

RapidEye DEM Product Specifications

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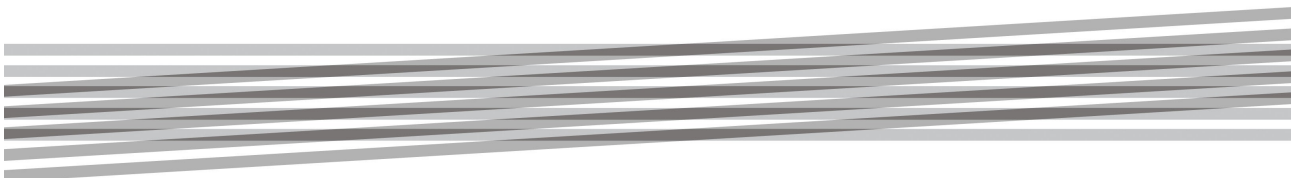


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Abbreviations

DEM	Digital Elevation Model
DTED	Digital Terrain Elevation Data
GCP	Ground Control Point
N/A	Not Applicable
NIR	Near Infra-red
NMAS	National Map Accuracy Standards
PSD	Product Support Data
SRTM	Shuttle Radar Topography Mission
TBC	To Be Confirmed
TBD	To Be Defined
TIFF	Tagged Image File Format
UTC	Coordinated Universal Time
UTM	Universal Transverse Mercator
WGS	World Geodetic System

1. Introduction

RapidEye offers image users a data source containing an unrivaled combination of large-area coverage, frequent revisit intervals, high resolution and multispectral capabilities. For the first time, there is a constellation of five earth imaging satellites that contain identical sensors, that are in the same orbital plane and are calibrated equally to one another. This means that large areas can be collected with the appropriate viewing angles to create stereo image pairs needed for the production of RE Digital Elevation Model (DEM) product.

This document provides detailed information on the following subjects related to the RapidEye DEM Product:

RapidEye Satellite Constellation: RapidEye's 5 satellite constellation offers something new and unique to the world of commercial remote sensing.

RE DEM Product Description: Attributes of the RapidEye DEM product are described in detail.

Product and Delivery Options: The RE DEM product is offered in two projections with several delivery options.

Product Licensing: RapidEye allows customers several licensing options to ensure that all users that need to use the data may do so.

Product Naming: Provides a description of the product naming convention used for the RapidEye DEM Product.

Product Support Data: All DEM files images are supported with a XML metadata file to aid the customer with the use and analysis of the data.

1. RapidEye Satellite Constellation

The RapidEye constellation of five satellites stands apart from other providers of satellite-based geospatial information in their unique ability to acquire high-resolution, large-area image data on a daily basis. The RapidEye system will be able to collect an unprecedented 4 million square kilometers of data per day at 6.5 meter nominal ground resolution. Each satellite measures less than one cubic meter and weighs 150 kg (bus + payload), and has been designed for at least a seven-year mission life. All five satellites are equipped with identical sensors and are located in the same orbital plane.

Table 1 below outlines general mission characteristics for the RapidEye system.

Mission characteristic	Information												
Number of Satellites	5												
Spacecraft Lifetime	7 years												
Orbit Altitude	630 km in Sun-synchronous orbit												
Equator Crossing Time	11:00 am (approximately)												
Sensor Type	Multi-spectral push broom imager												
Spectral Bands	Capable of capturing any of the following spectral bands: <table border="1"> <thead> <tr> <th>Name</th> <th>Spectral Bands (nm)</th> </tr> </thead> <tbody> <tr> <td>Blue</td> <td>440 – 510</td> </tr> <tr> <td>Green</td> <td>520 – 590</td> </tr> <tr> <td>Red</td> <td>630 – 685</td> </tr> <tr> <td>Red Edge</td> <td>690 – 730</td> </tr> <tr> <td>NIR</td> <td>760 – 850</td> </tr> </tbody> </table>	Name	Spectral Bands (nm)	Blue	440 – 510	Green	520 – 590	Red	630 – 685	Red Edge	690 – 730	NIR	760 – 850
Name	Spectral Bands (nm)												
Blue	440 – 510												
Green	520 – 590												
Red	630 – 685												
Red Edge	690 – 730												
NIR	760 – 850												
Ground sampling distance (nadir)	6.5 m												
Pixel size (orthorectified)	5 m												
Swath Width	77 km												
On board data storage	1500 km of image data per orbit												
Revisit time	Daily (off-nadir) / 5.5 days (at nadir)												
Image capture capacity	4 million sq km/day												
Dynamic Range	12 bit												

Table 1: RapidEye System Specifications

2. RapidEye DEM Product Specifications

RapidEye DEM products are derived from Level 1B image data. Table 2 summarizes the various processing levels of image products (see the RapidEye Standard Image Products Specifications for more details on image products).

Level	Description
1B	RE Basic Product - Radiometric and sensor corrections applied to the data. On-board spacecraft attitude and ephemeris applied to the data.
3A	RE Ortho Product – Radiometric, sensor and geometric corrections applied to the data. All products have been rectified using a DTED Level 1 SRTM DEM or better, and with appropriate ground control can meet an accuracy of 6m 1-sigma (12.7 m CE90). The highest accuracy achieved by these products will meet 1:25,000 NMAS standards

Table 2: RapidEye Standard Image Product Processing Levels

The RE DEM product is a derived product generated within the RapidEye ground processing system using appropriate image pairs. This product is designed for customers who require terrain data in areas where none exist or where a current, update terrain model is required.

Each DEM is produced using single band Level 1B images with a correct view angle difference between them to generate a stereographic surface model. Ground control points (GCPs) are used to correct the horizontal and vertical location of the stereo model. Complex algorithms are then used to derive the digital elevation model with the elevation model being checked against the stereo model for accuracy.

Table 3 lists the attributes for the RE DEM products.

Product Attribute	Description
Product Components and Format	RE DEM product consists of the following file components: <ul style="list-style-type: none"> • DEM File – GeoTiff file that contains image data and geolocation information • Metadata File – XML format metadata file
Product Orientation	Map North up
Product Framing	Bounding box specified by top left and bottom right in WGS84 latitude/longitude
Pixel spacing	30m (UTM projection) or 1 arc-second (Geographic projection)
Bit Depth	16-bit signed. A pixel value of -32767 indicates a NULL pixel (no data available)
Product Size	Variable with a minimum area size of 50,000 km ²
Horizontal Datum	WGS84
Vertical Datum	Mean sea level as determined by WGS84 Earth Gravitational Model (EGM) 1996 Geoid
Map Projection	Universal Transverse Mercator (UTM) or Geographic

Table 3: Attributes for RE Geo-corrected Products

2.1 Product Accuracy

The accuracy of RE DEMs depends on the availability of quality GCPs for the area of interest. The horizontal and vertical accuracy of the RE DEMs varies by location and terrain type, but when controlled with high quality GCPs they should meet or exceed DTED Level 2 specifications (23m CE90 Horizontal and 18m LE90 Vertical).

3. Product and Delivery Options

Table 4 summarizes the product and delivery options available for the RE DEM Products.

Processing Option	Discussion
Projection	<ul style="list-style-type: none">• Geographic (latitude/longitude) with post spacing in arc-seconds.• Universal Transverse Mercator (UTM) with post spacing in meters.
Image File Formats	<ul style="list-style-type: none">• GeoTIFF
Delivery	<ul style="list-style-type: none">• FTP Pull• DVD• CD

Table 4: Product Processing Options

4. Product Licensing

RapidEye grants the right to use the Products under a standard End-User License Agreement (EULA). RapidEye offers several licensing options to address the needs of end-users. Customers select the type of license when placing an order by identifying the end-users of the Products. The number of end-users identified by the customer during order placement determines the license type acquired. The following licensing options are available:

License Type	Number of Users	Conditions
Single-User	Permits use by one (1) end-user.	License is non-exclusive and non-transferable. Permits limited use by contractors and consultants. Permits creation of value-added products for internal use. See the EULA for terms and conditions.
Multi-User	Permits use by two (2) to five (5) end-users.	License is non-exclusive and non-transferable. Permits limited use by contractors and consultants. Permits creation of value-added products for internal use. See the EULA for terms and conditions.
Enterprise	Permits use by six (6) to ten (10) end-users.	License is non-exclusive and non-transferable. Permits limited use by contractors and consultants. Permits creation of value-added products for internal use. See the EULA for terms and conditions.
Expanded Enterprise	Permits use by eleven (11) or more end-users.	License is non-exclusive and non-transferable. Permits limited use by contractors and consultants. Permits creation of value-added products for internal use. See the EULA for terms and conditions.

Table 5: License Types

The inclusion of the imagery or data contained in the RapidEye Products in any product by an end-user is considered value-added work. Resale or distribution of these value-added products is not permitted under the standard EULA. To redistribute the Products or value-added products to third parties, the customer must request additional licensing from RapidEye. Licensing allowing additional use may be granted to the customer upon the conclusion of a license upgrade. Contact RapidEye for details.

5. Product Naming

The naming of RapidEye DEM Product provides information about the product. This information includes acquisition date of oldest image used for the DEM and order identification. The name of each product is designed to be unique and is composed of the following elements:

<acquisition time of oldest image used>_<product ID>_<order number>.<file extension>

For example:

2008-10-26T012345_4A-DEM_9876543210.tif

where:

<acquisition time> = 2008-10-26 (date) T012345 (time in UTC)
 <product ID> = <processing level>-<product description>
 = 4A (processing level) -DEM (product description)
 <order number> = 9876543210
 <file extension> = tif (GeoTIFF)

The expected values for the product ID (processing level + product description), file type and file extension fields are listed in Table 6.

Product ID		File Formats	
Processing Level	Product Description	File Type	File Extensions
4A – RE Derived Product	DEM – Digital Elevation Model	DEM product	.tif = GeoTIFF
		license	.txt
		metadata	.xml
		readme	.txt

Table 6: Expected product naming values by category

6. Product Support Data

All RapidEye DEM Products are accompanied by a set of three product support data (PSD) files. These PSD files provide important information regarding the product. The three PSD files are:

1. XML Metadata File
2. License File
3. Readme File

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

6.1 XML Metadata File

All RapidEye DEM Products will be accompanied by a single XML metadata file. This file contains a descriptions of basic elements of the product.

6.1.1 Contents

Table 7 describes the fields present in the XML metadata file for RE DEM products.

Metadata File Field Contents			
Field	Description	Range/Value	Conditions
DEM Format	Identifies the DEM as being in GeoTIFF format		
Vertical Accuracy	Estimated LE90 accuracy of the DEM		
Horizontal Accuracy	Estimated CE90 accuracy of the DEM		
Generation Date and Time	Date and time the DEM was generated		
Geographic Coverage	Polygon that defines the area of valid DEM height measurements		

Table 7: XML Metadata File Field Descriptions

File Naming

The XML Metadata file will follow the naming convention described in Section 5.

Example:

2008-10-26T012345_4A-DEM_9876543210_metadata.xml

6.2 License File

All RapidEye DEM products will be accompanied by a license file for the image.

6.2.1 Contents

The license file is a simple text file that contains the text of the license that was selected at the time the image order was placed.

6.2.2 File Naming

The license file will follow the naming convention described in Section 5.

Example:

2008-10-26T0123454A-DEM_9876543210_license.txt

6.3 Readme File

All RapidEye Standard Image products will be accompanied by a Readme file.

6.3.1 Contents

The Readme file is a simple text file that contains a number of fields with general information regarding the image and the files that accompany it. These field are described in Table 8.

Readme File Contents			
Field	Description	Range/Value	Conditions
version	Version of the ISD		
copyrightText	Copyright and restricted use text		
productStartTime	Start time of image order processing		
productEndTime	End time of image order processing		
orderNumber	Order number that the image belongs to		
fileList	A list of file names that accompany the image product file		
productType	Level of image product	REDEM	
comments	comment field for customer comments or other information pertaining to the order		'Null' if none supplied

Table 8: Readme File Contents

6.3.2 File Naming

The Readme file will follow the naming convention described in Section 5.

Example:

2008-10-26T012345_4A-DEM_9876543210_readme.txt

Appendix A – Glossary of Terms

The following list defines terms used to describe RapidEye image products.

- | | |
|--------------------------------------|--|
| Digital Elevation Model (DEM) | <ul style="list-style-type: none">• A digital model of the terrain surface, usually derived from stereo imagery. A DEM is used to remove terrain distortions from the imagery for the geo-corrected products. |
| Digital Number (DN) | <ul style="list-style-type: none">• The value assigned to a pixel in a digital image. This gray density value represents the intensity of reflected light from a feature collected by the sensor for a particular spectral range. |
| Dynamic Range | <ul style="list-style-type: none">• The number of possible DN values for each pixel in a band of an image. RapidEye has an 12-bit dynamic range which translates into 4096 possible values. |
| Ground Control Point (GCP) | <ul style="list-style-type: none">• A visible point on the ground with known geographic coordinates. GCPs can be planimetric (latitude, longitude) or vertical (latitude, longitude, elevation). GCPs can be collected from ground survey, maps, or orthorectified imagery. |
| Ground Sample Distance (GSD) | <ul style="list-style-type: none">• The size of one pixel, as measured on the ground. |
| Metadata | <ul style="list-style-type: none">• Ancillary data that describes and defines the RapidEye imagery product. Metadata files differ for the two image processing types. See Appendix C for a complete breakdown of metadata files and the fields within them. |
| Pixel | <ul style="list-style-type: none">• The smallest element comprising a digital image. |
| Radiometric Correction | <ul style="list-style-type: none">• The correction of variations in data that are not caused by the object or scene being scanned. These include correction for relative radiometric response between detectors, filling non-responsive detectors and scanner inconsistencies. |
| Resolution | <ul style="list-style-type: none">• The resampled image pixel size derived from the GSD. |
| Revisit Time | <ul style="list-style-type: none">• The amount of time it takes to image the same point on the ground. |
| Sensor Correction | <ul style="list-style-type: none">• The correction of variations in the data that are caused by sensor geometry, attitude and ephemeris. |
| Swath Width | <ul style="list-style-type: none">• The width of the ground area that is recorded by one image strip. |
| Terrain Correction | <ul style="list-style-type: none">• The correction for variations in data caused by terrain displacement due to off-nadir viewing. |