM. | number |
| black_fill | Ratio of image containing artificial black fill due to clipping to actual data. | number (0 - 1) |
| cloud_cover | Ratio of the area covered by clouds to that which is uncovered. | number (0 - 1) |
| columns | Number of columns in the image. | number |
| epsg_code | The identifier for the grid cell that the imagery product is coming from if the product is an Ortho Tile (not used if Scene). | number |
| grid_cell | The grid cell identifier of the gridded item. | string |
| 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. "PSOrthoTile") |
| origin_x | ULX coordinate of the extent of the data. The coordinate references the top left corner of the top left pixel. | number |
| origin_y | ULY coordinate of the extent of the data. The coordinate references the top left corner of the top left pixel. | number |
| pixel_resolution | Pixel resolution of the imagery in meters. | number |
| provider | Name of the imagery provider. | string (e.g. "planetscope","rapideye") |
| 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" or "test" |
| rows | Number of rows in the image. | number |
| satellite_id | Globally unique identifier of the satellite that acquired the underlying imagery. | 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) |

8.1.2 RapidEye

The table below describes the GeoJSON metadata schema for RapidEye Ortho Tile products:

Table 7-B: RapidEye Ortho Tile GeoJSON Metadata Schema

| RAPIDEYE ORTHO TILE GEOJSON METADATA SCHEMA | | |
|---------------------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------------------------|
| Parameter | Description | Type |
| acquired | The RFC 3339 acquisition time of the image. | string |
| catalog_id | The catalog ID for the RapidEye Basic Scene product. | string |
| anomalous_pixel | Percentage of anomalous pixels. Pixels that have image quality issues documented in the quality taxonomy (e.g. hot columns). This is represented spatially within the UDM. | number |
| black_fill | Ratio of image containing artificial black fill due to clipping to actual data. | number (0 - 1) |
| cloud_cover | Ratio of the area covered by clouds to that which is uncovered. | number (0 - 1) |
| columns | Number of columns in the image. | number |
| epsg_code | The identifier for the grid cell that the imagery product is coming from if the product is an Ortho Tile (not used if Scene) | number |
| grid_cell | The grid cell identifier of the gridded item. | string |
| 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 "REOrthoTile") |
| origin_x | ULX coordinate of the extent of the data. The coordinate references the top left corner of the top left pixel | number |

| | | |
|------------------|------------------------------------------------------------------------------------------------------------------|----------------------------------------|
| origin_y | ULY coordinate of the extent of the data. The coordinate references the top left corner of the top left pixel | number |
| pixel_resolution | Pixel resolution of the imagery in meters. | number |
| provider | Name of the imagery provider. | string (e.g. "planetscope","rapideye") |
| published | The RFC 3339 timestamp at which this item was added to the API. | string |
| rows | Number of rows in the image. | number |
| satellite_id | Globally unique identifier of the satellite that acquired the underlying imagery. | 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 |
| usable_data | Ratio of the usable to unusable portion of the imagery due to cloud cover or black fill. | number (0 - 1) |
| view_angle | Spacecraft across-track off-nadir viewing angle used for imaging, in degrees with + being east and - being west. | number (-25 - +25) |

8.2 ORTHO SCENES

8.2.1 PlanetScope

The table below describes the GeoJSON metadata schema for PlanetScope Ortho Scene products:

Table 7-C: PlanetScope Ortho Scene GeoJSON Metadata Schema

| PLANETSCOPE ORTHO SCENE GEOJSON METADATA SCHEMA | | |
|-------------------------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------------------------------------------|
| Parameter | Description | Type |
| acquired | The RFC 3339 acquisition time of the image. | string |
| anomalous_pixel | Percentage of anomalous pixels. Pixels that have image quality issues documented in the quality taxonomy (e.g. hot columns). This is represented spatially within the UDM. | number |
| cloud_cover | Ratio of the area covered by clouds to that which is uncovered. | number (0 - 1) |
| columns | Number of columns in the image. | number |
| 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 |
| instrument | The generation of the satellite telescope. | string (e.g. "PS2", "PS2.SD") |
| item_type | The name of the item type that models shared imagery data schema. | string (e.g. "PSScene3Band", "PSScene4Band") |
| origin_x | ULX coordinate of the extent of the data. The coordinate references the top left corner of the top left pixel. | number |
| origin_y | ULY coordinate of the extent of the data. The coordinate references the top left corner of the top left pixel. | number |
| pixel_resolution | Pixel resolution of the imagery in meters. | number |
| provider | Name of the imagery provider. | string (e.g. "planetScope", "rapideye") |

| | | |
|------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------------------------|
| 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" or "test" |
| rows | Number of rows in the image. | number |
| satellite_jd | Globally unique identifier of the satellite that acquired the underlying imagery. | 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) |

The PlanetScope Ortho Scenes Surface Reflectance product is provided as a 16-bit GeoTIFF image with reflectance values scaled by 10,000. Associated metadata describing inputs to the correction is included in a GeoTIFF TIFFTAG_IMAGEDESCRIPTION metadata header as a JSON encoded string.

The table below describes the metadata schema for Surface Reflectance products stored in the GeoTIFF header:

Table 7-D: PlanetScope Ortho Scene Surface Reflectance GeoTIFF Metadata Schema

PLANETSCOPE ORTHO SCENE SURFACE REFLECTANCE GEOTIFF METADATA SCHEMA

| Parameter | Description | Example |
|----------------------------------|---------------------------------------------------------------------------------------------------------------------------------|----------------------------------|
| aerosol_model | 6S aerosol model used | continental |
| aot_coverage | Percentage overlap between MODIS data and the scene being corrected | 0.5625 |
| aot_method | Method used to derive AOD value(s) for an image. Currently only 'fixed' is used, indicating a single value for the entire image | fixed |
| aot_mean_quality | Average MODIS AOD quality value for the overlapping NRT data in the range 1-10. This is set to 127 when no data is available | 1.0 |
| aot_source | Source of the AOD data used for the correction | mod09cma_nrt |
| aot_std | Standard deviation of the averaged MODIS AOD data | 0.033490001296168699 |
| aot_status | A text string indicating state of AOD retrieval. If no data exists from the source used, a default value 0.226 is used | Missing Data - Using Default AOT |
| aot_used | Aerosol optical depth used for the correction | 0.061555557780795626 |
| atmospheric_correction_algorithm | The algorithm used to generate LUTs | 6SV2.1 |
| atmospheric_model | Custom model or 6S atmospheric model used | water_vapor_and_ozone |
| luts_version | Version of the LUTs used for the correction | 3 |
| ozone_coverage | Percentage overlap between MODIS data and the scene being corrected | 0.53125 |
| ozone_mean_quality | Average MODIS ozone quality value for the overlapping NRT data. This will always be 255 if data is present | 255 |
| ozone_method | Method used to derive ozone value(s) for an image. Currently only 'fixed' is used, | fixed |

| | | |
|--------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------------|
| | indicating a single value for the entire image | |
| ozone_source | Source of the ozone data used for the correction | mod09cmg_nrt |
| ozone_status | A text string indicating state of ozone retrieval. If no ozone data is available for the scene being corrected, the corrections falls back to a 6SV built-in atmospheric model | Data Found |
| ozone_std | Standard deviation of the averaged MODIS ozone data. | 0 |
| ozone_used | Ozone concentration used for the correction, in cm-atm | 0.255 |
| satellite_azimuth_angle | Always defined to be 0.0 degrees and solar zenith angle measured relative to it | 0.0 |
| satellite_zenith_angle | Satellite zenith angle, fixed to nadir pointing | 0.0 |
| solar_azimuth_angle | Sun azimuth angle relative to satellite, in degrees | 111.42044562850029 |
| solar_zenith_angle | Solar zenith angle in degrees | 30.26950393461825 |
| sr_version | Version of the correction applied. | 1.0 |
| water_vapor_coverage | Percentage overlap between MODIS data and the scene being corrected | 0.53215 |
| water_vapor_mean_quality | Average MODIS ozone quality value for the overlapping NRT data in the range 1-10. This is set to 127 when no data is available | 1.5294 |
| water_vapor_method | Method used to derive water vapor value(s) for an image. Currently only 'fixed' is used, indicating a single value for the entire image | fixed |
| water_vapor_source | Source of the water vapor data used for the correction | mod09cma_nrt |
| water_vapor_status | A text string indicating state of water vapor retrieval. If no water vapor data is available for the scene being corrected, the corrections falls back to a 6SV built-in atmospheric model | Data Found |
| water_vapor_std | Standard deviation of the averaged MODIS AOD data | 0.0587 |

| | | |
|----------------------------------|-----------------------------------------------------------------------------------------------------------------------------------|----------------------------------|
| water_vapor_used | Water vapor concentration used for the correction in g/cm ² | 4.0512 |
| aerosol_model | 6S aerosol model used | continental |
| aot_coverage | Percentage overlap between MODIS data and the scene being corrected | 0.5625 |
| aot_method | Method used to derive AOD value(s) for an image. Currently only 'fixed' is used, indicating a single value for the entire image | fixed |
| aot_mean_quality | Average MODIS AOD quality value for the overlapping NRT data in the range 1-10. This is set to 127 when no data is available | 1.0 |
| aot_source | Source of the AOD data used for the correction | mod09cma_nrt |
| aot_std | Standard deviation of the averaged MODIS AOD data | 0.033490001296168699 |
| aot_status | A text string indicating state of AOD retrieval. If no data exists from the source used, a default value 0.226 is used | Missing Data - Using Default AOT |
| aot_used | Aerosol optical depth used for the correction | 0.061555557780795626 |
| atmospheric_correction_algorithm | The algorithm used to generate LUTs | 6SV2.1 |
| atmospheric_model | Custom model or 6S atmospheric model used | water_vapor_and_ozone |
| luts_version | Version of the LUTs used for the correction | 3 |
| ozone_coverage | Percentage overlap between MODIS data and the scene being corrected | 0.53125 |
| ozone_mean_quality | Average MODIS ozone quality value for the overlapping NRT data. This will always be 255 if data is present | 255 |
| ozone_method | Method used to derive ozone value(s) for an image. Currently only 'fixed' is used, indicating a single value for the entire image | fixed |
| ozone_source | Source of the ozone data used for the correction | mod09cmg_nrt |

| | | |
|--------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------------|
| ozone_status | A text string indicating state of ozone retrieval. If no ozone data is available for the scene being corrected, the corrections falls back to a 6SV built-in atmospheric model | Data Found |
| ozone_std | Standard deviation of the averaged MODIS ozone data. | 0 |
| ozone_used | Ozone concentration used for the correction, in cm-atm | 0.255 |
| satellite_azimuth_angle | Always defined to be 0.0 degrees and solar zenith angle measured relative to it | 0.0 |
| satellite_zenith_angle | Satellite zenith angle, fixed to nadir pointing | 0.0 |
| solar_azimuth_angle | Sun azimuth angle relative to satellite, in degrees | 111.42044562850029 |
| solar_zenith_angle | Solar zenith angle in degrees | 30.26950393461825 |
| sr_version | Version of the correction applied. | 1.0 |
| water_vapor_coverage | Percentage overlap between MODIS data and the scene being corrected | 0.53215 |
| water_vapor_mean_quality | Average MODIS ozone quality value for the overlapping NRT data in the range 1-10. This is set to 127 when no data is available | 1.5294 |
| water_vapor_method | Method used to derive water vapor value(s) for an image. Currently only 'fixed' is used, indicating a single value for the entire image | fixed |
| water_vapor_source | Source of the water vapor data used for the correction | mod09cma_nrt |
| water_vapor_status | A text string indicating state of water vapor retrieval. If no water vapor data is available for the scene being corrected, the corrections falls back to a 6SV built-in atmospheric model | Data Found |
| water_vapor_std | Standard deviation of the averaged MODIS AOD data | 0.0587 |
| water_vapor_used | Water vapor concentration used for the correction in g/cm ² | 4.0512 |

8.2.2 SkySat

The table below describes the GeoJSON metadata schema for SkySat Ortho Scene products:

Table 7-E: 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 a variety of quality standards, for example: PAN motion blur less than 1.15 pixels, compression bits per pixel less than 3. 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) |

8.3 BASIC SCENES

8.3.1 PlanetScope

The table below describes the GeoJSON metadata schema for PlanetScope Basic Scene products:

Table 7-F: PlanetScope Basic Scene GeoJSON Metadata Schema

PLANETSCOPE BASIC SCENE GEOJSON METADATA SCHEMA

| Parameter | Description | Type |
|-----------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------------|
| acquired | The RFC 3339 acquisition time of the image. | string |
| anomalous_pixel | Percentage of anomalous pixels. Pixels that have image quality issues documented in the quality taxonomy (e.g. hot columns). This is represented spatially within the UDM. | number |
| cloud_cover | Ratio of the area covered by clouds to that which is uncovered. | number (0 - 1) |
| columns | Number of columns in the image. | number |
| epsg_code | The identifier for the grid cell that the imagery product is coming from if the product is an imagery tile (not used if scene). | number |
| 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 |
| instrument | The generation of the satellite telescope. | string (e.g. "PS2", "PS2.SD") |
| item_type | The name of the item type that models shared imagery data schema. | string (e.g. "PSScene3Band", "PSScene4Band") |
| origin_x | ULX coordinate of the extent of the data. The coordinate references the top left corner of the top left pixel. | number |
| origin_y | ULY coordinate of the extent of the data. The coordinate references the top left corner of the top left pixel. | number |
| provider | Name of the imagery provider. | string (e.g. "planetscope","rapideye") |
| 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" or "test" |
| rows | Number of rows in the image. | number |
| satellite_id | Globally unique identifier of the satellite that acquired the underlying imagery. | 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) |

8.3.2 RapidEye

The table below describes the GeoJSON metadata schema for RapidEye Basic Scene products:

Table 7-G: RapidEye Basic Scene GeoJSON Metadata Schema

| RAPIDEYE BASIC SCENE GEOJSON METADATA SCHEMA | | |
|----------------------------------------------|---------------------------------------------------------------------------------------------------------------------------------|------------------|
| Parameter | Description | Type |
| acquired | The time that image was taken in ISO 8601 format, in UTC. | string |
| anomalous_pixel | Count of any identified anomalous pixels | number |
| cloud_cover | The estimated percentage of the image covered by clouds. | number (0 - 100) |
| gsd | The ground sample distance (distance between pixel centers measured on the ground) of the image in meters. | number |
| black_fill | The percent of image pixels without valid image data. It is always zero. | number (0) |
| catalog_id | The catalog ID for the RapidEye Basic Scene product. | string |
| satellite_id | A unique identifier for the satellite that captured this image. | string |
| view_angle | The view angle in degrees at which the image was taken. | number |
| strip_id | The RapidEye Level 1B catalog id for older LIB products or the ImageTake ID for newer versions. | string |
| sun_elevation | The altitude (angle above horizon) of the sun from the imaged location at the time of capture in degrees. | number |
| sun_azimuth | The azimuth (angle clockwise from north) of the sun from the imaged location at the time of capture in degrees. | number |
| updated | The last time this asset was updated in the Planet archive. Images may be updated after they are originally published | string |
| usable_data | Amount of image that is considered usable data, for example non-cloud cover pixels, | Number (0-1) |

| | | |
|-----------|-----------------------------------------------------------|--------------------|
| | expressed as a percentage. Applies only to RapidEye data. | |
| columns | The number of columns in the image | number |
| rows | The number of rows in the image | number |
| published | The date the image was originally published | string |
| provider | The satellite constellation | String: "rapideye" |
| item_type | The item type as catalogued in the Planet Archive | String: "REScene" |

8.3.3 SkySat

The table below describes the GeoJSON metadata schema for SkySat Basic Scene products:

Table 7-H: 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 a variety of quality standards, for example: PAN motion blur less than 1.15 pixels, compression bits per pixel less than 3. 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) |

8.4 ORTHO COLLECT

8.4.1 SkySat

The table below describes the GeoJSON metadata schema for SkySat Ortho Collect products:

Table 8: 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 a variety of quality standards, for example: PAN motion blur less than 1.15 pixels, compression bits per pixel less than 3. 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) |
| ground_lock_ratio | The percentage of SkySat frames that make up the full Collect product that have good ground control | Number (0 - 1) |



9. PRODUCT DELIVERY

All imagery products are made available via Application Processing Interface (API) and Graphical User Interface (GUI).

9.1 PLANET APPLICATION PROGRAMMING INTERFACE (API)

The Planet API offers REST API access that allows listing, filtering, and downloading of data to anyone using a valid API key. The metadata features described later in this document are all available in the responses to API queries. The full TIFF / GeoTIFF image data files are accessible (in the different product formats) at the /full URL endpoints.

Metadata associate with imagery products can be requested through the Data API endpoint:

api.planet.com/data/v1/.

The table below shows a list of all the item types in the Data API:

Table 9-A: Planet Data API - Item Types

| Item Type | Description |
|--------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| PSScene3Band | PlanetScope 3-band Basic and Ortho Scenes. Scenes are framed as captured. <ul style="list-style-type: none">Analytic imagery band order: Band 1 = Red, Band 2 = Green, Band 3 = BlueVisual imagery band order: Band 1 = Red, Band 2 = Green, Band 3 = Blue |
| PSScene4Band | PlanetScope 4-band Basic and Ortho Scenes. Scenes are framed as captured. <ul style="list-style-type: none">Analytic imagery band order: Band 1 = Blue, Band 2 = Green, Band 3 = Red, Band 4 = Near-infrared |
| PSOrthoTile | PlanetScope 4-band Ortho Tiles as 25 km x 25 km UTM tiles. <ul style="list-style-type: none">Analytic imagery band order: Band 1 = Blue, Band 2 = Green, Band 3 = Red, Band 4 = Near-infraredVisual imagery Band order: Band 1 = Red, Band 2 = Green, Band 3 = Blue |
| REScene | RapidEye 5-band Basic, scene-/strip- based framing. <ul style="list-style-type: none">Analytic imagery band order: Band 1 = Blue, Band 2 = Green, Band 3 = Red, Band 4 = Red edge, Band 5 = Near-infrared |
| REOrthoTile | RapidEye 5-band Ortho Tiles as 25 km x 25 km UTM tiles. <ul style="list-style-type: none">Analytic imagery band order: Band 1 = Blue, Band 2 = Green, Band 3 = Red, Band 4 = Red edge, Band 5 = Near-infraredVisual imagery band order: Band 1 = Red, Band 2 = Green, Band 3 = Blue |
| Sentinel2LIC | Sentinal-2 LIC data packed zip file |
| Landsat8LIG | Landsat 8 data packed zip file |
| SkySatScene | SkySat Basic and Ortho Scenes are framed as captured: <ul style="list-style-type: none">Basic Analytic DN: Band 1 = Blue, Band 2 = Green, Band 3 = Red, Band 4 = Near-infraredBasic Panchromatic DN: Band 1 = Pan |

| | |
|---------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| | <ul style="list-style-type: none"> • Visual: Band 1 = Red, Band 2 = Green, Band 3 = Blue • Pansharpend: Band 1 = Blue, Band 2 = Green, Band 3 = Red, Band 4 = Near-infrared • Analytic DN: Band 1 = Blue, Band 2 = Green, Band 3 = Red, Band 4 = Near-infrared • Panchromatic DN: Band 1 = Pan |
| SkySatCollect | The Ortho Collect product is created by composing SkySat Ortho Scenes along an imaging strip into segments typically consisting of about 60 SkySat Ortho Scenes. |

The table below shows a list of all the asset types in the Data API:

Table 9-B: Planet Data API - Asset Types

| Asset Type | Description |
|-----------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| analytic | <ul style="list-style-type: none"> • Radiometrically-calibrated analytic imagery stored as 16-bit scaled radiance, suitable for analytic applications. |
| analytic_b1 | Band 1 |
| analytic_b10 | Band 10 |
| analytic_b11 | Band 11 |
| analytic_b12 | Band 12 |
| analytic_b2 | Band 2 |
| analytic_b3 | Band 3 |
| analytic_b4 | Band 4 |
| analytic_b5 | Band 5 |
| analytic_b6 | Band 6 |
| analytic_b7 | Band 7 |
| analytic_b8 | Band 8 |
| analytic_b8a | Band 8a |
| analytic_b9 | Band 9 |
| analytic_bqa | Band QA |
| analytic_dn | Non-radiometrically-calibrated analytic image stored as 12-bit digital numbers |
| analytic_dn_xml | Non-radiometrically-calibrated analytic image metadata |
| analytic_ms | True Color Composite |
| analytic_sr | Atmospherically-corrected analytic imagery stored as 16-bit scaled (surface) reflectance, suitable for analytic applications. |

| | |
|------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| analytic_xml | Radiometrically-calibrated analytic image metadata |
| basic_analytic | Unorthorectified radiometrically-calibrated analytic image stored as 16-bit scaled radiance |
| basic_analytic_b1 | RapidEye band 1 (Blue) scaled Top of Atmosphere Radiance (at sensor) and Sensor corrected, Basic Scene product designed for users with advanced image processing and geometric correction capabilities. Scene based framing and not projected to a cartographic projection. |
| basic_analytic_b1_nitf | RapidEye band 1 (Blue) scaled Top of Atmosphere Radiance (at sensor) and Sensor corrected, Basic Scene product in the NITF format, designed for users with advanced image processing and geometric correction capabilities. Scene based framing and not projected to a cartographic projection. |
| basic_analytic_b2 | RapidEye band 2 (Green) scaled Top of Atmosphere Radiance (at sensor) and Sensor corrected, Basic Scene product designed for users with advanced image processing and geometric correction capabilities. Scene based framing and not projected to a cartographic projection. |
| basic_analytic_b2_nitf | RapidEye band 2 (Green) scaled Top of Atmosphere Radiance (at sensor) and Sensor corrected, Basic Scene product in the NITF format, designed for users with advanced image processing and geometric correction capabilities. Scene based framing and not projected to a cartographic projection. |
| basic_analytic_b3 | RapidEye band 3 (Red) scaled Top of Atmosphere Radiance (at sensor) and Sensor corrected, Basic Scene product designed for users with advanced image processing and geometric correction capabilities. Scene based framing and not projected to a cartographic projection. |
| basic_analytic_b3_nitf | RapidEye band 3 (Red) scaled Top of Atmosphere Radiance (at sensor) and Sensor corrected, Basic Scene product in the NITF format, designed for users with advanced image processing and geometric correction capabilities. Scene based framing and not projected to a cartographic projection. |
| basic_analytic_b4 | RapidEye band 4 (Red Edge) scaled Top of Atmosphere Radiance (at sensor) and Sensor corrected, Basic Scene product designed for users with advanced image processing and geometric correction capabilities. Scene based framing and not projected to a cartographic projection. |
| basic_analytic_b4_nitf | RapidEye band 4 (Red Edge) scaled Top of Atmosphere Radiance (at sensor) and Sensor corrected, Basic Scene product in the NITF format, designed for users with advanced image processing and geometric correction capabilities. Scene based framing and not projected to a cartographic projection. |
| basic_analytic_b5 | RapidEye band 5 (Near-infrared) scaled Top of Atmosphere Radiance (at sensor) and Sensor corrected, Basic Scene product designed for users with advanced image processing and geometric correction capabilities. Scene based framing and not projected to a cartographic projection. |
| basic_analytic_b5_nitf | RapidEye band 5 (Near Infrared) scaled Top of Atmosphere Radiance (at sensor) and Sensor corrected, Basic Scene product in the NITF format, designed for users with advanced image processing and geometric correction capabilities. Scene based framing and not projected to a cartographic projection. |
| basic_analytic_dn | Unorthorectified non-radiometrically-calibrated analytic image stored as 12-bit digital numbers |
| basic_analytic_dn_nitf | Unorthorectified non-radiometrically-calibrated analytic image stored as 12-bit digital numbers in NITF format |

| | |
|----------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------|
| basic_analytic_dn_rpc | Rational polynomial coefficient for unorthorectified non-radiometrically-calibrated analytic image stored as 12-bit digital numbers |
| basic_analytic_dn_rpc_nitf | Rational polynomial coefficient for unorthorectified non-radiometrically-calibrated analytic image stored as 12-bit digital numbers in NITF format |
| basic_analytic_dn_xml | Unorthorectified non-radiometrically-calibrated analytic image metadata |
| basic_analytic_dn_xml_nitf | Unorthorectified non-radiometrically-calibrated analytic image metadata in NITF format |
| basic_analytic_nitf | Unorthorectified radiometrically-calibrated analytic image stored as 16-bit scaled radiance in NITF format |
| basic_analytic_rpc | Rational polynomial coefficient for unorthorectified radiometrically-calibrated analytic image stored as 16-bit scaled radiance |
| basic_analytic_rpc_nitf | Rational polynomial coefficient for unorthorectified radiometrically-calibrated analytic image stored as 16-bit scaled radiance in NITF format |
| basic_analytic_sci | The RapidEye Spacecraft Information XML Metadata file. |
| basic_analytic_xml | Unorthorectified radiometrically-calibrated analytic image metadata |
| basic_analytic_xml_nitf | Unorthorectified radiometrically-calibrated analytic image metadata in NITF format |
| basic_panchromatic_dn | This is a Basic Scene Panchromatic DN Image |
| basic_panchromatic_dn_rpc | This is a Basic Panchromatic DN RPC File |
| basic_udm | Unorthorectified unusable data mask |
| basic_udm2 | Unorthorectified usable data mask |
| browse | Visual browse image for the Basic Scene product. |
| metadata_aux | Sentinel metadata |
| metadata_txt | Text file containing metadata information pertaining to the specific scene. |
| ortho_analytic_dn | Orthorectified 16-bit 4-Band DN Image |
| ortho_analytic_udm | Orthorectified 16-bit 4-Band DN Image Unusable Data Mask |
| ortho_panchromatic_dn | Orthorectified 16-bit 1-band Image |
| ortho_panchromatic_udm | Orthorectified 16-bit 1-band Image Unusable Data Mask |
| ortho_pansharpened | Orthorectified 16-bit 4-band Pansharpened Image |
| ortho_pansharpened_udm | Orthorectified 16-bit 4-band Pansharpened Image Unusable Data Mask |
| ortho_visual | Orthorectified 8-bit 3-band Pansharpened Image |
| udm | Unusable data mask |
| udm2 | Usable data mask |
| visual | Visual image with color-correction |

9.2 PLANET GRAPHICAL USER INTERFACE (GUI)

The Planet Explorer Beta is a set of web-based GUI tools that can be used to search Planet's catalog of imagery, view metadata, and download full-resolution images. The interface and all of its features are built entirely on the externally available Planet API.

The link to the Planet Explorer Beta is: www.planet.com/explorer.

Planet's GUI allows users to:

1. **View Timelapse Mosaics:** A user can view Planet's quarterly and monthly mosaics for all of 2016, and can zoom in up to zoom level 12 (38 m / pixel per [OpenStreetMap](#))
2. **Search:** A user can Search for any location or a specific area of interest by entering into the input box OR by uploading a geometry file (Shapefile, GeoJSON, KML, or WKT).
3. **Save Search:** The Save functionality allows a user to save search criteria based on area of interest, dates, and filters.
4. **Filter:** A user can filter by a specific date range and/or customizing metadata parameters (e.g. estimated cloud cover, GSD).
5. **Zoom and Preview Imagery:** Zoom and Preview allows a user to zoom in or out of the selected area and preview imagery.
6. **View Imagery Details:** A user can review metadata details about each imagery product.
7. **Download:** The Download icon allows a user to download imagery based on subscription type.
8. **Draw Tools:** These tools allow you to specify an area to see imagery results. The draw tool capabilities available are drawing a circle, drawing a rectangle, drawing a polygon, and/or limiting the size of the drawing to the size of loadable imagery.
9. **Imagery Compare Tool:** The Compare Tool allows you to compare sets of Planet imagery from different dates.

Planet will also enable additional functionality in the form of "Labs," which are demonstrations of capability made accessible to users through the GUI. Labs are active product features and will evolve over time based on Planet technology evolution and user feedback.

9.3 PLANET ACCOUNT MANAGEMENT TOOLS

As part of the Planet GUI, an administration and account management tool is provided. This tool is used to change user settings and to see past data orders. In addition, users who have administrator privileges will be able to manage users in their organization as well as review usage statistics.

The core functionality provided by account management tools are outlined below, and Planet may evolve Account Management tools over time to meet user needs:

1. **User Accounts Overview:** Every user account on the Planet Platform is uniquely identified by an email address. Each user also has a unique API key that can be used when interacting programmatically with the Platform.
2. **Organization and Sub-organization Overview:** Every user on the Planet Platform belongs to one organization. The Platform also supports “sub-organizations,” which are organizations that are attached to a “parent” organization. An administrator of a parent organization is also considered an administrator on all sub-organizations.
3. **Account Privileges:** Every user account on the Planet Platform has one of two roles: user or administrator. An administrator has elevated access and can perform certain user management operations or download usage metrics that are not available to standard users. An administrator of a parent organization is also considered an administrator on all sub-organizations. Administrators can enable or disable administrator status and enable or disable users’ access to the platform altogether.
4. **Orders and Usage Review:** This tool records all part orders made and allows users and administrators to view and download past orders. Usage metrics are also made available, including imagery products downloaded and bandwidth usage. Usage metrics are displayed for each individual API key that is part of the organization.

9.4 FILE FORMAT

The Basic Scene products are available as NITF and GeoTIFFs; the Visual and Analytic Ortho Tile products are GeoTIFFs.

The Ortho Tile product GeoTIFFs are resampled at 3.125 m, and projected in the UTM projection using the WGS84 datum. An alpha mask is provided as a binary color channel. The alpha mask can be used to remove or hide low-image-quality pixels near the periphery of a given scene. The alpha mask compensates for effects due to vignetting, low SNR, or hot or cold pixels.

The Ortho Scene product GeoTIFFs are resampled at 3 m, and projected in the UTM projection using the WGS84 datum. An alpha mask is provided as a binary color channel. The alpha mask can be used to remove or hide low-image-quality pixels near the periphery of a given scene. The alpha mask compensates for effects due to vignetting, low SNR, or hot or cold pixels. The Ortho Scene Surface Reflectance product is provided as a GeoTIFF image with reflectance values scaled by 10,000. Associated metadata describing inputs to the atmospheric correction is included in a GeoTIFF TIFFTAG_IMAGEDESCRIPTION metadata header as a JSON encoded string.

Landsat 8 and Sentinel-2 data are passed through in the original provider's format. In the case of Landsat 8 the format is geotiff. In the case of Sentinel-2, the format is jpeg2000.

9.5 BULK DELIVERY FOLDER STRUCTURE

Sets of imagery products can be ordered through the Planet API. The name of the parent folder is:

- planet_order_[id]

Bulk deliveries are delivered in a .zip folder file format. Each .zip file contains:

- A README file with information about the order.
- A subfolder for each scene requested named with the scene id.
- Each subfolder contains the TIFF or GeoTIFF requested and an associated metadata file.
- If basic data is requested, the subfolder will also contain an RPC text file.



APPENDIX A – IMAGE SUPPORT DATA

All PlanetScope Ortho Tile Products are accompanied by a set of image support data (ISD) files. These ISD files provide important information regarding the image and are useful sources of ancillary data related to the image. The ISD files are:

1. General XML Metadata File
2. Unusable Data Mask File
3. Usable Data Mask File

Each file is described along with its contents and format in the following sections.

1. GENERAL XML METADATA FILE

All PlanetScope Ortho Tile Products will be accompanied by a single general XML metadata file. This file contains a description of basic elements of the image. The file is written in Geographic Markup Language (GML) version 3.1.1 and follows the application schema defined in the Open Geospatial Consortium (OGC) Best Practices document for Optical Earth Observation products version 0.9.3, see <http://www.opengeospatial.org/standards/gml>.

The contents of the metadata file will vary depending on the image product processing level. All metadata files will contain a series of metadata fields common to all imagery products regardless of the processing level. However, some fields within this group of metadata may only apply to certain product levels. In addition, certain blocks within the metadata file apply only to certain product types. These blocks are noted within the table.

The table below describes the fields present in the General XML Metadata file for all product levels.

Table A-1: General XML Metadata File Field Descriptions

| GENERAL XML METADATA FILE FIELD DESCRIPTIONS | |
|----------------------------------------------|--------------------------------------------------------------------------------------|
| Field | Description |
| "metaDataProperty" Block | |
| EarthObservationMetaData | |
| Identifier | Root file name of the image |
| status | Status type of image, if newly acquired or produced from a previously archived image |
| downloadedTo | |
| acquisitionStation | X-band downlink station that received image from satellite |
| acquisitionDate | Date and time image was acquired by satellite |

| | |
|----------------------------------|-----------------------------------------------------------------------------------------|
| archivedIn | |
| archivingCenter | Location where image is archived |
| archivingDate | Date image was archived |
| archivingIdentifier | Catalog ID of image |
| processing | |
| processorName | Name of ground processing system |
| processorVersion | Version of processor |
| nativeProductFormat | Native image format of the raw image data |
| license | |
| licenseType | Name of selected license for the product |
| resourceLink | Hyperlink to the physical license file |
| versionIsd | Version of the ISD |
| orderId | Order ID of the product |
| tileId | Tile ID of the product corresponding to the Tile Grid |
| pixelFormat | Number of bits per pixel per band in the product image file |
| “validTime” Block | |
| TimePeriod | |
| beginPosition | Start date and time of acquisition for source image take used to create product, in UTC |
| endPosition | End date and time of acquisition for source image take used to create product, in UTC |
| “using” Block | |
| EarthObservationEquipment | |
| platform | |
| shortName | Identifies the name of the satellite platform used to collect the image |
| serialIdentifier | ID of the satellite that acquired the data |
| orbitType | Orbit type of satellite platform |
| instrument | |
| shortName | Identifies the name of the satellite instrument used to collect the image |
| sensor | |
| sensorType | Type of sensor used to acquire the data. |

| | |
|------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| resolution | Spatial resolution of the sensor used to acquire the image, units in meters |
| scanType | Type of scanning system used by the sensor |
| acquisitionParameters | |
| orbitDirection | The direction the satellite was traveling in its orbit when the image was acquired |
| incidenceAngle | The angle between the view direction of the satellite and a line perpendicular to the image or tile center |
| illuminationAzimuthAngle | Sun azimuth angle at center of product, in degrees from North (clockwise) at the time of the first image line |
| illuminationElevationAngle | Sun elevation angle at center of product, in degrees |
| azimuthAngle | The angle from true north at the image or tile center to the scan (line) direction at image center, in clockwise positive degrees. |
| spaceCraftView Angle | Spacecraft across-track off-nadir viewing angle used for imaging, in degrees with "+" being East and "-" being West |
| acquisitionDateTime | Date and Time at which the data was imaged, in UTC. Note: the imaging times will be somewhat different for each spectral band. This field is not intended to provide accurate image time tagging and hence is simply the imaging time of some (unspecified) part of the image. |
| "target" Block | |
| Footprint | |
| multiExtentOf | |
| posList | Position listing of the four corners of the image in geodetic coordinates in the format: ULX ULY URX URY LRX LRY LLX LLY ULX ULY where X = latitude and Y = longitude |
| centerOf | |
| pos | Position of center of product in geodetic coordinate X and Y, where X = latitude and Y = longitude |
| geographicLocation | |
| topLeft | |
| latitude | Latitude of top left corner in geodetic WGS84 coordinates |
| longitude | Longitude of top left corner in geodetic WGS84 coordinates |
| topRight | |
| latitude | Latitude of top right corner in geodetic WGS84 coordinates |
| longitude | Longitude of top right corner in geodetic WGS84 coordinates |
| bottomLeft | |
| latitude | Latitude of bottom left corner in geodetic WGS84 coordinates |

| | |
|-------------------------------|--------------------------------------------------------------------------------------------|
| longitude | Longitude of bottom left corner in geodetic WGS84 coordinates |
| bottomRight | |
| latitude | Latitude of bottom right corner in geodetic WGS84 coordinates |
| longitude | Longitude of bottom right corner in geodetic WGS84 coordinates |
| “resultOf” Block | |
| EarthObservationResult | |
| browse | |
| BrowseInformation | |
| type | Type of browse image that accompanies the image product as part of the ISD |
| referenceSystemIdentifier | Identifies the reference system used for the browse image |
| fileName | Name of the browse image file |
| product | |
| fileName | Name of image file. |
| size | The size of the image product in kbytes |
| productFormat | File format of the image product |
| spatialReferenceSystem | |
| epsgCode | EPSG code that corresponds to the datum and projection information of the image |
| geodeticDatum | Name of datum used for the map projection of the image |
| projection | Projection system used for the image |
| projectionZone | Zone used for map projection |
| resamplingKernel | Resampling method used to produce the image. The list of possible algorithms is extendable |
| numRows | Number of rows (lines) in the image |
| numColumns | Number of columns (pixels) per line in the image |
| numBands | Number of bands in the image product |
| rowGsd | The GSD of the rows (lines) within the image product |
| columnGsd | The GSD of the columns (pixels) within the image product |
| radiometricCorrectionApplied | Indicates whether radiometric correction has been applied to the image |
| geoCorrectionLevel | Level of correction applied to the image |
| atmosphericCorrectionApplied | Indicates whether atmospheric correction has been applied to the image |

| | |
|--------------------------------------------------------------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------|
| atmosphericCorrectionParameters | |
| autoVisibility | Indicates whether the visibility was automatically calculated or defaulted |
| visibility | The visibility value used for atmospheric correction in km |
| aerosolType | The aerosol type used for atmospheric correction |
| waterVapor | The water vapor category used |
| hazeRemoval | Indicates whether haze removal was performed |
| roughTerrainCorrection | Indicates whether rough terrain correction was performed |
| bBRDF | Indicates whether BRDF correction was performed |
| mask | |
| MaskInformation | |
| type | Type of mask file accompanying the image as part of the ISD |
| format | Format of the mask file |
| referenceSystemIdentifier | EPSG code that corresponds to the datum and projection information of the mask file |
| fileName | File name of the mask file |
| cloudCoverPercentage | Estimate of cloud cover within the image |
| cloudCoverPercentageQuotationMode | Method of cloud cover determination |
| unusableDataPercentage | Percent of unusable data with the file |
| The following group is repeated for each spectral band included in the image product | |
| bandSpecificMetadata | |
| bandNumber | Number (1-5) by which the spectral band is identified. |
| startDateTime | Start time and date of band, in UTC |
| endDateTime | End time and date of band, in UTC |
| percentMissingLines | Percentage of missing lines in the source data of this band |
| percentSuspectLines | Percentage of suspect lines (lines that contained downlink errors) in the source data for the band |
| binning | Indicates the binning used (across track x along track) |
| shifting | Indicates the sensor applied right shifting |
| masking | Indicates the sensor applied masking |
| radiometricScaleFactor | Provides the parameter to convert the scaled radiance pixel value to radiance. Multiplying the Scaled Radiance pixel values by the values, |

| | |
|---------------------------------------------------------------------------------------------|----------------------------------------------------------------------------------------------------------------------------------------|
| | derives the Top of Atmosphere Radiance product. This value is a constant, set to 0.01 |
| reflectanceCoefficient | The value is a multiplicative, when multiplied with the DN values, provides the Top of Atmosphere Reflectance values |
| harmonizationTransform | Provides coefficients to transform the Next-Generation PlanetScope sensor values to match those of the previous PlanetScope satellites |
| sourceSensor | The new instrument to be transformed to the targetSensor |
| targetSensor | The target instrument that the transform harmonizes values to |
| targetMeasure | The physical unit that the harmonization transform is valid for |
| bandCoefficients | Matrix of coefficients to transform band values to match those of the targetSensor, in combination with the finalOffset |
| finalOffset | An offset value for each band used in combination with the bandCoefficients to perform the transform |
| The remaining metadata fields are only included in the file for LIB RapidEye Basic products | |
| spacecraftInformationMetadataFile | Name of the XML file containing attitude, ephemeris and time for the 1B image |
| rpcMetadataFile | Name of XML file containing RPC information for the 1B image |
| mask | |
| MaskInformation | |
| type | Type of mask file accompanying the image as part of the ISD |
| format | Format of the mask file |
| referenceSystemIdentifier | EPSG code that corresponds to the datum and projection information of the mask file |
| fileName | File name of the mask file |
| cloudCoverPercentage | Estimate of cloud cover within the image |
| cloudCoverPercentageQuotationMode | Method of cloud cover determination |
| unusableDataPercentage | Percent of unusable data with the file |
| The following group is repeated for each spectral band included in the image product | |
| bandSpecificMetadata | |
| bandNumber | Number (1-5) by which the spectral band is identified. |
| startDateTime | Start time and date of band, in UTC |
| endDateTime | End time and date of band, in UTC |
| percentMissingLines | Percentage of missing lines in the source data of this band |
| percentSuspectLines | Percentage of suspect lines (lines that contained downlink errors) in the source data for the band |

| | |
|---------------------------------------------------------------------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| binning | Indicates the binning used (across track x along track) |
| shifting | Indicates the sensor applied right shifting |
| masking | Indicates the sensor applied masking |
| radiometricScaleFactor | Provides the parameter to convert the scaled radiance pixel value to radiance. Multiplying the Scaled Radiance pixel values by the values, derives the Top of Atmosphere Radiance product. This value is a constant, set to 0.01 |
| reflectanceCoefficient | The value is a multiplicative, when multiplied with the DN values, provides the Top of Atmosphere Reflectance values |
| harmonizationTransform | Provides coefficients to transform the Next-Generation PlanetScope sensor values to match those of the previous PlanetScope satellites |
| sourceSensor | The new instrument to be transformed to the targetSensor |
| targetSensor | The target instrument that the transform harmonizes values to |
| targetMeasure | The physical unit that the harmonization transform is valid for |
| bandCoefficients | Matrix of coefficients to transform band values to match those of the targetSensor, in combination with the finalOffset |
| finalOffset | An offset value for each band used in combination with the bandCoefficients to perform the transform |
| The remaining metadata fields are only included in the file for L1B RapidEye Basic products | |
| spacecraftInformationMetadataFile | Name of the XML file containing attitude, ephemeris and time for the 1B image |
| rpcMetadataFile | Name of XML file containing RPC information for the 1B image |

File Naming Example: Ortho Tiles

The General XML Metadata file will follow the naming conventions as in the example below.

Example: 2328007_2010-09-21_RE4_3A_visual_metadata.xml

2. UNUSABLE DATA MASK FILE

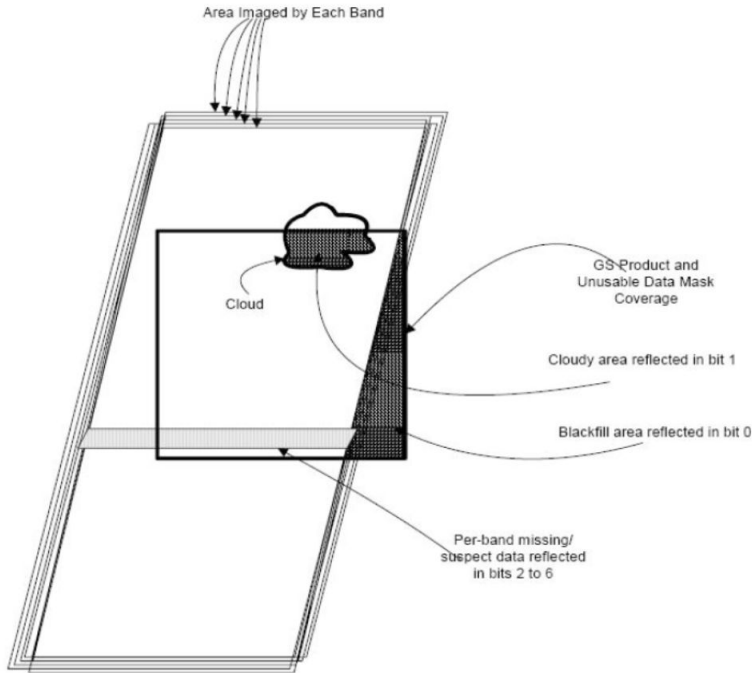
The unusable data mask file provides information on areas of unusable data within an image (e.g. cloud and non-imaged areas).

The pixel size after orthorectification will be 3.125 m for PlanetScope OrthoTiles, 3.0m for PlanetScope Scenes, 50 m for RapidEye, and 0.8 m for SkySat. It is suggested that when using the file to check for usable data, a buffer of at least 1 pixel should be considered. Each bit in the 8-bit pixel identifies whether the corresponding part of the product contains useful imagery:

- **Bit 0:** Identifies whether the area contains blackfill in all bands (this area was not imaged). A value of “1” indicates blackfill.
- **Bit 1:** Identifies whether the area is cloud covered. A value of “1” indicates cloud coverage. Cloud detection is performed on a decimated version of the image (i.e. the browse image) and hence small clouds may be missed. Cloud areas are those that have pixel values in the assessed band (Red, NIR or Green) that are above a configurable threshold. This algorithm will:
 - Assess snow as cloud
 - Assess cloud shadow as cloud free
 - Assess haze as cloud free
- **Bit 2:** Identifies whether the area contains missing (lost during downlink) or suspect (contains downlink errors) data in band 1. A value of “1” indicates missing/suspect data. If the product does not include this band, the value is set to “0”.
- **Bit 3:** Identifies whether the area contains missing (lost during downlink and hence blackfilled) or suspect (contains downlink errors) data in the band 2. A value of “1” indicates missing/suspect data. If the product does not include this band, the value is set to “0”.
- **Bit 4:** Identifies whether the area contains missing (lost during downlink) or suspect (contains downlink errors) data in the band 3. A value of “1” indicates missing/suspect data. If the product does not include this band, the value is set to “0”.
- **Bit 5:** Identifies whether the area contains missing (lost during downlink) or suspect (contains downlink errors) data in band 4. A value of “1” indicates missing/suspect data. If the product does not include this band, the value is set to “0”.
- **Bit 6:** Identifies whether the area contains missing (lost during downlink) or suspect (contains downlink errors) data in band 5. A value of “1” indicates missing/suspect data. If the product does not include this band, the value is set to “0”.
- **Bit 7:** Is currently set to “0”.

The figure below illustrates the concepts behind the Unusable Data Mask file.

Figure A-1: Concepts Behind the Unusable Data Mask File



File Naming

The UDM file will follow the naming conventions as in the example below.

Example: 2328007_2010-09-21_RE4_1B_udm.tif (**basic_udm** asset)
2328007_2010-09-21_RE4_3A_udm.tif (**udm** asset)

3. USABLE DATA MASK FILE

The usable data mask file provides information on areas of usable data within an image (e.g. clear, snow, shadow, light haze, heavy haze and cloud).

The pixel size after orthorectification will be 3.125 m for PlanetScope OrthoTiles and 3.0m for PlanetScope Scenes. The usable data mask is a raster image having the same dimensions as the image product, comprised of 8 bands, where each band represents a specific usability class mask. The usability masks are mutually exclusive, and a value of one indicates that the pixel is assigned to that usability class.

- Band 1: clear mask (a value of “1” indicates the pixel is clear, a value of “0” indicates that the pixel is not clear and is one of the 5 remaining classes below)
- Band 2: snow mask
- Band 3: shadow mask
- Band 4: light haze mask
- Band 5: heavy haze mask

- Band 6: cloud mask
- Band 7: confidence map (a value of “0” indicates a low confidence in the assigned classification, a value of “100” indicates a high confidence in the assigned classification)
- Band 8: unusable data mask

File Naming

The UDM2 file will follow the naming conventions as in the example below.

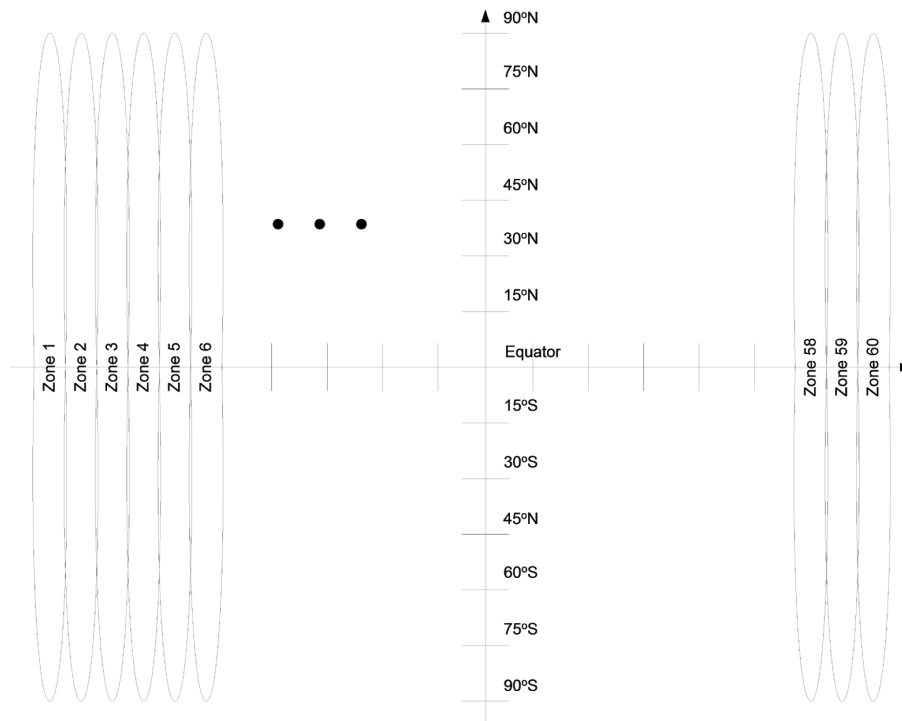
Example: 20180921_102852_0f34_1A_udm2.tif (**basic_udm2** asset)
 20180921_102852_0f34_3B_udm2.tif (**udm2** asset)



APPENDIX B - TILE GRID DEFINITION

Ortho Tile imagery products are based on the UTM map grid as shown in Figure B-1 and B-2. The grid is defined in 24km by 24km tile centers, with 1km of overlap, resulting in 25km by 25km tiles.

Figure B-1: Layout of UTM Zones



An Ortho Tile imagery products is named by the UTM zone number, the grid row number, and the grid column number within the UTM zone in the following format:

<ZZRRRCC>

Where:

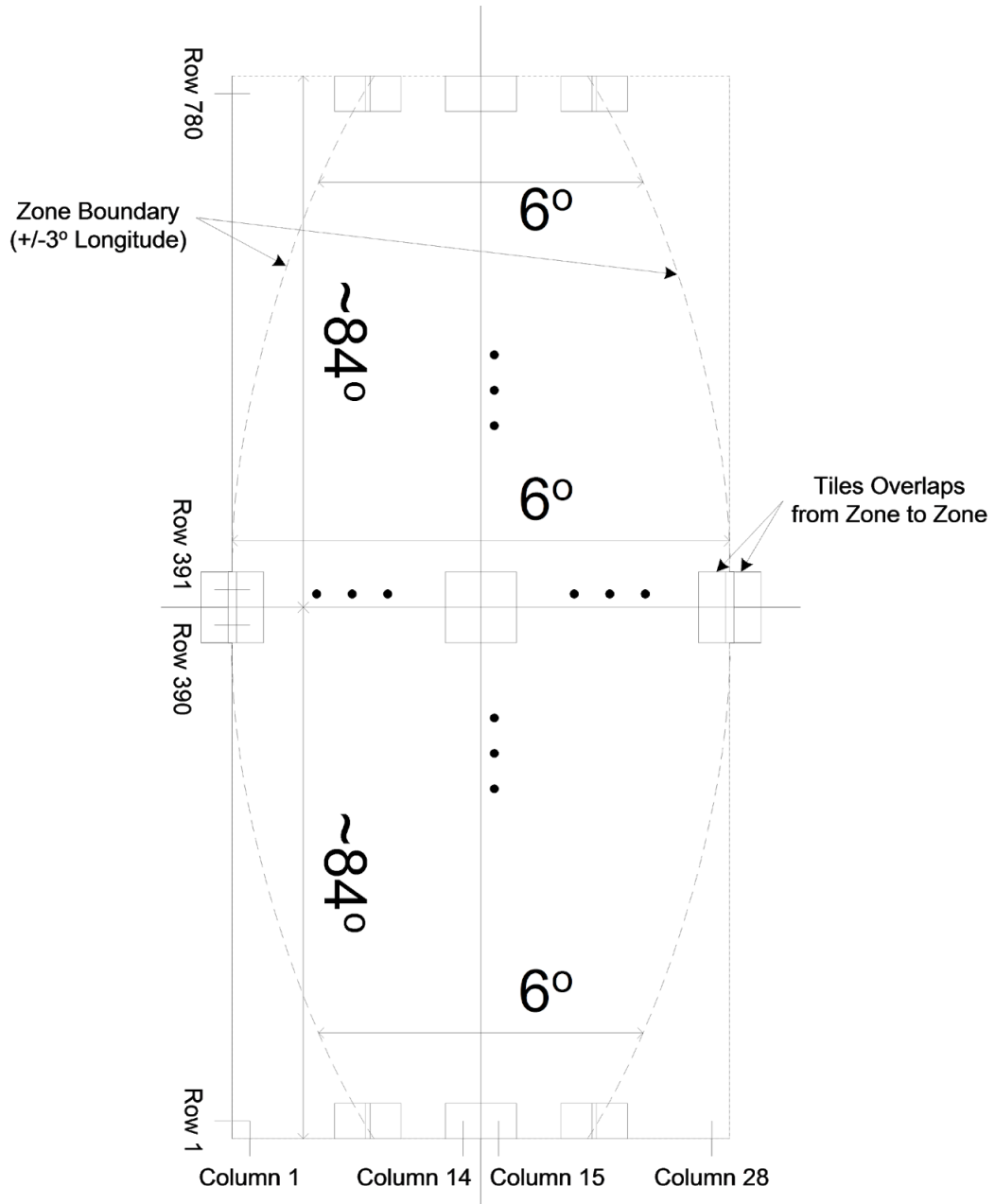
ZZ = UTM Zone Number (This field is not padded with a zero for single digit zones in the tile shapefile)

RRR = Tile Row Number (increasing from South to North, see Figure B-2)

CC = Tile Column Number (increasing from West to East, see Figure B-2)

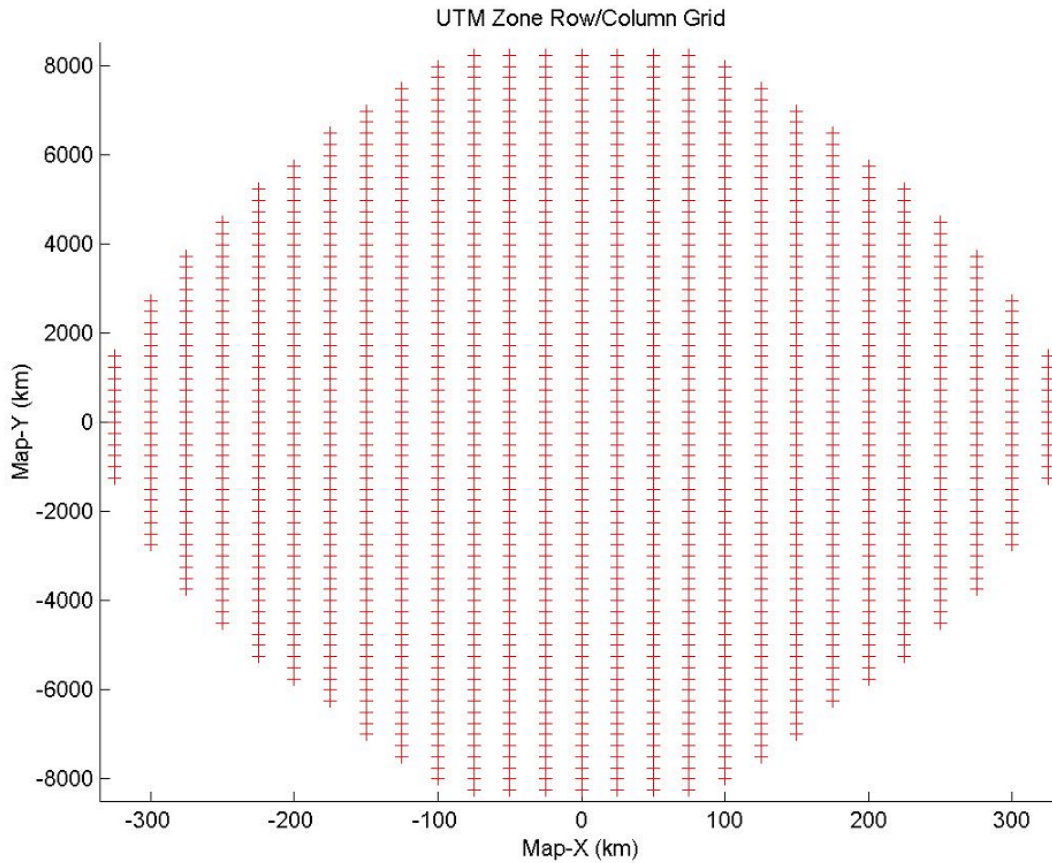
Example: Tile 547904 = UTM Zone = 5, Tile Row = 479, Tile Column = 04
 Tile 3363308 = UTM Zone = 33, Tile Row = 633, Tile Column = 08

Figure B-2: Layout of Tile Grid within a single UTM zone



Due to the convergence at the poles, the number of grid columns varies with grid row as illustrated in Figure B-3.

Figure B-3: Illustration of grid layout of Rows and Columns for a single UTM Zone



The center point of the tiles within a single UTM zone are defined in the UTM map projection to which standard transformations from UTM map coordinates (x,y) to WGS84 geodetic coordinates (latitude and longitude) can be applied.

```
col = 1..29
row = 1..780
Xcol = False Easting + (col - 15) x Tile Width + Tile Width/2
Yrow = (row - 391) x Tile Height + Tile Height/2
```

Where:

X and Y are in meters

- False Easting = 500,000m
- Tile Width = 24,000m
- Tile Height = 24,000m

The numbers 15 and 391 are needed to align to the UTM zone origin.