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PLANETSCOPE 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)

Web based interfaces enable users to interact with Planet's imagery products without needing knowledge of how to use APIs or Application Programming Interfaces.

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 operating between 2009 and 2020.

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) 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.

1.2 DATA PRODUCT OVERVIEW

Planet operates the PlanetScope (PS) 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.

Planet offers two geometry types (Basic & Ortho) for PlanetScope imagery

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.

Planet also offers two primary radiometry options for PlanetScope imagery

Visual products which are 3 band "RGB" which include color correction and sharpness enhancements to improve image interpretation with the human eye

Analytic Products (4 or 8 band) with options for delivery as scaled Top of Atmosphere Radiance (TOAR) or Surface Reflectance (SR). Analytic products are recommended for quantitative & modeling applications.

PlanetScope imagery asset naming example

An "ortho_analytic_8b_sr" is an orthorectified, 8-band, surface reflectance PlanetScope Scene.
A "basic_analytic_4b" is an unrectified, 4-band, top of atmosphere radiance PlanetScope Scene.
An "ortho_visual" is an orthorectified, 3-band, color corrected, sharpened PlanetScope Scene.



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) as technology improvements are deployed at a rapid pace.

Each PlanetScope Dove 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).

PlanetScope satellites launched starting in November 2018 have sensor characteristics that enable improved spectral resolution. This second generation of PlanetScope satellites (known as Dove-R or PS2.SD) have a sensor plane divided into four separate horizontal stripes (one per radiometric band) along the track of the flight path.

A third generation of PlanetScope sensors (known as SuperDove or PSB.SD) is currently in orbit and is producing imagery with 8 spectral bands.

Composite images from the second and third generation PlanetScope sensors are produced by an image registration process that involves compositing multiple frames ahead and behind an “anchor frame”. Band to band alignment is dependent on accurate ground-lock for the anchor frame and can vary according to scene content. For example, publication yield is observed to be lower in scenes over open water, mountainous terrain, or cloudy areas. Planet is always working to improve its publication rates and coverage and producing a higher volume of high quality imagery in challenging environments is an ongoing priority.

The band alignment quality threshold for image publication is based on across-track registration residuals, the publication criteria are currently set to 0.4 pixels (BGRN) for “standard” PlanetScope products (instruments PS2.SD and PSB.SD), 0.66 (BGRN) to qualify for “test.”

Table 2-A: PlanetScope Constellation and Sensor Specifications

CONSTELLATION OVERVIEW: PLANETSCOPE			
Mission Characteristics	Sun-synchronous Orbit		
Instrument	PS2	PS2.SD	PSB.SD
Orbit Altitude (reference)	450 - 580 km (~98° inclination)		
Max/Min Latitude Coverage	±81.5° (dependent on season)		
Equator Crossing Time	7:30 - 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, green, red, and NIR stripes	Eight-band frame imager with butcher-block filter providing coastal blue, blue, green I, green II, yellow, red, red-edge, and NIR stripes
Spectral Bands	Blue: 455 - 515 nm Green: 500 - 590 nm Red: 590 - 670 nm NIR: 780 - 860 nm	Blue: 464 - 517 nm Green: 547 - 585 nm Red: 650 - 682 nm NIR: 846 - 888 nm	Coastal Blue 431-452 nm Blue: 465-515 nm Green I: 513. - 549 nm Green II: 547. - 583 nm Yellow: 600-620 nm Red: 650 - 680 nm Red-Edge: 697 - 713 nm NIR: 845 - 885 nm
Ground Sample Distance (nadir)	3.7 m-4.1 m (approximate, altitude dependent)		
Frame Size	24 km x 8 km (approximate)	24 km x 16 km (approximate)	32.5 km x 19.6 km (approximate)
Maximum Image Strip per orbit	20,000 km ²		
Revisit Time	Daily at nadir		
Image Capture Capacity	200 million km ² /day		
Imagery Bit Depth	12-bit		

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3. PLANETSCOPE IMAGERY PRODUCTS

Table 3-A: PlanetScope Satellite Image Product Processing Levels

PLANETSCOPE SATELLITE IMAGE PRODUCT PROCESSING LEVELS		
Name	Description	Product Level
PlanetScope Basic Analytic 4B Scene	Scaled Top of Atmosphere Radiance (at sensor) and sensor corrected 4 band (BGRN) 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 are applied to the data.	Level 1B
PlanetScope Basic Analytic 8B Scene	Scaled Top of Atmosphere Radiance (at sensor) and sensor corrected 8-band 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 are applied to the data.	Level 1B
PlanetScope Ortho Analytic 4B Scene	Orthorectified, scaled Top of Atmosphere Radiance (at sensor) 4-band image product suitable for analytic applications. This product has scene based framing and projected to a cartographic projection.	Level 3B
PlanetScope Ortho Analytic 4B SR	Orthorectified, Surface Reflectance 4-band image product suitable for analytic applications. This product has scene based framing and projected to a cartographic projection.	Level 3B
PlanetScope Ortho Analytic 8B Scene	Orthorectified, scaled Top of Atmosphere Radiance (at sensor) 8-band image product suitable for analytic applications. This product has scene based framing and projected to a cartographic projection.	Level 3B

PlanetScope Ortho Analytic 8B SR	Orthorectified, scaled Surface Reflectance 8-band image product suitable for analytic applications. This product has scene based framing and projected to a cartographic projection.	Level 3B
PlanetScope Ortho Visual Scene	Orthorectified, scaled Top of Atmosphere Radiance (at sensor) or Surface Reflectance 8-band image product suitable for analytic applications. This product has scene based framing and projected to a cartographic projection.	Level 3B

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:

20210523_150823_65_242a_3B_AnalyticMS_SR_8b.tif
20210523_150823_65_242a_3B_Visual.tif

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

3.1 RADIOMETRIC INTERPRETATION

Analytic products are scaled to Top of Atmosphere Radiance first. Validation of radiometric accuracy of the on-orbit calibration has been measured at 10% using collects over all the RadCalNet sites. Surface Reflectance products are derived from TOAR precursors.

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:

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

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:

$$\text{REF}(i) = \text{DN}(i) * \text{reflectanceCoefficient}(i)$$

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 NASA & ESA supplied 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 is included with PlanetScope image products, with coefficients to perform a rigorous approximate transform of the Surface Reflectance measurements of the PS2 instrument PlanetScope satellites to the Surface Reflectance equivalents from PS2.SD and PSB.SD instrument PlanetScope satellites.

To convert the PS2 instrument PlanetScope Surface Reflectance values to a PSB.SD equivalent measurement, the `harmonizationTransform` parameters in the xml metadata should be used. This requires multiplying each band by its associated `bandCoefficient` given in the xml metadata file, under `bandSpecificMetadata`.

Note, the harmonization process only applies to bands with a PS2 equivalent, specifically Blue, Green, Red, and Near-Infrared and only for Surface Reflectance values.

3.2 PLANETSCOPE BASIC ANALYTIC SCENE PRODUCT SPECIFICATION

The PlanetScope Basic Analytic 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.

This product has not been processed to remove distortions caused by terrain and allows analysts to derive information products for data science and analytics. It 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 Analytic Scene product:

Table 3-B: PlanetScope Analytic Basic Scene Product Attributes

PLANETSCOPE BASIC ANALYTIC SCENE PRODUCT ATTRIBUTES	
Product Attribute	Description
Product Components and Format	The PlanetScope Basic Analytic product consists of the following file components: <ul style="list-style-type: none"> • Image File – GeoTIFF format • Metadata File – XML format • Rational Polynomial Coefficients (RPC) - XML format • Thumbnail File – GeoTIFF format • Unusable Data Mask (UDM) File – GeoTIFF format • Usable Data Mask (UDM2) File - GeoTIFF format
Information Content	
Analytic Bands	4-band multispectral image (blue, green, red, near-infrared) 8-band multispectral image (PSB.SD only)
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 PSB.SD : 32.5 km by 19.6 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 at 90th percentile

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 are regularly monitored and updated with on-orbit calibration techniques.
Map Projection	N/A

3.3 PLANETSCOPE ORTHO PRODUCT SPECIFICATION

PlanetScope Ortho Scene products are orthorectified and are designed for a wide variety of applications that require imagery with an accurate geolocation and cartographic projection. Ortho products have been processed to remove distortions caused by terrain and can be used for cartographic purposes.

The Ortho Scenes are delivered as 3-band visual (RGB) and analytic (4 band & 8 band) products. Ortho Scenes are radiometrically-, sensor-, and geometrically-corrected (optional atmospherically corrected to SR) 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 3-C: PlanetScope Ortho Scene Product Attributes

GENERAL 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 - $W\ m^{-2}\ sr^{-1}\ \mu m^{-1}$): 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

	<p>PS2.SD: 25 km by 23.0 km PSB.SD: 32.5 km by 19.6 km with some variability by satellite altitude.</p>
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 Ortho Visual Scene Product Specification

The PlanetScope Ortho Visual 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.

Ortho Visual scenes are designed to be 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 3-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 at 90th percentile
Color Enhancements	Color corrected, sharpened, and corrected for sun angle (for visual use)

3.3.2 PlanetScope Analytic Ortho Scene Product Specification

The PlanetScope Analytic Ortho Scene products are orthorectified calibrated multispectral imagery products that have been processed with an emphasis on deriving quantitative information (e.g. 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. The PlanetScope Ortho Analytic Scene is optimal for value-added image processing such as land cover classifications. The imagery has radiometric corrections applied to correct known sensor artifacts and to transform values to at-sensor radiance.

Table 3-E: PlanetScope Analytic Ortho Scene Product Attributes

PLANETSCOPE ORTHO ANALYTIC SCENE PRODUCT ATTRIBUTES	
Product Attribute	Description
Analytic Bands	4-band multispectral image (blue, green, red, near-infrared) 8-band multispectral image (PSB.SD only)
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 at 90th percentile
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 are 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 RADIOMETRIC INTERPRETATION

Analytic products are scaled to Top of Atmosphere Radiance. Validation of radiometric accuracy of the on-orbit calibration has been measured at 10% using collects over all the RadCalNet sites. 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.

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 ($W/m^2*sr*\mu m$).

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 (= $90^\circ - \text{sun elevation}$)

This is pre-calculated for each band and provided in the XML file for the Thuillier solar irradiance model.

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4. PRODUCT PROCESSING

4.1 PLANETSCOPE PROCESSING

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

Table 4-A: PlanetScope Processing Steps

PLANETSCOPE PROCESSING STEPS	
Step	Description
Darkfield/Offset Correction	Corrects for sensor bias and dark noise. For each satellite, a model is created using pre-launch dark field data to correct for the temperature varying response 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 $W/(m^2 \cdot str \cdot \mu m) \cdot 100$).
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).

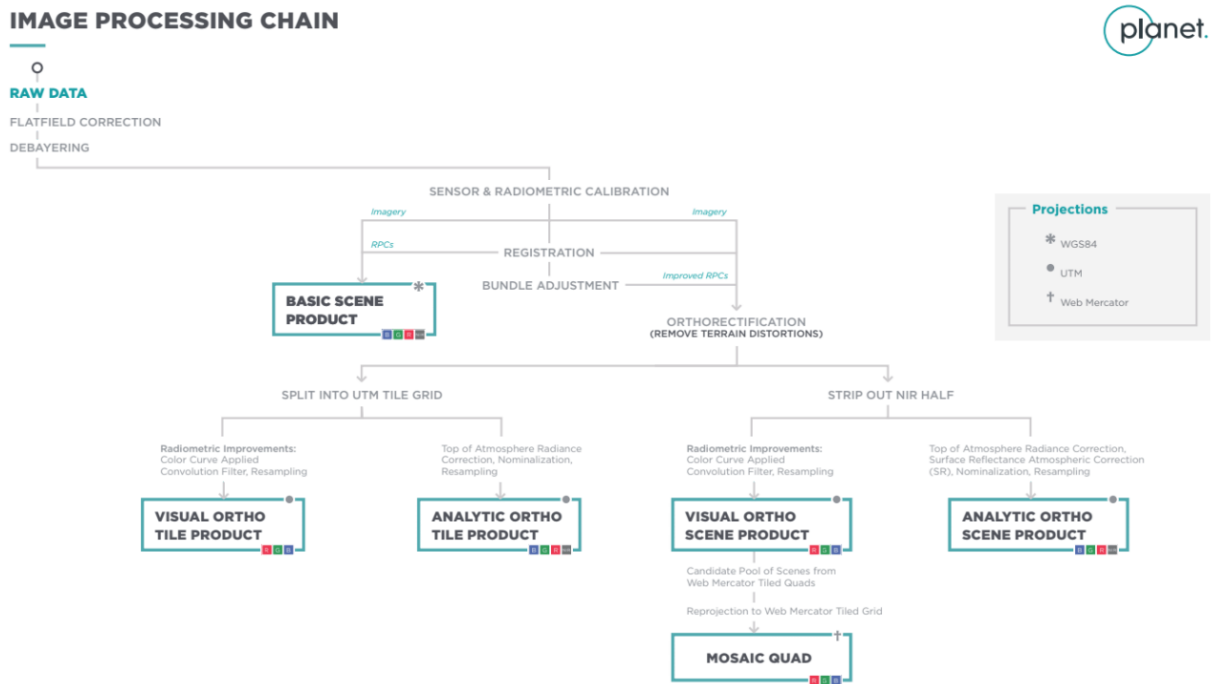
Atmospheric Correction

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 4: PlanetScope Image Processing Chain





5. PRODUCT METADATA

5.1 ORTHO SCENES

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

Table 5-A: 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	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	UL-X coordinate of the extent of the data. The coordinate references the top left corner of the top left pixel.	number
origin_y	UL-Y 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)

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 5-B: 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. 'Map' indicates that per-pixel AOD values are used based on an interpolated map over the scene; 'fixed' indicates a single value for the entire image used when there is not enough data coverage to produce a map.	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

5.2 BASIC SCENES

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

Table 5-C: 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", "PSB.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 a variety of quality standards, for example: 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)



6. PRODUCT DELIVERY

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

6.1 PLANET APPLICATION PROGRAMMING INTERFACES (APIS)

Planet offers REST API access that allows listing, filtering, and downloading of data to anyone using a valid API key. The metadata features described in this document are all searchable via our Data API and downloadable via our Orders API.

Details on searching and ordering via Planet APIs are available in Planet's [Developer Center](#). Links are also available below.

- [Catalog Overview \(Items Types & Assets Types\)](#)
- [Search with Planet's Data API](#)
- [Order with Planet's Orders API](#)

6.2 PLANET EXPLORER GRAPHICAL USER INTERFACE (GUI)

Planet Explorer is a web-based tool 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.

Planet Explorer allows users to:

1. **View Timelapse Mosaics:** A user can view Planet's quarterly and monthly mosaics, 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.

6.3 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.



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
acquisitionType	Nominal acquisition
productType	Product level listed in product filename
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.
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
elevationCorrectionApplied	Indicates the production elevation model used for ortho
atmosphericCorrectionApplied	Indicates whether atmospheric correction has been applied to the image
atmosphericCorrectionParameters	
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 (1-8) 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

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 3.0m for PlanetScope Scenes. 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”.

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)