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.

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 Dove 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.

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

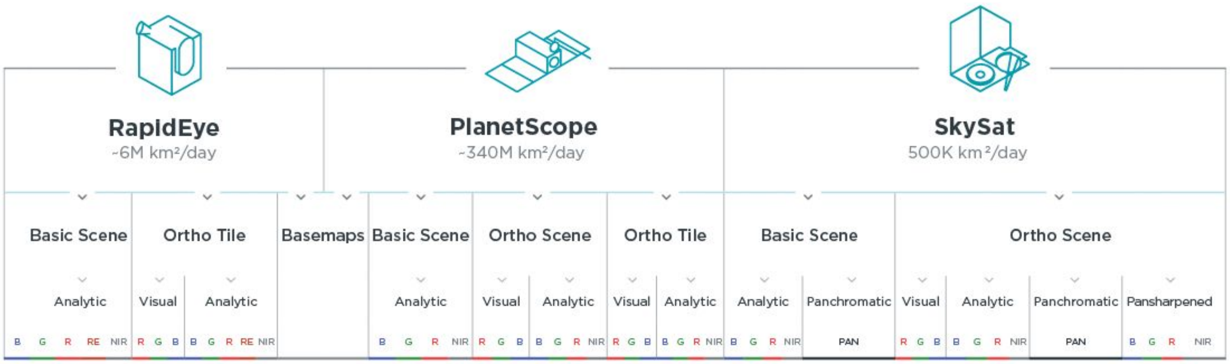
Planet operates the PlanetScope (PS), RapidEye (RE) and SkySat (SS) Earth-imaging constellations. Imagery is collected and processed in a variety of formats to serve different use cases, be it mapping, deep learning, disaster response, precision agriculture, or simple temporal image analytics to create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

Figure 1: Planet Imagery Product Offerings



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 will be able to image the entire land surface of the Earth every day (equating to a daily collection capacity of 340 million km²/day).

Table 1-A: PlanetScope Constellation and Sensor Specifications

CONSTELLATION OVERVIEW: PLANETSCOPE

Mission Characteristics	International Space Station Orbit	Sun-synchronous Orbit
Orbit Altitude (reference)	400 km (51.6° inclination)	475 km (~98° inclination)
Max/Min Latitude Coverage	±52° (depending on season)	±81.5° (depending on season)
Equator Crossing Time	Variable	9:30 - 11:30 am (local solar time)
Sensor Type	Three-band frame Imager or four-band frame Imager with a split-frame NIR filter	Three-band frame Imager or four-band frame Imager with a split-frame NIR filter
Spectral Bands	Blue: 455 - 515 nm Green: 500 - 590 nm Red: 590 - 670 nm NIR: 780 - 860 nm	Blue: 455 - 515 nm Green: 500 - 590 nm Red: 590 - 670 nm NIR: 780 - 860 nm
Ground Sample Distance (nadir)	3.0 m (approximate)	3.5 m - 4 m depending on flock
Frame Size	20 km x 12 km (approximate)	24.6 km x 16.4 km (approximate)
Maximum Image Strip per orbit	8,100 km²	20,000 km²
Revisit Time	Variable	Daily at nadir (early 2017)
Image Capture Capacity	Variable	340 million km²/day
Camera Dynamic Range	12-bit	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 km²/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. Eleven 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
Agility	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 - Current C-Gen satellites 13:00 - SkySat-1 and SkySat-2 13:00 - Block-2 C-Gen satellites

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 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: • Image File – GeoTIFF format • Metadata File – XML format • Rational Polynomial Coefficients - XML format • Thumbnail File – GeoTIFF format • Unusable Data Mask (UDM) 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 (orthorectified)	N/A
Bit Depth	Analytic (DN): 12-bit Analytic (Radiance - W m-2 sr-1 μm-1): 16-bit
Positional Accuracy	Less than 10 m RMSE
Radiometric Corrections	• 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

3.2 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.

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: • Image File – GeoTIFF format • Metadata File – XML format • Thumbnail File – GeoTIFF format • Unusable Data Mask (UDM) 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 24 km by 7 km, but varies by 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.
Horizontal Datum	WGS84
Map Projection	UTM
Resampling Kernel	Cubic Convolution

3.2.1 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)	3.125 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

3.2.2 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. In addition, the imagery has atmospheric corrections applied to account for atmospheric, surface and spectral conditions and geometry when converting top of atmosphere reflectance to surface reflectance.

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)	3.125 m
Bit Depth	Analytic (DN): 12-bit Analytic (Radiance - W m-2 sr-1 μm-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	• 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	• 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

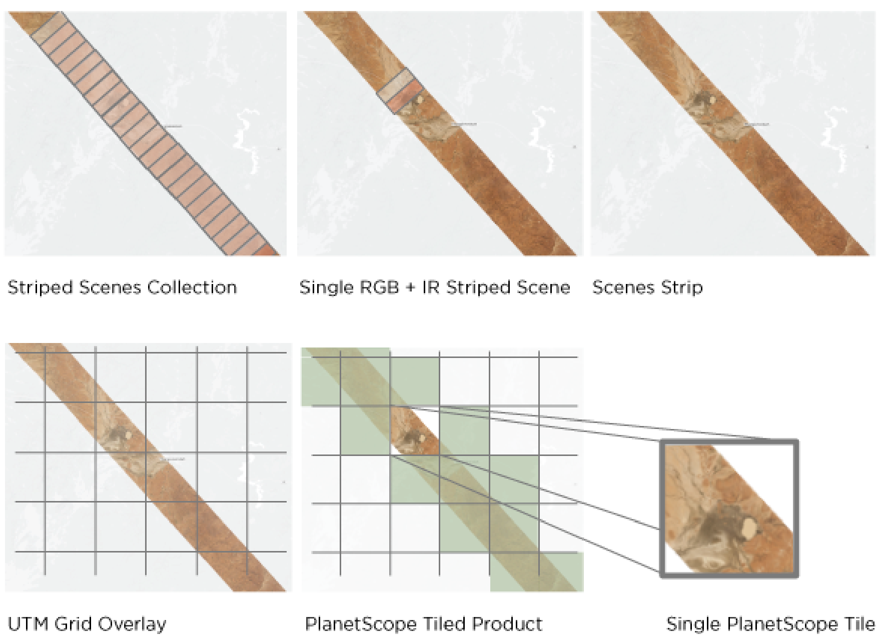
3.3 PLANETSCOPE ORTHO TILE PRODUCT SPECIFICATION

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: ● Image File – GeoTIFF format ● Metadata File – XML format ● Thumbnail File – GeoTIFF format ● Unusable Data Mask (UDM) File – GeoTIFF format
Product Orientation	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.
Product Framing	3.125 m
Pixel Size (orthorectified)	16-bit
Bit Depth	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.
Product Size	Sensor-related effects are corrected using sensor telemetry and a sensor model. Orthorectified using GCPs and fine DEMs (30 m to 90 m posting).
Geometric Corrections	WGS84
Horizontal Datum	UTM
Resampling Kernel	Cubic Convolution

3.3.1 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

3.3.2 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)

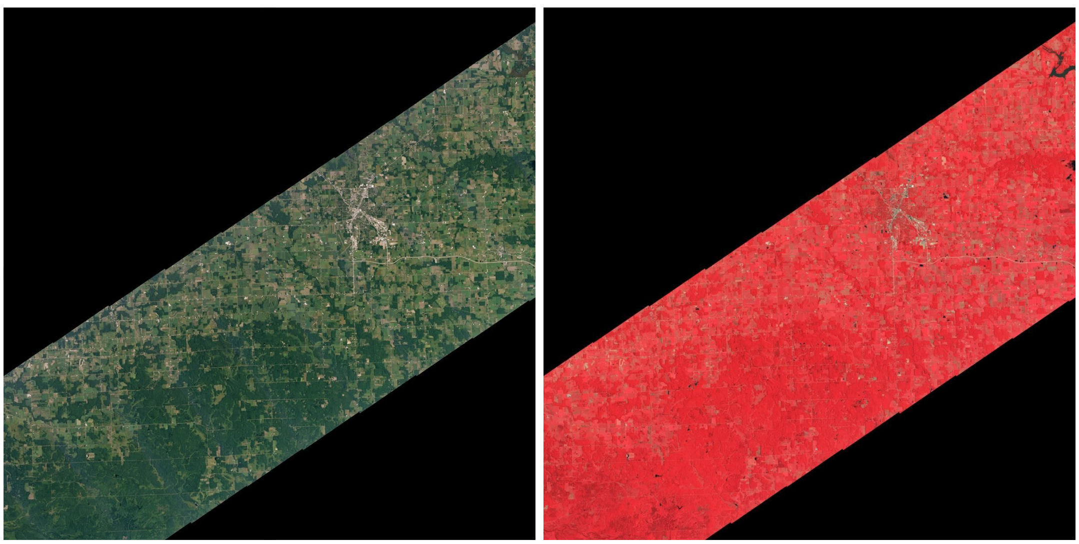


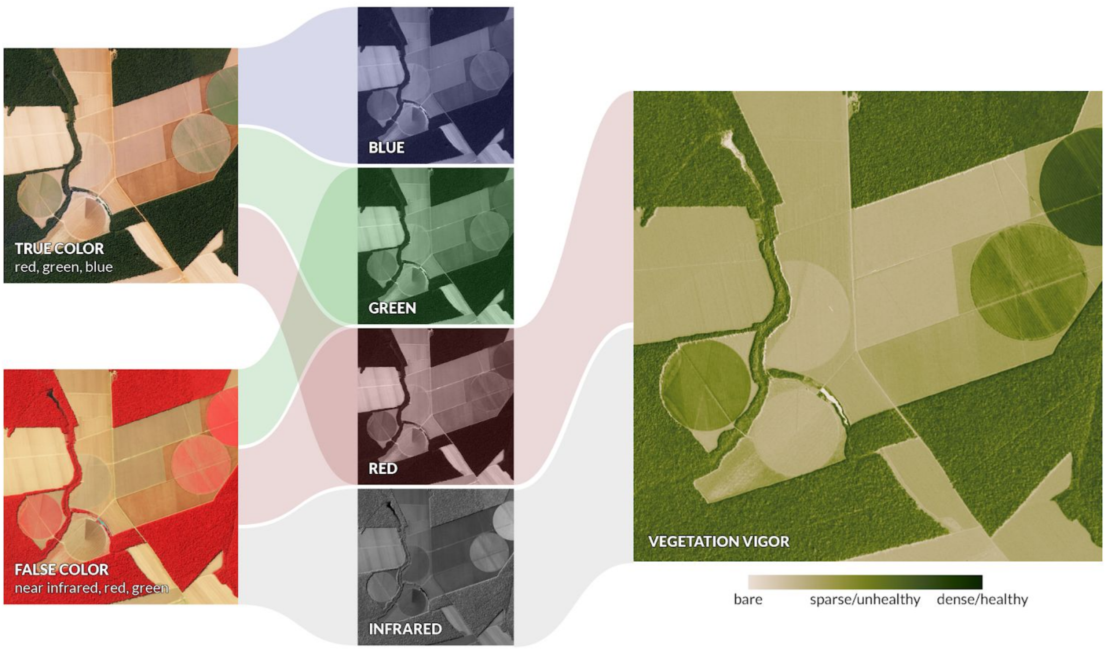
Table 2-H: PlanetScope Analytic Ortho Tile Product Attributes

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 μm-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	● 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



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 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
- Conversion to absolute radiometric values based on calibration coefficients

The geometric sensor corrections applied to this product correct for:

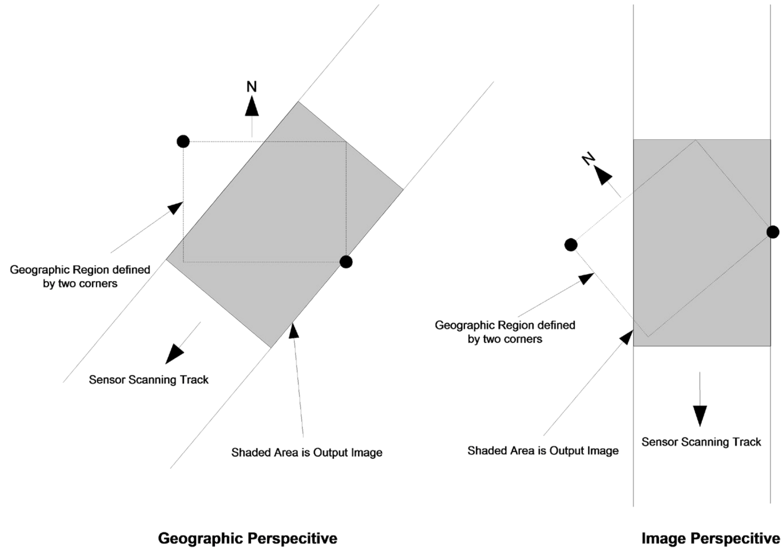
- Internal detector geometry which combines the two sensor chipsets into a virtual array
- Optical distortions caused by sensor optics
- Registration of all bands together to ensure all bands line up with each other correctly

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: • 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
Geometric Corrections	Idealized sensor, orbit and attitude models. Bands are co-registered.
Horizontal Datum	WGS84
Map Projection	N/A
Resampling Kernel	Cubic Convolution

4.2 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: ● 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 μm-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

4.2.1 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, ban 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	• 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

4.2.2 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
Geometric Corrections	Sensor-related effects are corrected using sensor telemetry and a sensor model, ban 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	• 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.

5. SKYSAT IMAGERY PRODUCTS

5.1 SKYSAT BASIC SCENE PRODUCT SPECIFICATION

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

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

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

Table 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	SkySat Satellites have three cameras per satellite, which capture overlapping strips. Each of these strips contain overlapping scenes. One scene is approximately 3199m x 1349m.
Sensor Type	CMOS Frame Camera with Panchromatic and Multispectral halves
Spectral Bands	Blue: 450 - 515nm Green: 515 - 595nm Red: 605 - 695nm NIR: 740 - 900nm Pan: 450 - 900nm
Processing	**Basic Scene v1 (Sep 15, 2017)**
Product Bit Depth	16-bit Unsigned Integer Multispectral and Panchromatic Imagery (12 bit data depth)
Radiometric Corrections	Cross-Sensor Non Uniformity Correction (1%) Color Balancing across cameras

Geometric Corrections	Idealized sensor model and Rational Polynomial Coefficients (RPC) Bands are co-registered
Horizontal Datum	WGS84
Map Projection	N/A
Resampling Kernel	Resampling of Analytic Multispectral Data to >= 1.0 m GSD
Ground Sample Distance	[SkySat-1, SkySat-2] Panchromatic: 0.86 m Multispectral: 1.0 m
	[SkySat-3 - SkySat-13] Panchromatic: 0.72 m Multispectral: 1.0 m
Geometric Accuracy	< 50 m RMSE

5.2 SKYSAT ORTHO SCENE PRODUCT SPECIFICATION

The Ortho Scene product enables users to create seamless imagery by stitching together SkySat Ortho Scenes of their choice and clipping them to a tiling grid structure as required. The SkySat 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 SkySat Ortho Scene product includes Visual, Analytic, Panchromatic, and Pansharpened Multispectral imagery that is calibrated or in a raw digital number format. 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.

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 UDM File – GeoTIFF format	
Information Content		
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 3199 m x 1349 m.	
Sensor Type	CMOS Frame Camera with Panchromatic and Multispectral halves	
Spectral Bands	Blue: 450 - 515nm Green: 515 - 595nm Red: 605 - 695nm NIR: 740 - 900nm Pan: 450 - 900nm	
Processing	**Basic Scene v1 (Sep 15, 2017)**	**Ortho Scene v1 (Jun 1, 2018)**
Radiometric Corrections	Digital Number and TOA Radiance	
Geometric Corrections	Sensor-related effects are corrected using sensor telemetry and a sensor model. Orthorectification uses GCPs and fine DEMs (30 m to 90 m posting).	
Horizontal Datum	WGS84	
Map Projection	UTM	
Resampling Kernel	Cubic Convolution	

Geometric Accuracy	< 10 m RMSE

5.2.1 SkySat Visual Ortho Scene

The SkySat Visual Ortho Scene product is orthorectified, pansharpened, 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	Pansharpened 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 (30 m to 90 m posting).
Positional Accuracy	Less than 10 m RMSE
Color Enhancements	Enhanced for visual use

5.2.2 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 ORTHO SCENE	
Product Attribute	**Description**
Analytic Bands	4-band Pansharpened Image (PS Blue, PS Green, PS Red, PS Near Infrared)
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 (30 m to 90 m posting).
Positional Accuracy	Less than 10 m RMSE

5.2.3 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 m
Processing	
Pixel Size (Orthorectified)	1 m
Bit Depth	16-bit Unsigned Integer (12 bit data depth)
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).
Positional Accuracy	Less than 10 m RMSE
Radiometric Calibration Accuracy	Initial availability: No correction applied; pixel values are digital numbers

5.2.4 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 (12 bit data depth)
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).
Positional Accuracy	Less than 10 m RMSE
Radiometric Calibration Accuracy	Initial availability: No correction applied; pixel values are digital numbers

5.2.5 SkySat Analytic Ortho Scene

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

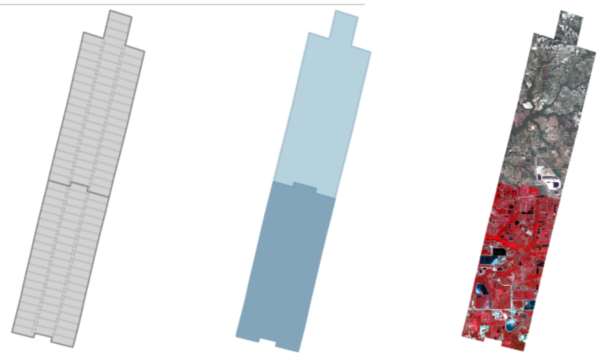
Attribute	Description
Analytic Bands	4-band Analytic Image (B, G, R, N)
Pixel Size	1.0 m
Image Bit Depth	16-bit Unsigned Integer
Projection	UTM WGS84
Resampling Kernel	Cubic Convolution
Size	Approximately 2560x1080 px
Radiometric Corrections	● Absolute Radiance derived using vicarious calibration methods ● Product is radiometrically calibrated to radiance units [W/(μm * m^2 * str)], and scaled by 100 to reduce quantization errors ● Calibration regularly monitored and updated with on-orbit calibration techniques.

5.3 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.

Table 4-H: SkySat Ortho Collect Attributes

SKYSAT ORTHO COLLECT ATTRIBUTES

Attribute	Description
Product Framing	Strip Based:  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.
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).
Geometric Accuracy	Less than 10m RMSE
Radiometric Corrections	Radiometric Corrections No correction applied; pixel values are digital numbers

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

Table 4-I: 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	• Converts the brightness of the L0R image pixels to absolute radiance in preparation for geometric correction.

	• Performs radiometric characterization of L0R 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	• 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.

	• 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	• 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	• 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. • QI_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

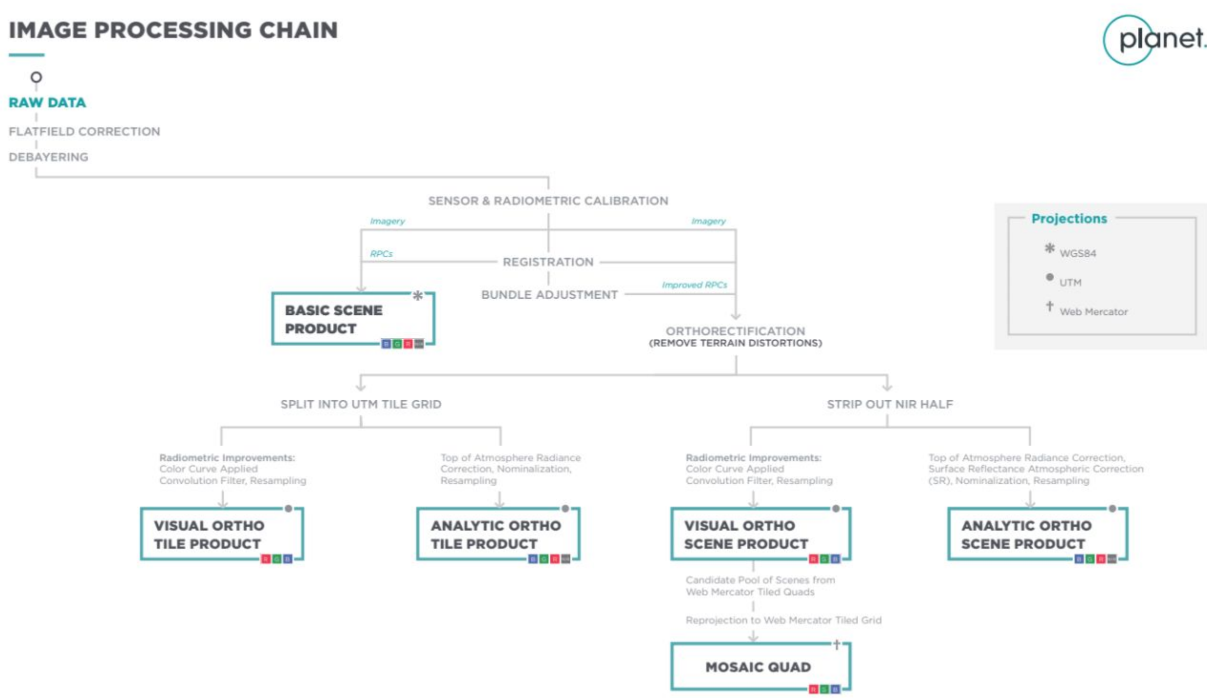
PLANETSCOPE PROCESSING STEPS

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.
Camera Acquisition Parameter Correction	Determines a common radiometric response for each image (regardless of exposure time, TDI, 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/(m²*str*μm)*100).
Visual Product Processing	Presents the imagery as natural color, optimize colors as seen by the human eye. This process is broken down into 4 steps: ● 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	Presents the imagery as natural color, optimize colors as seen by the human eye. This process is broken down into 4 steps: ● The rectification tiedown process wherein tie points are identified across the source images and a collection of reference images (NAIP, OSM, 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.

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.

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.

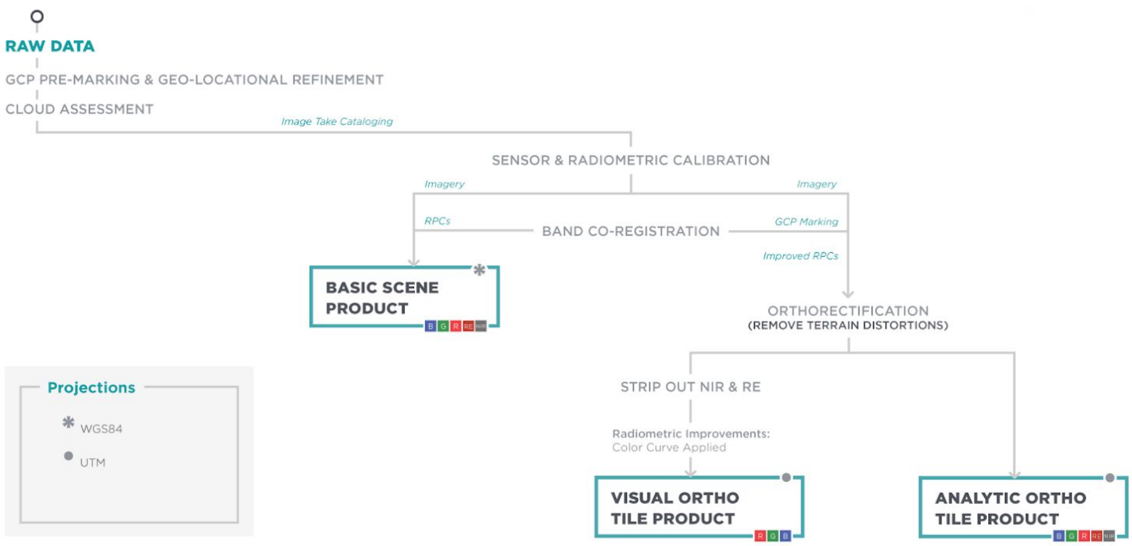
Table 6-B: RapidEye Processing Steps

RAPIDEYE PROCESSING STEPS

Step	Description
Flat Field Correction (also referred to as spatial calibration)	Correction parameters to achieve the common response of all CCD element when exposed to the same amount of light have been collected for each optical instrument prior to launch. During operations, these corrections are adjusted on an as-needed basis when effects become visible or measurable 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 $W/(m^2*str*\mu m)*100$).
Visual Product Processing	Presents the imagery as natural color, optimize colors as seen by the human eye. This process is broken down into 3 steps: ● 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	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, OSM, 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 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.

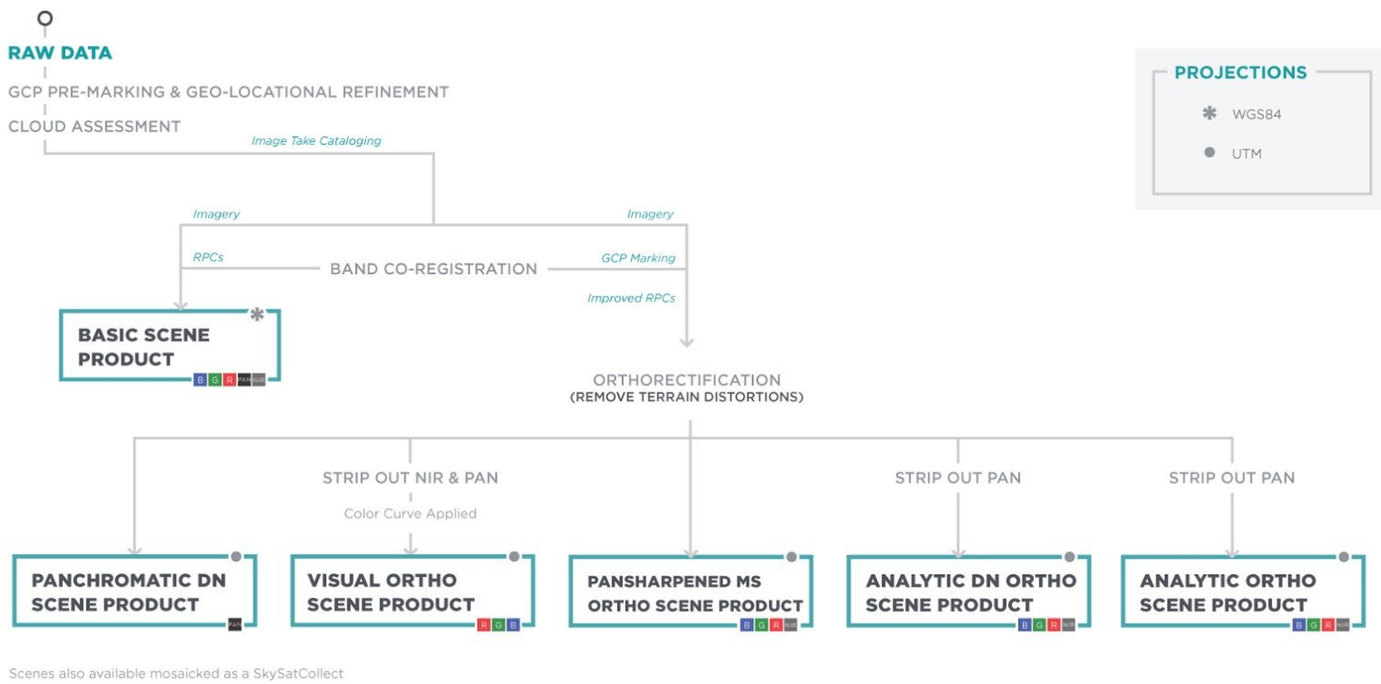
Table 6-C: SkySat Processing Steps

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



8. QUALITY ATTRIBUTES

8.1 PRODUCT GEOMETRIC POSITIONAL ACCURACY

The locational accuracy of all the imagery products depends on the quality of the reference data used: Ground Control Points (GCPs) and Digital Elevation Model (DEMs). Additionally, the roll angle of the spacecraft during the image acquisition and the number as well as the distribution of GCPs within the image will impact the final product accuracy.

Planet utilizes a unique imagery rectification approach that minimizes processing steps to increase overall processing efficiency in preparation for the large amounts of imagery data that will be downloaded and rectified at Full Operational Capability (FOC). This approach reduces resampling steps through a proprietary parallel processing approach that enables moving from raw to orthorectified imagery without degradation of imagery quality.

To ensure the high accuracy of all of our ortho products on a global basis, Planet uses GCPs derived from high resolution satellite and airborne imagery. For most of Earth's land mass, GCPs are derived from an ALOS 2.5 m resolution basemap. NAIP is used over the continental United States and Landsat 8 is used as a fallback solution over remote polar areas and some small islands.

The vertical component is derived from DEMs with a post spacing under 30 m globally. Planet products produced using GCPs and the World30 DEM will have a locational accuracy of 10 m RMSE or better. Internal testing conducted on multiple locations worldwide indicates that locational accuracy will typically (80% of the times) be better than 7 m RMSE.

8.2 CLOUD COVER

8.2.1 PlanetScope and SkySat

The cloud estimation for PlanetScope and the SkySats is based off of the expected radiance of pixels for a given time of year. A historical per-pixel database has been built from the Landsat 8 archive. If the radiance of a PlanetScope or SkySat pixel is significantly higher than expected for that time of year, the pixel is marked as 'cloudy'.

This method is fast and simple, but has limitations:

1. If a region may be covered by snow at a given time of year, clouds are much less likely to be identified.
2. Darker clouds are less likely to be identified. This includes both thin clouds and self-shadowed clouds.
3. Brighter areas, such as desert surfaces, sands, and salt flats, are less likely to be identified as containing clouds.
4. Specular reflection at noon local time are more likely to be marked as clouds.

8.2.2 RapidEye

Cloud cover assessment for RapidEye image products is done at the cataloging stage for each image using a semi-automated process.

This process automatically applies a regular grid pattern of 1 km by 1 km over a reduced resolution image at a 50 meter pixel size. The algorithm computes a confidence value for each pixel in the Image Take in order to determine whether the pixel is a cloud or non-cloud pixel by thresholding the radiance values of the pixels within the red band of the image. Each grid cell is then tested to determine if the minimum number of cloudy pixels are present in the cell for it to be marked automatically as cloudy. Currently, at least 10 % of the pixels in a grid should be cloudy for a grid cell to be automatically classified as cloudy.

After the automatic cloud mask is generated the Image Take processing will stops for operator intervention. This allows the operator to visually inspect the cloud mask and edit it if necessary by either removing falsely classified grid cells or marking more grid cells as cloudy that were not identified and marked automatically as cloudy. When the operator is satisfied with the cloud mask, the Image Take is accepted and the cloud assessment process is complete.

The results from this process are used to create the Unusable Data Mask (UDM) file that accompanies every image product is used to determine whether each tile can be accepted or whether a new collection is required and the area re-tasked. This value is also used to report the cloud cover percentage value for the product in the Planet platform.

8.3 BAND CO-REGISTRATION

8.3.1 PlanetScope

The RGB and the NIR “stripes” are 2 separate acquisitions (approximately 0.5 seconds apart). The imagery is first rectified to the ground and any adjacent rectified scenes with high accuracy. All tiepoints from this rectification solution (geographic and image coordinate tuples) are saved for future use. The Planet Pipeline is then able to quickly perform an operation similar to bundle adjustment over all scenes in a strip, optimizing for ground alignment and band co-registration. If one is familiar with the traditional bundle adjustment workflow, think of it as replacing the camera models with RPC equations, with the added benefit of ground tiepoints.

8.3.2 RapidEye

The focal plane of the RapidEye sensors is comprised of five separate CCD arrays, one for each band. This means that the bands have imaging time differences of up to three seconds for the same point on the ground, with the blue and red bands being the furthest apart in time. During processing, every product is band co-registered using a DEM to roughly correlate the bands to the reference band (Red Edge); a final alignment is done using an auto-correlation approach between the bands. For areas where the slope is below 10°, the band co-registration should be within 0.2 pixels or less (1-sigma). For areas with a slope angle of more than 10° and/or areas with very limited image structure (e.g. sand dunes, water bodies, areas with significant snow cover) the co-registration threshold mentioned above may not be met.

The separation between the RapidEye spectral bands leads to some effects that can be seen in the imagery. In a regular RapidEye scene with clouds, the cloud may show a red-blue halo around the main cloud. This is due to the Red and Blue bands being furthest apart on the sensor array, and the cloud moving during the imaging time between the two bands. Also, clouds are not reflected within the DEM which may lead to mis-registration. The same effect is visible for jet exhaust trails and flying planes. Bright vehicles moving on the ground will also look like colored streaks due to the image time differences.

8.3.3 SkySat

Each SkySat has three sensors, each of which have a panchromatic and multispectral half. These halves are adjacent. The multispectral half is in turn a butcher block filter design consisting of red, green, blue and near infrared bands. From the optical system standpoint these CMOS sensors have a different vertical separation and have a small overlap in the horizontal dimension. The output of the image processing is the classic tuning fork.

The image processing is divided up into various steps and starts with the analysis of the panchromatic bands to determine a minimal set that can be effectively mosaicked, stipulating a degree of overlap between them. With state of the art processing, an accurate transform is derived between each of the frames to each other. These are further refined at a local level to enable subpixel super resolvability.

As with the RapidEye processing, there are characteristic artifacts seen in SkySat imagery, namely at the interfaces of clouds and moving vehicles. These reflect that the objects are moving relative to the ground. Beyond the generation of the imagery, the Planet Pipeline is utilized to bundle adjust the imagery and create ortho rectifications.

8.4 RADIOMETRY AND RADIOMETRIC ACCURACY

8.4.1 PlanetScope

Significant effort is made to ensure radiometric image product quality of all PlanetScope Satellite Imagery Products. This is achieved through a vigorous sensor calibration concept that is based on lab calibration, regular checks of the statistics from all incoming image data, temporal monitoring using lunar calibration, and on-orbit absolute calibration using instantaneous crossovers with well calibrated satellites and vicarious campaigns.

Analytic Scene and Ortho Tiles are scaled to Top of Atmosphere Radiance using calibration data sourced either from pre-launch data or from absolute calibration data from on-orbit methods. Radiometric accuracy is maintained over time using monthly moon imaging by each satellite to detect temporal changes. Absolute calibration can be updated at any time if changes are detected - calibration data for each satellite is continually processed using instantaneous crossovers with well-calibrated satellites such as RapidEye and Landsat 8. 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. 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 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*sr*μm). 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*sr*μm).

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. Calculating Surface Reflectance is a pixel-by-pixel operation using lookup tables (LUTs) that have been generated using the 6SV2.1 radiative transfer code. The LUTs map TOA reflectance to bottom of atmosphere (BOA) reflectance for all combinations of selected ranges of physical conditions relevant for Planet imagery. A separate set of LUTs are used for each satellite sensor type using its individual spectral response.

When converting an TOA reflectance image to surface reflectance, water vapor and ozone inputs are retrieved from MODIS near-real-time (NRT) data for same day collects. In the event that there is no overlapping data, the a 6S atmospheric model is chosen based on the local latitude and time of year of the image acquisition following the scheme used by the FLAASH atmospheric correction tool. The AOD input for a scene is determined from MODIS NRT aerosol data, finding an overlapping region and using the average of the AOD values within that region. When looking up reflectance values from the LUTs, tables with the closest matching values of water vapor and ozone concentrations are used. Tables built with the two closest solar zenith angles are interpolated between and a linear interpolation is performed for AOD and TOA reflectance. Since Planet satellites are nadir pointing, zenith angle is fixed at 0 degrees.

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.

8.4.2 RapidEye

Significant effort is made to ensure radiometric image product quality of all RapidEye Satellite Imagery Products. This is achieved through a vigorous sensor calibration concept that is based on regular checks of the statistics from all incoming image data, acquisitions over selected temporal calibration sites, and absolute ground calibration campaigns.

The long term stability and inter-comparability among all five satellites is done by monitoring all incoming image data, along with frequent acquisitions from a number of calibration sites located worldwide. Statistics from all collects are used to update the gain and offset tables for each satellite. These statistics are also used to ensure that each band is 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 stored on-board the satellites with a bit depth of up to 12 bits. 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 DNs 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 $W/(m^2*sr*\mu m)$. 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.

The radiometric sensitivity for each band is defined in absolute values for standard conditions (21 March, 45° North, Standard Atmosphere) in terms of a minimum detectable reflectance difference. This determines the already mentioned bit depth as well as the tolerable radiometric noise within the images. It is more restrictive for the Red, Red Edge, and NIR bands, compared with the Blue and Green bands. During image quality control, a continuous check of the radiometric noise level is performed.

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 radiances into a reflectance it is necessary to relate the radiance values (e.g. the pixel DNs) 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 0.983 289 8912 AU and 1.016 710 3335 AU and has to be calculated for the image acquisition point in time.
- EAI = Exo-Atmospheric Irradiance
- SolarZenith = Solar Zenith angle in degrees (= 90° – sun elevation)

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

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

9. PRODUCT METADATA

9.1 ORTHO TILES

9.1.1 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
usable_data	Ratio of the usable to unusable portion of the imagery due to cloud cover or black fill. Applies only to RapidEye.	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)

9.1.2 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 "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
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. Applies only to RapidEye Data	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)

9.2 ORTHO SCENES

9.2.1 PlanetScope

The table below describe 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."PS0", "PS1" ,"PS2")
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_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. Applies only to RapidEye.	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)

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

9.2.2 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 the following criteria: sun altitude greater than or equal to 10 degrees, off nadir view angle less than 20 degrees, and saturated pixels fewer than 20%. If the image does not meet these criteria it is considered “test” quality.	string (“standard”, “test”)
satellite_azimuth	Angle from true north to the satellite vector at the time of imaging, projected on the horizontal plane in degrees.	number (0 - 360)
satellite_id	Globally unique identifier of the satellite that acquired the underlying imagery.	string
strip_id	Globally unique identifier of the image strip this scene was collected against	string

sun_azimuth	Angle from true north to the sun vector projected on the horizontal plane in degrees.	number (0 - 360)
sun_elevation	Elevation angle of the sun in degrees.	number (0 - 90)
updated	The RFC 3339 timestamp at which this item was updated in the API.	string
view_angle	Spacecraft across-track off-nadir viewing angle used for imaging, in degrees with + being east and - being west.	number (-25 - +25)

9.3 BASIC SCENES

9.3.1 PlanetScope

The tables below describe 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.”PS0”, “PS1” ,”PS2”)
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
usable_data	Ratio of the usable to unusable portion of the imagery due to cloud cover or black fill. Applies only to RapidEye.	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)

9.3.2 RapidEye

The table below describe 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 L1B 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, expressed as a percentage. Applies only to RapidEye data.	Number (0-1)
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”

9.3.3 SkySat

The table below describe 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 the following criteria: sun altitude greater than or equal to 10 degrees, off nadir view angle less than 20 degrees, and saturated pixels fewer than 20%. If the image does not meet these criteria it is considered “test” quality.	string (“standard”, “test”)
satellite_azimuth	Angle from true north to the satellite vector at the time of imaging, projected on the horizontal plane in degrees.	number (0 - 360)
satellite_id	Globally unique identifier of the satellite that acquired the underlying imagery.	string
strip_id	Globally unique identifier of the image strip this scene was collected against	string
sun_azimuth	Angle from true north to the sun vector projected on the horizontal plane in degrees.	number (0 - 360)
sun_elevation	Elevation angle of the sun in degrees.	number (0 - 90)
updated	The RFC 3339 timestamp at which this item was updated in the API.	string
view_angle	Spacecraft across-track off-nadir viewing angle used for imaging, in degrees with + being east and - being west.	number (-25 - +25)

9.4 ORTHO COLLECT

9.4.1 SkySat

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

Table 8: Skysat Ortho Scene Geojson Metadata Schema

SKYSAT ORTHO SCENE GEOJSON METADATA SCHEMA

Parameter	Description	Type
acquired	The RFC 3339 acquisition time of the image.	string
camera_id	The specific detector used to capture the scene.	string (e.g. “d1”, “d2”)
cloud_cover	The estimated percentage of the image covered by clouds.	number (0-100)
ground_control	If the image meets the positional accuracy specifications this value will be true. If the image has uncertain positional accuracy, this value will be false.	boolean
gsd	The ground sampling distance of the image acquisition.	number
item_type	The name of the item type that models shared imagery data schema.	string (e.g. “PSScene3Band”, ”SkySatScene”)
provider	Name of the imagery provider.	string ("planetscope","rapideye", “skysat”)
published	The RFC 3339 timestamp at which this item was added to the API.	string
quality_category	Metric for image quality. To qualify for “standard” image quality an image must meet the following criteria: sun altitude greater than or equal to 10 degrees, off nadir view angle less than 20 degrees, and saturated pixels fewer than 20%. If the image does not meet these criteria it is considered “test” quality.	string (“standard”, “test”)
satellite_azimuth	Angle from true north to the satellite vector at the time of imaging, projected on the horizontal plane in degrees.	number (0 - 360)
satellite_id	Globally unique identifier of the satellite that acquired the underlying imagery.	string

strip_id	Globally unique identifier of the image strip this scene was collected against	string
sun_azimuth	Angle from true north to the sun vector projected on the horizontal plane in degrees.	number (0 - 360)
sun_elevation	Elevation angle of the sun in degrees.	number (0 - 90)
updated	The RFC 3339 timestamp at which this item was updated in the API.	string
view_angle	Spacecraft across-track off-nadir viewing angle used for imaging, in degrees with + being east and - being west.	number (-25 - +25)
ground_lock_ratio	The percentage of SkySat frames that make up the full Collect product that have good ground control	Number (0 - 1)

10. PRODUCT DELIVERY

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

10.1 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. ● Analytic imagery band order: Band 1 = Red, Band 2 = Green, Band 3 = Blue ● Visual 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. ● 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. ● Analytic imagery band order: Band 1 = Blue, Band 2 = Green, Band 3 = Red, Band 4 = Near-infrared ● Visual imagery Band order: Band 1 = Red, Band 2 = Green, Band 3 = Blue
REScene	RapidEye 5-band Basic, scene-/strip- based framing. ● 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. ● Analytic imagery band order: Band 1 = Blue, Band 2 = Green, Band 3 = Red, Band 4 = Red edge, Band 5 = Near-infrared ● Visual imagery band order: Band 1 = Red, Band 2 = Green, Band 3 = Blue
Sentinel2L1C	Sentinal-2 L1C data packed zip file
Landsat8L1G	Landsat 8 data packed zip file
SkySatScene	SkySat Basic and Ortho Scenes are framed as captured: ● Basic Analytic DN: Band 1 = Blue, Band 2 = Green, Band 3 = Red, Band 4 = Near-infrared ● Basic Panchromatic DN: Band 1 = Pan

	• 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	• 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 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 Unuseable Data Mask
ortho_panchromatic_dn	Orthorectified 16-bit 1-band Image
ortho_panchromatic_udm	Orthorectified 16-bit 1-band Image Unuseable Data Mask
ortho_pansharpened	Orthorectified 16-bit 4-band Pansharpened Image
ortho_pansharpened_udm	Orthorectified 16-bit 4-band Pansharpened Image Unuseable Data Mask
ortho_visual	Orthorectified 8-bit 3-band Pansharpened Image
udm	Usable data mask
visual	Visual image with color-correction
visual_xml	Visual image metadata

10.2 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.

10.3 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.

10.4 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 Sentinal-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.

10.5 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:

A. General XML Metadata File
B. Unusable 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
downlinkedTo	
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
acquistionParameters	
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
bRDF	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
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
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
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).

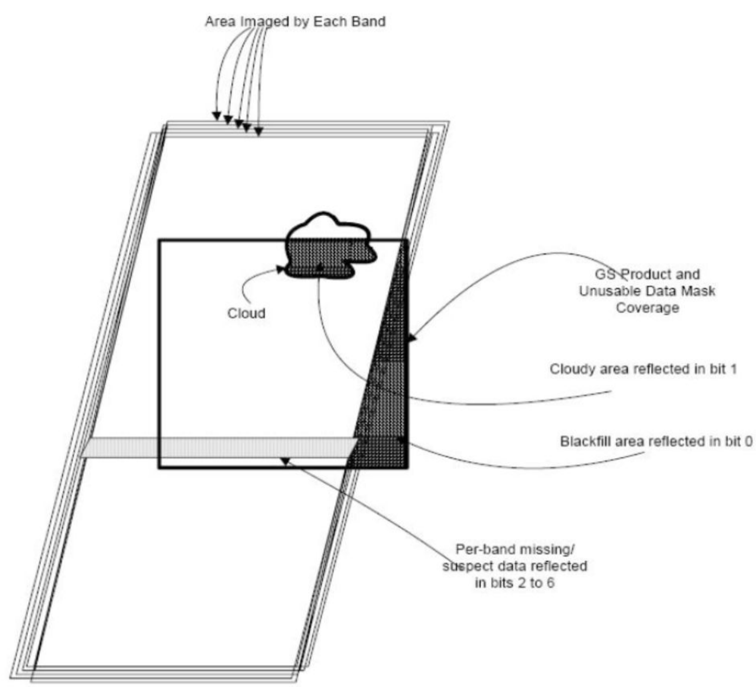
The pixel size after orthorectification will be 3.125 m for PlanetScope OrthoTiles, 3.0m for PlanetScope Scenes, 50 m for RapidEye, and 0.8 m for SkySat. It is suggested that when using the file to check for usable data, a buffer of at least 1 pixel should be considered. Each bit in the 8-bit pixel identifies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

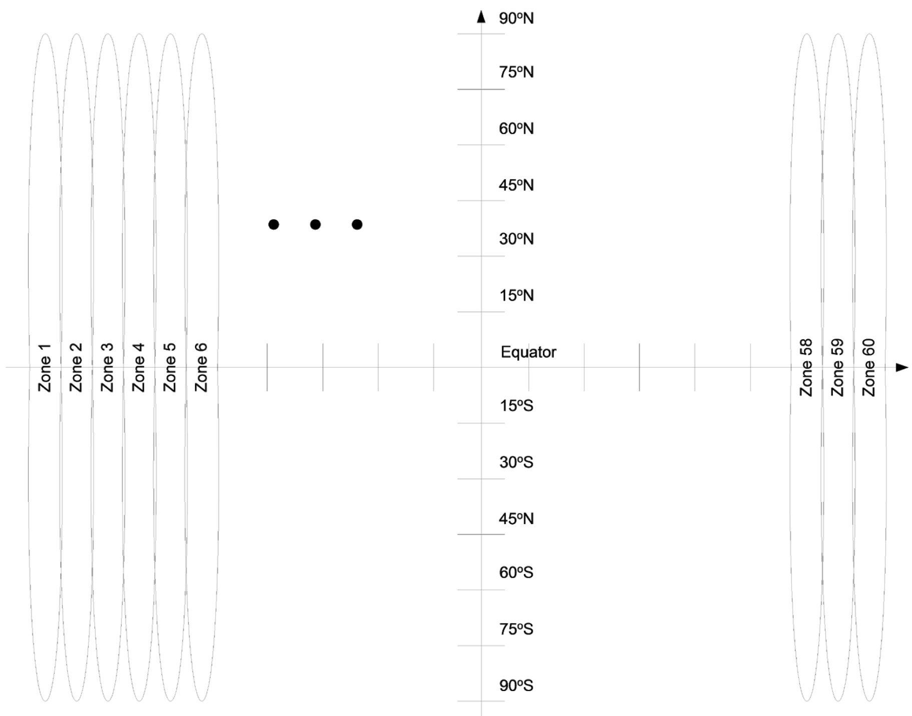
The UDM file will follow the naming conventions as in the example below.

Example: 2328007_2010-09-21_RE4_3A_udm.tif

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:

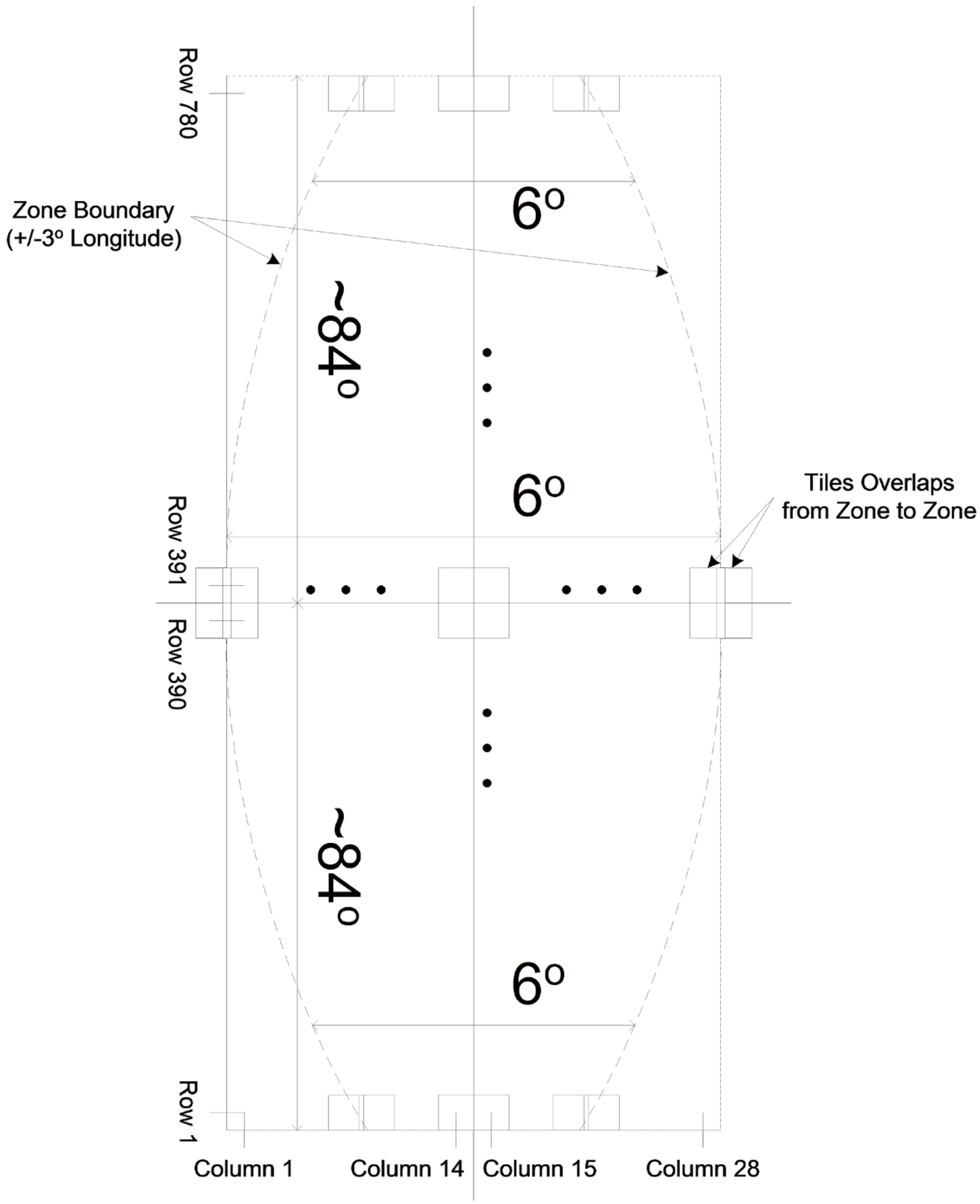
```
<ZZRRRCC>
```

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)
```

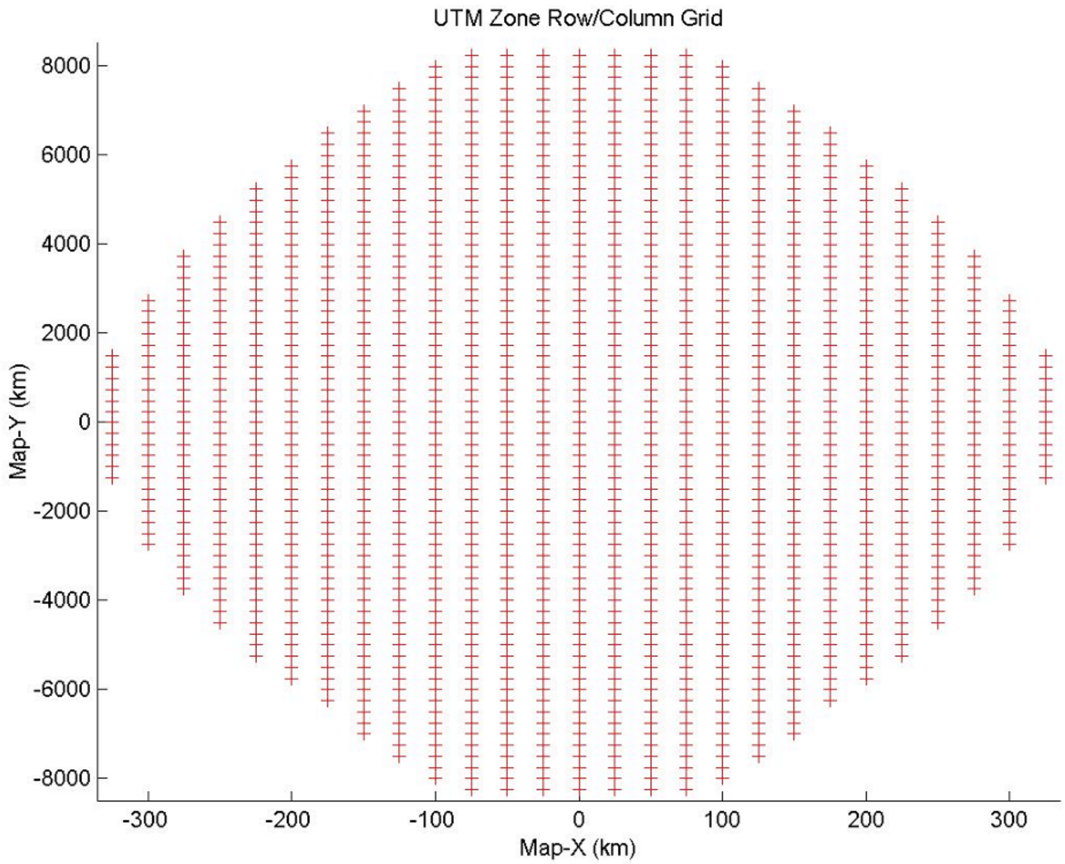
Example:	Tile 547904	= UTM Zone = 5, Tile Row = 479, Tile Column = 04
	Tile 3363308	= UTM Zone = 33, Tile Row = 633, Tile Column = 08

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.